Plastic Pipe
Database
Committee

PLASTIC PIPING DATA COLLECTION INITIATIVE STATUS REPORT

~~February~~ <ins>November</ins> 2023

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Contents

Plastic Piping Data Collection Initiative
Status Report
~~February~~ November 2023

PPDC History and Background

The Plastic Pipe Database Committee (PPDC), composed of representatives of the American Gas Association (AGA), American Public Gas Association (APGA), Plastics Pipe Institute (PPI), National Association of Regulatory Utility Commissioners (NARUC), National Association of Pipeline Safety Representatives (NAPSR), National Transportation Safety Board (NTSB) and U.S. Department of Transportation's (DOT) Pipeline and Hazardous Materials Safety Administration (PHMSA), has been coordinating since 1999 and receiving information since 2000 into a database of in-service plastic piping system failures and/or leak (failures[1]) with the objective of identifying possible performance issues. Participation in this initiative is voluntary and the database is designed to address the confidentiality concerns of the participants.

The data collection initiative arose from the NTSB Special Investigation Report *Brittle-Like Cracking in Plastic Pipe for Gas Service*[2]. The NTSB recommended that PHMSA determine how susceptible older plastic piping materials are to premature brittle-like cracking. The industry agreed to work with the regulatory community to voluntarily collect pertinent information to be placed into a secure database. The PPDC has and will continue to meet this objective. Based on the work of PPDC and PHMSA initiatives, the NTSB has classified the Safety Recommendation P-98-2 as Closed – Acceptable Action.

DOT Statistics

2022~~1~~ Gas Distribution Annual Report statistics from DOT indicate there were approximately 824,854 ~~805,588~~ miles of plastic main and over 54.5 ~~53.4~~ million plastic services installed in distribution systems in the U.S. at the end of 202~~2~~~~1~~. These statistics indicate an increase of 31,873 ~~28,889~~ miles of plastic pipe and 1,100,000 services from 2021~~0~~.

DOT/PHMSA Statistics for Year[3]	Total Miles of Plastic Main	Approximate Miles of Plastic Service	Approximate Total Miles of Plastic (Mains + Services)	Total Number of Plastic Services
2022	824,854	743,545	1,568,399	54.5 million
2021	805,716~~805,58~~8	730,810~~739,912~~	1,536,526~~00~~	53.4 million
2020	788,857~~788,824~~	718,601718,787	1,507,459~~611~~	52.3 million
2019	772,867~~772,861~~	703,270~~702,446~~	1,476,137~~5,307~~	51.2 million
2018	755,834~~755,827~~	688,263~~688,280~~	1,444,097~~109~~	50.4 million

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[1] See the PPDC definitions for additional information
[2] *Brittle-Like Cracking in Plastic Pipe For Gas Service*, NTSB Report No. NTSB/SIR-98/01, National Transportation Safety Board, Washington, D.C., April 1998.
[3] Data downloaded from PHMSA website November 5, 2023~~February 22, 2023~~

2017	739,243	677,794	1,417,037	49.4 million

Table 1 Miles of Plastic Main and Number of Plastic Services

Type of Plastic Material[4]	20222021 Miles of Main	20222021 Number of Services
ABS	2,148 2,194	1,254 1,252
Polyethylene	812,288 792,864	53,955,542 52,844,311
PVC	9,963 10,120	56,284 58,891
Other Plastic	456 410	474,835 488,015

Table 2. Miles of Main and Number of Services for Various Types of Plastics

Historical statistics have shown a steady increase over the years in the miles of installed plastic main and the number of plastic services. According to data submitted to PHMSA, approximately 61 60% of the pipe used for mains is plastic[5]. Since 1970, PHMSA has collected data about pipeline infrastructure from operators. The annual report formats have changed several times over the years.

The Distribution Mileage by Material for 2010-20221 and other pertinent information is available through the DOT/PHMSA website,https://www.phmsa.dot.gov/data-and-statistics/pipeline/pipeline-mileage-and-facilities . In the menu located on the left select *Data and Statistic Overview.* From the Frequently Requested Data select *Pipeline Mileage and Facilities* and then *2010 + Pipeline Miles and Facilities*. PHMSA's *2010 + Pipeline Miles and Facilities* database will emerge. Select *Gas Distribution* under System Type.

PPDC Volunteer and Active Submitter Statistics

All operators actively submitting data have agreed to be recognized and have their names published in **Appendix A**. While the names of the active volunteer operators are now public records, it should be noted that the database remains confidential and does not include operator identity or geographic information.

The information submitted to the PPDC through the initiative constitutes the PPDC database. As of May 2018, the operators who are actively submitting data account for 76% of the total mileage of installed plastic main in the U.S. and 86% of the total number of installed plastic services. The PPDC actively encourages additional operators to participate to ensure the broadest coverage possible and to enhance the value of the database as a tool to proactively monitor the performance of plastic pipe and metal and/or plastic appurtenances contained within plastic piping systems. AGA, APGA, NAPSR, NARUC, and PHMSA continue to encourage additional voluntary participation. In addition, PPI represents manufacturers and brings information on system

[4] Data downloaded from PHMSA website November 5, 2023 February 22, 2023
[5] Data downloaded from PHMSA website November 5, 2023, February 22, 2023

components used currently, and in the past, to aid in identification, as well as the ability to bring specific questions to manufacturers.

Explanation of Historical Data Collection

Historically collected data includes both actual through-wall failure, leak information, and negative reports (i.e., one-page forms completed by participating operators indicating that they had no failure data to submit during the month). The data collection report forms can be found at https://www.aga.org/?s=PPDC.

The scope of the committee was expanded to include failures and/or leaks of plastic pipe and metal and/or plastic appurtenances contained within plastic piping systems (not to include meters and regulators)[6]. Immediate excavation damages are not collected or evaluated (except where a delayed failure and/or leak occurs after the damage event) since these do not provide an indication of the long-term performance of plastic piping materials. Immediate failure due to excavation is collected by the Common Ground Alliance. The cumulative data supplied by volunteer participants in the Plastic Pipe Data Collection Initiative are examined in aggregate by the PPDC at each meeting to consider plastic system failures and/or leaks unrelated to excavation damage.

Historically Known Information

Although the data continues to be actively reviewed by the PPDC, the data cannot be directly correlated to quantities of each material that may be in service across the U.S. The failure and/or leak data points reinforce what is already (and historically) known about certain older plastic piping and components. Some of these were identified in 2000 by a government-industry group[7] and have resulted in PHMSA Advisory Bulletins[8]. The bulletins can be found on the PHMSA website at https://www.phmsa.dot.gov/phmsa-guidance/guidance under Guidance Documents. Historically known information includes the following plastic piping and components that have demonstrated a significantly lower resistance to stress intensification[9] that can result in material failure:

- Century Utility Products polyethylene (PE) pipe produced from 1970 through 1974
- DuPont Aldyl® A low ductile inner wall PE pipe manufactured from 1970 through 1972
- PE pipe manufactured from PE 3306 resin such as Swanson, Orangeburg and Yardley

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6 In July 2010 the PPDC clarified failures/leaks information to be reported and again in October 2022

7 Robert J. Hall, *Brittle-Like Cracking of Plastic Pipe*, Final Report No. DTRS56-96-C-0002-006, General Physics Corp., Columbia, Maryland, August 2000.

8 DOT Advisory Bulletin ADB-07-01, *Updated Notification of Susceptibility to Premature Brittle-Like Cracking of Older Plastic Pipe*, Federal Register, Volume 72, Number 172, p. 51301; ADB-02-07, *Notification of the Susceptibility to Premature Brittle-Like Cracking of Older Plastic Pipe*, Federal Register, Volume 67, Number 228, p. 70806, November 26, 2002 and corrected Federal Register, Volume 67, Number 232, p. 72027, December 3, 2002; ADB-99-02, Potential Failures Due to Brittle-Like Cracking of Older Plastic Pipe in Natural Gas Distribution Systems, Federal Register, Volume 64, p. 1212; ADB-99-01, *Potential Failure Due to Brittle-Like Cracking of Certain Polyethylene Plastic Pipe Manufactured by Century Utility Products Inc.*, Federal Register, Volume 64, p. 12211.

9 Stress intensification includes conditions such as rock impingement, squeeze off, soil settlement, bending, shear, over-tightening of caps.

- DuPont Aldyl® service tee with a white Delrin® polyacetal threaded insert
- Plexco service tee with Celcon® polyacetal threaded cap

Data Analysis and Information

All charts, tables and discussion in this Status Report are based on cumulative data unless indicated otherwise. Where the PPDC determined there was enough submitted data to potentially indicate a trend, the committee conducted further analysis on the following:

- General Failures - **Appendix B**
- Century Utility Products - **Appendix C**
- All Aldyl pipe and fittings manufactured by DuPont and Uponor - **Appendix D**
- PE 3306 - **Appendix E**
- Caps - **Appendix F**
- AMP/AMP-FIT - **Appendix G**
- PVC - **Appendix H**
- Kerotest – **Appendix I**
- Driscopipe® High Density Polyethylene (HDPE) Pipe - **Appendix J**

Note: "Percentages less than 0.1% are not listed in the chart" in the Status Report Charts and Tables.

Also, see **Appendix K**, Questions from Stakeholder Groups about the PPDC and PPDC Data. Questions for the PPDC can be submitted to the PPDC email account, PPDC@aga.org. Questions can also be submitted to an applicable stakeholder representative as shown on the PPDC roster https://www.aga.org/?s=PPDC.

The PPDC has seen an elevated number of reports of failures since 2010. This may be due to operators' preparation for and implementation of Distribution Integrity Management Programs (DIMP), https://www.phmsa.dot.gov/pipeline/gas-distribution-integrity-management/gas-distribution-integrity-management-program-dimp, and the Federal requirement to submit Mechanical Fitting Failure Reports, https://www.phmsa.dot.gov/data-and-statistics/pipeline/mechanical-fitting-failure-data-gas-distribution-operators.

Resin and Plastic Materials Improvement

The data indicates that some of the early plastic piping products manufactured in the 1960s to early 1980s are more susceptible to brittle-like cracking (also known as slow crack growth) than newer vintage materials. Brittle-like cracking failures occur under conditions of stress intensification. Stress intensification is more common in fittings and joints. Operators should actively monitor the performance of their piping systems.

Plastic materials, standards and manufacturing practices have steadily improved over the years. These enhancements have led to an improved ability to withstand stress intensification and have benefited long-term plastic gas piping system performance. Various milestones in the development and use of plastic materials are highlighted in the Plastic Timeline.

Failures on Newly Installed Pipe

In light of the data collected, it is suggested that operators remain vigilant in their efforts to maintain their operator qualification programs, training programs, installation procedure reviews and inspection efforts to assure the integrity of their systems. Table 3 shows Installation Error as the leading cause for failures that occurred within 0-5 years of installation. The need for vigilance is further supported by a June 2015 National Transportation Safety Board Pipeline Safety Alert, Safety through Reliable Fusion Joints (https://cdn.ymaws.com/members.iamu.org/resource/resmgr/Informer/NTSB_Plastic_Pipe.pdf) which reinforces the need for operators to pay special attention to manufacturer recommended installation procedures such as torque requirements, tapping cutter or stab depth and pipe surface conditions.

Cause	% of All Failures Occurring Within 0-5 Years in Service
Cap (Other)	1.7~~1.8~~%
Corrosion	0.3%
Excessive Expansion/Contraction	2.7~~2.4~~%
Excessive External Earth Loading	2.7~~2.8~~%
Gopher/rodent/worm damage	0.7%
Installation Error	39.7~~39.6~~%
Material Defect	11.0~~10.9~~%
Other	7.0%
Point Loading	1.4~~1.5~~%
Previous Impact	1.0~~0.9~~%
Squeeze Off	0.4%
Threaded Cap (Cracked Cap)	0.6~~0.4~~%
Threaded Cap (Loose cap, not cracked)	5.0~~4.6~~%
Threaded Cap (Other, describe)	0.7%
Threaded Cap (Seal/O-ring defect)	0.7~~0.8~~%
Unknown	23.9~~24.7~~%
Unknown- Abandoned	0.1%
Unknown - Not Excavated, Replaced	0.3%
Grand Total	**100.0%**

Table 3. Causes for All Failures Occurring Within 0-5 Years of Installation
Note: Percentages less than 0.1% are not listed in the chart

GPTC Guidance

In an effort to assist the gas utilities, the Gas Piping Technology Committee (GPTC) has published guidance information that an operator can use when older plastic pipe materials are known to be present in their piping system. The guidance information is contained in the 2021 edition of the *Guide for Transmission, Distribution and Gathering Piping Systems* under Subpart P[10].

AGA Plastic Pipe Manual Reference

In addition, the *AGA Plastic Pipe Manual for Gas Service*[11] contains information on plastic pipeline materials, including factors affecting plastic piping performance, engineering consideration for plastic pipe utilization, procurement considerations and acceptance tests, installation guidance, personnel training, field inspection and pressure testing, operations and maintenance, and emergency control procedures.

Manufacturer Information

The PPDC compiles historical plastic piping manufacturer information. The Plastics Pipe Institute (PPI) maintains this information to help operators identify the manufacturers of pipe, fittings and appurtenances. These data include material designations, date range of production, size ranges, and other important information. Corrections and/or additions are encouraged and should be communicated to Gerianne Cain at PPI (gcain@plasticpipe.org). Information on the historic plastic piping manufacturer database can be found on the following website: https://plasticpipe.org/EnergyPipingSystems/About-Energy/Manufacturing-History/EnergyPipingSystems/About-Energy/Manufacturing-History.aspx?hkey=fcb92aa4-e38e-4b56-99a2-4945a7b24a0a

Gas Distribution Integrity Management Program

PHMSA has developed and continues to enhance guidance to help the public and the affected industry understand the requirements of the regulations under Title 49 CFR Part 192, Subpart P, Gas Distribution Pipeline Integrity Management (DIMP). The DIMP Inspection Forms as well as other resources to support operators' implementation of their programs are on the DIMP Resources page https://www.phmsa.dot.gov/pipeline/gas-distribution-integrity-management/gas-distribution-integrity-management-program-dimp.

Rate Process Method

For the many miles of older PE materials still in service in the U.S., the key unknown is the projected performance of pipelines in situations where stress intensification may be present. The

[10] Information about the GPTC can be found at https://www.aga.org/?s=PPDC and the guide information can be purchased at https://www.techstreet.com/aga/searches/26663715

[11] The AGA Plastic Pipe Manual for Gas Service can be purchased at http://www.techstreet.com/aga/standards/aga-xr0603?product_id=1314445

rate process method (RPM) can be a useful tool for evaluating these compounds and their susceptibility to brittle-like cracking. The RPM can also be used to predict performance of PE materials at their in-ground temperatures and operating stresses based on both internal pressure as the primary load in combination with concentrated stresses such as rock impingement and squeeze-off.[12]

Assistance and Answers from PPDC

AGA is available to help participants fill out the report forms if there are any questions by a participant. A portion of the AGA website hosting the PPDC contains the latest versions of Frequently Asked Questions, data collection forms, form instruction, definitions, PPDC rosters, previous status and annual reports, a data collection PowerPoint tutorial entitled, "Plastic Pipe Data Collection" and further details on the goals of the Plastic Pipe Data Collection initiative.

The PPDC encourages questions, comments, or suggestions from the stakeholder groups. **Appendix K** contains a listing of questions reviewed at Committee meetings and responses from the PPDC.

With this status report, the PPDC continues to urge all natural gas distribution system operators to volunteer as active participants in this proactive and worthwhile initiative.

For questions or additional information about this initiative, contact PPDC c/o Debbie Ellis (by telephone 202.824.7338 or electronically at dellis@aga.org).

[12] Bragaw, C. G., "Prediction of Service Life of Polyethylene Gas Piping System," Proceedings Seventh Plastic Fuel Gas Pipe Symposium, pp. 20-24, 1980, and Bragaw, C. G., "Service Rating of Polyethylene Piping Systems by the Rate Process Method," Proceedings Eighth Plastic Fuel Gas Pipe Symposium, pp. 40-47, 1983, and Palermo, E. F., "Rate Process Method as a Practical Approach to a Quality Control Method for Polyethylene Pipe," Proceedings Eighth Plastic Fuel Gas Pipe Symposium, pp. 96-101, 1983, and Mruk, S. A., "Validating the Hydrostatic Design Basis of PE Piping Materials," and Palermo, E. F., "Rate Process Method Concepts Applied to Hydrostatically Rating Polyethylene Pipe," Proceedings Ninth Plastic Fuel Gas Pipe Symposium, pp. 215-240, 1985

Appendix A

Names of Gas Operators/Corporations Actively Submitting Reports to the Plastic Pipe Database

May 2018

Note: Depending on how annual reports are filed with PHMSA, some companies are listed under corporate names and some are listed by individual operating company names.

Alabama Gas Corp
Alliant Energy
Ameren Illinois Co
Atlanta Gas Light
Atmos Energy
Avista Corp
Austin Utilities
Baltimore Gas & Electric Co
Batesville Water & Gas Utility
Black Hills Energy
Black Hills Corporation/Source Gas
CenterPoint Energy
Central Hudson Gas & Electric Corp
Chambersburg Gas Dept
Chanute, City Of
Cheyenne Light Fuel and Power
Chesapeake Utilities Corporation
Citizens Gas and Coke Utility
City of Cartersville Gas System
City of Ellensburg Gas Department
City of Fort Morgan
Clearwater Gas System
Colorado Springs Utilities
Colquitt Gas System, City Of
Columbia Gas/Nisource
Consolidated Edison Co Of New York
Consumers Energy
Corning Natural Gas Corporation
Delmarva Power and Light
Dominion
Duke Energy
Eastern Natural Gas Co
Enstar Natural Gas Co
Equitable Gas Company
Greenville Utilities Commission
Greer Commission Of Public Works
Intermountain Gas Co
Island Energy
Jackson Energy Authority
Kansas Gas Service
Kokomo Gas & Fuel Co/NIPSCO
Knoxville Utilities Board
Laclede Gas Co
Lawrenceville, City of
Liberty Utilities
Long Beach Gas Dept, City Of
Louisville Gas and Electric
Madison Gas & Electric Co
Memphis Light Gas & Water Division
Mesa Municipal System, City Of
Michigan Consolidated Gas Co (Michcon)
Michigan Gas Utilities Co
Middle Tennessee Natural Gas Utility District
Middleborough Gas & Electric Dept
Midwest Natural Gas Corp
Minnesota Energy Resources Corporation
Missouri Gas Energy
Mobile Gas Service Corp
Montana - Dakota Utilities Co
Mountaineer Gas Co
National Fuel
National Grid/Keyspan
New England Gas Company
New Jersey Natural Gas Co
New Mexico Gas Co
North Shore Gas Co
Northern Illinois Gas Co
Northern States Power Co
Northern States Power Company of Minnesota
Northwest Natural Gas Co
Norwich Public Utilities
NV Energy
Oklahoma Natural Gas Co.
Orange and Rockland Utilities
Orangeburg Public Utilities
Osage City Municipal Gas System
Pacific Gas & Electric Co
Paris - Henry County Public Util Dist
PECO Energy Co
Peoples Gas Light & Coke Co

Peoples Natural Gas
Perryton, City Of
Philadelphia Gas Works
Piedmont Natural Gas Co Inc
Pike Natural Gas Co
Powell Clinch Utility District
Public Service Electric & Gas Co
Public Service Company of Colorado
Public Service Company of North Carolina
Puget Sound Energy
Questar Gas Company
Safford Utilities Div, City Of
San Diego Gas & Electric Co
Scottsboro Water Sewer & Gas Board
Semco Energy Gas Company
Sheffield Gas Department
South Carolina Electric & Gas Co
South Jersey Gas Co
Southeastern Natural Gas Co
Southern California Gas Co
Southwest Gas Corp
Tallahassee, City of
T.W. Phillips Gas & Oil Co.
Texas Gas Service Company
The Empire District Gas Company
Tipton Municipal Utilities
UGI Utilities
Union Utility Dept, City Of
Unisource Energy Services
Valley Energy, Inc.
Vectren Corporation
Vermont Gas System
Washington Gas Light Co
Watertown Municipal Utilities Department
We Energies
Wilson Gas Dept, City Of
Wisconsin Gas Co
Wisconsin Public Service Corp
Yankee Gas Services

Appendix B: General Failure Data Analysis – ~~February~~ November 2023

B1: Heat Map of All Causes by Years in Service

The following heat map shows all causes of failure broken down by years in service. Years in Service is only available for approximately 54% of the data. The map should be read by row, and each row is independent of each other. For example, if you look at gopher/rodent/worm damage you will see most damages are in the 0-5 years range. However, this does not indicate there are more gopher/rodent/worm damage relative to other causes.

