REMOVING RESERVOIR PUMPS

Turn off the switch controlling the pump to be removed.

Close off the butterfly valve on the pump discharge line (No. 4).

Disconnect the pump power cable.

Unplug the thermister and heat trace cables.

Disconnect the bubbler line (from the right side pump).

Disconnect the pump discharge line by removing the victaulic coupling on the discharge line.

Remove the flange on the pump casing.

Pull out the pump using the steel cable attached to the pump. Do not remove the pump by pulling on the discharge line. Be careful not to damage the power or heat trace cables.

The pump can be removed from the discharge line by removing the coupling.

When reinstalling the pump, ensure that the cables are attached to the discharge line with water proof tape.

CONTROL PANEL

Select the desired duty pump with the duty selector switch.

The white "2nd duty pump used" pilot light indicates duty pump failure and that the second duty pump selector outside has called for the second duty pump.

A labelled "window" in the alarm section of the control panel will flash when any of the following faults occur:

1) pump room temperature falls below 1°C
2) pump room temperature rises above 30°C
3) diesel generator room rises above 30°C
4) level in diesel fuel tank falls below half full
5) any diesel generator alarm is registered
6) diesel generator fails to start within 3 minutes after power failure.

To silence the alarm, press the "acknowledge" button on the alarm panel. The "window" will change from flashing to steady.

When the fault is corrected, press the reset button to turn out the light.

To test the operation of the lights, press the test button and make sure all "windows" light.

RADIO PAGER

When any of the above faults occur, all pocket pagers will give a tone for 4 seconds followed by 90 seconds of silence. This repeats until the alarm condition at the station is corrected or the alarm unit is shut down.

DIESEL GENERATOR

The diesel generator will start automatically after a power failure.

After power from the public system is restored, the station will run from the diesel system for two minutes and then will be disconnected from the diesel and reconnected to the public supply. The diesel engine will run for 3 minutes more and will then stop.

The following faults will cause the "diesel generator failed" light on the common pump control panel to light:

low oil pressure

engine overheat

engine overspeed

overcrank (diesel did not start when called)

low oil tank level

SUBDRAIN SYSTEM

The reservoir is equipped with an extensive subdrain system. The lines run from the top of the reservoir berm across the reservoir to the top of the berm on the opposite site. The pipes with the blind flanges attached are the ends of the subdrain pipes.

The header pipe through which the system drains is equipped with heat trace cables. The header pipe runs from the centre of the reservoir on the south side, across the reservoir, under the berm to the manhole located on the outside of the berm on the north side.

There is a gravity drain from the manhole to the outside of the berm. The drain is heat traced and it should remain open year round.

In the event it freezes, the manhole is equipped with a sump pump and the water will be pumped to the surface. This sump pump should be checked and operated at least twice a year.

One of the ends of the subdrain system terminates inside the building in the generator room. The tubing from the levelometer runs down into this subdrain line. If for any reason the subdrain system plugs up the water level in the subdrain system will rise. Using the levelometer, the water level in the subdrain system should be checked once a week.

If there is water in the subdrain system, carry out the following procedure:

(1) Inspect the header pipe outfall to check the flow and thaw out if required.

(2) Check out the manhole and sump pump. Make repairs if required.

(3) If the problem is not in the outfall or sump pump, the system is frozen or plugged. A sewer flushing machine was provided as part of the reservoir equipment. Starting at the header pipe, flush out the system by removing the flange and inserting the flusher cutting line into the subdrain pipe.

Continue on all pipes until the entire system is flushed.

(4) Should the water level in the subdrain system rise to more than 3 metres above the reservoir floor, damage to the liner may occur.

The system can be drained by inserting a submersible pump into the subdrain lines.

NORMAL OPERATING PROCEDURES

ITEM	PROCEDURE	FREQUENCY	NORMAL	REMARK
Chlorinator	Top up lower tank.	Daily	Never drop level below half full.	
	Overhaul pump.	Annually		See manufacturers literature.
Intake Screens	Backwashing.	Monthly		
Diesel Generator	Check Operation.	Weekly		Check engine oil level and fuel level in tank.
Cycling of Pumps	Rotation of duty pump.	Weekly		
Main Control Panel	Check pump operation and alarm lights.	Daily	All alarm lights should be off.	Check cause of alarm.
Water Meter	Record consumption.	Daily (approx. at the same time).		
Reservoir Levelometer	Check reservoir level and sub-drain water level.	Weekly		Subdrain system should always be dry. If not check outfall and sump pump in manhole.
Subdrain System	Check flow rate. Check sump pump.	Monthly		Check outfall and manhole.

PEEL ENGINE
SERVICE CO. LTD.

6074 SHAWSON DRIVE
MISSISSAUGA, ONTARIO L5T 1E6
TEL: (416) 677-0281
TELEX: 06-968702
FAX: (416) 677-6297

CERTIFICATE OF ACCEPTANCE

DATE OF START UP: September 21, 1987

CUSTOMER NAME: Nortuck Contracting Ltd.

PROJECT NAME: Pangnirtung, NWT

EQUIPMENT: Lister Nova II-TS3

REF. NO: M14017CA

THIS WILL CONFIRM THAT WE HAVE COMPLETED AN INSPECTION OF THIS INSTALLATION, PERFORMED AN INITIAL START UP OF THE EQUIPMENT AND DEMONSTRATED THE OPERATION OF THE EQUIPMENT WITH INSTRUCTIONS TO THE OPERATING PERSONNEL PRESENT.

THE INSTALLATION MEETS THE STANDARDS RECOGNIZED AS GOOD ENGINEERING PRACTICES AND AS REQUIRED BY THE PRINCIPAL EQUIPMENT MANUFACTURERS USED IN OUR PRODUCT.

ANY DEFICIENCIES FOUND ARE DETAILED ON THE ATTACHED FORM WHICH IS TO BE CONSIDERED AS PART OF THIS CERTIFICATE. IF DEFICIENCIES ARE NOTED, THEY MUST BE RECTIFIED BEFORE ANY WARRANTY PERIOD BECOMES VALID OR EFFECTIVE.

OUR STANDARD TERMS OF WARRANTY WILL COMMENCE FROM THE DATE OF THIS CERTIFICATE, SUBJECT TO THE RECTIFICATION OF ANY NOTED DEFICIENCY.

B. Vinckle

COLDSTREAM
PRODUCTS OF CANADA LTD.
1001 REGENT AVENUE WEST, WINNIPEG, MANITOBA R2C 4M2 TELEPHONE 1 (204) 669-1201
Telex 07-57152
FAX #203-663-0225

TEN YEAR GUARANTEE
COLDSTREAM BUILDING PANELS

DATE INSTALLED September, 1987 COLDSTREAM ORDER NUMBER BD46525

COLDSTREAM DRAWING NUMBER EC7016

ORIGINAL PURCHASER NORTUK CONTRACTING LTD.

