Sclairpipe®

high density polyethylene pipe

Construction

KWH PIPE

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high-density polyethylene pipe

CONSTRUCTION

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SCLAIRPIPE® "Construction"

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JOB PLANNING

The Importance of "Planning the Job"

Careful planning of the installation of your piping system will allow you to take advantage of the unique properties of SCLAIRPIPE® high density polyethylene pipe. Often advance planning can save you considerable time and money.

SCLAIRPIPE is lightweight, flexible and can be thermally fused into long lengths, resulting in easier handling and increased speed of assembly. Considerable cost savings can usually be achieved by detailed preconstruction planning. Complete product information on the SCLAIRPIPE polyethylene piping system is available in the "General Information" brochure. On larger installations, KWH Pipe representatives are available to provide general technical information. We advise that you should contact our technical representatives well in advance of receiving the pipe and joining equipment. During these discussions particular attention should be paid to: the sequence of joining and trenching; the amount and size of pipe handling equipment; and the manpower requirements when joining and installation is started. The disposition of pipe and fittings and the location of equipment at the work site depends closely on the joining and installation plans.

Receiving of Pipe and Fittings

Inspection

The contractor and purchaser must inspect all pipe and accessories for shortages, loss or damage upon receipt of the shipped material at the time of unloading, recording this information directly on the waybill received from the carrier. This is the most appropriate time to check to see if your order is complete. If requested in writing by the purchaser, all material may be inspected and approved by a representative of the purchaser at our plant before shipment. If later during the installation, some material is found to have defects such as those listed in the following section, that material should be rejected by the supervising engineer or his authorized inspector. This would include material that was obviously severely gouged. Defective material should be removed from the joining site and not used during the installation. With the approval of the supervising engineer, pipe may be repaired by cutting out the damaged sections and thermally fusing the remaining acceptable pipe.

Please refer to the repair instructions contained later in this document for more specific information on the repair procedures that should be used. During inspection, checks should be made for the following defects:

GOUGES OR CUTS - Any gouges or sharp cuts on the outside surface which are greater than 10% of the wall thickness may affect the service life of the pipe. Minor scuffing or scratching will not reduce the serviceability of SCLAIRPIPE.

KINKING - Any kinking of the pipe during transport will be indicated by excessive permanent deformation or "wrinkles" on the pipe's surface. Lengths damaged in this way should be set aside for repair.

OVALITY - If the pipe has been overloaded, excessive ovality may occur. Percent ovality is defined as:

$$\% \text{ OVALITY} = \frac{D_{ave} - D_{min}}{D_{avg}} \times 100$$

where: D_{min} = minimum diameter at point of deflection

D_{avg} = average of maximum and minimum diameters at this point

If the pipe has deformed beyond the ovality limits shown in Table 1, joining difficulties may occur. Such pipe should be isolated from the pile and left unstressed so that it will relax and gradually round out. Pipe deformed in this manner should be pointed out to the joining supervisor.

TABLE 1

OVALITY LIMITS

DR	Ovality Limit (%)
21	5.0
17	4.0
15.5	3.5
13.5	2.5
11	2.0
9	1.5

Handling Pipe and Fittings

Pipe and fittings should be handled carefully at all times to avoid damage. Straight lengths of small-diameter pipe can be safely unloaded using ropes, ramps or skids. For larger-diameter pipe and pipe bundles, the use of mobile handling equipment is necessary. This handling equipment must be capable of lifting the weight of pipe to a height of 4.6 m (15 ft.) to clear the stakes on the side of rail cars, and 3.4 m (11 ft.) to clear truck side racks.

Weights of individual straight pipe lengths may be calculated using the information available in the SCLAIRPIPE "General Information" brochure.

Wide belly-band slings are recommended for handling straight lengths of pipe. Thick nylon rope slings may also be used, either in an inverted "Y" or with a spreader beam to distribute the weight evenly over two lifting points. Forklifts or mobile cranes can be used to move straight lengths of pipe, providing that the load is lifted at mid-point. Forks should be checked for ragged edges or burrs. These should be removed or the forks wrapped to prevent damage to the pipe. Some typical handling techniques are illustrated in Figure 1.

FIGURE 1 - **Typical Handling Techniques**

Coiled pipe is usually delivered to the installation site stacked on pallets shrink wrapped for easy handling with forklifts. Individual coils of pipe can be lifted on their sides with wide belly band slings passed through their centres.

When reloading trucks or trailers to move the pipe to remote jobsites, the following rules should be observed:

1. Ensure that the truck bed is free of debris such as stones, nails, and loose concrete.
2. Where pipe of different wall thicknesses are involved, heavy wall pipe should be loaded first, with lighter wall pipe loaded on top.
3. When the pipe must overhang the edge of a truck or trailer bed, use a smooth protective strip of material to cover the edge to prevent damage to the pipe. The amount of overhang should be limited to prevent pipe deformation.
4. Ensure that the load is secure: When chains or steel cables are used to anchor the load, use pads or wooden blocks between the restraints and the pipe to prevent point loading on the pipe.
5. The practice of nesting one pipe within another to reduce the volume of load should be reviewed with your KWH Pipe representative. It is important to protect the interior of the pipe from damage at all times.

Storage of Pipe and Fittings at the Job Site

After receipt, pipe should be stockpiled adjacent to the site chosen for joining the pipe. If the pipe is piled directly on the ground, the surface should be level and free of stones and debris which might damage the pipe or make the pipe pile unstable.

Recommended ground conditions are levelled gravel, sand, snow or grass. Where such conditions do not exist or when a bed cannot be prepared, the pipe may be placed on planking. This planking should be evenly spaced along the pipe length. Care must be taken not to load the pipe in such a way that will cause flat spots.

When several different wall thicknesses of pipe are received, it is recommended that the pipe be segregated into piles, each pile containing a single size and pressure rating to minimize sorting of the pipe at a later date. When pipe of different wall thicknesses or pressure ratings must be stored in the same pile, the pipe with the thickest wall should be placed at the bottom of the pile with pipe of progressively decreasing wall thicknesses stacked on top, providing this matches the joining sequence. The pile should be constructed in a pyramidal, free-standing manner, with each successive layer having one less pipe than the layer below. The bottom layer should be braced to prevent movement under the weight of the pipe above. The maximum allowable stacking height for pipe stored in open yards, in stacks of one nominal size, shall not exceed those given in Table 2.

To prevent damage and to maintain deformation within allowable limits, it is recommended that the pile be tightly packed with the sides of the pipes in contact with each other. The top of the pile should be clear of debris and equipment.

It is recommended that the loose wooden dunnage used in transport not be inserted between the layers of pipe at the storage site. This dunnage, used to provide stability in a moving vehicle, can damage the pipe when used in longer term storage.

TABLE 2

Allowable Stacking Heights for Storage of SCLAIRPIPE Polyethylene Pipe

	NUMBER OF ROWS	
Nominal Pipe Size	On Flat Ground	On Recommended Planking*
3	20	15
4	15	12
6	10	8
8	8	6
10	7	6
11	7	5
12	6	5
14	6	5
16	6	4
18	5	4
20	4	3
22	4	3
24	3	2
28	3	2
32	2	1
36	2	1
40	2	1
42	2	1
48	2	1
63	1	1

***NOTE**: Only when preparation of a proper pilebed is impossible.

The interior of all pipe and fittings should be kept free of debris and equipment at all times. Pipe coils should always be stored upright on their skids on a level surface similar to that used for stacking straight lengths of pipe. Care should be taken to ensure that the coil stack is stable. Fittings, valves, hydrants and accessories should be handled carefully to avoid damage. Valves and hydrants should be kept drained when stored prior to installation to protect them from possible damage due to freezing.

Dragging pipe over gravel or rock should be avoided, as this may cause cutting, whereas pulling over ice, snow or reasonably smooth terrain will not damage SCLAIRPIPE.

FIGURE 2 - **On-Site Pipe Storage**

Joining Site

We urge that a complete check be made to ensure that the required material - pipe, stub-ends, flanges, bolts, gaskets, fittings, joining machine and generator - are at the job site before the joining supervisor is scheduled to arrive. The joining sites should be cleared and graded if necessary, to provide enough space for pipe storage and fusion. The site should be free of rocks, stumps, and debris which could cut, scar or gouge the pipe and as a result delay the fusing operation. The required area is generally 150 x 150 ft. For relatively small projects, an area of 100 x 125 ft. may be adequate. The fusion machine must be mounted on a level, stable base. We recommend 3/4 in. plywood secured on level ground. For machines joining pipe 28 in. diameter and larger, the base should be about 8 ft. wide x l6 ft. long. To allow the joining operation to continue in adverse weather conditions, a shelter is required. A shelter usually consists of 2 x 4 in. wooden frames and polyethylene film covering as shown in the accompanying photograph. For fusing pipe of 28 in. diameter and larger, these enclosures should be about l2 ft. wide x 20 ft. long x l2 ft. high. For smaller diameter pipe, smaller shelters about 8 ft.wide x l2 ft. long x 8 ft. high should be adequate.

FIGURE 3 - **Typical Joining Shelter**

Where roads can be used along the proposed pipeline, it would be more efficient to mount the fusing machine on mobile equipment, as shown in the accompanying photograph. In this procedure, the joining machine, rather than the fused pipe, is moved. This increases the efficiency of the joining process and can reduce the cost. To justify the initial expense of a joining sled or vehicle a pipeline generally should be over 2 miles long.

FIGURE 4 - **Mobile Joining Equipment**

Joining Systems

SCLAIRPIPE piping systems can be assembled by thermal fusion, socket fusion. flanged connections, compression couplings, VICTAULIC 995 mechanical couplings and by various other mechanical means.

By far the most popular method of joining SCLAIRPIPE in the field is by thermal fusion, a technique which is economical and fast, permitting the assembly of long continuous lengths. No additional fittings are involved in connecting straight lengths to each other. When the recommended fusion procedure is followed, the fused joints are reliable and are as strong as the pipe itself, resulting in a continuous leak proof piping system. KWH Pipe will sell or lease fusion joining machines for all sizes of polyolefin pipe from 3 in. to 63 in. and will provide the services of specialists to train customers' personnel in the thermal fusion technique. In addition to our own machines, thermal fusion machines made by other manufacturers can be easily adapted to the fusion of SCLAIRPIPE.

Fabricated fittings intended for use in pressure service are manufactured from SCLAIRPIPE with the same diameter but greater wall thickness as used in the remainder of the pipe system. This design provides fittings with a pressure rating equal to or greater than the piping system. Alternately fittings can be produced from SCLAIRPIPE with the same wall thickness as the system and enhanced with a factory-applied proprietary fibre and polyester resin reinforcement. All fabricated fittings can be supplied with either flanged ends and/or plain ends for field thermal fusion to the piping system. SCLAIRPIPE piping systems can be connected to pumps, valves and flanged metal pipes using standard polyethylene stub ends and slip-on metal flanges.

VICTAULIC 995 mechanical couplings can be used to join plain end pipe and fittings in diameters from 2 to 14 inch IPS without preparation or special equipment. Quick assembly and VICTAULIC couplings are especially helpful where space is at a premium.

Other mechanical fittings supplied by ROCKWELL, FORD and ROBAR can also be easily incorporated into a SCLAIRPIPE system.

Our representatives have broad practical and design experience, and can assist you to choose the most appropriate and cost-effective joining method for your particular application.

CHECKLIST

1. Inspect pipe at the rail side or on the truck for any damage that may have occurred during transport and check the pipe markings for the size and dimensional ratio (DR) to ensure you've received what you've ordered.

2. Make sure your transport facilities from the rail siding to the job site match the pipe length and quantity. Secure all loads against shifting.

3. Provide the **proper** unloading equipment. Unloading by hand or by ropes and skids is acceptable for small-diameter pipe (up to 8 in. diameter in most cases) - **but** equipment such as cranes or hydraulic-boomed vehicles are required for larger-diameter pipe and for coil bundles. The equipment must be able to lift pipe clear of 15 ft. side stakes on rail cars and 11 ft. side racks on trucks.

4. To lift pipe, use belly-band slings, inverted "Y" ropes, or spreader beams with rope slings.

5. Pile the pipe in a free-standing manner with wide-faced wooden chocks restraining the bottom layer.

6. When shipments involve the same pipe diameter in different pressure classifications, always stack the heaviest wall thicknesses at the bottom of the storage pile. Try to keep pipe sizes segregated to their own pile. Pipe with factory attached waterstops or butt-fused flanges should be placed on the pile so that these fused-on fittings extend beyond the rest of the pipe pile.

7. Set aside damaged, gouged, or heavily-scored pipe. The joining representative will evaluate its disposition when he arrives on the site.

8. Try to shelter the pipe storage piles from heavy ice and snow coverings. This could save a lot of labor when joining starts and minimize potential damage to the pipe from excessive weight.

9. Keep the pipe clean. This permits fast identification and minimizes cleaning and preparation of pipe ends during the joining operation.

10. Check your parts inventory for the job. Have you received all your bolts, nuts, gaskets, flange rings, fittings, and valve boxes?

11. For best results, with marine installations, concrete collars, underpads, and bolts should be manufactured prior to the start of joining. Waiting until joining starts may cause complications and may force you to install collars in an unorthodox and expensive manner. (See the "Marine Installation" brochure for more information.)

12. Prepare your joining site(s). These should be located on dry, level ground in previously agreed upon areas.

13. On the day the joining starts, erect the joining shelter if required.

JOINING PROCEDURE

Introduction to Thermal Fusion

One of the most widely used methods of joining SCLAIRPIPE in the field is thermal fusion. The fusion method is a fast and economical way of connecting straight lengths of pipe and attaching flange assemblies. Butt-fused joints are reliable and when properly made, are as strong as the pipe itself. The process is quite simple. When the high density polyethylene (HDPE) resin, used in the manufacture of SCLAIRPIPE, is heated above its melting point, it can be made to flow under pressure. When two heat-softened pipe ends are brought together and held under pressure, they fuse together and remain fused after the joint cools. A small bead of polyethylene forms on both the inside and the outside of the pipe producing a strong joint when this operation is performed.

FIGURE 5 - **WH 1600 (55 to 63 in.) Fusion Machine**

The fusion process may not be practical for every joint along the entire length of a long run. Extremely long lengths (1,000 feet or more) may become unmanageable and should be made up of shorter lengths which can later be jointed by mechanical connections. For some installations, a mobile joining vehicle or sled has been used successfully to provide long, continuous thermally fused lengths without mechanical fittings.

The same fusion process is used to connect a HDPE stub-end to a length of pipe. The stub-end is held in the moving half of the machine in a special stub-end holder which allows it to be aligned, trimmed and fused to the pipe.

FIGURE 6 - **Fusion Joining Procedure**

FIGURE 6 a)
Pipe aligned in machine prior to joining.

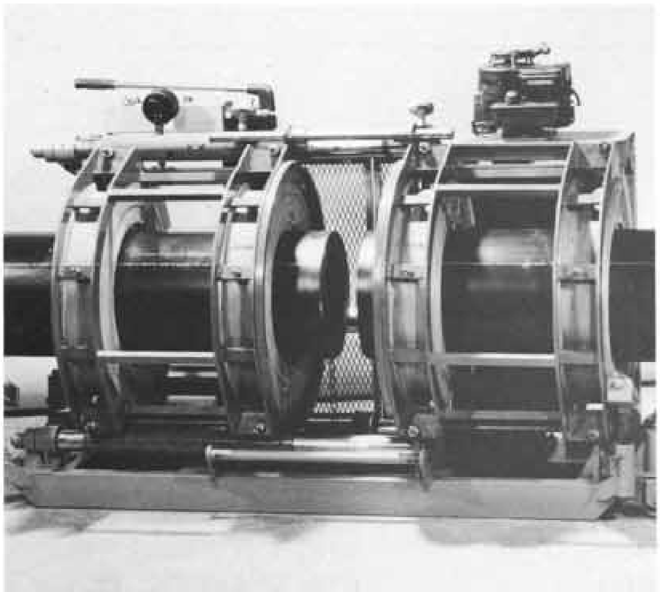


FIGURE 6 b)
Trimming Operation to prepare the pipe ends.

