Volume VI: Double Containment Piping Systems

Industrial Technical Manual Series

THIRD EDITION

DOUBLE CONTAINMENT PIPING SYSTEMS

Encase™ polypropylene piping
Guardian™ PVC and Corzan® CPVC
Clear-Guard™ system
CustomGuard® systems
Centra-Guard™ cable-leak detection

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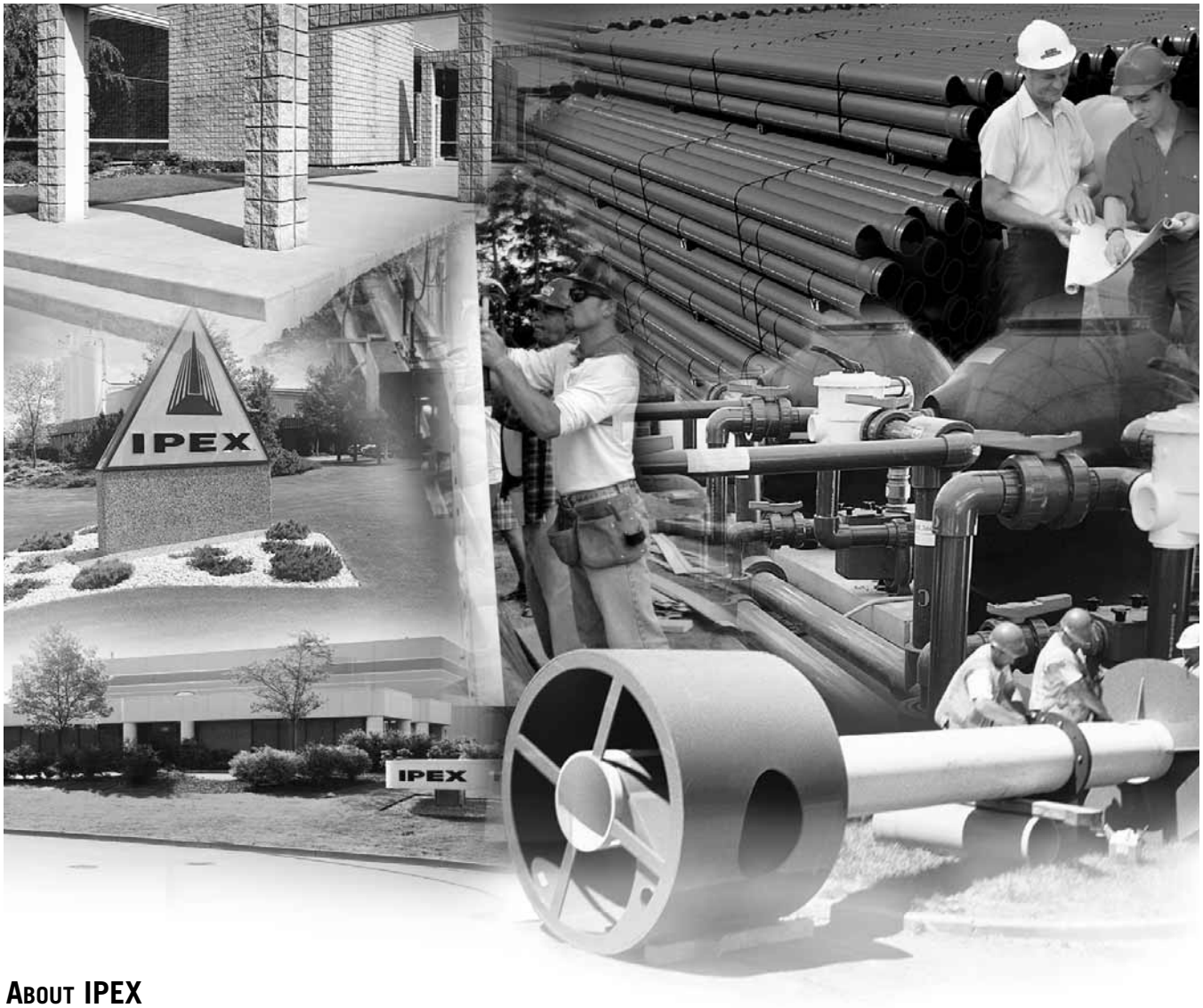
IPEX

Double Containment Piping Systems

Industrial Technical Manual Series

Vol. VI, 3rd Edition



About IPEX

At IPEX, we have been manufacturing non-metallic pipe and fittings since 1951. We formulate our own compounds and maintain strict quality control during production. Our products are made available for customers thanks to a network of regional stocking locations throughout North America. We offer a wide variety of systems including complete lines of piping, fittings, valves and custom-fabricated items.

More importantly, we are committed to meeting our customers' needs. As a leader in the plastic piping industry, IPEX continually develops new products, modernizes manufacturing facilities and acquires innovative process technology. In addition, our staff take pride in their work, making available to customers their extensive thermoplastic knowledge and field experience. IPEX personnel are committed to improving the safety, reliability and performance of thermoplastic materials. We are involved in several standards committees and are members of and/or comply with the organizations listed on this page.

For specific details about any IPEX product, contact our customer service department.

Safety Alerts

Engineered thermoplastics are safe inert materials that do not pose any significant safety or environmental hazards during handling or installation. However, improper installation or use can result in personal injury and/or property damage. It is important to be aware of and recognize safety alert messages as they appear in this manual.

The types of safety alert messages are described below.

This safety alert symbol indicates important safety messages in this manual. When you see this symbol be alert to the possibility of personal injury and carefully read and fully understand the message that follows.

WARNING

"WARNING" identifies hazards or unsafe practices that can result in severe personal injury or death if instructions, including recommended precautions, are not followed.

CAUTION

"CAUTION" identifies hazards or unsafe practices that can result in minor personal injury or product or property damage if instructions, including recommended precautions, are not followed.

Note: The use of the word "NOTE" signifies special instructions which are important but are not related to hazards.

For the materials described in this manual, the following warming applies.

WARNING

- **NEVER** use compressed air or gas in PVC/CPVC/PP/PVDF pipe and fittings.
- **NEVER** test PVC/CPVC/PP/PVDF pipe and fittings with compressed air or gas, or air-over-water boosters.
- **ONLY** use PVC/CPVC/PP/PVDF pipe for water and approved chemicals.

Use of compressed air or gas in PVC/CPVC/PP/PVDF pipe and fittings can result in explosive failures and cause severe injury or death.

CAUTION: Do not use or test the products in this manual with compressed air or other gases including air-over-water-boosters

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Section One: General Information

Overview

Safety and environmental issues, such as ground water contamination, have long been serious concerns for North American industry. Add to this the enormous costs of litigation, clean up, and increasingly stringent corporate guidelines and legal regulations, and the importance of fail-safe double containment systems becomes immediately clear.

However, exactly what constitutes 'double containment'? Although, on paper, simple solutions such as the lining of ditches or similar methods may appear to meet double containment requirements, in reality, they fall short. With double containment, engineers are not designing a single system or even two separate single-wall systems, but rather a combination of the two: interrelated systems, where changing conditions continually affect both primary and secondary pipes.

IPEX's Experience

By investing heavily in people and technology, IPEX has amassed more than 23 years of expertise in design and fabrication of double containment systems. In addition, IPEX is the only manufacturer of double containment systems offering all of the following:

- A specialized and dedicated division dealing exclusively with double containment.
- The ability to manufacture a large majority of double containment components in-house.
- A variety of materials including thermoplastics, thermosets, and metallic and dissimilar systems.
- Both drainage and pressure systems.
- A patented system with 60% fewer joints than conventional systems.
- Both off-the-shelf and custom-designed systems.
- Cable as well as point-of-collection leak detection systems.

Double Containment Systems

With such breadth and depth of products, IPEX offers customers proven designs that best suit their needs. Because of the large variety of systems available, it would be difficult to include all of them in one publication. Therefore this manual deals specifically with those systems most commonly used, including:

- **Encase™**, a polypropylene piping system that uses proven Enfusion joining methods to provide an easy-to-install, safe, reliable and cost-effective method to convey chemical waste under gravity-flow conditions.
- **Guardian™** systems. Made from PVC and Corzan® CPVC, these systems offer a complete selection of pre-tested modular components that are considered unmatched in the industry. Installed using its patented Centra-Lok™ design, Guardian reduces the number of joints in a system by as much as 60%.
- **Clear-Guard™** is a fail-safe, fully pressure rated clear containment system which allows for easy detection of leaks and eliminates the risks associated with piping aggressive chemicals overhead. Clear-Guard utilizes Guardian's patented Centra-Lok fitting design, which reduces the required joints by 40-60%. Fittings are available in clear or "cost saving" opaque containment fittings.
- **CustomGuard®** systems. Together with Encase and Guardian, CustomGuard sets IPEX apart from any other double containment system. CustomGuard is available in several different materials including carbon and stainless steel, copper, fiberglass, plastics and dissimilar materials. Unlike other manufacturers, IPEX is not constrained by a limited material selection. This variety enables IPEX to provide customers with the best solution for their double containment needs.
- **Centra-Guard™**, a cable leak detection system that offers an economical pro-active solution against potential containment challenges. Its automated, trouble-free and user-friendly design guards against environmental damage and the high cost of clean up.

Please contact your IPEX representative for details on all other systems not included in this manual.

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Section Two: Encase™

Overview

The Encase System has been designed to overcome the deficiencies of existing double containment systems. Some of the features and benefits of the system are described below.

Polypropylene Material

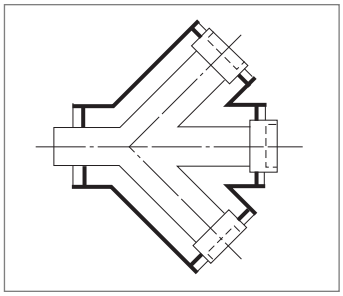
- Thirty years of success in chemical waste applications.
- High corrosion resistance.
- Wide temperature range.
- Excellent chemical resistance.

Same Material Inside and Out

- Eliminates differential expansion problems.
- Chemical resistance is the same for the entire piping system.
- System integrity is maintained in the event of a primary pipe leak.

Restrained System

- Expansion anchor plates are installed on each fitting to control expansion.
- No expansion loops necessary.



Full Product Range

- 1-1/2" to 8" primary sizes available.
- Manufactured in both non-flame retardant as well as flame retardant material for above ground installation.

Drainage Pattern Fittings

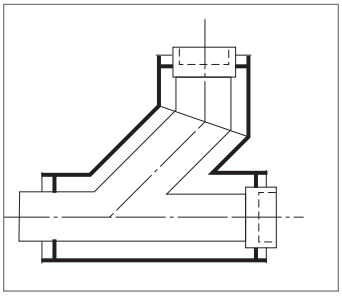
- Ensures smooth chemical flow.

Proven System

- Enfield piping has been used for chemical waste for over 23 years.

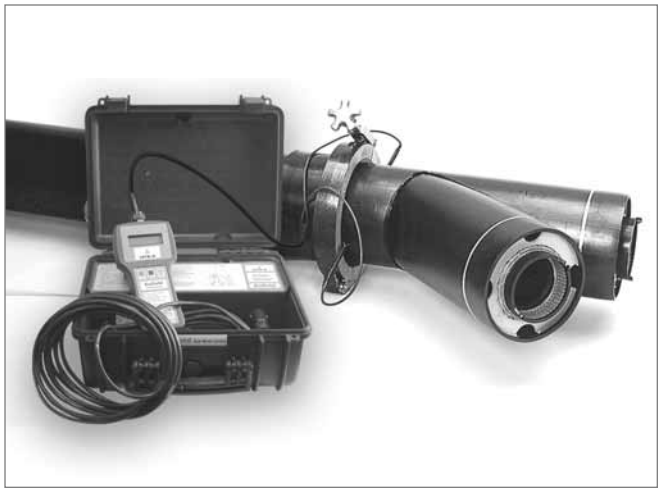
Modular Design

- Components are factory fabricated. The only site joining necessary is the fusion of couplings to pipes and fittings.
- Reduces labor costs.



Fast Joining Method

- All site joints are made by electrofusion using an Enfusion Hand Held Unit. Joints are completed in minutes, without the need for costly and cumbersome butt fusion machines.
- Quick and simple to make.
- Proven technology.
- Narrower trench widths than for butt fusion, resulting in quicker and cheaper installation.
- Joints can be made in the trench. This reduces installation time.
- Automatic microprocessor-controlled Enfusion unit ensures joint repeatability.



Easy System Testing

- The primary pipe can be inspected and tested prior to closing the secondary joint (impossible with butt-welded systems).
- Any suspect primary joints can be re-fused prior to final closure of the secondary pipe.

Leak Detection Compatible

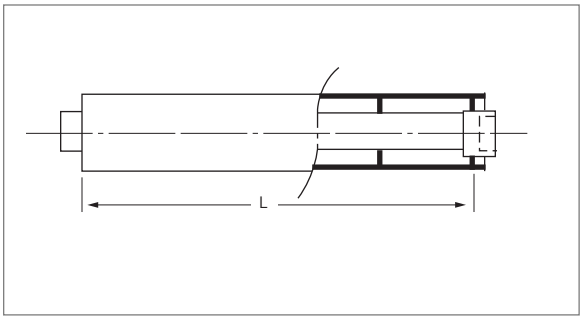
- Encase is compatible with all common types of leak detection systems.
- Upon request, pipe is furnished with knot-free twine to allow insertion of a pull rope for leak detection cable installation. This minimizes installation time.

Full Product Backup

- Expert personnel are available to assist in every facet of the Encase product.

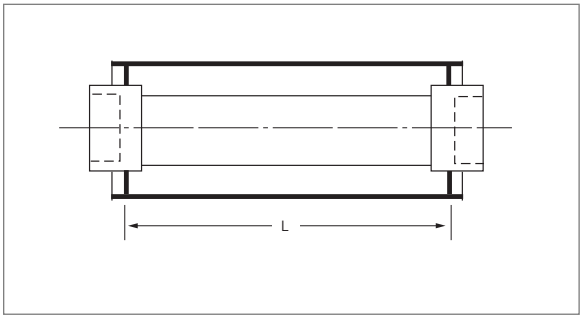
ENCASE™ DIMENSIONS

Pipe- Schedule 40, Socket x Spigot



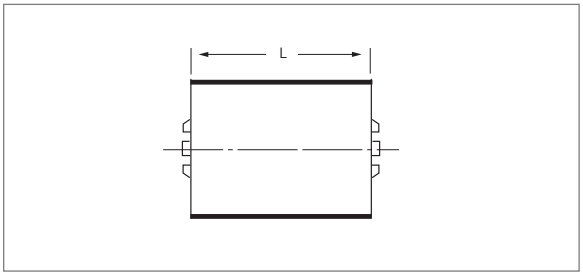
Primary/Secondary	Part No.	L (ft)
1-1/2 / 4	264150	20
2 / 4	264200	20
3 / 6	266300	20
4 / 7	268400	20
6 / 10	261060	20
8 / 12	261280	20

Pipe Spool- Schedule 40, Socket x Socket



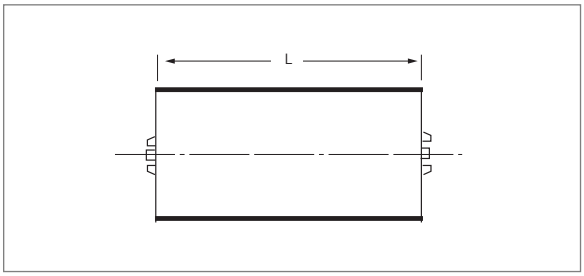
Primary/Secondary	Part No.	L
1-1/2 / 4	314150	MADE TO ORDER
2 / 4	314200	
3 / 6	316300	
4 / 8	318400	
6 / 10	311060	
8 / 12	311280	

Secondary Coupling - Socket



Secondary Size	Part No.	L (in.)
4	024000	57/8
6	026000	57/8
8	028000	63/8
10	021000	9
12	021200	10

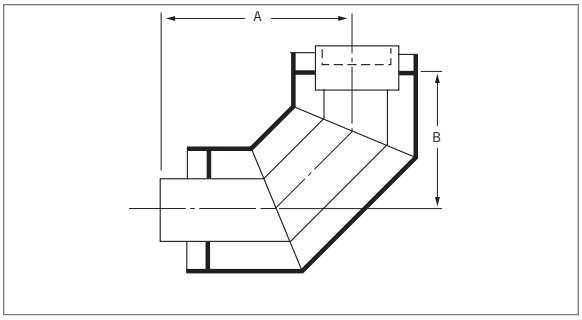
Secondary Repair Coupling - Socket



Secondary Size	Part No.	L (in.)
4	014000	8-5/8
6	016000	10-5/8
8	018000	11-1/2
10	011000	11-1/2
12	011200	11-1/2

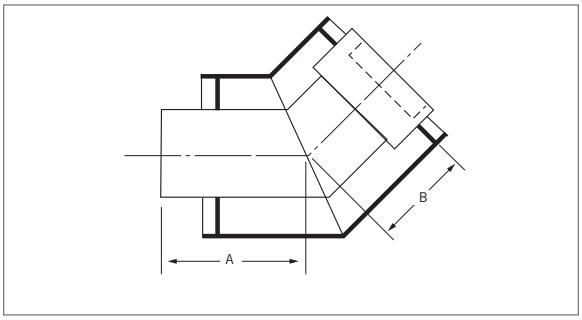
ENCASE™ DIMENSIONS

1/4 Bend - Socket x Spigot



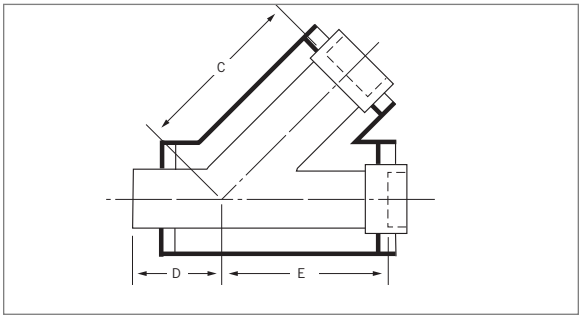
Primary/Secondary	Part No.	A (in.)	B (in.)
1-1/2 / 4	044150	12-3/8	11-1/4
2 / 4	044200	12-5/8	11
3 / 6	046300	13-7/8	11-1/8
4 / 8	048400	15-7/8	13-1/4
6 / 10	041060	20-3/8	14-5/8
8 / 12	041280	23	16

1/8 Bend - Socket x Spigot



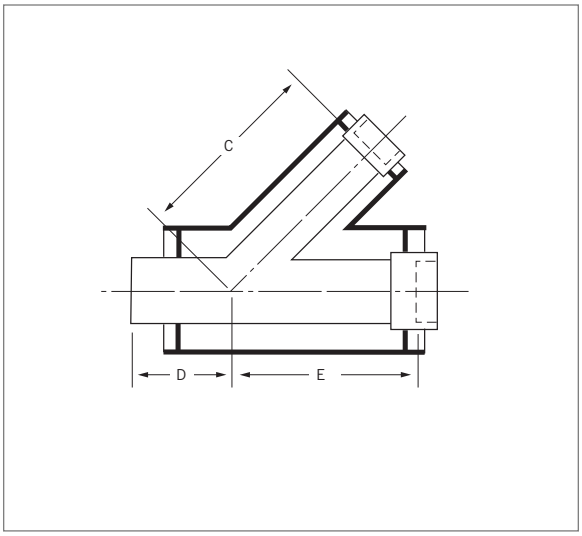
Primary/Secondary	Part No.	A (in.)	B (in.)
1-1/2 / 4	064150	8	6-7/8
2 / 4	064200	8-1/4	6-5/8
3 / 6	066300	9-1/8	6-3/8
4 / 8	068400	10-1/8	7-1/2
6 / 10	061060	13-7/8	8
8 / 12	061280	15-1/2	8-3/8

Equal Wye - Socket x Spigot x Socket



Primary/Secondary	Part No.	C (in.)	D (in.)	E (in.)
1-1/2 / 4	124150	9	8-1/8	9
2 / 4	124200	8-3/4	8-3/8	8-3/4
3 / 6	126300	13	9-1/8	13
4 / 8	128400	16-1/8	10-1/4	16-1/8
6 / 10	121060	18-3/4	13-7/8	18-3/4
8 / 12	121280	21-1/8	15-1/2	21-1/8

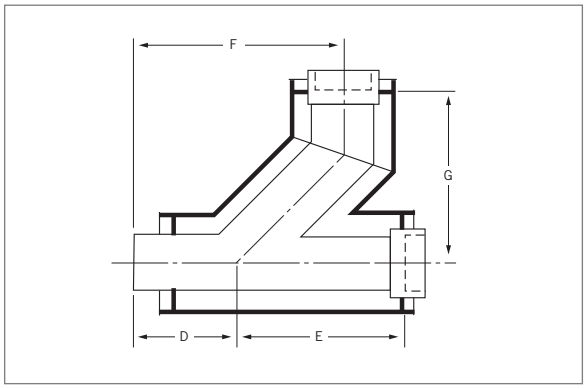
Reducing Wye - Socket x Spigot x Socket



Primary	Secondary	Part No.	C (in.)	D (in.)	E (in.)
2 x 1-1/2	4 x 4	154215	9	8-3/8	8-3/4
3 x 1-1/2	6 x 4	156315	12-1/2	7-5/8	11-1/2
3 x 2	6 x 4	156320	12-1/4	7-5/8	11-1/2
4 x 2	8 x 4	158420	13-3/4	7-1/4	13-1/4
4 x 3	8 x 6	158430	14-3/8	8-3/4	14-3/4
6 x 2	10 x 4	151062	14-3/4	9-3/8	14-1/2
6 x 3	10 x 6	151063	16-1/8	10-7/8	15-7/8
6 x 4	10 x 8	151064	17-3/4	12-3/8	17-1/4
8 x 3	12 x 6	151283	17-5/8	12	16-1/8
8 x 4	12 x 8	151284	19-1/2	12-5/8	18-1/4
8 x 6	12 x 10	151286	20-5/8	14-1/8	19-3/4

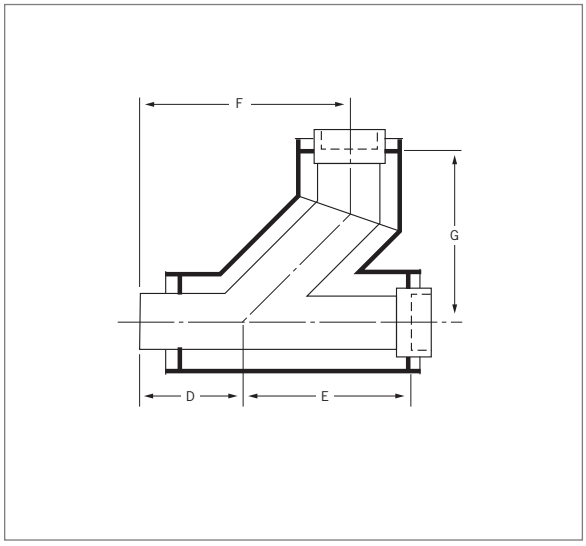
ENCASE™ DIMENSIONS

Comb. Wye & 1/8 Bend – Socket x Spigot x Socket



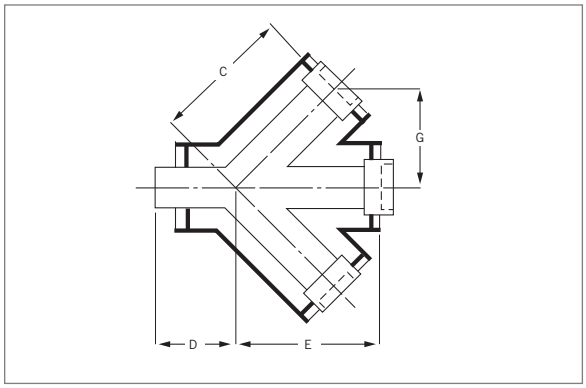
Primary	Secondary	Part No.	D (in.)	E (in.)	F (in.)	G (in.)
1-1/2	4	174150	8-1/8	9	15-7/8	12-1/4
2	4	174200	8-3/8	8-3/4	16-1/8	12
3	6	176300	9-1/8	13	19-3/4	17
4	8	178400	10-1/4	16-1/8	22-1/2	20
6	1	171060	13-7/8	18-3/4	26-7/8	22-1/2
8	12	171280	15-1/2	19-1/8	33-5/8	26-1/2

Reducing Comb. Wye & 1/8 Bend - Socket x Spigot x Socket



Primary	Secondary	Part No.	D (in.)	E (in.)	F (in.)	G (in.)
2 x 1-1/2	4 x 4	204215	8-3/8	8-3/4	13-5/8	12-1/4
3 x 1-1/2	6 x 4	206315	7-5/8	11-1/2	17-1/8	14-1/4
3 x 2	6 x 4	206320	7-5/8	11-1/2	17-3/8	14
4 x 2	8 x 4	208420	7-1/4	13-1/4	16-3/4	15-1/4
4 x 3	8 x 6	208430	8-3/4	14-3/4	20-1/4	17-7/8
6 x 2	10 x 4	201062	9-3/8	14-1/8	17-7/8	18-3/4
6 x 3	10 x 6	201063	10-7/8	15-7/8	25-3/8	20-3/4
6 x 4	10 x 8	201064	12-3/8	17-1/4	25-7/8	21
8 x 3	12 x 6	201283	11-1/4	17	26-1/4	21-3/8
8 x 4	12 x 8	201284	12-5/8	18-1/4	27-3/8	22-1/4
8 x 6	12 x 10	201286	14-1/8	16-3/4	30-1/4	24-1/8

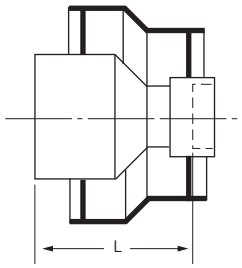
Double Wye - Socket x Spigot



Primary	Secondary	Part No.	D (in.)	E (in.)	F (in.)	G (in.)
1-1/2	4	224150	9	8-1/8	9	6-3/8
2	4	224200	8-3/4	8-1/4	8-3/4	6-3/16
3	6	226300	14	9-1/8	13	9-1/4
4	8	228400	16-1/8	10-1/4	16-1/8	11-3/8
6	10	221060	18-3/4	13-7/8	18-3/4	13-1/4
8	12	221280	21-1/8	15-1/2	21-1/8	15

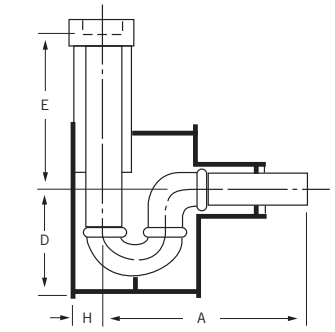
ENCASE™ DIMENSIONS

Reducer Coupling - Socket x Spigot



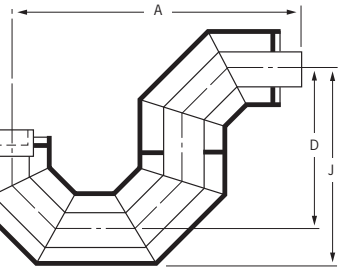
Primary	Secondary	Part No.	L (in.)
2 x 1-1/2	4 x 4	344215	5-7/8
3 x 1-1/2	6 x 4	346315	10-3/8
3 x 2	6 x 4	346320	11-3/8
4 x 1-1/2	8 x 4	348415	11-5/8
4 x 2	8 x 4	348420	11-3/4
4 x 3	8 x 6	348430	13-1/4
6 x 1-1/2	10 x 4	341061	18
6 x 2	10 x 4	341062	17-3/4
6 x 3	10 x 6	341063	15-7/8
6 x 4	10 x 8	341064	14-1/2
8 x 3	12 x 6	341283	19-3/4
8 x 4	12 x 8	341284	18-1/2
8 x 6	12 x 10	341286	15-1/4

P-Trap - Socket x Spigot



Primary	Secondary	Part No.	A (in.)	D (in.)	E (in.)	H (in.)
1-1/2	4	374150	13-3/8	8-1/4	8	3-3/8
2	4	374200	13-1/8	8-1/4	7-3/4	3-3/8

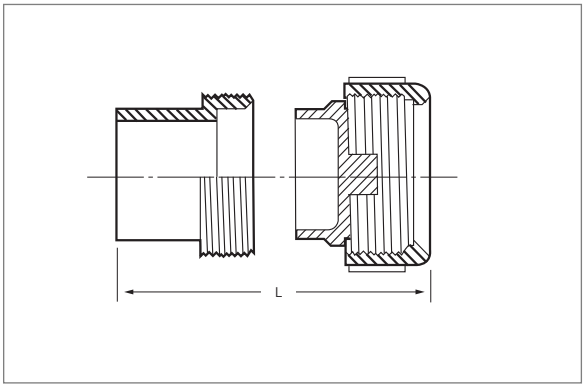
P-Trap - Socket x Spigot



Primary	Secondary	Part No.	A (in.)	D (in.)	J (in.)
3	6	376300	31-3/4	22-3/4	26-1/16
4	8	378400	37-1/2	25-1/8	29-3/16
6	10	371060	42	31-5/8	37
8	12	371280	44-5/8	37-1/4	35-1/8

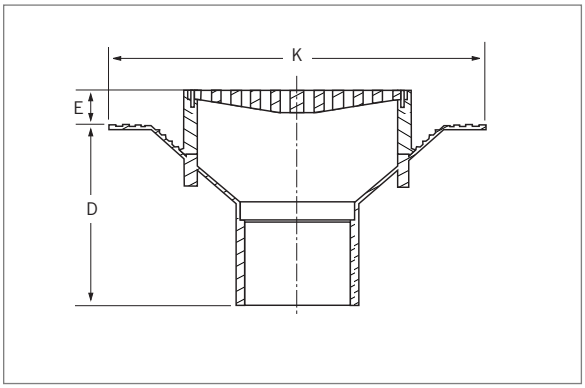
ENCASE™ DIMENSIONS

Cleanout - Spigot



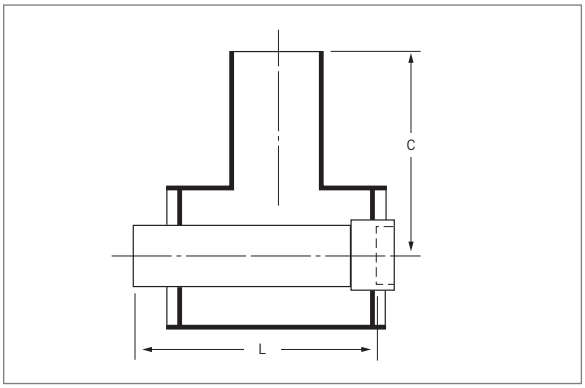
Primary	Part No.	L (in.)
1-1/2	L241	3
2	L242	3-1/8
3	L243	4-1/2
4	L244	4-3/4
6	L246	6-7/8

Floor Drain - Spigot



Primary	Secondary	Part No.	D (in.)	E (in.)	K (in.)
1-1/2	4	514150	11-1/8	1-1/2	14-1/2
2	4	514200	11-3/8	1-1/2	14-1/2
3	6	516300	6-3/4	1-1/2	14-1/2
4	8	518400	7	1-1/2	14-1/2
6	10	511060	6-5/8	1-1/2	14-1/2

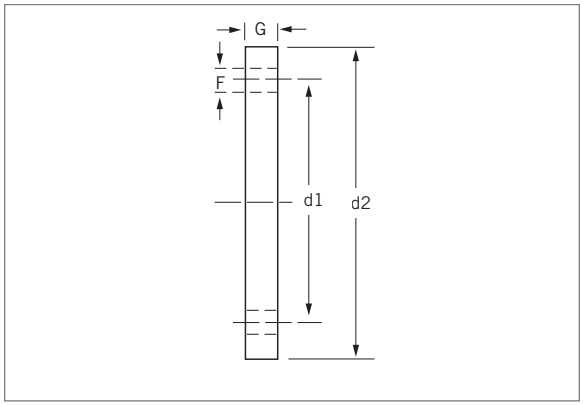
Access Tee - Socket x Spigot x Spigot



Primary	Secondary	Part No.	C (in.)	L (in.)
1-1/2	4	544150	11	15-3/4
2	4	544200	11	15-1/2
3	6 x 4	540643	12	17-1/4
4	8 x 4	540844	13	18-5/8
6	10 x 4	541046	14	21-7/8
8	12 x 4	541248	15	23-1/8

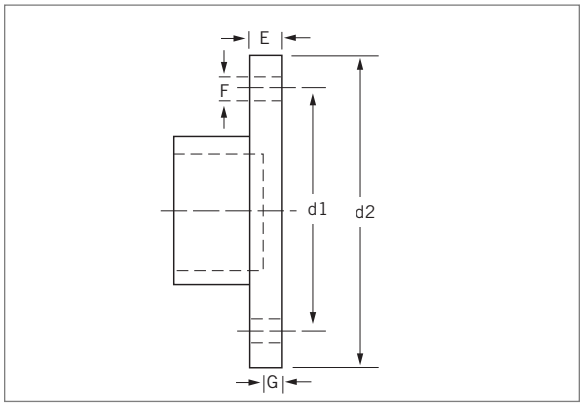
ENCASE™ DIMENSIONS

Blind Flange - ASA 150



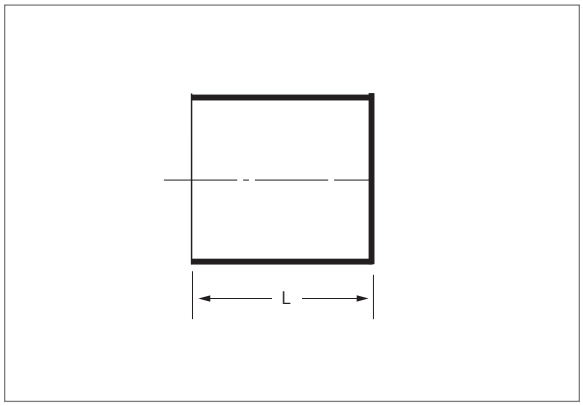
Size	Part No.	d1 (in.)	d2 (in.)	F (in.)	G (in.)
1-1/2	621500	3-7/8	5	3/4	3/4
2	622000	4-3/4	6	3/4	3/4
3	623000	6	7-1/2	3/4	3/4
4	624000	7-1/2	9	3/4	3/4
6	626000	9-1/2	11	7/8	3/4
8	628000	11-3/4	13-1/2	7/8	3/4
10	621000	14-1/4	16	1	3/4
12	621200	17	19	1	3/4

Flange - Socket, ASA 150



Size	Part No.	D1 (in.)	D2 (in.)	E (in.)	F (in.)	G (in.)
1-1/2	L361	3-7/8	5	1-1/8	9/16	5/8
2	L362	4-3/4	6	7/8	11/16	11/16
3	L363	6	7-1/2	1-1/4	11/16	7/8
4	L364	7-1/2	9	1-3/8	11/16	1-1/8
6	L366	9-1/2	10-7/8	1-3/8	13/16	1
8	L368	11-3/4	13-1/2	1-1/4	7/8	3/4
10	L3610	14-1/4	16	1-1/4	1	3/4
12	L3612	17	19	1-1/4	1	3/4

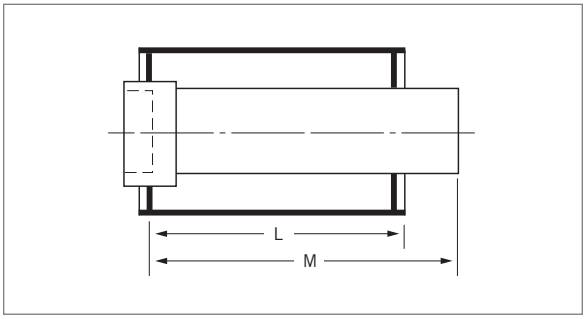
End Caps - Socket



Primary	Part No.	L (in.)
1-1/2	641500	1-3/4
2	642000	2-1/4
3	643000	3-1/8
4	644000	3-3/8
6	646000	4-1/2
8	648000	5
10	641000	5-3/8
12	641200	5-3/4

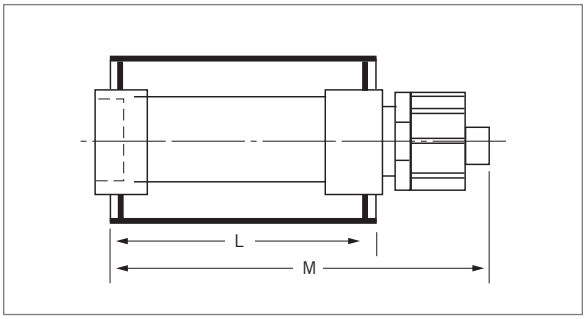
ENCASE™ DIMENSIONS

End Seal - Socket x Spigot



Primary	Secondary	Part No.	L (in.)	M (in.)
1-1/2	4	644150	8	24
2	4	664200	7-3/4	24
3	6	666300	8-1/2	24
4	8	668400	7-3/4	24
6	10	661060	6-3/4	24
8	12	661820	6-3/4	24

Cleanout Assembly - Socket



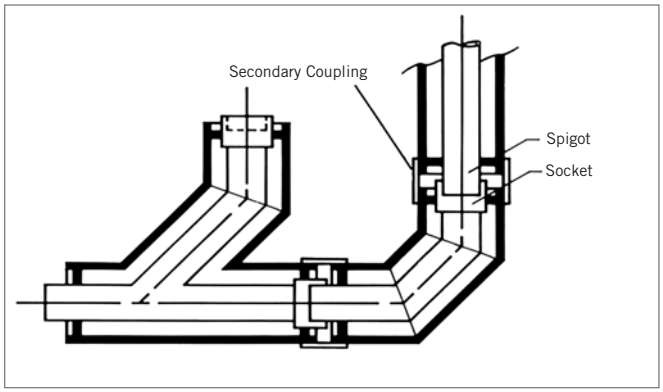
Primary	Secondary	Part No.	L (in.)	M (in.)
1-1/2	4	484150	8	12
2	4	484200	7-3/4	12
3	6	486300	8-1/2	12
4	8	488400	7-3/4	12
6	10	481060	6-3/4	12-1/2

Section Three: Encase™ Procedures

Installation

Pipe and Fittings Assembly

All pipes and fittings have a socket welded into position on the upstream side of the component, and a spigot on the downstream side. After fusing the primary joint, a secondary coupling is used to close the secondary sections together.



Enfusion™ Joints

Encase is easily joined by Enfield's Enfusion process. Both primary and secondary couplings are manufactured with an integral resistance wire which is precisely molded in place using a proprietary molding process. The wire is electrically heated by a microprocessor controlled Enfusion Hand Held Control Unit. This results in fusion, bonding the pipe to the fitting. Joining is achieved within minutes.

The Enfusion joint achieves the optimum level of performance where it matters most – at the joint interface. There is a controlled fit, controlled temperature and controlled time. All of this is achieved by the Enfusion Hand Held Control Unit, which ensures proper electrical connections, joint timing and input/output levels. The combination of these features provides both simplicity of joining and perfect control. The result is an unparalleled level of joint repeatability.

The integral resistance wire is manufactured from a chrome/nickel alloy, which allows for uniform electrical resistance and heating while offering excellent chemical resistance.The overall result is a joining method offering simplicity and efficiency, while guaranteeing repeatability.

