

	UNDERGROUND CONDUITS	062288
Asset Type: Electric Distribution	Function: Design and Construction	
Issued by: Lisseth Villareal (LDV2) 	Date: 07-02-26	
Rev. #24: This document becomes active on 09-02-26 For a description of the changes, see Page 28.		

Purpose and Scope

This document covers steel and plastic conduit for electric underground installations, with or without concrete encasement.

Definitions

Elbows: factory bends of any degree.

Factory elbows or bends: produced at conduit manufacturers per industry standards.

General Information

1. Applications for underground conduit are as follows:
 - A. Residential: All residential conduit installations should be made without concrete encasement.
 - B. Light Commercial, Industrial, and Underground Residential Distribution (URD) Feeder: Installation of circuits of this type, which are three-way or less, should normally be made without concrete encasement. In densely populated urban areas, conduit banks involving more than three primary conduits may require concrete encasement.
 - C. Severe exposure to “dig-ins” and other hazards may require concrete encasement of conduit lines.
 - (1) Conduit separation for concrete encasement of conduit lines using spacers to avoid obstacles is illustrated on Page 20.
 - (2) Conduit separation for concrete encasement of conduit lines terminating into a manhole or vault, is illustrated on Page 21.
 - (3) Concrete encasement conduit configuration is illustrated on Page 22.
2. For the minimum design requirements for trenches and conduits installed in PG&E electric distribution system see [Document 038193](#). Trench requirements previously listed in this document have been moved to [Document 038193](#).
3. For the design requirements of conduits installed specifically on bridges see Utility Procedure TD-2310P-10.
4. For the application, installation, recommendation and requirements of cable-in-conduit (CIC) see Utility Procedure TD-2312P-01.
5. In April of 2020, PG&E stopped purchasing rigid Polyvinyl Chloride (PVC) DB-120 for conduits, couplings, fittings, and bends for installation in its electric distribution system. After April 2020 PG&E purchases rigid single wall or co-extruded cellular core wall PVC Schedule 40 conduits, couplings, fittings and bends as the standard conduit type for open trench installations.
6. Rigid single wall or co-extruded cellular core wall PVC Schedule 40 conduits, couplings, fittings, and bends are interchangeable with rigid PVC DB-120 conduits, couplings, fittings, and bends, respectively. This interchangeability is possible because DB-120 and rigid PVC Schedule 40 materials have the same outside diameters. Refer to Note 9 on Page 2 for chamfering requirements.

General Information (continued)

7. When conduit, including service conduit, is to be installed for PG&E by others, the conduits must meet the requirements listed in this document. The conduits listed below are also acceptable alternatives to the required Rigid single wall or co-extruded cellular core wall PVC Schedule 40. For conduit installation under piers, hanging on bridges, or highly corrosive environment check with local authority jurisdiction since some cities and countries may have preference on which of the approved conduits (C or D) to use.
 - A. Single wall and co-extruded cellular core wall PVC Schedule 80, UL 651 approved conduit that is so marked.
 - B. Hot-dip galvanized rigid steel conduit conforming to American National Standards Institute (ANSI) Specification C80.1.
 - C. PVC coated steel conduit and fittings conforming to UL 6 and ANSI Specification C80.1. Conduit and Fittings must be threaded.
 - (1) Nominal urethane coating on interior and threads must be 2 mil.
 - (2) Minimum PVC coating bonded to exterior must be 40 mil.
 - D. Fiberglass conduit and fittings extra heavy wall (XW) conforming to UL 2515, UL 2515A for above ground application, and UL 2420 for below ground application.
8. The current carrying capacity of an insulated cable is reduced if it is surrounded by other loaded cables. For this reason, conduit banks should be arranged so that conduits located in an outside position are occupied first than conduits located in an inside position whenever possible or applicable.
9. It is the installer's responsibility to use the proper fitting to join conduits. This transition may involve changes in both conduit type and size. If equal diameter conduits of different wall thicknesses are joined, the inside edge of the spigot end must be chamfered.
 - A. Chamfering must be performed at 45° around the conduit edge and inside the conduit wall for at least 1/2" or until there is no more ridge when joining the conduits at the couplings. Chamfering helps to reduce the risk of damaging the cable jacket as it is pulled through the joined conduit.
10. In commercial distribution systems, consideration should be given to providing one or more spare conduits in the original construction for future load growth requirements. The addition of such conduits at a later time is much more costly.
11. An approved mandrel must be used to prove that all conduits are free and clear of dirt, rocks, and other debris. For further information refer to [Greenbook Section 3.11 and Section 3.12](#).
12. Install and attach to an end cap a non-detectable pulling tape with sequential footage markings (**Material Code M560154**) in all conduits that will be occupied after installation. The tape must be proven free and not glued or caught on joints.
 - A. Install the appropriate substructure to terminate vacant conduit runs exceeding 1,200 feet. Properly stub, install end caps, and a marker ball on vacant conduit runs shorter than 1,200 feet.
13. Install and attach to an end cap a detectable pulling tape with sequential footage marking (**Material Code M602679**) conduits that will be vacant more than 30 days after their installation. Refer to [Document 038193](#) and Utility Procedure TD-2002P-01 for further details.
14. All conduits must be capped. All conduits not terminating in a subsurface enclosure, pedestal, equipment pads, or vault are to be capped with unglued rigid caps (see Figure 13, Table 13 on Page 11). Conduits terminating in a subsurface enclosure, pedestal, equipment pads, or vault must be capped with temporary plugs (see Figure 14, Table 13 on Page 11).
15. Do not install back to back swedge reducer. Install a minimum of 12" long straight conduit between swedge reducers.
16. Every effort should be made to obtain a straight, watertight conduit line.
17. Seal all conduits entering and leaving a primary and secondary enclosure installed in areas prone to water intrusion issues.
 - A. Use Polywater® AFT or Duraline S-60-C6P conduit seals if continuous water head pressure is less than 11 feet height. (Water head is the height of the water in the system).
 - (1) Install Polywater® AFT following the instructions listed on Page 23 of this document.

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- (2) Install Duraline S-60-C6P following the installations listed on Page 24 and Page 25 of this document.
- B. Use the Rayflate Duct Sealing System (RDSS) conduit sealing system when the intrusion of water into buildings can be reasonably expected through lateral service ducts. PG&E is responsible for sealing both ends of the conduit. Refer to [Document 063927](#) and [Document 063928](#) for additional details.
- C. Use RDSS when waterproofing a subsurface transformer enclosure. Refer to [Document 072149](#) for additional details.
- (1) Install RDSS following the instructions listed on Page 26 and Page 27 of this document.
18. All conduits add fittings must be from PG&E approved manufactures listed in [Document 066211](#).

Material Specifications

19. PVC conduits and fittings must comply with PG&E engineering material specification EMS 64 which meets the following industry specifications:
- A. Tensile modulus of 500,000 psi.
 - B. National Electric Manufacturers Association (NEMA): NEMA TC-2 for straight conduit, couplings and NEMA TC-3 for fittings and bends.
 - C. Underwriters Laboratory (UL): UL 651 or Electrical Testing Labs (ETL) that conforms to UL 651.
 - D. UL 651 or ETL conforms to UL 651 must be marked on the outside wall of the PVC schedule 40.
 - E. Rigid solid and single wall or co-extruded cellular core wall PVC Schedule 40 conduits, couplings, fittings, and bends must be gray in color.
 - F. Marking must conform to UL 651 requirements.
20. High density polyethylene (HDPE) conduits and fittings must comply with PG&E engineering material specification EMS 63, and industry standards ASTM F2160, ASTM D3350, and UL 651A or ETL that conforms to UL 651A.
- A. HDPE conduit extruded over a cable (Cable-in-Conduit) must comply with UL 1990 or ETL that conforms to UL 1990.

Application

21. PVC conduit may be cut with a fine-toothed saw. Clean off burrs. Bevel the inside to eliminate sharp edges.
- A. Do not cut, shorten or alter in any way factory manufactured elbows or bends.
 - B. Use only elbows or bends listed in Table 17 on Page 12.
22. For PVC conduit, apply a thin, uniform coat of cement to both surfaces to be glued. Avoid excessive use of cement to prevent the formation of a bead of cement on the interior shoulder of the joint since, when hardened, the bead can cause cable damage during installation. Immediately after applying the coat of cement to the conduit, insert the conduit into the fitting socket until it bottoms at the fitting shoulder. Turn the conduit 1/4 turn during insertion to distribute the cement evenly. Hold the conduit in place for about 1 minute to prevent backing out in case of tight interference fit joints. Wipe any excess cement away from the outside of the joint. Weather conditions may vary the curing time. When using cement in confined areas, adequate ventilation must be provided. Table 1 below shows the codes to order PG&E approved conduit cement.

Table 1 Cement for Use With Plastic Conduits

Application	Quantity	Approved Manufacturer and Part Number		Material Code
		Oatey	Weld-on Duit 413	
PVC to PVC	1 Quart	30886V	12089	490157
	1 Pint	30885V	12090	490151

23. Conduit primer is not required for electric conduits. If customer or applicant chooses to use conduit primer, the primer must be compatible with PG&E approved PVC cement listed in Table 1 above. The customer or applicant is responsible for providing evidence such as manufacturer specification that conduit primer and PG&E approved PVC cement are compatible.
24. Use end bell fittings to terminate all conduits, unless the conduit has been terminated in an enclosure equipped with duct terminators. Use cable protectors on reconstruction projects only, when end bells cannot be installed.