Cause	Five Year Intervals									
	0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41+	Grand Total
Cap (Other)	9%	4%	5%	10%	21%	19%	14%	9%	7%	100%
Corrosion	1%	2%	6%	11%	19%	14%	14%	11%	22%	100%
Excessive Expansion/Contraction	8%	6%	5%	4%	8%	15%	29%	10%	14%	100%
Excessive External Earth Loading	6%	4%	4%	9%	16%	17%	16%	13%	15%	100%
Gopher/rodent/worm damage	20%	15%	12%	15%	9%	7%	6%	7%	8%	100%
Installation Error	15%	6%	6%	8%	14%	15%	15%	11%	9%	100%
Material Defect	5%	3%	3%	9%	17%	21%	17%	12%	13%	100%
Other	10%	5%	7%	7%	15%	14%	19%	10%	13%	100%
Point Loading	3%	2%	2%	4%	7%	14%	21%	22%	24%	100%
Previous Impact	13%	7%	7%	11%	8%	12%	12%	14%	15%	100%
Squeeze Off	3%	2%	1%	2%	7%	13%	21%	22%	28%	100%
Threaded Cap (Cracked Cap)	2%	2%	2%	2%	3%	10%	23%	34%	22%	100%
Threaded Cap (Loose cap, not cracked)	19%	11%	10%	8%	8%	10%	12%	8%	14%	100%
Threaded Cap (Other, describe)	17%	8%	7%	8%	11%	16%	13%	7%	14%	100%
Threaded Cap (Seal/O-ring defect)	8%	4%	4%	6%	7%	11%	34%	13%	13%	100%
Unknown	10%	5%	5%	7%	11%	17%	18%	13%	15%	100%
Unknown - Abandoned	9%	3%	2%	7%	8%	14%	10%	13%	35%	100%
Unknown, Not Excavated, Replaced	4%	2%	3%	2%	5%	14%	17%	26%	26%	100%
Grand Total	**9%**	**5%**	**5%**	**8%**	**13%**	**17%**	**17%**	**13%**	**14%**	**100%**

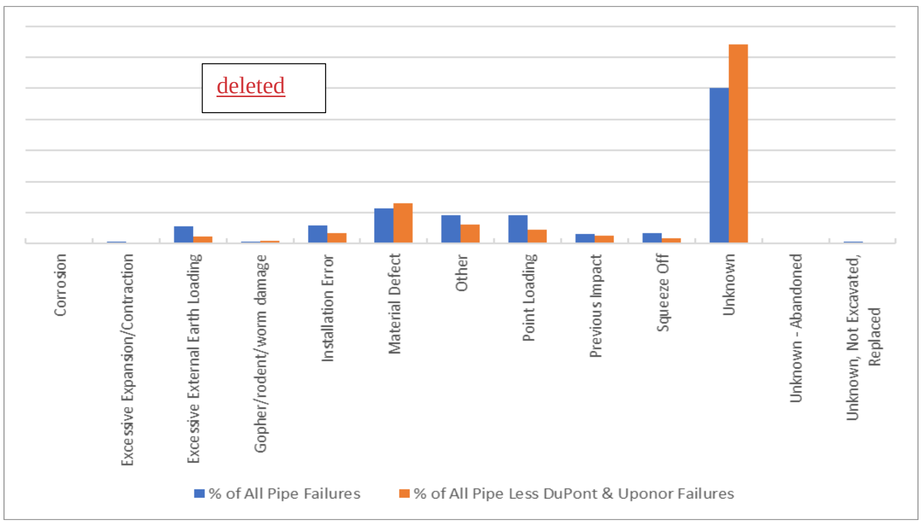
Only material types shown in the data are reflected in the table. Should additional materials be seen in future data, they will be added to the table at that time.

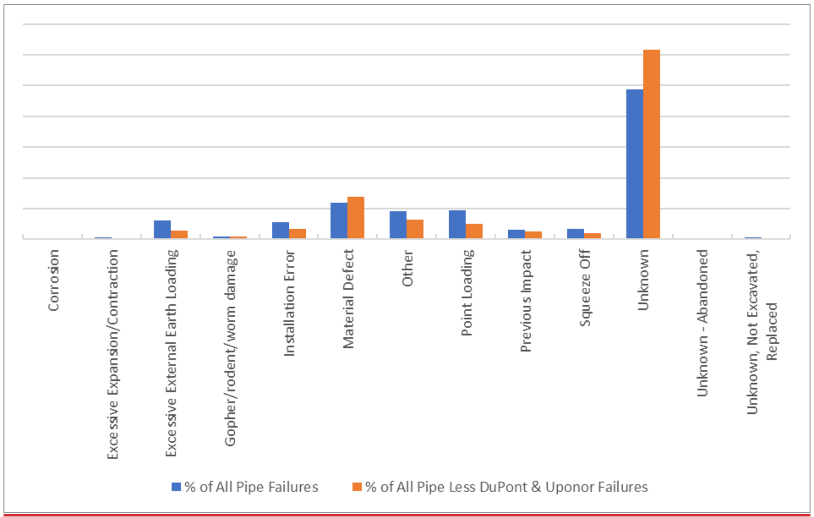
B2~~1~~: All Pipe Failures by Cause

Note: Percentages less than 0.1% are not listed in the chart

CAUSE	% of All Pipe Failures/Leaks	% of All Pipe Less DuPont & Uponor Failures/Leaks
Corrosion	0.4%	0.1%
Excessive Expansion/Contraction	0.5%	0.4%
Excessive External Earth Loading	6.0~~5.5~~%	2.8~~2.3~~%
Gopher/rodent/worm damage	0.8~~0.7~~%	0.9~~0.8~~%

Installation Error	5.7~~5.8~~%	3.5%
Material Defect	12.0~~11.4~~%	13.8~~13.0~~%
Other	9.2%	6.4~~6.2~~%
Point Loading	9.5~~9.2~~%	5.0~~4.6~~%
Previous Impact	3.1~~3.0~~%	2.7~~2.6~~%
Squeeze Off	3.4%	1.9%
Unknown	48.6~~50.2~~%	61.8~~64.9~~%
Unknown – Abandoned	0.2%	0.2%
Unknown - Not Excavated, Replaced	0.6%	0.5%
Total	100.0%	100.0%

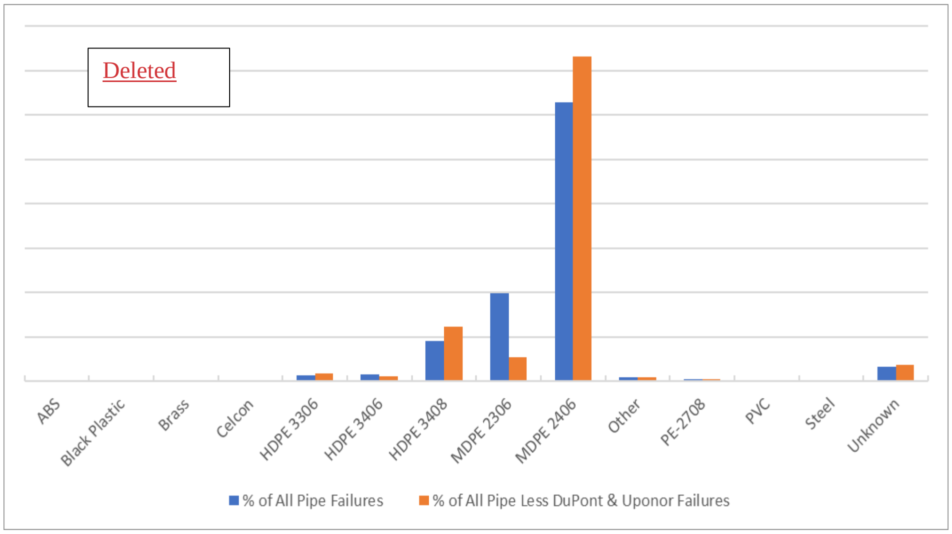




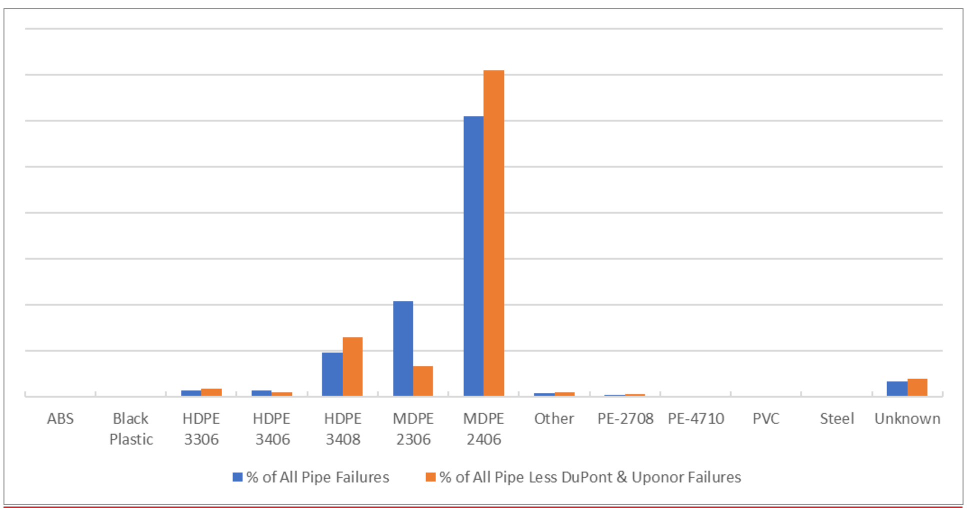
B32. All Pipe Failures by Material

Note: Percentages less than 0.1% are not listed in the chart

Material	% of All Pipe Failures	% of All Pipe Less DuPont & Uponor Failures
ABS	0.1%	0.1%
Black Plastic	0.1%	0.10.2%
Celcon	0.0%	0.1%
HDPE 3306	1.4%	1.9%
HDPE 3406	1.5%	1.1%
HDPE 3408	9.89.2%	13.112.3%
MDPE 2306	20.819.9%	6.75.4%
MDPE 2406	61.162.9%	71.073.3%
Other	0.80.9%	1.0%
PE-2708	0.60.4%	0.70.5%
PE-4710	0.0%	0.1%
PVC	0.3%	0.3%
Steel	0.1%	0.1%
Unknown	3.53.2%	4.03.8%
Total	**100.0%**	**100.0%**



Deleted
ABS
Black Plastic
Brass
Celcon
HDPE 3306
HDPE 3406
HDPE 3408
MDPE 2306
MDPE 2406
Other
PE-2708
PVC
Steel
Unknown
% of All Pipe Failures
% of All Pipe Less DuPont & Uponor Failures

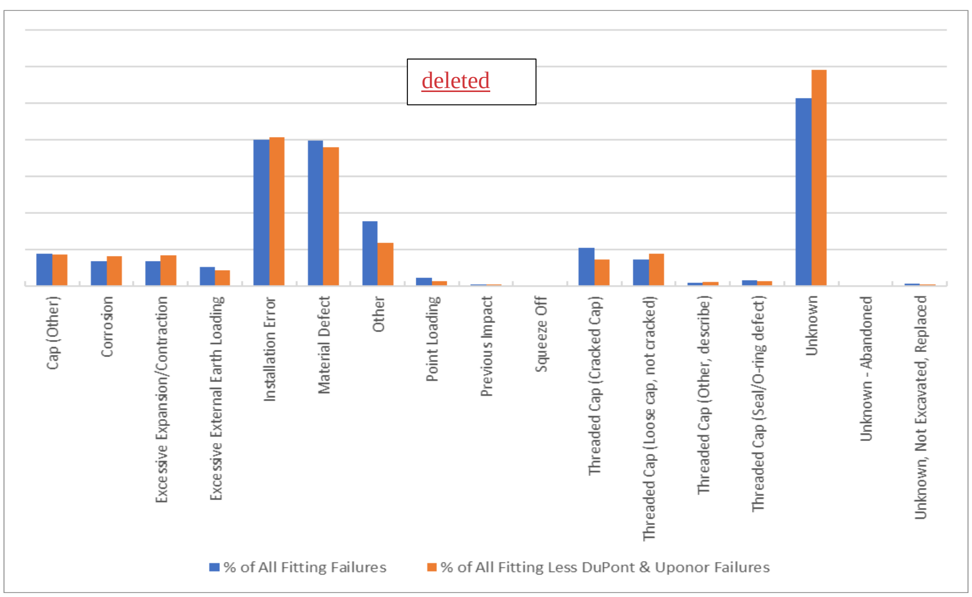


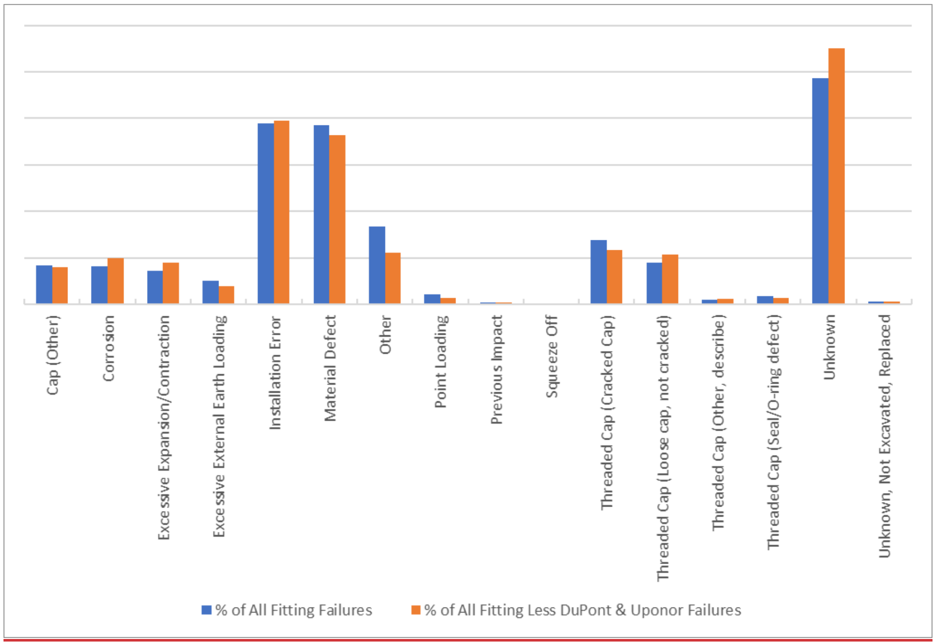
ABS
Black Plastic
HDPE 3306
HDPE 3406
HDPE 3408
MDPE 2306
MDPE 2406
Other
PE-2708
PE-4710
PVC
Steel
Unknown
% of All Pipe Failures
% of All Pipe Less DuPont & Uponor Failures

B4~~3~~. All Fitting Failures by Cause

Note: Percentages less than 0.1% are not listed in the chart

Cause	% of All Fitting Failures	% of All Fitting Less DuPont & Uponor Failures
Cap (Other)	4.2~~4.5~~%	4.0~~4.3~~%
Corrosion	4.0~~3.4~~%	4.9~~4.2~~%
Excessive Expansion/Contraction	3.6~~3.4~~%	4.5~~4.2~~%
Excessive External Earth Loading	2.5~~2.7~~%	1.9~~2.1~~%
Installation Error	19.5~~20.0~~%	19.7~~20.3~~%
Material Defect	19.2~~19.8~~%	18.2~~19.0~~%
Other	8.3~~8.8~~%	5.5~~5.9~~%
Point Loading	1.1%	0.7%
Previous Impact	0.2%	0.2%
Squeeze Off	0.1%	0.1%
Threaded Cap (Cracked Cap)	6.9~~5.3~~%	5.8~~3.6~~%
Threaded Cap (Loose cap, not cracked)	4.4~~3.6~~%	5.4~~4.4~~%
Threaded Cap (Other, describe)	0.4%	0.6~~0.5~~%
Threaded Cap (Seal/O-ring defect)	0.9~~0.8~~%	0.7%
Unknown	24.3~~25.7~~%	27.5~~29.5~~%
~~Unknown -Abandoned~~	~~0.0%~~	~~0.1%~~
Unknown - Not Excavated, Replaced	0.3%	0.2~~0.3~~%
Total	100.0%	100.0%

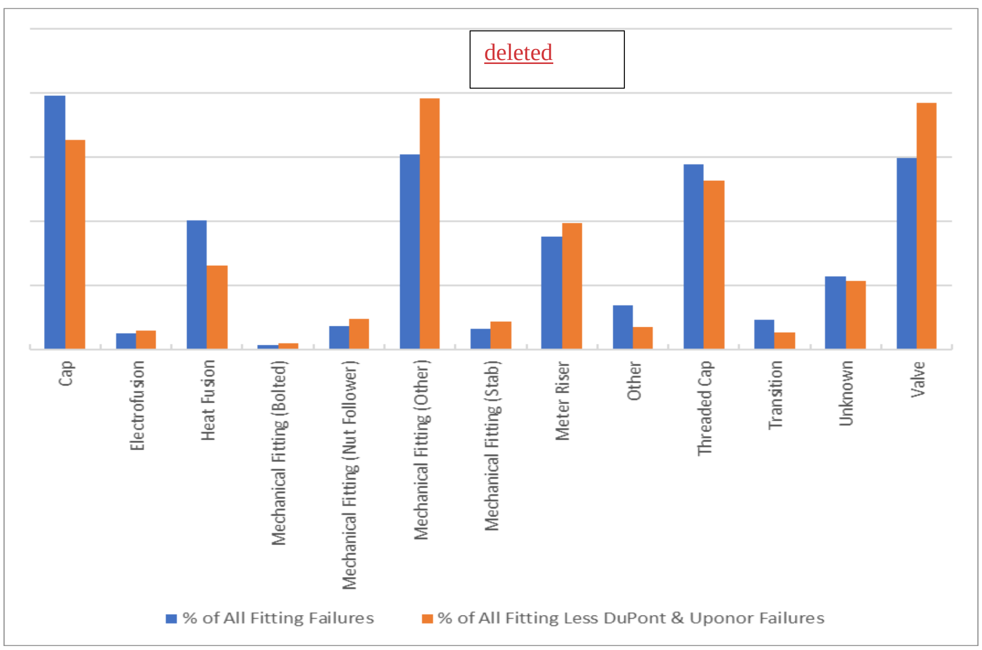


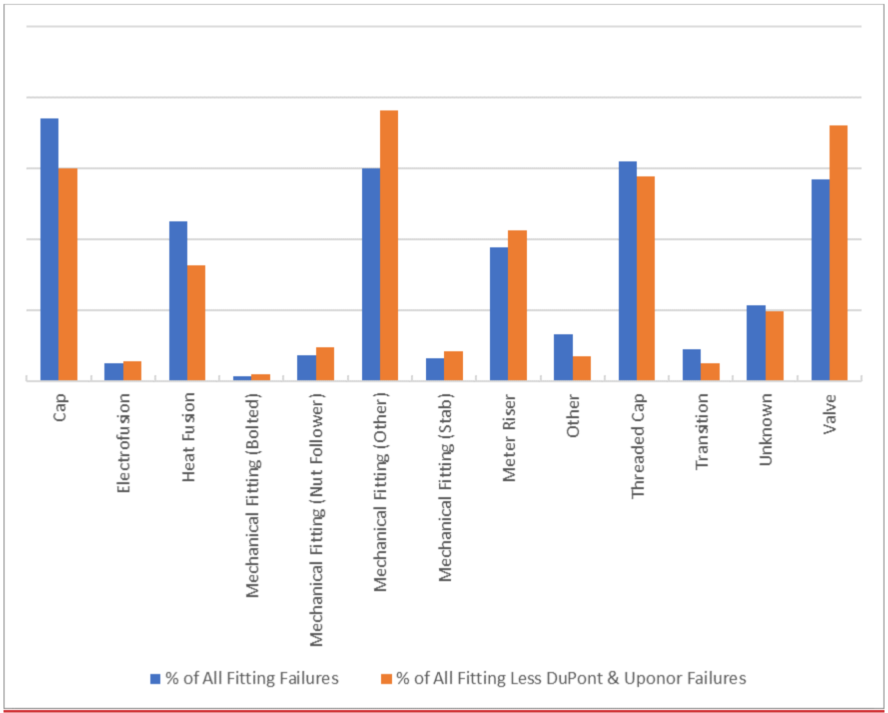

Cap (Other)
Corrosion
Excessive Expansion/Contraction
Excessive External Earth Loading
Installation Error
Material Defect
Other
Point Loading
Previous Impact
Squeeze Off
Threaded Cap (Cracked Cap)
Threaded Cap (Loose cap, not cracked)
Threaded Cap (Other, describe)
Threaded Cap (Seal/O-ring defect)
Unknown
Unknown, Not Excavated, Replaced
% of All Fitting Failures
% of All Fitting Less DuPont & Uponor Failures

