

## HDPE Conduit Catalog

# OSI PLASTICS

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## Telecommunications, Power Utility and CATV Industry Product Catalog

*Smoothwall Conduit*  
*Smooth Out/Ribbed In Conduit*  
*Ribbed Out/Ribbed In Conduit*  
*Aerial Conduit*  
*Corrugated Conduit*  
*Pre-Lubed Conduit*  
*Micro-Duct*  
*ETL Listed Conduit*  
*PVC Split Duct*  
*Split Steel Conduit*  
*PVC Houserisers*

***RUS Listed***  
***ISO 9001:2015 Registered***



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## HDPE Conduit

### Table of Contents

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2	Table of Contents	28	HDPE Conduit Truckload Capacity
3	OSI Plastics Story	29	Stick Pipe Pallet Size and Truckload Capacity
4	HDPE Model Conduit Specifications	30	HDPE Conduit Reel Return Policy
5	HDPE Model Conduit Specifications	31	Material Safety Data Sheet
6	HDPE Material Specifications	32	Material Handling Guide
7	HDPE Conduit Design—Cable Dim., Wall Determin.	33	Material Handling Guide
8	HDPE Conduit Design—Installation Method vs. Stress	34	Material Handling Guide
9	HDPE Conduit Design—Below Ground Installation	35	Material Handling Guide—Pipe Ovality
10	HDPE Conduit Design—Stiffness, Network Pulling	36	Material Handling Guide - Reel/Coil Unloading Guide
11	HDPE Conduit Design—General Considerations	37	Material Handling Guide - Pallet Unloading Guide
12	HDPE Conduit Design—Placement, Proofing	38	PVC Split Duct
13	HDPE Smoothwall Conduit Advantages	39	3 1/2" PVC Split Duct Drawing
14	Recommended HDPE Heat Fusion Procedure	40	4" PVC Split Duct Drawing
15	Recommended HDPE Butt Fusion Procedure	41	ST-14 Ga. Split Steel Conduit
16	HDPE Pipe Safe Pulling Strength	42	Standard PVC Houserisers
17	Minimum Allowable Bend Radius for HDPE Pipe	43	HDPE Conduit Limited Warranty
18	SORI/RORI Innerduct	44	HDPE Conduit Terms & Conditions
19	Above Ground/Aerial	45	Quality Assurance
20	HDPE Corrugated Conduit	46	Sales Contacts
21	Pull Tape/Rope		
22	Pre-Lubed HDPE Conduit		
23	HDPE Micro Duct		
24	ETL Listed Conduit		
25	Create Part Number for HDPE Conduit		
26	HDPE Conduit Dimensional Tables		
27	HDPE Conduit Reel Capacity		



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### OSI Plastics Story

# THE OSI PLASTICS STORY...

**Ohio Steel Industries** founded in Columbus, Ohio in **1958**, began operations as a fabricator of structural steel. Our diversified company today operates plastic extrusion, fabrication, production, warehousing and rental real estate facilities of more than 300,000 square feet, located in two Ohio cities. Our core business expertise is providing plastic extrusion, structural steel fabrication and contract manufacturing of plastic and steel products to the design and critical specifications established by our customers.

**O S I PLASTICS**, formerly known as the **Plastic Division of Ohio Steel Industries**, was established in **1975** in response to an extreme demand and shortage of supply in the marketplace for plastic sewer pipe. Our facilities and entrepreneurial spirit afforded us the opportunity to broaden our production capabilities and to apply our managerial and engineering strengths across a more diversified and broader base of customer, industry and marketplace. The diversity of our businesses provide us a competitive purchasing advantage and in the absorption of certain costs and affords us cyclical and seasonal stability over the traditional non-diversified organization. Since 1975, our expertise, production facilities, capabilities and our processes have developed and evolved in response to changes in the plastic industry and the marketplace. In celebration and recognition of our development and growth, and to better define our plastics business, we established and renamed our plastics division to **O S I PLASTICS**. This will allow our customers to recognize and associate our business to the plastics industry.

**O S I PLASTICS** is a recognized leader in the industry as a quality Pipe & Custom Plastic Profile Extrusion organization. As an **ISO 9001:2015 Registered Company**, we are continually in search of and undergoing a process of continuous improvement. We are continually evaluating our equipment and personnel. We are replacing outdated equipment, expanding our production facilities and adding new lines. We keep abreast of and develop the expertise to run new materials, expand our experience base of personnel and provide ongoing, continuous education and training of our workforce.

**O S I PLASTICS** has been in the extrusion of HDPE duct for the telephone, power and CATV industry since early in the industry's infancy. We produce smooth wall and ribbed products in all colors and with striping. Tooling for SDR and SIDR sizing is available 3/4" through 10". All capacities and types of pull tapes and ropes are available. We also produce 1", 1 1/4" and 1 3/8" corrugated product. PVC split duct, houserisers, conduit and custom profiles are also extruded. We have the capability and the facilities to fabricate plastics and steel.

We are committed to ensure that our customers get the best quality part at a competitive price. We are continually looking for new methods, new materials, updating and upgrading our equipment and establishing criteria to keep pace with the ever changing technologies of plastics and the extrusion process. With the human and capital resources of our company, we are able to grow as our customers require us. We recognize our two most important assets are our employees and our customers. Our employees experience enables them to produce high quality custom extrusions in an industry that is still more of an art than a science. Through training, all of our employees are closely involved in the daily operation of the plant.

**O S I PLASTICS** is **ISO 9001:2015** Registered and our HDPE Pipe, PVC Split Ducts and Houserisers are **RUS** Listed which helps in ensuring that our customers receive the quality that they require. **O S I PLASTICS** is part of the growing family of Ohio Steel Industries. We focus on giving our customers a **Value** in Pipe & Custom Plastic Profile Extrusion, which is **Quality + Service + Competitive Price**.



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# HDPE Conduit Model Specification

## Power and Communications Conduit

# HDPE Conduit

## Specifications

### 1. General Terms and Conditions

- 1.1. **Scope:** This specification covers requirements for flexible solid wall high-density polyethylene (HDPE) communications and power conduit and casing manufactured according to ASTM F 2160 for above ground use and below ground use by direct burial or trenchless installation.
- 1.2. **Engineered and Approved Plans:** Communications and power conduit and casing installation and construction shall be performed in accordance with engineered construction plans for the work prepared under the direction of a Professional Engineer.
- 1.3. **Referenced Standards:** Where all or part of a Federal, State or Local, ASTM, ANSI, NEMA, UL, etc., standard specification is incorporated by reference in these specifications, the reference standard shall be the latest edition and revision.
- 1.4. **Licenses and Permits:** A licensed and bonded General Contractor shall perform all communications and power conduit and casing construction work. The Contractor shall secure all necessary permits before commencing construction.
- 1.5. **Inspections:** All work shall be inspected by an Authorized Representative of the Owner who shall have the authority to halt construction if, in this opinion, these specifications or standard construction practices are not being followed. Whenever any portion of these specifications is violated, the Project Engineer or his Authorized Representative shall, by written notice order further construction to cease until all deficiencies are corrected. A copy of the order shall be filed with the Contractor's license application for future review. If the deficiencies are not corrected, performance shall be required of the Contractor's surety.

NOTICE: This publication is intended for use as a guide to support the designer of conduit systems, but it should not be used in place of the advice of a professional engineer. The Plastics Pipe Institute has made every reasonable effort to ensure the accuracy of this publication, but is may not provide all necessary information, particularly with respect to special or unusual applications. This publication may be changed from time to time without notice. Contact the Plastics Pipe Institute to determine if you have the most current edition.

### 2. High Density Polyethylene Solid Wall Conduit and Casing

- 2.1. **Qualification of Manufacturers:**
  - 2.1.1 The manufacturer shall have manufacturing and quality control facilities that are capable of producing and assuring the quality of the conduit or casing required by these specifications. The manufacturer's production facilities shall be open for inspection by the owner or his Authorized Representative.
  - 2.1.2 The conduit and casing manufacturer shall have a documented ISO 9001:2008 quality management system that defines product specifications and manufacturing and quality assurance procedures that assure conformance with customer and applicable regulatory. The latest Certificate of Compliance to the Quality Management System is available from the manufacturer and it is posted on their website.
- 2.2. **Approved Manufacturers:** Manufacturers that are qualified and approved by the Project Engineer are listed below. Products from unapproved manufacturers may be submitted for approval at the discretion of the Project Engineer.
- 2.3. **Materials:** Materials used for the manufacture of polyethylene conduit and casing shall be high-density polyethylene in accordance with ASTM F2160 requirements. Non-black materials shall not be used above ground.
- 2.4. **Size and Dimensions:** HDPE conduit and casing shall be manufactured to the dimensions and requirements of ASTM F2160.
  - 2.4.1. Other sizes and requirements shall be acceptable by advance mutual agreement between the customer (Owner, Purchaser or Project Engineer as appropriate) and the manufacturer.
  - 2.4.2. Ovality of 2 inch and smaller conduit shall not exceed 7% off the coil. Coiled conduit larger than 2 inch through 3 inch IPS shall not exceed 10%. Ovality in coiled 4 inch and greater diameter conduit and casing is largely a packaging condition where greater than 15% ovality shall be corrected in the field by processing the roundable conduit through re-rounding and straightening equipment during installation.
  - 2.4.3. Straight lengths of conduit shall have ovality of 5% or less.
  - 2.4.4. For below ground use, in addition to solid wall colors, permanent color identification shall be available either as stripes or as a coextruded skin. In either case the color layer shall be permanently bonded to the main body and exhibit the same chemical and mechanical properties as the underlying material. Colored conduit shall

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maintain its color for a period of 1 year when stored outside, or as otherwise agreed to by the specifier and producer.

Striped conduit shall have a minimum of 3 equally spaced stripes of sufficient width and color intensity to be easily distinguished from a distance of 10 feet and from any angle.

**Solid yellow or black with yellow stripes shall not be used for identification of conduit due to risk of misidentification with gas pipe.**

- 2.4.5. Friction reduction shall be available in the form of lubrication and/or interior ribbing. Ribbing shall not be sharp or severe. Factory pre-lubrication shall be performed with materials or agents that provide a permanent stable treatment and result in a coefficient of friction  $\leq 0.15$ . Lubricants shall be compatible with both conduit and cable jacket materials.
- 2.4.6. Pull media, if required, shall be available pre-installed into the conduit. Media shall consist of high tensile fiber tapes or rope. Tapes shall be pre-lubricated with sequential length marks. Sufficient slack shall be available in the tapes to prevent binding when paying the conduit out of the coil.
- 2.4.7. Conduit shall be permanently marked in accordance with ASTM F 2160.

2.5. **Compliance Tests:** Compliance Tests: Manufacturer's inspection and testing of materials — In case of conflict with Manufacturer's certifications, the Contractor, Project Engineer, or Owner may request retesting by the Manufacturer or have retests performed by an outside testing service. All retesting shall be at the requestor's expense and shall be performed in accordance with these Specifications.

- 2.5.1. Standard testing requirements are those noted in ASTM F2160 and include: Dimensional evaluation, elongation at break and low-temperature impact.
- 2.5.2. When specified in the purchase order or contract, a manufacturer's certification shall be furnished to the purchaser that the conduit was manufactured, sampled, tested and inspected in accordance with this Specification and found to meet the requirements.

### 3. Joining

- 3.1. HDPE conduit may be joined by mechanical couplings as long as high tensile loads, such as during pullback in horizontal directional drilling, are not encountered. Mechanical joint adapters, transition fittings, grooved couplings, threaded couplings and compression couplings may be used. The joining device manufacturer's recommendations shall be observed when making mechanical connections.
- 3.2. We recommend the procedures outlined in the Plastic Pipe Institute's Chapter 9 Polyethylene Joining Procedures in their Handbook of PE Pipe. This is available on PPI's website [http://plasticpipe.org/publications/pe\\_handbook.html](http://plasticpipe.org/publications/pe_handbook.html).
- 3.2. **Electro fusion** fittings may be used and are recommended for high-tensile applications.
- 3.3. **Butt fusion** may be used for casing applications where the inner bead does not interfere with cable insertion.
- 3.4. **Extrusion welding**, and hot gas welding shall not be used.

### 4. Construction and Installation

- 4.1. **Underground Installation:** Underground installations using open cut and burial techniques shall be performed in accordance with ASTM D2321 or as specified by the Project Engineer. The contractor shall observe all appropriate safety requirements in accordance with local, state and federal codes and regulations.
- 4.2. **Horizontal Directional Drilling (HDD)** applications are to be performed as specified by the Project Engineer or/and in accordance with ASTM F 1962, "Polyethylene Pipe for Horizontal Directional Drilling" published by the Plastics Pipe Institute (PPI), and "Mini Horizontal Directional Drilling Manual" published by the North American Society of Trenchless Technology (NASTT).
- 4.3. **Conduit sizing and placing** shall be consistent with the recommendations provided by "Polyethylene Duct and Conduit", Chapter 13 of the PPI Handbook of Polyethylene Pipe.



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## Specifications

### HDPE MATERIAL SPECIFICATIONS

PROPERTY	ASTM TEST METHOD	ENGLISH	SI UNITS
DENSITY	D 4883	.943 - .948 gm/cc	
MELT INDEX	D 1238	.1 - .3 g/10 min	
TENSILE STRENGTH	D 638	3,000-3,500 psi	23.1 MPa
at YIELD			
ELONGATION	D 638	800%	800%
at BREAK			
FLEX MODULUS	D 790	80,000-120,000 psi	827 Mpa
HARDNESS (Shore D)	D 2240	68	68
DEFLECTION TEMP	D 648	150 F	66 C
at 66psi			
BRITTLENESS TEMP	D 746	-180 F	-118 C
ENVIRONMENTAL	D 1693	192 HRS	192 HRS
STRESS CRACK *			
CELL CLASS	D 3350	335440A 3406/3408	335440A

\* Cond B, F20



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### HDPE Conduit Design Considerations

#### Design Considerations

##### Conduit vs. Pipe

In general, plastic conduits and plastic pipes are very similar in structure and composition, but deployment is where they differ.

- Conduits do not have long-term internal pressure. External forces are unchecked; if ovalized during installation, it may not recover during service.
- Long-term stress rupture is not a factor. (Hydrostatic Design Basis is not required in material selection.)
- Conduit ID is chosen by cable occupancy, where internal clearances are critical; whereas, for piping applications, ID is based on volumetric flow requirements.
- Path of installation for conduit is very important - radius of curvature, vertical and horizontal path deviations (undulations) and elevation changes all significantly affect cable placement.

