HOBAS®

Installation & Field Guide

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Handling, Unloading, Storage and Inspection

General
Care must be taken when unloading and handling HOBAS pipes. Severe impact with the ground, forklift tips, or other objects can cause damage to the pipe.

Safety
Use extreme caution while handling pipes to avoid dropping or rolling on an unsuspecting person.

Equipment and Materials

Forklift	Cherry Picker
Crane	Nylon Strap
Front End Loader	Chock

Note: Do not use chains or wire cables to handle or move HOBAS pipes

Handling

1. Severe impact with the ground or other objects can damage the pipe.

2. Never use chains or wire cables to handle HOBAS pipes. Use a fabric strap or carefully use a forklift.

3. Avoid letting the weight of the pipe rest on the coupling or bell end.

4. Avoid setting pipes on rocks or very uneven ground. A point load with a hard object can damage the pipe.

5. Be aware of the location of pipe ends while moving. An end or coupling can be easily damaged by an impact.

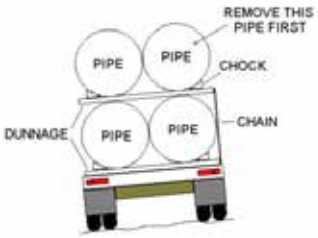
Unloading

1. After the shipping straps have been removed, use a cherry picker or crane with a nylon strap or a fork lift to remove the top pipes one at a time.

2. Take care that fork tips do not strike other pipes.

3. Pipe sections can be lifted with one support point (using a strap), although two support points may increase control.

4. A leaning or off-center load is extremely dangerous. When unloading, tie the ends of the pipe dunnage to the trailer to prevent them from flipping over. Remove the uphill pipe first. Be careful that the second pipe does not roll.



5. It is up to the installer to determine the best and safest method to unload special pieces (fittings, manholes, etc.). Use special caution to avoid damaging joint ends. Avoid picking up the special pieces by branches. Use the main pipe.

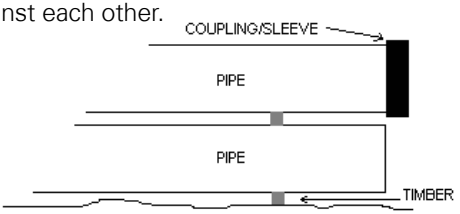
Storage

Short-Term

If possible, lay pipe on flat level ground. Avoid setting pipe on rocks or other objects that would cause a point load.

Long-Term

1. For long term storage, it is best to store HOBAS pipe in the same arrangement as it arrived on the truck. To avoid damage or deformation to the bell ends, do not allow the couplings/sleeves to rest against each other.



2. Always use timbers and chocks between layers when stacking pipe.

3. It is advisable to re-inspect pipe after long term storage to assure no damage has occurred during storage or handling. If storing pipe for a prolonged period of time (over six months) contact HOBAS for further considerations.

4. Use the following chart to determine recommended stacking height of your pipe.

DIAMETER	# OF PIPES IN STACK
18-20	4
24-30	3
36-60	2
>60	1

Along Ditchline

1. String the pipe as near as possible to the ditch to avoid excess handling.

2. String the pipe on the opposite side of the ditch from the excavated material.

3. Place pipe so that it will be protected from traffic and equipment during the construction process.

Pipes with Grout Fittings

1. Extra care should be taken in handling/unloading and storage with pipes where grout fittings are installed. HOBAS grout fittings are not typically flush to the pipe OD and protrude a small amount externally. Care should be taken that this raised area does not get contacted during handling/storage or installation.

2. Extreme care should be taken when rolling pipes with installed grout fitting over flat ground to avoid point loading the grout fitting location as it rolls under. Utilization of timber runners and shipping dunnage can assist in this.

3. Grout fittings should never be used to lift pipes. Threads can easily be damaged and they are not designed to carry pipe weight. Significant damage and injury can occur if the pipe is lifted from the grout fitting.

Inspection Procedures

1. Make an overall inspection of the loaded truck. If the load is intact, ordinary inspection while unloading should be sufficient to see if the pipe has arrived undamaged.

2. If the load has shifted during transit, each pipe needs to be carefully inspected for damage. Internal inspection is necessary for any pipes that have exterior scrapes, gouges, or impact marks.

3. Check total quantities against the bill of lading.

4. Any damaged or missing items should be noted on the bill of lading. Have the carrier's representative sign your copy of the receipt. Make a prompt claim according to the carrier's instructions.

5. Do not dispose of any damaged material. The carrier will notify you of the procedure to follow.

6. Check the factory markings on the pipe to assure that you have the correct pipe. The pipes are marked as follows:

DIA XX PN XXX SN XX
CODE XXXXXXXXX

WHERE: DIA = nominal diameter (in)
PN = pressure rating (psi)
(PN is left off gravity pipes)
SN = stiffness class (psi)
CODE = production code

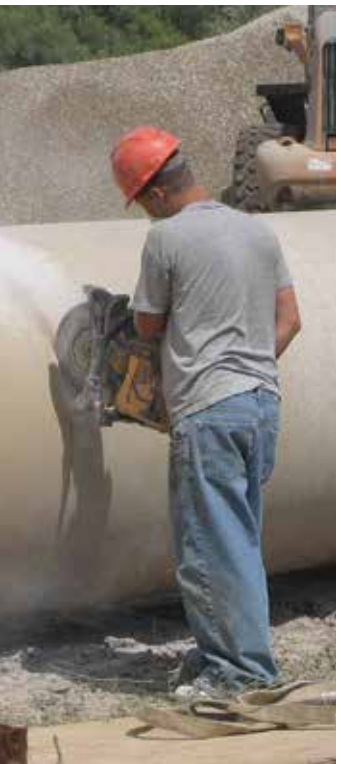
7. If damage is found on a pipe, contact a HOBAS Field Technician to discuss the possibility of a repair.

Cutting HOBAS Pipes

General
HOBAS centrifugally cast fiberglass pipes have a smooth and uniform exterior surface. This allows the pipe to be cut anywhere along its length and joined using the FWC or closure coupling. Chamfering of the pipe ends is the only preparation needed.

Safety
Cutting of HOBAS fiberglass pipes creates dust. The dust is not known to be harmful, but it can irritate unprotected body parts. It is advisable to wear a dust mask, eye protection, and gloves when cutting.

Equipment
HOBAS pipes can be cut using a gasoline, air or electric powered disc cutter. A masonry (aluminum oxide typical), diamond-tipped or other suitable abrasive cut-off saw blade can be used.



Cutting Instructions

1. Mark the pipe circumferentially. Measure from a square end making sure that the cutting mark is at a right angle to the main pipe axis.

2. Provide support to either side of the cut and the pipe as a whole, so that no part will drop during cutting. If the pipe has to be rolled during the cutting process, ensure that at least one-quarter of the circumference is intact; otherwise damage may occur when moving pipes.

3. If cutting in situ, it may be necessary to cut a hatchbox out of the top of the pipe and complete the cut from the inside, if full circumferential access is not possible.

4. Carefully cut along the marked line. Before completing the cut, check again that the cut piece will not drop as the cut is completed. If the pipe does drop, delamination of the pipe wall may occur. In that case, a re-cut or repair may be necessary.

5. Check the following:
   a. The cut ends of the pipe are in good condition.
   b. There is no damage to the pipe.
   c. There is no delamination of the pipe wall.