ADDRESS R.R. No. 2

Streetsville, Ontario POSTAL CODE L5M 2B2

LOCATION PANGNIRTUNG, NORTHWEST TERRITORIES

WE EXTEND THE FOLLOWING GUARANTEE to the original purchaser/user, which shall be deemed to mean the individual or company for whom the panels, as identified above, were originally installed:

WE GUARANTEE that this product is free from defects in material or workmanship, under normal use and service. In the event of failure, the obligation of Coldstream Products of Canada Ltd. under this Guarantee, shall be limited to repairing or replacing, at Coldstream's option, F.O.B. Factory, Winnipeg, Manitoba, any panel which proves defective and which our examination shall disclose, to our satisfaction, to be thus defective, within a maximum period of Ten Years from date of installation.

THIS GUARANTEE DOES NOT APPLY to panels which have been subject to any accident, alteration, abuse, misuse or improper installation.

THIS GUARANTEE DOES NOT INCLUDE any labour charges for replacement or repair of defective panels.

THIS GUARANTEE IS IN LIEU of any other Warranty, expressed or implied, including merchantability or fitness and of all other obligations or liabilities whatsoever, on Coldstream's part. Under no circumstances whatever shall Coldstream be liable to the purchaser for any special or consequential damages.

COLDSTREAM PRODUCTS OF CANADA LTD.

PER: Robt McConomy

DEDICATED TO EXCELLENCE

NILEX GEOTECHNICAL PRODUCTS INC.

Edmonton Head Office
3448 - 93 Street
P.O. Box 4063,
Edmonton, Alta., Canada
T6E 4S8
Phone: (403) 463-9535
Telex: 037-42562

Vancouver Branch
7832 Enterprise Street
Burnaby, B.C., Canada
V5A 4A7
Phone: (604) 420-6433
Telex: 04-354600

WARRANTY

GOVERNMENT OF NORTHWEST TERRITORIES/TOWER ARCTIC LTD.
WATER SUPPLY SYSTEM, PANGNIRTUNG, N.W.T.
H.D.P.E. LINER SUPPLY AND INSTALLATION

Under the terms and conditions agreed to between Nilex Geotechnical Products Inc., (the Subcontractor), and Tower Arctic Ltd., (the "Contractor"), dated June 24, 1985, the Subcontractor hereby warrants to rectify and make good any defect or fault in materials or workmanship as described in the General Contract, for a period of 2 years following the issuance of the Final Certificate of Completion. Defects will be limited to those directly attributable to the Subcontractor's negligence or workmanship and will not include any damage caused by conditions or circumstances not under the direct control of the Contractor. All remedies made will be at the Contractor's expense after such a time as responsibility is determined. Remedy will be limited to the repair and replacement of materials and will not include those expenses related to ancillary costs of loss of use of the reservoir. Should the defects be determined to be not the responsibility of the Subcontractor, all expenses incurred by the Subcontractor in order to make such a determination will be for the Contractor's account. Defects in workmanship and or materials will be corrected as soon as scheduling will permit and under no circumstances will such remedies be commenced more than thirty days past the point that they come to the attention of the Contractor.

Agreed to:

TOWER ARCTIC LTD. — 6 Oct. 1987 — DATE

NILEX GEOTECHNICAL PRODUCTS INC. — 17 Sept 87 — DATE

PANGNIRTUNG
PROJECT #83-4507

insulated pipe

shop drawings

DRAWING REVIEW

The review of this drawing does not in any way relieve the contractor of responsibility for its accuracy or for compliance with the contract documents.

✓	No Comment	Submission No.
	REVIEWED AS NOTED	Project No.
	AMEND & RESUBMIT	Date Oct. 2/85
	REJECTED SEE REMARKS	By

F.J. REINDERS & ASSOC. LTD.
CONSULTING ENGINEERS BRAMPTON

URECON LTD./LTÉE

1800 BOULEVARD BEDARD: TEL.: (514) 455-5629
ST-LAZARE • QUEBEC • CANADA • JOP 1V0
TELEX NO.: 05-821712

September 24, 1985

Tower Arctic Ltd
1350 Sherbrooke St. West
Suite 920
Montreal, PQ
H3G 1J1

Attention: Mr. John Barthe, V.P.

We are pleased to certify that the insulated pipe supplied by us for the Pangnirtung N.W.T. project conforms to the project specification #83-4507 as itemized below.

1) Core pipe:

Core pipe used is Canron's Techline polyethylene which is manufactured from type III, category 5, class C, grade P34 resin in ASTM D1248. Resin density is .957 black per ASTM D1505. The pipe is manufactured to CGSB specification #41-GP-25M and has a hydrostatic design basis of 11.03 MPa so exceeding the specification. The pipe conforms to specification section 02402, 2.2.1 and 2.2.2. The inner pipe is series 60, the outer pipe is series 45. The outer jacket in some cases is Rahn Metals "Thermolene" HDPE conforming fully to the forementioned specification.

2) Insulation:

Urecon's "U.I.P." rigid polyurethane foam system is approved for use in the N.W.T. and meets the following physical properties:

.../2

a) Material rigid polyurethane foam factory applied.

b) Insulation thickness as specified.

c) Density (ASTM D1622) .035 to .046 gm/cm cu. (2.21 to 3 lbs/cu.ft)

d) Closed cell content (ASTM D2856) 90% minimum.

e) Maximum water absorption (ASTM D2842-69) 4.0% by volume (ASTM D2127) 4.25% by volume.

f) Compressive strength (ASTM D2126) 206 kpa to 310 kpa (30 to 45 psi)

g) Thermal conductivity (ASTM C-158) .161 to .174 k cal/cm/hr/m sq/C^{o}

h) Service temperature $-45^{o}C$ to plus $120^{o}C$.

i) Centering $\pm$ 6.35 mm.

3) Insulation kits for fittings:

All fittings are FRP coated so exceeding the specification.

Insulation kits for fittings consisted of rigid urethane foam with a fully bonded FRP glass reinforced polyester coating on all exterior surfaces including ends. Kits were supplied complete with silicone caulking for seams, stainless steel attachment straps and clips, and heat shrink sleeves or tape to seal between pipe and kit.

a) Insulation

Rigid polyurethane foam.

b) FRP coating

1) Glass reinforced polyester fully bonded in insulation

2) Resin MIAPOL 2T-118 laminating resin or equivalent black in color UV inhibited.