#### Cable Dimension Considerations

Determination of a conduits dimensions begins with the largest cable, or group of cables or innerducts, intended for occupancy.

From a functional viewpoint, selection of diameter can be broken down into the following general considerations:

1. The inside diameter of the conduit is determined by the cable diameter and placement method (pulling or air-assisted pushing).
2. Pulling cables into underground conduits requires sufficient free clearance and is typically further distinguished by classifying the cables into two groups: power and coax (short lengths) and fiber (long lengths). Additionally, electrical cable is controlled by the National Electric Code (Chapter 9), whereas, dielectric, or fiber optic cables, are not.
3. Long pulling lengths require low volume fill, i.e. 36% max.
4. Short pulling lengths may be filled up to 53%, or up to the latest NEC limitations for groups of cables.
5. Push-blow installation methods for long length fiber cables utilize higher volume, i.e. up to 70% max.
6. Innerducts are smaller diameter conduits, intended for placement into larger conduits or casings. Their purpose is to subdivide the larger conduit space into discrete continuous pathways for incorporation of fiber optic cables. Diameters of conduits and innerducts are often specially designed to maximize the conduit fill.

Using these guidelines, one can determine the minimum ID of the conduit or innerduct. When over-sizing a conduit for power, coaxial or multi-pair telecom cables, the more room the better. This rule does not necessarily apply for push-blow methods of installation. Here, it is found to be more difficult to push a cable with additional clearance since a cable tends to form a helix, which transfers some of the axial load laterally into the wall causing friction. The air velocity moving over the cable can also be maximized with a minimum volume of air when the free volume is low. Higher air velocities result in improved drag forces on the cable, thus aiding with its placement.

#### Conduit Wall Determination

Conduit and duct products come in a wide range of sizes, spanning 1/4 -inch (5mm) to 24-inch (610mm) bore casings. The standard dimension ratio, SDR, of a conduit is determined as the ratio of the average conduit diameter divided by the minimum wall thickness. Wall thickness typically ranges between SDR 9 to SDR 17. (Larger SDR numbers indicate a thinner wall thickness.)

Conventions exist that work off of either the average outside diameter (SDR) or the average inside diameter (SIDR). Internally sized (SIDR) are usually chosen when the inside diameter clearance must be very carefully controlled. This usually does not apply to most duct installations because, as noted above, the free clearance between the cable and the inner wall of the conduit is not usually that close. Bore casings, on the other hand, offer situations that can benefit from close ID control because many times several innerducts are tightly fit into a casing. In this latter case, the conduit wall can be increased or decreased relative to service conditions without jeopardizing the inside clearance fit. Internally sized dimension tables tend to preserve the minimum ID above the nominal conduit size, whereas, externally sized conduits often fall below the nominal ID as the wall thickness increases. For most conduit installations, SDR sizing is utilized because the OD control lends itself to better joint formation using external couplers. This becomes very important when air-assisted placement methods are used for placing the cable. On the other hand, large diameter conduits (4 and above) typically undergo butt fusion as a means of joining. Determination of the wall thickness becomes a function of either the method by which the conduit is placed, or the nature of environmental stresses that it will be exposed to over the service life. ASTM F 2160, Standard Specification for Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD), explains the conduit sizing systems fully.

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### HDPE Conduit Design Considerations

#### Installation Method vs. Short-Term and Long-Term Stress

The viscoelastic nature of HDPE results in differences in the observed mechanical properties as a function of time (and/or temperature). The apparent stress/strain behavior of the material is time dependent under the influence of a sustained load. This is referred to as creep properties. In this regard, we can distinguish between short-term properties, such as those exhibited during a laboratory tensile test at a strain (stretching) rate of two inches per minute, as compared with long-term properties typical of conduit placement and sustained service loads.

Knowledge of the load-bearing capability of HDPE as a function of loading rate allows one to select appropriate strength values to substitute into design equations. Loads are applied to conduits both by the environment that they are placed into and by the placement means under which they are installed; the chief difference being the duration over which the load is applied. For example, a common means to install multiple conduits is to directly plow them into the ground using either a railroad plow or tractor-drawn plow. During this installation process, a certain amount of bending and tensile stress is encountered over a rather short period of time (only seconds to minutes). Whereas, after the plow cavity collapses about the conduit, the ground continues to settle upon stones that may be pressing directly against the conduit, thus setting up a long-term compressive load. For this application, we see that we would require both long-term and short-term moduli to assess the deflection resistance. Initially the conduit may offer resistance to ovalization, but in time, the resin may yield under the sustained load, resulting in a reduced pathway for the cable.

Numerous approaches to placing conduits have evolved over the years. Each method presents its own unique set of challenges with respect to the potential for conduit damage, or installation related predicaments. Perhaps one way to compare the potential sensitivity to damage of the various methods is the following table. Here the potential for damage is depicted by a numerical scale ranging from 0 to 5, where 5 is the most severe condition, resulting in yielding and permanent deformation of the conduit; 4 is the potential for loads greater than 75% of yield stress; 3 represents loads greater than 50%; 2 representing greater than 25%; 1 less than 25%, and 0 representing no significant load at all. The shaded areas depict the most severe condition.

**Relative Damage Sensitivity vs. Installation Method**

Installation Method	Short-Term Loading				Long-Term Loading		Recommended SDR Range
	Tensile	Bending	Crushing	Impact	Crushing	Tensile	
Conduit*	3 - 5	3	2	1	1	1 - 2	9.0 - 13.5
Horizontal Bore	4 - 5	2	3 - 4	0	3 - 5	1	9.0 - 11.0
Direct Plow	2	3	4 - 5	1 - 2	4 - 5	1	9.0 - 11.0
Continuous Trench	2	2	3 - 4	1 - 2	3 - 4	1	9.0 - 11.0
Open Trench	0	0	1 - 3	1	1 - 3	1	11.0 - 17.0
Aerial	1 - 2	3 - 5	2 - 3	1	1	2	11.0 - 13.5

The term “conduit” in this chart refers to the placement of HDPE innerducts into a buried 4” and 6” PVC conduit typical of the underground telecom plant. The SDR recommendation range attempts to select safe SDR’s based upon the potential for stressful conditions.

A comprehensive, industry consensus design guide for the proper use of polyethylene pipe is available from the Plastics Pipe Institute (PPI). The engineering handbook is available, free of charge, from the PPI website ([www.plasticpipe.org](http://www.plasticpipe.org)).



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### HDPE Conduit Design Considerations

It should be noted that the table on page 8 is not intended to be representative of all conduits installed by these methods, but is indicative of what can happen when the wrong diameter, wall or material is used. Check with supplier for specific design recommendations.

Perhaps the most serious and least controlled problem for cable placement is that of ovalization or kinking of the conduit. This condition can be brought about through tensile yielding, severe bending, excessive sidewall loading, or probably more frequently, the crushing action of rocks in the underground environment. In direct plow or bore applications, one gets little feedback from the process to indicate that a potential problem is developing. For these applications, the most robust conduit design should be considered.

### Below Ground Installations

#### Open Trench / Continuous Trenching

Conduits intended for buried applications are commonly differentiated into two classes, rigid and flexible, depending on their capacity to deform in service without cracking, or otherwise failing. PE conduit can safely withstand considerable deformation and is, therefore, classified as a flexible conduit. Flexible conduits deform vertically under load and expand laterally into the surrounding soil. The lateral movement mobilizes the soil's passive resistance forces, which limit deformation of the conduit. The accompanying vertical deflection permits soil-arching action to create a more uniform and reduced soil pressure acting on the conduit. PE stress relaxes over time to decrease the bending moment in the conduit wall and accommodates local deformation (strain) due to imperfections in the embedment material, both in the ring and longitudinal directions. The relationship between pipe stiffness, soil modulus (stiffness), compaction and vertical loading is documented by the work of Spangler and others. The pipe stiffness, as measured in ASTM D2412 and Spangler's Iowa formula provide a basis for prediction of conduit deflection as related to dimension ratio and resin modulus.

It should be noted, however, that creep affects the pipe stiffness, so the long-term modulus should be used. Additional information pertaining to soil embedment materials, trench construction and installation procedures can be found in the chapter on Underground Installation of Polyethylene Piping in this Handbook. Flexible conduit can occasionally fail due to stress cracking when localized forces (for example, from a large sharp rock) exceed the material's ability to relax and relieve stress. However, PE resins suitable for conduit applications should have adequate stress relieving properties to avoid these failures. Therefore, the design process should include consideration of the conduit resin's stress crack resistance, as well as the selection of appropriate embedment material and compaction.

#### Direct Plow

Flexible conduit materials need adequate compressive strength to safely resist the compressive stresses generated by external loading. However, the usual design constraint is not material failure due to overstraining, but, rather, excessive deflection or buckling under anticipated earth and ground water pressures. Deflection or buckling is more probable when the embedment material does not provide adequate side support. For example, pipe installed by directional drilling and plowing typically does not receive side support equivalent to that provided by the embedment material used in trench installations where bed and back? It can be engineered to provide a specific level of lateral support.

Plowing installations often encounter rocky soils, which would induce significant crush loads for conduits 2-inch diameter and smaller. In these cases, SDR 11 is the minimum wall thickness that should be used, and if rocky conditions were likely, SDR 9 would be more appropriate.

Pipe stiffness, as calculated per ASTM D2412, gives a measure of flexural stiffness of the pipe. Pipe stiffness equals the ratio of the applied load in units of lbs/lineal inch to the corresponding deflection in units of inches at 5% deflection. It should be understood, however, that although two conduits, 6-inch and 1.25-inch diameter, may possess the same pipe stiffness, the amount of soil load required to induce a 5% deflection in each is considerably different. As a result, the sensitivity of smaller diameter conduits to underground obstructions is that much greater. Another physical parameter for smaller conduits, crush strength, is often employed to establish limits of crush resistance. Unfortunately, there is no universally agreed upon criterion or test method for crush testing. Typically, the conduits are subjected to an increasing load, similarly applied as in ASTM D2412, but to a far greater deflection the order of 25 to 50% of the inside diameter. This deflection-limiting load is then reported on a per-foot basis.



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### Design Considerations

The following table illustrates the difference in the load required to induce a 5% deflection in conduits having different diameters but common pipe stiffness values. These values were generated assuming a flexural modulus of 150,000 psi for the resin. Units for pipe stiffness are in pounds/inch of length/inch of deflection, whereas those for the crush are presented as pounds per foot. It is apparent that a fixed external load more easily deflects smaller diameter conduits. It is also important to remember that, in long-term loading, the resin will maintain only about 22 to 25% of its original modulus; thus, smaller thin-wall conduits can be quite susceptible to localized loads brought about by buried obstructions.

**Pipe Stiffness (PS) vs. Crush Strength**

Conduit Size	OD In.	SDR 9			SDR 11			SDR 13.5			SDR 15.5			SDR 17		
		Wall In.	PS Lb/in. in.	Crush Lb./6 in.	Wall In.	PS Lb/in. in.	Crush Lb./6 in.	Wall In.	PS Lb/in. in.	Crush Lb./6 in.	Wall In.	PS Lb/in. in.	Crush Lb./6 in.	Wall In.	PS Lb/in. in.	Crush Lb./6 in.
1	1.315	.146	1310	804	.120	671	433	.097	344	231	.085	220	151	.077	164	114
1.25	1.660	.184	1310	1020	.151	671	547	.123	344	292	.107	220	190	.098	164	144
1.5	1.900	.211	1310	1160	.173	671	626	.141	344	33	.123	220	218	.112	164	165
2	2.375	.264	1310	1450	.216	671	782	.176	344	417	.153	220	272	.140	164	206
2.5	2.875	.319	1310	1760	.261	671	947	.213	344	50	.185	220	330	.169	164	249
3	3.5	.389	1310	2140	.318	671	1150	.259	344	615	.226	220	402	.206	164	304
4	4.5	.500	1310	2750	.409	671	1480	.333	344	790	.290	220	516	.265	164	390
6	6.625	.736	1310	4050	.602	671	2180	.491	344	1160	.427	220	760	.390	164	575

The above table is for comparative purposes only. Pipe stiffness values are based on 150,000-psi flexural modulus. Crush values are estimated from empirical data for 61 long conduit samples compression tested in accordance with ASTM D2412 to 50% deflection.

### Conduit Network Pulling

In the telephone and electrical utility industries, the underground plant is often comprised of a network of 3", 4", and 6" conduit banks. These rigid conduits are composed of clay tile, cement conduit, or more recently, PVC constructions. They are usually separated by manhole vaults or buried pull-boxes. Distances between, and placement of manholes and pull-boxes is largely a function of the following constraints:

1. Location of branch circuit intersections
2. Lengths of cables (or innerducts) available on reels
3. Access to, or limited by physical obstructions
4. Path difficulty for placement of cable or innerducts
5. Surface environment
6. Method of cable placement (mid-assist access)

In addition, Department of Transportation (DOT) regulations often require additional protection and support structure for buried conduits in road bores and traffic areas. Although steel casings have been used in the past, it is becoming more prevalent to horizontally bore under roadways (or waterways) and pull back an HDPE casing into which HDPE innerducts are installed.

Pull placement of innerducts has obvious similarity to traditional cable placement methods. Several good references on this subject exist, including *Guide For Installation of Extruded Dielectric Insulated Power Cable Systems Rated 69KV Through 138KV*, *Underground Extruded Power Cable Pulling Guide*, *AEIC Task Group 28* and *IEEE Guide Distribution Cable Installation Methods In Duct Systems*.

A comprehensive, industry consensus design guide for the proper use of polyethylene pipe is available from the Plastics Pipe Institute (PPI). The engineering handbook is available, free of charge, from the PPI website ([www.plasticpipe.org](http://www.plasticpipe.org)).

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# HDPE Conduit Model Specification

## Power and Communications Conduit

### HDPE Conduit Design Considerations

There are a number of variables that influence loading and selection of innerducts when pulling into conduit structures:

- Diameter of conduit and innerduct, and number of innerducts to be installed—clearance fit
- Length and direction changes of conduit run, sweeps
- Composition of conduit and coefficient of friction
- Jam combinations
- Pull speed and temperature
- Elevation and innerduct weight

### Horizontal Directional Bore

For directional drilling the design process should include consideration of tensile forces and bend radii created during these processes. Flexible conduits installed in continuous lengths are susceptible to potential tensile failures when pulled into place, so allowable tensile forces should be determined to avoid neck-down from tensile yield. The engineer should also account for the conduits allowable bend radius, especially on bends with no additional support given to the conduit, to prevent ovalization and kinking from installation. For additional information, please refer to the chapter on horizontal directional drilling in this Handbook.

