PIPING DESIGN AND TEST REQUIREMENTS A-34

Department:	Gas System Maintenance and Technical Support	**Section:**	System Integrity
Approved by:	[redacted]	**Approved by:** S. Y. Chwistek	**Date:** 10-19-98

Rev. #01: This document replaces Revision #00. For a description of changes, see Page 6.

Purpose and Scope

This gas standard establishes a uniform procedure for designing and testing gas piping systems that will meet the requirements of 49 Code of Federal Regulations (CFR), Part 192.

Note

California Public Utilities Commission (CPUC) General Order (G.O.) 112E, Section 125, requires written and verbal notification of certain work. See Gas Standard A-34.1, "General Requirements Work Reportable to the California Public Utilities Commission," for these requirements.

Definitions

The following definitions shall apply to this gas standard.

1. "Class Location" is a geographic area as classified and described in 49 CFR 192 and CGT Standard S4127.
2. "Design Factor" is the percentage of SMYS to which operating stress is limited, as further described in 49 CFR 192.
3. "Design Pressure" (D.P.) is the maximum operating pressure permitted by regulation as determined by design procedures. Design pressure depends on the pipe's size, wall thickness, composition material, and proposed location.
4. "Hoop Stress" is the stress in a pipe wall, acting circumferentially in a plane perpendicular to the longitudinal axis of the pipe, and produced by the pressure of the medium in the pipe.
5. "Leak Test" is a pressure test to determine the tightness of the system.
6. "Maximum Allowable Operating Pressure (MAOP)" is the maximum pressure at which a gas pipeline, pipeline segment, or component is qualified to operate according to the requirements of 49 CFR 192.
7. "Maximum Operating Pressure (MOP)" is the maximum pressure at which a system may be operated according to the criteria established in DCS/GTS Standard D-S0430/S4125.
8. "Operating Stress" is the stress in a pipe or structural member under normal operating conditions.
9. "Specified Minimum Yield Strength (SMYS)" is the minimum yield strength in pounds per square inch (psi) prescribed by the specification under which the pipe is purchased from the manufacturer or as specified in 49 CFR 192.
10. "Strength Test" is a pressure test to prove the mechanical strength of the system.
11. "Stress" is the resultant internal force per unit area that opposes change in the size or shape of a body that is acted on by external forces.
12. "Test Medium" is a substance such as water, air or gas used to exert an internal pressure to leak or strength test a facility.
13. "Test Pressure" is the pressure of the medium specified for testing.

General Information

1. Filing Information

   Revision 01 supersedes any previous instructions which are contrary to the content of this gas standard.

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Piping Design and Test Requirements

2. Policy and Application

All new and reconstructed gas piping systems and facilities are to be designed and tested according to the requirements of 49 CFR 192. This includes abandoned or temporarily disconnected piping that is reinstated.

3. Responsibility

A. The responsible engineer shall prepare a "Gas Pipeline Facilities Strength Test Pressure Report" (see Appendix E) for each facility designed to support a MAOP of 100 pounds per square inch gauge (psig) or greater. The engineer shall ensure that all applicable information is completed in "Part 1 – Design Data." These reports shall accompany the construction documents to the field.

B. The supervisor responsible for the facility's construction shall ensure it is tested according to this gas standard. Before testing any facility designed to support a MAOP of 100 psig or greater, the supervisor shall verify that a "Gas Pipeline Facilities Strength Test Pressure Report," with "Part I – Design Data" completely filled out and signed, is available at the jobsite. The supervisor shall also verify that the pipe specifications and footages are correct before proceeding with the test. After finishing the test, the supervisor shall complete "Part II - Test Data."

C. The engineer and the construction supervisor are responsible for ensuring that all other applicable provisions of 49 CFR 192 are followed when designing, constructing, and testing a facility.

4. Design

A. A design criteria stamp (see Figure 1 on Page 3) shall be completed for each size, specification, grade, seam-type and wall thickness of pipe shown on Plan and Profile/Sections sheets. A separate design criteria stamp is required for each MAOP to be established and for each test pressure. The D.P. and MAOP to be specified on the design criteria stamp are for the pipe segment to be tested.

B. When determining design requirements to establish the MAOP, consideration shall be given to the :

(1) Future development of the area.

(2) Current and future gas supply pressures.

(3) Probability of increases in supply pressure.

C. The design formula for steel pipe is given below.

$$P = \frac{2St}{D} \times F \times E \times T$$

Where: P = maximum allowable design pressure, psig
S = SMYS, psi
D = outside diameter, inches
t = nominal wall thickness, inches
F = design factor determined according to 49 CFR 192.111
E = longitudinal joint factor determined according to 49 CFR 192.113
T = temperature derating factor determined according to 49 CFR 192.115

D. Pressure ratings for fittings, valves and other piping components shall be equal to or greater than the design pressure established for the piping system.

E. Initial Construction

The design of all new gas facilities and any subsequent additions or alterations to existing facilities shall meet the expected future Class Location and, as a minimum, the planned future MAOP requirements of the pipeline. Appendices B and C of this gas standard contain specifications for commercially available pipe commonly used at PG&E. Other sizes and wall thicknesses are available from pipe manufacturers. Consult the Gas System Maintenance and Technical Support Department, Pipeline Engineering section for assistance.

F. Requirements for Pipeline Construction Drawings

Appendix F and Appendix G provide the content, format, technical and professional engineering review requirements for pipeline plan and profile construction drawings.

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DESIGN CRITERIA

LOCATION CLASS _____

DESIGN FACTOR _____

D.P. _____ SMYS _____ %

MAOP _____ SMYS _____ %

STRENGTH TEST PRESSURE

MAX. _____ PSIG _____ % SMYS

MIN. _____ PSIG _____ % SMYS

_____ PSIG = 90% SMYS

TEST MEDIUM _____

PIPE SPEC. _____

O.D. _____

W.T. _____

WELD INSPECTION (GAS STD. D-40)*

☐ RADIOGRAPHIC INSPECTION REQUIRED

☐ 20% MIN. (% of each welder's daily work)

☐ 100%

*VISUALLY INSPECT 100% OF ALL WELDS THAT ARE NOT RADIOGRAPHICALLY INSPECTED. (THIS REQUIREMENT APPLIES EVEN IF NO RADIOGRAPHIC INSPECTION IS REQUIRED.)

See Paragraph 4.A on Page 2

Figure 1
Design Criteria Stamp

5. Inspection

   A. Welds shall be inspected as required by Gas Standard D-40, "Weld Inspection."

   B. Girth welds used to tie-in fabricated units and short sections of pipe shall be inspected as required by Gas Standard D-40.

   C. Trench, pipe and pipe coating shall be inspected as required by Gas Standard A-36, "Design and Construction Requirements – Gas Lines and Related Facilities."

6. Testing

   A. All new, replaced or reconnected pipelines and facilities transporting natural gas shall be tested according to the requirements in this gas standard. Except as documented in Notes 2 and 3 to Table A-1 in Appendix A on Page 8, the test shall be conducted after the pipeline and/or facilities have been installed.

   B. The test medium shall be one permitted by Note 6 to Table A-1 in Appendix A on Page 8. Factors to be considered when choosing a test media shall include safety, availability and economy.

   C. Test pressure shall not be less than that required by Appendix A to test the tightness and strength of a system. All lines shall be tested according to Appendix A.

   D. Pipe held for emergency use shall be tested as specified in Appendix A.

   E. Pipelines should be tested as required to support a MAOP equal to the design pressure. Testing to support only a lower MAOP is acceptable, but an additional test or uprating will be required to justify any subsequent increases in the MAOP.

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F. Facilities Damaged by Construction Work

(1) All facilities known or suspected to have been struck during excavation or construction activities shall be checked to ensure their safety if they are to remain in service.

(2) Transmission and Distribution Lines

The inspection, repair and testing required for a damaged transmission or distribution line will depend on the extent of the damage and other conditions, which can best be determined by the responsible supervisor in the field. However, adequate steps must be taken, either by testing or leak survey, to ensure leaks are not present.

(a) Repairs to damaged steel transmission or distribution lines shall be made according to Gas Standard A-65, "Repair of Steel Pipeline Defects."

(b) Repairs to damaged plastic mains shall be made according to Gas Standard A-93.1, "Polyethylene Pipes."

(c) Special attention shall be given to a damaged casing for a plastic insert. Ensure that the damage did not result in a failure in the plastic at another location remote from the point of contact.

(3) Service Lines (Including Service Risers)

(a) If a steel, copper or other metallic service line or the casing for a metallic insert has been broken, bent, pulled, crushed, or otherwise deformed, the service shall be tested from tee to riser according to Appendix A.

(b) Steel, copper or other metallic service lines or casings for metallic inserts that have been hit but not moved or deformed, may be leak surveyed with a leak detector as an alternate check. The survey should include the entire length of the service and adjacent areas, as appropriate.

(c) See Gas Standard A-93.1 for a description of approved plastic lines and plastic inserts and for information on testing plastic service risers which may have been exposed to excessive heat.

