Description	To design pipe that can withstand the anticipated external pressures and loads that will be imposed on the pipe after installation and to determine the pressure the pipe is designed to carry.
Regulatory Applicability	☒ Transmission Pipelines ☒ Regulated Gathering Pipelines ☒ Distribution Pipelines
Applies to	All DOT regulated gas pipelines.
Frequency	As needed for new installation or replaced pipe.
Safety and Environmental Precautions	Thorough review of each new pipeline design is required to ensure that all design/configuration are minimizing/reducing natural gas releases.

References

49 CFR 192.101	*Scope*
49 CFR 192.103	*General*
49 CFR 192.105	*Design Formula for Steel Pipe*
49 CFR 192.107	*Yield Strength (S) for steel pipe*
49 CFR 192.109	*Nominal wall thickness (t) for steel Pipe*
49 CFR 192.111	*Design factor (F) for steel pipe*
49 CFR 192.112	*Additional design requirements for steel pipe using alternative maximum allowable operating Pressure*
49 CFR 192.113	*Longitudinal joint factor (E) for steel pipe*
49 CFR 192.115	*Temperature derating factor for steel pipe*
49 CFR 192.121	*Design of plastic pipe*
49 CFR 192.123	*Design limitations for plastic pipe*
49 CFR 192.143	*General requirements*
49 CFR 192.144	*Qualifying metallic components*
49 CFR 192.145	*Valves*
49 CFR 192.147	*Flanges and flange accessories*
49 CFR192.149	*Standard fittings*
49 CFR192.150	*Passage of internal inspection devices*
49 CFR192.153	*Components fabricated by welding*
49 CFR192.155	*Welded branch connections*
49 CFR192.157	*Extruded outlets*
49 CFR192.159	*Flexibility*
49 CFR 192.161	*Supports and anchors*
49 CFR 192.179	*Transmission line valves*

49 CFR 192.181	*Distribution line valves*
49 CFR 192.183	*Vaults: Structural design requirements*
49 CFR 192.185	*Vaults: Accessibility*
49 CFR 192.187	*Vaults: Sealing, venting and ventilation*
49 CFR 192.189	*Vaults: Drainage and waterproofing*
49 CFR 192.191	*Design pressure of plastic fittings*
49 CFR 192.193	*Valve installation in plastic pipe*
49 CFR 192.195	*Protection against accidental over-pressuring*
49 CFR 192.197	*Control of the pressure of gas delivered from high pressure distribution system*
49 CFR 192.199	*Requirements for design of pressure relief and limiting devices*
49 CFR 192.201	*Required capacity of pressure relieving and limiting stations*
49 CFR 192.203	*Instrument, control, and sampling pipe and components*
49 CFR 192.317	*Protection from hazards*

Agency 82 KAC Article 11 Section 4: Transportation of natural and other gas by pipeline minimum safety standards

Prerequisites

N/A

Forms / Record Retention

None

Related Procedures

None

Procedure Steps

Engineering will use this procedure to ensure pipe and components are designed in accordance with the design regulations in 49 CFR Part 192 which prohibits the use of cast iron, wrought iron, or bare steel pipelines.

Design Pressure of Steel Pipe (49 CFR Subpart C)

1. Determine the type of pipe to be used. From this, determine the Yield Strength as follows:
   a) For pipe manufactured in accordance with a specification listed in section I of appendix B of 49 CFR 192, the yield strength is the SMYS stated in the listed specification, if that value is known.
   b) For pipe that is manufactured in accordance with a specification not listed in section I of appendix B of 49 CFR Part 192 or whose specification or tensile properties are unknown, the yield strength is one of the following:
      i. If the pipe is tensile tested in accordance with section II-D of appendix B of 49 CFR Part 192, the lower of the following:
         a. 80 percent of the average yield strength determined by the tensile tests.
         b. The lowest yield strength determined by the tensile tests.
      ii. If the pipe is not tensile tested as provided in paragraph (b)(i) above, 24,000 p.s.i.
2. Determine the wall thickness of the pipe.
   a) If the nominal wall thickness for steel pipe is not known, it is determined by measuring the thickness of each piece of pipe at quarter points on one end.
   b) However, if the pipe is of uniform grade, size, and thickness and there are more than 10 lengths, only 10 percent of the individual lengths, but not less than 10 lengths, need be measured. The thickness of the lengths that are not measured must be verified by applying a gauge set to the minimum thickness found by the measurement. The nominal wall thickness to be used in the design formula is the next wall thickness found in commercial specifications that is below the average of all the measurements taken. However, the nominal wall thickness used may not be more than 1.14 times the smallest measurement taken on pipe less than 20 inches in outside diameter, nor more than 1.11 times the smallest measurement taken on pipe 20 inches or more in outside diameter.
3. Determine the nominal outside diameter of the pipe in inches.
4. Determine the design factor for the pipe as follows:
   a) Except as otherwise provided below, the design factor to be used in the design formula is determined in accordance with the following table:

