
USACE / NAVFAC / AFCEA UFGS-02556A (July 2003)

Preparing Activity: USACE Superseding
UFGS-02556A (June 2003)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 25 June 2004

Latest change indicated by CHG tags

SECTION 02556A

GAS DISTRIBUTION SYSTEM

07/03

NOTE: This guide specification covers the requirements for natural or manufactured gas distribution systems designed in accordance with ASME B31.8.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

PART 1 GENERAL

NOTE: This guide specification may be used for specifying liquefied petroleum gas (LPG) if the following modifications are made:

- a. Delete all references to fiberglass and add the following to paragraph "Polyethylene Pipe, Tubing, Fittings and Joints" in PART 2: Polyethylene pipe, tubing, and fittings shall be recommended by the manufacturer for use with LPG.
- b. Require, where applicable, the LPG distribution system to be in accordance with NFPA 58, Storage and Handling of Liquefied Petroleum Gases, instead of ASME B31.8.

1.1 REFERENCES

NOTE: Issue (date) of references included in
project specifications need not be more current than
provided by the latest guide specification. Use of
SpecsIntact automated reference checking is
recommended for projects based on older guide
specifications.

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN GAS ASSOCIATION (AGA)

AGA XR0104 (2001) AGA Plastic Pipe Manual for Gas Service

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI B109.2 (2000) Diaphragm Type Gas Displacement Meters (500 Cubic Feet per Hour Capacity and Over)

AMERICAN PETROLEUM INSTITUTE (API)

API Spec 5L (2000) Line Pipe

API Spec 6D (2002) Specification for Pipeline Valves

ASME INTERNATIONAL (ASME)

ASME B1.20.1 (1983; R 2001) Pipe Threads, General Purpose, Inch

ASME B16.11 (2002) Forged Fittings, Socket-Welding and Threaded

ASME B16.21 (1992) Nonmetallic Flat Gaskets for Pipe Flanges

ASME B16.34 (1996) Valves Flanged, Threaded, and Welding End

ASME B16.40 (2002) Manually Operated Thermoplastic Gas Shutoffs and Valves in Gas Distribution Systems

ASME B16.5 (1996) Pipe Flanges and Flanged Fittings

ASME B16.9 (2001) Factory-Made Wrought Steel Buttwelding Fittings

ASME B31.8 (2000) Gas Transmission and Distribution Piping Systems

ASME BPVC SEC VIII D1 (2001) Boiler and Pressure Vessel Code;
Section VIII, Pressure Vessels Division 1
- Basic Coverage

ASTM INTERNATIONAL (ASTM)

ASTM A 181/A 181M (2001) Carbon Steel Forgings, for
General-Purpose Piping

ASTM A 53/A 53M (2002) Pipe, Steel, Black and Hot-Dipped,
Zinc-Coated, Welded and Seamless

ASTM D 2513 (2003a) Thermoplastic Gas Pressure Pipe,
Tubing, and Fittings

ASTM D 2517 (2000e1) Reinforced Epoxy Resin Gas
Pressure Pipe and Fittings

ASTM D 2683 (1998) Socket-Type Polyethylene Fittings
for Outside Diameter-Controlled
Polyethylene Pipe and Tubing

ASTM D 3261 (2003) Butt Heat Fusion Polyethylene (PE)
Plastic Fittings for Polyethylene (PE)
Plastic Pipe and Tubing

ASTM D 3308 (2001) PTFE Resin Skived Tape

ASTM D 3350 (2002a) Polyethylene Plastics Pipe and
Fittings Materials

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS
INDUSTRY (MSS)

MSS SP-25 (1998) Standard Marking System for Valves,
Fittings, Flanges and Unions

MASTER PAINTERS INSTITUTE (MPI)

MPI 9 (Jan 2004) Exterior Alkyd, Gloss, MPI
Gloss Level 6

NACE INTERNATIONAL (NACE)

NACE RP0185 (1996) Extruded, Polyolefin Resin Coating
Systems with Soft Adhesives for
Underground or Submerged Pipe

NACE RP0274 (1998) High Voltage Electrical Inspection
of Pipeline Coatings

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 58 (2004) Liquefied Petroleum Gas Code

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 25 (1997; R 2000) Zinc Oxide, Alkyd, Linseed
Oil Primer for Use Over Hand Cleaned

Steel, Type I and Type II

SSPC SP 1 (1982; R 2000) Solvent Cleaning
SSPC SP 3 (1982; R 2000) Power Tool Cleaning
SSPC SP 6 (2000) Commercial Blast Cleaning
SSPC SP 7 (2000) Brush-Off Blast Cleaning

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS TT-E-2784 (Rev A) Enamel (Acrylic-Emulsion, Exterior
Gloss and Semigloss) (Metric)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

49 CFR 192 Transportation of Natural and Other Gas by
Pipeline: Minimum Federal Safety Standards

UNDERWRITERS LABORATORIES (UL)

UL Gas&Oil Dir (2003) Flammable and Combustible Liquids
and Gases Equipment Directory

1.2 SUBMITTALS

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy projects.

Submittal items not designated with a "G" are considered as being for information only for Army projects and for Contractor Quality Control approval

for Navy projects.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.] [for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Pipe, Fittings, and Associated Materials

Drawings shall contain complete schematic and piping diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of the system and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

SD-03 Product Data

Materials and Equipment

A complete list of equipment and materials, including manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions, including, but not limited to the following:

- a. Dielectric Waterways and Flange Kits.
- b. Meters.
- c. Pressure Reducing Valves.
- d. Regulators.
- e. [Earthquake Actuated Automatic Gas Shutoff System]
- f. Emergency Gas Supply Connection.

Spare Parts

Spare parts lists for each different item of material and equipment specified.

Connections to Existing Lines

Notification of the Contractor's schedule for making connections to existing gas lines, at least 10 days in advance.

Welding Steel Piping

A copy of qualified welding procedures along with a list of names and identification symbols of performance qualified welders and welding operators.

