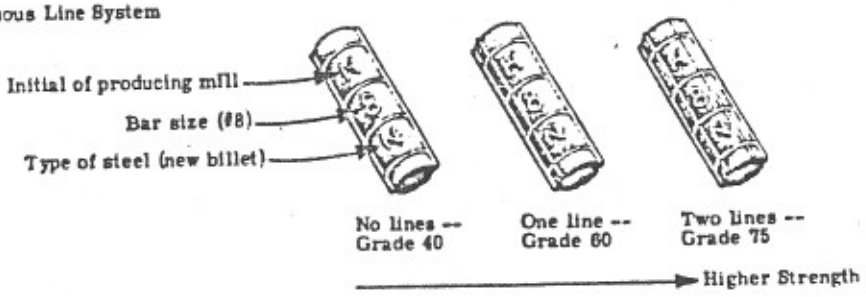
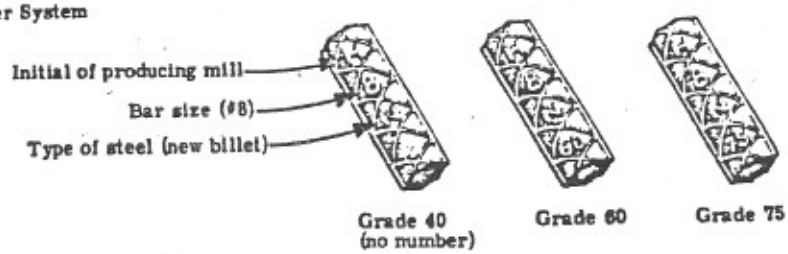
AMERICAN STANDARD BAR MARKS

Continuous Line System



Number System



Bar size numbers correspond to set diameters in inches. There are also standard weights per foot, cross-sectional areas and perimeters. The table below shows these relationships.

Bar numbers are based on the number of eighths of an inch included in the nominal diameter of the bars. Therefore, a #8 has a diameter of 8/8, or 1 inch.

WEIGHT LBS PER FT.	NOMINAL DIAMETER INCHES	SIZE	NUMBER	NOMINAL CROSS SECTIONAL AREA SQ. IN.	NOMINAL PERIMETER
.167	.250	1/4	2	.05	.786
.376	.375	3/8	3	.11	1.178
.668	.500	1/2	4	.20	1.571
1.043	.625	5/8	5	.31	1.963
1.502	.750	3/4	6	.44	2.356
2.044	.875	7/8	7	.60	2.749
2.670	1.000	1	8	.79	3.142
3.400	1.128	1 1/8	9	1.00	3.544
4.303	1.270	1 1/4	10	1.27	3.990
5.313	1.410	1 3/8	11	1.56	4.430
7.650	1.692	1 3/4	14	2.25	5.316
13.600	2.256	2	18	4.00	7.088

7-1. PIPE CONDUITS (PLASTIC)

USES

Plastic pipe has been in use in drainage work, irrigation and water supply, and waste disposal for a number of years. Recently there has been an increase in its use in other soil and water conservation practices. These uses include structural conduits and risers, road culverts, surface water inlets, and various structural appurtenances. Following are definitions, product descriptions, material reference and standard lists, and typical construction details as they apply to plastic pipe types normally used in soil and water conservation practices.

DEFINITIONS - RELATING TO PLASTIC PIPE

This list, while less than exhaustive, aims to define some of the less familiar terms or symbols encountered in the course of considering the many different types of plastic pipe for use in soil and water conservation work. Questions relating to these or other terms or symbols--not listed--should be forwarded to the state conservation engineer.

Frequently encountered terms and symbols are:

I. Technical Agency Designations

1. AASHTO — American Association of State Highway & Transportation Officials

2. AGA — American Gas Association

3. ANSI — American National Standards Institute Inc. - this institute is jointly sponsored by the Society of Automotive Engineers and the American Society of Mechanical Engineers

4. ASTM — American Society for Testing and Materials

5. AWWA — American Water Works Association

6. BOCA — Building Officials and Code Administrators International Inc. - usually encountered with reference to The BOCA Basic Building Code

7. nSf — National Sanitation Foundation (sometimes written NSF) - an independent non-profit, non-governmental organization which tests and certifies pipe and other plumbing materials for specific uses. In their testing work, they utilize the applicable ANSI, ASTM, CS OR PS standard for the physical characteristics of the product. The various forms of their insigne and the significance of each are:

Insigne Form	Permissible Product Use
NSF - pw	Potable Water Lines
NSF - drain	Drain Installations
NSF - cw	Corrosive Waste
NSF - sewer	Sewer Lines
NSF - dwv	Drain, Waste and Vent

8. PPI — Plastics Pipe Institute

II. Terms Unique to Plastic Pipe

1. DWV — Drain Waste And Vent

2. IPS — Iron Pipe Size - plastic pipe that has the same outside diameter as iron pipe for the same nominal inside diameter.

3. PIP — Plastic Irrigation Pipe - plastic pipe that has the indicated nominal inside diameter with the required wall thickness for the pressure rating.

4. PR — Pressure Rating - the estimated maximum pressure that water (at 73° F.) in the pipe can exert continuously with a high degree of certainly that failure of the pipe will not occur.

   The pressure rating is based on the allowable stresses for the plastic materials and the standard dimension ratio (see below) of the pipe.

5. SDR — Standard Dimension Ratio - the ratio of pipe diameter to wall thickness. For PVC and ABS pipe, it is calculated by dividing the average outside diameter of the pipe by the pipe's mimimum wall thickness. The minimum wall thickness shall not be less than 1.52 mm (0.06 in.). The SDR values shall be rounded off to the nearest 0.50. For PE pipe the SDR is calculated by dividing the average inside diameter of the pipe by the pipe's minimum wall thickness. The minimum wall thickness shall not be less than 1.52 mm (0.060 in.). The SDR values shall be rounded off to the nearest 0.10.

   By using this system, a 4" pipe and a 12" pipe each made of the same material and having the same SDR can each withstand the same internal pressure (psi)

6. SDR-PR — Pipe made in standard thermoplastic dimension ratios and pressure rated.

7. Schedule 40, 80, and 120 pipe - These terms refer to the outside diameter of various strengths of designations of iron pipe.

   Many years ago piping was designated as standard, extra strong, and double extra strong. This was later converted to a system which uses a symbol that is somewhat related to internal pressure which the pipe can withstand. Roughly the schedule number is determined by the following formula:

   Schedule No. = 1,000 X P/SE Where:

   P = operating pressure in psi
   SE = allowable stress in the pipe wall and joints.

   For pipe having a inside diameter of less 10", schedule 40 is standard strength, schedule 80 is extra strength and schedule 120 is between extra strength and double extra strength.

   Commercial sizes of wrought-iron and steel pipe are known by their nominal inside diameter (ID) from 1/8 to 12". Above 12" ID, pipe is usually known by its outside diameter (OD). All classes of pipe of a given nominal size have the same OD, the extra wall thickness for higher strengths is added to the inside.

8. Type PSM or Type PSP Poly(vinyl chloride) (PVC) Sewer Pipe And Fittings - the terms PSM and PSP are not abbreviations but rather an arbitrary designation for a product having certain dimensions. Both types of pipe are for non-pressure installations and are governed by ASTM-D3033 and D3034.

III. Terms Unique To Plastic Materials

1. Acrylonitrile-Butadiene-Styrene (ABS) Pipe And Fittings Plastics - These are plastics containing polymers and/or blends of polymers, in which the mimimum Butadiene content is 6%, the minimum Acrylonitrile content is 15%, the minimum Styrene and/or substituted content is 15% and the maximum content of all other monomers is not more than 5% and lubricants, stabilizers, and colorants.