Class location	**Design factor (*F*)**
1	0.72
2	0.60
3	0.50
4	0.40

   b) A design factor of 0.60 or less must be used in the design formula for steel pipe in Class 1 locations that:
      i. Crosses the right-of-way of an unimproved public road, without a casing;

ii. Crosses without a casing, or makes a parallel encroachment on, the right-of-way of either a hard-surfaced road, a highway, a public street, or a railroad;
iii. Is supported by a vehicular, pedestrian, railroad, or pipeline bridge; or
iv. Is used in a fabricated assembly, (including separators, mainline valve assemblies, cross-connections, and river crossing headers) or is used within five pipe diameters in any direction from the last fitting of a fabricated assembly, other than a transition piece or an elbow used in place of a pipe bend which is not associated with a fabricated assembly.

c) For Class 2 locations, a design factor of 0.50, or less, must be used in the design formula for uncased steel pipe that crosses the right-of-way of a hard-surfaced road, a highway, a public street, or a railroad.

d) For Class 1 and Class 2 locations, a design factor of 0.50, or less, must be used in the design formula for-
i. Steel pipe in a compressor station, regulating station, or measuring station; and
ii. Steel pipe, including a pipe riser, on a platform located offshore or in inland navigable waters.

5. Determine the longitudinal joint factor from the table below:

Specification	**Pipe class**	**Longitudinal joint factor (E)**
ASTM A 53/A53M	Seamless	1.00
	Electric resistance welded	1.00
	Furnace butt welded	.60
ASTM A 106	Seamless	1.00
ASTM A 333/A 333M	Seamless	1.00
	Electric resistance welded	1.00
ASTM A 381	Double submerged arc welded	1.00
ASTM A 671	Electric-fusion-welded	1.00
ASTM A 672	Electric-fusion-welded	1.00
ASTM A 691	Electric-fusion-welded	1.00
API 5 L	Seamless	1.00
	Electric resistance welded	1.00
	Electric flash welded	1.00
	Submerged arc welded	1.00
	Furnace butt welded	.60
Other	Pipe over 4 inches (102 millimeters)	.80

Other	Pipe 4 inches (102 millimeters) or less	.60

Note: If the type of longitudinal joint cannot be determined, the joint factor to be used must not exceed that designated for "Other."

6. Determine the temperature derating factor from the table below:

Gas temperature in degrees Fahrenheit	**Temperature derating factor (T)**
250°F or less	1.000
300°F	0.967
350°F	0.933
400°F	0.900
450°F	0.867

Note: For intermediate gas temperatures, the derating factor is determined by interpolation.

7. Use the items determined above to calculate the design pressure for the pipeline using the following formula:.

$P = (2\ St/D) \times F \times E \times T$

Where:

P =Design pressure in pounds per square inch gauge.

S =Yield strength in pounds per square inch determined in accordance with #1 above.

D =Nominal outside diameter of the pipe in inches.

t =Nominal wall thickness of the pipe in inches. If this is unknown, it is determined in accordance with #2 above. Additional wall thickness required for concurrent external loads in accordance with §192.103 may not be included in computing design pressure.

F =Design factor determined in accordance with #4 above.

E =Longitudinal joint factor determined in accordance with #5 above.

T =Temperature derating factor determined in accordance with #6 above.

Note: If the pipe was subjected to cold expansion to meet the SMYS and then subsequently heated, other than by welding or stress relieving as a part of welding, the design pressure is limited to 75% of the pressure determined here if the temperature of the pipe exceeds 900^0F at any time or is held above 600^0F for more than 1 hour.

8. If the pipe is to be designed using alternative maximum allowable operating pressure, all additional requirements of 49 CFR 192.112 will be satisfied.