(d) All service risers that have been struck and/or damaged in above-ground incidents shall be leak surveyed with a leak detector. The survey shall include the service line adjacent to the customer's building and/or other areas, as appropriate.

G. Instrument Lines

Although testing instrument piping is not explicitly required by regulation, it is a prudent engineering practice to test all buried instrument piping that is subjected directly to mainline gas pressures. Buried instrument piping shall be tested according to the applicable test requirements in Table A-1. It is not necessary to test tubing, but all fittings and connections should be checked for leaks after start-up.

H. Branch Connections and Fittings

(1) For installation of a hot tap branch connection with reinforcement pad or sleeve, the branch-to-header weld shall be leak tested for a minimum of 5 minutes before installing the reinforcement pad or sleeve. The minimum test pressure shall be 100 psig. The maximum test pressure shall be 110 psig.

(2) When installing line stopper fittings, the fitting shall be leak tested for a minimum of 5 minutes after it has been completely welded to the pipe and before tapping. The minimum test pressure shall be 100 psig. The maximum test pressure shall be 110 psig.

7. Test Limitations on Valves

A. When performing a hydrostatic test on a line, the test pressure to which a valve may be subjected shall not exceed the manufacturer's shell test pressure. Where the required MAOP of the line cannot be established because of these limitations, an engineering study shall be made to verify that it is safe to subject the valve to the higher pressure during the test. When making this study, consideration shall be given to:

(1) The pressure to which the valve was tested by the manufacturer,

(2) The age and condition of the valve, and

(3) The effect of stresses which may be transmitted to the valve by the pipeline.

B. When performing a test with air or inert gas, or an uprating with natural gas, the pressure to which a valve may be subjected shall be limited to 110% of the maximum working pressure of the valve. Where the required MAOP of the line cannot be established because of this limitation, the responsible operating department shall

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determine whether a higher test pressure may be permitted. This limitation shall not apply to the 100 psig air test on a service line.

C. When a valve is to be subjected to a test pressure which is greater than its maximum working pressure, it shall normally be in the open position. However, with prior approval from the responsible operating department, closed valves may be subjected to a hydrostatic test pressure exceeding their maximum working pressure. Approval will depend on the type and condition of the valve and will only be given with the limitations that (1) the differential pressure not exceed the working pressure and (2) the test pressure not exceed the manufacturer's shell test pressure.

D. When practical, mainline valve assemblies shall be tested separately from pipeline construction to prevent damage to the valves during the initial pipeline pigging. The separate valve assembly test shall be followed by a 100 psig leak test of the valve seats before welding the assembly in the pipeline.

8. Records

A. Facilities Designed to Operate at 100 psig or Greater

(1) Estimate sketches and design drawings shall contain the following information: specifications of pipe, fittings, and valves; design pressure; MAOP; class location; design factor and strength or leak test information. Where more than one size of pipe is involved, the required information shall be supplied for each size and type.

(2) A "Gas Pipeline Facilities Strength Test Pressure Report" (see Appendix E) is required for each facility being tested to support a MAOP of 100 psig or greater (see Appendix A).

(3) If the line is to have a MAOP equivalent to 30% of SMYS or greater, a test chart is required (see Paragraph 9, "Test Chart").

(4) If any portion of a line is tested to over 90% SMYS, a Dead Weight Tester (DWT) shall be in service continuously during the test in addition to the pressure recording chart. A log of the DWT reading shall be made every 1/2 hour. The pressure recording chart and the DWT log shall be submitted with the "Gas Pipeline Facilities Strength Test Pressure Report." The DWT log shall be considered the official record of the test. In the event that the DWT fails during the test, the pressure recording chart may be accepted as the official test record.

(5) "Job Estimate," form 62-6251, shall be marked by the person preparing the estimate to indicate if the pipe must be strength tested.

B. Facilities Designed to Operate at Less Than 100 psig

For facilities designed to operate at less than 100 psig, test information shall be recorded on the "Gas Service Record" form, on the estimate sketch, and on the work order or other authorized form.

C. For systems being uprated, it is required to complete a test chart according to Paragraph 9.

D. All required test records shall be retained by the responsible operating department for the useful life of the facility.

9. Test Chart

A chart record shall be made of the pressure test on all upratings and on pipelines being tested to support a MAOP equivalent to 30% of SMYS or greater. The procedure for handling the chart and the minimum information required on the chart are described below.

A. The chart shall be designed for the recorder on which it is to be used and shall have appropriate scale and time lines.

B. The recorder should have been calibrated no more than six months before the date of the test. The recorder's calibration records shall be checked before conducting the test.

C. The chart shall be set on the correct time at the start of the test. The actual time, date and initials of the person starting the test shall be written on the face of the chart at the start of the test.

D. The chart shall document a minimum of 8 hours of testing (except where a 4-hour test is permitted in Appendix A). Any discrepancies shall be explained.

E. At the end of the test, the actual time, date and initials of the person removing the chart shall be written on the face of the chart.

F. The section of pipe being tested shall be identified on the face of the chart, along with the job number.

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G. The following information shall be recorded on the back of the chart at the time of the test.
   (1) job number
   (2) location of test
   (3) test pressure, date and duration
   (4) size, wall thickness, pipe specification and length of section tested
   (5) serial number of the recorder or other means of identification
   (6) date the recorder was last calibrated and serial number of the DWT or other reference standard used

H. After the test is completed, the supervisor shall review the chart and then sign and date it to verify that it complies with the requirements of this gas standard.

I. The original test chart shall be attached to the original of the "Gas Pipeline Facilities Strength Test Pressure Report," form 62-4921. A copy of the test chart shall be attached to each copy of the "Gas Pipeline Facilities Strength Test Pressure Report." This record shall be retained for the life of the facility.

10. Appendices
   A. Test Requirements
   B. Steel Pipe Specifications - (API) 5L Grades B, A-25, X-42, X-52, X-60, X-65
   C. Minimum Wall Thickness for Special Applications
   D. Emergency Pipe Test Information Form
   E. Gas Pipeline Facilities Strength Test Pressure Report
   F. Requirements for Pipeline Plan and Profile Construction Drawings
   G. Required Information for Pipeline Construction Drawings

Revision Notes

Revision 01 has the following changes:

1. Editing done throughout; reformatted and/or rearranged portions of text; corrected typos; added and revised notes; corrected paragraph references; updated code and organizational references.
2. Revised weld inspection requirements shown on Design Criteria Stamp (Page 3).
3. Rearranged columns in Table A-1 of Appendix A; renumbered accompanying notes; added new Note 11 on leak testing cut, test, and transferred services in low pressure distribution systems.
4. Consolidated pipe specification tables into one appendix (Appendix B). In all tables deleted "Mill Test Pressure" column. Recalculated pressures in "Pressure at % of SMYS" columns (all pressures rounded up; e.g., 654.42 psig is shown in the table as 657 psig).
5. Revised Appendix C. Revised title to clarify the purpose of the table. Deleted Column and note pertaining to pipelines.
6. Added new Appendix E on Strength Test Pressure Report form and instructions. Instructions were previously found in the "Engineers Estimators Manual."
7. This document is part of Change 44.

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Appendix A – Test Requirements

Table A-1 Test Requirements for Pipelines, Mains, Services, Instrument Lines and Other Gas Facilities

Proposed MAOP		Plastic (See Note 1 on Page 8)	Steel					
			Less Than or Equal to 60 psig (Including Low Pressure)	Over 60 and Less Than 100 psig	Under 30% SMYS and At or Above 100 psig	30% SMYS or More		Pretested Pipe for Emergency Use (See Note 3 on Page 8)
Component to be Tested		Including Fabricated Units and Short Sections of Pipe				Pipeline (Including Fabricated Units Tested in Place)	Fabricated Units, Short Sections of Pipe (See Note 2 on Page 8)	
Type of Test		Leak	Leak	Leak	Strength	Strength	Strength	Strength
Test Medium (See Note 4 on Page 8)		Air or Gas (See Note 5 on Page 8)			Water, Air, Inert Gas, or Gas (See Notes 5, 6 and 7 on Page 8)			Water
Maximum Test Pressure (See Notes 6 and 7 on Page 8)		3 x Design Pressure	110 psig	300 psig	(See Notes 8 and 9 on Page 8)	100% SMYS or Factory Test Pressure of Fitting (See Notes 8 and 10 on Pages 8 and 9)		100% SMYS
Minimum Test Pressure		100 psig or 1.5x MAOP Whichever is Greater	100 psig (See Note 11 on Page 9)	1.5 x MAOP	1.5 x Design Pressure (See Note 12 on Page 9)	1.5 x Design Pressure (See Notes 10 and 12 on Page 9)		90% SMYS (Recom-mended)
Duration of Test		5 Minutes (For Plastic, See Note 13 on Page 9)			1 Hour Minimum (See Note 14 on Page 9)	8 Hours Minimum (See Note 14 on Page 9)	4 Hours Minimum (See Note 14 on Page 9)	4 Hours Minimum
Test Records Required (See Note 15 on Page 9)	Forms Required	Complete Box on Job Estimate Form or Gas Service Record Form			Completed Strength Test Pressure Report			
	Test Chart	No (See Note 16 on Page 9)			No (See Note 16 on Page 9)	Yes (See Note 17 on Page 9)		