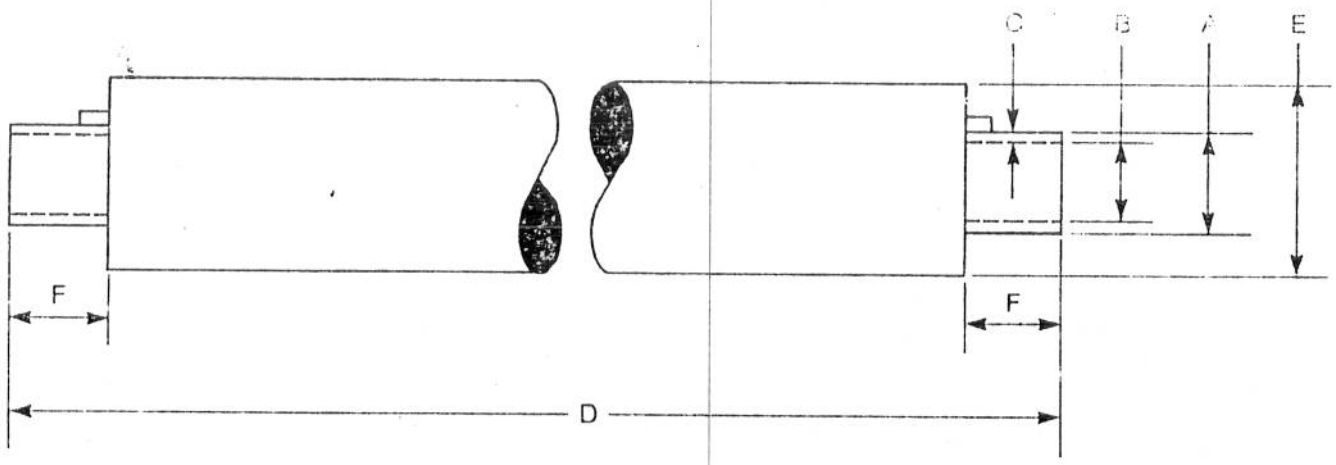
3) Thickness 2.54 mm minimum.

4) Exterior surface will consist of a resin rich hot coat of minimum thickness .25 mm.

We trust the above certification is satisfactory and we look forward to the successful installation of this project.

YOURS TRULY

Peter Murphy, V.P.



PIPE

NOMINAL DIAM.	250mm
SERIES	60
RESIN TYPE	III
RESIN GRADE	P-34
SPECIFICATION	41-CP-25m
MANUFACTURER	CANRON
OUTSIDE DIAM."A"	250mm
INSIDE DIAM."B"	232mm
WALL THICKNESS "C"	10.26mm
OVERALL LENGTH "D"	12.1m

INSULATION

THICKNESS	110mm
OUTSIDE DIAM."E"	500mm
CUTBACK "F"	508/914
TRACE CONDUIT	No
MASTIC on ENDS	YES

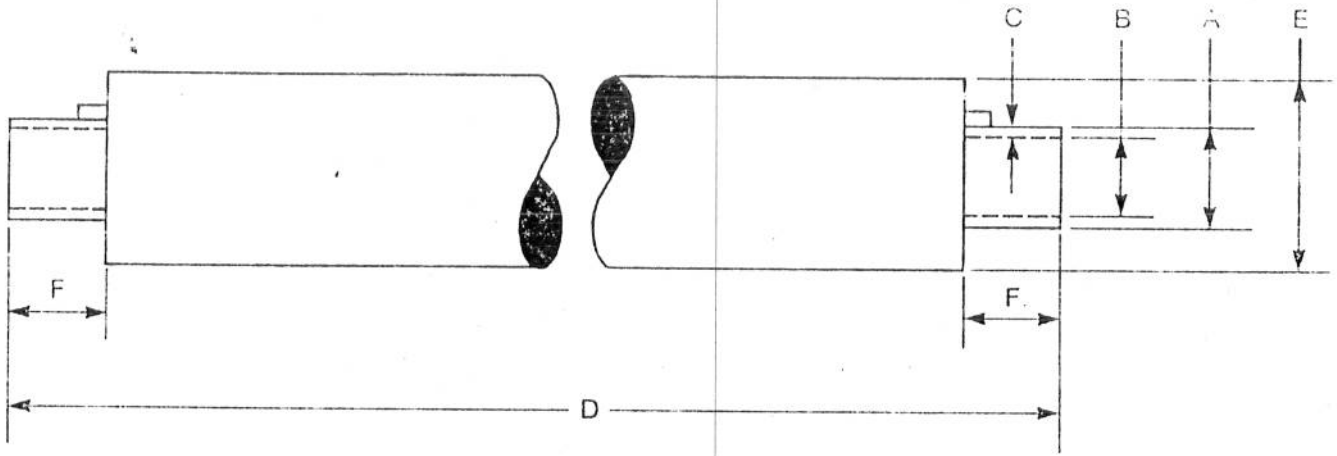
TRACING

TYPE	—
WATTS/m	—
VOLTAGE	—

JACKET

THICKNESS	16.3mm
COLOR	BLACK
UV INHIBITED	YES

URECON "U.I.P."® INSULATED PIPE	
PROJECT	PANGNIRTUNG
OWNER	PUBLIC WORKS NWT
ENGINEER	F.J. REINDERS
DATE	SEPT 24/85
CONTRACT NUMBER	1362



PIPE

NOMINAL DIAM.	200mm
SERIES	100
RESIN TYPE	II
RESIN GRADE	P-34
SPECIFICATION	CSA-CP-25M
MANUFACTURER	CANRON
OUTSIDE DIAM."A"	200.mm
INSIDE DIAM."B"	174.7mm
WALL THICKNESS "C"	14.2mm
OVERALL LENGTH "D"	12.1m