Design Pressure of Plastic Pipe

1. Determine the type of pipe to be used. For Polyethylene pipe (PE), select the thermoplastic pipe value (S) from pipe grade row and the design temperature column from the following table:

	Design Temp (°F)			
Grade	**73**	**100**	**120**	**140**
2306	1250	1250	1000	800
2406	1250	1250	1000	800
3406	1250	1250	1000	800
3408 / 4710	1600	1250	1000	800

2. Determine the wall thickness (t) of the pipe by dividing the outside diameter(D) by the pipe's Standard dimension ratio (SDR).
3. The design factor 'DF' is 0.32.
4. Use the items above to calculate the design pressure for the pipeline using the following formula:
   P = 2S x (t/D – t) x DF, or
   P = (2S / (SDR – 1) X DF
5. Check final selection and design pressure against the limitations below:
   a) Design pressure cannot exceed 100 psig when used in distribution systems or Class 3 and 4 locations.
   b) Plastic pipe cannot be used with operating temperatures in 49 CFR 192.121 (b).
   c) The wall thickness may not be less than 0.090 inches, unless specified in the following table:

PE pipe: minimum wall thickness and SDR values		
Pipe size (inches)	**Minimum wall thickness (inches)**	**Corresponding SDR (values)**
½ CTS	0.090	7
½ IPS	0.090	9.3
¾ CTS	0.090	9.7
¾ IPS	0.095	11
1 CTS	0.099	11
1 IPS	0.119	11
1 ¼ IPS	0.151	11
1 ½ IPS	0.173	11

2	0.216	11
3	0.259	13.5
4	0.265	17
6	0.315	21
8	0.411	21
10	0.512	21
12	0.607	21
16	0.762	21
18	0.857	21
20	0.952	21
22	1.048	21
24	1.143	21

* Copper Tubing Size (CTS)   Iron Pipe Size (IPS)

d) For PE pipe produced after July 14, 2004, but before January 22, 2019, a design pressure of up to 125 psig may be used, provided:
   i. The material designation code is PE2406 or PE3408.
   ii. The pipe has a nominal size (Iron Pipe Size (IPS) or Copper Tubing Size (CTS)) of 12 inches or less (above nominal pipe size of 12 inches, the design pressure is limited to 100 psig); and
   iii. The wall thickness is not less than 0.062 inches (1.57 millimeters).

e) For PE pipe produced on or after January 22, 2019, a DF of 0.40 may be used in the design formula, provided:
   i. The design pressure does not exceed 125 psig
   ii. The material designation code is PE2708 or PE4710
   iii. The pipe has a nominal size (IPS or CTS) of 24 inches or less and
   iv. The wall thickness for a given outside diameter is not less than that listed in the above table.

Other plastic pipe materials will be designed according to 49 CFR 192.121.

Design of Casings:
For each casing installed on a regulated gathering, transmission or distribution main pipeline, the casing must comply with**:**

1. The casing must be designed to withstand superimposed loads.
2. If there is a possibility of water entering the casing, the end must be sealed.
3. If the ends of an unvented casing are sealed and the sealing is strong enough to retain the MAOP pressure of the pipeline, the casing must be designed to hold the pressure at a stress level of < 72% SMYS.
4. If vents are installed on casing, the vents must be protected to prevent water from entering the casing.

Pipeline Components:
Ensure each component that will be installed in the pipeline complies with the following:

1. WTG must take all practicable steps to protect each transmission line or main from washouts, floods, unstable soil, landslides, or other hazards that may cause the pipeline to move or to sustain abnormal loads.
2. For each aboveground transmission line or main, not located offshore or in inland navigable water areas, must be protected from accidental damage by vehicular traffic or other similar causes, either by being placed at a safe distance from the traffic or by installing barricades.
3. It can withstand operating pressures and other anticipated loadings without impairment of its serviceability with unit stresses equivalent to those allowed for comparable material in pipe in the same location and kind of service. However, if design based upon unit stresses is impractical for a particular component, design may be based upon a pressure rating established by the manufacturer by pressure testing that component or a prototype of the component. Note: These components must also meet the requirements for corrosion control requirements in Subpart I of 49 CFR Part 192.
4. If manufactured in accordance with any other edition of a document incorporated by reference in §192.7 or Appendix B of 49 CFR Part 192, -
   a) It can be shown through visual inspection of the cleaned component that no defect exists which might impair the strength or tightness of the component; and
   b) The edition of the document under which the component was manufactured has equal or more stringent requirements for the following as an edition of that document currently or previously listed in §192.7 or appendix B of 49 CFR Part 192:
      i. Pressure testing
      ii. Materials; and
      iii. Pressure and temperature ratings.
5. Emergency Valves (49 CFR 192.145 / 19 CFR 192.179)
   a) Meet the minimum requirements of API 6D or to a national or international standard that provides an equivalent performance level. An emergency valve may not be used under operating conditions that exceed the applicable pressure-temperature ratings contained in those requirements.
   b) Can meet the anticipated operating conditions.
   c) Each transmission line has sectionalizing emergency block valves spaced as follows, unless in a particular case the Administrator finds that alternative spacing would provide an equivalent level of safety:
      i. Each point on the pipeline in a Class 4 location must be within 2 ½ miles of a valve.
      ii. Each point on the pipeline in a Class 3 location must be within 4 miles of a valve.
      iii. Each point on the pipeline in a Class 2 location must be within 7 ½ miles of a valve.
      iv. Each point on the pipeline in a Class 1 location must be within 10 miles of a valve.
   d) Each sectionalizing block valve on a transmission line complies with the following:
      i. The valve and the operating device to open or close the valve are readily accessible and protected from tampering and damage.
      ii. The valve is supported to prevent settling of the valve or movement of the pipe to which it is attached.
   e) Each section of a transmission line between main line emergency valves has a blowdown valve with enough capacity to allow the transmission line to be blown down as rapidly as practicable. Each blowdown discharge is located so the gas can be blown to the atmosphere without hazard and, if the transmission line is adjacent to an overhead electric line, so that the gas is directed away from the electrical conductors.
   f) Each high-pressure distribution system must have emergency valves spaced so as to reduce the time to shut down a section of main in an emergency. The valve spacing is determined by the operating pressure, the size of the mains, and the local physical conditions.

g) Each regulator station controlling the flow or pressure of gas in a distribution system must have an emergency valve installed on the inlet piping at a distance from the regulator station sufficient to permit the operation of the valve during an emergency that might preclude access to the station.
h) Each emergency valve on a main installed for operating or emergency purposes must comply with the following:
    i. The valve must be placed in a readily accessible location so as to facilitate its operation in an emergency.
    ii. The operating stem or mechanism must be readily accessible.
    iii. If the valve is installed in a buried box or enclosure, the box or enclosure must be installed so as to avoid transmitting external loads to the main.

6. Flange or flange accessory
    a) Meet the minimum requirements of ASME/ANSI B16.5, MSS SP-44, or the equivalent.
    b) The flange assembly is able to withstand the maximum pressure at which the pipeline is to be operated and maintain its physical and chemical properties at any temperature to which it is anticipated that it might be subjected in service.
7. Threaded fittings have a minimum metal thickness that is not less than specified for the pressures and temperatures in the applicable standards referenced in 49 CFR Part 192, or their equivalent.
8. Each steel butt-welding fitting has pressure and temperature ratings based on stresses for pipe of the same or equivalent material. The actual bursting strength of the fitting is at least equal the computed bursting strength of pipe of the designated material and wall thickness, as determined by a prototype that was tested to at least the pressure required for the pipeline to which it is being added.
9. Except for branch connections and assemblies of standard pipe and fittings joined by circumferential welds, the design pressure of each component fabricated by welding, whose strength cannot be determined, is established in accordance with paragraph UG-101 of section VIII, Division 1, of the ASME Boiler and Pressure Vessel Code.
10. Each prefabricated unit that uses plate and longitudinal seams will be designed, constructed, and tested in accordance with the ASME Boiler and Pressure Vessel Code.
11. Orange-peel bull plugs and orange-peel swages are not used on pipelines that are to operate at a hoop stress of 20 percent or more of the SMYS of the pipe.
12. Except for flat closures designed in accordance with section VIII of the ASME Boiler and Pressure Code, flat closures and fish tails are not used on pipe that either operates at 100 p.s.i. gauge, or more, or is more than 3 inches nominal diameter.
13. Each welded branch connection made to pipe in the form of a single connection, or in a header or manifold as a series of connections, is designed to ensure that the strength of the pipeline system is not reduced, taking into account the stresses in the remaining pipe wall due to the opening in the pipe or header, the shear stresses produced by the pressure acting on the area of the branch opening, and any external loadings due to thermal movement, weight, and vibration.
14. Each extruded outlet is suitable for anticipated service conditions and at least equal to the design strength of the pipe and other fittings in the pipeline to which it is attached.
15. Each pipeline is designed with enough flexibility to prevent thermal expansion or contraction from causing excessive stresses in the pipe or components, excessive bending or unusual loads at joints, or undesirable forces or moments at points of connection to equipment, or at anchorage or guide points.