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Appendix A, continued

Notes

1. The temperature of thermoplastic material shall not be more than 100°F, or the temperature at which the material's long-term hydrostatic strength has been determined under ASTM D 2513, whichever is greater.
2. Pre-installation Tests

   For fabricated units and short sections of pipe for which a post-installation test is impractical, a pre-installation test may be substituted. The pre-installation test shall be conducted whenever possible at the jobsite and shall comply with the pressure requirements for a post-installation test. If the test cannot be conducted at the jobsite, the pipe shall be visually inspected before installation to ensure that it has not been damaged during transit to the jobsite. For Gas Standard A-34, the following definitions shall apply:

   A. A short section of pipe is defined as a single piece of pipe containing no girth welds.

   B. A fabricated unit is defined as an assembly of one or more fittings, equipment and/or pieces of pipe joined together. A full 8-hour test shall be conducted if the fabricated unit contains (excluding fittings and equipment) over 40 feet of pipe.
3. Testing Emergency Pipe

   A. The following blocks in Part 1 of the "Gas Pipeline Facilities Strength Test Pressure Report" should not be completed for emergency pipe since it is not known at the time of the test where the pipe will be installed: "Location Class," "Design Factor," "MAOP of Existing Facilities," "MAOP to be Established by this Test," "Design Pressure – This Section (Use Future Design Pressure whenever possible,)" and "% of SMYS at Design Pressure."

   B. It is recommended that all emergency pipe be tested to a minimum of 90% of SMYS for a minimum of 4 hours.

   C. The Emergency Pipe Test Information form (see Appendix D) shall be completed after the strength test and attached to the "Gas Pipeline Facilities Strength Test Pressure Report."

   For emergency repairs, some exceptions to the design and test requirements may be permitted, but only with the approval of the Gas System Maintenance and Technical Support (GSM&TS) Department, Pipeline Engineering section.
4. All tests to over 50% of SMYS should be performed with water as the test medium, unless such a test is impractical. Where a hydrostatic test is impractical, air or inert gas may be used, with the limitations shown in Note 6 on Page 8. When a test using air or inert gas is being performed, buildings within 300 feet of the test section must be evacuated.
5. Testing using water, air or inert gas is not normally permitted where the test section is isolated from an operating line by only a closed valve, squeeze-off equipment or plugging equipment. This is because a leak may occur, creating an undesirable and potentially hazardous situation. If the test must be performed under these conditions, obtain approval from a GSM&TS Pipeline Engineer (see Appendix F, Professional Engineering Review). Additional precautions may be required in order to minimize the possibility of an accident. For test limitations on valves, see Paragraph 7 on Page 4.
6. Maximum test pressure permitted, expressed as a percent of SMYS.

Class Location	1	2	3	4
Air or Inert Gas (See Note 4 on Page 8)	80	75	50	40
Natural Gas	80	30	30	30
Water	100	100	100	100

7. Safety – When testing with air, inert gas or natural gas, the pressure shall be held at about 100 psig and observed for leakage before raising to the required test pressure.
8. Maximum test capabilities of fittings (i.e., valves and elbows) must be determined before testing (see Paragraph 7 on Page 4).
9. For facilities operating at under 30% of SMYS and at or above 100 psig, the maximum test pressure shall be determined by the project engineer. A reasonable differential between maximum and minimum test pressures should be allowed, considering elevation differentials and the requirements of Note 8.

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Appendix A, continued

10. Testing Pipelines and Station Piping
    A. All pipelines 6 inches and larger, designed to operate at more than 40% of SMYS shall be tested to a minimum of 90% of SMYS, and as close to 100% of SMYS as practical. (Tests of ERW pipe should be limited to a maximum of 95% of SMYS.) This will permit them to continue to operate at an established MAOP should a class location change occur. Do not use a test to 90% of SMYS as an alternative to designing a pipeline to meet a higher class location which may reasonably be anticipated to occur in the future.
    B. For pipelines 6 inches and larger which are designed to operate at over 20% of SMYS, up to 40% of SMYS, consideration should be given to test to a minimum of 90% of SMYS. Testing to this pressure will provide additional assurance of the integrity of the line and will minimize the possibility of a failure due to stress resulting from soil settlement or other environmental effects. The decision to conduct a test to the higher pressure should be based on engineering judgment, and take into account:
        1. The importance of the line to meet system demand, and
        2. Any potential environmental effects on the line as might be caused by intense development or heavy construction near the line.
    C. It is often not practical to test station piping to 90% of SMYS because of limitations of valves, flanges and other devices. In these cases, the station will not be able to continue to operate after a class location change that results in a design factor lower than the required minimum 0.5 design factor for stations. Therefore, it is extremely important that the station be designed for the lowest design factor that might occur during the life of the station. If an area is anticipated to change in the near future to Class 4, use a 0.4 design factor so the station can continue to operate after the change.
11. Cut, test, and transferred services in low pressure distribution systems that will remain low pressure shall be leak tested to 10 psig. This includes:
    A. Services which must be extended with new pipe in order to tie into the new main, and
    B. Repaired services (i.e., services with segments that have been repaired or replaced with new pipe).
12. The minimum test pressure shall not be less than 1.5 times the design pressure in Class 2, 3 and 4 locations, and not less than 1.25 times the design pressure in a Class 1 location. The only exception is for transmission lines where testing to 1.5 times the design pressure creates problems due to limitations imposed by valves (see Note 8) and where the future MAOP to be established is below the design pressure. The minimum test pressure may then be limited to 1.5 times the MAOP, with the approval of the GSM&TS Pipeline Engineering Section (see Appendix F, professional engineering review).
13. Although the test duration for plastic pipe is 5 minutes, it is desirable to maintain the test pressure for a longer period of time if the construction schedule permits. If the pipe is not gassed up on the same day as the test, it shall be retested before gassing up.
14. Where pipelines are installed on street or highway bridges under permits from governmental agencies, more stringent testing may be required by the agency than would be required by this gas standard. For pipelines with a MAOP over 200 psig located on California state bridges, the test pressure shall be maintained for a minimum of 24 hours.
15. All records which document leak and strength tests shall be retained for the life of the facility.
16. Table A-1 on Page 7 indicates test chart requirements for new facilities. Test charts are required for all upratings regardless of the operating pressure of the line.
17. Test charts shall be completed and retained as outlined in Paragraph 9 on Page 5.

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Appendix B – Steel Pipe Specifications

Notes

1. The symbols and abbreviations used in the tables in this appendix refer to the following:

   API – American Piping Institute

   ERW – Electric Resistance Welded

   DSAW – Double Submerged Arc Welded

   SMYS – Specified Minimum Yield Strength

   20%, 30%, etc. means % of SMYS.

2. A-25 and X-42 are the most economical choices for most applications through 10 inches.

   Grade B is normally used when seamless pipe is required.

   X-52, X-60 and X-65 become desirable as diameters and operating pressures increase.

3. Other combinations of size, grade and wall thickness are available.

   Gas System Maintenance and Technical Support should be consulted if a pipe that is not shown is to be used or if there is a question as to the most economical grade or wall thickness for a particular application.

4. "Standard Wall" pipe (see Gas Standards A-10, "Pipeline Dimensions and Properties" and A-10.1, "Dimensions and Properties") is the minimum allowable wall thickness for bridge crossings. Minimum allowable wall thicknesses for pipe sizes 2 inches through 8 inches for use in gathering systems are indicated in Table B-1, Table B-2 and Table B-4 of this appendix. Minimum allowable wall thickness for fabricated assemblies and stations are indicated in Appendix C. Consult the Gas System Maintenance and Technical Support Department, Pipeline Engineering section, if further information is required.

5. When specifying pipe, the following information shall be given in sequence:

   A. Outside diameter and wall thickness.

   B. API specification and grade.

   C. Longitudinal seam welding process.

   D. Coating: Specify bare or coated. If coated, the type of coating for each installation must be recorded in the permanent records (see Gas Standard E-10, "Names of Pipe Coatings for Use on Pipeline Survey Sheets and Other Records").

   E. PG&E Code number. (See Gas Standard A-15, "Code Numbers for Steel Pipe").

6. Examples

   A. Typical coated pipe specification for either orders or records:

      16 inch O.D. x 0.250 W.T.

      API 5L Grade X-42, ERW, Wrapped

      Code 011286

   B. Typical bare pipe specification for either orders or records:

      4.50 inch O.D. x .237 W.T.