B54. All Fitting Failures by Type

Note: Percentages less than 0.1% are not listed in the chart

Fitting	% of All Fitting Failures	% of All Fitting Less DuPont & Uponor Failures
Cap	18.519.8%	15.016.3%
Electrofusion	1.3%	1.41.5%
Heat Fusion	11.310.1%	8.26.6%
Mechanical Fitting (Bolted)	0.4%	0.5%
Mechanical Fitting (Nut Follower)	1.9%	2.4%
Mechanical Fitting (Other)	15.015.2%	19.119.6%
Mechanical Fitting (Stab)	1.61.7%	2.12.2%
Meter Riser	9.48.8%	10.79.9%
Other	3.33.4%	1.8%
Threaded Cap	15.514.4%	14.513.2%
Transition	2.22.3%	1.3%
Unknown	5.45.7%	5.05.4%
Valve	14.215.0%	18.019.2%
Total	**100.0%**	**100.0%**





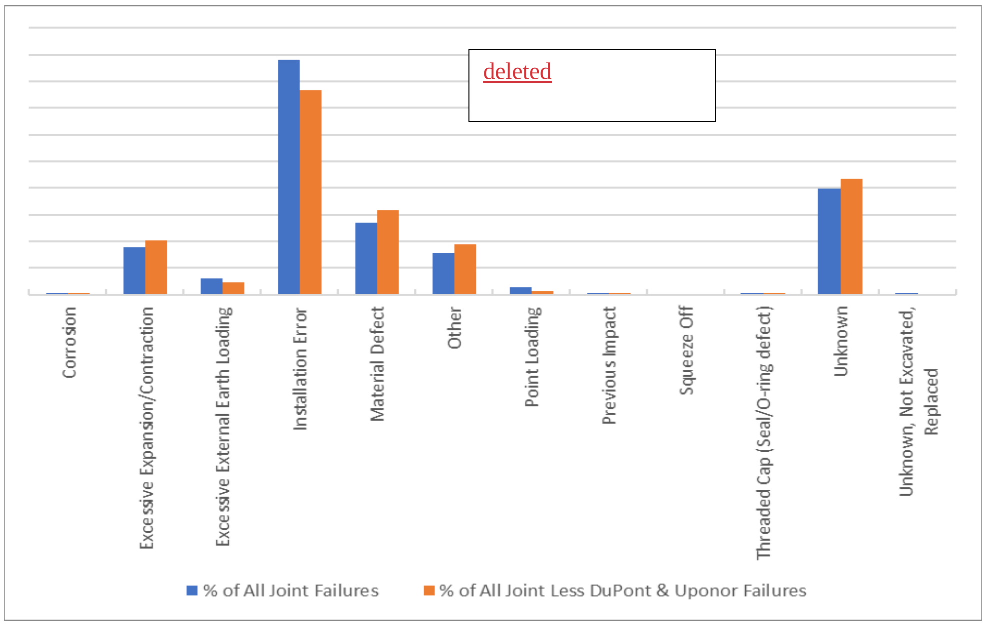
B65. All Joint Failures by Cause

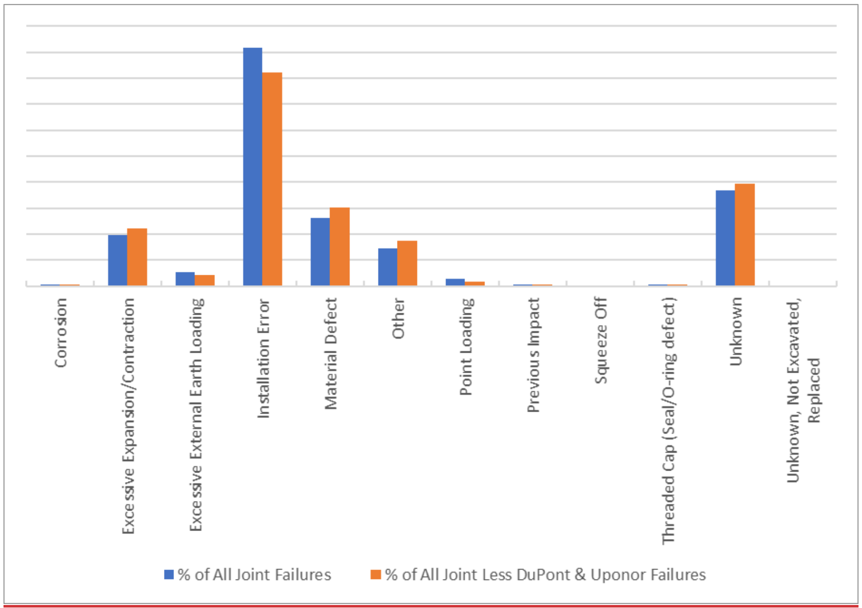
Note: Percentages less than 0.1% are not listed in the chart

Note: The Committee noted an increase in failures in "Excessive Expansion/Contraction" (October 2022 Meeting)

Cause	% of All Joint Failures	% of All Joint Less DuPont & Uponor Failures
Corrosion	0.3%	0.30.4%
Excessive Expansion/Contraction	9.99.0%	11.210.2%
Excessive External Earth Loading	2.83.1%	2.12.4%
Installation Error	45.944.1%	41.038.3%
Material Defect	13.213.5%	15.115.8%

Other	7.3~~7.8~~%	8.7~~9.4~~%
Point Loading	1.5~~1.4~~%	0.9~~0.7~~%
Previous Impact	0.3%	0.3%
Squeeze Off	0.1%	0.1%
Threaded Cap (Seal/O-ring defect)	0.3%	0.3~~0.4~~%
Unknown	18.4~~19.8~~%	19.7~~21.6~~%
Unknown - Not Excavated, Replaced	0.2~~0.3~~%	0.2%
Total	**100.0%**	**100.0%**





B76. All Joint Failures by Type

Note: Percentages less than 0.1% are not listed in the Chart
Note: The Committee noted an increase in failures in "Mechanical Nut Follower" (October 2022 Meeting)

Joint	% of All Joint Failures	% of All Joint Less DuPont & Uponor Failures
Butt fusion	12.5~~13.4~~%	10.7~~11.6~~%
Electrofusion	5.6~~5.5~~%	6.4%
Mechanical (Bolted)	0.8~~0.9~~%	1.0~~1.1~~%
Mechanical (Nut Follower)	17.0~~13.0~~%	21.0~~16.4~~%
Mechanical (Other and Unknown)	24.2~~26.2~~%	29.5~~32.8~~%
Mechanical (Stab)	3.6~~2.6~~%	4.3~~3.2~~%
Other	0.7~~0.6~~%	0.8~~0.6~~%
Saddle Fusion	8.4~~9.0~~%	5.3~~5.6~~%
Socket Fusion	17.6~~18.5~~%	12.4~~12.8~~%
Solvent	2.5~~2.8~~%	3.0~~3.6~~%
Unknown	7.1~~7.5~~%	5.6~~5.9~~%
Total	**100.0%**	**100.0%**

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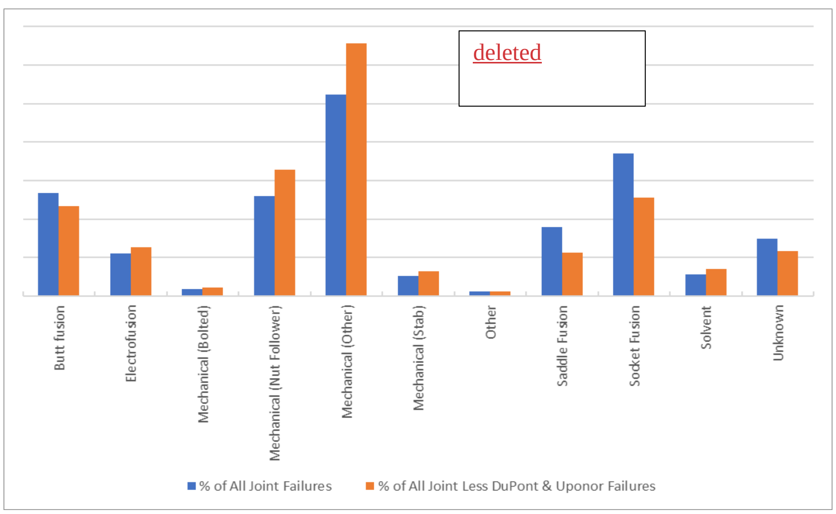
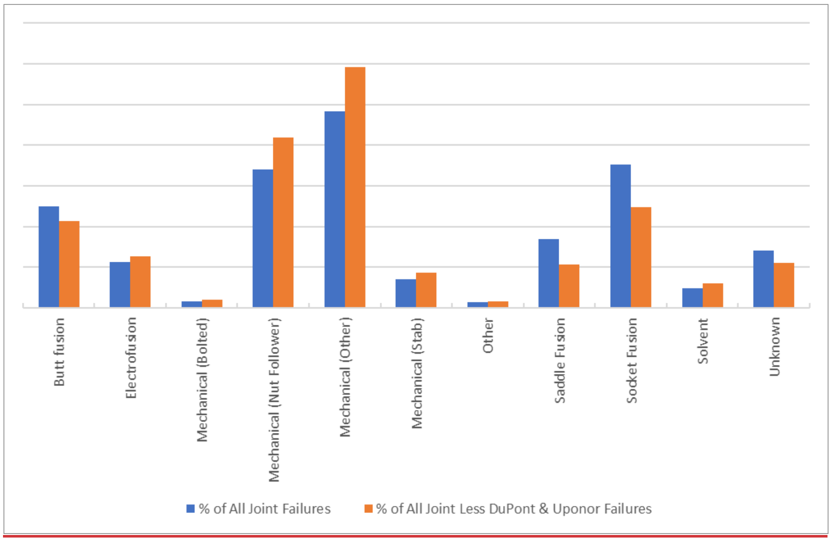
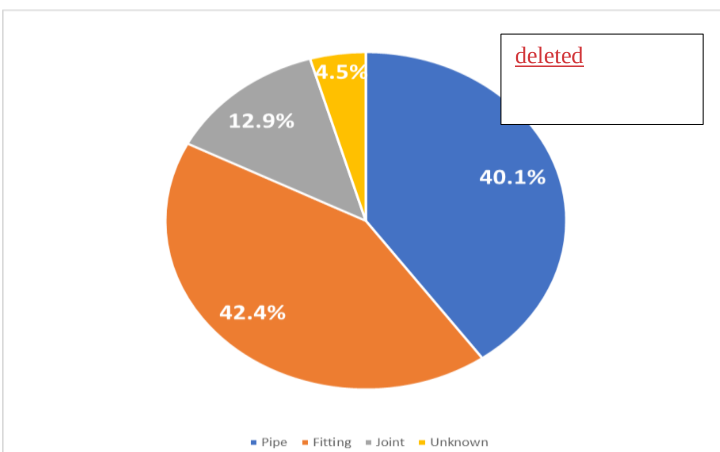
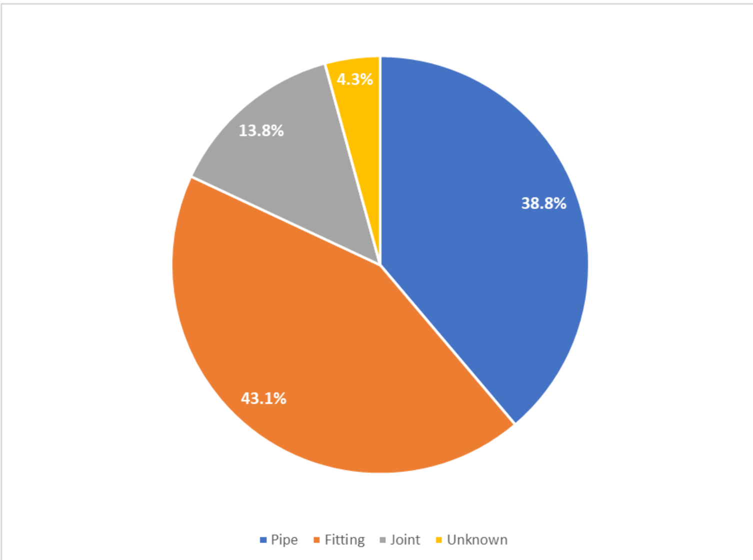




B87. All Polyethylene (PE) Failures by Component





From the 20222021 PHMSA Gas Distribution Annual reports[13], there are approximately 824,854 792,864 miles of PE main representing 98% of all plastic mains and 6160% of the total miles of distribution main installed in the US. For services, there are approximately 53,955,54252,844,331 PE services representing approximately 99% of all plastic services and 75% of the total number of distribution services installed in the US. "All PE" includes the following material types: HDPE 3306, HDPE 3406, HDPE 3408, HDPE 4710, MDPE 2306, MDPE 2406, MDPE 2708, PE 2708, and PE 4710.

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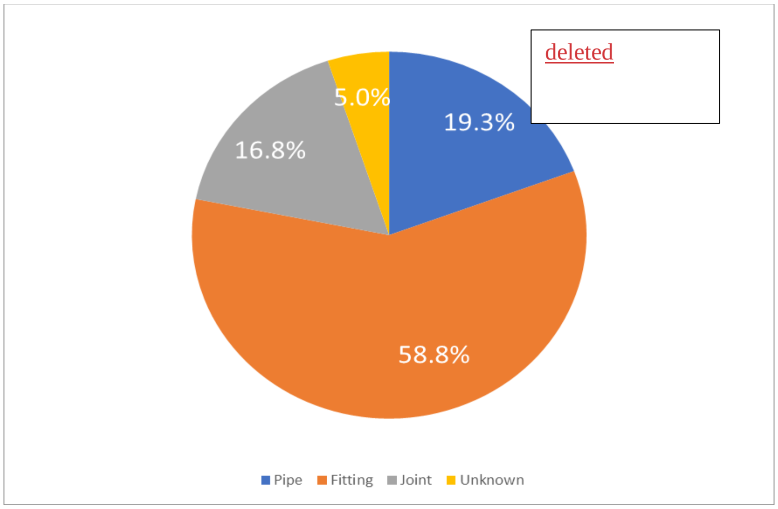
[13] Data downloaded from PHMSA website November 5, 2023March 22, 2022

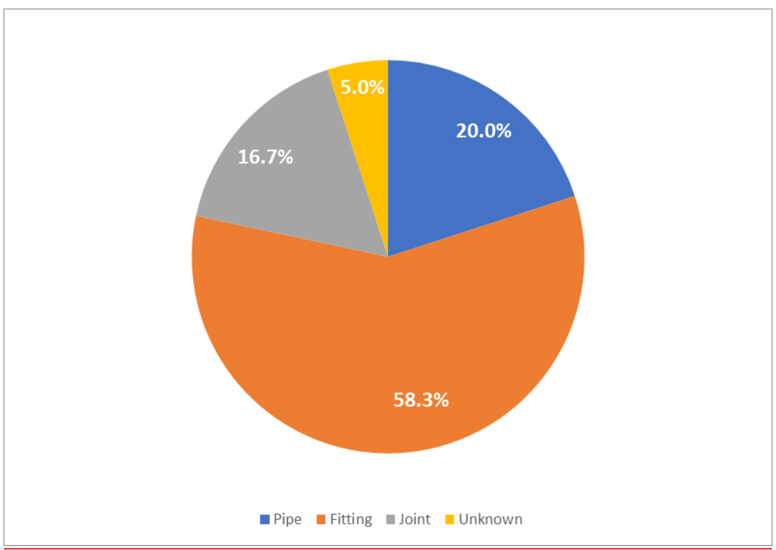
All PE Failures by Cause

Note: The Committee noted an increase in PE failures in "Expansion and Contraction" (October 2022 Meeting)
Note: Percentages less than 0.1% are not listed in the chart

Cause	% of PE Pipe Failures	% of PE Fitting Failures	% of PE Joint Failures	% of All PE Failures
Cap (Other)	0.0%	5.1~~5.6~~%	0.0%	2.3~~2.5~~%
Corrosion	0.3%	4.7~~3.9~~%	0.1~~0.2~~%	2.3~~1.9~~%
Excessive Expansion/Contraction	0.5%	2.6~~2.3~~%	12.0~~11.3~~%	3.1~~2.8~~%
Excessive External Earth Loading	5.9~~5.5~~%	2.9~~3.1~~%	2.8~~3.2~~%	4.1%
Gopher/rodent/worm damage	0.8~~0.7~~%	0.0%	0.0%	0.3%
Installation Error	5.4~~5.5~~%	23.1~~24.3~~%	54.2~~52.3~~%	20.4~~20.2~~%
Material Defect	12.0~~11.4~~%	14.5~~15.0~~%	8.0~~8.3~~%	12.5~~12.6~~%
Other	8.6%	10.4~~11.2~~%	3.9~~4.1~~%	8.7~~9.2~~%
Point Loading	9.6~~9.3~~%	1.6%	1.8~~1.7~~%	4.9%
Previous Impact	2.8~~2.7~~%	0.2%	0.2%	1.3%
Squeeze Off	3.4~~3.3~~%	0.1%	0.1%	1.4%
Threaded Cap (Cracked Cap)	0.0%	4.3~~1.4~~%	0.0%	2.0~~0.6~~%
Threaded Cap (Loose cap, not cracked)	0.0%	5.5~~4.5~~%	0.0%	2.5~~2.0~~%
Threaded Cap (Other, describe)	0.0%	0.4%	0.0%	0.2%
Threaded Cap (Seal/O-ring defect)	0.0%	1.0~~0.9~~%	0.3~~0.2~~%	0.5~~0.4~~%
Unknown	49.7~~51.3~~%	23.3~~25.0~~%	16.3~~17.9~~%	33.0~~35.1~~%
Unknown – Abandoned	0.2%	0.1%	0.0%	0.1%
Unknown - Not Excavated, Replaced	0.6%	0.4%	0.2%	0.4~~0.5~~%
% of All PE Failures	**100.0%**	**100.0%**	**100.0%**	**100.0%**

B98. Acrylonitrile Butadiene Styrene (ABS) Failures by Component





Based on 20222021 PHMSA Gas Distribution Annual Reports[14], there are approximately 2,1482,367 miles of ABS main representing less than ½% of all plastic mains installed in the US. For services, there

[14] Data downloaded from PHMSA website November 5, 2023 March 22, 2022.

are approximately 1,2541,252 ABS services representing approximately less than ½% of all plastic services installed in the US.

