NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

IRRIGATION WATER CONVEYANCE
HIGH-PRESSURE, UNDERGROUND, PLASTIC PIPELINE
(feet)
CODE 430-DD

DEFINITION

A pipeline and appurtenances installed in an irrigation system.

PURPOSE

Prevent erosion or loss of water quality or damage to the land, to make possible proper management of irrigation water, and reduce water conveyance losses.

CONDITIONS WHERE PRACTICE APPLIES

All pipelines shall be planned and located to serve as an integral part of an irrigation water distribution or conveyance system designed to facilitate the conservation use and management of the soil and water resources on a farm or group of farms.

Water supplies, water quality, and rates of irrigation delivery for the area served by the pipeline shall be sufficient to make irrigation practical for the crops to be grown and the irrigation water application method to be used. Plastic pipelines installed according to this standard shall be placed only in suitable soils where the bedding and backfill requirements can be fully met.

CRITERIA

Working pressure and flow velocity. The minimum acceptable class of pipe shall be that having a pressure rating for water of 80 pounds per square inch.

The pipeline shall be designed to meet all service requirements without an operating or static pressure at any point greater than the pressure rating of the pipe used at that point.

As a safety factor against surge or water hammer, the working pressure shall not exceed 72 percent of the pressure rating of the pipe, and the design flow velocity at system capacity shall not be greater than 5 ft/sec. If either of these limits is exceeded, special consideration must be given to the flow conditions and measures to adequately protect the pipeline against surge.

Capacity. The design capacity of the pipeline shall be based on whichever of the following criteria is greater:

1. The capacity shall be sufficient to deliver the volume of water required to meet the peak-period consumptive use of the crop or crops to be irrigated.

2. The capacity shall be sufficient to provide an adequate stream for all methods of irrigation planned.

Friction losses. For design purposes, friction head losses shall be no less than those computed by the Hazen-Williams equation, using a roughness coefficient, c, equal to 150.

Outlets. Appurtenances required to deliver water from the pipeline to an individual sprinkler or to a lateral line of sprinklers or surface pipe located on the ground surface shall be known as outlets. Outlets shall have adequate capacity to deliver the design flow to the individual sprinkler, surface lateral line of sprinklers, or surface pipe at the design operating pressure.

Check valves. A check valve shall be installed between the pump discharge and the pipeline where backflow may occur.

Pressure-relief valves. A pressure-relief valve shall be installed between the pump discharge and the pipeline if excessive pressure can build up when all valves are closed. Pressure-relief valves shall be installed on the discharge side of the check valve where a reversal of

flow may occur and at the end of the pipeline if needed to relieve surge at the end of the line.

Pressure-relief valves shall be no smaller than 1/4 inch nominal size for each diameter inch of the pipeline and shall be set to open at a pressure no greater than 5 pounds per square inch above the pressure rating of the pipe.

The pressure at which the valves start to open shall be marked on each pressure-relief valve. Adjustable pressure-relief valves shall be sealed or otherwise altered to prevent changing of the adjustment from that marked on the valve.

Manufacturers of pressure-relief valves marketed for use under this standard shall provide capacity tables, based on performance tests, that give the discharge capacities of the valves at the maximum permissible pressure and differential pressure settings. Such tables shall be the basis for design of pressure setting and of acceptance of these valves.

Air-release valves. The three basic types of air-release valves for use on irrigation pipelines are described below:

An air-release valve, a continuous acting valve that has a small venting orifice, generally ranging between 1/16 inch and 3/8 inch in size. This valve releases pockets of air from the pipeline once the line is filled and under working pressure.

An air-and vacuum valve, which has a large venting orifice, exhausts large quantities of air from the pipeline during filling operations and allows air to reenter the line and prevents a vacuum from forming during emptying operations. This type of valve is sometimes called air-vacuum-release valve or air-vent-and vacuum-relief valve. It is not continuous acting because it does not allow further escape of air at working pressure once the valve closes.

A combination air valve is sometimes called combination air-release and air-vacuum valve or combination air-and-vacuum-relief valve. It is continuous acting and combines the functions of both the air-release valve and the air-and-vacuum valve. Both valves are housed in one valve body.

If needed to provide positive means for air escape during filling and air entry while emptying, air-and-vacuum valves or combination air valves shall be installed at all summits, at the entrance and at the end(s) of the pipeline. Such valves generally are needed at these locations if the line is truly closed to the atmosphere. However, they may not be needed if other features of the pump system, such as permanently located sprinkler nozzles or other unclosed service outlets, adequately vent the particular location during filling and emptying operations.

The large orifice (opening that controls air flow during filling and emptying) of an air-and-vacuum valve or a combination air valve shall equal or exceed that specified below for the appropriate diameter pipeline:

1/2 inch for 5-inch or less pipelines
1 inch for 6- to 10-inches pipelines
1-3/4 inch for 12 to 15-inches pipelines

Air-release valves or combination air valves shall be used as needed to permit air to escape from the pipeline while the line is at working pressure. Small orifices of these types shall be sized according to the working pressure and venting requirements recommended by the valve manufacturer.

Manufacturers of air valves marketed for use under this standard shall provide dimensional data, which shall be the basis for selection and acceptance of these valves.