Job site Precautions

1. Do not test the system using compressed air or gases. Only use a hydrostatic test on the system. ***Testing with air is dangerous.***
2. Store pipe and fittings out of direct sunlight. If material is stored outside, it should be covered with a black tarp. If the ambient temperature exceeds 100ºF, make provisions to allow air to circulate beneath the tarp.
3. Handle the Enfusion hand held unit carefully. ***Do not tamper!*** Call your IPEX representative for machine service.
4. ***Do not mix brands.*** Good joints can only be made using Enfield pipe, fittings and clamps. Mixing brands voids all warranties.

Installation

For installation in cold weather, refer to the 'Cold Weather Fusion' procedure described later in this section.

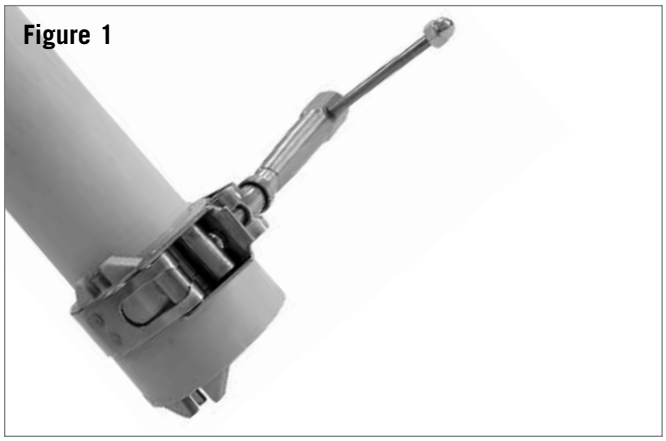
Before making the Enfield joint, it is important to check with an RMS meter, that the power source is providing between 96 and 162 volts @ 40 to 70 cycles with 11-amp capacity. The Enfusion hand held machine provides for normal power variations, however generators should be checked to assure the correct output is being provided.

1. Completely unwind all cables from the Enfusion machine's frame before use.
2. Using a tube cutter with a wheel designed for plastic (saw and miter box can also be used as an alternative), cut the pipe square making sure to remove all burrs and loose material. **Do not chamfer.**
3. Using 60-grit emery cloth, prepare the end of the pipe by removing dirt and oil (important to obtain a good bonding) and roughing up an area equal to 1.5 times the fitting's socket depth. Clean the roughed up area with ethyl or isopropyl alcohol to ensure complete removal of grease and residue. **Once treated do not handle this area of the pipe or allow it to get dirty.**
4. Insert the pipe all the way to the stop at the bottom of the socket.

5. Decide whether single or multiple joints are being made. In case of multiple joints consult the “Multiple Joints Fusion” table that follows for cable connections and maximum allowable number of simultaneous joints.

6. Loosely fit IPEX-supplied clamp(s) only over the hub(s) of the socket(s) to be fused. Clamps position must be flush with the outer edge of the socket (Figure 1).

Figure 1

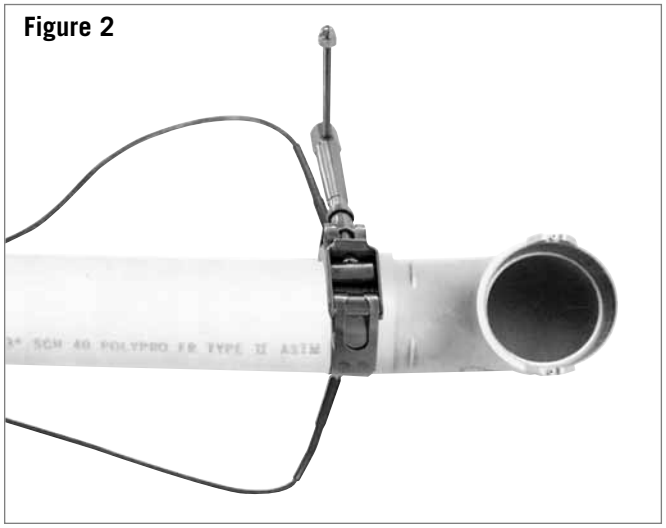


7. Tighten the clamp(s). A tight clamp is essential to the quality of the joint. **It should not be possible to rotate the pipe inside the fitting.**

8. Turn the Enfusion hand held machine on and observe the copyright message being displayed as the machine runs a self-diagnostic test.

9. Following the “CONNECT LEADS AND FITTINGS” instruction on the display, connect the output leads (Figure 2). If required, connect link cable for multiple fusions.

Figure 2



10. Following the “SELECT SIZE” instructions on the display, choose the size of the joint being fused by pressing the SELECT button until the proper diameter range is shown (Figure 3).

Figure 3

This will automatically set the fusion time.

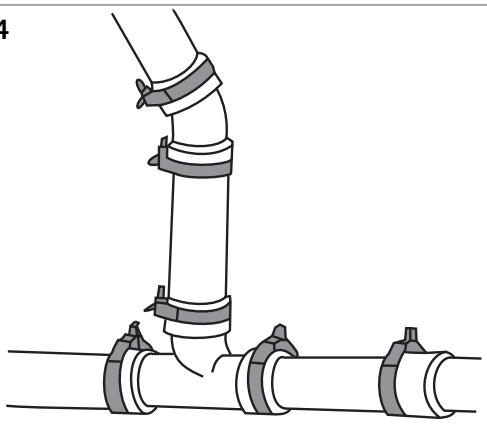
11. Once the correct size is displayed, press the START button. Temperature and welding time will be displayed. Press START again to begin. Time will count down to zero.

12. Upon completion of the fusion cycle an audible alarm will sound and the message ‘WELD COMPLETE DISCONNECT LEADS” will be displayed.

13. A 30 second rest period must be observed to allow the joint(s) to cool before disconnecting the leads. The Enfusion machine will automatically reset, ready for the next operation.

14. Allow five additional minutes before removing the clamps so that the joint can sufficiently cool and properly cure (Figure 4).

Figure 4



Note: If leads are accidentally disconnected during fusion the process "Reconnect Lead & Press Start" will appear and a 120 second countdown will begin on the hand held unit. Reconnect leads and press START to continue fusion. If leads are reconnected during the countdown, the fusion machine will automatically asses how long the fusion cycle must be depending on how long it has been disconnected. If the leads are not reconnected during the countdown the machine will sound an audible alarm and restart the fusion cycle time.

Trouble Shooting

Fault Codes

During operation, the welding unit monitors all aspects of its operation. If a fault occurs, an error message will be shown.

FAULT CODES	ACTION
1: Stuck button on start up	This fault shows when the power is first switched on. Either the Stop, Start, or Select button is stuck in. Free the button to clear the fault.
2: Output fault before weld start	This fault shows when the power is first switched on. The unit will check the output terminals to make sure no voltage is present when first switched on. If this fault happens, the internal power relays have stuck in the closed position. The unit will need to be returned for service.
4: No calibration	This fault happens when the unit has no calibration. This will normally not show and, if the unit has been calibrated, would be caused by a fault with the internal memory. Return the unit for service.
5: Low supply frequency < 40Hz	The unit has detected that the supply frequency is below 40 Hz. This will normally be caused by a poor quality generator. If this fault happens, check the supply or change the generator.
6: High supply frequency > 70Hz	The unit has detected that the supply frequency is above 70 Hz. This will normally be caused by a poor quality generator. If this fault happens, check the supply or change the generator.
7: High supply voltage > 162v	The unit has detected that the supply voltage is more than 162 volts. Check the supply voltage and, if necessary, use a different generator.
8: Low supply voltage < 96v	This fault can be caused by a few problems. It could be that the generator is running slowly and so the supply voltage is low. Try speeding the generator up or use a different generator. It could be caused by other tools drawing power from the same generator. Try dedicating the generator to the fusion tool alone. It could also be caused by a generator that is too small. If a large fitting is welded, a large amount of power will be needed from the generator. If it can not supply this power then it will stall and the voltage will drop away. Check that the generator is the correct size; if need be try another generator. It could be caused by the use of long extension leads. If a large fitting is welded, a high current will be taken from the supply. If extension leads are used, there will be a voltage drop down the lead making the unit sense a low supply voltage. Try not to use extension leads with the unit. If you have to, use just 30 feet of cable, the same size fitted to the unit.
9: Relay failed to latch on weld start	This fault could happen when the start button is pressed. If the main power relays do not operate correctly, this fault will be shown. The unit needs to be returned for service.

TROUBLE SHOOTING CON'T

FAULT CODES	ACTION
10: Welding current excessive (>150%)	This fault will happen if the welding current is more than 50% high for more than 0.3 seconds. This fault is normally caused by a fault within the unit, a short circuit triac. The unit must be returned for service.
11: Welding current high (>125%)	This fault will happen if the welding current is more than 25% high for more than 1 second. This fault is normally caused by a fault within the unit, a short circuit triac. The unit must be returned for service.
12: Welding current high (>112.5%)	This fault will happen if the welding current is more than 12.5% high for more than 1.5 seconds. This fault can be caused by a fault within the unit, a short circuit triac. It can also be caused by a poor quality generator with the supply voltage fluctuating. Try a different generator.
13: Welding current high (>106.25%)	This fault will happen if the welding current is more than 6.25% high for more than 2 seconds. This fault will normally be caused by a poor quality generator with the supply voltage fluctuating. Try a different generator.
14: Welding current high (>101.5%)	This fault will happen if the welding current is more than 1.5% high for more than 3 seconds. This fault will normally be caused by a poor quality generator with the supply voltage fluctuating. Try a different generator.
15: User stop button pressed	The operator has pressed the stop button.
16: Relay unlatched	During welding, if the main power relay disconnects this fault will be shown. It could be caused by the unit being knocked or a temporary dip in the power supply. If the fault persists, the unit should be returned for repair.
17: Fitting open circuit	This fault is shown if the output lead disconnects from the fitting while welding. Follow the guidelines from the fitting manufacturer, reconnect the lead, and try welding again.
18: Welding current low (<98.5%)	This fault will happen if the welding current is more than 1.5% low for more than 3 seconds. This can be caused by a generator that is not big enough to supply the required power to the fitting. Check the size of the generator and if need be try another generator. It can also be caused by using long extension leads with the unit. It is recommended that only 30 feet of extension be used, and the cable should be the same thickness as the input lead on the unit.
19: Welding current low (<50%)	This fault will happen if the welding current is more than 50% low for more than 1 second. It can be caused by a faulty fitting. Try another fitting. If this doesn't clear the fault then there is a problem inside the unit and it must be returned for repair.
20: Power off failure	The power has been turned off while the unit is welding.

Repair Information

There are no user serviceable parts inside the welding unit. If an internal fault happens with the unit then it must be returned to IPEX for repair. Please contact your local IPEX distributor for instructions on the proper return of your enfusion unit.

Specification

Operating Mode	Enfield Automatic
Operating Language	English
Operating Temperature	0ºF to 120ºF
Input Voltage	120V ac 96V to 162V (-20% + 35%)
Input Current	10.5 A
Input Frequency	50 Hz 40 Hz to 70 Hz
Input Power	100 VA to 1250 VA
Output Current	18 A ac true rms
Output Voltage	3 V to 50 V ac true rem
Output Power	50 W to 900 W
Output Stability	+/- 1.5%
Welding Temperature Bands	COLD: 0ºF to 39ºF NORMAL: 40ºF to 87ºF HOT: 88ºF to 120ºF
Power Factor	0.72
Unit Weight	33 lb
Hand Held Weight	2.2 lb
Size	15.7" x 12.6" x 6.3"
Environmental Protection	IP65
Lead Length (to power case)	3.3 ft
Lead Length (to hand held unit)	33 ft
Lead Length (to fitting)	6.6 ft

Cold Weather Fusion

Whenever possible pipe and fittings should be stored indoors. It is always preferable to perform pipe preparation and welding in a protected environment. However, should that not be possible, during cold weather (particularly at freezing or below) it is recommended that both pipe and fittings be stored in similar ambient temperature and conditions.

In addition, when the actual welding takes place in freezing or sub-freezing environments, this cold weather pre-fusion procedure must be followed.

1. Follow steps 1 through 9 of Standard Enfield Electrofusion Installation.
2. When the “SELECT SIZE” prompt appears on the screen keep pushing the select button until all pipe sizes have been displayed.
3. Next will appear the first flash cycle: 11/2" to 2".
4. If the fitting(s) being welded is within this flash range, press START.
5. If the fitting(s) being welded is not included in this flash range, press the SELECT button one more time to display the second flash cycle: 3" through 12".
6. Press START.
7. Upon completion of the flash cycle, the display will show the “WELD COMPLETE DISCONNECT LEAD” message. Do not disconnect the leads.
8. Tighten clamps if necessary (see notes below).
9. Allow 1-1/2" to 3" joints to cool for 5 minutes, 4" to 8" joints to cool for 7 minutes and 10" to 12" joints to cool for 10 minutes before beginning the fusion cycle.
10. After cooling, continue with steps 10 through 14 of the Standard Enfield Electrofusion Installation procedure.

Notes: Screen the joints being fused from the wind in very cold conditions to prevent heat loss. Particular care must be taken to adequately tighten the clamps during extremely cold weather because of increased stiffness of the materials. One or two additional turns of the tightening screw might be required, above and beyond what is commonly sufficient in fair weather conditions. This is particularly true when welding large diameters. The additional tightening of the clamps, designed to eliminate any gap between the pipe and the fitting, should be performed towards the end of the flash cycle. However, care must be taken not to over-tighten to avoid distorting or crushing the fitting joint.

Marking of the pipe (indicating socket depth) is also recommended to assure that the pipe remains fully seated in the socket during the fusion cycle.

Multiple Joint Fusion

The chart indicates the maximum number of joints (of one size) that can be fused at a time.

Maximum Allowable Joints Per Size

Pipe Size *(inches)*	1-1/2	2	3	4	6	8	10	12
Max # of joints	10	8	4	3	2	1	1	1

Attach the connector leads and link cable leads to fitting terminals as shown in Figure 6. ***The link cables should be connected in series.*** Follow the fusion procedure, as outlined in steps 1-14, to complete the multiple fusion.

Note: Each joint being fused must have an IPEX clamp flush with the outer edge of the socket.

Multiple Size Joint Fusion

The new hand held control unit utilizes fusion size ranges. These ranges adjust fusion time and output for two groups of fittings; Group A: 1-1/2" to 2" and Group B: 3" to 12". When fusing multiple joints it is possible to fuse different sizes as long as they are in the same Group and their diameter sizes, when added together, do not exceed an equivalent total of 12.

Example A

1 x 8" and 1 x 4" = 12.

Therefore one 8" fusion and one 4" fusion could be done at the same time.

Example B

1 x 8" and 2 x 3" = 14.

Therefore one 8" fusion and two 3" fusions could not be done at the same time.

The Tables below show all multiple size fusions possible for each fusion range.

Group A: 1-1/2" to 2" Fusion Range

Pipe Size (in)	Multiple Size Joint Fusion Combinations					
	Option A	Option B	Option C	Option D	Option E	Option F
1-1/2"	6	5	4	3	2	1
2	1	2	3	3	4	5
Equivalent Total:	11	11.5	12	10.5	11	11.5

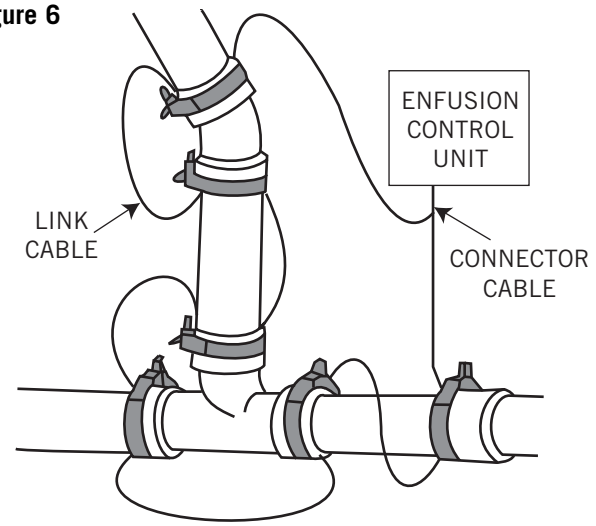
Group B: 3" to 12" Fusion Range

Pipe Size (in)	Multiple Size Joint Fusion Combinations						
	Option A	Option B	Option C	Option D	Option E	Option F	Option G
3	2	2	1	1	1		
4		1	2			1	1
6	1			1		1	
8					1		1
10							
12							
Equivalent Total:	12	10	11	9	11	10	12

In-Field Joining

The Encase system is manufactured in modular form from factory-assembled components. Minimal site fabrication is required and therefore site installation time is cut to a minimum. The only joining necessary is to fuse the primary and secondary pipe with Encase couplings. Both primary and secondary joints can be assembled in the trench, or above-ground local to the trench, depending on the site conditions. The general principles for fusing the primary and secondary Encase couplings to the Encase pipe is essentially the same as that described above – with some slight modifications in procedure. These are detailed in the following section.

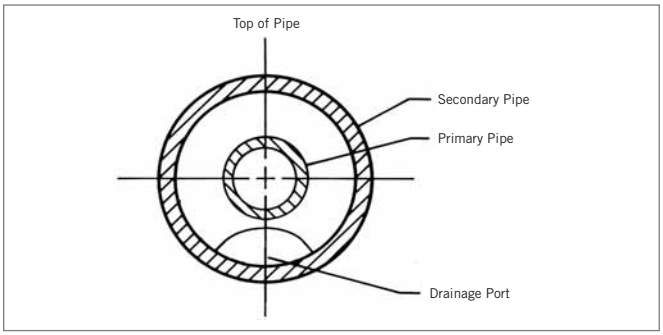
Figure 6



Primary Pipe Joining

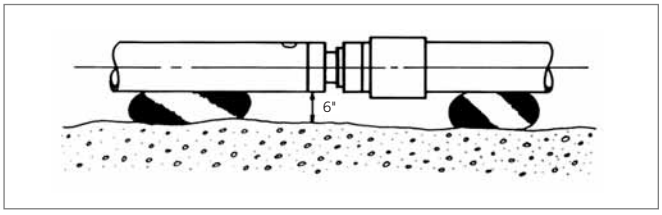
Prior to commencing joining, ensure the trench has been correctly prepared to accept the Encase system. Suggested trench and bedding preparation details are shown in Section Eight of this manual under “Buried Pipe”.

1. After preparing the trench, the Encase components should be placed in position with the pipe ends aligned for joining. Each pipe is labelled to facilitate correct alignment. Make sure there is at least 6” of clearance all around the pipe local to the joints to allow easy access.
2. It is essential that the anchor plate at each end of the pipe is positioned so that the drainage and leak detection cable port is at the bottom of the pipe.

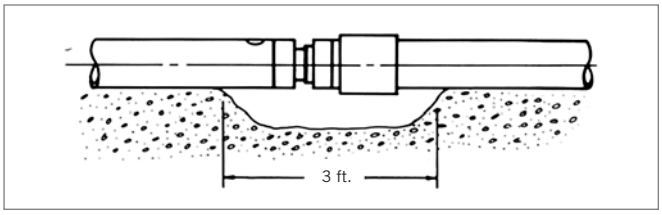


3. All fittings have four access ports to allow the fittings to be installed at the desired angle. Both pipe and fittings are supplied with twine to simplify installation of leak detection cable after primary joining. Make sure the twine is placed out of the way prior to commencing work.

4. Lay the pipe on sandbags in the trench to facilitate setting the necessary fall on the pipe run to allow free drainage as dictated by the local codes. This also allows easy access for pipe joining.

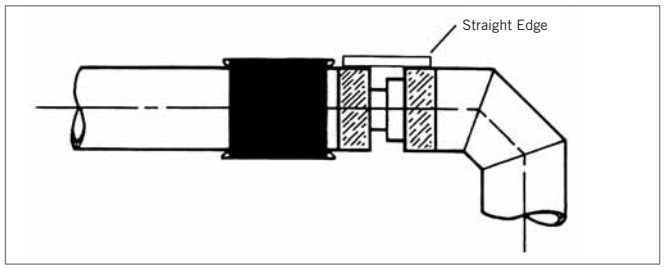


5. Alternatively, the trench bed may be completely covered with sand or pea gravel. In this case, the bedding material must be removed from underneath the secondary pipe to a depth of 6" and along a length of three feet either side of the joint centerline, to allow insertion and fusion of the secondary coupling.

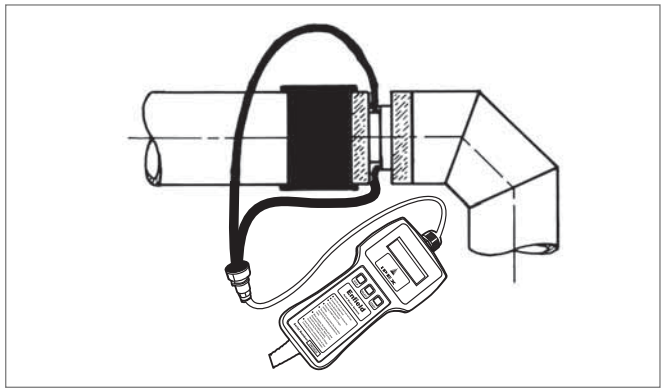


6. Clean off the outside surfaces of both the primary and secondary pipe sections, making sure that all moisture, mud and grit is removed and that the primary coupling is also clean.
7. Slide the secondary coupling over the one section of the pipe to be joined so that it is out of the way and does not interfere with the primary joining process.

8. Make sure the primary joint is properly aligned before fusion. We suggest a straight edge be placed across the gap (as shown) to ensure the joint is square before joining.

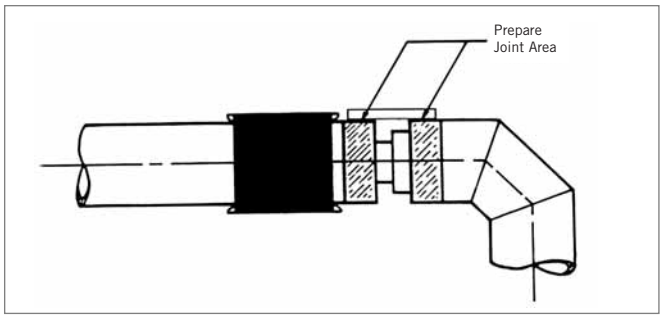


9. Prepare and fuse the primary pipe in the manner outlined on pages 11 and 12.



Secondary Pipe Joining

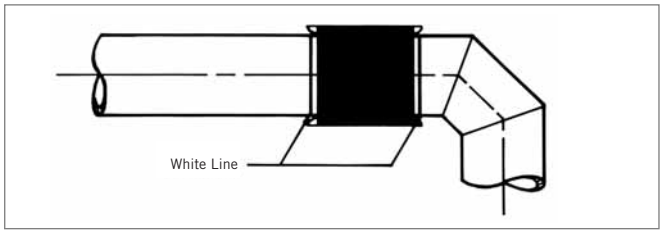
10. The ends of all fittings and pipe sections are marked with a white line to show where the secondary coupling should be positioned for joining. Make sure that all dirt, oil, water and grease is removed from the area between the pipe/fitting end and the white line, and then lightly abrade the pipe surfaces with a 60-grip emery cloth.



CAUTION: It is essential that the white lines are visible on either side of the coupling prior to commencing the joining operation.

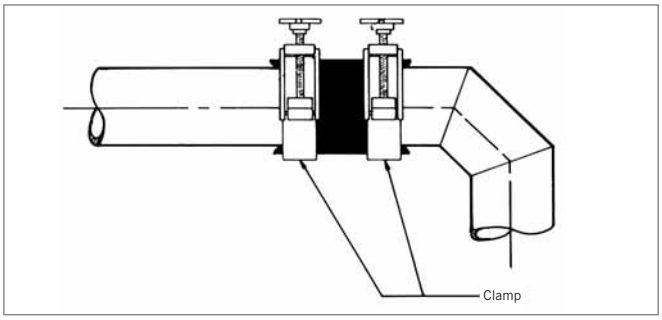
Failure to position the secondary coupling centrally between the white lines may result in the fusion wires being in contact with the secondary pipe. If this happens, the wire will overheat and a poor joint will result.

11. Slide the secondary coupling back over the joining area and onto the mating pipe/fitting. The coupling MUST be centrally located between the white lines of the mating components before fusing.



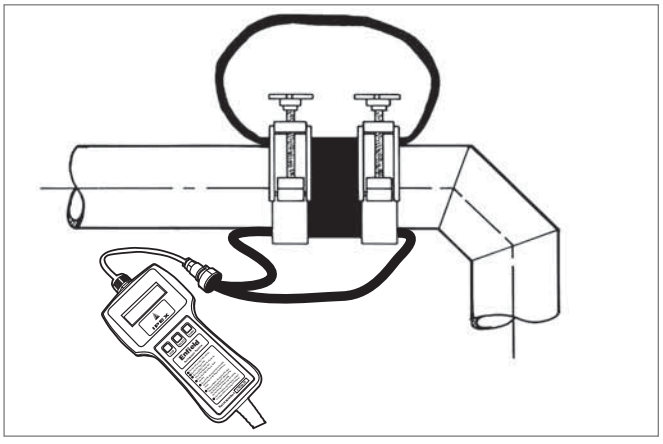
12. Place one secondary clamp on the outside edge of each end of the coupling and tighten. It is usually necessary to tighten by hand followed by three or four turns of a hand wrench to fully lock the secondary coupling into position. It is essential that, after tightening the clamp, the fit of the secondary coupling onto the pipe/fitting is checked. The coupling MUST NOT move. It if does, the clamp should be tightened further until the coupling is FIRMLY LOCKED onto the pipe/fitting.

Note: Extremes in ambient temperature may result in secondary clamps bottoming out before full pressure on the coupling can be achieved. Should this occur, the clamp must be replaced. When the coupling is correctly locked in place, the clamps should still have a gap between the clamp jaws. This must be verified prior to joint fusion.



13. Connect the blue Enfusion lead to the secondary coupling, select the correct fitting size and complete the Enfusion cycle as described previously in the 'Joining Procedure'.

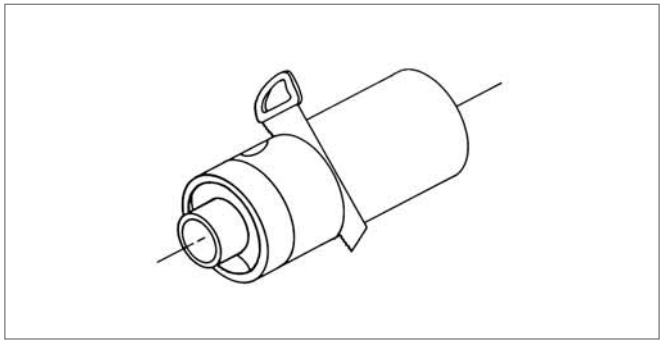
14. Leave the joint undisturbed for 10 minutes, after which time the secondary clamps can be removed and the system pressure tested according to the procedures detailed under 'Testing' at the end of this section.



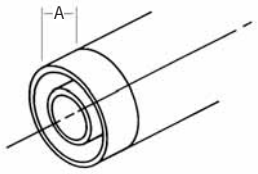
Pipe Modifications

Encase is factory-supplied in modular form ready for site assembly. The only fabrication that may be necessary in the field is modifying the pipe lengths. This should be done from the spigot end only and can be easily accomplished as shown below.

1. Mark the desired cutting length on the outside of the secondary pipe and transpose this mark around the entire circumference.
2. Cut squarely through both the secondary and primary pipe sections using a sharp carpenter's saw or band saw.

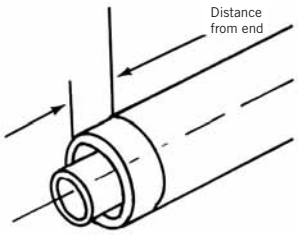


3. Mark the secondary pipe dimension 'A' from the end as shown in the table below and transpose this mark around the secondary pipe circumference.



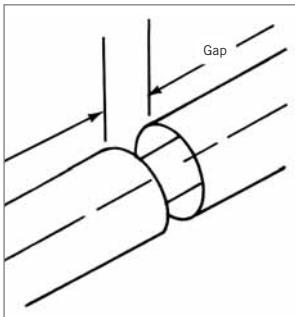
Size (in)	Spigot A (in)
1-1/2 / 4	1-1/8
2 / 4	1-3/8
3 / 6	1-3/4
4 / 8	1-7/8
6 / 10	2-5/8
8 / 12	2-7/8

4. Cut squarely through the secondary pipe, taking care not to cut into primary pipe, using a sharp carpenter's saw or large diameter pipe cutter.
5. Clean any burrs from the pipe ends.
6. Mark a pencil line on the end of the secondary pipe to locate the joining positions for the secondary coupling. The pencil line should be at the following distances from the pipe ends:



Size (in)	Dist. From End
1-1/2 / 4	2-3/8
2 / 4	1-3/8
3 / 6	2-9/16
4 / 8	2-5/8
6 / 10	3-3/4
8 / 12	4-1/4

7. Double-check the gap dimension to make sure the spigot length is correct before fusing the joint.



Size (in)	Gap (in)
1-1/2 / 4	1-1/8
2 / 4	1-1/4
3 / 6	3/4
4 / 8	1-1/8
6 / 10	1-1/2
8 / 12	1-1/2

Pipe Clean Out

Encase can be assembled a number of different ways in order to clean out the system. The individual pipe lengths and fittings can be assembled on-site from standard components to give the following configurations:

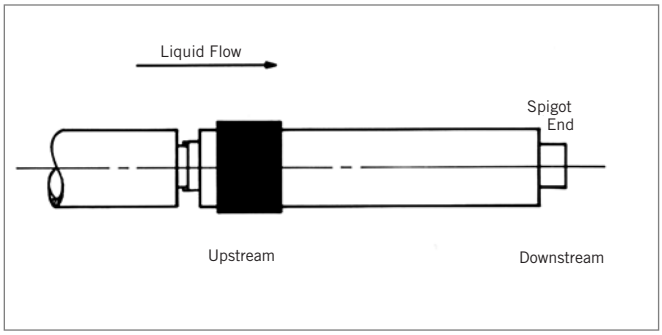
1. The secondary pipe vented and drained.
2. The secondary pipe completely sealed with no provision for draining or venting.

1. Secondary Pipe Vented and Drained

Spigot ended cleanout plugs, part number L24, can be used in sizes up to 6". The clean out can be used as follows.

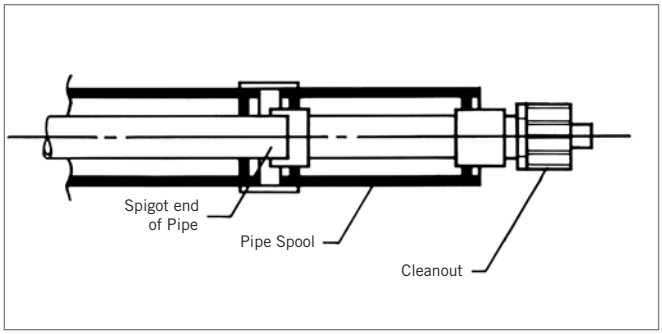
Pipe Assembly

All pipe is installed so that the downstream end is a primary spigot connection.

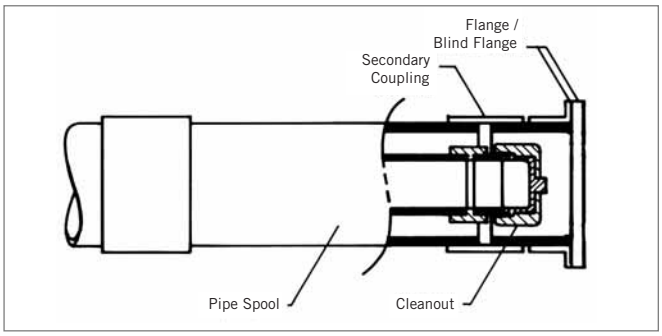


By fusing a pipe spool, part number Series 31, to the end of the system, the secondary pipe can be vented to atmosphere, as shown in the diagrams below.

First a pipe spool is fused to the downstream end of the pipe run. A cleanout plug, part number series L24, is then fused into the socket of the pipe spool.



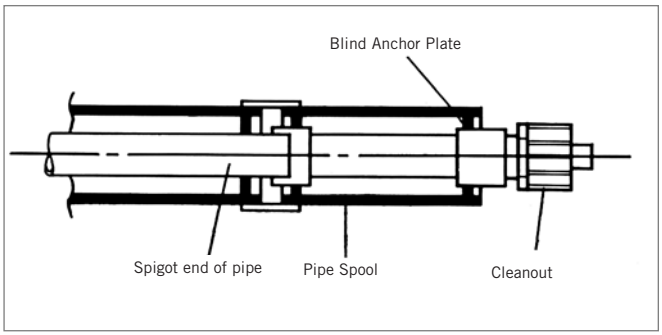
The assembly is completed by fusing a secondary coupling attached to a short section of secondary pipe, flange and blind flange, as shown in the diagram.



2. Secondary Pipe Sealed

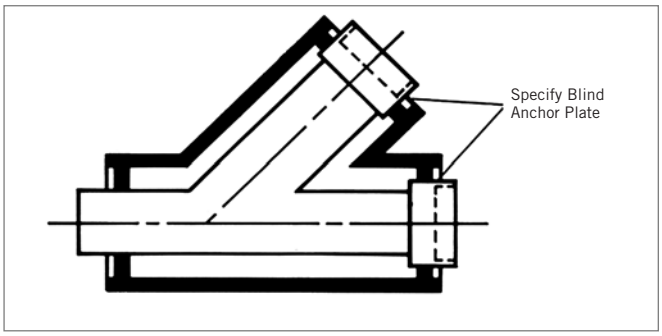
Pipe Assembly

Instead of using a pipe spool, a clean out spool is fused to the downstream end of the pipe run. It has a built-in clean out, plus a blind anchor on the downstream side of the spool. This allows for clean out of the primary pipe, while closing off the space between the primary and secondary pipe sections.



Fitting Assembly

Simply order the required number of fittings with a blind anchor plate at the clean out end. IPEX will supply the clean outs and blind fittings for site assembly.

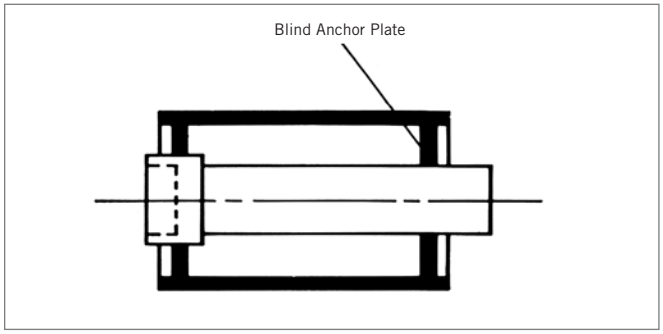


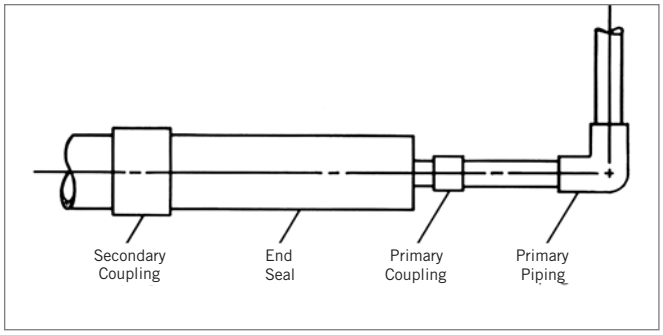
Pipe Termination Fittings

Pipes and fittings can be terminated with clean outs as described above, or by using “end seals”, “end caps” or flanges/blind flanges.

End Seals

End seals are used where the secondary pipe section is being terminated, but the primary pipe is continued. The end seal, part number series 66, shown below, is used for this purpose. The downstream anchor plate is blind.





End Caps and Flanges/Blind Flanges

End caps and flanges are socket-ended and can be fused to either the primary or secondary pipe runs to give a more permanent termination than a clean out.

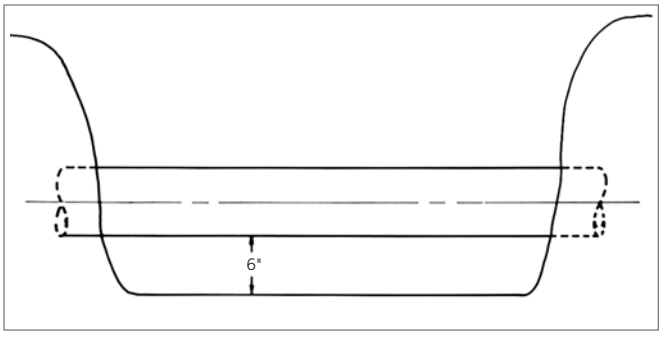
Pipe Repair

In the unlikely event of a leak from the primary pipe, Encase can be easily repaired. Encase secondary piping is designed with the same chemical resistance and integrity as the primary pipe. This means that the Encase system can continue to be used even after a leak has been detected. This enables the end-user to make the necessary repairs during a scheduled shutdown rather than having to instantly shut the plant down, with the consequential loss of production.

Procedure

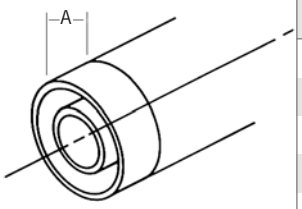
The leak detection system will activate an alarm and indicate the location of the leak (generally to within +/- one foot of the leak source for cable leak detection). Having been alerted to the presence of a leak, the plant operator may choose to either start immediate repairs, or wait for a scheduled maintenance shutdown. In any event, the plant operator should repair the pipe in the following manner:

1. Drain both the primary and secondary piping and then flush through with water to remove any residual chemicals
2. Open the cable access tees located on either side of the leak area, then carefully disconnect and remove this part of the leak detection cable from the system. (Remember to attach a pull rope to the cable prior to removal. This will enable the cable to be reinserted after the pipe repair has been completed.) The cable should be dried and stored in a clean area.
3. Excavate the ground near the pipe leak, taking care not to cause damage to the pipe in the process. Hand digging is suggested. The ground should be excavated to a depth of at least 6" below the bottom of the pipe.



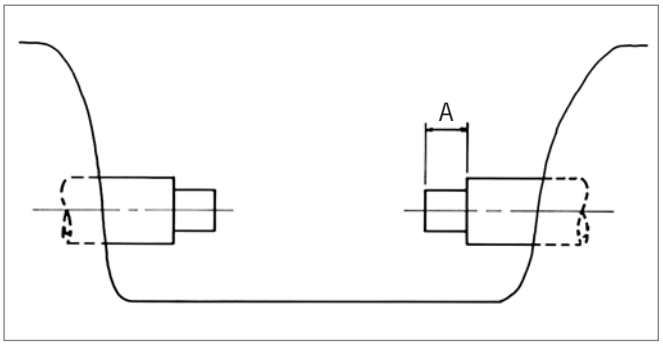
4. Measure the length of pipe to be removed then cut completely and SQUARELY through the primary and secondary pipe sections. Remove the leaking section of pipe.

5. Mark the secondary pipe dimension 'A' from the end as shown in the table below and transpose this mark around the secondary pipe circumference.



