
# PLASTIC PIPING DATA COLLECTION INITIATIVE STATUS REPORT

**March 24, 2016**

**Administered by**

**American Gas Association**
**400 North Capitol Street, N.W., 4th Floor**
**Washington, DC 20001**
**U.S.A.**

# NOTICE AND COPYRIGHT

*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), coordinates the creation and maintenance of a database ("PPDC Database") to proactively monitor the performance of plastic pipe and metal and/or plastic appurtenances contained within plastic piping systems. While AGA provides administrative services to the PPDC, it does not independently test, evaluate, or verify the accuracy or soundness of any statements contained in the PPDC database or made by the PPDC.*

*This document is based on information from the database that has not been verified or audited. The PPDC and the AGA disclaim liability for any personal injury, property or other damages of any nature whatsoever, whether special, indirect, consequential or compensatory, directly or indirectly resulting from the publication, use of, or reliance on this document. The PPDC and the AGA also make no representation, warranty or guarantee in connection with this document, including, the accuracy or completeness of the information therein. Nothing contained in this document should be viewed as an endorsement or disapproval of any particular manufacturer or product.*

*In issuing and making this document available, the PPDC and the AGA are not undertaking to render professional or other services for or on behalf of any person or entity. Nor are the PPDC and the AGA undertaking to perform any duty owed by any person or entity to someone else. Anyone using this document should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances.*

*Users of this document should consult applicable federal, state and local laws and regulations. The PPDC and the AGA do not, by the publication of this document, intend to urge action that is not in compliance with applicable laws, and this document may not be construed as doing so.*

*Information concerning safety and health risks, proper installation or use, performance or fitness or suitability for any purpose with respect to particular products or materials should be obtained from the User's employer, the manufacturer or supplier of the raw material used.*

*All questions, requests for revisions, or other communications relating to the PPDC, the PPDC database or this document should be sent to the PPDC c/o American Gas Association, 400 N. Capitol St., N.W., Suite 450, Washington, D.C. 20001.*

## Table of Contents



**Note: highlighted areas indicate updated information.**

# Plastic Piping Data Collection Initiative

# Status Report

# March 24, 2016

## 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 leaks with the objective of identifying possible performance issues. Company 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*[1]. 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

2014 Annual Report statistics from DOT indicate there were approximately 690,125 miles of plastic main and over 46.7 million plastic services installed in the distribution systems of approximately 1,483 gas companies in the U.S. at the end of 2014. These statistics indicate an increase of 15,145 miles of plastic main and 6 hundred thousand services from 2013.

| DOT Statistics for Year[2] | Total Miles of Plastic Main | Total Number of Plastic Services |
|---|---|---|
| 2014 | 690,125 | 46.7 million |
| 2013 | 674,980 | 46.1 million |
| 2012 | 661,380 | 45.1 million |
| 2011 | 649,530 | 44.3 million |
| 2010 | 637,138 | 43.4 million |

**Table 1 Miles of Plastic Main and Number of Plastic Services**

[1] *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.

[2] Data downloaded from PHMSA website March 7, 2016.

| Type of Plastic Material[3] | 2014 Miles of Main | 2014 Number of Services |
|---|---|---|
| ABS | 3,061 | 8,802 |
| Polyethylene | 674,819 | 46,577,551 |
| PVC | 11,625 | 131,525 |
| Other Plastic | 620 | 39,832 |

**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 54% of the pipe used for mains is plastic[4]. The Distribution Mileage by Material (1991-2014) – PHMSA Annual Report Data chart is available on the PPDC website, https://www.aga.org/plastic-pipe-database-collection-initiative/ppdc-resources

## PPDC Volunteer and Active Submitter Statistics

Currently there are 115 operators actively submitting data. All operators actively submitting data have agreed to be recognized and have their names published in **Appendix A**. The most up to date list of the active participants is available on the PPDC website hosted by AGA. 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. The operators who are actively submitting data account for 80% of the total mileage of installed plastic main in the U.S. and 87% of the total number of installed plastic services. The PPDC actively encourages additional voluntary participation 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 and APGA continue to encourage additional voluntary participation of their members. NAPSR, NARUC and PHMSA discuss the PPDC at regional and national meetings and encourage all operators within their states, whether or not they are members of AGA or APGA, to participate in the PPDC data collection effort. PPI represents the manufacturer base and brings information on system components used currently and in the past to aid in identification, as well as the ability to bring specific questions to manufactures to address inquiries that may arise.

## Explanation of Historical Data Collection

Historically collected data includes both actual through-wall failure and/or 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/plastic-pipe-database-collection-initiative/ppdc-forms

[3] Data downloaded from PHMSA website March 7, 2016
[4] Data downloaded from PHMSA website March 7, 2016

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[5]. Immediate third-party damages are not collected or evaluated (except where a delayed failure and/or leak occurs after the damage event) since this data is collected by the Common Ground Alliance and it does not provide an indication of the long-term performance of plastic piping materials. 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 third-party damage.

The figures in **Appendix B** reflect the data collected to date, and indicate percentage of failures and/or leaks by component type – pipe, fitting or joint. To coincide with PHMSA Annual Report data, the charts and tables show the information for in-service Polyethylene (PE), Polyvinyl Chloride (PVC), and Acrylonitrile Butadiene Styrene (ABS) reported failure causes and types of fittings and joints.

## 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[6] and have resulted in PHMSA Advisory Bulletins[7]. The bulletins can be found on the PHMSA website at http://www.phmsa.dot.gov/pipeline. Historically known information includes the following plastic piping and components that have demonstrated a significantly lower resistance to stress intensification[8] 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
- DuPont Aldyl® service tee with a white Delrin® polyacetal threaded insert
- Plexco service tee with Celcon® polyacetal threaded cap

[5] In August 2009 the PPDC clarified the scope to include failures of metal or plastic appurtenances in plastic piping systems. In July 2010 the PPDC clarified failures/leaks information to be reported.
[6] Robert J. Hall, *Brittle-Like Cracking of Plastic Pipe*, Final Report No. DTRS56-96-C-0002-006, General Physics Corp., Columbia, Maryland, August 2000.
[7] 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.
[8] Stress intensification includes conditions such as rock impingement, squeeze off, soil settlement, bending, shear, over-tightening of caps.

## Data Analysis and Information

The database was originally set up as an Excel file with columns representing each of the fields on the report form. Data was entered exactly as it was reported. The committee members agreed that to help with data analysis, typographical errors should be corrected. It was also agreed that manufacturer names and similar items should be standardized to allow for repeatable and consistent data analysis. Therefore, standardized columns were added to the Excel file. The original data continued to be entered exactly as received and standardized information was entered into the standardized columns. As the database grew, it was converted to Access format. Standardized fields replaced the standardized columns that were set up in the original Excel file. The original data submitted is preserved in fields marked 'Original' in the database and ensures accuracy should either further standardization into finer detail or adjustment of previous standardization become necessary. Standardization of the data continues as data is entered into the database and is refined by the data analysis discussions during the meetings.

In addition to information which has been released in the Advisory Bulletins, the PPDC has performed analysis on the following:

- 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**

Also see **Appendix J**, Questions from Stakeholder Groups about the PPDC and PPDC Data. Questions for the PPDC can be submitted to Kate Miller at kmiller@aga.org or 202.824.7342, to Junaid Faruq at jfaruq@aga.org or 202.824.7335, or on the PPDC website at https://www.aga.org/ppdc-forms. Questions can also be submitted to an applicable stakeholder representative as shown on the PPDC roster at https://www.aga.org/plastic-pipe-database-collection-initiative/

All charts, tables and discussion in this Status Report are based on cumulative data unless indicated otherwise.

The PPDC has seen an elevated report of number of failure/leaks since 2010. This may be due to preparation for and implementation of Distribution Integrity Management Programs (DIMP) and the Federal requirement to submit Mechanical Fitting Failure Reports.

## Resin and Plastic Materials Improvement

The data indicate 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 Pipe Timeline, **Appendix K**.

## Failures/Leaks 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. As demonstrated by the various appendices installation error is the leading cause of failures/leaks that occur within 5 years of being put into service. The need for vigilance is further supported by a June 2015 National Transportation Safety Board Pipeline Safety Alert, Safety through Reliable Fusion Joints (http://www.ntsb.gov/safety/safety-alerts/Documents/SA_047.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.

## 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 these older plastic pipe materials are known to be present in their piping system. The guidance information is contained in the 2015 edition of the Guide for Transmission, Distribution and Gathering Piping Systems under Subpart P.

## AGA Plastic Pipe Manual Reference

In addition, the AGA Plastic Pipe Manual 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 also compiled historical plastic piping manufacturer information. This ongoing effort is maintained by Plastics Pipe Institute and helps to identify the manufacturers of pipe, fittings and appurtenances for plastic gas distribution operations, including material designations, when the materials were produced, size ranges and other important information. Corrections and/or additions are encouraged and should be communicated to PPDC c/o Deb Bechtloff at PPI (dbechtloff@plasticpipe.org). It should be noted that operators are required to install piping that meets current regulations. This information should assist operators in the assessment of their plastic piping systems and is available on the portion of the AGA website hosting the PPDC. Go to https://www.aga.org/plastic-pipe-database-collection-initiative/ppdc-resources to access the PPDC information or go directly to the PPI website at http://plasticpipe.org/energy/energy-piping-systems-mfg-history.html.

## 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 CFR 49, Part 192, Subpart P, Gas Distribution Pipeline Integrity Management (DIMP). The DIMP Inspection Forms as well as other resources to support operators implement their program are on the DIMP Resources page and through PHMSA's Pipeline Safety website, http://primis.phmsa.dot.gov/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 rate process method (RPM) can be a useful tool for evaluating these compounds and their susceptibility to an early transition to brittle-like properties. 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.[9]

## 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 from the stakeholder groups. **Appendix J** 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 Kate Miller (by telephone 202.824.7342 or electronically at kmiller@aga.org) or Junaid Faruq (by telephone at 202.824.7335 or electronically at jfaruq@aga.org ).

[9] 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

March 2016

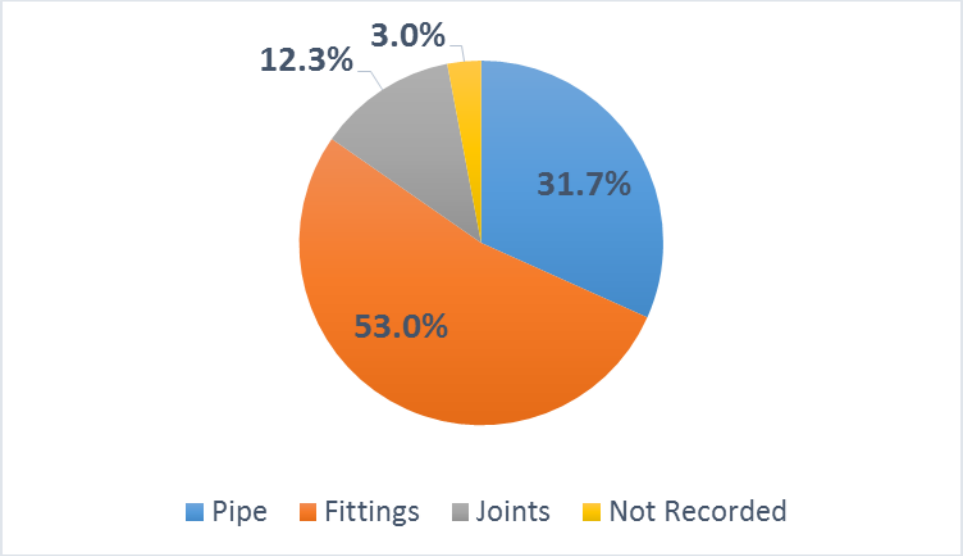
Note: Depending on how annual reports are filed with PHMSA, some companies are listed under corporate names and some are listed by individual operating company names.

Alabama Gas Corp
Alliant Energy
Ameren Illinois Co
Atlanta Gas Light
Atmos Energy
Avista Corp
Baltimore Gas & Electric Co
Batesville Gas Utility
Black Hills Energy
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 Ellenburg Gas Department
City of Fort Morgan
City of Tallahassee
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
Eastern Shore 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
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
Public Service Electric & Gas Co
Public Service Company of Colorado
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
Source Gas LLC/Arkansas Western Gas Co
South Carolina Electric & Gas Co
South Jersey Gas Co
Southeastern Natural Gas Co
Southern California Gas Co
Southwest Gas Corp
T.W. Phillips Gas & Oil Co.
Texas Gas Service Company
The Empire District Gas Company
UGI
Union Utility Dept, City Of
Unisource Energy Services
Valley Energy, Inc.
Vectren Energy Delivery Of Ohio
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 Co

# Appendix B
## Failures by Component and Causes

## B1. All Polyethylene (PE) Failures/Leaks by Component

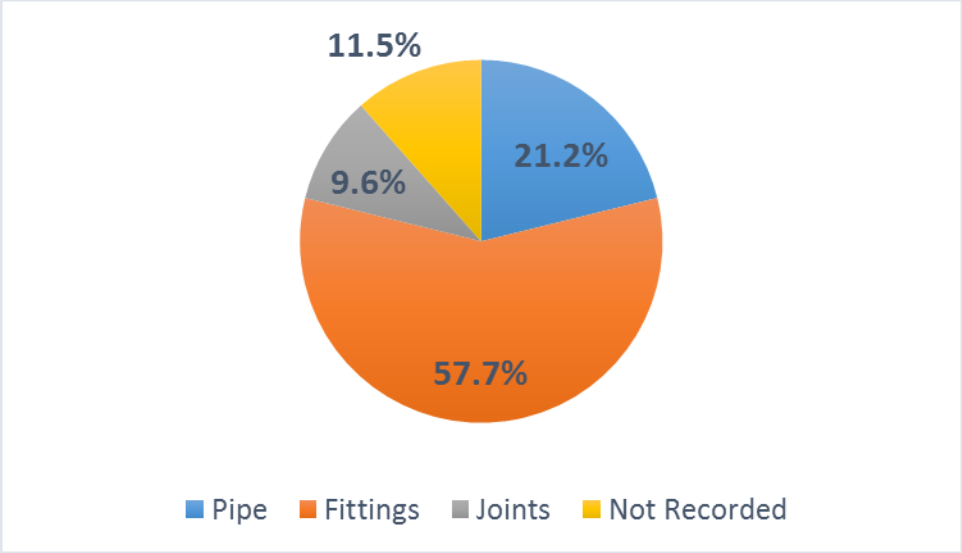



On the 2014 PHMSA Annual reports, PPDC submitters reported approximately 539,779 miles of PE main representing approximately 80% of all PE mains installed in the US and 40,511,862 PE services representing approximately 87% of all PE services installed in the US.