6. Add the homing mark to the freshly cut pipe ends. (optional)

7. Mark all cut pieces of pipe with the pipe stiffness and pressure rating.

8. If a standard FWC coupling is to be used, then a slight chamfer (see chart below) should be make to the outside edge of the pipe. This is best done with an abrasive disc grinder.

Diameter Range	Depth (in.) Min. – Max.	Length (in.) Min. – Max.
18″ – 27″	0.125 – 0.200	0.350 – 0.550
28″ – 36″	0.150 – 0.250	0.400 – 0.700
41″ – 57″	0.200 – 0.300	0.600 – 0.750
60″ – 96″	0.325 – 0.425	0.900 – 1.200
104″ – 126″	0.400 – 0.475	1.000 – 1.300

NOTE: This general cutting procedure is also appropriate for non-square cuts such as for miters, fittings, repairs, etc. Mark the pipe for the cut required and follow steps 2-5.

Installation of HOBAS Pipes

A Direct Bury

A1 Trench Construction

A1.1 Trench width
The minimum trench width should provide sufficient working room at the sides of the pipe to permit accurate placement and adequate compaction of the pipe zone backfill material.

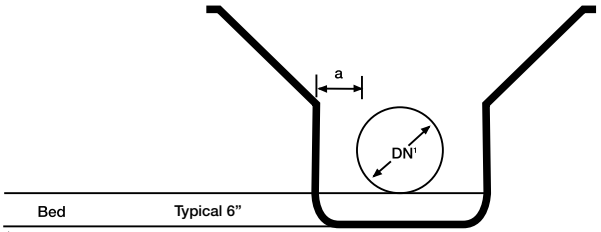
A1.1.1 Wide trenches
There is no maximum limit on trench width; however, it is required that the pipe zone backfill material be placed and compacted as specified for the full width of the trench or a distance of two diameters on each side of the pipe, whichever is less.

A1.2 Supported trench
When a permanent or temporary trench shoring is used, minimum trench width shall be per the figure on the next page. When using movable trench supports, care should be exercised not to disturb the pipe location, jointing or embedment. Removal of any trench protection below the top of the pipe and within two pipe diameters is not recommended after the pipe embedment has been compacted unless all voids created by sheeting removal are filled with properly densified embedment material and any loose soils at pipe zone elevation are properly compacted prior to loading the pipe with overburden. When possible, use movable trench supports on a shelf above the pipe with the pipe installed in a narrow, vertical wall subditch.

A1.3 Dewatering
Where conditions are such that running or standing water occurs in the trench bottom or the soil in the trench bottom displays a "quick" tendency, the water should be removed by pumps and suitable means such as well points or underdrain bedding. This system should be maintained in operation until the backfill has been placed to a sufficient height to prevent pipe flotation. Care should be taken that any underdrain is of proper gradation and thickness to prevent migration of material between the underdrain, pipe embedment and native soils in the trench, below and at the sides of the pipe.

Standard Minimum Trench Dimensions

DN (in.)	Typical Min. a (in.)	
	SPT[2] ≤ 8	SPT[2] > 8
18 to 20	6	4
24 to 33	9	6
36 to 48	12	8
51 to 72	18	12
78 to 126	24	16



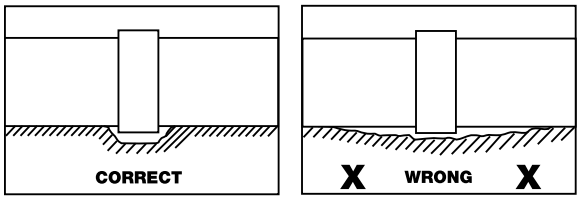
[1] DN is nominal diameter

[2] Standard Penetration Test Blows/ft.per ASTM D1586

A1.4 Preparation of Trench Bottom
The trench bottom should be constructed to provide a firm, stable and uniform support for the full length of the pipe. Bell holes should be provided at each joint to permit proper joint assembly and alignment. Any part of the trench bottom excavated below grade should be backfilled to grade and should be compacted as required to provide firm pipe support. When an unstable subgrade condition which will provide inadequate pipe support is

encountered, additional trench depth should be excavated and refilled with suitable foundation material. In severe conditions special foundations may be required such as wood pile or sheeting capped by a concrete mat, wood sheeting with keyed-in plank foundation, or foundation material processed with cement or chemical stabilizers. A cushion of acceptable bedding material should always be provided between any special foundation and the pipe. Large rocks and debris should be removed to provide four inches of soil cushion below the pipe and accessories.

Bell Holes

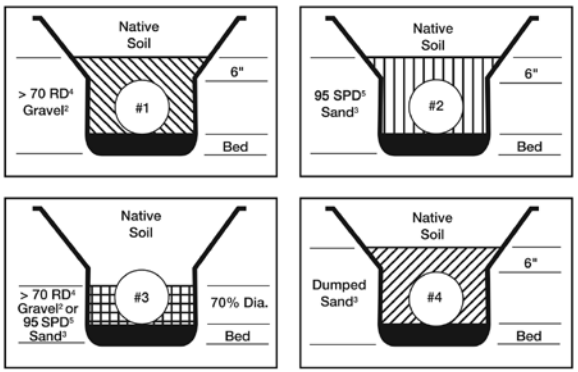


Note: After joint assembly, fill the bell holes with bedding material and compact as required.

A2 Standard Embedment Conditions

Four standard embedment conditions are given in the figure below. Others may be acceptable. Please consult us for advice on options.

Standard Embedment Conditions



A3 Pipe Zone (Embedment) Backfill Materials

Most coarse-grained soils as classified by ASTM D2487, Classification of Soils for Engineering Purposes, are acceptable bedding and pipe zone (embedment) backfill materials as given in the table below.

Specification	Definition	Symbols
Gravel	Gravel or crushed rock	GW, GP GW-GC, GW-GM GP-GC, GP-GM
Sand	Sand or sand-gravel mixtures	SW, SP SW-SC, SW-SM SP-SC, SP-SM

Maximum grain size should typically not exceed 1 to $1^1/_2$ times the pipe wall thickness or $1^1/_2$ inches, whichever is smaller.

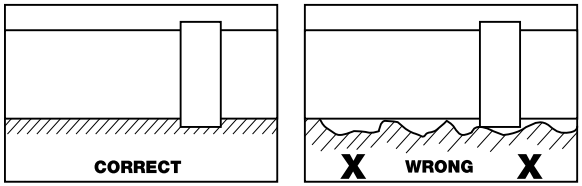
Well graded materials that will minimize voids in the embedment materials should be used in cases where migration of fines in the trench-wall material into the embedment can be anticipated. Alternatively, separate the open graded material from the non-cohesive soil with a filter fabric to prevent migration of the smaller-grained soil into the open-graded material. Such migration is undesirable since it would reduce the soil density near the pipe zone and thereby lessen the pipe support.

Embedment materials should contain no debris, foreign or frozen materials.

A4 Bedding

A firm, uniform bed should be prepared to fully support the pipe along its entire length. Bedding material should be as specified on the figure to the left. Bedding minimum depth should be equal to 25% of the nominal diameter or six inches, whichever is less.

Bedding



A firm trench bottom must be provided. Initially place and compact bedding to achieve $^{2}/_{3}$ of the total bed thickness (normally four inches). Loosely place the remaining bedding material to achieve a soft, uniform cushion in which to seat the pipe invert (bottom).