INSULATION

THICKNESS	45mm
OUTSIDE DIAM."E"	315mm
CUTBACK "F"	FLANGED
TRACE CONDUIT	NO
MASTIC on ENDS	YES

TRACING

TYPE	—
WATTS/m	—
VOLTAGE	—

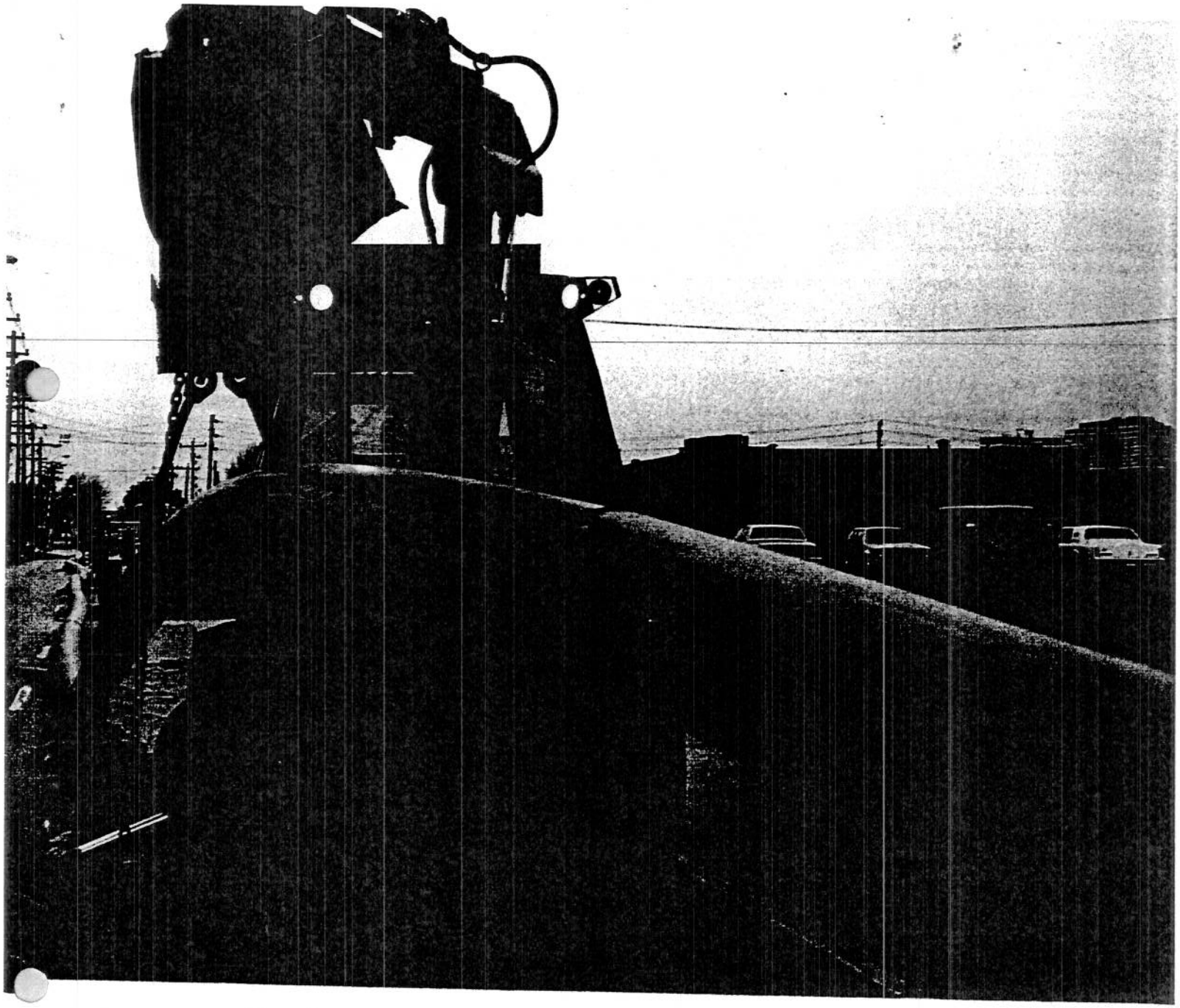
JACKET

THICKNESS	12.9mm
COLOR	BLACK
UV INHIBITED	YES

URECON "U.I.P."® INSULATED PIPE	
PROJECT	PANGNIRTUNG
OWNER	PUBLIC WORKS NWT
ENGINEER	F. J. REINDERS
DATE	SEPT 24/85
CONTRACT NUMBER	1362

techline® polyethylene

high-density polyethylene piping system.



grandview industries, limited

noranda group

Tel. (416) 625-8822 Telex: 06-961129

techline®

high-density polyethylene pipe

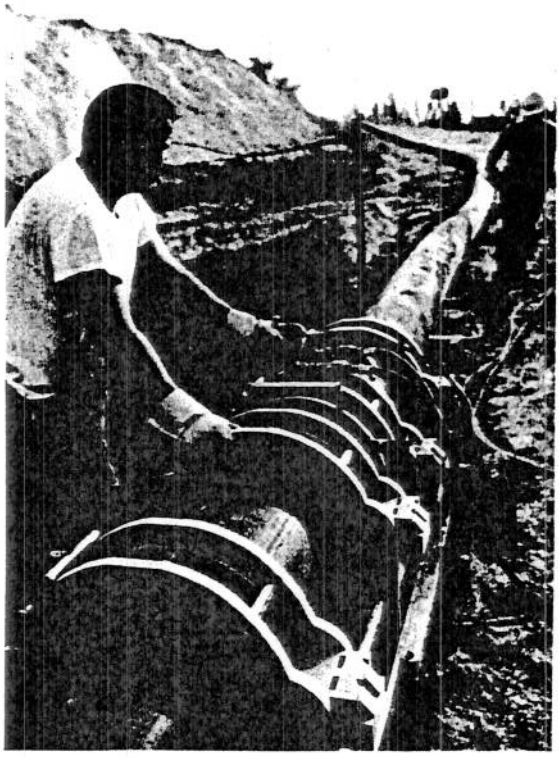
introduction

Grandview Industries, Limited, a Canadian company and a wholly owned member of the Noranda Group, has been one of Canada's major thermoplastic pipe manufacturers since 1964. Modern extrusion plants are located in three Canadian cities to service industrial, residential, electrical and, most recently, a greater range of municipal applications.

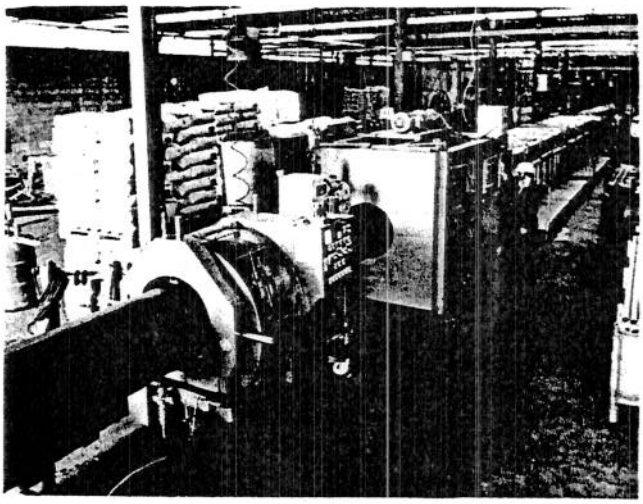
Techline® high-density polyethylene pipe (HDPE) is extruded to rigid quality specifications in our Rexdale Ontario plant using advanced extrusion equipment and technology.

Grandview is a multi-resin extruder with other product lines including the following materials:

- LDPE (low/medium-density coiled pipe)
- PVC (polyvinyl chloride)
- CPVC (chlorinated polyvinyl chloride)
- ABS (acrylonitrile butadiene styrene)
- PB (polybutylene)
- PP (polypropylene)



Techline HDPE pipe sections are joined by portable butt welding equipment.