2. Chlorinated poly(vinyl chloride) (CPVC) Pipe And Fittings Plastics - a special form of poly(vinyl choloride) which has special properties that are useful in industrial plant plastic pipe applications.

3. Degradation - A Deleterious change in the chemical structure of a plastic.

4. Polyethylene (PE) - A class of resins formed by polymerizing ethylene, a gas obtained from petroleum hydrocarbons.

5. Polypropylene - A class of resins that are somewhat similar to polyethylene but having unique features which are useful for some plastic applications. It is used chiefly for containers, electrical insulation and packaging.
6. Poly(vinyl chloride) (PVC) Polymerized Vinyl Chloride, A synthetic resin which when plasticized or softened with other chemicals has some rubber-like properties. It is derived from a acetylene and anhydrous hydrolchloric acid.

7. Stabilizer - A chemical substance which is frequently added to plastic compounds to inhibit undesirable changes in the material, such as discoloration due to heat or light. Often, a stabilzer is added to prevent the plastic material from deterioration due to oxygen attack in the presence of heat or light.

8. Thermoplastic Materials - Materials which soften when heated to normal processing temperatures without the occurrence of appreciable chemical change, but are quickly hardened by cooling. Unlike the thermosetting materials, they can be reheated to soften and recooled to "set" almost indefinitely. They may be formed and reformed many times by heat and pressure.

9. Thermosetting Materials - Plastic materials which undergo a chemical change and harden permanently when heated in processing. Further heating will not soften these materials.

10. Ultraviolet Shield - A chemical substance which is added to a plastic material to prevent the ultraviolet rays of the sun from penetrating into the plastic. One of the best and least expensive shields, is carbon black.

PRODUCT DESCRIPTION

CORRUGATED PLASTIC TUBING (POLYETHYLENE & POLYVINYL CHLORIDE)

General

Corrugated plastic tubing has emerged as a promising construction material in recent years. Beginning in about 1967 in the field of agricultural drainage, its use has been extended into numerous other fields of drainage around buildings, highways and various industrial sites. As with all new products, its advocates are often more optimistic than its capabilities warrant.

The general requirements and limitations in the use of corrugated plastic tubing include:

1. Corrugated polyethylene tubing shall meet standard specification ASTM F405 or ASTM F667. Corrugated poly(vinyl chloride) tubing shall meet Soil Conservation Service Standard Specification 606 - Subsurface Drain. Manufacturers whose products meet SCS requirements for testing and certification are listed in the current "Prequalified Conservation Construction Materials List" or current approved tile/tubing list.

2. The load carrying capacity is very dependent upon the width of the trench at the top of the tubing, a well formed groove for its bedding and upon dense (compacted) backfill along each side to provide good lateral support. The bedding groove must provide support for at least 90° of the bottom circumference of the tubing - see Figure A-1. On steep grades or in structures, where the tubing will flow under hydraulic head, the groove must be further modified as indicated in Item 3 to prevent water from flowing under the tubing and washing it out.

3. For tubing in these structures and other situations, use the following installation procedures:

   a. Cut a 120° groove to bed the tubing (see Figure A-2).

   b. Place a layer of friable soil material at least 1" deep entirely across the 120° groove.

   c. Lay the tubing in the center of the groove.

   d. While a workman stands on top of the tubing (or bags of sand are placed on top of the tubing), hand tamp earth fill on each side up to the top of the tubing. This procedure is required to prevent the tubing from being lifted by the tamping operation.

   e. Continue backfilling and hand tamping work (machine compaction may be used after the backfill is 12" or more above the top of tubing) until all backfill has been placed.

4. The tubing must be placed in a relaxed condition (as against a stretched condition).

5. It must be allowed to come to the surrounding soil temperature before it is backfilled. This will avoid problems resulting from expansion and contraction (see Tables I & II) and also insure that the tubing has adequate strength to support the earth load when it is backfilled (at 120° F., polyethylene tubing losses 50% of its strength). Also, at low temperatures, tubing can crack if it is unrolled from a coil.

6. Tubing must be protected against puncture damage by gravel (1" or larger) in the backfill material or from gravel (or bedrock) in the bedding groove. Where gravel or rock is encountered in the trench bottom, over-excavate the trench and backfill with a suitable bedding material.

   Also, tubing must be protected from damage by large chunks of earth or stone falling on it before it is well covered (6" or more) with backfill material.

7. It must have an adequate cover of soil-a minimum of 2' in mineral soils or 2.5' in organic soils (ASTM F 449) - to protect it from damage by vehicle wheel loads or tramping by livestock.

8. Heavy duty corrugated plastic tubing shall be used whenever <u>either</u> of the following conditions exist:

   a. The depth of cover over the tubing is more than 10'.

   b. The width of the trench (1' above the top of the tubing) is more than 24" inches.

9. It should not be exposed to chemicals other than those normally found in ground water or septic tank effluents (Appendix, ASTM F 405), see Tables I & II.

10. Because plastic tubing must deform (to transfer vertical loads to the soil at each side) to support loads, it is difficult to connect tubing to rigid material such as concrete. Normal embedment in concrete will create shear stresses in the tubing at the face of the concrete as the tubing deforms but the concrete does not. Therefore, special connections must be used when plastic tubing is connected to a concrete wall or other structural feature. Figure B illustrates a type of special connection.

11. Even though standard couplings for plastic tubing are not designed to resist internal pressures, they normally can be used in low pressure situations. When the hydraulic grade line is expected to extend five feet or more above ground line, a manufactured external pressure resisting coupler, or constructed coupler similar to that shown in Fig. C, page 17-36.28 should be used.

12. The quality of the resins used in the manufacture of corrugated polyethylene or polyvinyl chloride plastic tubing is not controlled sufficiently to insure protection against degredation from weathering and ultraviolet exposure (sunlight). Therefore, any installation which does not provide protection from sunlight is not recommended. The inlet and outlet of corrugated plastic tubing structures must be shielded from sunlight.

13. All tubing must be protected from burning operations.

14. Corrugated plastic tubing shall be marked at intervals of 10' or less with the following:

    a. The ASTM designation (or other specification designation) (example: ASTM F 405).

    b. A mark indicating whether it is standard or heavy duty tubing.

       Note: Items "a" and "b" are not required for corrugated PVC tubing.

    c. The manufacturer's identification symbol.

For those special installations where some internal pressures (hydrosatic) is allowed, the following conditions must be provided:

1. Only non-perforated plastic tubing may be used.

2. Use a continuous length of tubing or use special couplings and fittings which can withstand internal pressures - see Figure C. An exception to this rule allows standard couplings and fittings to be used when the internal pressures are limited to 2' or less of internal pressure head.

3. Internal pressures must be limited to 15' of pressure head. Design computations shall demonstrate that this limitation has been met.

4. Inlet and outlet features of the structure must be hydraulically and structurally adequate.

5. When local conditions or construction procedures dictate, it will be necessary to install anti-seep collars in order to prevent piping.

TABLE I -- POLYETHYLENE TUBING

PHYSICAL AND CHEMICAL PROPERTIES 1/

1.	Specific Gravity	0.92 (will float)
2.	Coefficient of Thermal Expansion	0.00012 (per degree F)
3.	Inflammability Characteristics	burns slowly
4.	Normal Maximum Temperature of Use	140° F
5.	Resistance to Ultraviolet Degredation	becomes brittle after about 3 years of exposure
6.	Resistance to Chemical Attack:	
	a. Acids	Generally resistant to most acids up to concentrations of 40% (except for acetic acid).
	b. Alkalis	Generally resistant to all alkalis except sodium hypochlorite and possible other exotic alkalis.
	c. Organic Compounds	Generally susceptible to attack by several organic compounds including - but not limited to: (1) Gasoline 2/ (2) Acetone (3) Benzene (4) Ethyl Alcohol (5) Mineral Oil (6) Animal Oils (7) Others

1/ Since corrugated polyethylene tubing (ASTM F 405) may be made of low, medium or high density material, the value given are generally for low density material.

