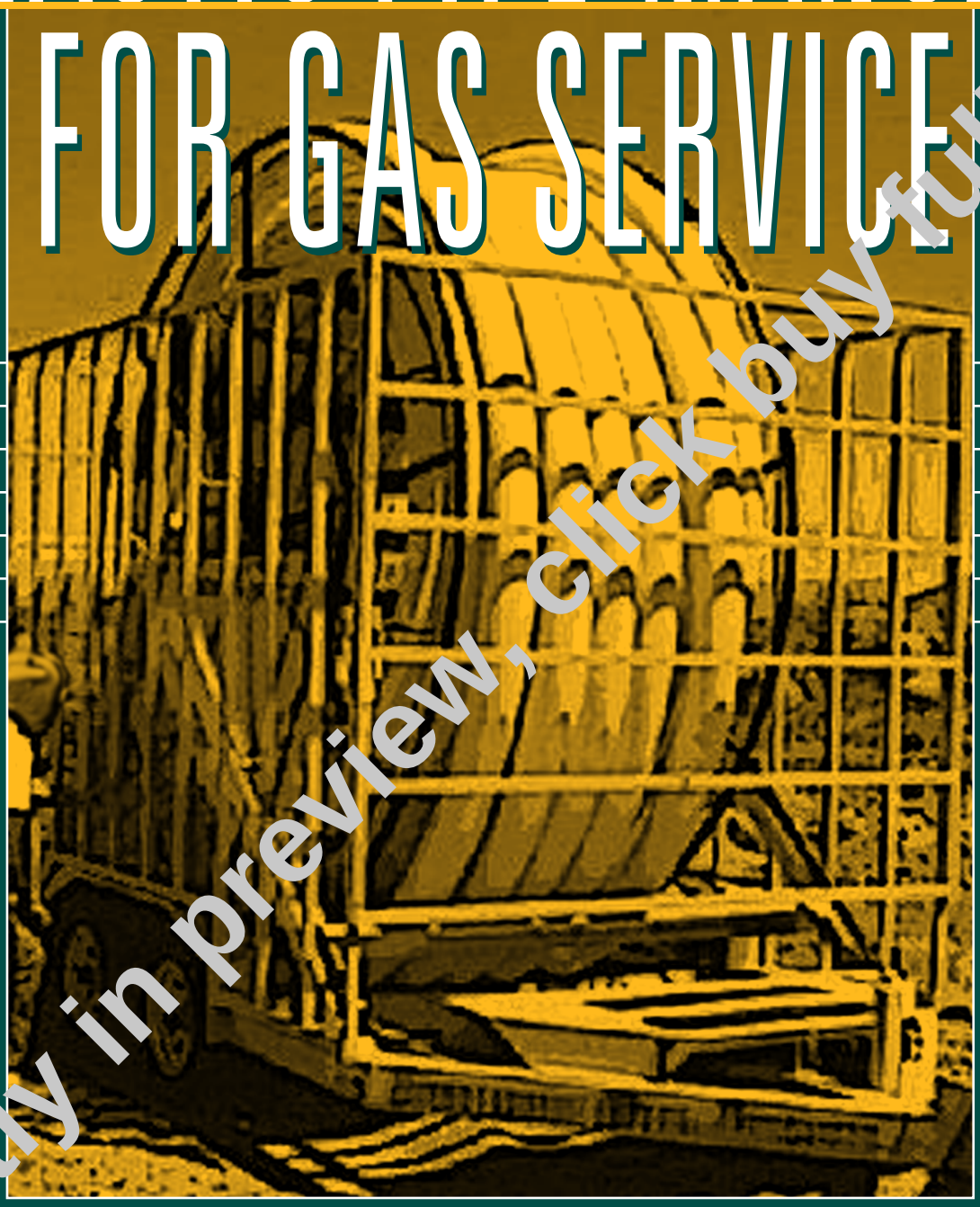
PLASTIC PIPE MANUAL FOR GAS SERVICE



AGA
American Gas Association

Eighth Edition

AGA

PLASTIC PIPE

MANUAL

FOR GAS SERVICE

Catalog No. XR0603

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FOREWORD

In addition to adding color photos throughout, the following revisions were made in the 2006 edition of the *Manual*.