Drainage. Provisions shall be made for completely draining the pipeline if a hazard is imposed by freezing temperatures, drainage is recommended by the manufacturer of the pipe, or drainage of the line is specified for the job. If provisions for drainage are required, drainage outlets shall be located at all low places in the line. These outlets may drain into dry wells or to points of lower elevation. If drainage cannot be thus provided by gravity, provisions shall be made to empty the line by pumping or by other means.

Flushing. If provisions are needed for flushing the line free of sediment or other foreign material, a suitable valve shall be installed at the distal end of the pipeline.

Thrust control. Abrupt changes in pipeline grade, horizontal alignment, or reduction in pipe size normally require an anchor or thrust blocks to absorb any axial thrust of the pipeline. Thrust control may also be needed at the end of the pipeline and at inline control valves.

Thrust blocks and anchors must be of sufficient size to withstand the forces tending to move the pipe, including those of momentum and pressure as well as forces due to expansion and contraction.

The pipe manufacturer's recommendations for thrust control shall be followed. In absence of the pipe manufacturer's requirements, the following formula must be used in designing thrust blocks:

$$A = \frac{98\ HD^2 \sin \frac{a}{2}}{B}$$

Where:

A = Bearing area of thrust block required
H = Maximum working pressure in feet
D = Inside diameter of pipe in feet
B = Allowable bearing pressure of the soil in pounds per square foot
a = Deflection angle of pipe bend

Area of thrust blocks for dead ends and tees shall be 0.7 times the area of block required for a 90-deflection angle of pipe bend.

If adequate soil tests are not available, the allowable bearing pressure may be estimated from the following:

	pounds per square foot
Sound shale	10,000
Cemented gravel and sand difficult to pick	4,000
Coarse and fine compact sand	3,000
Medium clay, can be spaded	2,000
Soft clay	1,000
Muck	0

The figures are applicable for a 4-feet cover measured from ground surface to the centerline of the thrust block. For other depths, divide the figures by 4 and multiply by the installation depth (in feet.).

Materials. All materials shall meet or exceed the minimum requirements indicated in "Specifications for Materials."

PLANS AND SPECIFICATIONS

Plans and specifications for constructing high-pressure underground plastic pipelines shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purposes.

OPERATION AND MAINTENANCE

All irrigation systems must be adequately maintained to perform as planned and designed. Provisions for maintenance access must be provided.

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NATURAL RESOURCES CONSERVATION SERVICE
CONSTRUCTION SPECIFICATION

FOR

IRRIGATION WATER CONVEYANCE

HIGH-PRESSURE, UNDERGROUND, PLASTIC PIPELINE SPECIFICATION
(feet)
CODE 430-DD

INSTALLATION

The installation shall conform to ASTM F690 or ASTM D2321 as appropriate unless otherwise shown below.

Minimum depth of cover. Pipe shall be installed at sufficient depth below the ground surface to provide protection from hazards imposed by traffic crossings, farming operations, freezing temperatures, or soil cracking. The installation shall comply with National Engineering Handbook Part 650, Chapter 14 - Drainage, Appendix A, MO-14-27.

At low places on the ground surface extra fill may be placed over the pipeline to provide the minimum depth of cover. The top width of the fill shall then be no less than 10 ft and the side slopes no steeper than 6:1. If extra protection is needed at vehicle crossings, encasement pipe or other approved methods may be used.

Trench construction. Trench at any point below the top of the pipe line shall be only wide enough to permit the pipe to be easily placed and joined and to allow the initial backfill material to be uniformly placed under the haunches and along the sides of the pipe. The maximum trench width shall be 36 inches If the trench is precision excavated and has a semicircular bottom that closely fits the pipe, the width shall not exceed the outside diameter of the pipe by more than 10 percent.

The trench bottom shall be uniform so that the pipe lays on the bottom without bridging. Clods, rocks, and uneven spots that can damage the pipe or cause non-uniform support shall be removed.

If rocks, boulders, or any other material that can damage the pipe are encountered, the trench bottom shall be undercut a minimum of 4 inches below final grade and filled with bedding material consisting of sand or compacted fine-grained soils.

Pipelines having a diameter of 1/2 through 2-1/2 inch that are to be placed in areas not subject to vehicular loads and in soils that do not crack appreciably when dry may be placed by using "plow-in" equipment instead of conventional trenching. Contact the state conservation engineer for approval of "plow-in" installation.

Provisions shall be made to insure safe working conditions where unstable soil, trench depth, or other conditions can be hazardous to personnel working the trench.

Placement. Care shall be taken to prevent permanent distortion and damage when handling the pipe during unusually warm or cold weather. The pipe shall be allowed to come within a few degrees of the temperature it will have after it is completely covered before placing the backfill, other than that needed for shading, or before connecting the pipe to other facilities. The pipe shall be uniformly and continuously supported over its entire length on firm stable material. Blocking or mounding shall not be used to bring the pipe to final grade.

For pipe with bell joints, bell holes shall be excavated in the bedding material, as needed, to allow for unobstructed assembly of the joint and to permit the body of the pipe to be in contact with the bedding material throughout its length.

Joints and connections. All joints and connections shall be designed and constructed to withstand the design maximum working pressure for the pipeline without leakage and to leave the inside of the line free of any

obstruction that may tend to reduce its capacity below design requirements.