2/ Since many asphaltic compounds are made plastic by solvents derrived from petroleum (gasoline or kerosene), such compounds may be detrimental to polyethylene.

TABLE II -- CORRUGATED POLY(VINYL CHLORIDE) TUBING

PHYSICAL AND CHEMICAL PROPERTIES

1.	Specific Gravity	1.39
2.	Coefficient of Thermal Expansion	0.000055 (per degree F)
3.	Inflammability Characteristics	self extinguishing (will soften and slump when heated)
4.	Normal Maximum Temperature of Use	140° F
5.	Resistance to Ultraviolet Degradation	becomes brittle after about 3 years of exposure
6.	Resistance to Chemical Attack:	
	a. Acids	Generally resistant to most acids up to concentrations of 40% (except for nitric acid, chromic acid and perhaps others).
	b. Alkalis	Generally resistant to all alkalis except perhaps some exotic alkalis.
	c. Organic Compounds	Generally susceptible to attacks by several organic compounds including - but not limited to: (1) Gasoline (2) Naptha (3) Alcohols (4) Benzene (5) Ethers (6) Butane (7) Turpentine (8) Some Lubicating Oils (9) Carbon Tetracholoride
	d. Other Compounds	Susceptible to - but not limited to - attack by: (1) Iodine (2) Chlorine (3) Other Exotic Materials

17-36.10

MATERIAL REFERENCE LIST ON CORRUGATED PLASTIC TUBING

The following list of references will provide technical information on corrugated plastic tubing as it relates to the quality, installation and use of that tubing. Obviously, this is not a complete list nor does each reference address all of the aspects of using corrugated plastic tubing. Rather, this list will serve as a starting point for the reader's further search for technical data.

1. Indiana Technical Guide and National Handbook of Conservation Practices - Practice Standards & Specifications

   606 Subsurface Drain (criteria for loading requirements and the material specification for corrugated poly(vinyl chloride) drainage tubing).

2. Cooperative Extension Service Circular 1078; Corrugated Plastic Drain Tubing; a cooperative effort of the University of Illinois, Michigan State University, Ohio State University and Purdue University.

3. ASAE Paper No. 78-2439; Failure Criteria for Corrugated Plastic Drain Tubing; by P. N. Walker, C. L. Armstrong, and P. N. Singh (Agric. Eng. Dept., University of Illinois).

4. Structural Performance of Buried Corrugated Polyethylene Tubing; by Reynold K. Watkins (Prof. of Mech. Eng. & Civil Eng. Utah State Univ., Logan, Utah) and Ronald C. Reeve (Tech. Dir., Advanced Drainage Systems, Inc., Columbus, Ohio) and presented at Thirtieth Annual Highway Geology Symposium, Portland, Oregon, August 8, 1979.

5. ASAE EP 260.3 Design And Construction Of Subsurface Drains In Humid Areas. (See information in sections 3 and 4 pertaining to loadings on tubing, couplings, exposure to sunlight, trench conditions and the groove in the bottom of the trench, problems with stretching, problems with temperature, problems with blinding, minimum cover, storage requirements and other data.)

6. ASTM F 405 77 Standard Specification for Corrugated Polyethylene (PE) Tubing and Fittings.

7. ASTM F 667-80 10, 12, and 15-in. Corrugated Polyethylene Tubing.

8. ASTM F 449-76 Standard Recommended Practice for Subsurface Installation of Corrugated Thermoplastic Tubing for Agricultural Drainage or Water Table Control.

9. Manufacturer's Literature - Use with Caution.

(EFM Notice IN39, April 1982)

PRODUCT DESCRIPTION

SMOOTH POLY(VINYL CHLORIDE) PIPE

Smooth poly(vinyl chloride) pipe (PVC) has many advantages in soil and water conservation applications. Among these are its light weight ability to be solvent welded, smooth interior surface, resistance to chemical attack, relative ease of cutting and fitting, etc.

As with all products, it has some disadvantages. Among these are its flexible nature (requires good lateral support), problems in connecting to rigid material, variability in plastic materials (requires diligent attention to quality), several different types of pipes (at least 13), and others.

To utilize its advantages and control the disadvantages, the limitations and capabilities of smooth PVC pipe must be recognized. These are:

1. Smooth PVC pipe which conforms to one of the following ASTM standards may be used with the following limitations when the properties of the pipe meet the site conditions.

   a. ASTM D3034 — Pipe PSM Poly(vinyl Chloride) Sewage Pipe and Fittings.

      Pipe conforming to this specification is made in sizes 4" through 15" (nominal I.D.) for non-pressure flow conditions in city sewers. However, a review of test requirements and other technical references has determined that pressures up to 10 feet may be allowed. This pipe may <u>not</u> be used in structures which permanently impound water.

   b. ASTM F 679 — Poly(vinyl Chloride) (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings.

      Pipe conforming to this specification is made in sizes 18" through 27" (nominal I.D.). Its use and limitations are the same as for pipe made under ASTM D 3034.

   c. ASTM D 1785 — Poly(vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.

      Pipe conforming to this specification is made in sizes 1/8" through 12" (nominal I.D.) for pressure flow applications. The dimensions and quality of materials must be adequate for the pressure conditions (including surge pressures) which will occur while the pipe is in use. Table III provides the limitations on the allowable pressures in Schedule 40 and 80 pipe.

d. ASTM D 2241 -- Poly(vinyl Chloride) (PVC) Plastic Pipe (SDR-PR).

Pipe conforming to this specification is made in sizes 1/8" through 12" (nominal I.D.) for pressure flow applications. The dimensions and quality of materials must be adequate for the pressure (including surge pressures) which will occur while the pipe is in use. Table IV provides the limitation on allowable pressures in SDR-PR pipe.

2. Plastic pipe materials meeting the pipe requirements of Engineering Standard 430EE may be used for situations where interior pipe pressures do not exceed those shown (including surge pressure).

3. As an aid to construction and inspection, SCS personnel must read the inprint on the side of plastic pipe carefully to:

   a. Determine that the pipe meets an ASTM pipe standard -- rather than a standard by some other agency.

   b. Determine that the pipe actually meets a complete ASTM pipe standard -- rather than only a part of a pipe standard (say the plastic materials requirements).

4. The load carrying capacity of plastic pipe is dependent on the trench width, backfill, and compaction (to provide lateral support) procedures used to install the pipe.

   For long (over 60') smooth PVC installations having cover over the pipe of 10' or less, the installation requirements of Engineering Specification 430-EE may be used. (See Figures A-1 and A-2.)

   For shorter conduits or sites having special problems (piping or other), use the requirements of FIGURE A-3. All initial backfill - up to 12" above the pipe - must be compacted with a mechanical tamper or by hand tamping.

   As with corrugated plastic tubing, care must be taken not to lift the pipe during tamping operations.

5. Smooth PVC pipe is susceptible to chemical attack in essentially the same way as PVC corrugated tubing. Refer to Table II under Corrugated Plastic Tubing for guidance in this matter.

