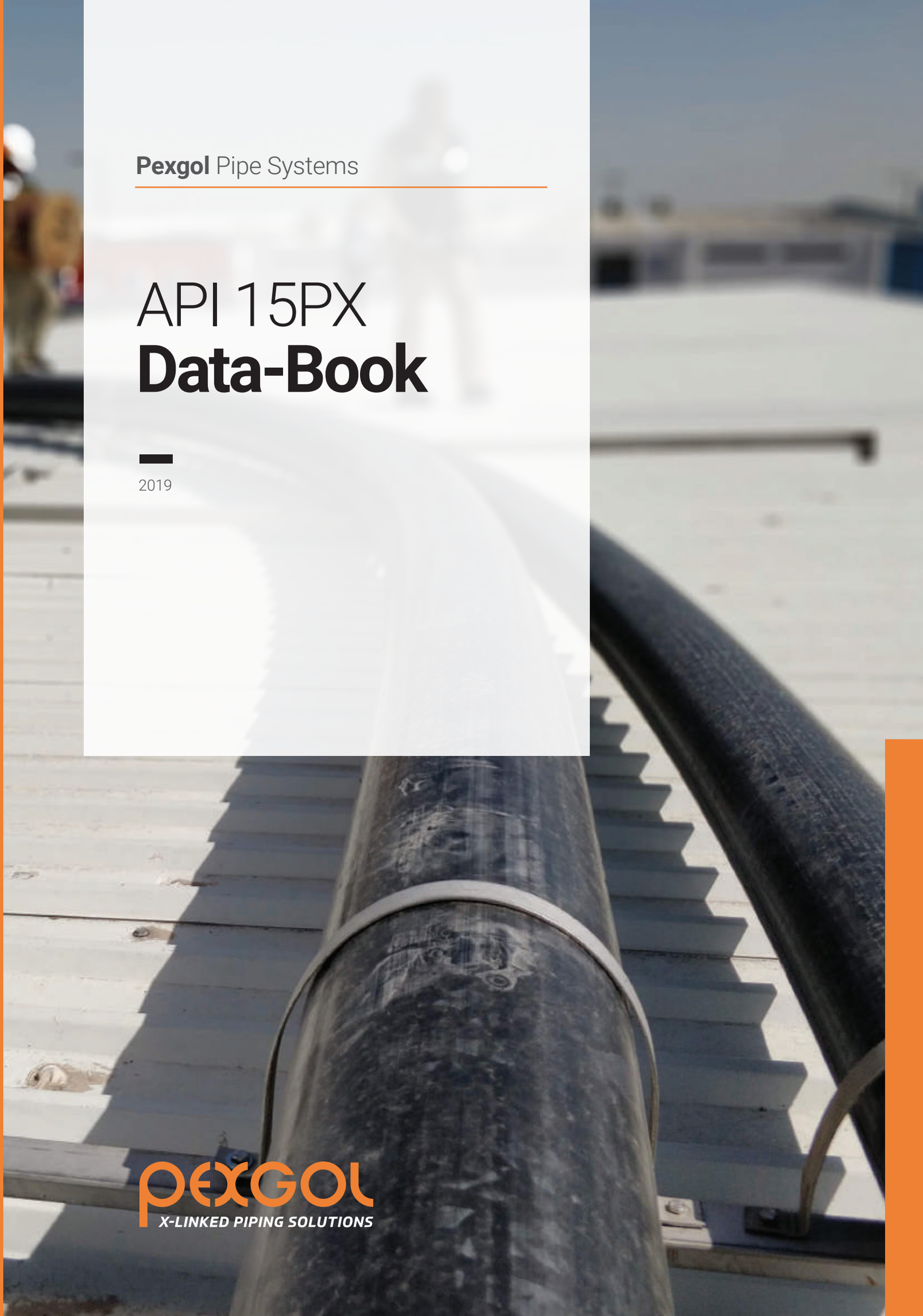


Pexgol Pipe Systems

API 15PX
Data-Book

2019

pexgol
X-LINKED PIPING SOLUTIONS

Table of Contents

1. Pexgol Technica

API 15 PX based Solutions for Industrial Applications

Pexgol pipes with their excellent resistance to temperature extremes, chemicals and abrasion are ideal conduits for a wide range of industrial applications.

Pexgol pipes offer a successful, cost-effective solution where conventional pipes would be unsatisfactory for conveying slurries due to their poor abrasion resistance or because of vulnerability to chemicals.

2. Introduction to API 15PX

The purpose of API 15PX is to provide standards for crosslinked polyethylene (PEX) line pipe suitable for use in conveying oil, gas, and non-potable water in underground, aboveground, and re-liner applications for the oil and gas producing industries.

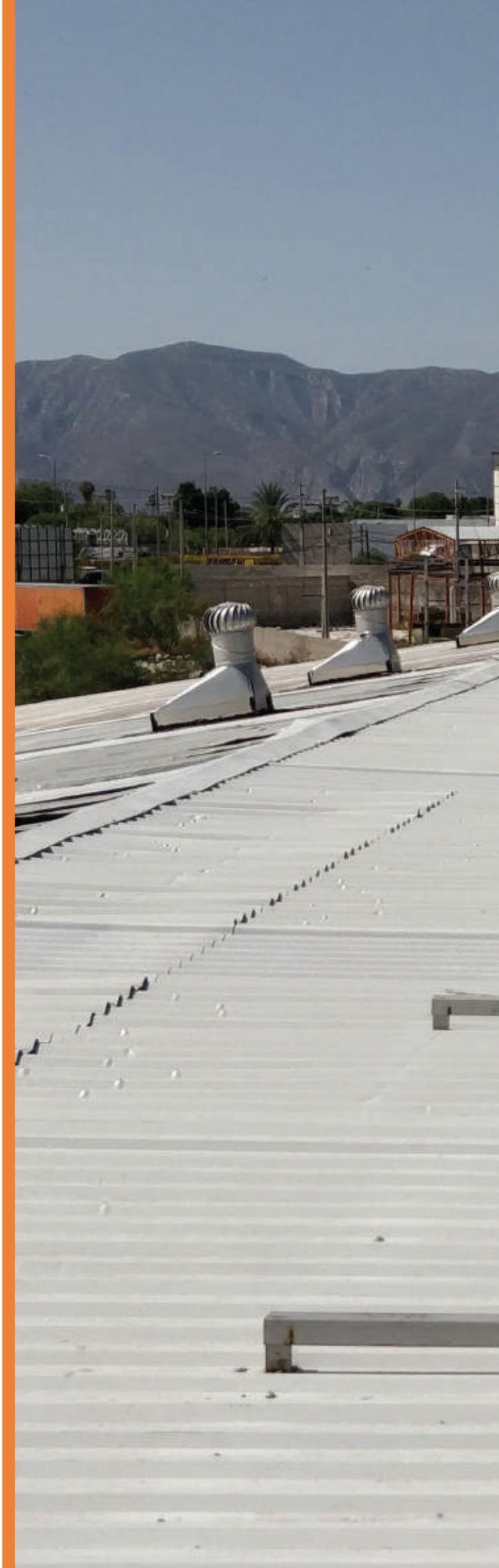
This specification does not propose to address all of the safety concerns associated with the design, installation, or use of products suggested herein. It is the responsibility of the user of the standard to utilize appropriate health and safety considerations.

All pipe produced under this standard utilizes pressure-rated materials used in pressurized, non-pressure, and negative pressure applications.

The technical content of this document provides requirements and guidelines for performance, design, materials inspection, dimensions and tolerances, marking, handling, storing, and shipping.

3. Scope

API 15PX covers PE-X line pipe utilized for the production and transportation of oil, gas, and non-potable water. The piping is intended for use in new construction, structural, pressure-rated liner, line extension and repair of both aboveground and buried pipe applications.



4. Service Conditions

The standard service conditions for the API 15PX standard pressure rating are as follows:

- Standard pressure ratings in non-chemically-aggressive fluids;
- Service temperature range: -50°C (-58°F) to 95° C (203°F);
- The fluid environment is oil, gas, and non-potable water and combinations thereof (see table “Fluid Service Factors”);

Note: Applications above 95°C (203°F) require special design consideration.

5. Long-Term Hydrostatic Strength

The API 15PX gives the designer / engineer the possibility to choose between two design methods. Either the HDB or DIN 16892/3 long-term strength shall be used to establish the maximum working pressure of a PE-X pipe.
The long-term strength of the material shall be established by the manufacturer in accordance with PPI TR-3 using ASTM D2837 or ISO 9080 methodology. PE-X materials meeting the requirements of this specification shall be tested for long-term hydrostatic strength witnessed or tested by a certified third-party auditing agency that conforms to ISO/IEC 17020 and/or ISO/IEC 17065, or have an HDB and/or MRS listed in PPI TR-4.

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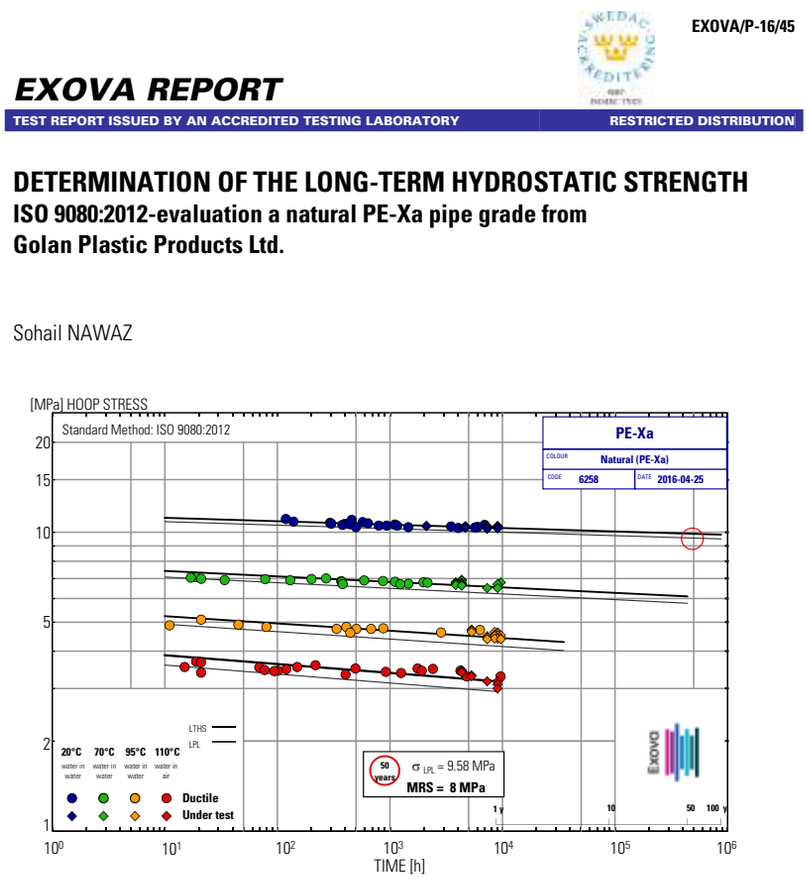


EXOVA/P-16/45

EXOVA REPORT

TEST REPORT ISSUED BY AN ACCREDITED TESTING LABORATORY — RESTRICTED DISTRIBUTION

DETERMINATION OF THE LONG-TERM HYDROSTATIC STRENGTH
ISO 9080:2012-evaluation a natural PE-Xa pipe grade from Golan Plastic Products Ltd.

Sohail NAWAZ

5.1 Regression line data of Pexgol done by EXOVA according to ISO 9080 – relevant for HDB (1250 psi in 230°C) and DIN 16892 requirements (9.5 MPa in 200°C).

The design process shall always include the effects of the internal and external chemical environment on the long-term strength, which comprises the design service factor for the HDB method or the design coefficient when using the DIN 16892/3 method; the operating temperature; and the chemical environment that is included in the fluid service factor (FSF). The design process shall also include consideration of the installation method.

6. Fluid Service Factors

Fluid service factor (FSF) is a factor applied in the determination of the maximum working pressure to account for the impact of the transported fluid on pipe performance.

The following table is used to compensate for possible effects of the transported fluid on the long-term performance of the piping and for the hazardous nature of some applications.

6.1 Fluid Service Factors (FSF)

ENVIRONMENT	FACTOR	HDB	DIN 16892/3
Produced water, seawater, brine, process water, and other oilfield water-based fluids, excluding oilfield water containing > 2 % liquid hydrocarbons [1]	1.0	Table 2	Table 4
Dry gas gathering (no associated hydrocarbon liquids) [2]	1.0	Table 2	Table 4
Dry gas gathering that is subject to Canadian Federal Regulations [3]	1.0	Table 2	Table 4
Multiphase fluids, wet natural gas, and liquid hydrocarbons	0.5	Table 3	Table 5

[1] Water containing significant quantities of liquid hydrocarbons (> 2 %) shall be treated as liquid hydrocarbon.

[2] Gas gathering in this standard refers to gas from a well or production source in a low-population-density area that is not subject to U.S. Department of Transportation, Office of Pipeline Safety, Title 49 CFR Part 192.

[3] CSA Z662 Clause 13.3.

When using the HDB Pressure Rating System, the following steps shall be followed:

- Determine the Fluid Service Factor (FSF) to determine whether to use Table 2 or Table 3.
- Select the appropriate HDB based on the anticipated operating temperature and the material designation code as shown in the appropriate rows of Table 2 if the FSF is 1.0 or Table 3 if the FSF is 0.5.
- Find the DR for the pipe in the column headings in Tables 2 or 3.
- The value for the maximum working pressure in water service is at the intersection of the DR column and the HDB row in Table 2, and includes the application of a design service factor of 0.71.
- The value for the maximum working pressure for multiphase fluids, wet natural gas, and liquid hydrocarbons is at the intersection of the DR column and the HDB row in Table 3, and includes the application of a design service factor of 0.71.

6.2 Standard Pressure Ratings (psi) of Pexgol Pipe Using the HDB Method of Design at Various Temperatures for Non-Chemically Aggressive Fluids

TEMPERATURE °C / °F	MATERIAL DESIGNATION CODE	HDB (PSI)	MAXIMUM WORKING PRESSURES (PSIG) FOR THE INDICATED DR				
			DR 7.4	DR 9	DR 11	DR 13.6	DR 17
23 / 73	PEXGOL	1250	277	222	178	141	111
60 / 140		800	178	142	114	90	71
82 / 180		800	178	142	114	90	71
93 / 200		630	140	112	89	71	56

NOTE: For the working pressure of multiphase fluids, wet natural gas, and liquid hydrocarbons, refer to Table 3.

6.3 Working Pressure (psi) of Pexgol Pipe Using the HDB Method of Design at Various Temperatures for Multiphase Fluids, Wet Natural Gas, and Liquid Hydrocarbons

TEMPERATURE °C / °F	MATERIAL DESIGNATION CODE	HDB (PSI)	MAXIMUM WORKING PRESSURES (PSIG) FOR THE INDICATED DR				
			DR 7.4	DR 9	DR 11	DR 13.6	DR 17
23 / 73	PEXGOL	1250	139	111	89	70	55
60 / 140		800	89	71	57	45	36
82 / 180		800	89	71	57	45	36
93 / 200		630	70	70	45	36	28

When using the DIN 16892/3 Pressure Rating System, the following step shall be followed:

- Determine the fluid service factor (FSF) according to Table 1 to determine whether to use Table 4 or Table 5 to determine the maximum working pressure.
- Select the anticipated operating temperature from the row headings in Table 4 if the FSF is 1.0 or in Table 5 if the FSF is 0.5.
- Find the DR for the pipe in the column headings in Table 4 or Table 5.
- The value for the maximum working pressure in water service is at the intersection of the DR column and

the Temperature row in Table 4.

- The value for the maximum working pressure for multiphase fluids, wet natural gas, and liquid hydrocarbons is at the intersection of the DR column and the Temperature row in Table 5.
- Table 5 shall be used for determining the maximum working pressure for pipes transporting multiphase fluids, wet natural gas, and liquid hydrocarbons.
- The values for the maximum working pressure listed in Table 4 and Table 5 include the application of a design coefficient of 1.25, and are for a 20 year service life for all temperatures less than 90°C; a 15-year service life at 90°C; and a 10 year service life at 95°C.
- The values for the maximum working pressure listed in Table 4a and Table 5a include the application of a design coefficient of 1.25, and are for a 50 year service life for temperatures.

6.4 Standard Pressure Ratings (psi) of PE-X Pipe Using the DIN 16892/3 Method of Design at Various Temperatures for Most Fluids

TEMPERATURE °C / °F	MAXIMUM WORKING PRESSURES (PSIG) FOR THE INDICATED DR			
	DR 7.4	DR 9	DR 11	DR 13.6
10 / 50	395.9	314.7	249.4	198.7
20 / 68	350.9	278.4	220.4	175.5
30 / 86	310.3	246.5	195.8	155.2
40 / 104	277.0	219.0	174.0	137.8
50 / 122	246.5	195.8	155.2	123.3
60 / 140	220.4	174.0	137.8	110.2
70 / 158	197.2	156.6	123.3	98.6
80 / 176	175.5	139.2	110.2	88.5
90 / 194	159.5	126.2	100.1	79.8
95 / 203	152.3	120.4	95.7	75.4

6.4.1 Pegol pipes Pressure Ratings (psi) Using the DIN 16892/3 Method of Design at Various Temperatures for Most Fluids for 50 years.

TEMPERATURE °C / °F	MAXIMUM WORKING PRESSURES (PSIG) FOR THE INDICATED DR			
	DR 7.4	DR 9	DR 11	DR 13.6
10 / 50	390	310	247	196
20 / 68	329	261	207	164
30 / 86	287	228	181	144
40 / 104	285	227	180	143
50 / 122	247	195	155	123
60 / 140	218	173	138	109
70 / 158	192	153	122	96
80 / 176	170	134	106	86
90 / 194	162	128	101	80
95 / 203	153	120	95	73

6.5 Maximum Working Pressure (psi) of PE-X Pipe Using the DIN 16892/3 Method of Design at Various Temperatures for Multiphase Fluids, Wet Natural Gas, and Liquid Hydrocarbons.

TEMPERATURE °C / °F	MAXIMUM WORKING PRESSURES (PSIG) FOR THE INDICATED DR			
	DR 7.4	DR 9	DR 11	DR 13.6
10 / 50	197.7	157.3	124.7	99.3
20 / 68	175.5	139.2	110.2	87.7
30 / 86	155.2	123.3	97.9	77.6
40 / 104	138.5	109.5	87.0	68.9

TEMPERATURE °C / °F	MAXIMUM WORKING PRESSURES (PSIG) FOR THE INDICATED DR			
	DR 7.4	DR 9	DR 11	DR 13.6
50 / 122	123.3	97.9	77.6	61.6
60 / 140	110.2	87.0	68.9	55.1
70 / 158	98.6	78.3	61.6	49.3
80 / 176	87.7	69.6	55.1	44.2
90 / 194	79.8	63.1	50.0	39.9
95 / 203	76.1	60.2	47.9	37.7

6.6 Pexgol Maximum Working Pressure (psi) Using the DIN 16892/3 Method of Design at Various Temperatures for Multiphase Fluids, Wet Natural Gas, and Liquid Hydrocarbons.

TEMPERATURE °C / °F	MAXIMUM WORKING PRESSURES (PSIG) FOR THE INDICATED DR			
	DR 7.4	DR 9	DR 11	DR 13.6
10 / 50	195.0	155.0	123.5	98.0
20 / 68	164.5	130.5	103.5	82.0
30 / 86	143.5	114.0	90.5	72.0
40 / 104	142.5	113.5	90.0	71.5
50 / 122	123.5	97.5	77.5	61.5
60 / 140	109.0	86.5	69.0	54.5
70 / 158	96.0	76.5	61.0	48.0
80 / 176	85.0	67.0	53.0	43.0
90 / 194	81.0	64.0	50.5	40.0
95 / 203	76.5	60.0	47.5	36.5

Note: The use of pipe sizes not listed in API 15PX are allowed.

The pressure ratings shall be calculated using the following:

6.7 Calculation of Pressure Ratings for Pipe Sizes Not Listed in this Standard

The various tables of pressure rating in API 15PX standard contain pressure ratings for a limited range of wall thicknesses. The HDB and DIN 16892/3 methods provide a means of calculating the maximum working pressure for nonstandard sizes that are not listed in this specification.

In this section which is taken from API 15PX annex D, methods are described to calculate maximum working pressure if certain information is available about the pipe and operating conditions.

6.7.1 Pressure Rating Based on HDB

Knowing the HDB and the dimension ratio (DR) enables calculation of the maximum working pressure for a given fluid environment. Equation D.1 defines the relationship between maximum working pressure and the DR, HDB, and fluid environment.

Where:

$$MWP = \frac{2HDB \bullet DF \bullet FSF}{DR - 1} \quad \text{(D.1)}$$

MWP:	maximum working pressure (psi)
HDB:	hydrostatic design basis (psi)
DR:	dimension ratio
	— (average outside diameter) / (minimum wall thickness)
DF	system design factor
	— 0.71 for this standard
FSF	fluid service factor
	— 1.0 for non-chemically-aggressive fluids
	— 0.5 for multiphase fluids, wet natural gas, and liquid hydrocarbons

Example: Calculating the MWP for a DR 6 pipe
MWP = **2 x 1250 x 0.71 x 1 / (6-1) = 355 psi**

6.7.2 Pressure Rating Based on DIN 16892/3

DIN 16892/3 pressure rating method is based on the long-term hydrostatic strength performance compared to reference lines published in the standard that relate the long-term hydrostatic pressure resistance of the pipe to the measured rupture time. It is necessary to use the reference lines to calculate the maximum working pressure for a known pipe diameter and wall thickness. Equation D.2 is derived from the equation in the DIN standard.
Where:

$$MWP = \frac{16\sigma \bullet t}{d - t} \bullet FSF \quad \text{(D.2)}$$

MWP: maximum working pressure (bars)
σ: long-term hydrostatic pressure resistance from reference lines (N/mm2)
t: minimum pipe wall thickness (mm)
d: average pipe diameter (mm)
DF: system design factor
— 1.25 for this standard
FSF: fluid service factor
— 1.0 for non-chemically-aggressive fluids
— 0.5 for multiphase fluids, wet natural gas, and liquid hydrocarbons

Example: Calculating the MWP for a DR 6 pipe
MWP = **(16 x 95 x 8.33 / (50-8.33)) x 1 = 303.85 = 30 bar**

7. External Pressure Rating (Collapse Pressure)

In certain applications, PEX pipe may be subjected to a “negative pressure” that could cause the collapse of the pipe.

A “negative pressure” situation exists where the external loading on the pipe is greater than the internal pressure in the pipe, which can result in pipe collapse if the external hydraulic pressure exceeds the flattening resistance of the pipe.

Flattening resistance should be considered for gravity flow lines, vacuum lines, submerged lines, and any line where the internal pressure is less than the static external hydraulic load.

Flattening resistance is usually not a consideration where the end of the line is open to an external water environment. Open-ended lines are pressure balanced, and the static head in a full pipe crossing a water body will usually be the same or higher than the water height above the pipeline.

A few examples of where negative pressure situations may occur are as follows.

a. Aboveground or below-ground gravity flow lines;
b. A vacuum line—a water suction line submerged 23 ft. in a lake (equivalent to 10 psi external loading) and that is operating under a partial vacuum of 5 psi. The net negative pressure is 15 psi;
c. a water line going over a hill. The velocity of the water flow down the hill can exceed the velocity of the water coming up the hill and cause a “negative pressure” to occur.

Excessive external pressure or net internal vacuum pressure can cause pipe flattening or collapse.
The maximum external load is determined not by material strength but by the pipe’s stiffness.

The pipe will flatten if the bending moment due to the load exceeds the resisting moment due to the elastic stresses in the pipe.

The critical external pressure above which round pipe will flatten or collapse can be estimated by using Love’s Equation (B.1) below:

Where:

$$P_{cr} = \frac{2E}{1 - \mu^2} \left\langle \frac{1}{DR - 1} \right\rangle^3 \quad \text{(B.1)}$$

Pcr: is the critical flattening pressure, lb./in.2;
E : is the elastic modulus, lb./in.2;
μ: is Poisson's ratio;
(0.40 for PE-X under long-term stress; 0.35 for PEX under short-term stress);
DR: is the pipe dimension ratio.

Example (Class 15 pipe, DR 11):

With a safety factor of 1.5 (as recommended in the technical literature)

$$P_{cr} = \frac{2\ X\ 23{,}780}{1\text{-}0.4^2} \left\{ \frac{1}{11\ -\ 1} \right\}^3 = 56.61$$

$$P_{cr} = \frac{56.61}{1.5} = 37.74\ psi\ -\ 2.6\ bar$$

8. Process of Manufacturing as Defined in API 15PX

REQUIREMENT	PARA.	API 15PX	PEXGOL	TEST REPORT	FREQUENCY
Long-term Hydrostatic Strength	5.3.1	HDB (1250 psi in 230°C)	HDB >1250 psi	EXOVA Sweden P-16/45	Type test
		DIN16892 (9.5 MPa in 200°C)	9.58 MPa		
Thermal Oxidative Stability	5.3.2	2.5 MPa hoop stress at 230 °F (110 °C) for 8760 hours . Or 2.4 MPa hoop stress at 230°F (110°C) for 15,000 hours. (For applications with high potential for oxidative attack)	> 27,216 hours at 2.9 MPa (Tests are still running)	Continuation of EXOVA P-16/45	Type test
Rapid Crack Propagation (RCP) Resistance	5.3.3	Lower than the minimum design temperature, but in no case higher than -20°C (-4°F)	-50ºC	TGM Austria - VAKU22740	Type test
Considerations for Chlorinated Water Service	5.3.4	Cell classification minimum value of 1 per ASTM F876	Cell classification value of 1 per ASTM F876	NSF project	Type test

Note: All reports are available at the section "Technical Reports".