Before installing the pipe, the interior of the FWC should be clean and dry. The pipe exterior in the joining area should also be clean and dry. The lube will not adhere to wet surfaces.

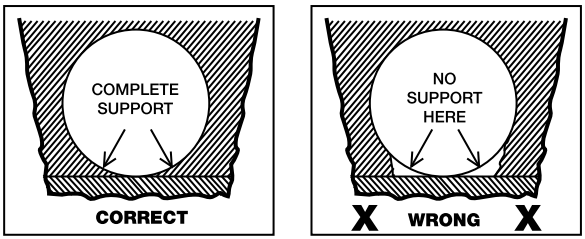
After joining pipes, assure that all bell holes are filled with the appropriate embedment materials and compacted as specified.

Note: Do not use blocking to adjust pipe grade.

A5 Haunching

A very important factor affecting pipe performance and deflection is the haunching material and its density. Material should be placed and consolidated under the pipe while avoiding both vertical and lateral displacement of the pipe from proper grade and alignment.

Haunching



A6 Backfilling

Pipe zone (embedment) material must be as specified in the Standard Embedment figure. (It must be the same as the bedding material to prevent potential migration.)

Place and compact the embedment material in lifts to achieve the depths and densities specified. Little or no tamping of the initial backfill directly over the top of the pipe should be done to avoid disturbing the embedded pipe.

Remaining backfill may be the native trench material, provided clumps and boulders larger than three to four inches in size are not used until 12 inches of pipe cover has been achieved.

A6.1 Maximum Cover Depth

Maximum recommended cover depth is given in the Maximum Cover Depth figure on the next page.

A6.2 Minimum Cover for Traffic Load Application

Minimum recommended cover depth of compacted fill above the pipe crown prior to application of vehicle loads is given in the above chart. Installation in poor soils or at shallower cover depths is possible by using a surface bridging slab or pipe encasement in concrete or similar.

Embedment Condition[1]	Minimum Cover (ft) for HS20 Load[2]		
	SN 18	SN 36 or 46	SN 72
1	4	3	2
2	5	4	3
3	–	5	4
4	–	–	5

[2] Installation in poor soils or at shallower cover depths is possible with improved pipe support such as cement stabilized sand or concrete encasement.

Maximum Cover Depth[1]

NATIVE SOIL [2, 5]	COVER DEPTH[1] (ft.)	EMBEDMENT CONDITION[3] 1	2	3	4
ROCK Stiff to V. Hard Cohesive (Qu ≥ 1 Tsf) Compact to V. Dense Granular (SPT N ≥ 8 bpf)	10 & <	SN[5] 36			SN[5] 72
	>10 to 20			SN 46	
	>20 to 30	SN 46		SN 72	
	>30 to 40	SN 72		ALTERNATE INSTALLATION[6]	
	>40 to 50				
	>50 to 60	SN 90			
	>60 to 70	SN 120			
Medium Cohesive (Qu ≥ 0.5 Tsf) Loose Granular (SPT N = 4 to 7 bpf)	10 & <	SN 36			SN 72
	>10 to 20			SN 46	
	>20 to 30	SN 46		SN 72	
	>30 to 40	SN 72		ALTERNATE INSTALLATION[6]	
Soft Cohesive (Qu ≥ 0.25 Tsf) V. Loose Granular (SPT N = 2 to 3 bpf)	10 & <	SN 36		SN 72	
	>10 to 20	SN 46			
	>20 to 30	SN 72		ALTERNATE INSTALLATION[6]	
V. Soft Cohesive (Qu ≥ 0.125 Tsf) V. V. Loose Granular (SPT N ~ 1 bpf)	10 & <	SN 72		ALTERNATE INSTALLATION[6]	
	>10 to 20				

[1] Assuming typ. 1.5 x OD Trench Width (or as in Figure 11)
[2] Soils adjacent to pipe (pipe zone elevation)
[3] Defined in Figure 13
[4] For zero blow (weight of hammer) soils, use Alternate Installation & SN 72
[5] SN is nominal stiffness in PSI
[6] Alternate Installation per section 14, A8-Typ. SN 72 min.

STIFFNESS CLASS KEY
SN 36
SN 46
SN 72
SN 90
SN 120
Alternate Installation

A7 Pipe Deflection

Pipe initial vertical cross-section deflection measured within the first 24 hours after completion of all backfilling and removal of dewatering systems, if used, shall not exceed 3% of the original pipe diameter.

Pipe deflection after 30 days should typically not exceed 4% of the original pipe diameter. Maximum long-term pipe deflection is 5% of the original pipe diameter. Maximum long-term deflection for pipes with vinyl ester resin liner is 4%.

For very high stiffness pipes (approx. SN 120 and above), the maximum long-term deflection may be reduced and the 24 hour and 30 day deflection limits also decreased proportionally.

A8 Alternate Installations

Alternate installations include cement-stabilized embedment, wide trenching, permanent sheeting, geo-fabrics or combinations of these systems. Installation design for these situations should be engineered to satisfy the specific conditions and circumstances that are present.

B Sliplining

B1 Existing Pipe Preparation

The existing sewer may be maintained in operation during the relining process. Obstructions such as roots, large joint offsets, rocks or other debris, etc. that would prevent passage or damage the liner pipe sections must be removed or repaired prior to installing the new pipe. Prior to starting the liner insertion, verify the existing pipe diameter is sufficient by pulling a mandrel through the line.

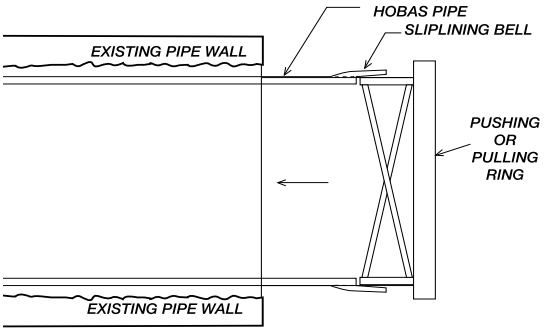
It must be determined that the rehabilitated pipeline will be structurally sufficient to carry the overburden loads for the intended design life.

Before installing pipe, the bell and spigot should be clean and dry before applying joint lube. The lube will not adhere to wet surfaces.

B2 Liner Pipe Insertion

Liner pipes may be pushed or pulled into the existing pipe. The pipes must be inserted spigot end first with the bell end trailing. Sometimes the leading pipe spigot end is protected by a nose piece designed to ride up and over offset joints and other minor inconsistencies or debris in the invert. The pushing force must be applied to the pipe wall end inside of the bell as shown in the figure below.