Jointing Polyethylene and Fiberglass Piping[; G] [; G, [____]]

A copy of qualified jointing procedures, training procedures, qualifications of trainer, and training test results for joiners and inspectors.

Connection and Abandonment Plan[; G][; G, [_____]]

A copy of procedures for gas line tie in, hot taps, abandonment/removal or demolition, purging, and plugging as applicable in accordance with ASME B31.8.

SD-06 Test Reports

Pressure and Leak Tests[; G][; G, [_____]]

Data from all pressure tests of the distribution system.

SD-07 Certificates

Utility Work

Certification from the Operating Agency/Utility Company that work for which the Utility is responsible has been completed.

Training

A copy of each inspector's and jointer's training certificate with respective test results.

SD-10 Operation and Maintenance Data

Gas Distribution System

[Six] [_____] copies, in booklet form and indexed, of site specific natural gas operation and maintenance manual for each gas distribution system including system operation, system maintenance, equipment operation, and equipment maintenance manuals described below. If operation and maintenance manuals are provided in a common volume, they shall be clearly differentiated and separately indexed.

The System Operation Manual shall include but not be limited to the following:

a. Maps showing piping layout and locations of all system valves and gas line markers.

b. Step-by-step procedures required for system startup, operation, and shutdown. System components and equipment shall be indexed to the gas maps.

c. Isolation procedures and valve operations to shut down or isolate each section of the system. Valves and other system components shall be indexed to the gas maps.

d. Descriptions of Site Specific Standard Operation Procedures including permanent and temporary pipe repair procedures, system restart and test procedures for placing repaired lines back in service, and procedures for abandoning gas

piping and system components.

e. Descriptions of Emergency Procedures including: isolation procedures including required valve operations with valve locations indexed to gas map, recommended emergency equipment, checklist for major emergencies and procedures for connecting emergency gas supply.

The Equipment Operation Manual shall include, but not be limited to, detail drawings, equipment data, and manufacturer supplied operation manuals for all equipment, valves and system components.

The System Maintenance Manuals shall include, but not be limited to:

- a. Maintenance check list for entire gas distribution system.
- b. Descriptions of site specific standard maintenance procedures.
- c. Maintenance procedures for installed cathodic protection systems.
- d. Piping layout, equipment layout, and control diagrams of the systems as installed.
- e. Identification of pipe materials and manufacturer by location, pipe repair procedures, and jointing procedures at transitions to other piping materials or piping from different manufacturer.

The Equipment Maintenance Manuals shall include but not be limited to the following:

- a. Identification of valves and other equipment by materials, manufacturer, vendor identification and location.
- b. Maintenance procedures and recommended maintenance tool kits for all valves and equipment.
- c. Recommended repair methods, either field repair, factory repair, or whole-item replacement for each valve component or piece of equipment or component item.
- d. Routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide.

1.3 GENERAL REQUIREMENTS

1.3.1 Welding Steel Piping

Welding and nondestructive testing procedures for pressure piping are specified in Section 05093 WELDING PRESSURE PIPING. Structural members shall be welded in accordance with Section 05090A WELDING, STRUCTURAL.

1.3.2 Jointing Polyethylene and Fiberglass Piping

Piping shall be joined by performance qualified joiners using qualified procedures in accordance with AGA XR0104. Manufacturer's prequalified

joining procedures shall be used. Joints shall be inspected by an inspector qualified in the joining procedures being used and in accordance with AGA XR0104. Joiners and inspectors shall be qualified at the jobsite by a person who has been trained and certified by the manufacturer of the pipe, to train and qualify joiners and inspectors in each joining procedure to be used on the job. Training shall include use of equipment, explanation of the procedure, and successfully making joints which pass tests specified in AGA XR0104. The Contracting Officer shall be notified at least 24 hours in advance of the date to qualify joiners and inspectors.

1.3.3 Standard Products

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Asbestos or products containing asbestos shall not be used. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site. Valves, flanges, and fittings shall be marked in accordance with MSS SP-25.

1.3.4 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

1.3.5 Handling

Pipe and components shall be handled carefully to ensure a sound, undamaged condition. Particular care shall be taken not to damage pipe coating. No pipe or material of any kind shall be placed inside another pipe or fitting after the coating has been applied, except as specified in paragraph INSTALLATION. Plastic pipe shall be handled in conformance with AGA XR0104.

1.3.6 Spare Parts

The Contractor shall submit spare parts data for each different item of equipment and material specified, after approval of the detail drawings and not later than [_____] months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

PART 2 PRODUCTS

2.1 PIPE, FITTINGS, AND ASSOCIATED MATERIALS

2.1.1 Steel Pipe

NOTE: Other material, such as ductile iron in iron pipe sizes, may be used with gases noncorrosive to such material. Delete inapplicable materials or equipment. Verify that pipe wall thickness conforms to ASME B31.8 for larger sizes and high pressures.

Steel pipe shall conform to ASTM A 53/A 53M, Grade A or B, Type E or S, Schedule 40; or API Spec 5L seamless or electric resistance welded,

Schedule 40, black steel pipe as specified in ASME B31.8. Furnace butt welded pipe may be used in sizes 40 mm (1-1/2 inches) 1-1/2 inches and smaller.

2.1.1.2 Small Fittings

Fittings 40 mm (1-1/2 inches) 1-1/2 inches and smaller shall conform to ASME B16.11.

2.1.1.3 Fittings, 50 mm (2 Inches) 2 Inches and Larger

Pipe flanges and flanged fittings including bolts, nuts, and bolt patterns shall be in accordance with ASME B16.5, Class [_____]. Butt welded fittings shall be in accordance with ASME B16.9. Weld neck flanges shall be used.

2.1.1.4 Steel Forged Branch Connections

Connections shall conform to ASTM A 181/A 181M, Class 60, carbon steel.

2.1.1.5 Flange Gaskets

Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21, 1.6 mm (1/16 inch) 1/16 inch minimum thickness, full face or self-centering flat ring type. The gaskets shall contain aramid fibers bonded with nitrile butadiene rubber (NBR), or glass fibers bonded with polytetrafluoroethylene, suitable for maximum 315 degrees C 600 degrees F service and meeting applicable requirements of ASME B31.8.