Application (continued)

25. In applications where a conduit dead-ends, cap the end of the conduit and place a marker ball (material code **M374945**, Refer to M-60 for more information) at the location. Identify the marker ball in construction drawings.
- A. HDPE conduits shown in Table 11 and PVC, Bore-Gard schedule 40 in Table 12 on Page 10 are approved for horizontal directional drilling (HDD) trench-less applications. However, they can also be used in open trench and plowing applications.
 - (1) Only 2", 3" and 4" HDPE conduits are approved for vibrational plowing. Soil compaction after plowing is required. See Note 29A – 29C on Page 4.
 - B. During installation, use a recommended Line Tamer like McElroy to straighten and round the entire run if coiled HDPE is used. Coiled HDPE conduits must be re-rounded as it comes off of the reel until 5% or less ovality is achieved. This requirement applies to all approved installation methods.
 - C. During HDD installation, HDPE conduits are joined by butt-fusion. This method involves super-heating the conduit ends, pressing them together, and allowing them to cool, producing a continuous joint with a small bead at its interior and exterior. If the interior bead is not removed, the cables can snag during cable pulling. Therefore, de-beading is recommended between all conduit segments to reduce the risk of damaging the cable jacket as it is pulled through the conduit. De-bead individual joints, conduit sections completely before pullback starts. Follow appropriate Utility Procedure TD-4170P-34 or TD-4170P-35 when joining HDPE conduits by butt-fusion. Additional reference is also found in job aid TD-4170S-JA04.
 - D. Mechanical couplings can be used for joining HDPE to HDPE conduits as well as HDPE to PVC conduits. See Figure 11 and Table 11 on Page 10 and Figure 35 and Table 26 on Page 19.
 - (1) When using the mechanical couplings, it is extremely important to chamfer the HDPE conduit until the ridge inside the coupler resulting from difference between the inside diameter dimension of PVC and HDPE conduits is eliminated. Chamfering helps to reduce the risk of damaging the cable jacket as it is pulled through the conduit size transition. The amount of chamfering varies depending on the size of the HDPE conduits being joined.
 - E. Another method to join HDPE to HDPE conduits as well as HDPE to PVC conduits is to use the approved conduit adhesive applied on conduit fittings. See Figure 1 below. Apply the conduit adhesive following the manufacturer instruction included in the conduit adhesive kit.

Table 2 Conduit Adhesive to join HDPE–HDPE and HDPE–PVC Conduits

Application	Kit Contents	Approved Manufacturer and Part Number		Material Code
HDPE to HDPE or HDPE to PVC	1 - 250 ML Adhesive Cartridge	Bonduit	BTXL – 250KITI	490836
	5 - Mixing Nozzels			
	5 - Type RP Cleaning Wipes			
	5 - Pair of Gloves			
	1 - Strip Sanding Cloth			
	1 - Instruction Sheet			
	10 - Pack Mixing Nozzles		MXR - 25B - 10	490837

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Application (continued)



Figure 1
Conduit Adhesive to join HDPE-HDPE and
HDPE-PVC Conduits

26. **Caution:** When pulling conduit(s) in boring applications, be certain to cut the conduits to provide sufficient extra length for the conduit to relax. It may take as long as 72 hours for an excessively stretched conduit to fully relax.
27. Use Snap-N-Stack Combo Spacers in concrete encased and slurry applications.
28. Conduit shown on Table 22 through Table 25 (flexible conduit) on Page 15 through Page 18 are for use in areas with minor soil settlement issues, and for large radius sweeps or re-routes.
29. Backfill containing large rock, paving material, cinders, large amounts of sharply angular substance, or corrosive material must not be placed in excavations where such material may damage conduits, prevent adequate compaction of the fill, or contribute to corrosion of the conduits. Soil compaction must meet PG&E's and any applicable federal, state, county, and local requirements. PG&E specific soil compaction requirements are as follows:
 - A. Trenches/plowing that run across or along public roads and streets in the franchise areas must have soil compacted to a minimum of 95% density. Compaction must be achieved in lifts of no more than 12 inches.
 - B. Trenches/plowing that run across private properties and in all other areas must have soil compacted to a minimum of 90% density. Compaction must be achieved in lifts of no more than 12 inches.
 - C. A compaction test report may be required by PG&E. This report must include the testing company information: Name, Address, Contact information. For plowing installations a compaction test report is required.

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References	Location	Document
Minimum Requirements for the Design and Installation of Conduit and Insulated Cable	UG-1: Cable/Greenbook	038193
Methods and Requirements for Installing Residential Underground Electric Services 0–600 V to Customer-Owned Facilities	UG-1: Services/Greenbook	063927
Methods and Requirements for Installing Commercial Underground Electric Services 0–600 Volts to Customer-Owned Facilities	UG-1: Services/Greenbook	063928
PG&E Approved Electric Distribution Materials Manufacturers	Greenbook	066211
Selection of the Type of Underground Equipment	UG–1: General/Greenbook	072149
Engineering Material Specification 63, “High Density Polyethylene (HDPE) Conduits and Fittings”	TIL	EMS 63
Engineering Material Specification 64, “Polyvinyl Chloride (PVC) Conduits and Fittings”	TIL	EMS 64
Engineering Material Specification 4123, “Backfill Sand	TIL	EMS4123
Installing Underground Cable in Conduit	TIL	TD-2002P-01
Electric Distribution Conduits Installed on Bridges	TIL	TD-2310P-10
Application and Installation of Underground Medium–Voltage Cable by Cable–in–Conduit (CIC)	TIL	TD–2312P–01
Request for Variance from Electric Distribution Standards	TIL	TD-2951P-01
Heat Iron Butt Fusion for Polyethylene Pipe (Mechanical)	TIL	TD-4170P-34
Heat Iron Butt Fusion (Hydraulic) for Polyethylene Pipe	TIL	TD-4170P-35
Heat Fusion Pocket Card	TIL	TD-4170S-JA04
Approved “Mark and Locate” Instruments, Equipment, Accessories, and Products	TIL	M60

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Rigid Steel Conduit and Fittings

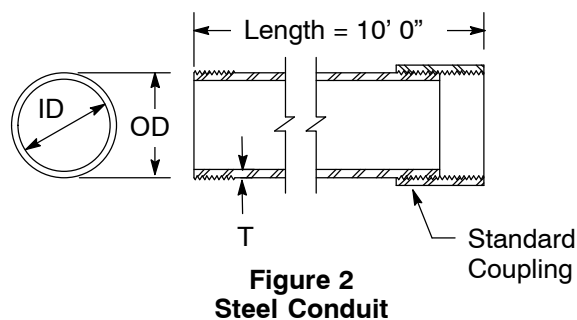


Table 3 Material Material Codes for Rigid Steel Conduit

Conduit Size (inches)	Dimensions (inches)			Weight (lbs.) ¹	Material Code
	OD	ID	T		
2	2.4	2.06	0.154	33	362103
3	3.5	3.06	0.216	69	362092
4	4.5	4.02	0.237	98	362093
5	5.6	5.04	0.258	134	362104
6	6.6	6.06	0.280	177	362141

¹ Weight for one 10-foot length, including one standard coupling furnished with each length.

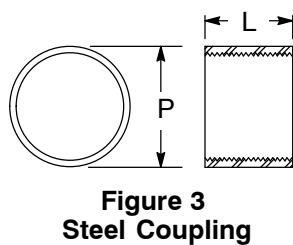


Table 4 Material Codes for Standard Steel Coupling

Conduit Size (inches)	Dimensions (inches)		Material Code
	P	L	
2	2.73	2.18	362105
3	4.00	3.25	362094
4	5.00	3.50	362095
5	6.29	3.75	362106
6	7.39	4.00	362142

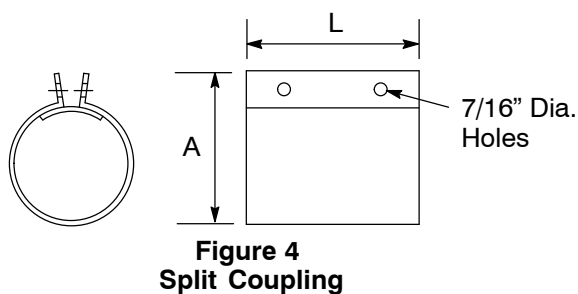


Table 5 Material Codes for Galvanized Steel Split Coupling

Conduit Size (inches)	Dimensions (inches)		Material Code
	A	L	
2	2.5	9	362019
3	3.5	9	362021
4	4.5	9	362023
5 ¹	5.5	9	362107
6 ¹	6.5	9	362143

¹ These sizes are made of zinc-plated malleable iron. Can be installed on rigid steel conduits.

Rigid Steel Conduit and Fittings (continued)

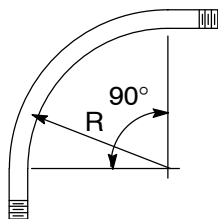


Figure 5
Conduit Elbow
Threaded Both Ends

Table 6 Material Codes for 90° Steel Conduit Elbows, TBE

Conduit Size (inches)	Radius (inches)	Material Code
2	24	360081
3	36	362091
4	36	362090
	60	360812
5	36	362109
6	36	362144
	48	362145
	60	360813

Note

1. Table 6 lists only 90-degree rigid steel elbow used which is typically what is used in our underground electric distribution system. However, sometimes underground electric conduit runs are installed under piers, bridges which may require elbows other than the 90-degree elbows listed in Table 6.
 - A. Other rigid steel elbows that meet the minimum horizontal and vertical radius listed in Table 17 on Page 12 are acceptable to use.
 - B. There are only material codes for 90-degree rigid steel elbows. Order other rigid steel elbows as non-coded items.