All fittings, such as couplings, reducers, bends, tees, and crosses, shall be installed according to the recommendations of the pipe manufacturer.

Fittings made of steel or other metals susceptible to corrosion shall be adequately protected by wrapping them with plastic tape or by applying a coating having high corrosion-preventative qualities. If plastic tape is used, all surfaces to be wrapped shall be thoroughly cleaned and coated with a primer compatible with the tape before wrapping.

Thrust blocks. Thrust blocks must be formed against a solid hand-excavated trench wall undamaged by mechanical equipment. They shall be constructed of concrete, and the space between the pipe and trench wall shall be filled to the height of the outside diameter of the pipe or as specified by the manufacturer.

Testing. The pipeline shall be tested for pressure strength, leakage, and proper functioning. The tests may be performed before backfilling or anytime after the pipeline is ready for service.

Tests for pressure strength and leaks shall be accomplished by inspecting the pipeline and appurtenances while the maximum working pressure is maintained and all joints and connections are uncovered, or by observing normal operation of the pipeline after it is put into service. Partial backfills needed to hold the pipe in place during testing shall be placed as specified in "Initial Backfill." Any leaks shall be repaired and the system retested.

The pipeline shall be tested to ensure that it functions properly at design capacity. At or below design capacity there shall be no objectionable flow conditions. Objectionable flow conditions shall include water hammer, continuing steady delivery of water, damage to the pipeline, or detrimental discharge from control valves.

Initial backfill. Hand, mechanical, or hand packing methods may be used.

The initial backfill material shall be soil or sand that is free from rocks or stones larger than 1 inch in diameter. At the time of placement, the moisture content of the material shall be such that the required degree of compaction can be obtained with the backfill method to be used. The initial backfill material shall be placed so that the pipe will not be displaced, excessively deformed, or damaged.

If backfilling is done by hand or mechanical means, the initial fill shall be compacted firmly around and above the pipe as required to provide adequate lateral support to the pipe.

If the water packing method is used, the pipeline first shall be filled with water. The initial backfill before wetting, shall be of sufficient depth to insure complete coverage of the pipe after consolidation. Water packing is accomplished by adding water to diked reaches of the trench in sufficient quantity to thoroughly saturate the initial backfill without excessive pooling of water. After the backfill is saturated, the pipeline shall remain full until after the final backfill is made. The wetted fill shall be allowed to dry until firm before beginning the final backfill.

Final backfill. The final backfill material shall be free of large rocks, frozen clods, and other debris greater than 3 inches in diameter. The material shall be placed and spread in approximately uniform layers so that there will be no unfilled spaces in the backfill. The backfill will be level with the natural ground or at the design grade required to provide the minimum depth of cover after settlement. Rolling equipment shall not be used to consolidate the final backfill until the specified minimum depth of cover has been placed.

All special backfilling requirements of the pipe manufacturer shall be met.

Basis of acceptance. The acceptability of the pipeline shall be determined by inspections to check compliance with all the provisions of the this standard with respect to the design of the line, the pipe, and pipe marking, the appurtenances, and the minimum installation requirements.

Certifications and guarantee. If requested by the state conservation engineer, a qualified

testing laboratory must certify with supporting test results that the pipe meets the requirements specified in this standard. The seal of approval of a recognized laboratory on pipe bearing one of the ASTM designations listed in this standard may be accepted for this certification.

The installing contractor shall certify that his installation complies with the requirements of this standard. He shall furnish a written guarantee that protects the owner against defective workmanship and materials for not less than 1 year. The certification identifies the manufacturer and markings of the pipe used.

MATERIALS

Quality of plastic pipe. The compound used in manufacturing the pipe shall meet the requirements of one of the following materials:

1. Polyvinyl chloride (PVC) as specified in ASTM D1784.

Material	Code classification
Type I, Grade 1 (12454-B)…….	PVC1120
Type I, Grade 2 (12454-C)…….	PVC1220
Type II, Grade 1 (14333-D)……	PVC2116
Type II, Grade 1 (14333-D)……	PVC2112
Type II, Grade 1 (14333-D)……...	PVC2110

2. Acrylinitrile-butadiene-styrene (ABS) as specified in ASTM D1527.

Material	Code classification
Type I, Grade 2.....….	ABS1208
Type I, Grade 2.....….	ABS1210
Type II, Grade 1…….	ABS2112
Type I, Grade 3.....	ABS1316

3. Polyethylene (PE) as specified in ASTM D1248.

Material	Code classification
Grade P14, …….....	PE1404
Grade P23, …….....	PE2305
Grade P23,…….....	PE2306
Grade P33,…….....	PE3306
Grade P34, …….....	PE3406

The pipe shall be homogeneous throughout and free from visible cracks, holes, foreign matter, or other defects. The pipe shall be as uniform in color, opacity, density, and other physical properties as is commercially practicable.

Pipe requirements. All pipe installed under this standard shall be pressure rated for water.