2.1.1.6 Pipe Threads

Pipe threads shall conform to ASME B1.20.1.

2.1.1.7 Polyethylene Pipe, Tubing, Fittings and Joints

NOTE: Before selecting polyethylene or fiberglass pipe material, the gas supplier should be contacted for a gas analysis to determine the types of chemicals which will be in the gas he will supply. Suitable polyethylene or fiberglass pipe material will be selected based on the gas analysis.

Polyethylene shall not be used for gas lines with design pressures above 690 kPa (100 psig) or with operating temperatures below 7 degrees C (20 degrees F) or above 60 degrees C (140 degrees F).

For thermoplastic (polyethylene) pipe in sizes from 15 mm through 150 mm (1/2 inch through 6 inches), select minimum wall thickness based on ASME B31.8, table 842.32(c); and select the standard dimension ratio (SDR) based on the long-term hydrostatic strength of $S = 8.6 \text{ MPa}$ (1,250 psi) for PE 2406 or $S = 11 \text{ MPa}$ (1,600 psi) for PE 3408 at 23 degrees C (73 degrees F) for the following pressures:

SDR	Design Pressure at 23 degrees C (73 Degrees F)			
	S = 8.62 MPa (1,250 psi)		S = 11 MPa (1,600 psi)	
11	550 kPa	(80 psig)	690 MPa	(100 psig)
13.5	415 kPa	(60 psig)	550 kPa	(80 psig)
17	345 kPa	(50 psig)	415 kPa	(60 psig)
21	275 kPa	(40 psig)	345 kPa	(50 psig)
26	207 kPa	(30 psig)	275 kPa	(40 psig)

Where the buried pipe system is expected to exceed 23 degrees C (73 degrees F) at the design pressures stated above, alternate materials must be used.

Polyethylene pipe, tubing, fittings and joints shall conform to ASTM D 3350 and ASTM D 2513, pipe designations PE 2406 and PE 3408, rated SDR [_____] or less, as specified in ASME B31.8. Pipe sections shall be marked as required by ASTM D 2513. Butt fittings shall conform to ASTM D 3261 and socket fittings shall conform to ASTM D 2683. Fittings shall match the service rating of the pipe. Minimum wall thickness shall be [_____] . [Polyethylene pipe, tubing, and fittings shall be recommended by the manufacturer for use with LPG.]

2.1.8 Fiberglass Pipe, Fittings and Adhesive

NOTE: Before selecting polyethylene or fiberglass pipe material, the gas supplier should be contacted for a gas analysis to determine the types of chemicals which will be in the gas he will supply. Suitable polyethylene or fiberglass pipe materials must be selected based on the gas analysis.

Reinforced thermosetting plastic (fiberglass reinforced plastic) shall not be used for gas lines with design pressures above 690 kPa (100 psig) or with operating temperatures below 29 degrees C (minus 20 degrees F) or above 66 degrees C (150 degrees F) .

For reinforced thermosetting plastic (fiberglass reinforced plastic) pipe sizes from 50 mm through 150 mm (2 inches through 6 inches), select minimum wall thickness based on ASME B31.8, table 842.33(c) .

Fiberglass pipe, fittings and adhesive shall conform to ASTM D 2517. Pipe sections shall be marked as required by ASTM D 2517. Minimum wall thickness shall be [_____] .

2.1.9 Sealants for Steel Pipe Threaded Joints

2.1.9.1 Sealing Compound

Joint sealing compound shall be as listed in UL Gas&Oil Dir, Class 20 or less.

2.1.9.2 Tape

Polytetrafluoroethylene tape shall conform to ASTM D 3308.

2.1.10 Identification

Pipe flow markings and metal tags for each valve, meter, and regulator shall be provided as required by the Contracting Officer.

2.1.11 Insulating Joint Materials

Insulating joint materials shall be provided between flanged or threaded metallic pipe systems where shown to isolate galvanic or electrolytic action.

2.1.11.1 Threaded Joints

Joints for threaded pipe shall be steel body nut type, dielectric waterways with insulating gaskets.

2.1.11.2 Flanged Joints

Joints for flanged pipe shall consist of full face sandwich-type flange insulating gasket of the dielectric type, insulating sleeves for flange bolts and insulating washers for flange nuts.

2.1.11.3 Dielectric Waterways and Flanges

Dielectric waterways shall have temperature and pressure rating equal to or greater than that specified for the connecting piping. Waterways shall have metal connections on both ends suited to match connecting piping. Dielectric waterways shall be internally lined with an insulator specifically designed to prevent current flow between dissimilar metals. Dielectric flanges shall meet the performance requirements described herein for dielectric waterways.

2.1.12 Gas Transition Fittings

Gas transition fittings shall be manufactured steel fittings approved for jointing steel and polyethylene or fiberglass pipe. Approved transition fittings are those that conform to AGA XR0104 requirements for transition fittings.

2.2 VALVES

NOTE: Valves and pressure regulators are necessary at all points where design requires pressure reduction or regulation. Require a shut-off valve upstream of the regulator. A central regulating station is generally provided by the gas company and is usually located near the entrance to the

installation. When valves, gas pressure regulators, and related devices are required in the contract, ensure that all necessary equipment will comply with the requirements of the gas company, and revise these paragraphs as required. Provide a detail of each regulating station and the following data for each pressure regulator: materials of construction, flow rate, type and specific gravity of the gas, inlet and outlet pressures, accuracy of control, and size and type of connections.

Valves shall be suitable for shutoff or isolation service and shall conform to the following:

2.2.1 Steel Valves

Steel valves 40 mm (1-1/2 inches) 1-1/2 inches and smaller installed underground shall conform to ASME B16.34, carbon steel, socket weld ends, with square wrench operator adaptor. Steel valves 40 mm (1-1/2 inches) 1-1/2 inches and smaller installed aboveground shall conform to ASME B16.34, carbon steel, socket weld or threaded ends with handwheel or wrench operator. Steel valves 50 mm (2 inches) 2 inches and larger installed underground shall conform to API Spec 6D, carbon steel, butt weld ends, Class [_____] with square wrench operator adaptor. Steel valves 50 mm (2 inches) 2 inches and larger installed aboveground shall conform to API Spec 6D, carbon steel, butt weld or flanged ends, Class [_____] with handwheel or wrench operator.