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PVC and HDPE Conduit and Fittings

Notes

- The depth of all couplings, adapters, swedge reducers, and bell ends must conform to the requirements listed in Table 2 of [ASTM Standard F512](#).



Figure 6
Rigid Plastic Conduit

Table 7 Data and Material Codes for Rigid Plastic Conduit Schedule 40¹

Conduit Size (inches)	Dimensions (inches)				Material Code
	Average Outside Diameter	Minimum Inside Diameter	Wall Thickness		
			Minimum	Maximum	
2	2.375	2.021	0.113	0.154	360153
3	3.500	3.008	0.148	0.216	016471
4	4.500	3.961	0.184	0.237	016472
5	5.563	4.975	0.221	0.258	016473
6	6.625	5.986	0.257	0.280	016474

¹ See Note 19 on Page 3 for material specifications.



Figure 7
PVC Coupling

Table 8 Material Codes for PVC Swedge Couplings

Swedge Coupling		
Conduit Size (inches)	Minimum Socket Depth	Material Code
2	2.25	360321
3	2.75	360322
4	3.75	360323
5	4.25	360401
6	4.75	360482

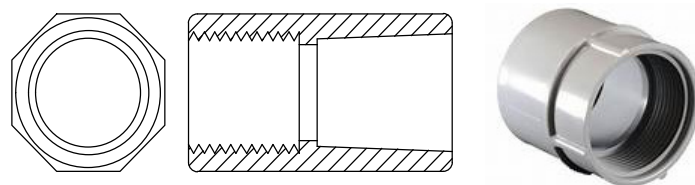


Figure 8
Plastic-to-Steel Adapter

Table 9 Material Codes for Plastic-to-Steel Adapters

Conduit Size (inches)	Minimum Socket Depth	Maximum Socket Depth	Material Code
2	1.125	2.00	360324
3	1.594	3.125	360325
4	1.750	3.375	360326
5	1.937	3.625	360402
6	2.125	3.750	360489

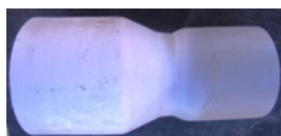
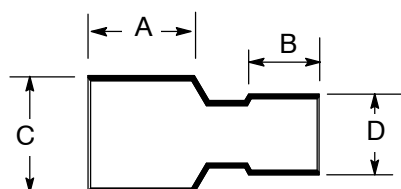


Figure 9
Swedge Reducer

Table 10 Data and Material Codes for PVC Swedge Reducers¹

Reducer Size (inches)	Dimensions (inches)				Material Code
	Minimum Length		Typical Belled End ID		
	A	B	C	D	
3 x 2	2.875	1.750	3.515	2.393	018585
4 x 3	3.375	2.875	4.515	3.515	018584
5 x 4	4.000	3.375	5.593	4.515	360777
6 x 5	5.000	4.000	6.658	5.593	360778

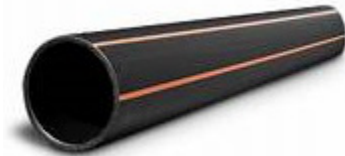
¹ Both belled ends must be chamfered 0.3 inches (min) by 45°.

Underground Conduits

PVC and HDPE Conduit and Fittings (continue)

Table 11 High Density Polyethylene (HDPE) Conduit ^{1, 6}

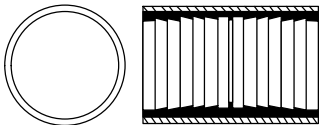
Conduit						Mechanical Couplings ^{2, 3}	
Size	Minimum Inside Diameter (Inches)	Min Wall Thickness (inch)	Length (feet)	Description	Material Code	Size (inches)	Material Code
2" Sch 80	1.913	0.238	500	Coil ⁴	360511	2	360690
2" Sch 80			40	Stick	360017		
3" Sch 80	2.864	0.300	500	Coil ⁴	360644	3	360691
3" Sch 80			40	Stick	360018		
4" Sch 80	3.786	0.377	625	Coil ⁵	360014	4	360692
4" Sch 80			40	Stick	360015		
5" SDR 13.5	4.689	0.412	450	Coil ⁵	360012	5	360694
5" SDR 13.5			40	Stick	360013		
6" SDR 13.5	5.585	0.491	450	Coil ⁵	360010	6	360695
6" SDR 13.5			40	Stick	360011		



**Figure 10
HDPE Conduit**



**Figure 11
PE Mechanical Coupling**



¹ Color must be black with at least 3 red longitudinal strips.

² May be used to connect HDPE conduit to PVC conduit (except in directional drilling apps.)

³ Mechanical couplings are not designed for directional drilling. Fusion joints are required.

⁴ No reel.

⁵ With reel.

⁶ Average outside diameter is the same as PVC conduit shown in Table 7, Page 9.

Table 12 PVC (Bore-Gard) Directional Boring Conduit

Size (inches)	Description	Material Code
3	Conduit 10', Schedule 40	360055
3	Conduit 20', Schedule 40	360056
4	Conduit 10', Schedule 40	360026
4	Conduit 20', Schedule 40	360025
4	Replacement Locking Straps ¹	360031
4	Replacement Seal Gaskets ¹	360029
6	Conduit 10', Schedule 40	360027
6	Conduit 20', Schedule 40	360028
6	Replacement Locking Straps ¹	360032
6	Replacement Seal Gaskets ¹	360030

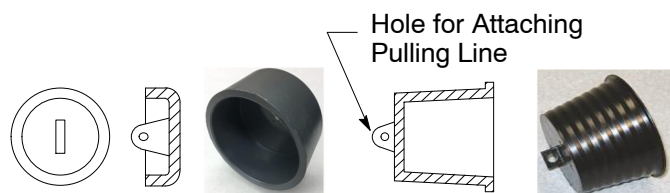
¹ Package of 10.



**Figure 12
PVC (Bore-Gard, Schedule 40)**

Underground Conduits

PVC Conduit and Fittings (continued)



Rigid Cap

Figure 13
Rigid Cap

Cap Plug

Figure 14
Plastic Conduit Cap

Table 13 Material Codes for Rigid Conduit Caps and Cap Plugs

Conduit Size (inches)	Material Codes	
	Rigid Cap	Cap Plug
2	360425	360440
3	360426	360441
4	360428	360443
5	360429	360444
6	360488	360494

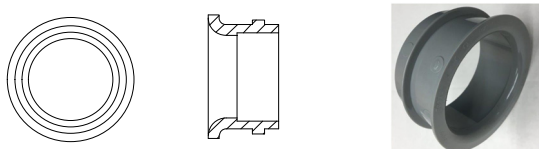


Figure 15
End Bell

Table 14 Material Codes for End Bells

Conduit Size (inches)	Material Code
2	360420
3	360421
4	360423
5	360424
6	360487

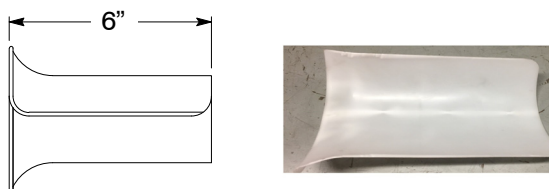


Figure 16
Cable Protector

Table 15 Material Codes for Cable Protectors ¹

Conduit Size (inches)	Material Code
2	382034
3	382045
4	
5	
6	

¹ Not for new installations; for replacement only.

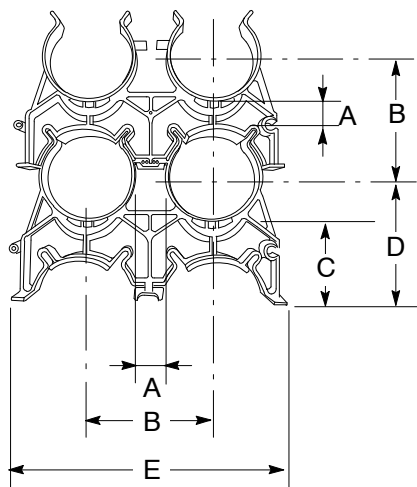


Figure 17
Snap-N-Stac Combo Spacers

Table 16 Material Codes for Snap-N-Stac Combo Spacers ¹

Conduit Size (inches)	Duct OD (inches)	Horizontal Duct Positions	Dimensions (inches)					Material Material Codes
			A	B	C	D	E	
3	3.500	2	2	5.5	3.63	5.38	11	360459
4	4.500	2	2	6.5	3.88	6.06	13	360460
5	5.563	2	2	7.56	4.38	7.25	15.12	360461
6	6.625	2	2	8.62	4.13	7.38	17.25	360491

¹ Use Snap-N-Stac Combo Spacers in concrete encased and slurry applications.