## All PE Failures/Leaks by Cause

| Cause | % of Total Failures/Leaks | % of Total Pipe Failures/Leaks | % of Total Fitting Failures/Leaks | % of Total Joint Failures/Leaks |
|---|---|---|---|---|
| Excessive Expansion/Contraction | 1.3% | 0.7% | 0.9% | 5.4% |
| Excessive External Earth Loading | 6.4% | 10.9% | 4.0% | 5.8% |
| Installation Error | 29.0% | 13.8% | 32.2% | 56.8% |
| Squeeze Off | 1.7% | 5.2% | 0.1% | 0.0% |
| Point Loading | 7.0% | 17.1% | 1.9% | 3.9% |
| Previous Impact | 1.5% | 4.2% | 0.3% | 0.1% |
| Unknown | 11.6% | 8.6% | 12.9% | 12.5% |
| Other | 15.8% | 17.5% | 17.1% | 1.7% |
| Cap | 5.8% | 0.0% | 11.0% | 0.0% |
| Not Recorded | 2.9% | 2.8% | 2.6% | 3.9% |
| Material Defect | 14.1% | 15.0% | 15.2% | 9.5% |
| Gopher/rodent/worm damage | 0.4% | 1.3% | 0.0% | 0.0% |
| Unknown - Not Excavated, Replaced | 1.3% | 1.6% | 0.5% | 0.5% |
| Unknown - Abandoned | 0.1% | 0.1% | 0.1% | 0.0% |
| Corrosion | 1.0% | 1.0% | 1.3% | 0.0% |
| | | | | |
| Total | 100.0% | 100.0% | 100.0% | 100.0% |

# B2. Acrylonitrile Butadiene Styrene (ABS) Failures/Leaks by Component



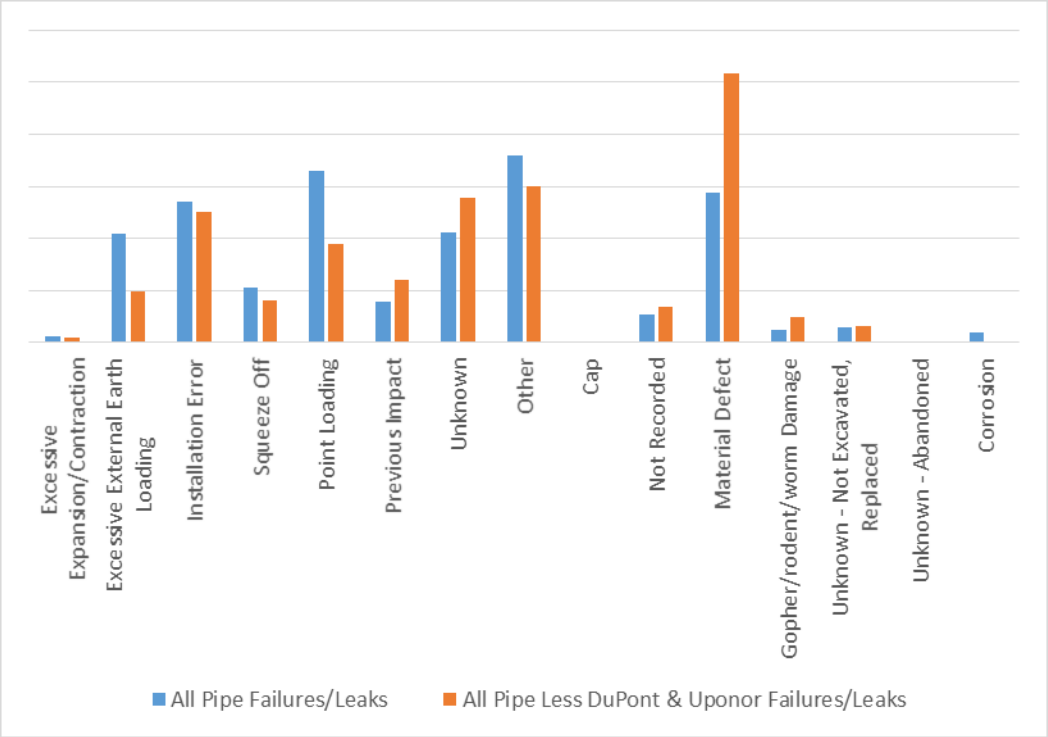

On the 2014 PHMSA Annual reports, PPDC submitters reported approximately 225 miles of ABS main representing approximately 7% of all ABS mains installed in the US and approximately 2,310 ABS services representing approximately 26% of all ABS services installed in the US.

## ABS Failures/Leaks by Cause

| Cause | % of All ABS Failures/Leaks | % of All ABS Pipe Failures/Leaks | % of All ABS Fitting Failures/Leaks | % of All ABS Joint Failures/Leaks |
|---|---|---|---|---|
| Excessive Expansion/Contraction | 1.9% | 0.0% | 3.3% | 0.0% |
| Excessive External Earth Loading | 3.8% | 18.2% | 0.0% | 0.0% |
| Installation Error | 23.1% | 9.1% | 23.3% | 80.0% |
| Squeeze Off | 1.9% | 9.1% | 0.0% | 0.0% |
| Point Loading | 0.0% | 0.0% | 0.0% | 0.0% |
| Previous Impact | 0.0% | 0.0% | 0.0% | 0.0% |
| Unknown | 42.3% | 63.6% | 40.0% | 20.0% |
| Other | 1.9% | 0.0% | 3.3% | 0.0% |
| Cap | 9.6% | 0.0% | 16.7% | 0.0% |
| Not Recorded | 5.8% | 0.0% | 3.3% | 0.0% |
| Material Defect | 5.8% | 0.0% | 10.0% | 0.0% |
| Gopher/rodent/worm damage | 0.0% | 0.0% | 0.0% | 0.0% |
| Unknown - Not Excavated, Replaced | 0.0% | 0.0% | 0.0% | 0.0% |
| Unknown - Abandoned | 3.8% | 0.0% | 0.0% | 0.0% |
| Corrosion | 0.0% | 0.0% | 0.0% | 0.0% |
| | | | | |
| Total | 100.0% | 100.0% | 100.0% | 100.0% |

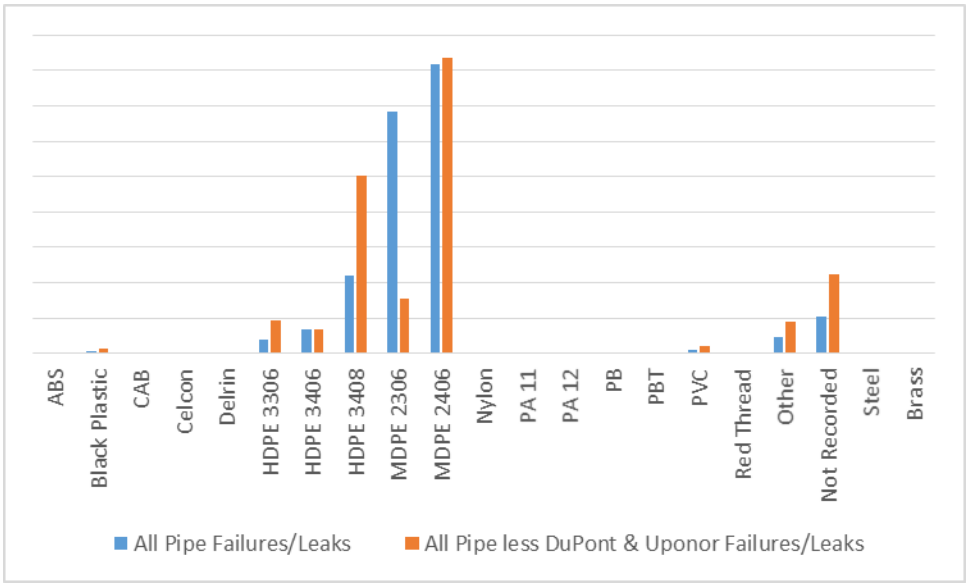
# B3. All Pipe Failures/Leaks by Cause

| Cause | % of All Pipe Failures/Leaks | % of All Pipe Less DuPont & Uponor Failures/Leaks |
|---|---|---|
| Excessive Expansion/Contraction | 0.7% | 0.5% |
| Excessive External Earth Loading | 10.5% | 4.9% |
| Installation Error | 13.6% | 12.6% |
| Squeeze Off | 5.3% | 4.1% |
| Point Loading | 16.5% | 9.5% |
| Previous Impact | 3.9% | 6.0% |
| Unknown | 10.6% | 13.9% |
| Other | 18.0% | 15.0% |
| Cap | 0.0% | 0.0% |
| Not Recorded | 2.7% | 3.5% |
| Material Defect | 14.4% | 25.9% |
| Gopher/rodent/worm Damage | 1.2% | 2.5% |
| Unknown - Not Excavated, Replaced | 1.5% | 1.6% |
| Unknown - Abandoned | 0.1% | 0.1% |
| Corrosion | 1.0% | 0.1% |
| | | |
| Total | 100.0% | 100.0% |



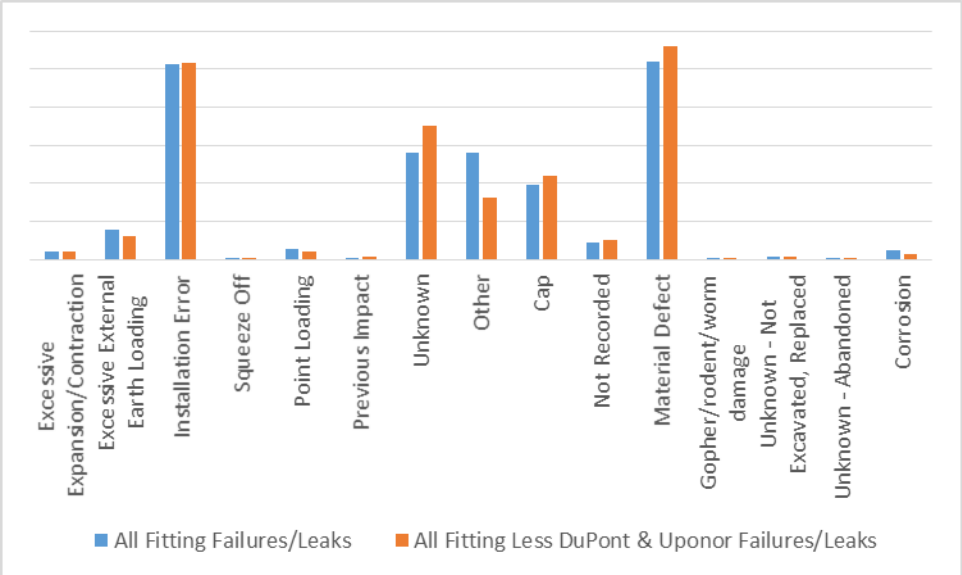
# B4. All Pipe Failures/Leaks by Material

| Material | % of All Pipe Failures/Leaks | % of All Pipe Less DuPont & Uponor Failures/Leaks |
|---|---|---|
| ABS | 0.1% | 0.2% |
| Black Plastic | 0.3% | 0.7% |
| CAB | 0.0% | 0.0% |
| Celcon | 0.0% | 0.0% |
| Delrin | 0.0% | 0.0% |
| HDPE 3306 | 2.0% | 4.6% |
| HDPE 3406 | 3.5% | 3.4% |
| HDPE 3408 | 11.0% | 25.0% |
| MDPE 2306 | 34.2% | 7.7% |
| MDPE 2406 | 41.0% | 41.7% |
| Nylon | 0.0% | 0.0% |
| PA 11 | 0.0% | 0.0% |
| PA 12 | 0.0% | 0.0% |
| PB | 0.0% | 0.0% |
| PBT | 0.0% | 0.0% |
| PVC | 0.5% | 1.0% |
| Red Thread | 0.0% | 0.0% |
| Other | 2.2% | 4.4% |
| Not Recorded | 5.2% | 11.1% |
| Steel | 0.0% | 0.0% |
| Brass | 0.0% | 0.0% |
| | | |
| Total | 100.0% | 100.0% |



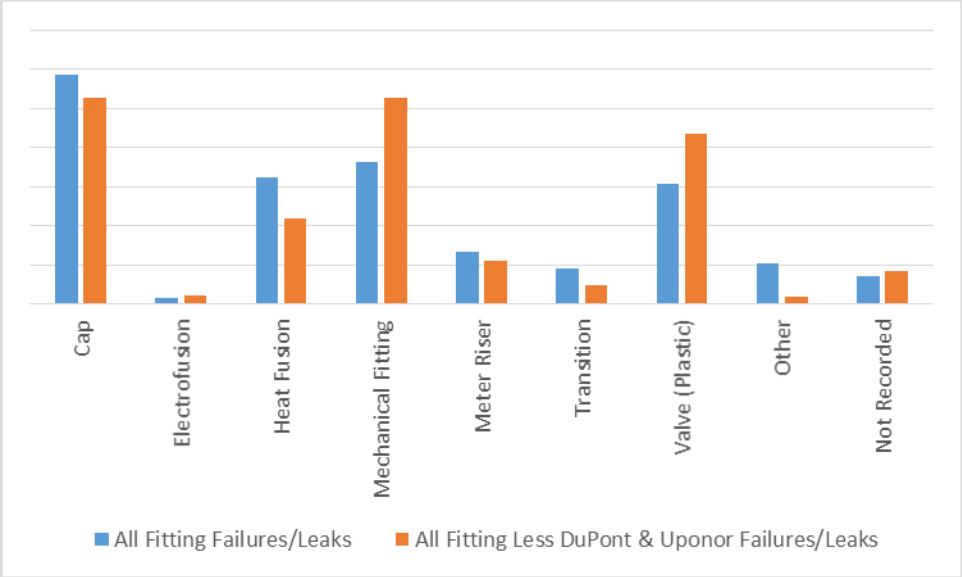
# B5. All Fitting Failures/Leaks by Cause

| Cause | % of All Fitting Failures/Leaks | % of All Fitting Less DuPont & Uponor Failures/Leaks |
|---|---|---|
| Excessive Expansion/Contraction | 1.0% | 1.1% |
| Excessive External Earth Loading | 3.9% | 3.1% |
| Installation Error | 25.6% | 25.8% |
| Squeeze Off | 0.1% | 0.1% |
| Point Loading | 1.5% | 1.1% |
| Previous Impact | 0.3% | 0.4% |
| Unknown | 14.0% | 17.5% |
| Other | 14.1% | 8.1% |
| Cap | 9.8% | 10.9% |
| Not Recorded | 2.1% | 2.6% |
| Material Defect | 25.9% | 28.0% |
| Gopher/rodent/worm damage | 0.0% | 0.0% |
| Unknown - Not Excavated, Replaced | 0.4% | 0.4% |
| Unknown - Abandoned | 0.0% | 0.1% |
| Corrosion | 1.2% | 0.7% |
| | | |
| Total | 100.0% | 100.0% |



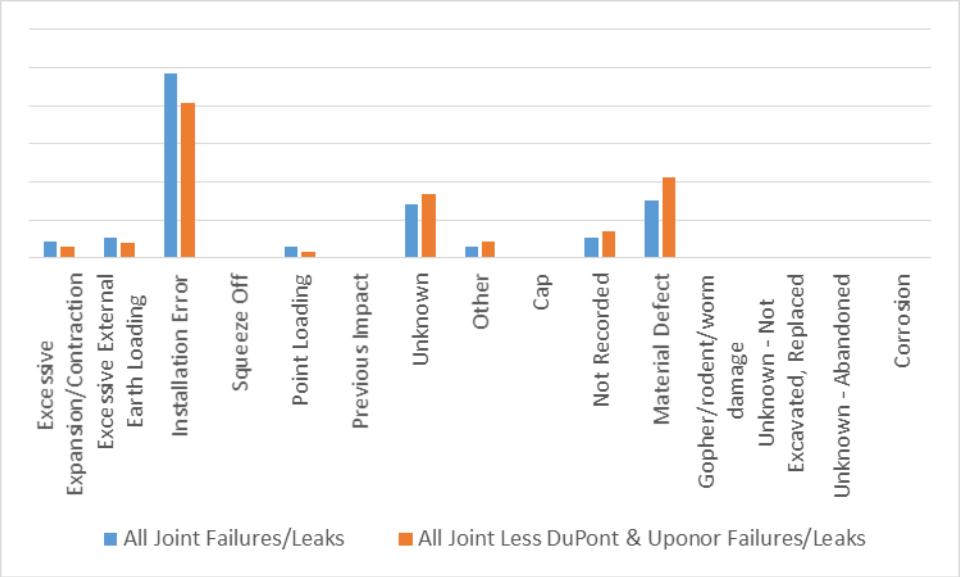
# B6. All Fitting Failures/Leaks by Type

| Fitting Type | % of All Fitting Failures/Leaks | % of All Fitting Less DuPont & Uponor Failures/Leaks |
|---|---|---|
| Cap | 29.3% | 26.4% |
| Electrofusion | 0.9% | 1.2% |
| Heat Fusion | 16.2% | 11.0% |
| Mechanical Fitting | 18.1% | 26.4% |
| Meter Riser | 6.6% | 5.6% |
| Transition | 4.6% | 2.4% |
| Valve (Plastic) | 15.4% | 21.8% |
| Other | 5.3% | 1.0% |
| Not Recorded | 3.6% | 4.3% |
| | | |
| Total | 100.0% | 100.0% |