The relationship between standard dimension ratios, dimensions, hydrostatic design stresses, and pressure ratings shall be determined by one of the following formulas:

For PVC, ABS, and PE pipe with outside diameter controlled:

$$\frac{2S}{P} = \frac{Do}{t} - 1 \text{ or } \frac{2S}{P} = R - 1$$

For PE pipe with inside diameter controlled:

$$\frac{2S}{P} = \frac{Di}{t} + 1 \text{ or } \frac{2S}{P} = R + 1$$

Where:

S = hydrostatic design stress, in pounds per square inch

P = pressure rating in pounds per square inch

Do= average outside diameter in inches

Di= average inside diameter in inches

t = minimum wall thickness in inches

R = standard thermoplastic pipe dimension ratio (SDR)

Hydrostatic design stresses for the plastic pipe material are given in table 1.

IPS-size (outside diameter same as that for iron pipe sizes) and I.D. controlled PE pipe manufactured, tested, and marked to meet one of the following ASTM specifications shall be acceptable under this standard. Water pressure ratings and pertinent dimensions for

this pipe are given in tables 3, 4, 5, 6, and 7.

ASTM- Standard specification for-

D1785 Poly (vinyl chloride) (PVC) Plastic Pipe, Schedules 40, 80, 120
D2241 Poly (vinyl chloride) (PVC) Plastic Pipe, (SDR-PR)
D2672 Bell-End Poly (vinylchloride) (PVC) Pipe
D2740 Poly (vinyl chloride) (PVC) Plastic Tubing
D1527 Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80
ASTM- Standard specification for-
D2282 Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe (SDR-PR)
D2104 Polyethylene (PE) Plastic Pipe, Schedule 40
D2239 Polyethylene (PE) Plastic Pipe (SDR-PR)
D2447 Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, based on outside diameter
D2737 Polyethylene (PE) Plastic Tubing
D3035 Polyethylene (PE) Plastic Pipe (SDR-PR), based on controlled outside diameter

PIP-size (plastic irrigation pipe) pipe shall meet the requirements of ASTM-D2241 or of ASTM-D2282 except that:

1. The outside diameters, wall thicknesses, and tolerances given in table 2 shall apply.

2. The sustained pressure test shall not be required.

3. The burst pressure tests shall be performed according to the procedures listed in ASTM D2241 or D2282 and shall meet the applicable requirements given in these ASTM's or those listed below for the standard dimension ratios (SDR's) currently not included in ASTM D2241 or D2282.

Burst pressure requirements for water at 23 degrees C (73.4 degrees F) for PVC 1120 and PVC 1220 plastic pipe are:

SDR	Minimum burst pressure[1] lb/in.^{2}
51	260

[1] The design stress levels used to derive these test pressures are PVC 1120--6,400 pounds per square inch; PVC 1220--6,400 pounds per square inch.

Burst pressure requirements for water 23 degrees C (73.4 degrees F) for ABS plastic pipe are:

	Minimum burst pressure[1]	
SDR	ABS 2112	ABS 1316
	lb/in.2	lb/in.2
32.5	420	380
41	---	300

[1] The fiber stresses used to derive these test pressures are ABS 2112--6,600 pounds per square inch; ABS 1316--6,000 pounds per square inch. To simplify testing, minor adjustments have been made to keep the test pressures uniform.

Markings. Markings on the pipe shall include the following, which shall be spaced at intervals of not more than 5 feet::

1. Nominal pipe size (for example, 2 inches).

2. Type of plastic pipe material, by designation code (for example, PVC 1120).

3. Pressure rating , in pounds per square inch, for water at 23^o C (73.4^o F) (for example, 160 pounds per square inch).

4. Specification designation with which the pipe complies:

a. For IPS-size pipe, the ASTM designation (for example, D-2241).

Pipe meeting one of the ASTM designations listed for IPS-size pipe and intended for the transport of potable water shall also be marked with the seal of a recognized laboratory making the evaluation for this purpose.

b. For plastic irrigation pipe, the designation PIP.

5. Manufacturer's name (or trademark) and code.

Fittings and couplers. All fittings and couplers shall meet or exceed the same

strength requirements as those of the pipe and shall be made of material that is recommended for use with the pipe.

Listed below are the ASTM standard specifications for fittings suitable for use with IPS-size pipe and inside diameter controlled PE pipe covered by this standard:

ASTM	Standard specification for
D2466	Socket-type Poly (vinyl chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
D2467	Socket-type Poly (vinyl chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
D3036	Poly (vinyl chloride) (PVC) Plastic Line Couplings, Socket type.
D2468	Socket-type Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe fittings, Schedule 40.
D2469	Socket-type Acrylonitrile-Butadiene-Styrene (ABS) Plastic fittings, Schedule 80.
D2609	Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe.
D2610	Butt Fusion Polyethylene (PE) Plastic Pipe Fittings, Schedule 40 (for PS pipe).
D2611	Butt Fusion Polyethylene (PE) Plastic Pipe Fittings, Schedule 80 (for IPS pipe).
D2683	Socket-type Polyethylene Fittings for SDR 11.0 Polyethylene pipe.
D3139	Standard Specification for Plastic Pressure Pipe using Flexible Elastomeric Seals.

Plastic irrigation pipe (PIP) shall have belled ends or separate couplers and fittings that are suitable for joining the pipe and appurtenances by solvent cement, rubber gaskets, or other methods recommended by the pipe manufacturer. Such fittings and joints shall be capable of withstanding a working pressure equal to or greater than that for the pipe.