PVC Conduit and Fittings (continued)

Table 17 Material Codes for Rigid PVC Schedule 40 Conduit Elbows ³

Conduit Size (inches)	Sweep		Material Code
	Degree	Radius ¹ (inches)	
2 ²	11-1/4	24	360155
		36	360156
	22-1/2	24	360157
		36	360158
	45	24	360159
		36	360160
3 ²	11-1/4	24	360161
		36	360162
	22-1/2	24	360801
		36	360800
	45	24	360403
		36	360405
4 ³	11-1/4	36	360328
		60	360804
	22-1/2	36	360805
		60	360760
	45	36	360761
		60	360412
5	11-1/4	36	360413
		60	360821, 360414
	22-1/2	36	360415
		60	360808
	45	36	360809
		60	360806
6	11-1/4	36	360763
		60	360416
	22-1/2	36	360417
		60	360418
	45	36	360419
		60	360811
6	11-1/4	36	360765
		60	360485
	22-1/2	36	360486
		60	360483
	45	36	360484
		60	

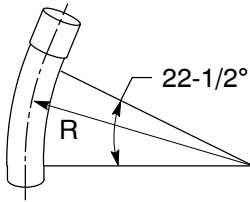


Figure 18
22-1/2° PVC Conduit Elbow

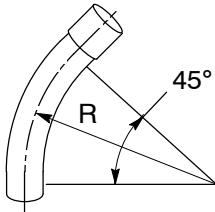


Figure 19
45° PVC Conduit Elbow

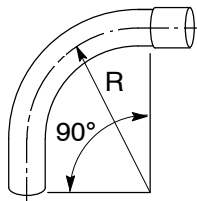


Figure 20
90° PVC Conduit Elbow

- ¹ For each conduit elbow and sweep; first row shows minimum vertical radius, second row shows minimum horizontal radius.
- ² For 2" and 3" primary conduits 90° bends, use 36" vertical radius. A 24" vertical radius can be used with secondary and service conduits only.
- ³ See Notes 1 and 2 on Page 13.
- ⁴ For 4" primary conduit 90° bends, use 36" vertical radius. A 24" vertical radius can be used only with secondary or service conduits and only for cable sizes up to and including 750 Al Kcmil triplex. Application: Risers, Pads, secondary enclosures, and service termination panels.

Underground Conduits

PVC Conduit and Fittings (continued)

Notes in reference to Table 17 on Page 12

1. A 36" may be allowed as the minimum horizontal radius when using 4" PVC conduits bends greater than 5° if field conditions make it not feasible to install 60" radius and if such field conditions are validated by PG&E inspectors.
2. Note 1 above does not apply to service conduits installations. For service conduits installations, 36" is the minimum horizontal radius for 4" conduit. See [Document 063927](#) and [Document 063928](#).

Large Radius Sweeps

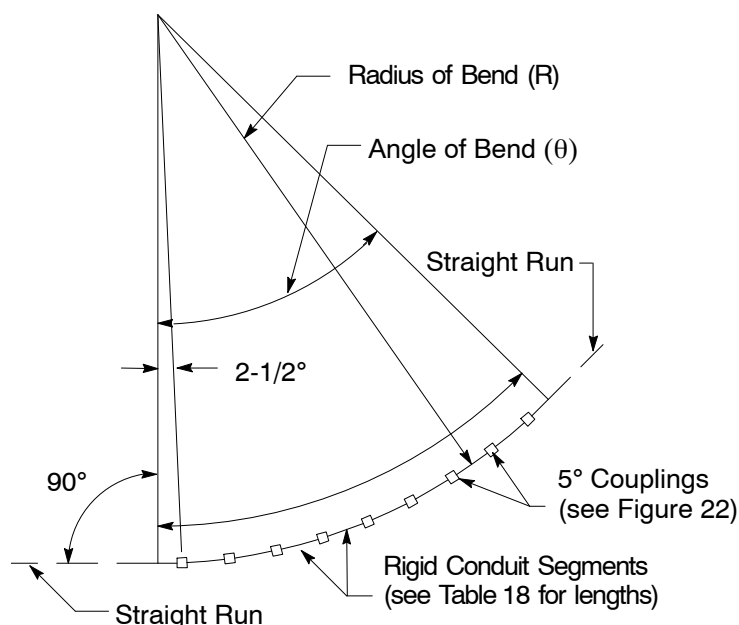


Figure 21
Typical Application of 5° Couplings

Table 18 Length of Rigid PVC Conduit Segments

Approximate Radius of Bend (R)	Length of Rigid Conduit Segments (feet)
11' 6"	1
17' 3"	1.5
23' 0"	2
28' 9"	2.5
34' 6"	3
40' 3"	3.5
46' 0"	4
51' 9"	4.5
57' 6"	5
69' 0"	6
80' 6"	7
92' 0"	8

Example

Radius Bend (R) = 60 Feet
Angle of Bend (θ) = 45°

From Table 18 The nearest value to 60-foot radius is 57' 6".
The length of conduit segments = 5 feet.

From Table 19 For a 45° angle bend:
The number of 5° couplings required = 9.
The number of conduit segments required = 8.

Table 19 Number of Couplings and Conduit Segments Required

Angle of Bend (θ)	Number of Couplings and Outside Diameter Conduit Segments Required	
	Coupling	Conduit
15°	3	2
30°	6	5
45°	9	8
60°	12	11
75°	15	14
90°	18	17

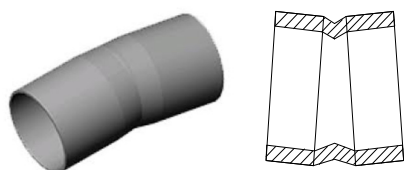


Figure 22
5° Coupling

Table 20 Material Codes for PVC Schedule 40, 5 Degree Coupling

Coupling Size (inches)	Material Code
2	360154
3	360399
4	360400
5	360407
6	360495

Longitudinal Bending of Straight Plastic Conduit

Notes

1. Longitudinal bending known as sweeping or roping refers to curving plastic conduits along their length for a certain amount without deformation. Figure 23 and Figure 24 show two important factors that limit the longitudinal bending of plastic conduits.

A. Bending radius induces stresses on the conduit wall. Stresses are higher on larger conduit sizes.

2. Longitudinal bending must be equal or larger than the values of the minimum bending radius and maximum end offset shown in Table 21.

A. Do not apply heat to obtain longitudinal bending of straight plastic conduits.

3. When performing cable pulling calculations, the aggregate total number of bends (factory bends plus longitudinal bending) must be included to calculate the total cable pulling tension. The maximum allowed degrees in the conduit run for factory bends remains unchanged. See [Document 038193](#).

A. Do not exceed the maximum allowed cable pulling tension.

Table 21 Criteria for longitudinal Bending of 20 ft. lengths Plastic Conduit:

Conduit Size (inches)	Minimum Bending Radius (R. ft)	Maximum End Offset (Z. ft)
2	30.9	6.2
3	45.6	4.3
4	58.6	3.4
5	72.4	2.7
6	86.3	2.3

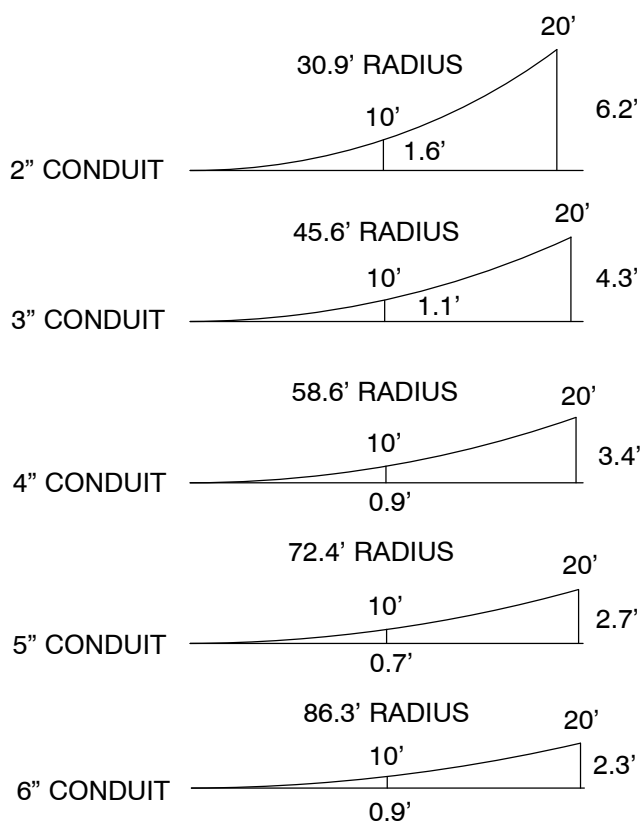


Figure 23
Min Bending Radius and
Max End Offset for Plastic Conduit

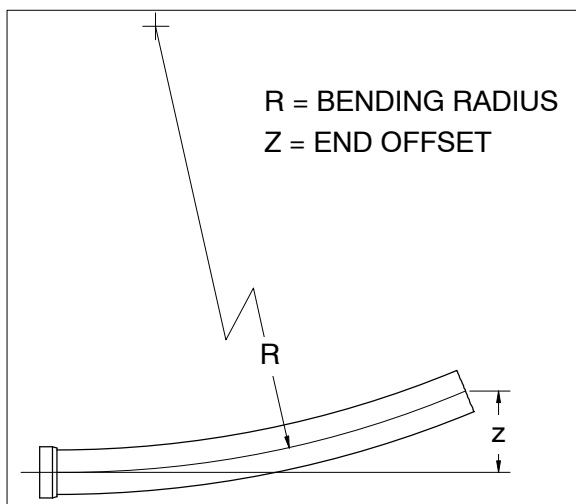


Figure 24
Longitudinal Curved Plastic Conduit

Underground Conduits

Flexible (HDPE) Conduit and Fittings

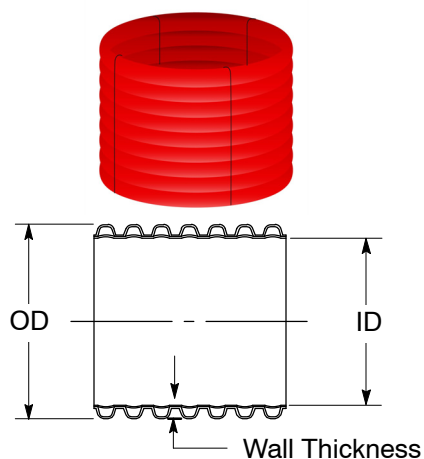


Figure 25
Corrugated Core Flex Conduit

Table 22 Data and Material Codes for Corrugated Core Flex Conduit With Couplers (250' coil) ^{1, 2, 3}

Conduit Size (inches)	Dimension (inches)			Material Code
	Outside Diameter	Inside Diameter	Wall Thickness	
2	2.375	2.050	.163	360095
3	3.500	2.950	.275	360096
4	4.750	3.975	.387	360097

¹ Conduit can be used in areas minor soil settlement issues or for re-routes.