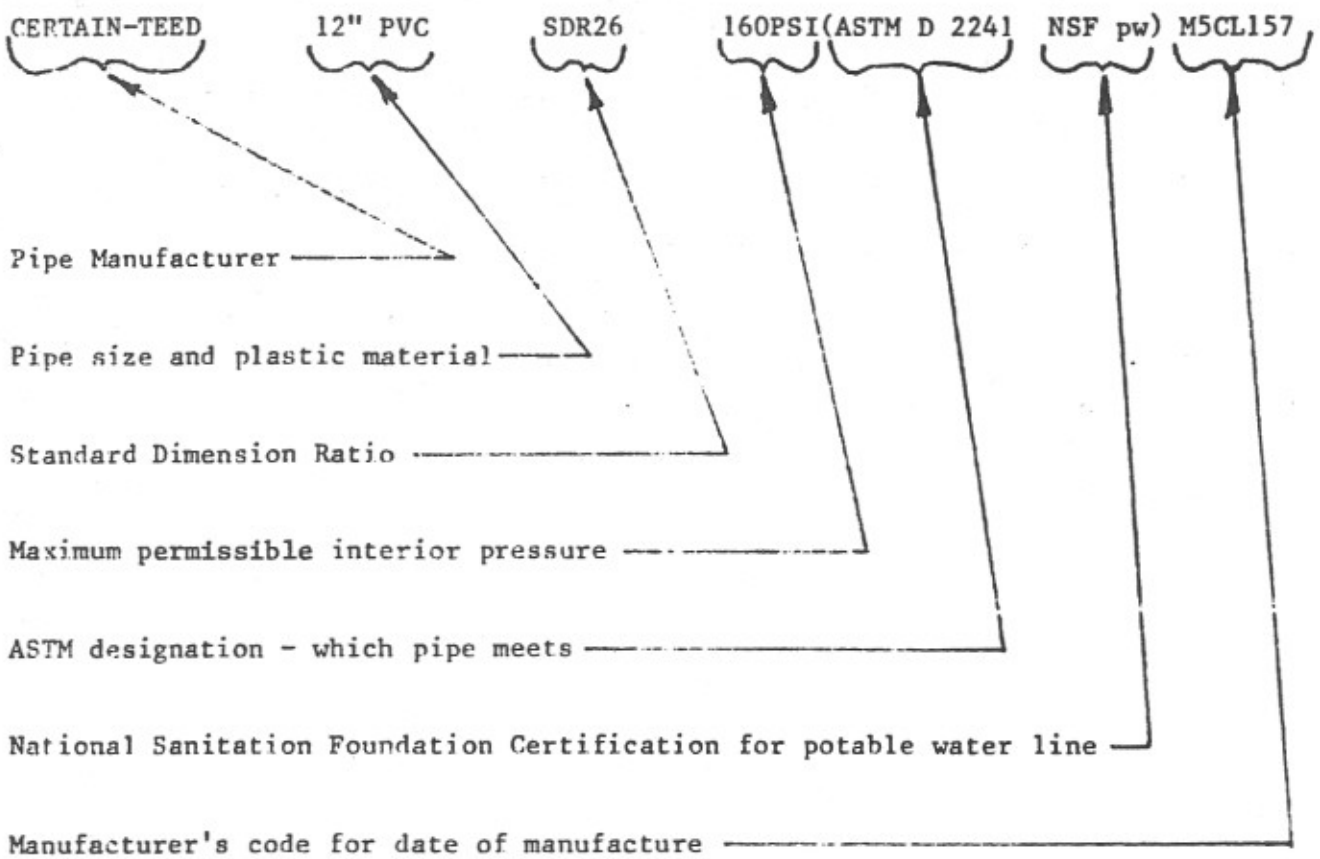
6. Smooth PVC pipe must be protected against shear forces (caused by earth loads) at any point where it connects to a rigid material - such as concrete. This protection may be accomplished as illustrated in Figures B and C under Corrugated Plastic Tubing.

7. Smooth PVC pipe is susceptible to ultraviolet degradation in much the same manner as corrugated PVC tubing. Therefore, the same guidelines (item 12, C.P.T., Product Description) should be used that are used for corrugated plastic tubing. When PVC pipe will be exposed to direct sunlight, it shall be of ultraviolet-resistant materials and protected by coating or shielding or provisions be made for easy replacement as necessary. Protection may be provided with an encasement pipe, other structural cover, a type of wrapping, or two coats of a good quality water-base paint.

8. Smooth PVC pipe may be used as a tile outlet pipe providing:

   a. It is cut flush with the ditch bank;
   b. Some erosion controlling material (riprap) is placed under the end of the pipe to prevent it from becoming a cantilever section;
   c. There are no plans to burn off the ditch bank; and
   d. An animal guard is provided.

EXHIBIT A



(EFM Notice IN39, April 1982)