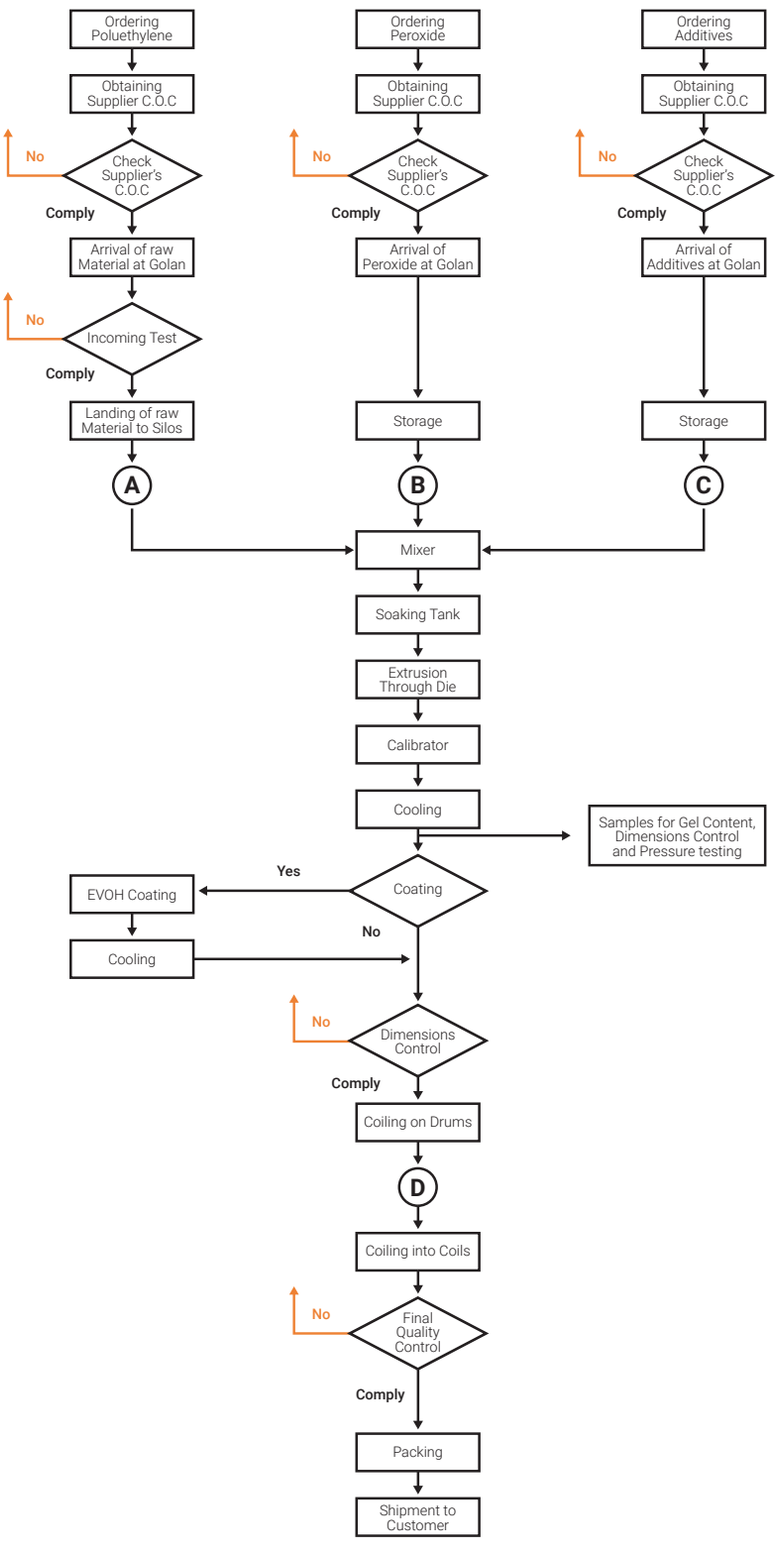
(*) UV resistance is shown by testing the pipe according to section 5.3.5 which refers to ISO 14531-1 annex C. please see the exposure document by ALLUNGA Australia (see Exposure Completion.pdf) which summarizes the exposure levels defined in ISO 14531 (3.5 GJ) and also the tests done after the exposure at the Danish standard institute – DTI (see Type Test (TT).pdf). The documents are connected by the batch number "69248" stated in both documents.

REQUIREMENT	PARA.	API 15PX	PEXGOL	TEST REPORT	FREQUENCY
UV Weathering Protection (relevant to para. 4.4)*	5.3.5	As defined in ISO 14531-1 Annex C	> ISO 14531-1 Annex c	DTI Denmark - Test report 558514 + exposure report from Allunga lab. Australia	Type test

Note: All reports are available at the section "Technical Reports".

(*) UV resistance is shown by testing the pipe according to section 5.3.5 which refers to ISO 14531-1 annex C. please see the exposure document by ALLUNGA Australia (see Exposure Completion.pdf) which summarizes the exposure levels defined in ISO 14531 (3.5 GJ) and also the tests done after the exposure at the Danish standard institute – DTI (see Type Test (TT).pdf). The documents are connected by the batch number "69248" stated in both documents.

8.1 Manufacturing process



8.2 List of materials

MATERIAL	DESCRIPTION / FUNCTION
High Density Polyethylene	Main resin
Anti-oxidant	Additive 1
Anti-oxidant	Additive 2
UV stabilizer	Addition to Carbon black
Peroxide	5.3.5

Note: Every bolt with a "no" is directed to the "non-compliance" procedure in the file of quality procedures.

9. Quality Management & Quality Control as Defined in API 15PX

9.1 Quality Management Program

Pexgol pipes meeting this specification are manufactured by **Golan Plastic Products** under a maintained and written quality management system in accordance with ISO 9001.

9.2 Quality Records Retention

Quality records in **Golan Plastic Products** remain legible, readily identifiable, and retrievable for a period of not less than 10 years.

9.3 Quality Control Tests – as per table 8 in API 15PX

REQUIREMENT	PARA.	TEST METHOD /CONDITIONS	PASS/FAIL CRITERIA	FREQUENCY – API 15PX	FREQUENCY – PEXGOL
Outside Diameter	Table 8	ASTM D2122 or ISO 3126	Dimensions specified in Table 5 or 6.	Once every 2 hours	Once every 2 hours
Wall Thickness	Table 8	ASTM D2122 or ISO 3126	Dimensions specified in Table 5 or 6.	Once every 2 hours	Once every 2 hours
Out of Roundness (Ovality)	Table 8	ASTM F2905	-For straight lengths of pipe, the requirements of ASTM F2905 shall be met. For coiled pipe, out of roundness shall be agreed on between the manufacturer and the buyer	Once/2 hours or once/coil, whichever is less frequent	Once/2 hours or once/coil, whichever is less frequent

(*) Hoop stress points are taken from the base regression lines in DIN 16892/3.

REQUIREMENT	PARA.	TEST METHOD /CONDITIONS	PASS/FAIL CRITERIA	FREQUENCY – API 15PX	FREQUENCY – PEXGOL
Crosslinking Degree (PE-Xa)	Table 8	ASTM F3203, ASTM D2765 Method B, or ISO 10147	Pexgol ≥ 70%	Once per three days per extrusion line	Once per batch/once per day whichever is more frequent
* Sustained Pressure Test	Table 8	ISO 1167 or ASTM D1598 667 psi (4.6 MPa) hoop stress at 203°F (95°C)	≥ 165 Hours	Once per two weeks per extrusion line	Once per two weeks per extrusion line
* Sustained Pressure Test	Table 8	ISO 1167 or ASTM D1598 638 psi (4.4 MPa) hoop stress at 203°F (95°C)	≥ 1,000 Hours	Once per year per extrusion line	At least once per year per extrusion line

(*) Hoop stress points are taken from the base regression lines in DIN 16892/3.

9.4 Additional tests done by Golan Plastic Products' laboratory.

REQUIREMENT	REFERENCE	TEST METHOD / CONDITIONS	PASS / FAIL CRITERIA	FREQUENCY	WORKING ORDER + DEVICE
MFR	Resin	ISO 1133	According to suppliers Melt Flow Index	Every batch	MFR testing machine according to QC-WI-001-11
Density	Resin	ISO 1183	> 0.926 g/cm3 (according to ASTM F2905)	Every batch	Analytic scale according to QC-WI-10.1.4.2
Water Content	Resin	ISO 15512	<0.5%	Every batch	Analytic scale + oven according QC-WI- QC-WI-046
Longitudinal Reversion	Pipe	ISO 2505	<3%	Once per two weeks per machine	Oven at 1200c According QC-WI-057-05

REQUIREMENT	REFERENCE	TEST METHOD / CONDITIONS	PASS / FAIL CRITERIA	FREQUENCY	WORKING ORDER + DEVICE
Stabilizers Migration	Pipe	NCh2086	≥50% of the average result of non-treated samples	Once per year	Oven at 1600c + glass flask according QC-WI-036-01
Oxidative Induction Time (OIT)	Pipe	EN 728	>20 minutes	Once per quarter	DSC machine according QC-WI-030-03
Oven Aging 160°	Pipe	DVGW W544	No defects	Once per two weeks per machine	Oven at 1600C accor-ding QC-WI-055-00
Thermal Stability at 110°C at 2.5 MPa	Pipe	DIN 16892/3	>8760 hours	Once per year	Oven at 1100c QCS-WI-001-11
Pent Test	Pipe	ASTM F876	>100 hours	Once per year	NSF Lab.

10. Quality control plan used for the realization of the "Long-Term Hydrostatic Strength" test

Form: QA-PR-026-02
Written by: Adi Arbel – Quality Manager
Date: March 2018

10.1 Quality control plan

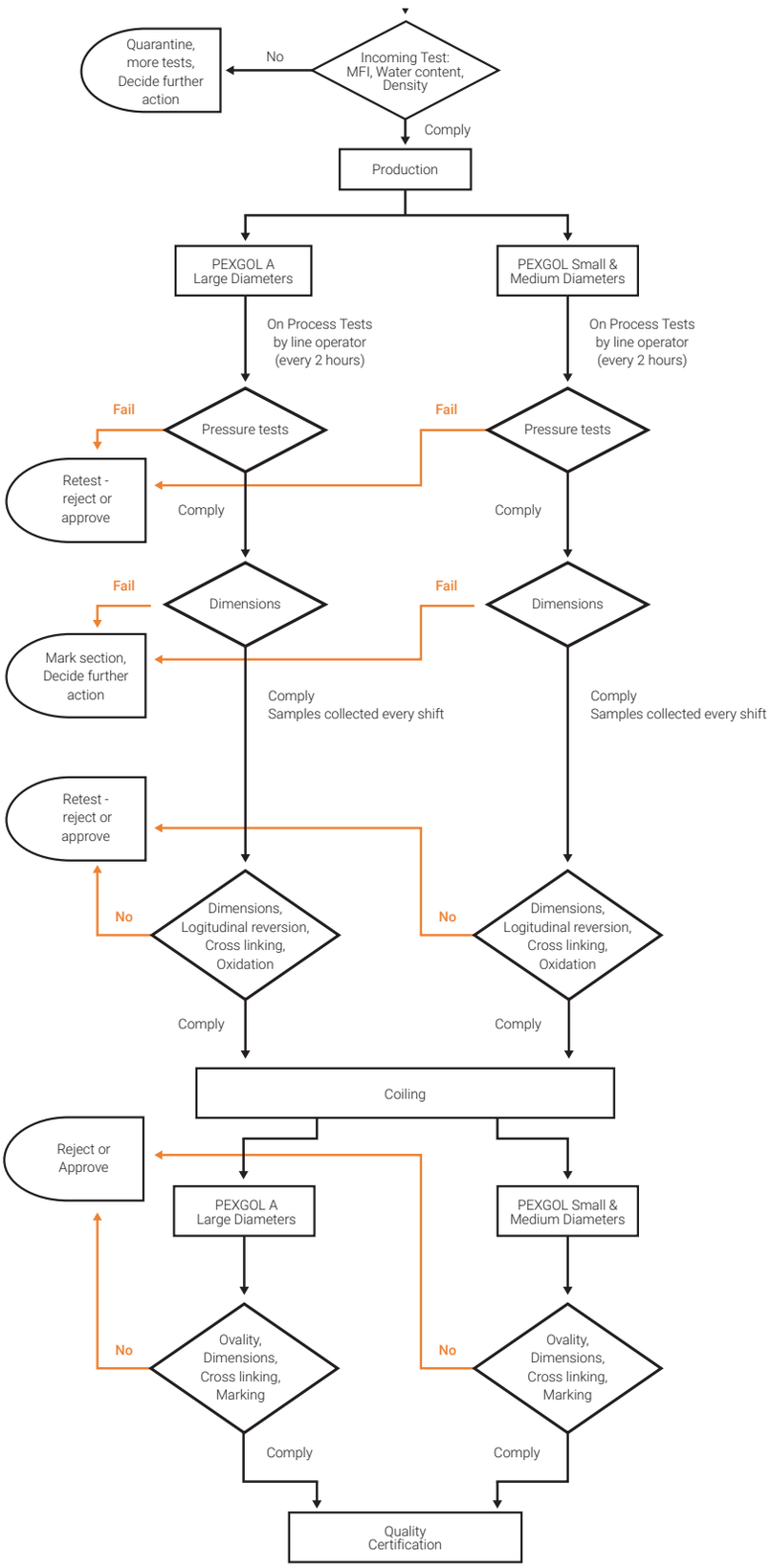
Appearance /appearance	No defects, bubbling or visible impurities		During production	Operators
			Production: Samples from the beginning and end of each section	Lab
			Coiling: 1. During coiling 2. Each sample	1. Operators 2. Lab
Dimensions (Wall thickness/Outer diameter/ Ovality)	According the tolerances defined in the specific item number	**ISO 3126**	Production -Set up, after 1/2 hour, every 4 hours and every end of section.	Operators
			Production - samples from the beginning and end of each section	Lab
			Coiling: 1. samples every 500 m 2. Beginning of drum	1. Lab 2. Operators

TEST DESCRIPTION	REQUIREMENT	TEST METHOD	FREQUENCY	RESPONSIBILITY
Hydrostatic pressure test	1 h/12 MPa /20°C	ISO 1167	At least once per year per dimension.	Lab
	1 h/4.8 MPa/95°C		At least once per year per machine.	Lab
	22 h/4.7 MPa /95°C 165 h/4.6 MPa /95°C		Each machine once a week or once per two weeks depending on standard.	Lab
	1000 h/4.4 MPa /95°C		At least once per year per machine.	Lab
Oxidation	24 h/ 160°C Procedure QC-WI-055 There will be no material change in shape	DVGW W544	Every batch.	Lab
Crosslinking	Degree of min 70% Procedure **QC-WI-007**	ISO 10147	Every batch.	Lab
Longitudinal reversion	120°c/ 1h Procedure **QC-WI-057** Max 3%	EN 743	Every batch.	Lab
Marking	According to specification of the specific item number and standard	According to relevant standard (e.g. API 15PX)	At Set up.	Coiling operators
			Once a shift (in two shifts out of three).	Lab
Thermal stability	8760h / 110 0C/ 2.5 MPa		Once a year.	Lab

In addition- once a shift QC team checks parameters of pipe and coils in the coiling department. Parameters been checked:

- Pipe: Outer diameter, wall thickness min and max, appearance, out of roundness.
- Marking details, marking length.
- Coil: core diameter, coil length, coil appearance- tying, carton match, label.
- Packaging

10.2 Control applied to the Manufacturing Process



10.3 Hydraulic Test, Marking, Inspection and Packing

Hydraulic Test done as described in "Quality Control Plane".

10.4 Record of production tests carried out in the laboratory

All information is recorded in the ERP system and can be printed out on a specific batch.

Technical Reports

1. Electrofusion Welding

Electrofusion fittings can be used to connect Pexgol cross-linked polyethylene pipes. The pipes and fitting are connected by means of fusion welding creating a leak-proof seal. There's no need for a sealing ring. During the electrofusion process a current is transported through a heating wire.

The surrounding material around the wire is melted and welds the pipe to the fitting.

Some of it advantages are:

- Electrofusion system is one of Pexgol's connector systems, providing all connection technologies for Pexgol pipes.
- Electrofusion fittings are the main means of connection in municipal water and industrial distribution systems.
- Fittings are tested and have a lifetime of 50 years, according to the European standards a working pressures of 16 atm in water networks.
- Lightweight and small volume welding connectors.
- Economical use especially for big diameters in water transportation.
- Connectors are offered in diameters ranging from 20 mm to 630 mm as well as in a wide variety: couplers, elbows, end plugs, Tees, saddles, tapping saddles (for connecting new outlets to "live line").

The entire electrofusion process is executed and fully monitored by the computerized control box ensuring safe, reliable connections.

1.1 Installation instructions for electrofusion fittings:

Installation can be performed only by trained workers who have received a valid certificate showing that they have been trained by a person authorized by Pexgol.

Use only electrofusion fittings approved for fusion with Pexgol cross-linked polyethylene pipes.
Wall thickness defined as follows:

25 – 75 mm pipes, minimum S.D.R. 11
90 – 355 mm pipes, minimum S.D.R. 16.2

1.2 Pressures:

PN 16 electrofusion fittings are suitable for working together with Pexgol pipes which are rated up to pressures of P.N. 15 in water or 10 bars in gas (only PE spigot connectors are produced in two levels, P.N. 10 and P.N. 16).

1.3 Rounding the pipe:

For a quality fusion and for easy insertion, rounding the pipe is compulsory. This is achieved by using rounding tools which are placed on the pipe end. The tools maintain a rounded pipe during the welding process.
Support of the fitting during the welding process:
When welding pipes in diameters 90mm and higher, the pipe should be inserted into the fitting by means of spanners (come-alongs) which allow controlled insertion and ensure the coupler does not move during the welding process.

1.4 Cooling time:

Please note the cooling time that appears on a sticker on each fitting. Do not disassemble spanners and rounding devices until the cooling time has elapsed.

A good practice: when the fusion process is completed, note the hour and add the cooling time. The result is the disassemble time. Mark this time on the fitting and do not disassemble it earlier than this time!

Pexgol electrofusion fittings are allowed for use at the following temperatures:

PIPE CLASS (P.N.)	TEMPERATURE
16	20°C
14.4	25°C
13	30°C
11.5	35°C
9.9	40°C
8.3	45°C
6.9	50°C

1.5 Preparations:

1. Preparing the fittings for welding: Preparation and welding can be conducted at ambient temperature if the weather is windy (with dust) or rain or other sources of humidity, the welding area should be protected by a cover or welding should be halted until the weather conditions are suitable.

2. Preparation (cleaning and scrubbing) must be done close to the welding time. Do not prepare pipes and fittings for welding if you plan to weld at a later stage.

3. Scraping and peeling of the pipe: universal or hand scraper must be in perfect working condition with a sharp blade. The blade in the universal scraper should be replaced when no longer sharp. The blade of the hand scraper should be sharpened from time to time using a fine iron file. The thickness of the scraped layer should be as follows:

Diameter: 20-25 mm, 0.15–0.20 mm

Diameter: 32-75 mm, 0.15-0.25 mm

Diameter: 90–355 mm, 0.20–0.30 mm

2. Natural Bends in Pexgol Pipes

To create turns with Pexgol pipes laid inside trenches, above the ground or over pipe bridges, the pipe can be bent according to the natural bending table.

The values in table below are relevant for installations at all ambient temperatures from low subzero temperatures and up to 40°C.

For pipe diameters lower than 110 mm use the values of the 110 mm pipes at all pressure classes.
Field bending involves excavating the trench to the appropriate bend radius, then sweeping or pulling the pipe string into the required bend and placing it in the trench.

This kind of pipeline design, which takes advantage of the natural flexibility of the pipe, reduces the number of connections and lowers head losses.

Observe appropriate safety precautions during field bending. Considerable force might be required to field bend the pipe, and the pipe could spring back forcibly if the restraints slip or are inadvertently released while bending.

Class 30	Class 24	Class 19	Class 15	Class 12	Class 10	Class 8	Class 6	Pipe OD
3.0D	3.5D	4.5D	5.0D	6.5D	8.0D	10.5D	13.5D	110
3.5D	4.5D	5.5D	6.5D	8.5D	10.0D	13.5D	16.5D	125
3.5D	4.5D	5.5D	6.5D	8.5D	10.0D	13.5D	16.5D	140
3.5D	4.5D	5.5D	6.5D	8.5D	10.0D	13.5D	16.5D	160
3.5D	4.5D	5.5D	6.5D	8.5D	10.0D	13.5D	16.5D	180
3.5D	4.5D	5.5D	6.5D	8.5D	10.0D	13.5D	16.5D	200
3.5D	4.5D	5.5D	6.5D	8.5D	10.0D	13.5D	16.5D	225
4.0D	5.0D	6.5D	8.0D	10.0D	12.0D	16.0D	20.0D	250
4.0D	5.0D	6.5D	8.0D	10.0D	12.0D	16.0D	20.0D	280
5.5D	7.0D	8.5D	11.0D	13.5D	16.0D	21.5D	27.0D	315
5.5D	7.0D	8.5D	11.0D	13.5D	16.0D	21.5D	27.0D	355

Class 30	Class 24	Class 19	Class 15	Class 12	Class 10	Class 8	Class 6	Pipe OD
7.0D	8.5D	10.5D	13.0D	17.0D	20.0D	27.0D	34.0D	400
7.0D	8.5D	10.5D	13.0D	17.0D	20.0D	27.0D	34.0D	450
8.0D	10.0D	13.0D	16.0D	20.0D	24.0D	32.0D	40.0D	500
9.0D	11.0D	13.5D	17.0D	22.0D	26.0D	34.5D	43.0D	560
9.5D	12.0D	14.5D	19.0D	23.5D	28.0D	37.0D	47.0D	630
10.0D	13.0D	16.0D	20.0D	25.0D	30.0D	40.0D	50.0D	710

2.1 Bending the Pipes

Use a suitable device, such as a winch or a lever, to bend the pipes. Remember that the pipe is rigid and considerable force is required for bending and fixing it – for example, 2 tons for a 110 mm pipe and 5 tons for a 280 mm pipe.

Bend the pipe carefully to avoid kinking. For best results, it is recommended to prepare a continuous support (with the radius of the pipe to be bent) for the pipe. Then bend the pipe against it.

The installation is complicated since it is difficult to calculate in advance the exact length of the pipe. As a result, on-site adaptation (field welding) is necessary.

2.2 Proper installation procedure:

1. The longer arm of the natural bend is more flexible than the shorter arm; therefore, always choose the longer arm as the pipe end whose length is adjusted.
2. Install the fitting onto the end of the shorter arm.
3. Connect the shorter arm to the existing counterflange.
4. If necessary, install a fixpoint clamp before the fitting to protect it during bending.
   4.1. If the fitting is an electrofusion fitting, wait three cooling times (3x) before continuing with the next step.
5. Adjust the length of the longer arm.
6. Cut the length and install the fitting.
   6.1. If the fitting is an electrofusion fitting with a stub-end (flared end) connection, perform the welding when the flared end is free (not connected to the counter-flange). Connect the flared end & flange to the counter-flange only after waiting three cooling times (3x).
   6.2. If the fitting is an electrofusion fitting which connects the longer arm to another Pexgol or PE pipe, install a temporary fixpoint bridge before welding in order to protect the electrofusion fitting during welding.
   6.3. Disassemble the temporary fixpoint bridge only after waiting three cooling times (3x).

3. Chemical Resistance

The Pexgol Chemical Resistance List is based on information included in the professional literature. The list is only intended as a guide.

Changes in the composition of the medium or special working conditions could lead to deviations. Consult the experts of **Golan Plastic Products** in each specific case.

3.1 Chemical resistance test for Pexgol pipes

The following procedure is an initial test for the chemical resistance of Pexgol pipes.

Each combination of service conditions (service temperature, chemical concentration) constitutes a different case. However, for the same pipeline the worst case is usually the highest temperature and the highest concentration.

The tested items are 20 “dumbbells” (also called “dogbones or “coupons”) made from Pexgol pipes.

3.2 Immersion Test

1. The dumbbells are immersed in the same material transported through the pipeline (same chemical composition and same temperature) for a period of 4 weeks.
2. After 2 weeks, 10 dumbbells are removed and stored.
3. After an additional 2 weeks, the other 10 dumbbells are removed.
4. The two groups of dumbbells are packed separately and the packages are marked appropriately to identify the removal and storage conditions.
5. The packages are sent to Golan for tensile testing.

3.3 Classification

A. Resistant: can be used within the working pressures (safety factor of 1.25).
B. Conditionally resistant: restrictions of 70% to 90% must be made regarding the working pressures.
C. Conditionally resistant: can be used within pressures up to 60% of the working pressures.
D. Conditionally resistant: can be used within pressures up to 20% of the working pressures.
U. Unknown, not recommended.

Note: In case of dangerous liquids (strong acids and bases) the safety factor should be increased to 1.5 or 2.0. In case of doubt please consult us.

