

CHAPTER IV

DESIGN, INSTALLATION, AND TESTING

840 DESIGN, INSTALLATION, AND TESTING

840.1 General Provisions. The design requirements of this code are intended to be adequate for public safety under all conditions usually encountered in the gas industry. However, special conditions that may cause additional stress in any part of a line or its appurtenances shall be provided for, using good engineering practice. Examples of such special conditions include: long self-supported spans, unstable ground, mechanical or sonic vibrations, weight of special attachments, and thermal forces other than seasonal.

841 STEEL PIPE

841.001 Population Density Indices

(a) Two population density indices, determined at the time of initial construction, are used to classify locations for design and testing purposes: (1) the one-mile density index, which applies to any specific mile of pipeline; and (2) the ten-mile density index, which applies to any specific ten-mile length of pipeline.

(b) To determine the one-mile density indices for a proposed pipeline, lay out a zone one-half mile wide along the route of the pipeline with the pipeline on the center line of this zone. Divide the zone into lengths, each containing one mile of pipeline. Count the number of buildings intended for human occupancy in each of these lengths. These numbers are the one-mile indices for the pipeline.

(c) To determine the ten-mile density indices for any given ten-mile length of pipeline, proceed as follows: Add the one-mile density indices for the ten-mile section. In case a one-mile index equals or exceeds 20, it is to be included in the sum as 20.

Divide the sum thus obtained by 10. The quotient is the ten-mile density index for the section.

841.01 Classification of Locations

841.011 Class 1 Locations

Class 1 locations include waste lands, deserts, rugged mountains, grazing land, and farm land, and combinations of these; provided, however, that:

(a) The ten-mile density index for any section of the line is 12 or less.

(b) The one-mile density index for any one mile of line is 20 or less.<sup>(1)</sup>

841.012 Class 2 Locations

Class 2 locations include areas where the degree of development is intermediate between Class 1 locations and Class 3 locations. Fringe areas around cities and towns, and farm or industrial areas where the one-mile density index exceeds 20 or the ten-mile density index exceeds 12 fall within this location class.

Note (1): It is not intended here that a full mile of lower-stress-level pipeline shall be installed if there are physical barriers or other factors that will limit the further expansion of the more densely populated area to a total distance of less than 1 mile. It is intended, however, that where no such barriers exist, ample allowance shall be made in determining the limits of the lower-stress design to provide for probable further development in the area.

## SECTION 8 GAS TRANSMISSION AND DISTRIBUTION

### 841.013 Class 3 Locations

Class 3 locations include areas subdivided for residential or commercial purposes where, at the time of construction of the pipeline or piping system, 10% or more of the lots abutting on the street or right-of-way in which the pipe is to be located are built upon, and a Class 4 classification is not called for. This permits classifying as Class 3, areas completely occupied by commercial or residential buildings with the prevalent height of three stories or less.

### 841.014 Class 4 Locations

Class 4 locations include areas where multistory<sup>(1)</sup> buildings are prevalent, and where traffic is heavy or dense and where there may be numerous other utilities underground.

841.015 It should be emphasized that Location Class (1, 2, 3 or 4), as described in the foregoing paragraphs, is defined as the general description of a geographic area having certain characteristics as a basis for prescribing the types of construction and methods of testing to be used in those locations or in areas that are respectively comparable. A numbered Location-Class refers only to the geography of that location or a similar area, and does not

necessarily indicate that a correspondingly numbered Construction-Type will suffice for all construction in that particular location or area. Example: In Location Class 1, all aerial crossings require Type B construction. (See 841.143)

841.016 When classifying locations for the purpose of determining the type of pipeline construction and testing that should be prescribed, due consideration shall be given to the possibility of future development of the area. If at the time of planning a new pipeline this future development appears likely to be sufficient to change the location class, this should be taken into consideration in the design and testing of the proposed pipeline.

It is also anticipated that some increase in population density will occur in all areas after a line is constructed, and this possibility has been taken into account in establishing the design, construction, and testing procedures for each location class.

Note (1): Multistory means 4 or more "floors" above ground including the first or ground floor. The depth of basements or number of basement floors is immaterial.

AMERICAN STANDARD CODE FOR PRESSURE PIPING

to, but the reverse of that described in 841.285(a) feasible, a slug of inert gas should be introduced to prevent the formation of an explosive mixture at the interface between gas and air. Nitrogen or carbon dioxide can be used for this purpose.

(c) If a pipeline or main containing gas is to be removed, the operation may be carried out in accordance with 841.282 or the line may be first disconnected from all sources of gas and then thoroughly purged with air, water or with inert gas before any further cutting or welding is done.

(d) If a gas pipeline or main or auxiliary equipment is to be filled with air after having been in service and there is a reasonable possibility that the inside surfaces of the facility are wetted with a volatile inflammable liquid, or if such liquids might have accumulated in low places, purging procedures designed to meet this situation shall be used. Steaming of the facility until all combustible liquids have been evaporated and swept out is recommended. Filling of the facility with an inert gas and keeping it full of such gas during the progress of any work that might ignite an explosive mixture in the facility is an alternative recommendation. The possibility of striking static sparks within the facility must not be overlooked as a possible source of ignition.