### General Considerations

#### Mechanical Stress

Regardless of the installation method, mechanical stress is of great concern during conduit placement. Exceeding the maximum allowable pulling tension or the minimum allowable bending radii can damage conduit. Consult the conduit supplier for allowable pulling tensions.

#### Pulling Tension

During conduit pulling placement, attention should be given to the number of sweeps, bends or offsets and their distribution over the pull. Tail loading is the tension in the cable caused by the mass of the conduit on the reel and reel brakes. Tail loading is controlled by two methods. Using minimal braking during the pay-off of the conduit from the reel at times can minimize tension; no braking is preferred. Rotating the reel in the direction of pay-off can also minimize tail loading. Breakaway swivels should be placed on the conduit to ensure that the maximum allowable tension for that specific conduit type is not exceeded. The swivel is placed between the winch line and pulling grip. A breakaway swivel is required for each conduit.

#### Bending Radii

Conduit is often routed around corners during placement, and pulling tension must be increased to complete the pull. It is important to determine the minimum radius to which the conduit can be bent without mechanically degrading the performance of the conduit. See Table 3.

**TABLE 3**  
Minimum Bend Radius as a function of Diameter and Standard Dimension Ratio

Size	OD In.	SDR 9		SDR 11		SDR 13.5		SDR 15.5		SDR 17	
		Wall In.	Min. Radius In.	Wall In.	Min. Radius In.	Wall In.	Min. Radius In.	Wall In.	Min. Radius In.	Wall In.	Min. Radius In.
1	1.315	.146	15.4	.120	20.1	.097	25.9	.085	30.6	.077	34.1
1.25	1.660	.184	17.1	.151	22.3	.123	28.9	.107	34.2	.098	38.1
1.5	1.900	.211	18.2	.173	23.8	.141	30.8	.123	36.4	.112	40.6
2	2.375	.264	20.0	.216	26.3	.176	34.2	.153	40.5	.140	45.2
2.5	2.875	.319	21.8	.261	28.0	.213	37.3	.180	44.3	.169	49.5
3	3.500	.389	23.8	.318	31.4	.259	40.9	.226	48.5	.206	54.2
4	4.500	.500	26.4	.409	35.0	.333	45.8	.290	54.5	.265	61.0
6	6.625	.736	30.9	.602	41.3	.491	54.4	.427	64.9	.390	72.8

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# HDPE Conduit Model Specification

## Power and Communications Conduit

### HDPE Conduit Design Considerations

#### Placing the conduit

An important consideration for **open-trench** installations of PE conduit is that conduit should be straightened to remove any residual coil memory, which can create a tortuous path for the cable and create significant challenges to cable installation. Conduit pay off can be accomplished by pulling the conduit into the trench from a stationary reel or by laying the conduit into the trench from a moving reel, usually attached to a trailer. Spacers should be used when placing multiple ducts in a trench. Spacers prevent the ducts from twisting over and around each other. By keeping the ducts in straight alignment, cable-pulling tensions are reduced. When water is present in the trench, or when using extremely wet concrete slurry, floating of the conduit can be restricted through the use of the spacers.



#### Cold Bend Radius

In open trench applications PE pipe may be cold bent in the field. The allowable bend ratio for SDR 13.5 and SDR 11 pipe is 25 x Pipe Outside Diameter.

#### Directional Bores

Directional boring allows the installation of conduit under obstacles that do not allow convenient plowing or trenching installations, for example rivers or highways. This unique installation method, which capitalizes on a primary strength of PE conduit its flexibility, can be accomplished over very long distances. Directional boring is accomplished using a steerable drill stem to create a pathway for the conduit. The equipment operator can control the depth and direction of the boring. A detailed discussion of this installation method is presented in the chapter on Polyethylene Pipe for Horizontal Directional Drilling in this Handbook. Also, consult the equipment supplier for detailed operating procedures and safety precautions. It is recommended that DR 11 or DR 9 be used, depending on conditions and conduit diameter.

#### Installation into Existing Conduit

Conduit (or multiple conduits) is often pulled into existing conduit systems as innerduct.

#### Proofing

An important step that should be taken prior to this type of installation is proofing the existing conduit to ensure that all obstructions are cleared and that conduit continuity and alignment is good. It is recommended that a rigid mandrel roughly 90% of the inner diameter of the conduit be used to perform the proof. Proofing conduit is typically performed by pushing a fiberglass fish with a rigid mandrel attached to the end of it through the conduit. Any problem areas should be felt by the person pushing the fiberglass fish and should then be marked on the fish so that the distance to the problem is recorded and if necessary can be located for repair with greater ease. If the fiberglass fish makes its way through the conduit without any difficulties experienced, then the conduit has been proofed out, and no repairs should be necessary.

Before placement of the innerduct inside the conduit can be started, it is important to have all of the necessary equipment to protect the innerduct. The use of sheaves, bending shoes, rolling blocks (45 and 90 degrees) and straight pulleys are required for protection of the innerduct during installation. It is important that they all meet the proper radius for the innerduct size. The use of a pulling lubricant will greatly reduce the tension and stress on the innerduct when pulling innerduct into an existing conduit. Ball bearing swivels are needed for attaching the winch line to the innerduct harness system.

#### After Pulling

The stress of pulling innerduct through existing conduit will vary with the length of the route and the number of turns it has to make, as well as the condition of the conduit it is being pulled into and the amount of lubrication used. The effects of the stress will cause the innerduct to elongate (or stretch) in proportion to the amount of stress, but should be less than 2% of the total length placed. Due to this effect, it is important to pull past the conduit system slightly to compensate for recovery to the original length. An allowance of at least one hour needs to be given for the innerduct to relax before cutting and trimming it.



A comprehensive, industry consensus design guide for the proper use of polyethylene pipe is available from the Plastics Pipe Institute (PPI). The engineering handbook is available from the PPI website ([www.plasticpipe.org](http://www.plasticpipe.org)).

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## Smoothwall HDPE Conduit and Smoothwall HDPE Innerduct

## HDPE Conduit Smoothwall Conduit



### Advantages of Smoothwall PE Conduit

- For use in existing conduit, direct buried or aerial applications.
- Ductility—HDPE conduit will resist brittleness with age and cold weather.
- PE withstands low temperature impact better than an other material used in the industry.
- HDPE bends and flexes without breakage over a wide range of temperatures.
- Large capacity continuous reels of products provide a lower cost of installation with fewer joints.
- PE's flexibility will eliminate or reduces the number of bends and sweeps used in the system.
- HDPE flexibility, strength, toughness and high tensile strength allow product to be directionally bored, direct buried, plowed in, concrete encased or used as an innerduct.
- Cable can be consistently pulled or blown into HDPE duct in great distances and fast rates due to its low coefficient of friction.
- HDPE conduit is resistant to many chemicals and soil conditions.
- HDPE offers longer service life than other products used in the industry.
- Available in a wide variety of standard or custom solid colors for color coding.
- For a larger number of colors, many combinations of color striping is also available.
- Available in smooth wall SDR and SIDR controlled pipe from 3/4" to 10" in diameter.
- Available in empty, with pull rope or pull tape installed.
- Available in standard or custom lengths on 50", 66", 84", 96", 102", 114" and 120" diameter steel reels.
- Silicone pre-lubed PE is an option where an additive is mixed in with the HDPE to create a more slippery material.
- Multiple sections of different color/stripe combinations can be delivered on one reel, up to 4-way.



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# Smoothwall HDPE Conduit and Smoothwall HDPE Innerduct

## HDPE Conduit Heat Fusion Procedure

### Heat Fusion Procedure

In addition to the material advantages of High Density (HDPE) Polyethylene Pipe (flexibility, corrosion resistance, light weight, etc.), the most compelling reason to choose HDPE pipe is that it provides a leak free joint that is as strong as the pipe itself and can be connected (heat fused) in a matter of minutes.

#### 1- Heat fusion joining, properly done, is **SAFE** and **SIMPLE**.

Heat fusion of polyethylene pipe is just a matter of melting the ends of two piping components together. The necessary equipment uses normal electrical sources, usually from a standard generator.

The process involves cleaning the pipe, preparing the surface, heating with a designed apparatus, joining and cooling under pressure.

#### 2- Heat fusion joining of PE pipe is **EASY TO LEARN**.

PPI has developed recommended fusion procedures that have been approved by member companies, and the process has a broad range of parameters to produce good joints as documented in PPI's publication number TR-33.

Inexperienced workers can be taught the basics in half an hour, and gain competence within a few hours.

Equipment is widely available from distributors and contractors for sale or rental.

Training is widely available from pipe manufacturers, distributors, and equipment manufacturers.

Skilled general contractors specializing in construction and natural gas distribution systems are available nationwide. Contact the Plastics Pipe Institute at 202-462-9607 or [www.plasticpipe.org](http://www.plasticpipe.org) for a list of distributors.

#### 3- Heat fusion joining is **RELIABLE**.

Fusion joining of PE pipe has been used for over 40 years in the distribution systems of natural gas utilities in North America, and has a remarkable safety record. In Europe, where PE pipe is often the predominant water pipe, it has been used since the 1960s. After the 1994 San Francisco earthquake, authorities were astonished at how heat-fused HDPE joints withstood the stresses created by the tremors.

The heat-fused joint is stronger than the pipe itself and is a water pipe joining method that is absolutely leak proof!

The natural gas industry has used a simple visual verification method for over 40 years to inspect joints. This process, combined with normal hydrostatic testing, has yielded an extraordinary record for both safety and efficiency.

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## Smoothwall HDPE Conduit and Smoothwall HDPE Innerduct

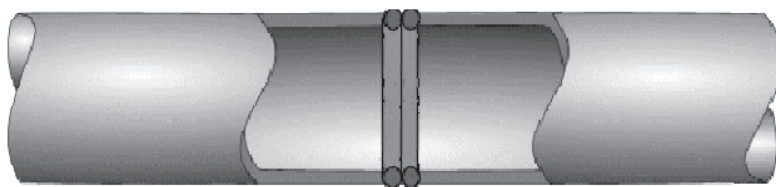
### HDPE Conduit Butt Fusion Procedure

#### Butt Fusion

The most widely used method for joining individual lengths of PE pipe and pipe to PE fittings is by heat fusion of the pipe butt ends as illustrated in Figure 1. This technique produces a permanent, economical and flow-efficient connection. Quality butt fusion joints are produced by using trained operators and quality butt fusion machines in good condition.

The butt fusion machine should be capable of:

- Aligning the pipe ends
- Clamping the pipes
- Facing the pipe ends parallel and square to the centerline
- Heating the pipe ends
- Applying the proper fusion force



**Figure 1** A Standard Butt Fusion Joint

The six steps involved in making a butt fused joint are:

1. Clean, clamp and align the pipe ends to be joined
2. Face the pipe ends to establish clean, parallel surfaces, perpendicular to the center line
3. Align the pipe ends
4. Melt the pipe interfaces
5. Join the two pipe ends together by applying the proper fusion force
6. Hold under pressure until the joint is cool

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# Smoothwall HDPE Conduit and Smoothwall HDPE Innerduct

## HDPE Conduit Safe Pulling Strength

### Safe Pulling Strength for HDPE Pipe

#### Mechanical Stress

Regardless of the installation method, mechanical stress is of great concern during conduit placement. Exceeding the maximum allowable pulling tension or the minimum allowable bending radii can damage conduit. Consult the conduit supplier for allowable pulling tensions.

#### Pulling Tension

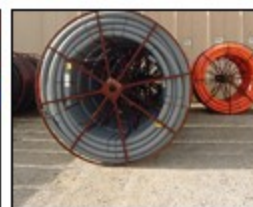
During conduit pulling placement, attention should be given to the number of sweeps, bends or offsets and their distribution over the pull. Tail loading is the tension in the cable caused by the mass of the conduit on the reel and reel brakes. Tail loading is controlled by two methods. Using minimal braking during the pay-off of the conduit from the reel at times can minimize tension; no braking is preferred. Rotating the reel in the direction of pay-off can also minimize tail loading. Breakaway swivels should be placed on the conduit to ensure that the maximum allowable tension for that specific conduit type is not exceeded. The swivel is placed between the winch line and pulling grip. A breakaway swivel is required for each conduit.

### Estimated Safe Pull Force, lbs

Size	Nominal OD	SDR 9	SDR 11	SDR 13.5
1"	1.315	800	670	550
1 1/4"	1.660	940	787	653
1 1/2"	1.900	1,232	1,030	855
2"	2.375	1,924	1,610	1,336
2 1/2"	2.875	3,800	3,200	2,600
3"	3.500	4,179	3,497	2,902
4"	4.500	6,908	5,780	4,797
5"	5.563	11,248	9,412	7,811
6"	6.625	14,973	12,529	10,398
8"	8.625	25,377	21,235	17,623
10"	10.750	39,423	32,988	27,377

12 hour Pull IPS Size

The above table represents safe pull strength under perfect conditions. Consideration should be given to variables such as type of soil, ground conditions, length of run and operator experience.



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# Smoothwall HDPE Conduit and Smoothwall HDPE Innerduct

## HDPE Conduit Allowable Bend Radius

### Minimum Allowable Bend Radius

#### Bending Radii

Conduit is often routed around corners during placement and pulling tension must be increased to complete the pull. It is important to determine the minimum radius to which the conduit can be bent without mechanically degrading the performance of the conduit. See Table below.

Minimum Bend Radius as a function of Diameter and Standard Dimension Ratio

Size	OD In.	SDR 9		SDR 11		SDR 13.5		SDR 15.5		SDR 17	
		Wall In.	Min. Radius In.	Wall In.	Min. Radius In.	Wall In.	Min. Radius In.	Wall In.	Min. Radius In.	Wall In.	Min. Radius In.
1	1.315	.146	15.4	.120	20.1	.097	25.9	.085	30.6	.077	34.1
1.25	1.660	.184	17.1	.151	22.3	.123	28.9	.107	34.2	.098	38.1
1.5	1.900	.211	18.2	.173	23.8	.141	30.8	.123	36.4	.112	40.6
2	2.375	.264	20.0	.216	26.3	.176	34.2	.153	40.5	.140	45.2
2.5	2.875	.319	21.8	.261	28.0	.213	37.3	.180	44.3	.169	49.5
3	3.500	.389	23.8	.318	31.4	.259	40.9	.226	48.5	.206	54.2
4	4.500	.500	26.4	.409	35.0	.333	45.8	.290	54.5	.265	61.0
6	6.625	.736	30.9	.602	41.3	.491	54.4	.427	64.9	.390	72.8



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## Smooth Out/Ribbed In and Ribbed In/Ribbed Out Innerduct

### HDPE Conduit SORI or RORI

#### Advantages of Smooth Outside, Ribbed Inside PE Conduit Advantages of Ribbed Outside, Ribbed Inside PE Conduit

- Extruded from HDPE with the same properties described in the Smoothwall Conduit section.
- Available in 3/4" to 2" diameter.
- The ribbed outer design reduces the surface contact area of the outside of the ribbed innerduct allowing for a faster, easier installation with less friction into conduit.
- The ribbed internal design reduces the surface contact area of the inside of the ribbed innerduct to allow a faster, easier installation of fiber with less friction between the contact surfaces.