2.2.2 Steel Valve Operators

Valves 200 mm (8 inches) 8 inches and larger shall be provided with worm or spur gear operators, totally enclosed, grease packed, and sealed. The operators shall have Open and Closed stops and position indicators. Locking feature shall be provided where indicated. Wherever the lubricant connections are not conveniently accessible, suitable extensions for the application of lubricant shall be provided. Valves shall be provided with lubricant compatible with gas service.

2.2.3 Polyethylene Valves

Polyethylene valves shall conform to ASME B16.40. Polyethylene valves, in sizes 15 mm to 150 mm (1/2 inch to 6 inches), 1/2 inch to 6 inches, may be used with polyethylene distribution and service lines, in lieu of steel valves, for underground installation only.

2.3 PRESSURE REGULATORS

NOTE: Coordinate this paragraph with the specified requirements in paragraph VALVES.

Regulators shall have ferrous bodies, shall provide backflow protection, and shall be designed to meet the pressure, load and other service conditions.

2.3.1 Gas Main Regulators

Pressure regulators for main distribution lines, supplied from a source of gas which is at a higher pressure than the maximum allowable operating pressure for the system, and shall be equipped with pressure regulating devices of adequate capacity. In addition to the pressure regulating devices, a suitable method shall be provided to prevent overpressuring of the system in accordance with ASME B31.8. Suitable protective devices are as follows:

- a. Spring-loaded relief valve meeting the provisions of ASME BPVC SEC VIII D1.
- b. Pilot-loaded back pressure regulator used as relief valve, so designed that failure of the pilot system will cause the regulator to open.
- c. Weight-loaded relief valves.
- d. Monitoring regulator installed in series with the primary pressure regulator.
- e. Series regulator installed upstream from the primary regulator, set to limit the pressure on the inlet of the primary regulator continuously to the maximum allowable operating pressure of the system, or less.
- f. Automatic shutoff device installed in series with the primary regulator, set to shut off when the pressure on the distribution system reaches the maximum allowable operating pressure of the system, or less. This device shall remain closed until manually reset.
- g. Spring-loaded, diaphragm type relief valves.

2.3.2 Service Line Regulators

NOTE: If service regulator does not have all the characteristics listed, or if gas contains materials which would interfere with operation of the regulator, protective devices will be installed to prevent overpressuring of the user's system should the regulator fail. The following devices should be considered to be installed as an integral part of the regulator or as separate devices operating in conjunction with the regulator.

- a. Monitoring regulator
- b. Relief valve
- c. Automatic shutoff device

Pressure regulators for individual service lines shall have ferrous bodies. Regulator shall be capable of reducing distribution line pressure to pressures required for users. Regulators shall be provided where gas will be distributed at pressures in excess of 2.5 kPa (10 inches of water column). 10 inches of water column. Pressure relief shall be set at a lower pressure than would cause unsafe operation of any connected user.

Regulators for liquified petroleum gas shall be adjusted to 2.5 to 3 kPa (10 to 12 inches of water column). 10 to 12 inches of water column. Pressure relief for liquified petroleum gas shall be set at 4 kPa (16 inches of water column). 16 inches of water column. Regulator shall have single port with orifice diameter no greater than that recommended by the manufacturer for the maximum gas pressure at the regulator inlet. Regulator valve vent shall be of resilient materials designed to withstand flow conditions when pressed against the valve port. Regulator shall be capable of regulating downstream pressure within limits of accuracy and shall be capable of limiting the buildup of pressure under no-flow conditions to 50 percent or less of the discharge pressure maintained under flow conditions. Regulator shall have a self contained service regulator. Regulator pipe connections shall not exceed 50 mm (2 inch) 2 inchsize.

2.4 METERS

NOTE: Provide gas meters for each service line to every building. Where meters have a maximum anticipated demand of less than 28 cubic meters/hour (1000 SCFH), require the meter to meet a design working pressure of 690 kPa (100 psi).

Delete mounting and special features that are not required. Retain strainer upstream of meter only if installed upstream of pressure regulator. Delete pulse switch and pulse requirements except for Air Force projects or when required by other users. Air Force Engineering Technical Letter Number 87-5 "Utility Meters in New and Renovated Facilities" provides guidance for when to exclude meters from Air Force new and major renovation projects. Review the requirements for gas meters in TI 800-01 Design Criteria and 10 CFR 435.

Meters shall conform to ANSI B109.2. Meters shall be [pipe] [pedestal] mounted [and be provided with a strainer immediately upstream]. [Meters shall be provided with [over-pressure protection as specified in ASME B31.8] [tamper-proof protection] [frost protection] [fungus-proof protection].] Meters shall be suitable for accurately measuring and handling gas at pressures, temperatures, and flow rates indicated. Meters shall have a pulse switch initiator capable of operating up to speeds of 500 pulses per minute with no false pulses and shall require no field adjustments. Initiators shall provide the maximum number of pulses up to 500 per minute that is obtainable from the manufacturer. It shall provide not less than one pulse per 2.83 cubic meter (100 cubic feet) 100 cubic feet of gas.

2.5 EARTHQUAKE ACTUATED AUTOMATIC GAS SHUTOFF SYSTEM

NOTE: Include earthquake actuated automatic gas shutoff system if the facility is either essential or hazardous and is located within Seismic Zone 3 or 4. The designer will determine the classification of the facility per TM 5-809-10 and provide a detail on the drawings showing this system.

ASCE has developed a "Public-Approved Version" of

ASCE 25-97 EARTHQUAKE ACTUATED AUTOMATIC GAS SHUTOFF DEVICES, dated March 27, 1998, which includes a test procedure to verify that the valve will activate during strong ground shaking but will not activate for minor ground shaking or accidental bumping by a pedestrian or vehicle.