ABS Failures by Cause

Note: Percentages less than 0.1% are not listed in the chart

Cause	% of ABS Pipe Failures	% of ABS Fitting Failures	% of ABS Joint Failures	% of All ABS Failures
Cap (Other)	0.0%	8.6%	0.0%	5.3%
Corrosion	0.0%	1.4%	5.0%	1.8%
Excessive Expansion/Contraction	4.24.3%	2.9%	0.0%	2.62.7%
Excessive External Earth Loading	8.38.7%	0.0%	10.0%	3.5%
Installation Error	8.38.7%	17.1%	45.0%	20.220.4%
Material Defect	12.513.0%	28.6%	5.0%	21.121.2%
Other	0.0%	1.4%	0.0%	0.9%
Point Loading	4.24.3%	1.40.0%	0.0%	1.8%
Previous Impact	4.2%	0.0%	0.0	0.9%
Squeeze Off	8.38.7%	0.0%	0.0%	1.8%
Unknown	50.052.2%	38.6%	35.0%	40.440.7%
% of All ABS Failures	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Appendix C: Century Data Analysis – February 2023

Background
Century Utility Products (Century) was identified by the NTSB Special Report[15] and PHMSA advisory as a material susceptible to brittle-like cracking[16].

The objective of this appendix is to provide information from the Plastic Pipe Database Committee (PPDC) database about Century pipe, fittings and joints.

Methods
The information below reflects data collected by the PPDC. PPDC collects information voluntarily submitted by gas distribution pipeline operators on failures of metal or plastic appurtenances contained within plastic piping systems excluding third party damages. The PPDC Report Form provides for collection of information by manufacturer. More information about the PPDC can be found at https://www.aga.org/?s=PPDC.

Results
Century represent less than 1% of all the reports in the database. The majority of the reported Century failures occur on pipe (56%). Other categories include fittings (32%), joints (11%) and unknown (1%). The distribution of failures for pipe, fittings and joints by year installed is shown in Figure 1. The figure shows the majority of failures occurred on pipe installed from 1970 to 1974.

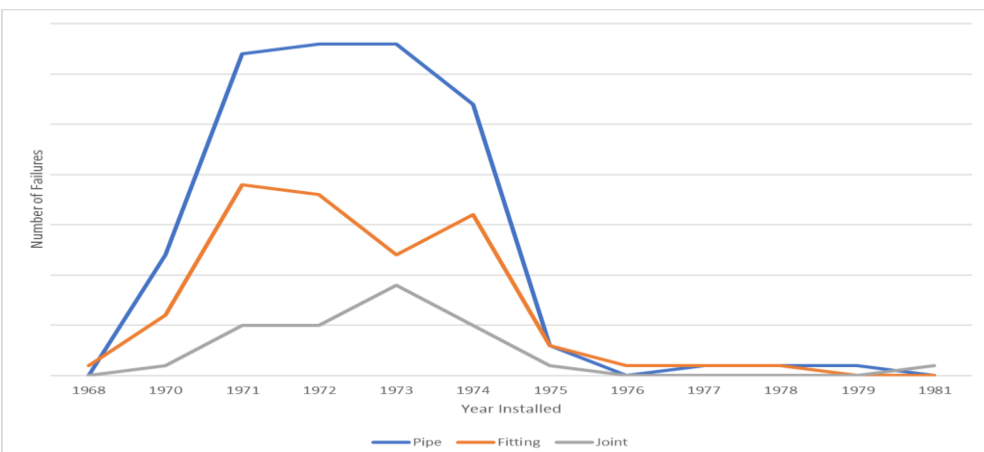


Figure 1. Failures by Years Installed as Reported to PPDC for Century Pipe, Fittings and Joints

[15] *Brittle-Like Cracking in Plastic Pipe For Gas Service*, NTSB Report No. NTSB/SIR-98/01, National Transportation Safety Board, Washington, D.C., April 1998.
[16] DOT Advisory Bulletin ADB-07-01, *Updated Notification of Susceptibility to Premature Brittle-Like Cracking of Older Plastic Pipe*, Federal Register, Volume 72, Number 172, p. 51301; ADB-02-07, *Notification of the Susceptibility to Premature Brittle-Like Cracking of Older Plastic Pipe*, Federal Register, Volume 67, Number 228, p. 70806, November 26, 2002 and corrected Federal Register, Volume 67, Number 232, p. 72027, December 3, 2002; ADB-99-02, Potential Failures Due to Brittle-Like Cracking of Older Plastic Pipe in Natural Gas Distribution Systems, Federal Register, Volume 64, p. 1212; ADB-99-01, *Potential Failure Due to Brittle-Like Cracking of Certain Polyethylene Plastic Pipe Manufactured by Century Utility Products Inc.*, Federal Register, Volume 64, p. 12211.

Figure 2 shows the failures by year of failure. The majority of the failures occurred prior to 2007; however, recently there have been additional reports submitted.

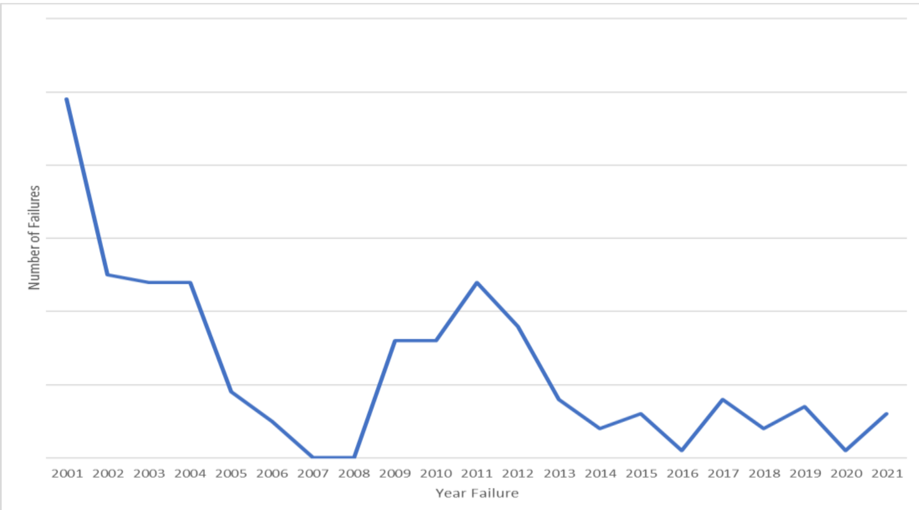


Figure 2. Failures by Year of Failure as Reported to PPDC for Century

Table 1 displays the percentages of failure causes for Century including pipe, fittings and joints. The highest identified cause is material defect.

Cause	% of Total Pipe Failure/Leaks	% of Total Fittings Failure/Leaks	% of Total Joints Failure/Leaks	% of Total
Cap (Other)	0.0%	4.8%	0.0%	1.5%
Excessive Expansion/Contraction	0.0%	1.2%	0.0%	0.4%
Excessive External Earth Loading	0.7%	0.0%	0.0%	0.4%
Installation Error	14.0%	23.8%	41.4%	20.2%
Material Defect	47.3%	45.2%	44.8%	46.4%
Other	28.0%	7.1%	13.8%	19.8%
Point Loading	2.0%	0.0%	0.0%	1.1%
Previous Impact	0.7%	0.0%	0.0%	0.4%
Threaded Cap (Cracked Cap)	0.0%	1.2%	0.0%	0.4%
Threaded Cap (Seal/O-ring defect)	0.0%	1.2%		0.4%
Unknown	7.3%	15.5%	0.0%	9.1%
Total	100.0%	100.0%	100.0%	100.0%

Table 1. Failures by Cause for Century Pipe, Fittings and Joints
Note: Percentages less than 0.1% are not listed in the chart

Limitations
Although the data continues to be actively reviewed by the PPDC, the data cannot be directly correlated to quantities of this material that may be in service across the U.S.

Based on the charter that governs the PPDC, reports are not associated with operator; therefore, analysis cannot be performed by operator or by location.

The PPDC database is a volunteer database and has inherent properties pertaining to the accuracy that comes with volunteer surveillance data. The data, such as manufacturer, other, year installed, year manufactured and failure cause, has not been independently tested, evaluated, verified for accuracy or audited.

Discussion
The information shown represents the detailed review of the available Century failure data by the PPDC and is intended to help operators in the analysis of their own systems and, where applicable, for consideration in DIMP methodologies.

While the amount of Century failures reported to the PPDC is relatively small, the data does confirm the material is the primary cause of failure, consistent with information in the NTSB Special Report. Recent reports of failure indicate this product is still in service.

Operators should look at the performance of their own piping systems. Each operator serves a unique and defined geographic area and their system infrastructures vary widely based on a multitude of factors, including facility condition, past engineering practices and materials. Each operator should evaluate the actions in light of system variables, the operator's independent integrity assessment, risk analysis and mitigation strategy. The responsibility lies with each operator to determine how best to utilize the information contained in this Appendix.

Appendix D: Aldyl Data Analysis -– November 2023March 2022

Background

The objective of this appendix is to provide information from the Plastic Pipe Database Committee (PPDC) database about Aldyl pipe and fittings manufactured by DuPont and Uponor.

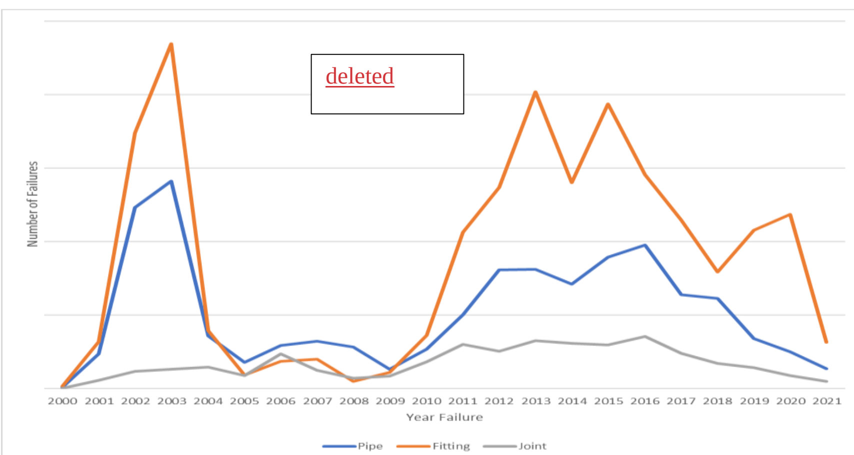
Methods

The information below reflects data collected by the PPDC. PPDC collects information voluntarily submitted by gas distribution pipeline operators on failures of metal or plastic appurtenances contained within plastic piping systems excluding third party damages. More information about the PPDC can be found at https://www.aga.org/?s=PPDC.

The PPDC Report Form provides for collection of information by manufacturer. Aldyl is a material trade name that was produced by DuPont and later Uponor. Therefore, the definition of "Aldyl" used for this analysis is the data reported as being manufactured by DuPont and Uponor.

Results

DuPont and Uponor represent approximately 2427% of all the reports in the database. Figure 1 shows the failures by year of failure. As reflected in the graph, there has been a recent increase in data submitted to the database. The majority of the reported Aldyl failures occur on fittings (56%). Other categories include pipe (32%), joints (11%) and unknown (1%).



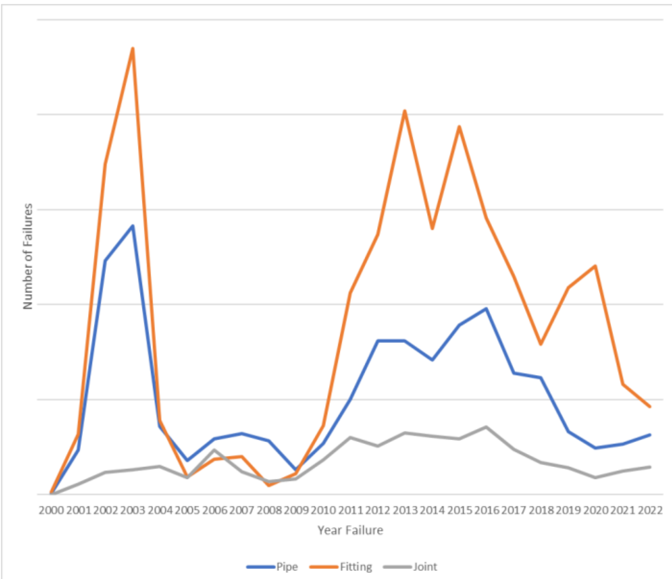


Figure 1. Failures by Year of Failure as reported to PPDC for Aldyl.

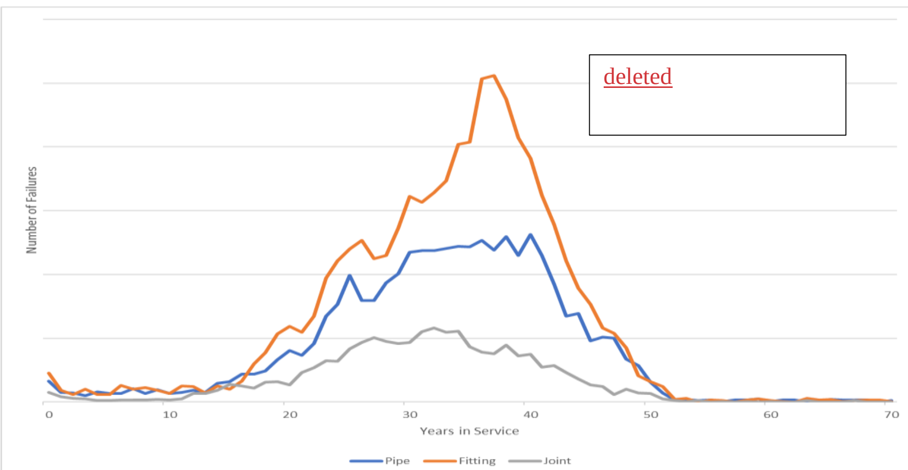
Table 1 reflects an analysis of the three peaks from Figure 1, comparing a change in fitting type failures from 2000-2005, 2010-2015 and 2016-2021. Noting the increase in Cap-type failures, reference Appendix F for more detailed analysis on Caps.

Fitting Type	% of Aldyl Fitting Failures between 2000 and 2005	% of Aldyl Fitting Failures between 2010 and 2015	% of Aldyl Fitting Failures between 2016 and 2022~~1~~
Cap	0.2%	59.3%	13.1~~13.7~~%
Electrofusion	0.1%	0.5%	1.4~~1.3~~%
Heat Fusion	23.7%	17.0%	18.1~~18.8~~%
Mechanical Fitting (Bolted)	0.1%	0.0%	0.1%
Mechanical Fitting (Nut Follower)	0.0%	0.5%	0.4%
Mechanical Fitting (Other)	2.5%	3.5%	2.5%
Mechanical Fitting (Stab)	0.0%	0.2%	0.0%
Meter Riser	13.6%	4.9%	1.8%
Other	29.0%	1.6%	1.5~~1.6~~%
Threaded Cap	0.0%	1.6%	54.7~~53.2~~%

Transition	16.1%	1.7%	0.30.4%
Unknown	4.7%	9.5%	4.95.2%
Valve	10.0%	1.2%	1.1%
Total	100.0%	100.0%	100.0%

Table 1: Fitting Types by Year Range of Failure
Note: Percentages less than 0.1% are not listed in the chart

The distribution of the Years in Service of failures is similar for pipe, fittings and joints (Figure 2).



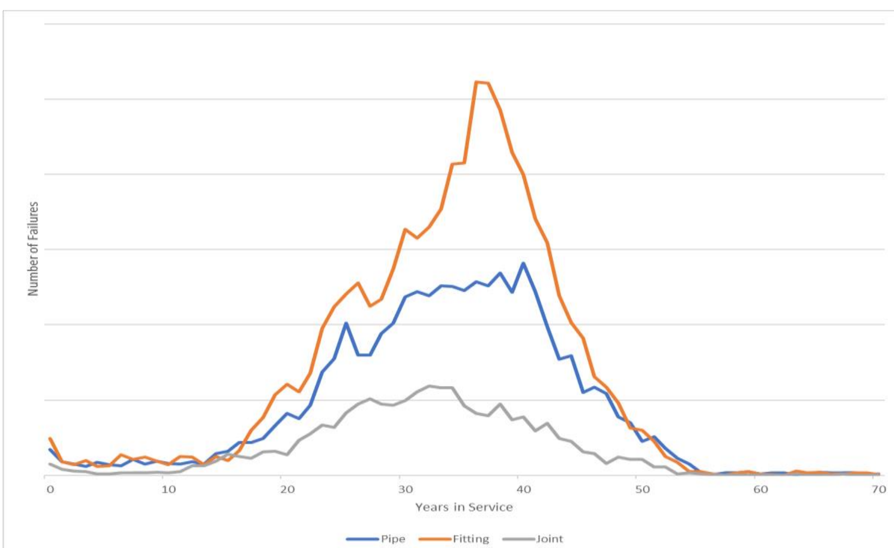
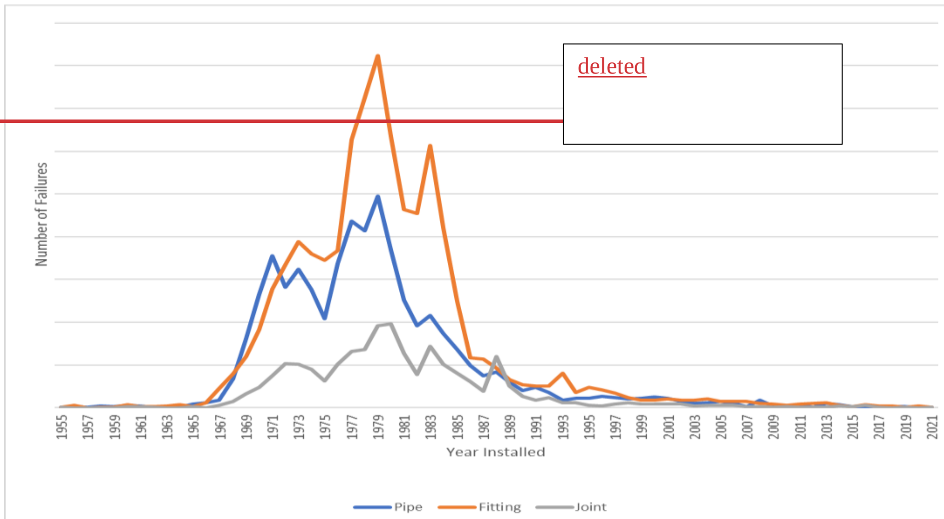


Figure 2. Failures by Years in Service as reported to PPDC for Aldyl pipe, fittings and joints

Figure 3 shows the failures by Year Installed. Although Figure 1 shows three data peaks, the year of installation range appears consistent.