Passage of Internal Inspection Devices

New transmission lines and replacement of pipe and components must be designed and constructed to allow for instrumented internal inspection devices in accordance with NACE SP0102, Section 7. This requirement does not include manifolds, compressor, meter, and regulator stations, line pipe sizes that cannot accommodate ILI tools, and other exceptions listed in 49 CFR 192.150.

Launcher and receiver safety

Any launcher or receiver used after July 1, 2021, must be equipped with a device capable of safely relieving pressure in the barrel before removal or opening of the launcher or receiver barrel closure or flange and insertion or removal of in-line inspection tools, scrapers, or spheres. An operator must use a device to either: Indicate that pressure has been relieved in the barrel; or alternatively prevent opening of the barrel closure or flange when pressurized, or insertion or removal of in-line devices (*e.g.* inspection tools, scrapers, or spheres), if pressure has not been relieved.

Vaults

1. Ensure vaults meet the following structural design requirements.
   a) able to meet the loads which may be imposed upon it, and to protect installed equipment.
   b) enough working space so that all of the equipment required in the vault or pit can be properly installed, operated, and maintained.
   c) each pipe entering, or within, a regulator vault or pit must be steel for sizes 10 inch and less, except that control and gage piping may be copper. Where pipe extends through the vault or pit structure, provision must be made to prevent the passage of gases or liquids through the opening and to avert strains in the pipe.
2. Ensure each vault is located in an accessible location and, so far as practical, away from:
   a) Street intersections or points where traffic is heavy or dense.
   b) Points of minimum elevation, catch basins, or places where the access cover will be in the course of surface waters; and
   c) Water, electric, steam, or other facilities.
3. Ensure each underground vault or closed top pit containing either a pressure regulating or reducing station, or a pressure limiting or relieving station, is sealed, vented or ventilated as follows:
   a) When the internal volume exceeds 200 cubic feet:
      i. The vault or pit must be ventilated with two ducts, each having at least the ventilating effect of a pipe 4 inches in diameter.
      ii. The ventilation must be enough to minimize the formation of combustible atmosphere in the vault or pit; and
      iii. The ducts must be high enough above grade to disperse any gas-air mixtures that might be discharged.
   b) When the internal volume is more than 75 cubic feet but less than 200 cubic feet:
      i. If the vault or pit is sealed, each opening must have a tight-fitting cover without open holes through which an explosive mixture might be ignited, and there must be a means for testing the internal atmosphere before removing the cover;
      ii. If the vault or pit is vented, there must be a means of preventing external sources of ignition from reaching the vault atmosphere; or
      iii. If the vault or pit is ventilated, paragraph (a) or (c) of this section applies.

   c) If a vault or pit covered by paragraph (b) of this section is ventilated by openings in the covers or gratings and the ratio of the internal volume, in cubic feet, to the effective ventilating area of the cover or grating, in square feet, is less than 20 to 1, no additional ventilation is required.
4. Ensure each vault is designed so as to minimize the entrance of water and is not connected by a drain connection to any other underground structure is the vault contains gas piping.
5. Ensure electrical equipment in vaults conforms to the applicable requirements of Class 1, Group D, of the National Electrical Code, ANSI/NFPA 70.

Supports and Anchors

1. Ensure pipeline and its associated equipment has enough anchors or supports to:
   a) Prevent undue strain on connected equipment
   b) Resist longitudinal forces caused by a bend or offset in the pipe; and
   c) Prevent or damp out excessive vibration.
2. Each exposed pipeline has enough supports or anchors to protect the exposed pipe joints from the maximum end force caused by internal pressure and any additional forces caused by temperature expansion or contraction or by the weight of the pipe and its contents.
3. Each support or anchor on an exposed pipeline is made of durable, noncombustible material and must be designed and installed as follows:
   a) Free expansion and contraction of the pipeline between supports or anchors may not be restricted.
   b) Provision must be made for the service conditions involved.
   c) Movement of the pipeline may not cause disengagement of the support equipment.
4. Each support on an exposed pipeline operated at a stress level of 50 percent or more of SMYS will comply with the following:
   a) A structural support may not be welded directly to the pipe.
   b) The support must be provided by a member that completely encircles the pipe.
   c) If an encircling member is welded to a pipe, the weld must be continuous and cover the entire circumference.
5. Each underground pipeline that is connected to a relatively unyielding line or other fixed object has enough flexibility to provide for possible movement, or has an anchor that will limit the movement of the pipeline.
6. Each underground pipeline that is being connected to new branches has a firm foundation for both the header and the branch to prevent detrimental lateral and vertical movement.