      API 5L Grade B, Seamless

      Code 011693

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Appendix B, continued

Table B-1 Steel Pipe Specification - API 5L Grade B Seamless, 35,000 PSI SMYS

Nominal Pipe Size (Inches)	Outside Diameter [3, 4] (Inches)	Wall Thickness [3, 4] (Inches)	Pressure at % of SMYS (psig)							
			Class Location:		1	2	3	4		
			100%	**90%**	**72%**	**60%**	**50%**	**40%**	**30%**	**20%**
3/4 [1]	1.05	0.113	7534	6780	5424	4520	3767	3014	2260	1507
1-1/4 [1]	1.66	0.140	5904	5314	4251	3543	2952	2362	1772	1181
2 [1, 2]	2.375	0.154	4539	4086	3269	2724	2270	1816	1362	908
3 [1]	3.5	0.216	4320	3888	3111	2592	2160	1728	1296	864
4 [1]	4.5	0.237	3687	3318	2655	2212	1844	1475	1106	738
6 [1]	6.625	0.280	2959	2663	2131	1776	1480	1184	888	592
8 [1]	8.625	0.322	2614	2352	1882	1568	1307	1046	784	523
10	10.75	0.365	2377	2140	1712	1427	1189	951	714	476
12	12.75	0.375	2059	1853	1483	1236	1030	824	618	412
16	16.0	0.375	1641	1477	1182	985	821	657	493	329
20	20.0	0.375	1313	1182	945	788	657	525	394	263
24	24.0	0.375	1094	985	788	657	547	438	329	219

1 Pipe normally in stock. For codes, see Gas Standard A-15.
2 Pipe is the minimum allowable grade and wall thickness for use in gas field gathering systems with a MAOP of 800 psig or less.
3 In the design formula for steel pipe, these correspond to outside diameter (D) and nominal wall thickness (t).
4 Other sizes and wall thickness are available from pipe manufacturers. Consult the Gas System Maintenance and Technical Support Department, Pipeline Engineering section, for assistance.

Table B-2 Steel Pipe Specification - API 5L Grade B ERW, 35,000 PSI SMYS

Nominal Pipe Size (Inches)	Outside Diameter [3, 4] (Inches)	Wall Thickness [3, 4] (Inches)	Pressure at % of SMYS (psig)							
			Class Location:		1	2	3	4		
			100%	**90%**	**72%**	**60%**	**50%**	**40%**	**30%**	**20%**
3 [1, 2]	3.5	0.156	3120	2808	2247	1872	1560	1248	936	624
4 [1, 2]	4.5	0.156	2427	2184	1748	1456	1214	971	728	486
6	6.625	0.219	2314	2083	1667	1389	1157	926	695	463
8	8.625	0.219	1778	1600	1280	1067	889	711	534	356
10	10.75	0.219	1427	1284	1027	856	714	571	428	286
12	12.75	0.219	1203	1083	866	722	602	481	361	241
14	14.0	0.250	1250	1125	900	750	625	500	375	250
16	16.0	0.250	1094	985	788	657	547	438	329	219

1 Pipe normally in stock. For codes, see Gas Standard A-15.
2 Pipe is the minimum allowable grade and wall thickness for use in gas field gathering systems with a MAOP of 800 psig or less.
3 In the design formula for steel pipe, these correspond to outside diameter (D) and nominal wall thickness (t).
4 Other sizes and wall thickness are available from pipe manufacturers. Consult the Gas System Maintenance and Technical Support Department, Pipeline Engineering section, for assistance.

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Appendix B, continued

Table B-3 Steel Pipe Specification – API 5L Grade A-25, Furnace Butt Weld [2], 25,000 PSI SMYS

Nominal Pipe Size (Inches)	Outside Diameter [3, 4] (Inches)	Wall Thickness [3, 4] (Inches)	(Company's Operating Limit for A-25 Pipe is 400 psig)	Pressure at % of SMYS (psig)
3/4 [1]	1.05	0.113	–	>400
1-1/4 [1]	1.66	0.140	–	>400
2 [1]	2.375	0.154	–	389

1 Pipe normally in stock. For codes, see Gas Standard A-15.
2 Butt weld pipe has 0.6 joint factor. However, for pipe specified in this table, calculated pressures exceed the 400 psig company limit.
3 In design formula for steel pipe, these correspond to outside diameter (D) and nominal wall thickness (t).
4 Other sizes and wall thickness are available from pipe manufacturers. Consult the Gas System Maintenance and Technical Support Department, Pipeline Engineering section, for assistance.

Table B-4 Steel Pipe Specification – API 5L Grade X-42, 6"–18" ERW, 16"–42" DSAW, 42,000 SMYS

Nominal Pipe Size (Inches)	Outside Diameter [3, 4] (Inches)	Wall Thickness [3, 4] (Inches)	Pressure at % of SMYS (psig)							
			Class Location:		1	2	3	4		
			100%	**90%**	**72%**	**60%**	**50%**	**40%**	**30%**	**20%**
6	6.625	0.156 [1, 2]	1978	1781	1425	1187	989	792	594	396
		0.172	2181	1963	1571	1309	1091	873	655	437
		0.188 [1]	2384	2146	1717	1431	1192	954	716	477
8	8.625	0.172 [2]	1676	1508	1207	1006	838	671	503	336
		0.188 [1]	1831	1648	1319	1099	916	733	550	367
		0.219 [1]	2133	1920	1536	1280	1067	854	640	427
10	10.75	0.219	1712	1541	1233	1027	856	685	514	343
		0.250 [1]	1954	1759	1407	1173	977	782	587	391
		0.281	2196	1977	1581	1318	1098	878	659	440
		0.365	2853	2567	2054	1712	1427	1141	856	571
12	12.75	0.219	1443	1299	1039	866	722	578	433	289
		0.250	1648	1483	1186	989	824	659	495	330
		0.281 [1]	1852	1667	1333	1111	926	741	556	371
		0.375 [1]	2471	2224	1779	1483	1236	989	742	495
16	16.0	0.250	1313	1182	945	788	657	525	394	263
		0.281	1476	1328	1063	886	738	591	443	296
		0.375 [1]	1969	1772	1418	1182	985	788	591	394
18	18.0	0.250	1167	1050	840	700	584	467	350	234
		0.312	1456	1311	1049	874	728	583	437	292
		0.250	1050	945	756	630	525	420	315	210
20	20.0	0.281	1181	1063	850	709	591	473	355	237
		0.312	1310	1180	944	787	656	525	394	263
		0.344	1445	1301	1041	867	723	578	434	289
		0.375	1575	1418	1134	945	788	630	473	315

1 Pipe normally in stock. For codes, see Gas Standard A-15.
2 Pipe is the minimum allowable grade and wall thickness for use in gas field gathering systems with MAOP of 800 psig or less. Refer to Gas Standard B-20, "Steel Butt – Welding Fittings," for thin wall fittings suitable for welding to this pipe.
3 In the design formula for steel pipe, these correspond to outside diameter (D) and nominal wall thickness (t).
4 Other sizes and wall thickness are available from pipe manufacturers. Consult the Gas System Maintenance and Technical Support Department, Pipeline Engineering section, for assistance.

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Appendix B, continued

Table B-4 Steel Pipe Specification – API 5L Grade X-42, 6"–18" ERW, 16"–42" DSAW, 42,000 SMYS, continued

Nominal Pipe Size (Inches)	Outside Diameter [1, 2] (Inches)	Wall Thickness [1, 2] (Inches)	Pressure at % of SMYS (psig)							
		Class Location:	1		2	3	4			
			100%	**90%**	**72%**	**60%**	**50%**	**40%**	**30%**	**20%**
22	22.0	0.250	955	860	688	573	478	382	287	191
		0.312	1192	1073	858	715	596	477	358	239
24	24.0	0.250	875	788	630	525	438	350	263	175
		0.281	984	886	709	591	492	394	296	197
		0.312	1092	983	787	656	546	437	328	219
		0.344	1204	1084	867	723	602	482	362	241
		0.375	1313	1182	945	788	657	525	394	263
26	26.0	0.281	908	818	654	545	454	364	273	182
		0.312	1008	908	726	605	504	404	303	202
		0.344	1112	1001	801	667	556	445	334	223
30	30.0	0.406	1137	1024	819	683	569	455	342	228
		0.438	1227	1104	884	736	614	491	368	246
		0.469	1314	1182	946	788	657	526	394	263
32	32.0	0.469	1232	1109	887	739	616	493	370	247
		0.500	1313	1182	945	788	657	525	394	263
		0.562	1476	1328	1063	886	738	591	443	296
34	34.0	0.469	1159	1043	835	696	580	464	348	232
		0.500	1236	1112	890	742	618	495	371	248
		0.562	1389	1250	1000	834	695	556	417	278
36	36.0	0.500	1167	1050	840	700	584	467	350	234
		0.562	1312	1181	945	787	656	525	394	263
		0.625	1459	1313	1050	875	730	584	438	292
40	40.0	0.562	1181	1063	850	709	600	473	355	237
		0.625	1313	1182	945	788	657	525	394	263
		0.688	1445	1301	1041	867	723	578	434	289
42	42.0	0.562	1124	1012	810	675	562	450	338	225
		0.625	1250	1125	900	750	625	500	375	250
		0.688	1376	1239	991	826	688	551	413	276

1 In the design formula for steel pipe, these correspond to outside diameter (D) and nominal wall thickness (t).

2 Other sizes and wall thickness are available from pipe manufacturers. Consult the Gas System Maintenance and Technical Support Department, Pipeline Engineering section, for assistance.