Chapter I. Plastic Piping Materials

1. Addressed reprocessed/rework materials.
2. Discussed higher performance polyethylenes, e.g. PE 4710.
3. Added new developments in PE resins.
4. Expanded section on Polyamide-11 (PA-11) piping materials and installations.
5. Revised ASTM D 3350 PE callouts.
6. Added PEX fusion joining information.
7. Revised the PE slow crack growth sections.
8. Revised the chemical resistance and weathering sections.
9. Added additional RCP information.
10. Added note that PVC piping is only permitted in repair applications.
11. Deleted HDS column "For Fuel Gas" in Table I-2.

Chapter II. Engineering Considerations for Plastic Pipe Utilization

1. Revised slow crack growth resistance (SCG) language.
2. Resistance to Rapid Crack propagation (RCP).
3. Expanded discussion of hydrostatic design basis (HDB) including elevated temperature HDBs.
4. Inclusion of references to PA-11.
5. Expanded notes about joining including electrofusion joining and Generic Fusion Procedures.
6. Advice concerning design for high temperature environments and pressures above 100 psi.

Chapter IV. Installation of Plastic Pipe

1. Format was changed for easier reading.
2. Added information about Cold Weather Handling.
3. Added color photos.
4. Added information to be considered when installing Category 2, full seal only fittings.
5. Updated old Standards references.
6. Modified trenching and backfilling section.
7. Added reference to ASTM design standard for Weak Links.

Chapter V. Personnel Training, Field Inspection, and Pressure Testing

1. General revision and rewrite of Typical Outline for Training.
2. Revisions to Pressure Testing sections.
3. Added Project Investigations section.

Chapter VI. Maintenance, Operation, and Emergency Control Procedures

1. Added sections on the Plastic Pipe Data Collection Committee (PPDC).
2. Revised the Static Electricity section.
3. Revised the Pipe Locating section.
4. Added additional guidance to the Repair section.

Added new Appendix H

1. PPI TN-30/2006 "Requirements for the Use of Rework Materials in Manufacturing of Polyethylene Gas Pipe"

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INTRODUCTION

This Manual is the **eighth edition** and is an updating of the issue published in 2001. Information is presented on those plastic materials, piping components, and design and installation procedures currently covered in codes and standards concerned with piping systems for natural gas distribution. It presents and summarizes data from manufacturers, users, trade associations and research organizations. The Manual has been prepared for use with the referenced ASTM standards and Part 192 of the Title 49, Code of Federal Regulations, which contains the Minimum Federal Safety Standards for the transportation of gas and for pipeline facilities. The Code hereafter will be referred to as 49 CFR 192, Federal Code or Minimum Federal Safety Standards. When a Code section is referenced it is designated 49 CFR 192.XXX unless it is clear from context the reference is to Part 192 of Title 49.

The Plastic Pipe Manual Task Group recognizes that the data and information presented in this Manual could not include the complete details of the available information on plastic gas pipe. New knowledge and developments continually tend to supplement or make obsolete some of the present manual material. Some of the referenced standards quoted or cited as references also are undergoing continual modernization and must of necessity be consulted to determine applicability. State and local codes may specify additional requirements or restrictions. The Engineer should consult all applicable codes. It is, however, the hope of the AGA Plastic Materials Committee that this Manual will be acceptable to both users and suppliers as a prime reference on the subject of plastic gas piping.

In view of the rapid progress of technology in this field, it is recommended that this Manual be used in conjunction with a current copy of the Minimum Federal Safety Standards, 49 CFR 192, and the ASTM Book of Standards, Volumes 8.01 through 8.04 Plastics.