² Inside wall is corrugated.

³ Minimum bending radius is 24 inches for all sizes.

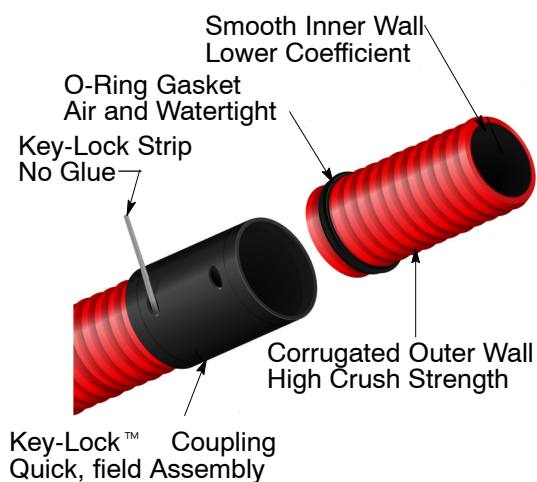


Table 23 Data and Material Codes for Key-Lock™ Couplers ¹

Conduit Size (inches)	Insertion Lengths (inches)	Material Code
2	2.725	360102
3	3.125	360103
4 ²	2.875	360105

¹ Kit has coupler, two keylocks and two O-ring gaskets.

² Coupler to connect corrugated core flex to corrugated core flex.

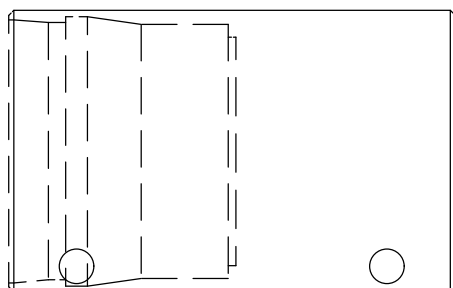


Figure 26
Key-Lock™ Couplers

Flexible (HDPE) Conduit and Fittings (continued)

Install the Key-Lock Coupler Following the Procedure Below

1. Ensure conduit has a clean, perpendicular cut.
 - A. Cut the corrugated conduit at the valley of the corrugation, rather than the dip, to enable proper alignment as shown in Figure 27.

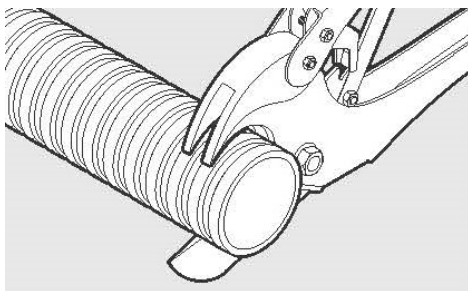


Figure 27
Cutting Flexible HDPE

2. Overlap ends of the corrugated conduit. Place conduit at center of coupler and mark at the end as shown in Figure 28.

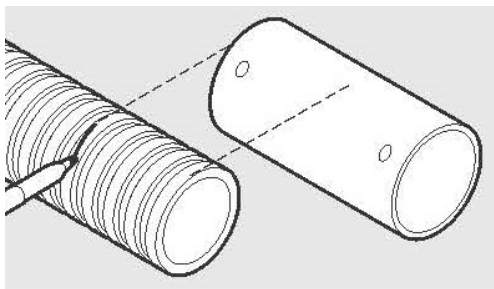


Figure 28
Key-Lock™ Couplers and Corrugated
Conduit Alignment

3. Install the O-ring gasket.
 - A. Snap the O-ring gasket into place.
 - B. Ensure O-ring gasket is seated in the second corrugation as shown in Figure 29.

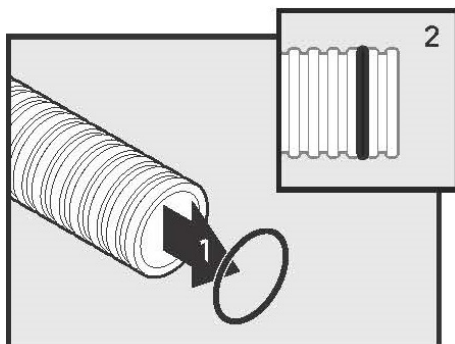


Figure 29
Key-Lock™ Couplers Gasket Position

4. Use only a water-based lubricant. Apply the lubricant to the outside surface of the gasket. A light coating of lubricant should also be applied to the chamfered leading edge of the coupler.

Underground Conduits

Flexible (HDPE) Conduit and Fittings (continued)

5. Insert the gasketed end of the corrugated conduit into the coupler, making sure it's inserted all the way to the insertion mark. The lock ring on the inside surface of the coupler should snap into the matching corrugation as shown on Figure 30.

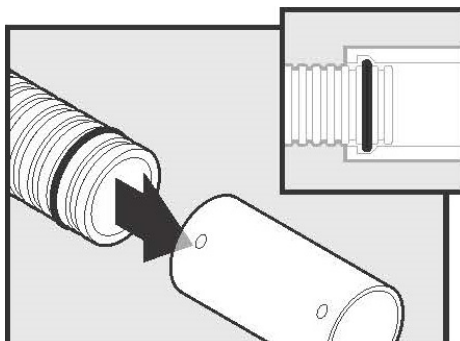


Figure 30
Key-Lock™ Couplers Insertion

6. Insert the Key-Lock™ strip following the directional arrow shape into the pre-drilled hole in the coupler.
 - A. Apply a small amount of lubricant to aid in the insertion.
 - B. Push the Key-Lock strip (in the direction of the arrow on the label) around the entire circumference, locking the corrugated grooves in the conduit and coupler securely together as shown in Figure 31.

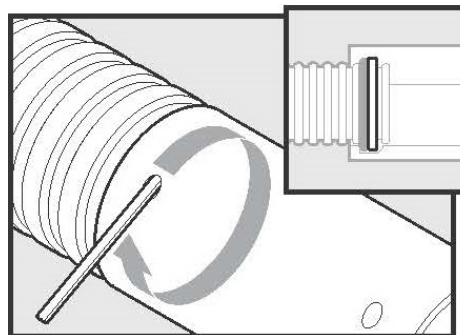


Figure 31
Key-Lock™ Couplers Locked in Place

7. Trim excess key lock strip material as shown in Figure 32.

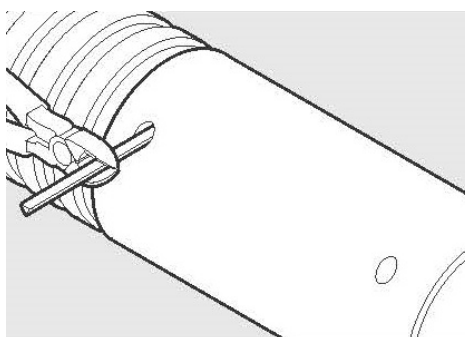


Figure 32
Trim Excess Key-Lock™ Strip Material

Flexible (HDPE) Conduit and Fittings (continued)

8. Repeat steps 1–7 for the opposite end of the coupler and corrugated conduit. See Figure 32 for complete installation.

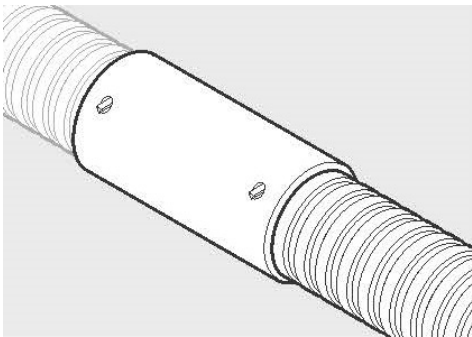


Figure 33
Key-Lock™ Couplers Complete Installation

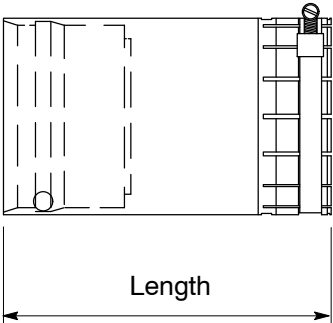
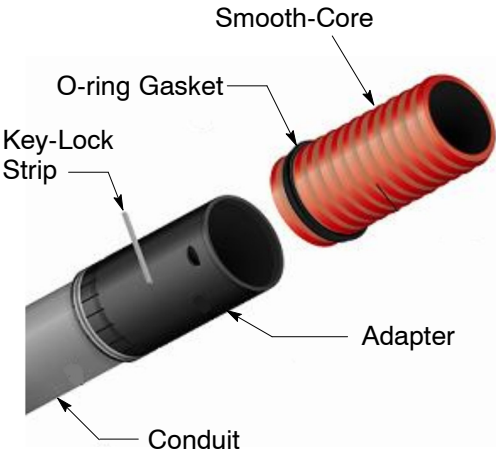


Figure 34
Key-Lock™ Adapter

Table 24 Data and Material Codes for
Shurlock/Key-Lock™ (Adapter
Smooth-Core-Shur-Lock Kit™ 1, 2)

Conduit Size (inches)	Dimension (inches)	Material Code
	Length	
2	6.7	360106
3	6.63	360107
4	8.0	360108

- ¹ Kit has adapter, one keylock, and one O-ring gasket.
² Adapter works connecting SC conduit to PVC, HDPE, and SC conduit to threaded steel conduit.