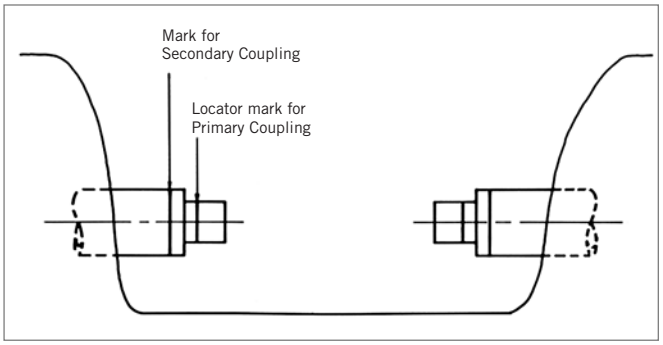
Primary/Secondary Size (in)	Gap (in)
1-1/2 / 4	1-1/8
2 / 4	1-3/8
3 / 6	1-3/4
4 / 8	1-7/8
6 / 10	2-5/8
8 / 12	2-7/8

6. Cut squarely through the secondary pipe ends, taking care not to cut into the primary pipe. Clean any burrs from pipe ends.

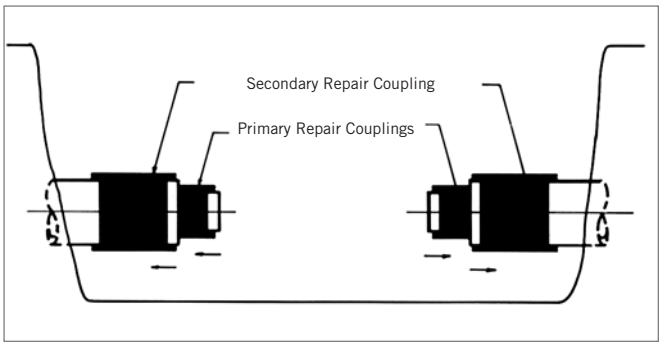


7. Mark a pencil line on the ends of each primary and secondary pipe section to locate the joining position for the primary and secondary repair couplings. The pencil line should be at the following distances from the pipe ends.

Primary Size (in)	Primary Mark (in)	Secondary Size (in)	Secondary Mark (in)
1-1/2	3/4	4	2-1/8
2	1	4	2-1/8
3	1-3/8	6	1-7/8
4	1-1/2	8	1-7/8
6	2	10	1-1/8
8	2-1/4	12	2-7/16

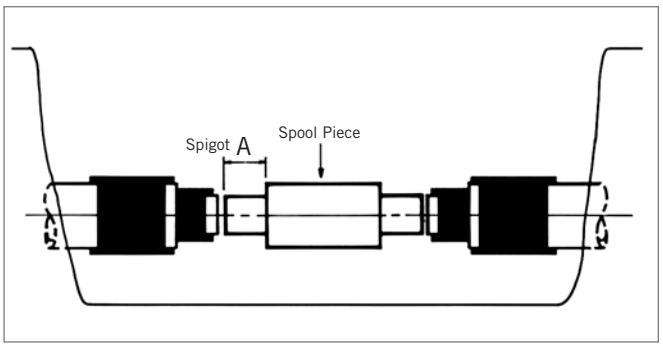


8. Slide one secondary repair coupling over each end of the exposed secondary pipe sections, and one primary repair coupling over the exposed spigots of the primary pipe sections.



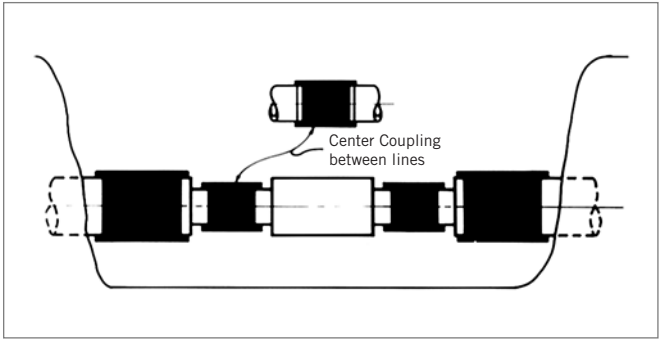
9. Measure, prepare and insert a pipe spool piece into the line to be repaired. For dimensions refer to the table that follows.

Note: IPEX will cut and supply short pipe lengths to suit site conditions. Please contact our Customer Service Representatives for details.

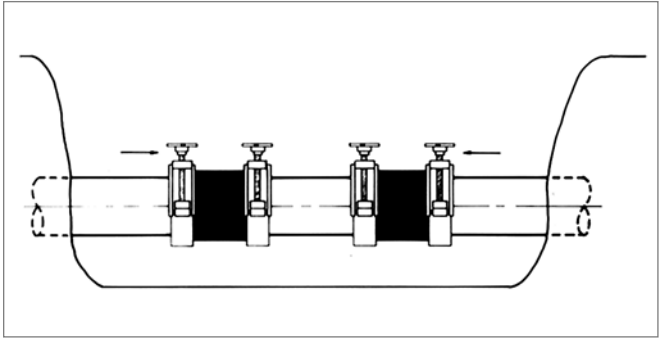


Primary Size	Secondary Size	Spigot A
1-1/2	4	1-1/8
2	4	1-3/8
3	6	1-3/4
4	8	1-7/8
6	10	2-5/8
8	12	2-7/8

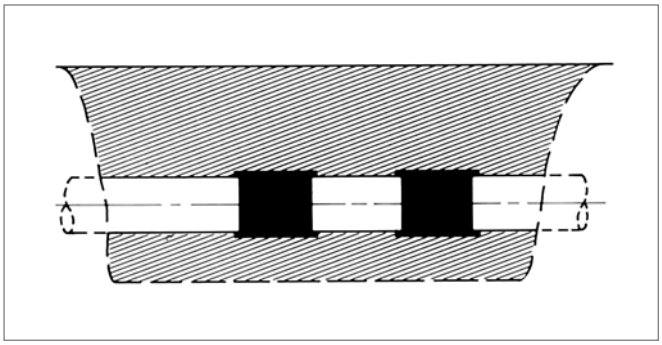
10. Prepare the primary and secondary pipe sections for joining, as described earlier in Section 4. (See 'Primary Pipe Joining' and 'Secondary Pipe Joining').
11. Slide the primary repair couplings back into position to close the joint. Make sure they are centrally located between the pencil marks previously scribed onto the primary spigot ends. Place the hub clamps over the primary repair couplings and fuse the joints in the normal manner.



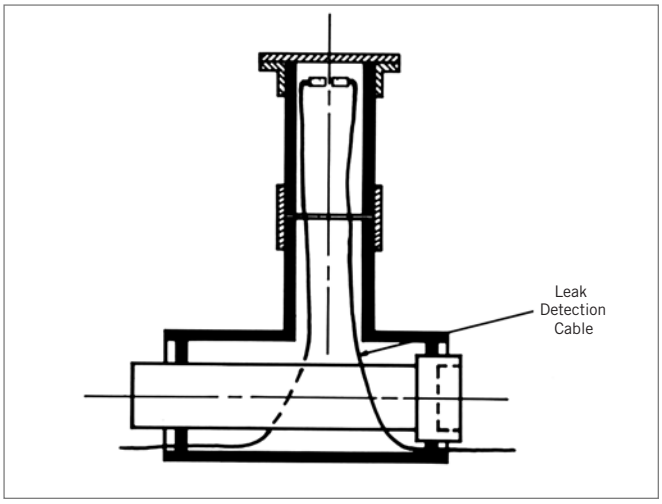
12. Remove the hub clamps after allowing the joints to cool for 10 minutes.
13. Test the primary joints as detailed in the next section.
14. Slide the secondary repair couplings into position between the pencil lines previously scribed onto secondary pipe ends. Place the secondary clamps over the secondary repair couplings and fuse the joints as described in 'Secondary Pipe Joining'.



15. Remove the hub clamps after allowing the joints to cool for 10 minutes.
16. Test the secondary joints as detailed in the next section, then fully drain the system.
17. Surround the pipe with pea gravel, then backfill and consolidate.



18. Purge the gap between the primary and secondary pipe section with dry nitrogen, or air, making sure the pressure does not exceed 5 psi.
19. Replace the leak detection cable and re-seal the access tees.



20. Close any drain valves.
21. Reset the leak detection alarm module.

TESTING

The purpose of a site pressure test is to establish that all joints have been correctly made. Encase allows for the individual testing of the primary and secondary piping.

Primary Pipe

Hydrostatic testing of the primary joint can be performed ten minutes after the final primary joint has been completed. The pressure testing procedure detailed below should be strictly followed.

1. Fully inspect the installed piping for evidence of mechanical abuse and suspect joints.
2. Split the system into convenient test sections, not exceeding 1,000 ft. The piping should be capped off with an expandable plug at the end of the pipe section to be tested.
3. Prior to starting the test, straight lengths of pipe should be backfilled between fittings that are tested.
4. Slowly fill the pipe section with cold water, taking care to evaluate all trapped air in the process. Use air release valves in any high spots in the system. Do not pressurize at this stage.
5. Leave the pipe for at least one hour to allow an equilibrium temperature to be achieved.
6. Visually check the system for leaks. If clear, check for, and remove any, remaining air from the system.
7. Pressurize the system to a suggested maximum of 10 feet head by means of a standard 10 foot standing water test using a 10 foot vertical riser, or a low-pressure hand pump.
8. Leave the line at 10 feet head for a period of up to eight hours, during which time the water level should not change (standing water test), nor should the pressure gauge reading change (hand pump test).
9. If there is a significant drop in pressure, or extended times are required to achieve the desired pressure, either joint leakage has occurred or air is still entrapped in the line. In this event, inspect for joint leaks. If none are found, check for entrapped air – this must be removed prior to continuing the test.
10. If joints are found to be leaking, the system must be fully drained and the joints repaired. Dry, or marginal, Encase joints can be simply re-fused by following the procedure detailed in this manual. Prior to re-fusing the joint, make sure the hub clamps are in position, then use the flash cycle to drive off any moisture left in the joint. Re-fuse using the correct time for the size of pipe being joined. It should not be necessary to cut out the joint, unless the joint has previously been overheated, contaminated or very badly made in the first instance. Where joints have to be cut out and replaced, the procedures for pipe modification detailed in this manual should be strictly followed.
11. Repeat the 10 feet head test after repairing any leaking joints, following the procedure described above.

Secondary Pipe - Hydrostatic Testing

1. After successfully completing the primary pipe 10 foot head test, the secondary pipe can be joined and tested. Do not drain the primary pipe. Simply leave the primary pipe at a 10 foot-head hydrostatic pressure to avoid any possibility of the primary pipe collapsing due to the external load from the secondary pipe test.
2. Fill the secondary pipe with cold water and repeat steps 5 to 11 in 'Primary Pipe' procedure..
3. After successfully completing the secondary pipe test, leave the primary pipe full of water and under pressure. Drain the secondary pipe and purge through with low pressure, dry (-100F dewpoint), air or nitrogen to purge out all moisture from the system.

Secondary Pipe - Air Testing

1. For cable leak detection systems, an alternative to hydrostatically testing the secondary pipe exists. This alternative testing uses dry, low pressure air, subject to the engineer and/or authority having jurisdiction.
2. Leave the primary pipe at a 10-foot head hydrostatic pressure to avoid any possibility of the primary pipe collapsing due to external load from the secondary pipe test.
3. Fill secondary pipe with air to a maximum of 5 psi for 1 hour using the Encase test cap (see below).

Note: For more information on lower pressure air testing of thermoplastic piping systems, reference Unibell B6.

4. While taking great care not to impact or damage the secondary pipe, the exposed secondary joints should be wiped with an IPEX approved leak detector. In addition, check the pressure gauge to make sure that there is no pressure decay. It is essential that the system is closely monitored and that the pipe suffers no impact or other damage during the test.

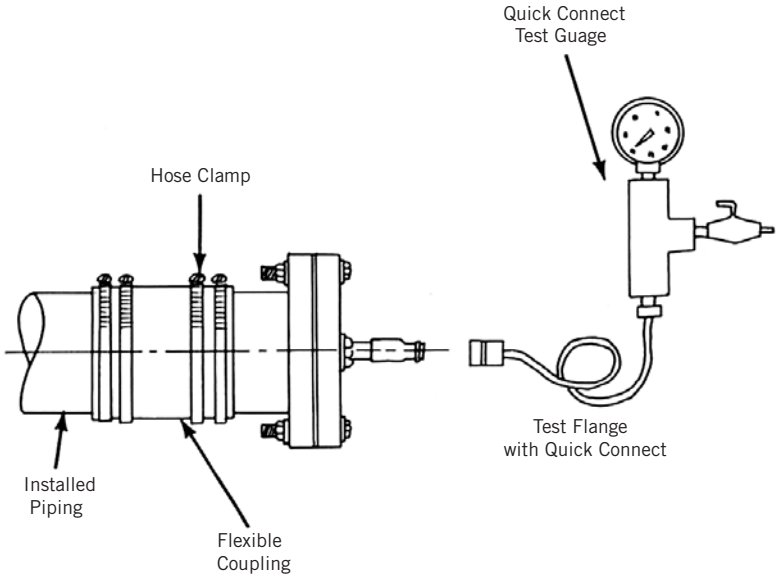
Note: If the secondary system is tested using air, IPEX recommends using the Encase test cap. This test cap is designed to be used with the system and will provide safe, repeatable test results. It comes complete with air valve, quick disconnect, gage and regulator valve. These test caps are available in all secondary pipe sizes. Contact our Customer Service Department to order.

⚠ WARNING

Take special care to avoid causing impact to the piping when testing the interstitial space of rigid thermoplastic systems using compressed gases. Impact to the system during air testing can cause failure which may result in injury or death.

Conduct this test only when the ambient temperature is 50ºF or above.

The secondary pipe should never be pressurized to any more than 5 psi when using air.



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Section Four: Guardian

Overview

Material Selection

Xirtec®140 PVC and Corzan® CPVC are the chosen materials for the Guardian systems. IPEX controls not only the design and fabrication of the systems, but also the blending of the PVC resin, the extrusion and injection molding of most components. This unparalleled consistency of quality and resin as well as dimensional compatibility results in superior systems that are unmatched in the industry.

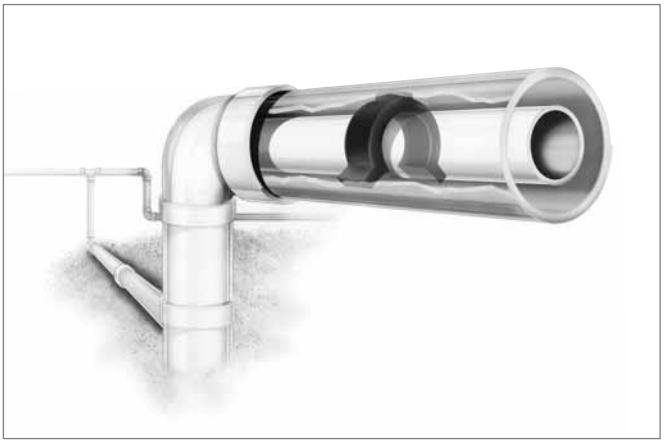
Clear-Guard utilizes a fail-safe, fully pressure rated clear PVC that uses a solvent cement jointing method identical to traditional vinyl pressure pipe. This eliminates the need for expensive caulking guns and epoxy adhesive for assembly. Clear-Guard can be used in conjunction with Both Schedule 40 and 80 Xirtec 140 PVC or Corzan CPVC Primary pipe.

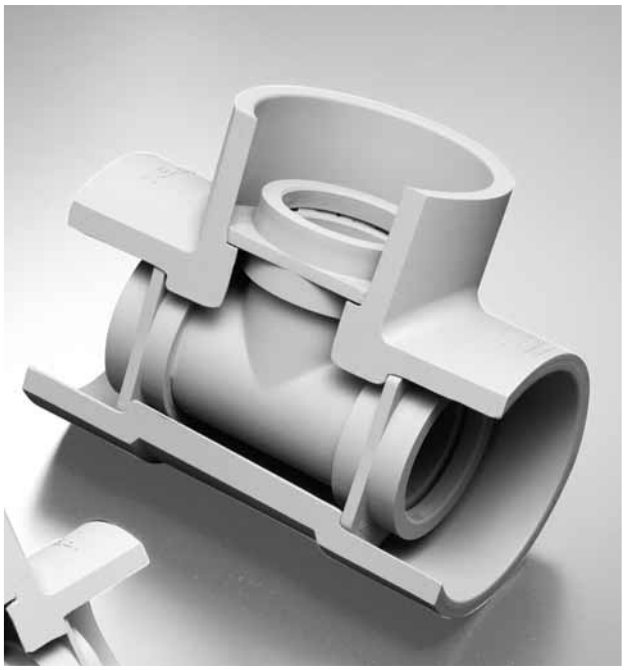
Design

Guardian and Clear-Guard systems offer a complete selection of pretested modular components which are extremely easy to install.

Our Centra-lok™ patented design allows IPEX to offer vinyl systems which average up to 60% fewer overall joints and up to 10% fewer field joints. Since joints are always the most common source of premature failures and leaks, it is easy to realize the immense impact the Centra-lok design has on maintenance, repair and installation costs. The patented ingenuity and simplicity of the Centra-lok design also reduces the purchase cost of IPEX systems, making Guardian and Clear-Guard the industry's most cost-effective vinyl system.

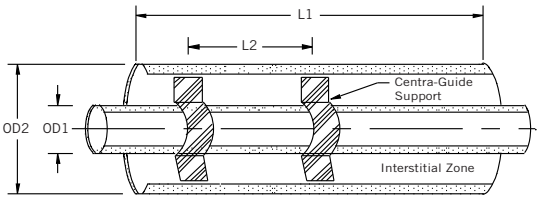
As with all our containment systems, the IPEX patented Centra-Guard™ point-of-collection or cable leak detection systems are also available.





GUARDIAN™ DIMENSIONS

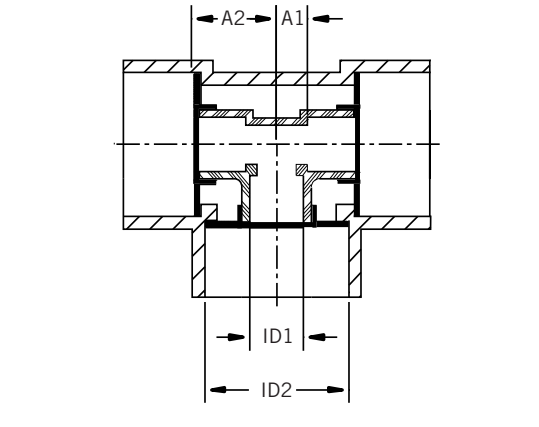
Vinyl / Vinyl Pipe



Note: Clear-Guard containment piping is available from 2" to 8".

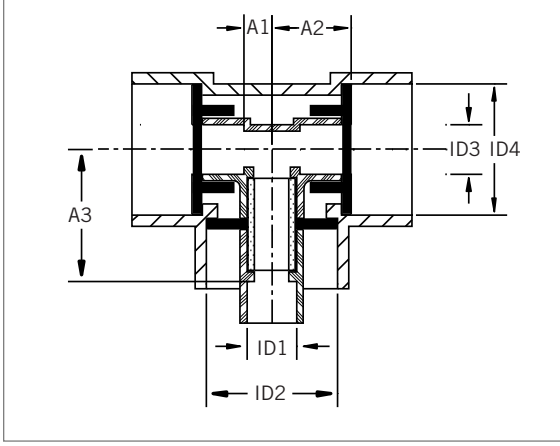
Carrier / Containment	L1 (ft)	L2 (ft)	OD1	OD2
1/2 x 2	20	5	0.84	2.38
3/4 x 3	20	5	1.05	3.50
1 x 3	20	5	1.32	3.50
3/4 x 4	20	5	1.05	4.50
1 x 4	20	5	1.32	4.50
1-1/2 x 4	20	5	1.90	4.50
2 x 4	20	5	2.38	4.50
2 x 6	20	5	1.38	6.62
3 x 6	20	5	3.50	6.62
4 x 8	20	5	4.50	8.62
6 x 10	20	5	6.62	10.75
8 x 12	20	5	8.62	12.75

Vinyl / Vinyl Centra-Lok™ Tee



Carrier / Containment	A1	A2	ID1	ID2
1/2 x 2	0.50	1.38	0.84	2.38
3/4 x 4	0.68	1.96	1.05	3.50
1 x 3	0.75	1.96	1.32	3.50
1-1/2 x 4	1.06	2.59	1.90	4.50
2 x 4	1.25	2.59	2.38	4.50
3 x 6	1.84	3.74	3.50	6.62
4 x 8	2.34	4.81	4.50	8.62

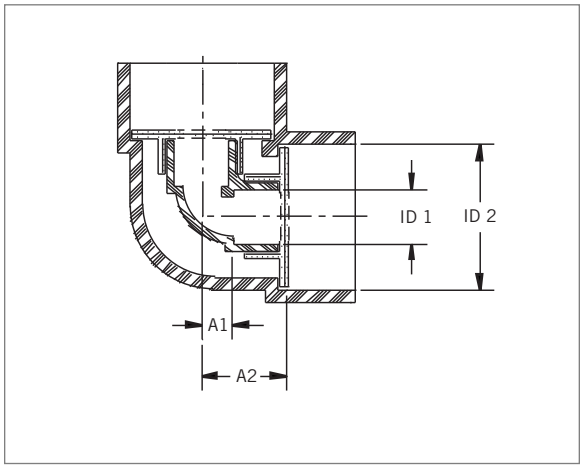
Vinyl / Vinyl Tee



Carrier / Containment	A1	A2	ID1	ID2
6 x 10	6.12	9.38	6.62	10.75
8 x 12	7.12	11.87	8.62	12.75

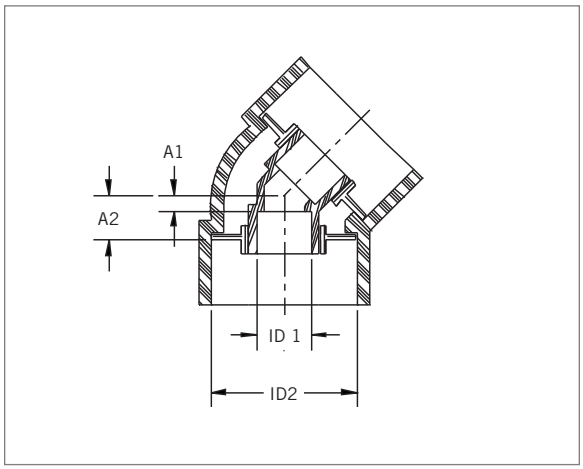
GUARDIAN™ DIMENSIONS

Vinyl / Vinyl Centra-Lok™ 90º Elbow



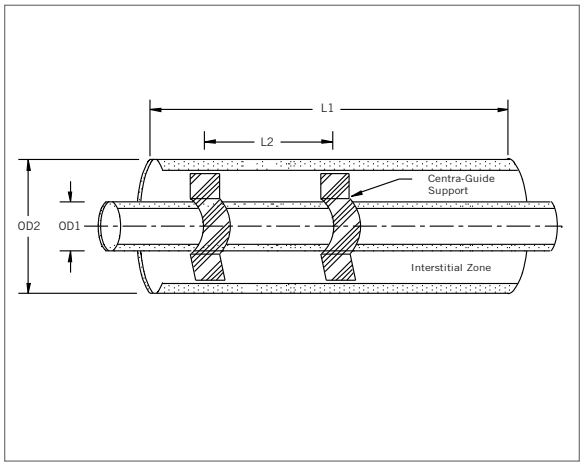
Carrier / Containment	A1	A2	ID1	ID2
1/2 X 2	0.50	1.38	0.84	2.38
3/4 X 3	0.68	1.96	1.05	3.50
1 X 3	0.75	1.96	1.32	3.50
1-1/2 X 4	1.06	2.59	1.90	4.50
2 X 4	1.25	2.59	2.38	4.50
3 X 6	1.84	3.74	3.50	6.62
4 X 8	2.34	4.81	4.50	8.62
6 X 10	3.50	5.93	6.62	10.75
8 X 12	4.56	6.93	8.62	12.75

Vinyl / Vinyl Centra-Lok™ 45º Elbow



Carrier / Containment	A1	A2	ID1	ID2
1/2 x 2	0.25	0.87	0.84	2.38
3/4 x 3	0.34	1.00	1.05	3.50
1 x 3	0.38	1.00	1.32	3.50
1-1/2 x 4	0.50	1.25	1.90	4.50
2 x 4	0.62	1.25	2.38	4.50
3 x 6	0.75	2.00	3.50	6.62
4 x 8	1.00	2.25	4.50	8.62
6 x 10	1.75	4.75	6.62	10.75
8 x 12	2.00	6.81	8.62	12.75

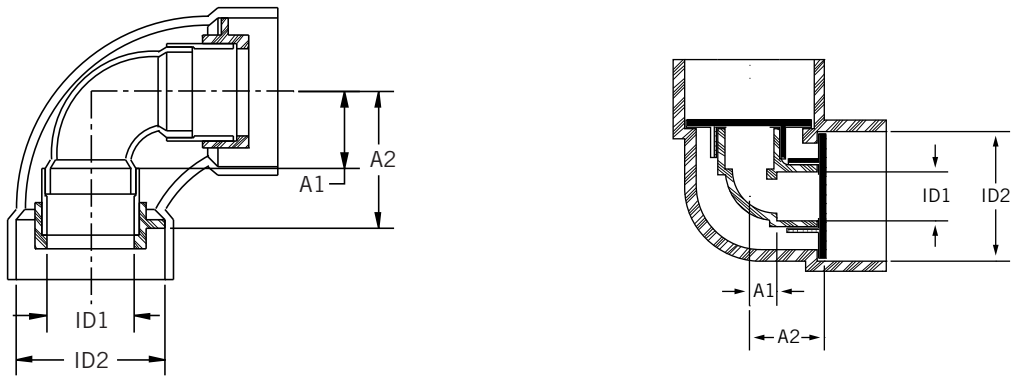
PVC DWV / PVC DWV Pipe



Carrier / Containment	L1 (ft)	L2 (ft)	OD1	OD2
1-1/2 x 4	20	5	1.90	4.50
2 x 4	20	5	2.38	4.50
3 x 6	20	5	3.50	6.62
4 x 8	20	5	4.50	8.62
6 x 10	20	5	6.62	10.75
8 x 12	20	5	8.62	12.75

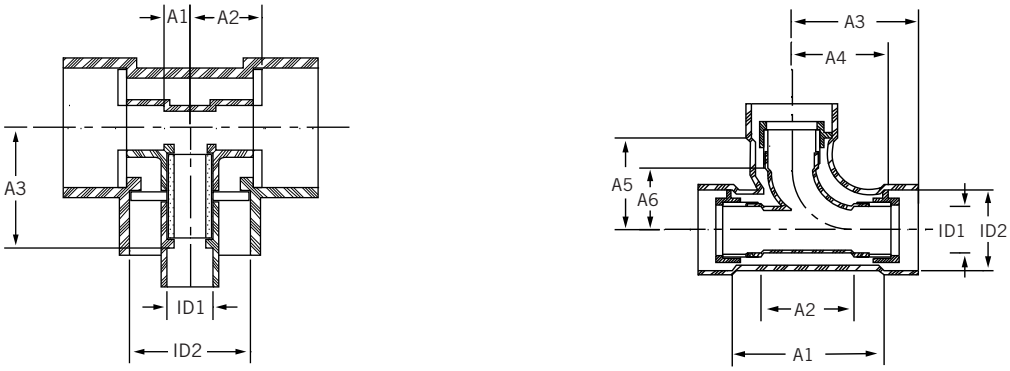
GUARDIAN™ DIMENSIONS

PVC DWV / PVC DWV 90º Elbow



Carrier / Containment	L1 (ft)	L2 (ft)	OD1	OD2
1-1/2 x 4	20	5	1.90	4.50
2 x 4	20	5	2.38	4.50
3 x 6	20	5	3.50	6.62
4 x 8	20	5	4.50	8.62
6 x 10	20	5	6.62	10.75
8 x 12	20	5	8.62	12.75

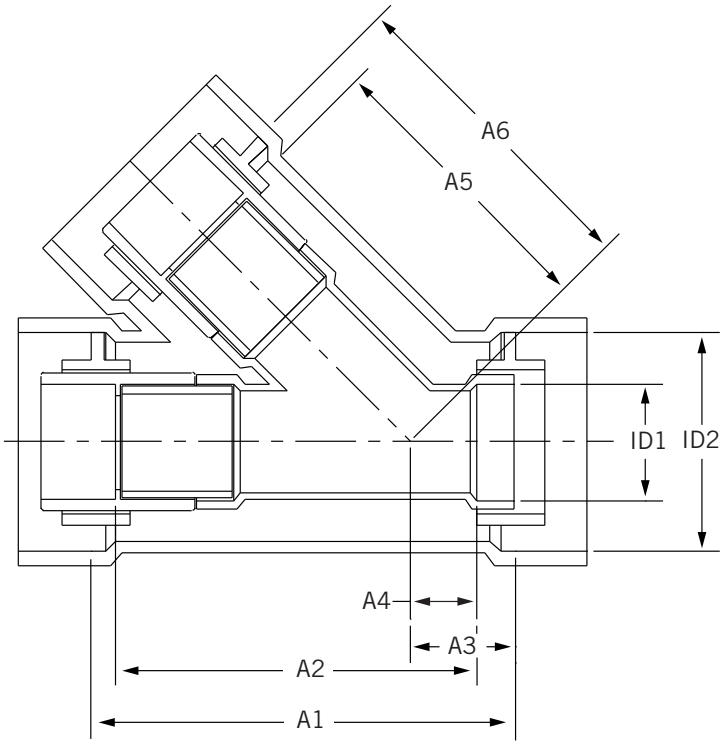
PVC DWV / PVC DWV Sanitary Tee



Carrier / Containment	A1	A2	A3	A4	A5	A6	ID1	ID2
1-1/2 x 4	6.13	2.75	3.88	1.75	3.88	4.36	1.90	4.50
2 x 4	6.13	3.68	3.88	2.31	3.88	5.11	2.38	4.50
3 x 6	8.50	4.88	4.94	3.06	4.94	7.13	3.50	6.62
4 x 8	10.88	6.13	5.94	3.88	5.94	8.35	4.50	8.62
6 x 10	3.50	6.00	9.29	-	-	-	6.62	10.75
8 x 12	4.50	7.14	11.87	-	-	-	12.22	12.75

GUARDIAN™ DIMENSIONS

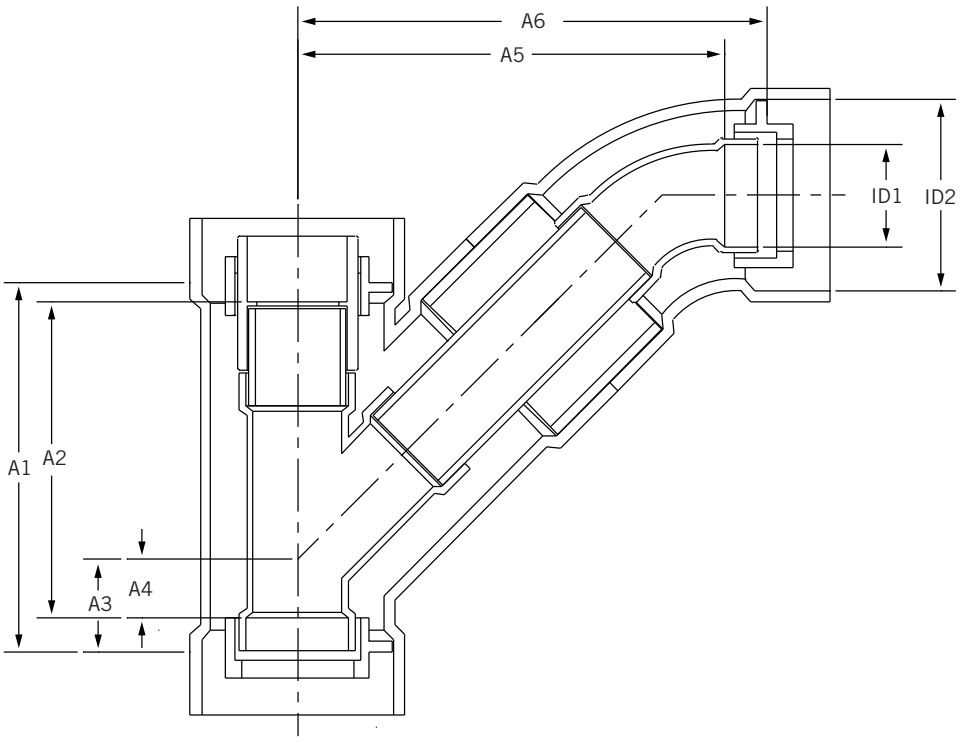
PVC DWV / PVC DWV Wye



Carrier / Containment	A1	A2	A3	A4	A5	A6	ID1	ID2
1-1/2 x 4	8.75	5.38	2.13	1.13	4.25	6.38	1.90	4.50
2 x 4	8.75	6.50	2.13	1.38	5.13	6.38	2.38	4.50
3 x 6	10.69	9.63	2.00	1.63	8.00	8.44	3.50	6.62
4 x 8	12.25	11.75	2.63	1.87	9.88	11.75	4.50	8.62
6 x 10	23.50	16.19	7.50	1.75	14.44	19.25	6.62	10.75
8 x 12	28.00	19.75	9.50	2.38	19.75	22.75	8.62	12.75

GUARDIAN™ DIMENSIONS

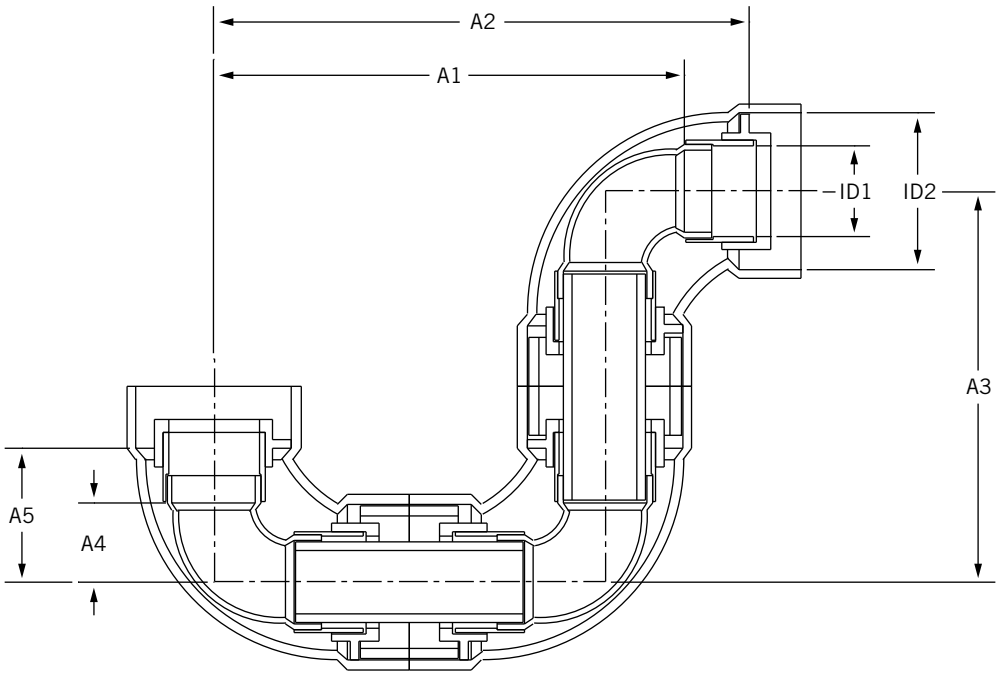
PVC DWV / PVC DWV Wye with ⅛ Bend



Carrier / Containment	A1	A2	A3	A4	A5	A6	ID1	ID2
1-1/2 x 4	8.75	5.38	2.13	1.13	9.66	10.72	1.90	4.50
2 x 4	8.75	6.50	2.13	1.38	10.03	10.72	2.38	4.50
3 x 6	10.69	9.63	2.00	1.63	14.34	16.22	3.50	6.62
4 x 8	12.25	11.75	2.63	1.87	17.17	17.74	4.50	8.62
6 x 10	23.50	16.19	7.50	1.75	36.28	38.55	6.62	10.75
8 x 12	28.00	19.75	9.50	2.38	39.71	44.30	8.62	12.75

GUARDIAN™ DIMENSIONS

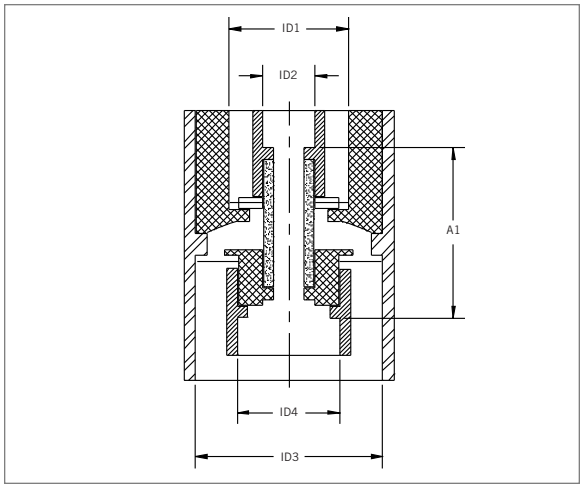
PVC DWV / PVC DWV P Trap



Carrier / Containment	A1	A2	A3	A4	A5	ID1	ID2
1-1/2 x 4	13.00	15.30	11.25	1.75	4.14	2.38	4.50
2 x 4	13.55	15.30	11.25	2.31	4.15	3.50	6.62
3 x 6	20.30	23.42	17.25	3.06	5.87	4.50	8.62
4 x 8	23.88	26.55	20.00	3.88	6.25	6.62	10.75
6 x 10	26.98	27.60	21.75	3.50	5.93	8.62	12.75
8 x 12	31.40	32.90	25.40	4.56	6.93	8.62	12.75

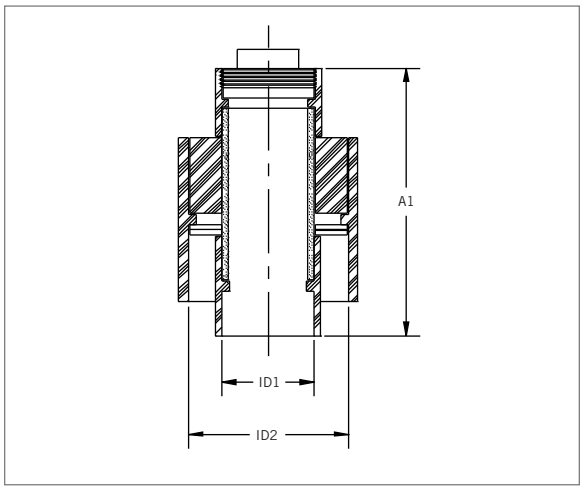
GUARDIAN™ DIMENSIONS

PVC DWV / PVC DWV Reducer / Increaser



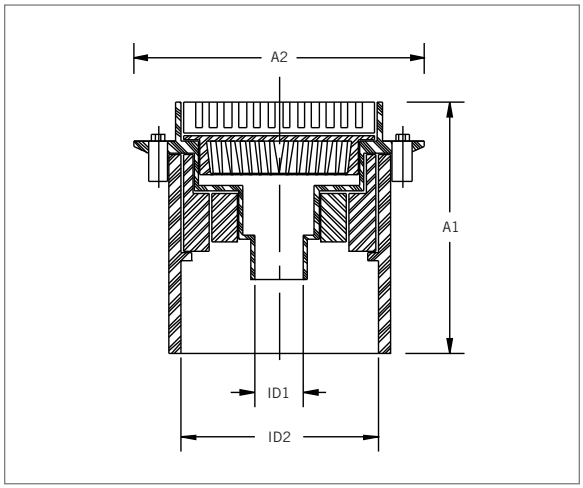
Carrier / Containment	A1	ID1	ID2	ID3	ID4
3 x 2 / 6 x 4	4.90	4.50	2.38	6.63	3.50
4 x 2 / 8 x 4	6.50	4.50	2.38	8.63	4.50
4 x 3 / 8 x 6	6.40	6.63	3.50	8.63	4.50
6 x 4 / 10 x 8	7.75	8.63	4.50	10.75	6.63
8 x 6 / 12 x 10	9.25	10.75	6.63	12.75	8.63