The State of California, Division of the State Architect/Real Estate Services Division maintains a list of devices that have been tested and conform to the ASCE Standard; inquiries can be directed to telephone no. 916-445-2600.

Show the earthquake actuated automatic gas shutoff on the drawings when required in the project. The designer must fill the bracketed blank and ensure that a copy of ASCE 25-97 is included with the Contract documents.

Earthquake Actuated Automatic Gas Shutoff devices shall conform to [_____] [and] [requirements furnished by the Contracting Officer], and shall be listed by the State of California, Division of the State Architect as being tested and in conformance with specified requirements. The system shall safely interrupt the flow of gas to the building due to strong ground shaking of an earthquake.

2.6 EMERGENCY GAS SUPPLY CONNECTION

NOTE: Include emergency gas supply connections when the customer determines the ability to provide gas to the building is necessary during an outage of the gas distribution system. Show the emergency gas piping connection on the drawings when required in the project.

The emergency gas supply connection shall consist of piping (same size as service line) and accessories that will enable a portable, commercial-sized gas cylinder system to be connected to the gas piping system. This connection shall be capped to prevent gas leakage with a lockable manual valve located to be capable of shutting off flow. The entire assembly should be contained in a weatherproof, lockable box. The box shall contain permanently installed written instructions stating the type and pressure of the gas allowed to be connected to the line. The instructions shall also indicate and provide specific instruction for testing of the integrity of the building's gas system with an inert gas before the fuel gas connection is made. A subplate shall be provided in the box that is required to be unbolted to gain access to the connection. The subplate shall contain a warning regarding the potential consequences of using gas other than that specified or of failing to test system integrity before hooking up emergency fuel supply.

2.7 PROTECTIVE COVERING MATERIALS

Continuously extruded polyethylene and adhesive coating system materials shall conform to NACE RP0185, Type A.

2.8 TELEMETERING OR RECORDING GAUGES

NOTE: On distribution systems supplied by a single district pressure regulating station, the designer will determine the necessity of installing telemetering or recording gauges in the supply line, taking into consideration the number of buildings supplied, the operating pressures, the capacity of installation, and other operating conditions.

Each distribution system supplied by more than one district pressure regulating station shall be equipped with telemetering or recording pressure gauges to indicate the gas pressure in the district line.

PART 3 EXECUTION

3.1 EXCAVATION AND BACKFILLING

Earthwork shall be as specified in Section 02300 EARTHWORK.

3.2 GAS MAINS

Pipe for gas mains shall be [steel] [polyethylene] [or] [fiberglass]. [Steel pipe and fittings shall be coated with protective covering as specified.] [Polyethylene or fiberglass mains shall not be installed aboveground.]

3.3 SERVICE LINES AND EMERGENCY GAS SUPPLY CONNECTION

NOTE: Service line isolation valve will be located as close to the supply main as possible but at a safe distance from traffic lanes.

Service lines shall be constructed of materials specified for gas mains and shall extend from a gas main to and including the point of delivery within 1.5 meters (5 feet) 5 feet of the building. The point of delivery is the [meter set assembly] [service regulator] [shutoff valve]. The service lines shall be connected to the gas mains [as indicated] [through service tees, with end of run plugged]. Where indicated, service line shall be provided with an isolation valve of the same size as the service line. The service lines shall be as short and as straight as practicable between the point of delivery and the gas main and shall not be bent or curved laterally unless necessary to avoid obstructions or otherwise permitted. Service lines shall be laid with as few joints as practicable using standard lengths of pipe. Shorter lengths shall be used only for closures. Polyethylene or fiberglass service lines shall not be installed aboveground [except as permitted in ASME B31.8].

3.3.1 Emergency Gas Supply Connection

NOTE: If it is expected that a portable gas tank providing pressure regulated gas would be provided during an emergency, locate the emergency gas connection downstream of the building's pressure

regulator.

An aboveground locked, valved and capped emergency gas supply connection shall be provided [downstream] [upstream] of the pressure regulator. The connection shall be located outside of the building within 300 mm (12 inches) 12 inches of the exterior wall and installed in a weatherproof box which is mounted on the exterior wall and clearly marked with an appropriate metal sign mounted on wall above.

3.4 WORKMANSHIP AND DEFECTS

Pipe, tubing, and fittings shall be clear and free of cutting burrs and defects in structure or threading and shall be thoroughly brushed and blown free of chips and scale. Defective pipe, tubing, or fittings shall be replaced and shall not be repaired.

3.5 PROTECTIVE COVERING

3.5.1 Protective Covering for Underground Steel Pipe

Except as otherwise specified, protective coverings shall be applied mechanically in a factory or field plant especially equipped for the purpose. Valves and fittings that cannot be coated and wrapped mechanically shall have the protective covering applied by hand, preferably at the plant that applies the covering to the pipe. Joints shall be coated and wrapped by hand. Hand coating and wrapping shall be done in a manner and with materials that will produce a covering equal in thickness to that of the covering applied mechanically.

3.5.1.1 Thermoplastic Resin Coating System

The coating system shall conform to NACE RP0185, Type A. The exterior of the pipe shall be cleaned to a commercial grade blast cleaning finish in accordance with SSPC SP 6. Adhesive compound shall be applied to the pipe.

Immediately after the adhesive is applied, a seamless tube of polyethylene shall be extruded over the adhesive to produce a bonded seamless coating. The nominal thickness of the pipe coating system shall be 0.25 mm (10 mils) 10 mils (plus or minus 10 percent) of adhesive and 1.0 mm (40 mils) 40 mils (plus or minus 10 percent) of polyethylene for pipes up to 400 mm (16 inches) 16 inches in diameter. For pipes 450 mm (18 inches) 18 inches and larger in diameter, the pipe coating system thickness shall be 0.25 mm (10 mils) 10 mils (plus or minus 10 percent) adhesive and 1.5 mm (60 mils) 60 mils (plus or minus 10 percent) polyethylene. Joint coating and field repair material shall be applied as recommended by the coating manufacturer and shall be one of the following:

- a. Heat shrinkable polyethylene sleeves.
- b. Polyvinyl chloride pressure-sensitive adhesive tape.
- c. High density polyethylene/bituminous rubber compound tape.