Design pressure of plastic fittings

Design pressure for fittings exceeds or is equal to pipe design pressure. Ensure thermosetting fittings for plastic pipe conforms to ASTM 2513.

Valve installation in plastic pipe

Design pressure for valves exceeds or is equal to pipe design pressure. Ensure each valve installed in plastic pipe protects the plastic material against excessive torsional or shearing loads when the valve or shutoff is operated, and from any other secondary stresses that might be exerted through the valve or its enclosure.

Protection against accidental over-pressuring

General requirements

Except as provided in §192.197, ensure each pipeline that is connected to a gas source so that the maximum allowable operating pressure could be exceeded as the result of pressure control failure or of some other type of failure, has pressure relieving or pressure limiting devices that meet the requirements below.

Additional requirements for distribution systems

Ensure each distribution system that is supplied from a source of gas that is at a higher pressure than the maximum allowable operating pressure for the system -

(1) Has pressure regulation devices capable of meeting the pressure, load, and other service conditions that will be experienced in normal operation of the system, and that could be activated in the event of failure of some portion of the system; and

(2) Is designed so as to prevent accidental overpressuring.

Control of the pressure of gas delivered from high-pressure distribution systems

1. If the maximum actual operating pressure of the distribution system is 60 p.s.i. gage, or less and a service regulator having the following characteristics is used, no other pressure limiting device is required:

    a) A regulator capable of reducing distribution line pressure to pressures recommended for household appliances.
    b) A single port valve with proper orifice for the maximum gas pressure at the regulator inlet.
    c) A valve seat made of resilient material designed to withstand abrasion of the gas, impurities in gas, cutting by the valve, and to resist permanent deformation when it is pressed against the valve port.
    d) Pipe connections to the regulator not exceeding 2 inches (51 millimeters) in diameter.
    e) A regulator that, under normal operating conditions, is able to regulate the downstream pressure within the necessary limits of accuracy and to limit the build-up of pressure under no-flow conditions to prevent a pressure that would cause the unsafe operation of any connected and properly adjusted gas utilization equipment.
    f) A self-contained service regulator with no external static or control lines.

2. If the maximum actual operating pressure of the distribution system is 60 p.s.i. gage, or less, and a service regulator that does not have all of the characteristics listed in paragraph (a) of this section is used, or if the gas contains materials that seriously interfere with the operation of service regulators, there must be suitable protective devices to prevent unsafe overpressuring of the customer's appliances if the service regulator fails.

3. If the maximum actual operating pressure of the distribution system exceeds 60 p.s.i. gauge, one of the following methods must be used to regulate and limit, to the maximum safe value, the pressure of gas delivered to the customer:

   a) A service regulator having the characteristics listed in paragraph (a) of this section, and another regulator located upstream from the service regulator. The upstream regulator may not be set to maintain a pressure higher than 60 p.s.i. gauge. A device must be installed between the upstream regulator and the service regulator to limit the pressure on the inlet of the service regulator to 60 p.s.i. gauge or less in case the upstream regulator fails to function properly. This device may be either a relief valve or an automatic shutoff that shuts, if the pressure on the inlet of the service regulator exceeds the set pressure (60 p.s.i. gauge or less), and remains closed until manually reset.
   b) A service regulator and a monitoring regulator set to limit, to a maximum safe value, the pressure of the gas delivered to the customer.
   c) A service regulator with a relief valve vented to the outside atmosphere, with the relief valve set to open so that the pressure of gas going to the customer does not exceed a maximum safe value. The relief valve may either be built into the service regulator or it may be a separate unit installed downstream from the service regulator. This combination may be used alone only in those cases where the inlet pressure on the service regulator does not exceed the manufacturer's safe working pressure rating of the service regulator, and may not be used where the inlet pressure on the service regulator exceeds 125 p.s.i. gauge. For higher inlet pressures, the methods in paragraph (c) (1) or (2) of this section must be used.
   d) A service regulator and an automatic shutoff device that closes upon a rise in pressure downstream from the regulator and remains closed until manually reset.