Solvent cement joints. Solvent for solvent cement joints shall conform to ASTM Specification D2564 for PVC pipe and fittings and to ASTM D2235 for ABS pipe and fittings.

Solvent cement joints shall be used and constructed according to the recommendations of the pipe manufacturer.

Rubber gasket joints. Rubber gasket joints shall conform to ASTM Specification D3139.

Table 1.--Hydrostatic design stress and designation--plastic pipe

Plastic pipe material	Hydrostatic design stress	Designation
	lb/in.2	
PVC Type I, Grade 1	2,000	PVC 1120
PVC Type I, Grade 2	2,000	PVC 1220
PVC Type II, Grade 1	1,000	PVC 2110
PVC Type II, Grade 1	1,250	PVC 2112
PVC Type II, Grade 1	1,600	PVC 2116
ABS Type I, Grade 2	800	ABS 1208
ABS Type I, Grade 2	1,000	ABS 1210
ABS Type I, Grade 3	1,600	ABS 1316
ABS Type II, Grade 1	1,250	ABS 2112
PE Grade P14	400	PE 1404
PE Grade P23	500	PE 2305
PE Grade P23	630	PE 2306
PE Grade P33	630	PE 3306
PE Grade P34	630	PE 3406

Tables 2-8 are taken from ASTM Specifications shown. This information will also be shown in National Engineering Handbook, Part 636, Chapter 52-Flexible Conduits.

Table 2 PVC and ABS plastic irrigation pipe (PIP)
nonthreaded

Nominal pipe size (in.)	SDR	PVC pressure rating (lb/in.^{2}) Material 1120 1220	2116	2112	2110	Dimension and Tolerance Wall thickness Min (in.)	tolerance (in.)	Outside Diameter Avg OD (in.)	tolerance average (in.)	+/- (in.)	ABS pressure rating (lb/in.^{2}) Material 1316	2112	1210
4	51	80				0.081	+0.020	4.130	0.009	0.050			
	41	100	80			0.101	+0.020				80		
	32.5	125	100	80		0.127	+0.020				100	80	
	26	160	125	100	80	0.159	+0.020				125	100	80
6	51	80				0.120	+0.020	6.140	0.011	0.050	80		
	41	100	80			0.150	+0.020				100	80	
	32.5	125	100	80		0.189	+0.023				125	100	80
	26	160	125	100	80	0.236	+0.028						
8	51	80				0.160	+0.020	8.160	0.015	0.070			
	41	100	80			0.199	+0.024				80		
	32.5	125	100	80		0.251	+0.031				100	80	
	26	160	125	100	80	0.314	+0.038				125	100	80
10	51	80				0.200	+0.024	10.200	0.015	0.075			
	41	100	80			0.249	+0.030				80		
	32.5	125	100	80		0.314	+0.038				100	80	
	26	160	125	100	80	0.392	+0.047				125	100	80
12	51	80				0.240	+0.029	12.240	0.015	0.075			
	41	100	80			0.299	+0.036				80		
	32.5	125	100	80		0.377	+0.045				100	80	
	26	160	125	100	80	0.471	+0.056				125	100	80
14	51	80				0.280	+0.034	14.280	0.015	0.075			
	41	100	80			0.348	+0.042				80		
	32.5	125	100	80		0.439	+0.053				100	80	
	26	160	125	100	80	0.549	+0.066				125	100	80
15	51	80				0.300	+0.036	15.3	0.015	0.075			
	41	100	80			0.373	+0.045				80		
	32.5	125	100	80		0.471	+0.057				100	80	
	26	160	125	100	80	0.588	+0.071				125	100	80