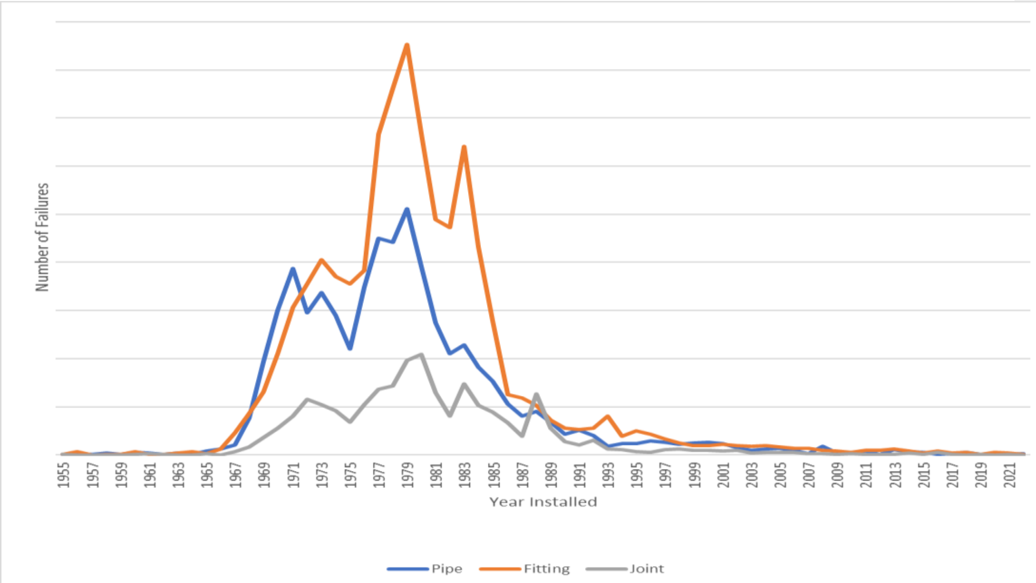


Figure 3. Failures by Year Installed as reported to PPDC for Aldyl pipe, fittings and joints

Table 2 displays the percentages of failure causes for Aldyl including pipe, fittings and joints.

CAUSE	% of All Dupont & Uponor Failures	% of All Dupont & Uponor Pipe Failures	% of All Dupont & Uponor Fitting Failures	% of All Dupont & Uponor Joint Failures
Cap (Other)	2.7~~2.8~~%	0.0%	4.8~~5.0~~%	0.0%
Corrosion	1.2~~1.3~~%	1.1~~1.2~~%	1.5~~1.6~~%	0.0~~0.1~~%
Excessive Expansion/Contraction	1.4%	0.9%	1.2%	4.5~~4.6~~%
Excessive External Earth Loading	7.9~~7.5~~%	15.1~~13.6~~%	4.2%	5.4~~5.7~~%
Gopher/Rodent/Worm damage	0.1%	0.4%	0.0%	0.0%
Installation Error	21.6~~22.0~~%	11.9~~12.3~~%	18.7~~19.5~~%	65.6~~64.7~~%
Material Defect	15.2~~15.3~~%	6.8~~6.9~~%	22.1~~22.2~~%	5.0~~4.9~~%
Other	15.0~~15.5~~%	17.1~~17.4~~%	16.3~~17.0~~%	1.8%
Point Loading	8.9~~9.1~~%	22.2~~22.4~~%	2.2~~2.3~~%	3.9~~4.0~~%
Previous Impact	1.5%	4.2~~4.1~~%	0.1%	0.4%
Squeeze Off	2.6~~2.5~~%	7.7~~7.5~~%	0.0%	0.0%
Threaded Cap (Cracked Cap)	5.8~~5.5~~%	0.0~~0.2~~%	10.3~~9.6~~%	0.0%
Threaded Cap (Loose, not cracked)	1.0~~0.3~~%	0.0%	1.8~~0.5~~%	0.0%
Threaded Cap(Other, Describe)	0.0~~0.6~~%	0.0%	0.0~~1.0~~%	0.0%
Threaded Cap (Seal/O-ring defect)	0.8~~0.6~~%	0.0%	1.4~~1.0~~%	0.0%
Unknown	13.6~~13.9~~%	11.2~~11.6~~%	15.1~~15.4~~%	12.9~~13.3~~%
Unknown – Abandoned	0.1%	0.3%	0.0%	0.0%
Unknown – Not Excavated, Replaced	0.6%	1.1%	0.3%	0.3~~0.4~~%

Total	100.0%	100.0%	100.0%	100.0%

Table 2. Failures by Cause as reported to PPDC for Aldyl pipe, fittings and joints
Note: Percentages less than 0.1% are not listed in the chart

Table 3 displays the percentages of types of Aldyl joints reported to the PPDC. Socket fusions are the most common type to failure.

JOINT	**% of All Dupont & Uponor Joint Failures**
Butt Fusion	14.513.9%
Electrofusion	2.01.5%
Mechanical (Nut Follower)	0.80.5%
Mechanical (Other)	2.22.3%
Mechanical (Stab)	0.30.2%
Saddle Fusion	16.2 %
Socket Fusion	28.828.7%
~~Solvent~~	~~0.0%~~
Other	3.13.2%
Unknown	32.033.4%
Total	100.0%

Table 3. Aldyl Joint Types failures as reported to PPDC
Note: Percentages less than 0.1% are not listed in the chart

Limitations
Although the data continues to be actively reviewed by the PPDC-, the data cannot be directly correlated to quantities of this material that may have been placed in service or may be in continued service across the U.S.

Based on the charter that governs the PPDC, reports are not associated with operator; therefore, analysis cannot be performed by operator or by location.

The PPDC database is a volunteer database and has inherent properties pertaining to the accuracy that come with volunteer surveillance data. The data, such as manufacturer, other, year installed, year manufactured and failure cause, has not been independently tested, evaluated, verified for accuracy or audited.

The PPDC Data Report Form does not request brand name, trade name or product name. The PPDC's definition of Aldyl is broader than the product name of Aldyl A.

Discussion
The information shown represents the detailed review of the available Aldyl failure data by the PPDC and is intended to help operators in the analysis of their own systems and where applicable, for consideration in DIMP methodologies.

Aldyl failure data continues to be reported. Moreover, as depicted in Figure 1, there are now three peaks of failure data submissions (2000-2005, 2010-2015, 2016-2021). Analysis has determined that the range of installation years for these peaks appears consistent. Therefore, the installation years are more reflective of materials experiencing failures. Failure causes demonstrate that installation practices and the operating environment can greatly impact the service life of the Aldyl piping.

Operators should look at the performance of their own piping systems. Each operator serves a unique and defined geographic area and their system infrastructures vary widely based on a multitude of factors, including facility condition, past engineering practices and materials. Each operator should evaluate the actions in light of system variables, the operator's independent integrity assessment, risk analysis and mitigation strategy. The responsibility lies with each operator to determine how best to utilize the information contained in this Appendix.

Appendix E: PE 3306 Data Analysis – February 2023

Background

Polyethylene (PE) pipe manufactured from PE3306 resin was included in PHMSA advisories[17] as one of the historically known materials susceptible to brittle-like cracking[18]. PE3306 resins include pipe manufactured by companies such as Swanson, Orangeburg and Yardley, starting in the 1950s and peaking in the 1970s.

The objective of this appendix is to provide information from the Plastic Pipe Database Committee (PPDC) database about PE3306 pipe, fittings, and joints.

Methods

The information below reflects data collected by the PPDC. PPDC collects information voluntarily submitted by gas distribution pipeline operators on failures of metal or plastic appurtenances contained within plastic piping systems excluding third party damages. The PPDC Report Form provides for collection of information by material. More information about the PPDC can be found at https://www.aga.org/?s=PPDC

Results

PE3306 failures represent less than 1% of all the reports in the database. The majority of the reported failures occur on pipe (51%), other categories include fittings (32%), joints (13%) and unknown (4, includes blank). Figure 1 shows the distribution of failures for pipe, fittings and joints by years in service and indicates an accelerated rate of failure for PE3306 in service for over 20 years.

[17] DOT Advisory Bulletin ADB-07-01, *Updated Notification of Susceptibility to Premature Brittle-Like Cracking of Older Plastic Pipe*, Federal Register, Volume 72, Number 172, p. 51301; ADB-02-07, *Notification of the Susceptibility to Premature Brittle-Like Cracking of Older Plastic Pipe*, Federal Register, Volume 67, Number 228, p. 70806, November 26, 2002 and corrected Federal Register, Volume 67, Number 232, p. 72027, December 3, 2002; ADB-99-02, Potential Failures Due to Brittle-Like Cracking of Older Plastic Pipe in Natural Gas Distribution Systems, Federal Register, Volume 64, p. 1212; ADB-99-01, *Potential Failure Due to Brittle-Like Cracking of Certain Polyethylene Plastic Pipe Manufactured by Century Utility Products Inc.*, Federal Register, Volume 64, p. 12211.

[18] *Brittle-Like Cracking in Plastic Pipe For Gas Service*, NTSB Report No. NTSB/SIR-98/01, National Transportation Safety Board, Washington, D.C., April 1998.

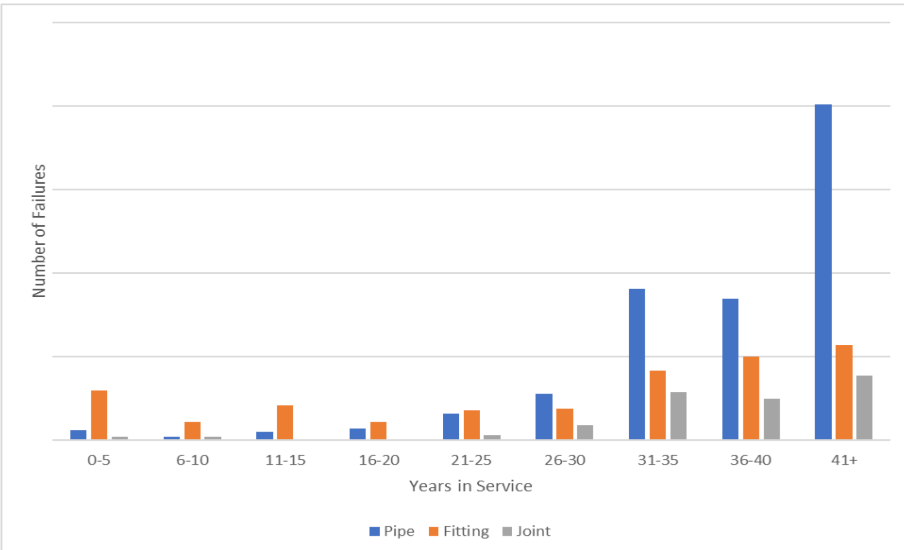


Figure 1. PE3306 Failures by Years in Service, 5 Year Intervals.

Figure 2 shows the failures by year of failure. Of these PE3306 failures that have occurred, the majority of those with reported sizes (88%) are associated with service size piping (1" CTS in diameter or less) and 64% are ½" CTS.

Between 2019 and 2021, the total number of reported fittings failures exceeded the number of reported pipe failures. During this period, the top three reported fitting failures are: threaded caps at 45%, valves at 24%, and meter risers at 16%."

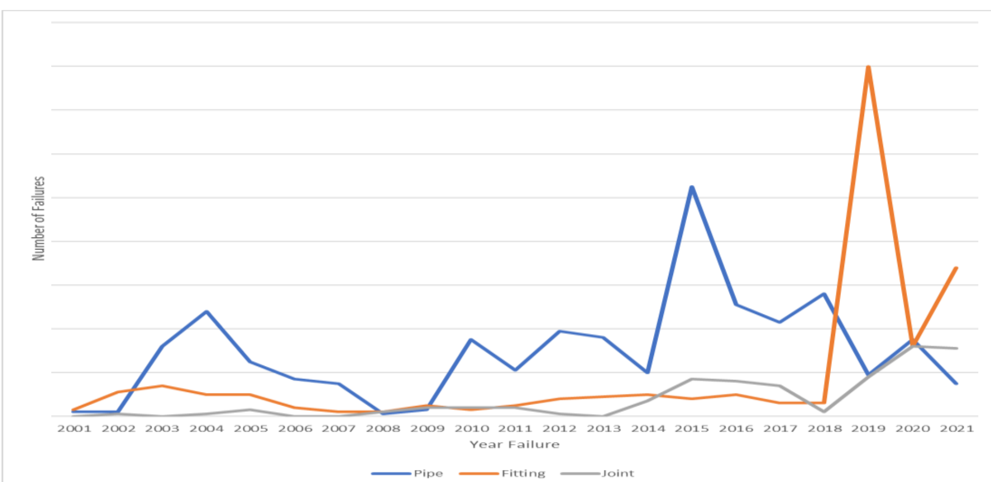


Figure 2. Failures by Year of Failure as Reported to PPDC for PE3306

Table 1 displays the percentages of failure causes for PE3306 including pipe, fittings and joints. The highest identified failure causes are squeeze off for pipe, material defect for fittings and other for joints.

Table 1. Failures by Cause for PE3306 Pipe, Fittings, Joints (Less than 1% of All Reports in the Database)

Note: Percentages less than 0.1% are not listed in the chart

Cause	% of All PE3306 Pipe Failures	% of All PE3306 Fitting Failures	% of All PE3306 Joint Failures	% of All PE 3306 Failure / Leaks Total
Corrosion	0.2%	7.5%	0.0%	2.6%
Excessive Expansion/Contraction	0.8%	8.2%	24.7	6.5%
Excessive External Earth Loading	9.0%	2.1%	3.2%	5.9%
Installation Error	1.0%	18.8%	30.4%	10.8%
Material Defect	5.0%	12.1%	12.0%	8.3%
Other	7.4%	4.9%	17.7%	7.9%
Point Loading	22.4%	2.1%	0.6%	12.7%
Previous Impact	1.0%	0.3%	0.0%	0.6%
Squeeze Off	39.4%	1.8%	0.0%	21.6%
Threaded Cap (Cracked Cap)	0.0%	5.4%	0.0%	1.8%
Threaded Cap (Loose cap, not cracked)	0.0%	12.6%	0.0%	4.2%
Threaded Cap (Other, described)	0.0%	0.3%	0.0%	0.1%
Threaded Cap (Seal/O-ring defect)	0.0%	1.0%	3.8%	0.9%
Unknown	13.1%	23.1%	7.6%	15.7%
Unknown- Abandoned	0.6%	0.0%	0.0%	0.3%
Unknown - Not Excavated, Replaced	0.3%	0.0%	0.0%	0.2%
% of All PE 3306 Failure /Leaks Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Limitations

Although the data continues to be actively reviewed by the PPDC the data cannot be directly correlated to quantities of this material that may be in service across the U.S.

Based on the charter that governs the PPDC, reports are not associated with operator; therefore, analysis cannot be performed by operator or by location.

The PPDC database is a volunteer database and has inherent properties pertaining to the accuracy that comes with volunteer surveillance data. The data, such as manufacturer, other, year installed, year manufactured and failure cause, has not been independently tested, evaluated, verified for accuracy or audited.

Discussion

The information shown represents the detailed review of the available PE3306 failure data by the PPDC and is intended to help operators in the analysis of their own systems and where applicable, for consideration in DIMP methodologies.

While the amount of PE3306 failures reported to the PPDC is relatively small, this material is of particular interest because of its susceptibility to brittle-like cracking as evidenced by the high percentage of squeeze off and point loading which is approximately 62% of the PE3306 data for pipe. Recent reports of failure indicate this product is still in service.

Operators should look at the performance of their own piping systems. Each operator serves a unique and defined geographic area and their system infrastructures vary widely based on a multitude of factors, including facility condition, past engineering practices and materials. Each operator should evaluate the actions in light of system variables, the operator's independent integrity assessment, risk analysis and mitigation strategy. The responsibility lies with each operator to determine how best to utilize the information contained in this Appendix.

Appendix F: Cap Data Analysis – February 2023

Background
In its Status Reports, the Plastic Pipe Database Committee (PPDC) has recognized the following two historically known issues:

- DuPont Aldyl® service tee with a white Delrin® polyacetal threaded insert
- Plexco service tee with Celcon® polyacetal threaded cap

The objective of this appendix is to provide more detailed information from the PPDC database about these known cap issues, as well as caps from other manufacturers and materials for comparison. For purposes of this Appendix, 'other manufacturers' includes manufacturers other than DuPont and Plexco as well as reported failures from unspecified manufacturers.

Methods
The information below reflects data collected by the PPDC. PPDC collects information voluntarily submitted by gas distribution pipeline operators on failures of metal or plastic appurtenances contained within plastic piping systems excluding third party damages. The PPDC Report Form provides for collection of information by manufacturer. More information about the PPDC can be found at https://www.aga.org/?s=PPDC

Originally, cap was not listed as a type of fitting on the standard report form. In the process of reviewing historical data, the PPDC identified caps as an area of interest. In 2017, Threaded Cap was added to the report form as a type of fitting. Four new failure causes specific to caps were also added.

Results
Caps represent approximately 18% of all reports in the database and 40% of all fitting failures. Figure 1 shows elevated reports of cap failures in recent years.

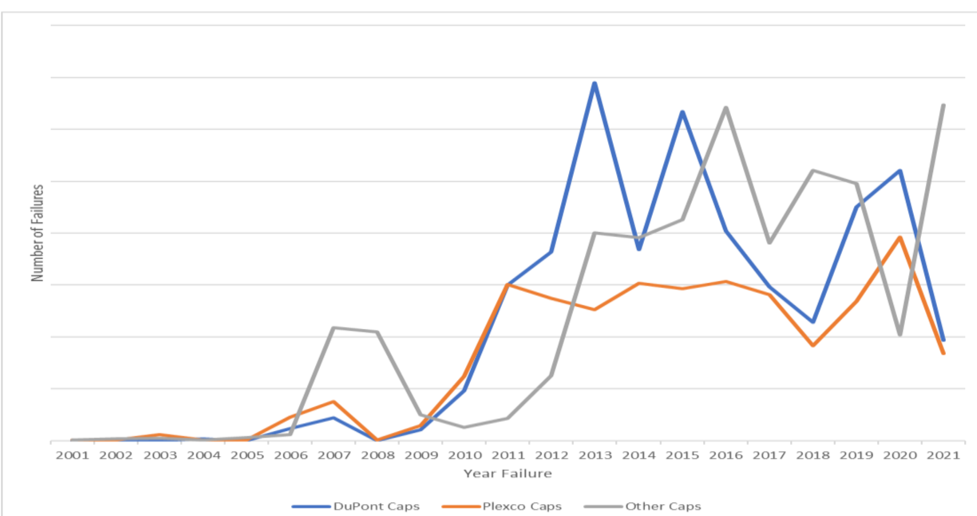


Figure 1. Failures by Year of Failure

Figure 2 shows concentrations of failures in specific installation years for DuPont, Plexco and Other Manufacturers. The year of installation was reported for 42% of DuPont cap data, 43% of Plexco cap data, and 68% of Other Manufacturers cap data. Overall, the year of installation was reported for 53% for all cap data. The installation dates for DuPont and Plexco match what is historically known about the manufacturing timeframes. Because the year of installation data is limited, the DuPont and Plexco peaks identified below are underrepresented.