Requirements for design of pressure relief and limiting devices

Except for rupture discs, ensure each pressure relief or pressure limiting device:

1. Is constructed of materials such that the operation of the device will not be impaired by corrosion.
2. Has valves and valve seats that are designed not to stick in a position that will make the device inoperative
3. Is designed and installed so that it can be readily operated to determine if the valve is free, can be tested to determine the pressure at which it will operate, and can be tested for leakage when in the closed position;
4. Has support made of noncombustible material.
5. Has discharge stacks, vents, or outlet ports designed to prevent accumulation of water, ice, or snow, located where gas can be discharged into the atmosphere without undue hazard.
6. Is designed and installed so that the size of the openings, pipe, and fittings located between the system to be protected and the pressure relieving device, and the size of the vent line, are adequate to prevent hammering of the valve and to prevent impairment of relief capacity.
7. Where installed at a district regulator station to protect a pipeline system from overpressuring, is designed and installed to prevent any single incident such as an explosion in a vault or damage by a vehicle from affecting the operation of both the overpressure protective device and the district regulator; and
8. Except for a valve that will isolate the system under protection from its source of pressure, is designed to prevent unauthorized operation of any stop valve that will make the pressure relief valve or pressure limiting device inoperative.

Required capacity of pressure relieving and limiting stations

1. Ensure each pressure relief station or pressure limiting station or group of those stations installed to protect a pipeline has enough capacity, and is set to operate, to insure the following:

    a) In a low-pressure distribution system, the pressure may not cause the unsafe operation of any connected and properly adjusted gas utilization equipment.
    b) In pipelines other than a low-pressure distribution system:

        i. If the maximum allowable operating pressure is 60 p.s.i. gauge or more, the pressure may not exceed the maximum allowable operating pressure plus 10 percent, or the pressure that produces a hoop stress of 75 percent of SMYS, whichever is lower.
        ii. If the maximum allowable operating pressure is 12 p.s.i. gauge or more, but less than 60 p.s.i.) gauge, the pressure may not exceed the maximum allowable operating pressure plus 6 p.s.i. gauge; or
        iii. If the maximum allowable operating pressure is less than 12 p.s.i. gauge, the pressure may not exceed the maximum allowable operating pressure plus 50 percent.

2. When more than one pressure regulating or compressor station feeds into a pipeline, ensure relief valves or other protective devices are installed at each station to ensure that the complete failure of the largest capacity regulator or compressor, or any single run of lesser capacity regulators or compressors in that station, will not impose pressures on any part of the pipeline or distribution system in excess of those for which it was designed, or against which it was protected, whichever is lower.

3. Relief valves or other pressure limiting devices will be installed at or near each regulator station in a low-pressure distribution system, with a capacity to limit the maximum pressure in the main to a pressure that will not exceed the safe operating pressure for any connected and properly adjusted gas utilization equipment.

Instrument, control, and sampling pipe and components

Note: This section applies to the design of instrument, control, and sampling pipe and components. It does not apply to permanently closed systems, such as fluid-filled temperature-responsive devices.

1. *Ensure all* materials employed for pipe and components are designed to meet the particular conditions of service and the following:

    a) Each takeoff connection and attaching boss, fitting, or adapter is made of suitable material, can withstand the maximum service pressure and temperature of the pipe or equipment to which it is attached, and is designed to satisfactorily withstand all stresses without failure by fatigue.
    b) Except for takeoff lines that can be isolated from sources of pressure by other valving, a shutoff valve is installed in each takeoff line as near as practicable to the point of takeoff. Blowdown valves are installed where necessary.
    c) Brass or copper material is not used for metal temperatures greater than 400° F.
    d) Pipe or components that may contain liquids are protected by heating or other means from damage due to freezing.
    e) Pipe or components in which liquids may accumulate have drains or drips.

f) Pipe or components subject to clogging from solids or deposits have suitable connections for cleaning.
g) The arrangement of pipe, components, and supports provides safety under anticipated operating stresses.
h) Each joint between sections of pipe, and between pipe and valves or fittings, is made in a manner suitable for the anticipated pressure and temperature condition. Slip type expansion joints are not used. Expansion is allowed for by providing flexibility within the system itself. Each control line is protected from anticipated causes of damage and must be designed and installed to prevent damage to any one control line from making both the regulator and the over-pressure protective device inoperative.