Pipe Insertion



Low-Profile Bell-Spigot Joint Allowable Compressive Load					
Nom. Dia. (in.)	O.D. (in.)		Safe Compressive Load Pushing "Straight" (U.S. Tons)		
	Pipe Wall	Bell	SN 36	SN 46	SN72
18	19.5	20.4	–	25 (SN 62)	27
20	21.6	22.5	–	29	36
24	25.8	26.8	39	44	54
27	28.0	29.0	48	54	66
28	30.0	31.0	56	63	77
30	32.0	33.0	51	58	74
33	34.0	35.0	60	67	85
36	38.3	39.3	82	92	115
41	42.9	44.0	108	122	149
42	44.5	45.6	119	134	162
44	45.9	47.0	128	143	175
45	47.7	48.8	141	159	192
48	50.8	51.9	164	183	220
51	53.9	55.0	188	211	254
54	57.1	58.2	215	239	288
57	60.0	61.2	242	268	322
60	62.9	64.1	271	297	358
63	66.0	67.2	302	333	396
66	69.2	70.4	305	342	412
69	72.5	73.8	339	378	458
72	75.4	76.7	373	417	501
78	81.6	82.9	448	496	595
84	87.0	88.4	520	575	686
85	88.6	90.0	544	601	717
90	94.3	95.7	625	690	820
96	99.5	101.0	702	776	924
104	108.0	109.5	844	930	1101
110	114.0	115.5	950	1050	1240
120	126.0	127.5	1190	1300	1535
126	132.5	134.3	1300	1420	1705

DO NOT apply the pushing load to the end of the bell. Assure that the safe (F of S ≈ 3) jacking loads given in the table are not exceeded. For pipes with flush bell-spigot joints, see the full HOBAS Brochure for typical allowable push loads. Allowable safe jacking loads may be reduced by point loading (i.e. pushing through curves).

B3 Laterals

Laterals may be typically reconnected to the new liner pipe using "Inserta Tees" or similar accessories.

B4 Grouting

Grout the annular space between the OD of the installed liner pipe and the ID of the existing pipe with a cement or chemical-based grout. Minimum compressive strength of the grout shall be as required to assure the structural adequacy of the rehabilitated pipe. During grout placement, assure that the safe (F of S ≈ 2) grouting pressure given in the table below is not exceeded and that the grout density, lift heights, and sewage flow depth are coordinated to control the liner pipe flotation and deformation to within allowable limits.

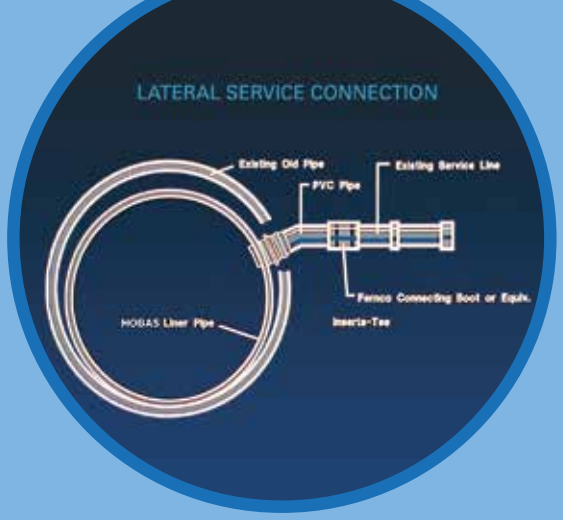
Max. Safe Grouting Pressure (psi)		
Diameter Difference	Fluid Flow Level None or low	Fluid Flow Level Over 1/2 to full
≤ 5%	SN÷4	SN÷3
≤ 10%	SN÷5	SN÷4
≤ 20%	SN÷6	SN÷5
> 20%	SN÷7	SN÷6

Notes:

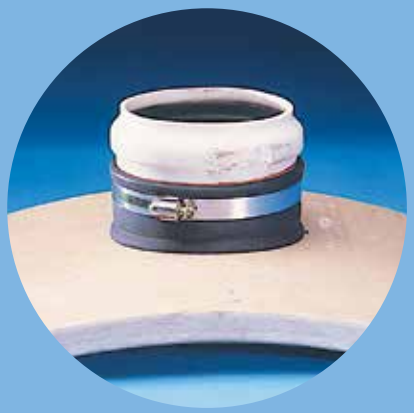
Diameter Difference =

$$\left(\frac{\text{ID Host Pipe - OD Liner Pipe}}{\text{OD Liner Pipe}}\right) \text{X } 100$$

SN is nominal pipe stiffness in psi



Lateral Service reconnection using an "Inserta Tee".



"Inserta Tee" installed in HOBAS Pipe.

Underside (inside) of "Inserta Tee" installation.

C Jacking

C1 General

A boring head begins the tunnel excavation from an access shaft and is pushed along by a hydraulic jacking unit that remains in the pit. The link to the boring head is maintained by adding jacking pipe between the pushing unit and the head. By this procedure, the pipe is installed as the tunnel is bored.

C2 Maximum Allowable Safe Jacking Load

The jacking contractor must control the jacking loads within the safe limits for the pipe. The adjacent table shows allowable safe jacking loads (pushing "straight") for the typical design. However, the ultimate pipe load capacity is the choice and responsibility of the purchaser and can be affected by a number of factors including the anticipated loads, the amount of steering, the amount of over-cut, the amount of lubrication, the pipe section length, the distance of the jacking operation, and any point loading. Pipes should be jacked bell-trailing.

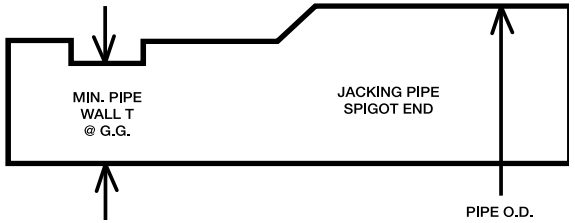
C3 Tunnel Diameter

Overcut the tunnel diameter and lubricate the annular space to minimize jacking loads. Take care to control the external pressure to within the safe buckling capacity of the pipe.

C4 Joint & Pipe Deflection

The typical allowable joint angular deflection is between one and two degrees, depending on the spacer thickness and joint configuration. Maximum long-term pipe deflection is typically 3% of the original pipe diameter. For pipes with stiffness exceeding 400 psi, a lower deflection limit normally applies.

Jacking Pipe Spigot End



Jacking Bell-Spigot Joint Allowable Compressive Load							
Nom Dia. (in.)	O.D. (in.)	Nom. Inside Dia. (in.)	Min. Pipe Wall Thickness (in.)	Min. Pipe Wall Thickness @ Gasket Groove (in.)	Allowable Safe Jacking Load Pushing "Straight" (U.S. Tons) F of S = 3.0	F of S = 2.5	Weight (lb/ft)
24	25.8	22.7	1.40	0.99	125	150	107
27	28.0	24.8	1.47	1.06	145	175	120
28	30.0	26.6	1.53	1.12	166	200	137
30	32.0	28.3	1.71	1.21	191	230	159
33	34.0	30.1	1.80	1.29	216	260	179
36	38.3	34.3	1.85	1.31	250	300	208
41	42.9	38.7	1.91	1.32	283	340	245
42	44.5	40.3	1.93	1.33	295	355	255
44	45.9	41.7	1.95	1.34	308	370	263
45	47.7	43.4	1.98	1.35	325	390	280
48	50.8	46.4	2.03	1.37	350	420	306
51	53.9	49.4	2.07	1.38	375	450	333
54	57.1	52.5	2.10	1.39	400	480	361
57	60.0	55.4	2.13	1.40	425	510	380
60	62.9	58.2	2.16	1.41	450	540	408
63	66.0	61.2	2.20	1.42	475	570	438
66	69.2	64.2	2.31	1.43	500	600	478
69	72.5	67.4	2.38	1.47	541	650	512
72	75.4	70.1	2.46	1.52	583	700	553
78	81.6	76.0	2.58	1.60	667	800	634
84	87.0	81.2	2.70	1.68	750	900	701
85	88.6	82.8	2.73	1.69	770	925	727
90*	94.3	88.2	2.85	1.76	854	1025	800
96*	99.5	93.1	3.00	1.87	958	1150	886
104*	108.0	101.3	3.13	1.94	1083	1300	1009
110*	114.0	106.9	3.29	2.05	1208	1450	1129
120*	126.0	118.4	3.58	2.25	1470	1765	1350
126*	132.5	124.5	3.76	2.37	1600	1920	1500

** Lead times may be lengthy, please inquire.*

Note: Alternate pipe designs are available upon request.