PVC DWV / PVC DWV Clean Out



Carrier / Containment	A1	ID1	ID2
1-1/2 x 4	7.12	4.50	1.90
2 x 4	7.12	4.50	2.38
3 x 6	11.00	6.63	3.50
4 x 8	12.50	8.63	4.50
6 x 10	18.50	10.75	6.63

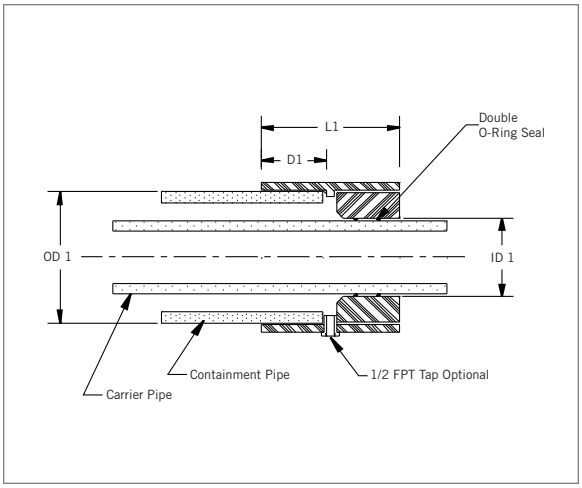
PVC DWV / PVC DWV Floor Drain



Carrier / Containment	A1	A2	ID1	ID2
3 x 6	11.88	12.00	3.50	6.63
4 x 8	11.88	12.00	4.50	8.63

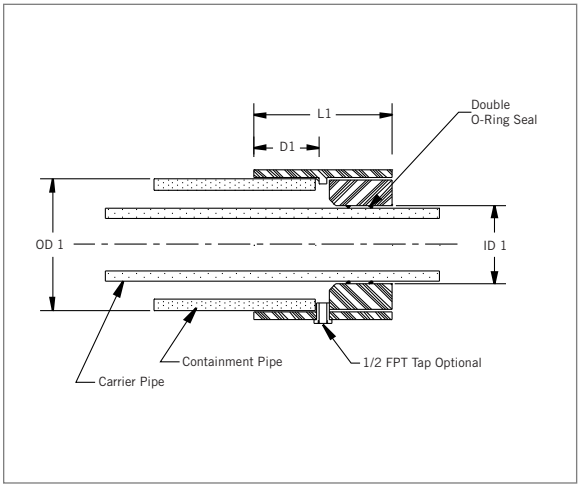
GUARDIAN™ DIMENSIONS

PVC Vinyl Style B Termination Fitting - Schedule 40



Carrier / Containment	L1	D1	ID1	OD1
1/2 x 2	2.41	1.16	0.84	2.38
3/4 x 3	3.94	1.88	1.05	3.50
3/4 x 4	4.19	2.00	1.05	4.50
1 x 3	3.94	1.88	1.32	3.50
1 x 4	4.19	2.00	1.32	4.50
1-1/2 x 4	4.19	2.00	1.90	4.50
2 x 4	4.19	2.00	2.37	4.50
2 x 6	6.25	3.00	2.37	6.63
3 x 6	6.25	3.00	3.50	6.63
4 x 8	8.25	4.00	4.50	8.63

PVC Vinyl Style B Termination Fitting - Schedule 80



Carrier / Containment	L1	D1	ID1	OD1
1/2 x 2	2.41	1.50	0.84	2.38
3/4 x 3	3.97	1.88	1.05	3.50
3/4 x 4	4.69	2.25	1.05	4.50
1 x 3	3.97	1.88	1.32	3.50
1 x 4	4.69	2.25	1.32	4.50
1-1/2 x 4	4.69	2.25	1.90	4.50
2 x 4	4.69	2.25	2.37	4.50
2 x 6	6.25	3.00	2.37	6.63
3 x 6	6.25	3.00	3.50	6.63
4 x 8	8.50	4.00	4.50	8.63

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Section Five: Guardian™ Procedures

Installation

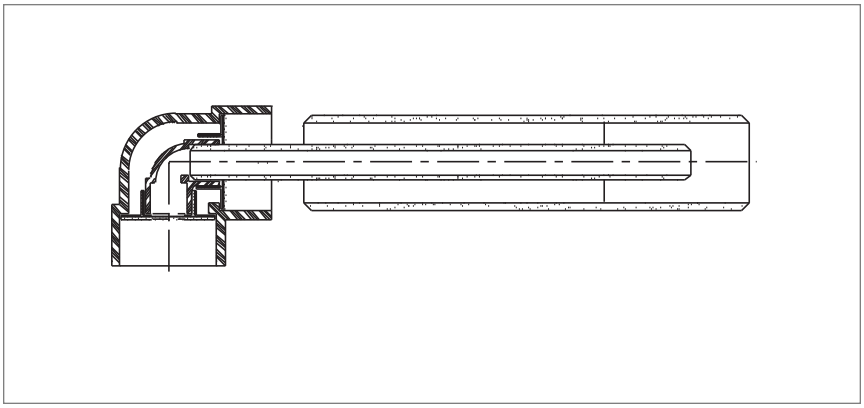
PVC and CPVC

1. Square cut pipe using a saw and miter box or plastic tube cutter. Remove all burrs from both the inside and outside edge of the pipe with a knife, file or reamer bevel all ends. Remove dirt, grease and moisture. A thorough wipe with a clean, dry rag is usually sufficient. Check dry fit. Pipe should insert easily into socket, approximately 1/4 to 3/4 of the total socket depth.

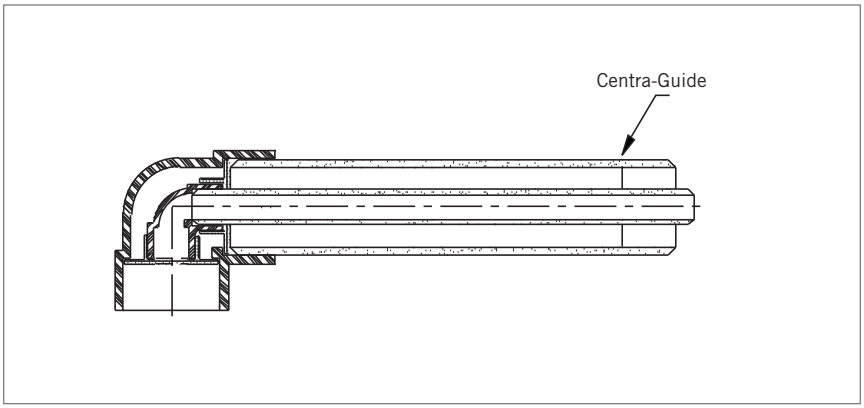
2. Using a suitable applicator, apply an approved primer to the socket of the fitting. (Care should be taken not to allow primer to puddle in fitting socket.) Next, apply primer to pipe surface equal to the depth of the fitting socket. Apply primer again to fitting socket. (Primer is used to soften the surfaces of pipe and fitting, making them suitable for solvent cementing.) Continue to next step immediately.
3. With the same type of applicator, apply a full, even coat of an approved solvent cement to the pipe equal to the depth of the fitting socket. Coat the fitting socket with a medium layer of cement. (Care should be taken not to allow cement to puddle in fitting socket). Apply a second, full, even layer to the pipe. Cement must be applied in sufficient quantities to fill the joint.
4. Without delay assemble while cement is still wet. Use sufficient force to ensure that pipe bottoms in socket. If possible, twist the pipe or fitting 1/8 to 1/4 turn as assembled. Hold together for about thirty seconds to make sure joint does not separate. With a rag, wipe off excess cement. Avoid disturbing the joint.

Simultaneous Solvent Cementing

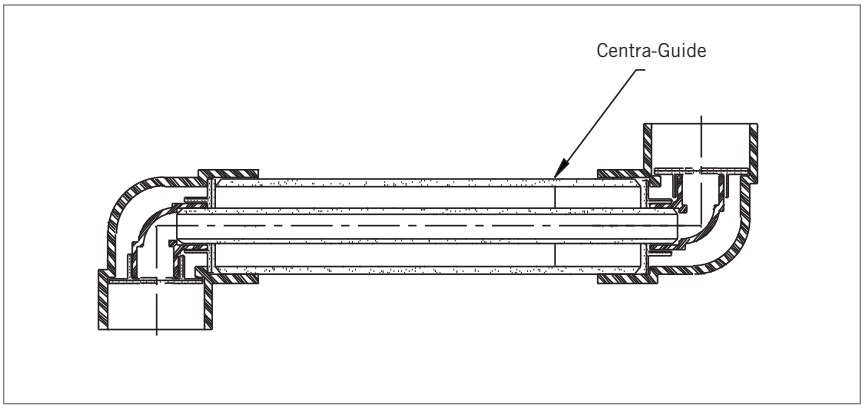
1. Determine proper carrier and containment pipe lengths to achieve desired center-to-center dimension. Cut to size and prep ends.
2. Prime and solvent cement carrier pipe to carrier fitting socket.



3. Prime and solvent cement containment pipe to containment socket.
4. Install Centra-guide support at pipe's end. Distance between the fitting and support should not exceed 5 feet. Install additional supports if required.

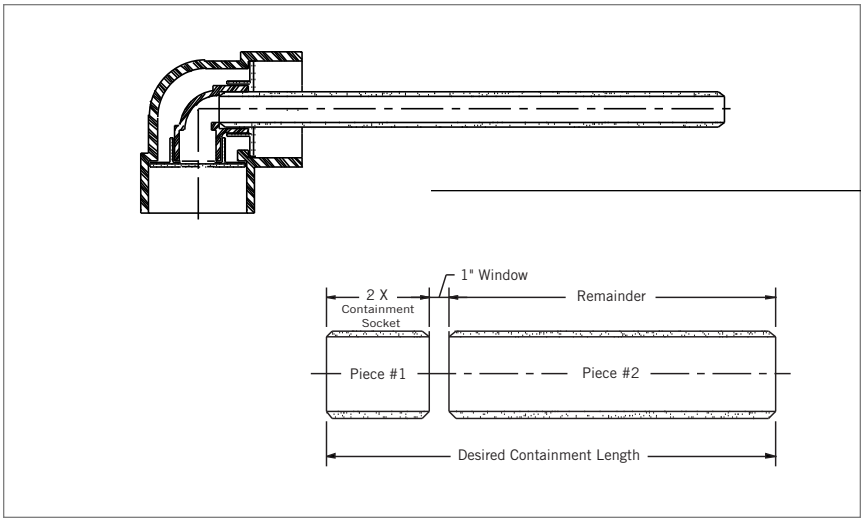


5. Dry-fit fitting to pipe end to ensure proper fit and alignment. Mark containment pipe to ensure full insertion during simultaneous solvent cementing.
6. Apply primer and solvent cement to carrier and containment hubs and pipe ends. Position fitting onto pipe ends, making sure fitting bottoms out completely.

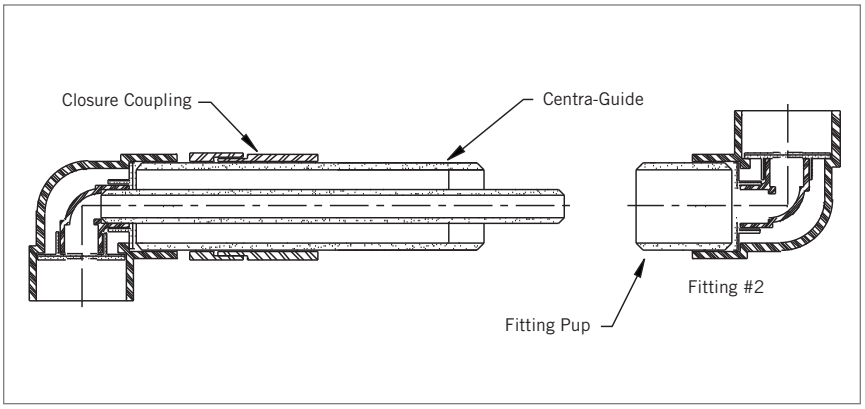


Single Closure Coupling Method

1. Determine proper carrier and containment length to achieve desired center-to-center dimension. Cut carrier pipe to size and prep ends. For single closure coupling installations, the containment pipe is cut into 2 pieces. Piece #1 is equal to 2 x containment socket depth. Piece #2 is equal to the predetermined containment pipe length less the overall length of piece #1 plus 1". See example.

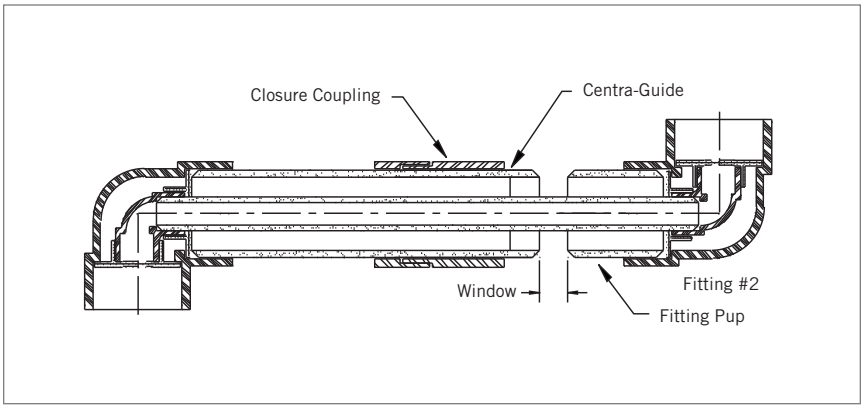


2. Prime and solvent cement piece #2 into fitting. Install support(s) as required. Slide closure coupling onto clean, dry containment pipe, making sure coupling is installed in proper direction. (Take appropriate precautions to ensure closure coupling is kept free of dirt and moisture prior to closure coupling installation. i.e. wrap with plastic or tape ends.) Prime and solvent cement fitting pup into socket of fitting #2.



3. Prime and solvent cement carrier pipe to fitting #2. If containment pipe was cut properly, there should be a 1" window between containment pipe pieces. After successfully testing carrier pipe, install closure coupling per instructions.

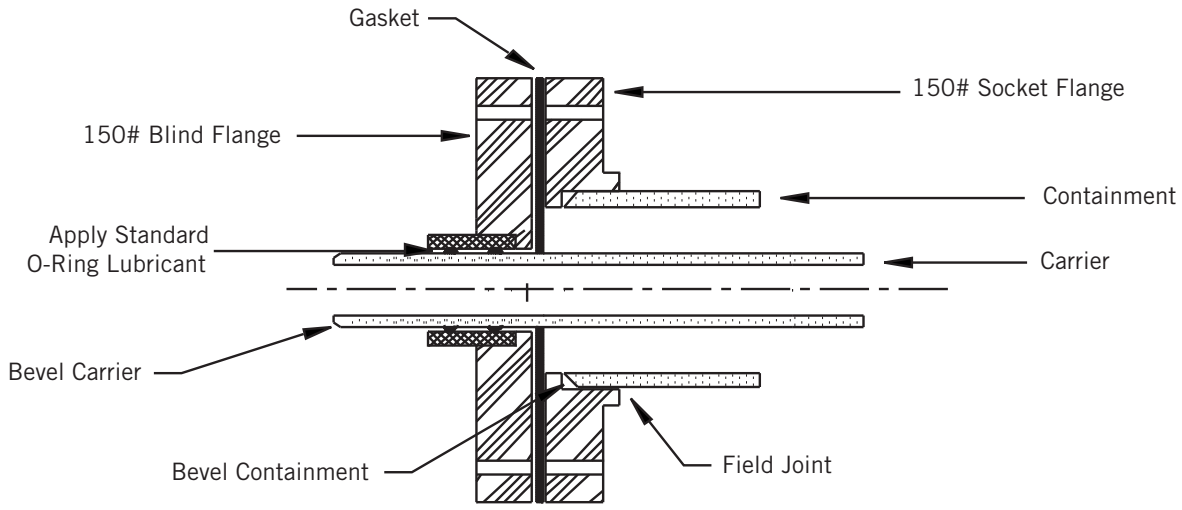
   Note: IPEX recommends that vinyl/vinyl systems be installed without closure couplings whenever possible.



Termination Fittings

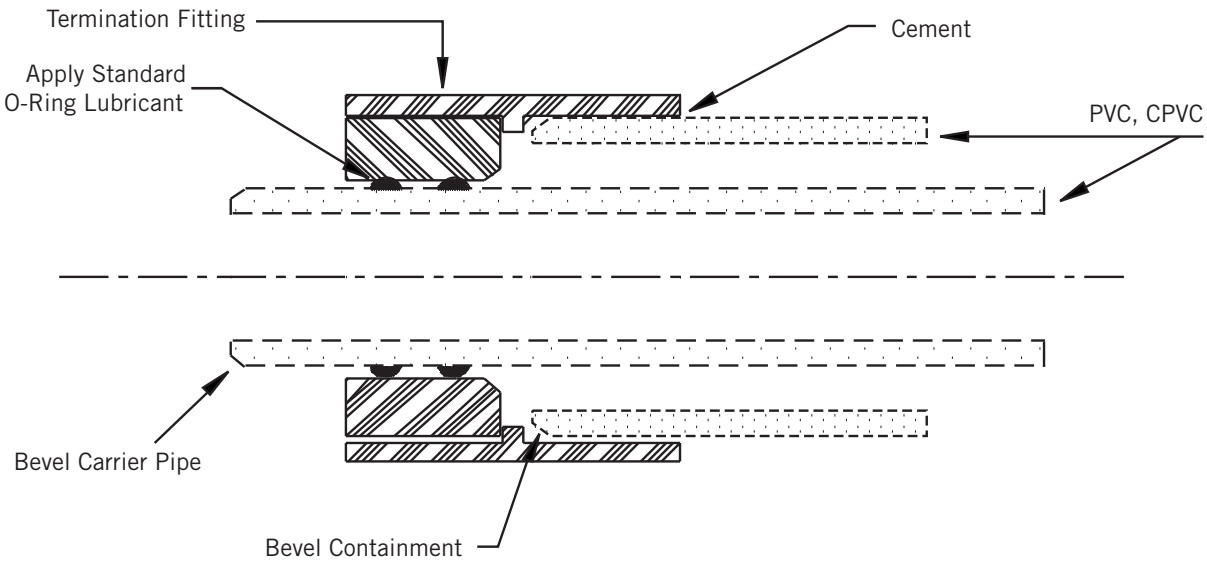
Style A

Install containment pipe socket flange using standard procedure. Always bevel carrier pipe end or damage to the o-rings will occur. The blind flange can be ordered with taps to allow for venting, draining, etc.



Style B

PVC and CPVC termination fittings are supplied as one-piece components, complete with carrier pipe o-rings. Always bevel carrier pipe end or damage to the o-rings will occur. Prime both the containment pipe and socket of termination fitting. Apply cement to both containment pipe and termination socket and slide into position, rotating 1/8 to 1/4 turn. Allow 24 hours cure time prior to testing. The fitting can be ordered with taps to allow for venting, draining, etc. **Do not apply primer or solvent cement to o-rings.**



Closure Couplings

PVC and CPVC Notes

Guardian vinyl closure coupling installations 3" and up requires the following:

- gallon containers of primer and cement
- medium-body, slow-set cement
- large daubers/rollers/brushes

IMPORTANT: Always apply primer and cement liberally. Do not take shortcuts. Follow Guardian's instructions explicitly.

Note: Always allow 48 hours or more, depending on environmental conditions, to cure before testing vinyl carrier/containment pipe.

Factory testing of trial joints made by contractor is available at no charge. This is strongly recommended.

Common Mistakes

- insufficient amount of cement
- incorrect or outdated cement
- incorrect or no primer used
- pipe ends not bevelled
- pipes misaligned
- contamination (dirt) on cementing area
- improper positioning of closure coupling on containment pipe
- pipe window too large
- movement of pipe sections before cement is fully cured
- wrong size applicator
- closure coupling and/or pipe not dry prior to solvent cementing closure coupling

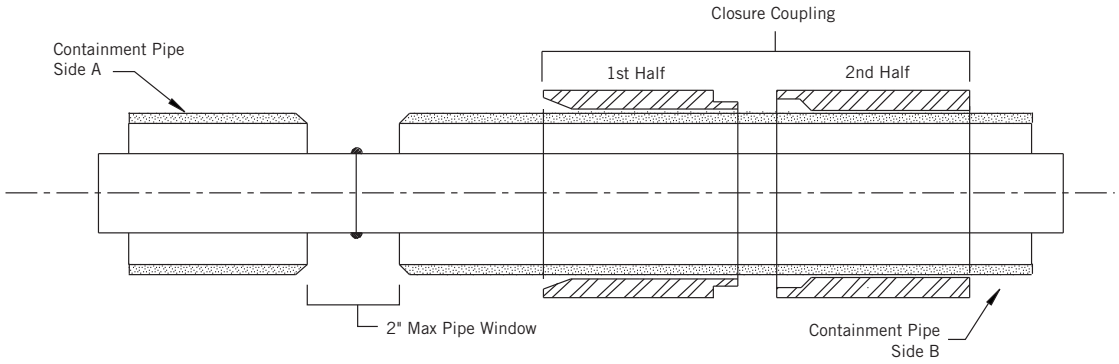
PVC and CPVC Instructions

1. Thermally equalize both the pipe and closure coupling by exposing them to similar temperatures for over 60 minutes. Clean containment pipe with a clean cloth prior to sliding closure coupling onto pipe with minimum resistance. If coupling does not respond accordingly, contact factory. Wrap the coupling with a waterproof plastic bag, or wrap with tape while on containment pipe to keep it clean and dry prior to solvent cementing.

   Note: Always use an approved primer and a "medium body – slow net" cement for all cementing procedures on PVC. Check expiration date on cement. If cement exceeds the date, throw away and use cement by expiry date.

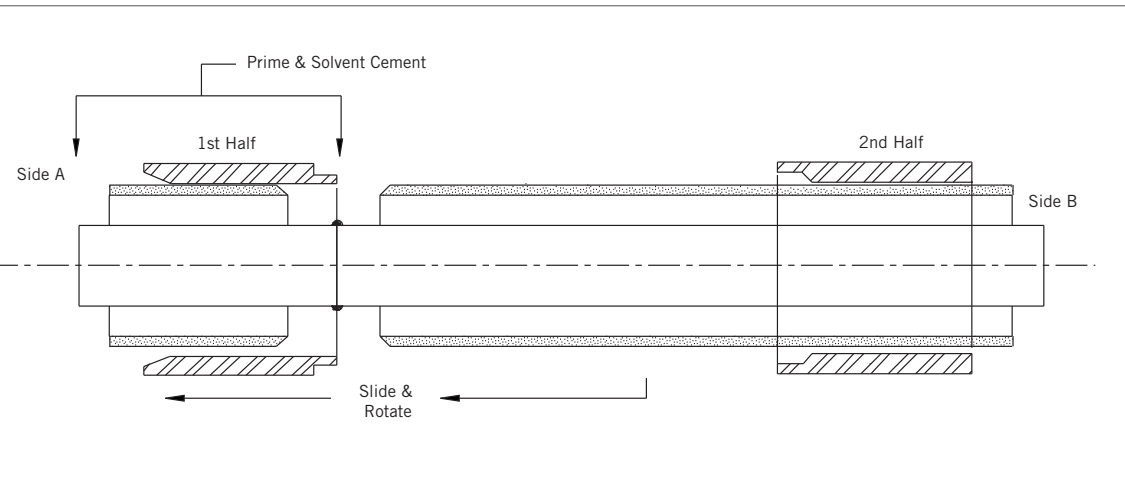
2. Bevel all ends of pipe. Slide the closure coupling across the pipe window to check for proper alignment. If resistance is met when transitioning from one side to the other, reposition containment pipe to eliminate resistance

   Note: All closure coupling installations require two people

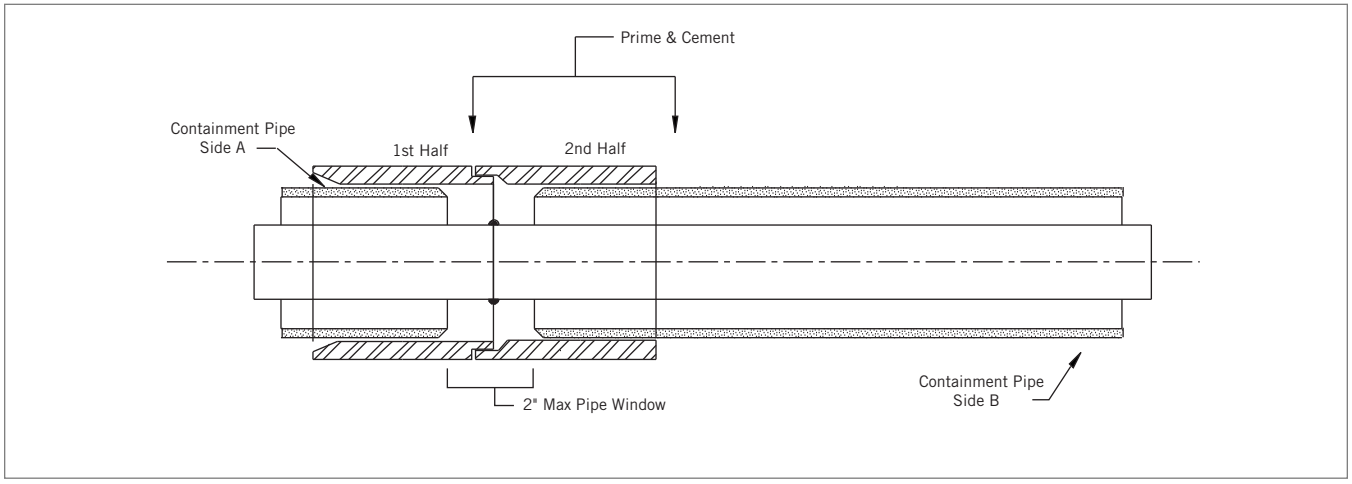


3. Liberally apply primer to 'Side A' of containment pipe as indicated above. Quickly slide the first half of the closure coupling onto the pipe (rotating constantly). Slide closure coupling back to Side B. Do not stop rotating. Apply more primer to Side A and repeat. Perform the same procedure with solvent cement and position first half on Side A as shown below.

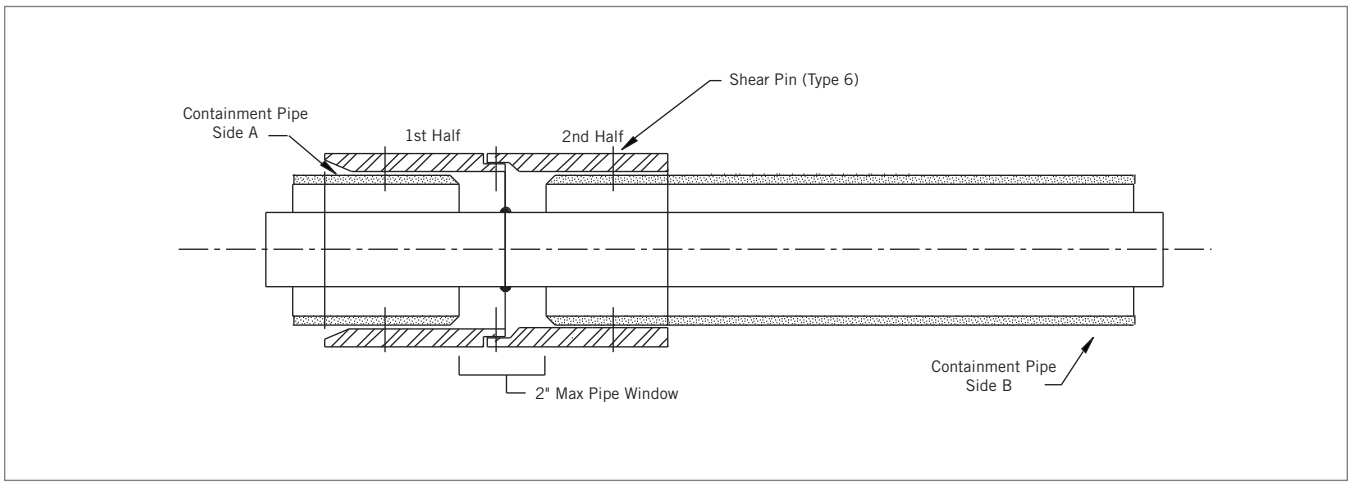
   Note: Restrain the first half of closure coupling so it doesn't move from its position while cementing the second half of the closure coupling.



4. Repeat the previous step with the second half of the closure coupling on Side B and place into position as shown below.

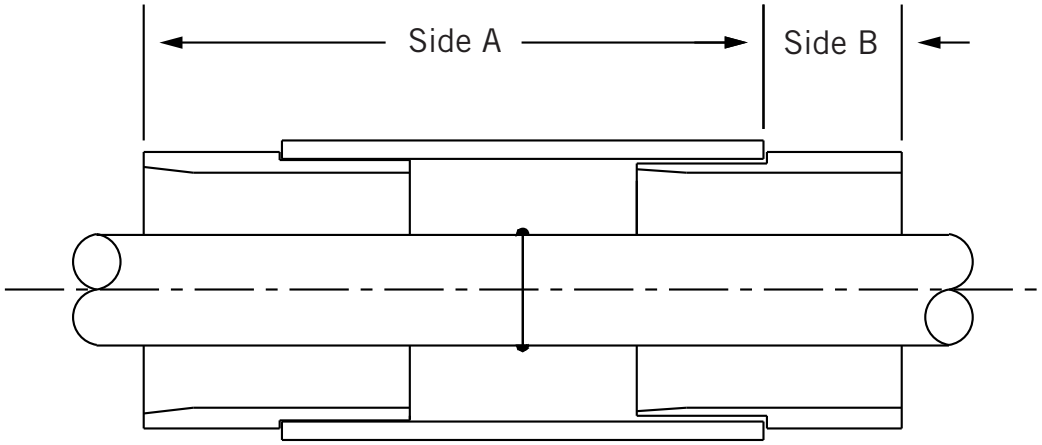


5. If the containment pipe will see temperature changes during the curing process or while in operation, shear pins need to be installed. Using a 3/8" bit, drill holes through the closure coupling and containment pipe as shown above. Use caution while drilling to prevent any damage to the carrier pipe. Apply primer and solvent cement to the shear pins (provided with the closure coupling) and insert into hole. Allow 24 to 48 hours cure time before pressure testing.



2" and 3" Closure Couplings

The procedure for installing 2" and 3" closure couplings is the same as 4" and above, except that the design is slightly different. The 2" and 3" closure couplings have a female socket on the trailing edge of the first half piece and a male end on the leading edge of the second half. Also, the first half piece is much longer than the second half piece. This means that the trailing edge of the first half piece will rest on 'Side B' of the containment pipe as opposed to being in the 2" window (see drawing below).



Section Six: CustomGuard®

Overview

Material Selection

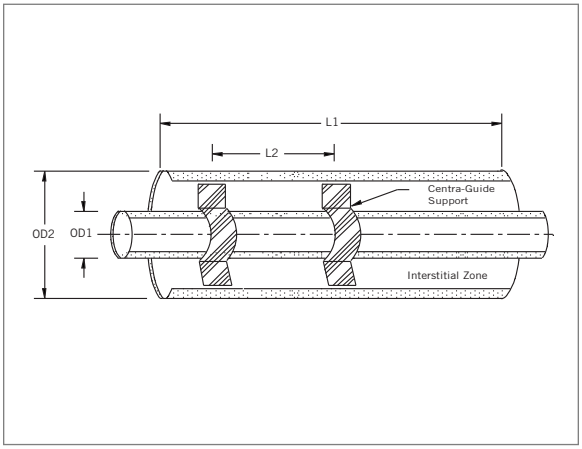
Carbon and stainless steel, copper, fiberglass (polyester and vinylester resins), PVDF, PP and dissimilar materials, are all available in CustomGuard® systems. This comprehensive offering, unmatched by any one company, gives IPEX the unique ability to examine just about any double containment requirement and truly offer the best suited, most cost-effective system. While other manufacturers have vested interests in recommending their one and only material/system, IPEX isn't confined by that limitation.

Design

Drawing on more that 15 years of experience in double containment, IPEX has developed a variety of product-specific designs to maximize efficiency and reduce installation costs. As with all our containment systems, our own patented Centra-Guard™ point-of-collection or cable leak detection systems are also available.

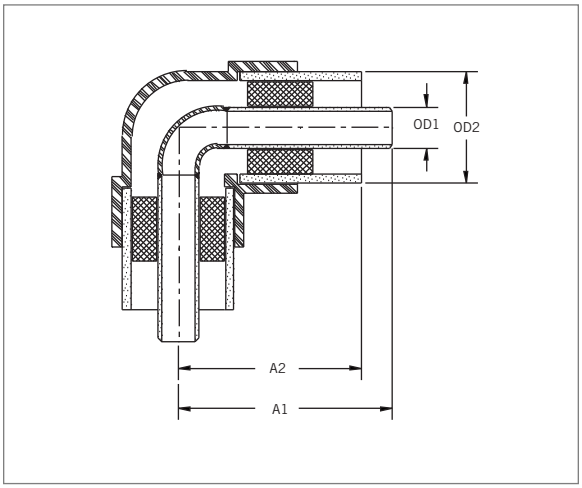
CustomGuard® Dimensions

Steel / Vinyl - Pipe



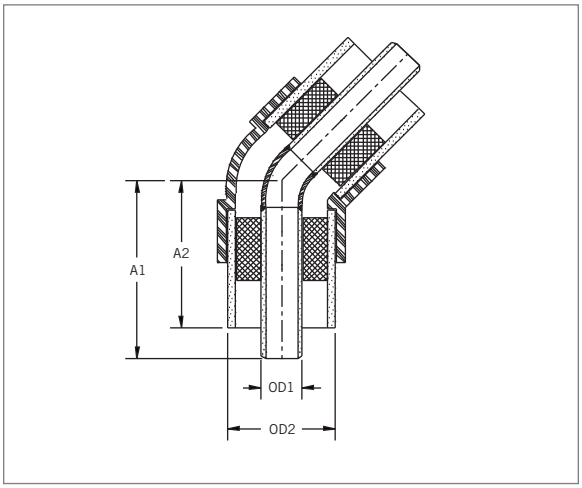
Carrier / Containment	L1 (ft)	L2 (ft)	OD1	OD2
1/2 x 2	20.00	5.00	0.84	2.38
3/4 x 3	20.00	5.00	1.05	3.50
1 x 3	20.00	5.00	1.32	3.50
1-1/2 x 4	20.00	5.00	1.90	4.50
2 x 4	20.00	5.00	2.38	4.50
3 x 6	20.00	5.00	3.50	6.62
4 x 8	20.00	5.00	4.50	8.62
6 x 10	20.00	5.00	6.62	10.75
8 x 12	20.00	5.00	8.62	12.75

Steel / Vinyl - 90º Elbow



Carrier / Containment	A1	A2	OD1	OD2
1/2 x 2	7.50	6.50	0.84	2.38
3/4 x 3	8.50	7.50	1.05	3.50
1 x 3	8.50	7.50	1.32	3.50
1-1/2 x 4	8.50	7.50	1.90	4.50
2 x 4	9.25	8.25	2.38	4.50
3 x 6	10.50	9.50	3.50	6.63
4 x 8	15.00	14.00	4.50	8.63
6 x 10	18.00	17.00	6.63	10.75
8 x 12	21.70	20.70	8.63	12.75

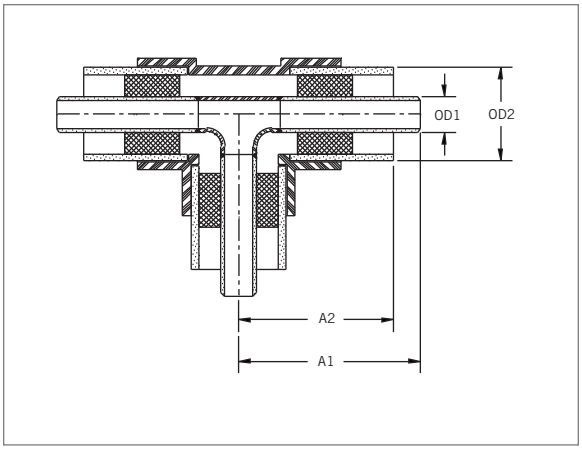
Steel / Vinyl - 45º Elbow



Carrier / Containment	A1	A2	OD1	OD2
1/2 x 2	8.50	7.50	0.84	2.38
3/4 x 3	8.50	7.50	1.05	3.50
1 x 3	8.62	7.62	1.32	3.50
1-1/2 x 4	8.75	7.75	1.90	4.50
2 x 4	9.25	8.25	2.38	4.50
3 x 6	8.75	7.75	3.50	6.63
4 x 8	11.00	10.00	4.50	8.63
6 x 10	15.00	14.00	6.63	10.75
8 x 12	18.94	17.94	8.63	12.75

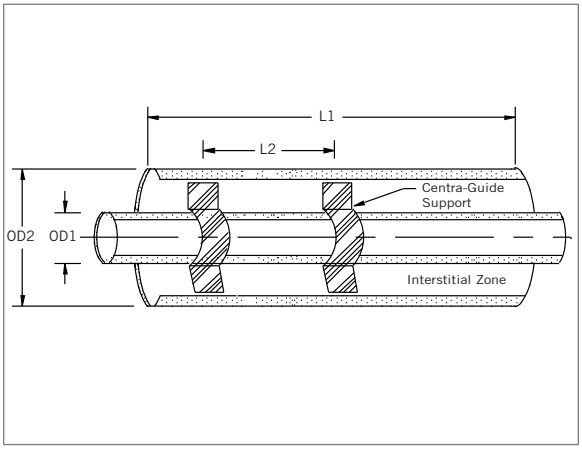
CustomGuard® Dimensions

Steel / Vinyl - Tee



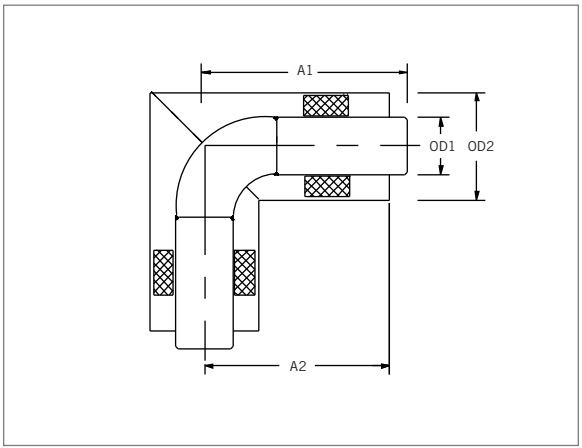
Carrier / Containment	A1	A2	OD1	OD2
1/2 x 2	5.25	4.25	0.84	2.38
3/4 x 3	6.60	5.60	1.05	3.50
1 x 3	6.60	5.60	1.32	3.50
1-1/2 x 4	8.10	7.10	1.90	4.50
2 x 4	8.10	7.10	2.38	4.50
3 x 6	10.50	9.50	3.50	6.63
4 x 8	14.50	13.50	4.50	8.63
6 x 10	17.90	16.90	6.63	10.75
8 x 12	21.70	20.70	8.63	12.75