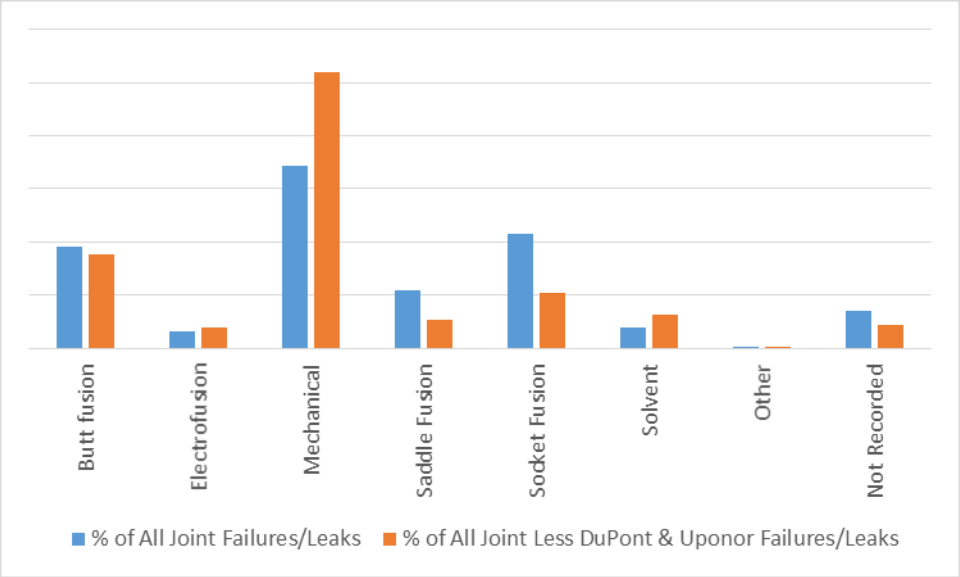
# B7. All Joint Failures/Leaks by Cause

| Cause | % of All Joint Failures/Leaks | % of All Joints Less DuPont & Uponor Failures/Leaks |
|---|---|---|
| Excessive Expansion/Contraction | 4.4% | 3.0% |
| Excessive External Earth Loading | 5.4% | 4.0% |
| Installation Error | 48.6% | 40.9% |
| Squeeze Off | 0.1% | 0.1% |
| Point Loading | 3.1% | 1.8% |
| Previous Impact | 0.2% | 0.2% |
| Unknown | 14.3% | 17.0% |
| Other | 3.2% | 4.2% |
| Cap | 0.0% | 0.0% |
| Not Recorded | 5.4% | 7.1% |
| Material Defect | 15.0% | 21.3% |
| Gopher/rodent/worm damage | 0.0% | 0.0% |
| Unknown - Not Excavated, Replaced | 0.3% | 0.3% |
| Unknown - Abandoned | 0.0% | 0.0% |
| Corrosion | 0.1% | 0.1% |
| | | |
| Total | 100.0% | 100.0% |



# B8. All Joint Failures/Leaks by Type

| Joint Type | % of All Joint Failures/Leaks | % of All Joint Less DuPont & Uponor Failures/Leaks |
|---|---|---|
| Butt fusion | 19.1% | 17.8% |
| Electrofusion | 3.1% | 3.8% |
| Mechanical | 34.2% | 52.0% |
| Saddle Fusion | 10.9% | 5.4% |
| Socket Fusion | 21.5% | 10.3% |
| Solvent | 4.0% | 6.2% |
| Other | 0.1% | 0.1% |
| Not Recorded | 7.0% | 4.4% |
| | | |
| Total | 100.0% | 100.0% |



# Appendix C
## Century Data Analysis
## July 2015

### Background

Century Utility Products (Century) was identified by the NTSB Special Report[10] and PHMSA advisory as a material susceptible to brittle-like cracking[11].

The objective of this appendix is to provide information from the Plastic Pipe Data 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 and/or leaks 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/plastic-pipe-database-collection-committee

### Results

Century represent less than 1% of all the reports in the database. The majority of the reported Century failures/leaks occur on pipe (56%). Other categories include fittings (31%), joints (12%) and not recorded (1%). The distribution of failures/leaks 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.

[10] *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.

[11] 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.

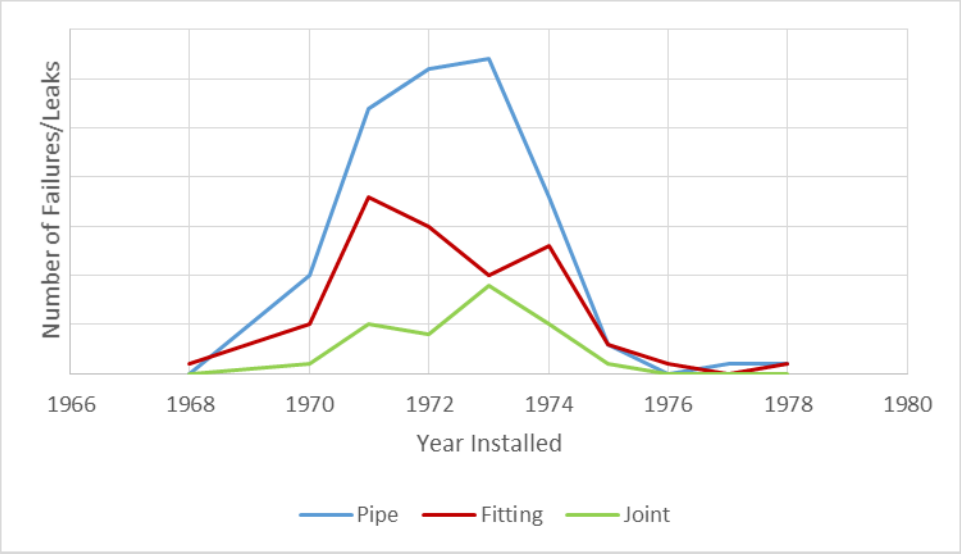



**Figure 1.** Failures/Leaks by Years Installed as reported to PPDC for Century pipe, fittings and joints

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

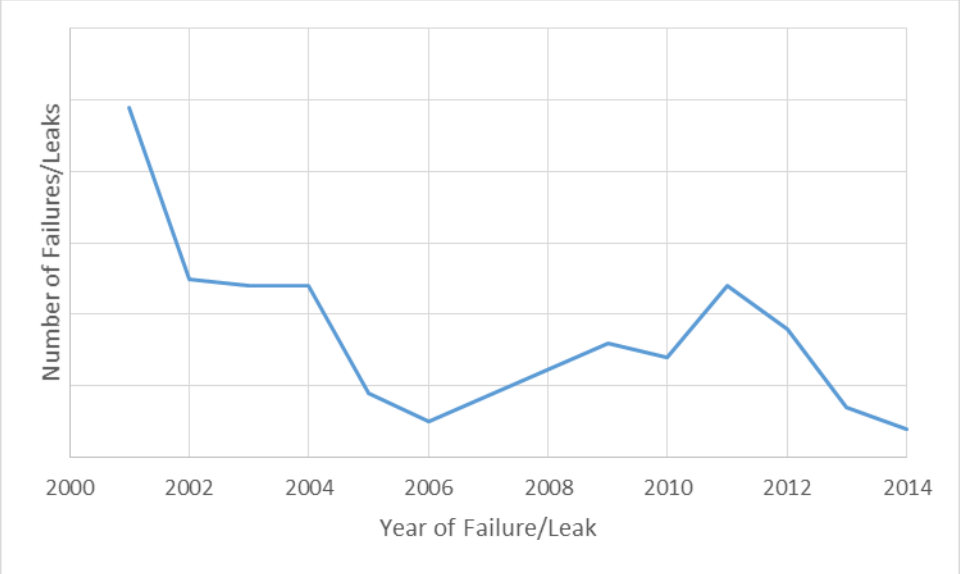



**Figure 2.** Failures/Leaks by Year of Failure as reported to PPDC for Century

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

| Cause | % of All Century Failures/Leaks | % of Century Pipe Failures/Leaks | % of Century Fitting Failures/Leaks | % of Century Joint Failures/Leaks |
|---|---|---|---|---|
| Excessive Expansion/Contraction | 0.0% | 0.0% | 0.0% | 0.0% |
| Excessive External Earth Loading | 0.5% | 0.8% | 0.0% | 0.0% |
| Installation Error | 20.3% | 11.3% | 26.5% | 44.4% |
| Squeeze Off | 0.0% | 0.0% | 0.0% | 0.0% |
| Point Loading | 1.4% | 2.4% | 0.0% | 0.0% |
| Previous Impact | 0.5% | 0.8% | 0.0% | 0.0% |
| Unknown | 5.9% | 5.6% | 7.4% | 0.0% |
| Other | 19.8% | 29.0% | 5.9% | 14.8% |
| Cap | 1.8% | 0.0% | 5.9% | 0.0% |
| Not Recorded | 0.9% | 0.0% | 2.9% | 0.0% |
| Material Defect | 49.1% | 50.0% | 51.5% | 40.7% |
| Gopher/rodent/worm damage | 0.0% | 0.0% | 0.0% | 0.0% |
| Unknown - Not Excavated, Replaced | 0.0% | 0.0% | 0.0% | 0.0% |
| Unknown - Abandoned | 0.0% | 0.0% | 0.0% | 0.0% |
| Corrosion | 0.0% | 0.0% | 0.0% | 0.0% |
| | | | | |
| Total | 100.0% | 100.0% | 100.0% | 100.0% |

**Table 1.** Failures/Leaks by Cause for Century pipe, fittings and joints

## 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/leak 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 was still in service in 2015

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
## March 2015

### Background

The objective of this appendix is to provide information from the Plastic Pipe Data 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 and/or leaks 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/plastic-pipe-database-collection-committee.

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 44% of all the reports in the database. Figure 1 shows the failures/leaks 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/leaks occur on fittings (51%). Other categories include pipe (35%), joints (10%) and not recorded (4%).

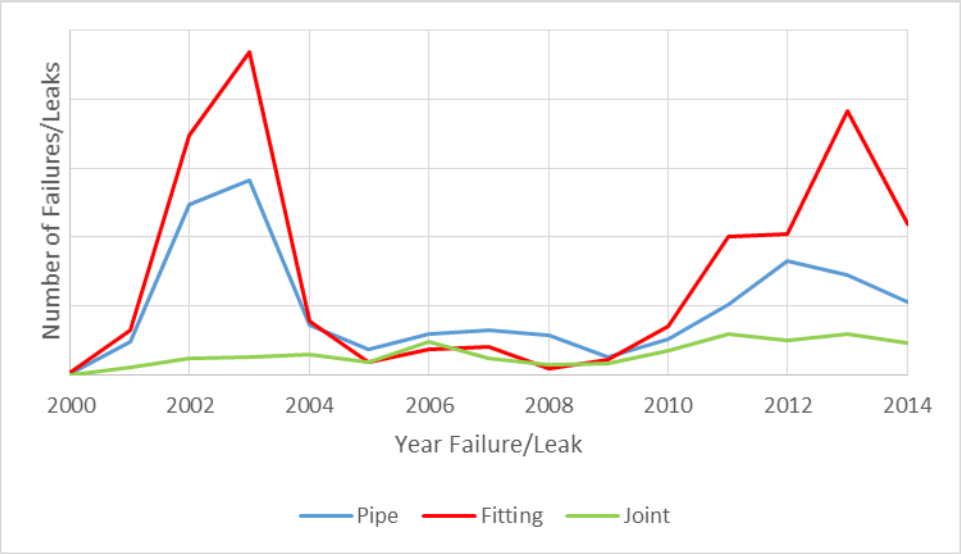



**Figure 1.** Failures/Leaks by Year of Failure as reported to PPDC for Aldyl.

Table 1 reflects an analysis of the two peaks from Figure 1, showing a change in fitting type failures from 2000-2005 compared to 2010-2014. Noting the increase in Cap-type failures, reference Appendix F for more detailed analysis on Caps.

| Fitting Type | % of DuPont & Uponor Fitting Failures/Leaks Between 2000 and 2005 | % of DuPont & Uponor Fitting Failures/Leaks Between 2010 and 2014 |
|---|---|---|
| Cap | 0.1% | 62.6% |
| Electrofusion | 0.1% | 0.6% |
| Heat Fusion | 28.5% | 19.7% |
| Mechanical Fitting | 2.6% | 4.5% |
| Meter Riser | 13.5% | 5.2% |
| Transition | 16.0% | 2.5% |
| Valve (Plastic) | 9.9% | 0.8% |
| Other | 29.1% | 0.2% |
| Not Recorded | 0.2% | 3.9% |
| | | |
| Total | 100.0% | 100.0% |

**Table 1:** Fitting Types by Year Range of Failure

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

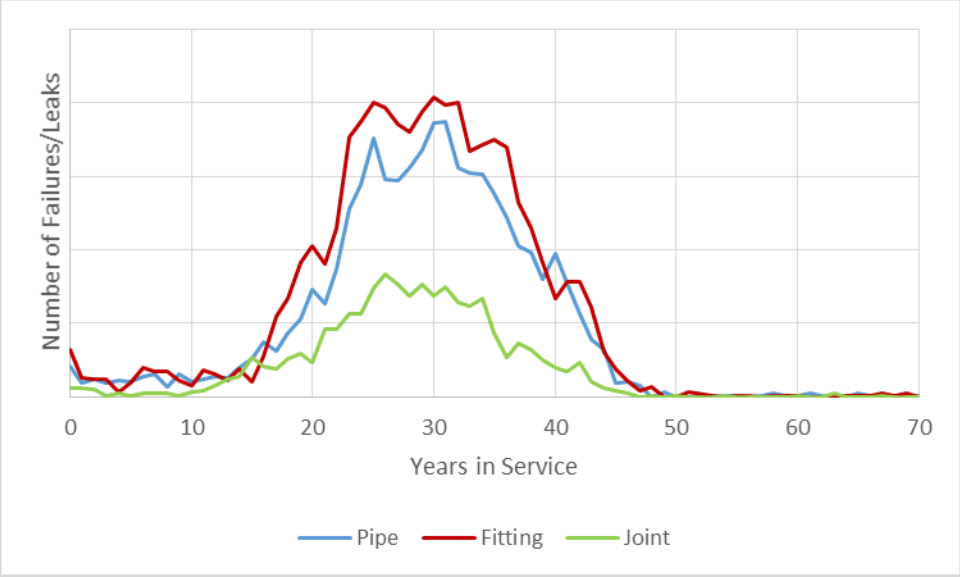



**Figure 2.** Failures/Leaks by Years in Service as reported to PPDC for Aldyl pipe, fittings and joints

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

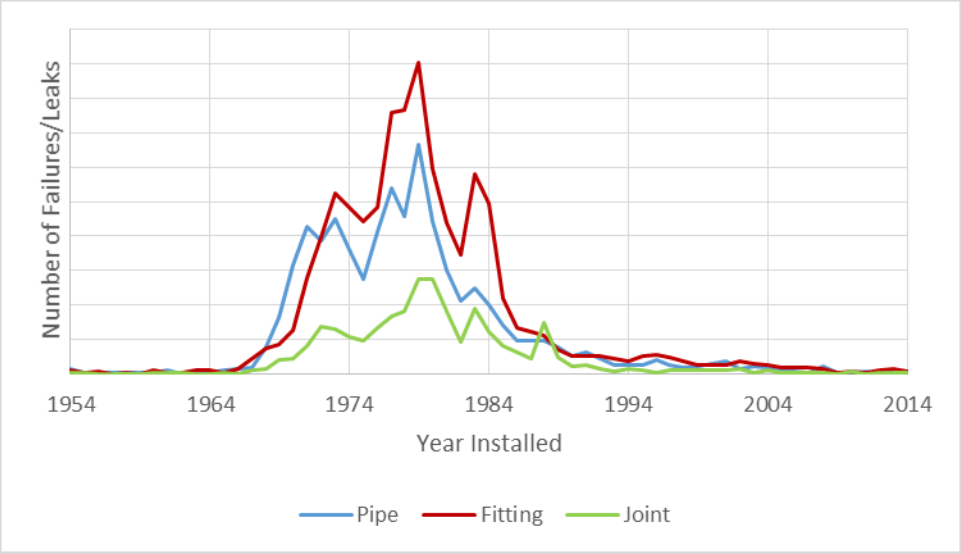



**Figure 3.** Failures/Leaks by Year Installed as reported to PPDC for Aldyl pipe, fittings and joints

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

| Cause | % of All DuPont & Uponor Failures/Leaks | % of DuPont & Uponor Pipe Failures/Leaks | % of DuPont & Uponor Fitting Failures/Leaks | % of DuPont & Uponor Joint Failures/Leaks |
|---|---|---|---|---|
| Excessive Expansion/Contraction | 1.5% | 0.8% | 0.8% | 7.0% |
| Excessive External Earth Loading | 8.8% | 14.9% | 5.3% | 7.9% |
| Installation Error | 25.5% | 14.3% | 25.4% | 62.1% |
| Squeeze Off | 2.2% | 6.2% | 0.0% | 0.0% |
| Point Loading | 9.3% | 22.0% | 2.1% | 5.5% |
| Previous Impact | 0.8% | 2.3% | 0.1% | 0.1% |
| Unknown | 8.5% | 8.0% | 8.2% | 9.5% |
| Other | 20.7% | 20.2% | 24.1% | 1.3% |
| Cap | 4.1% | 0.0% | 8.0% | 0.0% |
| Not Recorded | 1.7% | 2.1% | 1.4% | 2.4% |
| Material Defect | 14.0% | 5.5% | 22.4% | 3.9% |
| Gopher/rodent/worm damage | 0.1% | 0.3% | 0.0% | 0.0% |
| Unknown - Not Excavated, Replaced | 1.1% | 1.4% | 0.3% | 0.3% |
| Unknown - Abandoned | 0.1% | 0.2% | 0.0% | 0.0% |
| Corrosion | 1.6% | 1.7% | 1.9% | 0.0% |
| | | | | |
| Total | 100.0% | 100.0% | 100.0% | 100.0% |