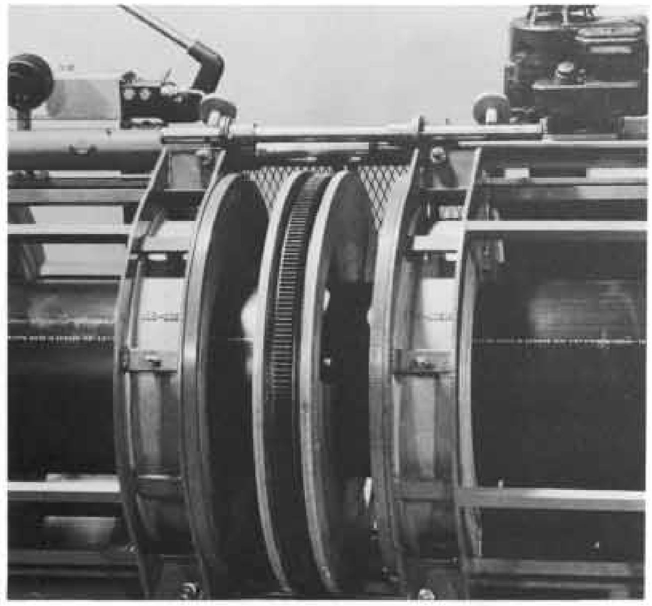


FIGURE 4 c)
Heater Plate in position with melt bead forming

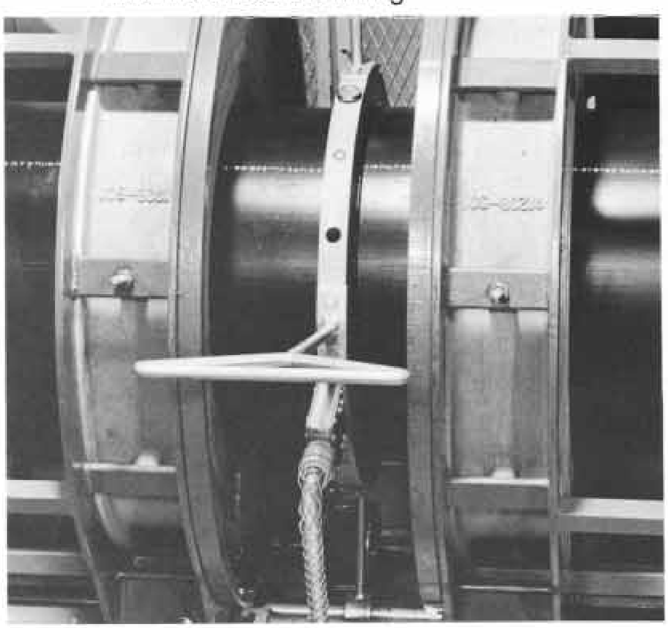
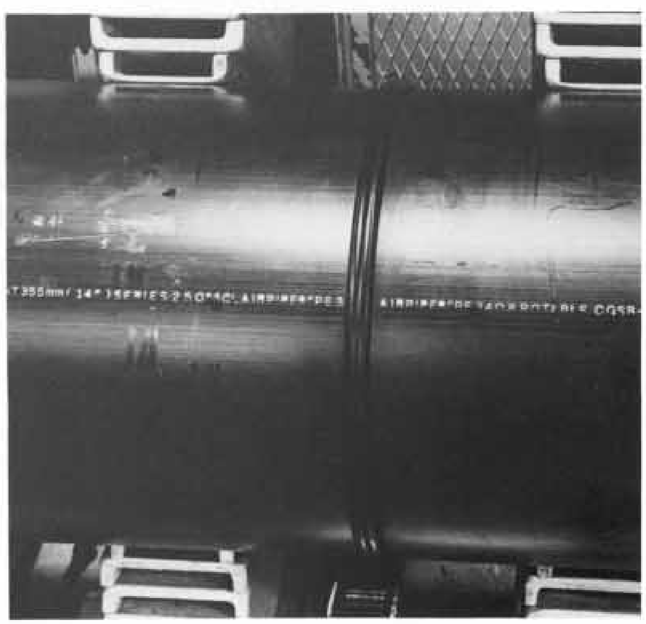


FIGURE 4 d)
Completed fusion joint



NOTE: For more information on fusion joining procedures contact your KWH Pipe representative

TABLE 3

FUSION EQUIPMENT

Common Nominal Pipe Sizes (in.)	DR	Machine Type WH	McElroy
2	all	CP-1	28
3	all	WH280	28
6	all	WH280	28, 412, 618
8	all	WH280	28, 412, 618, 824
10, 11	21 and above	WH280 WH400	412, 618, 824
10, 11	17 and lower	WH400	412, 618, 824
12	all	WH400	412, 618, 824, 1236
14	11 and above	WH400	618, 824, 1236
14	9 and lower	WH630	618, 824, 1236
16	17 and above	WH400	618, 824, 1236, 1648
16	13.5 and lower	WH630	618, 824, 1236, 1648
18, 20, 22	all	WH630	824, 1236, 1648
24	21 and above	WH630 WH800	824, 1236, 1648, 2065
24	17 and lower	WH800	824, 1236, 1648, 2065
28, 32	all	WH800	1236, 1648, 2065
32, 36, 40	all	WH1000	1648, 2065
42, 48	all	WH1200	1648, 2065
55, 63	all	WH1600	2065
55, 63	all	WH1600A	2065

Contact your KWH Pipe sales representative for an estiamte of fusion rates and guidelines for additional manpower and equipment required.

Contact McElroy or T.D. Williamson for exact sizing of equipment and availability.

TABLE 4

JOINING MACHINE SPECIFICATIONS

Type	Size Range	Approximate Unit Dimensions L x W x H (in.)	Machine Weight	Minimum Power Requirements	Heater Plate	Crated Dimensions L x W x H (in.)	Crate Dimensions (cu. ft.)	TOTAL Weight (lb.)*
KWH Pipe Joining Machines								
WH280	3in.-11 in.	38 29 29	700 lb.	4 kW	110 Vac, 1800 W	58 44 44	65	1,800
WH400	10in.-16in.	68 28 40	1,400 lb.	4 kW	220 Vac, 2800 W	87 44 50	111	2,800
WH630	16in.-24in.	84 48 48	1,800 lb.	5 kW	220 Vac, 5400 W	105 56 90	306	5,200
WH800	24in.-32in.	84 48 60	2,400 lb.	15 kW	220 Vac, 10 kW†	122 83 83	486	9,800
WH1000	32in.-40in.	96 65 71	4,000 lb.	15 kW	220 Vac, 12 kW†	146 92 104	808	12,900
WH1200	40in.-48in.	116 82 82	4,140 lb.	15 kW	220 Vac, 15 kW†	144 92 102	785	13,800
WH1600	55in.-63in.	100 91 91	16,590 lb.		self contained 50 kW generator and low boy trailer			36,500
WH1600A	55in.-63in.	100 91 91	17,000 lb.					36,500
McElroy Joining Machines								
28	2in.-8in.	65 37 50	539 lb.	3.5 kW	120/1/60, 1750 W			
412	4in.-12in.	94 49 50	1,225 lb.	5.5 kW	240/1/60, 3000 W			
618	6in.-18in.	94 49 50	1,335 lb.	6.5 kW	240/1/60, 3000 W	Contact McElroy for more detail on crating		
824	8in.-24in.	127 66 59	3,800 lb.	17.5 kW	240/3/60, 10950 W			
1236	12in.-36in.	127 69 65	4,500 lb.	30 kW	240/3/60, 20,400 W			
1648	16in.-48in.	151 95 86	8,800 lb.	50 kW	240/3/60, 37,021 W			
2065	20in.-65in.	187 102 106	14,000 lb.	50 kW	240/3/60, 38,437 W			

where V = volts
ac = alternating current
k = kilo
W = watts
a = amps

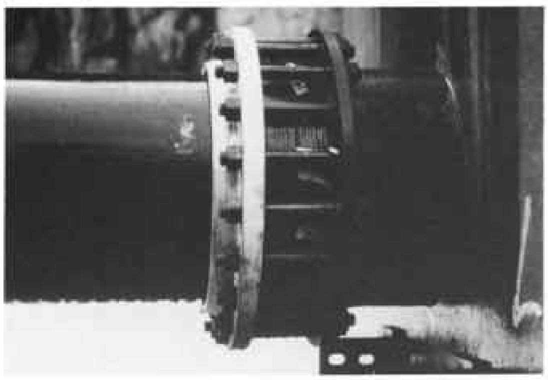
* TOTAL Weight includes both Joining Machine and Container
† 3 phase 30 amp Twist Lock Plug 4 prong

Flange Assemblies

The preferred method of connecting SCLAIRPIPE to fittings, valves, tanks, pumps or other pipe is by use of a flange assembly. Long lengths of joined polyethylene pipe are often connected by flange assemblies to reduce handling problems in the field. A flange assembly consists of:

(i) a HDPE stub-end, which is butt-fused to the end of the pipe
(ii) a metal slip-on flange.

FIGURE 7 - **Typical Flange Assemblies**



These polyethylene stub-ends are manufactured from the same resin as the pipe, and are supplied with the same wall thicknesses and pressure ratings as the pipe they are intended to be used with. Stock flanges are made from ductile iron and are made to fit behind the polethtylene stub-ends. Flanges are available in all pipe sizes and are designed to the highest pressure rating for each pipe size. The metal flanges are drilled to ANSI B 16.5 bolt circles. For specific applications flanges can be supplied with corrosion resistant coatings, or can be manufactured in other materials.

NOTE: Because of the increased thickness of a polyethylene stub-end, when compared to a conventional steel flange assembly, it is necessary to use longer bolts with the standard flange assemblies as detailed in the "Slip-On Metal Flanges" section of the SCLAIRPIPE "General Information" brochure. When connecting to flanges of other piping materials, you **must** calculate the correct bolt lengths as detailed in the "Joining SCLAIRPIPE to Other Materials" in the "General Information" brochure.

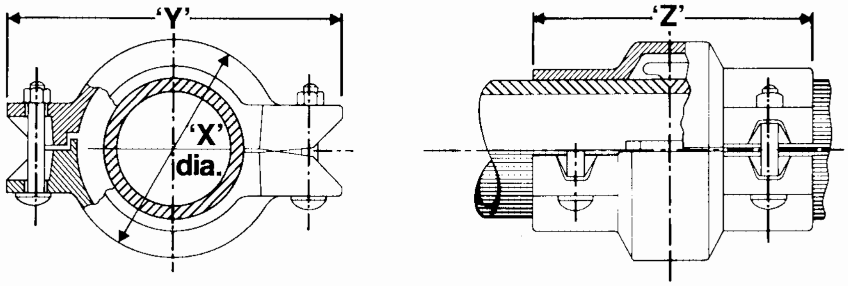
Other Mechanical Connections

VICTAULIC 995 couplings, are a practical mechanical means of joining plain end HDPE pipe and provide reliable leak-free joints without thermal fusion. These couplings can join plain-end IPS pipe and fittings from 2 to 14 in. without special preparation or equipment.

VICTAULIC 995 couplings should be used where thermal fusion is impractical due to space limitations, or if there is a requirement to periodically relocate the piping system. These couplings can be installed quickly: just line up the marked pipe ends; slide on the pressure responsive gasket; and place the two coupling housings over the pipe ends. The housings have tongue and recess mating features ensuring proper alignment and penetration depth for the teeth gripping the pipe. The joint is complete when the housings are bolted together and snugged up with the oval-track bolts provided. Contact your KWH Pipe representative for more detailed installation information.

TABLE 5

VICTAULIC 995 Couplings - Dimensional Data



All Dimensions in Inches

"X", "Y" & "Z" dimensions as per diagram

Nominal Pipe Size	Pipe O.D.	Coupling Dimensions "X"dia.	"Y"	"Z	Bolt Dimensions No.	Diameter x Length	Assembled Weight (approx.)
2	2.375	3.640	5.500	3.620	2	0.550 x 2.500	3.6 lb.
3	3.500	4.625	7.125	5.000	4	0.375 x 2.000	6.4 lb.
4	4.500	5.875	7.750	5.750	4	0.500 x 2.750	13.4 lb.
6	6.625	8.000	10.500	5.875	4	0.625 x 3.250	18.5 lb.
8	8.625	10.188	13.000	6.000	4	0.625 x 3.250	25.0 lb.
10	10.750	12.375	15.813	6.500	4	0.75 x 5.000	38.0 lb.
12	12.750	14.375	17.750	7.000	4	0.75 x 5.000	46.0 lb.
14	14.000	16.250	21.000	7.750	4	0.875 x 7.000	81.0 lb.

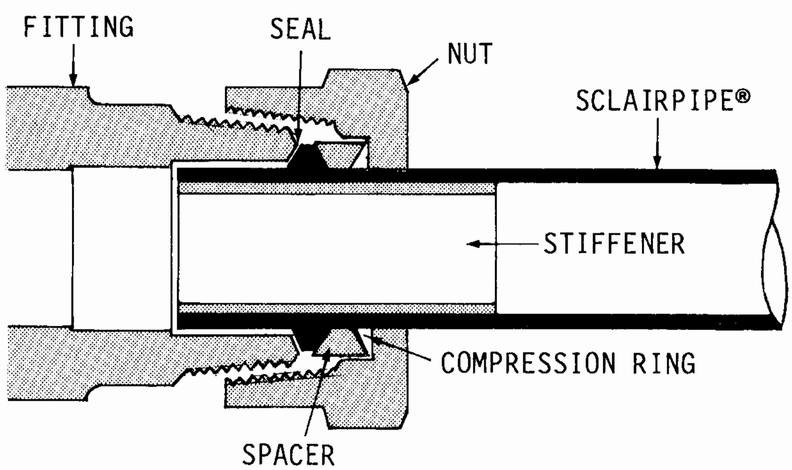
Compression Couplings for Small Diameter SCLAIRPIPE

SCLAIRPIPE, manufactured in diamteres of 3/4 in. and 1 in. and with a pressure rating of 160 psi is produced to a Copper Tube Size (CTS) specification. When used in water service applications, it is often necessary to join the SCLAIRPIPE to copper service lines or fittings. Brass compression-type fittings are recommended for these joints. These fittings are designed to compress the wall of the polyethylene CTS pipe, by means of a flexible seal, against a stainless steel insert stiffener, which must always be used in this application. Fittings designed for inside diameter controlled (ID) polyethylene pipe will not work with outside diameter controlled SCLAIRPIPE CTS pipe.