Steel / Steel - Pipe



Carrier / Containment	L1 (ft)	L2 (ft)	OD1	OD2
1/2 x 2	20	5	0.84	2.38
3/4 x 3	20	5	1.05	3.50
1 x 3	20	5	1.32	3.50
1-1/2 x 4	20	5	1.90	4.50
2 x 4	20	5	2.38	4.50
3 x 6	20	5	3.50	6.62
4 x 8	20	5	4.50	8.62
6 x 10	20	5	6.62	10.75
8 x 12	20	5	8.62	12.75

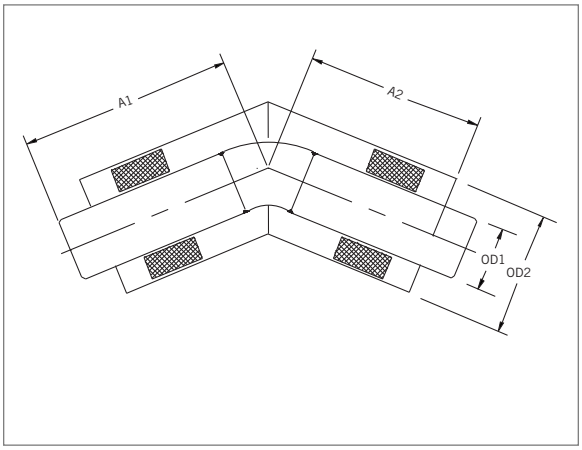
Steel / Steel - 90º Elbow



Carrier / Containment	A1	A2	OD1	OD2
1/2 x 2	7.50	6.50	0.84	2.38
3/4 x 3	8.50	7.50	1.05	3.50
1 x 3	8.50	7.50	1.32	3.50
1-1/2 x 4	8.50	7.50	1.90	4.50
2 x 4	9.25	8.25	2.38	4.50
3 x 6	10.75	9.75	3.50	6.63
4 x 8	15.00	14.00	4.50	8.63
6 x 10	17.62	16.63	6.63	10.75
8 x 12	19.00	18.00	8.63	12.75

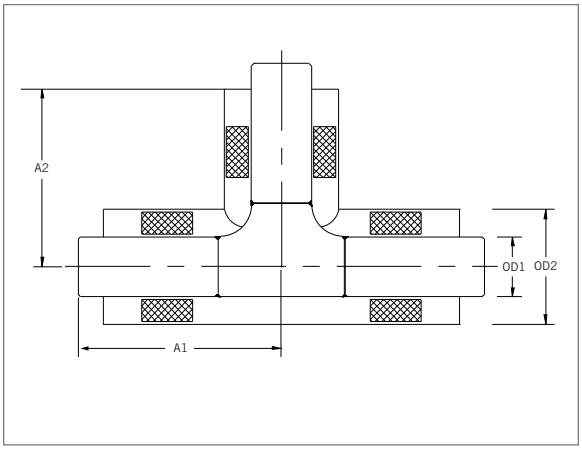
CustomGuard® Dimensions

Steel / Steel - 45º Elbow



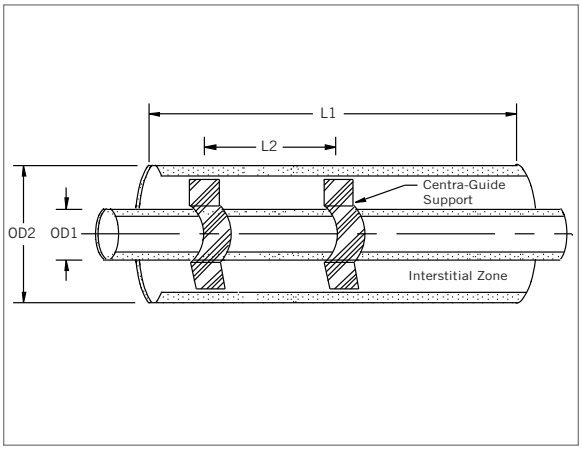
Carrier / Containment	A1	A2	OD1	OD2
1/2 x 2	8.50	7.50	0.84	2.38
3/4 x 3	8.50	7.50	1.05	3.50
1 x 3	8.62	7.62	1.32	3.50
1-1/2 x 4	8.75	7.75	1.90	4.50
2 x 4	9.25	8.25	2.32	4.50
3 x 6	8.75	7.75	3.50	6.63
4 x 8	13.00	12.00	4.50	8.63
6 x 10	18.25	17.25	6.63	10.75
8 x 12	19.50	18.50	8.63	12.75

Steel / Steel - Tee



Carrier / Containment	A1	A2 (ft)	OD1	OD2
1/2 x 2	4.50	3.50	0.84	2.38
3/4 x 3	7.00	6.00	1.05	3.50
1 x 3	6.70	5.70	1.32	3.50
1-1/2 x 4	7.75	6.75	1.90	4.50
2 x 4	7.30	6.30	2.37	4.50
3 x 6	9.63	8.63	3.50	6.63
4 x 8	13.13	12.13	4.50	8.63
6 x 10	17.63	16.63	6.63	10.75
8 x 12	19.00	18.00	8.63	12.75

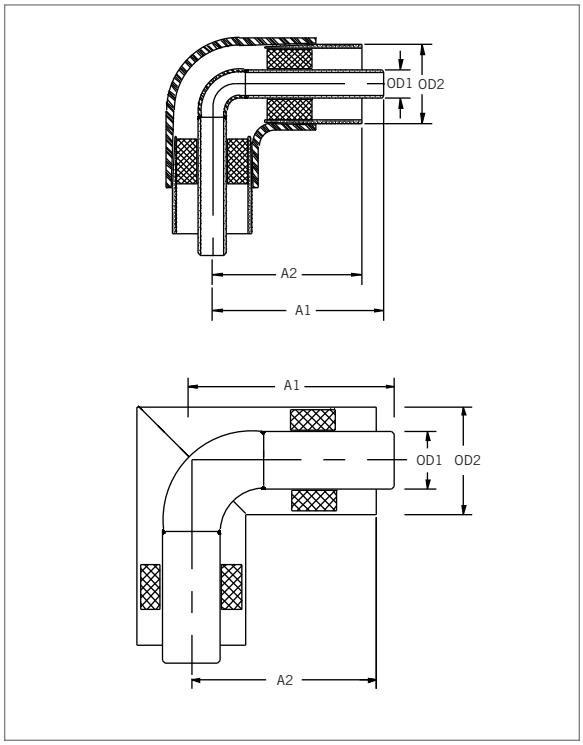
Steel / FRP - Pipe



Carrier / Containment	L1 (ft)	L2 (ft)	OD1	OD2
1/2 x 2	20.00	5.00	0.84	2.38
3/4 x 3	20.00	5.00	1.05	3.50
1 x 3	20.00	5.00	1.32	3.50
1-1/2 x 4	20.00	5.00	1.90	4.50
2 x 4	20.00	5.00	2.38	4.50
3 x 6	20.00	5.00	3.50	6.62
4 x 8	20.00	5.00	4.50	8.62
6 x 10	20.00	5.00	6.62	10.75
8 x 12	20.00	5.00	8.62	12.75

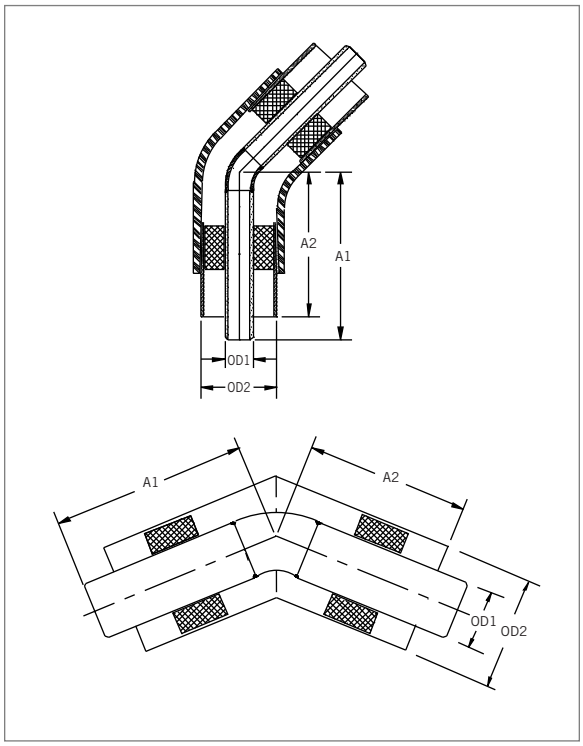
CustomGuard® Dimensions

Steel / FRP - 90º Elbow



Carrier / Containment	A1	A2	OD1	OD2
1/2 x 2	7.50	6.50	0.84	2.38
3/4 x 3	8.50	7.50	1.05	3.50
1 x 3	8.50	7.50	1.32	3.50
1-1/2 x 4	8.50	7.50	1.90	4.50
2 x 4	9.25	8.25	2.38	4.50
3 x 6	11.50	10.50	3.50	6.63
4 x 8	15.00	14.00	4.50	8.63
6 x 10	17.63	16.63	6.63	10.75
8 x 12	19.00	18.00	8.63	12.75

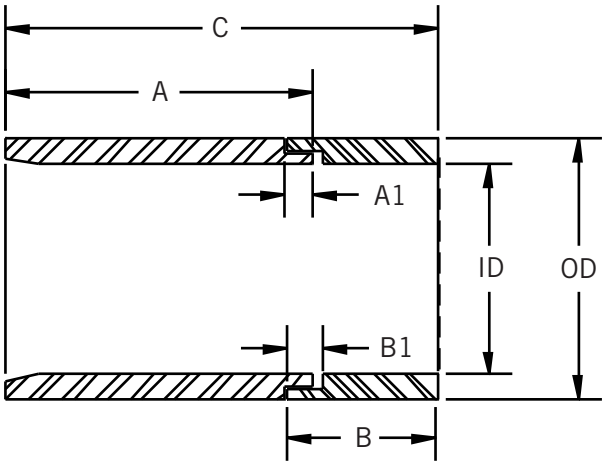
Steel / FRP - 45º Elbow



Carrier / Containment	A1	A2	OD1	OD2
1/2 x 2	8.50	7.50	0.84	2.38
3/4 x 3	8.50	7.50	1.05	3.50
1 x 3	8.62	7.62	1.32	3.50
1-1/2 x 4	8.75	7.75	1.90	4.50
2 x 4	9.25	8.25	2.38	4.50
3 x 6	8.75	7.75	3.50	6.63
4 x 8	13.00	12.00	4.50	8.63
6 x 10	18.25	17.25	6.63	10.75
8 x 12	19.50	18.50	8.63	12.75

CustomGuard® Dimensions

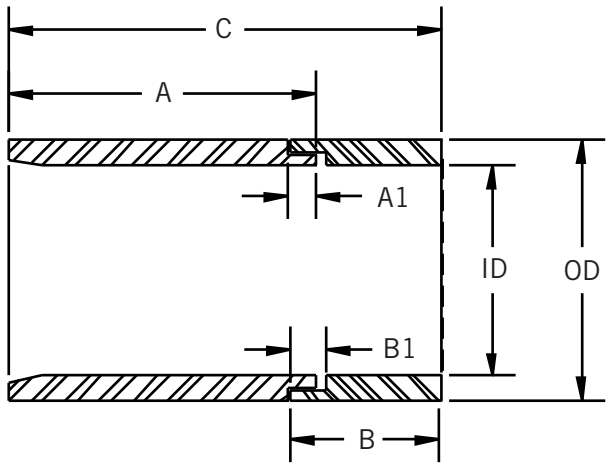
PVC Closure Coupling - Schedule 40



Carrier / Containment	A	A1	B	B1	C	ID	OD
2	4.30	1.00	2.40	1.00	6.75	2.37	2.72
3	8.00	2.00	4.00	2.00	10.00	3.50	4.00
4	8.00	2.00	4.70	2.00	11.00	4.50	5.05
6	7.25	2.00	3.50	2.00	9.00	6.63	7.37
8	9.25	2.00	4.50	2.00	12.00	8.63	9.81
10	11.20	2.00	5.20	2.00	14.50	10.75	11.50
12	14.00	2.00	7.00	2.00	19.50	12.75	13.62

CustomGuard® Dimensions

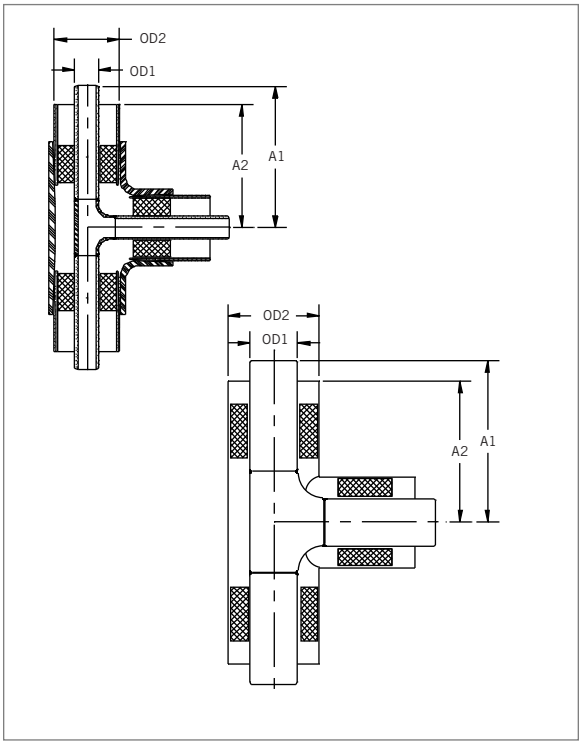
PVC Closure Coupling - Schedule 80



Carrier / Containment	A	A1	B	B1	C	ID	OD
2	3.25	1.00	3.25	1.00	5.75	2.37	2.89
3	4.00	1.00	4.00	1.00	7.00	3.50	4.17
4	4.75	2.00	4.75	2.00	8.00	4.50	5.23
6	6.50	1.50	3.00	1.50	8.00	6.63	8.00
8	9.25	1.50	4.50	1.50	12.50	8.63	10.12
10	12.00	2.00	6.00	2.00	14.00	10.75	11.87
12	14.00	2.00	7.00	2.00	19.50	12.75	14.12

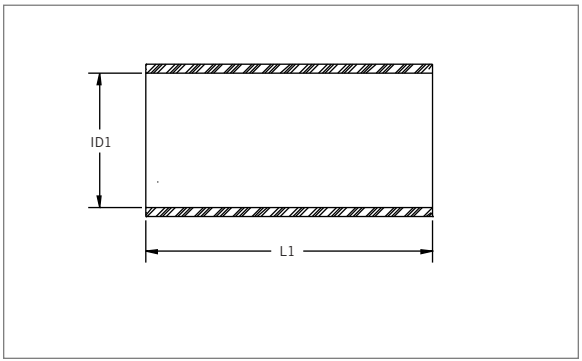
CustomGuard® Dimensions

Steel / FRP - Tee



Carrier / Containment	A1	A2	OD1	OD2
1/2 x 2	7.00	6.00	0.84	2.38
3/4 x 3	7.38	6.32	1.05	3.50
1 x 3	7.75	6.75	1.32	3.50
1-1/2 x 4	9.25	8.25	1.90	4.50
2 x 4	9.00	8.00	2.38	4.50
3 x 6	11.50	10.50	3.50	6.63
4 x 8	13.13	12.13	4.50	8.63
6 x 10	17.63	16.63	6.63	10.75
8 x 12	19.00	18.00	8.63	12.75

Carbon Steel - Closure Coupling

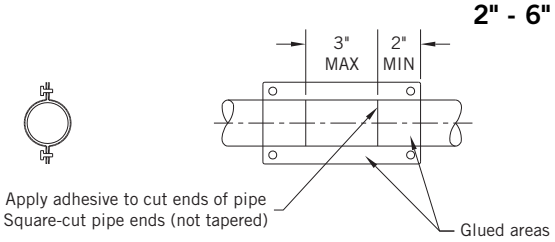


Containment	L1	ID1
2.00	6.00	2.50
3.00	6.00	3.62
4.00	6.00	4.62
6.00	6.00	6.75
8.00	6.00	8.75
10.00	6.00	10.87
12.00	6.00	12.87

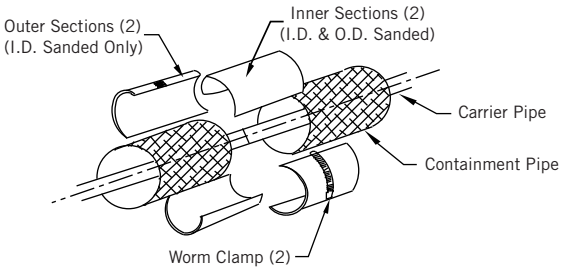
CustomGuard® Dimensions

FRP - Closure Coupling

2" - 6"



6" - 12"

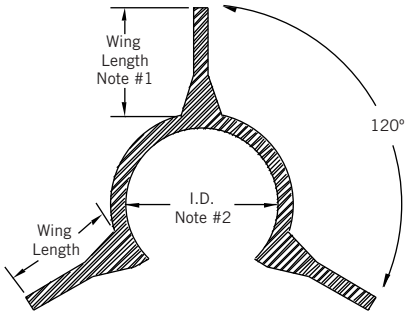


Adhesive Requirement Chart (5 oz. kits)	
Pipe Size (in)	Adhesive Required
2	1/2
3	1/2
4	1
6	2
8	2
10	3
12	3

2" to 6" Kit contains:
- 2 - 180º halves
- 4 bolts and nuts
- 1 required epoxy kit

6" to 12" Kit contains:
- 2 inner 180º FRP shells I.D & O.D. de-glossed
- 2 outer 180º FRP shells I.D. de-glossed
- 2 worm clamps
- 1 epoxy resin/hardener bonding kit
- 2 mixing sticks, gloves, sand paper and a brush

Pipe / Fitting Support, Centra-Guide™



Size (in)	Stock	I.D.#2	Wing Length	Part #
1/2	0.19	0.83	1.75	728007
3/4	0.19	1.04	1.75	728008
1	0.25	1.30	1.25	728009
1-1/2	0.25	1.89	1.10	728011
2	0.25	2.36	2.13	728012
3	0.38	3.49	1.50	728014
4	0.38	4.49	1.75	728016
6	0.50	6.61	1.75	728018
8	0.50	8.61	1.75	728019
10	0.75	10.70	2.00	728020

General Notes:

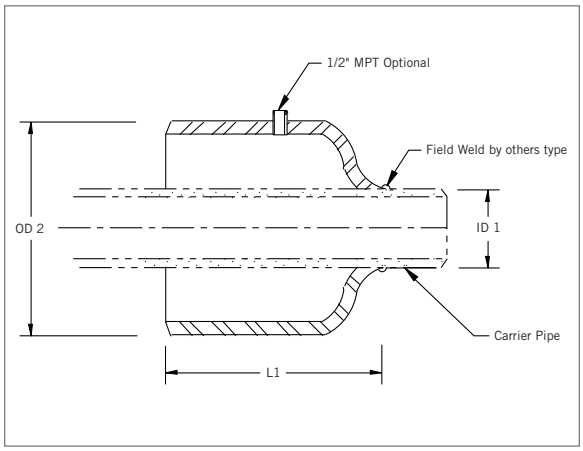
1.Length is sized to fit bore of containment pipe.

2.I.D. sized to provide non-slip against carrier pipe.

Clip is approx. 2" wide.

CustomGuard® Dimensions

Carbon Steel Butt Weld Termination



Carrier / Containment	L1	ID1	OD2
1/2 x 2	3.00	0.89	2.38
1 x 3	3.50	1.37	3.50
1-1/2 x 4	4.00	1.96	4.50
2 x 4	4.00	2.43	4.50
3 x 6	5.50	3.55	6.62
4 x 8	6.00	4.56	8.62
6 x 10	6.00	6.68	10.75
8 x 12	7.00	8.68	12.75

Section Seven: CustomGuard® Procedures

Installation

Metal/Vinyl, Metal/FRP

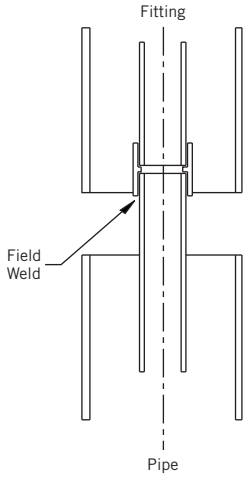
This is an example of a metal carrier and vinyl containment 90-degree elbow being joined to its mating pipes. Fitting is supplied with metal pipe beveled for welding and spigot containment ends. Metal pipe is welded and, after testing, the closure coupling is installed. The pipe window should not exceed two inches. All joints on this type of system require this procedure.

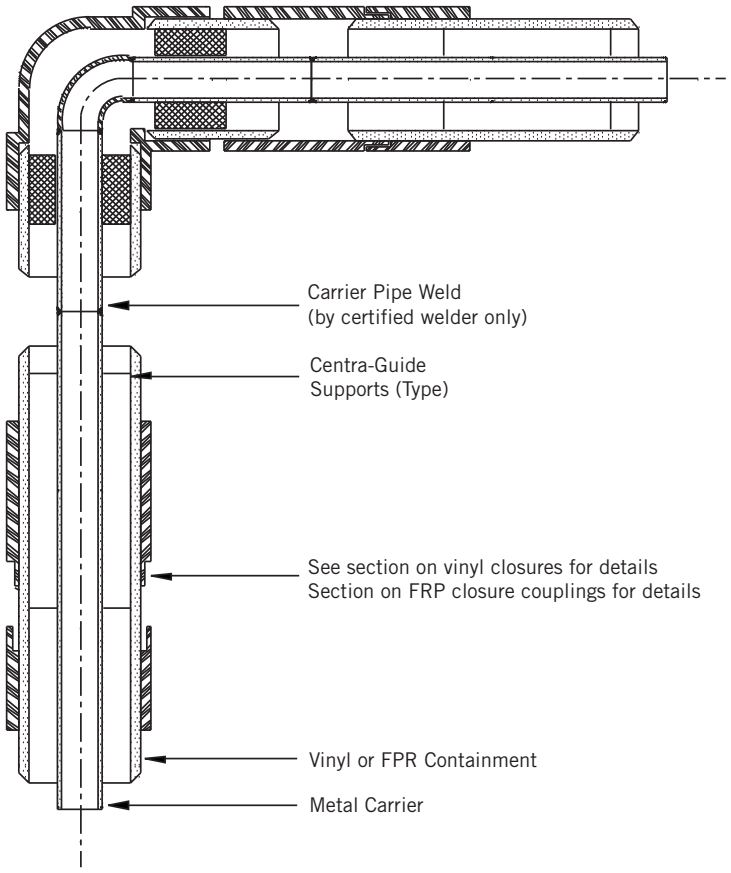
Note: To close FRP window, see FRP closure coupling instructions.

WARNING

Flammable vapors may be present in the space between the carrier pipe and containment pipe. Use caution when an open flame is present or when welding.

Typical Socket Weld





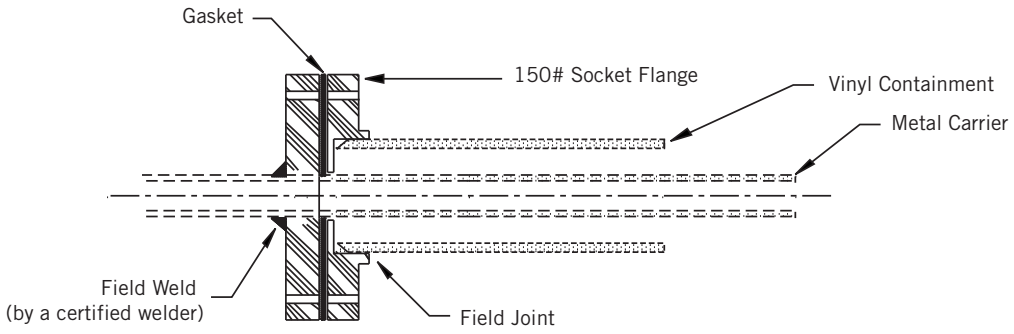
Metal/Vinyl: Style A Termination Fitting

Install containment pipe socket flange using standard procedure. The pre-bored blind flange should be installed and back-welded to the carrier pipe. The blind flange can be ordered with tape to allow for venting, draining, etc.

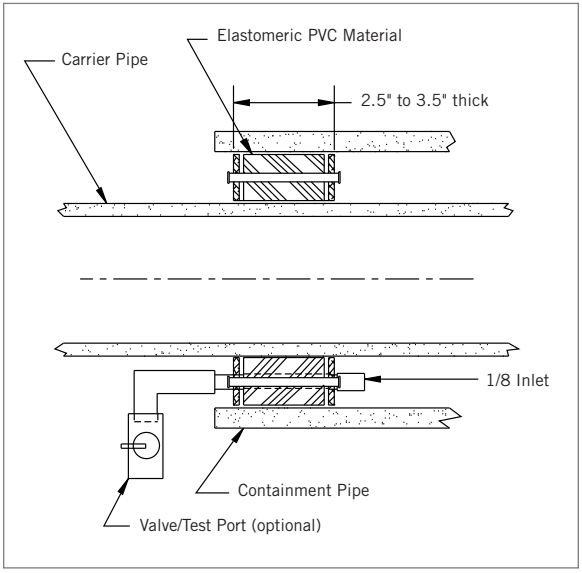
Always purge the space between the carrier pipe and the containment pipe with clean, dry nitrogen and then test with a gas fume meter (sniffer) before welding or subjecting the system to an open flame.

⚠ WARNING

Flammable vapors may be present in the space between the carrier pipe and containment pipe. Use caution when an open flame is present or when welding.



Metal/Vinyl, Metal/FRP: Style C Termination



Installation Procedure

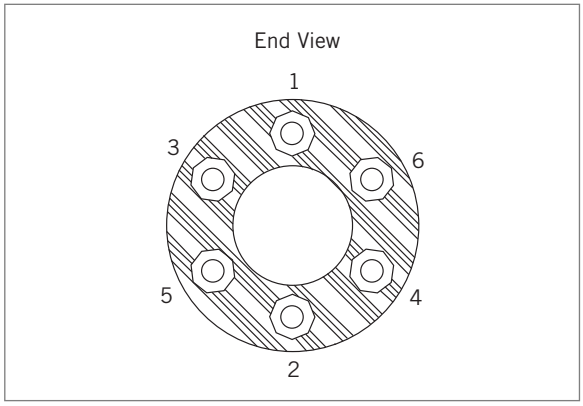
All Style C termination fittings are shipped to job site completely assembled and ready for field installation.

Slide the termination fitting over the carrier pipe and into the end of the containment pipe, recessing it approximately one inch from the containment pipe end. As the bolts are tightened, the end plates compress the elastomeric material creating a seal between the carrier and containment pipe.

Tighten all bolts following the torque sequence. When HDPR, polypro, PVDF and FRP containment pipes are used, installation of a restraining collar is necessary.

NOTE: I.D. and O.D. of termination fitting are sized per specified carrier and containment pipe.

Torque Sequence for Installation



Pipe Size	No. of Bolts	Bolt Size	Max Torque ft. lbs
1 x 3	3	1/4 NC	8
1 x 4	4	1/4 NC	8
1-1/2 x 4	4	1/4 NC	8
2 x 4	4	1/4 NC	8
3 x 6	6	1/4 NC	8
4 x 8	6	5/16 NC	10
6 x 10	6	5/16 NC	10
8 x 12	6	5/16 NC	10

Test Fitting

To properly test the containment pipe joints, first seal the interstitial space located at both ends of the pipe run.

Second, provide a port to pressurize and depressurize the section of pipe to be tested. This test fitting is designed to seal the interstitial space and provide a pressurization port for testing purposes. When permanently installed, it acts as a termination fitting with a drain valve. It is also used temporarily to test containment joints in subassemblies before joining to your next subassembly.

Once a successful pressure test is completed, the fitting can be removed and used again.

⚠ WARNING

Never exceed 5 psi (pneumatic) when testing plastic containment piping.

FRP Closure Coupling Installation

Adhesive Requirement Chart (5 oz. kits)	
Pipe Size (in)	Adhesive Required
2	1/2
3	1/2
4	1
6	2
8	2
10	3
12	3

2", 3" & 4" kit contains:

2 180º shells

4 sets nuts / bolts

1 epoxy resin/hardener kit

2 mixing sticks, gloves, sandpaper & brush

6" & up kit contains:

2 inner 180º FRP shellsI.D & O.D. de-glossed

2 outer 180º FRP shellsI.D. de-glossed

2 worm clamps

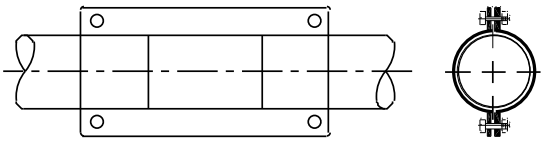
1 epoxy resin/hardener bonding kit

2 mixing sticks, gloves, sandpaper & brush

General Notes

Epoxy adhesive may require a heat source to enhance curing in cold weather conditions. Please consult factory. If heat blankets are required, refer to cure times shown on adhesive instruction and heating blanket.

Carefully handle FRP parts to avoid contamination. Use new gloves or clean, dry cotton cloths. Protect the bonding surfaces from any moisture; during wet weather, tenting is required.



Installation Instructions

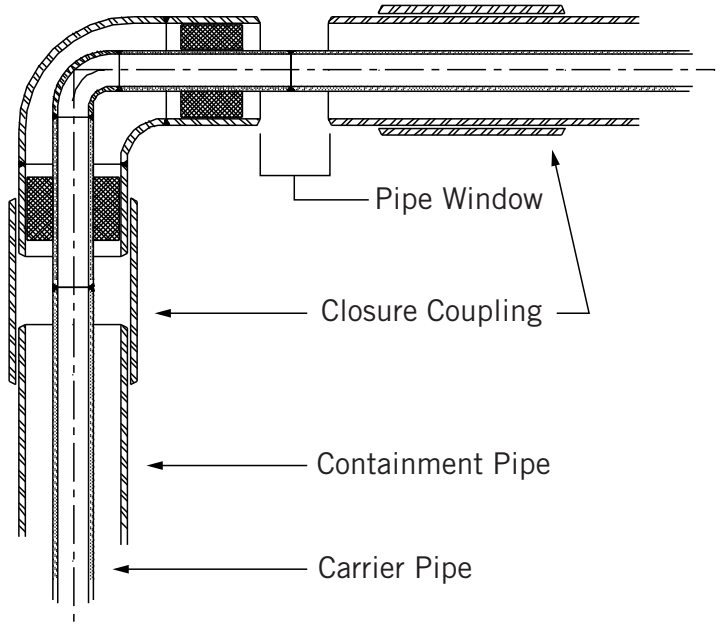
1. Center the inner FRP shells over the containment pipe window. Mark the pipe at each end of the shells. Using a sander with 40-grit belt, sand (de-gloss only) the overlay area of the containment pipe beyond your marks.
2. Again, place the inner frp shells over the pipe window. Examine and fit, as necessary, the mating edge of the shells to provide a 1/8 inch maximum gap between mating edge (one side only). Remove after proper fit is verified.
3. Using sandpaper, lightly finish sanding all shell bonding surfaces, then brush any dust from all shell and pipe surfaces to be bonded. Install a loose worm clamp outside each pipe mark.
4. Following the mixing instructions furnished with your kit, mix the hardener and resin until a consistent color is achieved. Pot life allows for a 15 to 20 minute working cycle.
5. Apply a thin, even coat of mixed epoxy to the sanded pipe and inner shells. Place the inner shells over the pipe window (center), re-coat the complete O.D. of the two inner shells including seams as well as the two I.D. surface of the outer shells. Place the coated outer shells over the coated inner shells ensuring seam overlap occurs.
6. Position the two worm clamps by dividing the closure coupling into thirds evenly and tighten them to provide a thin bond layer between the shells. Spread excess adhesive along all seams and ends of the shells and pipe connections.

Metal/Metal Installation

Double containment installations of this kind always require staggered assembly. First weld all the carrier joints. Leave a window (gap) between the containment pipe ends, to be closed with a closure coupling later. One advantage of this method is the ability to test and inspect all carrier pipe joints before closing the containment pipe sections. Pipe and fittings are supplied with spigot ends on all outlets. All fittings are supplied with the carrier nipple or socket extending beyond the end of the containment pipe. Carrier pipe nipples are supplied with beveled ends.

When joining pipe sections or pipe to fittings, it is important to slip a closure coupling onto the containment pipe before you weld the carrier pipe. A window will be created by proper back cutting of the containment pipe. Every carrier pipe weld will have its own closure coupling to seal the containment pipe window. Windows lengths will vary depending on the length of the closure coupling. Proper window length will allow for a minimum one-inch overlap of closure coupling on both sides of containment pipe.

After the carrier pipe system has been fitted, welded, tested and accepted, the closure couplings are then installed over the window to seal the containment piping. Position the coupling over the pipe window (centerline of the coupling should meet the centerline of the pipe window). Weld the closure coupling to the containment pipe (per welding specifications). Test containment as per IPEX testing instructions.



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Section Eight: System Design

Guidelines

1. Always use containment pipe dimensions as the basis for determining piping layout and center to center dimensions.
2. Termination fittings are usually required at the beginning, end and at any branch line of double containment systems, except when draining back to a collection sump, pit or tank.
3. Closure couplings are normally required at all field joints for systems with dissimilar materials.
4. Systems with long runs or extreme temperature changes may require expansion loops or elbows. Consult factory.
5. Complete information regarding media should always be provided to the factory to determine proper piping material and elastomer seals.
6. For above-ground and outdoor applications, UV protection may be required on certain materials. Consult factory.

Standard Sizes

1/2 x 2	4 x 8
3/4 x 3	6 x 10
1 x 3	8 x 12
2 x 4	10 x 16
3 x 6	

Note: Containment pipe may need to be sized larger to accommodate cable leak detection. Consult factory.

External Support

Support and spacing requirements for double containment pipe systems parallels overhead process piping installations. PVC and fiberglass materials are frequently selected as a secondary jacket. Therefore it is important to place hangers near interstitial supports. Extra support considerations should be given to components such as valves, in-line pumps, etc.

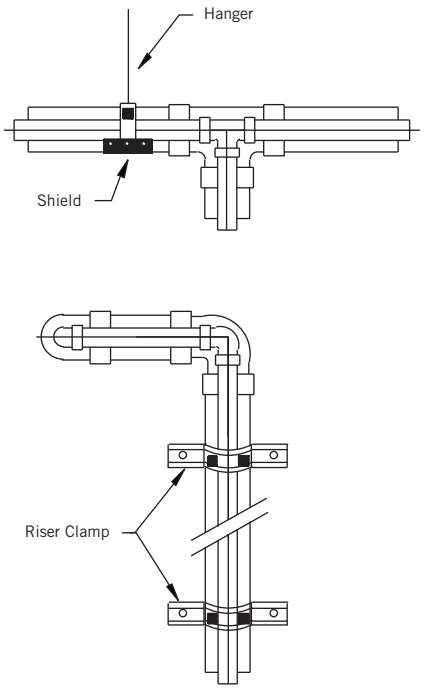
Horizontal piping systems should be supported on uniform centers, which are determined by maximum containment pipe temperatures (see support chart for recommendations). Valves apply to uninsulated lines either in a building or exposed to the environment.

Regardless of the type of hanger selected, it is important to note that a wide surface is recommended, free from burrs and sharp edges. Pipe saddles work fine for this. Do not anchor by means of a U-bolt directly to the containment pipe. Double containment anchors are available for all systems.

When pipe clamps are used, they should not force the pipe fittings into position. Each pipe section should be laid out and jointed to its mating section whether it is cemented or welded. Once the joints have been completed, the final clamping is done. When correctly installed, a clamp or anchor can be loosened or removed without the pipe shifting.

Recommended Support Spacing (ft)

Pipe Size	Temperature ºF (ºC)					System Option
	60 (16)	80 (27)	100 (38)	120 (49)	140 (60)	
1 x 3	12.0	11.5	10.5	6.7	6.0	
2 x 4	13.5	12.7	11.2	7.5	6.7	PVC
3 x 6	15.0	14.2	13.5	9.0	7.5	S/8080
4 x 8	16.5	13.5	13.5	9.7	8.5	
1 x 3	10.5	10.5	9.0	6.0	5.5	
2 x 4	11.2	10.5	9.7	6.7	6.0	PVC
3 x 6	12.7	12.0	11.2	7.5	6.7	S/4040
4 x 8	13.5	12.7	12.0	7.5	6.7	S/8040
1 x 3	12.0	12.0	11.2	10.5	10.5	
2 x 4	13.5	13.5	12.7	12.0	11.2	CPVC
3 x 6	16.5	16.5	15.0	13.5	12.5	S/8080
4 x 8	18.0	18.0	16.5	13.5	13.5	
1 x 3	12.0	10.5	10.5	10.5	9.0	
2 x 4	12.2	11.7	11.7	10.5	9.0	CPVC
3 x 6	14.2	12.7	12.0	11.2	10.5	S/4040
4 x 8	14.2	12.7	12.0	11.2	10.5	S/8040
1 x 3	20.0	20.0	20.0	18.0	17.0	
2 x 4	22.0	22.0	22.0	20.0	19.0	FRP/
3 x 6	26.0	26.0	25.0	23.0	21.0	FRP
4 x 8	34.0	34.0	30.0	27.0	25.0	
1 x 3	26.0	26.0	26.0	24.0	22.0	
2 x 4	30.0	30.0	30.0	27.0	25.0	Metal/
3 x 6	35.0	35.0	33.0	32.0	30.0	FRP
4 x 8	45.0	45.0	40.0	36.0	33.0	
1 x 3	22.0	22.0	20.0	18.0	18.0	
2 x 4	24.0	24.0	20.0	20.0	20.0	Metal/
3 x 6	26.0	26.0	22.0	20.0	20.0	PVC
4 x 8	28.0	28.0	24.0	22.0	22.0	



Notes:

All valves and points of concentrated loads such as tees and flanges should have supports independent of normal span supports.

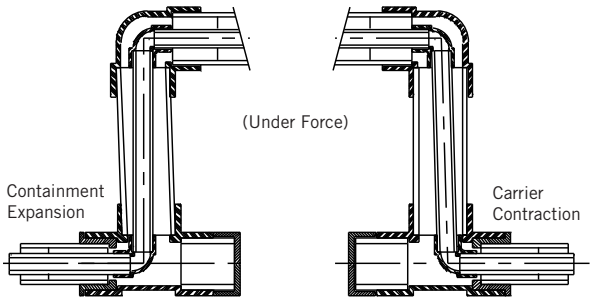
Riser clamps evenly distribute vertical loads. Clamps are always placed at interstitial supports.