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Appendix B, continued

Table B-5 Steel Pipe Specification – API 5L Grade X-52, 10"–18" ERW, 16"–42" DSAW, 52,000 SMYS

Nominal Pipe Size (Inches)	Outside Diameter [2, 3] (Inches)	Wall Thickness [2, 3] (Inches)	Pressure at % of SMYS (psig)							
			Class Location:		1	2	3	4		
			100%	**90%**	**72%**	**60%**	**50%**	**40%**	**30%**	**20%**
10	10.750	0.219	2119	1907	1526	1272	1060	848	636	424
12	12.750	0.219	1787	1608	1287	1072	894	715	536	358
		0.250	2040	1836	1469	1224	1020	816	612	408
16	16.0	0.250	1625	1463	1170	975	813	650	488	325
		0.281	1827	1644	1316	1096	914	731	548	366
		0.312	2028	1826	1461	1217	1014	812	609	406
18	18.0	0.250	1445	1300	1040	867	723	578	434	289
20	20.0	0.250	1300	1170	936	780	650	520	390	260
		0.281	1462	1316	1053	877	731	585	439	293
		0.312	1623	1461	1169	974	812	649	487	325
		0.344	1789	1610	1288	1074	895	716	537	358
		0.375 [1]	1950	1755	1404	1170	975	780	585	390
		0.406	2112	1901	1521	1267	1056	845	634	423
22	22.0	0.250	1182	1064	851	710	591	473	355	237
24	24.0	0.250	1084	975	780	650	542	434	325	217
		0.281	1218	1096	877	731	609	488	366	244
		0.312	1352	1217	974	812	676	541	406	271
		0.344	1491	1342	1074	895	746	597	448	299
		0.375	1625	1463	1170	975	813	650	488	325
		0.438	1898	1709	1367	1139	949	760	570	380
26	26.0	0.281	1124	1012	810	675	562	450	338	225
		0.312	1248	1124	899	749	624	500	375	250
		0.344	1376	1239	991	826	688	551	413	276
		0.375	1500	1350	1080	900	750	600	450	300

1 Pipe normally in stock. For codes, see Gas Standard A-15.
2 In the design formula for steel pipe, these correspond to outside diameter (D) and nominal wall thickness (t).
3 Other sizes and wall thickness are available from pipe manufacturers. Consult the Gas System Maintenance and Technical Support Department, Pipeline Engineering section, for assistance.

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Appendix B, continued

Table B-5 Steel Pipe Specification – API 5L Grade X-52, 10"–18" ERW, 16"–42" DSAW, 52,000 SMYS, continued

Nominal Pipe Size (Inches)	Outside Diameter [1, 2] (Inches)	Wall Thickness [1, 2] (Inches)	Pressure at % of SMYS (psig)							
			Class Location:		1	2	3	4		
			100%	**90%**	**72%**	**60%**	**50%**	**40%**	**30%**	**20%**
30	30.0	0.375	1300	1170	934	780	650	520	390	260
		0.406	1408	1267	1014	845	704	563	423	282
		0.438	1519	1367	1091	912	760	608	456	304
32	32.0	0.406	1320	1188	950	792	660	528	396	264
		0.438	1424	1282	1028	855	712	570	428	285
		0.469	1525	1372	1097	915	763	610	458	305
		0.500	1625	1463	1170	975	813	650	488	325
34	34.0	0.438	1340	1206	965	804	670	536	402	268
		0.469	1435	1292	1033	861	718	574	431	287
		0.500	1530	1377	1102	918	765	612	459	306
36	36.0	0.438	1266	1139	912	760	633	507	380	254
		0.469	1355	1220	976	813	678	542	407	271
		0.500	1445	1300	1040	867	723	578	434	289
40	40.0	0.500	1300	1170	936	780	650	520	390	260
		0.562	1462	1316	1053	877	731	585	439	293
		0.625	1625	1463	1170	975	813	650	488	325
42	42.0	0.500	1239	1115	892	743	620	496	372	248
		0.562	1392	1253	1002	835	696	557	418	279
		0.625	1548	1393	1115	929	774	620	465	310

1 In the design formula for steel pipe, these correspond to outside diameter (D) and nominal wall thickness (t).

2 Other sizes and wall thickness are available from pipe manufacturers. Consult the Gas System Maintenance and Technical Support Department, Pipeline Engineering section, for assistance.

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Appendix B, continued

Table B-6 Steel Pipe Specification – API 5L Grade X-60, 20"–42" DSAW, 60,000 SMYS

Nominal Pipe Size (Inches)	Outside Diameter [2, 3] (Inches)	Wall Thickness [2, 3] (Inches)	Pressure at % of SMYS (psig)							
			Class Location:		1	2	3	4		
			100%	**90%**	**72%**	**60%**	**50%**	**40%**	**30%**	**20%**
20	20.0	0.250	1500	1350	1080	900	750	600	450	300
		0.281	1686	1518	1214	1012	843	675	506	338
		0.312	1872	1685	1348	1124	936	749	562	375
		0.375	2250	2025	1620	1350	1125	900	675	450
22	22.0	0.250	1364	1228	982	819	682	546	410	273
24	24.0	0.250	1250	1125	900	750	625	500	375	250
		0.281	1405	1265	1012	843	703	562	422	281
		0.312 [1]	1560	1404	1124	936	780	624	468	312
		0.375	1875	1688	1350	1125	938	750	563	375
		0.406	2030	1827	1462	1218	1015	812	609	406
26	26.0	0.281	1297	1168	934	779	649	519	390	260
		0.312	1440	1296	1037	864	720	576	432	288
		0.344	1588	1429	1144	953	794	636	477	318
		0.375	1731	1558	1247	1039	866	693	520	347
		0.406	1874	1687	1350	1125	937	750	563	375
30	30.0	0.375	1500	1350	1080	900	750	600	450	300
		0.406	1624	1462	1170	975	812	650	488	325
		0.438	1752	1577	1262	1052	876	701	526	351
32	32.0	0.375	1407	1266	1013	844	704	563	422	282
		0.406	1523	1371	1097	914	762	609	457	305
		0.438	1643	1479	1183	986	822	657	493	329
34	34.0	0.406	1433	1290	1032	860	716	574	430	287
		0.438	1546	1392	1114	928	773	619	464	310
		0.469	1656	1490	1192	994	823	663	497	332
		0.500	1765	1589	1271	1059	882	706	530	353
36	36.0	0.406	1354	1218	975	812	677	542	406	271
		0.438	1460	1314	1052	876	730	584	438	292
		0.469	1564	1407	1126	938	782	626	469	313
		0.500	1667	1500	1200	1000	834	667	500	334
40	40.0	0.438	1314	1183	947	789	657	526	395	263
		0.469	1407	1267	1014	845	704	563	423	282
		0.500	1500	1350	1080	900	750	600	450	300
42	42.0	0.469	1340	1206	965	804	670	536	402	268
		0.500	1429	1286	1029	858	715	572	429	286
		0.562	1606	1446	1157	964	803	643	482	322

1 Pipe normally in stock. For Codes, See Gas Standard A-15, "Code Numbers for Steel Pipe."
2 In the design formula for steel pipe, these correspond to outside diameter (D) and nominal wall thickness (t).
3 Other sizes and wall thickness are available from pipe manufacturers. Consult the Gas System Maintenance and Technical Support Department, Pipeline Engineering section, for assistance.

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Appendix B, continued

Table B-7 Steel Pipe Specification – API 5L Grade X-65, 34"–42" DSAW, 65,000 SMYS

Nominal Pipe Size (Inches)	Outside Diameter [1, 2] (Inches)	Wall Thickness [1, 2] (Inches)	Pressure at % of SMYS (psig)							
			Class Location:		1	2	3	4		
			100%	**90%**	**72%**	**60%**	**50%**	**40%**	**30%**	**20%**
34	34.0	0.375	1434	1291	1033	861	717	574	431	287
		0.406	1553	1398	1118	932	777	621	466	311
		0.438	1675	1508	1206	1005	838	670	503	335
36	36.0	0.406	1467	1320	1056	880	734	587	440	294
		0.438	1582	1424	1139	949	791	633	475	317
		0.469	1694	1525	1220	1017	847	678	509	339
		0.500	1806	1625	1300	1084	903	723	542	362
40	40.0	0.438	1424	1282	1025	855	712	570	428	285
		0.469	1525	1372	1098	915	763	610	458	305
		0.500	1625	1463	1170	975	813	650	488	325
42	42.0	0.469	1452	1307	1046	871	726	581	436	291
		0.500	1548	1393	1115	929	774	620	465	310
		0.562	1740	1566	1253	1044	870	696	522	348

1 In the design formula for steel pipe, these correspond to outside diameter (D) and nominal wall thickness (t).

2 Other sizes and wall thickness are available from pipe manufacturers. Consult the Gas System Maintenance and Technical Support Department, Pipeline Engineering section, for assistance.