Table 25 Required Rigid PVC stub out length ¹

Conduit Size (inches)	PVC Stub Out (inches)
2	14.8
3	14.5
4	15
6	17.5

- ¹ Stub out length needed to provide enough space for the adapter to connect rigid PVC, HDPE, to flexible conduit.

Note

1. The key-lock bell end adapters smooth-core bell are no longer commercially available. Before the end of the flexible conduit run, it is necessary to transition from the flexible conduit to PVC conduit by following the steps below.
 - A. Use appropriate size Shurlock/Key-Lock™ coupler listed in Table 24.
 - B. Use a straight section of at least 18 inches of appropriate size PVC conduit listed in Table 7 on Page 9.
 - C. Use appropriate size end bell for PVC conduit listed in Table 14 on Page 11.

Underground Conduits

Flexible (HDPE) Conduit and Fittings (continued)



Figure 35
Shur-Lock II Coupler

Table 26 Data and Material Codes for
Shur-Lock II Coupler ¹

Conduit Size (inches)	Dimension (inches)	Material Code
	Length	
2	5.70	027241
3	10.75	027242
4	12.00	027243
5	14.25	027244
6	14.25	027256

¹ For use to join HDPE–HDPE and HDPE–PVC conduit, threaded or non-threaded steel conduit.

Conduit Construction, Built-up Method

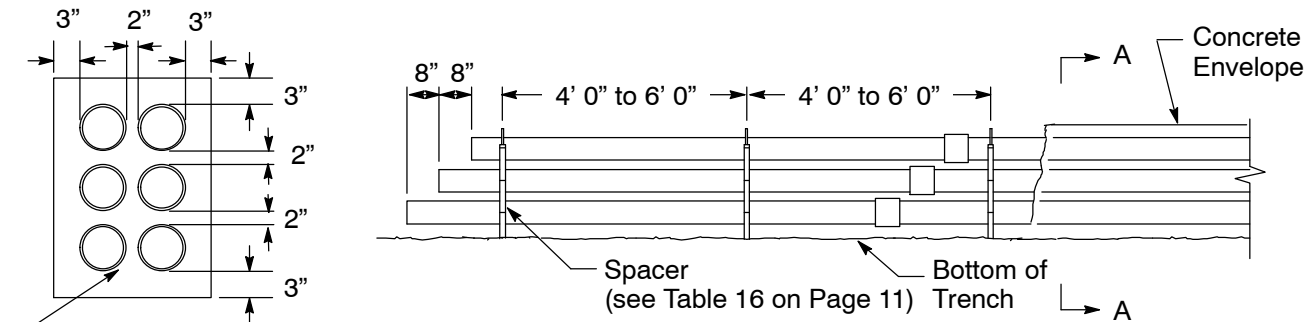


Figure 36
Typical Straight Run Installation
(6" conduit, 6-way shown)

Section A-A

Plastic Conduit
(see Table 7 on Page 9)
Separation between conduits
inside a trench when using
spacers. See Figure 17 on
Page 11.