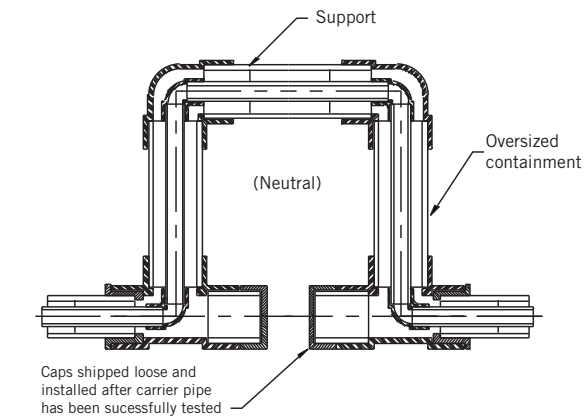
Regardless of the type of support, place inner and outer supports near each other. This will eliminate point loading.

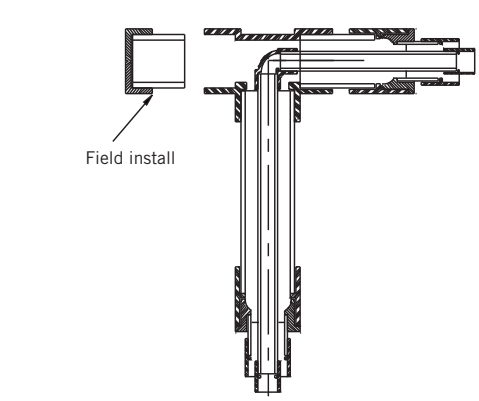
Expansion Loops and Elbows

A common method to control the effects of expansion or contraction in a piping system is to install a combination of anchors and guides with expansion loops or ells. Anchors direct pipe to free movement area. Guides control the carrier pipe movement down the bore of the containment pipe to, and away from, the expansion loop or ells. A relaxed expansion loop as well as one subjected to temperature change are depicted above. As you can see, when a pipe is subjected to temperature change, some degree of movement will occur. Failure to compensate for temperature change may cause stress and ultimately failure.

Note: Always consult factory for loop sizing.







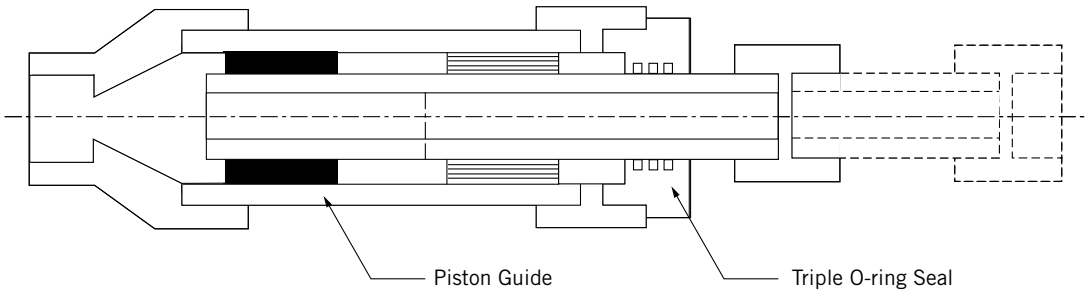
Loop Sizing

Free space Schedule 40 and Schedule 80 PVC fittings			
Size (in)	Free Space Area (in)	Size (in)	Free Space Area (in)
1 x 3	0.400	4 x 8	1.500
1 x 4	0.950	4 x 10	1.750
1 x 6	2.000	4 x 12	3.500
2 x 4	0.300	6 x 10	1.300
2 x 6	1.250	6 x 12	2.100
2 x 8	2.750	6 x 14	2.500
3 x 6	0.750	8 x 12	1.000
3 x 8	1.375	8 x 14	1.600
3 x 10	3.000	8 x 16	2.200

Note: Free space area denotes maximum movement of carrier to initial interference with containment

Unwanted stresses resulting from thermal expansion can be minimized or eliminated by providing for flexibility in a double containment piping system. This is achieved by incorporating expansion loops or elbows.

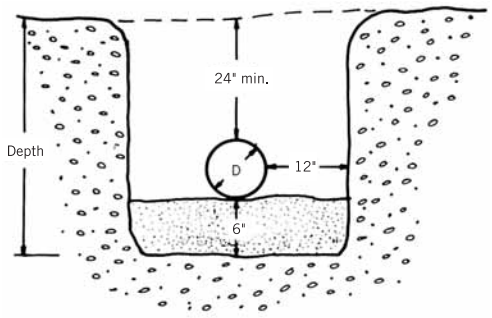
Linear expansion and contraction factors per 100 ft of pipe in. / 20ºF / 100'						
D ºF	Steel	Copper	PVC	CPVC	FRP	PVDF
0	0	0	0	0	0	0
20	0.150	0.25	0.62	0.82	0.26	2.00
40	0.300	0.45	1.30	1.63	0.52	4.00
60	0.455	0.65	2.20	2.45	0.78	6.00
80	0.610	0.87	2.80	3.25	1.05	8.00
100	0.770	1.10	3.50	4.08	1.31	10.00
120	0.915	1.35	4.25	4.90	1.57	12.00
140	1.076	1.57	4.80	5.71	1.83	14.00
160	1.235	1.77	5.50	6.53	2.09	16.00
180	1.400	2.00	6.30	7.34	2.35	18.00
200	1.570	2.25	7.12	8.16	2.62	20.00



Buried Pipe

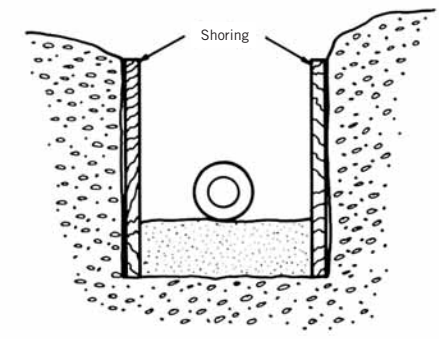
When installing below-ground systems, simple precautions should be taken.

Trench widths can be much narrower than for butt-fused systems. A distance of about one foot on either side of the pipe should be allowed for access during joining.

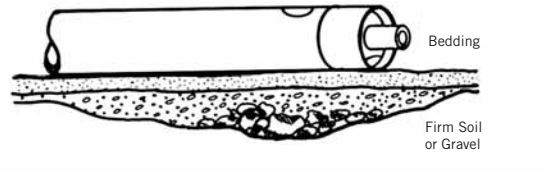


The pipe should be buried to a minimum depth of 24" from the crown of the pipe where normal foot traffic is expected. Local codes may require different burial depths and these should be strictly followed. The effects of “frost heave” should be considered when installing in ground subject to freezing. Where heavy ground traffic is expected, the pipe may require further protection, such as a greater burial depth or a structural encasement of concrete or steel.

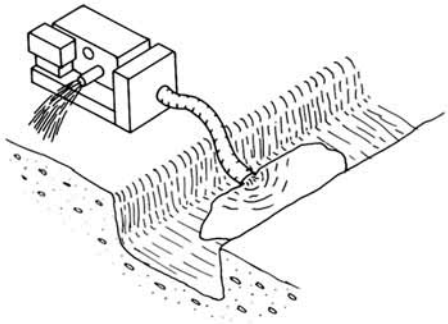
When excavating in unstable soil, the trench walls should be shored up according to local regulations. Do not lower any pipe into a trench until the walls are stabilized.



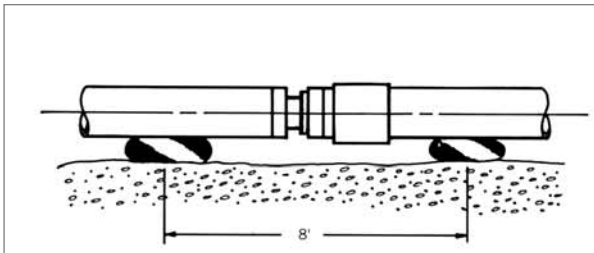
The **trench bottom** should be continuous and free of rocks and sharp objects. Where ledge rock, hardpan or boulders are encountered, they should be padded with sand or compacted, friable, fine-grain soil.



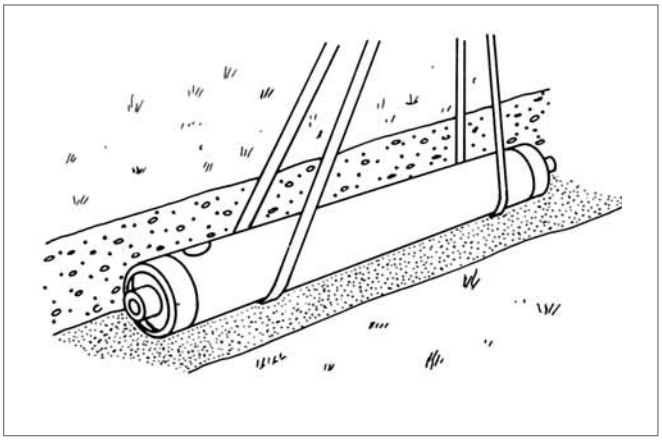
All free-standing water should be removed from the trench before lowering any piping into it. This will eliminate water entering the gap between the primary and secondary pipe walls, which could lead to problems when using cable leak detection systems. It will also ensure the joints remain dry.



Sandbags should be placed on the trench bed at eight foot spacings to facilitate the temporary support of the pipe during joining. This will also make it easier for the contractor to lay the pipe at a suitable fall for gravity flow conditions as required by the local codes. Alternatively, the trench should be lined with a 6" depth of a suitable bedding material such as sand, rock-free soft soil or 3/8" pea gravel.

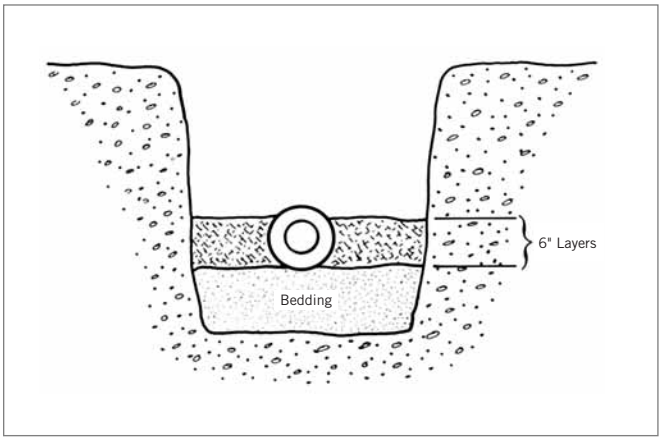


The pipe should be carefully lowered into the trench to avoid breakage. To avoid damage to the pipe, chains must not be used. Use nylon rope or straps only. Make sure the cable access port is at the bottom of the pipe and that the pipe label is at the top of the pipe. The pipe end protectors should be removed prior to joining.

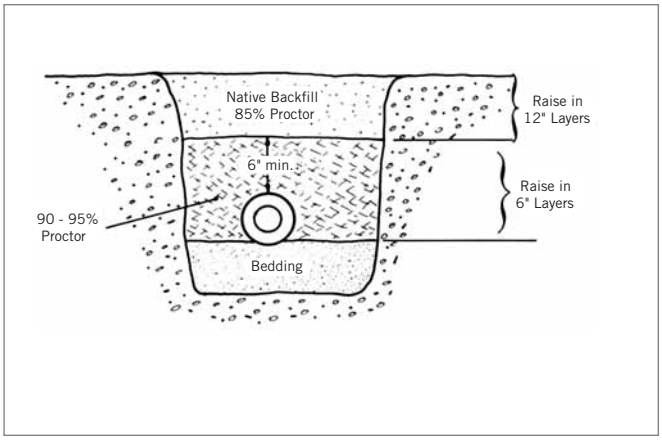


Bedding material should be placed all around the pipe with at least 6" of bedding above the crown of the pipe. This will offer the pipe protection from undue stresses and sharp objects.

The bedding material should be hand-tamped. Make sure to compact the bedding material firmly and evenly around the pipe.



Backfill should consist of earth that is free of large rocks and stones which could damage the pipe. The backfill should be sand or a sand gravel mixture in which the gravel is either pea gravel or crushed stone without sharp edges. Particles should be no larger than 1/2" and 90% of the soil should pass through a No. 4 sieve. The backfill should be built up in 6" layers and carefully compacted using either a hand tamper or water saturation. A mechanical tamper should not be used since this may damage the pipe.



Prior to testing, additional bedding and backfill material may be placed around the pipe, making sure that the joint areas are fully exposed to allow secondary joining to take place.

Section Nine: Leak Detection

Centra-Guard™

The basic concept behind cable leak detection is that a monitor detects any changes in the electrical properties of the cable caused by contact with a liquid. The monitor then raises an alarm in the plant to warn operators that a leak has been detected. Usually the detection system will pinpoint the leak and report its location. This allows operators to quickly rectify the situation.

Centra-Guard™

IPEX'S patented leak detection systems offer the ultimate defense against potential containment challenges. Centra-Guard™ is automated, trouble-free and user-friendly. It offers an economical, proactive solution for guarding against environmental damage and the high cost of cleanup.

Centra-Guard™ is the only non-intrusive leak detection system available. The sensor never comes in contact with the media.

Application

Centra-Guard™ leak detection systems are well suited to above-ground suspended pipeline applications, with sensors housed in a saddle-type clamp, as well as underground pipeline systems with drip leg assembly.

- Sensors

To detect the presence of fluid leakage into the interstitial space, individual external capacitive sensors are affixed to the containment pipe at each zone. Each sensor is completely self-contained in plastic housing to ensure protection and maximum performance. A built-in sensitivity control enables sensing point adjustment.

- Electrical Connections

The capacitive proximity sensors are 3-wire, 24 VDC, normally closed solid state switches. Regulated power is sourced to the sensors from the control panel. Sensor switches open when they detect fluid in the outer containment pipe.

- **Control Panel**

The internally fused panel requires 120 VAC. Plug-in 24 VDG general-purpose relays offer easy maintenance. The controls are housed in a NEMA 4 enclosure and handle one to ten leak detection zones each. Panel size is 14 x 12 x 6.2 with mounting flange.

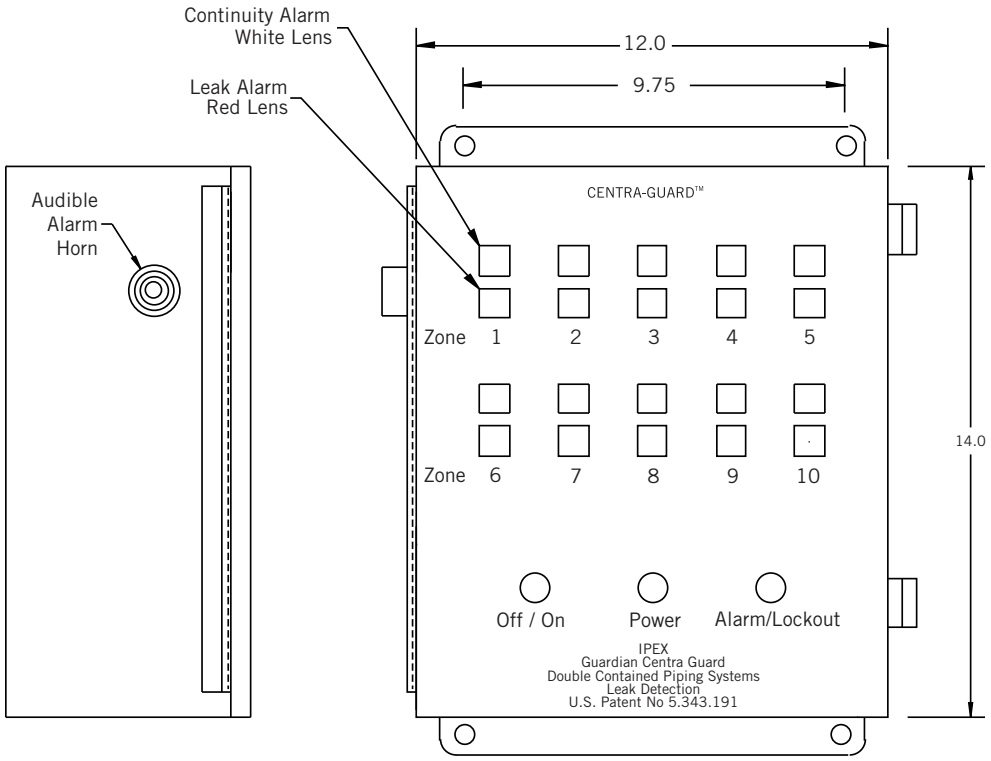
When leaks are detected, audible and visual signals in the panel alert the operators; a 95 dB alarm sounds, and an LED indicator in the sensor also illuminates. Each panel comes with a SPDT general alarm relay switch which allows the panel to interact with a plant PLC.

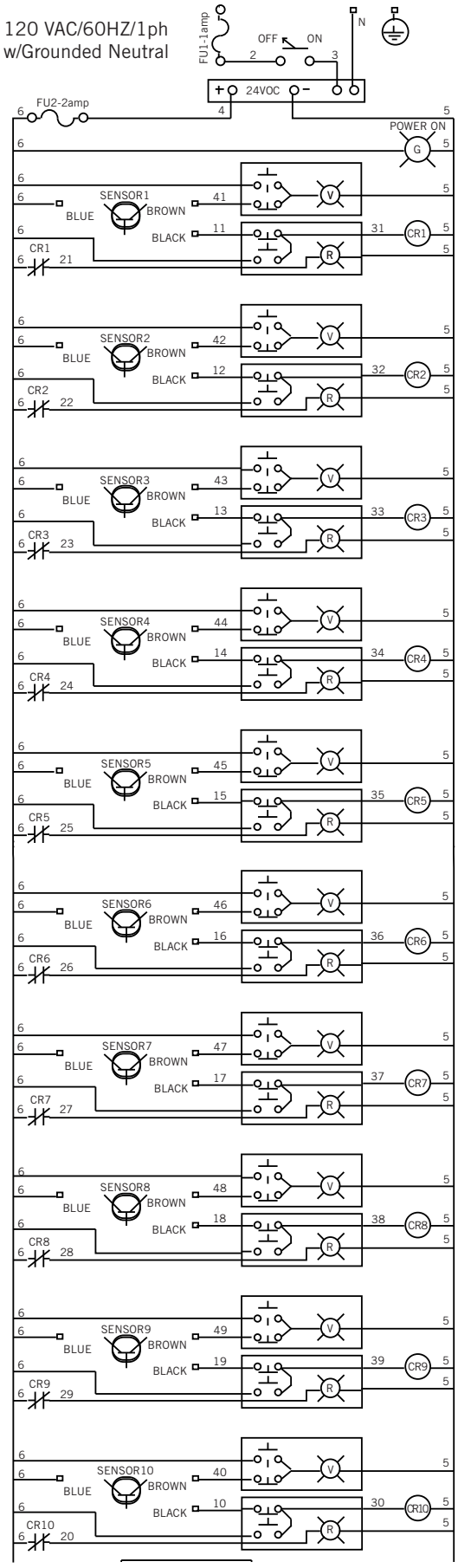
10-Zone Leak Detection Panel

Guardian, Centra-Guard

1-, 5, and 10-zone panels

- Failsafe Design has separate lights for detection of fluid by sensor and continuity of wire.
- Standard general alarm SPDT relay contacts allow communication with plant PLC.
- Standard NEMA 4X powder-coated steel enclosure.
- Optional NEMA 4X enclosures: FRP, aluminum, T304 stainless steel, T316 stainless steel.
- Specially designed panels available upon request.

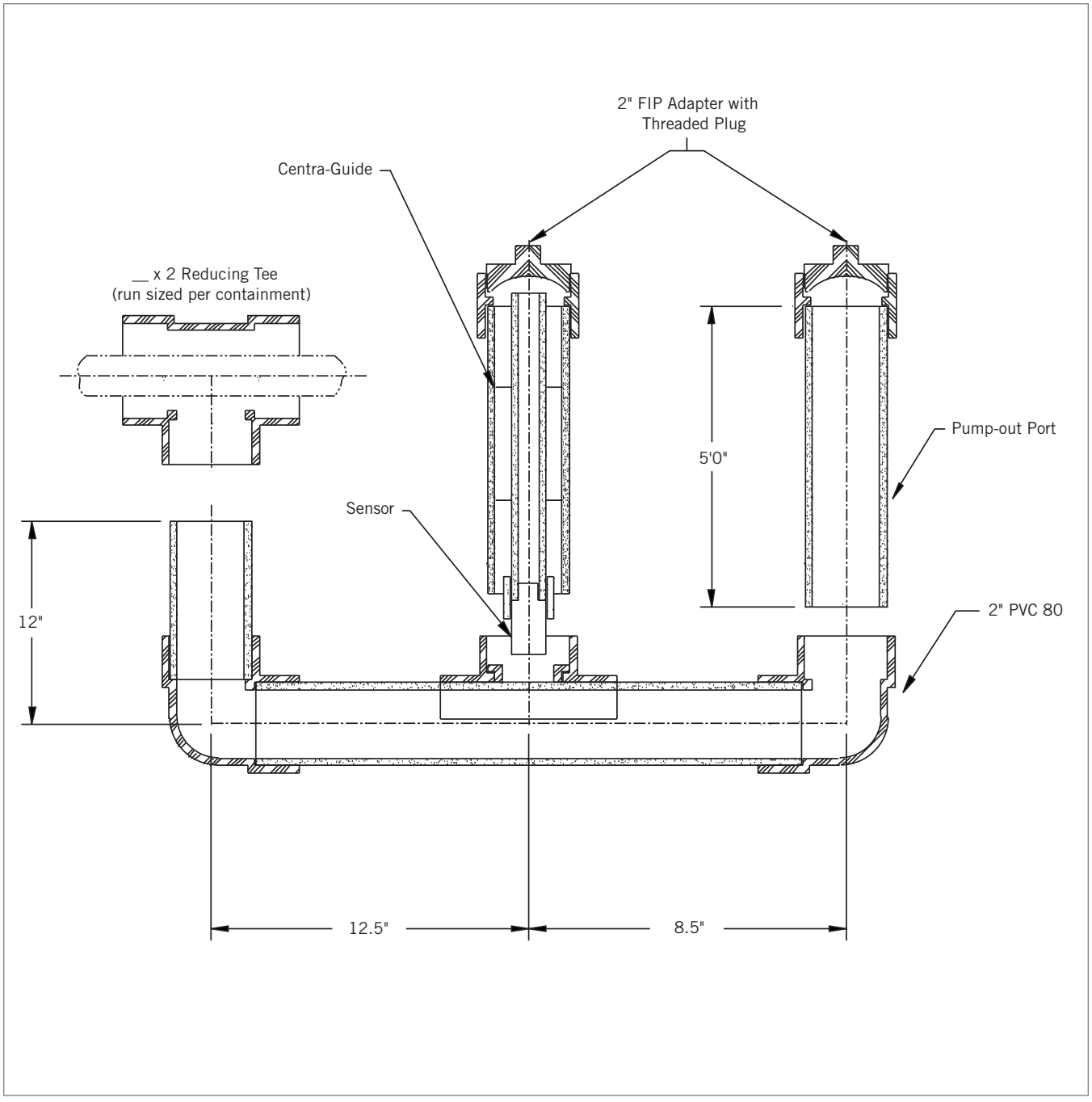




Underground Leak Detection Station with Sensor and Pump Out Port

General Notes

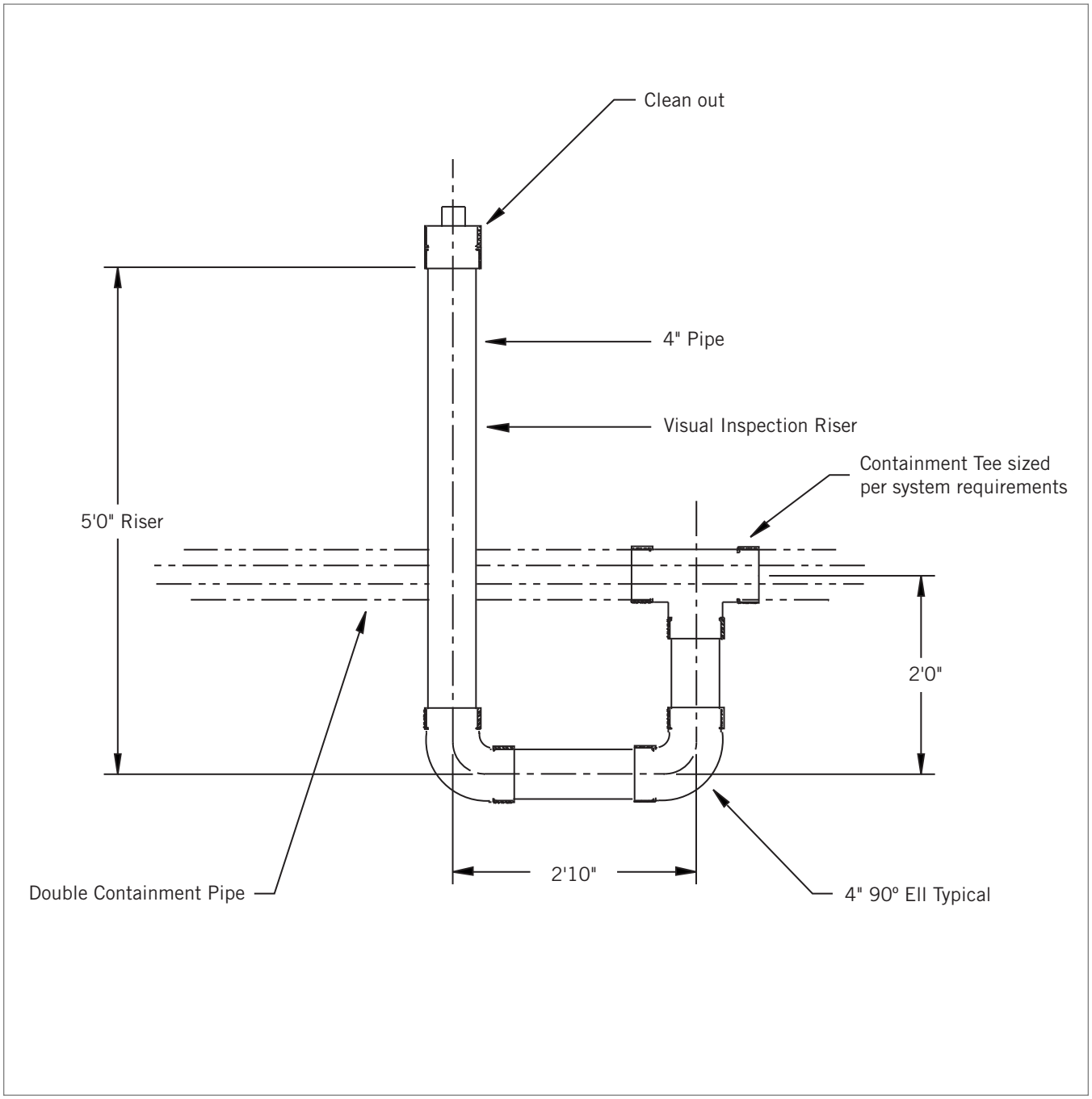
- All fittings are factory tested.
- Leak detection shipped in four separate pieces consisting of: containment tee, saddle, sensor riser, pump out riser and u-bend.
- Containment tee sized per system requirement.
- Leak detection – U.S. patent no. 5,343,191.



Visual Underground Leak Detection Station

General Notes

- Leak detection shipped in three separate pieces consisting of containment tee, saddle, riser and U-bend.
- Containment tee sized per system requirement.



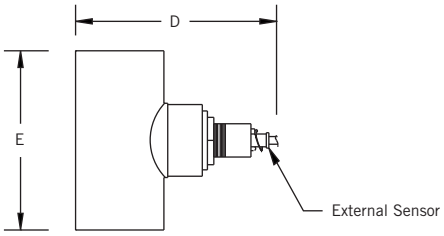
Above-Ground Leak Detection Station With Sensor

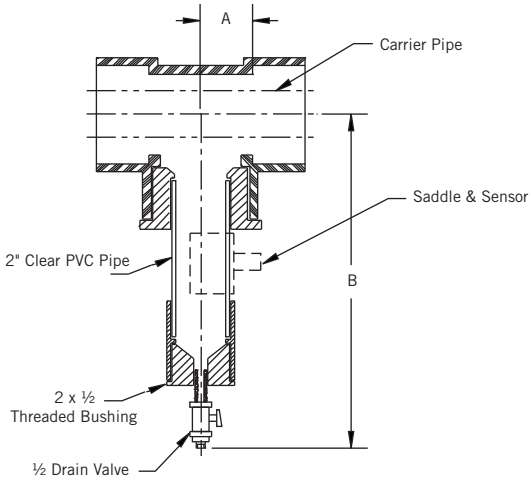
General Notes

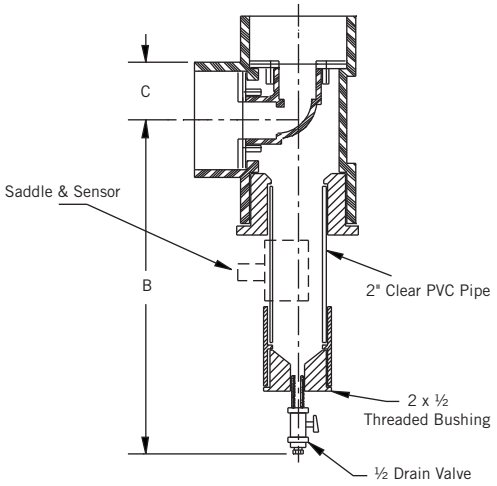
- All fittings are factory tested.
- All dimensions are in inches unless otherwise indicated.
- Containment tee sized per system requirement.
- Guardian leak detection – U.S. patent no. 5,343,191.

Dimensions

Carrier / Containment	A	B	C	D	E
2	1.25	19.25	1.50	5.00	5.25
3	1.88	19.75	2.13	5.00	5.25
4	2.31	20.40	2.56	5.00	5.25
6	3.50	21.50	3.75	5.00	5.25
8	4.56	22.50	4.81	5.00	5.25







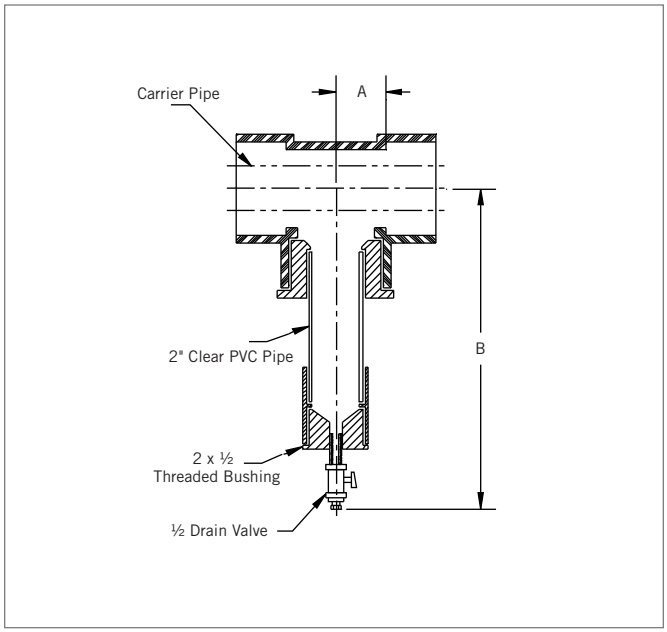
Above-Ground Leak Detection Station

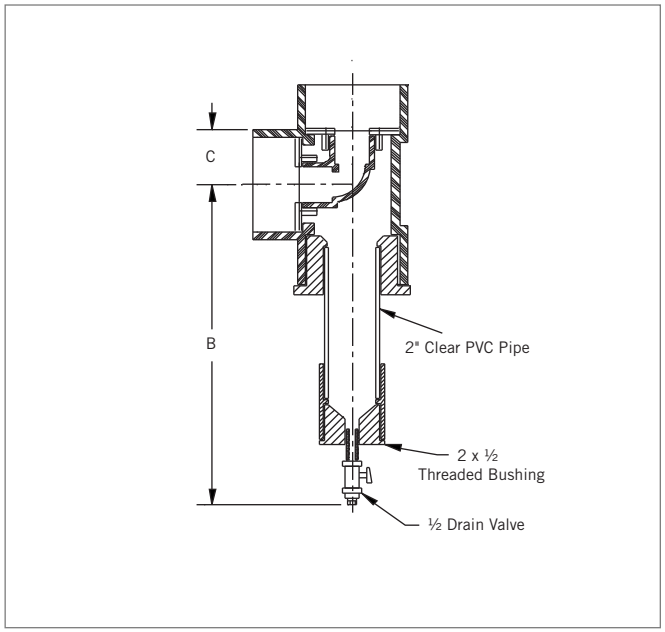
General Notes

- All fittings are factory tested.
- All dimensions are in inches unless otherwise indicated.
- Containment tee sized per system requirement.

Dimensions

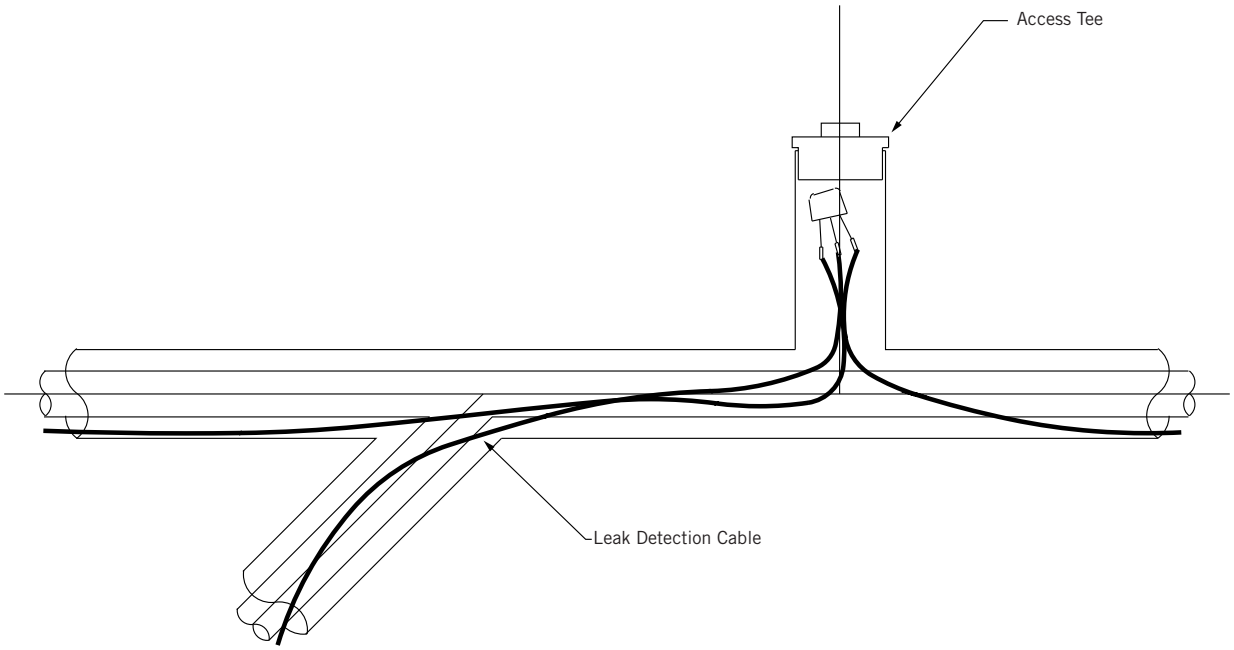
Carrier / Containment	A	B	C	D	E
2	1.25	19.25	1.50	5.00	5.25
3	1.88	19.75	2.13	5.00	5.25
4	2.31	20.40	2.56	5.00	5.25
6	3.50	21.50	3.75	5.00	5.25
8	4.56	22.50	4.81	5.00	5.25





Cable Leak Detection

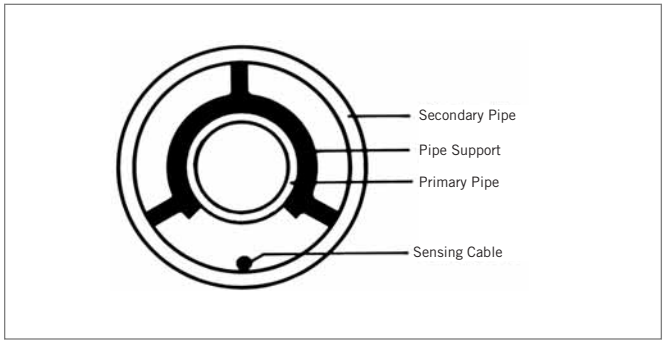
Although several different cable leak detection systems are on the market, they all operate on similar principles. The leak detection cable is manufactured from corrosion-resistant material and rests on the bottom of the piping. Should any chemical spillage occur, the cable will automatically detect the leak.



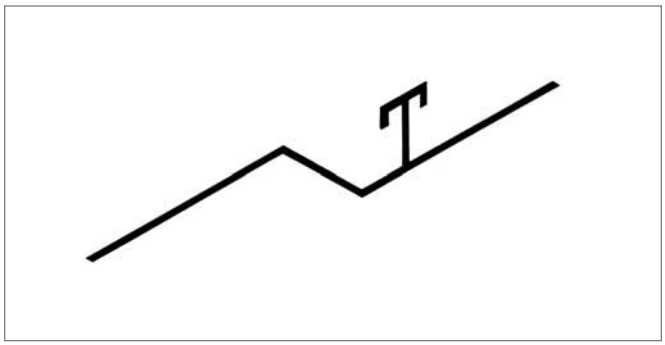
General Requirements For Leak Detection Cable

These general requirements are intended as a guide only and are not a substitute for the detailed instructions given by IPEX. IPEX recommends that in all cases, the designer and installer contact us for specific design installation advice.

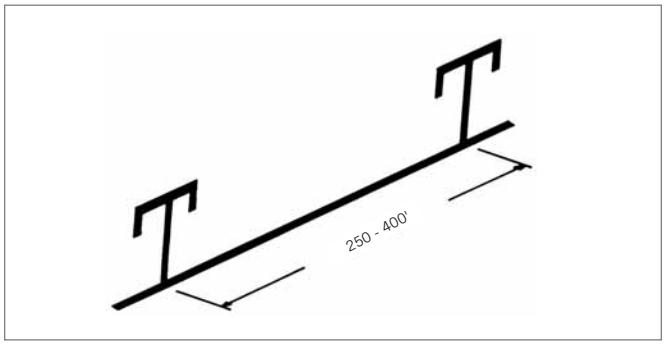
1. The leak detection cable should be installed in the gap between the primary and secondary pipe sections, at the "6 o'clock position".



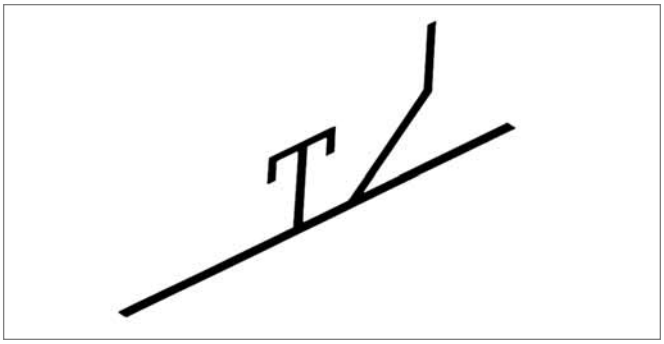
2. Access points to the pipe are required for proper installation of the sensing cable and for future modification. IPEX recommends that an access tee should be placed at the following points in the system:
   - After each 180 degrees of pipe bend.