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Appendix C – Minimum Wall Thickness for Fabricated Assemblies and Stations

Table C-1 Plain End Pipe Minimum Wall Thickness

Nominal Pipe Size (Inches)	Outside Diameter (Inches)	Minimum Wall Thickness
3/4	1.050	.113 (GR. B)
1	1.315	.133 (GR. B)
1-1/4	1.660	.140 (GR. B)
2	2.375	.154 (GR. B)
3	3.5	.216 (GR. B)
4	4.5	.237 (GR. B)
6	6.625	.280 (GR. B)
8	8.625	.322 (GR. B)
10	10.750	.365 (GR. B)
12	12.750	.375 (GR. B)
14	14.0	.375 (GR. B)
16	16.0	.375 (GR. B)
18	18.0	.375 (GR. B)
20	20.0	.375 (GR. B)
22	22.0	.375 (GR. B)
24	24.0	.375 (GR. B)
26	26.0	.375 (GR. B)
30	30.0	.375 (GR. B)
32	32.0	.375 (GR. B)
34	34.0	.375 (GR. B)
36	36.0	.500 (GR. B)
40	40.0	.500 (GR. B)
42	42.0	.500 (GR. B)

Notes

1. For fabricated assemblies/compressor stations (above ground piping), the minimum Grade B Material with standard or extra strong wall thickness is based on compatibility with standard and extra heavy wall fittings. Extra strong pipe should be used for all screwed connections through a 2 inch nominal diameter.
2. Extra strong pipe through a 2 inch nominal diameter is recommended for compressor stations because of the potential fatigue failure problems due to vibration.

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Appendix D – Emergency Pipe Test Information Form

This form is to be completed after the strength test and attached to the "Gas Pipeline Facilities Strength Test Pressure Report."

Part 1

This information is available from the completed "Gas Pipeline Facilities Strength Test Pressure Report" (Form 62-4921).

Location of Test	_____
Date of Test	_____
Duration of Test	_____ Hours _____ Minutes
Pipe Specification (O.D. x W.T. x SMYS)	_____
Footage Tested	_____ Ft.
Test Pressure	_____ psig

Part 2

For a given class location, this pipe may be used in pipeline facilities having future design pressures up to and including the pressure calculated in the "maximum pressure" column.

Design Factor (F)	Test Factor	Limited by Design Factor (1) psig	Limited by Test Pressure (2) psig	Allowable Use [1]	
				Maximum Pressure psig	Class Location
.72	1.25	–	–	–	1
.60	1.50	–	–	–	2
.50	1.50	–	–	–	3
.40	1.50	–	–	–	4

[1] When determining if the emergency pipe is qualified for a particular gas facility, the Design Factor (F) of the gas facility must be compared to the Design Factors listed in the table above. The Design Factor for certain types of gas facilities can be less than shown in the table above. If the Design Factors are different, (1) must be recalculated using the correct Design Factor for the specific gas facility and then compared to (2). The smaller of (1) or (2) will be the new "Maximum Pressure".

$$(1) = \frac{2 \times SMYS\ (PSI) \times w.t.\ (Inch)}{O.D.\ (Inch)} \times F$$

$$(2) = \frac{Test\ Pressure\ (From\ Part\ 1)}{Test\ Factor}$$

Maximum pressure = the smaller of (1) or (2)

Name:_____Date:_____

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Appendix E – Gas Pipeline Facilities Strength Test Pressure Report

Purpose and Scope

This appendix provides instructions for completing the "Gas Pipeline Facilities Strength Test Pressure Report," form 62-4921.

General

1. **Maintain a test record for the life of the facility.** For all strength tests, and for leak tests performed on facilities operating at greater than 100 psig, make the test record on the "Gas Pipeline Facilities Strength Test Pressure Report." Where geographical conditions, such as mountainous terrain, make it necessary to divide the pipeline being tested into two or more test sections, use a separate form for each test section.

Explanation of Form Entries

2. Part I – Design Data
   A. Description of Job: Provide a brief description of the pipe to be tested, including pipe size, pipe length, pipe location, and reference construction drawing number.
   B. Location Class: Determine the location class as described in 49 CFR 192.5.
   C. Design Factor: Determine the design factor as described in 49 CFR 192.111.
   D. Present MAOP of Facilities (psig): Show the present MAOP of any existing pipeline facilities involved with the test or construction project as established according to the applicable provisions of 49 CFR 192. Where the test involves extending, paralleling, replacing, or uprating an existing pipeline facility, show the MAOP of that facility. If the test covers an entirely new facility, write "none" in the space.
   E. MAOP to be Established by this Test: This test will establish the MAOP according to the requirements of DCS/GTS Standard D-S0430/S4125, "Maximum Allowable Operating Pressure, Requirements for Distribution Systems and Transmission Gathering Lines." The test shall be conducted according to the requirements of Gas Standard A-34, "Piping Design and Test Requirements." The MAOP may equal but shall never exceed the Future Design Pressure. For pipelines that operate at or over 20% of SMYS, this is the MAOP recorded in PG&E Drawing No. 086868.
   F. Design Pressure — This Section: This is the Future Design Pressure recorded in PG&E Drawing No. 086868. Use when designing all future additions, modifications, or replacement of a facility. All materials and equipment installed in the facility shall be designed and installed so that they may qualify for a MAOP equal to the design pressure, according to the applicable requirements of 49 CFR 192. Under certain circumstances, the design pressure may be greater than the MAOP to be established for the segment involved.
   G. Static Head Due to Elevation Difference: When a line is installed through an area where there are appreciable differences in elevation, make an allowance for the static head due to the weight of the test fluid used for the hydrostatic test. When determining the test pressure for a section of line, ensure that the test pressure at the highest elevation point in the line is above the minimum test pressure specified in Table A-1 of Appendix A. The test pressure at the lowest elevation point in the test section does not exceed the maximum test pressure specified in Table A-1 of Appendix A. At no point along the line shall the test pressure be greater than the pressure which produces a stress level equal to the yield strength of the pipe being tested.
   H. Static Head Calculation: To obtain the hydrostatic test pressure difference in the line due to the difference in elevation, multiply the difference in elevation (in feet) between the highest point and the lowest point in the test section by 0.433 psi/foot, if the test fluid is water. This will give the pressure differential in psi due to the static head:

$$0.433\ \frac{psi}{ft}\ x\ (difference\ in\ elev.)\ ft \qquad (pressure\ differential)\ psi$$

   If using a test fluid other than water, make a correction for the difference in specific gravities. Consult the Pipeline Engineering section of the Gas System Maintenance and Technical Support Department for assistance.
   I. Verified in Field: Pipe outside diameter (O.D.), wall thickness, specification, and footage must be verified by the person supervising the test. The supervisor shall indicate this verification is complete by initialing the space provided beside the information.

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Appendix E, continued

J. % of SMYS: Obtained from the hoop stress equation. Let stress at any given pressure P_1 be denoted by S_1.

$$\text{Then,} \quad S_1 = \frac{P_1 D}{2t}$$

$$\text{by definition,} \quad \% \text{ SMYS @ } P_1 = \frac{S_1}{SMYS} \times 100$$

$$\text{Therefore,} \quad \% \text{ SMYS @ } P_1 \frac{P_1 D}{2t(SMYS)} \times 100$$

Substitute the design pressure, minimum test pressure, and maximum test pressure in the equation as P_1 to obtain their corresponding % of SMYS.

Note

For some older pipe, a longitudinal joint factor must be included when performing the calculations (see Gas Standard A-11, "Identification of Steel Pipe"). A temperature derating factor must also be used if the gas temperature exceeds 250°F (see 49 CFR 192.115). Contact the Pipeline Engineering section when either of these conditions occur.

K. Pressure to give 90% of SMYS:

$$\text{from,} \quad P = \frac{2St}{D}$$

$$P \text{ @ } 90\%SMYS = \frac{2(.9)\ (SMYS)\ (t)}{D} = \frac{1.8(SMYS)\ (t)}{D}$$

L. Minimum Pressure for Test:

(1) Testing New Facilities: See Appendix A Note 5 on Page 8. In some situations, the test pressure may be reduced as allowed by Appendix A Note 4. Where an elevation difference exists, the minimum test pressure will be at the maximum elevation.

Note

The static head due to elevation difference must not cause the pressure at the lowest point in the test section to exceed the pressure which produces a stress level equal to the yield strength of the pipe being tested.

(2) Uprating Existing Facilities: When an uprating is to occur by taking the pipeline, main, or segment out of service and performing a strength test, the facility must be successfully tested as described in Gas Standard A-34; specifically to the requirements applicable for a new line of the same material in the same location. Prepare and complete a strength test pressure report for the work performed.

M. Maximum Permissible Test Pressure: The test pressure for any pipeline shall not be greater than the pressure which produces a hoop stress of 100% of SMYS of the pipe, regardless of the strength of the valves, regulators, and similar equipment. If the MAOP of the pipeline cannot be established without exceeding the rated pressure of the equipment, consult the Pipeline Engineering section. Where an elevation difference exists, the maximum test pressure will occur at the lowest elevation point in the test section.