D Aboveground

D1 Support Configuration

Recommended pipe support configuration for ambient temperatures is shown. Pipe diameters and classes shown acceptable for support scheme A require only one support location per 20-ft. section. This is best accomplished by a single cradle support on each FWC coupling. These pipes may also be supported as shown in scheme B with cradles on the pipe wall immediately adjacent to both sides of each coupling, however the mid-point support is not required.

Pipe diameters and classes shown acceptable for support scheme B require supports on 10-ft. centers. This must include a double pipe wall cradle bridging each FWC coupling and a mid-span pipe wall cradle support.

Special pipe designs are available for elevated temperature applications or longer support spans. Protection from long-term exposure to ultraviolet rays is typically required to prevent surface degradation to joints and fittings.

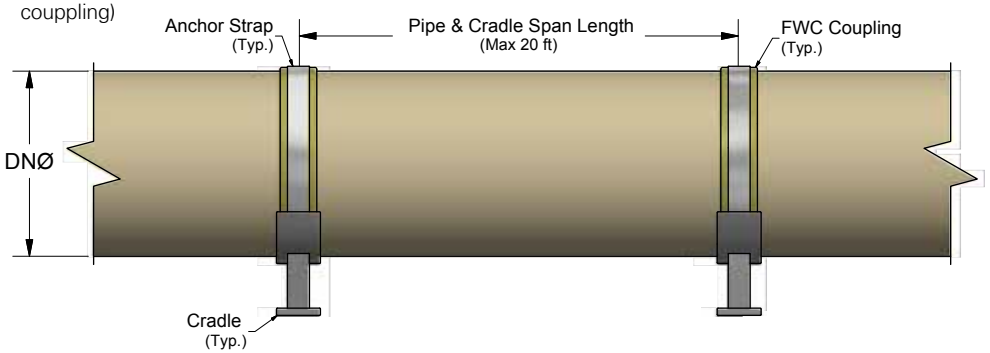
Pipe Support Configurations

Pipe Support Configurations*							
PN**	25 & 50			100	150	200	250
DIA. (In.)	SN+ 18	36/46	≥72	≥18	≥36	≥36	≥72
18 & 20	SCHEME A or SCHEME B						
24 to 28							
30 to 36							
41 to 45				SCHEME A FIGURE 20			
48 & 51							
54 & 57							
60 & 63						NON-STANDARD	
66 to 72							
78 to 126							

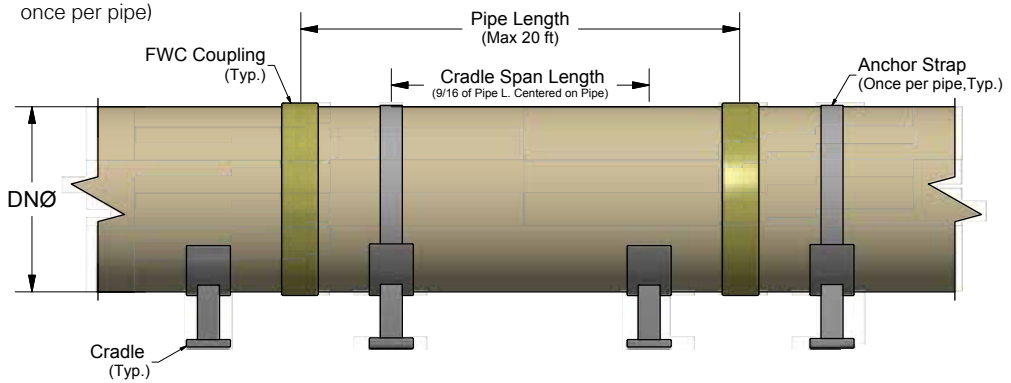
* *At ambient temperature* ***PN is pipe pressure class in psi*
+ *SN is pipe stiffness class in psi*

Pipe Support Spacing and Schemes

SCHEME A
(Pipe supported and anchored at every couppling)



SCHEME B
(Pipe supported on pipe wall and anchored once per pipe)



D2 Cradles

Cradles shall have a minimum 120° support arc and be dimensioned as shown on the figure below. All cradles should be faced with a 1/4" thick rubber padding (approx. 50 to 60 durometer).

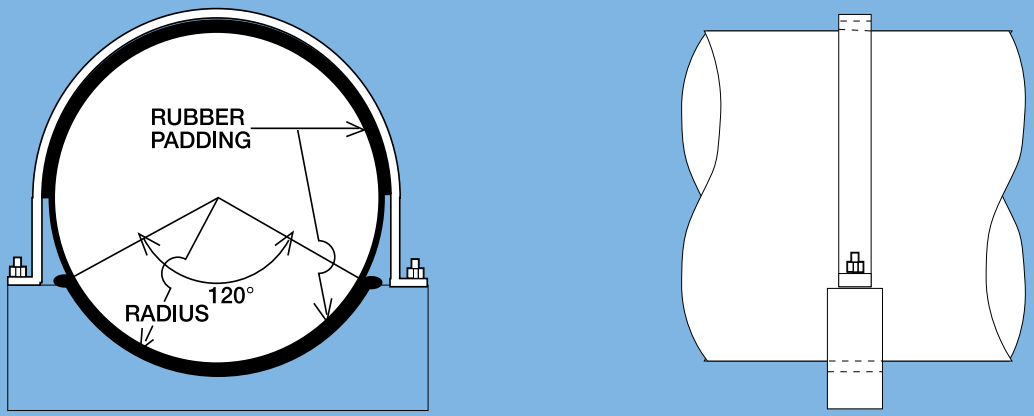
D3 Anchors

Both support schemes require one anchored cradle for each pipe section. The anchor strap over the pipe or coupling shall be padded with rubber to create maximum friction resistance to pipe movement. In support scheme A, all cradle positions (support on FWC coupling) must be anchored. In support scheme B, one pipe wall cradle (near the FWC coupling) per section should be anchored as shown. At the other cradle locations, the pipe may be restrained loosely to prevent lateral or vertical movement but should not be so fixed as to restrict axial sliding.

D4 Pipe Restraint

The pipe support and restraint system must be designed to withstand any unbalanced thrust forces at angularly deflected joints or at fittings that may be developed due to pipe pressurization. Other loads caused by wind, temperature changes, fluid momentum, etc. must also be considered.