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Accumulator Acid	A	A	A	
Acetaldehyde 40%	A	A		B
Acetaldehyde 100%	U			
Acetamide	A	A	A	
Acetic Acid 05%	A	A		
Acetic Acid 10%	A	A		
Acetic Acid 20%	A	A		
Acetic Acid 50%	A	A		
Acetic Acid 60%	A	A		
Acetic Acid 80%	A	A		
Acetic Acid Ethyl Ester	A	A		
Acetic Anhydride	A	D		
Acetoacetic Acid	A			
Acetone	C			
Acetophenone			B	
Acetyl Bromide	U			
Acetyl Chloride			B	
Acetylene	A	A	A	
Acetylene Dichloride	see Dichloroethylene			
Acid mixture H2SO4-HNO3-H2O	U			
Acid mixture H2SO4-H3PO4-H2O		B		
Acrylic emulsions	A			
Acroline dispersion	A			
Acroline solution	B			
Acronal	C			
AcryloNitritle	A	A	A	
Acrylic Acid	A	A		
Adipic Acid	A	A	A	
Air	A	A	A	
Aktivin	A	A		
Alcohol	see Ethylalcohol			

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Aliphatic Esters	A	A	A	
Allyl Acetate	A	C		
Allyl Alcohol 7%	A	A	A	U
Allyl Alcohol 95%	A			
Allyl Aldehyde	see Acroline			
Allyl Chloride	C	U		
Alum	A	A	A	B
Aluminium Acetate	A	A	A	
Aluminium Chloride	A	A	A	
Aluminium Fluoride	A	A	A	
Aluminium Hydroxide	A	A	A	
Aluminium Metaphosphate	A	A		
Aluminium Nitrate sol.	A	A	A	
Aluminium Phosphate	A	A	A	
Aluminium Potassium Phosphate	A	A	A	
Aluminium Potassium Sulphate	A	A	A	A
Aluminium Sodium Sulphate sol.	A	A	A	
Aluminium Sulphate	A	A	A	
Amino Acids	A	A		B
Aminoacetic Acid	B	B		
Ammonia Aqueous	A	A	A	
Ammonia, dry gas	A	A	A	
Ammoniacal Liquor	A	A		
Ammonium Acetate	A	A	A	
Ammonium Aluminium Sulphate	A	A		
Ammonium Bromide	B	B		
Ammonium Carbonate	A	A	A	
Ammonium Chloride	A	A	A	
Ammonium Fluoride 20%	A	A	A	
Ammonium Hydrogen Carbonate	A	A	A	
Ammonium Hydrogen Sulphide	A	A	A	
Ammonium Hydroxide	A	A	A	

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Ammonium Metaphosphate	A	A	A	
Ammonium Molybdate	A		B	
Ammonium Nitrate	A	A	A	
Ammonium Persulphate	A	A	A	
Ammonium Phosphate	A	A	A	
Ammonium Sulfide	A	A	A	
Ammonium Sulphate	A	A	A	
Ammonium Sulphocyanide	A			
Ammonium Thiocyanate	A	A	A	
Amyl Acetate	A	A		
Amyl Alcohol	A	A	A	
Amyl Chloride	U			
Amyl Methyl Carbinol	B			
Amyl Naphthaline	B			
Amyl Phthalate	A	B		
Aniline Hydrochloride	D			
Aniline Sulphate	U			
Aniline, coloured	see Aniline			
Aniline, pure	A	A		
Aniline, water soluble	B			
Animal Fats	A	A	A	
Animal Oils	B	B	B	
Anis Oil	B			
Aniseed Oil	C	U		
Anisole	see Cyclohexanone			
Antifreeze solution	A	A	A	
Antimony Pentachloride	A	A	A	
Antimony Trichloride	A	A	A	
Antrhoquinone Sulphonic Acid	A	A		
Aqua regia	U			
Aromatic Acids	A	A	A	
Aromatic Hydrocarbons	U			

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Arsenic	B	B		
Arsenic Acid 80%	A	A	A	
Arsenic Acid Anhydride	A	A		
Arsenic Salts	A			
Arsenic Trichloride	U			
Ascorbic Acid	A			
Asphalt	A	C		
ASTM Oil no. 1	A	A	A	
ASTM Oil no. 2	A	A	A	
ASTM Oil no. 3	A	A	A	
Atropine Sulphate	A			
Barium Carbonate	A	A	A	
Barium Chloride	A	A	A	
Barium Hydrosulphide, Bone Oil			B	
Barium Hydroxide	A	A	A	
Barium Salts	A	A		
Barium Sulphate	A	A	A	
Barium Sulphide	A	A	A	
Battery Acid	A	B		
Beater Glues	A			
Beer Colours	A	A	A	
Beer, trading quality	A			
Beet Juice	A	A		
Benzaldehyde 0.1%			C	
Benzaldehyde 100%	A	C		
Benzaldehyde Oxime 2%	A			
Benzaldoxime	see Benzaldehyde Oxime			
Benzene (Benzole)	D	U		
Benzene Carbonic Acid	see Bensoic Acid			
Benzene Dicarbonic Acid	see Phthalic Acid			
Bezene Sulphonic Acid	A		B	
Benzoic Acid	A	A	B	

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Benzole Carbon Acid	see Bensoic Acid			
Benzole Dicarbon Acid	see Phthalic Acid			
Benzole Sulphonic Acid	U			
Benzyl Acetate	B			
Benzyl Alcohol	A	A	B	
Benzyl Benzoate		B		
Benzyl Chloride	A			
Bichromate Sulfuric Acid	B	U		
Bismuth Carbonate	A	A	A	
Bisulfite	see Sodium Bisulfite			
Bitumen	A	C		
Black Liquor	B	B		
Bleach	D	U		
Bleach Lye 10%	B	B		
Bloodstream Salt, red	see Potassium Ferricyanide			
Bloodstream Salt, yellow	see Potassium Ferricyanid			
Bone Oil	A	A		
Bonewax	A		U	
Borax	see Sodium Tetraborate			
Boric Acid	A	A	A	
Boric Acid Methyl Ester	B	U		
Boric Copper Sulphate	A			
Boric Trifluoride	A			
BoronTrifluoride	A	D		
Brake Fluids	A	A	A	
Brandy	A			
Brines, saturated	A	A		
Brom Oil	A		B	
Bromate Solution	A	A		
Bromoethane	U			
Bromic Acid	A	A	A	

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Bromine Vapours, low conc.	B			
Bromine Water	U			
Bromine, Liquid	U			
Bromochloromethane	U			
Butadiene 50%	A	A	A	
Butadiene 100%		B		
Butane (gas)	U			
Butanediol up to 10%	A	A	A	
Butanediol up to 100%	B			
Butanetriol	A	A		
Butanol 100%	A	A	A	
Butanone	A	U		
Butene	U			
Butoxyl	A	C		
Butter	A		B	
Butter Acid	C			
Butter Acid in water, conc.	C			
Butter Acid in water, sol. 20%	C			
Butyl Acetate	A	B	C	
Butyl Acrylate	A	B		
Butyl Alcohol	see Butanol			
Butyl Aldehyde	A		B	
Butyl Benzyl Phtalate	A	A		
Butyl Carbinol			B	
Butyl Cellulose solution	U			
Butyl Phenol	U			
Butyl Stearate	A	A	A	
Butylene	see Butene			
Butylene Glycol	see Butanediol			
Butyric Acid	C	D		
Cadmium Salts	A			

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Caffeine Citrate	B	B		
Calcium Acetate	A	A	A	
Calcium Bisulphide	A	B		
Calcium Bisulphite	A	A	A	
Calcium Bromide 50%	A	A		
Calcium Bromide 80%	A			
Calcium Carbide	A	A		
Calcium Carbonate (Soda)	A	A	A	
Calcium Chlorate	A	A	A	
Calcium Chloride	A	A	A	B
Calcium Hydrosulphite containing SO2	B	B		
Calcium Hydroxide	A	A	A	
Calcium Hypochlorite	A	A	A	
Calcium Nitrate	A	A	A	
Calcium Oxide	A			
Calcium Phosphate	A			
Calcium Sulphate	A	A	A	
Calcium Sulphide			B	
Calcium Water	A			
Camphor	C			
Cane Sugar	A			
Cane Sugar Juice	A	A	A	
Carbamide 33%	A	A	A	
Carbazole	A	A		
Carbolic Acid	A	B		
Carbolic Acid (Phenol)	A	A		
Carbolineum	A	C		
Carbon Bisulfide	U			
Carbon Dioxide	A	A	A	
Carbon Dioxide damp	A	A	A	U
Carbon Dioxide dry	A	A	A	A

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Carbon Disulphide		D	U	
Carbon Monoxide - lamp gas	A	A	A	
Carbon Tetrachloride		D	U	
Carbonic Acid H2CO3	A	A		
Carnbevox	A			
Carrot Juice	A	A		
Castor Oil	A	B		
Caustic Potash	A	A		
Caustic Soda	see Sodium Hydroxide			
Cedar Leaf Oil	D			
Cedar Wood Oil	D			
Cellulose dissolver	See Ethylene Glycol Monoethyl Ether			
Cetyl Alcohol	A	A	B	
Chalk	A	A	A	
Cheese Enzyme	A	A	A	
Chloral Hydrate	A	A	A	
Chloramine	A	A	A	
Chloramine T	see Paratoulene Sulpho- Chlor			
Chloride Acid	see Hydrochloric Acid			
Chlorine water 10 PPM	A	A		
Chlorine water sturated	A		B	
Chlorine, damp gas	C	U		
Chlorine, dry gas	B		U	
Chlorine, liquid	U			
Chloro Acetic Acid Ethyl Ester	A	A		
Chloro Acetic Acid Methyl Ester	A	A		
Chloro Carbonic Acid	A	C		
Chloroacetic Acid 85%	B	B		
Chloroacetic Acid 98%	B			
Chloroacetic Acid 100%		B		U
Chlorobenzene	D	U		

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Chlorocalcium (in H2O)	A	A	A	
Chloroethane	see Ethyl Chloride			
Chloroethanol	A	A	A	
Chloroethyl Alcohol	see Chloroethanol			
Chloroethyl Phosphate	A	A		
Chloroform	D	U		
Chloromethane	see Methyl Chloride			
Chloropicrin	U			
Chloropropane	see Glycerine Chlorhydrin			
Chlorosulfonic Acid	U			
Chrome Alum	A	A	A	
Chrome Anode Mud	A	A		
Chrome Mercury	B			
Chromic Acid 50%	A	A	A	
Chromic Acid 80%	A		B	
Chromic Acid Anhydride	see Chromium Trioxide			
Chromium Oxide	see Chromium Trioxide			
Chromium Salts	A			
Chromium Trioxide 20%	A	A	A	
Chromium Trioxide 50%	A		B	
Chromium Trioxide 80%				
Chromo Sulfuric Acid	A	U		
Cider	A	B		
Cinnamon	B	C		
Cinnamon Oil	D			
Cis - Oxime	see Benzaldehyde Oxime			
Citric Acid	A			
Citronella	B	D		
Citrus Juices	A	A		
Cloves	C	C		
Coal Tar	D	U		

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Cobalt Chloride	A	A	A	
Coca Cola	A	A		
Coca Cola Syrup	A	B		
Cocanut Oil Alcohols	B	C		
Cocoa Fat	A	A	A	
Cocoa Fat Alcohol	A	A	A	
Coconut Oil	A	B		
Cod Liver Oil	B	C		
Coffee	A			
Cognac	A			
Colanut, concentrated	A	A	A	
Cooking Salt		see Sodium Chloride		
Copper Acetate			B	
Copper Chloride (cupric)	A	A	A	
Copper Chloride (cuprous)	A	A	A	
Copper Cyanide	A	A	A	
Copper Fluoride	A	A	A	
Copper Nitrate	A	A	A	
Copper Salts	A	A		
Copper Sulphate	A	A	A	
Corn Oil	A	A	A	
Corn Syrup	A	A		
Cotton d Oil	A	B	C	
Coumarone Resins	A	A		
Cranberry Sauce	B	B		
Creosote	A	B		
Cresol 100%	A	C		
Cresol diluted	A	C		
Crop Protection Agent	A	A		
Croton Aldehyde	A	C		
Crude Oil	A	B	C	D

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Cupric Salts Cuprous Chloride,	A			
saturated	B	B		
Cupprous Oxide	B	B		
Cyanides	A	A	A	
Cyclanone	A	A		
Cyclohexane	C	D		
Cyclohexanol	A			
Cyclohexanone	D	U		
Cyclohexyl Alcohol	A	B		
DDT	A	A		
Decahydro Naphthalene	B	C		
Decalin	A	C		
Defoamer	A	C		
Denatured Spirit	see Methyl Alcohol			
Deodorants	A	A		
Detergents	A	B		
Dextrine	A	A	A	
Dextrose	A	A	A	A
Diacetone	A	A	A	
Diacetone Alcohol	A			
Diammonium Salts	A	A	A	
Diazo Salts	A	A		
Dibenzyl Ether			B	
Dibromoethane	D	U		
Dibutyl Ether	B	D		
Dibutyl Phthalate	B	C		
Dibutyl Sebacate	A	B	B	
Dichloracetic Acid	A	A	A	
Dichloracetic Acid Methylester	A	A	A	
Dichlorobenzene	C	U		
Dichloroethane	see Ethyl Chloride			

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Dichloroethylene	U			
Dichloromethane	see Methyl Chloride			
Dicyclohexamine			B	
Diesel Fuel	A	U		
Diesel Oil	A	U		
Diethlene Glycol Monobutylene	A			
Diethyl Benzene				B
Diethyl Ether	see Ethyl Ether			
Diethyl Ketone	B	C		
Diethyl Phthalate	A			
Diethylamine			B	
Diethylene Dioxide	see Dioxane			
Diethylene Glycol	A	A		
Diglycolic Acid	A	A	A	
Dihexyl Phthalate	A	A	A	
Diisobutylene			B	
Diisopropyl Ether	B	U		
Diisopropyl Ketone	A	A	A	
Dimethyl Amine	C	U		
Dimethyl Aniline			B	
Dimethyl Benzole	see Xylol			
Dimethyl Formamide	A	B		
Dimethyl Ketone	see Acetone			
Dimethyl Phthalate	A	A	A	
Dimethyl Sulphoxide	A	A		
Dioctyl Phthalate	B	C		
Dioctyl Sebacate			B	
Dioxalane			B	
Dioxane	A	B	C	
Dioxyethyl Ether	see Diethylene Glycol			
Diphenyl			B	

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Diphenyl Amine	A	C		
Diphenyl Oxide	B	C		
Dishwash Detergents	A	A	B	
Disodium Phosphate	A	A		
Disodium Sulphate	A	A		
Dispersions	A			
Dodecylbenzene Sulfonic Acid	A	C		
Dop (Diethylhexyl Phthalate)	A	C		
Edible Oil	A			
Electrolyte 10%	A	A	A	
Elementine normal conc.	A	A	A	A
Emulsions, Photographic	A	A	A	
Engine Oils	A	C		
Ephetin	A	A		
Epichlorohydrin	A	A	B	
Epoxy Ethane	see Ethylene Oxide			
Epsom Salts	A	A		
Essential Oils	C	U		
Esteric Oils	B	B	B	
Ethanal	see Acetaldehyde			
Ethandiol	see Ethylene Glycol			
Ethane	A	A		
Ethane Diamine	see Ethylene Diamine			
Ethanol	see Ethyl Alcohol			
Ethanolamine	A	A	B	
Ethers	C	D	U	
Ethoxyethane	see Ethyl Ether			
Ethyl Acetate	A	B	C	
Ethyl Alcohol	A	A	A	B
Denaturated with 2% Toluol	A			
plus Acetic Acid, quality use	A			

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Ethyl Benzene	D	U		
Ethyl Benzoate	B			
Ethyl Carbitol			B	
Ethyl Cellulose			B	
Ethyl Chloride	C	U		
Ethyl Dibromide	C	U		
Ethyl Ether	C	D	U	
Ethyl Formate			B	
Ethyl Glycol			B	
Ethyl Methyl Ketone		see Butanone		
Ethyl Oxalate	A	A	A	
Ethyl Pentachloro Benzene	U			
Ethyl Salicylate	B			
Ethyl Silicate	A	A	A	
Ethyl Valeriate	A			
Ethylamine	A	A	A	
Ethylene	A	B		
Ethylene Chlorhydrin	U			
Ethylene Chloride	U			
Ethylene Diamine	A	A		
Ethylene Diamine Tetraacetic Acid	A	A		
Ethylene Dichloride	D	U		
Ethylene Glycol 100% trading quality	A	A	A	B
Ethylene Glycol \Monoethyl Ether	A			
Ethylene Oxide, gaseous	A	A		
Ethylene Oxide, liquid	U			
Ethylene Trichloride	D			
Ethylhexyl Alcohol	A	B		
“Eugenol”	B			
Euron B	B	B		
Euron G	A	A		

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Fatty Acid	A	B	C	
Fatty Acid Amides	A	C		
Fatty Alcohols	A	C		
Fatty Oils	A	C		
Ferric Chloride	see Iron Chloride			
Ferric Nitrate	see Iron Nitrate			
Ferrous Ammonium Citrate	A	B		
Ferrous Chloride	A	B		
Ferrous Sulphate Fe SO4	A	A		
Fertilizer Salts	A	A	A	B
Fir Wool Oil	A	C		
Fish Oil	A	A	A	
Fish Solubles	B			
Fluoboric Acid	A	B		
Fluorbenzene	U			
Fluorides	A	A	A	
Fluorine, liquid	C			
Fluorine (solution)	U			
Fluosilicic Acid 25%	A	C		
Formaldehyde 40%	A	A		
Formaldehyde, diluted	A	A	A	
Formamide	A	A	A	
Formic Acid	A	A	B	
Freon 12	C	U		
Freon 13	A	A	A	
Freon 21	U			
Freon 22	A	A	A	
Freon 113	A			
Freon 114	A	A	A	
Frigen	C	U		
Fructose	A	A		

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Fruit Juice	A	A	A	U
Fruit Mass (fruit pulp)	A	A	A	
Fruit Sugar	A			
Fuel Oils	A	D		
Fuming Sulphuric Acid	see Oleum			
Furan	D			
Furfural	A	C	U	
Furfural Alcohol	A	B		
Gallic Acid	A	A		
Gas Liquor	A	A		
Gas, Natural	see Natural Gas			
Gases, containing Carbon Dioxide, Carbon Acid	A	A	A	A
Gases containing Chlorine	A	A	A	B
Gases, containin Fluorine traces	A	A	A	U
Gases, containin Nitrious Oxide traces	A	A	A	U
Gases, containin Oleum, low conc.	U			
Gases, containin Sulphur Dioxide 50%	A	A		
Gases, containin Sulphur Dioxide, low conc.	A	A	A	B
Gases, containin Sulphuric Acid	A	A	A	
Gasoline-Benzene mixture 80/20	B		C	
Gasoline, Leaded	A			
Gasoline, pure, 100 Octane	B	C		
Gasoline, Sour	A			
Gasoline, Unleaded	A			
Gelatine	A	A	A	
Genantin	A	A		
Gin	A	A		
Glaubers Salt	A	A		
Glucose	see Dextrose			
Glycerine Chlorhydrin	A	A	A	
Glycerine, Glycerol	A	A	A	

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Glycerol Chloro Hydrin	A	A		
Glycine	see Glycol			
Glycois	A	A		
Glycol 10%	A	A		
Glycol Dichloride	see Ethylene Chloride			
Glycol Ester	A	A	A	
Glycolic Acid 37%	A	B		
Glycolic Acid Butyl Ester	A	A		
Glysantin	A	A		
Grape Juice	A	A		
Grape Sugar	A	A		
Grapefruit Juice	A	A		
Grease	A			
Grisiron 8302	B	B		
Grisiron 8702	A	A		
Hair Oil/Tonic Oil	A	A		
Halothane	C	D		
Hand Lotions	A	A		
Heating Oil, Barrel Oil	A			
Heavy Emulsion	see Barium Carbonate			
Heavy Oil			B	
Heptane	B	D		
Hexachlorobenzene	A	B		
Hexadecylalcohol	A	A		
Hexane	C	D		
Hexane Triol	A	A		
Hexyl Alcohol	D			
Honey	A			
Household Cleaners	A	B		
Hydrobromic Acid 20%	A	A		
Hydrobromic Acid 50%	A	A		

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Hydrochloric Acid 10%	A	A	A	U
Hydrochloric Acid 20%	A	A	B	U
Hydrochloric Acid 30%	A	A	A	U
Hydrochloric Acid ≥ 30%	A	A	B	U
Hydrochloric dry gas	A			
Hydrocyanic Acid		see Hydrogen Cyanide		
Hydrocyanic Acid 10%	A	C		
Hydrofluoric Acid 20%	A	C		
Hydrofluoric Acid 50%	A	C		
Hydrofluoric Acid 75%, HF	A	C		
Hydrofluosilicic Acid	A	A		
Hydrogen	A	A	A	
Hydrogen Bromide	A	A	A	
Hydrogen Chloride gas dry and moist	A	A	A	
Hydrogen Cyanide	A	A	A	
Hydrogen Fluoride 40%	A	A		
Hydrogen Fluoride 70%	A			
Hydrogen Peroxide 30%	A	A	A	
Hydrogen Peroxide 50%	B			
Hydrogen Peroxide 90%	C			
Hydrogen Peroxide 100%	A	U		
Hydrogen Phosphide	A			
Hydrogen Sulphide, H2S	A	A	A	B
Hydrogen Sulphide (Aq. Sol.)	A	A		
Hydrogen Sulphide, dry	A	A	A	B
Hydroquinone	A	A		
Hydrosulphite	A	A		
Hydroxylamine Sulphate	A	A		
Hypochlorous Acid	A	A		
Hyraulic Fluids	A	B		
Hyrazine Hydrate	A	A		

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Igepal	A	A	A	
Ink	A	A	A	
Iodine	A			
Iodine, alcoholic sol.	B			
Iodine ink	A			
Iodine-Potassium Iodide, 3%	A	A		
Iodine Solution	U			
Iodine, Tincture of	A	C		
Iron (II) Chloride	A	A	A	
Iron (II) Sulphate	A	A	A	
Iron (III) Chloride	A	A	A	A
Iron (III) Nitrate	A	A	A	
Iron (III) Sulphate	A	A	A	
Isobutyl Alcohol	A	A		
Isooctane	A	B		
Isopropanol	A	A		
Isopropyl Acetate	A	C		
Isopropyl Ether	D	U		
Jams	A	A		
Kerosene	B	C		
Kerosine	B	C		
Ketones	B	D		
Labarraques Solution	D	U		
Lacquer	U			
Lactic Acid 90%	A	A	A	
Lactose	A	A		
Lanolin	A	A	A	
Latex	A			
Lauryl Alcohol	B			
Lavender Oil			B	
Lead Acetate	A	A	A	B

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Lead Arsenate	A			
Lead Nitrate	A	A	A	
Lead Sulphamate	A	A	A	
Lemon Juice	A	A		
Lemon Oil	B	U		
Lime	A	A		
Lime Chloride	A	A		
Lime Juice	B	B		
Lime Water	A	A		
Lind Oil	A	B	C	
Liquor, Trading Quality	C	U		
Lithium Bromide	A	A		
LPG	A	A		
Lubricating Oils	A	C		
Machine Oils	A	B		
Magnesium Carbonate	A	A	A	
Magnesium Chloride	A	A	A	
Magnesium Fluosilicate	A	A		
Magnesium Hydroxide	A	A	A	
Magnesium Iodine	A	A		
Magnesium Nitrate	A	A	A	
Magnesium Salts	A	A		
Magnesium Sulphate	A	A	A	A
Maleic Acid	A	A	A	A
Malic Acid	A	A		
Manganese Sulphate	A	A	A	
Manure, liquid	A	A		
Margarine	B	C		
Marmelade	A	A	A	
Masa	A	A		
Mascara	A	A	A	

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Mash	A	A		
Mayonnaise	A			
Melase spices, industrial conc.	A	A	A	
Melase, industrial conc.	A	A	A	A
Menthanol	see Menthol			
Menthol	A	C		
Mercuric Chloride	A	B		
Mercuric Cyanide	B	B		
Mercurochrome	A	A		
Mercurous Nitrate	B	B		
Mercury	A	A	A	
Mercury Salts	A	A	A	
Mesityl Oxide				B
Metallic Mordants	A	A		
Methacrylate	A	A		
Methacrylic Acid	A	A		
Methane			B	
Methane Amide	see Formamide			
Methanol	see Methyl Alcohol			
Methoxy Butanol	A	A	A	
Methoxybutyl Alcohol	A	B		
Methyl-2-Pentanone (4-)	A	A		
Methyl Acetate			B	
Methyl Alcohol	A	A	A	
Methyl Amine, 32%	A			
Methyl Bromide	see Bromethane			
Methyl Butyl Ketone	A	A	A	
Methyl Cellulose Solvent	A			
Methyl Chloride	D	U		
Methyl Ethyl Ketone	B	D		
Methyl Formate			B	

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Methyl Glycol	A	A	A	
Methyl Isobutyl Ketone	A	C		
Methyl Methacrylate	A	A	B	
Methyl n-Propyl Ketone	A	B		
Methyl Oleate	A	A	A	
Methyl Phenol	see Cresol			
Methyl Pyrrolidone	A	A		
Methyl Salicate	B			
Methyl Salicylate	A	B		
Methyl Sulphate	A	A		
Methyl Sulphuric Acid up to 50%	B	B		
Methylbenzene	D	U		
Methylcyclohexane	C	D		
Methylene Chloride	C	U		
Milk	A	A	A	
Mineral Oils	B	U		
Mineral Spirits	A	C		
Mineral Water	A	A	A	
Molasses	A	A		
Mold Release	A	A		
Monochloride Acetic Acid	A	A	A	
Monochloride Acetic Acid Ethylester	A	A	A	
Monochloride Acetic Acid Methylester	A	A	A	
Monochloro Benzene	D			
Monoethanolamine	A			
Monoethyl Ether	A	A	A	
Monomethyl Aniline	A	A	A	
Morpholine	A	A		
Motor Oil			C	
Mowilth	A	A		
Mustard	A	B		

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Nafta	B	U		
Naphthalene, Naphthaline	A	C		
Natural gas	A	A		
Nickel	A			
Nickel Chloride	A	B		
Nickel Nitrate	A	B		
Nickel Salts	A	A		
Nickel Sulphate	A	B		
Nicotine	A	A		
Nicotine Acid	B	B		
Nitric Acid ¥30%	A	A		
Nitric Acid 30-50%	B	C		
Nitric Acid 40%	B			
Nitric Acid 70%	C			
Nitric Acid 98%			U	
Nitrobenzene (Oil of Mirbane)	C	U		
Nitrocellulose	A			
Nitroethane	A		U	
Nitrogen	A	A	A	
Nitroglycerin	B	D		
Nitromethane	A		U	
Nitrotoluene	A	B		
Nitrous gases, conc.	A		U	
Nonyl Alcohol	A	A		
Octane	A	B		
Octyl Alcohol	A		B	
Octyl Cresol	B	U		
Oil	C	C		
Oil Acid			C	
Oleic Acid	A	C		
Oleic Acid (Red Oil)	U			

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Oleum	U			
Oleum vapeur (SO3)	B			
Olive Oil	A	A	A	
Optical Brighteners	A	A		
Orange Extract	A	A		
Ortho-Boric Acid	see Boric Acid			
Oxalic Acid	A	B		
Oxyacetic Acid	see Glycolic Acid			
Oxybensole	see Phenol			
Oxydiethanole	see Diethylene Glycol			
Oxygen	A	A		
Oxypropionic Acid	see Lactic Acid			
Oxyrane	see Ethylene Oxide			
l-Oxytoluol	see Benzyl Alcohol			
m-Oxytoluol	see Cresol			
Ozone	C		U	
Painting Turpentine	see Thinner			
Palm Kernal Oil	A	A		
Palm Oil	B	B		
Palmatic Acid	A	A	B	
Palmityl Alcohol	A	A		
Palmolive Oil	A			
Paraffin	A	B	C	
Paraffin emulsion, trading qual.		B		
Paraffin Oil	A	A	A	
Paraformaldehyde	A	A		
Paratoluene Sulpho Chloramide Sodium 1%	A			
Peanut Butter	B	B		
Pentanol	see Amyl Alcohol			
Pentanol Acetate	see Amyl Acetate			
Pepper	B	B		