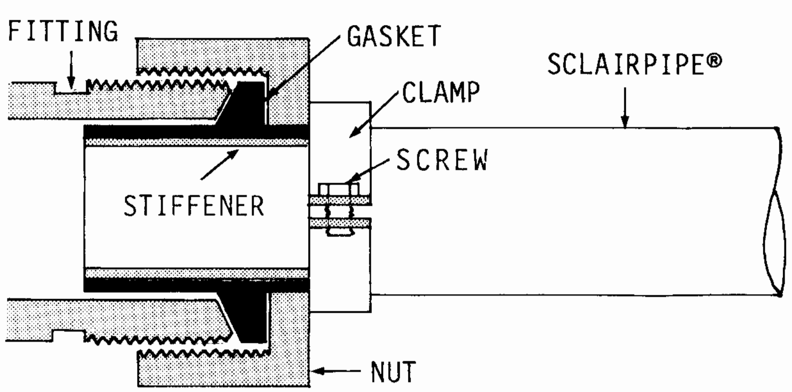
Suggested suppliers for compressiom fittings are:

1. EMCO Limited, London, Ontario, CANADA ("Successor*" brand)
2. THE FORD METER BOX Co. Inc., Wabash. Indiana, U.S.A.

FIGURE 8 - Typical Compression Fittings



EMCO



FORD

BURIED PIPE INSTALLATION

Introduction

In any below grade piping application, the quality of the installation is one of the key factors in the long-term performance of piping materials. In many applications SCLAIRPIPE offers several unique qualities that can aid in safer and faster installation. These qualities are enhanced by proper design considerations and installation procedures.

This section offers a guide to good underground installation of SCLAIRPIPE and should serve to supplement the specifying engineer's knowledge of local conditions. Other guides to below grade piping installations are contained in publications such as ASCE/WPCF Manuals of Practice and ASTM Standard D2321 - "Standard Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe."

Excavation of Trench

The trench should be dug to the required alignment and depth shown on the contract drawings, or as directed by the supervising engineer, and only so far in advance of pipe laying as he permits. The recommended trench opening for the installation of continuous lengths of pipe assembled above the trench is shown in Table 6. Where space or ground conditions do not permit the minimum specified trench openings, joining and laying may be conducted in the trench, using the joining machine or flange connections. In special cases where trench sidewalls are sloped, shorter trenches may be used.

The flexibility and light weight of SCLAIRPIPE, together with its ability to be thermally fused into long lengths above ground, permit the use of installation techniques which are different from those used for rigid piping materials.

Joining the pipe above ground allows the use of narrower trench widths where ground conditions permit. Slot trenches excavated by rotary trenchers, back-hoes or bucket shovels are ideal.

FIGURE 9 - **Trench Excavation**

At fittings, service connections and similar work locations where it is necessary to descend into the trench, the trench should be braced and drained so that the construction crew can work safely and efficiently as required by local safety codes and regulations.

TABLE 6

TRENCH OPENING FOR THE INSTALLATION OF JOINED LENGTHS OF POLYETHYLENE PIPE

Nominal Pipe Size (inches)	Depth of Trench (feet)						
	3	5	7	9	11	13	15
1/2 - 3	8	10	11	11	12	12	12
4 - 8	13	16	19	21	23	24	25
10 - 14	17	21	25	28	30	32	34
16 - 22	21	27	31	35	39	42	44
24 - 40	28	36	43	48	53	57	61
42 - 63	36	46	54	61	67	73	78

NOTE: The values in this table are based on installation conditions at 73°F. They are given as a guide only, and are calculated using the largest pipe in each group.

Trench Widths

Since flexible pipe has to support, at most, only the weight of the "prism" or vertical column of soil directly over the pipe, the precaution of keeping the trench as narrow as possible is not the concern that it is for a rigid pipe which can be subjected to the weight of the soil beside the prism as well as the prism itself. With PE pipe, widening the trench will generally not cause a loading greater than the prism load on the pipe. Trench width in firm, stable ground is determined by the practical consideration of allowing sufficient room for the proper preparation of the trench bottom and placement and compaction of the pipe embedment materials, and the economic consideration of the costs of excavation and of imported embedment materials.

Trench width in firm, stable ground will generally be determined by the pipe size and compacting equipment used. The following table gives minimum trench width values. The trench width may need to be increased over the values in Table 3 to allow for sufficient clearance between the trench sidewalls and the pipe for compaction equipment. Typically for large diameter pipe (18" and larger), this required clearance will vary from 12 to 18 inches. If two or more pipe are laid in the same trench, sufficient space must be provided between the pipes so that embedment material can be compacted. When the pipe is installed by trenching or ploughing, the trench width may be less than that given in Table 7 since the trenching machine or plough typically shapes the trench bottom to provide appropriate haunching for the pipe.

TABLE 7 - **Minimum Trench Width in Stable Ground**

Nominal Pipe Size (in.)	Minimum Trench Width (in.)
3 to 16	Pipe O.D. + 12
18 to 42	Pipe O.D. + 18
48 and larger	Pipe O.D. + 24

Ground conditions may not permit sharp trench profiles in sandy, silty areas. The trench walls may be sloped at an angle of 45 degrees or the angle of repose of the material. When wide trenches are necessary, the initial bedding material should be compacted in order to withstand the final earth burial load.

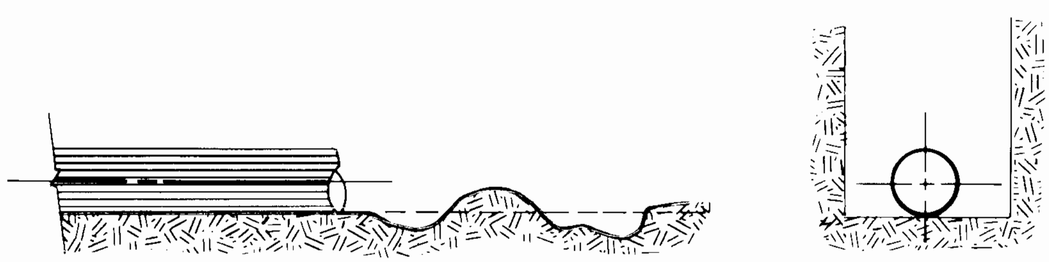
Preparation of Trench Bottom

For pressure systems such as watermains, sewage forcemains, or long distance transmission lines, the accurate levelling of trench bottoms is not essential unless specified in the drawing. For pressureless systems such as gravity drainage systems, the slope should be graded as evenly as it would be for other piping materials.

Flat Trench Bottom

Bedding is not necessary if the bottom of the trench is reasonably smooth and straight and the soil is essentially free of rock. An undisturbed bottom meeting these requirements is ideal. When trench bottoms must be disturbed, they should be compacted to a density at least equal to the density of the surrounding bedding material. Large rocks, stones and boulders should be removed to provide a minimum of 6 inches of clear bedding material on each side of and below all pipe and accessories. Excavations below subgrade should be filled and levelled with suitable material approved by the supervising engineer. Generally smooth stones no larger than two inches in any dimension are acceptable if mixed with sandy soil or clay. All sizes of SCLAIRPIPE will accomodate themselves to trench bottoms that are somewhat uneven. Sharp-edged rocks or hard shale, however, can create overstressed areas in the pipe wall which can damage the pipe when it is backfilled. (see figure 10)

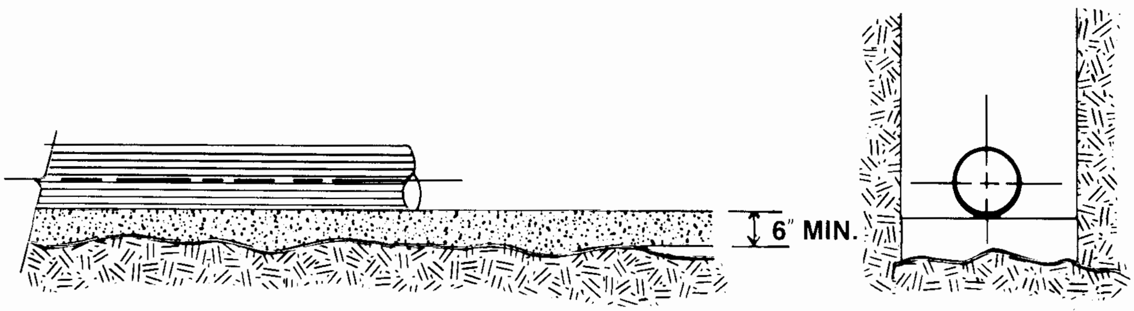
FIGURE 10 - **Flat Trench Bottom**



Excavation in Shale and Loose Rocky Soil

To avoid "point contacts" with loose rock, and to provide a uniform bed for the polyethylene pipe to rest on, the trench should be excavated at least six inches deeper than grade. The trench bottom should then be filled to grade with selected fill approved by the supervising engineer, tamped to 90 per cent Standard Proctor Density or greater. (see figure 11)

FIGURE 11 - **Improved Trench Bottom**



Excavation in Solid Rock

Bedding should be prepared in the same manner as for "Excavation in Shale and Loose Rocky Soil". In cases where the excavated trench slopes sharply and ground water flows through it, the trench bottom should be filled with coarse crushed stone (1 inch minus) and compacted to 90 per cent Standard Proctor Density or greater in order to help prevent the washing out of the bedding and the subsequent settlement of the pipeline.

Soils Requiring Special Treatment

Unstable soils, such as wet clay and sandy soils with poor bearing strength, should be excavated 4 to 6 inches deeper than specified for the pipe invert. The trench bottom should be refilled with selected imported or excavated material (gravel, crushed stone, etc.) to provide uniform support for the polyethylene pipe, as already discussed in this section. In unstable organic soils, where the ground water table can cover the pipe at its installed elevation, extra weight may be added to impart negative buoyancy to the pipe, if specified by the supervising engineer. The weights should be designed to not exceed the bearing strength of the foundation material.

Placing the Pipe in the Trench

Pipe and accessories should be inspected for defects prior to their lowering into the trench. Under no circumstances should they be dropped, dumped or rolled into the trench. All foreign matter or dirt must be removed from the interior and ends of the pipe and accessories before they are lowered into the position in the trench. Pipe should be kept clean by means approved by the supervising engineer before, during and after laying.

Pipe is usually joined above ground and laid out above the right-of-way before or during excavation. It may be placed in the trench as the digging progresses, thereby keeping a minimum amount of trench open behind the digger. In special circumstances, the pipe may be prejoined into lengths of approximately 500 feet, stored in an assembly area, and then pulled to the installation site. There they can be either thermally fused or mechanically connected together.

FIGURE 12 - **Placing Pipe in the Trench**

Pipe sizes up to 8 in. nominal diameter may be moved manually into the trench. All larger pipe, fittings, valves, hydrants and accessories should be lowered carefully using suitable mobile equipment in a manner that will prevent damage to pipe and fittings. Typical equipment used to place pipe into the trench would include back-hoes, cranes and telescoping lifting equipment. For lifting long lengths of joined pipe, band or nylon rope slings are mandatory to minimize damage to the pipe. It is recommended that slings be used when handling pipe of any length.

Assembly of Final Pipe Connections

Fused Joints

Pipe to be joined in the trench by thermal fusion should be joined in the same manner as for pipe joined outside the trench. Consult the "Joining Procedure" section for a more detailed description of this process. Lengths of pipe should be allowed to cool to the ambient soil temperature before any joining is performed.

Flanged Joints

Connections to metal fittings, valves, tanks, pumps, or other pipe materials are generally made by flange assemblies. They may also be used to connect lengths of polyethylene pipe, where fusion is impractical.

Where necessary to eliminate galvanic corrosion, insulating sleeves can be used to separate the bolt from the metal slip-on flange. Alternatively, 8-mil polyethylene film "tubing" may be pulled over the flange assembly and tightly taped to the pipe on each side with plastic tape. The length(s) of pipe to be connected should be made longer and allowed to cool to ambient soil temperature before making up the joint. The faces to be joined must be properly aligned and, if possible, installed so that one face is in compression against the other. **Under no circumstances** should the bolts be used to **pull up the mating faces** to overcome an evident gap or misalignment. These bolted joints should be left exposed for a minimum of 8 hours and then retightened prior to pressure testing.

Installation of Fittings and Valves

All fittings should be carefully inspected and cleaned before being carefully lowered into the trench. Well compacted (90 per cent Standard Proctor Density or greater) crushed stone or gravel should be applied in 6 in. layers (extending to the trench walls) at all elbows, tees, wyes and other fittings so that the fittings are encased in stable backfill. The compacted material should extend a minimum distance of three pipe diameters beyond the ends of the fitting unless the same compaction has been specified by the supervising engineer for the remainder of the pipeline.

All geared valves, and any other valves designated, should be set in masonry valve pits, unless otherwise specified by the supervising engineer. The wrench nuts should be readily accessable for operation through the manhole opening. Pits should be constructed in a manner that will permit minor valve repairs and afford protection for the pipe against impact or settlement where the pipe passes through the pit walls. Cast-iron valve boxes should be firmly supported prior to backfilling and compacted to the finished grade to prevent tilting or tipping.

Joints at Fittings and Structures

Relative movement between polyethylene pipe, fittings and other rigid structures should be prevented at flanged joints. This may be done by either: ensuring that the soil bearing the pipe will provide equal, long-term support for the pipe and the fitting; or by supporting the fitting and the length of pipe (support equal to at least five times the length of the fitting) by means of continuous longitudinal timber(s) or a concrete cradle centered under the fitting.

Where polyethylene pipe is connected to flanged pipe or fittings **fixed in a rigid structure**, such as a valve pit or manhole, a reinforced concrete pad should be poured under the pipe and the flange, and the pad connected to the structure by means of a reinforcing rod. This support should extend from the flanged joint: a minimum of one pipe diameter for pipe larger than 12 in. nominal; or a minimum of one ft. for smaller pipe. In such cases, assemblies similar to those shown in figures 13(a) and 13(b) have proven to be effective in preventing damage to the connections. Alternatively, in stable, well compacted soils where settlement is unlikely, a retaining device can be clamped to the pipe embedded in the wall. Where SCLAIRPIPE extends through a wall, as in a manhole for example, anchor assemblies similar to figure 13(c) should be used to avoid movement of the pipe through the wall.