**Table 2. Failures/Leaks by Cause as reported to PPDC for Aldyl pipe, fittings and joints**

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

| Joint Type | % of DuPont & Uponor Joint Failures/Leaks |
|---|---|
| Butt fusion | 21.4% |
| Electrofusion | 1.9% |
| Mechanical | 3.3% |
| Saddle Fusion | 20.5% |
| Socket Fusion | 41.1% |
| Solvent | 0.0% |
| Other | 0.0% |
| Not Recorded | 11.7% |
| | |
| Total | 100.0% |

**Table 3. Aldyl Joint Types failures/leaks as reported to PPDC**

## 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/leak 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 two peaks of failure data submissions (2000-2005, 2010-2014). 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/leaks. 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
## March 2015

### Background

Polyethylene (PE) pipe manufactured from PE3306 resin was included in PHMSA advisories[12] as one of the historically known materials susceptible to brittle-like cracking[13]. 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 Data 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 and/or leaks 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/plastic-pipe-database-collection-committee.

### Results

PE3306 failures/leaks represent less than 1% of all the reports in the database. The majority of the reported failures occur on pipe 70%), other categories include fittings (23%), joints (6%) and not recorded (1%). Figure 1 shows the distribution of failures/leaks for pipe, fittings and joints by years in service and indicates an accelerated rate of failure for PE3306 in service for over 20 years.

[12] 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.

[13] *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.

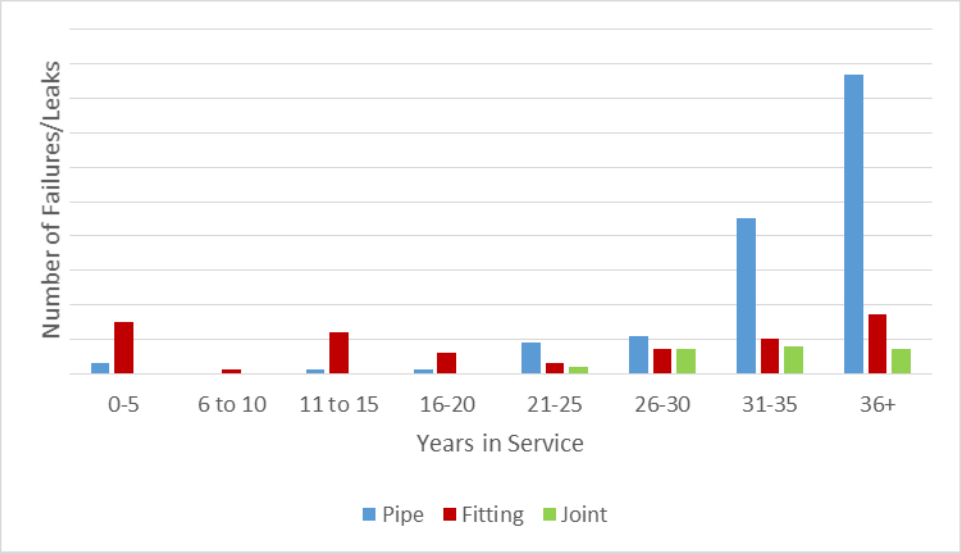



**Figure 1. PE3306 Failures by Years in Service, 5 year intervals.**

Figure 2 shows the failures/leaks by year of failure. The majority of the failures occurred prior to 2008; however, recently there have been additional reports submitted. Of these failures that have occurred since 2010, the majority (90%) of the reported PE3306 failures/leaks are associated with service size piping (1" CTS in diameter or less).

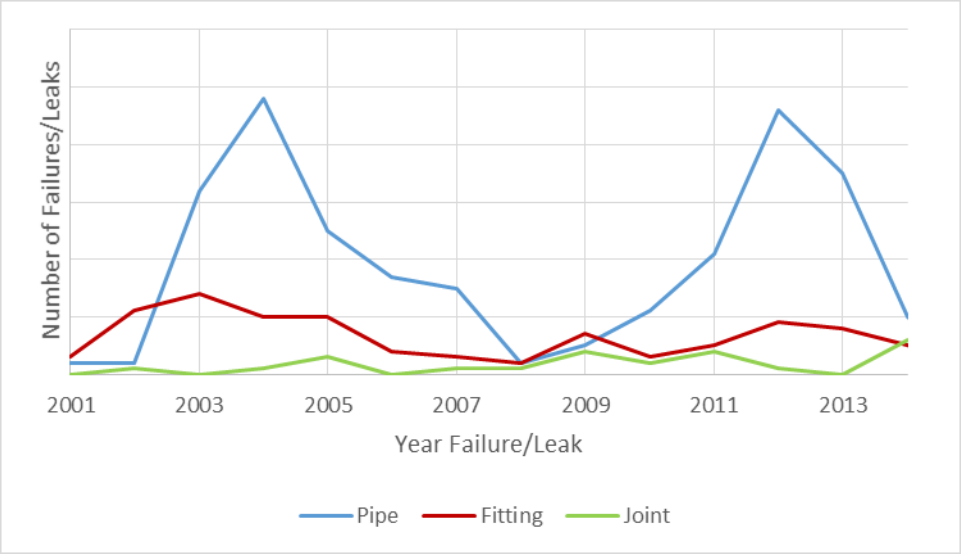



**Figure 2. Failures/Leaks by Year of Failure as reported to PPDC for PE3306**

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

| Cause | % of All PE 3306 Failures/Leaks | % of PE 3306 Pipe Failures/Leaks | % of PE 3306 Fitting Failures/Leaks | % of PE 3306 Joint Failures/Leaks |
|---|---|---|---|---|
| Excessive Expansion/Contraction | 0.8% | 0.7% | 1.1% | 0.0% |
| Excessive External Earth Loading | 8.1% | 8.8% | 4.3% | 15.4% |
| Installation Error | 7.1% | 1.5% | 13.8% | 42.3% |
| Squeeze Off | 24.7% | 35.0% | 2.1% | 0.0% |
| Point Loading | 14.9% | 20.1% | 3.2% | 3.8% |
| Previous Impact | 1.3% | 1.8% | 0.0% | 0.0% |
| Unknown | 27.5% | 23.7% | 38.3% | 23.1% |
| Other | 3.3% | 3.3% | 4.3% | 0.0% |
| Cap | 0.8% | 0.0% | 3.2% | 0.0% |
| Not Recorded | 2.3% | 1.1% | 5.3% | 0.0% |
| Material Defect | 9.1% | 3.6% | 23.4% | 15.4% |
| Gopher/rodent/worm damage | 0.0% | 0.0% | 0.0% | 0.0% |
| Unknown - Not Excavated, Replaced | 0.3% | 0.4% | 0.0% | 0.0% |
| Unknown - Abandoned | 0.0% | 0.0% | 0.0% | 0.0% |
| Corrosion | 0.3% | 0.0% | 1.1% | 0.0% |
| | | | | |
| Total | 100.0% | 100.0% | 100.0% | 100.0% |

**Table 1. Failures/Leaks by Cause for PE3306 pipe, fittings and joints (less than 1% of all reports in the database)**

## 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/leak 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 55% 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
## December 2015

### 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/leaks 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 and/or leaks 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/plastic-pipe-database-collection-committee

Cap is not specifically listed as a type of fitting on the standard report form. For purposes of this analysis, cap was defined as any fitting denoted as a cap in the "OTHER (Describe):" category field, as well as any CAUSE identified involving a cap.

### Results

Caps represent approximately 17% of all reports in the database and 34% of all fitting failures. Figure 1 shows elevated reports of cap failures/leaks in recent years.

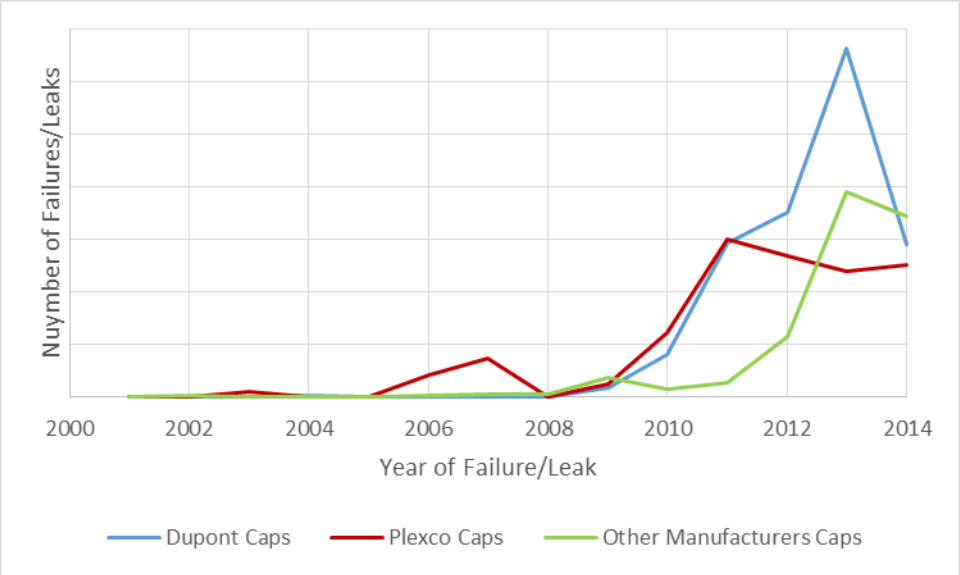



**Figure 1. Failures/Leaks by Year of Failure**

Figure 2 shows concentrations of failures/leaks in specific installation years for DuPont, Plexco and Other Manufacturers. The year of installation was reported for 62% of DuPont cap data, 38% of Plexco cap data, and 98 % of Other Manufacturers cap data. Overall, the year of installation was reported for 65% for all cap data.

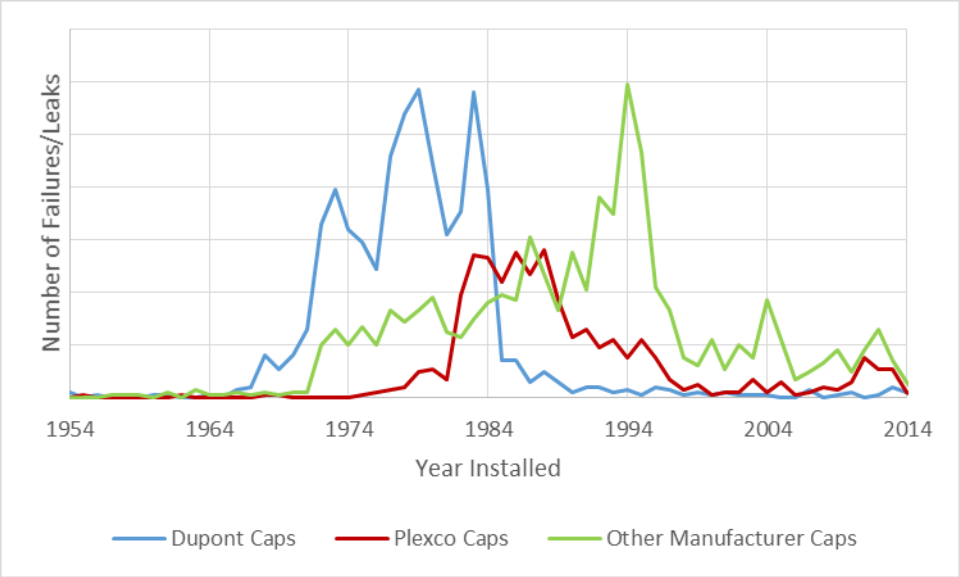



**Figure 2. Failures/Leaks by Year Installed**

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

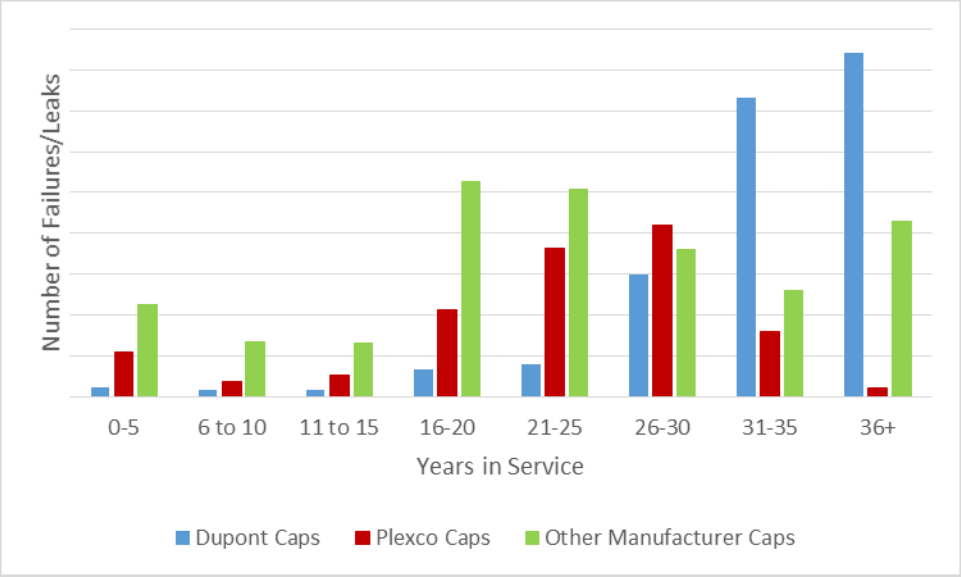



**Figure 3. Failures/Leaks by Years in Service, 5 Year Intervals.**

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

| Material | % of Dupont Caps Failures/Leaks | % of Plexco Caps Failures/Leaks | % of Other Manufacturer Caps Failures/Leaks |
|---|---|---|---|
| ABS | 0.0% | 0.1% | 0.3% |
| Black Plastic | 0.0% | 0.0% | 0.0% |
| CAB | 0.0% | 0.0% | 0.0% |
| Celcon | 0.0% | 84.0% | 0.8% |
| Delrin | 53.3% | 0.0% | 0.0% |
| HDPE 3306 | 0.0% | 0.0% | 0.3% |
| HDPE 3406 | 0.0% | 0.0% | 2.9% |
| HDPE 3408 | 0.0% | 0.4% | 4.1% |
| MDPE 2306 | 16.1% | 1.4% | 8.7% |
| MDPE 2406 | 29.9% | 11.5% | 68.3% |
| Nylon | 0.1% | 0.0% | 0.6% |
| PA 11 | 0.0% | 0.3% | 0.1% |
| PA 12 | 0.0% | 0.0% | 0.0% |
| PB | 0.0% | 0.0% | 0.0% |
| PBT | 0.0% | 0.0% | 0.0% |
| PVC | 0.0% | 0.0% | 0.2% |
| Red Thread | 0.0% | 0.0% | 0.0% |
| Other | 0.0% | 0.7% | 0.6% |
| Not Recorded | 0.6% | 1.6% | 13.1% |
| Steel | 0.0% | 0.0% | 0.0% |
| Brass | 0.0% | 0.0% | 0.0% |
| | | | |
| Total | 100.0% | 100.0% | 100.0% |

**Table 1. Cap Failures/Leaks by Material Type**

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 that excluding the failure cause being reported as "cap" without specific explanation, Material Defect followed by Installation Error were the two major causes for DuPont and Plexco cap failures/leaks. For other manufacturers the major cause was Installation Error followed by Material Defect.

| Cause | % of Dupont Caps Failures/Leaks | % of Plexco Caps Failures/Leaks | % of Other Manufacturer Caps Failures/Leaks |
|---|---|---|---|
| Excessive Expansion/Contraction | 0.4% | 0.0% | 0.4% |
| Excessive External Earth Loading | 0.3% | 0.5% | 0.1% |
| Installation Error | 17.5% | 2.5% | 38.5% |
| Squeeze Off | 0.0% | 0.0% | 0.0% |
| Point Loading | 0.3% | 0.1% | 0.1% |
| Previous Impact | 0.0% | 0.0% | 0.0% |
| Unknown | 2.2% | 1.7% | 1.2% |
| Other | 5.6% | 8.9% | 1.9% |
| Cap | 18.3% | 23.6% | 22.0% |
| Not Recorded | 1.1% | 0.1% | 2.2% |
| Material Defect | 53.9% | 62.4% | 33.2% |
| Gopher/rodent/worm damage | 0.0% | 0.0% | 0.0% |
| Unknown - Not Excavated, Replaced | 0.3% | 0.0% | 0.3% |
| Unknown - Abandoned | 0.0% | 0.1% | 0.3% |
| Corrosion | 0.1% | 0.0% | 0.0% |
| | | | |
| Total | 100.0% | 100.0% | 100.0% |

**Table 2. Cap Failures/Leaks by Cause**

## 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/leak cause, etc., has not been independently tested, evaluated, verified for accuracy or audited.