If the minimum test pressure is substantially less than the pressure which produces 100% of SMYS, an arbitrary maximum may be established which is close to, but higher than, the minimum test pressure. The difference should be sufficient to permit variations in the test pressure due to elevation, temperature changes during the test, minor leaks, or equipment problems or limitations. A 200 psi differential should normally be adequate.

N. Minimum Test Duration: Facilities being tested which are designed to operate at under 30% of SMYS must be tested for a minimum of one hour. If they are to operate at or over 30% of SMYS, they must be tested for a minimum of eight hours.

Note

Conduct a pre-installation strength test for fabricated units and short sections of pipe scheduled to operate at or over 30% of SMYS, for which a post-installation test is impractical. Conduct the test by maintaining the pressure at or above the test pressure for a minimum of four hours. Refer to Appendix A Note 6 on Page 8.

O. The person preparing the "Gas Pipeline Facilities Strength Test Pressure Report" **and** the person approving the report are **both** required to sign it.

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Appendix E, continued

3. Part II – Test Data

A. Any changes brought about by unexpected field conditions from the requirements specified in Part I of the test report must be approved by the person preparing Part I of the report.

B. Actual Duration of Test: Testing must never take less time than that specified in Part I and must be continuous for the required time period. Any drop of test pressure below the required minimum test pressure represents a termination of the test. The facility must be retested for the **entire** required time period. Be certain that the duration of the test checks is documented on the form and test chart, including the starting and stopping times.

It may be desirable to maintain the test pressure for a few minutes longer than the minimum required in Part I. This could avoid questions concerning chart or timing errors.

C. Elevation at Test Point: Note the mile post (location) and ground elevation of the point where the test pressure gauge(s) is to be installed. If the test pressure gauge(s) is not installed at the minimum or maximum elevation in the test section, adjust the information in the spaces provided for "Minimum Pressure for Test" and "Maximum Permissible Test Pressure" accordingly.

D. Indicated Test Pressure: This is the actual test pressure indicated on the pressure gauge(s) at the test point. If the pressure varies during the test, the lowest pressure during the period shall be the indicated test pressure. To ensure an acceptable test, the test pressure should be held a few psi above the minimum to prove that minor fluctuations do not drop the pressure below minimum. This would require restarting the test period.

E. Test Pressure at Maximum Elevation: This is the minimum pressure in the test section and is determined as described below.

(1) When the test pressure is recorded at the highest elevation in the test section, the indicated test pressure is the "Test Pressure at Maximum Elevation."

(2) When the test pressure is taken at a point other than the highest elevation in the test section, the indicated test pressure **less** the static head due to the elevation difference between the test point and the highest elevation, is the "Test Pressure at Maximum Elevation."

The pressure at the highest elevation in the test section must be greater than or equal to the pressure stated for "Minimum Pressure for Test," as indicated in Part I – Design Data.

F. Test Pressure at Minimum Elevation: This is the maximum pressure in the test section and is determined as described below.

(1) When the test pressure is recorded at the lowest elevation in the test section, the indicated test pressure is the "Test Pressure at Minimum Elevation."

(2) When the test pressure is recorded at a point other than the lowest elevation in the test section, the indicated test pressure plus the static head due to the elevation difference between the test point and the lowest elevation, is the "Test Pressure at Minimum Elevation."

The pressure at the lowest elevation in the test section must not exceed the pressure stated for "Maximum Permissible Test Pressure," as indicated in Part I – Design Data.

G. Test Fluid: Indicate whether water, air, gas, inert gas, or some other fluid is used as the test medium.

H. Pipe Specification Verified and Pipe Footage Verified: Pipe specification and footage must be verified by the person supervising the test (see Part I).

I. The information on the test gauge and/or dead weight tester used during the test must be recorded, including the instrument's last calibration date. See Paragraph 9 on Page 5 for the test chart requirements.

J. The person supervising the test and the person approving the test report must sign the report. Signatures should be completed in the field at the time of the test. Signatures should **not** be entered by a clerk at a later date.

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Appendix E, continued

K. Schematic Sketch: It is necessary to provide the following information on the schematic sketch.

(1) The location of the facility tested.

(2) The minimum and maximum elevation (in feet).

(3) Mile points or engineering stations, valve numbers, and incorporated areas.

(4) Piping, equipment, fittings, etc., included in the test section.

(5) If additional space is required, use the back of the form or another sheet. Be sure that the job number and any reference numbers are shown on the face of all attachments.

(6) If the person preparing the Strength Test Pressure Report included a sketch, the sketch must be verified in the field and corrected as necessary to represent the actual test setup. The sketch should also include information on the job number and the time and date of the test.

L. Any failure when strength testing a pipeline to be operated at a hoop stress of 20% or more of SMYS shall be reported within two hours of the failure as required by DCS/GTS Standard D-S0355/S4413, "CPUC and DOT Reportable Incidents, Curtailments and Conditions and Low Pressure System Problem Reporting." A written report is required for all test failures.

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Piping Design and Test Requirements

Pacific Gas and Electric Company

Gas Pipeline Facilities Strength Test Pressure Report

(For Pipeline Facilities Designed to Operate over 100 PSIG)

62-4921 (Rev. 7/98)
California Gas Transmission
(Use according to Gas Standard A-34 and 49CFR Part 192)
Sheet _____ of _____

PART I - DESIGN DATA (TO BE PREPARED BY PROJECT ENGINEER)

Feeder Main, Line Number, or Station	Area	Division/District	Job Number	Date Job Authorized

Description of Job — Include Reference Drawing Numbers

Location Class / Design Factor (F)	MAOP of Existing Facilities	MAOP to be Established for this Section by this Test	Design Pressure — This Section (Use Future Design Pressure Whenever Possible)
	PSIG	PSIG	PSIG

STATIC HEAD DUE TO ELEVATION DIFFERENCE (WHERE APPLICABLE)			Static Head Calculation		
	Max. Elevation _____	Ft.	for Water	0.433 X Elev. Diff. =	PSIG
	Min. Elevation	Ft.	Other (Specify)	X Elev. Diff. =	PSIG
	Elev. Diff.	Ft.			

Pipe Specification			Pipe Spec. and	% of SMYS			
Size		API or ASTM Grade	Footage to	Footage Verified	At Design	At Min.	At Max.	Pressure to Give 90%
O.D.	W.T.	Long Seam (ERW, DSAW, Seamless, Etc.)	Be Tested	In Field	Pressure	Test Press.	Test Press.	SMYS

Minimum Test Pressure @ Max. Elevation	PSIG	Test Medium To Be Used	MINIMUM TEST DURATION - UNDER 30% SMYS (1 HR. MINIMUM) - 30% SMYS & OVER (8 HRS. MINIMUM) - PRE-INSTALLATION TEST (SEE APPENDIX "A", GAS STD. A-34)
Maximum Test Pressure @ Min. Elevation	PSIG		HOURS

Prepared By:	Date:	For Information or Changes, Call:	Approved By:	Date:

PART II - TEST DATA (TO BE PREPARED BY PERSON SUPERVISING TEST AT TIME OF TEST)

Note: Minimum test pressure and duration are not to be changed without written approval.

Time and Date Test Pressure Reached		Elevation at Test Point		Min. Required Test Press. at Test Point (1)		Max. Allowable Test Press at Test Point (4)	
Time and Date Test Ended		Max. Elevation in Test Section		Min. Indicated Test Pressure (2)		Max. Indicated Test Pressure (5)	
Actual Duration of Test		Min. Elevation in Test Section		Min. Test Pressure at Max. Elevation (3)		Max. Test Pressure at Min. Elevation (6)	

Test Fluid Used	Pipe Specification and Footage Verified (See Part I)

Make, Range, and Serial No. of Pressure Recording Gauge	Date Last Calibrated	Make, Range, and Serial No. of Dead Weight Tester (See Note 7)	Date Last Calibrated

Test Supervised By:	Date:	Approved By:	Date:

PUT SCHEMATIC PIPING SKETCH ON BACK OF THIS SHEET

SHOW LOCATION OF FACILITY TESTED, MINIMUM AND MAXIMUM ELEVATION IN FEET, MILE POINTS, VALVE NUMBERS AND INCORPORATED AREAS. USE AN ADDITIONAL SHEET IF NECESSARY (SHOW REFERENCE NUMBERS ON FACE OF ALL DRAWINGS AND ATTACHMENTS). FOR STATION PIPING, FABRICATED UNITS AND SHORT SECTIONS OF PIPE, ALSO SHOW A DETAILED SKETCH OF EACH ASSEMBLY TESTED.