Advanced extrusion equipment for large diameter pipe.

product description

Techline® high-density polyethylene pipe is manufactured in accordance with the Canadian Government Standards Board Standard CGSB 41-GP-25M.

Techline® HDPE is available in pipe diameters of up to 630mm (24 inch) and pressure ratings up to 1379 KPa (200 psig.)

Techline® HDPE has many outstanding physical properties which set it apart from most other piping materials. In numerous cases polyethylene pipe can be the solution to unique design situations allowing increased flexibility in engineered systems.

proven uses

- Sewage forcemains
- Marine intakes and outfalls
- Pressure watermains
- Gravity sewers
- Sewer relining
- River and lake crossings
- Leachate collection systems
- Dredging and slurry lines
- Irrigation systems
- Aeration lines
- Mine tailings
- Industrial effluent

Contact Grandview Industries, Limited for case history information.

engineered pipe that provides:

LIGHTWEIGHT

Techline® HDPE pipe weights are listed in Table I.

Relative to traditional piping materials, Techline® is substantially lighter (approx. 1/10 that of equal diameter concrete). Significant time and cost savings can be achieved in transportation, handling, installation and repair.

FLEXIBILITY

The flexible properties of Techline® HDPE enable the pipe to follow the contours of most terrains, including river and lake bottoms.

Often, the need for costly mitered elbows is eliminated by the inherent bending properties of HDPE. In turn this will significantly enhance the system's flow characteristics. Moreover, Techline® HDPE pipe is not susceptible to shear fractures that can occur in rigid conduits such as cast iron.

For design purposes the minimum bending radii are:

50 x O.D. for pressure applications
35 x O.D. for gravity applications.

REACTION TO WATER HAMMER

The effects of water hammer, caused by the sudden decrease in the velocity of a fluid, must be considered in the design of most piping systems. Techline® polyethylene, because of its elasticity, can withstand the shock of water hammer far better than rigid piping materials. Elastic strain of the pipe wall has a damping effect on the dynamic pressure wave.

Water hammer is most commonly caused by sudden shut-down/start-up of pumps, or rapid valve closure. Care should be taken to eliminate the possibility of these conditions.

SUPERIOR FLOW CHARACTERISTICS

Techline® polyethylene pipe has an extremely smooth interior surface. Its resistance to scaling, corrosion and tuberculation guarantees high flow and minimum friction loss for the life of the system.

Techline® HDPE exhibits a Manning roughness coefficient of 0.009, corresponding to a Hazen-Williams 'C' factor of 150.

This low friction loss permits Techline® polyethylene to carry higher flow rates for a given cross-section, or conversely, a smaller pipe diameter may be substituted for a given flow rate.

INERT TO MOST CHEMICALS

Techline® polyethylene pipe is inert to most chemicals at normal operating temperatures. It resists most organic solvents, aqueous salts, mineral acids and alkalis, as well as algae and marine growths.

Oxidizers, detergents, some hydrocarbons and plasticizers can affect the material. A complete chemical resistance guide for Techline® HDPE is available from your nearest Grandview Sales Office.

RESISTANCE TO EARTH LOADING

Techline® polyethylene pipe can withstand unexpectedly heavy earth load conditions. Unlike rigid pipe, polyethylene is a flexible conduit which will deflect circumferentially under earth loading. This deflection causes the side walls of the pipe to compress against the soil thereby creating lateral support. The degree of vertical pipe defection is directly related to the degree of soil compaction.

Pipe which is supported laterally by the soil exhibits much more strength to withstand earth pressure loading.

To ascertain the permissible depth of burial, consideration must be given to both the degree of soil compaction and the total vertical load, (including live loads) on the pipe.

Your Grandview Design Catalogue or a Grandview Sales Representative can assist in the detailed engineering analysis of earth load design.

ABRASION RESISTANCE

Techline® HDPE pipe installations in Canada have proven Techline® to be up to four times more abrasion resistant than carbon steel.

The resistance and ductility of HDPE allows it to handle many types of abrasive solids. Performance will vary, however, depending on three major factors:

- Impingement angle
- Fluid velocity and viscosity
- Particle size, abrasivity, concentration, and specific gravity

TEMPERATURE EXTREMES

Techline® HDPE offers outstanding resistance to very low temperatures and exhibits an elastic modulus with operating temperatures as low as -56°C (-70°F). Excellent impact resistance is assured even at -30°C (-22°F).

The thermal coefficient of expansion of Techline® HDPE pipe is 16 cm per 100 meters per 10C°. (1.1 inches/100 feet/10F°).

TABLE I Techline® Dimensions of High-Density Polyethylene Pipe (acc. to CGSB 41-GP-25M)

Nominal Diameter (mm)	3'' (90)	4'' (110)	6'' (160)	8'' (200)	10'' (250)	11'' (280)	12'' (315)	14'' (355)	16'' (400)	18'' (450)	20'' (500)	22'' (560)	24'' (630)
Avg. O.D.	3.58''	4.37''	6.36''	7.93''	9.90''	11.08''	12.46''	14.04''	15.83''	17.80''	19.76''	22.13''	24.89''
Series 45 (315 KPa)													
inside dia. (SDR 33)		4.10''	5.97''	7.45''	9.30''	10.40''	11.70''	13.19''	14.87''	16.72''	18.56''	20.78''	23.38''
wall (av.)		.143''	.206''	.256''	.319''	.360''	.404''	.454''	.513''	.576''	.643''	.719''	.807''
weight lbs/ft		.79	1.65	2.56	3.98	5.03	6.35	8.03	10.24	12.92	16.02	20.05	25.31
Series 60 (400 KPa)													
inside dia. (SDR 26)	3.30''	4.04''	5.87''	7.32''	9.14''	10.23''	11.51''	12.96''	14.62''	16.44''	18.25''	20.44''	22.98''
wall (av.)	.148''	.179''	.261''	.324''	.404''	.454''	.508''	.576''	.647''	.727''	.807''	.903''	1.018''
weight lbs/ft	.66	.96	2.07	3.21	5.00	6.25	7.91	10.10	12.80	16.17	19.93	24.97	31.65
Series 80 (560 KPa)													
inside dia. (SDR 19)	3.20''	3.91''	5.69''	7.10''	8.85''	9.91''	11.15''	12.56''	14.16''	15.92''	17.67''	19.79''	22.26''
wall (av.)	.202''	.244''	.358''	.445''	.560''	.620''	.702''	.790''	.892''	1.005''	1.114''	1.248''	1.404''
weight lbs/ft	.89	1.31	2.80	4.34	6.82	8.47	10.75	13.63	17.36	21.99	27.07	33.95	42.94
Series 100 (710 KPa)													
inside dia. (SDR 15)	3.11''	3.80''	5.53''	6.88''	8.59''	9.62''	10.81''	12.19''	13.74''	15.45''	17.15''	19.21''	21.60''
wall (av.)	.252''	.307''	.445''	.560''	.698''	.779''	.879''	.988''	1.114''	1.252''	1.391''	1.560''	1.757''
weight lbs/ft	1.09	1.63	3.43	5.38	8.37	10.42	13.26	16.79	21.35	26.99	33.30	41.80	52.93
Series 125 (900 KPa)													
inside dia. (SDR 12)	3.00''	3.65''	5.32''	6.63''	8.28''	9.26''	10.41''	11.73''	13.23''	14.87''	16.40''		
wall (av.)	.311''	.382''	.555''	.694''	.866''	.967''	1.093''	1.232''	1.387''	1.564''	1.667''		
weight lbs/ft	1.33	1.98	4.20	6.55	10.19	12.77	16.19	20.55	26.09	33.07	39.30		
Series 160 (1100 KPa)													
inside dia. (SDR 10)	2.88''	3.51''	5.11''	6.37''	7.95''	8.90''	10.00''	11.27''	12.45''				
wall (av.)	.374''	.458''	.669''	.833''	1.042''	1.160''	1.311''	1.480''	1.670''				
weight lbs/ft	1.56	2.33	4.96	7.70	12.03	15.02	19.04	24.21	30.80				
Series 200 (1370 KPa)													
inside dia. (SDR 8)	2.722''	3.320''	4.834''	6.022''	7.516''	8.410''	9.456''						
wall (av.)	.458''	.561''	.815''	1.019''	1.273''	1.420''	1.604''						
weight lbs/ft	1.86	2.78	5.89	9.18	14.31	17.95	22.69						