## Discussion

Cap failures/leaks reported to the PPDC are of particular interest due to known historical issues and have been included in a PHMSA Advisory Bulletin[14]. The fact that reported cap failures/leaks have been

[14] 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.

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/leaks reported for DuPont were primarily on caps installed in the 1970s and 1980s and Plexco primarily in the 1980s and 1990s, while failures/leaks for other manufacturers' caps also include a peak for installations in the mid-1990s which is a recent change in reported data.

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.

# Appendix G

## AMP Data Analysis

## March 2015

### Background

Fittings commonly known as AMP-FIT or AMP fittings 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.[15]

The objective of this appendix is to provide information from the Plastic Pipe Data 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 and/or leaks 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/plastic-pipe-database-collection-committee.

### Results

AMP fittings represent approximately 2% of all the reports in the database. The majority of the data reported (92%) are fitting failures/leaks.

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

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

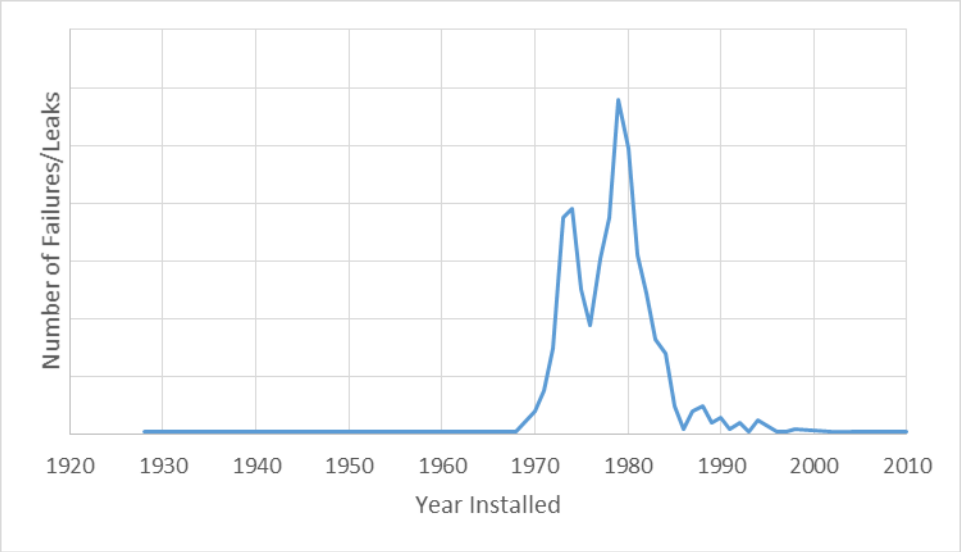



**Figure 1. AMP Fitting Failures by Year Installed**

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

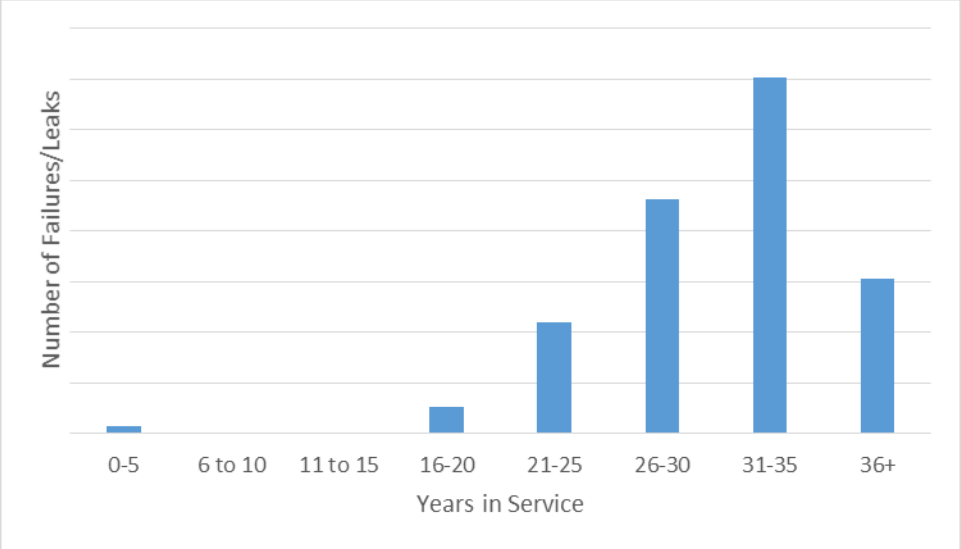



**Figure 2. AMP Fittings Failures by Years in Service, 5 year intervals.**

Figure 3 shows the failures/leaks by year of failure. The number of reported failures/leaks is variable across the years. From 2006 forward, the data is not displaying an upward or downward trend.

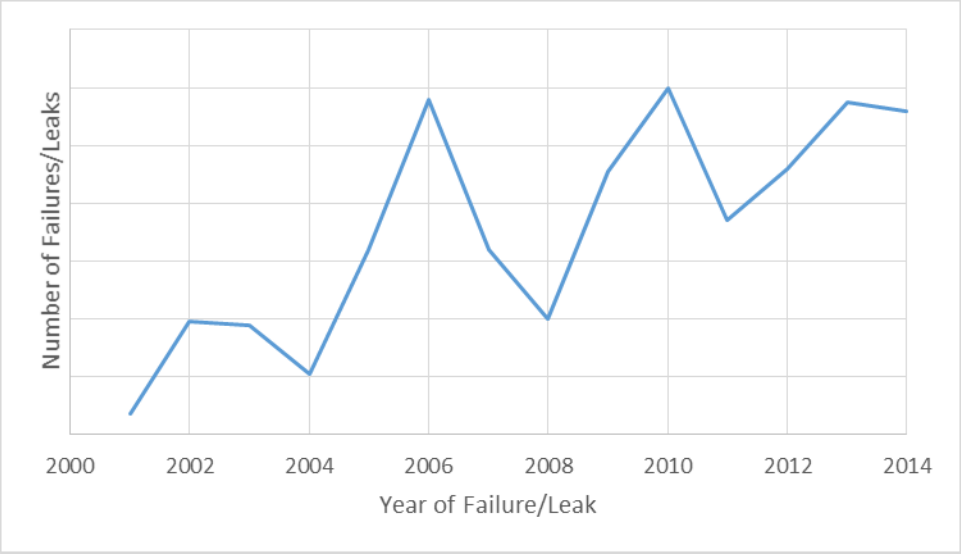



**Figure 3. Failures/Leaks by Year of Failure as reported to PPDC for AMP Fittings**

Table 1 displays the percentages of failure/leak causes for AMP. The highest reported failure causes are unknown and material defect (each 30% and 28%), followed by excessive external earth loading (21%). Although corrosion is reported as being only 0.5% of the data submitted; it should be noted corrosion is not a listed cause on the report form. 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 Failures/Leaks |
|---|---|
| Excessive Expansion/Contraction | 4.3% |
| Excessive External Earth Loading | 19.3% |
| Installation Error | 12.9% |
| Squeeze Off | 0.0% |
| Point Loading | 1.0% |
| Previous Impact | 0.1% |
| Unknown | 26.2% |
| Other | 2.6% |
| Cap | 0.0% |
| Not Recorded | 2.2% |
| Material Defect | 30.8% |
| Gopher/rodent/worm damage | 0.0% |
| Unknown - Not Excavated, Replaced | 0.0% |
| Unknown - Abandoned | 0.0% |
| Corrosion | 0.5% |
| | |
| Total | 100.0% |

**Table 1. Failures/Leaks by Cause for AMP**

## 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/leak cause, has not been independently tested, evaluated, verified for accuracy or audited.

## Discussion

The information shown represents the detailed review of the available AMP fittings failure/leak 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

December 2015

## 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 11,625 miles of main were reported in 2014.

The objective of this appendix is to provide information from the Plastic Pipe Data 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 and/or leaks 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/plastic-pipe-database-collection-initiative/ppdc-forms.

## Results

PVC represents approximately 3% of all the reports in the database. The majority of the reported failures occur on fittings (72%). Other categories include joints (23%), pipe (5%), and not recorded (0.1%).

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

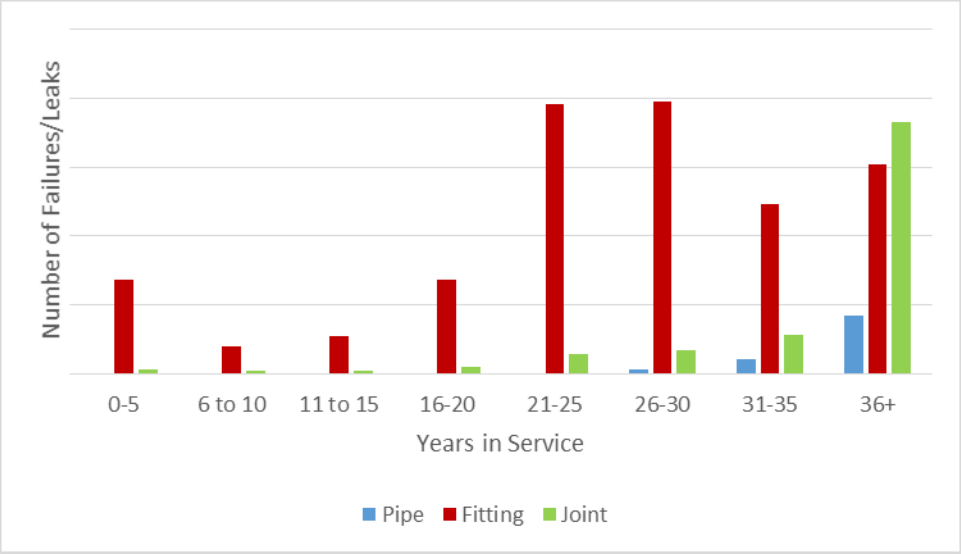



**Figure 1. PVC Failures by Years in Service, 5 year intervals.**

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

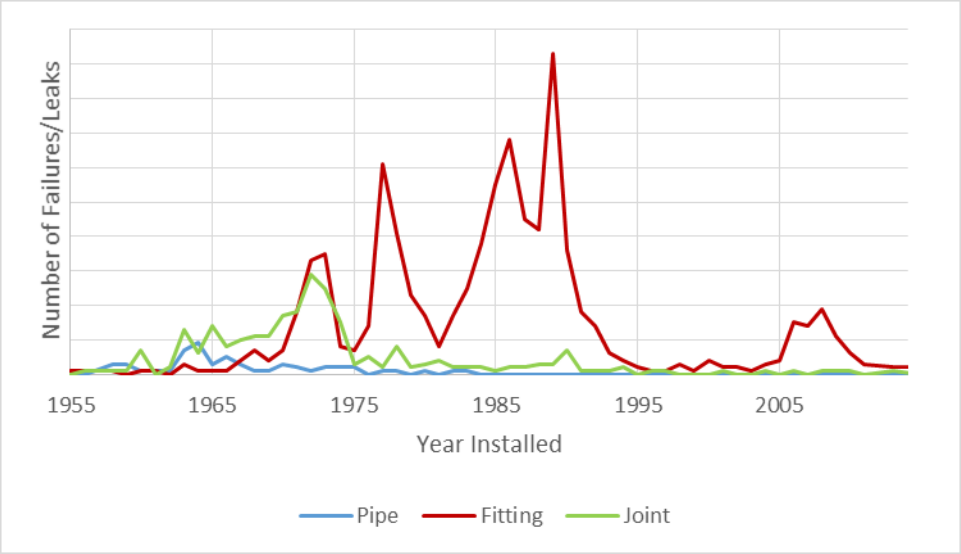



**Figure 2. PVC failures by Year Installed**

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

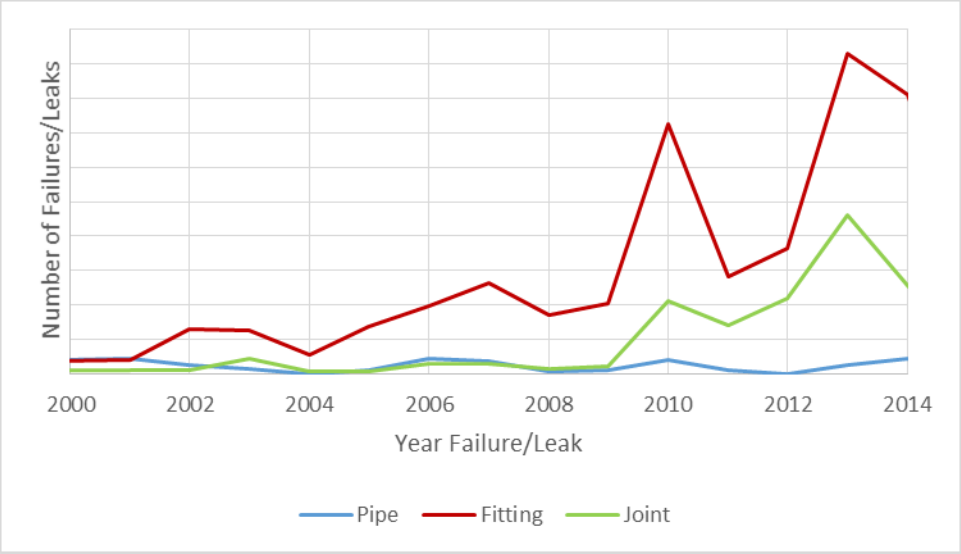



**Figure 3. PVC Failures by Year of Failure**

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

| Cause | % of All PVC Failures/Leaks | % of All PVC Pipe Failures/Leaks | % of All PVC Fitting Failures/Leaks | % of All PVC Joint Failures/Leaks |
|---|---|---|---|---|
| Excessive Expansion/Contraction | 3.8% | 3.2% | 4.8% | 1.0% |
| Excessive External Earth Loading | 10.7% | 19.0% | 9.1% | 14.0% |
| Installation Error | 32.0% | 4.8% | 34.3% | 30.5% |
| Squeeze Off | 0.2% | 4.8% | 0.0% | 0.0% |
| Point Loading | 2.6% | 41.3% | 0.4% | 1.6% |
| Previous Impact | 0.7% | 3.2% | 0.6% | 0.3% |
| Unknown | 5.9% | 6.3% | 5.8% | 5.8% |
| Other | 2.0% | 0.0% | 2.5% | 1.0% |
| Cap | 0.3% | 0.0% | 0.4% | 0.0% |
| Not Recorded | 9.7% | 4.8% | 0.5% | 39.3% |
| Material Defect | 31.8% | 11.1% | 41.4% | 6.2% |
| Gopher/rodent/worm damage | 0.0% | 0.0% | 0.0% | 0.0% |
| Unknown - Not Excavated, Replaced | 0.2% | 1.6% | 0.1% | 0.0% |
| Unknown - Abandoned | 0.0% | 0.0% | 0.0% | 0.0% |
| Corrosion | 0.2% | 0.0% | 0.1% | 0.3% |
| | | | | |
| Total | 100.0% | 100.0% | 100.0% | 100.0% |

**Table 1. Failures/Leaks by Cause for PVC pipe, fittings and joints**

## 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/leak 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. Figure 1 also highlights this spike of failures 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
# March 2016

## 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/leak 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 http://www.kerotest.com/Kerotite-Customer-Letter.pdf

## Methods

The information below reflects data collected by the PPDC. PPDC collects information voluntarily submitted by gas distribution pipeline operators on failures and/or leaks 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/plastic-pipe-database-collection-committee.