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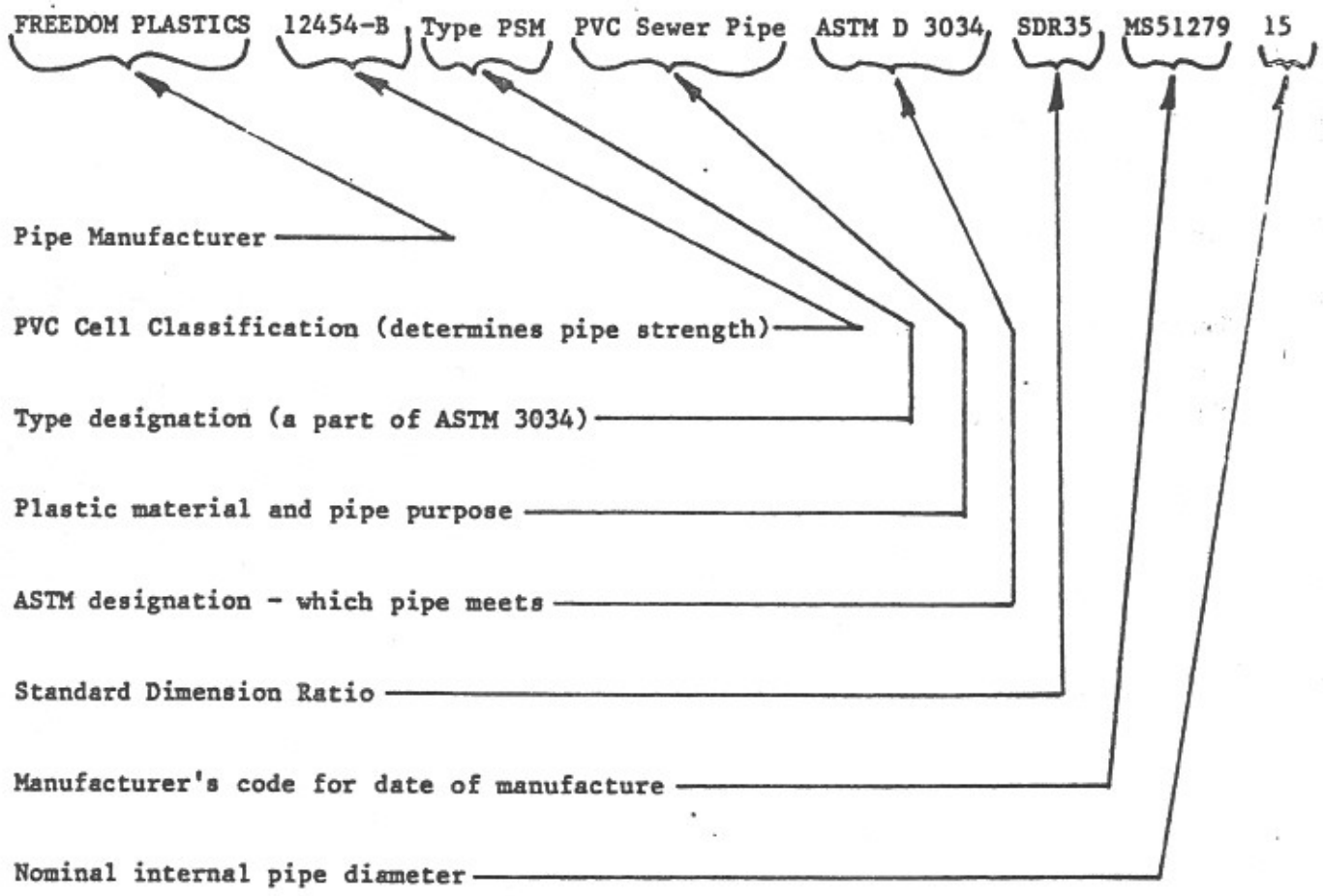
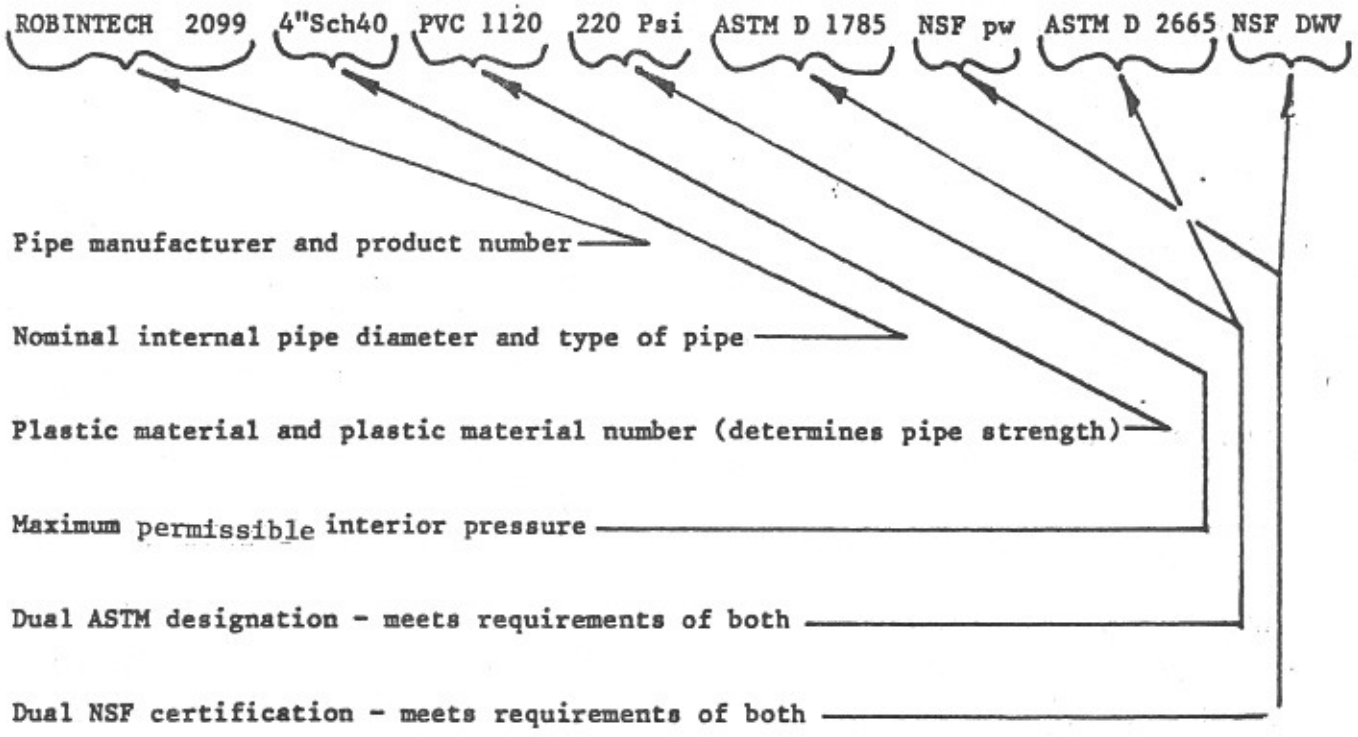


(EFM Notice IN39, April 1982)

EXHIBIT C



(EFM Notice IN39, April 1982)

TABLE III - SMOOTH POLY(VINYL CHLORIDE) PIPE

ALLOWABLE PRESSURES IN PSI FOR SCHEDULE 40 AND 80 PIPE

PVC MATERIAL CODE DESIGNATION

Pipe Diam		PVC 1120 PVC 1220 PVC 2120	PVC 2116	PVC 2112	PVC 2110
4	40*	220	180	140	110
	80 Uth*	320	260	200	160
	80 Thr*	160	130	100	80
5	40*	190	160	120	100
	80 Uth	290	230	180	140
	80 Thr	140	120	90	70
6	40*	180	140	110	90
	80 Uth	280	220	170	140
	80 Thr	140	110	90	70
8	40	160	120	100	80
	80 Uth	250	200	150	120
	80 Thr	120	100	80	60
10	40	140	110	90	70
	80 Uth	230	190	150	120
	80 Thr	120	90	70	60
12	40	130	110	80	70
	80 Uth	230	180	140	110
	80 Thr	110	90	70	60

* 40 - Schedule 40 unthreaded pipe, threading not recommended for Sch 40 pipe 6" and smaller.

* 80 Uth - Schedule 80 Untreaded Pipe

* 80 Thr - Schedule 80 Threaded Pipe

TABLE IV - SMOOTH POLY(VINYL CHLORIDE) PIPE

ALLOWABLE PRESSURE (PR) IN PSI FOR PIPE HAVING STANDARD THERMOPLASTIC PIPE DIMENSION RATIOS (SDR)

PVC MATERIAL CODE DESIGNATIONS

SDR*	PVC 1120 PVC 1220 PVC 2120	PVC 2116	PVC 2112	PVC 2110
13.5	315	250	200	160
17	250	200	160	125
21	200	160	125	100
26	160	125	100	80
32.5 1/	125	100	80	63
41 2/	100	80	63	50
64 3/	63	50	NPR 4/	NPR 4/

* Standard Dimension Ratio - Applies to all pipe sizes

1/ Available only in nominal sizes (I.D.) of 3 to 12 in.

2/ Available only in nominal sizes (I.D.) Of 3 1/2 to 12 in.

3/ Available only in nominal sizes (I.D.) of 6 to 12 in.

4/ NPR = Not Pressure Rated

MATERIAL REFERENCE LIST
ON
SMOOTH POLY(VINYL CHLORIDE) PIPE

The following list of references will provide technical information on smooth poly(vinyl chloride) (PVC) pipe as it relates to quality, installation and use of that pipe in pond spillways, animal waste management systems and similar soil and water conservation practices. Obviously. this is not a complete list nor does each reference address all of the aspects of using smooth PVC pipe. Rather. this list will serve as a starting point for the reader's further search for technical data.

1. Practice Standards & Specifications -- Indiana Technical Guide and National Handbook of Conservation Practices

   These two references are listed together since the material which they contain is essentially identical.

   a. 410 Grade Stabilization Structure (criteria for spillway capacity, earth enbankments, conduit size, inlet conditions, etc.).

   b. 378 Pond (criteria for earth enbankments and emergency spillways).

   c. 430-DD Irrigation Water Conveyance Pipeline (High Pressure Underground Plastic).

   d. 430-EE Irrigation Water Conveyance Pipeline (Low Pressure Underground Plastic).

2. SCS Engineering Field Manual, Chapter 3, Pages 3-19 through 3-37.

3. SCS National Engineering Handbook, Section 15; Chapter 3, Pages 3-73 through 3-86 and Chapter 11 (sprinkler irrigation).