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Peppermint Oil	B	D		
Perchloric Acid 10%	A	A		
Perchloric Acid 20%	A	A	A	
Perchloric Acid 50%	A	B	C	
Perchloric Acid 70%	A	D		
Perchloro Ethylene	U			
Perfumes	C	U		
Petroleum	A	B	C	
Petroleum Ether	A	D		
Petroleum Jelly	B	B		
Petroleum Spirits	C	D		
Phenol up to 90%	A	A		U
Phenolic Resins	A	A		
Phenols 100% (Carbolic Acid)	D			
Phenyl Alcohol	see Benzyl Alcohol			
Phenyl Ethane	see Ethyl Benzene			
Phenyl Ethyl Alcohol	A	A		
Phenyl Hydrazine	C	D		
Phenyl Hydrazine Hydrochloride	A	U		
Phenyl Methane	see Toluol			
Phenyl Methyl Ether	see Cyclohexanone			
Phenyl Sulfonate	A	A		
Phosgene, gas	U			
Phosphates	A	A	A	
Phosphoric Acid 80%	A	A	A	A
Phosphoric Acid 90%	A	A	A	A
Phosphoric Acid 95%	A	A		
Phosphorus Oxychloride	A	B	B	
Phosphorus Pentoxide	A	A	A	
Phosphorus Trichloride	A	B		
Phosphorus Yellow	A			

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Photographic Developer	A	A		
Photographic solution, Fixer	A	A	A	
Phthalic Acid 50%	A	A	A	
Phtalic Acid Ester	A	C		
Phtalic Anhydride	B	B		
Pickling Baths	B	C		
Picric Acid 1%	A		B	
Pine Oil	B	D		
Pineapple Juice	A	A		
Pinene			B	
Plasticizers of Polyester	A	B		
Plating Solutions, Brass	A	B		
Plating Solutions, Cadmium	A	B		
Plating Solutions, Copper	A	B		
Plating Solutions, Gold	A	B		
Plating Solutions, Indium	A	B		
Plating Solutions, Iron	A	B		
Plating Solutions, Lead	A	B		
Plating Solutions, Nickel	A	B		
Plating Solutions, Rhodium	A	B		
Plating Solutions, Silver	A	B		
Plating Solutions, Tin	A	B		
Plating Solutions, Zinc	A	B		
Polyesters (Resins)	C	U		
Polyglycols	A	A		
Polysolvan O	A	A		
Potash Alum	A	A		
Potassium Acetate			B	
Potassium Bicarbonate	A	B		
Potassium Bichromate 40%	see Potassium Dichromate			
Potassium Bisolphate	A	A		

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Potassium Borate 1%	A	A	A	
Potassium Bromate	A	A	A	
Potassium Bromide	A	A	A	
Potassium Carbonate	A	A	A	
Potassium Chlorate	A	A	A	
Potassium Chloride	A	A	A	
Potassium Chromate	A	A	A	
Potassium Chromium Sulphate	A	A	A	B
Potassium Cupro Cyanide	A	A	A	
Potassium Cyanide	A	A	A	
Potassium Dichromate 40%	A	A	A	
Potassium Ferricyanide	A	A	A	B
Potassium Ferrocyanide	A	B		
Potassium Fluoride	A	A	A	
Potassium Hydrogen Carbonate	A	A	A	
Potassium Hydrogen Sulphate	A	A	A	
Potassium Hydrogen Sulphite solution	A	A	A	
Potassium Hydroxide 50%	A	A	A	U
Potassium Hydroxide 60%	A	A	B	
Potassium Hypochlorite, solution	A		B	
Potassium Iodide, cold saturated	A	A	A	
Potassium Nitrate	A	A	A	
Potassium Orthophosphate	A	A	A	
Potassium Perborate	A	A	A	
Potassium Perchlorate 1%	A	A	A	A
Potassium Perchlorate 10%	A			
Potassium Permanganate 18%	A	A	A	
Potassium Persulfate	A			
Potassium Phophate	A	A	A	
Potassium Salts	A			
Potassium Sulphate	A	A	A	

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Potassium Sulphate, cold saturated	A	A	A	
Potassium Sulphide	A	A	A	
Potassium Sulphite	A	A		
Potassium Supersulphate	A	A	A	U
Potassium Tetracyao Cuprate	A	A		
Potassium Thiosulphate	A	A		
Propargyl Alcohol	A			
Propane Acid	see Propionic Acid			
Propane Diol	see Propylene Glycol			
Propane Triol	see Glycerine			
Propane, gas	A	B		
Propane, liquid	B			
Propanol	A	A	A	
Propanone	see Acetone			
Propargyl Alcohol	A	B		
Propene	A	A	A	
Propionic Acid	A	A	A	
Propyl Acetate			B	
Propyl Alcohol	see Propanol			
Propylene Dichloriole	U			
Propylene Glycol	A	A	A	
Propylene Oxide	A	A		
Prune Juice	A			
Pseudo Cumol/Pseudo Cumene	B	B		
Pyridine	A	B	C	
Pyrol			B	
Quinine	A	A		
Rayon Coagulating Bath	A	B		
Resorcinol	A	B		
Ricine Oil	A		B	
Rinser Loosener	A	A	A	

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Road Tar	U			
Roasting Gases	A	A		
Rouge	A	A		
Rubbers Dispersions/Latex	A	A		
Sagrotan	A	B		
Salicylic Acid	A	A	A	
Salicylic Acid Methyl Ester	A	B		
Sauerkraut	A	A		
Sea Water	A	A		
Selenic Acid	A	A		
Shampoos, Shaving Lotion	A	A		
Shortening	A	B		
Silicic Acid	A	A		
Silicone Fats	A	A	A	
Silicone Oils	A	A	A	
Silver Nitrate≤80%	A	A	A	B
Silver Salts, cold saturated	A	A	A	
Soap	A	A	A	
Soap Loosener	A	A	A	
Soap Solution	A	A	A	
Soda	see Sodium Carbonate			
Sodium Acetate	A	A	A	
Sodium Aluminate	A	A	A	
Sodium Aluminium Sulphate	A	A	A	
Sodium Benzoate	A	A	A	
Sodium Benzoate to 36%	A	A	A	
Sodium Bicarbonate	A	A	A	
Sodium Bisulphate	A	A	A	
Sodium Bisulphite	A	A	A	A
Sodium Borate	A	A	A	
Sodium Bromide	A	A	A	

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Sodium Carbonate	A	A	A	
Sodium Chlorate	A	A	A	
Sodium Chloride	A	A	A	A
Sodium Chlorite 50%	A	A	A	A
Sodium Chlorite and Bleach	A		B	
Sodium Chlorite and Water	A	A	A	A
Sodium Chromate	A	A		
Sodium Cyanide	A	A	A	
Sodium Dichromate	A	A		
Sodium Dodecylbenzene Sulfonate	A	A		
Sodium Ferricyanide	A	A	A	
Sodium Ferrocyanide	A	A	A	
Sodium Fluoride	A	A	A	
Sodium Hexacyano Ferrate	A	A		
Sodium Hexametaphosphate	A			
Sodium Hydrogen Carbonate	A	A	A	
Sodium Hydrogen Phosphate	A	A	A	
Sodium Hydrogen Sulphite sol.	A	A	A	
Sodium Hydrosulphite 10%	A	A	A	
Sodium Hydroxide 15%	A	A		
Sodium Hydroxide 20%	A	A		
Sodium Hydroxide 30%	A	A		
Sodium Hydroxide 50%	A	A		
Sodium Hydroxide 70%	A	A		
Sodium Hydroxide Conc. (Caustic Soda)	A	A		
Sodium Hypochlorite 12%	B	D		
Sodium Hypochlorite Solution	B			
Sodium Metaphosphate	A	A	A	
Sodium Nitrate	A	A	A	
Sodium Nitrite	A	A	A	
Sodium Perborate	A	C		

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Sodium Perchlorate	A	A		
Sodium Peroxide 10%	A	A	A	
Sodium Phosphate	A	A	A	
Sodium Polyacrylate (GR 894)	A	A	A	
Sodium Silicate	A	A	A	
Sodium Sulphate	A	A	A	
Sodium Sulphide	A	A	A	
Sodium Sulphite	A	A	A	
Sodium Tetraborate	A	A	A	
Sodium Thiosulphate	A	A	A	
Soya Oil	A	B		
Spermaceti	A	B		
Spindle Oil	C	D		
Spinning Oil	A		B	
Spinning-Bath Oil containing Carbon Disulphide 0.01%	A	A		
Spinning-Bath Oil containing Carbon Disulphide 0.07%	A	A		
Spot Solvents	A	A	A	
Stain Removers	C	D		
Stannic Chloride	A	A		
Stannic Salts	A			
Stannous Chloride	A	A		
Starch	A	A	A	A
Starch Syrup	A	A	A	
Steam	A	A	A	
Stearic Acid	A	A	B	
Styrene	C	U		
Succinic Acid	A	A		
Sucrose Solution	A	A	A	
Sugar	A	A		
Sulphates	A	A		
Sulphur	A	A	A	

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Sulphur Dioxid, dry	A	A	A	B
wet, in water solution	A	A	A	
Sulphur Solution	A			
Sulphur Trioxide	U			
Sulphuric Acid 10%	A	A	A	A
Sulphuric Acid lower than 50%	A	A	A	
Sulphuric Acid 70%	A		C	
Sulphuric Acid 80-90%	A	C		
Sulphuric Acid 96%	A	C		
Sulphuric Acid 98%	C			
Sulphuric Ether	B	C		
Sulphurous Acid	A	A		
Sulphuryl Chloride	B			
Superchloric Acid	see Perchloric Acid			
Synthetic Washing Powder, home quality	A	A	A	
Tallow	A	B		
Tannic Acid	A	A		
Tannin	see Ascorbic Acid			
Tar	U			
Tartaric Acid (Dihydrxy Succinic Acid)	A	A		
Tea	B	B		
Tertiary Butyl Alcohol	A	A	A	
Tetrabromo Ethane	D	U		
Tetrachloro Ethane	D	U		
Tetraethyl Lead	A			
Tetrahydro Furane	U			
Tetrahydro Furfuryl Alcohol	A			
Tetrahydro Naphtalene	B	U		
Tetraline	see Tetrahydro Naphtalene			
Tetramethylene Oxide	see Tetrahydro Furane			
Tin Chloride	A	A		

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Tin Salts	A	A	A	
Thinner	D			
Thioglycolic Acid	A	A		
Thionyl Chloride	D	U		
Thiophene	D	U		
Titanium Tetrachloride	U			
Toluene	D	U		
Tomato Juice	A	A		
Transformer Oils	A	C	D	
Tributile Phosphate	A	A		
Tributro Ethyl Phosphate			B	
Trichloro Acetic Acid	A		B	
Trichloro Acetic Acid 50%	A	C		
Trichloro Benzene	U			
Trichloro Ethane	C		U	
Trichloro Ethylene (Tri)	U			
Trichloro Methane		see Chloroform		
Tricresyl Phosphate	A	A		
Triethanolamine	A	B		
Triethylene Glycol	A	A		
Trifluoroacetic acid (TFA)	A			
Trilom, trade quality	A	A	A	
Trimethyl Borate	U			
Trimethylbenzene		see Pseudocumol		
Trimethylol Propane	A	A		
Trinitro Phenol		see Picric Acid		
Trinitro Toluene	U			
Trioctyl Phosphate	A	B		
Trisodium Phosphate	A	B	C	
Trybutyl Phosphate	A	A	A	
Turbine Oil			B	

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Turpentine	D	U		
Tutogen U	A	A		
Tween 20	B	U		
Tween 80	B	U		
Urea	A	B		
Uric Acid	A	A		
Uric Compounds	see Carbamide			
Urine	A	A		
Urine, normal conc.	A	A	A	
Vanille Extract	A	B		
Vaseline	A	B	C	
Vaseline Oil	A		B	
Vegetable Dyes	A	A		
Vegetable Oils	B	B	B	
Vinegar	A	A	A	
Vinegar Acid Anhydride	A	A	B	U
Vinegar Acid Butyl Ester	see Butyl Acetate			
Vinegar Acid Ethyl Ester	see Ethyl Acetate			
Vinegar Ester	see Ethyl Acetate			
Vinegar, trading quality	A	A	A	
Vinyl Acetate	A	A		
Vinyl Chloride	A	A	A	
Vinyl Cyanide	see AcryloNitritle			
Viscose Spinning Solution	A	A		
Vitamine C	A	A		
Walnut Oil	A	B		
Wastegases with Acid	A	A		
Wastegases with Carbon Monoxide	A	A		
Wastegases with HCL	A	A		
Wastegases with H2SO4	A	A		
Wastegases with low sodium Dioxide	A	A		

COMPOUND	CHEMICAL RESISTANCE			
	40°C	60°C	80°C	100°C
Wastegases with traces of Hydrogen Fluoride	A	A		
Wastegases with traces of Nitrosyl Sulfuric Acid	A	A		
Water	A	A	A	A
Water Acid Mine	A			
Water Deionized	A			
Water Distilled	A			
Waterglass	A			
Waxes	A	C		
Wetting Agents	A	B		
Whey	A	A		
Whisky	see Ethyl Alcohol			
Whitener	see Sodium Hypochlorite			
Wine Vinegar	see Vinegar			
Wine, red and white	A	A	A	
Wohlstone Acid	A	A	A	
Wood Glue, type Polyvinyl Acetate	B			
Wood Stains	A	C		
Wool Fat	see Lanolin			
Xylol	C		U	
Yeast	A	A	A	
Zinc Bromide	A	A		
Zinc (II) Chloride	A	A	A	B
Zinc Carbonate	A	A	A	
Zinc Hydrate	A	A	A	
Zinc Oxide	A	A	A	
Zinc Salts	A			
Zinc Sludge	A	A		
Zinc Stearate	A	A		
Zinc Sulphate	A	A	A	

4. Installation Manual for Conduction Pipelines

4.1 Above the ground

Above-ground installation of Pexgol pipes is advantageous in the following cases:

- Slurry lines which are frequently relocated.
- Installation through marshes or areas with difficult access.
- Quick installation of temporary pipelines.

Pexgol pipes withstand exposure to sunlight for pipe lifetime.

The coefficient of expansion of Pexgol pipes is high compared to steel pipes, but the forces generated by thermal stresses are much lower. The reason is the low modulus of elasticity and the fact that the Pexgol pipes feature stress relaxation.

Pexgol pipes installed above ground might increase in length as a result of temperature increases and tend to undergo “snaking”. Longitudinal elongation and contraction of the pipe is not uniform due to the coefficient of friction between the pipe and the ground varies. However, the toughness and the exceptional abrasion resistance of Pexgol pipes enable the pipes to move across the soil without affecting strength or service life.

When the design temperature is lower than the installation temperature. The pipe tends to contract. The contraction creates axial stresses in the pipes which tend to pullout the pipes from the fittings.

Installing Pexgol pipes above the ground with a calculated slack rather than in a straight line, is a way to reduce thermal stresses. This procedure reduces the tendency of the pipe to pull out of its fittings.

The slack (calculated according to the Pexgol coefficient of thermal contraction) is 0.2% or 2 mm for every meter per 10°C. The actual value depends on the temperature difference between the installation temperature and the lowest temperature.

The slack can be maintained by pushing the mid span of the pipe slightly sidewise during the installation. Axially unrestrained fittings should be secured and protected from pull out,
If a straight pipeline is required, guiding the pipeline at intervals is a good method of limiting and controlling thermal expansion and contraction of the pipeline.

The smaller the distance between the guides, the smaller the theoretic increase in pipe length. As a result, lateral deflections decrease and the pipeline remains straight.

Determining the maximum distance between two guides

The distance between two adjacent guides is calculated according to the following formula:

L = F x D where:

L is the distance (in m) between the guides.
D = outside pipe diameter (in mm).
F is a coefficient which depends on the temperature increase ΔT between the installation temperature and the design temperature

The formula allows for a maximum sidewise deflection of 50 mm between two adjacent guides.

Example:

Pipe diameter 200 mm, installation temperature 20°C, maximum ambient temperature 40°C, design temperature is 20 + 40 = 60°C.

ΔT = 60° - 20° = 40° I F = 0.064 I L = 0.064 x 200 = 12.8 m

Coefficients F:

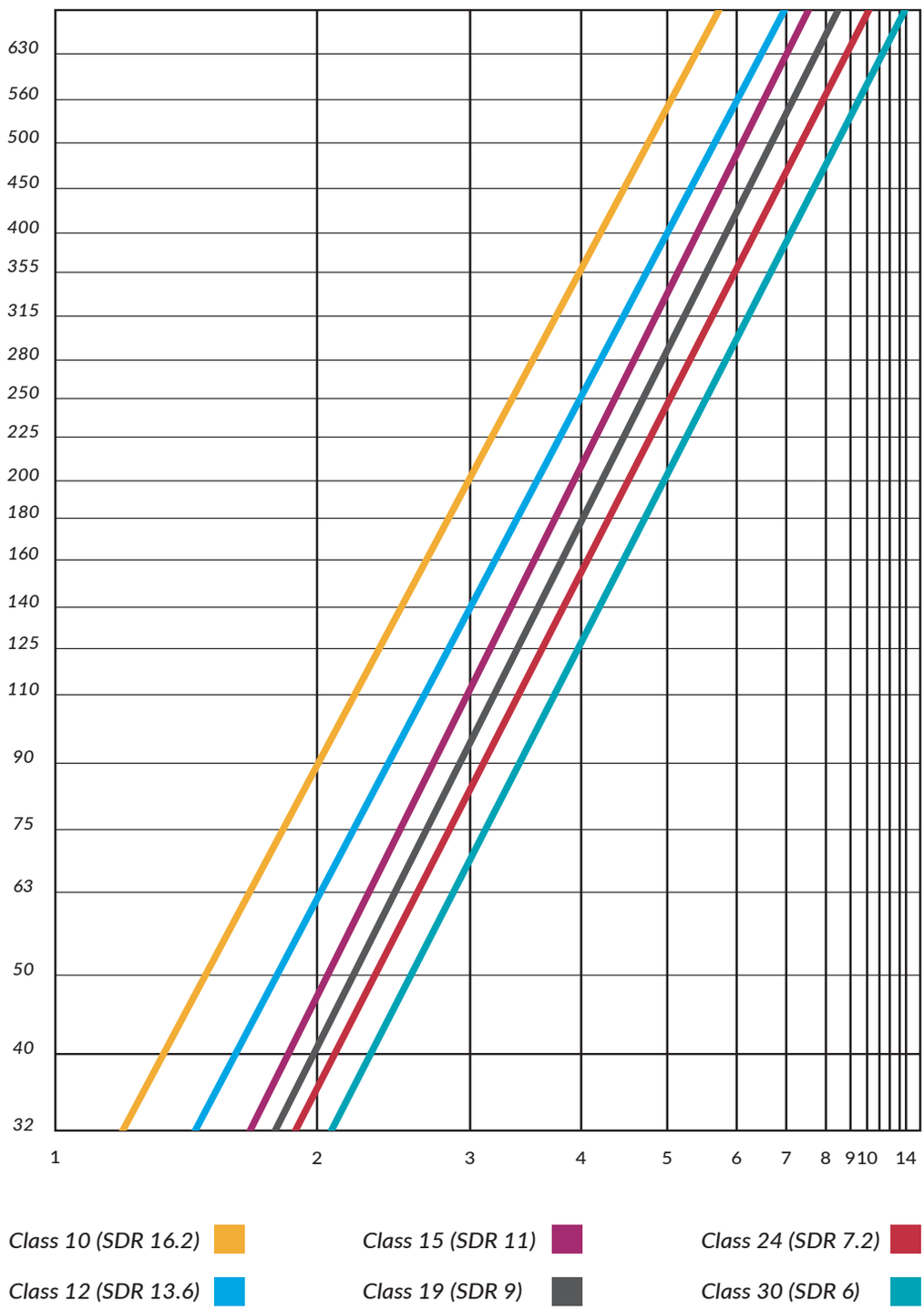
ΔT	COEFFICIENTS F
100	0.25
200	0.125
300	0.085
400	0.065
500	0.05
600	0.04
700	0.036
800	0.03

Correction Factors:

DESIGN TEMPERATURE	CORRECTION FACTOR
0°	1.15
10°	1.11
20°	1.07
30°	1.03
40°	0.99
50°	0.95
60°	0.91
70°	0.87
80°	0.83
90°	0.79
100°	0.75

4.1.2 Horizontally Supported Pipelines

Recommended distance between supports for various SDRs and pipe diameters. The values shown in this table must be multiplied by the following correction factors in the table above.



4.2 5. Instructions for underground installations

For all Pexgol pipe classes, the minimum recommended depth of the trench is 60 cm, to prevent mechanical damage to the pipe. If the pipe is to be covered only to prevent solar heating, the designer may reduce this depth.

In cold areas the installation depth may be increased by the designer to prevent freezing of the transported fluids.

For the maximum allowed installation depth for each pipe class, please contact the application engineer.

If required, the width can be increased to allow more comfortable work in the trench. The minimum recommendation depth of the trench is 60 cm, to prevent mechanical damage of the pipe. For a route change, for example a 90° angle, it is recommended to dig the trench with a suitable radius.

The following table shows the minimum required trench width for Pexgol pipes:

OUTSIDE PIPE DIAMETER	MINIMUM TRENCH WIDTH (MM)
90	240
110	250
125	265
140	280
160	300
180	350
200	400
225	400
280	450
315	550
255	650
450	750
500	850
630	1000

5. Repair Procedure

Small fissure (up to 5 cm diameter):

1. Uncover the pipe, 2 meters along the pipe and 0.5 meter below the pipe.
2. Carefully clean the soil from the pipe and make sure no scratches extend beyond the repair area.
3. Use a repair fitting, supplied by Pexgol or use a branch-off saddle.

Notes:

- In case of vertical installation (dewatering line), the fitting must be protected by a fixpoint bridge.
- Careless excavation could damage Pexgol pipes.

Large fissure (requiring replacing a pipe section):

1. Uncover the pipe, 3 meters along the pipe and 0.5 meters below the pipe.
2. Cut out the section of the pipe with the hole and replace with a new section.
3. In most cases, the maximum length of the section to be replaced does not exceed 1 meter in length.
4. The new section will be connected by:
    a. Two electrofusion repair couplers
    b. Four Pexgol's flanged couplings
    c. Two Plasson mechanical couplers (for pipes up to 160mm)

Notes:

- Only technicians trained by Pexol's field service personnel are authorized to perform the repair.
- Stop water flow using common squeeze-off techniques.
- In case of a vertical installation (dewatering line), the pipe must be secured by a fixpoint bridge prior to cutting the pipe

6. Electrofusion Fittings

Electrofusion fittings are used to connect Pexgol cross-linked polyethylene pipes (for example, ISO 14531). The pipes and fitting are joined by electrofusion welding, reating a leak-proof seal. During the electrofusion process, a current is transported through a heating wire. The surrounding material (around the wire) is melted, welding the pipe to the fitting.

Service temperature for the PE 100 electrofusion fittings is limited to 40°C. For higher temperatures, Pex2Pex electrofusion couplers can be used.

Golan approves and supplies the following fittings systems and installation tools: **Plasson, Friatec, GF/Wavin**.

Coupler

20 to 710 mm

Branch Saddles

63 to 710 mm

Elbows 22.5°, 45° & 90°

20 to 250 mm

Tees & Reducing Tees

20 to 250 mm

End Cups

20 to 315 mm

Flage Adaptors

20 to 400 mm

PP Coated Flanged Backing Ring

20 to 400 mm

Transition Couplers

20 to 110 mm

Tapping Saddles

40 to 250 mm

Electrofusion Control Box & Installation Tools

7. Inspections and Test Plan

Samples fabrication to carry out the EXOVA regression.