The latest information, as issued by the manufacturers of resins, pipe, piping components or tools, will contain in more detail, special or specific properties and recommendations related to their product. Unavoidably, the publications of the Gas Piping Technology Committee (GPTC) will, in part, parallel this Manual on many items as they specifically relate to the requirements of the Minimum Federal Safety Standards. Users are encouraged to reference the additional information provided by these sources.

Modern methods of physical and chemical analysis started to uncover the principles that govern the properties of natural polymers in 1920. Polymer compounds such as poly (vinyl chloride) were developed in 1931. But it took the shortages of copper and steel during World War II to start the use of plastic pipe in natural gas distribution.

The gas industry recognized the potential of plastic pipe after limited installation by a few companies in the late 1940s. Beginning in the early 1950s many companies were evaluating plastic pipe performance and developing know-how on an experimental basis. In 1953 the AGA Distribution Committee formed a subcommittee on Plastic Pipe Standards. The objective was to compile the physical and chemical data on specific types and formulations of plastic materials. In cooperation with the membership of the Society of the Plastic Industry, and through AGA sponsored research at the Battelle Memorial Institute, the gas industry proceeded with the development of such data. In a meeting of the Subcommittee in 1954, a special committee of the Thermoplastic Pipe Division of SPI recommended the first three thermoplastic materials for natural gas distribution pipe.

After the mid 1950s the installation of plastic pipe on an operational basis grew rapidly. Annual installations rose from approximately 100 miles to over 1,700 miles in 1965 and 2,600 miles in 1966.

Operational data, together with field data from experimental installations, was gathered by gas utilities and the material, pipe and fitting manufacturers for many years leading to the development of gas pipe standards. This work was supported by the American Gas Association (AGA), the Plastics Pipe Institute (PPI) (a Division of the Society of the Plastic Industry), the American Society of Testing and Materials (ASTM), and the American Society of Mechanical Engineers (ASME). Results of the research were incorporated in 1966 into the ASTM Standards D 2513 "Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings" and D 2517, "Specification for Reinforced Thermosetting Resin Plastic Gas Pressure Pipe and Fittings." These, in turn, provided the basis for acceptance and inclusion of plastic piping into the USAS B31.8 1967, "Pressure Piping Code for Gas Transmission and Distribution Piping Systems."

In 1967, with formal acceptance by code groups, the door was opened for general use of plastic pipe. The cumulative miles of plastic pipe in use grew from 9,200 miles in 1965 to over 45,800 miles at the end of 1970, an increase of almost 500%. Annual plastic installations increased by over 500% in the five year period to 10,600 miles in 1970.

Extensive use of plastic for main and service installations has continued in the United States. In 1996 a magazine survey noted its respondents installed over 32,000 miles of polyethylene mains and services annually for

the past five years. The cumulative mileage of plastic pipe in use at the end of 1998 was estimated at over 550,000 miles. By the end of 2004 there were over 1 million miles of plastic mains and services installed in the U.S.

Since 1960 polyethylene has evolved into the dominant material used in the gas distribution industry. Today, over 98% of all the plastic distribution piping installed is polyethylene. In this edition of the Manual recognition is placed on the almost exclusive use of polyethylene pipe in current installations with expanded coverage of its material characteristics, pipe design factors, acceptance testing, and fusion, installation and maintenance procedures. Developments in materials, pipe and fitting technology, and installation and maintenance procedures continue to improve plastic utilization in gas distribution systems.

In recent years additional thermoplastic materials have received approvals for use in gas piping applications by their addition to ASTM D2513. These materials, which are now discussed in the Manual, include PEX (Crosslinked polyethylene) and Polyamide-11 (PA-11) piping. Other plastics installed in prior years are providing satisfying service to many users, but they are not covered in this manual.