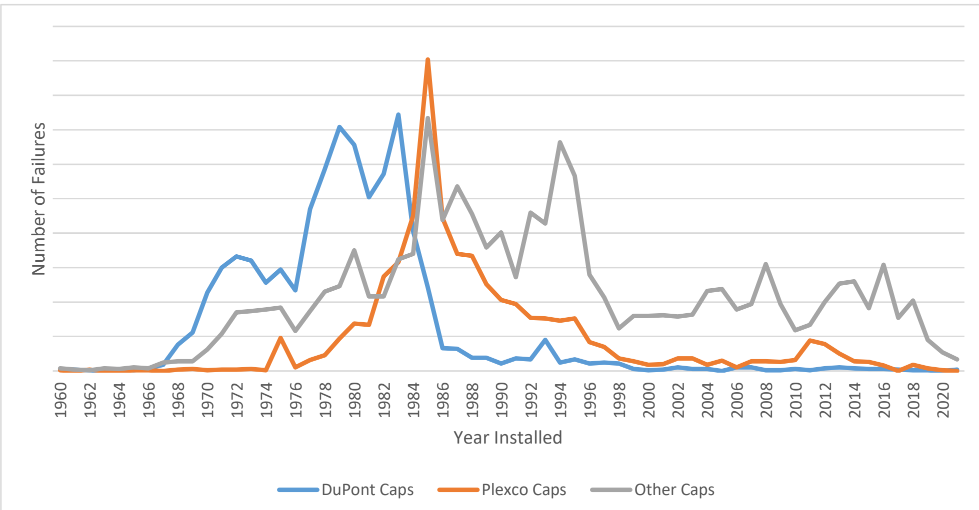


Figure 2. Failures by Year Installed

Figure 3 shows the failure by years in service in 5 year intervals reflecting the performance over time.

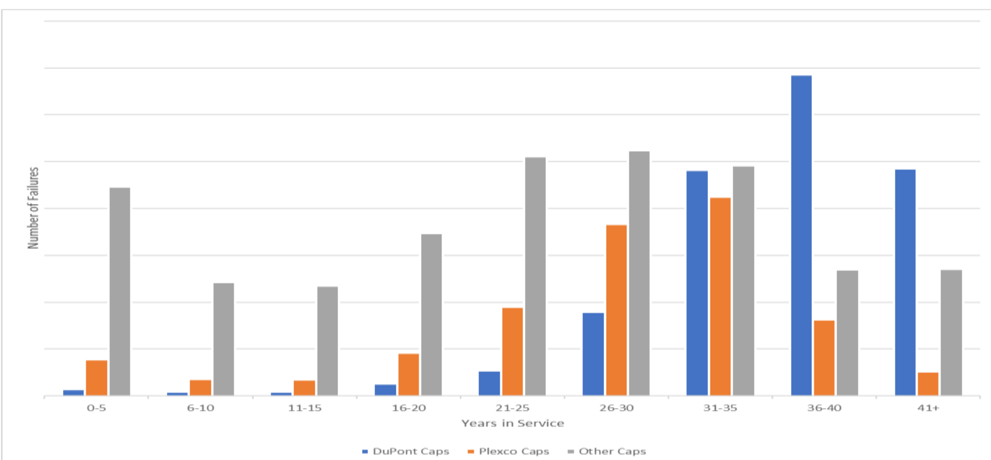


Figure 3. Failures by Years in Service, 5 Year Intervals

Table 1 provides the distribution of reported material types for the cap failures. The majority of materials reported for DuPont and Plexco are reflective of the known issues.

Material	% of DuPont Caps Failures	% of Plexco Caps Failures	% of Other Caps Failures
ABS	0.0%	0.0%	0.1%
Celcon	0.0%	74.9%	0.1%
Delrin	56.4%	0.0%	0.0%
HDPE 3306	0.0%	0.6%	1.0 %
HDPE 3406	0.1%	1.0%	6.0%
HDPE 3408	0.0%	0.8%	11.9%
MDPE 2306	15.2%	6.8%	17.6%
MDPE 2406	17.5%	7.9%	46.1%
Nylon	7.5%	4.1%	7.9%
Other	3.3%	2.6%	1.8%
PA 11	0.0%	0.1%	0.0%
PB	0.0%	0.0%	0.1%
PE-2708	0.0%	0.6%	2.2%
PE-4710	0.0%	0.0%	2.0%
Polyacetal or POM	0.0%	0.6%	2.8%
PVC	0.0%	0.0%	0.3%
Steel	0.0%	0.0%	0.1%
Grand Total	**100.00%**	**100.00%**	**100.00%**

Table 1. Cap Failures by Material Type

Note: Percentages less than 0.1% are not listed in the chart

NOTE: Celcon® and Delrin® are polyoxymethylene (POM) also known as polyacetal. These are trade names not material types; but were reported as a material type.

Table 2 shows cap failures by cause. Material Defect was the major cause for DuPont and Plexco cap failures. It should be noted that the cause shown as "Not Recorded" or left blank has been moved to the "Unknown" data.

Cause	% of DuPont Caps Failures	% of Plexco Caps Failures	% of Other Manufacturer Caps Failures
Cap (Other)	10.3%	10.3%	16.4%
Excessive Expansion/Contraction	1.4%	0.6%	4.2%
Excessive External Earth Loading	0.2%	0.5%	0.3%
Installation Error	9.8%	5.4%	17.8%
Material Defect	33.8%	37.4%	11.6%
Other	4.0%	6.9%	1.7%
Point Loading	0.2%	0.2%	0.1%

Threaded Cap (Cracked Cap)	20.6%	20.3%	8.3%
Threaded Cap (Loose cap, not cracked)	3.1%	2.2%	21.9%
Threaded Cap (Other, describe)	0.2%	0.0%	2.8%
Threaded Cap (Seal/O-ring defect)	2.8%	2.4%	3.9%
Unknown	13.4%	13.7%	10.9%
Unknown – Abandoned	0.0%	0.1%	0.1%
Unknown - Not Excavated, Replaced	0.1%	0.0%	0.1%
Grand Total	**100.0%**	**100.0%**	**100.0%**

Table 2. Cap Failures by Cause
Note: Percentages less than 0.1% are not listed in the chart

Limitations
Although the data continues to be actively reviewed by the PPDC the data cannot be directly correlated to quantities of this material that may be in service across the U.S.

Based on the charter that governs the PPDC, reports are not associated with operator; therefore, analysis cannot be performed by operator or by location.

The PPDC database is a volunteer database and has inherent properties pertaining to the accuracy that comes with volunteer surveillance data. The data, such as manufacturer, other, year installed, year manufactured and failure cause, etc., has not been independently tested, evaluated, verified for accuracy or audited.

Discussion
Cap failures reported to the PPDC are of particular interest due to known historical issues and have been included in a PHMSA Advisory Bulletin[19]. The fact that reported cap failures have been elevated in recent years, as indicated on Figure 1, may be attributable to operators preparing for and implementing Distribution Integrity Management Programs and Mechanical Fitting Failure Reports.

Figure 2 indicates that failures reported for DuPont were primarily on caps installed in the 1970s and 1980s and Plexco primarily in the 1980s and 1990s, while failures for other manufacturers' caps also include a peak for installations in the mid-1990s. The primary cause of failures for the mid-1990s peak is material defect.

Given the recently submitted data, operators should look at the performance of their own piping systems. Each operator serves a unique and defined geographic area and their system infrastructures vary widely based on a multitude of factors, including facility condition, past engineering practices and materials. Each operator should evaluate the actions in light of system variables, the operator's independent integrity assessment, risk analysis and mitigation strategy. The responsibility lies with each operator to determine how best to utilize the information contained in this Appendix.

[19] DOT Advisory Bulletin ADB-07-01, *Updated Notification of Susceptibility to Premature Brittle-Like Cracking of Older Plastic Pipe*, Federal Register, Volume 72, Number 172, p. 51301; ADB-02-07, *Notification of the Susceptibility to Premature Brittle-Like Cracking of Older Plastic Pipe*, Federal Register, Volume 67, Number 228, p. 70806, November 26, 2002 and corrected Federal Register, Volume 67, Number 232, p. 72027, December 3, 2002; ADB-99-02, Potential Failures Due to Brittle-Like Cracking of Older Plastic Pipe in Natural Gas Distribution Systems, Federal Register, Volume 64, p. 1212; ADB-99-01, *Potential Failure Due to Brittle-Like Cracking of Certain Polyethylene Plastic Pipe Manufactured by Century Utility Products Inc.*, Federal Register, Volume 64, p. 12211.

Appendix G: AMP Data Analysis – October 2022

Background
Fittings commonly known as AMP-FIT or AMP were manufactured in the 1970s and 1980s for use in natural gas distribution systems. These fittings were primarily used in natural gas service line applications and main line repairs. Rights to the manufacturing process and name of the fittings went through changes as they were sold to other manufacturers, including Uponor in 1996.[20]

The objective of this appendix is to provide information from the Plastic Pipe Database Committee (PPDC) database about AMP fittings and joints.

Methods
The information below reflects data collected by the PPDC. PPDC collects information voluntarily submitted by gas distribution pipeline operators on failures of metal or plastic appurtenances contained within plastic piping systems excluding third party damages. The PPDC Report Form provides for collection of information by material. More information about the PPDC can be found at https://www.aga.org/?s=PPDC.

Results
AMP represents approximately 1.3% of all the reports in the database. The majority of the data reported (81%) are fitting failures.

Figure 1 shows AMP failures by year installed, which depicts the majority being installed between 1970 and 1990.

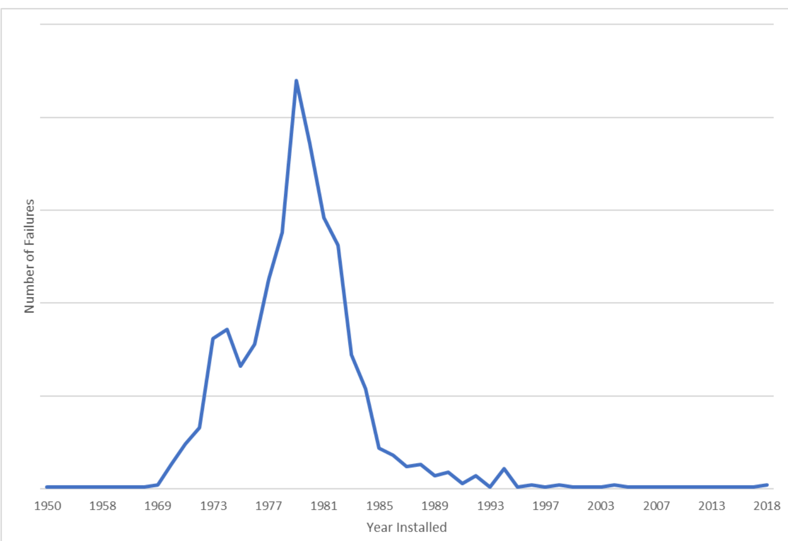


Figure 1. AMP Failures by Year Installed

[20] Uponor in the US is now part of J M Eagle™.

The distribution of failures for AMP by years in service is shown in Figure 2.

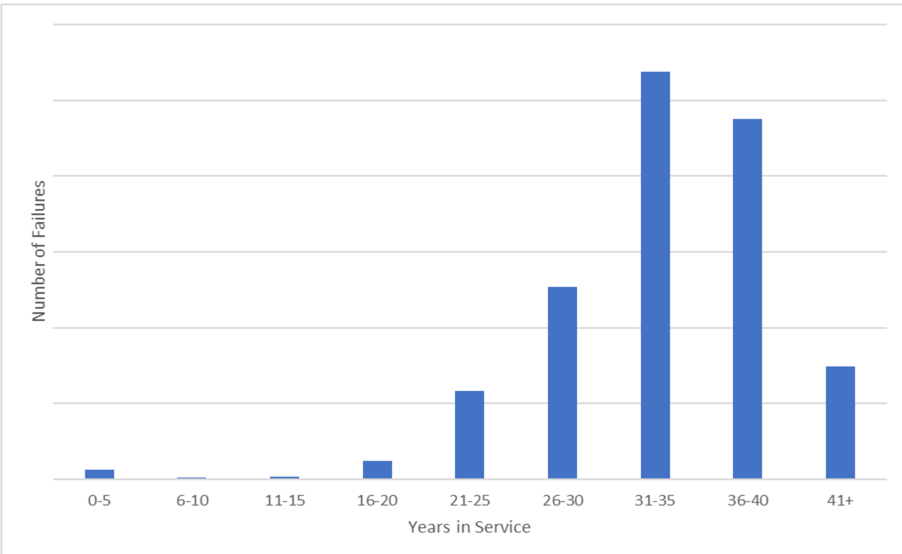


Figure 2. AMP Failures by Years in Service, 5 year intervals

Figure 3 shows the failures by year of failure. The number of reported failures is variable across the years.

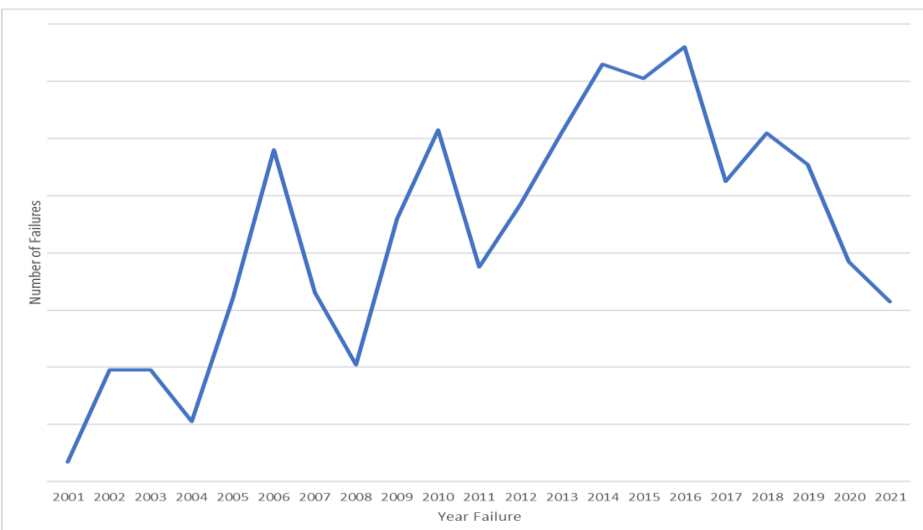


Figure 3. AMP Failures by Year of Failure

Table 1 displays the percentages of failure causes for AMP. The highest reported failure causes are material defect and unknown (42 % and 21%), followed by excessive external earth loading (13%). Although corrosion is reported as being only 0.4% of the data submitted, based on the expertise of the PPDC members, it is our opinion corrosion of the external steel compression rings may be a larger contributing factor than represented by the data submitted.

Cause	**% of Total AMP Failure**
Cap (Other)	0.1%
Corrosion	0.4%
Excessive Expansion/Contraction	4.2%
Excessive External Earth Loading	13.3%
Installation Error	12.0%
Material Defect	42.2%
Other	5.1%
Point Loading	0.8%
Previous Impact	0.1%
Threaded Cap (Cracked Cap)	0.1%
Threaded Cap (Loose cap, not cracked)	0.1%
Threaded Cap (Seal/O-ring defect)	0.3%
Unknown	21.3%
Unknown - Not Excavated, Replaced	0.1%
Total	**100.0%**

Table 1. Failures by Cause for AMP

Note: Percentages less than 0.1% are not listed in the chart

Limitations

Although the data continues to be actively reviewed by the PPDC the data cannot be directly correlated to quantities of this material that may be in service across the U.S.

Based on the charter that governs the PPDC, reports are not associated with operator; therefore, analysis cannot be performed by operator or by location.

The PPDC database is a volunteer database and has inherent properties pertaining to the accuracy that comes with volunteer surveillance data. The data, such as manufacturer, other, year installed, year manufactured and failure cause, has not been independently tested, evaluated, verified for accuracy or audited.

Discussion

The information shown represents the detailed review of the available AMP failure data by the PPDC and is intended to help operators in the analysis of their own systems and where applicable, for consideration in DIMP methodologies.

Operators should look at the performance of their own piping systems. Each operator serves a unique and defined geographic area and their system infrastructures vary widely based on a multitude of factors, including facility condition, past engineering practices and materials. Each operator should evaluate the actions in light of system variables, the operator's independent integrity assessment, risk analysis and mitigation strategy. The responsibility lies with each operator to determine how best to utilize the information contained in this Appendix.

Appendix H: PVC Data Analysis - October 2022

Background

Due to the evolution of piping materials and construction methods, the installation of new PVC pipe diminished significantly due to operator preferences after the mid-1980s. PVC is currently used only for repair purposes.

According to data submitted to PHMSA on annual reports, mileage for PVC has been decreasing since 2000. Approximately 10,102 miles of main were reported in 2021.

The objective of this appendix is to provide information from the Plastic Pipe Database Committee (PPDC) database about PVC pipe, fittings and joints.

Methods

The information below reflects data collected by the PPDC. PPDC collects information voluntarily submitted by gas distribution pipeline operators on failures of metal or plastic appurtenances contained within plastic piping systems excluding third party damages. The PPDC Report Form provides for collection of information by material. More information about the PPDC can be found at https://www.aga.org/?s=PPDC.

Results

PVC represents approximately 2% of all the reports in the database. The majority of the reported failures occur on fittings (72%). Other categories include joints (24%), pipe (4%), and unknown (less than 1%).

The distribution of failures for pipe, fittings and joints by years in service is shown in Figure 1.

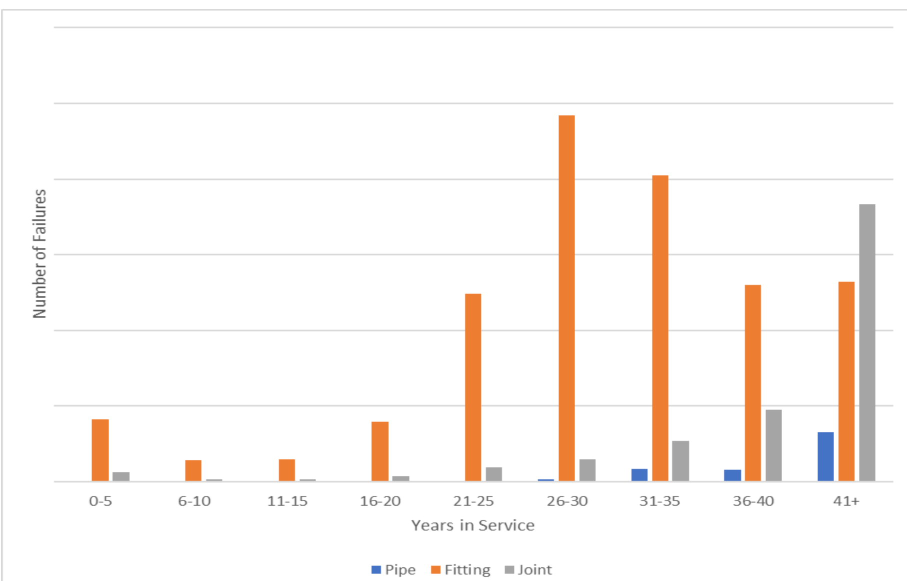


Figure 1. PVC Failures by Years in Service, 5 Year Intervals

Figure 2 shows the failures by year installed. This chart also demonstrates the lack of pipe installation after the mid-1980s.

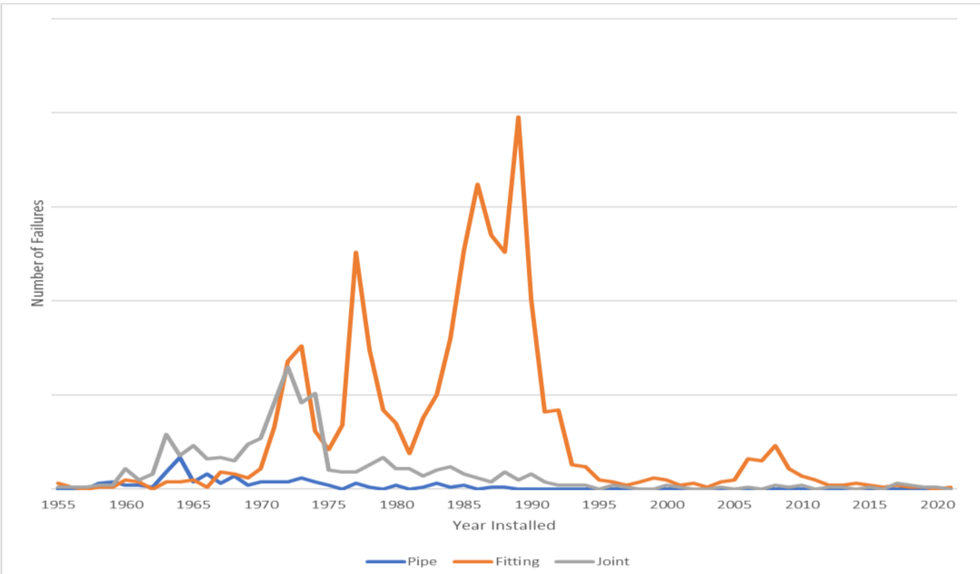


Figure 2. PVC failures by Year Installed

Figure 3 shows the failures by year of failure. The plot shows the trend of failures of fittings and joints.