841.286 Whenever the accidental ignition in the open air of a gas-air mixture might be likely to cause personal injury or property damage, precautions shall be taken as, for example

(a) Prohibit smoking and open flames in the area, and

(b) Install a metallic bond around the location of cuts in gas pipes to be made by other means than cutting torches, and

(c) Take precautions to prevent static electricity sparks, and

(d) Provide a fire extinguisher of a class approved by the National Fire Protection Association, or the National Board of Fire Underwriters.

841.3 Testing After Construction

841.31 General Provisions. All pipelines,

mains and services shall be tested after construction, except as follows:

Tie-ins. Because it is sometimes necessary to divide a pipeline or main into test sections and install test heads, connecting piping, and other necessary appurtenances for testing, it is not required that the tie-in sections of pipe be tested.

841.4 Test Requirements

841.41 ~~Test Required to Prove Strength of Pipelines and Mains to Operate at Hoop Stresses of 30% or More of the Specified Minimum Yield Strength of the Pipe~~

841.411 All pipelines and mains to be operated at a hoop stress of 30% or more of the specified minimum yield strength of the pipe shall be given a field test to prove strength after construction and before being placed in operation.

841.412 (a) Pipelines and mains located in Location Class 1 shall be tested either with air or gas to 1.1 times the maximum operating pressure or hydrostatically to at least 1.1 times the maximum operating pressure. See 841.5.

(b) Pipelines or mains located in Location Class 2 shall be tested either with air to 1.25 times the maximum operating pressure or hydrostatically to at least 1.25 times the maximum operating pressure. See 841.5.

(c) Pipelines and mains in Location Classes 3 and 4 shall be tested hydrostatically to a pressure not less than 1.4 times the maximum operating pressure.

(d) The test requirements given in 841.412 (a), (b) and (c) above are summarized in Table 841.412 (d).

841.413 Requirements of 841.412 (c) for hydrostatic testing of mains and pipelines in Location Classes 3 and 4 do not apply if at the time the pipeline or main is first

SECTION 8 GAS TRANSMISSION AND DISTRIBUTION

Table 841.412(d)

Test Requirements for Pipelines and Mains to Operate at Hoop Stresses of 30% or More of the Specified Minimum Yield Strength of the Pipe

1 Location Class	2 Permissible Test Fluid	3 Prescribed Test Pressure		4 Maximum Allowable Operating Pressure, the lesser of
		Minimum	Maximum	
1	Water	1.1 x m.o.p.	None	) ( t.p. ÷ ) ( 1.1 ) ( or ) ( d.p.
	Air	1.1 x m.o.p.	1.1 x d.p.	
	Gas	1.1 x m.o.p.	1.1 x d.p.	
2	Water	1.25 x m.o.p.	None	) ( t.p. ÷ ) ( 1.25 ) ( or ) ( d.p.
	Air	1.25 x m.o.p.	1.25 x d.p.	
3	Water	1.40 x m.o.p.	None	t.p. ÷ 1.40 or d.p.
4	Water	1.40 x m.o.p.	None	t.p. ÷ 1.40 or d.p.

m.o.p. = maximum operating pressure (not necessarily the maximum allowable operating pressure)

d.p. = design pressure

t.p. = test pressure

Note (1) This table brings out the relationships between test pressures and maximum allowable operating pressures subsequent to the test. If an operating company decides that the maximum operating pressure will be less than the design pressure a corresponding reduction in prescribed test pressure may be made as indicated in Column 3. However, if this reduced test pressure is used the maximum operating pressure cannot later be raised to the design pressure without retesting the line to the test pressure prescribed in Column 4. See 805.14, 845.22 and 845.23.

ready for test, one or both of the following conditions exist:

(a) The ground temperature at pipe

depth is 32° F. or less, or might fall to that temperature before the hydrostatic test could be completed, or

AMERICAN STANDARD CODE FOR PRESSURE PIPING

(b) Water of satisfactory quality is not available in sufficient quantity.

(c) In such cases an air test to 1.1 times the maximum operating pressure shall be made and the limitations on operating pressure imposed by 841.412(d) above do not apply.

841.414 Other provisions of this code notwithstanding, pipelines and mains crossing highways and railroads may be tested in each case in the same manner and to the same pressure as the pipeline on each side of the crossing.

841.415 Other provisions of this code notwithstanding, fabricated assemblies, including mainline valve assemblies, cross connections, river crossing headers, etc., installed in pipelines in Class 1 locations and designed in accordance with Type B construction, as required in 841.142, may be tested as required for Class 1 locations.

841.416 Notwithstanding the limitations on air testing imposed in 841.412 (c), air testing may be used in Location Classes 3 and 4, provided that all of the following conditions apply:

(a) The maximum hoop stress during test is less than 50% of the specified minimum yield strength in Class 3 locations, and less than 40% of the specified minimum yield strength in Class 4 locations.