Table 3 PVC and ABS thermoplastic pipe (SDR-PR)-(IPS)
nonthreaded

		(PVC-ASTM-D-2241)									(ABS-ASTM-D-2282)			
Nominal pipe size (in.)	SDR	PVC pressure rating ($lb/in.^2$) Material 1120 1220	2116	2112	2110	Dimension and Tolerance Wall thickness Min (in.)	tolerance (in.)	Outside Diameter Avg OD (in.)	tolerance average (in.)	+/- (in.)	ABS pressure rating ($lb/in.^2$) Material 1316	2112	1210	1208
1/2	17					0.060	+0.020	0.840	0.004	0.008	200	160	125	100
	13.5	315	250	200	160	0.062	+0.020			0.008	250	200	160	125
3/4	21	200	160	125	100	0.060	+0.020	1.050	0.004	0.015	160	125	100	80
	17	250	200	160	125	0.062	+0.020			0.010	200	160	125	100
	13.5	315	250	200	160	0.078	+0.020			0.010	250	200	160	125
1	26	160	125	100	80	0.060	+0.020	1.315	0.005	0.015	125	100	80	
	21	200	160	125	100	0.063	+0.020			0.015	160	125	100	80
	17	250	200	160	125	0.077	+0.020			0.010	200	160	125	100
	13.5	315	250	200	160	0.097	+0.020			0.010	250	200	160	125
1-1/4	32.5	125	100	80		0.060	+0.020	1.660	0.005	0.015	100	80		
	26	160	125	100	80	0.064	+0.020			0.015	125	100	80	
	21	200	160	125	100	0.079	+0.020			0.015	160	125	100	80
	17	250	200	160	125	0.098	+0.020			0.012	200	160	125	100
	13.5	315	250	200	160	0.123	+0.020			0.012	250	200	160	125
1-1/2	32.5	125	100	80		0.060	+0.020	1.900	0.006	0.030	100	80		
	26	160	125	100	80	0.073	+0.020			0.030	125	100	80	
	21	200	160	125	100	0.090	+0.020			0.030	160	125	100	80
	17	250	200	160	125	0.112	+0.020			0.012	200	160	125	100
	13.5	315	250	200	160	0.141	+0.020			0.012	250	200	160	125
2	32.5	125	100	80		0.073	+0.020	2.375	0.006	0.030	100	80		
	26	160	125	100	80	0.091	+0.020			0.030	125	100	80	
	21	200	160	125	100	0.113	+0.020			0.030	160	125	100	80
	17	250	200	160	125	0.140	+0.020			0.012	200	160	125	100
	13.5	315	250	200	160	0.176	+0.020			0.012	250	200	160	125
2-1/2	32.5	125	100	80		0.088	+0.020	2.875	0.007	0.030	100	80		
	26	160	125	100	80	0.110	+0.020			0.030	125	100	80	
	21	200	160	125	100	0.137	+0.020			0.030	160	125	100	80
	17	250	200	160	125	0.169	+0.020			0.015	200	160	125	100
	13.5	315	250	200	160	0.213	+0.026			0.015	250	200	160	125
3	32.5	125	100	80		0.108	+0.020	3.500	0.008	0.030				
	26	160	125	100	80	0.135	+0.020			0.030	125	100	80	
	21	200	160	125	100	0.167	+0.020			0.030	160	125	100	80
	17	250	200	160	125	0.206	+0.025			0.015	200	160	125	100
	13.5	315	250	200	160	0.259	+0.031			0.015	250	200	160	125
3-1/2	41	100	80			0.098	+0.020	4.000	0.008	0.050				
	32.5	125	100	80		0.123	+0.020			0.050				
	26	160	125	100	80	0.154	+0.020			0.050	125	100	80	
	21	200	160	125	100	0.190	+0.023			0.050	160	125	100	80
	17	250	200	160	125	0.235	+0.028			0.015	200	160	125	100
	13.5	315	250	200	160	0.296	+0.036			0.015	250	200	160	125

Table 3 PVC and ABS thermoplastic pipe (SDR-PR)-(IPS)
nonthreaded

		(PVC-ASTM-D-2241)									(ABS-ASTM-D-2282)			
Nominal pipe size (in.)	SDR	PVC pressure rating ($lb/in.^2$) Material				Dimension and Tolerance Wall thickness		Outside Diameter			ABS pressure rating ($lb/in.^2$) Material			
		1120 1220	2116	2112	2110	Min (in.)	tolerance (in.)	Avg OD (in.)	average (in.)	+/- (in.)	1316	2112	1210	1208
4	41	100	80			0.110	+0.020	4.500	0.009	0.050				
	32.5	125	100	80		0.138	+0.020			0.050				
	26	160	125	100	80	0.173	+0.021			0.050	125	100	80	
	21	200	160	125	100	0.214	+0.026			0.050	160	125	100	80
	17	250	200	160	125	0.265	+0.032			0.015	200	160	125	100
	13.5	315	250	200	160	0.333	+0.040			0.015	250	200	160	125
5	41	100	80			0.136	+0.020	5.563	0.010	0.050				
	32.5	125	100	80		0.171	+0.021			0.050				
	26	160	125	100	80	0.214	+0.027			0.050	125	100	80	
	21	200	160	125	100	0.265	+0.032			0.050	160	125	100	80
	17	250	200	160	125	0.327	+0.039			0.030	200	160	125	100
	13.5	315	250	200	160	0.412	+0.049			0.030	250	200	160	125
6	41	100	80			0.162	+0.020	6.625	0.011	0.050				
	32.5	125	100	80		0.204	+0.024			0.050				
	26	160	125	100	80	0.255	+0.031			0.050	125	100	80	
	21	200	160	125	100	0.316	+0.038			0.050	160	125	100	80
	17	250	200	160	125	0.390	+0.047			0.035	200	160	125	100
	13.5	315	250	200	160	0.491	+0.059			0.035	250	200	160	125
8	41	100	80			0.210	+0.025	8.625	0.015	0.075				
	32.5	125	100	80		0.265	+0.032			0.075				
	26	160	125	100	80	0.332	+0.040			0.075	125	100	80	
	21	200	160	125	100	0.410	+0.049			0.075	160	125	100	80
	17	250	200	160	125	0.508	+0.061			0.045				
10	41	100	80			0.262	+0.031	10.750	0.015	0.075				
	32.5	125	100	80		0.331	+0.040			0.075				
	26	160	125	100	80	0.413	+0.050			0.075	125	100	80	
	21	200	160	125	100	0.511	+0.061			0.075	160	125	100	80
	17	250	200	160	125	0.632	+0.076			0.050				
12	41	100	80			0.311	+0.037	10.750	0.015	0.075				
	32.5	125	100	80		0.392	+0.047			0.075				
	26	160	125	100	80	0.490	+0.059			0.075	125	100	80	
	21	200	160	125	100	0.606	+0.073			0.075	160	125	100	80
	17	250	200	160	125	0.750	+0.090			0.060				