BATCH	TEST CODE	TEST DESCRIPTION	MIN. VALUE	MAX. VALUE	RESULT	COMPLY
102,463	202	Wall thickness	2.9	3.1	3.070	Y
102,463	202	Wall thickness	2.9	3.1	3.1	Y
102,463	202	Wall thickness	2.9	3.1	3.09	Y
102,463	202	Wall thickness	2.9	3.1	3.08	Y
102,463	202	Wall thickness	2.9	3.1	3.1	Y
102,463	202	Wall thickness	2.90	3.10	3.08	Y
102,463	202	Wall thickness	2.90	3.10	3.08	Y
102,463	202	Wall thickness	2.9	3.1	3.090	Y
102,463	203	Wall thickness	2.9	3.1	2.960	Y
102,463	203	Wall thickness	2.9	3.1	2.900	Y
102,463	203	Wall thickness	2.9	3.1	2.91	Y
102,463	203	Wall thickness	2.9	3.1	2.91	Y
102,463	203	Wall thickness	2.9	3.1	3.030	Y
102,463	203	Wall thickness	2.90	3.10	2.92	Y
102,463	203	Wall thickness	2.90	3.10	3.04	Y
102,463	203	Wall thickness	2.9	3.1	3.010	Y
102,463	208	Outside diameter	32.00	32.3	32.25	Y
102,463	208	Outside diameter	32.00	32.3	32.25	Y
102,463	208	Outside diameter	32.00	32.3	32.25	Y
102,463	208	Outside diameter	32.00	32.3	32.2	Y

	PRODUCTION ORDER	LENGTH	LINE	PRODUCTION DATE	DEPARTMENT	STATUS	SAMPLE NUMBER
	PEXA27505	Meter	30A	1/27/2015	PEX-a	Goods	46,524
	PEXA27505	Meter	30A	1/27/2015	PEX-a	Goods	46,530
	PEXA27505	Meter	30A	1/27/2015	PEX-a	Goods	46,536
	PEXA27505	Meter	30A	1/27/2015	PEX-a	Goods	46,542
	PEXA27505	Meter	30A	1/27/2015	PEX-a	Goods	46,548
	PEXA27513	Meter	30A	1/22/2015	PEX-a	Goods	1,435,179
	PEXA27513	Meter	30A	1/22/2015	PEX-a	Goods	1,435,216
	PEXA27505	Meter	30A	1/27/2015	PEX-a	Goods	46,554
	PEXA27505	Meter	30A	1/27/2015	PEX-a	Goods	46,524
	PEXA27505	Meter	30A	1/27/2015	PEX-a	Goods	46,530
	PEXA27505	Meter	30A	1/27/2015	PEX-a	Goods	46,536
	PEXA27505	Meter	30A	1/27/2015	PEX-a	Goods	46,542
	PEXA27505	Meter	30A	1/27/2015	PEX-a	Goods	46,548
	PEXA27513	Meter	30A	1/22/2015	PEX-a	Goods	1,435,179
	PEXA27513	Meter	30A	1/22/2015	PEX-a	Goods	1,435,216
	PEXA27505	Meter	30A	1/27/2015	PEX-a	Goods	46,554
	PEXA27505	Meter	30A	1/27/2015	PEX-a	Goods	46,524
	PEXA27505	Meter	30A	1/27/2015	PEX-a	Goods	46,530
	PEXA27505	Meter	30A	1/27/2015	PEX-a	Goods	46,536
	PEXA27505	Meter	30A	1/27/2015	PEX-a	Goods	46,542

BATCH	TEST CODE	TEST DESCRIPTION	MIN. VALUE	MAX. VALUE	RESULT	COMPLY
102,463	208	Outside diameter	32.00	32.3	32.15	Y
102,463	208	Outside diameter	32.00	32.3	32.15	Y
102,463	208	Outside diameter	32.00	32.3	32.20	Y
102,463	208	Outside diameter	32.00	32.3	32.15	Y
102,463	210	Ovality	0	2	0.77	Y
102,463	210	Ovality	0	2	0.82	Y
102,463	210	Ovality	0	2	0.15	Y
102,463	210	Ovality	0	2	0.35	Y
102,463	210	Ovality	0	2	0.82	Y
102,463	211	Longitudinal reversion	0	3	2.085	Y
102,463	212	Visual			Comply	Y
102,463	212	Visual			Comply	Y
102,463	218	Oxidation			Comply	Y
102,463	218	Oxidation			Comply	Y
102,463	231	Crosslinking degree	70	90	73.723	Y
102,463	231	Crosslinking degree	70	90	84.798	Y
102,463	231	Crosslinking degree	70	90	83.777	Y
102,463	231	Crosslinking degree	70	90	85.758	Y
102,463	231	Crosslinking degree	70	90	84.516	Y

	PRODUCTION ORDER	LENGTH	LINE	PRODUCTION DATE	DEPARTMENT	STATUS	SAMPLE NUMBER
	PEXA27505	Meter	30A	1/27/2015	PEX-a	Goods	46,548
	PEXA27513	Meter	30A	1/22/2015	PEX-a	Goods	1,435,179
	PEXA27513	Meter	30A	1/22/2015	PEX-a	Goods	1,435,216
	PEXA27505	Meter	30A	1/27/2015	PEX-a	Goods	46,554
	PEXA27505	Meter	30A	1/27/2015	PEX-a	Goods	46,524
	PEXA27505	Meter	30A	1/27/2015	PEX-a	Goods	46,542
	PEXA27513	Meter	30A	1/22/2015	PEX-a	Goods	1,435,179
	PEXA27513	Meter	30A	1/22/2015	PEX-a	Goods	1,435,216
	PEXA27505	Meter	30A	1/27/2015	PEX-a	Goods	46,554
	PEXA27513	Meter	30A	1/22/2015	PEX-a	Goods	1,435,179
	PEXA27513	Meter	30A	1/22/2015	PEX-a	Goods	1,435,187
	PEXA27513	Meter	30A	1/22/2015	PEX-a	Goods	1,435,179
	PEXA27513	Meter	30A	1/22/2015	PEX-a	Goods	1,435,179
	PEXA27513	Meter	30A	1/22/2015	PEX-a	Goods	1,435,216
	PEXA27513	Meter	30A	1/22/2015	PEX-a	Goods	1,435,187
	PEXA27513	Meter	30A	1/23/2015	PEX-a	Goods	1,435,258
	PEXA27505	Meter	30A	1/27/2015	PEX-a	Goods	46,538
	PEXA27513	Meter	30A	1/22/2015	PEX-a	Goods	1,435,179
	PEXA27513	Meter	30A	1/22/2015	PEX-a	Goods	1,435,216

8. Oil & Gas Catalog

7.1 Fluid Service Factors: Produced water, seawater, brine, process water with < 2% liquid hydrocarbons = 1,0

Calculation of Pressure Ratings for Pipe Sizes según API Spec 15PX, September 2018 (Annex D). Pipe Inside diameter is calculated as 88% of Schedule 40 steel pipes (see Pexgol Engineering Guide page 80 paragraph 3).

DF: System design factor = 0,71

Class 30 bar

- 435,1 Psi | 30,59 Kg/cm² | 3 Mpa

Temperature: 20°C (68°F) | **Working pressure:** 435 Psi (30.6 Kg/cm²)

SIZE	PIPE DIMENSIONS							
Pipe (in)	Inside Diameter		Outside Diameter		Min. Wall Thickness		Pipe Weight	
	in	(mm)	in	(mm)	in	(mm)	lbs/ft	(Kg/m)
2	1.6	42	2.5	63	0.41	10.5	1.1	1.7
3	2.9	73	4.3	110	0.72	18.3	3.5	5.2
4	3.65	93	5.5	140	0.92	23.3	5.7	8.5
6	5.25	133.5	7.9	200	1.31	33.2	11.6	17.2
8	7.36	187	11	280	1.83	46.5	22.8	34
10	9.3	237	14	355	2.32	59	37.0	55
12	10.5	266.5	15.75	400	2.63	66.7	47.0	70
14	11.8	300	11.7	450	2.95	75	59.8	89
16	13	333	19.7	500	3.29	83.5	72.9	108.5
18	14.7	373	22	560	3.68	93.5	91.1	135.5

(*) Not possible to be coil. Deliver in straight section of 11.8 meters.

	Connection Diameter		Minimum Bending Radius		Short Term Rating Radius		Reel Capacity (m)
	in	(mm)	ft	(m)	(Psi)	Kg/cm2	
	3.2	82	0.6	0.19	544	38	4500
	5.5	140	1.1	0.33	544	38	1300
	6.9	174	1.6	0.49	544	38	870
	9.5	242	2.3	0.7	544	38	300
	13.4	340	3.7	1.12	544	38	185
	17.0	431	6.4	1.95	544	38	*
	19.1	485	9.2	2.8	544	38	*
	21.2	539	11.3	3.46	544	38	*
	23.7	603	13.1	4	544	38	*
	26.5	674	16.4	5	544	38	*

SIZE	PIPE DIMENSIONS							
Pipe (in)	Inside Diameter		Outside Diameter		Min. Wall Thickness		Pipe Weight	
	in	(mm)	in	(mm)	in	(mm)	lbs/ft	(Kg/m)
20	18.6	473	28	710	4.66	118.3	146.3	217.7
22	21	533	31.5	800	5.26	133.5	186.1	277
24	23.6	600	35.4	900	5.91	150	235.2	350

(*) Not possible to be coil. Deliver in straight section of 11.8 meters.

	Connection Diameter		Minimum Bending Radius		Short Term Rating Radius		Reel Capacity (m)
	in	(mm)	ft	(m)	(Psi)	Kg/cm2	
	33.6	853	23.3	7.1	544	38	*
	37.6	955	26.2	8	544	38	*
	42.5	1880	29.5	9	544	38	*

Class 15 bar

- 217,6 Psi | 15,30 Kg/cm² | 1,5 Mpa

Temperature: 20°C (68°F) | **Working pressure:** 217 Psi (15 Kg/cm²)

SIZE	PIPE DIMENSIONS							
Pipe (in)	Inside Diameter		Outside Diameter		Min. Wall Thickness		Pipe Weight	
	in	(mm)	in	(mm)	in	(mm)	lbs/ft	(Kg/m)
2	2	51.4	2.5	63	0.23	5.8	0.7	1.03
3	2.9	73.6	3.5	90	0.32	8.2	1.4	2.09
4	3.6	3.6	4.3	110	0.39	10	2.1	3.11
6	6.45	6.45	7.9	200	0.71	18.1	6.9	10.23
8	7.25	7.25	8.6	225	0.80	20.4	8.7	13
10	9	9	11	280	1.00	25.4	13.5	20.1
12	10	10	12.4	315	1.13	28.6	17.1	25.46
14	11.44	11.44	14	355	1.27	32.2	21.7	32.3
16	13	13	15.75	400	1.43	36.3	27.9	41.5
18	16	16	20	500	1.79	45.4	43.7	65
20	18	18	22	600	2.00	50.9	55.1	82
22	20	20	24.8	630	2.26	57.3	69.2	103
24	22.9	22.9	28	710	2.54	64.5	87.0	129.5

(*) Not possible to be coil. Deliver in straight section of 11.8 meters.

Connection Diameter		Minimum Bending Radius		Short Term Rating Radius		Reel Capacity (m)
in	(mm)	ft	(m)	(Psi)	Kg/cm2	
3.2	82	0.984	0.3	270	18.75	4500
4.6	117	1.476	0.45	270	18.75	2000
5.5	140	1.804	0.55	270	18.75	1300
9.5	242	4.264	1.3	270	18.75	300
10.7	272	4.592	1.4	270	18.75	230
13.4	340	10.496	3.2	270	18.75	108
15.2	387	11.48	3.5	270	18.75	50
17.0	431	12.792	3.9	270	18.75	*
19.1	485	17.056	5.2	270	18.75	*
23.7	603	26.24	8	270	18.75	*
26.5	674	31.16	9.5	270	18.75	*
29.9	759	39.36	12	270	18.75	*
33.6	853	46.576	14.2	270	18.75	*

Class 10 bar

- 145 Psi | 10,20 Kg/cm² | 1 Mpa

Temperature: 20°C (68°F) | **Working pressure:** 145 Psi (10 Kg/cm²)

SIZE	PIPE DIMENSIONS							
Pipe (in)	Inside Diameter		Outside Diameter		Min. Wall Thickness		Pipe Weight	
	in	(mm)	in	(mm)	in	(mm)	lbs/ft	(Kg/m)
2	2.17	55.2	2.5	63	0.15	3.9	0.48	0.72
3	2.6	65.8	3	75	0.19	4.7	0.69	1.03
4	3.8	96.4	4.3	110	0.27	6.8	1.46	2.18
6	5.5	140	6.3	160	0.39	9.9	3.09	4.6
8	6.9	175	7.9	200	0.49	12.4	4.86	7.23
10	8.6	219	9.8	250	0.61	15.5	7.59	11.3
12	10.9	276	12.4	315	0.77	19.5	12.03	17.9
14	12.25	311	14	355	0.86	21.9	15.23	22.67
16	13.8	350.6	15.75	400	0.97	24.7	19.35	28.8
18	15.5	394.4	17.7	450	1.09	27.8	24.53	36.5
20	17.25	438	19.7	500	1.22	30.9	30.27	45.05
22	19.3	490.8	22	560	1.36	34.6	36.02	53.6
24	19.3	490.8	22	560	1.36	34.6	36.02	53.6

(*) Not possible to be coil. Deliver in straight section of 11.8 meters.

Connection Diameter		Minimum Bending Radius		Short Term Rating Radius		Reel Capacity (m)
in	(mm)	ft	(m)	(Psi)	Kg/cm2	
3.23	82	1.64	0.5	180	12.5	*
3.86	98	1.968	0.6	180	12.5	*
5.51	140	2.8864	0.88	180	12.5	*
7.64	194	5.248	1.6	180	12.5	*
9.72	247	6.56	2	180	12.5	*
12.24	311	9.84	3	180	12.5	*
15.24	387	16.4	5	180	12.5	*
16.97	431	18.696	5.7	180	12.5	*
19.09	485	26.24	8	180	12.5	*
21.22	539	29.52	9	180	12.5	*
23.74	603	39.36	12	180	12.5	*
26.54	674	47.56	14.5	180	12.5	*
26.54	674	47.56	14.5	180	12.5	*

7.2 Fluid Service Factors: Produced water, seawater, brine, process water with >2% liquid hydrocarbons = 0.5

Calculation of Pressure Ratings for Pipe Sizes según API Spec 15PX, sept 2018 (Annex D).Pipe Inside diameter is calculated as 88% of Schedule 40 steel pipes (see Pexgol Engineering Guide page 80 parag. 3).

DF: System design factor = 0,71

Class 30 bar

- 435,1 Psi | 30,59 Kg/cm² | 3 Mpa

Temperature: 65°C (150°F) | **Working pressure:** 130 Psi (9 Kg/cm²)

SIZE	PIPE DIMENSIONS							
Pipe (in)	Inside Diameter		Outside Diameter		Min. Wall Thickness		Pipe Weight	
	in	(mm)	in	(mm)	in	(mm)	lbs/ft	(Kg/m)
2	1.6	42	2.5	63	0.41	10.5	1.1	1.7
3	2.9	73	4.3	110	0.72	18.3	3.5	5.2
4	3.65	93	5.5	140	0.92	23.3	5.7	8.5
6	5.25	133.5	7.9	200	1.31	33.2	11.6	17.2
8	7.36	187	11	280	1.83	46.5	22.8	34
10	9.3	237	14	355	2.32	59	37.0	55
12	10.5	266.5	15.75	400	2.63	66.7	47.0	70
14	11.8	300	11.7	450	2.95	75	59.8	89
16	13	333	19.7	500	3.29	83.5	72.9	108.5
18	14.7	373	22	560	3.68	93.5	91.1	135.5
20	18.6	473	28	710	4.66	118.3	146.3	217.7
22	21	533	31.5	800	5.26	133.5	186.1	277
24	23.6	600	35.4	900	5.91	150	235.2	350

(*) Not possible to be coil. Deliver in straight section of 11.8 meters.

Connection Diameter		Minimum Bending Radius		Short Term Rating Radius		Reel Capacity (m)
in	(mm)	ft	(m)	(Psi)	Kg/cm2	
3.2	82	0.6	0.19	163	11.25	4500
5.5	140	1.1	0.33	163	11.25	1300
6.9	174	1.6	0.49	163	11.25	870
9.5	242	2.3	0.7	163	11.25	300
13.4	340	3.7	1.12	163	11.25	185
17.0	431	6.4	1.95	163	11.25	*
19.1	485	9.2	2.8	163	11.25	*
21.2	539	11.3	3.46	163	11.25	*
23.7	603	13.1	4	163	11.25	*
26.5	674	16.4	5	163	11.25	*
33.6	853	23.3	7.1	163	11.25	*
37.6	955	26.2	8	163	11.25	*
42.5	1880	29.5	9	163	11.25	*

Class 15 bar

- 217,6 Psi | 15,3 Kg/cm² | 1,5 Mpa

Temperature: 65°C (150°F) | **Working pressure:** 130 Psi (9 Kg/cm²)

SIZE	PIPE DIMENSIONS							
Pipe (in)	Inside Diameter		Outside Diameter		Min. Wall Thickness		Pipe Weight	
	in	(mm)	in	(mm)	in	(mm)	lbs/ft	(Kg/m)
2	2	51.4	2.5	63	0.23	5.8	0.7	1.03
3	2.9	73.6	3.5	90	0.32	8.2	1.4	2.09
4	3.6	90	4.3	110	0.39	10	2.1	3.11
6	6.45	163.8	7.9	200	0.71	18.1	6.9	10.23
8	7.25	184.2	8.6	225	0.80	20.4	8.7	13
10	9	229.2	11	280	1.00	25.4	13.5	20.1
12	10	257.8	12.4	315	1.13	28.6	17.1	25.46
14	11.44	290.6	14	355	1.27	32.2	21.7	32.3
16	13	327.4	15.75	400	1.43	36.3	27.9	41.5
18	16	409.2	20	500	1.79	45.4	43.7	65
20	18	458.4	22	560	2.00	50.9	55.1	82
22	20	515.6	24.8	630	2.26	57.3	69.2	103
24	22.9	581	28	710	2.54	64.5	87.0	129.5

(*) Not possible to be coil. Deliver in straight section of 11.8 meters.

Connection Diameter		Minimum Bending Radius		Short Term Rating Radius		Reel Capacity (m)
in	(mm)	ft	(m)	(Psi)	Kg/cm2	
3.2	82	0.984	0.3	82	5.6	4500
4.6	117	1.476	0.45	82	5.6	2000
5.5	140	1.804	0.55	82	5.6	1300
9.5	242	4.264	1.3	82	5.6	300
10.7	272	4.592	1.4	82	5.6	230
13.4	340	10.496	3.2	82	5.6	108
15.2	387	11.48	3.5	82	5.6	50
17.0	431	12.792	3.9	82	5.6	*
19.1	485	17.056	5.2	82	5.6	*
23.7	603	26.24	8	82	5.6	*
26.5	674	31.16	9.5	82	5.6	*
29.9	759	39.36	12	82	5.6	*
33.6	853	46.576	14.2	82	5.6	*

Class 10 bar

- 145 Psi | 10,20 Kg/cm² | 1 Mpa

Temperature: 20°C (68°F) | **Working pressure:** 145 Psi (10 Kg/cm²)

SIZE	PIPE DIMENSIONS							
Pipe (in)	Inside Diameter		Outside Diameter		Min. Wall Thickness		Pipe Weight	
	in	(mm)	in	(mm)	in	(mm)	lbs/ft	(Kg/m)
2	2.17	55.2	2.5	63	0.15	3.9	0.48	0.72
3	2.6	65.8	3	75	0.19	4.7	0.69	1.03
4	3.8	96.4	4.3	110	0.27	6.8	1.46	2.18
6	5.5	140	6.3	160	0.39	9.9	3.09	4.6
8	6.9	175	7.9	200	0.49	12.4	4.86	7.23
10	8.6	219	9.8	250	0.61	15.5	7.59	11.3
12	10.9	276	12.4	315	0.77	19.5	12.03	17.9
14	12.25	311	14	355	0.86	21.9	15.23	22.67
16	13.8	350.6	15.75	400	0.97	24.7	19.35	28.8
18	15.5	394.4	17.7	450	1.09	27.8	24.53	36.5
20	17.25	438	19.7	500	1.22	30.9	30.27	45.05
22	19.3	490.8	22	560	1.36	34.6	36.02	53.6
24	19.3	490.8	22	560	1.36	34.6	36.02	53.6

(*) Not possible to be coil. Deliver in straight section of 11.8 meters.

Connection Diameter		Minimum Bending Radius		Short Term Rating Radius		Reel Capacity (m)
in	(mm)	ft	(m)	(Psi)	Kg/cm2	
3.23	82	1.64	0.5	65	4.5	*
3.86	98	1.968	0.6	65	4.5	*
5.51	140	2.8864	0.88	65	4.5	*
7.64	194	5.248	1.6	65	4.5	*
9.72	247	6.56	2	65	4.5	*
12.24	311	9.84	3	65	4.5	*
15.24	387	16.4	5	65	4.5	*
16.97	431	18.696	5.7	65	4.5	*
19.09	485	26.24	8	65	4.5	*
21.22	539	29.52	9	65	4.5	*
23.74	603	39.36	12	65	4.5	*
26.54	674	47.56	14.5	65	4.5	*
26.54	674	47.56	14.5	65	4.5	*

7.3 Fluid Service Factors: Produced water, seawater, brine, process water with <2% liquid hydrocarbons = 1.0

Calculation of Pressure Ratings for Pipe Sizes according to API Spec 15PX, sept 2018 (Annex D). Pipe Inside diameter is calculated as 88% of Schedule 40 steel pipes (see Pexgol Engineering Guide page 80 paragraph 3).

DF: System design factor = 0,71

Class 30 bar

- 435,1 Psi | 30,59 Kg/cm² | 3 Mpa

Temperature: 95°C (203°F) | **Working pressure:** 186 Psi (12.8 Kg/cm²)

SIZE	PIPE DIMENSIONS							
Pipe (in)	Inside Diameter		Outside Diameter		Min. Wall Thickness		Pipe Weight	
	in	(mm)	in	(mm)	in	(mm)	lbs/ft	(Kg/m)
2	1.6	42	2.5	63	0.41	10.5	1.1	1.7
3	2.9	73	4.3	110	0.72	18.3	3.5	5.2
4	3.65	93	5.5	140	0.92	23.3	5.7	8.5
6	5.25	133.5	7.9	200	1.31	33.2	11.6	17.2
8	7.36	187	11	280	1.83	46.5	22.8	34
10	9.3	237	14	355	2.32	59	37.0	55
12	10.5	266.5	15.75	400	2.63	66.7	47.0	70
14	11.8	300	11.7	450	2.95	75	59.8	89
16	13	333	19.7	500	3.29	83.5	72.9	108.5
18	14.7	373	22	560	3.68	93.5	91.1	135.5
20	18.6	473	28	710	4.66	118.3	146.3	217.7
22	21	533	31.5	800	5.26	133.5	186.1	277

(*) Not possible to be coil. Deliver in straight section of 11.8 meters.

Connection Diameter		Minimum Bending Radius		Short Term Rating Radius		Reel Capacity (m)
in	(mm)	ft	(m)	(Psi)	Kg/cm2	
3.2	82	0.6	0.19	232	16	4500
5.5	140	1.1	0.33	232	16	1300
6.9	174	1.6	0.49	232	16	870
9.5	242	2.3	0.7	232	16	300
13.4	340	3.7	1.12	232	16	185
17.0	431	6.4	1.95	232	16	*
19.1	485	9.2	2.8	232	16	*
21.2	539	11.3	3.46	232	16	*
23.7	603	13.1	4	232	16	*
26.5	674	16.4	5	232	16	*
33.6	853	23.3	7.1	232	16	*
37.6	955	26.2	8	232	16	*

SIZE	PIPE DIMENSIONS							
Pipe (in)	Inside Diameter		Outside Diameter		Min. Wall Thickness		Pipe Weight	
	in	(mm)	in	(mm)	in	(mm)	lbs/ft	(Kg/m)
24	23.6	600	35.4	900	5.91	150	235.2	350

(*) Not possible to be coil. Deliver in straight section of 11.8 meters.

Class 15 bar

- 217,6 Psi | 15,3 Kg/cm² | 1,5 Mpa

Temperature: 95°C (203°F) | **Working pressure:** 93 Psi (6.4 Kg/cm²)

SIZE	PIPE DIMENSIONS							
Pipe (in)	Inside Diameter		Outside Diameter		Min. Wall Thickness		Pipe Weight	
	in	(mm)	in	(mm)	in	(mm)	lbs/ft	(Kg/m)
2	2	51.4	2.5	63	0.23	5.8	0.7	1.03
3	2.9	73.6	3.5	90	0.32	8.2	1.4	2.09
4	3.6	90	4.3	110	0.39	10	2.1	3.11
6	6.45	163.8	7.9	200	0.71	18.1	6.9	10.23
8	7.25	184.2	8.6	225	0.80	20.4	8.7	13
10	9	229.2	11	280	1.00	25.4	13.5	20.1
12	10	257.8	12.4	315	1.13	28.6	17.1	25.46
14	11.44	290.6	14	355	1.27	32.2	21.7	32.3
16	13	327.4	15.75	400	1.43	36.3	27.9	41.5
18	16	409.2	20	500	1.79	45.4	43.7	65
20	18	458.4	22	560	2.00	50.9	55.1	82

(*) Not possible to be coil. Deliver in straight section of 11.8 meters.

Connection Diameter		Minimum Bending Radius		Short Term Rating Radius		Reel Capacity (m)
in	(mm)	ft	(m)	(Psi)	Kg/cm2	
42.5	1880	29.5	9	232	16	*

Connection Diameter		Minimum Bending Radius		Short Term Rating Radius		Reel Capacity (m)
in	(mm)	ft	(m)	(Psi)	Kg/cm2	
3.2	82	0.984	0.3	116	8	4500
4.6	117	1.476	0.45	116	8	2000
5.5	140	1.804	0.55	116	8	1300
9.5	242	4.264	1.3	116	8	300
10.7	272	4.592	1.4	116	8	230
13.4	340	10.496	3.2	116	8	108
15.2	387	11.48	3.5	116	8	50
17.0	431	12.792	3.9	116	8	*
19.1	485	17.056	5.2	116	8	*
23.7	603	26.24	8	116	8	*
26.5	674	31.16	9.5	116	8	*

SIZE	PIPE DIMENSIONS							
Pipe (in)	Inside Diameter		Outside Diameter		Min. Wall Thickness		Pipe Weight	
	in	(mm)	in	(mm)	in	(mm)	lbs/ft	(Kg/m)
22	20	515.6	24.8	630	2.26	57.3	69.2	103
24	22.9	581	28	710	2.54	64.5	87.0	129.5

(*) Not possible to be coil. Deliver in straight section of 11.8 meters.

	Connection Diameter		Minimum Bending Radius		Short Term Rating Radius		Reel Capacity (m)
	in	(mm)	ft	(m)	(Psi)	Kg/cm2	
	29.9	759	39.36	12	116	8	*
	33.6	853	46.576	14.2	116	8	*

7.4 Fluid Service Factors: Produced water, seawater, brine, process water with >2% liquid hydrocarbons = 0.5

Calculation of Pressure Ratings for Pipe Sizes según API Spec 15PX, sept 2018 (Annex D). Pipe Inside diameter is calculated as 88% of Schedule 40 steel pipes (see Pexgol Engineering Guide page 80 paragraph 3).

DF: System design factor = 0,71

Class 30 bar

- 435,1 Psi | 30,59 Kg/cm² | 3 Mpa

Temperature: 95°C (203°F) | **Working pressure:** 186 Psi (6.5 Kg/cm²)

SIZE	PIPE DIMENSIONS							
Pipe (in)	Inside Diameter		Outside Diameter		Min. Wall Thickness		Pipe Weight	
	in	(mm)	in	(mm)	in	(mm)	lbs/ft	(Kg/m)
2	1.6	42	2.5	63	0.41	10.5	1.1	1.7
3	2.9	73	4.3	110	0.72	18.3	3.5	5.2
4	3.65	93	5.5	140	0.92	23.3	5.7	8.5
6	5.25	133.5	7.9	200	1.31	33.2	11.6	17.2
8	7.36	187	11	280	1.83	46.5	22.8	34
10	9.3	237	14	355	2.32	59	37.0	55
12	10.5	266.5	15.75	400	2.63	66.7	47.0	70
14	11.8	300	11.7	450	2.95	75	59.8	89
16	13	333	19.7	500	3.29	83.5	72.9	108.5
18	14.7	373	22	560	3.68	93.5	91.1	135.5
20	18.6	473	28	710	4.66	118.3	146.3	217.7
22	21	533	31.5	800	5.26	133.5	186.1	277
24	23.6	600	35.4	900	5.91	150	235.2	350

(*) Not possible to be coil. Deliver in straight section of 11.8 meters.