FIGURE 13 - **Buried Connections to Rigid Structures**

13 a)

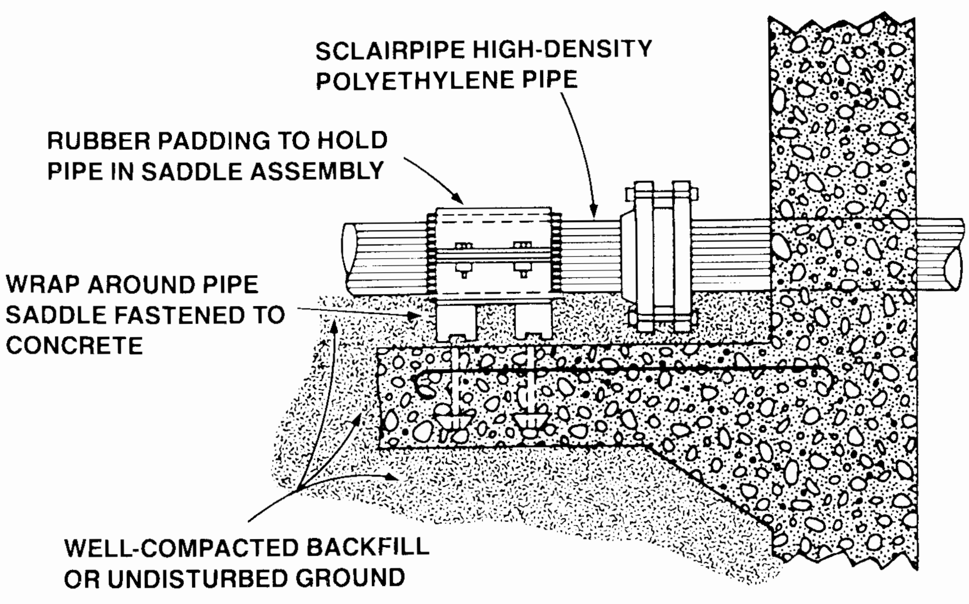
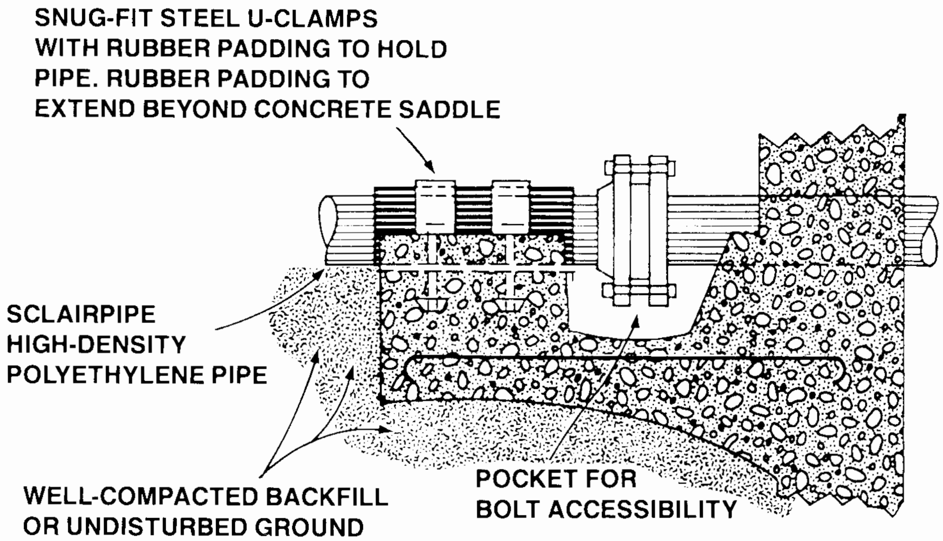
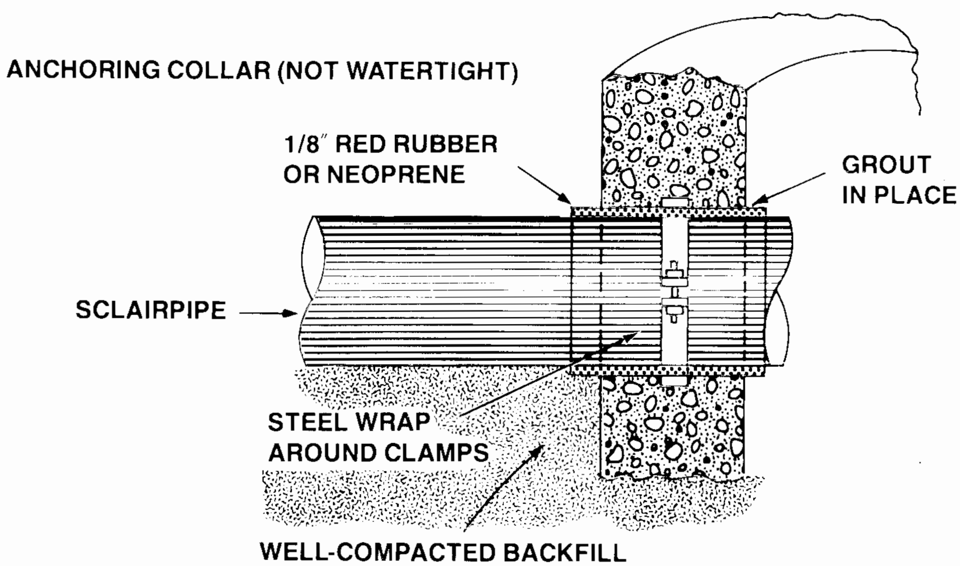


FIGURE 13 - **Buried Connections to Rigid Structures** (cont'd)

13 b)



13 c)

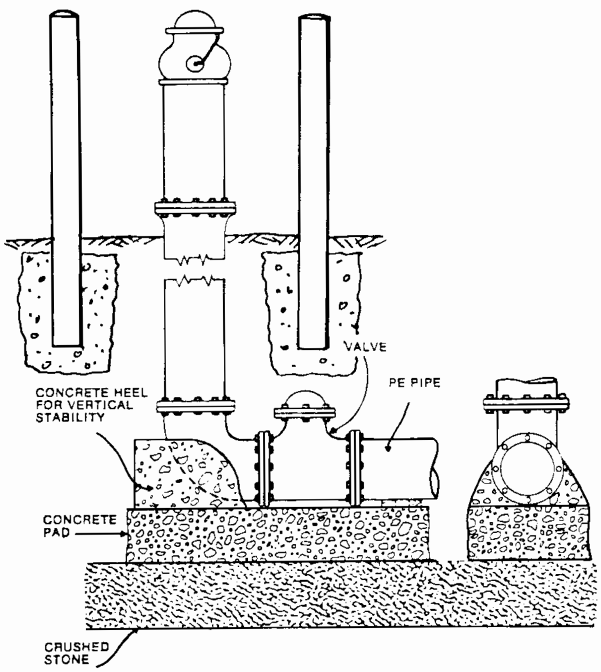


NOTE: For methods of watertight entry to a manhole see figure 24 (Pg. 34)

Setting of Hydrants

Hydrants should be inspected, lowered into the trench and joined to SCLAIRPIPE as specified in the preceding sections. Bearing pads should be provided as detailed in figure 14. Where required the barrel drain should be clear for adequate drainage. Hydrants should be positioned to provide complete accessibility while minimizing the possibility of damage from vehicles or injury to pedestrians. All hydrants should be independently supported prior to backfilling to ensure that excessive torquing or bending stressses are not placed on the flange connections and that the hydrants continue to stand plumb. Each hydrant should be connected to the main and controlled by an independent gate valve unless otherwise specified by the supervising engineer.

FIGURE 14 - **Hydrant Connection**



Pressure Testing of SCLAIRPIPE

Pressure testing with air is **not** recommended for SCLAIRPIPE high density polyethylene pipe under any circumstances. Water is the recommended pressure medium for the pressure testing of SCLAIRPIPE piping systems. Testing can be done before or after the pipe is in the trench. If the pipe must be backfilled before it is tested, the mechanical joints should be left open for visual inspection during testing.

Basic Procedure for Pressure Testing

When pressurized, SCLAIRPIPE exhibits a relatively rapid rate of initial deformation (i.e. noticeable radial expansion), followed by a slower, more constant rate of deformation with time. As the pipe expands, the pressure decreases and more water must be pumped into the system to maintain the pressure. If a leak exists in the system, the amount of water required to maintain the pressure will be considerably more than this pre-determined amount of make-up water. The pressure test involves pressurizing the pipe and adding make-up water until the pipe has reached its initial deformation. This level of deformation is usually attained after 3 to 4 hours depending on the size of the pipe. It is characterized by a noticeable reduction in the amount of make-up water required to return the piping system to the test pressure. It is at this time that the actual test period begins. Its duration can be 1 to 3 hours. At the end of the test period, a measured amount of make-up water should be added to return the pipe to the test pressure. The amount of make-up water should not exceed the allowance given in Table 8.

The amount of expansion taking place during the pressure testing of SCLAIRPIPE is also dependent on the temperature of the pipe during testing. The temperature of the pipe can be taken as an average of the temperature of the water pumped into the pipe and the temperature of the empty pipe immediately before testing (ambient air temperature). When testing the pipe at temperatures below 73.4°F, the amount of make-up water shown in Table 8 should be multiplied by the appropriate correction factor taken from figure 15.

FIGURE 15 - **Correction Factor for Pressure Testing**

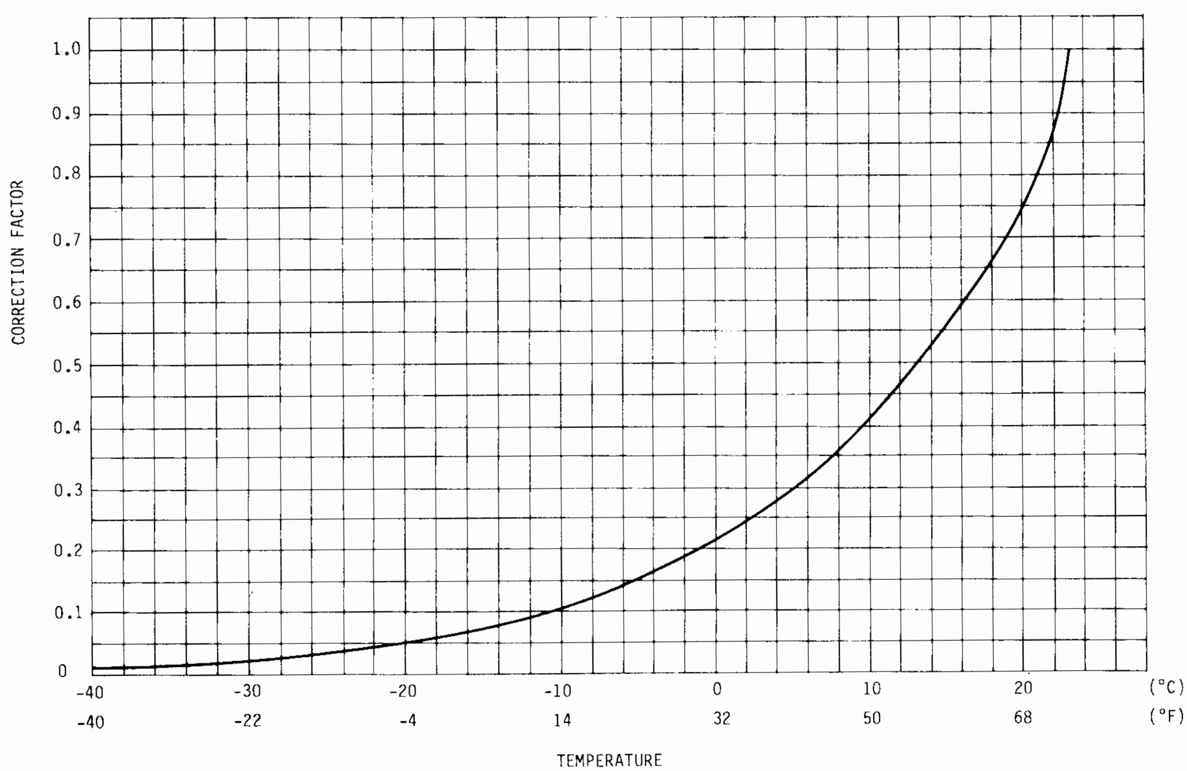


TABLE 8

ALLOWANCE FOR EXPANSION UNDER TEST PRESSURE*

Allowance for Expansion [U.S. gal per 100 ft. of pipe] at 73.4°F

Nominal Pipe Size (in.)	1 hour Test	2 hour Test	3 hour Test
3	0.10	0.15	0.25
4	0.13	0.25	0.4
6	0.3	0.6	0.9
8	0.5	1.0	1.5
10	0.7	1.3	2.1
11	1.0	2.0	3.0
12	1.1	2.3	3.4
14	1.4	2.7	4.2
16	2.7	3.3	5.0
18	2.2	4.3	6.5
20	2.7	5.5	8.0
22	3.5	7.0	10.5
24	4.5	8.9	13.3
28	5.5	11.1	16.7
32	7.0	14.3	22.5
36	9.0	18.0	27.0
40	11.0	22.0	33.0
42	12.5	25.0	37.5
48	16.0	32.0	48.0
54	20.5	41.5	62.0
63	28.0	60.0	85.0

*These allowances refer **to the actual Test Period.**

Testing Outside the Trench

If agreed to by the supervising engineer; pressure testing with water can be conducted after joining is complete, before laying the pipe into the trench. The pipe should be subjected to a maximum hydrostatic test pressure of 1.5 times the rated pressure of the pipe (1.5 x the Standard Pressure Rating as obtained from Table 9) for a maximum period of 3 hours. The pipe can be maintained at the “Test Pressure” by the periodic addition of make-up water.

As the lines pressure-tightness is determined by visual examination, it is not necessary to calibrate the make-up water for the initial stretching of the pipe. The fused joints should be examined for leakage and any joints showing leakage must be removed from the pipeline. The pipe should then be rejoined, and the system retested.

NOTE: It is the responsibility of the Contractor to ensure that normal safety precautions are observed for above ground hydrostatic pressure tests.

TABLE 9

STANDARD PRESSURE RATING

Hydrostatic Design Basis	Standard Pressure Rating (DR) [psig @ 73.4°F]									
	32.5	26	21	17	15.5	13.5	11	9	7.3	6.3
800 psi	50	64	80	100	110	128	160	200	250	300

Pressure testing in the Trench

After the pipeline has been laid it can be filled with water and subjected to a hydrostatic pressure test. The "Test Pressure" should be 50 per cent greater than the rated pressure of the pipe **at the lowest elevation of the system** for a particular pressure rating of pipe. When in the opinion of the supervising engineer, local conditions require that the trenches be backfilled immediately after the pipe has been laid, the pressure test may commence: after the backfilling has been completed and at least 7 days after the last concrete bearing pad has been cast.

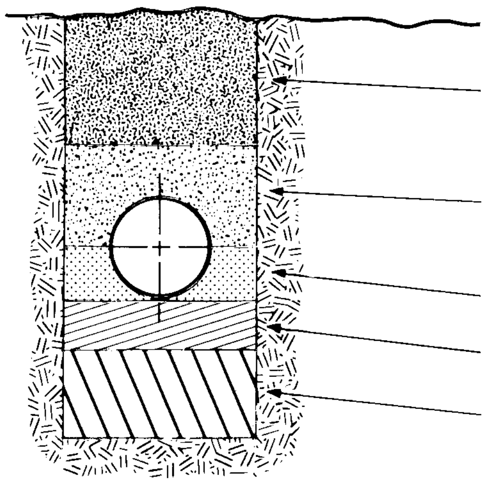
The test procedure consists of two steps: the initial expansion phase and the test period. In order to accomodate the initial expansion of the pipe under test, sufficient make-up water is added to the system at hourly intervals, returning the piping system to the Test Pressure. This repressurization is repeated 3 times after the original pressurization of the pipe. After the completion of the initial expansion phase, (eg. 3 hours after initially pressurizing the piping system under test) the actual test period will begin. The Test Period **must not exceed 3 hours**. After this Test Period, a measured amount of make-up water should be added to return the piping system to the Test Pressure. The amount of make-up water **should not** exceed the allowance given in Table 8.

NOTE: Under no circumstances should the total time under test exceed eight (8) hours at 1.5 times the pressure rating. If the test is not completed due to leakage, equipment failure or any other reason within this time period, the test section should be permitted to "relax" for an additional eight hour period prior to starting the next testing sequence.

Backfilling and Tamping

The backfilling should be carried out according to one of the following methods: with reference to one of the following sub-sections; as required by the drawings; or as otherwise specified by the supervising engineer. The terms referred to throughout this section are those shown in Figure 16.

FIGURE 16 - **Backfilling and Tamping**



Unless otherwise specified by the supervising engineer, the "Haunching" and "Initial Backfill" should be completed prior to the leakage test, with the remainder of the backfill completed after the completion of a satisfactory test. In all cases the Haunching and Intial Backfill material must be placed and compacted to provide support as specified by the supervising engineer.

The particular material used for backfilling will vary according to local conditions, the type of application and the specific requirements of the supervising engineer. In general, three types of backfill material have been found acceptable for the installation of SCLAIRPIPE. Full details on these bedding materials can be found in these basic reference works : (1) WPCF - "Manual of Practice" #FD-5; (2) "Standard Handbook of Plant Engineering", McGraw-Hill Inc.; (3) ASTM D2321, "Underground Installation of Flexible Thermoplastic Sewer Pipe"; (4) PPI No.TR31, "Underground Installation of Polyolefin Pipe".

The following includes a number of process materials and soil classifications listed under the "Unified Soil Classification System."