NOTE:
1. Series number is the recommended operating pressure of the pipe in psi using water at 23°C
2. Design stress 5.0 MPa (725 psi).
3. Coiled pipe is available from ½" to 2" - Contact your Grandview office for details.
4. Above weights are average and may vary slightly within wall tolerances of governing standards.
5. Inside diameters are based upon minimum wall thickness.

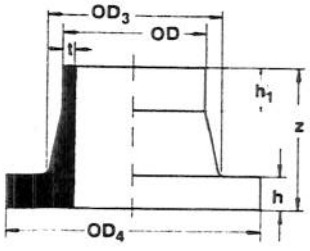
TABLE II Physical Properties of Techline® High-Density Polyethylene

PROPERTY AT 75°F	ASTM TEST METHOD	IMPERIAL UNITS	IMPERIAL VALUE	SI UNITS	SI VALUE
Specific gravity	D-792	—	—	g/cm³	.957
Melt index (pipe condition E)	D-1238	—	—	g/10min.	0.11
Melting point (Vicat softening temperature)	D-1525	°F	252	°C	122
Brittleness temperature	D-746	°F	<-105	°C	<-76
Coefficient of thermal expansion/contraction	D-696	in/in/F°	$9x10^{-5}$	mm/mm/C°	$1.6x10^{-4}$
Thermal conductivity	C-177	BTU-in./hr.-ft²-°F	2.5	W/m • °C	0.36
Tensile strength, yield (2.0 in/min)	D-638	PSI	3200	MPa	22.1
Tensile strength, ultimate (2.0 in/min)	D-638	PSI	>4000	MPa	>27.6
Elongation (2.0 in/min.)	D-638	%	>800	%	>800
Flexural modulus	D-790	PSI	125,000	MPa	862
Hardness	D-2240	Shore "D"	D58	Shore "D"	D58
Environmental stress crack resistance (condition C)	D-1693	F_0, hours	> 500	F_0, hours	> 500

Grandview Industries, Limited, in its efforts to continually improve its Techline® products' performance, reserves the right to alter individual resin properties within governing design standards.

TABLE III

Butt Fusion Stub Ends

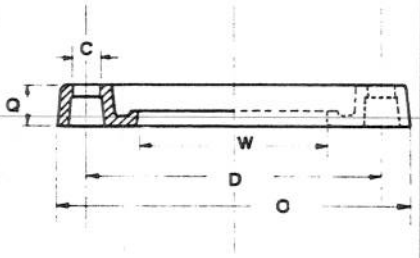


Nom. dia.	OD	OD_3	OD_4	z	h_1	h
3"	3.58"	4.00"	5.43"	3.15"	.79"	.67"
4"	4.37"	4.75"	6.22"	3.15"	.79"	.71"
6"	6.36"	6.88"	8.35"	3.15"	.79"	.98"
8"	7.93"	9.00"	10.55"	3.94"	1.18"	1.38"
10"	9.9"	10.3"	12.6"	3.94"	1.26"	1.57"
11"	11.08"	11.3"	12.6"	3.94"	1.38"	1.77"
12"	12.46"	12.7"	14.57"	3.94"	1.38"	1.97"
14"	14.04"	14.3"	16.93"	3.94"	.79"	1.97"
16"	15.83"	16.3"	18.98"	3.94"	.79"	1.97"
18"	17.80"	18.3"	21.38"	3.94"	.79"	1.97"
20"	19.76"	20.3"	23.03"	3.94"	79"	1.97"
22"	22.13"	22.13"	26.97"	2.36"	—	1.97"
24"	24.89"	24.89"	26.97"	2.36"	—	1.97"

NOTE:
"t" (wall thickness) values can be obtained from Table I.

TABLE IV

Ductile Iron Flanges*



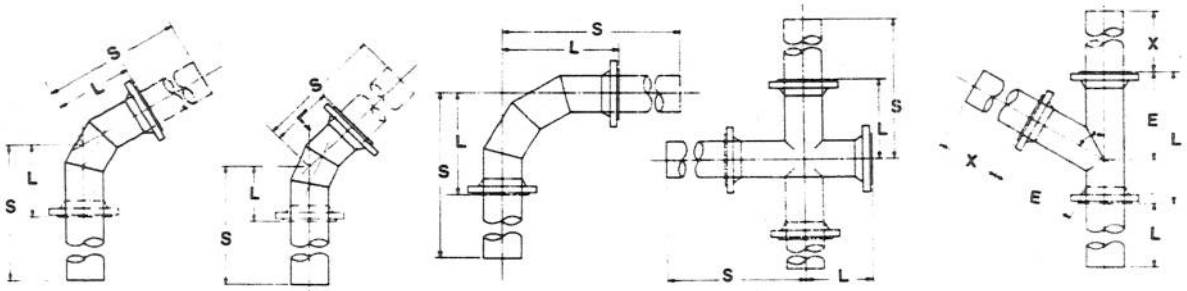
NPS	O	Q	W	C	D	BOLTS No.	BOLTS Dia.	LENGTH A	LENGTH B
3"	7.25"	.94"	4.00"	.75"	6.00"	4	0.625"	4.5"	4.0"
4"	9.00"	.94"	4.75"	.75"	7.50"	8	0.625"	4.5"	4.0"
6"	11.00"	1.00"	7.00"	.875"	9.50"	8	0.75"	5.5"	4.5"
8"	13.50"	1.12"	9.00"	.875"	11.75"	8	0.75"	6.5"	5.5"
10"	16.00"	1.19"	10.31"	1.00"	14.25"	12	0.875"	7.0"	5.5"
11"	16.00"	1.19"	11.37"	1.00"	14.25"	12	0.875"	7.5"	6.0"
12"	19.00"	1.25"	12.78"	1.00"	17.00"	12	0.875"	8.0"	6.0"
14"	21.00"	1.38"	14.38"	1.125"	18.75"	12	1.0"	8.5"	6.5"
16"	23.50"	1.44"	16.38"	1.125"	21.25"	16	1.0"	8.5"	6.5"
18"	25.00"	1.56"	18.38"	1.250"	22.75"	16	1.125"	9.0"	7.0"
20"	27.50"	1.69"	20.38"	1.250"	25.00"	20	1.125"	9.0"	7.0"
22"	32.00"	1.75"	22.67"	1.375"	29.50"	20	1.125"	9.0"	7.0"
24"	32.00"	1.75"	25.43"	1.375"	29.50"	20	1.125"	9.0"	7.0"