## Results

Kerotest failures/leaks represent approximately 7% of all the reports in the database. The majority of the Kerotest data reported (75%) are fitting failures/leaks and 25% are reported as joint failure/leaks.

Table 1 shows Kerotest fitting failures/leaks by type. Of the fitting failures, approximately 88% are reported as plastic valves. Comments provided in reports identify that 16% of the reported valve failures/leaks are due to the valve's compression connections.

| Fitting Type | % of Kerotest Fitting Failures/Leaks |
|---|---|
| Cap | 0.1% |
| Electrofusion | 0.1% |
| Heat Fusion | 0.0% |
| Mechanical Fitting | 10.2% |
| Meter Riser | 0.2% |
| Transition | 0.3% |
| Valve (Plastic) | 87.8% |
| Other | 0.3% |
| Not Recorded | 1.0% |
| | |
| Total | 100.0% |

**Table 1. Kerotest Fitting Failures/Leaks by Type**

Table 2 shows Kerotest joint failures/leaks by type. Of the joint failures/leaks, approximately 98% are mechanical.

| Joint Type | % of Kerotest Joint Failures/Leaks |
|---|---|
| Butt fusion | 0.6% |
| Electrofusion | 1.0% |
| Mechanical | 97.9% |
| Saddle Fusion | 0.0% |
| Socket Fusion | 0.1% |
| Solvent | 0.0% |
| Other | 0.0% |
| Not Recorded | 0.4% |
| | |
| Total | 100.0% |

**Table 2. Kerotest Joint Failures/Leaks by Type**

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

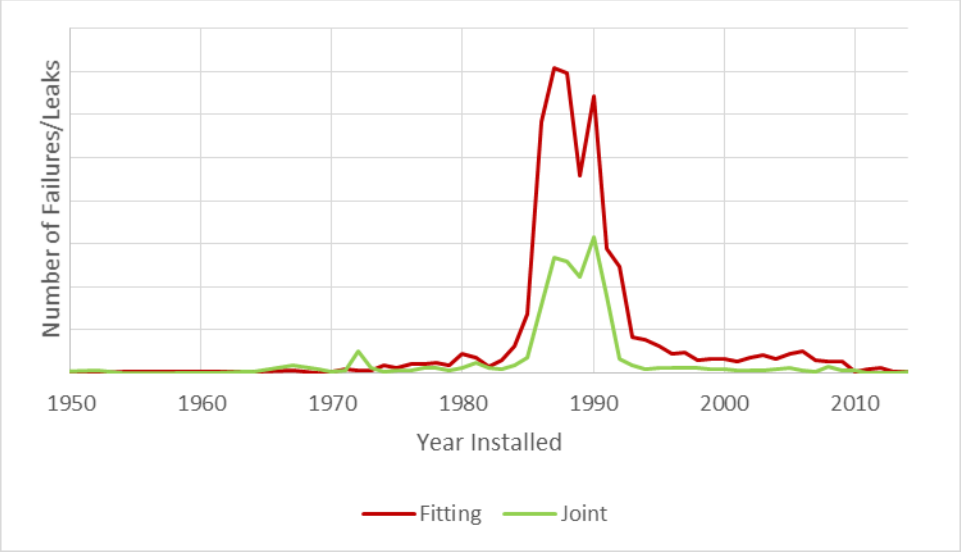



**Figure 1. Kerotest Fitting and Joint Failures/Leaks by Year Installed.**

Figure 2 shows the Kerotest fitting and joint failures/leaks by year of failure/leak and shows elevated reports in recent years.

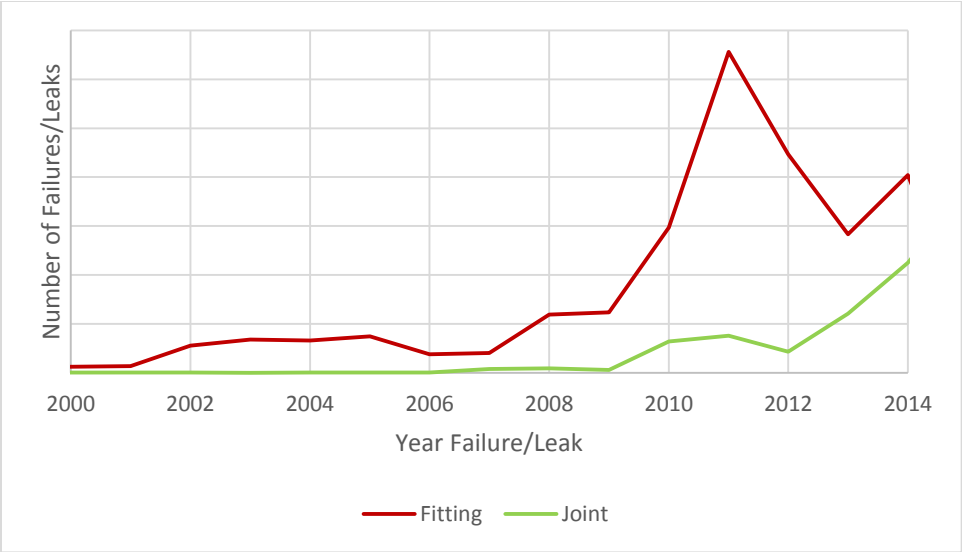



**Figure 2. Kerotest Fitting and Joint Failures/Leaks by Year of Failure/Leak**

Table 3 displays the percentages of failure/leak causes for Kerotest.

| Cause | % of Kerotest Failures/Leaks | % of Kerotest Fitting Failures/Leaks | % of Kerotest Joint Failures/Leaks |
|---|---|---|---|
| Excessive Expansion/Contraction | 0.9% | 0.3% | 2.6% |
| Excessive External Earth Loading | 1.6% | 1.2% | 3.0% |
| Installation Error | 6.0% | 5.8% | 6.5% |
| Squeeze Off | 0.3% | 0.4% | 0.1% |
| Point Loading | 0.1% | 0.1% | 0.0% |
| Previous Impact | 0.1% | 0.1% | 0.0% |
| Unknown | 29.8% | 31.1% | 25.6% |
| Other | 10.7% | 13.7% | 1.7% |
| Cap | 0.1% | 0.2% | 0.0% |
| Not Recorded | 1.5% | 1.6% | 1.3% |
| Material Defect | 48.7% | 45.4% | 59.1% |
| Gopher/rodent/worm damage | 0.0% | 0.0% | 0.0% |
| Unknown - Not Excavated, Replaced | 0.0% | 0.0% | 0.0% |
| Unknown - Abandoned | 0.0% | 0.0% | 0.0% |
| Corrosion | 0.1% | 0.1% | 0.0% |
| | | | |
| Total | 100.0% | 100.0% | 100.0% |

**Table 3. Failures/Leaks by Cause for Kerotest**

## 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/leak 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/leak 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

## Questions from Stakeholder Groups about the PPDC and PPDC 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/leaks 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/Leak. The table shows distribution of socket fusion failures/leaks 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/leaks 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/leaks 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/leaks 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/leaks 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.

**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/leaks. While the trend of failures/leaks reported was going upward through 2010, since then, failures/leaks 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/Leaks 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/leaks 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/leaks? 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/leaks 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 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 represents 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/leaks 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/leaks 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/leaks 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:** 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/leaks 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?

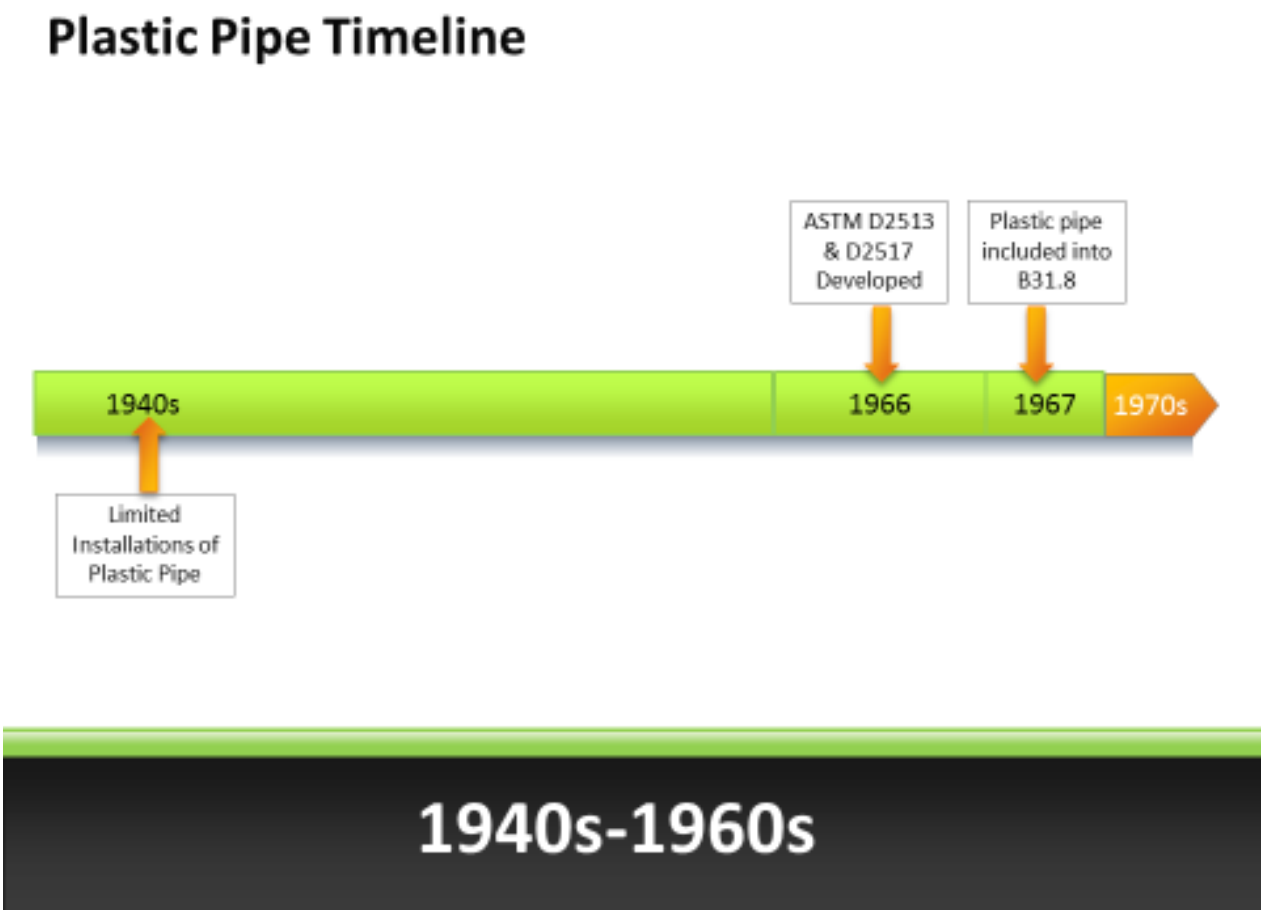
**Response from PPDC:** The number of failures/leaks seems to be decreasing; however, failure reports are still being submitted indicating this manufacturer.

**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/leaks are less than ½ of 1% of the data and no trend in indicated.

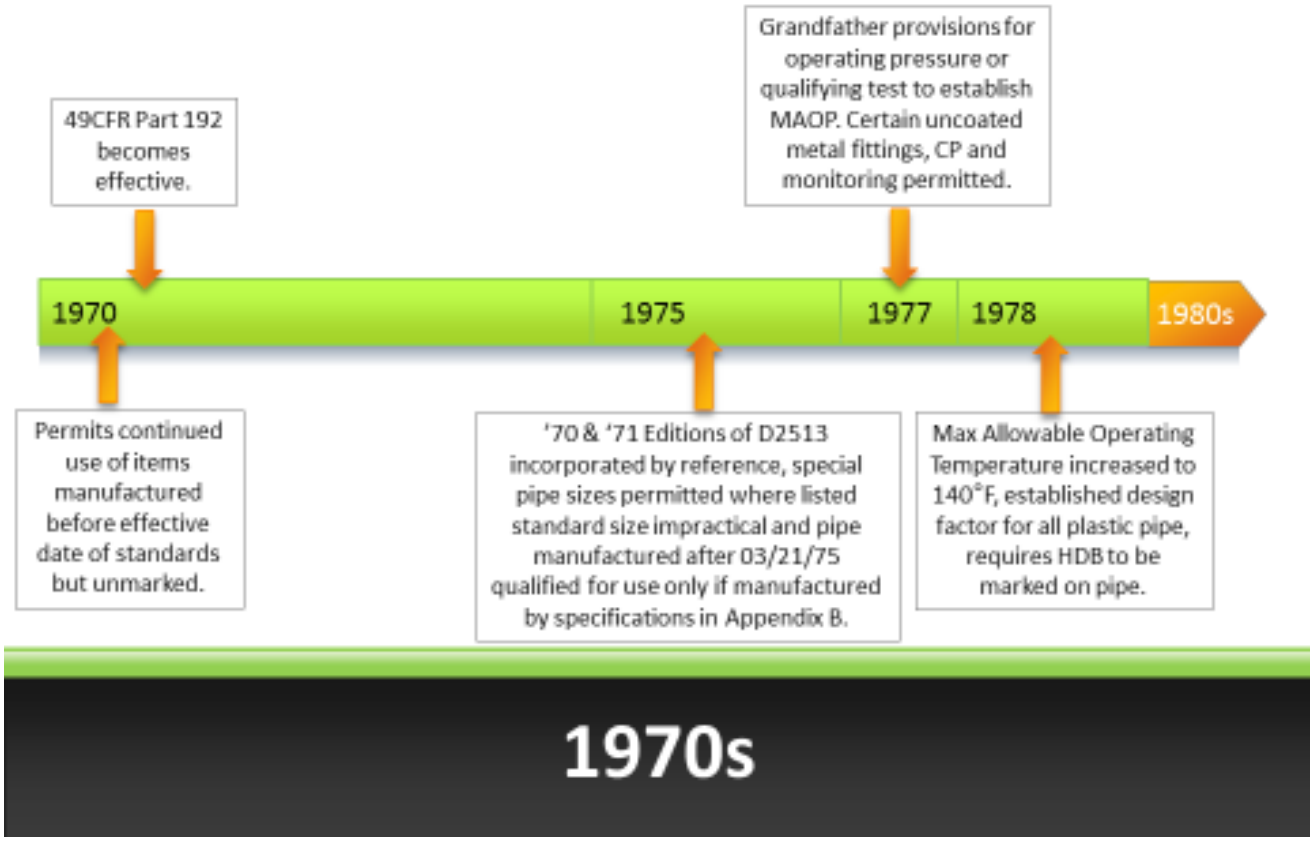
**Question from PHMSA:** Do socket fusion failures appear in the database?
**Response from PPDC:** Yes, socket fusions are a type of joint. 3% of all failures are socket fusions and of those 60% are known to be ½" to 1" CTS size.