Connection Diameter		Minimum Bending Radius		Short Term Rating Radius		Reel Capacity (m)
in	(mm)	ft	(m)	(Psi)	Kg/cm2	
3.2	82	0.6	0.19	118	8.1	4500
5.5	140	1.1	0.33	118	8.1	1300
6.9	174	1.6	0.49	118	8.1	870
9.5	242	2.3	0.7	118	8.1	300
13.4	340	3.7	1.12	118	8.1	185
17.0	431	6.4	1.95	118	8.1	*
19.1	485	9.2	2.8	118	8.1	*
21.2	539	11.3	3.46	118	8.1	*
23.7	603	13.1	4	118	8.1	*
26.5	674	16.4	5	118	8.1	*
33.6	853	23.3	7.1	118	8.1	*
37.6	955	26.2	8	118	8.1	*
42.5	1880	29.5	9	118	8.1	*

Class 15 bar

- 217,6 Psi | 15,30 Kg/cm² | 1,5 Mpa

Temperature: 95°C (203°F) | **Working pressure:** 46.5 Psi (3.2 Kg/cm²)

SIZE	PIPE DIMENSIONS							
Pipe (in)	Inside Diameter		Outside Diameter		Min. Wall Thickness		Pipe Weight	
	in	(mm)	in	(mm)	in	(mm)	lbs/ft	(Kg/m)
2	2	51.4	2.5	63	0.23	5.8	0.7	1.03
3	2.9	73.6	3.5	90	0.32	8.2	1.4	2.09
4	3.6	90	4.3	110	0.39	10	2.1	3.11
6	6.45	163.8	7.9	200	0.71	18.1	6.9	10.23
8	7.25	184.2	8.6	225	0.80	20.4	8.7	13
10	9	229.2	11	280	1.00	25.4	13.5	20.1
12	10	257.8	12.4	315	1.13	28.6	17.1	25.46
14	11.44	290.6	14	355	1.27	32.2	21.7	32.3
16	13	327.4	15.75	400	1.43	36.3	27.9	41.5
18	16	409.2	20	500	1.79	45.4	43.7	65
20	18	458.4	22	560	2.00	50.9	55.1	82
22	20	515.6	24.8	630	2.26	57.3	69.2	103
24	22.9	581	28	710	2.54	64.5	87.0	129.5

(*) Not possible to be coil. Deliver in straight section of 11.8 meters.

Connection Diameter		Minimum Bending Radius		Short Term Rating Radius		Reel Capacity (m)
in	(mm)	ft	(m)	(Psi)	Kg/cm2	
3.2	82	0.984	0.3	58	4	4500
4.6	117	1.476	0.45	58	4	2000
5.5	140	1.804	0.55	58	4	1300
9.5	242	4.264	1.3	58	4	300
10.7	272	4.592	1.4	58	4	230
13.4	340	10.496	3.2	58	4	108
15.2	387	11.48	3.5	58	4	50
17.0	431	12.792	3.9	58	4	*
19.1	485	17.056	5.2	58	4	*
23.7	603	26.24	8	58	4	*
26.5	674	31.16	9.5	58	4	*
29.9	759	39.36	12	58	4	*
33.6	853	46.576	14.2	58	4	*

Class 10 bar

- 145 Psi | 10,20 Kg/cm² | 1 Mpa

Temperature: 95°C (203°F) | **Working pressure:** 30 Psi (2 Kg/cm²)

SIZE	PIPE DIMENSIONS							
Pipe (in)	Inside Diameter		Outside Diameter		Min. Wall Thickness		Pipe Weight	
	in	(mm)	in	(mm)	in	(mm)	lbs/ft	(Kg/m)
2	2.17	55.2	2.5	63	0.15	3.9	0.48	0.72
3	2.6	65.8	3	75	0.19	4.7	0.69	1.03
4	3.8	96.4	4.3	110	0.27	6.8	1.46	2.18
6	5.5	140	6.3	160	0.39	9.9	3.09	4.6
8	6.9	175	7.9	200	0.49	12.4	4.86	7.23
10	8.6	219	9.8	250	0.61	15.5	7.59	11.3
12	10.9	276	12.4	315	0.77	19.5	12.03	17.9
14	12.25	311	14	355	0.86	21.9	15.23	22.67
16	13.8	350.6	15.75	400	0.97	24.7	19.35	28.8
18	15.5	394.4	17.7	450	1.09	27.8	24.53	36.5
20	17.25	438	19.7	500	1.22	30.9	30.27	45.05
22	19.3	490.8	22	560	1.36	34.6	36.02	53.6
24	19.3	490.8	22	560	1.36	34.6	36.02	53.6

(*) Not possible to be coil. Deliver in straight section of 11.8 meters.

Connection Diameter		Minimum Bending Radius		Short Term Rating Radius		Reel Capacity (m)
in	(mm)	ft	(m)	(Psi)	Kg/cm2	
3.23	82	1.64	0.5	36	2.5	4500
3.86	98	1.968	0.6	36	2.5	2000
5.51	140	2.8864	0.88	36	2.5	1300
7.64	194	5.248	1.6	36	2.5	300
9.72	247	6.56	2	36	2.5	230
12.24	311	9.84	3	36	2.5	108
15.24	387	16.4	5	36	2.5	50
16.97	431	18.696	5.7	36	2.5	*
19.09	485	26.24	8	36	2.5	*
21.22	539	29.52	9	36	2.5	*
23.74	603	39.36	12	36	2.5	*
26.54	674	47.56	14.5	36	2.5	*
26.54	674	47.56	14.5	36	2.5	*

Standards

Long-term Hydrostatic Strengh

EXOVA REPORT

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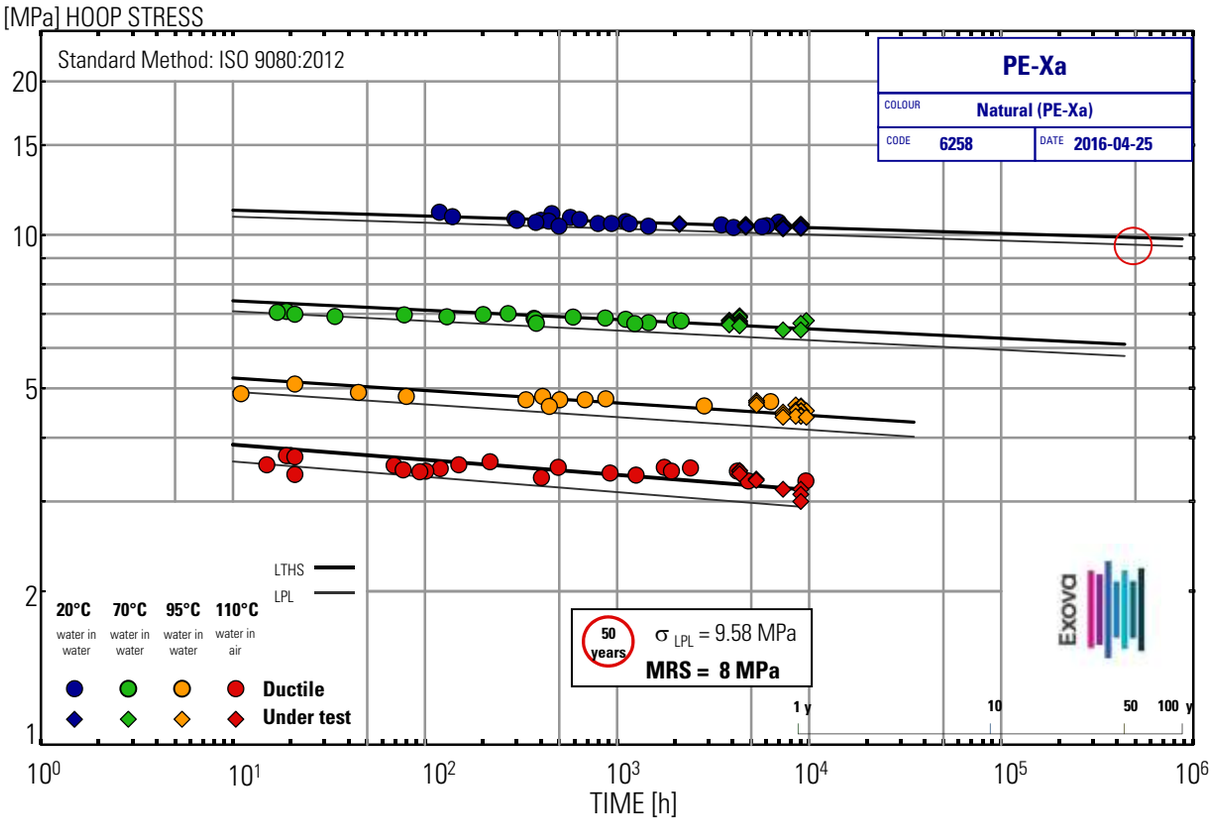
DETERMINATION OF THE LONG-TERM HYDROSTATIC STRENGTH

ISO 9080:2012-evaluation a natural PE-Xa pipe grade from Golan Plastic Products Ltd.

Sohail NAWAZ



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DETERMINATION OF THE LONG-TERM HYDROSTATIC STRENGTH ISO 9080:2012-evaluation a natural PE-Xa pipe grade from Golan Plastic Products Ltd.

ABSTRACT

The aim of this project was to determine the long term hydrostatic strength of a natural PE-Xa pipe grade according to ISO 9080 and then MRS-classify it according to ISO 12162. The ISO 9080-evaluation of the pipe grade gives the following strength values at 20 and 70°C at 50 years;

T	TIME	σ_{LPL}	σ_{LTHS}
20°C	50 yrs	9.58 MPa	9.90 MPa
70°C	50 yrs	5.78 MPa	6.10 MPa

By its LPL value of 9.58 MPa at 20°C and 50 years the PE-Xa pipe grade has a minimum required strength (MRS) of 8 MPa and is thereby designated PE-Xa 80 according to ISO 12162:2009.

The resulting design hoop stresses for the different application classes 1, 2, 4 and 5, given in ISO 10508:2006, using the LPL line of PE-Xa pipe grade are summarised below.

APPLICATION CLASS	DESIGN HOOP STRESS		RESULT
	PE-Xa using σ_{LPL}	ISO 15875-2 (PE-X)	
1	4.16 MPa	3.85 MPa	Pass
2	3.87 MPa	3.54 MPa	Pass
4	4.22 MPa	4.00 MPa	Pass
5	3.42 MPa	3.24 MPa	Pass
Cold water (20°C, 50 yrs)	7.68 MPa	7.60 MPa	Pass

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1 EVALUATED PIPE GRADE

A short presentation of the evaluated pipe grade is presented below and detailed information is given in Appendix B.

Table 1 *Evaluated pipe grade*

Trade name	PE-Xa
Pipe colour	Natural
Pipe material	PE-Xa
Nominal pipe dimension	32 x 3 mm
EXOVA internal code	6258

2 EXPERIMENTAL PROCEDURE

The hydrostatic pressure testing is performed at Exova according to ISO 1167:2006. The pressure testing at 20, 70 and 95°C is performed using deionised water on the inside and on the outside of the pipe specimens. At 110°C air is used on the outside. The accuracy for temperature[1] and pressure[1] is better than ±1°C and +2/-1% respectively. The measurements of the wall thickness[1] are accurate within ±0.01 mm and the diameter[1] within ±0.1 mm.

3 RESULTS FROM THE HYDROSTATIC PRESSURE TESTING

The results obtained from the hydrostatic pressure testing are presented in Appendix B and shown in Appendix C. Table 2 gives a summary of the observations.

Table 2 *Summary of the results from the hydrostatic pressure testing*

T	TOTAL NO OF SAMPLES [1]	BURST SAMPLES [1]	ONGOING SAMPLES [1]	STOPPED SAMPLES [1]	LONGEST BURST TIME [h]	LONGEST TEST TIME [h]
20°C	47	28	19	0	6 940	9 047
70°C	54	23	31	0	2 156	9 672
95°C	38	16	22	0	6 307	9 672
110°C	47	26	21	0	9 612	9 672

[1] The expanded uncertainty of measurement has been calculated as the standard uncertainty of measurement multiplied by the coverage factor K=2, which for a normal distribution corresponds to a coverage probability of approximately 95%. The standard uncertainty of measurement has been determined in accordance with EA Publication EA-4/16:2003 and is documented at EXOVA.

4 ISO 9080-EVALUATION

The ISO 9080-evaluation consists of multiple linear regression analysis (MLR) on the stress rupture data obtained at the different test temperatures. The MLR is performed using the latest version of the software Pipeson Analyzer from Pipeson.

The ISO 9080 also includes extrapolation factors that determine to what times we can extrapolate at each temperature.

4.1 General model for the regression analysis according to ISO 9080

The general 4-parameter model used in ISO 9080 is the following:

$$Log(t) = C_1 + C_2 \cdot \frac{1}{T} + C_3 \cdot Log(\sigma) + C_4 \cdot \frac{Log(\sigma)}{T} + e$$

where

C_1 *to* C_4	*parameters used in this model*	
t	*time to failure*	*[h]*
T	*Temperature*	*[K]*
σ	*Hoop stress*	*[MPa]*
e	*error variable*	*Laplace-Gaussian distribution, with zero mean and constant variance (the errors are assumed to be independent)*

The 4-parameter model shall be reduced to a 3-parameter model if the probability level of C_3 is greater than 0.05. i.e. $C_3 = 0$.

5 RESULTS FROM THE ISO 9080 EVALUATION

The diagram in Appendix C.2 shows the observations and lines for σ_{LPL} and σ_{LTHS} for the selected analysis.

5.1 Comments on selecting the data set for ISO 9080

The following procedures are based on the current version of ISO 9080, and Exova's experience of ISO 9080 evaluations.

- Data points equal to and below 102 h at 20°C was excluded from the analysis in accordance with paragraph 4.2.3 in ISO 9080.
- The software detected knees at 70 and 95 °C. The knee detection is caused by the on test samples, it is therefore disregarded and all data designated to type A.

5.2 Distribution of stress rupture data

Table 3 presents the distribution of observations for the data set that was used in the ISO 9080-evaluation.

Table 3 *Distribution of the stress rupture data included in the ISO 9080 evaluation*

T	SAMPLES				DISTRIBUTION		EXCLUDED SAMPLES[2)]
	TOTAL	BURST	ONGOING	STOPPED	>7 000 h	>9 000 h	
20°C	30	21	9	0	5	3	0
70°C	32	18	14	0	4	3	0
95°C	30	12	18	0	15	8	0
110°C	31	22	9	0	5	4	0
Requirement[1)]	*30*	-	-	-	*4*	*1*	-

1) Indicate the required number of observations according to ISO 9080.

2) Number of samples included in the distribution analysis, but not in the regression analysis.

5.3 Regression analysis model

Different analyses were performed adding pipes that still were in progress and using the 3 or 4-parameter models. The 4-parameter model was finally chosen, as the probability level for C_3 was ≤0.05. Table 4 presents the regression coefficients and the standard error values for the selected analysis, i.e. only valid for the pipes with the Exova code 6258.

Table 4 *Regression coefficients for the selected model*

FIRST BRANCH	C_1	C_2	C_3	C_4
Value	-214.067	90 027.918	142.010	-67 366.782
Standard error	16.941	6 997.833	11.482	5 323.764

5.4 Extrapolation time limits

Table 5 below shows the maximum test times for the different test temperatures.

Table 5 *Maximum test times*

T_t [1]	t_{max} [2]	
20°C	8 312 h	0.95 yrs
70°C	7 589 h	0.87 yrs
95°C	9 308 h	1.06 yrs
110°C	8 781 h	1.00 yrs

1) *T_t is the test temperature*

2) *The maximum test time, t_{max}, is the logarithmic average of the 5 longest observations.*

Table 6 below shows the maximum extrapolation time limits for the different test temperatures.

Table 6 *Maximum extrapolation time limits*

T_s [1]	**EXTRAPOLATION TIME LIMIT, t_e [2], at T_s**	
20°C	930 801 h	106 yrs
70°C	439 034 h	50.1 yrs
95°C	35 123 h	4.01 yrs
110°C	8 781 h	1.00 yrs

1) *T_s is the service temperature (the extrapolated temperature)*

2) *The extrapolation time limit, t_e, is calculated from the relation: $t_e = t_{max} \cdot k_e$, where k_e is the extrapolation time factor and is a function of the difference in extrapolated temperature, T_s, and the test temperature, T_t.*

5.5 Extrapolated strength values

The selected model gives the following extrapolated strength values corresponding to 50 years at 20°C and to the extrapolation time limits at the test temperatures.

Table 7 *Extrapolated strength values*

TIME	σ_{LTHS} [MPa]				σ_{LPL} [MPa]			
[h]	**20°C**	**70°C**	**95°C**	**110°C**	**20°C**	**70°C**	**95°C**	**110°C**
10	11.178	7.426	5.239	3.877	10.853	7.083	4.923	3.594
100	10.888	7.118	4.953	3.622	10.575	6.792	4.656	3.359
1 000	10.607	6.822	4.682	3.384	10.299	6.507	4.399	3.134
10 000	10.332	6.539	4.427	-	10.025	6.228	4.150	-
100 000	10.065	6.268	-	-	9.752	5.956	-	-
50 yrs	9.897	6.100	-	-	9.578	5.785	-	-
100 yrs	9.819	-	-	-	9.497	-	-	-
106 yrs (t_e 20°C)	9.812	-	-	-	9.490	-	-	-
50.1 yrs (t_e 70°C)	-	6.099	-	-	-	5.785	-	-
4.01 yrs (t_e 95°C)	-	-	4.293	-	-	-	4.019	-
1.00 yrs (t_e 110°C)	-	-	-	3.173	-	-		2.932

5.6 Classification and designation according to ISO 12162

By its LPL value of 9.58 MPa at 20°C and 50 years the PE-Xa pipe grade has a minimum required strength (MRS) of 8 MPa and is thereby designated PE-Xa 80 according to ISO 12162:2009.

6 MINER'S RULE CALCULATIONS

Miner´s rule calculations have been performed according to ISO 13760:1998 for application classes Class 1, 2, 4 and 5. Table 8 below shows an excerpt from paragraph 4, Table 1 of ISO 10508.

Table 8 *Classification of service conditions according to ISO 10508*

CLASS	T_D		T_{max}		T_{mal}		EXAMPLE OF APPLICATION
	[°C]	[yrs]	[°C]	[yrs]	[°C]	[h]	
1	60	49	80	1	95	100	Hot water supply (60°C)
2	70	49	80	1	95	100	Hot water supply (70°C)
4	20[1)]	2.5	70	2.5	100	100	Under-floor heating and low-temperature radiators
	40	20					
	60	25					
5	20[1)]	14	90	1	100	100	High-temperature radiators
	60	25					
	80	10					
1) Any balancing time required to make the time equal to a service life of 50 years shall be at 20°C (T_{cold})							

6.1 Calculations of design hoop stresses for PE-X

Calculations were performed to determine the design hoop stress at the application classes Class 1, 2, 4 and 5. The following calculations have been taken into account; results of the regression analysis according to ISO 9080 (eq. 1), application classes according to ISO 10508 and different operating coefficients on the design hoop stress in accordance with Table 9.

Table 9 *Overall service (design) coefficients*

TEMPERATURE [°C]	OVERALL SERVICE COEFFICIENT (C) [1]
T_0	1.5
T_{max}	1.3
T_{mal}	1.0
T_{cold}	1.25

The resulting design hoop stresses of the Miner´s rule calculations for a design time of 50 years are presented in Table 10 below.

Table 10 *Resulting design hoop stresses for the PE-Xa pipe grade*

APPLICATION CLASS	DESIGN HOOP STRESS		RESULT
	PE-Xa using σ_{LPL}	ISO 15875-2 (PE-X)	
1	4.16 MPa	3.85 MPa	Pass
2	3.87 MPa	3.54 MPa	Pass
4	4.22 MPa	4.00 MPa	Pass
5	3.42 MPa	3.24 MPa	Pass
Cold water (20°C, 50 yrs)	7.68 MPa	7.60 MPa	Pass

7 ADDITIONAL COMMENTS

The delivered pipes showed good visual appearance and no unusual behaviour were observed during the hydrostatic pressure testing.

REFERRED DOCUMENTS

- ISO 1167:2006
  Thermoplastics pipes, fittings and assemblies for the conveyance of fluids – Determination of the resistance to internal pressure
- ISO 9080:2012
  Plastics piping and ducting systems – Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation
- ISO 12162:2009
  Thermoplastics materials for pipes and fittings for pressure applications – Classification, designation and design coefficient
- ISO 15875:2003
  Plastics piping systems for hot and cold water installations — Crosslinked polyethylene (PE-X)
- ISO 9080 evaluation software
  Pipeson Analyzer® 3.2.5 from Pipeson AB, www.pipeson.se
- ISO/IEC 17025:2005
  General requirements for the competence of testing and calibration laboratories
- EA-4/16:2003
  EA guidelines on the expression of uncertainty in quantitative testing
- ISO 10508:2006
  Plastics piping systems for hot and cold water installations — Guidance for classification and design

CLIENT INFO

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MATERIAL INFO

Exova code	6258
Trade name	PE-Xa
Material	PE-Xa
Colour	Natural
Nominal dimension	32 x 3 mm
Arrival date at Exova	2015-02-11
Amount	350 x 0.35 m
Consignor	Golan Plastic Products Ltd.
Condition of material at arrival	No visual defects
Marking	No commercial marking
Resin producer	na
Resin production site	na
Resin production batch no	na
Resin production date	na
Pipe producer	na
Pipe production site	na
Pipe production batch no	na
Pipe production date	na
Method of manufacturing	Extrusion

TEST INFO

Test laboratory	Exova Plastic Pipes, ISO/IEC 17025 Swedac accreditation no. 0067
Responsible	Jarno HASSINEN - Technical Manager
Test method	ISO 1167:2006
Length (total/free)	350/310 mm
Fittings	Brass fittings and type A, unless remarked
Internal medium	Water
External medium	Water (Air at 110°C)
Conditioning time	3 h, unless remarked
Situation on	2016-04-25

TABLE REMARKS

Code	Exova internal code
T	Test temperature
Start date	Date when the sample was started
Reg date	Date when the sample was stopped or registered as failure.
$\mathbf{e_{min}}$	Minimum wall thickness
$\mathbf{d_{em}}$	Mean outside diameter
p	Internal pressure
σ	Circumferential stress (hoop stress)
->	The sample is under test

PIPE REMARKS

1 Data points equal to and below 102 h at 20°C was excluded from the analysis in accordance with paragraph 4.2.3 in ISO 9080

2 The sample not included in evaluation as the precision of the recorded failure time is not in line with paragraph 5.8 in ISO 1167-1:2006

3 The sample failed in mixed mode which is “less” ductile, but not brittle

4 The sample is conditioned for 24 h

5 The sample is fitted with PVDF-fittings

The sample is included in the ISO 9080 evaluation as data type A

HYDROSTATIC PRESSURE TESTING

Code	T	Start date	Reg date	d_{em}	e_{min}	p	σ	Burst time	Burst mode	Test time	Remark
	[°C]	[yymmdd]	[yymmdd]	[mm]	[mm]	[bar]	[MPa]	[h]		[h]	
6258-1	20	150319	150320	32.20	2.93	24.03	12.00	20	Ductile		*1*
6258-2	20	150319	150320	32.20	2.91	23.54	11.85	17	Ductile		*1*
6258-3	20	150319	150320	32.20	2.95	23.54	11.67	13	Ductile		*1*
6258-4	20	150319	150323	32.20	2.93	23.05	11.51	91	Ductile		*1*
6258-5	20	150319	150323	32.20	2.93	22.65	11.31	41	Ductile		*1*
6258-6	20	150319	150324	32.20	2.92	22.26	11.16	102	Ductile		*1*
6258-32	20	150414	150420	32.20	2.94	22.26	11.08	119	Ductile		
6258-7	20	150319	150408	32.20	2.91	21.87	11.01	458	Ductile		
6258-33	20	150414	150420	32.20	2.91	21.58	10.86	139	Ductile		
6258-34	20	150414	150508	32.20	2.92	21.58	10.82	572	Ductile		
6258-180	20	160128	160210	32.20	3.02	22.26	10.76	294	Ductile		
6258-35	20	150414	150511	32.20	2.92	21.38	10.72	638	Ductile		
6258-181	20	160128	160210	32.20	3.04	22.26	10.68	301	Ductile		
6258-182	20	160128	160215	32.20	3.04	22.26	10.68	401	Ductile		
6258-183	20	160128	160216	32.20	3.05	22.26	10.64	441	Ductile		
6258-184	20	160128	160315	32.20	2.97	21.58	10.62	1 108	Ductile		
6258-87	20	150625	160411	32.40	2.97	21.38	10.59	6 940	Ductile		
6258-36	20	150414	150430	32.20	2.93	21.18	10.58	378	Ductile		
6258-136	20	151013	151116	32.40	3.01	21.58	10.53	796	Ductile		
6258-88	20	150625	150803	32.40	2.96	21.18	10.53	935	Ductile		
6258-185	20	160128	160318	32.20	2.97	21.38	10.52	1 160	Ductile		
6258-186	20	160128		32.20	2.95	21.18	10.50	->		*>2 111*	
6258-138	20	151013	160307	32.40	2.98	21.18	10.46	3 491	Ductile		
6258-37	20	150414		32.20	2.91	20.79	10.46	->		*>9 047*	
6258-38	20	150414		32.20	2.91	20.79	10.46	->		*>9 047*	
6258-137	20	151013		32.40	2.93	20.79	10.46	->		*>4 679*	
6258-89	20	150625		32.40	2.89	20.50	10.46	->		*>7 319*	
6258-90	20	150625	160302	32.40	2.99	21.18	10.42	6 011	Ductile		
6258-139	20	151013		32.40	2.90	20.50	10.42	->		*>4 679*	
6258-140	20	151013	151214	32.40	3.02	21.38	10.40	1 457	Ductile		
6258-141	20	151013	151103	32.40	3.02	21.38	10.40	499	Ductile		
6258-39	20	150414	150512	32.20	2.93	20.79	10.38	671	Ductile		*2*