#### Friction in Conduit Systems

Friction is a critical limiting factor in determining the type and length of cable installation. Although very little information on cable installation is provided in this guide, this section has been made available as a background reference on frictional properties.

#### Definitions

**Friction:** the nature of interaction occurring between two surfaces. The basis of friction has its roots in the mechanical and physical-chemical makeup of the interface created by bringing together two surfaces.

**Coefficient of friction, COF:** the ratio of the force required to move a body relative to the normal, or clamping force, acting to keep the bodies together.

**Static COF:** the ratio of forces required to bring about the onset of motion between two bodies at rest with each other.

**Kinetic COF:** the ratio of forces acting on a body already in motion. It is essentially a measure of the effort required to keep the body in motion.

Geometry of the inner surface of the conduit can also play a role in friction reduction. As the normal load increases, the COF is found to decrease, unless the surface is damaged in such a way so as to increase the contact area, or heat is allowed to build up at a rate faster than it can be conducted away. Ribs formed on the inner conduit wall are a common design feature to reduce friction. Longitudinal ribbing results in a reduction of the contact surface between the cable and the conduit wall from an area to a line of contact. Decreasing the area of contact under the same sidewall load results in a higher localized normal force. Within a limited range of sidewall loads, the COF is found to go down in at least until the loading causes localized damage to the jacket sheath.



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## Above Ground/Aerial Power and Communications Conduit

## HDPE Conduit Above Ground/Aerial

### Above Ground/Aerial

There are many applications for aerial conduit, which include but are not limited to road crossings, rail crossings, trolley line crossings, and water crossings. Also used in areas where the terrain makes buried duct installation difficult.

They provide for efficient means of supporting cable that can easily be replaced and/or allow for the addition of cables without requiring encroachment in often hazardous or difficult to access spaces.

A critical consideration for aerial applications is UV protection. For this reason, only conduit materials with special carbon black pigments can be used, since constant direct exposure to UV radiation significantly shortens the lifetime of unprotected PE conduit.

Aerial HDPE is available only in black due to the use of carbon black for the additional UV protection requirement.

This product is available with our combination of pull tapes, pre-lubed option in various put-ups.

### Installation

The two preferred methods for aerial installation of conduit are the back-pull/stationary reel method and the drive-off/moving reel method. Circumstances at the construction site and equipment/manpower availability will dictate which placement method will be used.

Design consideration must be given to the expansion/contraction potential of PE conduit. This consideration is more important when lashing conduit than with the use of self-supporting conduit.



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# Corrugated Conduit

## Power and Communications Conduit

### HDPE Conduit

### Corrugated Conduit

#### Advantages of Corrugated PE Conduit

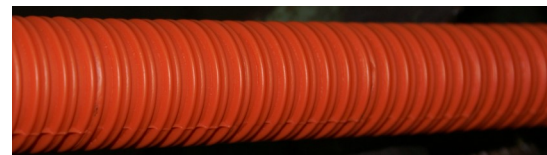
- Extruded from HDPE with the same properties described in the Smoothwall Conduit section.
- Corrugated design provides a light weight yet still flexible and strong product.
- The corrugations provide crush resistance in a light weight design.
- The corrugations also reduce the inside surface area of the conduit, reducing friction when pulling fiber.
- Available in 1 1/4" diameter.
- Standard lengths available from 500' coils to 5,000' reels.
- Larger reels, 2, 3, 4-way sectioned reels are available.
- Available in empty or pull tape installed.

Ribbing, or corrugated profiles, results in similar friction reducing geometries. However, there is a tendency for field-added lubrication to be scraped off the cable by the corrugations. In addition, the high degree of flexibility requires careful placement of the duct to reduce the buildup of friction due to path curvature.

Corrugated conduit has properties that generally make it easier to work with in difficult and confined environments. Primarily, this is a result of the lack of memory with corrugated and greater flexibility vs. smooth wall conduit. The lack of memory also provides a corrugated conduit that, when installed as an innerduct (inside of another larger conduit), does not spiral and therefore has lower friction when cables are pulled through it. The greater degree of flexibility makes corrugated conduit easier to handle when used in confined spaces and other restricted environments. Corrugated conduit is not appropriate for use in direct buried applications because of its limited crush resistance and the difficulty of laying it in a straight path.

Corrugated conduit is also not appropriate for use when cables are to be installed using air-assisted placement. Corrugated conduit is relatively thin-walled and may not be able to handle the air pressure of air-assisted placement. The corrugations create air turbulence that is counterproductive to the air-assisted placement systems and significantly reduce the distance cables can be blown through it.

Corrugated conduit should not be installed using directional drilling equipment due to limited tensile strength and the fact that the corrugations will create significant friction during the pullback that will likely cause the conduit to separate. The ASTM standards that cover SIDR and SDR designs do not apply to corrugated duct. Corrugation equipment varies from producer to producer, and inside and outside diameter may vary from each source of supply. All corrugated conduit specifications are per the producer only. Generally a minimum ID is specified and a maximum OD. Corrugated design greatly affects the properties of the conduit such as crush resistance and tensile strength. Tooling used to produce corrugated conduit does not allow the producer to change dimensions without costly retooling.



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## Pull Tape/Rope

### Power and Communications Conduit

## HDPE Conduit

### Pull Tape/Rope



POLYESTER FIBER PULLTAPE™

### Pulling Cable into Conduit

The traditional method of installing cable-in-conduit has been to attach a pull line (or rope) to the cable and pull the cable into the conduit. This placement method requires equipment to do the actual pulling, to apply lubricants to reduce friction, and devices that measure the amount of tension being applied to the cable. Conduit may be supplied with a pre-installed pull line. This line is either a twisted rope or a woven tape. These pull lines come in a wide variety of tensile strengths that range from 500 - 6000 pounds-force. Pull lines are also available pre-lubricated to reduce friction.

Pull tapes are available with sequential footage marks. This type of tape is useful in determining the progress of the cable pull. Empty conduit would require a pull line to be installed. Blowing a pull line directly or blowing a lightweight line through the conduit using compressed air accomplishes this. This line is then used to pull a pull line or a winch line into the conduit to pull the cable. A winch mechanism with a take-up reel is used to pull the pull line with the cable attached. The winch should have a tension meter to monitor the amount of tension being placed on the cable during the pull. This monitor will reduce the risk of damaging a sensitive fiber optic cable during the pull. Check with the cable manufacturer to determine the amount of tension a cable can safely withstand.

The use of cable lubricants is strongly recommended. Cable lubricants reduce the amount of friction during a pull and therefore allow longer cable pulls and reduce the risk of damage to a cable during the pull. When the cable is attached to the pull line, it is recommended that a swivel be used between the two. This swivel will allow the cable and pull line to move independently in the conduit during the pull and prevent unnecessary twisting of the cable or pull line.

On very long pulls the use of mid-assists is common. Mid-assist equipment can be as simple as a person pulling on the cable midway or it can be a capstan type device that provides a controlled amount of pulling tension to the cable to reduce the tension on the cable and increase the possible length of the pull. If the conduit is in a manhole, protective devices are needed to guide the cable into the manhole and then into the conduit. These guides protect the cable from scraping on metal or concrete surfaces that could damage the cable sheath.

Pull-line construction also plays a significant role in burn-through. Polypropylene ropes or even HDPE pull-lines exhibit low COF at low sidewall loads, but rapidly cut through both PVC conduit and PE conduit when the load increases. The tendency for these materials to soften, combined with high structural similarity (to PE), limit the pull load range over which they may be used. Polyester and polyaramid pull lines, particularly in tape form, offer greater protection from burn through. We stock the following pull tapes and ropes:



- 900# Unmarked Flatline Tape
- 1,250# Polyester Lubricated Pulltape
- 1,800# Polyester Lubricated Pulltape
- 2,500# Polyester Lubricated Pulltape
- 1,250# Kevlar Blend Lubricated Pulltape
- 1,250# Polyester Lubricated Detectable Pulltape



# OSI PLASTICS

DIVISION OF **OHIO STEEL**  
INDUSTRIES

## OSI Plastics

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2575 Ferris Road, Columbus, OH 43224  
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[www.osiplastics.com](http://www.osiplastics.com)

## HDPE Pre-Lubed Duct

### Power and Communications Conduit

## HDPE Conduit

### Pre-Lubed Duct

**Pre-Lube is an option on the following products:**

- Smooth wall Conduit
- SORI Conduit
- RORI Conduit
- Micro Duct



Conduits may be pre-lubricated during the manufacturing process by incorporation of lubricants directly onto the conduit inner wall, or via a lubricant-modified coextruded layer. The most common type of lubricant used for this type of application is silicone polymer, although other agents such as mineral oils, fatty acid derivatives and glycols have also found use. Pre-lubrication finds particular value with fiber cable push-blow systems. Because the sidewall loads with these techniques are quite low compared with pulling, and the distances so great, the viscous drag contributed by water-soluble lubes can be detrimental. The ultra-light amount of lubricants employed by factory pre-lubrication methods can be a real advantage.

We, at OSI Plastics use a silicone polymer additive to our resin when our customer specifies pre-lubricated innerduct. This assures that the lubricant is mixed into the entire cross section of the pipe.



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## HDPE Micro Duct

Power and Communications Conduit

## HDPE Conduit

### HDPE Micro Duct



- Extruded from HDPE with the same properties described in the Smoothwall Conduit section.
- Available in 16 mm diameter.
- The ribbed internal design reduces the surface contact area of the inside of the ribbed innerduct to allow a faster, easier installation of fiber with less friction between the contact surfaces.
- Variety of colors and stripes available for identification
- We can produce on various size reels to accommodate the length of run most suitable for the job.
- Optional pull tape is available.

MICRODUCT						
	OUTSIDE DIAMETER		WALL		INSIDE DIAMETER	
NOM. SIZE	NOM.	TOL.	MIN.	TOL.	AVG.	LB/FT
16 MM	0.630	+/- .005	0.079	+.010/.000	0.456	0.056



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# ETL LISTED HDPE CONDUIT

## Power Utility Conduit

# HDPE Conduit

## ETL LISTED PIPE

**ETL Listed HDPE** is a protective pathway for electrical cable and wire for innerduct and underground applications produced to ASTM F 2160 and UL Standard 651-A. Installation must be in accordance to the National Electrical Code direct buried or encased on concrete. If conduit is placed above ground it must be encased in at least 2" of concrete.

Our **ETL listed UL 651-A** conduit is gray in color, and includes 1250# pull tape. Product is printed with product description and manufacturing identification. The conduit has sequentially printed footage 24" apart. This product is available only in smooth wall. Following are the available sizes in ETL listed pipe.

P/N	PIPE SIZE	SDR CONTROLLED BY OUTSIDE DIAMETER AND MINIMUM WALL								3-21-17 LK
		OUTSIDE DIAMETER			WALL		ID			
		SCH/SDR	NOM.	TOL.	MIN.	TOL.	AVG.	LB/FT		FT/REEL
E075S135GYNA80T	3/4"	13.5	1.050	+/- .005	0.078	+.020/- .000	0.874	0.110	8,000	66"
E075S040GYNA80T	3/4"	40	1.050	+/- .005	0.113	+.020/- .000	0.804	0.148	8,000	66"
E075S080GYNA80T	3/4"	80	1.050	+/- .005	0.095	+.020/- .000	0.850	0.189	8,000	66"
E100S135GYNA60T	1"	13.5	1.315	+/- .007	0.097	+.020/- .000	1.101	0.170	6,000	66"
E100S040GYNA60T	1"	40	1.315	+/- .007	0.133	+.020/- .000	1.029	0.221	6,000	66"
E100S080GYNA60T	1"	80	1.315	+/- .007	0.179	+.020/- .000	0.937	0.281	6,000	66"
E125S135GYNA80T	1 1/4"	13.5	1.660	+/- .008	0.123	+.020/- .000	1.394	0.263	8,000	96"
E125S040GYNA80T	1 1/4"	40	1.660	+/- .008	0.140	+.020/- .000	1.360	0.299	8,000	96"
E125S080GYNA80T	1 1/4"	80	1.660	+/- .008	0.191	+.023/- .000	1.258	0.387	8,000	96"
E150S135GYNA60T	1 1/2"	13.5	1.900	+/- .010	0.141	+.020/- .000	1.598	0.342	6,000	96"
E150S040GYNA60T	1 1/2"	40	1.900	+/- .010	0.145	+.020/- .000	1.590	0.357	6,000	96"
E150S080GYNA60T	1 1/2"	80	1.900	+/- .010	0.200	+.025/- .000	1.480	0.468	6,000	96"
E200S135GYNA30T	2"	13.5	2.375	+/- .012	0.176	+.021/- .000	2.002	0.529	3,000	96"
E200S040GYNA30T	2"	40	2.375	+/- .012	0.154	+.020/- .000	2.049	0.479	3,000	96"
E200S080GYNA30T	2"	80	2.375	+/- .012	0.218	+.026/- .000	2.041	0.644	3,000	96"
E250S135GYNA20T	2 1/2"	13.5	2.875	+/- .014	0.213	+.026/- .000	2.424	0.790	2,000	96"
E250S040GYNAXSP	2 1/2"	40	2.875	+/- .014	0.203	+.024/- .000	2.444	0.750	-	STICK PIPE
E250S080GYNA20T	2 1/2"	80	2.875	+/- .014	0.276	+.026/- .000	2.290	0.990	2,000	96"
E300S135GYNA10T	3"	13.5	3.500	+/- .018	0.259	+.031/- .000	2.951	1.150	1,000	96"
E300S040GYNAXSP	3"	40	3.500	+/- .018	0.216	+.025/- .000	3.043	0.970	-	STICK PIPE
E300S080GYNA10T	3"	80	3.500	+/- .018	0.300	+.036/- .000	2.864	1.310	1,000	96"
E400S135GYNA05T	4"	13.5	4.500	+/- .023	0.337	+.040/- .000	3.786	1.869	500	96"
E400S040GYNAXSP	4"	40	4.500	+/- .023	0.237	+.028/- .000	4.006	1.386	-	STICK PIPE
E400S080GYNA05T	4"	80	4.500	+/- .023	0.337	+.040/- .000	3.786	1.869	500	96"
E500S135GYNA50T	5"	13.5	5.563	+/- .028	0.412	+.049/- .000	4.690	2.897	500	114"
E500S080GYNAXSP	5"	80	5.563	+/- .028	0.375	+.045/- .000	4.764	2.660	-	STICK PIPE
E600S135GYNAX4T	6"	13.5	6.625	+/- .033	0.491	+.059/- .000	5.584	4.120	450	120"
O600S080GYNAXSP	6"	80	6.625	+/- .033	0.432	+.052/- .000	5.702	3.674	-	STICK PIPE

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# HDPE Conduit Part Numbering System

## Power and Communications Conduit

# HDPE Conduit

## Create Pipe Part No.

Following is a guideline on how we create Part Numbers for HDPE pipe.