4. ASAE S376 Design, Installation & Performance of Underground Thermoplastic Irrigation Pipelines

   This document is pointed toward most aspects of the use of smooth plastic pipe and therefore is a good general reference.

5. ASAE Paper No. 73-233 Waterhammer Considerations for PVC Piping in Irrigation Systems; by W. R. Seipt, Manager Sales Engineering, Certain-Teed Products Corporation, Valley Forge, PA.

6. Civil Engineering - ASCE, June 1975 (magazine article); Structural Response of Buried PVC Pipe; by A. P. Moser, R. K. Watkins and R. R. Bishop.

   This article reports on research work done at Utah State University at Logan, Utah and is relevant to the relationship between the SDR and pipe deflection under trench loads.

7. ASTM Standards (see standards list for titles) D 1784, D 1785, D 2321, D 2241, D 2464, D 2466, D 2467, D 2665, D 2672, D 2729, D 2774, D 3033, D 3034, D 3139, D 3212, F 412, F 480, F 512, F 679 and others pertaining to pipe systems, joint solvents, etc.

8. Manufacturer's Literature - use with caution.

STANDARDS LIST (ASTM)
FOR
SMOOTH PLASTIC PIPE AND CORRUGATED PLASTIC TUBING

This list includes the majority of ASTM standards that will be encountered by SCS field personnel in the course of their work with landowners. Undoubtedly, there are some omissions in such a partial list. Field office staffs are encouraged to make inquiry - through channels - regarding other ASTM standards which they encounter.

The list, for the sake of simplicity, will show only the capital letter and the number of each standard plus the most recent year of adoption or revision (example "-77"). The most recent revision of an ASTM standard should be used. It will be understood that the letters "ASTM" must always preceed this symbol when the standard is referred to in any document. The list is:

General

F 412-79c . . . . Plastic Piping Systems
F 480-79 . . . . . Thermoplastic Water Well Casing & Couplings Made in Standard Dimension Ratios (SDR)
D 883-78a . . . . Standard Definitions of Terms Relating to PLASTICS
D 2749-68(1979). . Dimensions of Plastic Pipe Fittings

Plastic Compounds

D 1788-78a . . . . Acrylonitrile-Butadiene-Styrene Plastic (ABS) Plastics Rigid
D 2581-78(1979). . Polybutylene (PB) Plastics Molding & Extrusion Materials
D 3350-80 . . . . Polyethylene Plastics Pipe & Fittings Materials
D 1784-78 . . . . Ridged Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds

Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings

D 2680-79a . . . . Acrylonitrile-Butadiene-Styrene (ABS) Composite Sewer Piping
D 2661-78 . . . . Acrylonitrile-Butadiene-Styrene (ABS) Plastic Drain, Waste, and Vent Pipe and Fittings
D 1527-77 . . . . Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80
D 2282-77 . . . . Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe (SDR-PR)
D 2751-77a . . . . Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings
D 2468-76 . . . . Socket-Type Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe Fittings, Schedule 40
D 2469-76 . . . . Socket-Type Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe Fittings, Schedule 80
F 409-77 . . . . . Thermoplastic Excessible and Replaceable Plastic Tube and Tubular Fittings
D 2465-73(1979). . Threaded Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe Fittings, Schedule 80

Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Tubing, and Fittings

F 443-77 . . . . . Bell-End Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedule 40
F 441-77 . . . . . Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
F 442-77 . . . . . Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)
F 438-77 . . . . . Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40
F 439-77 . . . . . Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
F 437-77 . . . . . Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80

Polybutylene (PB) Plastic Pipe and Tubing

D 2662-78 . . . . Polybutylene (PB) Plastic Pipe (SDR-PR)
D 3000-73 . . . . Polybutylene (PB) Plastic Pipe (SDR-PR) Based On Outside Diameter

Polyethylene (PE) Plastic Pipe, Tubing, and Fittings

D 3261-78 . . . . Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
D 2104-74 . . . . Polyethylene (PE) Plastic Pipe, Schedule 40
D 2239-74 . . . . Polyethylene (PE) Plastic Pipe (SDR-PR)
D 3035-74 . . . . Polyethylene (PE) Plastics Pipe (SDR-PR) Based on Controlled Outside Diameter
D 2447-74 . . . . Polyethylene (PE) Plastic Pipe, Schedules 40 and 80 Based on Outside Diameter

Poly(Vinyl Chloride) (PVC) Plastic Pipe, Tubing, and Fittings

D 2672-78 . . . . Bell-End Poly(Vinyl Chloride) (PVC) Pipe
D 2665-78 . . . . Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
D 2466-78 . . . . Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
D 1785-76 . . . . Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120
D 2241-78 . . . . Poly(Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)
D 2729-78 . . . . Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
F 512-79 . . . . . Smooth-Wall Poly(Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation
D 3036-73 . . . . Socket-Type Poly(Vinyl Chloride) (PVC) Plastic Line Couplings
D 2467-76a . . . . Socket-Type Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
D 2464-76 . . . . Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
D 2949-78 . . . . 3.25-in. Outside Diameter Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
D 3034-78 . . . . Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings

Poly(Vinyl Chloride) (PVC) Plastic Pipe, Tubing, and Fittings - Continued

D 3033-79 . . . . Type PSP Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
F 679-80 . . . . . Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings

Styrene-Rubber Plastic Pipe and Fittings

D 3298-74 . . . . Styrene-Rubber (SR) Plastic Drain Pipe, Perforated
D 2852-77 . . . . Styrene-Rubber (SR) Plastic Drain and Building Sewer Pipe and Fittings

Corrugated Polyethylene (PE) Tubing and Fittings

F 405-77a . . . . Corrugated Polyethylene (PE) Tubing and Fittings
F 667-80 . . . . . 10, 12, and 15-in. Corrugated Polyethylene Tubing

Joints and Seals, Including Joint Cements

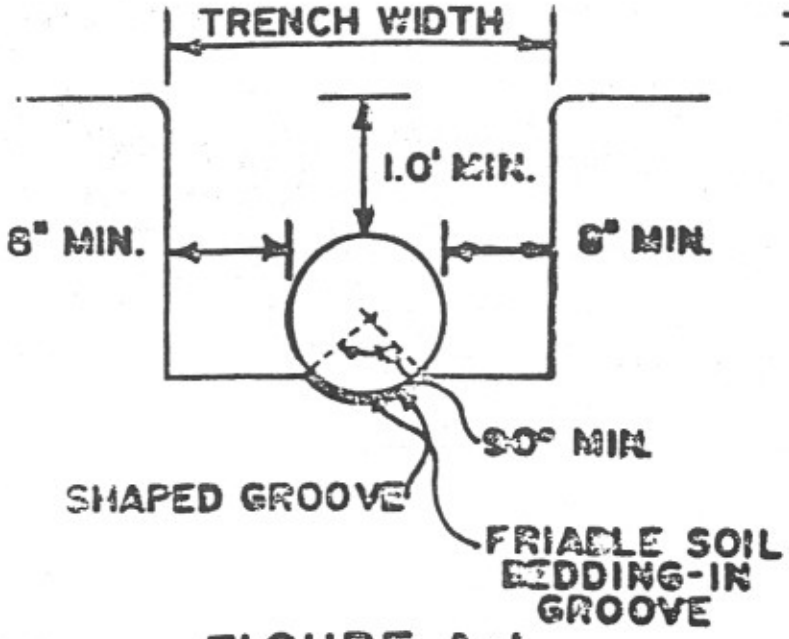
F-477-76 . . . . . Elastomeric Seals (Gaskets) for Joining Plastic Pipe
D 3212-76 . . . . Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
D 3139-77 . . . . Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
D 2855-78 . . . . Making Solvent-Cemented Joints With Poly(Vinyl Chloride) (PVC) Pipe and Fittings
D 3138-79 . . . . Solvent Cements for Transition Joints Between Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Non-Pressure Piping Components
D 2235-79 . . . . Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
F 493-79 . . . . . Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings
D 2564-79 . . . . Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings
D 3122-78 . . . . Solvent Cements for Styrene-Rubber Plastic Pipe and Fittings
F 402-74 . . . . . Safe Handling of Solvent Cements Used for Joining Thermoplastic Pipe and Fittings