CLASS I - Angular 1/4 in. to 1-1/2 in. graded stone, including a mumber of materials that may be available locally such as coral,crushed slag, crushed stone and crushed shells.

CLASS II - Coarse sands and gravels having a 1-1/2 in. maximum particle size, including variously graded sands and gravels containing small percentages of fines, generally granular and non-cohesive, either wet or dry. Soil types GW, GP, SW and SP are included in this class.

CLASS III - Fine sands and clay gravels, including fine sands; sand-clay and gravel-clay mixtures. Soil types GM, GC, SM and SC are included in this class.

Haunching and Initial Backfill

The requirements for Haunching and Initial Backfill using Class I, Class II and Class III materials are given in ASTM D2321. The specific compaction requirements may vary from job to job but, in general, Haunching and Initial Backfilll should be compacted to 90 percent Standard Proctor Density as determined by the "American Association of State Highway Officials Method: T99". In certain non-critical applications, a lower level of compaction can be specified by the supervising engineer. Compaction should be carried out in 6 in. layers until the top of the pipe is reached. Compaction directly over the pipe should be avoided with less than one foot of cover on top of the pipe.

FIGURE 17 - **Haunching Small Diameter Pipe**

Final Backfill

Final backfill to finished grade may be excavated material or other soil. This material must be unfrozen, free from voids, lumps of clay, stones and boulders over 8 in. in their longest diameter. In all cases the supervising engineer should judge the suitability of the material for use as backfill. Under certain conditions, the type of final backfill material may be important to the design of the piping system and methods for applying the Initial Backfill should apply.

Final Backfill Under Roads

Trenches in the right of way of a road should be backfilled to finished grade with an approved grannular material to a compaction of 90 percent Standard Proctor, or to a compaction density specified by the supervising engineer.

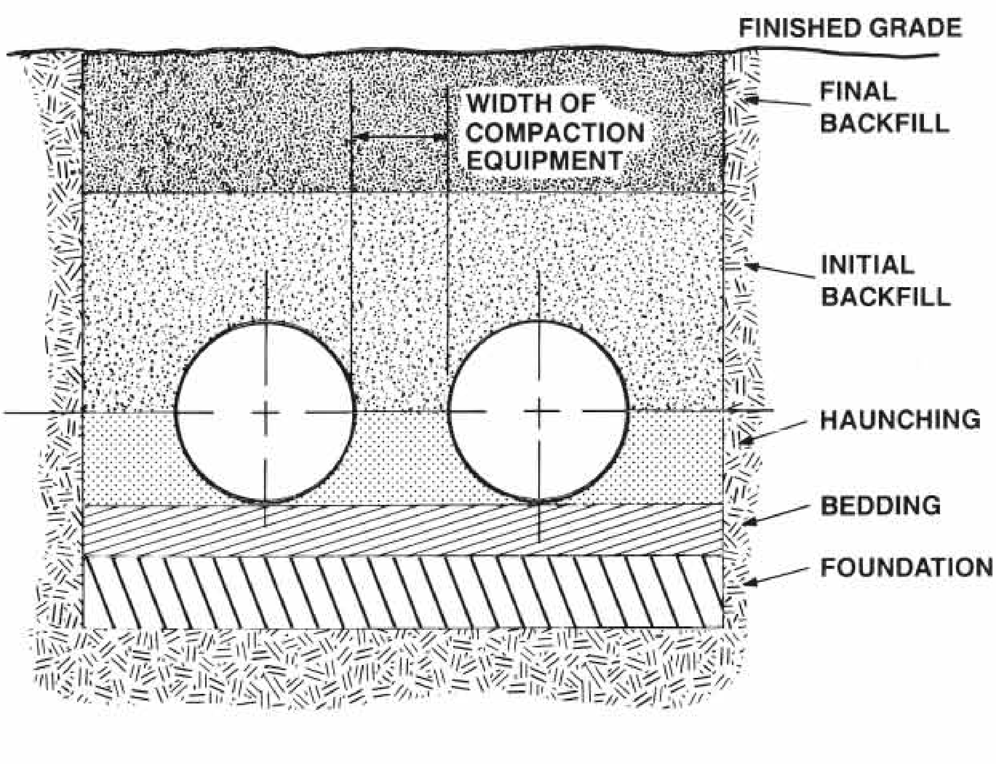
NOTE: Where the pipe crosses a road or right of way, the supervising engineer should consider the use of a culvert or casing for easier accessability to the pipeline (e.g. removing the pipe from the culvert to change pipe size).

FIGURE 18 - **Multiple Pipes in a Trench**

Two or More Pipes in a Common Trench

In the case of multiple pipes in the same trench, the requirements previously outlined apply in all cases. Care must be taken in the spacing of pipes to allow for full and adequate compaction of the Haunching and Initial backfill, around **each** pipe, using conventional compaction equipment, as shown in Figure 19. The supervising engineer should examine each particular application to decide whether an embankment condition applies when designing a support for the soil around the pipe.

FIGURE 19 - **Two or More Pipes in a Common Trench**



SURFACE INSTALLATION

Introduction

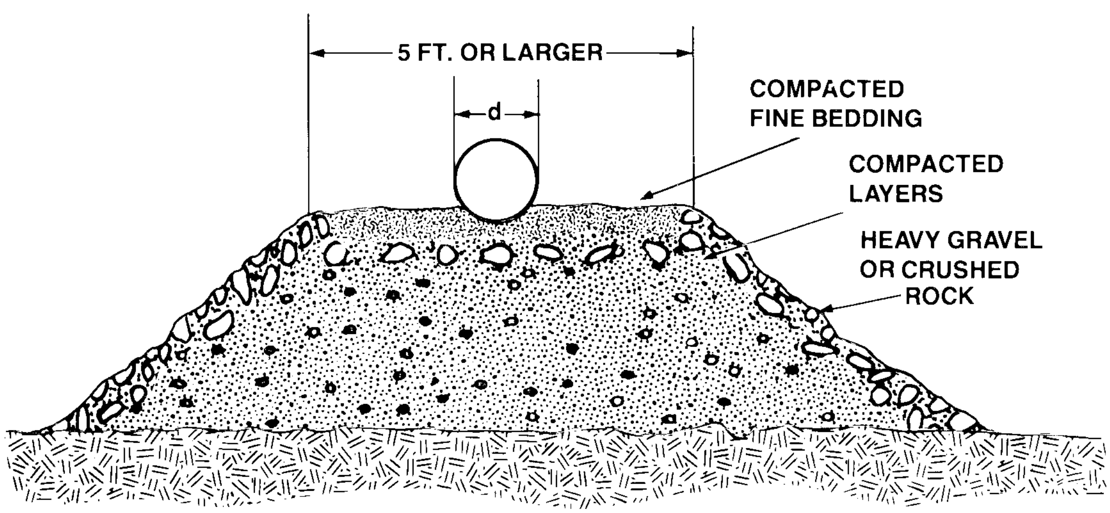
Although for practical and traditional reasons most pipelines are installed below ground, sometimes for a number of reasons, an above ground installation could be a better choice. An above ground installation may be necessary because of environmental or other factors (e.g. an abrasive slurry line requiring periodic rotation; areas of difficult installation in unstable ground as in bogs or permafrost; or areas where excavation is impractical as in areas of solid rock.) Surface installations also permit easy access to the pipeline in the event of line blockage and can simplify line relocation (e.g. relocation of tailings, dredging and temporary water supply lines).

Surface Preparation

The proposed pipeline route should be carefully surveyed to ensure that proper grading can be achieved and that the pipe will not be bent to greater extent than its minimum bending radius, either horizontally or vertically.

The pipe bed should not be located directly adjacent to a roadway where it could be damaged by passing traffic or snowplows. The pipe bed should be constructed in a manner similar to that used in constructing an unpaved secondary road. The bed should be formed in layers, each compacted to 90 percent Standard Proctor Density, to support the weight of the pipe and limited traffic along the top of the bed. The sides of the bed should be covered with "rip-rap" or a minimum of 2 in. gravel or crushed rock to prevent erosion. (see Figure 20)

FIGURE 20 - **Typical Pile Bed**



If the pipe bed runs close to a watercourse, it should be protected with large "rip-rap" or sand/cement bags. Where it crosses a watercourse, the bed should be perforated with culverts of suitable dimensions, with the entrances protected against erosion.

The dimensions and slope of the bed depend on local conditions. In most situations, an adequate top width should be allowed for both stability and access to the pipeline and to accomodate its thermal expansion or contraction. The surface of the bed should be compacted smoothly so that the pipeline is continuously supported. Sharp rocks must be removed to avoid point loading on the pipe should pipe movement occur.

FIGURE 21 - **Typical Surface Installation**

Minimum Permanent Bending Radius

SCLAIRPIPE because of its flexibility, can be field bent during installation, often eliminating the need for bends of 45 degrees or less. Sweeping directional changes larger than 45 degrees can also be made but minimum bending radii must be observed.

Table 10 gives multipliers for calculating the minimum permanent bending radii for SCLAIRPIPE in both pressure and non-pressure service. The minimum permanent bending radius (in inches) is equal to the nominal pipe diameter (in inches) times the appropriate multiplier.

TABLE 10

MULTIPLIERS FOR MINIMUM BENDING RADII

Application	Multiplier
Pressure Pipe	50
Non-Pressure Pipe	35

Where space will not permit the use of the minimum bending radius, standard fabricated polyethylene fittings should be used.

Connections to Fittings and Structures

As in connections made in buried installations, relative movement between the polyethylene pipe, fittings and other rigid structures should be prevented at flanged joints. Please refer to the following sections in the BURIED INSTALLATION chapter of this document for more specific information on assembly and connections to rigid structures for surface installations: “Assembly of Final Pipe Connections”; “Installation of Fittings and Valves”; “Joints at Fittings and Structures”.

There are some special considerations, however, for surface piping systems. When fittings are installed on the surface, you must prevent potential movement by ensuring that the haunching is firmly compacted beneath the pipe and fittings. Where bearing strength of the soil is inadequate to support heavy fittings, valves or clusters of fittings, concrete bearing pads, large enough in area to provide a stable support, should be used.

Where polyethylene pipe is to be connected to flanged pipe or to fittings fixed in a rigid structure, a reinforced-concrete pad should be poured under the pipe and the flange and the pad should be connected to the structure by means of a reinforcing rod. This connection is quite similar to the ones discussed in the BURIED INSTALLATION chapter. For details on the differences in connections between buried and surface installations compare Figure 13 (Buried) with Figure 22 (Surface). Alternatively, in stable well-compacted soils where settlement is unlikely, a retaining device should be welded to the pipe embedded in the wall. Figure 23 describes some of the several methods that have been used to provide a watertight entry at a manhole.

FIGURE 22 - **Surface Connections to Rigid Structures**

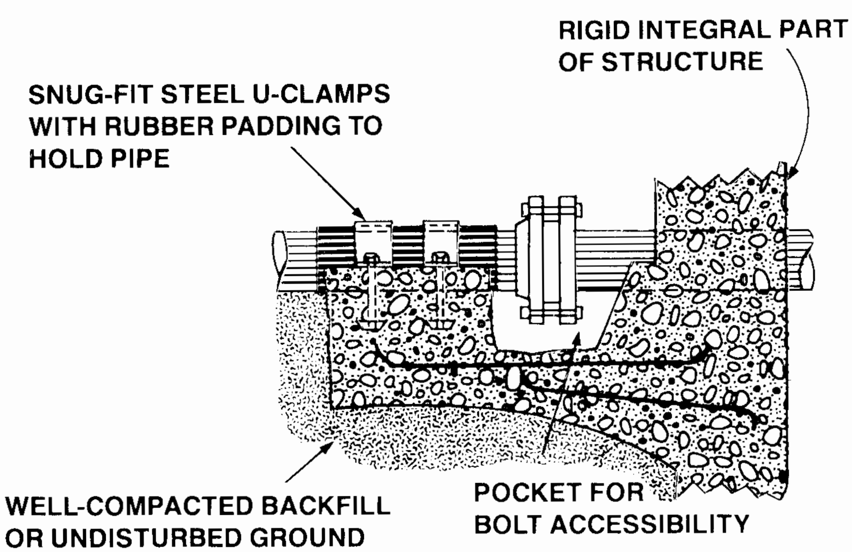
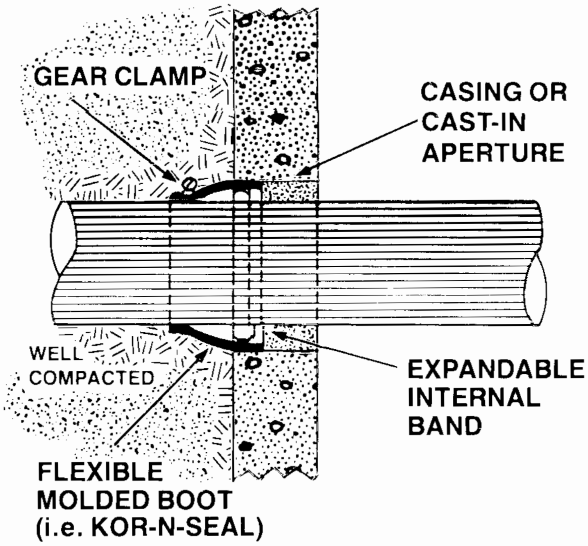
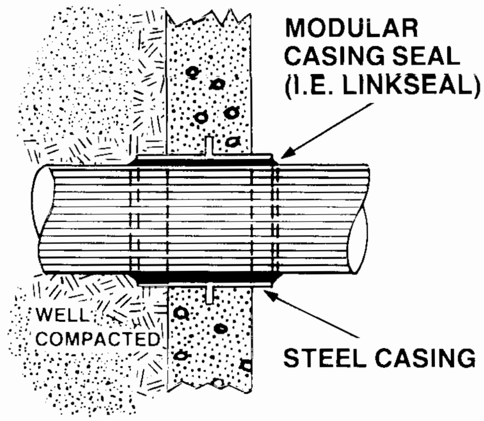


FIGURE 23 - **Methods of Watertight Entry at a Manhole**

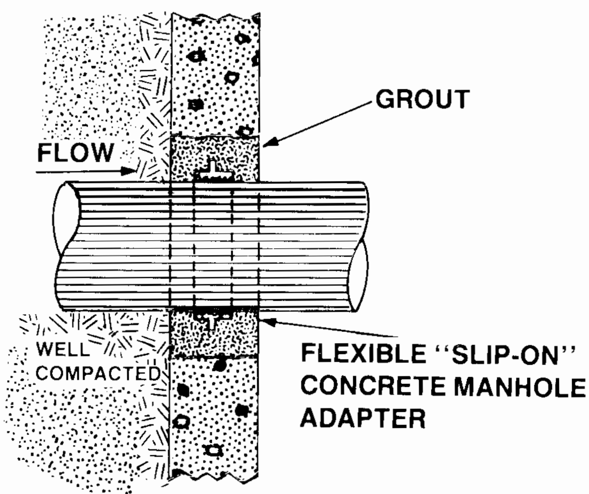
23 a)



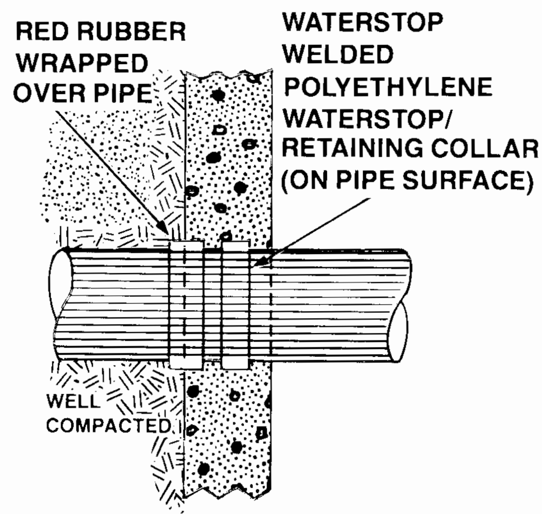
23 b)



23 c)



23 d)



Thermal Effects

SCLAIRPIPE high density poyethylene pipe has a relatively high coefficient of linear expansion when compared to steel pipe. Taken by itself, this factor might cause concern about longitudinal stresses in the piping system. However, there are other factors offsetting the expansion factor. One factor is that SCLAIRPIPE has a relatively low modulus of elasticity. Another factor is that stress relaxation occurs in most typical installations, rapidly at first, and then more gradually.