CREATING HDPE PIPE PART NUMBERS														
1 1/2"			SDR (SOSI)		11		ORANGE		BLACK STRIPE		2,000 FT ON REEL			WITH 1250 WOVEN POLY TAPE
1	5	0	S	S	0	1	1	O	R	B	K	2	0	T
1	2	3	4	5	6	7	8	9	10	1	12	13	14	15
X X X			X X		X X X		X X		X X		X X		X	
CONDUIT SIZE			WALL		TYPE		TYPE		COLOR		STRIPE			
CONDUIT SIZE					TYPE				COLOR		STRIPE		FT PER REEL	
1/2"		050			SDR 9			009			NONE		NA	NON STD XX
3/4"		075			SDR 11			011	BLACK BK		BLACK BK		450 FT X4	
1"		100			SDR 13.5			135	ORANGE OR		ORANGE OR		500 FT 05	
1 1/4"		125			SDR 15.5			155	RED RD		RED RD		550 FT X5	
1 3/8"		137			SIDR 15			015	BLUE BL		BLUE BL		600 FT 06	
1 1/2"		150			SIDR 19			019	GREEN GR		GREEN GR		700 FT 07	
2"		200			SCHD 40			040	BROWN BN		BROWN BN		750 FT X7	
2 1/2"		250			SCHD 80			080	LT. BROWN LB		LT. BROWN LB		766 FT 76	
3"		300							GRAY GY		GRAY GY		800 FT 08	
4"		400							WHITE WH		WHITE WH		1000 FT 10	
5"		500							YELLOW YE		YELLOW YE		2000 FT 20	
6"		600							BEIGE BE		BEIGE BE		2500 FT 25	
8"		800							LAVENDER LV		LAVENDER LV		3000 FT 30	
10"		1X0							PINK PK		PINK PK		3350 FT 33	
									AQUA AQ		AQUA AQ		4000 FT 40	
									BUFF BF		BUFF BF		4500 FT 45	
													5000 FT 50	
													6000 FT 60	
													6500 FT 65	
													7500 FT 75	
													10000 FT 1X	
WALL														
SMOOTH OUT AND IN			SS											
SMOOTH OUT/RIBBED IN			SR											
RIBBED OUT/SMOOTH IN			RS											
RIBBED OUT/ RIBBED IN			RR											
CORRUGATED			CR											

# HDPE Conduit Dimensional Tables

## Power and Communications Conduit

# HDPE Conduit

## Dimensional Tables

### HDPE INNERDUCT PRODUCT SPECIFICATIONS

SDR CONTROLLED BY OUTSIDE DIAMETER AND MINIMUM WALL										SDR CONTROLLED BY INSIDE DIAMETER AND MINIMUM WALL																			
OUTSIDE DIAMETER			WALL THICKNESS		IN SIDE DIAMETER		AVAIL.		STICK PIPE	INSIDE DIAMETER			WALL		OUTSIDE DIAMETER		AVAIL.		STICK PIPE										
SDR / SCH	NOM.	TOL.	MIN.	TOL.	AVG.	LB/FT	S/S	S/R		SDR	NOM.	TOL.	MIN.	TOL.	AVG.	LB/FT	S/S	S/R											
3/4" DIAMETER										1" DIAMETER																			
NOMINAL PIPE SIZE										NOMINAL PIPE SIZE																			
13.5	1.050	+/- .005	0.078	+020/- .000	0.890	0.110	x			15	1.049	+010 /-.020	0.070	+020/- .000	1.209	0.117													
11	1.050	+/- .005	0.095	+020/- .000	0.850	0.128	x			11.5	1.049	+010 /-.020	0.091	+020/- .000	1.251	0.151	x												
NOMINAL PIPE SIZE										NOMINAL PIPE SIZE																			
13.5	1.315	+/- .007	0.097	+020/- .000	1.101	0.170	x	x		9	1.049	+010 /-.020	0.117	+020/- .000	1.303	0.194													
11	1.315	+/- .007	0.120	+020/- .000	1.055	0.200	x	x		1 1/4" DIAMETER																			
SCH 40	1.315	+/- .007	0.133	+020/- .000	1.029	0.221	x	x		15	1.380	+010/- .020	0.092	+020/- .000	1.584	0.196													
9	1.315	+/- .007	0.146	+020/- .000	1.003	0.234	x	x		11.5	1.380	+010/- .020	0.120	+020/- .000	1.640	0.254	x												
SCH 80	1.315	+/- .007	0.179	+021/- .000	0.937	0.281	x	x		9	1.380	+010/- .020	0.153	+020/- .000	1.706	0.326													
NOMINAL PIPE SIZE										NOMINAL PIPE SIZE																			
13.5	1.660	+/- .008	0.123	+020/- .000	1.394	0.263	x	x		1 1/2" DIAMETER																			
SCH 40	1.660	+/- .008	0.140	+020/- .000	1.360	0.299	x	x		11.5	1.610	+015/- .020	0.140	+020/- .000	1.910	0.342	x												
11	1.660	+/- .008	0.151	+020/- .000	1.338	0.313	x	x		9	1.610	+015/- .020	0.179	+020/- .000	1.988	0.440													
9	1.660	+/- .008	0.184	+022/- .000	1.267	0.373	x	x		NOMINAL PIPE SIZE																			
SCH 80	1.660	+/- .008	0.191	+023/- .000	1.258	0.387	x	x		11.5	2.067	+015/- .020	0.180	+022/- .000	2.449	0.558	x												
NOMINAL PIPE SIZE										NOMINAL PIPE SIZE																			
13.5	1.900	+/- .010	0.141	+020/- .000	1.598	0.342	x	x		9	2.067	+015/- .020	0.230	+028/- .000	2.555	0.730													
SCH 40	1.900	+/- .010	0.145	+020/- .000	1.590	0.357	x	x		3" DIAMETER																			
11	1.900	+/- .010	0.173	+021/- .000	1.533	0.408	x	x		15	3.068	+015/- .030	0.205	+020/- .000	3.498	0.915													
SCH 80	1.900	+/- .010	0.200	+024/- .000	1.480	0.468	x	x		11.5	3.068	+015/- .030	0.267	+032/- .000	3.634	1.239	x												
9	1.900	+/- .010	0.211	+025/- .000	1.453	0.485	x			NOMINAL PIPE SIZE																			
NOMINAL PIPE SIZE										NOMINAL PIPE SIZE																			
SCH 40	2.375	+/- .012	0.154	+020/- .000	2.049	0.479	x	x	x	11.5	4.026	+015/- .035	0.350	+042/- .000	4.768	2.110	x												
13.5	2.375	+/- .012	0.176	+021/- .000	2.002	0.529	x	x		CORRUGATED INNERDUCT																			
11	2.375	+/- .012	0.216	+026/- .000	1.917	0.636	x	x		OUTSIDE DIAMETER			WALL		INSIDE DIAMETER														
SCH 80	2.375	+/- .012	0.218	+026/- .000	1.919	0.646	x	x		NOM. SIZE	NOM.	TOL.	MIN.	MAX.	AVG.	LB/FT													
9	2.375	+/- .012	0.264	+032/- .000	1.815	0.760	x			1"	1.400	+030/- .020	0.050	0.080	1.000	0.120													
NOMINAL PIPE SIZE										NOMINAL PIPE SIZE																			
13.5	2.875	+/- .014	0.213	+026/- .000	2.424	0.790	x	x		1 1/4"	1.600	+030/- .020	0.050	0.080	1.250	0.140													
11	2.875	+/- .014	0.261	+031/- .000	2.321	0.940	x	x		1 3/8"	1.660	+030/- .020	0.055	0.080	1.380	0.155													
SCH 80	2.875	+/- .014	0.276	+026/- .000	2.297	0.990	x	x		MICRODUCT																			
NOMINAL PIPE SIZE										NOMINAL PIPE SIZE																			
13.5	2.875	+/- .014	0.213	+026/- .000	2.424	0.790	x	x		OUTSIDE DIAMETER			WALL		INSIDE DIAMETER														
11	2.875	+/- .014	0.261	+031/- .000	2.321	0.940	x	x		NOM. SIZE	NOM.	TOL.	MIN.	TOL.	AVG.	LB/FT													
SCH 80	2.875	+/- .014	0.276	+026/- .000	2.297	0.990	x	x		16 MM	0.630	+/- .005	0.079	+010 /-.000	0.456	0.056	x												
NOMINAL PIPE SIZE										NOMINAL PIPE SIZE																			
SCH 40	3.500	+/- .018	0.216	+025/- .000	3.043	0.970	x		x	<p>Standard and custom colors Available in solid colors and with striping for color coding Product is printed with product description and manufacturing identification Product is printed with sequential footage every 24" Available smooth wall and smooth outside/ribbed inside wall sizes are shown on chart 1", 1 1/4" SDR 13.5 and SDR 11 also available in ribbed outside/ribbed inside wall Produced to the following industry specifications: ASTM F 2160, and D2239 Available in single put ups or multiple sectional reels Produced empty, with pull tape or rope as specified - detectable tape available Standard and custom reel quantities 50", 66", 84", 96", 102", 114" and 120" reels are available RUS Accepted</p>																			
13.5	3.500	+/- .018	0.259	+031/- .000	2.951	1.150	x	x																					
SCH 80	3.500	+/- .018	0.300	+035/- .000	2.865	1.310	x	x																					
11	3.500	+/- .018	0.318	+038/- .000	2.826	1.380	x	x																					
NOMINAL PIPE SIZE																				NOMINAL PIPE SIZE									
SCH 40	4.500	+/- .023	0.237	+028/- .000	4.006	1.386	x		x																				
13.5	4.500	+/- .023	0.333	+040/- .000	3.786	1.869	x	x																					
SCH 80	4.500	+/- .023	0.337	+040/- .000	3.786	1.869	x	x																					
11	4.500	+/- .023	0.409	+049/- .000	3.633	2.160	x	x																					
NOMINAL PIPE SIZE																				NOMINAL PIPE SIZE									
13.5	5.563	+/- .028	0.412	+049/- .000	4.532	2.897	x	x																					
11	5.563	+/- .028	0.506	+061/- .000	4.298	3.487	x	x																					
NOMINAL PIPE SIZE																				NOMINAL PIPE SIZE									
13.5	6.625	+/- .033	0.491	+059/- .000	5.640	4.130	x	x																					
11	6.625	+/- .033	0.602	+072/- .000	5.420	4.970	x	x																					
9	6.625	+/- .033	0.736	+088/- .000	5.065	5.930	x	x																					
NOMINAL PIPE SIZE																				NOMINAL PIPE SIZE									
13.5	8.625	+/- .043	0.639	+077/- .000	7.193	6.980	x		x																				
11	8.625	+/- .043	0.784	+094/- .000	6.869	8.460	x		x																				
NOMINAL PIPE SIZE																				NOMINAL PIPE SIZE									
13.5	10.750	+/- .054	0.796	+096/- .000	8.966	10.920	x		x																				
11	10.750	+/- .054	0.977	+117/- .000	8.562	13.140	x		x																				

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# HDPE Conduit Reel Capacity

## Power and Communications Conduit

# HDPE Conduit

## Reel Capacity



50" REEL	SINGLE RUN	TWO WAY	THREE WAY	FOUR WAY
PRODUCT SIZE	FOOTAGE/REEL	FOOTAGE/REEL	FOOTAGE/REEL	FOOTAGE/REEL
16 MM	10,000'			
3/4" SDR	3,000'			
1" SDR	2,000'			
66" REEL	SINGLE RUN	TWO WAY	THREE WAY	FOUR WAY
PRODUCT SIZE	FOOTAGE/REEL	FOOTAGE/REEL	FOOTAGE/REEL	FOOTAGE/REEL
3/4" SDR	9,000'	8,000'		
1" SDR	6,000'	5,000'		
1 1/4" SDR	3,350'	3,000'		
1 1/2"	2,200'			
2" SDR	1,100'			
84" REEL	SINGLE RUN	TWO WAY	THREE WAY	FOUR WAY
PRODUCT SIZE	FOOTAGE/REEL	FOOTAGE/REEL	FOOTAGE/REEL	FOOTAGE/REEL
3/4" SDR	12,000'	10,000'		
1" SDR	8,000'	7,000'	6,500'	6,000'
1 1/4" SDR	6,000'	5,000'	4,000'	4,000'
1 1/2" SDR	3,500'	3,000'		
2" SDR	3,000'			
2 1/2" SDR	1,500'			
96" REEL	SINGLE RUN	TWO WAY	THREE WAY	FOUR WAY
PRODUCT SIZE	FOOTAGE/REEL	FOOTAGE/REEL	FOOTAGE/REEL	FOOTAGE/REEL
3/4" SDR	15,000'	14,000'		
1" SDR	10,000'	10,000'	9,800'	9,500'
1 1/4" SDR	8,000'	7,800'	7,500'	7,200'
1 1/2" SDR	6,000'	5,600'	5,400'	5,000'
2" SDR	4,000'	3,400'	3,300'	3,200'
2 1/2" SDR	2,000'			
3" SDR	1,000'			
4" SDR	600'			
102" REEL	SINGLE RUN	TWO WAY	THREE WAY	FOUR WAY
PRODUCT SIZE	FOOTAGE/REEL	FOOTAGE/REEL	FOOTAGE/REEL	FOOTAGE/REEL
1" SDR	12,000'	12,000'	12,000'	12,000'
1 1/4" SDR	9,000'	8,800'	8,400'	8,200'
1 1/2" SDR	7,000'	6,800'	6,600'	6,400'
2" SDR	5,000'	4,500'	4,200'	
2 1/2" SDR	2,500'			
3" SDR	1,200'			
4" SDR	800'			
4" SIDR	700'			
114" REEL	SINGLE RUN			
PRODUCT SIZE	FOOTAGE/REEL			
2 1/2" SDR	3,500'			
3" SDR	1,700'			
4" SDR	1,000'			
4" SIDR	900'			
5" SDR	500'			
120" REEL	SINGLE RUN			
PRODUCT SIZE	FOOTAGE/REEL			
4" SDR	1,250'			
4" SIDR	1,100'			
5" SDR	750'			
6" SDR	450'			

# OSI PLASTICS

DIVISION OF **OHIO STEEL**  
INDUSTRIES

## OSI Plastics

Division of Ohio Steel Industries  
2575 Ferris Road, Columbus, OH 43224  
Phone: 614-568-4300 Fax: 614-471-1190

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# HDPE Conduit Truckload Capacity

## Power and Communications Conduit

# HDPE Conduit

## Truckload Capacity

The following chart shows the number of reels of pipe we can load on a standard 48' long flat-bed trailer.