HYDROSTATIC PRESSURE TESTING

Code	T	Start date	Reg date	d_{em}	e_{min}	p	σ	Burst time	Burst mode	Test time	Remark
	[°C]	[yymmdd]	[yymmdd]	[mm]	[mm]	[bar]	[MPa]	[h]		[h]	
6258-91	20	150625	160218	32.40	2.95	20.79	10.38	5 695	Ductile		
6258-142	20	151013		32.40	2.95	20.79	10.38	->		*>4 679*	
6258-143	20	151013	160330	32.40	3.01	21.18	10.34	4 042	Ductile		
6258-40	20	150414		32.20	2.91	20.50	10.32	->		*>9 047*	
6258-144	20	151013		32.40	2.93	20.50	10.31	->		*>4 679*	
6258-145	20	151013		32.40	3.02	21.18	10.30	->		*>4 679*	
6258-92	20	150625		32.40	2.97	20.79	10.30	->		*>7 319*	
6258-41	20	150414		32.20	2.94	20.50	10.20	->		*>9 047*	
6258-42	20	150414		32.20	2.91	20.10	10.12	->		*>9 047*	
6258-93	20	150625		32.40	2.93	20.10	10.11	->		*>7 319*	
6258-43	20	150414		32.20	2.94	20.10	10.00	->		*>9 047*	
6258-94	20	150625		32.40	2.97	20.10	9.96	->		*>7 319*	
6258-44	20	150414		32.20	2.93	19.91	9.94	->		*>9 047*	
6258-95	20	150625		32.40	2.99	19.91	9.79	->		*>7 319*	
6258-45	20	150414		32.20	2.92	19.42	9.74	->		*>9 047*	

HYDROSTATIC PRESSURE TESTING

Code	T	Start date	Reg date	d_{em}	e_{min}	p	σ	Burst time	Burst mode	Test time	Remark
	[°C]	[yymmdd]	[yymmdd]	[mm]	[mm]	[bar]	[MPa]	[h]		[h]	
6258-8	70	150319	150319	32.20	2.91	14.91	7.50	0.0	Ductile		
6258-9	70	150319	150319	32.20	2.92	14.71	7.38	0.8	Ductile		
6258-10	70	150319	150319	32.20	2.90	14.32	7.23	0.8	Ductile		
6258-11	70	150319	150320	32.20	2.92	14.12	7.08	19	Ductile		
6258-46	70	150414	150415	32.20	2.92	14.12	7.08	4.7	Ductile		
6258-47	70	150414	150415	32.20	2.93	14.12	7.05	17	Ductile		
6258-48	70	150414	150415	32.20	2.93	14.12	7.05	3.2	Ductile		
6258-146	70	151013	151026	32.40	2.91	13.83	7.01	271	Ductile		
6258-12	70	150319	150320	32.20	2.90	13.83	6.99	21	Ductile		
6258-156	70	151027	151105	32.40	2.90	13.73	6.98	201	Ductile		
6258-147	70	151013	151019	32.40	2.98	14.12	6.97	78	Ductile		
6258-157	70	151027		32.40	2.86	13.44	6.94	->		*>4 344*	
6258-148	70	151013	151015	32.40	3.00	14.12	6.92	34	Ductile		
6258-49	70	150414	150420	32.20	2.93	13.83	6.91	130	Ductile		
6258-149	70	151013	151109	32.40	2.95	13.83	6.90	590	Ductile		
6258-158	70	151027		32.40	2.88	13.44	6.89	->		*>4 344*	
6258-150	70	151013	151123	32.40	3.02	14.12	6.87	868	Ductile		
6258-50	70	150414	150430	32.20	2.93	13.73	6.86	370	Ductile		
6258-151	70	151013	151029	32.40	2.96	13.73	6.83	374	Ductile		
6258-159	70	151027	151214	32.40	2.96	13.73	6.83	1 109	Ductile		
6258-152	70	151013	160104	32.40	2.97	13.73	6.80	1 989	Ductile		
6258-170	70	151117		32.40	2.97	13.73	6.80	->		*>3 839*	
6258-13	70	150319		32.20	2.90	13.44	6.79	->		*>9 672*	
6258-153	70	151013	160111	32.40	3.00	13.83	6.78	2 156	Ductile		
6258-160	70	151027		32.40	2.92	13.44	6.78	->		*>4 344*	
6258-171	70	151117		32.40	2.89	13.24	6.76	->		*>3 839*	
6258-154	70	151013	151214	32.40	3.00	13.73	6.73	1 458	Ductile		
6258-161	70	151027		32.40	2.94	13.44	6.73	->		*>4 344*	
6258-14	70	150319	150407	32.20	2.93	13.44	6.71	380	Ductile		
6258-51	70	150414		32.20	2.93	13.44	6.71	->		*>9 047*	
6258-172	70	151117		32.40	2.91	13.24	6.71	->		*>3 839*	
6258-155	70	151013	151204	32.40	3.01	13.73	6.70	1 236	Ductile		

HYDROSTATIC PRESSURE TESTING

Code	T	Start date	Reg date	d_{em}	e_{min}	p	σ	Burst time	Burst mode	Test time	Remark
	[°C]	[yymmdd]	[yymmdd]	[mm]	[mm]	[bar]	[MPa]	[h]		[h]	
6258-162	70	151027		32.40	2.96	13.44	6.68	->		*>4 344*	
6258-173	70	151117		32.40	2.97	13.44	6.66	->		*>3 839*	
6258-163	70	151027		32.40	2.94	13.24	6.63	->		*>4 344*	
6258-174	70	151117		32.40	2.87	12.85	6.61	->		*>3 839*	
6258-175	70	151117		32.40	2.97	13.24	6.56	->		*>3 839*	
6258-164	70	151027		32.40	2.89	12.85	6.56	->		*>4 344*	
6258-52	70	150414		32.20	2.93	13.04	6.51	->		*>9 047*	
6258-96	70	150625		32.40	2.91	12.85	6.51	->		*>7 319*	
6258-176	70	151117		32.40	2.92	12.85	6.49	->		*>3 839*	
6258-97	70	150625		32.40	2.94	12.85	6.44	->		*>7 319*	
6258-98	70	150625		32.40	2.96	12.75	6.34	->		*>7 319*	
6258-53	70	150414		32.20	2.92	12.55	6.29	->		*>9 047*	
6258-99	70	150625		32.40	2.90	12.36	6.28	->		*>7 319*	
6258-100	70	150625		32.40	2.94	12.36	6.19	->		*>7 319*	
6258-101	70	150625		32.40	2.93	12.06	6.07	->		*>7 319*	
6258-54	70	150414		32.20	2.92	12.06	6.05	->		*>9 047*	
6258-102	70	150625		32.40	3.01	12.36	6.03	->		*>7 319*	
6258-55	70	150414		32.20	2.93	12.06	6.02	->		*>9 047*	
6258-103	70	150625		32.40	2.93	11.87	5.97	->		*>7 319*	
6258-104	70	150625		32.40	2.96	11.87	5.90	->		*>7 319*	
6258-56	70	150414		32.20	2.92	11.77	5.90	->		*>9 047*	
6258-57	70	150414		32.20	2.92	11.57	5.80	->		*>9 047*	

HYDROSTATIC PRESSURE TESTING

Code	T	Start date	Reg date	d_{em}	e_{min}	p	σ	Burst time	Burst mode	Test time	Remark
	[°C]	[yymmdd]	[yymmdd]	[mm]	[mm]	[bar]	[MPa]	[h]		[h]	
6258-15	95	150319	150320	32.20	2.90	10.10	5.10	21	Ductile		
6258-116	95	150916	150916	32.40	3.00	10.30	5.05	0.9	Ductile		
6258-16	95	150319	150320	32.20	2.94	10.00	4.98	2.4	Ductile		
6258-117	95	150916	150917	32.40	2.97	10.00	4.96	2.0	Ductile		
6258-118	95	150916	150918	32.40	2.94	9.81	4.91	45	Ductile		
6258-17	95	150319	150320	32.20	2.94	9.81	4.88	11	Ductile		
6258-119	95	150916	150917	32.40	3.02	10.00	4.87	4.6	Ductile		
6258-120	95	150916	150921	32.40	2.99	9.81	4.82	80	Ductile		
6258-58	95	150413	150430	32.20	2.92	9.61	4.82	410	Ductile		
6258-121	95	150916	151023	32.40	3.02	9.81	4.77	873	Ductile		
6258-18	95	150319	150417	32.20	2.93	9.51	4.75	681	Ductile		
6258-59	95	150413	150504	32.20	2.93	9.51	4.75	503	Ductile		
6258-60	95	150413	150428	32.20	2.93	9.51	4.75	336	Ductile		
6258-122	95	150916		32.40	2.96	9.51	4.73	->		*>5 327*	
6258-82	95	150506	160125	32.40	2.97	9.51	4.71	6 307	Ductile		*3*
6258-123	95	150916		32.40	2.90	9.22	4.69	->		*>5 327*	
6258-124	95	150916		32.40	3.01	9.51	4.64	->		*>5 327*	
6258-83	95	150506		32.40	2.93	9.22	4.64	->		*>8 519*	
6258-19	95	150319	150716	32.20	2.92	9.22	4.62	2 844	Ductile		
6258-61	95	150413		32.20	2.92	9.22	4.62	->		*>9 073*	
6258-125	95	150916	151005	32.40	3.03	9.51	4.61	444	Ductile		
6258-62	95	150413		32.20	2.93	9.22	4.60	->		*>9 073*	
6258-84	95	150506		32.40	2.99	9.22	4.53	->		*>8 519*	
6258-20	95	150319		32.20	2.92	9.02	4.52	->		*>9 672*	
6258-63	95	150413		32.20	2.92	9.02	4.52	->		*>9 073*	
6258-64	95	150413		32.20	2.93	9.02	4.51	->		*>9 073*	
6258-85	95	150506		32.40	2.95	9.02	4.50	->		*>8 519*	
6258-105	95	150625		32.40	2.96	9.02	4.49	->		*>7 319*	
6258-106	95	150625		32.40	2.99	9.02	4.44	->		*>7 319*	
6258-65	95	150413		32.20	2.92	8.83	4.43	->		*>9 073*	
6258-66	95	150413		32.20	2.93	8.83	4.41	->		*>9 073*	
6258-86	95	150506		32.40	2.95	8.83	4.41	->		*>8 519*	

HYDROSTATIC PRESSURE TESTING

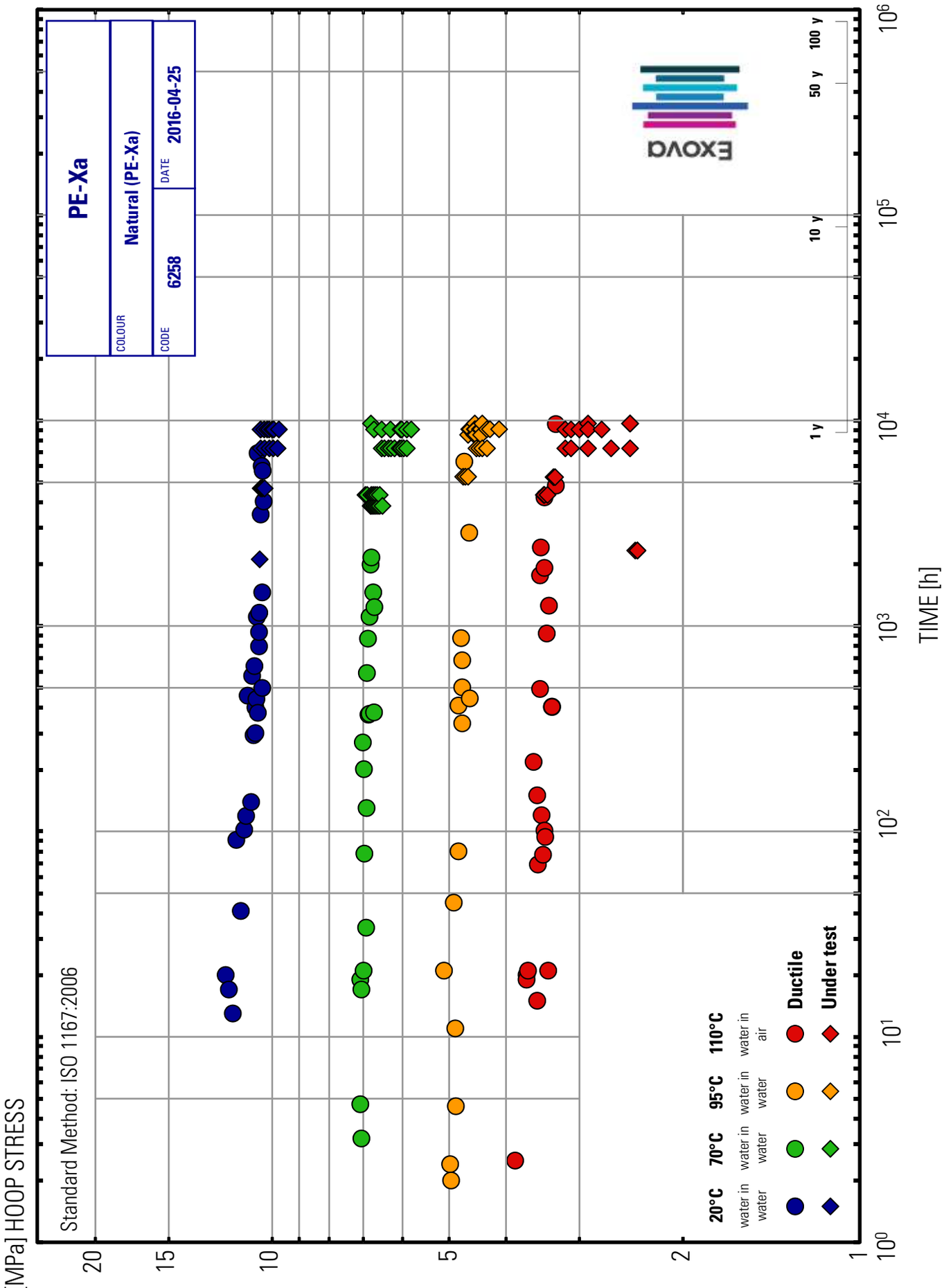
Code	T	Start date	Reg date	d_{em}	e_{min}	p	σ	Burst time	Burst mode	Test time	Remark
	[°C]	[yymmdd]	[yymmdd]	[mm]	[mm]	[bar]	[MPa]	[h]		[h]	
6258-21	95	150319		32.20	2.94	8.83	4.39	->		*>9 672*	
6258-107	95	150625		32.40	2.96	8.83	4.39	->		*>7 319*	
6258-67	95	150413		32.20	2.93	8.63	4.31	->		*>9 073*	
6258-108	95	150625		32.40	2.95	8.63	4.31	->		*>7 319*	
6258-68	95	150413		32.20	2.93	8.53	4.26	->		*>9 073*	
6258-69	95	150413		32.20	2.93	8.24	4.11	->		*>9 073*	

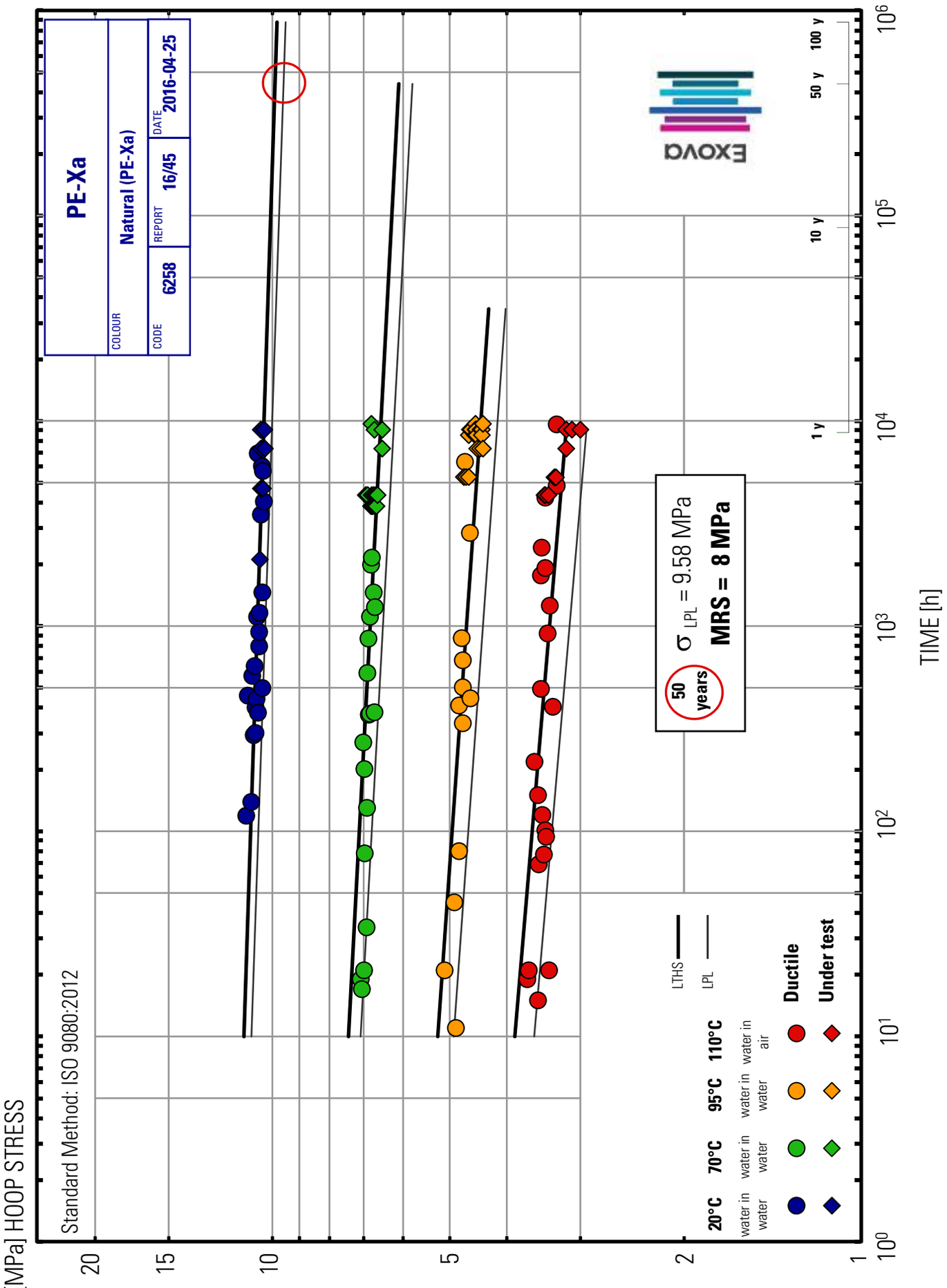
HYDROSTATIC PRESSURE TESTING

Code	T	Start date	Reg date	d_{em}	e_{min}	p	σ	Burst time	Burst mode	Test time	Remark
	[°C]	[yymmdd]	[yymmdd]	[mm]	[mm]	[bar]	[MPa]	[h]		[h]	
6258-22	110	150319	150319	32.20	2.94	8.04	4.00	0.8	Ductile		*4*
6258-23	110	150319	150320	32.20	2.90	7.65	3.86	2.5	Ductile		*4*
6258-24	110	150319	150319	32.20	2.92	7.45	3.74	0.0	Ductile		*4*
6258-25	110	150319	150320	32.20	2.92	7.36	3.69	20	Ductile		*4*
6258-70	110	150414	150415	32.20	2.92	7.36	3.69	19	Ductile		*4*
6258-71	110	150414	150415	32.20	2.93	7.36	3.67	21	Ductile		*4*
6258-72	110	150414	150423	32.20	2.92	7.16	3.59	218	Ductile		*4*
6258-26	110	150319	150326	32.20	2.92	7.06	3.54	150	Ductile		*4*
6258-73	110	150414	150415	32.20	2.92	7.06	3.54	15	Ductile		*4*
6258-74	110	150414	150417	32.20	2.93	7.06	3.53	69	Ductile		*4*
6258-126	110	150917	151201	32.40	2.97	7.06	3.50	1 763	Ductile		*4*
6258-165	110	151027	151117	32.40	2.97	7.06	3.50	494	Ductile		*4*
6258-166	110	151027	160205	32.40	2.90	6.86	3.49	2 412	Ductile		*4*
6258-127	110	150917	150922	32.40	3.02	7.16	3.48	120	Ductile		*4*
6258-128	110	150917	150921	32.40	3.00	7.06	3.46	77	Ductile		*4*
6258-167	110	151027		32.40	2.93	6.86	3.45	->		*>4 344*	*4*
6258-27	110	150319	150608	32.20	2.92	6.86	3.44	1 918	Ductile		*4*
6258-75	110	150414	150420	32.20	2.92	6.86	3.44	101	Ductile		*4*
6258-76	110	150414	151009	32.20	2.92	6.86	3.44	4 227	Ductile		*4*
6258-168	110	151027		32.40	2.94	6.86	3.44	->		*>4 344*	*4*
6258-109	110	150625	150629	32.40	2.95	6.86	3.43	68	Ductile		*2, 4, 5*
6258-129	110	150917	150921	32.40	2.95	6.86	3.43	94	Ductile		*4*
6258-130	110	150917	151026	32.40	3.04	7.06	3.41	920	Ductile		*4*
6258-169	110	151027		32.40	2.97	6.86	3.40	->		*>4 344*	*4*
6258-131	110	150917	150918	32.40	2.98	6.86	3.39	21	Ductile		*4*
6258-132	110	150917	151109	32.40	2.99	6.86	3.38	1 256	Ductile		*4*
6258-133	110	150917	151005	32.40	3.02	6.86	3.34	404	Ductile		*4*
6258-134	110	150917		32.40	2.92	6.57	3.32	->		*>5 303*	*4*
6258-135	110	150917		32.40	3.05	6.86	3.30	->		*>5 303*	*4*
6258-28	110	150319	160425	32.20	2.92	6.57	3.29	9 612	Ductile		*4*
6258-110	110	150625	160112	32.40	2.94	6.57	3.29	4 823	Ductile		*4, 5*
6258-77	110	150414		32.20	2.92	6.33	3.17	->		*>9 053*	*4, 5*

HYDROSTATIC PRESSURE TESTING

Code	T	Start date	Reg date	d_{em}	e_{min}	p	σ	Burst time	Burst mode	Test time	Remark
	[°C]	[yymmdd]	[yymmdd]	[mm]	[mm]	[bar]	[MPa]	[h]		[h]	
6258-111	110	150625		32.40	2.94	6.33	3.17	->		*>7 319*	*4, 5*
6258-78	110	150414		32.20	2.92	6.18	3.10	->		*>9 053*	*4, 5*
6258-112	110	150625		32.40	2.94	6.18	3.10	->		*>7 319*	*4, 5*
6258-79	110	150414		32.20	2.92	5.98	3.00	->		*>9 053*	*4,5*
6258-29	110	150319		32.20	2.92	5.79	2.90	->		*>9 672*	*4, 5*
6258-80	110	150414		32.20	2.92	5.79	2.90	->		*>9 053*	*4, 5*
6258-113	110	150625		32.40	2.94	5.79	2.90	->		*>7 319*	*4, 5*
6258-81	110	150414		32.20	2.92	5.49	2.75	->		*>9 053*	*4, 5*
6258-114	110	150625		32.40	2.94	5.30	2.65	->		*>7 319*	*4, 5*
6258-30	110	150319		32.20	2.92	4.90	2.46	->		*>9 672*	*4, 5*
6258-31	110	150319		32.20	2.92	4.90	2.46	->		*>9 672*	*4, 5*
6258-115	110	150625		32.40	2.94	4.90	2.46	->		*>7 319*	*4, 5*
6258-179	110	160119		32.40	2.99	4.90	2.41	->		*>2 330*	*4, 5*
6258-177	110	160119		32.40	3.01	4.90	2.39	->		*>2 330*	*4, 5*
6258-178	110	160119		32.40	3.01	4.90	2.39	->		*>2 330*	*4, 5*


PE-Xa
Natural (PE-Xa)
CODE 6258
COLOUR
DATE 2016-04-25
EXOVA
[MPa] HOOP STRESS
Standard Method: ISO 1167:2006
TIME [h]
1 y
10 y
50 y
100 y
20°C water in water
70°C water in water
95°C water in water
110°C water in air
Ductile
Under test


PE-Xa
Natural (PE-Xa)
CODE 6258
COLOUR
REPORT 16/45
DATE 2016-04-25
[MPa] HOOP STRESS
Standard Method: ISO 9080:2012
TIME [h]
20
15
10
5
2
1
10^0
10^1
10^2
10^3
10^4
10^5
10^6
1 y
10 y
50 y
100 y
LTHS
LPL
20°C water in water
70°C water in water
95°C water in water
110°C water in air
Ductile
Under test
50 years
σ_{LPL} = 9.58 MPa
MRS = 8 MPa
EXOVA

EXOVA/P-16/45

DETERMINATION OF THE LONG-TERM HYDROSTATIC STRENGTH ISO 9080:2012-evaluation a natural PE-Xa pipe grade from Golan Plastic Products Ltd.

Sohail NAWAZ

Exova Materials Technology
Plastic Pipes
SE-611 99 TYSTBERGA · Sweden
Phone +46 (0)13 16 90 00 Fax 46 (0)13 16 90 20
www.polymer.exova.com · sales.sweden@exova.com

Standards

Rapid Crack Propagation Resistance

HÖHERE TECHNISCHE BUNDES-LEHR-UND VERSUCHSANSTALT WIEN XX
Technologisches Gewerbemuseum
A-1200 Wien, Wexstraße 19-23

FEDERAL TESTING CENTRE – TGM

PLASTICS TECHNOLOGY AND ENVIRONMENTAL ENGINEERING

EXPERTISE/REPORT

TGM - VA KU 22 740

RCP (S4) Arrest Temperature Test

Client: GOLAN PLASTIC PRODUCTS LTD.

Address: Israel 15145, Jordan Valley

Date of order: 2009 01 07

Sign of order: Mr. Nimrod Zeira

Order received: 2009 01 07

Samples received: A-1907 / 2008 12 09

Testing period: KW3 / 2009

TGM-number: 36 / 2009

1 Samples

From company GOLAN PLASTIC PRODUCTS LTD., Israel 15145, Jordan Valley we received

15 sections PE-X 80 pipes dn 110, SDR 11, á approx. 1m, dimensions acc. ISO 14531-1: 2002 with the order to achieve the RCP (S4) Arrest Temperature Test.

2 Performed Tests

2.1 Determination of geometry acc. ÖNORM EN ISO 3126: 2005

Conditions: Determination of diameter $d_{e,m}$ and wall thickness e profile.