The coating system shall be inspected for holes, voids, cracks, and other damage during installation.

3.5.1.2 Inspection of Pipe Coatings

Any damage to the protective covering during transit and handling shall be

repaired before installation. After field coating and wrapping has been applied, the entire pipe shall be inspected by an electric holiday detector with impressed current set at a value in accordance with NACE RP0274 using a full-ring, spring-type coil electrode. The holiday detector shall be equipped with a bell, buzzer, or other type of audible signal which sounds when a holiday is detected. All holidays in the protective covering shall be repaired immediately upon detection. The Contracting Officer reserves the right to inspect and determine the suitability of the detector. Labor, materials, and equipment necessary for conducting the inspection shall be furnished by the Contractor.

3.5.2 Protective Covering for Aboveground Piping Systems

Finish painting shall conform to the applicable paragraphs of Section 09900 PAINTING, GENERAL and as follows:

3.5.2.1 Ferrous Surfaces

Shop primed surfaces shall be touched up with ferrous metal primer same type paint as the shop primer. Surfaces that have not been shop primed shall be solvent-cleaned in accordance with SSPC SP 1. Surfaces that contain loose rust, loose mill scale, and other foreign substances shall be mechanically cleaned by power wire brushing in accordance with SSPC SP 3 or brush-off blast cleaned in accordance with SSPC SP 7 and primed with ferrous metal primer in accordance with SSPC Paint 25. Primed surfaces shall be finished with two coats of exterior alkyd paint conforming to MPI 9.

3.5.2.2 Nonferrous Surfaces

NOTE: Retain only the first sentence for normal conditions; delete the first sentence for corrosive conditions.

[Nonferrous surfaces shall not be painted.] [Nonferrous surfaces shall be painted due to corrosive conditions. The surfaces shall be solvent-cleaned in accordance with SSPC SP 1. A first coat of FS TT-E-2784, Type III, Flat, and 2 coats of FS TT-E-2784, Enamel [Type I, Gloss] [or] [Type II, Semigloss] shall be applied.]

3.5.3 Protective Covering for Piping in Valve Boxes and Manholes

Piping in valve boxes or manholes shall receive protective coating as specified for underground steel pipe.

3.6 INSTALLATION

NOTE: When existing gas piping is abandoned, show disconnect details on the drawings. Refer to ASME B31.8 for guidance on preparing the disconnect details. ASME B31.8 requires physical disconnection from gas sources. Shutoff valves are not an acceptable means of disconnect.

Gas distribution system and equipment shall be installed in conformance with the manufacturer's recommendations and applicable sections of ASME

B31.8, AGA XR0104 and 49 CFR 192. Abandoning existing gas piping shall be done in accordance with ASME B31.8. Pipe shall be cut without damaging the pipe. Unless otherwise authorized, cutting shall be done by an approved type of mechanical cutter. Wheel cutters shall be used where practicable. On steel pipe 150 mm (6 inches) and larger, an approved gas-cutting-and-beveling machine may be used. Cutting of plastic pipe shall be in accordance with AGA XR0104. Valve installation in plastic pipe shall be designed to protect the plastic pipe against excessive torsional or shearing loads when the valve is operated and from other stresses which may be exerted through the valve or valve box. [Polyethylene mains and service lines for LPG shall only be installed below ground in accordance with NFPA 58.]

3.6.1 Installing Pipe Underground

NOTE: Indicate profile of gas lines on the drawing.
If it is impractical to comply with the minimum
cover specified for pipe, and necessary to prevent
damage from external loads, the pipe will be
installed in a casing. The locations of all casings
and details of the installation will be indicated.

Gas mains and service lines shall be graded as indicated. Joints in steel pipe shall be welded except as otherwise permitted for installation of valves. Mains shall have 600 mm 24 inch minimum cover; service lines shall have 485 mm 18 inch minimum cover; and both mains and service lines shall be placed on firmly compacted select material for the full length. Where indicated, the main shall be encased, bridged, or designed to withstand any anticipated external loads as specified in ASME B31.8. The encasement material shall be standard weight black steel pipe with a protective coating as specified. The pipe shall be separated from the casing by insulating spacers and sealed at the ends with casing bushings. Trench shall be excavated below pipe grade, bedded with bank sand, and compacted to provide full-length bearing. Laying the pipe on blocks to produce uniform grade will not be permitted. The pipe shall be clean inside before it is lowered into the trench and shall be kept free of water, soil, and all other foreign matter that might damage or obstruct the operation of the valves, regulators, meters, or other equipment. When work is not in progress, open ends of pipe or fittings shall be securely closed by expandable plugs or other suitable means. Minor changes in line or gradient of pipe that can be accomplished through the natural flexibility of the pipe material without producing permanent deformation and without overstressing joints may be made when approved. Changes in line or gradient that exceed the limitations specified shall be made with fittings.

When cathodic protection is furnished, electrically insulated joints or flanges shall be provided. When polyethylene or fiberglass piping is installed underground, foil backed magnetic tape shall be placed above the pipe to permit locating with a magnetic detector. After laying of pipe and testing, trench shall be backfilled in accordance with Section 02300 EARTHWORK.

3.6.2 Installing Pipe Aboveground

Aboveground piping shall be protected against dirt and other foreign matter as specified for underground piping. Joints in steel pipe shall be welded; however, joints in pipe 40 mm (1-1/2 inches) 1-1/2 inches in diameter and smaller may be threaded; joints may also be threaded to accommodate the

installation of valves. Flanges shall be of the weld neck type to match wall thickness of pipe.

3.7 PIPE JOINTS

Pipe joints shall be designed and installed to effectively sustain the longitudinal pullout forces caused by the contraction of piping or superimposed loads.

3.7.1 Threaded Steel Joints

Threaded joints in steel pipe shall have tapered threads evenly cut and shall be made with UL approved graphite joint sealing compound for gas service or polytetrafluoroethylene tape applied to the male threads only. Caulking of threaded joints to stop or prevent leaks will not be permitted.