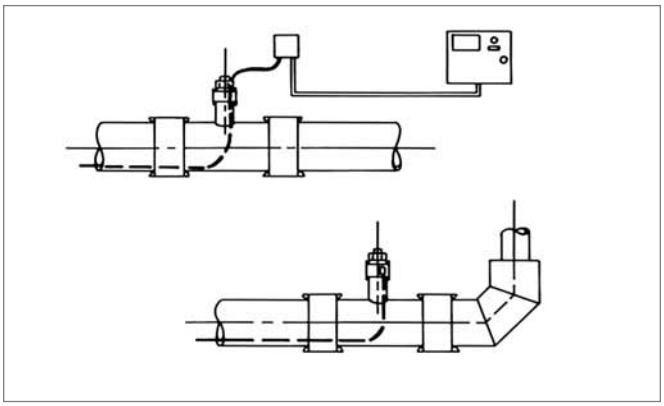
   - Every 250 to 400 feet of straight pipe run.



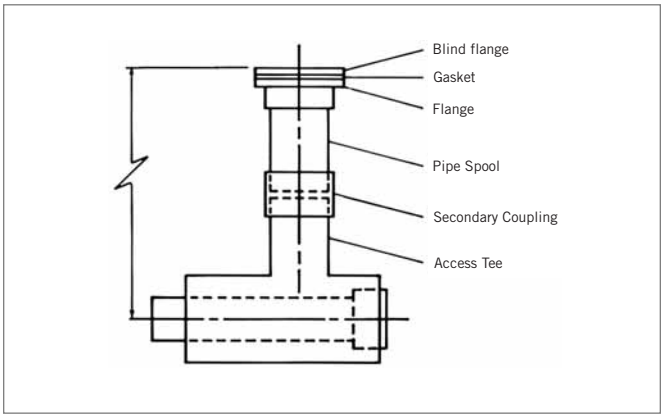
   - Local to each wye.



   - At every cable entry and termination point.



IPEX manufactures an access tee to meet the above requirements.

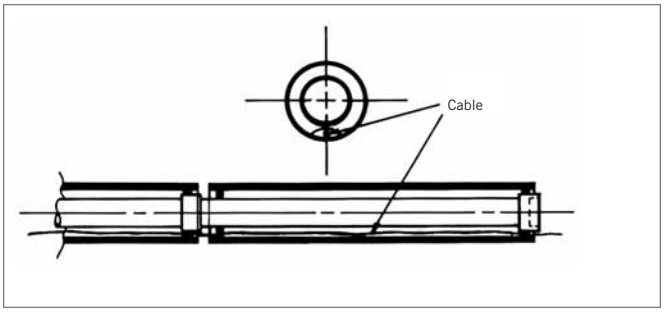


3. A cable service loop (i.e. an extra loop of sensing cable reaching to the top of the access) should be provided to allow easy access to the cable connector.
4. The system should be free of contaminants and water before installing the leak detection cable. **Failure to remove contaminants such as oil, grease or other non-evaporative substances may cause the cable to be permanently in the alarm mode.**

   IPEX systems are shipped to the site complete with end protection to minimize the amount of contamination of the piping.
5. During installation, the pull rope, (which should be a minimum of ¼" and 300 lbs. pulling strength), should extend at least three feet from the access point. Tie or tape the pull rope to the top of the access point.

   After a successful hydrostatic testing of the primary pipe, the leak detection cable can be installed, as required, followed by joining the secondary pipe.

Leak detection cable should be installed in full compliance with the manufacturer's recommendations. Nylon pulling-rope, similar to ski tow rope, is normally recommended to pull the leak detection cable through the piping system. The rope should be at least ¼" diameter and knot-free. IPEX pre-inserts twine into every Encase component to assist the installer in pulling the rope through the piping, prior to installing the leak detection cable.



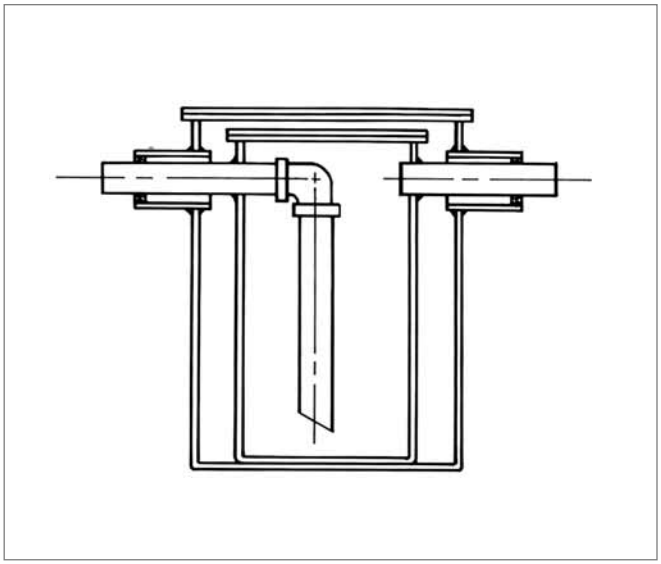
The leak detection cable must always be installed after the primary pipe has been tested. It should not be installed as the primary joints are being made, since site conditions, or leaking joints during testing, may wet the cable and cause installation/operational problems. The cable must remain dry during installation. After inserting the leak detection cable, the secondary joints can be made.

Section Ten: Specialty Components

Neutratank®

Neutralization Tanks

IPEX double containment Neutratanks™ are designed for use in gravity-flow systems where neutralization of chemicals is required prior to discharge into public sewers. The double-contained feature of the IPEX Neutratank ensures that, in the event of a failure of the primary tank, the secondary tank will accommodate any spill until the necessary repairs can be made. Neutratanks are molded from chemically resistant polyethylene or polypropylene and are custom-fabricated to suit individual customers' requirements regarding inlet, outlet and vent connections.



Double contained Neutratanks are manufactured in secondary sizes up to 2,000 gallons, with primary tanks as small as 5 gallons. IPEX will manufacture double containment tanks in the primary/secondary combinations that the individual customer requires. Tanks in sizes up to 275 gallons can be equipped with either an easy access cover, or a bolted style cover. Further details on both styles of tanks are shown in the IPEX Acid Waste Piping Systems Technical Manual.

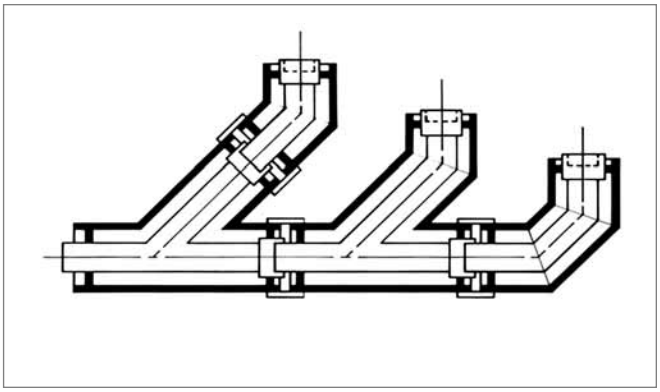
In all cases, IPEX recommends that Neutratanks are installed in a concrete vault to enable easy access for drainage and repair, and that some method of automatic leak detection is employed.

IPEX's exclusive "EZ Access Cover" is an assembly that is permanently welded to the top of the tank. The assembly includes a threaded cover, collar and neoprene seal. The EZ Access Cover allows for quick and easy removal of the tank cover and facilitates quick installation, inspection and maintenance. Using the EZ Access Cover eliminates the tedious and time-consuming chores associated with traditional tank covers, including aligning the gasket and securing its numerous bolts.

ENCASE™

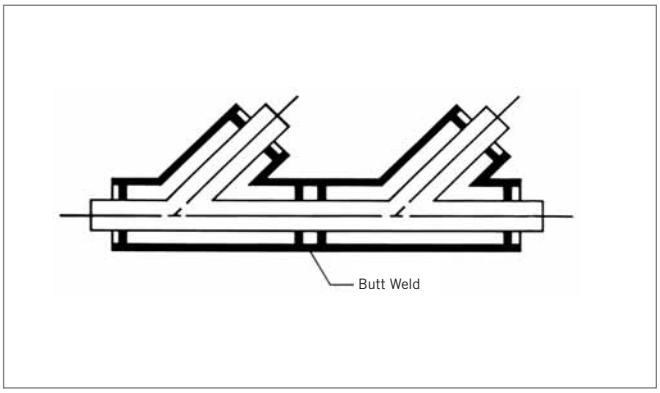
Encase is designed in modular form to allow contractors to take stock items and assemble them with the minimal site fabrication.

Where a contractor requires a pre-assembled manifold (similar to that shown below), these can be provided by IPEX upon receipt of dimensional drawings. This type of custom fabrication can be provided in lengths up to 40 feet.



Order a composite assembly where two or more fittings are pre-assembled at IPEX to your specifications. These can be done in lengths up to 40 feet.

Encase is also available in flame-retardant materials. Contact IPEX's customer service department for pricing.

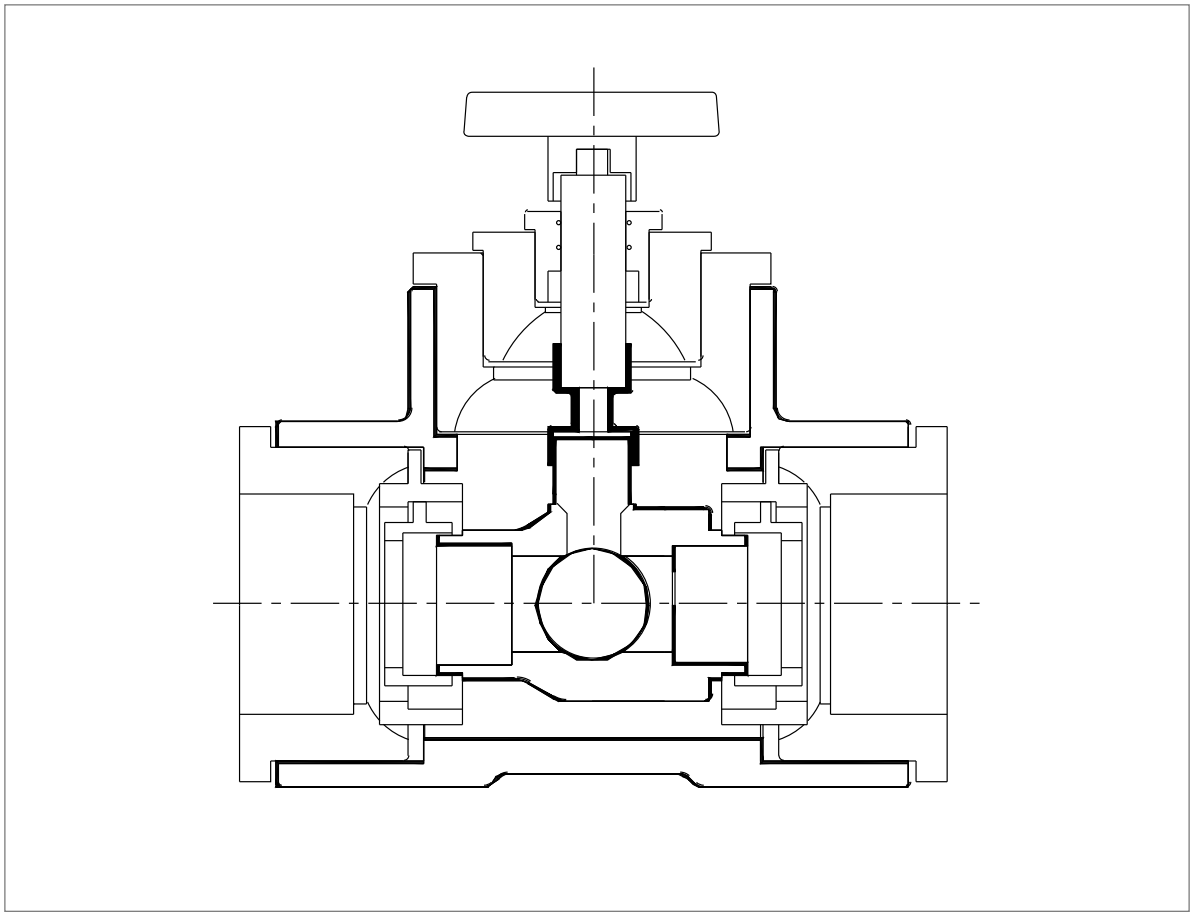


GUARDIAN/CUSTOMGUARD™

IPEX also provides a number of specialty components and services. These include:

- Ball Valve - Manual & Actuated (Electric or Pneumatic)
- Check Valves
- Expansion Loops
- Expansion Ells
- Access Tees
- Sub-Assemblies (IPEX provides isometric and detail drawings of system)
- Detailed Stress Analysis by licensed professional engineer

Consult IPEX for more detailed information.



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Section Eleven: Specifications

Encase™

Encase Long Form

General

Acid waste double containment drain lines, as shown on drawings, shall be Encase, manufactured by IPEX, with no substitutions. Pipe and fittings shall be manufactured from Schedule 40 polypropylene and joined by the Enfusion method.

Material

Pipe, fittings, internal pipe supports and anchor plates shall be manufactured from Type 1 homopolymer or Type 2 copolymer polypropylene material as described in ASTM D 4101.

Pipe and Fittings – Construction

All pipe fittings shall be factory assembled and of unitized construction, with the primary and secondary components integrally anchored together to prevent movement of the primary pipe/fitting within the containment pipe/fitting. All piping components shall be manufactured to Schedule 40 dimensions. The primary pipe shall be adequately supported by means of support plates welded to the primary pipe. Anchor plates shall be provided at each end of the pipe/fitting section to restrain pipe expansion. All anchor plates must be mechanically located in a machined recess on the inside of each secondary pipe/fitting and welded to both the primary and secondary pipe/fitting sections.

Factory Welded Joints

All factory joints shall be made either by butt fusion or Enfusion. Joining by means of fillet welding is expressly forbidden.

Site Joints

All site joints shall be made using Enfusion couplings, manufactured from polypropylene with a nickel/chrome resistance wire, molded in place. Components with copper wire elements are prohibited. Solvent, butt-welded or fillet-welded site joints are also prohibited.

Installation

Installation shall be in accordance with the contract drawings, the manufacturer's recommendations and the local plumbing code. The entire installation shall be installed in proper alignment and free of stress.

Testing

The system shall be tested in accordance with the manufacturer's recommendations and the local plumbing code. The primary pipe shall be tested prior to making the secondary joints.

If Secondary pipe cannot be hydro-tested, as determined by the engineer or authority having jurisdiction, then the use of nitrogen or air at a MAXIMUM 5 psi (gauge) shall be allowed. It is imperative that a working-pressure regulator be used during the pneumatic test to ensure that over-pressurization of the PVC, beyond 5 psi, cannot occur. The following must also be noted: Air or nitrogen under pressure is compressed and therefore poses a potential hazard. If a failure of the pipe or fitting occurs during such test, the air exits at the failure point and expands rapidly. This increase in velocity can cause the system to fail in a catastrophic mode. Therefore during such air test all personnel involved in the test or present in the test surrounding area must be aware of such a possibility and take all necessary precautions. Precautions include, but are not limited to, taking extreme care not to impact or damage the system in any way.

Such procedure is a limited exception to IPEX standard policy which forbids the use of its rigid systems with any compressed gases.

Encase Short Form

Acid waste double containment drain lines shall be Encase, as manufactured by IPEX, with no substitutions. Pipe and fittings shall be manufactured from Schedule 40, ASTM D 4101 Type 1 homopolymer or Type 2 Copolymer polypropylene. Joining shall be made using Enfusion couplings and a nickel/chrome wire molded in place. All pipe fittings shall be factory assembled, with Enfusion, or butt fusion welds, and be of unitized construction, with primary and secondary components integrally anchored together to control expansion and contraction. All primary joints shall be pressure tested and inspected, in accordance with the manufacturer's instructions and any local plumbing codes, prior to making any secondary joints.

GUARDIAN™

PVC Double Containment Piping System

General

Scope of Work

Furnish all labor, materials, equipment and incidentals required to install a Guardian PVC (Primary) / PVC (Secondary) double containment piping, valves and appurtenances for complete systems as shown on the drawings and as specified herein.

Description of Systems

_____% Chemical Names (To be inserted)

Submittals

Shop drawings shall be submitted to the engineer and include details of pipe fabrications (including supporting devices, method of attachment, spacing, etc.), prefabricated double containment fitting dimensions, starting and terminating connections, high-point vent and low-point drain details for the secondary containment, valves and accessories. Submit joint details, methods and location of supports, and all other pertinent technical data for all piping to be furnished.

Qualifications

The double containment piping system shall be a Guardian prefabricated system as manufactured by IPEX. The system shall be fabricated, installed and tested in accordance with IPEX's recommendations and as specified herein and shall be suitable for the intended service. Manufacturer shall have a minimum of five (5) years experience. Contractor shall not design and/or fabricate the piping system.

Products

General

Each contained piping system shall consist of Xirtec®140 PVC primary piping system supported within a Xirtec®140 PVC secondary containment housing. Carrier fitting sizes 1/2" through 4" will use Centra-Lok [U.S. Patent No. 5,398,973] molded supports minimizing the number of field (factory assembled) fitting joints. Carrier sizes 6" and larger will use IPEX standard polypropylene fitting discs to support and centralize. Each system shall be provided with suitable drains and vents and be designed to provide complete drainage of both the primary and secondary containment piping. Interstitial supporting devices shall be made from Polypropylene Centra-Guide supports and shall be provided within the secondary containment pipe, and shall be designed to allow continuous drainage in the annular space to the drain points. Drain fittings shall be designed to allow a valve attachment to be made so that the secondary containment compartment may be readily drained and manually checked for leaks.

Materials

The primary pipe and fittings shall be manufactured from Xirtec140 DWV, schedule 40, or schedule 80 PVC materials as manufactured by IPEX and as listed by ASTM and ANSI.

The secondary containment pipe and fittings shall be manufactured from Xirtec 140 DWV, schedule 40, or schedule 80 PVC materials as manufactured by IPEX And as listed by ASTM and ANSI.

All listed primary pipe shall be shall be Xirtec 140 DWV, schedule 40 or schedule 80 materials. Pipe shall have DWV thickness according to ASTM D-2665, schedule 40 thickness according to ASTM D-1785, or schedule 80 thickness according to ASTM D-1785. All listed primary pressure fittings shall be schedule 40 PVC according to ASTM D-2466, or schedule 80 PVC according to ASTM D-2467 specifications. All other unlisted components intended for use as pressure retaining components shall have sufficient thickness and reinforcement so as to be able to maintain the same pressure ratings as the equivalent DWV or schedule PVC pipe. Interstitial supporting devices used to center and support the primary piping within the secondary containment piping shall be manufactured from Polypropylene Centra-Guide supports, according to ASTM and ANSI.

All listed secondary containment pipe and fittings shall be IPEX's Xirtec140 DWV, schedule 40, or schedule 80 materials as manufactured by IPEX. Pipe shall have DWV thickness according to ASTM D-2665, schedule 40 thickness according to ASTM D-1785, or schedule 80 thickness according to ASTM D-1785. All listed pressure fittings shall be schedule 40 according to ASTM D-2466 or schedule 80 according to ASTM D-2467. All other unlisted components intended for use as pressure retaining components shall have sufficient thickness and reinforcement so as to be able to maintain the same pressure ratings as the equivalent DWV or schedule PVC pipe.

All fittings will be pre-assembled (1/2" through 4" carrier fittings will be supported with the Centra-Lok [U.S. Patent No. 5,398,973] system, 6" and larger carrier will be supported with IPEX standard Polypropylene fitting discs) and pre-tested by the manufacturer (IPEX).

GUARDIAN™

Execution

Installation

All installation procedures shall be according to the manufacturer's (IPEX) specific recommendations. The manufacturer shall furnish the services of a competent representative to supervise the contractor's personnel during the start of the installation.

All secondary containment joints shall be solvent-cemented joints using heavy body-slow set PVC cement ASTM D-2564, made in accordance with ASTM D-2855 procedure. The splitting and re-welding of fittings shall not be permitted. The use of hot gas welding for pressure-retaining joints shall be kept to those locations where deemed necessary by IPEX.

All contractor personnel that will prepare solvent cemented joints shall be qualified for such bonding practices according to the bonding qualifications procedures described in ASME B 31.3, Chapter VII for bonding of plastic piping.

Cleaning and Testing

Upon completing installation, the primary piping system shall be hydrostatically tested at 150% of the system design pressure for a period of one hour. Additionally, the system may be tested during the installation at intervals to be determined by the manufacturer (IPEX).

If Secondary pipe cannot be hydro-tested, as determined by the engineer or authority having jurisdiction, then the use of nitrogen or air at a MAXIMUM 5psi (gauge) shall be allowed. The external joint should be visually inspected for leaks using an IPEX approved leak detector.

⚠ WARNING

It is imperative that a working-pressure regulator be used during the pneumatic test to ensure that over-pressurization of the PVC, beyond 5 psi, cannot occur. The following must also be noted: Air or nitrogen under pressure is compressed and therefore poses a potential hazard. If a failure of the pipe or fitting occurs during such test, the air exits at the failure point and expands rapidly. This increase in velocity can cause the system to fail in a catastrophic mode. Therefore during such air test all personnel involved in the test or present in the test surrounding area must be aware of such a possibility and take all necessary precautions. Precautions include, but are not limited to, taking extreme care not to impact or damage the system in any way. Such procedure is a limited exception to IPEX standard policy which forbids the use of its rigid systems with any compressed gases, unless the product(s) is specifically designed for the conveyance of compressed gases.

Both the preliminary and final tests shall be performed in strict accordance with the recommendations of the manufacturer (IPEX) including the sequence and duration of such tests.

Following installation of the systems, the primary piping system shall be flushed clean. The contractor shall check the operation of all valves, leak detection devices and appurtenances.

The annular space shall be purged of moisture containing air by replacing the volume of air with clean, dry nitrogen.

Leak Detection – U.S. Patent No. 5,343,191

Provide and install at each zone a density sensor station consisting of an external clip-on sensor, drip leg and drain valve with hose connection and/or riser and sensor extension handle. Each sensor shall have an LED testing lamp, adjusting potentiometer and be removable for periodic testing. Sensor shall not penetrate the containment piping jacket. Control console shall be housed in a NEMA IV enclosure, operating on 120 VAC and supplies 24 VDC to zone sensors. Console shall have alarm lamps, pilot lamp, test buttons and mute switch. Console shall also have a common audible alarm and external output switch for accessory alarms. Leak detection system shall be Centra-Guard™ as manufactured by IPEX.

GUARDIAN™

CPVC Double Containment Piping System

General

Scope of Work

Furnish all labor, materials, equipment and incidentals required to install a Guardian CPVC (Primary)/CPVC (Secondary) double containment piping, valves and appurtenances for complete systems as shown on the drawings and as specified herein.

Description of Systems

_____% Chemical Names (To be inserted)

Submittals

Shop drawings shall be submitted to the engineer and include details of pipe fabrications (including supporting devices, method of attachment, spacing, etc.), prefabricated double containment fitting dimensions, starting and terminating connections, high-point vent and low-point drain details for the secondary containment, valves and accessories. Submit joint details, methods and location of supports, and all other pertinent technical data for all piping to be furnished.

Qualifications

The double containment piping system shall be a Guardian prefabricated system as manufactured by IPEX. The system shall be fabricated, installed and tested in accordance with IPEX's recommendations and as specified herein and shall be suitable for the intended service. Manufacturer shall have a minimum of five (5) years experience. Contractor shall not design and/or fabricate the piping system.

Products

General

Each contained piping system shall consist of Corzan® CPVC primary piping system supported with a Corzan® CPVC secondary containment housing. Carrier fitting sizes 1/2" through 4" will use Centra-Lok [U.S. Patent No. 5,398,973] molded supports minimizing the number of (factory assembled) fitting joints. Carrier sizes 6" and larger will use IPEX standard polypropylene fitting discs to support and centralize. Each system shall be provided with suitable drains and vents and be designed to provide complete drainage of both the primary and secondary containment piping. Interstitial supporting devices shall be made from Polypropylene Centra-Guide™ supports and shall be provided within the secondary containment pipe, and shall be designed to allow continuous drainage in the annular space to the drain points. Drain fittings shall be designed to allow a valve attachment to be made so that the secondary containment compartment may be readily drained and manually checked for leaks.

Materials

The primary pipe and fittings shall be manufactured from Corzan schedule 80 CPVC materials as manufactured by IPEX and as listed by ASTM and ANSI.

The secondary containment pipe and fittings shall be manufactured from Corzan schedule 40 or schedule 80 CPVC materials as manufactured by IPEX. And as listed by ASTM and ANSI.

All listed primary pipe shall be shall be Corzan schedule 40 or schedule 80 materials. Pipe shall have schedule 40 or schedule 80 thickness according to ASTM F-441 All listed primary pressure fittings shall be schedule 80 CPVC according to ASTM F-439 specifications. All other unlisted components intended for use as pressure retaining components shall have sufficient thickness and reinforcement so as to be able to maintain the same pressure ratings as the equivalent schedule CPVC pipe.

Interstitial supporting devices used to center and support the primary piping within the secondary containment piping shall be manufactured from Polypropylene Centra-Guide supports, according to ASTM and ANSI.

All listed secondary containment pipe and fittings shall be IPEX's Corzan® schedule 40, or schedule 80 materials as manufactured by IPEX. Pipe shall have schedule 40 or schedule 80 thickness according to ASTM F-441. All listed pressure fittings shall be schedule 80 according to ASTM F-439. All other unlisted components intended for use as pressure retaining components shall have sufficient thickness and reinforcement so as to be able to maintain the same pressure ratings as the equivalent schedule CPVC pipe.

All fittings will be pre-assembled (1/2" through 4" carrier fittings will be supported with the Centra-Lok [U.S. Patent No. 5,398,973] system, 6" and larger carrier will be supported with IPEX standard Polypropylene fitting discs) and pre-tested by the manufacturer (IPEX).

GUARDIAN™

Execution

Installation

All installation procedures shall be according to the manufacturer's (IPEX) specific recommendations. The manufacturer shall furnish the services of a competent representative to supervise the contractor's personnel during the start of the installation.

All secondary containment joints shall be solvent-cemented joints using heavy body-slow set PVC cement ASTM D-2564, made in accordance with ASTM D-2855 procedure. The splitting and re-welding of fittings shall not be permitted. The use of hot gas welding for pressure-retaining joints shall be kept to those locations where deemed necessary by IPEX.

All contractor personnel that will prepare solvent cemented joints shall be qualified for such bonding practices according to the bonding qualifications procedures described in ASME B 31.3, Chapter VII for bonding of plastic piping.

Cleaning and Testing

Upon completing installation, the primary piping system shall be hydrostatically tested at 150% of the system design pressure for a period of one hour. Additionally, the system may be tested during the installation at intervals to be determined by the manufacturer (IPEX).

If Secondary pipe cannot be hydro-tested, as determined by the engineer or authority having jurisdiction, then the use of nitrogen or air at a MAXIMUM 5psi (gauge) shall be allowed. The external joint should be visually inspected for leaks using an IPEX approved leak detector.

Both the preliminary and final tests shall be performed in strict accordance with the recommendations of the manufacturer (IPEX) including the sequence and duration of such tests.

⚠ WARNING

It is imperative that a working-pressure regulator be used during the pneumatic test to ensure that over-pressurization of the PVC, beyond 5 psi, cannot occur. The following must also be noted: Air or nitrogen under pressure is compressed and therefore poses a potential hazard. If a failure of the pipe or fitting occurs during such test, the air exits at the failure point and expands rapidly. This increase in velocity can cause the system to fail in a catastrophic mode. Therefore during such air test all personnel involved in the test or present in the test surrounding area must be aware of such a possibility and take all necessary precautions. Precautions include, but are not limited to, taking extreme care not to impact or damage the system in any way. Such procedure is a limited exception to IPEX standard policy which forbids the use of its rigid systems with any compressed gases, unless the product(s) is specifically designed for the conveyance of compressed gases.

Following installation of the systems, the primary piping system shall be flushed clean. The contractor shall check the operation of all valves, leak detection devices and appurtenances.

The annular space shall be purged of moisture containing air by replacing the volume of air with clean, dry nitrogen.

Leak Detection – U.S. Patent No. 5,343,191

Provide and install at each zone a density sensor station consisting of an external clip-on sensor, drip leg and drain valve with hose connection and/or riser and sensor extension handle. Each sensor shall have an LED testing lamp, adjusting potentiometer and be removable for periodic testing. Sensor shall not penetrate the containment piping jacket. Control console shall be housed in a NEMA IV enclosure, operating on 120 VAC and supplies 24 VDC to zone sensors. Console shall have alarm lamps, pilot lamp, test buttons and mute switch. Console shall also have a common audible alarm and external output switch for accessory alarms. Leak detection system shall be Centra-Guard™ as manufactured by IPEX.

CLEAR-GUARD™

PVC Carrier Double Containment Piping System

General

Scope of Work

Furnish all labor, materials, equipment and incidentals required to install a Xirtec 140 PVC (Primary)/ Clear-Guard PVC (Secondary) double containment piping, valves and appurtenances for complete systems as shown on the drawings and as specified herein.

Description of Systems

_____% Chemical Names (To be inserted)

Submittals

Shop drawings shall be submitted to the engineer and include details of pipe fabrications (including supporting devices, method of attachment, spacing, etc.), prefabricated double containment fitting dimensions, starting and terminating connections, high-point vent and low-point drain details for the secondary containment, valves and accessories. Submit joint details, methods and location of supports, and all other pertinent technical data for all piping to be furnished.

Qualifications

The double containment piping system shall be a Clear-Guard prefabricated system as manufactured by IPEX. The system shall be fabricated, installed and tested in accordance with IPEX's recommendations and as specified herein and shall be suitable for the intended service. Manufacturer shall have a minimum of five (5) years experience. Contractor shall not design and/or fabricate the piping system.

Products

General

Each contained piping system shall consist of Xirtec 140 PVC primary piping system supported within a Clear-Guard Schedule 40 clear PVC secondary containment housing. Carrier fitting sizes 1/2" through 4" will use Centra-Lok [U.S. Patent No. 5,398,973] molded supports minimizing the number of field (factory assembled) fitting joints. Each system shall be provided with suitable drains and vents and be designed to provide complete drainage of both the primary and secondary containment piping. Interstitial supporting devices shall be made from Polypropylene Centra-Guide supports and shall be provided within the secondary containment pipe, and shall be designed to allow continuous drainage in the annular space to the drain points. Drain fittings shall be designed to allow a valve attachment to be made so that the secondary containment compartment may be readily drained and manually checked for leaks.

Materials

The primary pipe and fittings shall be manufactured from Xirtec140 DWV, schedule 40, or schedule 80 PVC materials as manufactured by IPEX and as listed by ASTM and ANSI.

The secondary containment pipe and fittings shall be manufactured from Clear-Guard Schedule 40 clear PVC materials as manufactured by IPEX and as listed by ASTM.

All listed primary pipe shall be shall be Xirtec 140 DWV, schedule 40 or schedule 80 materials. Pipe shall have DWV thickness according to ASTM D-2665, schedule 40 thickness according to ASTM D-1785, or schedule 80 thickness according to ASTM D-1785. All listed primary pressure fittings shall be schedule 40 PVC according to ASTM D-2466, or schedule 80 PVC according to ASTM D-2467 specifications. All other unlisted components intended for use as pressure retaining components shall have sufficient thickness and reinforcement so as to be able to maintain the same pressure ratings as the equivalent DWV or schedule PVC pipe.

Interstitial supporting devices used to center and support the primary piping within the secondary containment piping shall be manufactured from Polypropylene Centra-Guide supports, according to ASTM and ANSI.

All listed secondary containment pipe shall be IPEX's Clear-Guard schedule 40 materials as manufactured by IPEX. Pipe shall have schedule 40 thickness according to ASTM D-1785. All listed pressure fittings shall be schedule 40 according to ASTM D-2466. All other unlisted components intended for use as pressure retaining components shall have sufficient thickness and reinforcement so as to be able to maintain the same pressure ratings as the equivalent schedule PVC pipe.

Pipe and fittings shall be shielded from UV radiation at all times. These sources include sunlight and artificial lighting lamps that emit UV radiation. Above ground outside installations must be protected. Consult IPEX for more detailed information.

All fittings will be pre-assembled (1/2" through 4" carrier fittings will be supported with the Centra-Lok [U.S. Patent No. 5,398,973] system, 6" and larger carrier will be supported with IPEX standard Polypropylene fitting discs) and pre-tested by the manufacturer (IPEX).

CLEAR-GUARD™

Execution

Installation

All installation procedures shall be according to the manufacturer's (IPEX) specific recommendations. The manufacturer shall furnish the services of a competent representative to supervise the contractor's personnel during the start of the installation. All secondary containment joints shall be solvent-cemented joints using heavy body-slow set PVC cement ASTM D-2564, made in accordance with ASTM D-2855 procedure. The splitting and re-welding of fittings shall not be permitted. The use of hot gas welding for pressure-retaining joints shall be kept to those locations where deemed necessary by IPEX. All contractor personnel that will prepare solvent cemented joints shall be qualified for such bonding practices according to the bonding qualifications procedures described in ASME B 31.3, Chapter VII for bonding of plastic piping.

Cleaning and Testing

Upon completing installation, the primary piping system shall be hydrostatically tested at 150% of the system design pressure for a period of one hour. Additionally, the system may be tested during the installation at intervals to be determined by the manufacturer (IPEX).

If Secondary pipe cannot be hydro-tested, as determined by the engineer or authority having jurisdiction, then the use of nitrogen or air at a MAXIMUM 5psi (gauge) shall be allowed. The external joint should be visually inspected for leaks using an IPEX approved leak detector.

Both the preliminary and final tests shall be performed in strict accordance with the recommendations of the manufacturer (IPEX) including the sequence and duration of such tests.

⚠ WARNING

It is imperative that a working-pressure regulator be used during the pneumatic test to ensure that over-pressurization of the PVC, beyond 5 psi, cannot occur. The following must also be noted: Air or nitrogen under pressure is compressed and therefore poses a potential hazard. If a failure of the pipe or fitting occurs during such test, the air exits at the failure point and expands rapidly. This increase in velocity can cause the system to fail in a catastrophic mode. Therefore during such air test all personnel involved in the test or present in the test surrounding area must be aware of such a possibility and take all necessary precautions. Precautions include, but are not limited to, taking extreme care not to impact or damage the system in any way. Such procedure is a limited exception to IPEX standard policy which forbids the use of its rigid systems with any compressed gases, unless the product(s) is specifically designed for the conveyance of compressed gases.

Following installation of the systems, the primary piping system shall be flushed clean. The contractor shall check the operation of all valves, leak detection devices and appurtenances. The annular space shall be purged of moisture containing air by replacing the volume of air with clean, dry nitrogen.

Leak Detection – U.S. Patent No. 5,343,191

Provide and install at each zone a density sensor station consisting of an external clip-on sensor, drip leg and drain valve with hose connection and/or riser and sensor extension handle. Each sensor shall have an LED testing lamp, adjusting potentiometer and be removable for periodic testing. Sensor shall not penetrate the containment piping jacket. Control console shall be housed in a NEMA IV enclosure, operating on 120 VAC and supplies 24 VDC to zone sensors. Console shall have alarm lamps, pilot lamp, test buttons and mute switch. Console shall also have a common audible alarm and external output switch for accessory alarms. Leak detection system shall be Centra-Guard™ as manufactured by IPEX.

CLEAR-GUARD™

CPVC Carrier Double Containment Piping System

General

Scope of Work

Furnish all labor, materials, equipment and incidentals required to install a Corzan CPVC (Primary)/ Clear-Guard PVC (Secondary) double containment piping, valves and appurtenances for complete systems as shown on the drawings and as specified herein.

Description of Systems

_____% Chemical Names (To be inserted)

Submittals

Shop drawings shall be submitted to the engineer and include details of pipe fabrications (including supporting devices, method of attachment, spacing, etc.), prefabricated double containment fitting dimensions, starting and terminating connections, high-point vent and low-point drain details for the secondary containment, valves and accessories. Submit joint details, methods and location of supports, and all other pertinent technical data for all piping to be furnished.

Qualifications

The double containment piping system shall be a Clear-Guard prefabricated system as manufactured by IPEX. The system shall be fabricated, installed and tested in accordance with IPEX's recommendations and as specified herein and shall be suitable for the intended service. Manufacturer shall have a minimum of five (5) years experience. Contractor shall not design and/or fabricate the piping system.

Products

General

Each contained piping system shall consist of Corzan CPVC primary piping system supported within a Clear-Guard Schedule 40 clear PVC secondary containment housing. Carrier fitting sizes 1/2" through 4" will use Centra-Lok [U.S. Patent No. 5,398,973] molded supports minimizing the number of field (factory assembled) fitting joints. Each system shall be provided with suitable drains and vents and be designed to provide complete drainage of both the primary and secondary containment piping. Interstitial supporting devices shall be made from Polypropylene Centra-Guide supports and shall be provided within the secondary containment pipe, and shall be designed to allow continuous drainage in the annular space to the drain points. Drain fittings shall be designed to allow a valve attachment to be made so that the secondary containment compartment may be readily drained and manually checked for leaks.

Materials

The primary pipe and fittings shall be manufactured from Corzan schedule 40, or schedule 80 PVC materials as manufactured by IPEX and as listed by ASTM and ANSI.

The secondary containment pipe and fittings shall be manufactured from Clear-Guard Schedule 40 clear PVC materials as manufactured by IPEX and as listed by ASTM.

All listed primary pipe shall be shall be Corzan schedule 40 or schedule 80 materials. Pipe shall have schedule 40 thickness according to ASTM F-441, or schedule 80 thickness according to ASTM F-441. All listed primary pressure fittings shall be schedule 80 CPVC according to ASTM F-439 specifications. All other unlisted components intended for use as pressure retaining components shall have sufficient thickness and reinforcement so as to be able to maintain the same pressure ratings as the equivalent schedule CPVC pipe.

Interstitial supporting devices used to center and support the primary piping within the secondary containment piping shall be manufactured from Polypropylene Centra-Guide supports, according to ASTM and ANSI.

All listed secondary containment pipe shall be IPEX's Clear-Guard schedule 40 materials as manufactured by IPEX. Pipe shall have schedule 40 thickness according to ASTM D-1785. All listed pressure fittings shall be schedule 40 according to ASTM D-2466. All other unlisted components intended for use as pressure retaining components shall have sufficient thickness and reinforcement so as to be able to maintain the same pressure ratings as the equivalent schedule PVC pipe.

Pipe and fittings shall be shielded from UV radiation at all times. These sources include sunlight and artificial lighting lamps that emit UV radiation. Above ground outside installations must be protected. Consult IPEX for more detailed information.

All fittings will be pre-assembled (1/2" through 4" carrier fittings will be supported with the Centra-Lok [U.S. Patent No. 5,398,973] system.

CLEAR-GUARD™

Execution

Installation

All installation procedures shall be according to the manufacturer's (IPEX) specific recommendations. The manufacturer shall furnish the services of a competent representative to supervise the contractor's personnel during the start of the installation.

All secondary containment joints shall be solvent-cemented joints using heavy body-slow set PVC cement ASTM D-2564, made in accordance with ASTM D-2855 procedure. The splitting and re-welding of fittings shall not be permitted. The use of hot gas welding for pressure-retaining joints shall be kept to those locations where deemed necessary by IPEX. All contractor personnel that will prepare solvent cemented joints shall be qualified for such bonding practices according to the bonding qualifications procedures described in ASME B 31.3, Chapter VII for bonding of plastic piping.