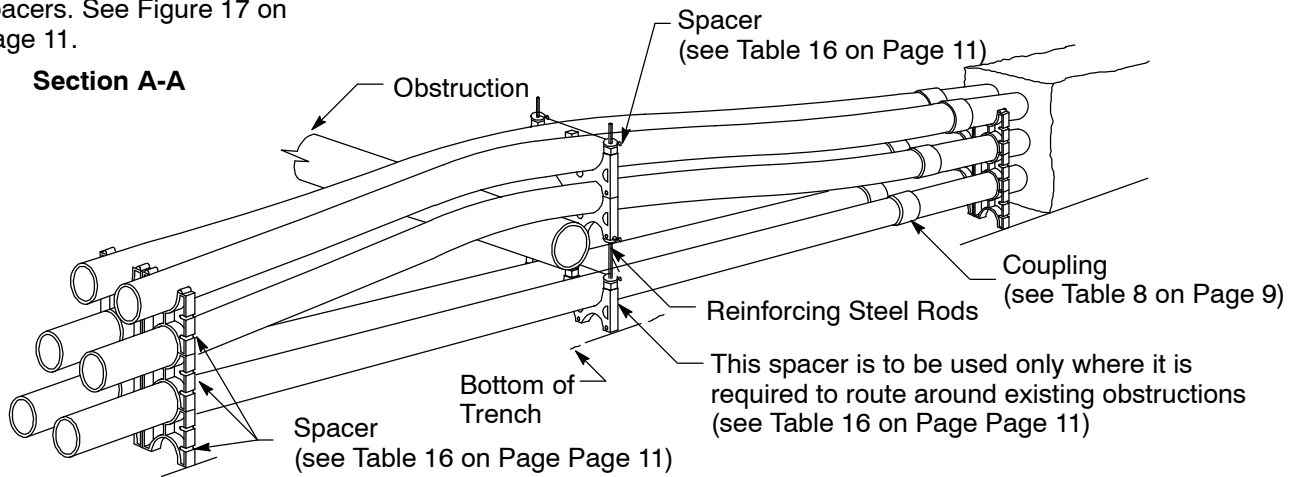


Figure 37
Typical Perspective View of
Installation Around Obstruction

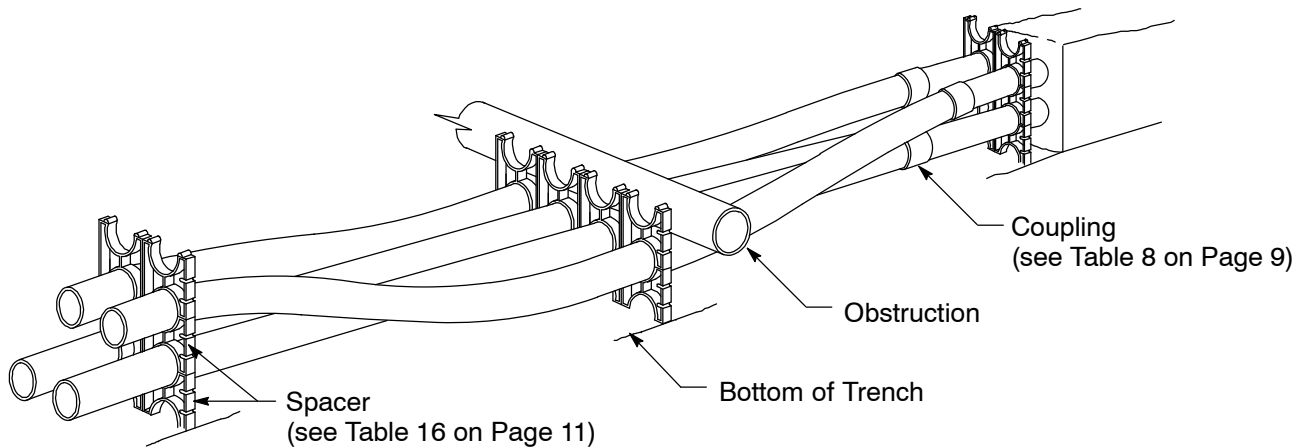


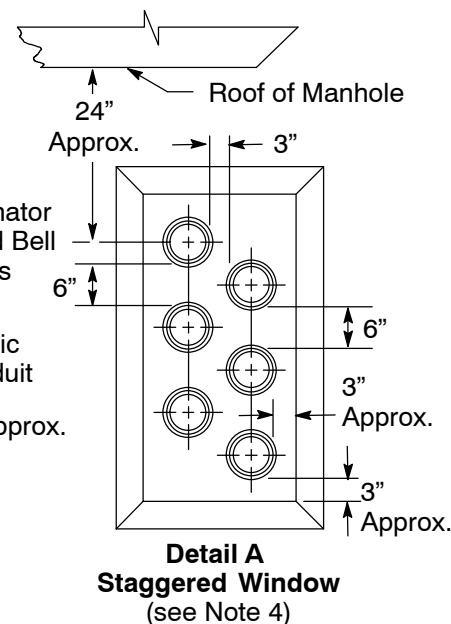
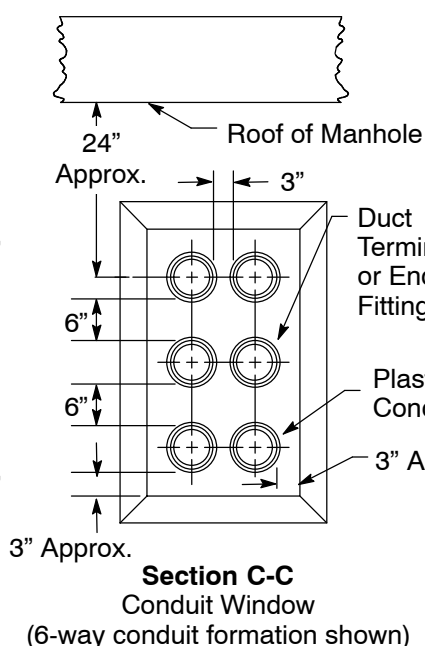
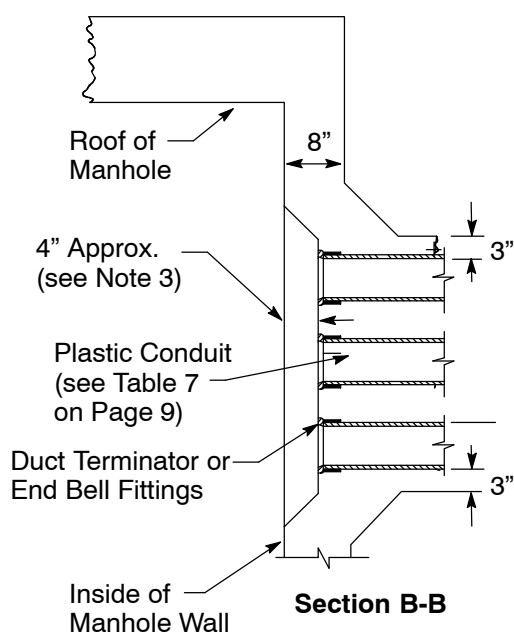
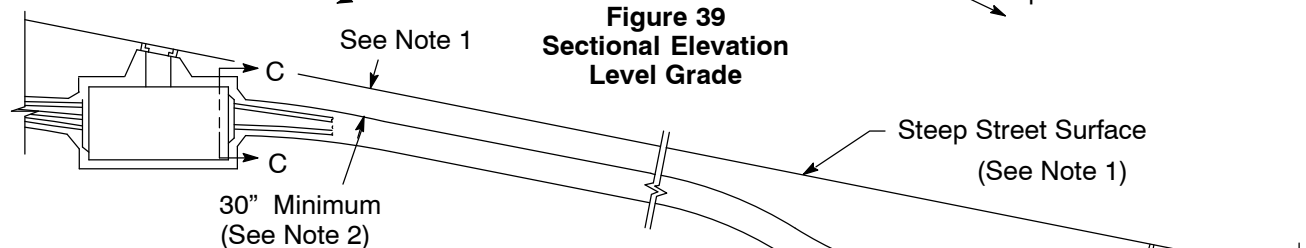
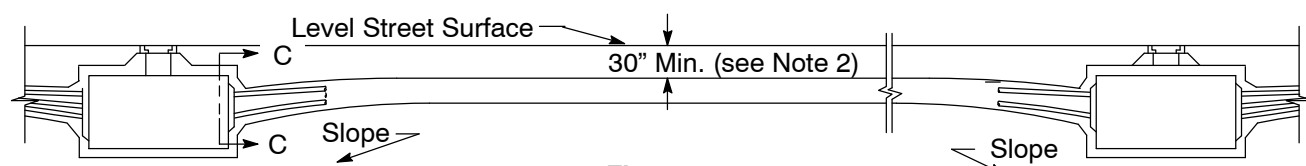
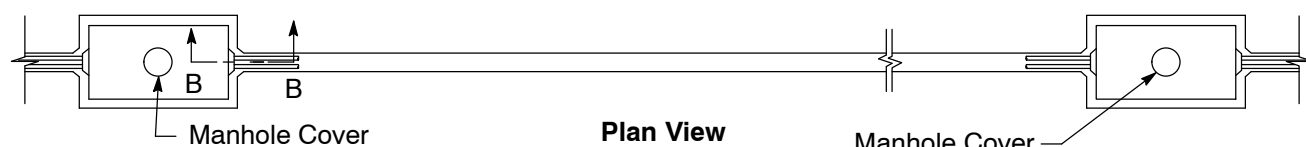
Figure 38
Typical Perspective View of
Installation Under Obstruction

Underground Conduits

Construction and Termination of Conduit Line into a Manhole or Vault

Notes

1. Slope the conduit sufficiently to provide adequate drainage. On level ground, slope the duct line from the center to each manhole.
2. Local city ordinances may require a minimum cover greater than PG&E's requirements of 24" for conduits containing circuits energized at 750 volts or less, and 30" for conduits containing circuits energized in excess of 750 volts. Depth may be reduced in either case if adequate mechanical protection – as defined in [Section 3.10 of the Greenbook](#) – is provided.
3. Where required, the depth of the conduit window may be increased. Where this is necessary, tie the conduit envelope concrete into the manhole reinforcing steel.
4. Vertical staggering of conduits at entrance shown in Detail A will assist in arranging for cable crossover if required.



Concrete Encasement Conduit Configuration Tables

Notes

1. For conduit lines two-way and larger, install #4 reinforcing bars in all four corners of the conduit envelope. Overlap bars 15 inches and install a minimum of 3 inches from the top or bottom and 1 inch from the side of the envelope.
2. Where the width of the trench is greater than the required width of the envelope, the horizontal spacing between conduits may be increased as long as 3-inch spacing between the conduit and the outside edge of the envelope is maintained.
3. Separation for conduits installed in concrete encasement will remain 3" to facilitate safe concrete removal and conduit access.
4. Concrete: Normal Weight
Aggregate, ASTM, C33 Uniformly Graded
Maximum Aggregate Size 3/4 inch type
Minimum Compressive Strength: $f'_c = 3,000$ pound-force per square inch (psi).

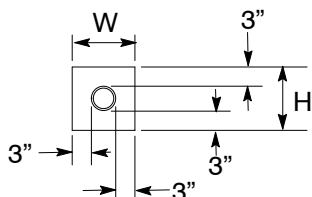


Figure 41
Single Conduit Configuration

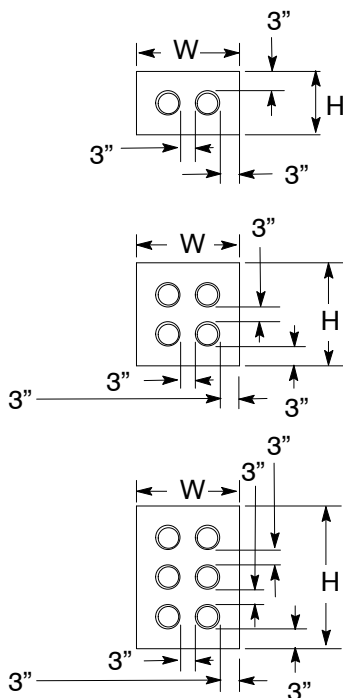


Figure 42
Two, Four, and Six-Way Conduit Configuration

Table 27 Dimensions for Single Conduit Configurations

Conduit		Envelope Dim.		Concrete Reqd. Cubic Yards per 100 ft. ¹
Description	Size	W	H	
Single	2"	8-1/2"	8-1/2"	1.9
	3"	9-1/2"	9-1/2"	2.3
	4"	10-1/2"	10-1/2"	2.8
	5"	11-1/2"	11-1/2"	3.4
	6"	12-1/2"	12-1/2"	4.0

¹ Quantities may vary due to variations encountered in construction. Value does not deduct the volume of the encased conduit.

Table 28 Dimensions for Multiple Conduit Configurations

Conduit		Envelope Dim.		Concrete Reqd. Cubic Yards per 100 ft. ¹
Description	Size	W	H	
2-way	3"	16"	9-1/2"	3.9
	4"	18"	10-1/2"	4.9
	5"	20"	11-1/2"	5.9
	6"	22-1/2"	12-1/2"	7.2
4-way	4"	18"	18"	8.3
	5"	20"	20"	10.3
	6"	22-1/2"	22-1/2"	13.0
6-way	4"	18"	25-1/2"	11.8
	5"	20"	29"	15.0
	6"	22-1/2"	32"	18.5
8-way	4"	18"	33"	15.3
	5"	20"	37-1/2"	19.3
	6"	22-1/2"	41-1/2"	24.0

¹ Quantities may vary due to variations encountered in construction. Value does not deduct the volume of the encased conduits.

Underground Conduits

Instructions for Sealing Conduit Using Duraline S-60-C6P Foam**Notes**

1. Within minutes, polyurethane foam expands to form a water and gas barrier that can be easily removed in the future.
2. Consult the manufacturer's instructions included in each kit.

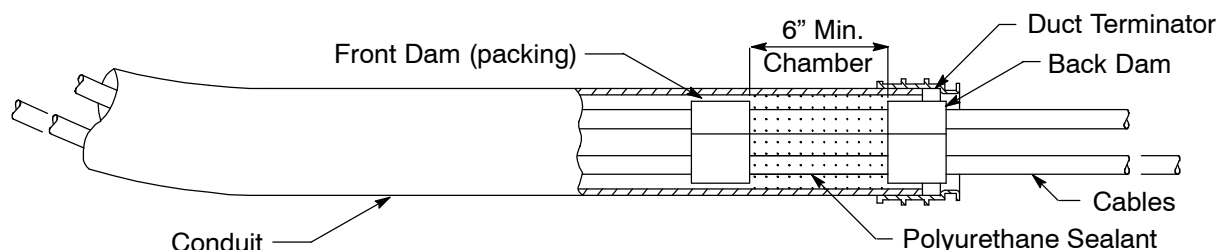


Figure 43
Details of a Polyurethane Seal

- Step 1 Wipe off loose dirt and grime from cables.
- Step 2 Install front dam (packing). Wind a strip of packing around each cable. Push the dam approximately 6 inches to 8 inches into the conduit. Install the back dam in the same manner as the front dam, and push it into the conduit until the dam is flush with the duct terminator.

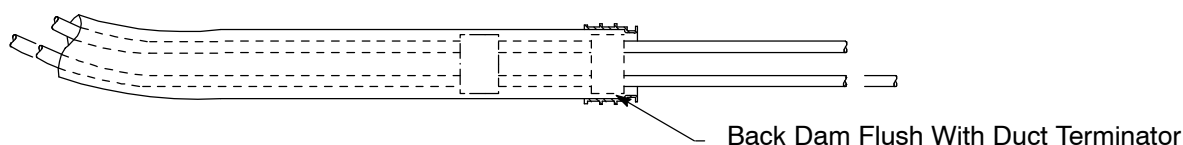


Figure 44
Front Dam Installation

- Step 3 Insert the nozzle into the chamber between the dams and inject polyurethane.