* Also available in aluminum
- 22 inch nominal dia. available in aluminum

Suggested bolt lengths
A. - P.E. to P.E. connections
B. - P.E. to metal flange connections

TABLE V

Butt Fusion or Flanged Fabricated Fittings



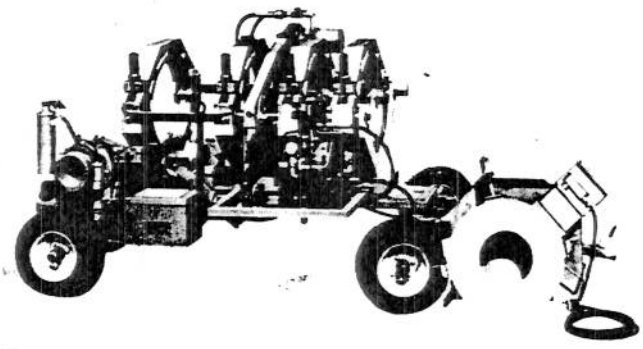
Nom. Dia.	45° L	45° S	60° L	60° S	90° L	90° S	TEE OR CROSS L	TEE OR CROSS S	45° OR 60° LATERAL* L	45° OR 60° LATERAL* E	45° OR 60° LATERAL* X
4"	8 1/2"	20 1/2"	9 1/2"	21 1/2"	12"	24"	10"	22"	18"	12"	12"
6"	9 3/4"	21 3/4"	11"	23"	15"	27"	12"	24"	24"	16"	12"
8"	11"	23"	11 3/4"	27 3/4"	18"	33"	14"	29"	30"	20	15"
10"	12 1/4"	27 1/4"	14 1/2"	29 1/2"	21"	36"	15"	30"	36"	24"	15"
11"	12 3/4"	27 3/4"	15 1/4"	30 1/2"	22 1/2"	37 1/2"	16 1/2"	31 1/2"	39"	26"	15"
12"	13 1/2"	28 1/2"	16 3/8"	31 3/8"	24"	39"	18"	33"	42"	28"	15"
14"	14 3/4"	34 3/4"	18"	38"	27"	47"	20"	40"	48"	32"	20"
16"	16"	36"	19 3/4"	39 1/2"	30"	50"	22"	42"	54"	36"	20"
18"	17 1/4"	37 1/4"	21 1/2"	41 1/2"	33"	53"	24"	44"	60"	40"	20"
20"	18 1/2"	38 1/2"	22 3/4"	43 1/2"	36"	56"	26"	46"	64"	44"	24"
22"	19 3/4"	39 3/4"	24"	45 1/2"	39"	59"	28"	48"	68"	48"	24"
24"	21"	40"	25 1/4"	47 1/2"	42"	62"	30"	50"	72"	52"	24"

*Reducing tees, crosses and laterals also available.

The thermal butt fusion technique utilized in joining Techline® HDPE pipe provides excellent joint integrity. Butt fused joints require no external couplings and joint strength is compatible with the inherent performance of the pipe.

The Techline® fusion procedure:

1. Clean pipe ends.
2. Clamp pipe ends tightly into the fusion machine and trim both surfaces squarely by rotating the double edged trimmer. Continuous ribbon-like shavings will be evident.
3. Remove trimmer and check for square, uniform alignment by pressing the pipe ends together.
4. With pipe ends properly faced, insert the heater plate at 200 °C (392 ° F) and compress the pipe ends against the plate at the pressure specified in Figure 1. Watch for a proper melt-bead formation uniformly around the circumference of both pipe ends. (Melt-bead should be approx. 1/8 inch dia. for pipe sizes up to 6 inch and 3/16 inch dia. for 8 inch pipe and larger).
5. Once the heating process is complete, quickly remove the heater plate to ensure that the plate does not rub the molten pipe ends.
6. Press the melted pipe ends together using the specified joining pressure (see Figure 1) forming a twin roll-back fusion bead. Maintain pressure until joint is cool to touch. Allow joint to cool for another 30 minutes before exerting stresses on the newly fused joint.



Butt fusion unit for 6" thru 18" manufactured by McElroy Manufacturing, Inc.

The thermal butt fusion technique for polyethylene stub-ends and fabricated fittings follows the Techline® fusion procedure. A special stub-end holder, supplied with each machine, allows stub ends to be aligned, trimmed and butt-fused to the pipe.

Fusion pressures **Figure 1.**

The following interfacial pressures are recommended for butt fusion of Techline® HDPE pipe:

Heating pressure — 12 psi
Fusion pressure — 24 psi

With the variety of butt fusion equipment available to join HDPE pipe, the following formula can be applied to obtain the correct gauge pressure readings that provide the desired interfacial pressure.

$$Pg = \left(\frac{Ax}{Ae}\right) \cdot Pi$$

Where:
Pg = Gauge pressure reading
Ax = Cross-sectional area of pipe wall
Ae = Effective cross-sectional area of the hydraulic cylinder(s).
Pi = Interfacial pressure as recommended above.

Example:
For 16 inch Series 100 pipe
OD = 15.83 inches
t = 1.11 inches
ID = 13.60 inches

$$Ax = \frac{\pi (OD^2 - ID^2)}{4} = \frac{\pi}{4}(15.83^2 - 13.60^2) = 51.54 \text{ in.}^2$$

Ae = 6.01 in² (Note: refer to machine manufacturer for Ae value of each different model)

Hence for heating $Pg = \frac{51.54}{6.01} \times 12 = 103$ psi

And for fusion $Pg = \frac{51.54}{6.01} \times 24 = 206$ psi

NOTE: - Pressure due to track friction on butt fusion apparatus must be added to the above Pg value.
- Multiply by 0.0689 for conversion to bars (Kg/cm²)

INSTALLATION APPLICATIONS

Techline® polyethylene pipe has many unique physical properties which make it the most efficient and economical piping system for a variety of applications.