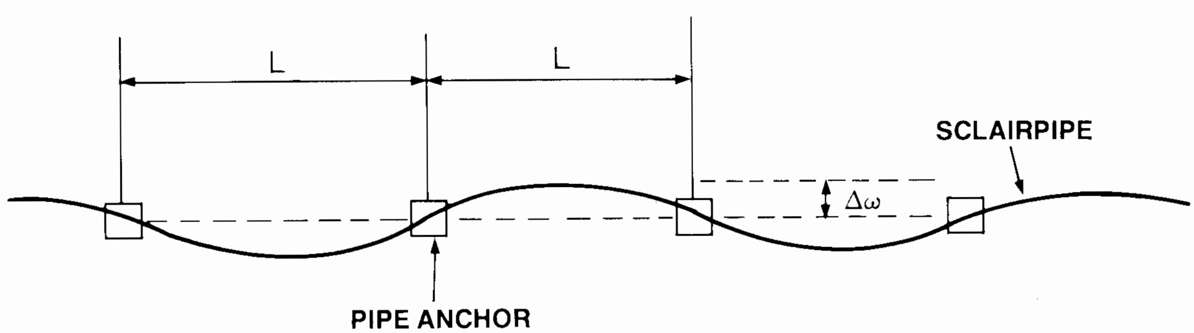
As a result, although thermal expansion should be a consideration in the design and construction of a SCLAIRPIPE piping system, generally, no special procedures are required. Day-to-day variations in ambient air temperatures will cause unrestrained SCLAIRPIPE to contract or expand. During installation, when the pipe is empty, this effect is more pronounced and must be taken into account when joining pre-determined lengths of pipe. During normal operation, movement of the pipe is generally much lower because of the relatively constant temperature of the fluid in the pipeline.

The coefficient of thermal expansion for SCLAIRPIPE high density polyethylene pipe is approximately 0.1 in./100 ft. per degree F. Accordingly, 100 ft. of unrestrained SCLAIRPIPE can shrink or expand longitudinally about 1.0 in. for every 10°F change in temperature. Because SCLAIRPIPE exhibits a lower modulus of elasticity (apparent modulus) as compared to rigid or conventional pipe, the stresses induced in the pipe when restrained, and the force transferred to the restraining device are relatively low. As a result, the pipeline is normally allowed to move laterally as temperatures change. The pipe is restrained only in areas where pipe movement is likely to cause damage to pipe itself, to attached or surrounding structures, or make access to the right of way difficult.

Lateral Movement

The pipe, when laid on a prepared bed, may be allowed to move laterally. Normally the pipe should be anchored at intervals along its length allowing the pipe to deflect laterally between the anchors. (see Figure 24) This method is the simplest where adequate space on the bed is available to accomodate this deflection. On normal straight runs, the spacing of the anchors depends on the allowable lateral displacement and the degree of curvature of the pipeline. The lateral displacement depends on the expected temperature change. If the pipeline is installed in mid-summer, the displacement will be the largest; as the temperature drops, the displacement will decrease as the pipe contracts.

FIGURE 24 - **Lateral Deflection Due to Thermal Movement**



Where the pipe diameter is small in relation to the length between anchors, the amount of lateral deflection can be calculated as follows:

$$\Delta w = B \times L \sqrt{\Delta T}$$

Where -

Δw = lateral deflection of the pipe (ft.)
L = length of pipe between anchors (ft.)
ΔT = temperature variation (°F)
B = coefficient for consistency in units
[B = 0.0067 (for ft. and °F)]

TABLE 11

LATERAL DEFLECTION OF ANCHORED PIPE

Temperature Change (°F)	Anchor Spacing 25	50	75 (Feet)
20	0.75	1.50	2.20
40	1.10	2.10	3.20
60	1.30	2.60	3.90
80	1.50	3.00	4.50

NOTE: These deflections are theoretical maximums; actual deflections will generally be less due to the pipe's stiffness and the friction between the pipe and the ground.

This relationship can be used to calculate both expansion and contraction. If the pipe is installed at the warmest time of year, it can be deflected during installation in such a way that when the temperature drops the deflection will decrease. The equation can also be used to calculate, for various anchor spacings, the amount of deflection that will occur as the pipeline expands at warmer temperatures.

It is not necessary to provide for a single bend between anchors. The deflection may be achieved by "snaking" the pipe so that the sum of the individual defections is equivalent to the Δw, above. However, care should be taken not to exceed the minimum bending radius. Anchors should be used on sharp bends to prevent all pipe movement from concentrating in this area. Similarly, anchors should be used to prevent the pipe from moving up against an existing structure or rock outcrop, or from moving itself off the pipe bed or trestle.

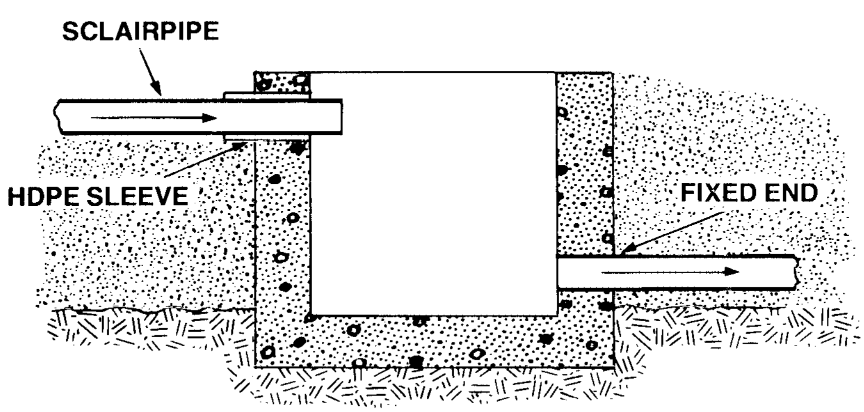
Longitudinal Movement

When lateral deflection is unacceptable, thermally induced movement may be accomodated by several types of sliding joints. Because of friction the actual amount of movement will be less than that calculated using the coefficient of thermal expansion and contraction. However, the coefficient calculation will provide expansion length that can be used for the design of the sliding joint.

When the length of the pipe is long in relation to the pipe diameter (in excess of 100 : 1), it may be necessary to restrain the pipeline laterally to ensure that the thermal movement is taken up by the sliding joint and not by snaking. This can be accomplished by installing guide posts or hoops at approximately 10 ft. intervals for pipe sizes up to 12 in. diameter, or at 20 ft. intervals for all larger sizes. Alternatively, the pipe can be placed in a wooden trough to reduce friction.

Gravity sliding joints can be fabricated on-site. For example, it may be feasible to accomodate thermal movement by allowing the pipe to slide in one side of a drop box or manhole as shown in figure 25.

FIGURE 25 - **Sliding Connection at a Manhole**



Restrained Pipelines

The forces developed in SCLAIRPIPE high density poyethylene pipe due to changes in temperatures are very low when compared to metal pipe. It is often feasible to restrain or partially restrain the pipe in locations where it will be subject to temperature changes. The method used to restrain the pipeline will vary according to the temperature change expected, the steepness of the pipeline grades and the soil upon which the pipeline is laid. Design of the pipe restraints and calculation of the allowable loads imposed on them should be left to the engineer designing the piping system. For additional information or technical assistance on piping system design, please contact your KWH Pipe representative.

Probably the most common and most cost-effective method of anchoring or restaining the pipeline is a strategically placed pile of soil, or a continuous berm. A berm also offers other advantages: it will reduce the temperature variations in the pipeline; minimizes the occurence of freeze-up even in cases where the frost penetration in the berm reaches the level of the pipeline; and also provides protection against damage.

The height and dimensions of the berm or embankment will vary with the purpose given to it and the nature of the material used to construct it. It is always recommended that the pipe be placed on a well compacted bottom layer. Also, the material supporting the pipe laterally should be compacted in a manner similar to that for a buried installation. (see Figure 26)

FIGURE 26 - **Typical Berm or Embankment**

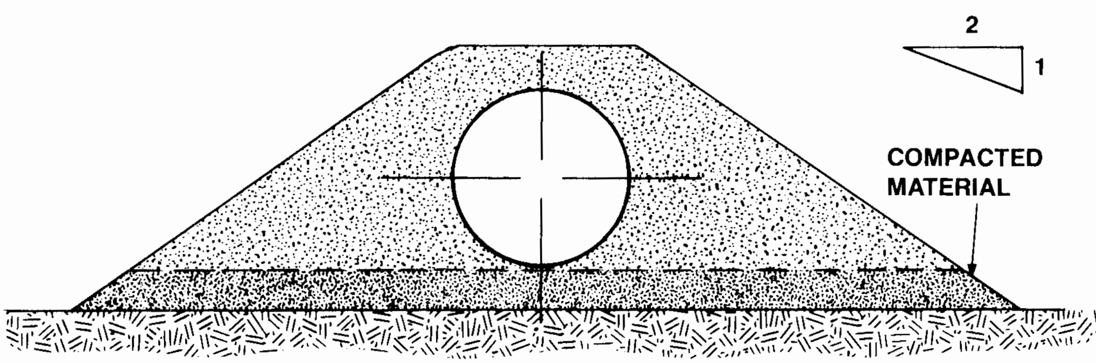
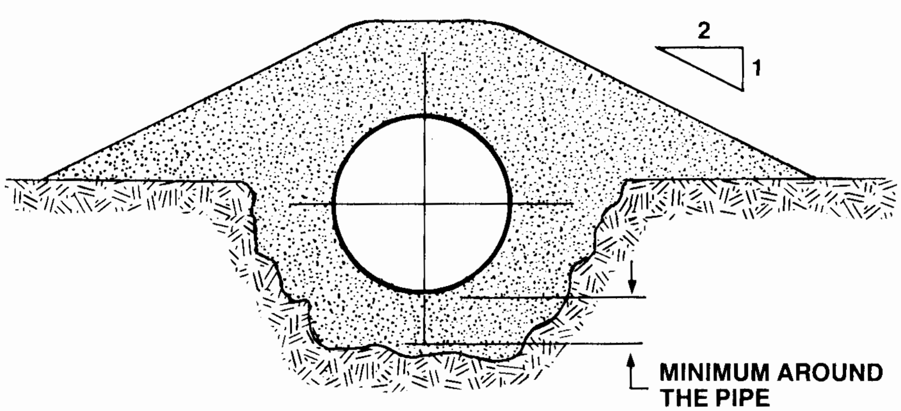
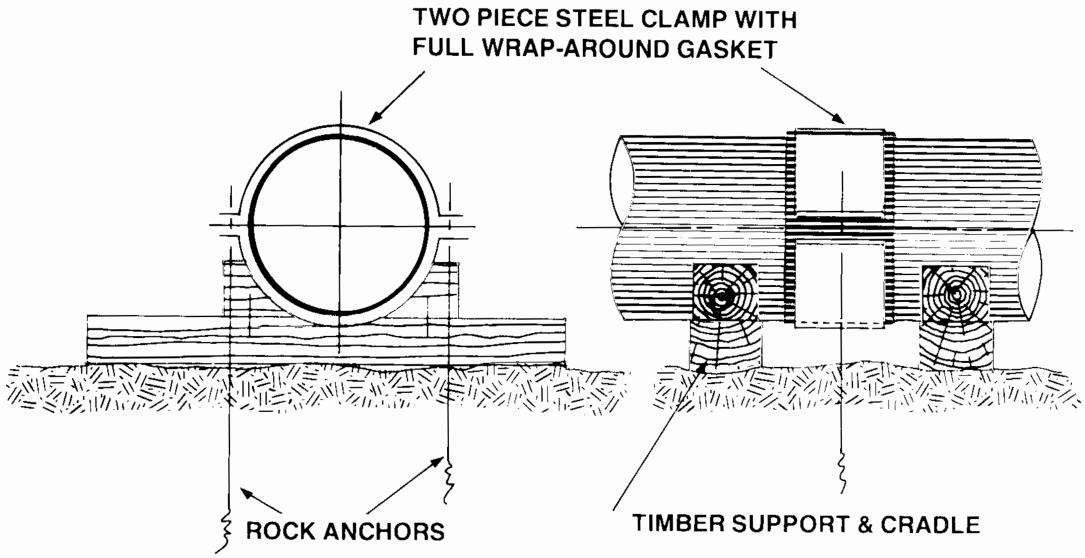


FIGURE 27 - **Typical Berm for Semi-Buried Installation**



In areas where soil cover is minimal, or for installations directly on rock surfaces, a cradle support with specially designed rock anchors can be used. (see figure 28)

FIGURE 28 - **Anchoring System for Rock Installation**



Cast in place or bolt-on concrete blocks are a simple, but somewhat expensive, alternative of restraining the pipe in areas of unstable soil (see figures 29 and 30). Where the bolt-on anchors or bands are used, their width should be at least as large as the outside diameter of the pipe and may, in some cases, require a rubber blanket between the anchor and the pipe.

FIGURE 29
Cast-in-Place Concrete Block

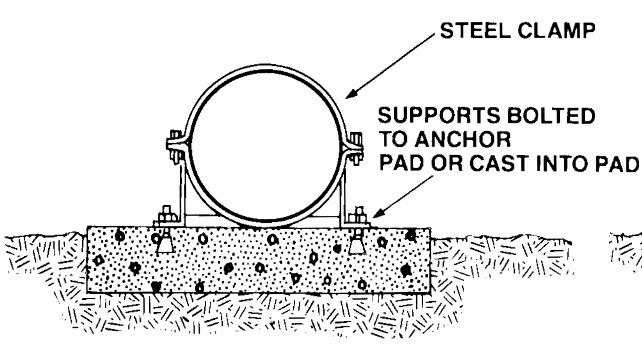
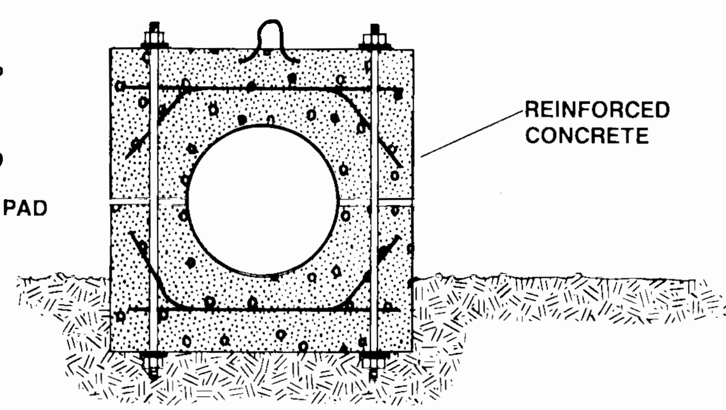


FIGURE 30
Bolt-on Concrete Block



A very effective and often used way of anchoring the pipe is the use of wooden sleepers and strapping (see figures 31 and 32). In effect the steel strapping acts as a relief mechanism because of their tendency to break loose if the lateral loads reach unusually high levels. This method is not designed to restrain longitudinal movement of the pipeline.