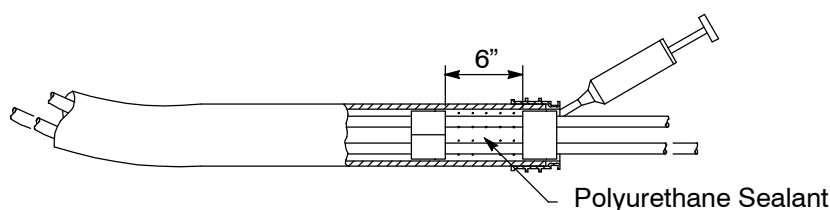


Figure 45
Nozzle Application

Table 29 Material Codes for Polyurethane Conduit Seal Kits ¹

Conduit Size	Material Code	Manufacturer	Catalog Number
2" Through 6"	019178	Dura-Line (Arnco) Hydro Seal	S-60-C6P

¹ Kits have a 12 month shelf-life.

Sealing Conduit Using Polywater[®] Aerosol Foam Technology (AFT)

Note

1. Polywater[®] AFT is compatible with all cable jackets.
2. Adheres to duct and cable jacket surfaces with a compressive strength of 25 psi.
3. Removes easily to facilitate new cable installation or old cable removal.
4. Service temperature ranges from –20°F to 200°F (–30°C to 95°C).
 - A. Protect can from sunlight and do not expose the can to temperatures exceeding 122°F (50°C).
5. Resistant to gasoline, oils, diluted acid and bases, and most unsaturated hydrocarbons.
6. 12 months shelf life. Any remaining product left after initial use may be used up to one month after it has been first deployed.
7. Any unreacted material may be cleaned from surfaces with a solvent/cleaning wipe (**M490814**). Once reacted, the foam has strong adhesion and may be scraped from surface.
8. Multi-purpose, effective in wide range of field applications, including vertical conduits. Figure 46 below shows successful installation of the Polywater[®] AFT.



Figure 46
Example of Polywater[®] AFT Installation in
Riser Poles and Raceway Entrances

9. Polywater[®] AFT is the preferred foam to seal the following applications:
 - Riser poles
 - Casing ends when casings are used in electric applications
 - Continuous water head pressure of up to 11 feet height for PVC conduit and up to 6 feet height for rigid steel conduit
10. Polywater[®] AFT like the other two approved conduit sealants: Dura-Line S-60-C6P and RDSS can be used to seal conduits in pad-mounted and subsurface enclosures and vaults.

Table 30 Material Codes for Polywater[®] Conduit Seal Kits ¹

Conduit Size	Material Code	Description	Catalog Number	Unit (Package)
2" Through 6"	490844	Two-Part Aerosol Air Foam Sealant (AFT) ²	AFT-16P4	4
	490845	Actuators with Standard Extension Tube	AFT-SAE10	10

¹ Kits have a 12 month shelf-life.

² Each package contains one-16 OZ. Can and two-actuators.

Underground Conduits

Instructions for Sealing Conduit Using Polywater[®] Aerosol Foam Technology (AFT)

- Step 1 Create a dam with clean rags about 6-inches into the conduit.
- Step 2 Shake for 60 seconds to mix.
- Step 3 Lift hinge and insert dispensing nozzle into top offices so that the arrow lines up with the dispensing nozzle.
- Step 4 Invert aerosol can. Insert nozzle all the way into the seal space and fully squeeze the hinge to spray sealant into the conduit between and around cables. See Figure 1 below.



Figure 47
Polywater[®] AFT Conduit Seal

- A. It is important to hold the can upside down and fully depress the hinge to spray. The foam should be a uniform purple color, if it isn't; then, it is not properly mixed and must be removed and re-installed. In cold weather, keep can at 68F (20C) or higher before use.
- B. Remove actuator tube if it is not used within 15 seconds. If actuator tube is left on, it will expand and blow itself off.
- C. Table 31 below shows fill chart for 6-inch plug depth:

Table 31 Polywater[®] AFT Conduit Fill Chart

Conduit Size (inches)	Fill Time (Sec)	Seals per Can
2"	2	15
3"	4.5	7
4"	7	5
5"	11	3
6"	16	2

- Step 5 Fill conduit three-fourths full. Place an additional dam on the outside of the conduit or hold with gloved hands to prevent the expanding foam from escaping from the conduit for 2 to 3 minutes.
- A. For u-shaped molding, use a clean rag to scrape off excess foam and pat down top of seal so that the foam is even with u-shaped molding. Once foam becomes tacky (1–2 minutes), allow foam to expand undisturbed.

Removal Instructions

- Step 1 AFT sealant can be mechanically removed from conduits or U-moldings.
- A. Use a long screwdriver or similar tool to break apart pieces of the cured seal before removal.
- B. Be careful not to damage existing cables.

Instructions for Sealing Conduit Using Rayflate Duct Seal System (RDSS)

Notes

1. Consult the manufacturer's instructions included in each kit.
2. Installation tool IT-16 is needed to install RDSS. This tool uses CO₂ cartridges. Both of these materials need to be ordered separately. See Figure 50 on Page 27 .
3. Select the appropriate RDSS size per Table 32.
4. When sealing three or more cables, the RDSS sealing clip listed on Table 32 must be used with the DRSS duct deal. One clip seals up to four cables.
5. For vacant conduits, do not bring the polyester pulling tape out of the conduit as it provides a path for water. Coil it and stuff it inside the conduit with no polyester pulling tape passing through the RDSS seal.
6. Order RDSS as indicated in Table 33 on Page 27.
7. For additional reference, the link below provides an installation video. This video was developed by the manufacturer and may not reflect the use of the company required PPE. When performing this work, please be sure to use the appropriate PPE (i.e. long sleeves, hard hat, etc.) as required by PG&E. The video titled "RDSS – Rayflate Duct Seal System Installation and Removal" is posted in Microsoft Stream. Access Microsoft Stream Internet Explorer and Chrome at <https://portal.office.com>, click on all apps, scroll down to Stream and click on the Stream icon.

Table 32 RDSS Size Selection

Normal Duct (Conduit) Size (Inches)	RDSS-45 Cable/Cable Bundle Diameter (Inches)	RDSS-60 Cable/Cable Bundle Diameter (Inches)	RDSS-75 Cable/Cable Bundle Diameter (Inches)	RDSS-100 Cable/Cable Bundle Diameter (Inches)	RDSS-125 Cable/Cable Bundle Diameter (Inches)	RDSS-150 Cable/Cable Bundle Diameter (Inches)
1-1/2	0-1.25					
2		0-1.50	0-1.00			
3				0-2.00		
4				0-3.25	0-2.75	
5 ²					2.75-4.5	2.50-4.25
6 ²						2.50-5.50
RDSS Clip Size	N/A	75	75	100	125	150

¹ One RDSS clip per RDSS seal is included in the kit.

² For 5" and 6" ducts with cable bundle diameters less than listed on this table or empty; an RDSS-AT/AP-150 device must be used along with RDSS. RDSS-AT/AP-150 must be ordered separately. See Figure 50 on Page 27.



Figure 48
RDSS Seal and Clip



Figure 49
AT/AP-150 Device

Underground Conduits

Instructions for Sealing Conduit Using RDSS (continued)



Figure 50
IT-16 Installation Tool and CO₂ Cartridges

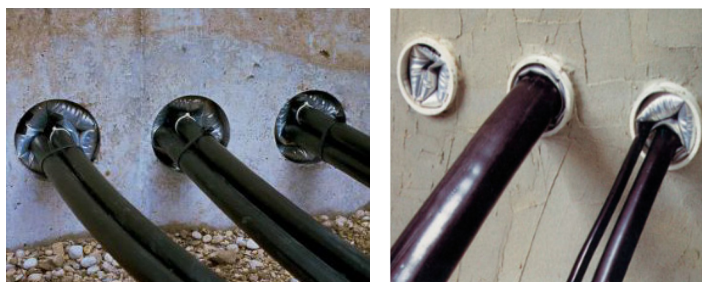


Figure 51
RDSS Installed

Table 33 Material Codes for RDSS Kits and Installation Tool

Item	Material Description	Material Code
1	RDSS-45-PG&E	360213
2	RDSS-60-PG&E	360214
3	RDSS-75-PG&E	360215
4	RDSS-100-PG&E	360216
5	RDSS-125-PG&E	360217
6	RDSS-150-PG&E	360218
7	RDSS-AT/AP-150 Device	360219
8	RDSS-IT-16 Tool	360220
9	Compressed CO ₂ Gas Cylinders	360221

¹ Installation tool re-usable. Unless damaged, only need to order once.

² Only these types of cylinders are compatible with this tool.

Revision Notes

Revision 24 has the following changes:

1. This document replaces PG&E Document 062288, Rev. #23
2. Expanded Note 7 on Page 2 to specify conduit location applications.
3. Added Fiberglass conduit and fittings extra wall as one conduit option to be used in locations listed in Note 7 on Page 2.
4. Added new Note 1 on Page 8 to clarify what GRS conduit bends can be used.
5. Expanded and clarified the requirements and application of conduit seals in Note 17 on Page 2 and Page 3.
6. Added new material code for 4", 90-degree, 24" radius elbow, allowed for risers, pads, secondary enclosures, service termination panels up to and including 750 Al Kcmil TPX.
7. Updated Table 29 on Page 23 to delete Polywater conduit seal that is now substituted by Polywater[®] AFT conduit seal
8. Incorporated content of bulletin TD-062288-B007 on Page 23 to Page 24.
9. Added Note 5 on Page 26 to indicate how to handle pulling tape when sealing conduits using RDSS.
10. Removed incorrect zero shown in the cable bundle diameter for RDSS-125 size in Table 30 on Page 24.
11. Deleted duplicate word in Title of Table 33 on Page 27.