Reel Diameter	Reel Width	Number of Reels per Full T/L
50"	30"	36
66"	45"	16
84"	45"	14
96"	45"	12
102"	45"	12
114"	45"	8
120"	45"	8

Of course we can combine different sizes of reels on a truck.

When 8 reels of 114" or 120" diameter reels are loaded on a truck, an additional 2 reels of 102" or smaller reels can be loaded on the same load on the top deck as seen on the picture below.



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# HDPE Conduit Truckload Capacity

## Power and Communications Conduit

### HDPE Conduit Stick Pipe Bundles

The following chart shows the standard packaging for our HDPE Stick Pipe.



Nominal Pipe Size	Pipe Length (FT)	Pcs/Bulk Pack	Feet/Bulk Pack	# of Bulk Packs/Truck	Total Footage Per Truck
2"	40	99	3,960	12	47,520
3"	40	46	1,840	14	25,760
4"	40	29	1,160	14	16,240
5"	40	45	1,800	6	10,800
6"	40	13	520	14	7,280
8"	40	9	360	10	3,600
10"	40	11	440	6	2,640
2"	50	99	4,950	12	59,400
3"	50	46	2,300	14	32,200
4"	50	29	1,450	14	20,300
5"	50	45	2,250	6	13,500
6"	50	13	650	14	9,100
8"	50	9	450	10	4,500
10"	50	11	550	6	3,300
2"	20	99	1,980	24	47,520
3"	20	46	920	48	44,160
4"	20	29	580	48	27,840
5"	20	45	900	12	10,800
6"	20	13	260	28	7,280
8"	20	9	180	20	3,600
10"	20	11	220	12	2,640

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## HDPE Conduit Reel Return Policy

### Power and Communications Conduit

## HDPE Conduit Reel Return Policy



For information on recycling/returning steel reels please contact your salesman or our office.

We are able to use only usable, undamaged, complete reels. We cannot accept reels that are flattened, have structural damage or have components missing.

We can only use the following size reels: 50", 66", 84", 96", 102", 114" and 120".

Reels may be returned complete or broken down. All reels are to be shipped pre-paid. Customer is responsible for loading, shipping the reels. Collect shipments are not accepted.



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# HDPE Conduit MSDS Sheet

## Power and Communications Conduit

# HDPE Conduit

## MSDS

### MATERIAL SAFETY DATA SHEET –TECHNICAL BULLETIN

Customer satisfaction and safety are top priorities to OSI Plastics. We are providing this information regarding our products as part of this commitment.

This document is provided to clarify the need for Material Safety Data Sheets for the products OSI Plastics Manufactures.

In accordance to the Hazard Communications Standard of the Occupational Safety and Health Administration, MSDS's are required for all hazardous chemicals: however, the Standard specifically exempts all "Articles" from this requirement 29 CFR 1910.1200.

"Articles" by definition of the Standard, "means a manufactured item other than a fluid or particle:

- (i) which is formed to a specific shape or design during manufacture,
- (ii) has end use functions dependent in whole or in part upon its shape and design during end use, and
- (iii) which under normal conditions of use does not release more than very small quantities, e.g., minute or trace amounts of hazardous chemical (as determined under paragraph (d) of this section), and does not pose a physical hazard or health risk to employees".

Based on the best of our knowledge, our products are "Articles" according to the above definition, and are therefore exempt from MSDS requirements.

If you require any additional information, please contact our customer service: 614-568-4300 ext. 213.



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# HDPE Conduit Material Handling Guide

## Power and Communications Conduit

# HDPE Conduit

## Material Handling

The Plastic Pipe Institute provides complete guidelines and safety information on how pipe and fittings should be handled in their Material Handling Guide: [http://plasticpipe.org/publications/material-handling\\_guide.html](http://plasticpipe.org/publications/material-handling_guide.html).

## INTRODUCTION

Polyethylene pipe and fittings have been used safely in thousands of applications. Still, there are precautions that should be adhered to when handling any product, and polyethylene pipe and fittings are no exception.

This material handling guide covers a wide range of safety issues regarding the handling, loading and installation of polyethylene pipe and fittings. Job site safety, storage guidelines, unloading guidelines, heat fusion joining and installation guidelines are just a few of the important topics covered in this guide.

As valuable as this guide may be, it does not purport to address all of the product applications or construction practices that could be used, nor all of the safety practices necessary to protect persons and property. It is the responsibility of the users of this guide and the installers of polyethylene piping systems to establish appropriate safety and health practices and to determine the applicability of regulatory limitations before any use or installation.

## PERSONAL PROTECTIVE EQUIPMENT

When handling pipe and other materials, the first step to protect yourself from injury is to wear adequate personal protective equipment. Personal protective equipment such as hard hats and steel-toed safety shoes help prevent injuries from heavy falling objects and rolling pipe.

Hard hats should be worn when loading or unloading PE pipe and fittings in storage areas, pipe yards and other areas where overhead hazards and low overhead clearance exist. At job sites, hard hats not only protect your head, but also give motorists an eye-level warning of your presence. As a general rule, steel-toed safety shoes should be worn at all times. They are especially important if there is any possibility that falling objects could land on your feet or when using pneumatic tools such as pavement breakers and tampers.

Work gloves help prevent cuts and bruises from sharp or rough edges on pipe, fusion equipment and other objects. When moving or lifting boxes, pipe drums and other heavy items, place your hands carefully to avoid getting them pinched or caught.

Wear high-visibility vests when working at or near a public street or highway or when working at night. This reduces your chance of being hit by a vehicle passing the job site.

## JOB SITE SAFETY

Numerous hazards exist on the job site. While no summary of safe working practices can cover all aspects of safety, there are a number of important guidelines that should be followed.

Before work begins at the job site, the potential hazards should be identified. Check the work site for hazards created by unguarded machinery, chemicals and fuels, heat, excessive noise, nearby equipment, buried pipes and /or power lines. Many hazards are difficult to identify. Materials, equipment, and the work environment should all be considered. Specific plans should be made to minimize such hazards. Documenting these plans and posting them in a public place may be beneficial to those involved in the operations.

Field personnel should avoid working alone or arrange for periodic safety contacts. If injured, a co-worker can assist you or call for emergency medical service.



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# HDPE Conduit Material Handling Guide

## Power and Communications Conduit

# HDPE Conduit

## Material Handling

### LOADING, UNLOADING AND TRANSPORTING PE PIPE AND FITTINGS

The truck must be parked on level ground. The parking brake (hand brake) should be set and the wheels chocked. It is preferred that the truck be shut off and left in gear. The location of the driver should be known at all times.

### POWER LIFTING EQUIPMENT

A wide variety of Power Lifting Equipment is available. When operated properly, Power Lifting Equipment can be used safely to load, unload and transport pipe. The selection of the right type of equipment will depend on a number of factors including project requirements, availability, preference, cost and terrain. Most pipe producers use large and small forklifts in their yards. Smaller forklifts accommodate the tight corners encountered around stacked piles. Most distribution yards also use forklifts to load and offload pipe. However, job site requirements are extremely variable, and equipment selection will vary as well.

### GUIDELINES FOR PALLETIZED/NON-PALLETIZED COILS

Trailer must be level before straps or bands are removed and the coils unloaded. Do not push, pull or roll coils off of the truck. Never stand behind, under or around the load as it is being unloaded. Do not remove straps until sling is secured. If coils are in silos do not push or pull the silo pack off the end of the truck with a lift truck. Chocks should never be removed before unloading the truck. Before lifting, load should be centered and forks positioned at the widest position under the load for correct stability. When carrying loads large enough to block view, travel in reverse with load close to the ground. Carry all loads close to the ground. When traveling on grade with a load, travel with counterweight in the direction of travel. Use extra caution in uneven areas of pavement and reduce speed to cross the areas safely. Forklift safety rules are to be observed during all phases of the unloading process. Never leave forklift running unattended.

### GUIDELINES FOR STRAIGHT LENGTHS

#### Loading Bundles to a Flatbed Trailer

Hard-side bundles should be offset “wood-on-pipe” during transportation. A transport strapping policy should establish minimum requirements regarding the number of truckers’ straps used by all transportation providers to secure bundles. The policy should also contain conditions regarding the tightening of straps after a carrier leaves a manufacturing facility.

#### Unloading Bundles from a Flat-Bed Trailer

People not involved in the unloading process should remain clear of the unloading area. There should be adequate space on both sides of the trailer.

The truck must be parked on level ground. The parking brake should be set and the wheels chocked.

Only after checking that the load has not shifted should the truck driver remove the nylon straps securing the load to the trailer. Caution should be taken when straightening shifted loads before unloading.

Bundles should be unloaded with fork trucks or cranes equipped with spreader bars with at least three wide web slings. The equipment should be sufficiently rated to safely handle the load.



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## Material Handling

Bundles may be stacked and individually strapped to the truck. In such a case, the bulk packs should be unloaded one at a time from the top, taking care to remove only the straps over the pack being unloaded.

When using fork trucks, the bundles should be picked up one at a time under their midpoint. For load stability, the forks should be as far apart as possible. Forks should have sufficient length to safely support the bundles.

The forks should enter the load slowly to reduce the possibility of pipe damage caused by scraping or gouging. The potential for damage can be further reduced if steel forks are covered by protective material.

If a crane with a single sling is used to unload the bundles, the lengths should be handled at their midpoints using wide web slings. If multiple slings or a spreader bar equipped with wide web slings are used, the equipment manufacturer's recommended capabilities, methods, and procedures should be used.

Steel bands used on bundles should not be removed until the bundles have been transported to the storage area and secured in a stable and safe manner.

Finally, never stand on a load of pipe. Standing on the load is extremely dangerous. Do not roll or drop pipe off the truck. Do not use backhoes, end loaders, or other material handling equipment to push or pull the load off the trailer. This is dangerous to unloading personnel and may damage pipe.

## UNLOADING LOADS FROM A FLAT-BED TRAILER

People not involved in the unloading of the trailer should remain clear of the unloading area. The operator must have adequate room on both sides of the trailer.

When unloading with a forklift, a second truck (or some other means) should be placed on the opposite side to the unloading equipment to prevent pipe from being pushed from the truck.

## INDOOR/OUTDOOR STORAGE

Since black HDPE pipe generally contains greater than 2% carbon black, it will resist damage from sunlight. Colored products are compounded with antioxidants, thermal stabilizers and UV stabilizers. These UV stabilizers will eventually be depleted; therefore, non-black products should remain in unprotected outdoor storage for no more than one year. Black products with stripes are generally suitable for unprotected outdoor storage and service.

Expansion and contraction caused by uneven heating in the sun may cause the pipe to bow if not restrained by racks. This does not damage the pipe but may be inconvenient when the pipe is taken out of storage for installation.

## INSTALLATION SAFETY GUIDELINES

Job site safety begins with personal safety. Personal protective equipment, hazard identification, and emergency preparation are essential safety elements at the installation site.

Ice, snow and rain are not harmful to polyethylene components but may make the job site more troublesome for handling equipment and personnel. Unsure footing and traction require greater care and caution to prevent damage or injury. Inclement weather can make pipe surfaces slippery. It is generally a good idea not to walk on PE pipe, but this is especially true when your footing is unsure.



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# HDPE Conduit Material Handling Guide

## Power and Communications Conduit

### HDPE Conduit Material Handling

#### CUTTING PE PIPE

When cutting the pipe with chain saws or other power equipment, keep your feet in the clear and block the pipe so it will not move during cutting. Wear protective equipment and never leave tools lying about. Cutting shears or guillotines blades are available for pipe eight inches and smaller. Hand-held tubing cutters are also available for pipe and tubing less than or equal to four inch nominal.



The pipe is under tension when it is coiled on the reels. When cutting the pipe, make sure the pipe is secured to the reel to avoid the pipe snapping back and causing injury. Be especially careful with larger size product.

#### JOINING PE PIPE AND FITTINGS

For detailed joining information, refer to "Polyethylene Joining Procedures" a chapter of the PPI "Handbook of Polyethylene Pipe" and/or ASTM D2657. Reference also TR-33 "Generic Butt Fusion Joining Procedure for Polyethylene Gas Pipe" and TN-11 "General Guidelines for the Heat Fusion of unlike Materials" may be available in individual chapters.

A detailed safety guide should be obtained from the fusion equipment manufacturer. Operators should read this document carefully before fusing pipe or fittings. If not used properly, blades, pinch points, heaters and moving parts on the fusion equipment can cause injury. As mentioned earlier, caution should be taken with heater plates as temperatures may exceed 400°F.

#### PIPE OVALITY

Pipe coiled on reels will flatten out and cause the pipe to ovalize. The larger the pipe diameter, the more the pipe is affected. Re-rounding in the field is recommended for pipe larger than 3" as needed.

The Plastic Pipe Institute addresses this issue in MS-5/2005 in section 2.4.2 where it is stated that where ovality in coiled 4" or larger diameter conduit and casing is largely a packaging condition where greater than 15% ovality shall be corrected in the field by processing the roundable conduit through re-rounding and straightening equipment during installation.

Generally pipe extruded and packaged as a stick pipe, will not exhibit the ovality issues inherent in pipe coiled on steel reels or coiled without reels.