Single Cradle with Anchor Detail



SUPPORT LOCATION	CRADLE RADIUS TO RUBBER FACE	MINIMUM CRADLE WIDTH
On Pipe Wall (Scheme B)	PIPE O.D. */2	18" to 24" dia. = 3" 27" to 44" dia. = 4" 45" to 78" dia. = 6" 84" to 126" dia. = 8"
On FWC Coupling (Scheme A)	FWC O.D. **/2	Width of FWC Coupling (8", 10" or 11 1/2")

E Tunnel Carrier

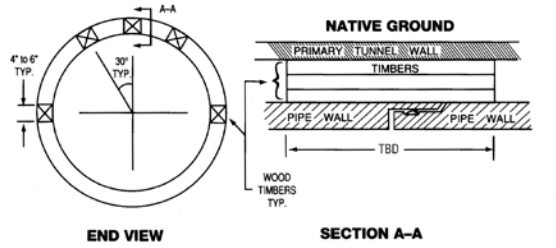
E1 Carrier Pipe Insertion

Carrier pipes can be placed in the tunnel one at a time or can be inserted in a continuous push. If the insertion method involves sliding, the HOBAS carrier pipes must be protected from excessive abrasion. Normally, insert the carrier pipes spigot end first with the pushing force, if used, applied to the pipe wall end inside of the bell as shown in the Sliplining Insertion figure. DO NOT apply the pushing load to the end of the bell. Assure that the allowable safe (F of S ≈ 3) pushing load given in the adjacent table is not exceeded.

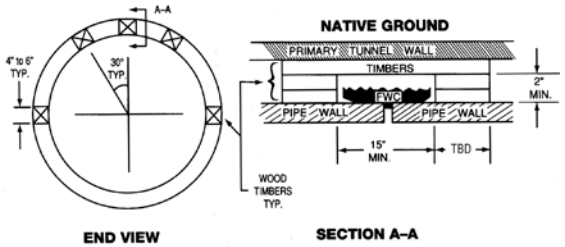
E2 Blocking Schemes

The carrier pipes must be blocked within the tunnel to fix line and grade and to aid in control of deformation of the carrier pipes during grouting. Two typical blocking schemes are shown below. The actual blocking scheme must be designed so the uplift contact pressure of the blocks on the pipe wall does not exceed allowable limits (maximum contact pressure approximately equal to the pipe stiffness).

Typical blocking scheme at each flush joint.



Typical blocking scheme at each FWC coupling joint.



Flush Relining Bell-Spigot Joint Allowable Compressive Load						
Nom. Dia. (in.)	O.D. (in.)	Min. Pipe Wall Thickness. (in.)	Nom. Pipe Stiffness (psi.)	Min. Pipe Thickness @ Gasket Groove(in.)	Safe Compressive Load Pushing "Straight" (U.S. Tons)	Wt. lb./ft.
20	21.6	0.75	245	0.34	34	48
24	25.8	0.76	160	0.35	42	62
27	28.0	0.76	130	0.35	46	68
28	30.0	0.76	105	0.35	49	73
30	32.0	0.86	130	0.36	54	87
33	34.0	0.87	110	0.37	59	94
36	38.3	0.90	90	0.40	73	110
41	42.9	0.96	83	0.44	91	131
42	44.5	0.99	82	0.46	99	140
44	45.9	1.02	82	0.47	105	148
45	47.7	1.05	80	0.49	114	158
48	50.8	1.09	74	0.51	127	175
51	53.9	1.13	69	0.53	141	192
54	57.1	1.17	65	0.55	155	210
57	60.0	1.21	62	0.58	173	225
60	62.9	1.27	62	0.61	191	251
63	66.0	1.33	62	0.64	211	276
66	69.2	1.45	71	0.66	228	315
69	72.5	1.47	64	0.67	243	335
72	75.4	1.49	59	0.68	257	352
78	81.6	1.53	51	0.71	292	393
84	87.0	1.57	45	0.75	330	430
85	88.6	1.58	43	0.76	342	440
90	94.3	1.66	42	0.82	394	491
96	99.5	1.75	42	0.88	448	547
104	108.0	1.85	39	0.94	521	628
110	114.0	1.94	38	0.99	580	695
120	126.0	2.10	36	1.09	710	829
126	132.5	2.2	36	1.16	780	915

E3 Grouting

Grout the annular space between the tunnel I.D. and the carrier pipe O.D. with a cement or chemical-based grout. Minimum compressive strength of the grout should be as required to assure the structural adequacy of the completed installation. During grout placement, assure that both the safe (F of S ≈ 2) grouting pressure of the carrier pipe (pipe stiffness ÷ 5) is not exceeded and that the grout density, lift heights, and blocking scheme are coordinated to control the carrier pipe deformation loads to within allowable limits.

Appendix

Pipe Dimensions & Weights

Class SN 36

(minimum pipe stiffness of 36 psi)

Nominal Pipe Size (in.)	Pipe O.D. (in.)	Class PN*/SN									
		25 /36		50/36		100/36		150/36		200/36	
		min. wall t (in.)	weight (lb/ft)	min. wall t (in.)	weight (lb/ft)	min. wall t (in.)	weight (lb/ft)	min. wall t (in.)	weight (lb/ft)	min. wall t (in.)	weight (lb/ft)
18	19.5	0.36	23	0.36	23	0.35	21	0.35	21	0.34	20
20	21.6	0.40	28	0.39	28	0.39	26	0.38	25	0.37	24
24	25.8	0.46	39	0.46	39	0.45	36	0.45	35	0.44	33
27	28.0	0.50	45	0.50	45	0.49	42	0.48	40	0.47	38
28	30.0	0.53	51	0.53	51	0.52	48	0.51	45	0.50	44
30	32.0	0.57	59	0.56	58	0.55	54	0.54	51	0.53	49
33	34.0	0.60	66	0.59	64	0.58	60	0.57	57	0.56	55
36	38.3	0.67	82	0.66	81	0.65	76	0.64	72	0.63	69
41	42.9	0.74	101	0.74	101	0.73	95	0.71	89	0.70	86
42	44.5	0.77	109	0.76	108	0.75	101	0.74	96	0.72	92
44	45.9	0.79	116	0.79	116	0.77	107	0.76	102	0.74	97
45	47.7	0.82	125	0.81	123	0.80	116	0.78	109	0.77	105
48	50.8	0.87	141	0.86	139	0.85	131	0.83	123	0.82	119
51	53.9	0.92	157	0.91	156	0.90	147	0.88	138	0.86	132
54	57.1	0.97	176	0.97	176	0.95	164	0.93	155	0.91	148
57	60.0	1.02	194	1.01	192	1.00	181	0.98	171		
60	62.9	1.07	213	1.06	211	1.04	197	1.02	186		
63	66.0	1.12	234	1.11	232	1.09	217	1.06	203		
66	69.2	1.17	256	1.16	254	1.14	237	1.12	225		
69	72.5	1.22	279	1.21	277	1.20	261	1.17	246		
72	75.4	1.27	302	1.26	300	1.24	281				
78	81.6	1.37	353	1.36	350	1.34	328				
84	87.0	1.46	400	1.45	398	1.43	373				
85	88.6	1.49	416	1.48	413	1.45	385				
90	94.3	1.58	469	1.57	466	1.54	435				
96	99.5	1.66	520	1.65	516	1.62	482				
104	108.0	1.80	611	1.79	608						
110	114.0	1.90	680	1.89	676						
120	126.0	2.10	829	2.08	821						
126	132.5	2.20	900	2.18	892						

** Maximum nominal working pressure class in psi.*

Class SN 46

(minimum pipe stiffness of 46 psi)