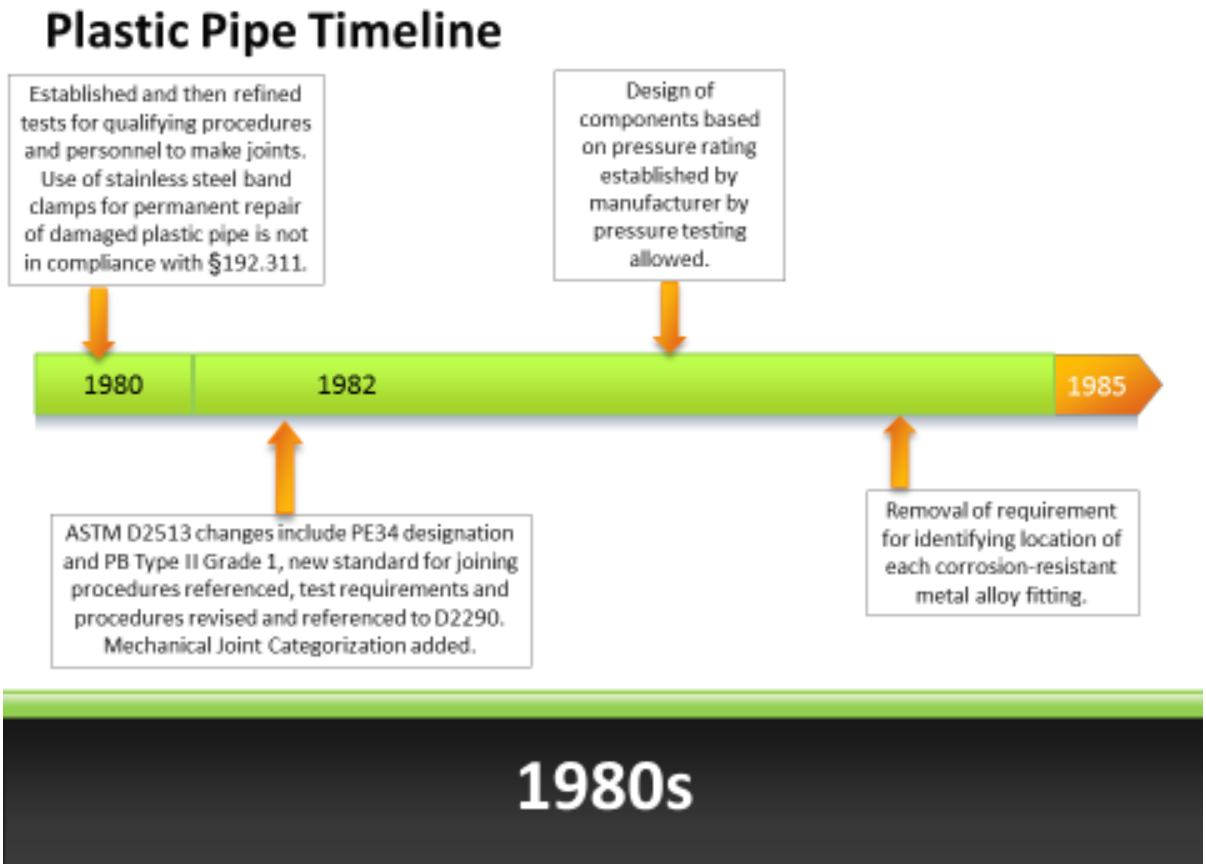
# Appendix J

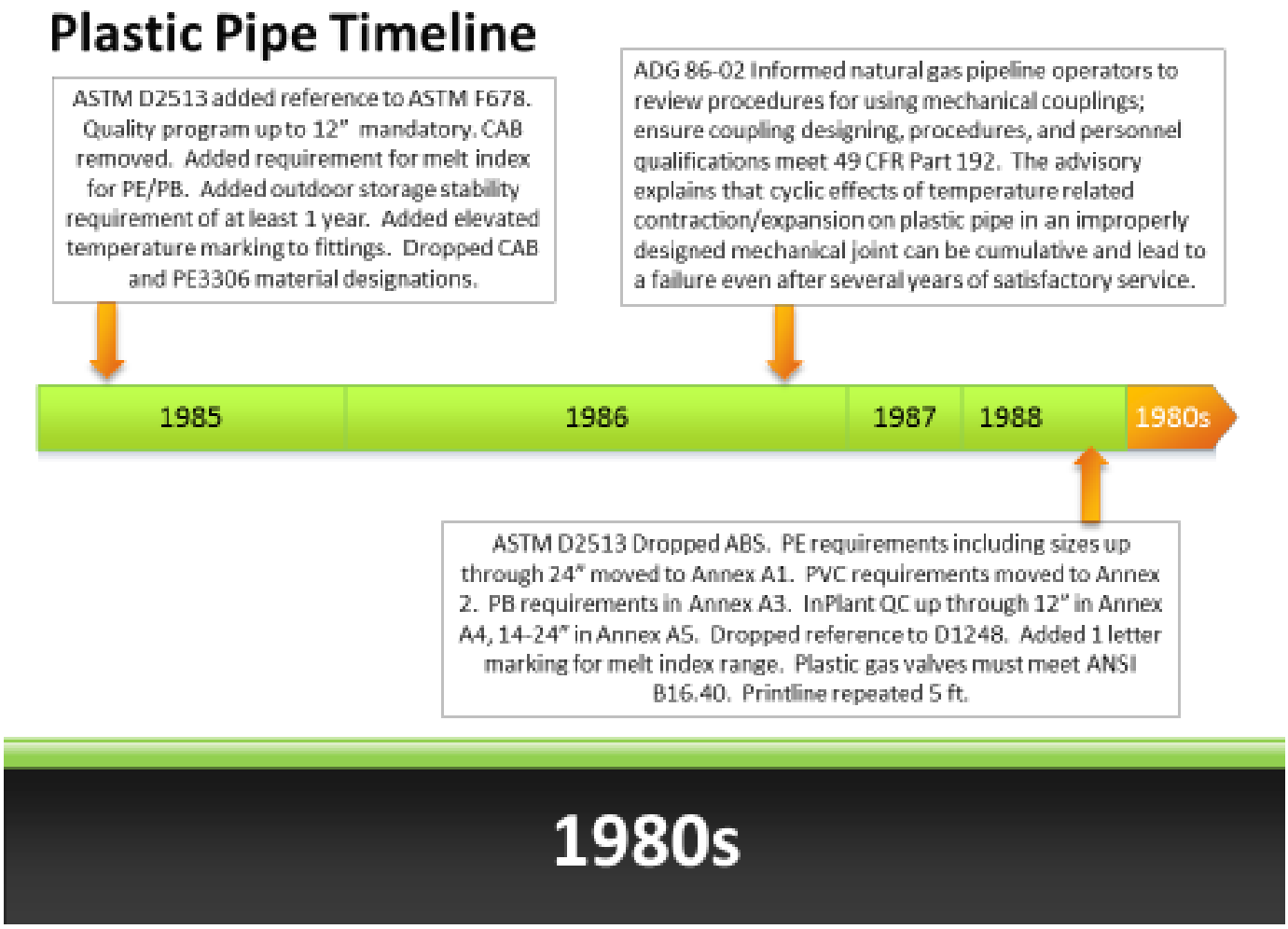
Revised March 2016

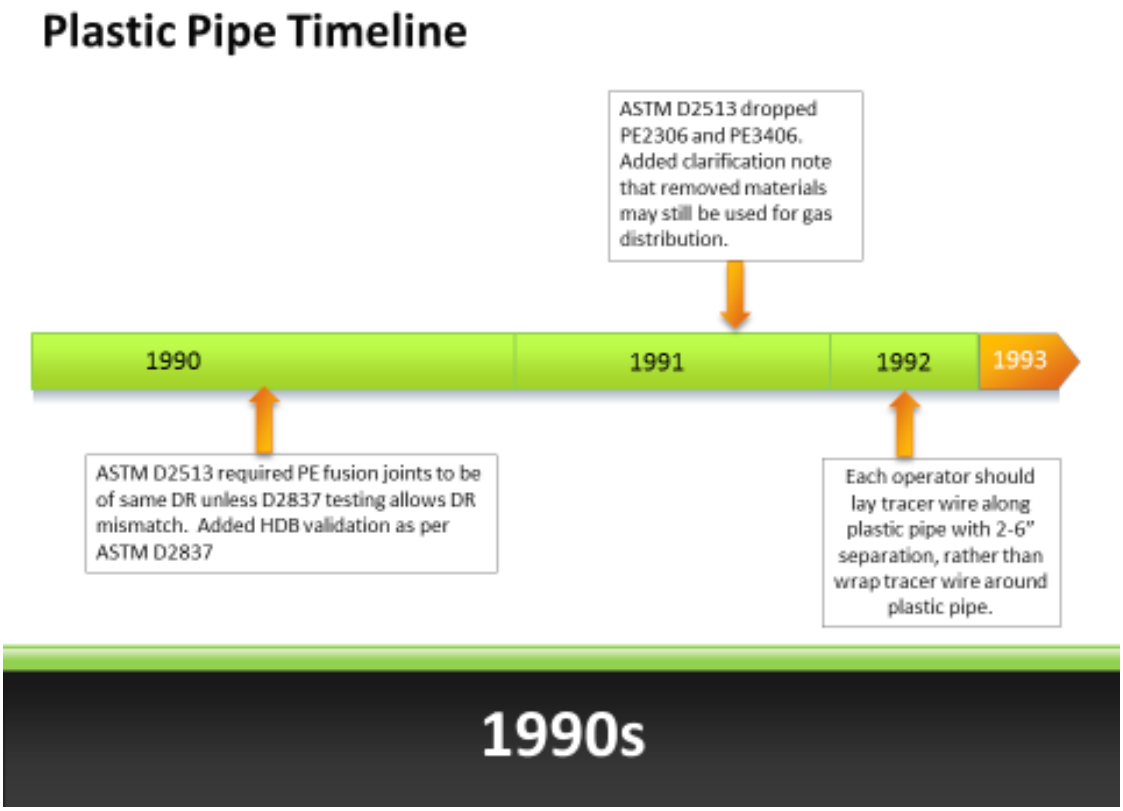


# Plastic Pipe Timeline

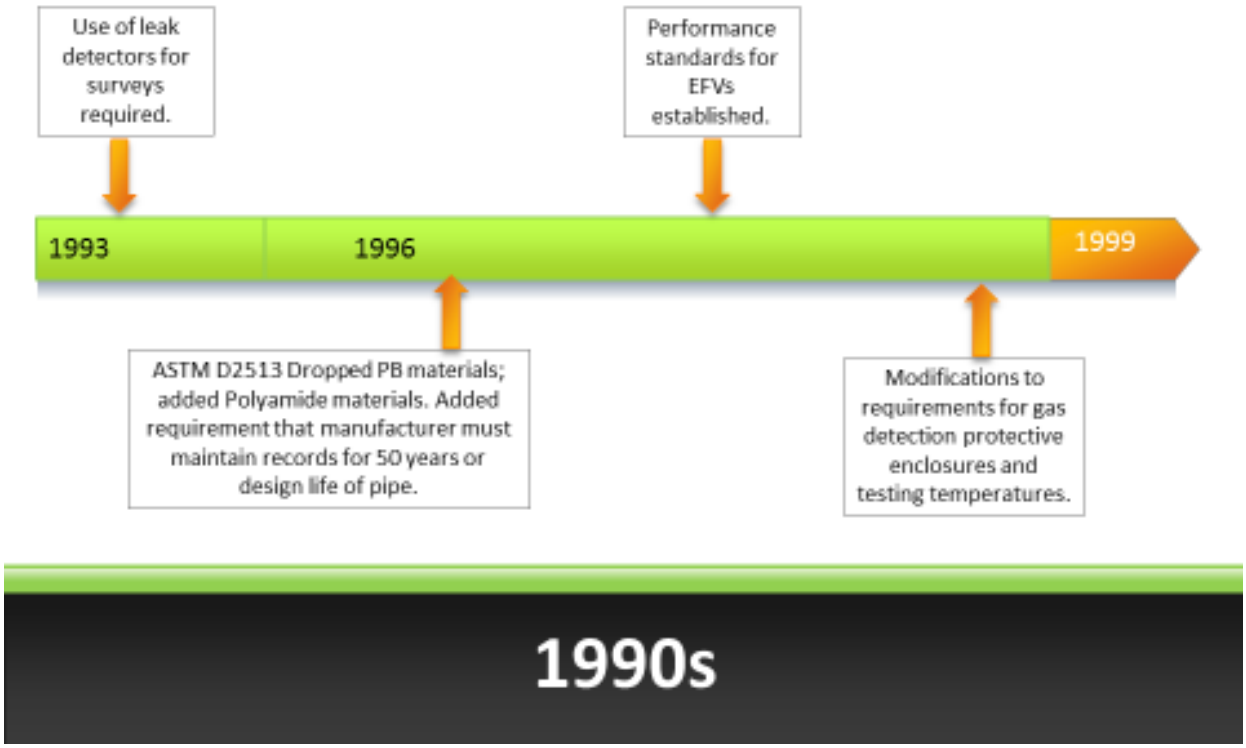



Plastic Pipe Timeline
Established and then refined tests for qualifying procedures and personnel to make joints. Use of stainless steel band clamps for permanent repair of damaged plastic pipe is not in compliance with §192.311.
Design of components based on pressure rating established by manufacturer by pressure testing allowed.
1980
1982
1985
ASTM D2513 changes include PE34 designation and PB Type II Grade 1, new standard for joining procedures referenced, test requirements and procedures revised and referenced to D2290. Mechanical Joint Categorization added.
Removal of requirement for identifying location of each corrosion-resistant metal alloy fitting.
1980s

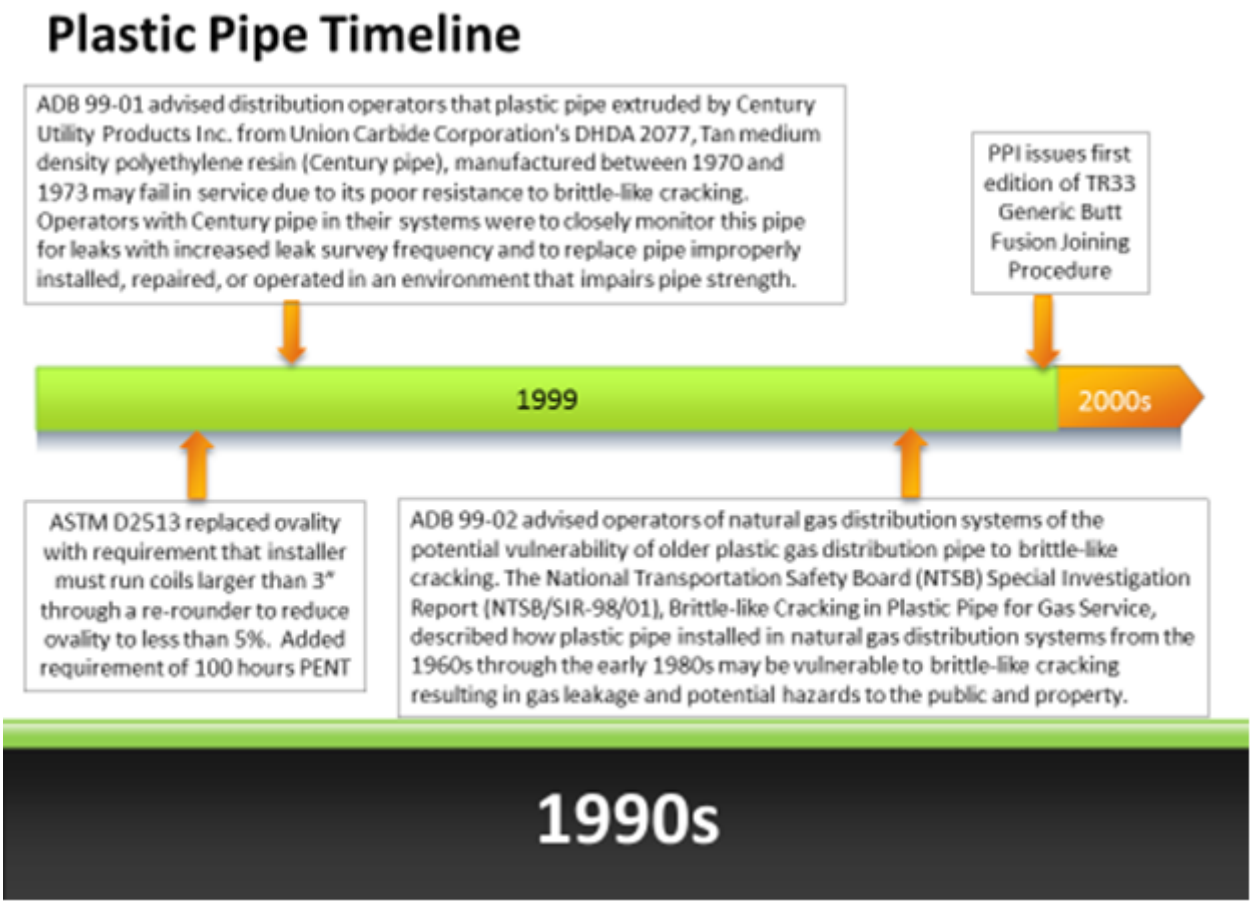

Plastic Pipe Timeline
ASTM D2513 added reference to ASTM F678. Quality program up to 12" mandatory. CAB removed. Added requirement for melt index for PE/PB. Added outdoor storage stability requirement of at least 1 year. Added elevated temperature marking to fittings. Dropped CAB and PE3306 material designations.
ADG 86-02 Informed natural gas pipeline operators to review procedures for using mechanical couplings; ensure coupling designing, procedures, and personnel qualifications meet 49 CFR Part 192. The advisory explains that cyclic effects of temperature related contraction/expansion on plastic pipe in an improperly designed mechanical joint can be cumulative and lead to a failure even after several years of satisfactory service.
1985
1986
1987
1988
1980s
ASTM D2513 Dropped ABS. PE requirements including sizes up through 24" moved to Annex A1. PVC requirements moved to Annex 2. PB requirements in Annex A3. InPlant QC up through 12" in Annex A4, 14-24" in Annex A5. Dropped reference to D1248. Added 1 letter marking for melt index range. Plastic gas valves must meet ANSI B16.40. Printline repeated 5 ft.
1980s