Table 4 Polyethylene plastic pipe (SIDR-PR) I.D. controlled

(PE-ASTM-D-2239)

Nominal pipe size (in.)	SIDR	Pressure rating (lb/in.^{2}) 3306 3406 2306	2305	1404	Dimension and Tolerance: Wall thickness Min (in.)	tolerance (in.)	Inside Diameter tolerance: Avg ID (in.)	+ (in.)	- (in.)
1/2	15	80			0.060	+0.020	0.622	0.010	0.010
	11.5	100	80		0.060	+0.020			
	9	125	100	80	0.069	+0.020			
	7	160	125	100	0.089	+0.020			
	5.3	200	160	125	0.117	+0.020			
3/4	15	80			0.060	+0.020	0.824	0.010	0.015
	11.5	100	80		0.072	+0.020			
	9	125	100	80	0.092	+0.020			
	7	160	125	100	0.118	+0.020			
	5.3	200	160	125	0.155	+0.020			
1	15	80			0.070	+0.020	1.049	0.010	0.020
	11.5	100	80		0.091	+0.020			
	9	125	100	80	0.117	+0.020			
	7	160	125	100	0.150	+0.020			
	5.3	200	160	125	0.198	+0.024			
1-1/4	15	80			0.092	+0.020	1.380	0.010	0.020
	11.5	100	80		0.120	+0.020			
	9	125	100	80	0.153	+0.020			
	7	160	125	100	0.197	+0.024			
	5.3	200	160	125	0.260	+0.031			
1-1/2	15	80			0.107	+0.020	1.610	0.015	0.020
	11.5	100	80		0.140	+0.020			
	9	125	100	80	0.179	+0.020			
	7	160	125	100	0.230	+0.028			
	5.3	200	160	125	0.304	+0.036			
2	15	80			0.138	+0.020	2.067	0.015	0.020
	11.5	100	80		0.180	+0.022			
	9	125	100	80	0.230	+0.028			
	7	160	125	100	0.295	+0.035			
	5.3	200	160	125	0.390	+0.047			
2-1/2	15	80			0.165	+0.020	2.469	0.015	0.025
	11.5	100	80		0.215	+0.025			
3	15	80			0.205	+0.020	3.068	0.015	0.030
	11.5	100	80		0.267	+0.032			
4	15	80			0.268	+0.032	4.026	0.015	0.035
	11.5	100	80		0.35	+0.042			
6	15	80			0.404	+0.048	6.065	0.02	0.035
	11.5	100	80		0.527	+0.063			

Table 5 Polyethylene plastic pipe (SDR-PR) O.D. controlled (IPS)

(PE-ASTM-D-3035)

Nominal pipe size (in.)	SDR	Pressure rating ($lb/in.^2$) 3306 3406 2306	2305	1404	Dimension and Tolerance: Wall thickness Min (in.)	Wall thickness tolerance (in.)	Outside Diameter: Avg OD (in.)	Outside Diameter tolerance + (in.)	Outside Diameter tolerance - (in.)
1/2	17	80			0.062	+0.020	0.84	0.004	0.004
	13.5	100	80		0.062	+0.020			
	11	125	100	80	0.076	+0.020			
3/4	17	80			0.062	+0.020	1.05	0.004	0.004
	13.5	100	80		0.078	+0.020			
	11	125	100	80	0.095	+0.021			
1	17	80			0.077	+0.020	1.315	0.005	0.005
	13.5	100	80		0.097	+0.020			
	11	125	100	80	0.119	+0.026			
1-1/4	17	80			0.098	+0.020	1.660	0.005	0.005
	13.5	100	80		0.123	+0.020			
	11	125	100	80	0.151	+0.026			
1-1/2	17	80			0.112	+0.020	1.900	0.006	0.006
	13.5	100	80		0.141	+0.020			
	11	125	100	80	0.173	+0.026			
2	17	80			0.140	+0.020	2.375	0.006	0.006
	13.5	100	80		0.176	+0.021			
	11	125	100	80	0.216	+0.026			
3	17	80			0.206	+0.025	3.500	0.008	0.008
	13.5	100	80		0.259	+0.031			
	11	125	100	80	0.318	+0.038			
4	17	80			0.264	+0.032	4.500	0.009	0.009
	13.5	100	80		0.333	+0.040			
	11	125	100	80	0.409	+0.049			
6	17	80			0.390	+0.047	6.625	0.011	0.011
	13.5	100	80		0.491	+0.059			
	11	125	100	80	0.602	+0.072			

Table 6 - Water Pressure rating for schedules 40 and 80 unthreaded plastic pipe.