Nominal Pipe Size (in.)	Pipe O.D. (in.)	Class PN*/SN									
		25/46		50/46		100/46		150/46		200/46	
		min. wall t (in.)	weight (lb/ft)	min. wall t (in.)	weight (lb/ft)	min. wall t (in.)	weight (lb/ft)	min. wall t (in.)	weight (lb/ft)	min. wall t (in.)	weight (lb/ft)
18	19.5	0.39	25	0.39	25	0.38	23	0.37	22	0.37	21
20	21.6	0.43	30	0.42	29	0.42	28	0.41	27	0.40	25
24	25.8	0.50	42	0.50	42	0.49	39	0.48	37	0.47	35
27	28.0	0.54	49	0.53	48	0.53	46	0.52	43	0.51	41
28	30.0	0.57	55	0.57	55	0.56	51	0.55	49	0.54	47
30	32.0	0.61	63	0.60	62	0.60	59	0.58	55	0.57	53
33	34.0	0.64	70	0.64	70	0.63	65	0.62	62	0.60	59
36	38.3	0.72	88	0.72	88	0.70	81	0.69	77	0.68	75
41	42.9	0.80	109	0.80	109	0.78	101	0.77	96	0.75	92
42	44.5	0.83	117	0.82	116	0.81	109	0.79	103	0.78	99
44	45.9	0.85	124	0.85	124	0.84	117	0.82	110	0.80	105
45	47.7	0.89	135	0.88	133	0.87	125	0.85	118	0.83	113
48	50.8	0.94	151	0.93	150	0.92	141	0.90	133	0.88	127
51	53.9	1.00	171	0.99	169	0.97	158	0.95	149	0.93	142
54	57.1	1.05	190	1.04	188	1.03	177	1.01	167	0.98	159
57	60.0	1.10	209	1.09	207	1.08	195	1.05	183		
60	62.9	1.15	228	1.15	228	1.13	213	1.10	200		
63	66.0	1.21	252	1.20	250	1.18	234	1.15	220		
66	69.2	1.27	277	1.26	275	1.24	257	1.21	242		
69	72.5	1.32	301	1.31	299	1.29	280	1.26	264		
72	75.4	1.38	328	1.36	323	1.34	303				
78	81.6	1.48	380	1.47	377	1.45	354				
84	87.0	1.58	432	1.57	429	1.54	400				
85	88.6	1.61	448	1.60	445	1.57	416				
90	94.3	1.71	506	1.69	500	1.67	470				
96	99.5	1.80	562	1.79	559	1.76	522				
104	108.0	1.95	660	1.93	654						
110	114.0	2.06	710	2.04	703						
120	126.0	2.27	863	2.25	855						
126	132.5	2.38	975	2.36	967						

** Maximum nominal working pressure class in psi.*

Class SN 72

(minimum pipe stiffness of 72 psi)

Nominal Pipe Size (in.)	Pipe O.D. (in.)	Class PN*/SN									
		25 & 50/72		100/72		150/72		200/72		250/72	
		min. wall t (in.)	weight (lb/ft)	min. wall t (in.)	weight (lb/ft)	min. wall t (in.)	weight (lb/ft)	min. wall t (in.)	weight (lb/ft)	min. wall t (in.)	weight (lb/ft)
18	19.5	0.44	28	0.44	26	0.43	25	0.42	24	0.42	24
20	21.6	0.49	34	0.48	32	0.47	30	0.47	29	0.46	28
24	25.8	0.57	47	0.56	44	0.56	42	0.55	41	0.54	40
27	28.0	0.62	55	0.61	52	0.60	49	0.59	47	0.58	46
28	30.0	0.66	63	0.65	59	0.64	56	0.63	54	0.62	52
30	32.0	0.70	71	0.69	67	0.68	64	0.67	61	0.66	59
33	34.0	0.74	80	0.73	75	0.72	71	0.71	69		
36	38.3	0.83	101	0.81	94	0.80	89	0.79	86		
41	42.9	0.92	125	0.91	117	0.89	111	0.88	107		
42	44.5	0.95	134	0.94	126	0.93	120	0.91	115		
44	45.9	0.98	142	0.97	134	0.95	126	0.94	122		
45	47.7	1.02	153	1.00	143	0.99	137	0.97	131		
48	50.8	1.08	173	1.07	163	1.05	154	1.03	148		
51	53.9	1.15	195	1.13	182	1.11	173	1.10	167		
54	57.1	1.21	217	1.19	203	1.17	193	1.16	187		
57	60.0	1.27	239	1.25	224	1.23	212				
60	62.9	1.33	263	1.31	246	1.29	233				
63	66.0	1.39	288	1.37	270	1.35	256				
66	69.2	1.46	317	1.44	297	1.41	280				
69	72.5	1.53	348	1.50	324	1.48	308				
72	75.4	1.59	375	1.56	350						
78	81.6	1.71	437	1.69	410						
84	87.0	1.82	495	1.79	463						
85	88.6	1.86	515	1.83	482						
90	94.3	1.97	581	1.94	543						
96	99.5	2.08	646	2.05	605						
104	108.0	2.25	758								
110	114.0	2.38	817								
120	126.0	2.62	992								
126	132.5	2.75	1125								

** Maximum nominal working pressure class in psi.*

Appendix

Deflected Pipe Minimum Inside Diameters

Class SN 36

Nominal Pipe Size (in.)	Pipe O.D. (in.)	Pressure Class									
		PN 25		PN 50		PN 100		PN 150		PN 200	
		Min. Dia (in.)		Min. Dia (in.)		Min. Dia (in.)		Min. Dia (in.)		Min. Dia (in.)	
		@ 3% defl.	@ 5% defl.	@ 3% defl.	@ 5% defl.	@ 3% defl.	@ 5% defl.	@ 3% defl.	@ 5% defl.	@ 3% defl.	@5% defl.
18	19.5	18.08	17.71	18.08	17.71	18.11	17.73	18.11	17.73	18.13	17.75
20	21.6	20.04	19.63	20.06	19.65	20.06	19.65	20.08	19.67	20.10	19.69
24	25.8	23.99	23.50	23.99	23.50	24.01	23.52	24.01	23.52	24.03	23.54
27	28	26.04	25.51	26.04	25.51	26.06	25.53	26.09	25.55	26.11	25.57
28	30	27.92	27.35	27.92	27.35	27.94	27.37	27.96	27.39	27.98	27.41
30	32	29.78	29.17	29.80	29.19	29.82	29.21	29.84	29.23	29.86	29.25
33	34	31.66	31.01	31.68	31.03	31.70	31.05	31.72	31.07	31.74	31.09
36	38.3	35.69	34.95	35.71	34.97	35.73	34.99	35.75	35.01	35.77	35.03
41	42.9	40.01	39.18	40.01	39.18	40.03	39.20	40.07	39.24	40.09	39.26
42	44.5	41.50	40.64	41.52	40.66	41.54	40.68	41.56	40.70	41.60	40.74
44	45.9	42.82	41.93	42.82	41.93	42.86	41.97	42.88	41.99	42.92	42.03
45	47.7	44.50	43.58	44.52	43.60	44.54	43.62	44.58	43.66	44.60	43.68
48	50.8	47.41	46.43	47.43	46.45	47.45	46.47	47.49	46.51	47.51	46.53
51	53.9	50.31	49.27	50.33	49.29	50.35	49.31	50.39	49.35	50.43	49.39
54	57.1	53.31	52.21	53.31	52.21	53.35	52.25	53.40	52.29	53.44	52.33
57	60	56.03	54.87	56.05	54.89	56.07	54.91	56.11	54.95		
60	62.9	58.74	57.53	58.76	57.55	58.80	57.59	58.84	57.63		
63	66	61.64	60.37	61.66	60.39	61.70	60.43	61.76	60.49		
66	69.2	64.64	63.31	64.66	63.33	64.70	63.37	64.75	63.41		
69	72.5	67.74	66.35	67.76	66.37	67.78	66.39	67.84	66.45		
72	75.4	70.45	69.00	70.47	69.02	70.52	69.06				
78	81.6	76.26	74.69	76.28	74.71	76.33	74.75				
84	87	81.32	79.64	81.34	79.66	81.38	79.70				
85	88.6	82.81	81.10	82.83	81.12	82.89	81.18				
90	94.3	88.16	86.34	88.18	86.36	88.24	86.42				
96	99.5	93.04	91.12	93.06	91.14	93.12	91.20				
104	108	101.00	98.91	101.02	98.93	101.08	98.99				
110	114	106.61	104.41	106.63	104.43	106.69	104.49				
120	126	117.85	115.42	117.89	115.46	117.95	115.52				
126	132.5	123.95	121.39	123.99	121.43	124.05	121.49				