Underground Installation

F 481-76 . . . . . Installation of Thermoplastic Pipe and Corrugated Tubing in Septic Tank Leach Fields
F 449-76 . . . . . Subsurface Installation of Corrugated Thermoplastic Tubing for Agricultural Drainage or Water Table Control
D 2321-74 . . . . Underground Installation of Flexible Thermoplastic Sewer Pipe
D 2774-72(1978). . Underground Installation of Thermoplastic Pressure Piping

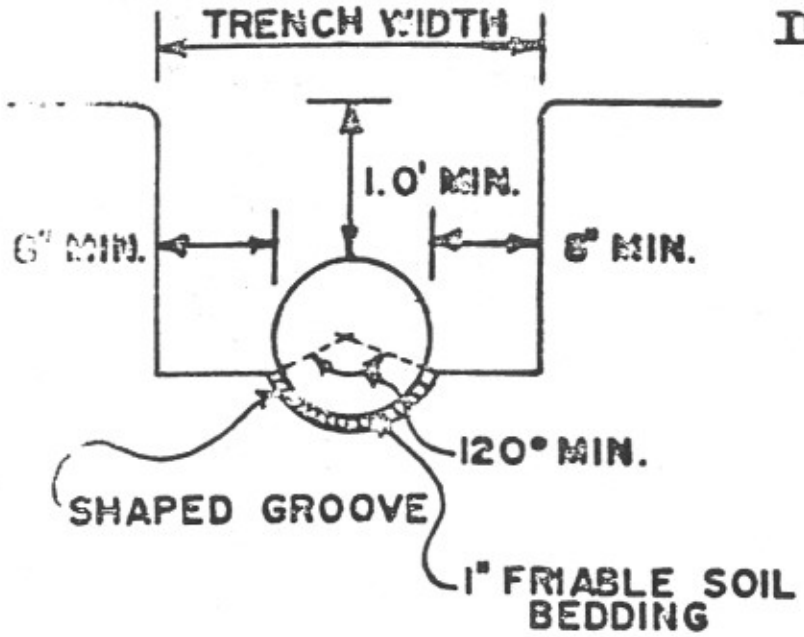
General Test Methods

D 2412-77 . . . . External Loading Properties of Plastic Pipe by Parallel-Plate Loading
D 2444-70(1977). . Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (falling weight)



TUBING DIAMETER I.D.	O.D.	GROOVE DEPTH
10"	11.9	1 3/4"
12"	14.8	2 3/8"
15"	18.8	2 3/4"

FIGURE A-1



TUBING DIAMETER I.D.	O.D.	GROOVE DEPTH
10"	11.9	6
12"	14.8	7 1/2
15"	18.8	9 1/2

FIGURE A-2

NOTE:
Trench dimensions shown on this sheet may be used for total conduit lengths greater than 60 feet.

For shorter conduit lengths, use trench dimensions shown in Figure A—3.

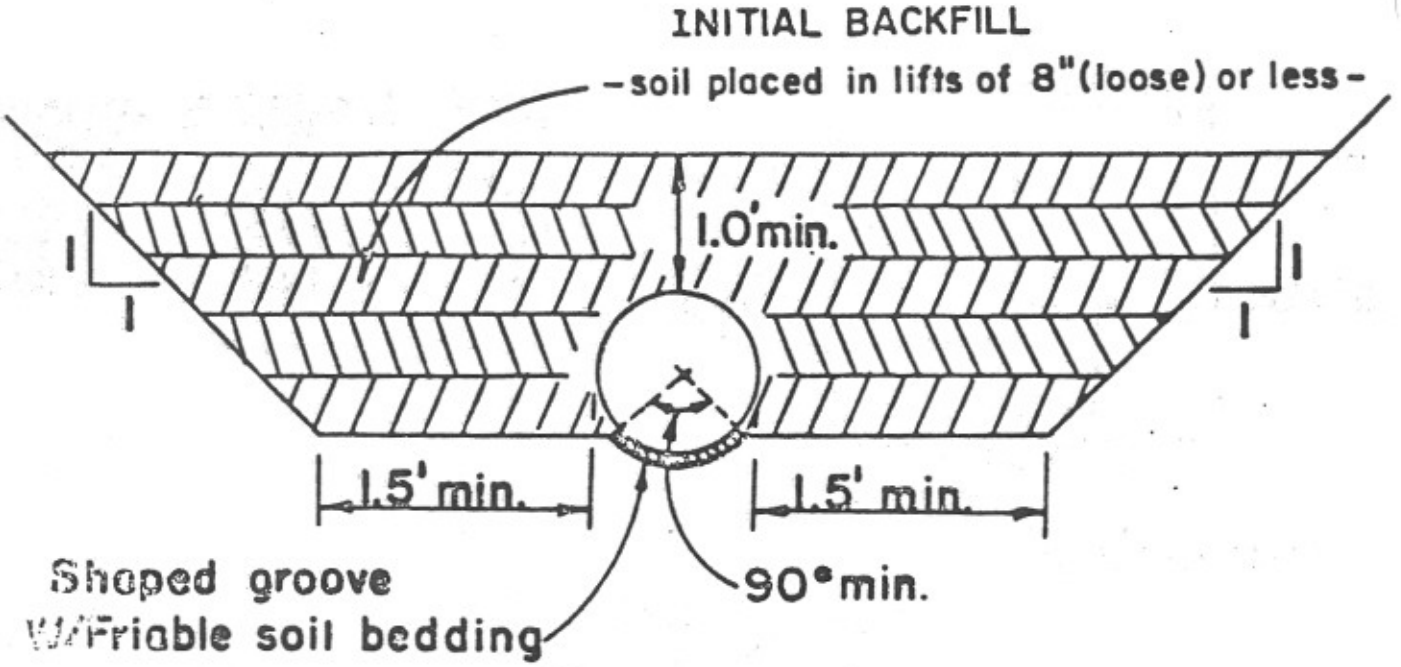


FIGURE A-3

SMOOTH PVC PIPE DIAMETER I.D.(nom.)	O.D.(actual)	GROOVE DIMENSION* width**	depth**
10"	10.50"	7-1/2"	1-1/2"
12"	12.50"	8-3/4"	1-3/4"
15"	15.30"	10-3/4"	2-1/4"
18"	18.70"	13-1/4"	2-3/4"
21"	22.05"	15-1/2"	3-1/4"
24"	24.80"	17-1/2"	3-3/4"
27"	27.95"	19-3/4"	4"