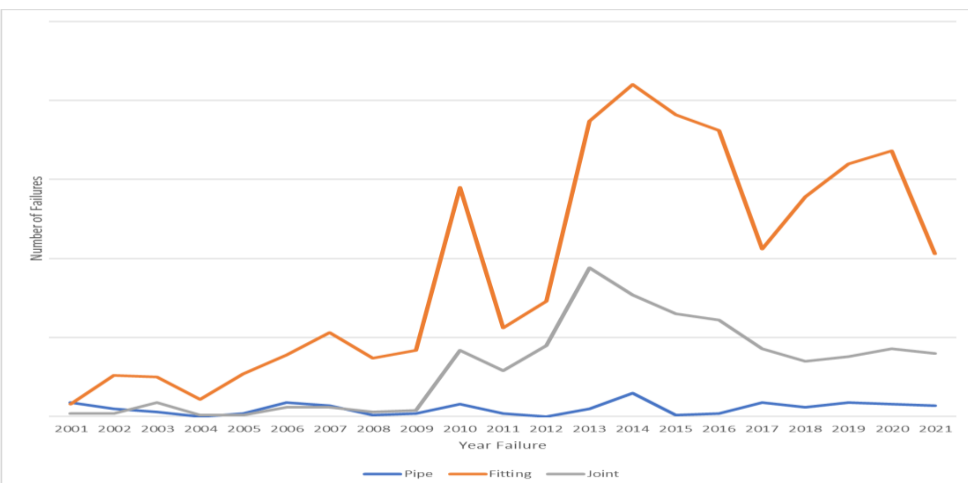


Figure 3. PVC Failures by Year of Failure

Table 1 displays the percentages of failure causes for PVC including pipe, fittings and joints. The highest failure causes for PVC fittings, which are the majority of failures, are installation error and material defect. The highest known failure cause for PVC joints is material defect. The highest failure cause for PVC pipe is point loading.

Cause	% of All PVC Pipe Failures	% of All PVC Fitting Failures	% of All PVC Joint Failures	Total
Cap (Other)	0.0%	0.5%	0.0%	0.3%
Corrosion	0.0%	0.3%	0.2%	0.2%
Excessive Expansion/Contraction	2.7%	2.3%	0.5%	1.9%
Excessive External Earth Loading	17.1%	4.7%	6.7%	5.6%
Installation Error	9.0%	46.6%	19.1%	38.6%
Material Defect	16.2%	36.2%	25.3%	32.8%
Other	3.6%	2.6%	8.1%	3.9%
Point Loading	27.9%	0.4%	1.4%	1.7%
Previous Impact	5.4%	0.5%	0.5%	0.7%
Squeeze Off	2.7%	0.0%	0.0%	0.1%
Threaded Cap (Loose cap, not cracked	0.0%	0.1%	0.0%	0.0%
Threaded Cap (Other, describe)	0.0%	0.5%	0.0%	0.3%
Threaded Cap (Seal/O-ring defect)	0.0%	0.0%	0.3%	0.1%
Unknown	12.6%	5.6%	38.0%	13.5%
Unknown - Not Excavated, Replaced	2.7%	0.1%	0.0%	0.1%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 1. Failures by Cause for PVC Pipe, Fittings and Joints
Note: Percentages less than 0.1% are not listed in the chart

Limitations

Although the data continues to be actively reviewed by the PPDC the data cannot be directly correlated to quantities of this material that may be in service across the U.S.

Based on the charter that governs the PPDC, reports are not associated with operator; therefore, analysis cannot be performed by operator or by location.

The PPDC database is a volunteer database and has inherent properties pertaining to the accuracy that comes with volunteer surveillance data. The data, such as manufacturer, other, year installed, year manufactured and failure cause, has not been independently tested, evaluated, verified for accuracy or audited.

Discussion

The information shown represents the detailed review of the available PVC failure data by the PPDC and is intended to help operators in the analysis of their own systems and where applicable, for consideration in DIMP methodologies.

The spike in fitting failures in Figure 2, between 2005 and 2011, are primarily attributed to material defect and occur between 0 and 5 years in service.

Operators should look at the performance of their own piping systems. Each operator serves a unique and defined geographic area and their system infrastructures vary widely based on a multitude of factors, including facility condition, past engineering practices and materials. Each operator should evaluate the actions in light of system variables, the operator's independent integrity assessment, risk analysis and mitigation strategy. The responsibility lies with each operator to determine how best to utilize the information contained in this Appendix.

Appendix I: Kerotest Data Analysis – – November 2023March 2022

Background
Kerotest began manufacturing a variety of plastic gas carrying components including valves in the 1980s. The objective of this appendix is to provide information from the Plastic Pipe Database Committee (PPDC) database about Kerotest fittings and joints due to elevated failure reports in recent years for valves installed between 1985 and 1992. Kerotest provides a customer letter addressing their investigation of Kerotite valves on their website at https://kerotest.com/kerotite-customer-letter-2/

Methods
The information below reflects data collected by the PPDC. PPDC collects information voluntarily submitted by gas distribution pipeline operators on failures of metal or plastic appurtenances contained within plastic piping systems excluding immediate failures due to excavation damage.

Results
Kerotest failures represent approximately 7% of all the reports in the database. The majority of the Kerotest data reported (55%) are valve failures, (1072%)65% are fitting failures and (3428%) are reported as joint failure.

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Table 1 shows Kerotest fitting failures by type. Of the fitting failures, approximately 85% are reported as plastic valves. Comments provided in reports identify that 16% of the reported valve failures are due to the valve's compression connections[21].

FITTING	% of All Kerotest Fitting Failures
Electrofusion	0.1%
Heat Fusion	0.30.2%
Mechanical Fitting (Other)	8.0%
Mechnical Fitting (Nut Follower)	3.23.3%
Meter Riser	2.92.8%
Other	0.2%
Threaded Cap	0.1%
Transition	0.10.2%
Valve (Plastic)	84.884.9%
Unknown	0.40.3%
Total	100.0%

Table 1. Kerotest Fitting Failures by Type
Note: Percentages less than 0.1% are not listed in the chart

Table 2 shows Kerotest joint failures by type. Of the joint failures, approximately 9796% are mechanical.

JOINT	% of All Kerotest Joint Failures
Butt Fusion	0.40.5%

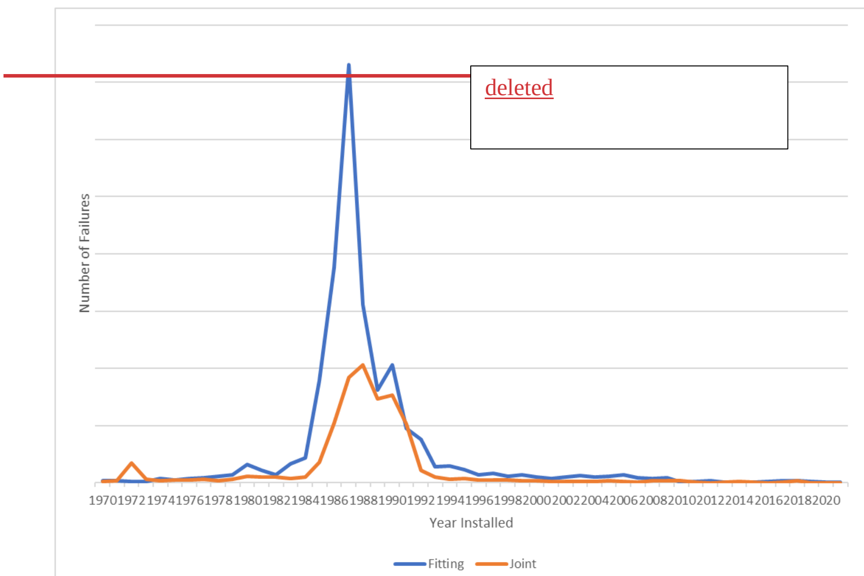
[21] Analysis as of March 2022

Electrofusion	0.4%
Mechanical (Nut Follower)	39.325.0%
Mechanical (Other)	57.070.4%
Mechanical (Stab)	0.2%
Other	0.5%
Saddle Fusion	0.30.4%
Socket Fusion	0.2%
Unknown	1.72.3%
Total	100.0%

Table 2. Kerotest Joint Failures by Type

Note: Percentages less than 0.1% are not listed in the chart

Figure 1 shows Kerotest fittings and joint failures by year installed, which depicts the majority being installed between 1985 and 1992.



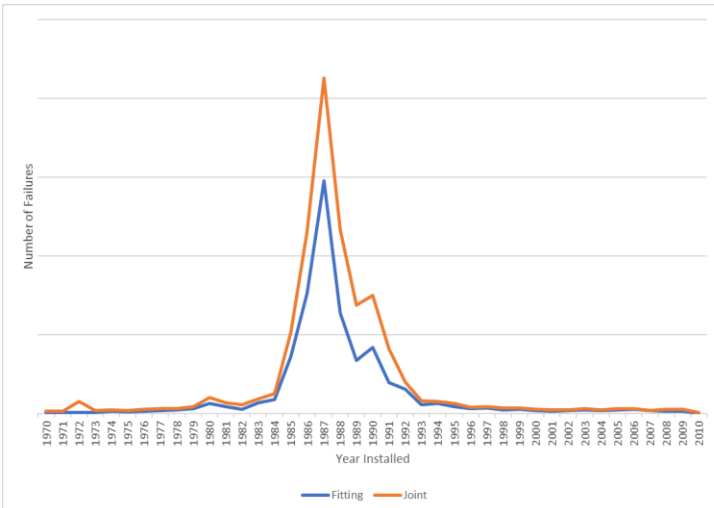
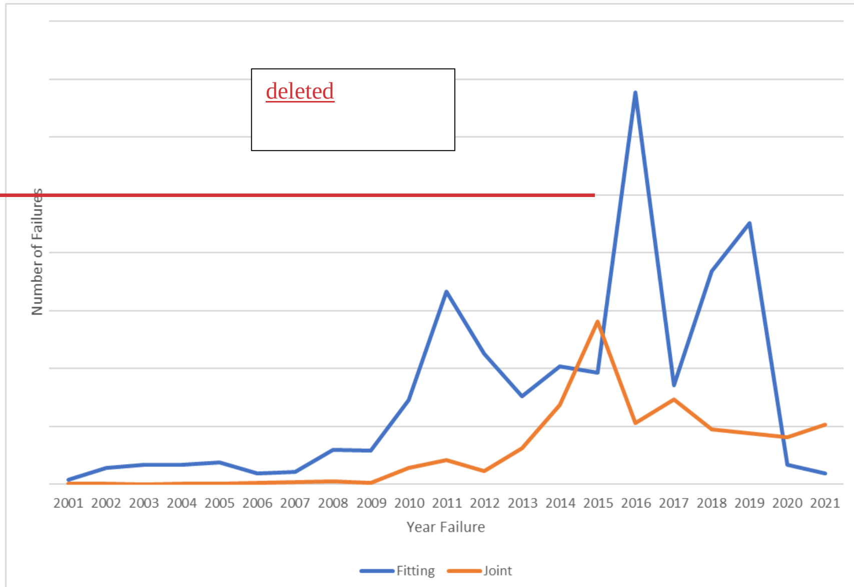


Figure 1. Kerotest Fitting and Joint Failures by Year Installed

Figure 2 shows the Kerotest fitting and joint failures by year of failure and shows elevated reports in 2016 and 2018.



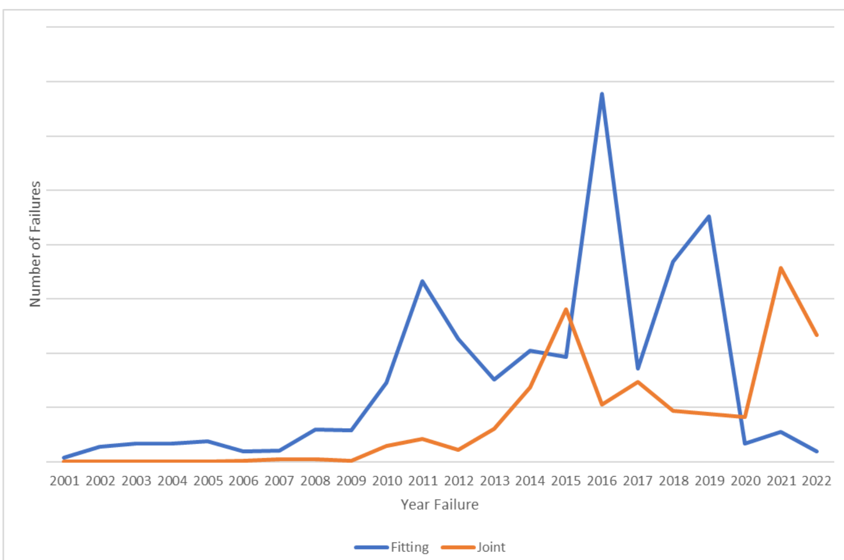


Figure 2. Kerotest Fitting and Joint Failures by Year of Failure

Table 3 displays the percentages of failure causes for Kerotest.

CAUSE	% of All Kerotest Failures	% of All Kerotest Fitting Failures	% of All Kerotest Joint Failures
All Cap	0.1%	0.1%	0.0%
Corrosion	0.3%	0.5~~0.4~~%	0.0%
Excessive Expansion/Contraction	9.7~~7.1~~%	8.5%	12.0~~3.1~~%
Excessive External Earth Loading	1.2~~1.4~~%	1.0%	1.6~~2.4~~%
Installation Error	13.8~~9.7~~%	10.7~~10.8~~%	19.7~~6.6~~%
Material Defect	29.1~~30.5~~%	27.5~~27.1~~%	32.0~~39.6~~%
Other	9.3~~10.3~~%	6.3~~6.2~~%	14.9~~21.4~~%
Point Loading	0.0%	0.1%	0.0%
Previous Impact	0.0%	0.1%	0.0%
Squeeze Off	0.1~~0.2~~%	0.2%	0.0%
Threaded Cap (Seal/O-ring defect)	0.1%	0.0%	0.3~~0.4~~%
Unknown	36.0~~40.1~~%	44.8~~45.2~~%	19.3~~26.2~~%
Unknown – Not Excavated, Replaced	0.2%	0.2%	0.1~~0.2~~%
Total	100.0%	100.0%	100.0%

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Table 3. Failures by Cause for Kerotest

Note: Percentages less than 0.1% are not listed in the chart

Limitations

Although the data continues to be actively reviewed by the PPDC the data cannot be directly correlated to quantities of this material that may be in service across the U.S.

Based on the charter that governs the PPDC, reports are not associated with operator; therefore, analysis cannot be performed by operator or by location.

The PPDC database is a volunteer database and has inherent properties pertaining to the accuracy that come with volunteer surveillance data. The data, such as manufacturer, other, year installed, year manufactured and failure cause, has not been independently tested, evaluated, verified for accuracy or audited.

Discussion

The information shown represents the detailed review of the available Kerotest failure data by the PPDC and is intended to help operators in the analysis of their own systems and where applicable, for consideration in DIMP methodologies.

Operators should look at the performance of their own piping systems. Each operator serves a unique and defined geographic area and their system infrastructures vary widely based on a multitude of factors, including facility condition, past engineering practices and materials. Each operator should evaluate the actions in light of system variables, the operator's independent integrity assessment, risk analysis, and mitigation strategy. The responsibility lies with each operator to determine how best to utilize the information contained in this Appendix.

Appendix J: Driscopipe® High Density Polyethylene (HDPE) Pipe Data Analysis –October 2022

Background

Driscopipe® 7000 HDPE pipe was sold from approximately 1973 through 1980 and Driscopipe 8000 HDPE pipe was sold from late 1979 through 2000 by Phillips Products Company, a subsidiary of Phillips Chemical Company which was later called Phillips Driscopipe, Inc. The pipes were produced from Marlex® M-7000 and M-8000 compounded black resins produced by Phillips Chemical Company.

The manufacturer worked with operators and identified two product concerns with Driscopipe HDPE pipe. One concern related to both Phillips Driscopipe 7000 and 8000 pipe is degradation in high temperature applications. Information about this is available on the manufacturer's website at https://www.cpchem.com/sites/default/files/2020-05/DriscopipeDegradation.pdf. In March 2012, this concern was highlighted through PHMSA Advisory Bulletin ADB-2012-03 https://www.phmsa.dot.gov/regulations-fr/notices/2012-5424.

The second concern is related to plastic contamination known to have occurred in Phillips Driscopipe 8000 pipes. Information about this is available on the manufacturer's website at https://www.cpchem.com/sites/default/files/2020-05/DriscopipeContamination.pdf

The objective of this appendix is to provide information from the Plastic Pipe Database Committee (PPDC) about Driscopipe HDPE pipe manufactured by Phillips Driscopipe.

Methods

The information below reflects data collected by the PPDC. The PPDC collects information voluntarily submitted by gas distribution pipeline operators on failures of metal or plastic appurtenances contained within plastic piping systems excluding third party damages. The PPDC Report Form provides for collection of information by material. More information about the PPDC can be found at https://www.aga.org/?s=PPDC.

The PPDC Report Form provides for collection of information by manufacturer. Driscopipe is a registered trademark for pipe produced by Phillips Driscopipe. This analysis was limited to Phillips Driscopipe HDPE data which includes Phillips Driscopipe 7000 and 8000 pipes.

Results

Phillips Driscopipe HDPE represents approximately 2% of all the reports in the database. The majority of the Phillips Driscopipe data reported are pipe failures (76%).

Figure 1 shows Phillips Driscopipe HDPE failures by year installed.

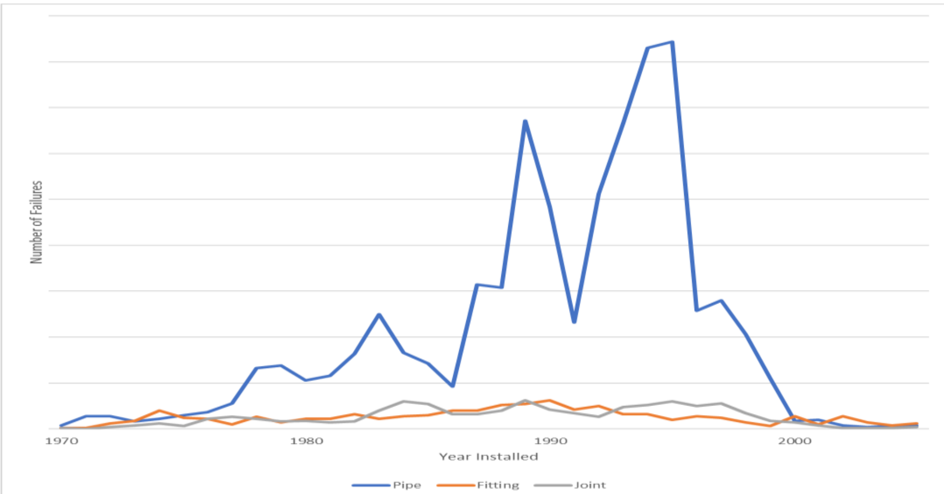

Figure 1. Phillips Driscopipe HDPE Failures by Year Installed

Figure 2 shows Philips Driscopipe HDPE failures by year of failure. Following the various notifications in 2012, there was an immediate increase in reports to the PPDC.