3.7.2 Welded Steel Joints

Gas pipe weldments shall be as indicated. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connection may be made with either welding tees or forged branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.8. Weld defects shall be removed and repairs made to the weld, or the weld joints shall be entirely removed and rewelded. After filler metal has been removed from its original package, it shall be protected or stored so that its characteristics or welding properties are not affected adversely. Electrodes that have been wetted or have lost any of their coating shall not be used.

3.7.3 Polyethylene and Fiberglass Pipe Jointing Procedures

Jointing procedures shall conform to AGA XR0104. Indiscriminate heat fusion joining of plastic pipe or fittings made from different polyethylene resins by classification or by manufacturer shall be avoided if other alternative joining procedures are available. If heat fusion joining of dissimilar polyethylenes is required, special procedures are required. The method of heat fusion joining dissimilar polyethylene resins shall be tested in accordance with paragraph TESTS, subparagraph Destructive Tests of Plastic Pipe Joints.

3.7.4 Connections Between Metallic and Plastic Piping

Connections shall be made only outside, underground, and with approved transition fittings.

3.8 VALVE BOXES

Valve boxes of cast iron not less than 4.7 mm (3/16 inch) 3/16 inch thick shall be installed at each underground valve except where concrete or other type of housing is indicated. Valve boxes shall be provided with locking covers that require a special wrench for removal. Wrench shall be furnished for each box. The word "gas" shall be cast in the box cover. When the valve is located in a roadway, the valve box shall be protected by a suitable concrete slab at least 1 square meter. 3 square feet. When in a sidewalk, the top of the box shall be in a concrete slab 600 mm 2 feet square and set flush with the sidewalk. Boxes shall be adjustable

extension type with screw or slide-type adjustments. Valve boxes shall be separately supported, not resting on the pipe, so that no traffic loads can be transmitted to the pipe. Valves shall only be located in valve boxes or inside of buildings.

3.9 DRIPS

NOTE: If gas mains are for the distribution of high-pressure natural gas (above 400 kPa (60 psig)) only, delete the entire paragraph: DRIPS. Require drips for lines transmitting natural gas at the low point immediately following reduction from high pressure (above 400 kPa (60 psig)) to medium pressure (400 kPa (60 psig) or less), and at occasional low points throughout the system, to provide for blowing out the lines. Require drips at all low points in lines transmitting manufactured gas or a mixture of manufactured and natural gas. Indicate locations of drips. Locate drip points to provide for proper drainage of pipe system. Detail drips and discharge terminal (outlet) piping. If the need to contain and dispose of liquids through the valve for environmental concerns is required, delete the first bracketed sentence.

Drips shall be installed at locations where indicated. Drips shall conform to the details shown or may be commercial units of approved type and capacity. A blow off pipe 32 mm (1-1/4 inches) 1-1/4 inches or larger shall be connected to each drip at its lowest point and shall extend to or near the ground surface at a convenient location away from traffic. Discharge for each drip terminal (outlet) shall be provided with a reducing fitting, a plug valve, and a 15 mm (1/2 inch) 1/2 inch nipple turned down. The discharge terminal (outlet) shall be inside a length of 300 mm 12 inches or larger vitrified clay pipe, concrete sewer pipe or concrete terminal box [set vertically on a bed of coarse gravel 300 mm 1 foot thick and 1 m 3 feet square,] [with concrete bottom to contain liquids and a connection to remove liquids for disposal,] and closed at the ground surface with a suitable replacement cover.

3.10 PRESSURE REGULATOR INSTALLATION

3.10.1 Main Distribution Line Regulators

NOTE: Remove reference to bypasses around pressure regulators for main distribution lines unless continuity of service is imperative and the bypass is regulated to prevent possible overpressure of downstream lines.

Pressure regulators shall be installed where shown. A valve shall be installed on each side of the regulator for isolating the regulator for maintenance. A bypass line with bypass valves or 3 way valves and an overpressurization pressure regulating device shall be provided. Regulators and valves shall be installed in rectangular reinforced concrete boxes. Boxes shall be large enough so that all required equipment can be

properly installed, operated, and maintained. Sidewalls shall extend above ground line. The boxes shall be provided with [steel door] [cast iron manhole] covers with locking provisions and 100 mm (4 inch) 4 inch diameter vents. One key or other unlocking device shall be furnished with each cover. Discharge stacks, vents, or outlet ports of all pressure relief devices shall be located where gas can be discharged into the atmosphere without undue hazard. Stacks and vents shall be provided with fittings to preclude entry of water.

3.10.2 Service Line Regulators

NOTE: Delete inapplicable requirements.

A shutoff valve, meter set assembly, and service regulator shall be installed on the service line outside the building, 450 mm 18 inches above the ground on the riser. An insulating joint shall be installed on the inlet side of the meter set assembly and service regulator and shall be constructed to prevent flow of electrical current. A 10 mm (3/8 inch) 3/8 inch tapped fitting equipped with a plug shall be provided on both sides of the service regulator for installation of pressure gauges for adjusting the regulator. All service regulator vents and relief vents shall terminate in the outside air in rain and insect resistant fittings. The open end of the vent shall be located where gas can escape freely into the atmosphere, away from any openings into the building and above areas subject to flooding.

3.11 METER INSTALLATION

Meters shall be installed in accordance with ASME B31.8. Permanent gas meters shall be installed with provisions for isolation and removal for calibration and maintenance, and shall be suitable for operation in conjunction with an energy monitoring and control system.

3.12 CONNECTIONS TO EXISTING LINES

NOTE: If connections to existing mains are required, retain this subparagraph, and select the appropriate Paragraph. Drawings will show existing gas lines when interface with the existing gas system is required.

Connections between new work and existing gas lines, where required, shall be made in accordance with ASME B31.8, using proper fittings to suit the actual conditions. When connections are made by tapping into a gas main, the connecting fittings shall be the same size as the pipe being connected.

3.12.1 Connections to Publicly or Privately Operated Gas Utility Lines

NOTE: Delete inapplicable requirements.