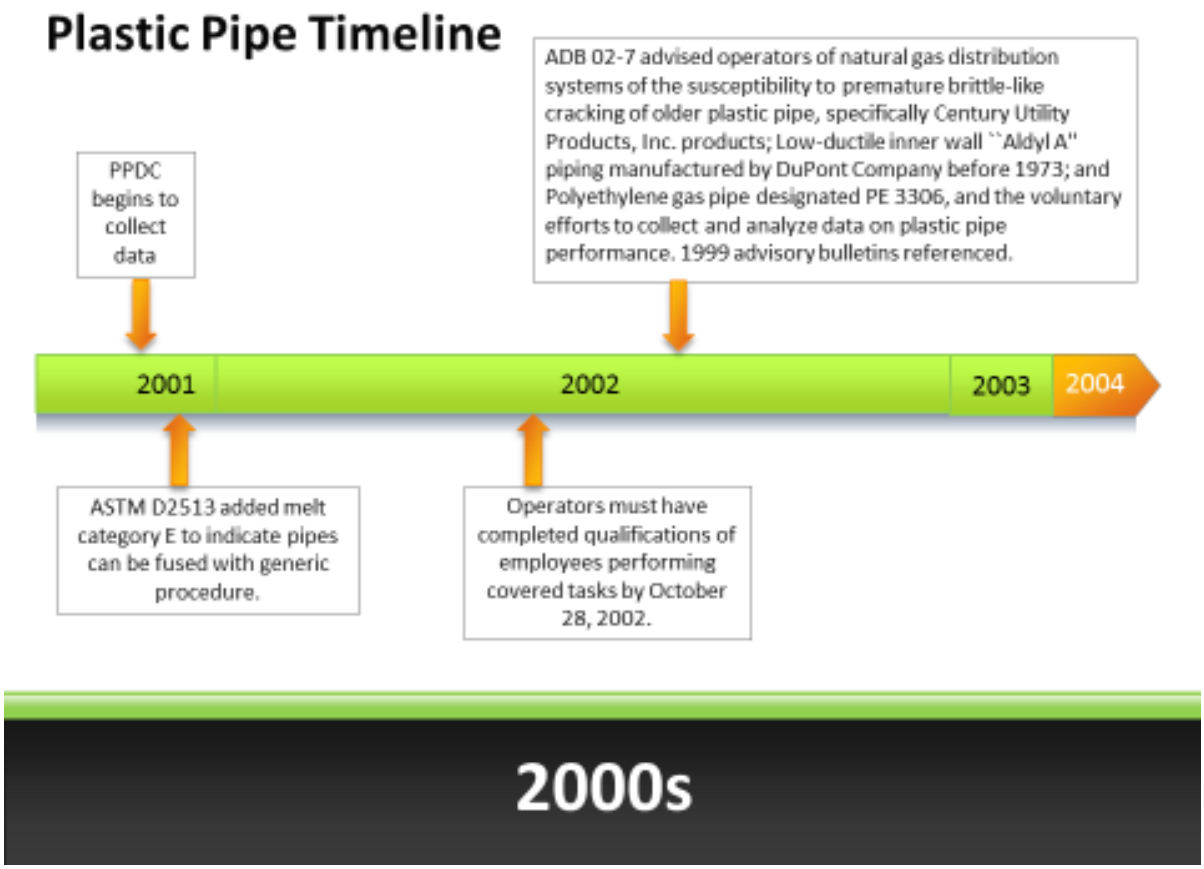

Plastic Pipe Timeline
ASTM D2513 dropped PE2306 and PE3406. Added clarification note that removed materials may still be used for gas distribution.
1990
1991
1992
1993
ASTM D2513 required PE fusion joints to be of same DR unless D2837 testing allows DR mismatch. Added HDB validation as per ASTM D2837
Each operator should lay tracer wire along plastic pipe with 2-6" separation, rather than wrap tracer wire around plastic pipe.
1990s

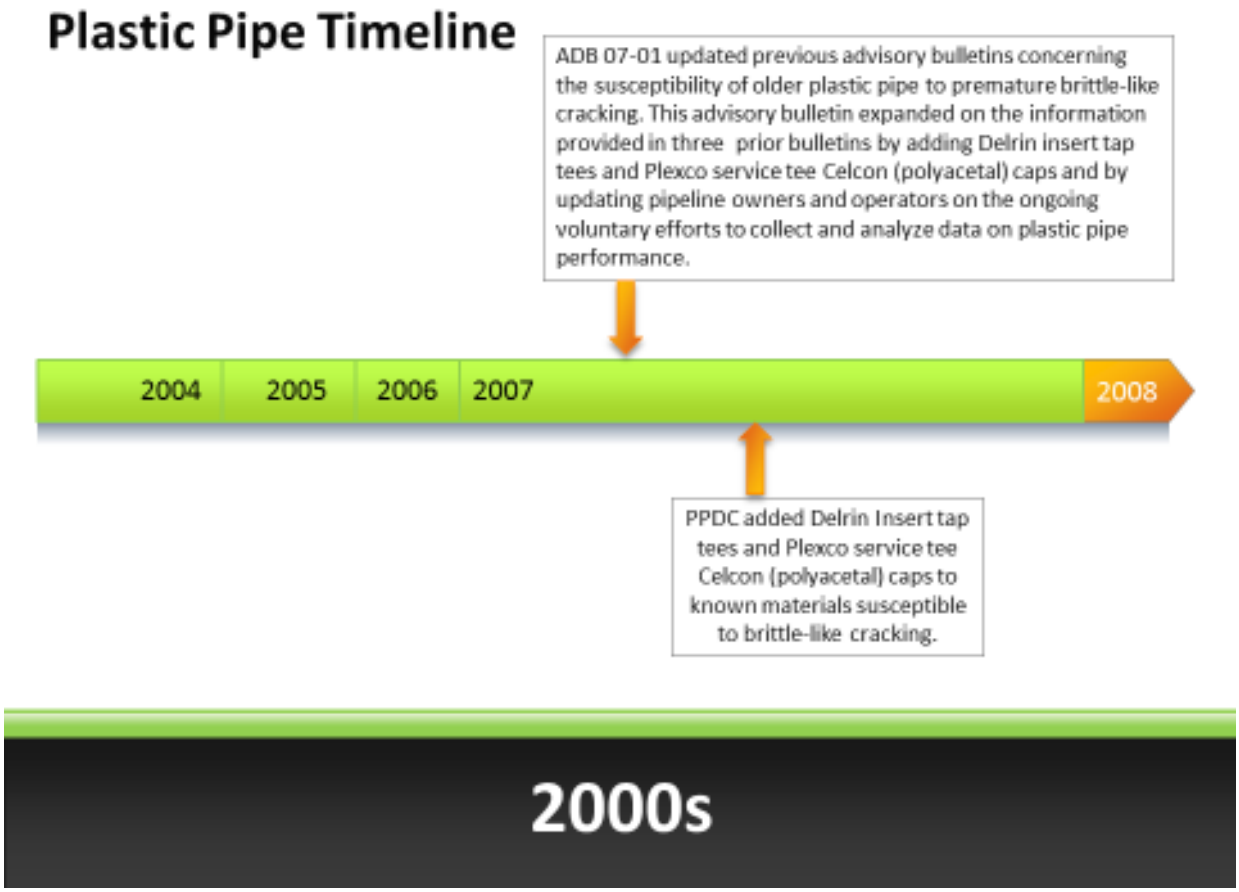
# Plastic Pipe Timeline

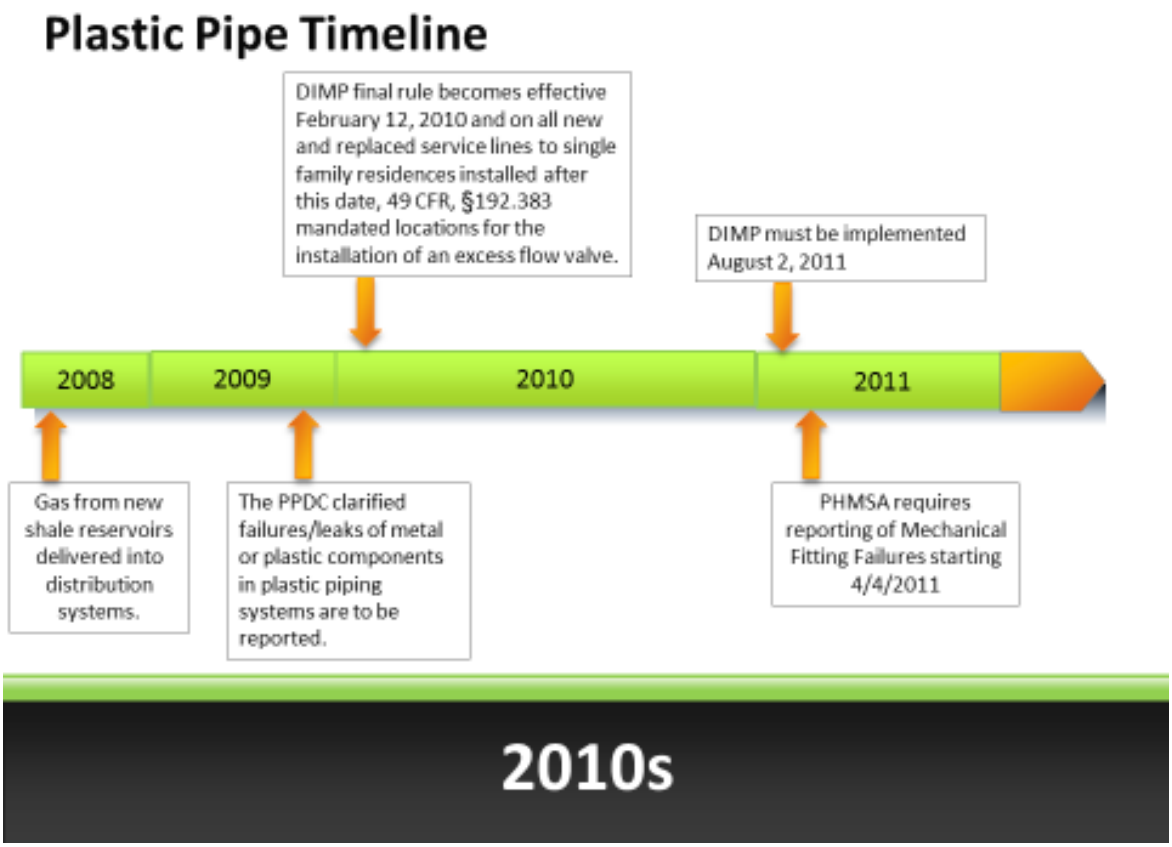



## 1990s


Plastic Pipe Timeline
ADB 99-01 advised distribution operators that plastic pipe extruded by Century Utility Products Inc. from Union Carbide Corporation's DHDA 2077, Tan medium density polyethylene resin (Century pipe), manufactured between 1970 and 1973 may fail in service due to its poor resistance to brittle-like cracking. Operators with Century pipe in their systems were to closely monitor this pipe for leaks with increased leak survey frequency and to replace pipe improperly installed, repaired, or operated in an environment that impairs pipe strength.
PPI issues first edition of TR33 Generic Butt Fusion Joining Procedure
1999
2000s
ASTM D2513 replaced ovality with requirement that installer must run coils larger than 3" through a re-rounder to reduce ovality to less than 5%. Added requirement of 100 hours PENT
ADB 99-02 advised operators of natural gas distribution systems of the potential vulnerability of older plastic gas distribution pipe to brittle-like cracking. The National Transportation Safety Board (NTSB) Special Investigation Report (NTSB/SIR-98/01), Brittle-like Cracking in Plastic Pipe for Gas Service, described how plastic pipe installed in natural gas distribution systems from the 1960s through the early 1980s may be vulnerable to brittle-like cracking resulting in gas leakage and potential hazards to the public and property.
1990s


Plastic Pipe Timeline
PPDC begins to collect data
ADB 02-7 advised operators of natural gas distribution systems of the susceptibility to premature brittle-like cracking of older plastic pipe, specifically Century Utility Products, Inc. products; Low-ductile inner wall ``Aldyl A'' piping manufactured by DuPont Company before 1973; and Polyethylene gas pipe designated PE 3306, and the voluntary efforts to collect and analyze data on plastic pipe performance. 1999 advisory bulletins referenced.
2001
2002
2003
2004
ASTM D2513 added melt category E to indicate pipes can be fused with generic procedure.
Operators must have completed qualifications of employees performing covered tasks by October 28, 2002.
2000s


Plastic Pipe Timeline
ADB 07-01 updated previous advisory bulletins concerning the susceptibility of older plastic pipe to premature brittle-like cracking. This advisory bulletin expanded on the information provided in three prior bulletins by adding Delrin insert tap tees and Plexco service tee Celcon (polyacetal) caps and by updating pipeline owners and operators on the ongoing voluntary efforts to collect and analyze data on plastic pipe performance.
2004
2005
2006
2007
2008
PPDC added Delrin Insert tap tees and Plexco service tee Celcon (polyacetal) caps to known materials susceptible to brittle-like cracking.
2000s


Plastic Pipe Timeline
DIMP final rule becomes effective February 12, 2010 and on all new and replaced service lines to single family residences installed after this date, 49 CFR, §192.383 mandated locations for the installation of an excess flow valve.
DIMP must be implemented August 2, 2011
2008
2009
2010
2011
Gas from new shale reservoirs delivered into distribution systems.
The PPDC clarified failures/leaks of metal or plastic components in plastic piping systems are to be reported.
PHMSA requires reporting of Mechanical Fitting Failures starting 4/4/2011
2010s

# Plastic Pipe Timeline

ADB 2012-03 issued to alert operators using Driscopipe® 8000 High Density Polyethylene Pipe (Drisco8000) of the potential for material degradation. Degradation has been identified on pipe between one-half inch to two inches in diameter that was installed between 1978 and 1999 in desert-like environments in the southwestern United States. However, since root causes of the degradation have not been determined, PHMSA cannot say with certainty that this issue is isolated to these regions, operating environments, pipe sizes, or pipe installation dates.


NTSB issues Safety Alert for plastic fusions 6/2015

## 2010s