Many aspects of design, joining, installation, operations and maintenance of plastic gas pipelines are covered in 49 CFR 192 and the AGA / ANSI Z380 Gas Piping Technology Committee's *Guide*. The role of code requirements, personnel training and inspection procedures are considered so essential that our text emphasizes them to the point of repetition. Excellent training aids, including slide presentation and videotapes, are now available from gas companies, manufacturers and trade associations.

Future revisions of this Manual will be necessitated by the dynamics of technological progress. It is the intent of the Plastic Materials Committee to periodically update this Manual.

The Committee acknowledges with appreciation the work of the Task Group responsible for these Manual revisions consisting of:

Frank Volgstadt, chairman	Volgstadt & Associates, Inc.
Stephen Boros	Plastics Pipe Institute
Richard Conley	Kerotest Manufacturing
Jim Craig	McElroy Manufacturing Company
John Goetz	Peoples Gas Light & Co
White Jee	BP Solvay Polyethylene
Tim Lauder	Public Service Electric & Gas
Karen Lively	Performance Pipe
Brian Moidel	Dominion
Sudheer Pimputkar	Battelle Columbus Laboratories
Perry Sheth	Keyspan Energy
Rich Stockand	Pacific Gas & Electric

The Committee gratefully acknowledges all those who so generously contributed their data, expertise and time to publishing this edition of the Manual.

This edition of the Manual is dedicated to Larry Ingels of the American Gas Association Staff, who assisted in this timely update for the manual.

CHAPTER I
PLASTIC PIPING MATERIALS

Plastic materials used for the fabrication of pipe and fittings exhibit as broad a range of properties as those of other piping materials, including metals. The properties of a particular plastic are derived from:

- The type of polymer (e.g. polyethylene (PE), polyamide (PA), poly(vinyl chloride)(PVC), crosslinked polyethylene (PEX)).
- The structural characteristics of the polymer (e.g. average molecular length, frequency and length of branches).
- The amount and type of additives.
- The manufacturing process by which the end product is made.

For protection of properties during processing and service, and for other purposes, plastic piping materials are always formulated with additives. Some common examples are processing and ultraviolet stabilizers, pigments, antioxidants, and sometimes modifiers to enhance a property like impact strength or stiffness. It is essential when considering a plastic for an engineering application to recognize that its properties will be determined by the quality and nature of the additives as well as by the polymer or resin type.

PRIMARY CHARACTERISTICS

The primary characteristics of its widespread use in buried application include the following:

- Outstanding corrosion resistance
- Light weight
- Ease of joining and installing
- Economy

Corrosion Resistance

Plastic piping materials are not susceptible to the corrosion mechanisms that affect metallic pipe. Since plastics are nonconductors of electricity, they are immune to the electrochemical reactions caused by acids, bases, and salts that cause corrosion to metals. Plastics may be susceptible to other forms of attack such as the action of certain strong oxidizing, reducing, or other reagents that break down or alter the polymer molecules. They may absorb solvents that cause softening or weakening.

They may crack if, when under stress, they contact substances called environmental stress cracking agents. These chemicals increase a plastic's susceptibility to crack initiation and propagation.

These substances are not present in normal soils so that plastic pipe is well suited to buried applications.

Gas piping systems may sometimes contain hydrocarbon condensates which act as solvents. When plastic piping is likely to contact them or other adverse substances, selection and design should be based on the effects of the substance on both the long- and short-term strength of the material. Some important known environmental limitations are discussed later in the chapter under “Factors Affecting the Performance of Plastic Piping Materials”.

Weight

Plastic pipes are significantly lighter than metal pipes. For example, polyethylene (PE) pipe weighs less than 1/6 of the weight of an equivalent sized steel pipe. Weight of plastic pipe can be calculated using the density of the plastic pipe compound, the nominal or stated diameter, and the nominal wall thickness.[*]

[*] PPI TN-7/2000, Recommended Method for Calculation of Nominal Weight of Solid Wall Plastic Pipe