PVC - ASTM-D-1785 Schedule 40 and 80 Pipe

Nominal size inches	Average inside diameter inches		Working pressure rating (psi.)							
			PVC 1120 1220		PVC 2116		PVC 2112		PVC 2110	
	Sch 40	Sch 80	Sch 40	Sch 80	Sch 40	Sch 80	Sch 40	Sch 80	Sch 40	Sch 80
1/2	0.622	0.546	600	850	480	680	370	530	300	420
3/4	0.824	0.742	480	690	390	550	300	430	240	340
1	1.049	0.957	450	630	360	500	280	390	220	320
1-1/4	1.380	1.278	370	520	290	420	230	320	180	260
1-1/2	1.610	1.500	330	470	260	380	210	290	170	240
2	2.067	1.939	280	400	220	320	170	250	140	200
2-1/2	2.469	2.323	300	420	240	340	190	260	150	210
3	3.068	2.900	260	370	210	300	160	230	130	190
3-1/2	3.548	3.364	240	350	190	280	150	220	120	170
4	4.026	3.826	220	320	180	260	140	200	110	160
5	5.047	4.813	190	290	160	230	120	180	100	140
6	6.065	5.761	180	280	140	220	110	170	90	140
8	7.981	7.625	160	250	120	200	100	150	80	120
10	10.020	9.564	140	230	110	190	90	150		120
12	11.938	11.376	130	230	110	180	80	140		110

Table 6 - Water Pressure rating for schedules 40 and 80 unthreaded plastic pipe.

ABS - ASTM-D-1527 Schedule 40 and 80 Pipe

Nominal size inches	Average inside diameter inches		Working pressure rating (psi.)							
			ABS 1316		ABS 2112		ABS 1210		ABS 1208	
	Sch 40	Sch 80	Sch 40	Sch 80	Sch 40	Sch 80	Sch 40	Sch 80	Sch 40	Sch 80
1/2	0.622	0.546	430	680	370	530	300	420	240	340
3/4	0.824	0.742	390	550	300	430	240	340	190	280
1	1.049	0.957	360	500	280	390	220	320	180	250
1-1/4	1.380	1.278	290	420	230	330	180	260	150	210
1-1/2	1.610	1.500	260	380	210	290	170	240	130	190
2	2.067	1.939	220	320	170	250	140	200	110	160
2-1/2	2.469	2.323	240	340	190	270	150	210	120	170
3	3.068	2.900	210	300	160	230	130	190	100	150
3-1/2	3.548	3.364	190	280	150	220	120	170	90	140
4	4.026	3.826	180	260	140	200	110	160	90	130
5	5.047	4.813	160	230	120	180	100	140	80	120
6	6.065	5.761	140	220	110	170	90	140		110
8	7.981	7.625	120	200	100	150	80	120		100
10	10.020	9.564	110	190	90	150		120		90
12	11.938	11.376	110	180	80	140		110		90

Table 6 - Water Pressure rating for schedules 40 and 80 unthreaded plastic pipe.

			PE-ASTM-D2104 Schedule 40 - I.D. Control			PE-ASTM-D-2447 Schedule 40 and 80 pipe O.D. Control					
			Working pressure rating (psi)			Working pressure rating (psi)					
Nominal size inches	Average inside diameter inches		PE 2306 3306 3406	PE 2305	PE 1404	PE 2306 3306 3406		PE 2305		PE 1404	
	Sch 40	Sch 80	Sch 40	Sch 40	Sch 40	Sch 40	Sch 80	Sch 40	Sch 80	Sch 40	Sch 80
1/2	0.622	0.546	190	150	120	188	267	149	212	119	170
3/4	0.824	0.742	150	120	100	152	217	120	172	96	137
1	1.049	0.957	140	110	90	142	199	113	158	90	126
1-1/4	1.380	1.278	120	90		116	164	92	130		104
1-1/2	1.610	1.500	100	80		104	148	83	118		94
2	2.067	1.939	90			87	127		101		81
2-1/2	2.469	2.323	100	80		96	134		106		85
3	3.068	2.900	80			83	118		94		
3-1/2	3.548	3.364					109		86		
4	4.026	3.826					102		81		
5	5.047	4.813					91				
6	6.065	5.761					88				

Table 7 - Polyethylene and PolyVinyl Chloride plastic tubing

Nominal size inches	Outside Diameter inches	Inside Diameter (inches)						Pressure Rating psi
		PE - ASTM-D-2737		PVC - ASTM-D2740				
		PE 2306 PE 3306 PE 3406	PE 2305	PVC 1120 PVC 1220	PVC 2116	PVC 2112	PVC 2110	
1/2	0.625	0.487	0.453	0.501	0.501	0.501	0.501	160
5/8	0.750	0.584	0.544					160
3/4	0.875	0.681	0.635	0.751	0.751	0.751	0.745	160
1	1.125	0.875	0.817	1.001	1.001	0.993	0.959	160
1-1/4	1.375	1.069	0.999	1.251	1.251	1.213	1.171	160
1-1/2	1.625	1.263	1.159					160
2	2.125	1.653	1.543					160

Table 8 - Pressure rating factors for PVC and PE pipe for water at elevated temperatures

Temp. deg F	PVC factor	PE factor
73.4	1.00	1.00
80	0.88	0.92
90	0.75	0.81
100	0.62	0.70
110	0.50	
120	0.40	
130	0.30	
140	0.22	

Note: To obtain the pipe's reduced rating because of water temperatures above 73.4 deg F (23 deg C) multiply normal pressure rating by the appropriate factor.