Contractor shall provide materials for the connections to the existing gas lines. Final connections and the turning on of gas shall be made by the utility. Existing lines that are to be abandoned or taken out of service shall be disconnected, purged and capped, plugged or otherwise effectively

sealed by the Utility. The Contractor shall notify the Contracting Officer, in writing, 10 days before final connections and turning on of gas lines. The Contractor shall make necessary arrangements with the Utility for tie in and activation of new gas lines. Only the Operating Agency/Utility Company may reactivate the system after tie in. The Contractor shall furnish a certification by the Operating Agency/Utility Company that all Utility work has been satisfactorily completed.

3.12.2 Connection to Government Owned/Operated Gas Lines

NOTE: Provide the name and location of the utility or operating agency of the existing gas lines. Show on the drawings, the location of valves to be operated for existing system deactivation. When lines are to be abandoned, consideration shall be given to any effects the abandonment may have on an active cathodic protection system and appropriate action taken. If the segment is long and there are few line valves, consideration should be given to plugging the abandoned segment at intervals.

The Contractor shall provide connections to the existing gas lines in accordance with approved procedures. Deactivation of any portion of the existing system shall only be done at the valve location shown on the drawings. Reactivation of any existing gas lines will only be done by the Government. The Contractor's Connection and Abandonment Plan shall be submitted and approved prior to making any connections to existing gas lines. This plan shall include the Operating Agency's required procedures which may be obtained from [____]. The Contractor shall notify the Contracting Officer, in writing, 10 days before connections to existing lines are to be made.

a. If facilities are abandoned in place, they shall be physically disconnected from the piping system. The open ends of all abandoned facilities shall be purged, capped, plugged or otherwise effectively sealed. Abandonment shall not be completed until it has been determined that the volume of gas or liquid hydrocarbons contained within the abandoned section poses no potential hazard. Air or inert gas may be used for purging, or the facility may be filled with water or other inert material. If air is used for purging, the Contractor shall ensure that a combustible mixture is not present after purging.

b. When a main is abandoned, together with the service lines connected to it, only the customer's end of such service lines is required to be sealed as stipulated above.

c. Service lines abandoned from the active mains shall be disconnected as close to the main as practicable.

d. All valves left in the abandoned segment shall be closed.

e. All abovegrade valves, risers, and vault and valve box covers shall be removed. Vault and valve box voids shall be filled with suitable compacted backfill material.

3.13 CATHODIC PROTECTION

NOTE: Cathodic protection is mandatory for underground metallic gas distribution lines. The type and design of cathodic protection will be in accordance with TM 5-811-7. Stations will be provided for testing the cathodic protection system.

Cathodic protection shall be provided for all metallic gas piping installed underground and shall be installed as specified in [Section 13110ACATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE)] [Section 13112A CATHODIC PROTECTION SYSTEM (IMPRESSED CURRENT)].

3.14 TESTS

3.14.1 Destructive Tests of Plastic Pipe Joints

NOTE: Destructive tests of plastic pipe joints are provided as a designer option. Destructive tests are considered useful in assuring that good joints will be made. Delete the paragraph if this option is not exercised.

Each day, prior to making polyethylene heat fusion joints or fiberglass adhesive joints, a joint of each size and type to be installed that day shall be made by each person performing joining of plastic pipe that day and destructively tested. At least 3 longitudinal straps shall be cut from each joint. Each strap shall be visually examined, shall not contain voids or discontinuities on the cut surfaces of the joint area, and shall be deformed by bending, torque, or impact, and if failure occurs, it must not initiate in the joint area. If a joint fails the visual or deformation test, the qualified joiner who made that joint shall not make further field joints in plastic pipe on this job until that person has been retrained and requalified. The results of the destructive tests shall be recorded to include the date and time of the tests, size and type of the joints, ambient conditions, fusion iron temperature and names of inspectors and joiners.

3.14.2 Pressure and Leak Tests

NOTE: Specify correct test pressure (including Class Location) to be used for tests of gas line systems in accordance with ASME B31.8. Test pressures should recognize the weakest component of each system tested for the design pressure, the maximum allowable operating pressure, and the gas supplier's maximum operating pressure.

The test pressure will be 150 percent of the maximum operating pressure or 350 kPa (50 psig), whichever is greater. However, the maximum test pressure must not be more than three times the design pressure of the pipe.

The system of gas mains and service lines shall be tested after construction and before being placed in service using air as the test medium. The normal operating pressure for the system is [____]. The test pressure is [____]. Prior to testing the system, the interior shall be blown out, cleaned and cleared of all foreign materials. All meters, regulators, and controls shall be removed before blowing out and cleaning and reinstalled after clearing of all foreign materials. Testing of gas mains and service lines shall be done with due regard for the safety of employees and the public during the test. Persons not working on the test operations shall be kept out of the testing area while testing is proceeding. The test shall be made on the system as a whole or on sections that can be isolated. Joints in sections shall be tested prior to backfilling when trenches must be backfilled before the completion of other pipeline sections. The test shall continue for at least 24 hours from the time of the initial readings to the final readings of pressure and temperature. The initial test readings of the instrument shall not be made for at least 1 hour after the pipe has been subjected to the full test pressure, and neither the initial nor final readings shall be made at times of rapid changes in atmospheric conditions. The temperatures shall be representative of the actual trench conditions. There shall be no indication of reduction of pressure during the test after corrections have been made for changes in atmospheric conditions in conformity with the relationship $T(1)P(2)=T(2)P(1)$, in which T and P denote absolute temperature and pressure, respectively, and the numbers denote initial and final readings. During the test, the entire system shall be completely isolated from all compressors and other sources of air pressure. Each joint shall be tested by means of soap and water or an equivalent nonflammable solution prior to backfilling or concealing any work. The testing instruments shall be approved by the Contracting Officer. All labor, materials and equipment for conducting the tests shall be furnished by the Contractor and shall be subject to inspection at all times during the tests. The Contractor shall maintain safety precautions for air pressure testing at all times during the tests.

-- End of Section --