NOTES:

(1) Add the static head due to elevation difference (between test point and maximum elevation) to "minimum test pressure at maximum elevation" from PART I.
(2) Use lowest pressure on test gauge at any time during test.
(3) Subtract static head due to elevation difference (between test point and maximum elevation) from minimum indicated test pressure.
(4) Subtract static head due to elevation difference (between test point and minimum elevation) from "maximum test pressure at minimum elevation" from PART I.
(5) Highest pressure on test gauge at any time during test.
(6) Add static head due to elevation difference (between test point and minimum elevation) to maximum indicated test pressure.
(7) A dead weight tester is only required when testing to a pressure which produces a stress level of 90% of SMYS or greater. However, if a dead weight tester is used on any test, enter the information in the space provided above.

DISTRIBUTION

JOB FILE (AT SPONSORING ORGANIZATION)
GAS SYSTEM MAINTENANCE and TECHNICAL SUPPORT SUPERINTENDENT
PROJECT MANAGER/PROJECT ENGINEER
CAPITAL ACCOUNTING (FOREMAN'S COPY OF JOB)
RECORDS, GAS SYSTEM MAINTENANCE and TECHNICAL SUPPORT - TRANSMISSION JOBS ONLY
REPORT FAILURES UNDER TEST TO GAS ENGINEERING & PLANNING

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Appendix F – Requirements for Pipeline Plan and Profile/Sections Construction Drawings

Purpose and Scope

1. This appendix establishes formatting and review requirements for pipeline drawings. Similar requirements for station drawings are being drafted for inclusion into this gas standard at a later date.
2. Any gas pipeline work that is reportable to the CPUC (Section 125 of G.O. 112) must have construction drawings that show the plan and profile.
3. In addition, because CPUC G.O. 112 requirements are a minimum criteria and plan and profile/sections drawings demonstrate good pipeline engineering practice, plan and profile/sections drawings shall be used for pipeline work on the following critical lines (even if the work is not reportable under Section 125).
   - All numbered transmission pipelines.
   - DFMs that operate at or greater than 20% of SMYS.
   - Any critical lines which operate over 60 psig and have elevation variations.

Drawing Format

4. The requirement for pipeline construction drawings can be met by using the existing 3- or 4-size plan and profile construction drawing format. For small projects or simple offsets to clean underground structures, the requirement can be met by using a sections and details drawing format.

Technical Review

5. Any gas pipeline work that is reportable to the CPUC must have a technical review by a qualified engineer as designated by the manager responsible for the facilities.
6. In addition to the CPUC-reportable projects, it is recommended that drawings for pipeline sections that are more than 100 feet in length or 12 inches in diameter or larger, and are to be installed on bridges, also be submitted for technical review before being issued for bids or construction.

Professional Engineering Review

7. There is currently no legal requirement for pipeline construction drawings (other than civil and structural drawings) to be stamped by a licensed professional engineer. However, it is current practice to stamp new construction drawings for gas facilities. To emphasize professional engineering reviews and focus accountability, all pipeline plan and profile/section drawings for work on pipelines with a design pressure or future design pressure greater than 60 psig must be reviewed and stamped by a professional engineer. The engineer (civil or mechanical) must be currently registered in the state of California and competent in pipeline engineering as designated by the manager responsible for the facilities.

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Appendix G – Required Information for Pipeline Construction Drawings

Purpose and Scope

1. This appendix provides guidelines for preparing and reviewing pipeline construction drawings.

Plan and Profile/Sections

2. In plan view, show the dimensions from the pipeline to fixed, above-ground structures and/or the property line. Show ETSs and all applicable details in the Reference Details section. Show the right-of-way and all substructures. Clearly identify new, existing or to-be-abandoned gas lines.
3. In profile view, or a section detail, identify significant offsets and approximate dimensions to substructures which require the offsets. Show the stationing for survey details.
4. Specify the minimum depth of cover.
5. In the pipeline details stationing section, show the stations for all pipeline details, including tie-ins, substructures, valves, elbows, and transition points (changes in pipe wall thickness, SMYS, coating, etc.), and ETSs. Indicate all applicable details (tie-ins, ETSs, etc.) shown in the Reference Details section.

Bill(s) of Material

6. A bill(s) of material is required for all pipeline drawings. The Bill of Materials Section must include a complete description of all items. Include all PG&E Material Codes and reference drawings or gas standards.
   A. Pipe – Indicate the size, wall thickness, longitudinal seam type, grade and specification to which the pipe is to be manufactured. Also, identify the type of coating (and joint tape).
   B. Fittings – Indicate the size, wall thickness, special end preparation, material and grade of pipe to be used. Also, include the specification to which the fitting is to be manufactured.
   C. Valves – Indicate the type of valve (ball, plug, gate, etc.), size, pressure rating, type of end connections, type and configuration of operator (gearing or lever or automatically operated) with dimensions, wall thickness of weld ends (if applicable), and the serial number.
   D. Taps – Indicate the type of reinforcement including grade, wall thickness, size and the specification of plate material to be used. Refer to the appropriate gas standard for construction information on either the cold branch or hot tap.
   E. Sleeves – Indicate the size, wall thickness, grade and the specification of the plate material to be used. Also, specify back up strips and the appropriate gas standard containing information on installing and fabricating the sleeve.
   F. Casings – Indicate the size, wall thickness and grade. Also, specify the gas standard containing information on casings, and the approved vent material. Specify the appropriate insulators and end seals.
   G. Pipeline Markers – Specify the type and the gas standard containing information on pipeline markers.
   H. Cathodic Protection – Specify the type and location and the gas standard containing information on cathodic protection. If an insulating fitting is to be installed, specify the manufacturer, size and type of end connections (e.g., wall thickness, grade and specification of the pipe to which the fitting is to be welded). If pipe flanges, insulating gaskets and insulating kits for bolts are to be used, be sure to specify the pressure rating, size and bore of flanges; size and number of bolts required; and the size and number of insulating kits required.

Reference Details Section

7. Tie-in details
   A. Include the diameter, wall thickness, grade, seam and specification of new pipe and the existing pipe to which the new pipe is to be tied. Do not make a tie-in at a fitting or a valve. Also, because stresses due to pipe expansion and contraction tend to be concentrated at elbows, if the new pipe is to be tied to existing pipe having a thinner wall thickness, and the tie-ins point is near an existing thin wall elbow or an elbow fabricated from sections of mitered pipe, the design should be changed to replace the existing elbow with one matching the strength of the new pipe.

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Appendix G, continued

B. At the tie-in location, if there is a wall thickness difference greater than 3/32 inch, or a pipe yield strength difference between the new and existing pipe, show the applicable weld detail from Gas Standard D-22, "Arc Welding Procedure Requirement – All Stress Levels," on the drawing. In every case, an attempt shall be made to attain an acceptable butt-welded joint. However, if misalignment of carrier pipes or other problems preclude any reasonable possibility of obtaining an acceptable butt-welded joint, use a sleeve. A single-split sleeve is preferred over the double-split sleeve for this purpose.

8. Welding details – Show wall thickness changes greater than 3/32 inch between adjoining pipe components. Include detail at each change in the line pipe. Line pipe-to-fitting detail can be typical.
9. Trench details – Include a typical trench detail indicating minimum cover, back fill material and minimum trench width.
10. Crossing details – Include railroad and highway crossings and all casings and vents. Also, show locations of vent risers.
11. Cathodic protection details – Include a detail for each type of cathodic protection station and reference Gas Standard O-10, "Electrolysis Test Station Connection to Main." For Type E stations, show the dimension between the connection points.

Miscellaneous Requirements

12. Use design criteria stamps for each size, specification, grade, seam type, wall thickness and location class of pipe shown on specific Plan and Profile/Sections sheets. A separate design criteria stamp is required for each MAOP and for each test pressure.
13. Use a welding requirements stamp.
14. Testing requirements – Include the time duration of the test and the maximum and minimum pressures recorded during tests. Fill out a "Strength Test Pressure Report" for each hydro test performed.
15. Signatures of approving parties – Drawings must be signed by the manager responsible for the facility or his or her designated representative.
16. Include the following notes on each sheet:
    A. "All field bends are smooth field bends, except where elbows are noted. Field bends shall be made according to Gas Standard A-36, 'Design and Construction Requirements – Gas Lines and Related Facilities,' Section 4.D."
    B. "This pipeline must be installed with at least 12 inches of clearance from any other underground structure not associated with the pipeline."
17. List any reference drawings pertinent to the installation of the piping shown on the plan and profile sections of the drawing.
18. Indicate mile posts at the beginning and end of the project. Also, include the mile post (or stationing) of any taps or valves being installed.
19. Special notes – Indicate additional information if CPUC notification is required. Also, indicate if it is required to notify local agencies and PG&E personnel before starting work. Indicate any special construction conditions imposed by the CPUC, local agencies or PG&E.
20. When hot tapping is required, indicate the maximum pressure allowed in the pipeline during welding and tapping operations.
21. All pipeline plan and profile/sections construction drawings for pipeline work with a Design Pressure or Future Design Pressure greater than 60 psig shall be reviewed, signed and stamped by a professional engineer. The engineer (mechanical or civil) must be currently registered in the state of California and competent in pipeline engineering as designated by the manager responsible for the facilities.

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