Class SN 46

Nominal Pipe Size (in.)	Pipe O.D. (in.)	Pressure Class									
		PN 25		PN 50		PN 100		PN 150		PN 200	
		Min. Dia (in.)		Min. Dia (in.)		Min. Dia (in.)		Min. Dia (in.)		Min. Dia (in.)	
		@ 3% defl.	@ 5% defl.	@ 3% defl.	@ 5% defl.	@ 3% defl.	@ 5% defl.	@ 3% defl.	@ 5% defl.	@ 3% defl.	@ 5% defl.
18	19.5	18.02	17.65	18.02	17.65	18.04	17.67	18.06	17.69	18.06	17.69
20	21.6	19.98	19.57	20.00	19.59	20.00	19.59	20.02	19.61	20.04	19.63
24	25.8	23.91	23.42	23.91	23.42	23.93	23.44	23.95	23.46	23.97	23.48
27	28	25.96	25.43	25.98	25.45	25.98	25.45	26.00	25.47	26.02	25.49
28	30	27.84	27.27	27.84	27.27	27.86	27.29	27.88	27.31	27.90	27.33
30	32	29.70	29.09	29.72	29.11	29.72	29.11	29.76	29.15	29.78	29.17
33	34	31.58	30.93	31.58	30.93	31.60	30.95	31.62	30.97	31.66	31.01
36	38.3	35.59	34.85	35.59	34.85	35.63	34.89	35.65	34.91	35.67	34.93
41	42.9	39.89	39.06	39.89	39.06	39.93	39.10	39.95	39.12	39.99	39.16
42	44.5	41.38	40.52	41.40	40.54	41.42	40.56	41.46	40.60	41.48	40.62
44	45.9	42.69	41.81	42.69	41.81	42.71	41.83	42.76	41.87	42.80	41.91
45	47.7	44.36	43.44	44.38	43.46	44.40	43.48	44.44	43.52	44.48	43.56
48	50.8	47.26	46.29	47.28	46.31	47.30	46.33	47.35	46.37	47.39	46.41
51	53.9	50.15	49.12	50.17	49.13	50.21	49.17	50.25	49.21	50.29	49.25
54	57.1	53.15	52.06	53.17	52.08	53.19	52.10	53.23	52.14	53.29	52.19
57	60	55.86	54.71	55.88	54.73	55.90	54.75	55.96	54.81		
60	62.9	58.57	57.37	58.57	57.37	58.61	57.41	58.68	57.47		
63	66	61.46	60.19	61.48	60.21	61.52	60.25	61.58	60.31		
66	69.2	64.44	63.11	64.46	63.13	64.50	63.17	64.56	63.23		
69	72.5	67.54	66.15	67.56	66.17	67.60	66.21	67.66	66.27		
72	75.4	70.23	68.78	70.27	68.82	70.31	68.86				
78	81.6	76.04	74.47	76.06	74.49	76.10	74.53				
84	87	81.07	79.40	81.09	79.42	81.16	79.48				
85	88.6	82.57	80.86	82.59	80.88	82.65	80.94				
90	94.3	87.89	86.08	87.93	86.12	87.97	86.16				
96	99.5	92.75	90.84	92.77	90.86	92.83	90.92				
104	108	100.69	98.61	100.73	98.65	100.79	98.71				
110	114	106.29	104.10	106.33	104.14	106.39	104.20				
120	126	117.50	115.08	117.54	115.12	117.60	115.18				
126	132.5	123.58	121.03	123.62	121.07	123.68	121.13				

Class SN 72

Nominal Pipe Size (in.)	Pipe O.D. (in.)	Pressure Class									
		PN 25 & 50		PN 100		PN 150		PN 200		PN 250	
		Min. Dia (in.)		Min. Dia (in.)		Min. Dia (in.)		Min. Dia (in.)		Min. Dia (in.)	
		@ 3% defl.	@ 5% defl.	@ 3% defl.	@ 5% defl.	@ 3% defl.	@ 5% defl.	@ 3% defl.	@ 5% defl.	@ 3% defl.	@ 5% defl.
18	19.5	17.92	17.55	17.92	17.55	17.94	17.57	17.96	17.59	17.96	17.59
20	21.6	19.86	19.45	19.88	19.47	19.90	19.49	19.90	19.49	19.92	19.51
24	25.8	23.77	23.28	23.79	23.30	23.79	23.30	23.81	23.32	23.83	23.34
27	28	25.80	25.27	25.82	25.29	25.84	25.31	25.86	25.33	25.88	25.35
28	30	27.66	27.09	27.68	27.11	27.70	27.13	27.72	27.15	27.74	27.17
30	32	29.52	28.91	29.54	28.93	29.56	28.95	29.58	28.97	29.60	28.99
33	34	31.38	30.73	31.40	30.75	31.42	30.77	31.44	30.79		
36	38.3	35.36	34.63	35.40	34.67	35.42	34.69	35.44	34.71		
41	42.9	39.64	38.82	39.66	38.84	39.70	38.88	39.72	38.90		
42	44.5	41.13	40.28	41.15	40.30	41.17	40.32	41.21	40.36		
44	45.9	42.43	41.55	42.45	41.57	42.49	41.61	42.51	41.63		
45	47.7	44.09	43.19	44.14	43.23	44.16	43.24	44.20	43.28		
48	50.8	46.98	46.01	47.00	46.03	47.04	46.07	47.08	46.11		
51	53.9	49.84	48.82	49.88	48.86	49.92	48.90	49.95	48.92		
54	57.1	52.83	51.74	52.87	51.78	52.91	51.82	52.93	51.84		
57	60	55.52	54.37	55.56	54.41	55.60	54.45				
60	62.9	58.21	57.01	58.25	57.05	58.29	57.09				
63	66	61.09	59.83	61.13	59.87	61.17	59.91				
66	69.2	64.05	62.73	64.09	62.77	64.15	62.83				
69	72.5	67.11	65.73	67.17	65.79	67.21	65.83				
72	75.4	69.80	68.36	69.86	68.42						
78	81.6	75.57	74.01	75.61	74.05						
84	87	80.59	78.92	80.65	78.98						
85	88.6	82.06	80.36	82.12	80.42						
90	94.3	87.36	85.56	87.42	85.62						
96	99.5	92.18	90.28	92.24	90.34						
104	108	100.08	98.02	100.16	98.10						
110	114	105.63	103.46	105.72	103.54						
120	126	116.79	114.38	116.87	114.46						
126	132.5	122.83	120.29	122.91	120.37						

HOBAS®

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