FIGURE 31
Bolt-on Wooden Blocks

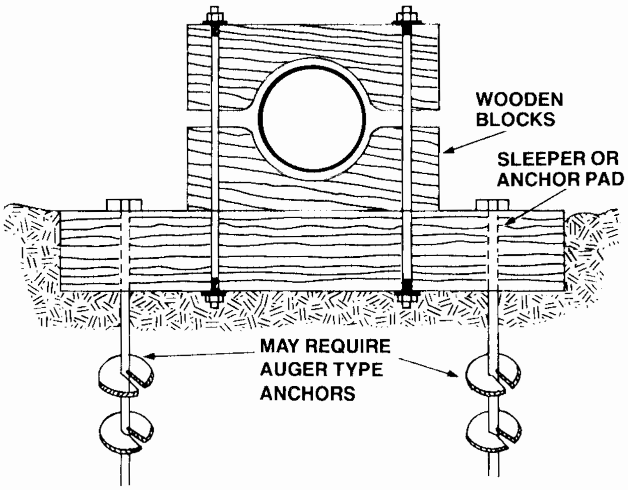
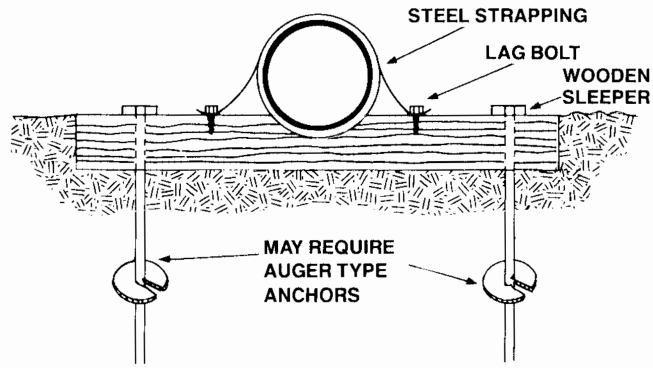


FIGURE 32
Wooden Sleeper and Strapping



Mechanical restraints can also be used for trestle or bridge crossing applications. Anchors can be placed at the ends of a pipeline or at intermediate points. Those placed on the pipeline ends should restrain both longitudinal and lateral movement. Normally those at intermediate points are designed primarily to restrain lateral movement. Poorly designed anchors may themselves become the source of future problems. Accordingly, they should be designed to eliminate “stress risers” and they must be firmly bedded to prevent them from sinking.

REPAIR METHODS

Introduction to SCLAIRPIPE Polyethylene Pipe Repair Methods

This chapter deal primarily with repairs to SCLAIRPIPE high-density polyethylene pipe which has been damaged after installation, the damage having been found by inspection or as a result of malfunction of the pipeline. It is assumed that any SCLAIRPIPE damaged in transit and/or during installation will be dealt with as detailed in the “Job Planning” section of this brochure.

Pipe-To-Pipe Joint Separation

Fusion Repair - Small Diameter Pipe (up to and including 4 in. Diameter)

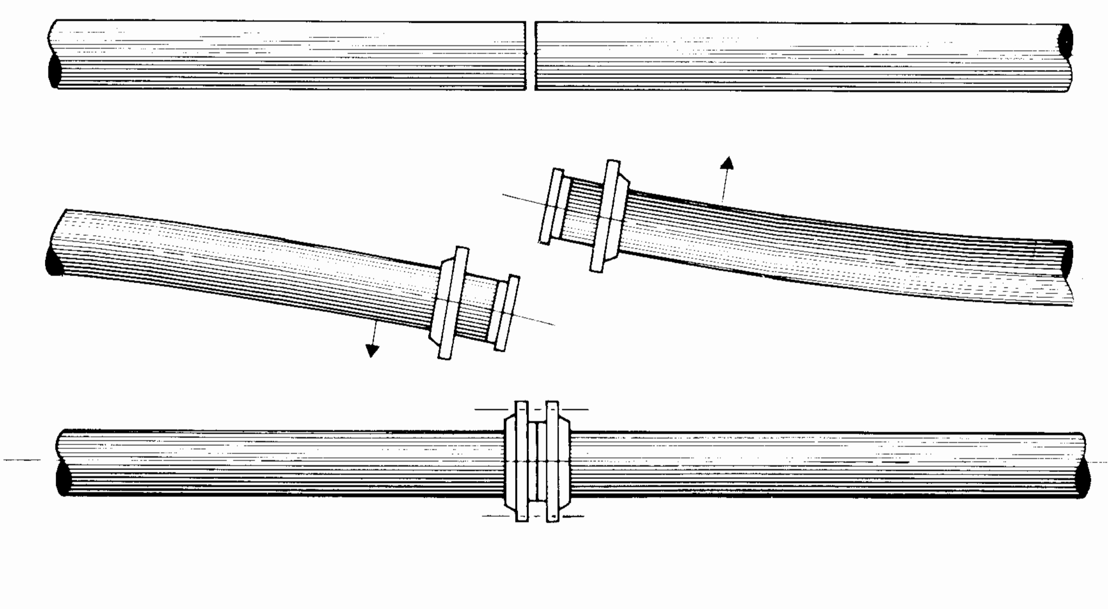
Small-diameter pipe is sufficiently flexible that the pipe ends can usually be moved to one side to facilitate a fusion repair; it is generally not necessary to remove a great deal of the adjacent backfill material beyond the location of the damage.

Normally, a flange assembly is fused to each of the pipe ends (by either socket fusion or butt fusion), a gasket is installed, and the flanges are bolted together. If the damage occurs within half a pipe length of a flanged fitting, the pipe can be excavated to the fitting, the flanged connection unbolted, and the pipe ends fused by means of a socket-fusion coupling. The flanged joint is then reconnected.

It is necessary to adjust the length of the pipe to compensate for the addition of the fittings. It is prefereable to allow some overlap so that the bolted connection is in compression. **Under no circumstances** should the bolts be used to pull up a flanged joint.

This type of repair is suitable for both above-ground lines and buried lines. (See Figure 33)

FIGURE 33 - **Repair to Damaged Pipe-to-Pipe Joint : Small Diameter Pipe**



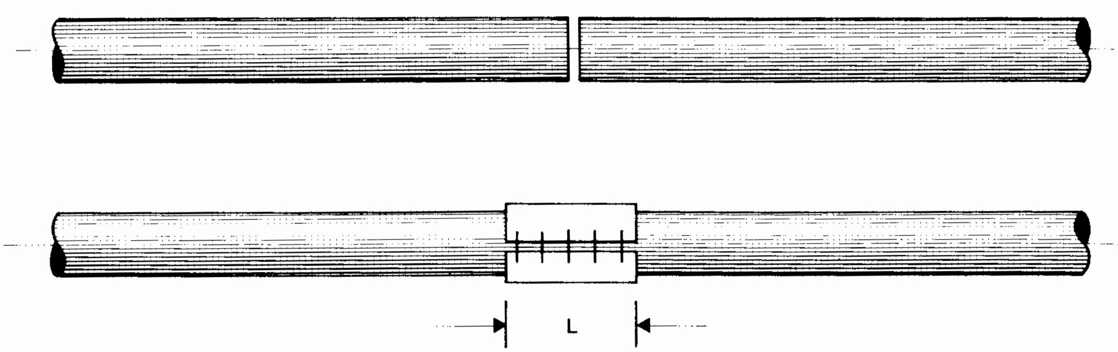
Mechanical Repair - Small Diameter Pipe (up to and including 4 in. diameter)

This type of damage can also be repaired by using a full wrap-around-type repair clamp, with integral gasket. **The minimum clamp length must equal twice the pipe nominal diameter.**

When this type of clamp is used, the pipe ends must be suitably prepared by removing the external weld bead, using a rasp. To ensure that the gasket seals against the pipe, the pipe must be wiped clean of any sand, grit and dirt before installing the clamp. The clamp must then be tightened evenly and securely, and bedding suitably compacted around and over both the clamp and the pipe before any pressure test is attempted. All wrap-around-type repair clamps should have full integral gaskets extending at least 1/4 in. beyond the ends of the clamp preventing the metal from cutting into the pipe.

This method of repair, for pressure service, is suitable for **buried lines only**. The high lateral forces, caused by internal pressure, must be restrained by the compacted backfill. (See Figure 34)

FIGURE 34 - **Repair Using Wrap-around Clamp - All Sizes**

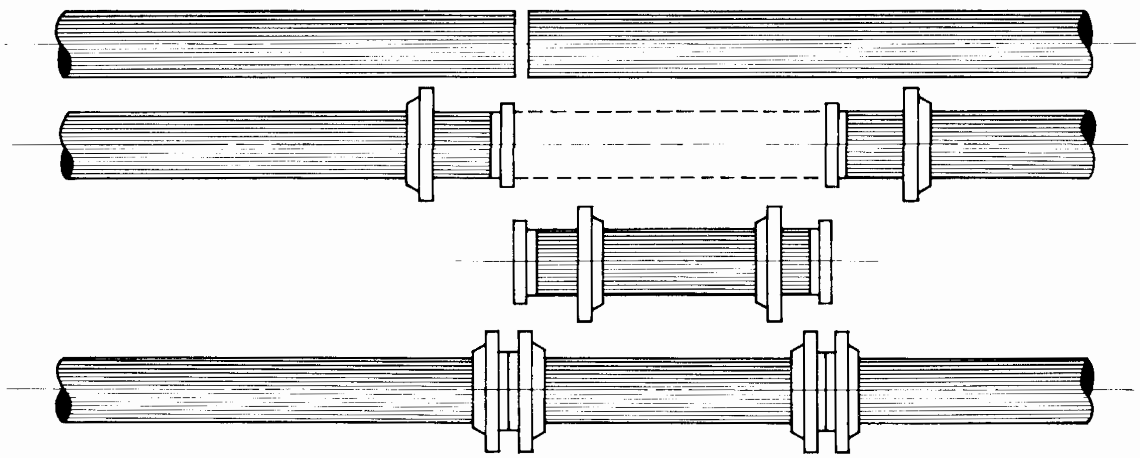


Fusion Repair - Large Diameter Pipe (above 4 in. diameter)

Because of the lower flexibility of large-diameter pipe, it is necessary to use a flanged spool piece to avoid uncovering a large amount of pipe on either side of the damaged section. The damaged pipe is cut out, and the fusion machine lowered into the trench to install a flange assembly (stub-end and metal slip-on flange) on each pipe end. A flanged spool piece is then made from spare pipe to precisely fit the resulting gap, and the flanged connections are bolted up.

This type of repair is suitable for both above ground and buried lines. (See Figure 35)

FIGURE 35 - **Repair Using Flanged Spool Piece - Large Diameter Pipe**



Mechanical Repair - Large Diameter Pipe (above 4 in. diameter)

If a repair by fusion is not practical, a full wrap-around-type repair clamp, with integral gasket,can be installed. **The minimum clamp length must equal twice the pipe nominal diameter.**

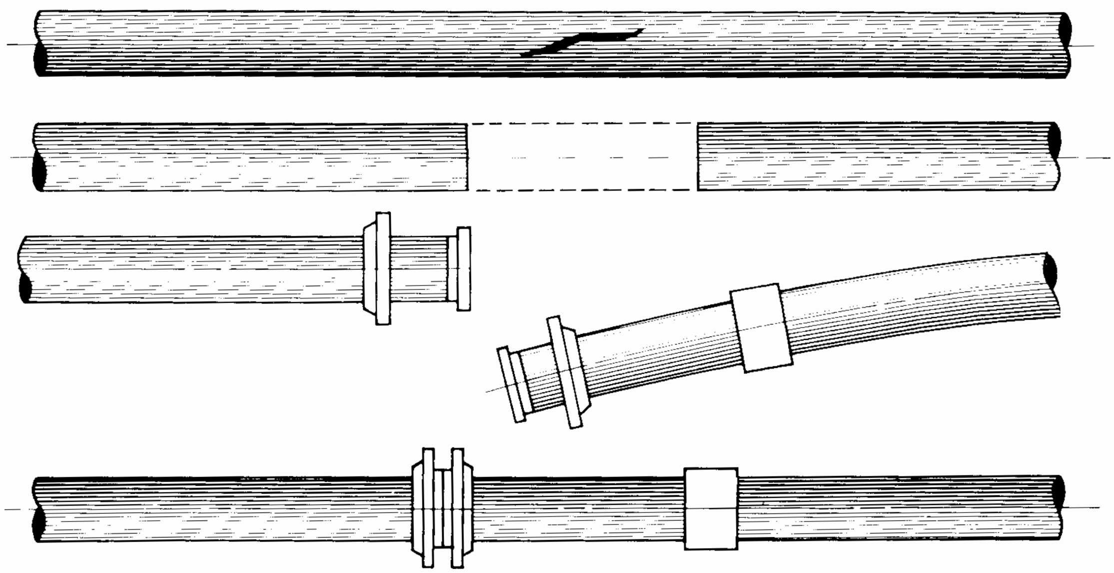
NOTE: The same precautions and preparations are required as were noted for "small-diameter pipe".

Pipe Puncture or Split

Fusion Repair - Small Diameter Pipe (up to and including 4 in. diameter)

This type of repair is best made by cutting out the damaged section, at least 6 in. beyond the ends of any visible split (or crack), and replacing it with a new section of pipe, using a combination of socket-fusion couplings and flange assemblies. The procedures to be followed are the same as those given in "Pipe to Pipe Joint Separation". (See Figure 36)

FIGURE 36 - **Fusion Repair of Damaged Small Diameter Pipe**



Mechanical Repair - Small Diameter Pipe (up to and including 4 in. diameter)

A wrap-around repair clamp can be used successfully to repair this type of damage, particularly a puncture. To prevent a split (or crack) from propagating, it is necessary to drill small holes through the pipe wall at either end of the split. The repair clamp should extend at least 6 in. beyond the location of these drilled holes.

Most splits (or cracks) are found to be slightly longer on the inside surface of the pipe wall than on the outside; the following procedure is therefore suggested for preventing crack propagation:

a) drill a small hole (3/16 in. diameter) through the pipe wall at each end of the visible crack. These holes will ensure intersection with the crack.
b) drill a second set of holes each approximately 2 in. beyond both ends of the crack, along the "line of the crack". These holes will prevent any further propagation of the inside crack. (see figure 37)

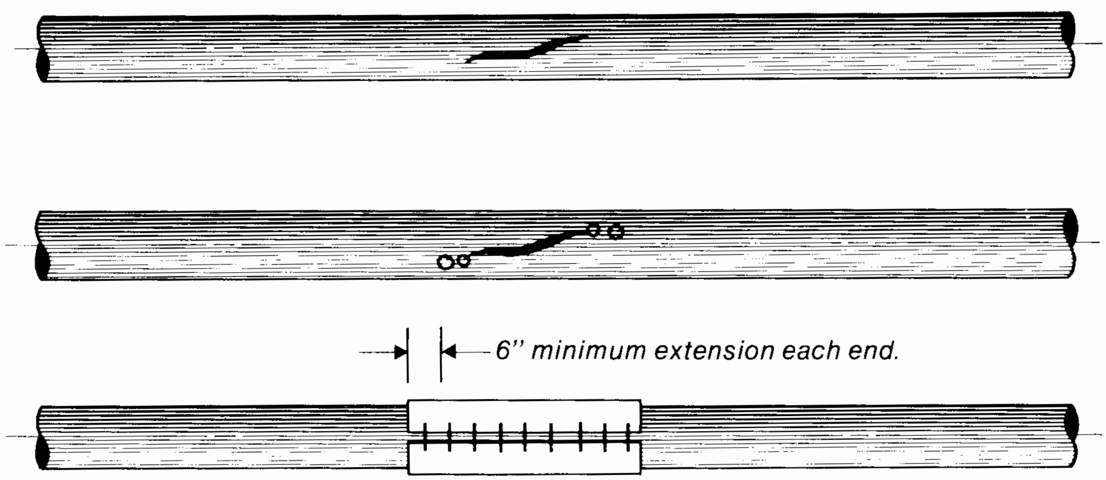
Precaution: It is not always practical to drill these holes, and it may not be possible to remove the section of damaged pipe. In such a case it is recommended that the following procedures be followed:

i) determine the characteristics and location of the split (or crack) by "feel".

ii) provide a repair clamp with a minimum of 6 in. extending beyond each end of the crack.

iii) arrange for a shipment of additional new pipe to the site, in preparation for a fusion/ mechanical repair and the subsequent removal of the damaged section.