Cleaning and Testing

Upon completing installation, the primary piping system shall be hydrostatically tested at 150% of the system design pressure for a period of one hour. Additionally, the system may be tested during the installation at intervals to be determined by the manufacturer (IPEX).

If Secondary pipe cannot be hydro-tested, as determined by the engineer or authority having jurisdiction, then the use of nitrogen or air at a MAXIMUM 5psi (gauge) shall be allowed. The external joint should be visually inspected for leaks using an IPEX approved leak detector.

Both the preliminary and final tests shall be performed in strict accordance with the recommendations of the manufacturer (IPEX) including the sequence and duration of such tests.

⚠ WARNING

It is imperative that a working-pressure regulator be used during the pneumatic test to ensure that over-pressurization of the PVC, beyond 5 psi, cannot occur. The following must also be noted: Air or nitrogen under pressure is compressed and therefore poses a potential hazard. If a failure of the pipe or fitting occurs during such test, the air exits at the failure point and expands rapidly. This increase in velocity can cause the system to fail in a catastrophic mode. Therefore during such air test all personnel involved in the test or present in the test surrounding area must be aware of such a possibility and take all necessary precautions. Precautions include, but are not limited to, taking extreme care not to impact or damage the system in any way. Such procedure is a limited exception to IPEX standard policy which forbids the use of its rigid systems with any compressed gases, unless the product(s) is specifically designed for the conveyance of compressed gases.

Following installation of the systems, the primary piping system shall be flushed clean. The contractor shall check the operation of all valves, leak detection devices and appurtenances. The annular space shall be purged of moisture containing air by replacing the volume of air with clean, dry nitrogen.

Leak Detection – U.S. Patent No. 5,343,191

Provide and install at each zone a density sensor station consisting of an external clip-on sensor, drip leg and drain valve with hose connection and/or riser and sensor extension handle. Each sensor shall have an LED testing lamp, adjusting potentiometer and be removable for periodic testing. Sensor shall not penetrate the containment piping jacket. Control console shall be housed in a NEMA IV enclosure, operating on 120 VAC and supplies 24 VDC to zone sensors. Console shall have alarm lamps, pilot lamp, test buttons and mute switch. Console shall also have a common audible alarm and external output switch for accessory alarms. Leak detection system shall be Centra-Guard™ as manufactured by IPEX.

CUSTOMGUARD®

Schedule 40 A-53 Carbon Steel/UL FRP Double Containment Piping System

General

Scope of Work

Furnish all labor, materials, equipment and incidentals required to install a CustomGuard™ Schedule 40 A-53 Carbon Steel (Primary)/UL FRP (Secondary) double containment piping, valves and appurtenances for complete systems as shown on the drawings and as specified herein.

Description of Systems

_____% Chemical Names (To be inserted)

Submittals

Shop drawings shall be submitted to the engineer and include details of pipe fabrications (including supporting devices, method of attachment, spacing, etc.), prefabricated double containment fitting dimensions, starting and terminating connections, high-point vent and low-point drain details for the secondary containment, valves and accessories. Submit joint details, methods and location of supports and all other pertinent technical data for all piping to be furnished. Manufacturer shall submit mill certs for all metal piping used in this project.

Qualifications

The double containment piping systems shall be a CustomGuard™ prefabricated system as manufactured by IPEX. The system shall be fabricated, installed and tested in accordance with IPEX's recommendations and as specified herein and shall be suitable for the intended service. Manufacturer shall have a minimum of five (5) years experience. Contractor shall not design and/or fabricate the piping system.

Products

General

Each contained piping system shall consist of Schedule 40 A-53 Carbon Steel primary piping system supported within a UL FRP secondary containment housing. Each system shall be provided with suitable drains and vents and be designed to provide complete drainage of both the primary and secondary containment piping. Interstitial supporting devices shall be made from Polypropylene Centra-Guide supports and shall be provided within the secondary containment pipe, and shall be designed to allow continuous drainage in the annular space to the drain points. Drain fittings shall be designed to allow a valve attachment to be made so that the secondary containment compartment may be readily drained and manually checked for leaks.

Materials

The primary pipe and fittings shall be manufactured from A-53 Carbon Steel materials as listed by ASTM and ANSI.

The secondary containment pipe and fittings shall be UL FRP.

All listed primary pipe and containments shall be Schedule 40 materials. Pipe shall have Schedule 40 steel pipe thickness according to ANSI. All listed pressure fittings shall be Schedule 40 according to ANSI. All other unlisted components intended for use as pressure retaining components shall have sufficient thickness and reinforcement so as to be able to maintain the same pressure rating as the equivalent Schedule 40 steel pipe.

Interstitial supporting devices used to center and support the primary piping within the secondary containment pipe and fittings shall meet ASTM specifications D-2310, D-2992, D-2996 and MIL 29206. Containment fittings shall have carrier components pre-assembled, supported and tested. Carrier fittings will be pre-beveled, ready for field welding. Containment fittings shall have spigot ends to allow for a closure coupling to be installed after primary system is pressure tested.

All fittings will be pre-assembled and pretested by the manufacturer of CustomGuard™ (IPEX).

CUSTOMGUARD®

Execution

Installation

All installation procedures shall be according to the manufacturer's (IPEX) specific recommendations. The manufacturer shall furnish the services of a competent representative to supervise the contractor's personnel during the start of the installation.

All secondary containment joints shall be solvent-cemented joints using heavy body-slow set PVC cement ASTM D-2564, made in accordance with ASTM D-2855 procedure. The splitting and re-welding of fittings shall not be permitted. The use of hot gas welding for pressure-retaining joints shall be kept to those locations where deemed necessary by IPEX.

All contractor personnel that will prepare solvent cemented joints shall be qualified for such bonding practices according to the bonding qualifications procedures described in ASME B 31.3, Chapter VII for bonding of plastic piping.

Cleaning and Testing

Upon completing installation, the primary piping system shall be hydrostatically tested at 150% of the system design pressure for a period of one hour.

Upon completing the installation, the secondary containment piping system shall be pneumatically tested at a minimum duration of 2-1/2 hours. The external joints should be visually inspected for leaks using an IPEX approved leak detector. It is imperative that a working pressure regulator be used during the pneumatic test to insure that over-pressurization of the UL FRP, beyond 5psi cannot occur. Also, all precautions should be taken to protect against the hazards of a possible brittle fracture of UL FRP under compressed gas.

Following installation of the systems, the primary piping system shall be flushed clean. The contractor shall check the operation of all valve, leak detection devices and appurtenances.

Leak Detection – U.S. Patent No. 5,343,191

Provide and install at each zone a density sensor station consisting of an external clip-on sensor, drip leg and drain valve with hose connection and/or riser and sensor extension handle. Each sensor shall have an LED testing lamp, adjusting potentiometer and be removable for periodic testing. Sensor shall not penetrate the containment piping jacket. Control console shall be housed in a NEMA IV enclosure, operating on 120 VAC and supplies 24 VDC to zone sensors. Console shall have alarm lamps, pilot lamp, test buttons and mute switch. Console shall also have a common audible alarm and external output switch for accessory alarms. Leak detection system shall be Centra-Guard™ as manufactured by IPEX.

CUSTOMGUARD®

Schedule 40 A-53 Carbon Steel/Schedule 80 PVC Double Containment Piping System

General

Scope of Work

Furnish all labor, materials, equipment and incidentals required to install a Custom-Guard™ Schedule 40 A-53 Carbon Steel (Primary)/Sch 80 PVC (Secondary) double containment piping, valves and appurtenances for complete systems as shown on the drawings and as specified herein.

Description of Systems

_____% Chemical Names (To be inserted)

Submittals

Shop drawings shall be submitted to the engineer and include details of pipe fabrications (including supporting devices, method of attachment, spacing, etc.), prefabricated double containment fitting dimensions, starting and terminating connections, high-point vent and low-point drain details for the secondary containment, valves and accessories. Submit joint details, methods and location of supports, and all other pertinent technical data for all piping to be furnished. Manufacturer shall submit mill certs for all metal piping used in this project.

Qualifications

The double containment piping systems shall be a CustomGuard™ prefabricated system as manufactured by IPEX. The system shall be fabricated, installed and tested in accordance with IPEX's recommendations and as specified herein and shall be suitable for the intended service. Manufacturer shall have a minimum of five (5) years experience. Contractor shall not design and/or fabricate the piping system.

Products

General

Each contained piping system shall consist of Schedule 40 A-53 Carbon steel primary piping system supported within a Xirtec 140™ PVC Schedule 80 secondary containment housing. Each system shall be provided with suitable drains and vents and be designed to provide complete drainage of both the primary and secondary containment piping. Interstitial supporting devices shall be made from Polypropylene Centra-Guide supports and shall be provided within the secondary containment pipe, and shall be designed to allow continuous drainage in the annular space the drain points. Drain fittings shall be designed to allow a valve attachment to be made so that the secondary containment compartment may be readily drained and manually checked for leaks.

Materials

The primary pipe fittings shall be manufactured from Schedule 80 PVC materials as manufactured by IPEX and as listed by ASTM and ANSI.

The secondary containment pipe and fittings shall be manufactured from Schedule 80 PVC materials as manufactured by IPEX and as listed by ASTM and ANSI.

All listed primary pipe shall be Schedule 40 materials. Pipe shall have Schedule 40 steel pipe thickness according to ANSI. All listed pressure fittings shall be Schedule 40 according to ANSI. All other unlisted components intended for use as pressure retaining components shall have sufficient thickness and reinforcement so as to be able to maintain the same pressure ratings as the equivalent Schedule 40 steel pipe.

Interstitial supporting devices used to center and support the primary piping within the secondary containment piping shall be manufactured from Polypropylene Centra-Guide supports, according to ASTM and ANSI.

All listed secondary containment pipe and fittings shall be Schedule 80 materials as manufactured by IPEX. Pipe shall have Schedule 80 thickness according to ASTM D-1784 Type 1, Grade 1. All listed pressure fittings shall be schedule 80 according to ASTM D-2466. All other unlisted components intended for use as pressure retaining components shall have sufficient thickness and reinforcement so as to be able to maintain the same pressure ratings as the equivalent Schedule 80 PVC pipe.

All fittings will be pre-assembled and pretested by the manufacturer of Custom-Guard™ (IPEX).

CUSTOMGUARD®

Execution

Installation

All installation procedures shall be according to the manufacturer's (IPEX) specific recommendations. The manufacturer shall furnish the services of a competent representative to supervise the contractor's personnel during the start of the installation.

All secondary containment joints shall be solvent-cemented joints using heavy body-slow set PVC cement ASTM D-2564, made in accordance with ASTM D-2855 procedure. The splitting and re-welding of fittings shall not be permitted. The use of hot gas welding for pressure-retaining joints shall be kept to those locations where deemed necessary by IPEX.

All contractor personnel that will prepare solvent cemented joints shall be qualified for such bonding practices according to the bonding qualifications procedures described in ASME B 31.3, Chapter VII for bonding of plastic piping.

Cleaning and Testing

Upon completing installation, the primary piping system shall be hydrostatically tested at 150% of the system design pressure for a period of one hour. Additionally, the system may be tested during the installation at intervals to be determined by the manufacturer (IPEX).

If Secondary pipe cannot be hydro-tested, as determined by the engineer or authority having jurisdiction, then the use of nitrogen or air at a MAXIMUM 5psi (gauge) shall be allowed. The external joint should be visually inspected for leaks using an IPEX approved leak detector.

Both the preliminary and final tests shall be performed in strict accordance with the recommendations of the manufacturer (IPEX) including the sequence and duration of such tests.

⚠ WARNING

It is imperative that a working-pressure regulator be used during the pneumatic test to ensure that over-pressurization of the PVC, beyond 5 psi, cannot occur. The following must also be noted: Air or nitrogen under pressure is compressed and therefore poses a potential hazard. If a failure of the pipe or fitting occurs during such test, the air exits at the failure point and expands rapidly. This increase in velocity can cause the system to fail in a catastrophic mode. Therefore during such air test all personnel involved in the test or present in the test surrounding area must be aware of such a possibility and take all necessary precautions. Precautions include, but are not limited to, taking extreme care not to impact or damage the system in any way. Such procedure is a limited exception to IPEX standard policy which forbids the use of its rigid systems with any compressed gases, unless the product(s) is specifically designed for the conveyance of compressed gases.

Following installation of the systems, the primary piping system shall be flushed clean. The contractor shall check the operation of all valves, leak detection devices and appurtenances.

The annular space shall be purged of moisture containing air by replacing the volume of air with clean, dry nitrogen.

Leak Detection – U.S. Patent No. 5,343,191

Provide and install at each zone a density sensor station consisting of an external clip-on sensor, drip leg and drain valve with hose connection and/or riser and sensor extension handle. Each sensor shall have an LED testing lamp, adjusting potentiometer and be removable for periodic testing. Sensor shall not penetrate the containment piping jacket. Control console shall be housed in a NEMA IV enclosure, operating on 120 VAC and supplies 24 VDC to zone sensors. Console shall have alarm lamps, pilot lamp, test buttons and mute switch. Console shall also have a common audible alarm and external output switch for accessory alarms. Leak detection system shall be Centra-Guard™ as manufactured by IPEX.

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Conversion Charts

Contents of Pipe

Capacities in Cubic Feet and United States Gallons (231 Cubic Inches) per foot of Length											
Dia. in.	Dia. ft.	For 1 Foot Length		Dia. in.	Dia. ft.	For 1 Foot Length		Dia. in.	Dia. ft.	For 1 Foot Length	
		$ft.^3$ Also Area $in.\ ft.^2$	U.S. Gal. ($231\ in.^3$)			$ft.^3$ Also Area $in.\ ft.^2$	U.S. Gal. ($231\ in.^3$)			$ft.^3$ Also Area $in.\ ft.^2$	U.S. Gal. ($231\ in.^3$)
1/4	0.0208	0.0003	0.0026	4-1/4	0.3542	0.0985	0.7370	10-1/2	0.8750	0.6013	4.4980
5/16	0.0260	0.0005	0.0040	4-1/2	0.3750	0.1105	0.8263	10-3/4	0.8958	0.6303	4.7140
3/8	0.0313	0.0008	0.0057	4-3/4	0.3958	0.1231	0.9205	11	0.9167	0.6600	4.9370
7/16	0.0365	0.0010	0.0078	5	0.4167	0.1364	1.0200	11-1/4	0.9375	0.6903	5.1630
1/2	0.0417	0.0014	0.0102	5-1/4	0.4375	0.1503	1.1240	11-1/2	0.9583	0.7213	5.3950
9/16	0.0469	0.0017	0.0129	5-1/2	0.4583	0.1650	1.2340	11-3/4	0.9792	0.7530	5.6330
5/8	0.0521	0.0021	0.0159	5-3/4	0.4792	0.1803	1.3490	12	1.0000	0.7854	5.8760
11/16	0.0573	0.0026	0.0193	6	0.500	0.1963	1.4690	12-1/2	1.0420	0.8523	6.3750
3/4	0.0625	0.0031	0.0230	6-1/4	0.5208	0.2130	1.5940	13	1.0830	0.9218	6.8950
13/16	0.0677	0.0036	0.0270	6-1/2	0.5417	0.2305	1.7240	13-1/2	1.1250	0.9940	7.4350
7/8	0.0729	0.0042	0.0312	6-3/4	0.5625	0.2485	1.8590	14	1.1670	1.0690	7.9970
15/16	0.0781	0.0048	0.0359	7	0.5833	0.2673	1.9990	14-1/2	1.2080	1.1470	8.5780
1	0.0833	0.0055	0.0408	7-1/4	0.6042	0.2868	2.1440	15	1.2500	1.2270	9.1800
1-1/4	0.1042	0.0085	0.0638	7-1/2	0.6250	0.3068	2.2950	15-1/2	1.2920	1.3100	9.8010
1-1/2	0.1250	0.0123	0.0918	7-3/4	0.6458	0.3275	2.4500	16	1.3330	1.3960	10.4400
1-3/4	0.1458	0.0168	0.1250	8	0.6667	0.3490	2.6110	16-1/2	1.3750	1.4850	11.1100
2	0.1667	0.0218	0.1632	8-1/4	0.6875	0.3713	2.7770				
2-1/4	0.1875	0.0276	0.2066	8-1/2	0.7083	0.3940	2.9480				
2-1/2	0.2083	0.0341	0.2550	8-3/4	0.7292	0.4175	3.1250				
2-3/4	0.2292	0.0413	0.3085	9	0.7500	0.4418	3.3050				
3	0.2500	0.0491	0.3673	9-1/4	0.7708	0.4668	3.4920				
3-1/4	0.2708	0.0576	0.4310	9-1/2	0.7917	0.4923	3.6820				
3-1/2	0.2917	0.0668	0.4998	9-3/4	0.8125	0.5185	3.8790				
3-3/4	0.3125	0.0767	0.5738	10	0.8333	0.5455	4.0810				
4	0.3333	0.0873	0.6528	10-1/4	0.8542	0.5730	4.2860				

Volume

Volume of a pipe is computed by: $V = \frac{1}{4} ID^2 \times \pi \times L \times 12$

Where: V = volume (in cubic inches)
ID = inside diameter (in inches)
π = 3.14159
L = length of pipe (in feet)

Weight

1 U.S. gallon @ 50°F..... 8.33 lbs. x sg
1 cubic foot ..... 62.35 lbs. x sg
..... 7.48 U.S. gal.
1 cu. ft. of water @ 50°F . 62.41 lbs.
1 cu. ft. of water @ 39.2°F 62.43 lbs.
(39.2°F is water temp. at its greatest density)
1 kilogram ..... 2.2 lbs.
1 imperial gallon of water. 10.0 lbs.
1 pound..... 12 U.S. gal ÷ sg
..... .016 cu. ft. ÷ sg

Capacity or Flow

1 U.S. gallon per minute (gpm) 0.134 cfm
.....500 lb. per hr. x sp. gr.
.....500 lb. per hr. 1 gpm ÷ sp. gr.
1 cu. ft. per minute (cfm) .....449 gph
1 cu. ft. per second (cfs) .....449 gpm
1 acre foot per day .....227 gpm
1 acre inch per hour .....454 gpm
1 cubic meter per minute .....264.2 gpm
1,000,000 gal. per day .....595 gpm
Brake H.P. = $\frac{\text{(gpm) (total head in ft.) (specific gravity)}}{\text{(3960) (pump eff.)}}$

APPENDIX A

Pressure Conversion BY FACTOR TO OBTAIN

Multiply Given Number of ↑

Given	lb./in.^{2}	in.H_2O (at +39.2°F)	cmH_2O (at +4°C)	in. Hg (at +32°F)	mm Hg (Torr) (at 0°C)	dyne/cm^2 (1m bar)	newton/m^2 (PASCAL)	kgm/cm^2	bar	atm. (An)	lb./ft.^{2}	ft.H_2O (at +39.2°F)
lb./in.2	1.000	$2.7680x10^{1}$	$7.0308x10^{1}$	2.0360	$5.1715x10^{1}$	$6.8948x10^{4}$	$6.8948x10^{3}$	$7.0306x10^{-2}$	$6.8947x10^{-2}$	$6.8045x10^{-2}$	$1.4400x10^{2}$	2.3067
in.H20 (at +39.2°F)	$3.6127x10^{-2}$	1.0000	2.5400	$7.3554x10^{-2}$	1.8683	$2.49808x10^{3}$	$2.4908x10^{2}$	$2.5399x10^{-3}$	$2.4908x10^{-3}$	$2.4582x10^{-3}$	5.2022	$8.3333x10^{-2}$
cm H_2O (at +4°C)	$1.4223x10^{-2}$	0.3937	1.0000	$2.8958x10^{-2}$	0.7355	$9.8064x10^{2}$	$9.8064x10^{1}$	$9.9997x10^{-4}$	$9.8064x10^{-4}$	$9.6781x10^{-4}$	2.0481	$3.2808x10^{-2}$
in. Hg (at +32°F)	$4.9116x10^{-1}$	$1.3596x10^{1}$	$3.4532x10^{1}$	1.0000	$2.5400x10^{1}$	$3.3864x10^{4}$	$3.3864x10^{3}$	$3.4532x10^{-2}$	$3.3864x10^{-2}$	$3.3421x10^{-2}$	$7.0727x10^{1}$	1.1330
mm Hg (Torr) (at 0°C)	$1.9337x10^{-2}$	$5.3525x10^{-1}$	1.3595	$3.9370x10^{-2}$	1.0000	$1.3332x10^{3}$	$1.3332x10^{2}$	$1.3595x10^{-3}$	$1.3332x10^{-3}$	$1.3158x10^{-3}$	2.7845	$4.4605x10^{-2}$
dyne/cm^2 (1m bar)	$1.4504x10^{5}$	$4.0147x10^{-4}$	$1.0197x10^{-3}$	$2.9530x10^{-5}$	$7.5006x10^{-4}$	1.0000	$1.0000x10^{-1}$	$1.0197x10^{-6}$	$1.0000x10^{-6}$	$9.8692x10^{-7}$	$2.0886x10^{-3}$	$3.3456x10^{-5}$
newton/m^2 (PASCAL)	$1.4504x10^{-4}$	$4.0147x10^{-3}$	$1.0197x10^{-2}$	$2.9530x10^{-4}$	$7.5006x10^{-3}$	$1.0000x10^{1}$	1.0000	$1.0197x10^{-5}$	$1.0000x10^{-5}$	$9.8692x10^{-6}$	$2.0885x10^{-2}$	$3.3456x10^{-4}$
kgm/cm^2	$1.4224x10^{1}$	$3.9371x10^{2}$	$1.00003x10^{3}$	$2.8959x10^{1}$	$7.3556x10^{2}$	$9.8060x10^{5}$	$9.8060x10^{4}$	1.0000	$9.8060x10^{-1}$	$9.678x10^{-1}$	$2.0482x10^{3}$	$3.2809x10^{1}$
bar	$1.4504x10^{1}$	$4.0147x10^{2}$	$1.0197x10^{3}$	$2.9530x10^{1}$	$7.5006x10^{2}$	$1.0000x10^{6}$	$1.0000x10^{5}$	1.0197	1.0000	$9.8692x10^{-1}$	$2.0885x10^{3}$	$3.3456x10^{1}$
atm. (An)	$1.4696x10^{1}$	$4.0679x10^{2}$	$1.0333x10^{3}$	$2.9921x10^{1}$	$7.6000x10^{2}$	$1.0133x10^{6}$	$1.0133x10^{5}$	1.0332	1.0113	1.0000	$2.1162x10^{3}$	$3.3900x10^{1}$
lb./ft.^{2}	$6.9445x10^{-3}$	$1.9223x10^{-1}$	$4.882x10^{-1}$	$1.4139x10^{-2}$	$3.591x10^{-1}$	$4.7880x10^{2}$	$4.7880x10^{1}$	$4.8824x10^{-4}$	$4.7880x10^{-4}$	$4.7254x10^{-4}$	1.0000	$1.6019x10^{-2}$
ft. H_2O (at +39.2°F)	$4.3352x10^{-1}$	$1.2000x10^{1}$	$3.0480x10^{1}$	$8.826x10^{-1}$	$2.2419x10^{1}$	$2.9890x10^{4}$	$2.9890x10^{3}$	$3.0479x10^{-2}$	$2.9890x10^{-2}$	$2.9499x10^{-2}$	$6.2427x10^{1}$	1.0000

Decimal and Millimeter Equivalents of Fractions

Inches Fractions	Inches Decimals	mm	Inches Fractions	Inches Decimals	mm	Inches Fractions	Inches Decimals	mm	Inches Fractions	Inches Decimals	mm
1/64	.015625	.397	17/64	65625	6.747	33/64	.515625	13.097	49/64	.765625	19.447
1/32	03125	.794	9/32	.28125	7.144	17/32	.53125	13.494	25/32	.78125	19.844
3/64	.046875	1.191	19/64	.296875	7.541	35/64	.546875	13.891	51/64	.796875	20.241
1/16	.0625	1.588	5/16	.3125	7.938	9/16	.5625	14.288	13/16	.8125	20.638
5/64	.078125	1.984	21/64	.328125	8.334	37/64	.578125	14.684	53/64	.828125	21.034
3/32	.09375	2.381	11/32	.34375	8.731	19/32	.59375	15.081	27/32	.83475	21.431
7/64	.109375	2.778	23/64	.359375	9.128	39/64	.609375	15.478	55/64	.859375	21.828
1/8	.125	3.175	3/8	.375	9.525	5/8	.625	15.875	7/8	.875	22.225
9/64	.140625	3.572	25/64	.390625	9.922	41/64	.640625	16.272	57/64	.890625	22.622
5/32	.15625	3.969	13/32	.40625	10.319	21/32	.65625	16.669	29/32	.90625	23.019
11/64	.171875	4.366	27/64	.421875	10.716	43/64	.671875	17.066	59/64	.921875	23.416
3/16	.1875	4.763	7/16	.4375	11.113	11/16	.6875	17.463	15/16	.9375	23.813
13/64	.203125	5.159	29/64	.453125	11.509	45/64	.703125	17.859	61/64	.953125	24.209
7/32	21875	5.556	15/32	.46875	11.906	23/32	.71875	18.256	31/32	.96875	24.606
15/64	.23475	5.953	31/64	.484375	12.303	47/64	.734375	18.653	63/64	.984375	25.003
1/4	.250	6.350	1/2	.500	12.700	3/4	.750	19.050	1	1.000	25.400

Conversion Charts

Units of Length	Multiply units in left column by proper factor below							
	in.	ft.	yd.	mile	mm	cm	m	km
1 inch	1	0.0833	0.0278	-	25.4	2.540	0.0254	-
1 foot	12	1	0.3333	-	304.8	30.48	0.3048	-
1 yard	36	3	1	-	914.4	91.44	0.9144	-
1 mile	-	5280	1760	1	-	-	1609.3	1.609
1 millimeter	0.0394	0.0033	-	-	1	0.100	0.001	-
1 centimeter	0.3937	0.0328	0.0109	-	10	1	0.01	-
1 meter	39.37	3.281	1.094	-	1000	100	1	0.001
1 kilometer	-	3281	1094	0.6214	-	-	1000	1

(1 micron = 0.001 millimeter)

Units of Weight	Multiply units in left column by proper factor below						
	grain	oz.	lb.	ton	gram	kg	metric ton
1 grain	1	-	-	-	0.0648	-	-
1 ounce	437.5	1	0.0625	-	28.35	0.0283	-
1 pound	7000	16	1	0.0005	453.6	0.4536	-
1 ton	-	32,000	2000	1	-	907.2	0.9072
1 gram	15.43	0.0353	-	-	1	0.001	-
1 kilogram	-	35.27	2.205	-	1000	1	0.001
1 metric ton	-	35,274	2205	1.1023	-	1000	1

Units of Density	Multiply units in left column by proper factor below				
	lb./in.^{3}	lb./ft.^{3}	lb./gal.	g/cm^3	g/liter
1 pound/in.^{3}	1	1728	231.0	27.68	27,680
1 pound/ft.^{3}	-	1	0.1337	0.0160	16.019
1 pound/gal.	0.00433	7.481	1	0.1198	119.83
1 gram/cm^3	0.0361	62.43	8.345	1	1000.0
1 gram/liter	-	0.0624	0.00835	0.001	1

Units of Area	Multiply units in left column by proper factor below						
	in.^{2}	in.^{2}	acre	mile^2	cm^2	m^2	hectare
1 inch^2	1	1	-	-	6.452	-	-
1 foot^2	144	144	-	-	929.0	0.0929	-
1 acre	-	-	1	0.0016	-	4047	0.4047
1 mile^2	-	-	640	1	-	-	259.0
1 centimeter^2	0.1550	0.1550	-	-	1	0.0001	-
1 meter^2	1550	1550	-	-	10,000	1	-
1 hectare	-	-	2.471	-	-	10,000	1

Units of Volume	Multiply units in left column by proper factor below							
	in.^{3}	ft.^{3}	yd.^{3}	cm.^{3}	meter^3	liter	U.S. gal.	Imp. gal.
1 inch^3	1	-	-	16.387	-	0.0164	-	-
1 foot^3	1728	1	0.0370	28,317	0.0283	28.32	7.481	6.229
1 yard^3	46,656	27	1	-	0.7646	764.5	202.0	168.2
1 centimeter^3	0.0610	-	-	1	-	0.0010	-	-
1 meter^3	61,023	35.31	1.308	1,000,000	1	999.97	264.2	220.0
1 liter	61.025	0.0353	-	1000.028	0.0010	1	0.2642	0.2200
1 U.S. gallon	231	0.1337	-	3785.4	-	3.785	1	0.8327
1 Imp. gallon	277.4	0.1605	-	4546.1	-	4.546	1.201	1

Conversion Charts

Units of Pressure	Multiply units in left column by proper factor below							
	lbs./in.^{2}	lb./ft.^{2}	Int. etc.	kg/cm^2	mm Hg at 32°F	in. Hg at 32°F	ft. water at 39.2°F	kPa
lb./in.^{2}	1	144	-	0.0703	51.713	2.0359	2.307	6.894
lb./ft.^{2}	0.00694	1	-	-	0.3591	0.01414	0.01602	0.04788
Int. etc.	14.696	2116.2	1	1.0333	760	29.921	33.90	-
kg/cm^2	14.223	2048.1	0.9678	1	735.56	28.958	32.81	98.066
mm Hg	0.0193	2.785	-	-	1	0.0394	0.0446	0.1333
in Hg	0.4912	70.73	0.0334	0.0345	25.400	1	1.133	3.386
ft H20	0.4335	62.42	-	0.0305	22.418	0.8826	1	2.988
kPa	0.00145	20.89	-	0.010169	7.5006	0.2953	0.3346	1

Units of Energy	Multiply units in left column by proper factor below					
	ft.-lb.	BTU	g. cal.	Joule	kw-hr.	hp-hr.
1 foot-pound	1	0.001285	0.3240	1.3556	-	-
1 BTU	778.2	1	252.16	1054.9	-	-
1 gram calorie	3.0860	0.003966	1	4.1833	-	-
1 Int. Joule	0.7377	0.000948	0.2390	1	-	-
1 Int. kilowatt-hour	2,655,656	3412.8	860,563	-	1	1.3412
1 horsepower-hour	1,980,000	2544.5	641,617	-	0.7456	1

Units of Specific Pressure	Multiply units in left column by proper factor below				
	Absolute Joule/g	Int. Joule/g	cal/g	Int. cal/g	BTU/lb.
1 absolute Joule/gram	1	0.99984	0.23901	0.23885	0.42993
1 Int. Joule/gram	1.000165	1	0.23904	0.23892	0.43000
1 calorie/gram	4.1840	4.1833	1	0.99935	1.7988
1 int. calorie/gram	4.1867	4.1860	1.00065	1	1.8000
1 BTU/lb.	2.3260	2.3256	0.55592	0.55556	1

Units of Power (rates of energy use)	Multiply units in left column by proper factor below							
	hp	watt	kw	BTU/min.	ft.-lb./sec.	ft.-lb./min.	g. cal/sec.	metric hp
1 horsepower	1	75.7	0.7475	42.41	550	33.000	178.2	1.014
1 watt	-	1	0.001	0.0569	0.7376	44.25	0.2390	0.00136
1 kilowatt	1.3410	1000	1	56.88	737.6	44,254	239.0	1.360
1 BTU per minute	-	-	-	1	12.97	778.2	4.203	0.0239
1 metric hp	0.9863	735.5	0.7355	41.83	542.5	32.550	175.7	1

Units of Refrigeration	Multiply units in left column by proper factor below				
	BTU (IT) /min.	BTU (IT) /hr.	kg cal/hr.	ton (U.S.) comm	ton (Brit.) comm
1 ton (U.S.) comm	200	12,000	3025.9	1	0.8965
1 ton (Brit.) comm	223.08	13,385	3375.2	1.1154	1

NOTE: BTU is International Steam Table BTU (IT).

Conversion Charts

Temperature Conversion									
°F	°C	°F	°C	°F	°C	°F	°C	°F	°C
-459.4	-273	1	-17.2	61	16.1	300	149	900	482
-450	-268	2	-16.7	62	16.7	310	154	910	488
-440	-262	3	-16.1	63	17.2	320	160	920	493
-430	-257	4	-15.6	64	17.8	330	166	930	499
-420	-251	5	-15.0	65	18.3	340	171	940	504
-410	-246	6	-14.4	66	18.9	350	177	950	510
-400	-240	7	-13.9	67	19.4	360	182	960	516
-390	-234	8	-13.3	68	20.0	370	188	970	521
-380	-229	9	-12.8	69	20.6	380	193	980	527
-370	-223	10	-12.2	70	21.1	390	199	990	532
-360	-218	11	-11.7	71	21.7	400	204	1000	538
-350	-212	12	-11.1	72	22.2	410	210	1020	549
-340	-207	13	-10.6	73	22.8	420	215	1040	560
-330	-201	14	-10.0	74	23.3	430	221	1060	571
-320	-196	15	-9.4	75	23.9	440	227	1080	582
-310	-190	16	-8.9	76	24.4	450	232	1100	593
-300	-184	17	-8.3	77	25.0	460	238	1120	604
-290	-179	18	-7.8	78	25.6	470	243	1140	616
-280	-173	19	-7.2	79	26.1	480	249	1160	627
-273	-169	20	-6.7	80	26.7	490	254	1180	638
-270	-168	21	-6.1	81	27.2	500	260	1200	649
-260	-162	22	-5.6	82	27.8	510	266	1220	660
-250	-157	23	-5.0	83	28.3	520	271	1240	671
-240	-151	24	-4.4	84	28.9	530	277	1260	682
-230	-146	25	-3.9	85	29.4	540	282	1280	693
-220	-140	26	-3.3	86	30.0	550	288	1300	704
-210	-134	27	-2.8	87	30.6	560	293	1350	732
-200	-129	28	-2.2	88	31.1	570	299	1400	760
-190	-123	29	-1.7	89	31.7	580	304	1450	788
-180	-118	30	-1.1	90	32.2	590	310	1500	816
-170	-112	31	-0.6	91	32.8	600	316	1550	843
-160	-107	32	0.0	92	33.3	610	321	1600	871
-150	-101	33	0.6	93	33.9	620	327	1650	899
-140	-96	34	1.1	94	34.4	630	332	1700	927
-130	-90	35	1.7	95	35.0	640	338	1750	954
-120	-84	36	2.2	96	35.6	650	343	1800	982
-110	-79	37	2.8	97	36.1	660	349	1850	1010
-100	-73	38	3.3	98	36.7	670	354	1900	1038
-90	-68	39	3.9	99	37.2	680	360	1950	1066
-80	-62	40	4.4	100	37.8	690	366	2000	1093
-70	-57	41	5.0	110	43	700	371	2050	1121
-60	-51	42	5.6	120	49	710	377	2100	1149
-50	-46	43	6.1	130	54	720	382	2150	1177
-40	-40	44	6.7	140	60	730	388	2200	1204
-30	-34	45	7.2	150	66	740	393	2250	1232
-20	-29	46	7.8	160	71	750	399	2300	1260
-10	-23	47	8.3	170	77	760	404	2350	1288
0	-17.8	48	8.9	180	82	770	410	2400	1316
		49	9.4	190	88	780	416	2450	1343
		50	10.0	200	92	790	421	2500	1371
		51	10.6	210	99	800	427	2550	1399
		52	11.1	212	100	810	432	2600	1427
		53	11.7	220	104	820	438	2650	1454
		54	12.2	230	110	830	443	2700	1482
		55	12.8	240	116	840	449	2750	1510
		56	13.3	250	121	850	454	2800	1538
		57	13.9	260	127	860	460	2850	1566
		58	14.4	270	132	870	466	2900	1593
		59	15.0	280	138	880	471	2950	1621
		60	15.6	290	143	890	477	3000	1649

The following formulas may also be used for converting Celsius or Fahrenheit degrees into the other scales.

Degrees Celsius $°C = \frac{5}{9}(°F - 32)$ Degrees Fahr. $°F = \frac{9}{5}°C + 32$

Degrees Kelvin $°T = °C + 273.2$ Degrees Rankine $°R = °F + 459.7$

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Double Containment Material Recommendation Checklist

Project Name: _____

Anticipated Start Date: _____

Please answer the following questions to help determine the best system for your particular needs.

Fluid to be transported: _____

Chemical Concentration: _____

Working Pressure: _____

Design Pressure min./max.: _____

Working Temperature: _____

Design Temperature min./max.: _____

Carrier Pipe Size: _____

Preferred Carrier Piping Material: _____

Preferred Containment Piping Material: _____

Test Method Carrier: _____

Test Method Containment: _____

Test Pressure Carrier: _____

Test Pressure Containment: _____

Type of Installation

❑ Underground

❑ Above-Ground

❑ Combination

Leak Detection

Guardian Standard ❑ Yes ❑ No

Other: Please specify _____

_____

Special Requirements/Conditions:

_____

_____

_____

_____

_____

For firm quotation, please furnish line drawing or blueprints for system with approximate dimensional information or bill of material.

Company: _____ Phone: _____

Company Contact: _____ Distributor: _____

Guardian Salesperson: _____ Date: _____

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Project Start-Up Checklist

Start-Up Date: _____

A: General Information

Project Name: _____

End-User/Owner: _____

Consulting Engineer: _____

Installing Contractor: _____

Type of Material: _____

B: Stored Conditions

Pipe: _____

Fittings: _____

Closure Coupling: _____

Temperature Conditions: _____

General Appearance: _____

C: Installation Conditions

Weather ❑ Good ❑ Poor _____ Temp

Remarks _____

_____

_____

_____

_____

D: Installation Procedures

1. Have all IPEX product installers been trained on installation procedures?

❑ Yes ❑ No

Rep. Initials _____ Cont. Initials _____

2. Project Start-up Training

a) Installation Jointing Method

❑ Solvent Cementing
❑ Metal
❑ FRP
❑ Other

b) Where held:

❑ On-site
❑ Contractor Shop
❑ Indoors
❑ Outdoors

c) Application

❑ Above-ground
❑ Below ground

Remarks _____

_____

_____

_____

_____

IPEX Representative Project Start-up Assessment:

Remarks: _____

_____

_____

_____

_____

Field Report: _____

_____

_____

_____

_____

IPEX Representative: _____

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SALES AND CUSTOMER SERVICE

Canadian Customers call
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U.S. Customers call
Toll free: (800) 463-9572

Technical Support
Toll free: (800) 490-0077

www.ipexinc.com

About IPEX

IPEX is a leading supplier of thermoplastic piping systems. We provide our customers with one of the world's largest and most comprehensive product lines. All IPEX products are backed by over 50 years of experience. With state-of-the-art manufacturing facilities and distribution centers across North America, the IPEX name is synonymous with quality and performance.

Our products and systems have been designed for a broad range of customers and markets. Contact us for information on:

- PVC, CPVC, PP, ABS, PEX and PE pipe and fittings (1/4" to 48")
- Industrial process piping systems
- Double containment systems
- Acid waste systems
- High purity systems
- Industrial, plumbing and electrical cements
- Municipal pressure and gravity piping systems
- PE Electrofusion systems for gas and water
- Plumbing and mechanical pipe systems
- Electrical systems
- Telecommunication systems
- Irrigation systems
- Radiant heating systems

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