(b) The maximum pressure at which the pipeline or main is to be operated does not exceed 80% of the maximum field test pressure used.

(c) The pipe involved is new pipe having a longitudinal joint factor E in Table 841.12 of 1.00.

841.417 Records. The operating company shall maintain in its file for the useful life of each pipeline and main, records showing the type of fluid used for test and the test pressure.

841.42 Tests Required to Prove Strength for Pipelines and Mains to Operate at Less than 30% of the Specified Minimum Yield Strength of the Pipe, but in Excess of 100 psi.

Steel piping that is to operate at stresses less than 30% of the specified minimum yield strength but in excess of 100 psi in location classes 2, 3 and 4 shall be tested to at least 1.5 times the maximum operating pressure.

The test medium used may be water, air or gas; provided, however, that no medium shall be used to a higher hoop stress during the test than the maximums set in Table 841.421.

Table 841.421

Maximum Hoop Stress Permissible During Test

Location class	Percent of Specified Minimum Yield Strength			
	1	2	3	4
Test medium				
Water	No max.	No max.	No max.	No max.
Air	79.2	75	50	40
Gas	79.2	30	30	30

841.43 Leak Tests for Pipelines or Mains to Operate at 100 psi or More

841.431 Each pipeline and main shall be tested after construction and before being placed in operation to demonstrate that it does not leak. If the test indicates that a leak exists, the leak or leaks shall be located and eliminated, unless it can be determined that no undue hazard to public safety exists.

841.432 The test procedure used shall be capable of disclosing all leaks in the section being tested and shall be selected after giving due consideration to the volumetric content of the section and to its location.

841.433 In all cases where a line is to be stressed in a strength-proof test to 20% or more of the specified minimum yield strength of the pipe, and gas or air is

SECTION 8 GAS TRANSMISSION AND DISTRIBUTION

the test medium, a leak test shall be made at a pressure in the range from 100 psi to that required to produce a hoop stress of 20% of the minimum specified yield, or the line shall be walked while the hoop stress is held at approximately 20% of the specified minimum yield.

841.44 Leak Tests for Pipelines and Mains to Operate at Less Than 100 psi

841.441 At the time of or prior to placing in operation distribution mains and related equipment to operate at less than 100 psi, they shall be tested to determine that they are gas-tight.

841.442 Gas may be used as the test medium at the maximum pressure available in the distribution system at the time of the test. In this case the soap bubble test may be used to locate leaks if all joints are accessible during the test.

841.443 Testing at available distribution system pressures as provided for above in 841.442 may not be adequate if substantial protective coatings are used that would seal a split pipe seam. If such coatings are used, the leak test pressure shall be 100 psi.

841.5 Safety During Tests All testing of pipelines and mains after construction shall be done with due regard for the safety of employees and the public during the test. When air or gas is used, suitable steps shall be taken to keep persons not working on the testing operations out of the testing area during the period in which the hoop stress is first raised from 50% of the specified minimum yield to the maximum test stress, and until the pressure is reduced to the maximum operating pressure.

842 CAST IRON

842.1 Cast Iron Pipe Design

842.11 Basic Equation to Determine Required Wall Thickness. Cast iron pipe shall be designed in accordance with

the methods set forth in the ASA A21.1 "American Recommended Practice Manual for the Computation of Strength and Thickness of Cast Iron Pipe."

842.12 Maximum Allowable Values of S and R. The values of S, bursting tensile strength, and R, modulus of rupture, to be used in the equations given in ASA A21.1 are:

Specification	Type of Pipe	S	R
		Bursting Tensile Strength	Modulus of Rupture
ASA A21.3	Pit Cast	11,000 psi	31,000 psi
ASA A21.7	Centrifugal (Metal Mold)	18,000 psi	40,000 psi
ASA A21.9	Centrifugal (Sand-lined Mold)	18,000 psi	40,000 psi

842.13 Allowable Thicknesses for Cast Iron Pipe. The least cast iron pipe thicknesses permitted are the lightest standard classes for each nominal pipe size as shown in ASA Specifications A21.3, A21.7 and A21.9.

842.14 Standard Thickness for Cast Iron Pipe. The wall thickness, diameter, and maximum working pressure permitted under ASA A21.1 for the type and sizes of cast iron pipe most commonly used for gas piping are shown in Tables 842.141 and 842.142. For pipe sizes, pressure, thicknesses, or laying conditions not shown in these tables, reference should be made to ASA A21.1 for the method of calculation.

Table 842.141

(See Table on page 53).

Table 842.142

(See Table on page 54).

842.15 Cast Iron Pipe Joints

(a) Caulked Bell and Spigot Joints Dimensions for caulked bell and spigot joints shall conform to the American Standards Association Specifications A21.3, A21.7, A21.9 and A21.10. This type of joint shall not be used for pressures in excess of 25 psig, unless reinforced with mechanical clamps.

(b) Mechanical Joints Mechanical joints shall utilize gaskets made of a resil-