FIGURE 37 - **Mechanical Repair to Pipe Containing a Split**



Fusion Repair - Large Diameter Pipe (above 4 in. diameter)

The best method of repair is the removal of the damaged section of pipe and the installation of a flanged spool piece, as detailed in "Pipe to Pipe Joint Separation - Fusion Method"

Mechanical Repair - Large Diameter Pipe (above 4 in. diameter)

The information contained in "Pipe to Pipe Joint Separation - Mechanical Repair" applies here in total, with the same precautions.

Damage to a Pipe/Flange Assembly

Fusion Repair - Small Diameter Pipe (up to and including 4 in. diameter)

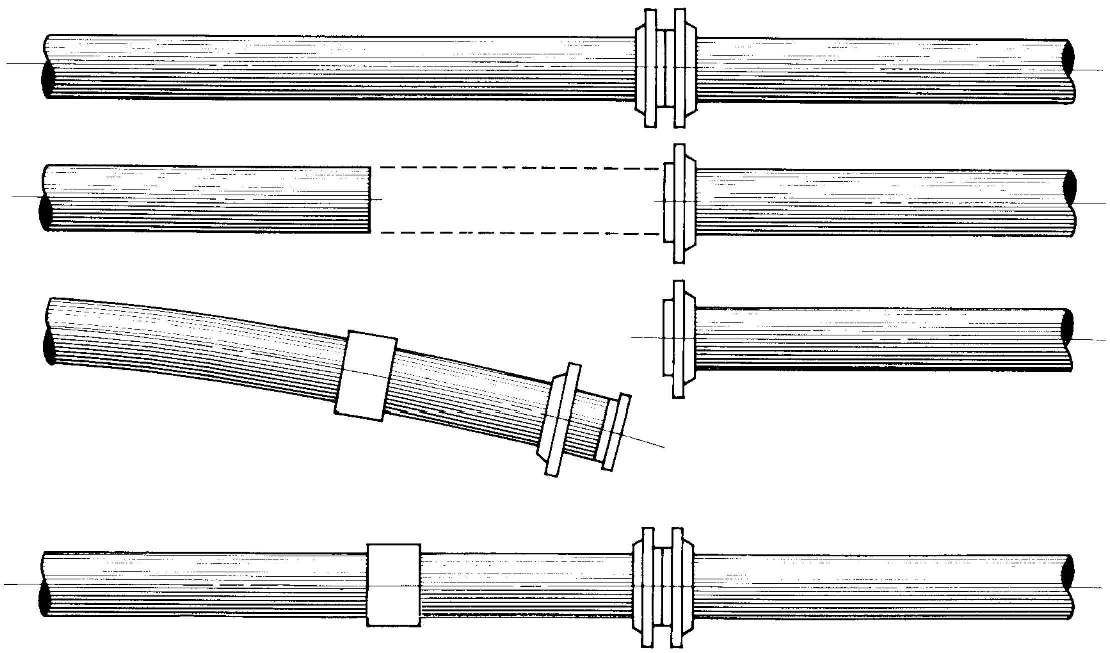
This type of damage is easily repaired by using a half spool piece, made up of a length of pipe fused to a flange assembly. The damaged flange assembly and approximately 3 ft. of pipe are cut out and removed. The new half spool piece, with a metal slip-on flange installed is cut to length and joined by fusion (either socket fusion or thermal fusion) to the existing line, and the bolted connection is then made. (See Figure 38). The use of hand heater tools for socket fusion facilitates this type of repair in the field.

Mechanical Repair - Small Diameter Pipe (up to and including 4 in. diameter)

Where fusion is not practical, a half spool piece can be inserted as outlined earlier, the spool piece is connected to the line by using a wrap-around repair clamp, instead of a fused joint. This is suitable for buried lines only, and requires the use of a prefabricated half spool piece (in either polyethylene or metal). (See figure 40)

NOTE: The pipe should be compacted and partially buried before pressurizing.

FIGURE 38 - **Repair of Small Diameter Pipe/Flange Assembly**



Fusion Repair - Large Diameter Pipe (above 4 in. diameter)

The lower flexibility of large-diameter pipe complicates this type of repair. Depending upon the size and series of pipe involved, the following techniques have been used successfully in the field:

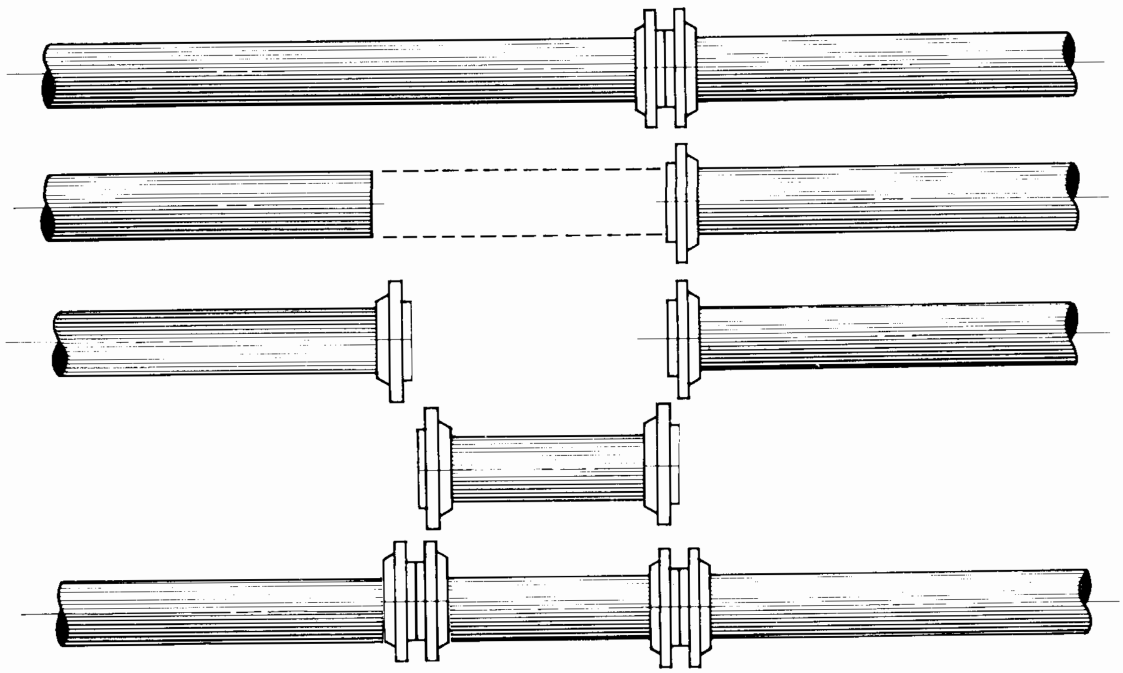
a) Replace the Stub End and Add a Spacer-

This technique can be used only where it is possible to remove a metal fitting to allow space for the butt-fusion machine in the trench. A new stub end is butt-fused to the pipe, and a spacer plate (in metal or polyethylene) used to fill in the gap resulting from cutting back the pipe end.

b) Add a Full Spool Piece-

The flange assembly and a section of the pipe are removed from the line, and a new stub end is thermally fused on the pipe end. A complete spool piece is then made to fit between the new flange assembly and the mating flange. (see figure 39)

FIGURE 39 - **Fusion Repair Using full Spool Piece - Flanged**

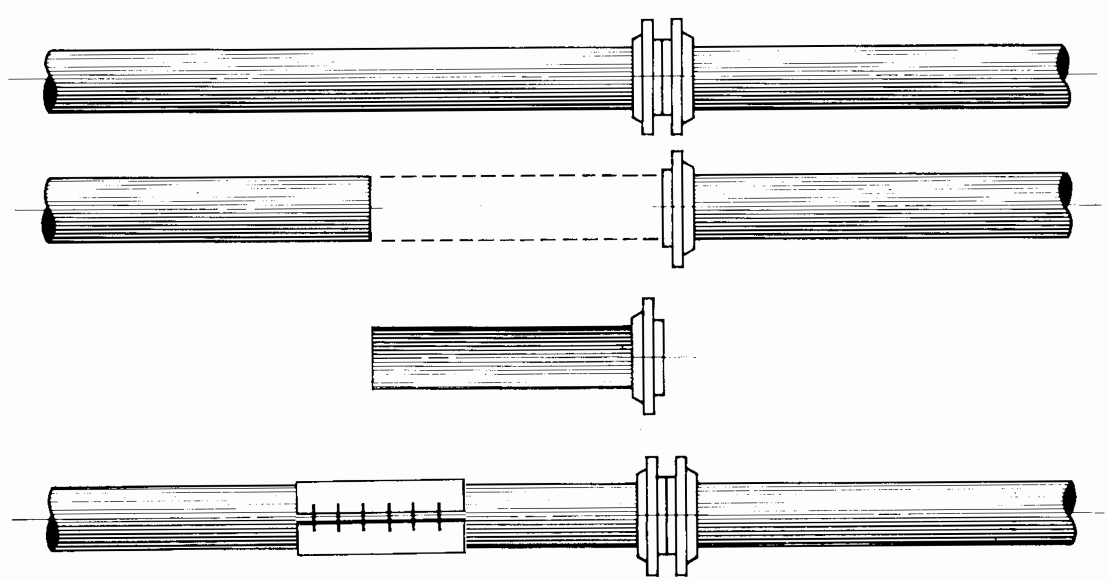


Mechanical Repair - Large Diameter Pipe (above 4 in. diameter)

a) Add a Half Spool Piece and Repair Clamp-

The damaged flange assembly and a section of pipe are removed, and a similar pre-fabricated thermally fused half spool piece is installed in its place. This half spool piece is connected to the existing pipeline by means of a repair clamp **minimum length must equal 2 times nominal pipe diameter**. (See figure 40) The pipe should be compacted and partially buried before pressurizing.

FIGURE 40 - **Mechanical Repair of Damaged Flange Assembly**



Fabricating, Cutting and Sawing SCLAIRPIPE

Small diameter SCLAIRPIPE (up to 4 in.) can be cut using a tube cutter. Larger sizes can be cut with a carpenter saw or a chain saw. If the pipe is later to be fusion joined or connected together using a VICTAULIC coupling, the ends should then be squared using the trimmer blade in the fusion machine. The practice of cutting holes in pipes requires care and use of the proper equipment. For holes up to 6 in. in diameter, a hole saw is the best choice. Cutting speeds should be slow, so that the friction developed during the cutting process does not soften the plastic and gum up the cutting teeth. For holes larger than 6 in. special tools are needed. These holes should not be cut using a sabre saw. Please contact your KWH Pipe representative for further information.

Fusion style saddle fittings

These fittings should be attached to the pipe using a McElroy fusion unit designed especially for this job. (Further information is available from your KWH Pipe Representative.)

Fabricating using hot gas or extruder gun techniques

These two techniques are accepted methods for manufacturing fittings and items such as manholes that will be used in **non-pressure** applications **only**. The best environment to do this work is the shop, where conditions, skills and proper jigs are available. Neither of these techniques can be used to repair damage done to a pressure pipe.

SAFETY

The Importance of Safety on the Jobsite

The subject of safe field working conditions is important to KWH Pipe personnel. Our field joining technicians are trained to use only safe working practices and the best safety equipment. Any activity that might endanger the health or safety of others will be avoided. While no summary of safe working practices can cover all aspects of safety included here are a number of important rules:

1. Define the potential hazards of the operation, materials, equipment and environment and plan the work to minimize such hazards. Many hazards may not be easily identified or readily apparent.

2. Wear the necessary safety equipment such as hard hats, safety shoes and gloves while working on the job site.

3. Avoid working alone or arrange for routine periodic safety contacts.

4. Around the fusion machine watch out for pinch points, sharp edges such as the trimmer blades and rotating machinery such as gears and shafts. Do not remove guards on the equipment. Remove any loose clothing or dangling straps that might get caught.

5. When handling the heater plate be aware that it is operating at a temperature greater than 400 degrees F. This plate is heated electrically and is supplied current at 110/220 volts. All work practices regarding the safe use of electrical tools should be observed.

6. The work site should be checked for hazards created by unguarded machinery, chemicals and fuels, heat, excessive noise, nearby traffic, overhead equipment, power lines, buried pipes and/or power cables. Steps should be taken to remove or minimize the hazards that might compromise safe working conditions.

7. Before work begins establish with the work crew mutually agreed upon safety procedures for working around the fusion machine. This includes establishing the proper hand signals to be used when hauling, lifting and/or moving pipe or machinery.

8. Before entering a confined area of trench make sure that the proper shoring and timbering is in place meeting industry standards, and that proper entry procedures are followed.

9. Establish the location of fire fighting equipment and when using a portable heater in a joining shelter and have an adequate size Class ABC fire extinguisher on hand. Keep flammable liquids such as gasoline in EXPLOSAFE containers and away from hot surfaces such as heater plates.

10. Get immediate first aid or medical attention if injured.

11. Be prepared in case an accident or injury should occur. Familiarize yourself with the procedures set up to deal with this emergency. (i.e. the nearest phone, phone numbers for police, fire departments, etc.)

Personal Protection Considerations

1. Wear safety glasses in operating areas and additional eye protection such as chemical goggles and face shields when greater danger of eye injury exists.

2. Remove rings, watches, tuck in or remove ties, secure cuffs and loose clothing when near moving machinery.

3. Wear safety footwear, gloves, hearing protection, and head protection as appropriate.

4. Use a lock, tag, or equivalent procedure to prevent accidental starting of machinery when making changes, adjustment or repairs on powered equipment.

This section is not intended to be a comprehensive guide to Government regulations or to the practices and methods applicable to every situation. It is equally important and advisable for you to refer to the appropriate Government regulations applicable to your jurisdiction.

Product Warranty

KWH Pipe warrants that the product purchased will meet its specifications in force at the time of delivery. There are no warranties of merchantability or fitness for a particular purpose expressed or implied. When KWH Pipe provides fusion services our product warranty is extended to include workmanship performed by us to the following extent only. If during the initial pressure test a pipe fusion fails due to defective workmanship, we will re-do the fusion at our cost. Claims for labour costs and all other expenses incidental to this work such as the cost of excavation and other preparatory work are not recoverable. In addtion, we must disclaim any liability for other direct, indirect, consequential or economic losses arising in consequence of defective workmanship.

The accuracy or applicability of all information contained herein is intended as a guide and is not guaranteed. Hence, KWH Pipe assumes no obligation or liability for this information. All tables and statements may be considered as recommendations but not as warranty. Users of our products should make their own tests to determine the suitability of each such product for their particular purposes. KWH Pipe's liability for defective products is limited to the replacement, without charge, of any product found to be defective. Under no circumstances shall it be responsible for any damages beyond the price of the products, and in no event shall it be liable for consequential damages.

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