* FOR 90° and 120° GROOVE DIMENSIONS FOR CORRUGATED PLASTIC TUBING, SEE FIGURES A-1 and A-2

** THESE VALUES SHOWN TO THE NEAREST 1/4"

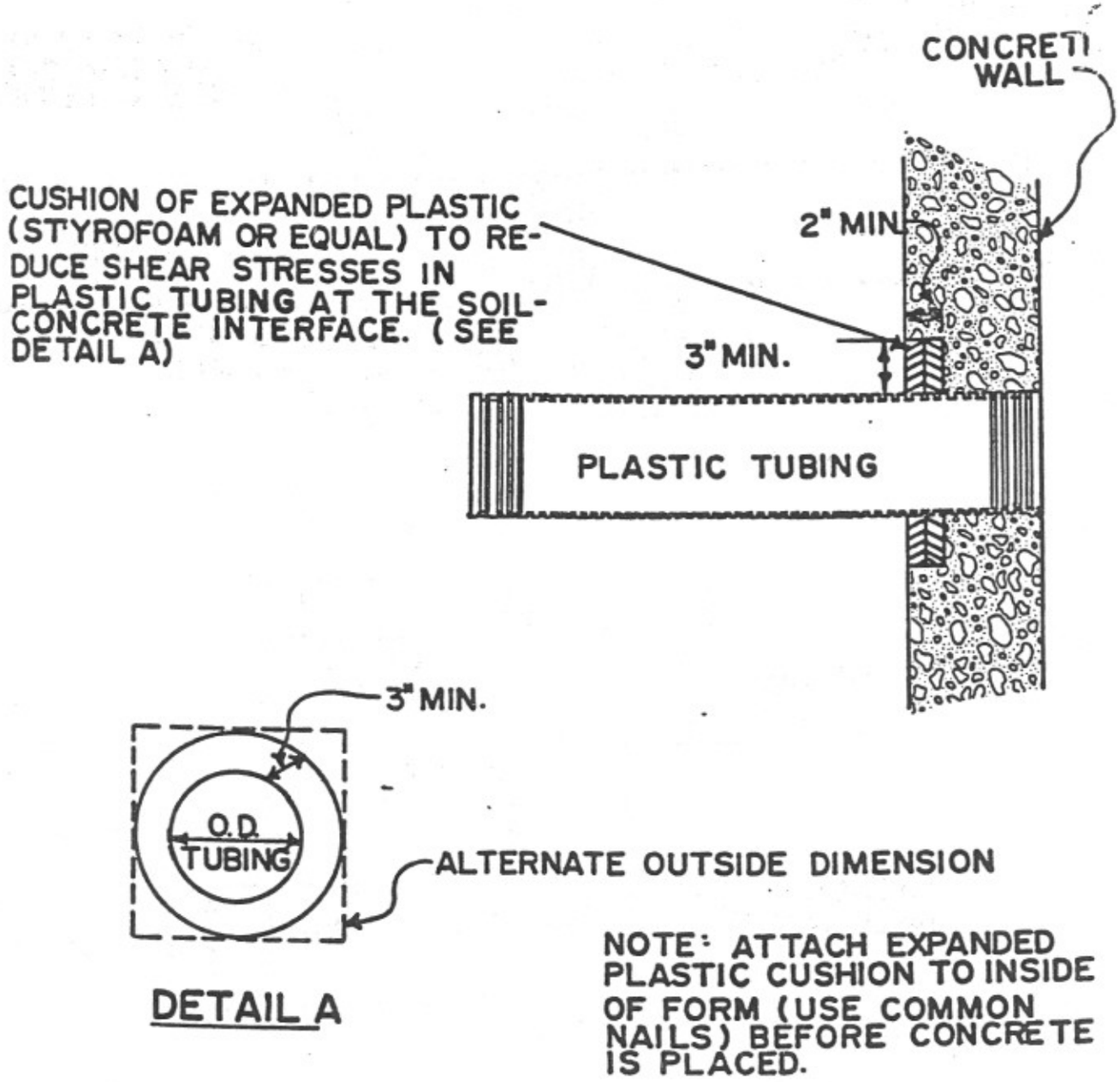
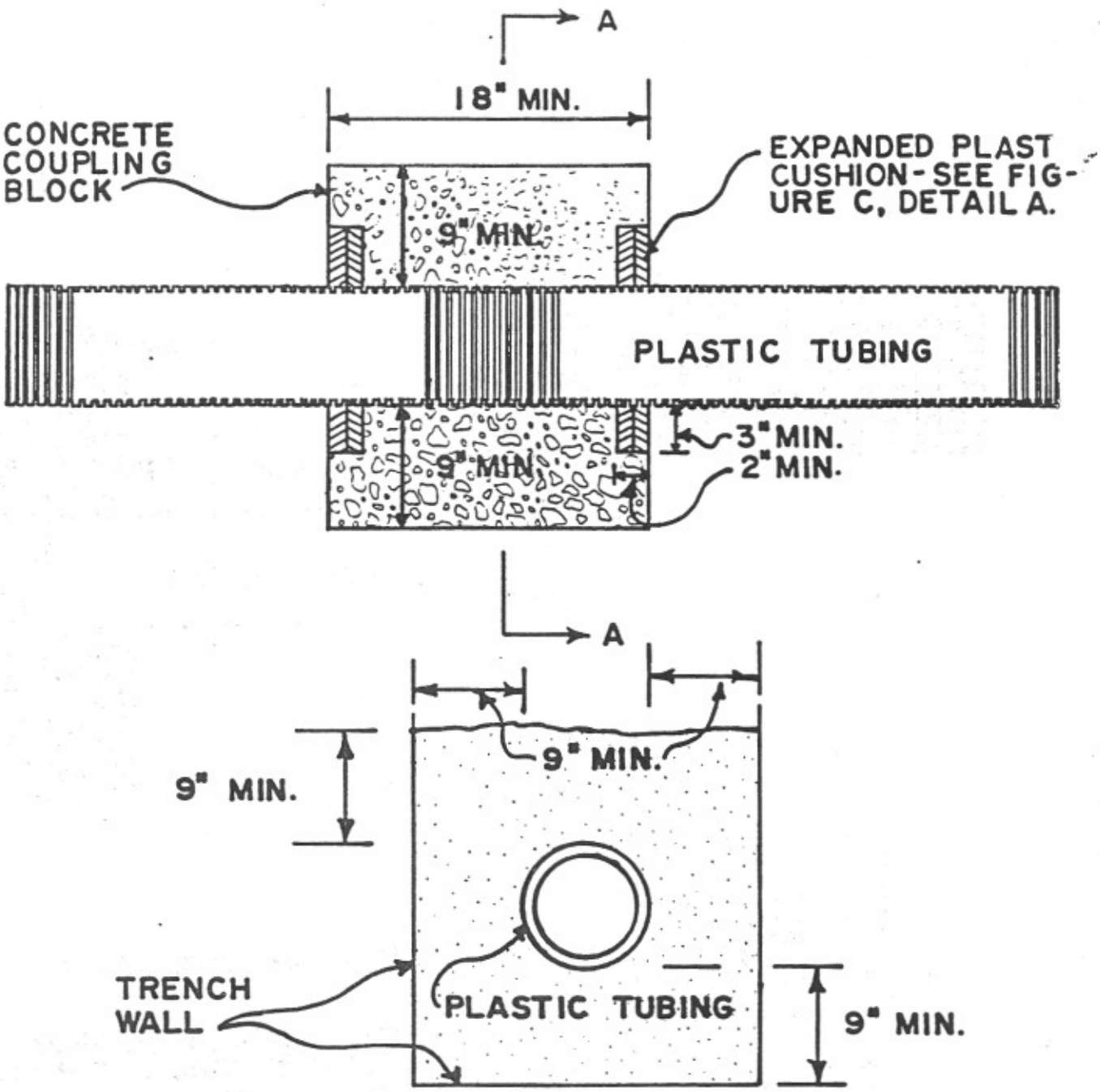


FIGURE B

LASTIC TUBING CONNECTION TO CONCRETE WALL



SECTION AA

FIGURE C

SPECIAL COUPLING-FOR PLASTIC TUBING
(TO RESIST INTERNAL PRESSURE).

(EFM Notice IN39, April 1982)