Based on the ASTM and PPI standards and our own experience, following is the accepted ovality of the pipe coming off the reels:

2" and smaller	7%
2" to 3"	10%
4" and over	15%
6"	20% plus

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# HDPE Conduit Material Handling Guide

## Power and Communications Conduit

# HDPE Conduit

## Unloading Guide

### WARNING!

**GIVE THESE INSTRUCTIONS TO UNLOADING PERSONNEL  
WHEN ARRIVING AT THE DELIVERY SITE!**

### UNLOADING GUIDELINES FOR POLYETHYLENE PIPE/DUCT FREE- STANDING COILS AND REELS

1. Make sure truck is parked on level ground. If not, have driver move truck to a level area. Engage hand brakes and chock wheels.
2. People not involved in the unloading of the trailer and the truck driver should remain clear of the unloading area.
3. The trucker's chains or straps should be removed from the load only after checking that the load has not shifted and will remain stable. Use caution straightening shifted loads.
4. It is suggested that silo packs be unloaded from the side of the trailer with a forklift having a capacity rating sufficient to handle the load. The equipment should be inspected for condition prior to use.
5. Most trailers have a natural downward slope from the front of the trailer to the rear. It is suggested to begin unloading from the front to allow the strapped reels or coils to stay in place.
6. Chains should not be applied directly to pipe/duct unless special precautions are used to prevent damage to duct. Chains should be properly rated for the loads being lifted. When lifting reels with chains, do not lift by the flange rings. Thread the chain through the arbor holes. Nylon straps should never be threaded through the arbor holes because the strap may be cut by the arbor plate.
8. If using a forklift to unload free-standing coils or reels, raise the carriage until the forks will prevent the loaded pipe/duct from moving when the shipping straps are removed. For lifting coils, place forks on inside surface of coil; for reels, cradle reel flanges from below between the forks. Tilt forks slightly upward before they are unstrapped. After coils or reels are off the truck, place the load on level ground and chock them to prevent moving before removing forks or slings.
9. Do not roll or drop reels or coils off the truck!
10. Do not use backhoes, end loaders, or other material handling equipment to push or pull the load off the trailer. This is dangerous to unloading personnel and may damage the pipe/duct.

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# HDPE Conduit Material Handling Guide

## Power and Communications Conduit

# HDPE Conduit

## Unloading Guide

### WARNING!

**GIVE THESE INSTRUCTIONS TO UNLOADING PERSONNEL  
WHEN ARRIVING AT THE DELIVERY SITE!**

### UNLOADING GUIDELINES FOR PALLET/SKID PACK POLYETHYLENE PIPE/DUCT

1. Make sure truck is parked on level ground. If not, have driver move truck to a level area. Engage hand brakes and chock wheels.
2. People not involved in the unloading of the trailer and the truck driver should remain clear of the unloading area.
3. The trucker's chains or straps should be removed from the load only after checking that the load has not shifted and will remain stable. Use caution straightening shifted loads.
4. It is suggested that pallet/skid packs be unloaded from the side of the trailer with a forklift having a capacity rating sufficient to handle the load. The equipment should be inspected for condition prior to use.
5. The forks should have sufficient length to safely support the pallet/skid pack during unloading and transportation to the storage area.
6. To prevent possible injury or damage, the forks should slowly enter the pack between the top and bottom boards of the pallet.
7. Steel bands used on silo packs should not be removed until the silo packs have been transported to the storage area and secured in a stable and safe manner.
8. Avoid unnecessary standing on the load. Do not remain on the load during unloading operations!
9. Do not use backhoes, endloaders, or other material handling equipment to push or pull the load off the trailer. This is dangerous to unloading personnel and may damage the pipe/duct.



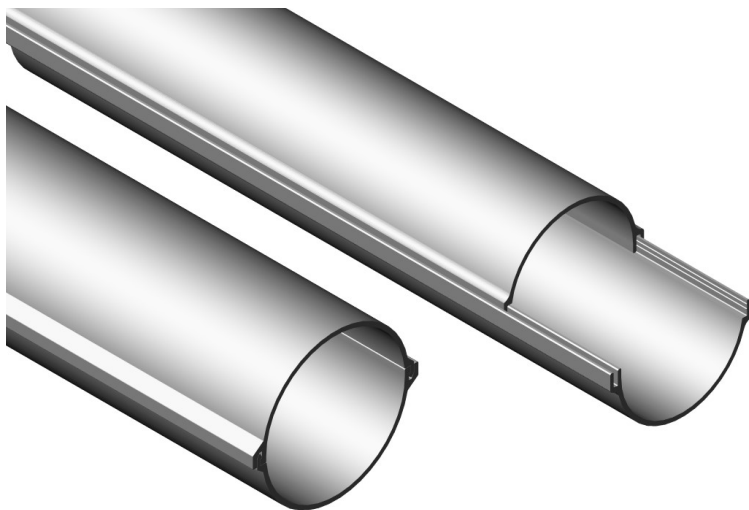
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## PVC Split Duct

For Power, Communications and CATV Repairs

### PVC PVC Split Duct



- Available in 3 1/2" and 4" diameter sizes.
- Standard color: white.
- Standard length: 10' long pieces bundled and palletized.
- Custom colors and lengths available.
- RUS Listed

For enclosing fiber optics and cables, installing conduit around existing cable, or repairing sections of damaged conduit.

When snapped together, the unique interlocking design of our PVC SPLIT CONDUIT provides a smooth, tight seal protecting the cable or fiber optics from weathering. No tape, plastic, or metallic straps are needed to seal or provide extra strength to the SPLIT CONDUIT.

DESCRIPTION	LENGTH	WALL	FT/BUNDLE	WT/BUNDLE	FT/PALLET	WT/PALLET
3 1/2" PVC SPLIT DUCT	120"	1/8"	50'	48#	1,000'	970#
4" PVC SPLIT DUCT	120"	1/8"	50'	50#	1,000'	1,020#

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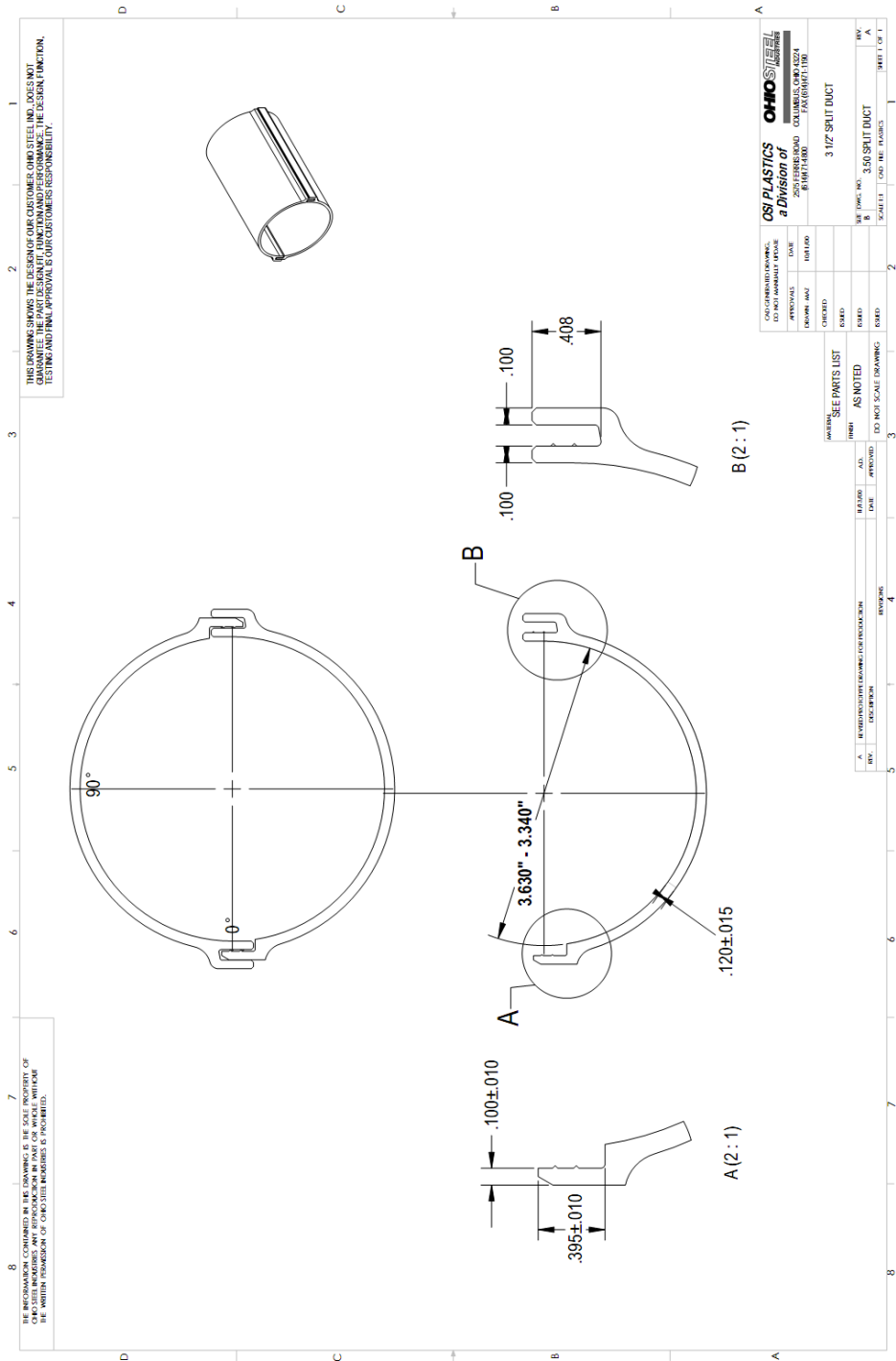


# PVC Split Duct

For Power, Communications and CATV Repairs

PVC

3 1/2" PVC Split Duct



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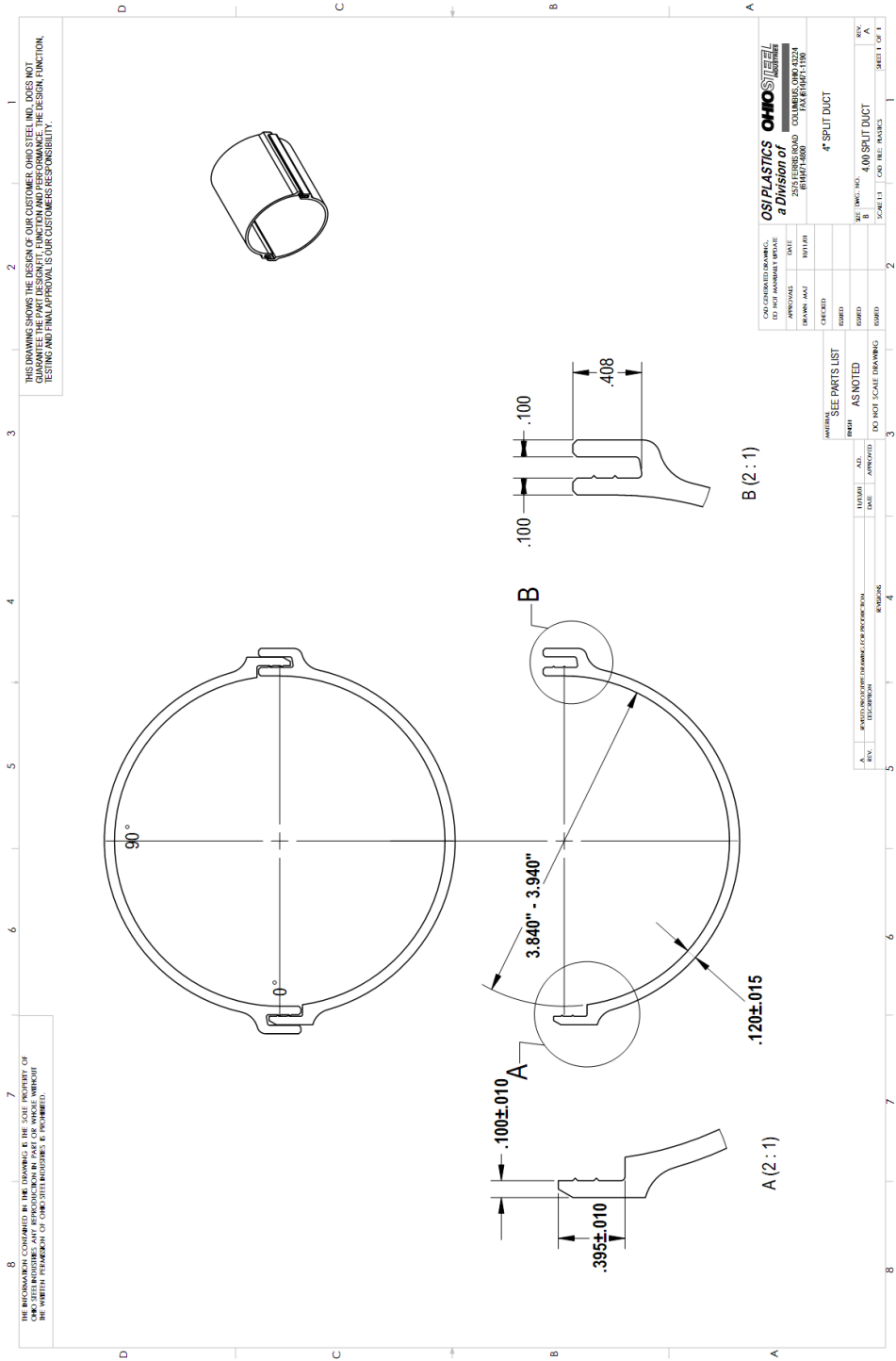
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# PVC Split Duct

For Power, Communications and CATV Repairs

PVC

4" PVC Split Duct



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## ST-14 Ga. Split Steel Conduit

For Power, Communications and CATV Repairs

**STEEL**

**ST-14 GA Split Steel**



### Primary Uses:

- \* Under bridge applications
- \* Vandal protection
- \* Crush resistant applications
- \* Temporary and emergency cable protection
- \* Buried/maintenance applications

### 14 GA Split Steel Advantages:

- \* Light weight
- \* Galvanized for weather protection
- \* Bolts and nuts are stainless steel to reduce corrosion and to help opening
- \* One end of the conduit is belled to eliminate the need for a coupling

### AVAILABLE SIZES

Part #	Size	OD	ID	Wall	Length	Weight/ft
ST-2.5	2 1/2"	2 5/8"	2 1/2"	14 GA	10'	2.6
ST-4	4"	4 1/8"	4"	14 GA	10'	4.2

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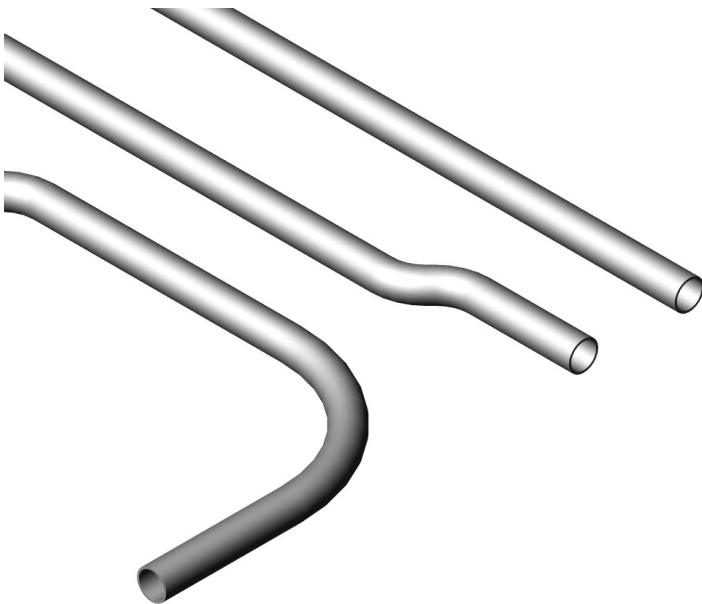
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## Standard PVC Houserisers For Telecommunications and CATV



### PVC Standard Houserisers



7/8" OD	DESCRIPTION	LENGTH	OFFSET	NOTCH	PCS/ CTN
12-119-1	7/8" OD STRAIGHT HOUSERISER W/CLAMPS	60"	x	x	60
12-119-2	7/8" HOUSERISER W/18" L-BEND W/CLAMPS	78"	7/8"	YES	30
12-119	7/8" OD STAND. HOUSERISER W/CLAMPS	60"	7/8"	YES	60
14-44	7/8" CLAMP	x	x	x	100
1 1/4" OD	DESCRIPTION	LENGTH	OFFSET	NOTCH	PCS/ CTN
14-54	1 1/4" CLAMP	x	x	x	100
12-219	1 1/4" OD HOUSERISER W/CLAMPS	60"	7/8"	YES	60

**RUS LISTED**

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## HDPE Conduit Warranty

### Power and Communications Conduit

## HDPE Conduit Warranty

### LIMITED WARRANTY

OSI Plastics, Division of Ohio Steel Industries, Inc. warrants that this product is manufactured in compliance with applicable material specifications and are free from manufacturing defects. The limit of this liability for failure of this product to meet said material specifications (or breach of other warranties) express or implied shall be the replacement of an equivalent amount of product alleged/reported to be defective and returned to Ohio Steel Industries, Inc. within 12 months from the date of shipment and found to be defective by us.