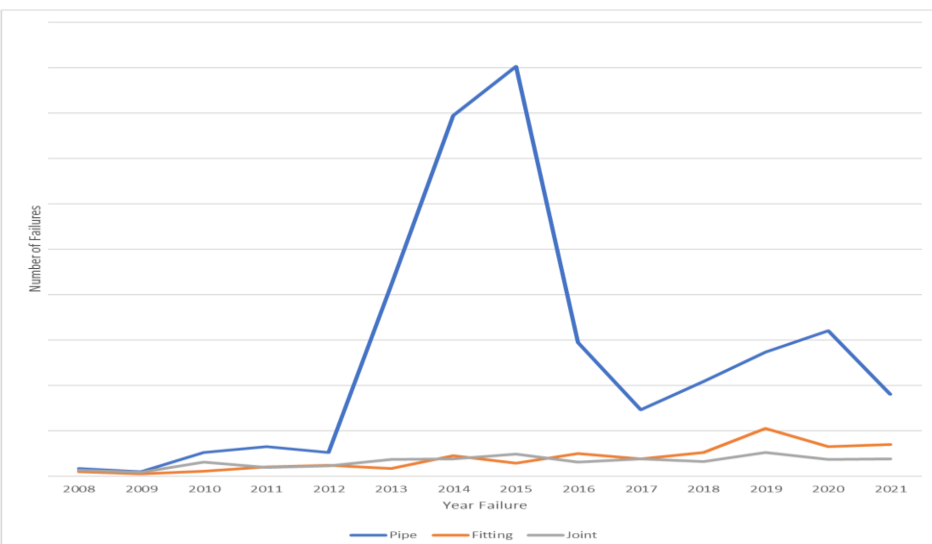

Figure 2. Phillips Driscopipe HDPE Failures by Year of Failure

Table 1 shows Phillips Driscopipe HDPE failures by material type.

Material	% of All Driscopipe HDPE Pipe Failures	% of All Driscopipe HDPE Fitting Failures	% of All Driscopipe HDPE Joint Failures	% of All Driscopipe HDPE Failures
HDPE 3306	2.8%	3.1%	2.4%	2.8%
HDPE 3406	6.4%	26.7%	19.0%	10.3%
HDPE 3408	90.8%	70.2%	78.6%	86.9%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 1. Failures by Material Type for Phillips Driscopipe
Note: Percentages less than 0.1% are not listed in the chart

The material designation of Driscopipe 7000 was PE3306 and PE3406 (due to a change in ASTM standards). The material designation of Driscopipe 8000 was PE3408.

Table 2 shows Phillips Driscopipe HDPE failures by cause. It should be noted that the cause shown as "Not Recorded" or left blank has been moved to the "Unknown" data.

Cause	% of All Driscopipe HDPE Pipe Failures	% of All Driscopipe HDPE Fitting Failures	% of All Driscopipe HDPE Joint Failures	% of All Driscopipe HDPE Failures
Cap (Other)	0.0%	10.8%	0.4%	1.4%
Corrosion	0.0%	0.3%	0.0%	0.0%
Excessive Expansion/Contraction	0.3%	1.6%	3.1%	0.8%
Excessive External Earth Loading	2.3%	2.3%	3.1%	2.3%
Gopher/rodent/worm damage	1.4%	0.0%	0.0%	1.1%
Installation Error	1.0%	12.1%	48.5%	7.6%
Material Defect	82.2%	11.4%	6.8%	65.1%
Other	2.8%	13.0%	5.8%	4.4%
Point Loading	5.0%	1.8%	2.6%	4.3%
Previous Impact	0.1%	0.6%	0.2%	0.9%
Squeeze Off	0.6%	0.2%	0.0%	0.5%
Threaded Cap (Cracked Cap)	0.0%	0.2%	0.0%	0.0%
Threaded Cap (Loose cap, not cracked)	0.0%	14.0%	0.0%	1.7%
Threaded Cap (Other, describe)	0.0%	10.3%	0.0%	1.3%
Threaded Cap (Seal/O-ring defect)	0.0%	6.1%	0.0%	0.8%
Unknown	3.2%	15.3%	29.6%	7.6%
Unknown - Abandoned	0.2%	0.0%	0.0%	0.2%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 2. Failures by Cause for Phillips Driscopipe
Note: Percentages less than 0.1% are not listed in the chart

Material defect is the predominant cause for all Phillips Driscopipe HDPE pipe failures (82.2%). Approximately 42% of the Phillips Driscopipe HDPE Pipe Failures was on 2 IPS pipe and 23% was on ½ IPS and CTS.

Limitations
Although the data continues to be actively reviewed by the PPDC the data cannot be directly correlated to quantities of this material that may be in service across the U.S.

Based on the charter that governs the PPDC, reports are not associated with operator; therefore, analysis cannot be performed by operator or by location.

The PPDC database is a volunteer database and has inherent properties pertaining to the accuracy that comes with volunteer surveillance data. The data, such as manufacturer, other, year installed, year manufactured and failure cause, has not been independently tested, evaluated, verified for accuracy or audited.

Discussion
The information shown represents the detailed review of the available Phillips Driscopipe HDPE failure data by the PPDC and is intended to help operators in the analysis of their own systems and where applicable, for consideration in DIMP methodologies.

Operators should look at the performance of their own piping systems. Each operator serves a unique and defined geographic area and their system infrastructures vary widely based on a multitude of factors, including facility condition, past engineering practices and materials. Each operator should evaluate the actions in light of system variables, the operator's independent integrity assessment, risk analysis and mitigation strategy. The responsibility lies with each operator to determine how best to utilize the information contained in this Appendix.

Appendix K: Questions from Stakeholder Groups about the PPDC and PPDC Data

(Responses to these questions are based on the data available at the time the question was answered by the PPDC. Recognize numerical values such as percentages may change over time and will generally not be updated in this appendix.)

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The following question and response were reviewed by the PPDC at their October 2022 meeting.
Question from Okaloosa Gas: Have companies experienced internal degradation of the Drisco 8000 series pipe? Okaloosa Gas has experienced the occurrence of degradation of the Drisco 8000 series pipe. They have experienced both internal and now external degradation of the 1-1/4" Drisco 8000 pipe. The incidents are tied to late 80's vintage pipe (87-89).

As you can see from Figures 1 & 2, the internal degradation gives a scaled appearance that results in microfracture leaks. When the pipe is squeezed off, it has a crackling sound which results in more fractures of the pipe. The degradation was on a dead-end line at a low spot in the pipe. Okaloosa Gas has no known history of water intrusion or oils in the area. Figure 3 is an example of the smooth interior of the pipe in the same area. The small specks in the interior are dirt particles. The pipe is shiny and smooth internally.

Figure 1

Figure 2

Figure 3

Figures 4 & 5 show external degradation is a peeling effect of the pipe.

Figure 4

Figure 5

Response from PPDC: A review of current PPDC data does not correspond with internal degradation processes. The PPDC will continue monitoring data for potential Drisco 8000 internal pipe wall issues with cracking and brittleness and external degradation of peeling of the pipe.

The following questions and responses were reviewed by the PPDC at their June 2021 meeting.
Question from PHMSA: What does the PPDC database show for butt fusion joint failures overall, and in particular 8 inch to 12 inch**?**

Response from PPDC: Butt fusion joint failures represent 1.7% of total database. Of those butt fusion joint failures 0.6% of these failures are 8 inch and larger. Of the 8 inch and larger 77% are due to installation error.

At the August 2019 meeting, the following analysis was performed based on an NTSB release. On February 25, 2019, the NTSB issued a Pipeline Accident Brief on the incident that occurred on July 2, 2017 in Millersville, PA. The NTSB identified the probable cause of the failure was "…an improperly installed mechanical tapping tee that leaked and allowed gas to migrate into the home where it ignited." The NTSB issued two recommendations to Honeywell International, Incorporated:

- Update your PermaLock mechanical tapping tee assembly installation instructions to specify the exact tools that should be used during installation and explain what an installer should sense while using those tools throughout the installation process. (Safety Recommendation P-18-003)
- Specify in your PermaLock mechanical tapping tee assembly installation instructions a not-to-exceed torque limit for Nylon bolts and have that value checked and adjusted with a torque wrench immediately after installation (Safety Recommendation P-18-004)

From the NTSB Safety Recommendation Report, "Perfection Corporation, later known as Elster Perfection Corporation, which is currently a division of Honeywell[22], manufactured the PermaLock mechanical tapping tee assembly involved in the accident. Since 1987, three versions of the PermaLock tee assembly have been manufactured, and millions of the tee assemblies have been sold worldwide[23]. Each of the three versions has a different cutter tool design and method of attaching the tower to the main. The tee assembly in this accident was manufactured in 1998; it was the third version."

The PPDC Report Form provides for collection of information by manufacturer. Therefore, the committee could not perform a review on the model Permalock since data is only collected by manufacturer. Based on the information within the NTSB Safety Recommendation Report, the PPDC reviewed the Plastic Piping Failure database for failure/leak reports related to Honeywell, mechanical fittings/joints, and installation errors.

The following are the committee's observations:

- Honeywell, represents approximately 4% of the entire data set of reported failures/leaks
- The Plastic Piping Failure Report form does not specify broken bolts as a cause
- Mechanical fitting/joint failures/leaks are approximately 17% of the entire data set of reported failures
- Of the failures/leaks reported as mechanical fitting/joint failures, Honeywell was the manufacturer 14% of the time
- Of the Honeywell mechanical fitting/joint failures/leaks, approximately 58% were reported as installation error
- Of the mechanical fitting/joint failures/leaks for the aggregate of manufacturers other than Honeywell, approximately 25% were reported as installation error

The following questions and responses were reviewed by the PPDC at their April 2017 meeting.
Question from APGA member: Given the safety advisory notice from the Tennessee Regulatory Authority from March 30, 2017 regarding electrofusion burn-throughs, does the PPDC have any data indicating this is a wider trend?

Response from PPDC: Electrofusion failures represent 0.01% of the total database (as of April 2017). The PPDC report form does not specifically identify burn-through as a cause of failure. A review of the individual failure report comments did not identify any specific references to burn-through.

The following questions and responses were reviewed by the PPDC at their August 2016 meeting. **Question from AGA member:** Is the industry seeing any trends regarding Permasert® coupling failures and, if so, is there concrete evidence? What is the general consensus on this product? Is it a product that has a finite life and at a certain time, it begins to fail? Is there a reason (with concrete evidence) to stop using these?

Response from PPDC: The PPDC collects data by manufacturer (Perfection) not by brand (Permasert). The fitting types are collected as mechanical fittings and are not broken down further. Additional data on stab type mechanical fittings is available in the PHMSA Mechanical Fitting Failure Report database. https://www.phmsa.dot.gov/data-and-statistics/pipeline/mechanical-fitting-failure-data-gas-distribution-operators. In looking at comments submitted to the database, there were few references to Permasert within the Perfection data.

The following questions and responses were reviewed by the PPDC at their March 2016 meeting.
Question from PPI: What does the PPDC database show for failures on socket heat fusion joints? Are there specific trends?

Response from the PPDC: Socket fusions are a type of joint on the failure report form. Socket fusions represent 3% of all data submitted to the PPDC, with 59% of this 3% caused by installation error. There does not appear to be any increase or decrease in the number of reports by Year of Failure. The table shows distribution of socket fusion failures by size.

Size of Socket Fusion Joint	Percentage
1/2 to 1 1/4"	72%
2"	20%
>2"	8%

The following questions and responses were reviewed by the PPDC at their December 2015 meeting.
Question from ASTM F17.20: What does the PPDC database show for failures on sidewall heat fusion joints? Are there specific trends relating to preparation of the joint?

Response from the PPDC: Saddle fusions are a type of joint on the failure report form. Saddle fusions represent 1.4% of all data submitted to the PPDC. 63.5% of these failures were caused by installation error. The majority were installed prior to 1985. Limited information, with regard to specific aspects of the installation error, was reported. Approximately 90% of the saddle fusion failures were on piping 3" and under.

The following questions and responses were reviewed by the PPDC at their March 2015 meeting.

Question from NAPSR: What does the PPDC database show for Handley curb valves? Is there any trend in data since 2007? Are they still being manufactured?

Response from the PPDC: Handley represents less than 0.1% of the data submitted to the PPDC. The data does indicate an increasing trend of failures since 2007. Due to the small amount of data submitted, we suggest NAPSR encourage operators who have Handley curb valves in their plastic piping systems to submit data. Handley is not currently listed in the manufacturer database available on the PPDC website. However, Handley has a currently active website; and produces natural gas carrying components.

Updated Response from PPDC at May 2018 Meeting:
Handley now represents 0.2% of the data submitted to the PPDC. The majority of the failures occurred after 2010. 38% of the Handley failures reported to the PPDC were on valves installed in 1988 and 1989. Handley stopped making gas valves in June 2015 and the company's website is accessible but not active for valve information. Handley has been added to the manufacturer database.

Question from AGA: Should Aldyl A and Century failure data still be submitted?
Response from the PPDC: Yes, additional data points support additional analysis.

The following question and response was reviewed by the PPDC at their March 2014 meeting.
Question from APGA: Regarding Rockwell valves**,** is there a common cause for reports submitted to the PPDC? What about the involved component; pipe, fitting or joint? Are there any trends for installation dates? And are there any rising trends for any of the reported data?

Response from the PPDC: Rockwell represents less than ¼ of 1% of the data submitted to the PPDC. Most of the Rockwell reports were for valves. Installations between 1981 and 1990 show the highest reported failures. While the trend of failures reported was going upward through 2010, since then, failures reported appear to be declining. Unfortunately, the majority of the reported causes were listed as unknown or left blank. However, causes reported include material defects, excessive earth loading and installation error.

The following question and response was reviewed by the PPDC at their December 2013 meeting.
Question from PHMSA: Is there a way to normalize the data? Can the number of data points be released? Is there a way to show data by state or geographical region?

Response from the PPDC: Although the data continues to be actively reviewed by the PPDC the data cannot be directly correlated to quantities of this material that may be in service across the U.S. Based on the charter that governs the PPDC, the exact number of reports in the database cannot be released; only percentages of amounts can be released. Reports in the database are not associated with any operator information; therefore, analysis cannot be performed by operator or by geographic location.

The following question and response was reviewed by the PPDC at their July 2013 meeting.
Question from PHMSA: What does the PPDC data reflect regarding failures due to squeeze-off? For all plastic pipe? For plastic that has been known to be susceptible to brittle-like cracking? For pipe installed through the early 1980s? Are there any trends of squeeze-off failures over time for the any/all of the categories above?

Response from the PPDC: Squeeze off represents approximately 2 % of all the data submitted. When considering pipe only, squeeze off represents approximately 6%. Failures due to squeeze off for certain pipe materials known to be susceptible to brittle-like cracking (Century, Aldyl A and PE3306) are included in other appendices in this status report. For pipe installed prior to and including 1983, squeeze offs represent approximately 9% of all data reported. Failures due to squeeze offs are trending down in all categories requested.

The following questions and responses were reviewed by the PPDC at their March 2013 meeting.
Question from Puget Sound Energy: We have a copy of the PPDC Status Report Appendix D which analyzes all Aldyl product but are interested in obtaining data for Aldyl High Density (HD). Does the PPDC have a report available that trends just Aldyl HD failures? If not, can we request the PPDC to generate a report for Aldyl HD?

Response from the PPDC: No, the PPDC has not produced a separate report on DuPont & Uponor HD. The reports submitted to the PPDC containing DuPont & Uponor HD represent only 1.5% of all the data in the database. The distribution of failures for years in service for DuPont & Uponor HD is similar to the information contained in Figure 1 of the DuPont & Uponor appendix.

The following questions and responses were reviewed by the PPDC at their December 2012 meeting.
Question from PHMSA: Interactive threat events are often a combination of individual low frequency events that can culminate into a high consequence event. Does the PPDC collect data and perform analysis based on interactive threats, consequences and regional trends?
Response from the PPDC: The reports submitted to the PPDC attribute cause to individual factors. The PPDC does not collect data on consequences or regional information. The PPDC committee looks at broad national trends. Other sections of this PPDC Status Report address possible contributing factors, reported causes, and collective perspective of the PPDC committee members.

The following questions and responses were reviewed by the PPDC at their August 2012 meeting.
Question from PMC to PPDC Feedback Task Group: What does the PPDC data reflect regarding the 5 known concerns? How large a percentage of the data do they represent?
Response from PPDC: Century Utility Products polyethylene (PE) pipe produced from 1970 through 1974 represents less than 1% of the data.
DuPont Aldyl® A low ductile inner wall PE pipe manufactured from 1970 through 1972 represents 1.5% of the data; the PPDC database contains a small amount of data on year manufactured. However, DuPont and Uponor installed between 1970 and 1973, represent 4% of the data.
PE pipe manufactured from PE 3306 resin such as Swanson, Orangeburg and Yardley represent 1% of the data.
DuPont Aldyl® service punch tee with a white Delrin® polyacetal threaded insert; This is not listed as a distinct type of fitting on the PPDC report form. However, Delrin has been reported as a type of material.
Plexco service tee with Celcon® polyacetal cap; This is not listed as a distinct type of fitting on the PPDC report form. However, Celcon has been reported as a type of material.

Question from the PMC PPDC Feedback Task Group: Is there a way to generally say how much PE is Aldyl A?
Response from the PPDC: Aldyl represents approximately 62 % of the PE reports in the database. The definition of "Aldyl" used for PPDC data analysis is the data reported as being manufactured by DuPont and Uponor. For additional information about Aldyl, see Appendix E.

The following questions and responses were reviewed by the PPDC at their April 2012 meeting.
Question from PHMSA: What does the PPDC data reflect with respect to lightning strikes?
Response from PPDC: Lightning strikes listed as the cause of the failures account for ½ of 1% of the data and no trend is indicated.

Question from PHMSA: Do static discharge failures appear in the database?
Response from PPDC: Yes, static discharge failures account for less than ½ of 1% of the data and no trend is indicated.

Question from PHMSA: Combination of lightning strikes and static discharge?
Response from PPDC: Lightning strikes and static discharge failures account for less than ½ of 1% of the data and no trend is indicated.

Question from PHMSA: Are there failures of Performance Pipe bolt on service tees with nylon bolts, metal bolts or other failure causes?
Response from PPDC: It is the PPDC's understanding that Performance Pipe did not produce bolt on service tees. Please note the PPDC report form (click here to access a copy of the report form) and clarify the question. Note that bolt-on tees are not listed as a distinct type of fitting on the PPDC report form.

Question from PHMSA: Is there an increase in failure numbers compared to earlier data on medium density 2306 materials?
Response from PPDC: The number of failures seems to be decreasing; however, failure reports are still being submitted for this type of plastic.

Question from PHMSA: Is there an increase in failure numbers compared to earlier data on pipe and fittings manufactured by DuPont?
Response from PPDC: The number of failures seems to be decreasing; however, failure reports are still being submitted indicating this manufacturer.

Question from PHMSA: Is there an increase in failure numbers compared to earlier data on Driscopipe® 8000 pipe?
Response from PPDC: This is a high density pipe. High Density pipe failures are less than ½ of 1% of the data and no trend in indicated.

Question from PHMSA: Do socket fusion failures appear in the database?
Response from PPDC: Yes, socket fusions are a type of joint. 3% of all failures are socket fusions and of those 60% are known to be ½" to 1" CTS size.