DIRECT BURIAL INSTALLATIONS

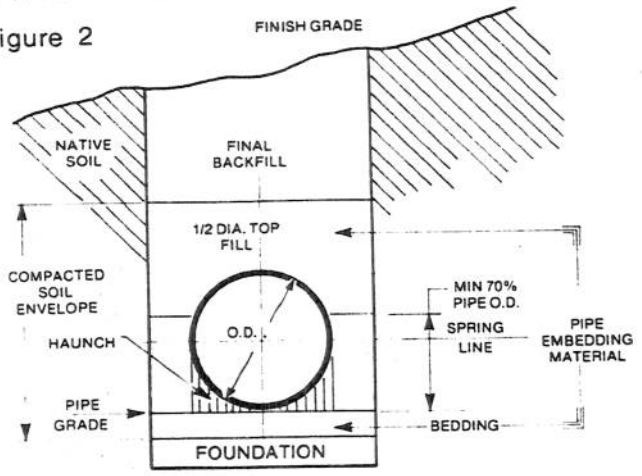
Techline® HDPE pipe has definite advantages in many below ground installations. The butt fused joints allow the pipe to be prefabricated into continuous lengths above ground. The flexibility and light weight of the pipe permits easy installation into a narrow trench. The use of light equipment is possible on most Techline® HDPE projects and in many cases diameters of up to 250mm can be snaked manually into the trench. Trench bed preparation may progressively precede pipe placement and burial, thereby maintaining a compact construction area.

Techline® HDPE pipe is particularly well adapted for installation in areas of unstable soil conditions since Techline® will flex rather than fracture in response to ground shifts.

The trench bottom should be smooth and free of any objects which may cause point loading on the pipewall. In areas where bedding is required, sand or gravel (with particle sizes no greater than 1") is recommended. Pressure systems of Techline® HDPE pipe may be installed with less concern for accurate levelling of the trench bottom.

TYPICAL TRENCH DETAIL

Figure 2



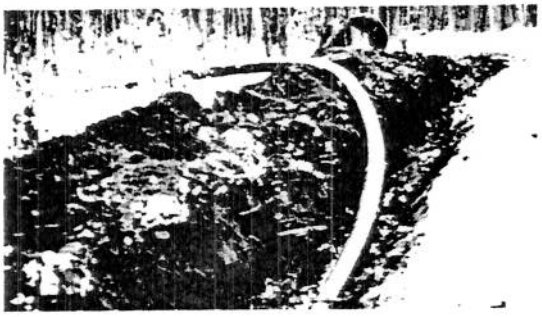
Normally, the pipe is placed in a trench one foot wider than the pipe diameter allowing proper compaction around the pipe. Loose material should be placed in the trench and compacted in 4" to 6" layers under the haunches of the pipe. This material should be well tamped between the pipe and the trench wall, until the haunching layers are firm to the springline of the pipe.

The initial backfill is compacted to a point 6" to 10" above the pipe. (See figure 2.)

Both haunching and initial backfill should be compacted to a density of over 90% of Standard Procter (AASHTO T-99) density.

Backfilling is usually completed by bulldozing excavated material back into the trench to ground level. In areas where heavy traffic is expected, a final back-fill of granular material should be compacted to a density of 90% to 95%.

For additional information regarding underground installation of Techline® HDPE, consult ASTM D2321, ASTM D2774, Plastic Pipe Institute Technical Report TR-31/9-79 or the Grandview Design Catalogue (Engineering Design Section).



Flexible Techline® easily handled in long butt fused lengths.

PRE-INSULATED INSTALLATIONS

In northern communities, shallow buried systems can be protected from freezing with Grandview's pre-insulated Techline® HDPE piping system. The factory insulated package is available with optional electrical heat tracing capabilities.

Significant cost savings can be realized through reduced operating and maintenance costs.

MARINE INSTALLATIONS

Marine installations include intakes, outfalls, and water crossings. The lightweight and flexibility of Techline® and its ability to float when full of water offers time and cost savings to installation.

For marine bottom placement of Techline® HDPE, air-locked continuous lengths can be floated with anchor ballasts attached to the proper location.

The sinking process is initiated by pumping water into the shore end of the pipe. At the same time the pipe is lifted near its shore end to create a local water pocket (see figure 3). By continuing this process the pipe can be gradually sunk to the marine bottom.

During the water filling operation, air must be allowed to escape from the other end. This is best accomplished with one or more valves installed in the elevated blind flange bulkhead.

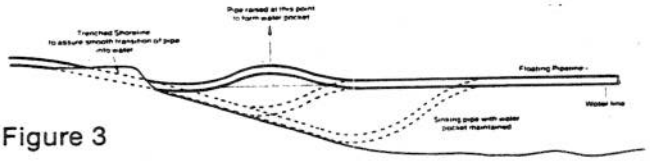


Figure 3

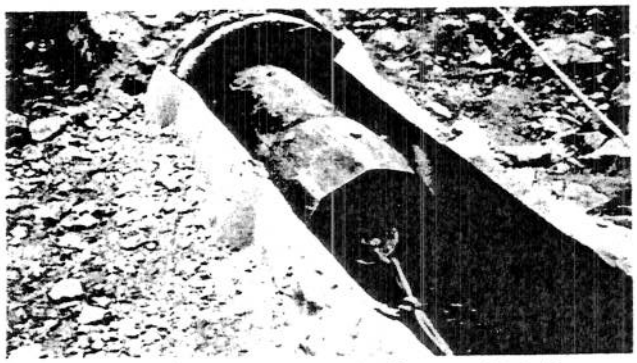
Ballast weights are designed to anchor the pipe to the bottom and generally are formed of steel reinforced concrete.

Spacing and correct weights can be obtained from the Grandview Design Catalogue.

Auxiliary marine system components, such as water intake structures and outfall diffusers, are also fabricated by Grandview.

SEWER RELINING

Insertion renewal using Techline® HDPE is a practical and permanent method of sewer rehabilitation.



Relining sanitary sewer in Ottawa, Ontario

Relining with polyethylene allows sewer replacement with a minimum of excavation and can result in cost savings of 40% to 85%. Traffic diversions are minimized and there is usually no interruption of service. Elimination of infiltrating ground water can substantially reduce the cost of waste water treatment while elimination of exfiltrating sewage reduces the risk of environmental pollution.