Due to the broad spectrum of conditions under which Ohio Steel Industries, Inc. plastic products are installed and used, Ohio Steel Industries, Inc. offers no warranty either expressed or implied as to the product's suitability or length of service for any specific purpose. In no event shall Ohio Steel Industries, Inc. (or its authorized representatives) be liable for consequential damages. This warranty does not extend to any product or damage to a product caused by the attributable freight damage, abuse, misuse, improper or abnormal usage or alterations not authorized by Ohio Steel Industries, Inc. This warranty does not cover damage due to incorrect installation, excessive pulling tension, burn through from pull lines or rope, exposure to chemicals and use of lubricants soap or pipe dope. No other warranty beyond that specifically set forth above is authorized.

Ohio Steel Industries, Inc. is not responsible or liable for bodily injury indirect, special or consequential damages arising out of or in connection with the use or performance of this product or other damages with respect to any economic loss, loss of property, loss of profits, loss of use, costs of removal, installing or other consequential damages of whatsoever nature. Some states do not allow the exclusion or limitation of incidental or consequential damages. Accordingly, the above limitations may not apply to you.

The limited warranty extended hereunder is in lieu of any and all other warranties and any implied warranties of merchantability or fitness for a particular purpose is limited in its scope and duration to the terms set forth herein. Some states do not allow limitation on how long an implied warranty lasts. Accordingly, the above limitation may not apply to you.



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# HDPE Conduit Terms and Conditions

## Power and Communications Conduit

### Terms & Conditions

#### TERMS AND CONDITIONS

All purchase orders submitted by the customer pursuant to this quotation, and accepted by OSI Plastics, A Division of Ohio Steel Industries, Inc., are subject to the following terms and conditions which are an integral part of this quotation and shall govern whether and wherever they modify, conflict with, or contradict the printed form provisions of the customer's purchase orders.

#### ACCEPTANCE OF CONTRACT TERMS

1. Quotation is based on the specifications supplied if written, or if verbal on the information given and as interpreted by the correspondent. This quotation is offered for acceptance within 30 days from the date thereof, and being dependent upon market conditions, is subject to change without notice.
2. The customer's acceptance of the quotation by customer's purchase order or otherwise, constitutes a contract subject to the terms and conditions set forth herein, and said contract shall not be changed, canceled, altered or suspended, except by our written consent and upon terms and/or with payments that will indemnify and protect us against loss.
3. No variation of these terms and conditions, by customer's purchase order or otherwise, is authorized or valid unless made in writing and signed by or on behalf of OSI Plastics, a Division of Ohio Steel Industries, Inc by the General Manager at its office in Columbus, Ohio.
4. This quotation is subject to correction for clerical and typographical errors.
5. We reserve the right to over-ship ten (10%) percent of the specified amount of the order, the difference to be paid for or allowed at the prevailing price.
6. Prices include standard packaging unless otherwise stated.

#### DELIVERY

8. Performance and delivery pursuant to this quotation are subject to interruptions and delays due to strikes, fire, acts of God, acts of terrorism, accidents, and other causes beyond our control.
9. Prices are subject to change without notice.

#### CREDIT

10. All contracts and orders are subject to credit approval and to our written acceptance, we may, at any time, alter or suspend credit, refuse shipment or cancel unfilled orders when in our opinion the financial condition of the purchaser, or the status of his accounts warrants it, or when delivery is delayed by the fault of the purchaser, or the purchaser is delinquent in any payment.

#### ORDER CHANGES

11. Alterations in dies, approval of samples, changes in delivery specifications, and instructions of every kind must be submitted to us by the customer in writing and accepted by us in writing.

#### SAMPLES

12. Samples submitted by us for customer's approval shall be deemed approved if notice of rejection is not received within ten (10) days after date of delivery thereof by us to the carrier. No production quantities will be run on any new or reworked die without written approval from the customer of sample parts run from such die.

#### PRODUCT LIABILITY

13. A drawing provided by the Customer is the design desired by the customer. Nothing herein should be considered to be a warranty of any kind with respect to the, actual performance of any part made in accordance with this drawing. The ultimate design, testing and selection of materials for construction of such parts rest solely with the customer. OSI Plastics, a Division of Ohio Steel Industries, Inc. disclaim all expressed and implied warranties, including the implied warranties of merchantability and fitness for a particular purpose.
14. Our liability for defective products or parts shall be limited to the value thereof and credit in full shall be rendered on all such products or parts provided that we have had an opportunity to inspect them and authorize their return within 15 days after date of shipment to you. No credit will be issued on any products or parts, which have been altered or defaced in anyway, or upon which any additional operation has been performed. We will not assume liability, or be responsible for products or parts lost or damaged in transit.

#### PATENT INFRINGEMENT

15. It is expressly understood and agreed that the products or parts furnished pursuant to this quotation and customer's accepted order do not infringe any patents, and we claim protection from any claims or suits resulting from infringement of patents on the part of the customer, who shall indemnify and save us harmless therefrom, and we are not to be held responsible or liable for the artistic, mechanical, functional, or practical advantages or disadvantages in design or construction of said products or parts.



**OSI Plastics**  
 Division of Ohio Steel Industries  
 2575 Ferris Road, Columbus, OH 43224  
 Phone: 614-568-4300 Fax: 614-471-1190

[www.osiplastics.com](http://www.osiplastics.com)



# HDPE Manufacturing Quality Assurance

## Power and Communications Conduit

### HDPE Conduit

#### Quality Assurance

#### QUALITY CONTROL/QUALITY ASSURANCE TESTING

The three phases of quality control for our HDPE pipe involve the following:

##### Testing the incoming resin:

The incoming HDPE resin is checked for contamination and melt flow rate. Our suppliers test our resin for density. If the resin does not meet our criteria, the resin is not used in our process.

##### Testing during the manufacturing phase:

During the extrusion process, our operators check the pipe per our production specifications. The results of these inspections and tests are recorded and retained in our quality files. The shift supervisor double checks each operator at an hourly bases minimum.

##### Testing and inspection after the product has been produced:

After the product has been produced, it goes through additional tests and checks before it is released for shipment.

Following are some of the criteria that is being checked:

##### Workmanship, Finish and Appearance

According to ASTM product specifications, the pipe shall be homogeneous throughout and free of visible cracks, holes, foreign substances, blisters and dents or other injurious defects. The pipe shall be as uniform as commercially practicable in color, opacity, density and other physical properties.

##### Dimensions

Pipe diameter, wall thickness, ovality and length are measured on a regular basis to insure compliance with the prevailing specifications.

##### Physical Properties

Several tests are conducted to ensure that the final pipe product complies to the applicable specification.



# OSI PLASTICS

DIVISION OF **OHIO STEEL**  
INDUSTRIES

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## HDPE Conduit Sales Contacts

Power and Communications Conduit

## HDPE Conduit Contact Information

### *OSI Plastics—Sales Contact Information*

#### *HDPE Innerduct & Telecom Accessories*

#### ***EH Enterprises*** ***Eric Hall***

ehall@ironhed.com

***Sales Contact******OH, IN, FL and Northeast******Phone: 614-414-0737******Fax: 614-414-0738******Cell: 614-284-3005***

#### ***Plastic Resources*** ***Teri Meister***

TeriM@plastic-resources.com

***Inquiries, Quote Requests  
And Scheduling******Toll Free: 800-652-2321 ext. 210******Phone: 614-471-4804 ext. 210******Fax: 614-471-0283***

#### ***Anthony Seipel***

tony@plastic-resources.com

***Selected Customer Contact******Phone: 614-471-4804 ext. 215******Fax: 614-471-0283******Cell: 614-561-0061***

#### ***Plant Contacts***

***Phone: 614-568-4300******Fax: 614-471-1190***

#### ***Jon Van Gundy ext. 172***

***Direct: 614-568-4301***

JVanGundy@ohiosteel.com

***General Manager******Sales & Technical Info.******In all Areas******Gary Stewart ext. 224***

GStewart@ohiosteel.com

***Project Manager******Tawnia Burgett ext. 213***

TBurgett@ohiosteel.com

***Customer Service******Tom Anderton ext. 227***

TAnderton@ohiosteel.com

***Plant Superintendent******Kevin Cahalan ext. 241***

KCahalan@ohiosteel.com

***Quality Control******Shipping & Receiving  
ext. 225******Robert Hays ext. 217***

RobtHays@ohiosteel.com

***VP, Director of Finance  
& Admin.***

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DIVISION OF **OHIO STEEL**  
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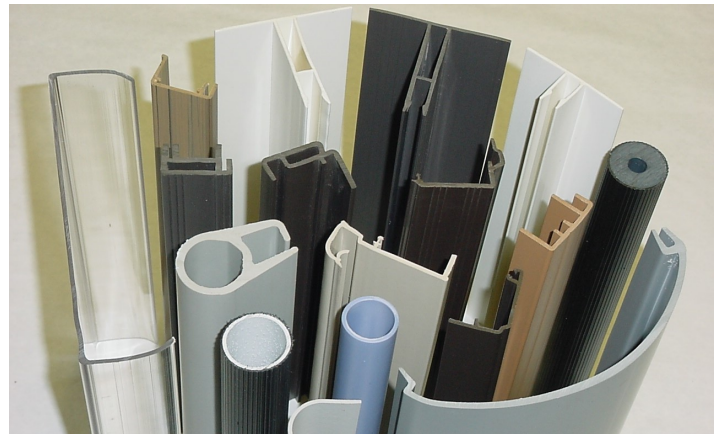
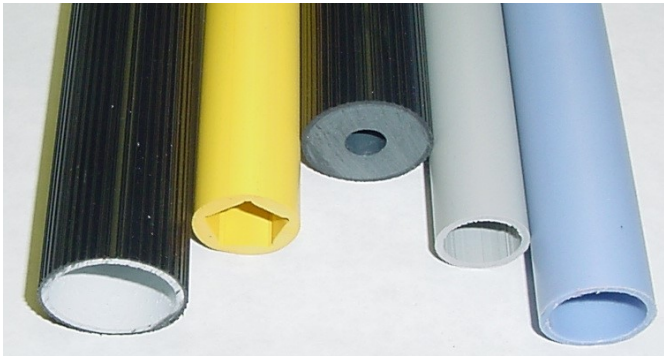
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## Custom Plastic Profile Extrusions

### HDPE Conduit Catalog

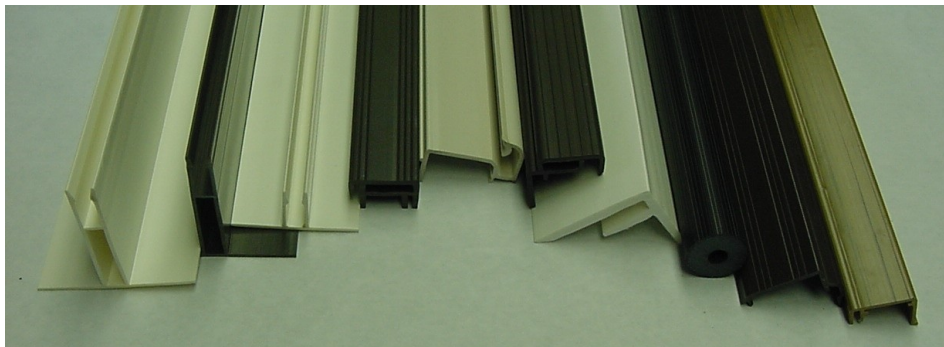


We at OSI Plastics also produce *custom plastic profile extrusions*. If you have a need for a custom part, please let us know.

We extrude rigid, co-extruded PVC, polyethylene, polypropylene, polystyrene and other thermoplastics materials. We run co-extrusion of dual durometers and different color materials. Custom coloring, in-line and off-line fabrication, tape application, hot stamp foil application, assembly and custom packaging are part of our value added processes.

Equipment is available for short and long runs, small and large parts in a wide variety of materials. Our facility and processes are ISO 9001: 2015 registered.

Please e-mail, fax or send us your drawing for us to quote. You may also send your sample for us to look at.



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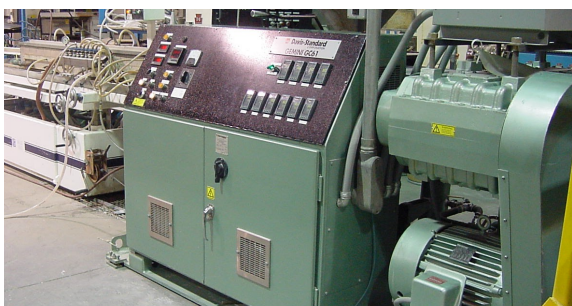
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## HDPE Conduit Catalog



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