Results: See Tab.1 measurement of 3 sections PEX-80 pipes

Pipe No.	actual measure						
	diameter $d_{e,m}$		wall thickness e				
	actual	Tolerance	Mean e_m	Tolerance	Min.	Max.	Tolerance
1	110,60 mm	fulfilled	10,46 mm	fulfilled	10,31 mm	10,62 mm	fulfilled
2	110,60 mm	fulfilled	10,46 mm	fulfilled	10,29 mm	10,61 mm	fulfilled
3	110,60 mm	fulfilled	10,46 mm	fulfilled	10,31 mm	10,62 mm	fulfilled

Tab.1: Sample geometry

Requirement of sample geometry acc. ISO 14531-1: 2002(E) is met with no exception.

2.2 Determination RCP arrest temperature acc. ISO 1453-1: 2002 (E)

Conditions: RCP (S4)-Testing facility IPT V1629-0001 acc. ISO 13477: 2008 (E), Testing Temperature -50 °C, pre cooling temperature -59 °C, testing speed 15m/s.
Crack arrest where lc/dn ≤ 4,7; Crack propagation where lc/dn > 4,7; lc= crack length;
testing pressure 13,1 bar according actual geometry and ISO 14531-1: 2002 (E), Tab1. where required stress has to be PE-X 80: 6,4 MPa

Results: See Tab. 2

Pipe No.	Testing pressure /[bar]	lc/dn	Result
1	0	0,2	Initiation test
2	13,1	0,2	Crack arrest
3	13,4	0,2	Crack arrest
4	13,6	0,2	Crack arrest
5	16,4	0,2	Crack arrest (acc. PE-X 100: 9,2 MPa)

Tab.2: RCP (S4) arrest temperature

Requirement of RCP (S4) arrest temperature acc. ISO 14531-1: 2002 (E), Tab.1 for testing temperature ≤ 50 °C at stress for PE-X 80: 6,4 MPa is met with no exception.

-.-.-.-.-.-.-.-.-.-.-.-.-.-.-

The present expertise/report KU

consits of 3 pages with 2 tables, 0 graphics,

0 figures and 0 attachments (with 0 pages).

Executive officer: Dr.Muschik Vienna, 2009 01 19

Rund-
siegel

Prof. Dipl.-Ing.Dr.techn. Heinz Muschik
Authorised signatory

Prof. Dipl.-Ing. Dr.techn. Heinz Dragaun
Head of Department

Dipl.-Ing. Karl Reischer
Principal

Standards

Thermal Oxidative Stability

PROGRESS REPORT FROM EXOVA FOR

Golan Plastic Products Ltd.

PROJECT	DATE OF LAST REPORT	DATE FOR THIS REPORT	SITUATION ON
10829	2018-01-15	2018-05-22	2018-05-22

N/A

CODE	T [C]	Start	Dm [mm]	Dim_e_min [mm]	P [bar]	S [MPa]	Failure time [h]	Failure mode	Test time [h]	Changes
6258-78	110	150414	32.20	2.92	6.18	3.10	9053	Stopped		*Cond.time: 24 h -PVDF*
6258-112	110	150625	32.40	2.94	6.18	3.10	7319	Stopped		*Cond.time: 24 h -PVDF*
6258-79	110	150414	32.20	2.92	5.98	3.00	9053	Stopped		*Cond.time: 24 h -PVDF*
6258-29	110	150319	32.20	2.92	5.79	2.90	19152	Mixed		*Cond.time: 24 h -PVDF-*
6258-80	110	150414	32.20	2.92	5.79	2.90	->		27 216	*Cond.time: 24 h -PVDF-*
6258-113	110	150625	32.40	2.94	5.79	2.90	->		25 482	*Cond.time: 24 h -PVDF-*
6258-81	110	150414	32.20	2.92	5.49	2.75	->		27 216	*Cond.time: 24 h -PVDF-*
6258-114	110	150625	32.40	2.94	5.30	2.65	->		25 482	*Cond.time: 24 h -PVDF-*
6258-30	110	150319	32.20	2.92	4.90	2.46	->		27 834	*Cond.time: 24 h -PVDF-*
6258-31	110	150319	32.20	2.92	4.90	2.46	22079	Brittle		*Cond.time: 24 h -PVDF-Close to fitting*
6258-115	110	150625	32.40	2.94	4.90	2.46	24779	Mixed		*Cond.time: 24 h -PVDF-Close to fitting*
6258-179	110	160119	32.40	2.99	4.90	2.41	->		20 493	*Cond.time: 24 h -PVDF-*
6258-177	110	160119	32.40	3.01	4.90	2.39	4730	Brittle		*Cond.time: 24 h -PVDF-Close to fitting*
6258-178	110	160119	32.40	3.01	4.90	2.39	->		20 493	*Cond.time: 24 h -PVDF-*

Standards

Exposure Completion

Allunga Exposure Laboratory

Tel: +61-747-781-697
Fax: +61-747-783-115
Lat: 19°S Long: 146°E

Locked Bag 369
Aitkenvale Mail Centre
Qld Australia 4814

1209-1231 Flinders Hwy
Brookhill via Townsville
Qld Australia 4816

www.allunga.com.au
test@allunga.com.au

Attention:
Nimrod Zeira
Golan Plastic Products
Jordan Valley
Shaar Hagolan 15145

Date: **04-Feb-2013**
Your Reference: Plastic Pipes 1-12
Our Reference: 12G24YT-1-12
Exposure Start: 25-Jul-2012
Exposure End: 31-Jan-2013

Exposure Completion

This notice certifies that the series below was exposed at Allunga Exposure Laboratory to the following specifications:

Client Series: Plastic Pipes 1-12, Black (90 mm x 1 m)
GOLAN PEXGOL PE-XA 90 x 8.2 MAT. 5261Z DIN 16892/3
NO.69248 23.06.12

Standard: Exposure in accordance with ISO 14531 Part 1 Annex C (AS2492)

Exposure Type: 45° North Open

Duration of Exposure: 3.5 GJ/m²

Start Date: 25-July-2012

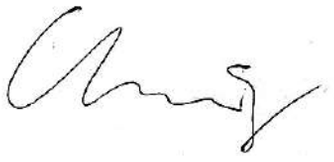
Final Date: 3.5 GJ/m² reached 31-January-2013

Samples Returned: 1 Sample delivered to
Bureau Veritas Integrity and Reliability Services
35-37 Stirling Street
Thebarton SA 5031
For tensile testing:

- Thermal Stability
- Hydrostatic Strength
- Elongation at break

11 Samples returned to client.

Chris Cooper, Director,
Allunga Exposure Laboratory



Standards

Type Test

DANISH
TECHNOLOGICAL
INSTITUTE

TYPE TEST (TT)

Product:
Golan PE-XA 80 pipes, dimension 90 mm

This report contains resistance to weathering test.

Applicant:
Golan Plastic Products Ltd.
Kibbutz Shaar Hagolan
15145 Jordan Valley
Israel

Place of production:
Golan Plastic Products Ltd.
Kibbutz Shaar Hagolan
15145 Jordan Valley
Israel

Date:
8 August 2013

Contact person:
Allan Pedersen, Metrology Engineer

Order No.:
558514

Testing according to:
ISO 14531-1: 2003 Plastics pipes and fittings- Crosslinked Polyethylene (PE-X) Pipe systems for the conveyance of gaseous fuels.

TEST Reg. No. 300

DANISH TECHNOLOGICAL INSTITUTE

Teknologiparken
Kongsvang Allé 29
DK-8000 Århus C
Tel.: +45 72 20 10 00
Fax: +45 72 20 10 19

info@teknologisk.dk
www.teknologisk.dk

Test report

Date: 8 August 2013
Order No.: 558514
Initials: ARP/HLB
Number of appendices: 2

Applicant:
Golan Plastic Products Ltd.
Kibbutz Shaar Hagolan
15145 Jordan Valley
Israel

Place of production:
Golan Plastic Products Ltd.
Kibbutz Shaar Hagolan
15145 Jordan Valley
Israel

Danish Technological Institute has carried out testing of the following product(s):
Golan PE-XA 80 pipes, dimension 90 mm

in compliance with the specifications stated in:
ISO 14531-1: 2003 Plastics pipes and fittings- Crosslinked Polyethylene (PE-X) Pipe systems for the conveyance of gaseous fuels.

Result:
The requirements in the above specifications were met.

Conditions: Accredited testing was carried out in compliance with current guidelines laid down by DANAK (Danish Laboratory Accreditation Scheme), please see www.danak.dk, and in compliance with Danish Technological Institute's General Terms and Conditions regarding Commissioned Work Accepted by the Danish Technological Institute, February 2009.
The test results apply to the tested products only.
This test report may be reproduced in extract only if the Laboratory has approved the extract in writing.

Division/Centre: Energy and Climate
VA Testing and Inspection

Signature: Allan Pedersen
Metrology Engineer

Type test (TT):

Requested by:	Golan Plastic Products Ltd.
Contact person:	Nimrod Zeira
Tel.:	97246677604
Mobile:	-
Fax:	-
E-mail:	nimrod@golan-plastic.com patrisia@golan-plastic.com
Product:	Golan PE-XA 80 pipes, dimension 90 mm
Samples taken by:	Golan Plastic Products Ltd.
Place of sampling/inspection:	-
Date of sampling/inspection:	-
Date of receipt:	6 June 2013
Date of reply:	8 August 2013
Testing site:	Danish Technological Institute (DTI)

Test programme in accordance with: ISO 14531-1			Testing site	Table No.	Requirements met		Accredited		Sub contractor Accredita-tion No.
					Yes	No	Yes	No	
Item 5.6	**Table 8**	**Hydrostatic strength**	DTI	1	X		X		
Item 5.6	**Table 8**	**Thermal stability**	DTI	App. 2	X		X		DANAK 127
Item 5.6	**Table 8**	**Elongation at break**	DTI	App. 2	X		X		DANAK 127
		Marking/ Photo	DTI	2					

Table 1

Item 5.6 table 8 - Hydrostatic strength

Nominal size	Number of test pieces	Test temperature °C	Hoop stress MPa	Test pressure bar	Testing time h	Failure time h	Requirements met Yes	Requirements met No
90	3	95	3.8	7.89	165	>165	X	
	3	95	3.7	7.68	1000	>1000	X	

Equipment used: 270-A-1063, 270-A-1071, 91171

Table 2

Marking/ Photo

Pipes:

GOLAN PEXGOL PE-XA 90X8.2 MAT. 5261Z DIN 16892/3 NO. 69248 23.06.12

Label marking on pipes:

12G25YT..

DANAK

TEST Reg. no. 127

24 June 2013
ten-sfp/eta

DANISH
TECHNOLOGICAL
INSTITUTE

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DK-2630 Taastrup
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www.teknologisk.dk

Test report

Customer

Danish Technological Institute
Installation and Calibration
Teknologiparken
DK-8000 Århus C

Test

Elongation at break
OIT, Induction time

Samples

3 x 90 mm PE-XA pipes

The samples were received here on 12 June 2013 from Installation and Calibration, Århus

Test methods

Analyses of the plastic pipe according to ISO 14531-1: 2003
Elongation, which refers to ISO 6259-1: 2001 and ISO 6259-3:2002
OIT, which refers to ISO/TR 10837.
ISO/TR 10837 is no longer valid. Consequently, the analysis has been made according to DS/EN ISO 11357-6:2013 which is identical and replaces ISO/TR 10837.

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INSTITUTE

Test results

Test period: 13 - 21 June 2013

Elongation at break

Sample no.	Elongation at break mean value
90 mm PE-XA pipes	>350 %

The single values are shown in enclosure 1
The requirement for elongation >350 % has been fulfilled

OIT

Sample no.	OIT at 200 °C mean value
90 mm PE-XA pipes	30 min*

*OIT has been carried out on a sample taken 0.2 mm below the outer layer of the pipe

The single values are shown in enclosure 1
The requirement for OIT, induction time >20 min has been fulfilled

Signature

Søren Pedersen
B.Sc. (Chem.Eng.)
Centre for Plastics Technology

Phone: +45 72 20 31 15 (direct)

Enclosure 1,
24 June 2013
Rep. no. 85/13

DANISH
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Elongation at break

Sample no.	ø90 mm PE-XA pipes speed 50 mm/min
1	>350
2	>350
3	>350
4	>350
5	>350
Mean	>350

OIT at 200 °C

Sample no.	ø90 mm PE-XA pipes
1	28.4 min
2	27.8 min
3	33.0 min
Mean	29.7 min

Standards

ISO Certificate - ISO 9001-2015

CERTIFICATE

This is to certify that the Quality Management System of

GOLAN PLASTIC PRODUCTS LTD.

P.S Jordan Valley , Sha'ar Hagolan , Israel

Has been assessed and complies with the requirements of :

ISO 9001:2015

This Certificate is Applicable to

development, production and distribution of pipe systems of various technologies for the transportation of liquids (hot and cold) and gaseous fluids: cross-linked polyethylene pipes (pexgol), multilayer pipes (multygol and flexigol) irradiation services.

Certificate No.:	87562	**Certificate Issue Date:**	31/12/2018
Initial Certification Date:	23/11/1994	**Certification Expiry Date:**	30/12/2021

SII-QCD assumes no liability to any party other than the client, and then only in accordance with the agreed upon Certification Agreement.
This certificate's validity is subject to the organization maintaining their system in accordance with SII-QCD requirements for system certification. The continued validity may be verified via scanning the code with a smartphone, or via website www.sii.org.il. This certificate remains the property of SII-QCD.

Ilan Carmit
Acting Director General

R.N 513029975

Avital Weinberg
Director, Quality & Certification Division

Our Vision: To Enhance Both Global Competitiveness of our Services, with our Uncompromised Quality and Integrity

Standards

Pexgol According to ISO 14531

Süddeutsches Kunststoff-Zentrum Würzburg

International akkreditiertes Prüflabor nach DIN EN 45001, 45004 und ISO Guide 25

Test certificate no.: **42759/00**

Client: Golan Plastic Products
Kibbutz Sháar Hagolan
IL-15145 M.P. Jordan Valley

Order: Testing of gas pipes made of PE-Xa according to ISO/DIS 14531-1 of the dimensions 32 x 2.9 mm and 110 x 10 mm

Letter dt: 2000-09-14 **Reference:** Sarit Cohen

Receipt of samples: 2000-11-21 **Date of sampling:** —

Test period: 2000-10-31 to 2001-10-09

Result: See summary on page 7, item 5

This test certificate comprises 7 pages.

Würzburg, 2001-11-14
Stä/Ne/we

by proxy

Dr. rer. nat. Anton Zahn

SKZ-Prüflabor International akkreditiert

by order

Manfred Altheimer

Süddeutsches Kunststoff-Zentrum
Frankfurter Straße 15-17
97082 Würzburg

Tel.: +49 (0)9 31-41 04-0
Fax: +49 (0)9 31-41 04-177
www.skz.de · eMail: info@skz.de

Rechtsträger: Fördergemeinschaft für das Süddeutsche Kunststoff-Zentrum e.V.
Geschäftsführung: Prof. Dr. Burghard Schmitt

1 Order

By its letter of 14 September 2000 the company Golan Plastic Products, Kibbutz Sháar Hagolan, IL-15145 M.P. Jordan Valley, instructed the Süddeutsche Kunststoff-Zentrum -SKZ- to execute tests on gas pipes made of PE-X 80 of the dimensions 32 x 2.9 mm and 110 x 10 mm in accordance with ISO/DIS 14531-1.

2 Test material

On 21 November 2000 the SKZ received the following test material:

Sample no.	Product	Dimension mm	Pieces	Material)[1]
1	gas pipe	32 x 2.9	30 x 1 m	PE-X 80
2	gas pipe	110 x 10.0	28 x 1 m	PE-X 80

)[1] according to a letter by Golan Plastic Products of 15 January 2001.

3 Test procedure

The test procedure was executed out on both dimensions according to the following test programme:

No.	Test type	Standard	Requirement
1	State of delivery and surface finish	ISO DIS 14531	Section 5.2.1
2	Marking	ISO DIS 14531	Chart 9
3	Colour	ISO DIS 14531	Section 5.2.2
4	Dimensions	ISO DIS 14531	Section 5.3
5	Dimensional change after heat ageing	ISO DIS 14531	Chart 8
6	Degree of crosslinking	ISO DIS 14531	Chart 8
7	Long-term hydrostatic pressure test	ISO DIS 14531, chart 7	Temperature [°C] at 20 95 95 Time-to-failure [hours] at 1000 165 1000 Test stress [N/mm^2] at 8.3 3.8 3.7
8	Thermal stability OIT	ISO \ TR 10837	Temperature 200°C, test period ≥ 20 minutes
9	Elongation at break	ISO DIS 14531	---
10	Slow crack growth	ISO DIS 14531	Long-term hydrostatic pressure test at 80°C lasting 5,000 hours and at a test stress of 8.0 bar
11	Squeeze-off properties	ISO / DIS 4531-1, Annex E	Preparation at conditioning atmosphere of -50°C, squeeze-off to 0.8 x double wall thickness for 15 min, then long-term hydrostatic pressure test at 95°C for 1,000 h by using a test stress of 3.7 N/mm^2
12	Resistance to weathering	ISO / DIS 14531-1	Thermal stability 95°C hydrostatic strength, 165 h and 1,000 h Elongation at break

4 Results

4.1 State of delivery

The state of delivery and the surface finish of the pipes delivered were without any objection.

4.2 Marking

Sample no.	Dimension mm	Marking
1	32 x 2.9	PEXGOL FOR GAS 32 x 2,9 PE-Xa SDR 11 PEX 80 ISO DIS 14531-1 N0. 2222 469 31.10.00 MZ
2	110 x 10.0	PEXGOL FOR GAS 110 x 10 PE-Xa SDR 11 PEX 80 ISO DIS 14531-1 N0. 1111 469 02.11.00 MZ

4.3 Colour

The pipe surface has got a yellow signal coating applied during extrusion. The pipe has got a nature colour.

4.4 Dimensions in mm

Sample no.	Designation	Actual value		Set value	
		Maximum	Minimum	Maximum	Minimum
1	Outside diameter d1	32.3	32.2	32.3	32.0
	Wall thickness s1	3.3	3.1	3.3	2.9
2	Outside diameter d1	110.7	110.5	110.7	110.0
	Wall thickness s1	10.9	10.5	11.0	10.0

4.5 Dimensional change after heat ageing

Sample no.	Actual value %	Set value %	Surface finish after heat ageing
1	0.6	≤ 3.0	without any objection
2	0.2	≤ 3.0	Inner surface without any objection, whereas there are slight bubbles on the yellow outside surface.

4.6 Degree of crosslinking

Sample no.	Actual value %	Set value %	Remark
1	88	≥ 60 ≤ 90	without any objection
2	90	≥ 60 ≤ 90	without any objection

4.7 Long-term hydrostatic pressure test

Sample no.	Temperature °C	Test stress N/mm²	Time in hours	
			Actual value	Set value
1	20	8.3	> 1,000	≥1,000
1	95	3.7	> 1,000	≥ 1,000
1	95	3.8	> 165	≥ 165
2	20	8.3	> 1,000	≥ 1,000
2	95	3.7	> 1,000	≥ 1,000
2	95	3.8	> 165	≥ 165

4.8 Thermal stability (OIT)

Sample no.	Test temperature °C	Induction time min		Remark
		Actual value	Set value	
1	200	55.1	≥ 20	without any objection
2	200	53.3	≥ 20	without any objection

4.9 Mechanical properties

Sample no.	Type	Units	Minimum	Mean	Standard deviation	Set value
1	Elongation at break	%	452	499	34.2	≥ 350
2	Elongation at break	%	370	415	31.7	≥ 350

4.10 Slow crack growth

Sample no.	Temperature °C	Test stress bar	Time-to-failure h		Remark
			Actual value	Set value	
1	80	8.0	> 5,000	≥ 5,000	without any objection
2	80	8.0	> 5,000	≥ 5,000	without any objection

4.11.1 Squeeze-off test

Sample no.	Deformation mm	Force N	Degree of squeeze	
			Actual value	Set value
1	27.0	20988	0.83	0.8
2	93.6	99516	0.8	0.8

4.11.2 Long-term hydrostatic pressure test after squeeze-off test

Sample no.	Temperature °C	Test stress N/mm²	Time-to-failure h		Remark
			Actual value	Set value	
1	95	3.7	> 1,000	≥ 1,000	without any objection
2	95	3.7	> 1,000	≥ 1,000	without any objection

4.12 Weathering test

Golan Plastic Products particularly asked us not to execute the tests on the material weathered according to ISO DIS 14531, section 5, chart no. 8 such as thermal stability, long-term hydrostatic pressure test at 95°C lasting 165 hours and 1,000 hours as well as elongation at break because the gas pipes are not designated for exposure to light.

5 Summary

Gas pipes made of PE-Xa of the dimensions 32 x 2.9 mm and 110 x 10 mm supplied for testing by Golan Plastic Products, Kibbutz Sháar Hagolan, IL-15145 M.P. Jordan Valley, meet the requirements according to ISO/DIS 14531-1, edition 2000-11-08, except item 4.12 weathering.

Standards

Examination Report Pexgol PE-Xa (Natural)

Partner for progress

EXAMINATION REPORT PEXGOL PE-Xa (Natural)

Determination of the resistance to gas constituents

REPORT NUMBER
125714

AUTHORISATION
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TESTING
RvA L 248

Contents:

Determination of the resistance to gas constituents

Manufacturer: GOLAN Plastic products

Place of production: SHAAR-HAGOLAN

Certificate number: n/a

Reference number: 125714

According to standard: ISO 14531, part 4.2 table 1

1. **Order**

   By order of GOLAN Plastic Products, the samples mentioned below were tested by the Laboratory for Material Testing on the determination of the resistance to gas constituents according to ISO 14531, part 4.2 table 1.

2. **Principle**

   After conditioning 1500 hours, the test pieces are subjected to a specified constant internal hydrostatic pressure inside medium synthetic condensate and outside medium water for a specified period of time.

3. **General**

   The samples were received on 15-12-2010 and registered with number C100923. The test was started on 15-03-2011 after conditioning 1500 hours, and was carried out by J. Braamhaar.

4. **Sample description**

Pipe identification	: C100923
Date of sampling	: n/a
Sampled by	: n/a
Number/type of samples	: 3 pipe samples 50cm
Compound	: PE-Xa (Natural)
Dimensions	: DN32 SDR11
Marking	: No marking
Date of production	: unknown
Other	: n/a

5. Preparation of the sample

After determining the dimensions, the test pieces were assembled with end caps and filled with synthetic condensate.
Subsequently the test pieces were conditioned according to ISO 14531, annex b.

6. Apparatus

Tank or oven with an average temperature of ± 0.1°C of the required value.
Pressure unit with an average pressure of +2 en -1% of the required value.
Measuring equipment according to NEN-EN 3126.

7. Preservation of samples

In case of failure the samples will be kept for 3 months.

8. Test conditions

Standard	: NEN-EN-ISO 1167
Test temperature	: 80°C (condensate/water)
Hoop stress	: 2 MPa
End cap	: type A
Pressure station nr.	: Condensate/P1/P2/P3
Total length of the sample	: 50 cm
Free length of the sample	: 32 cm
Conditioning time	: 1500 hours
Time to achieve test pressure	: 1 min.
Orientation o/t test pieces	: vertical

9. Examination results

Dimensions

Measured according to NEN-EN ISO 3126

Ambient temperature: 23°C

Properties	**Dimensions**	**1**	**2**	**3**
d_e mean	mm	32.15	32.15	32.15
d_e min.	mm	32.15	32.15	32.15
d_e max.	mm	32.15	32.15	32.15
e min.	mm	2.99	3.02	3.01
e max.	mm	3.25	3.30	3.32

Measured values

Properties	**Dimensions**	**1**	**2**	**3**
test pressure	bar	4.10	4.15	4.13
proving time	h	>1000	>1000	>1000
type of failure	brittle/ductile	interrupted	interrupted	interrupted

10. **Conclusion**

The test pieces meet the requirements for the investigated aspects in accordance with ISO 14531, part 4.2 table 1.

Standards

TR-4 HDB/HDS/SDB/PDB/MRS Listed Materials

TR-4

HDB/HDS/SDB/PDB/MRS

Listed Materials

3/7/2018

PPI Listing of
Hydrostatic Design Basis (HDB), Hydrostatic Design Stress (HDS), Strength Design Basis (SDB), Pressure Design Basis (PDB) and Minimum Required Strength (MRS) Ratings For Thermoplastic Piping Materials or Pipe

PLASTICS·PIPE·INSTITUTE®
105 Decker Court, Suite 825, Irving, TX 75062 · P: 469-499-1044 ·F: 469-499-1062 ·www.plasticpipe.org

TABLE OF CONTENTS

Hydrostatic Design Basis (HDB), Hydrostatic Design Stress (HDS), Strength Design Basis (SDB), Pressure Design Basis (PDB) and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe

FOREWORD

This report lists thermoplastic piping materials with a Plastics Pipe Institute (PPI) recommended Hydrostatic Design Basis (HDB), Strength Design Basis (SDB), Pressure Design Basis (PDB) or Minimum Required Strength (MRS) rating for thermoplastic piping materials or pipe.

These listings have been established in accordance with PPI TR-3, *"Policies and Procedures for Developing Hydrostatic Design Basis (HDB), Strength Design Basis (SDB), Pressure Design Basis (PDB) or Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe".* Copies are available from the PPI website. Questions concerning any listing in this report should be referred to:

Plastics Pipe Institute, Inc.
105 Decker Court, Suite 825
Irving, TX 75062

www.plasticpipe.org

In the case of any deviation or circumstance not covered by a specific policy, a disposition will have to be made by the HSB (Hydrostatic Stress Board) in consultation with the manufacturer.

The Plastics Pipe Institute (PPI) as a service to the industry has prepared this report. Reasonable efforts are made by PPI, its members and staff to ensure that the required methods, policies, standards and procedures have been followed and that the presented test data are reliable. PPI expressly disclaims any warranty, expressed or implied, regarding the HDB, SDB, PDB or MRS values derived from submitted information, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Each product manufacturer that lists compositions with the Hydrostatic Stress Board does so voluntarily and with the express agreement that PPI assumes no liability in regard to the lists, and that it will hold PPI harmless from any claims or liability in connection with its listed pipe compositions. PPI does not endorse the proprietary products or processes of any manufacturer, and assumes no responsibility for compliance with applicable laws and regulations.

PPI offers various technical reports, technical notes and statements to assist engineers, code officials, specifiers, installers and users in proper selection and application of plastics piping. Copies of this report, as well as other publications, are available for download from PPI on the website www.plasticpipe.org.

This report was first published in September 1967. This update was issued in March 2011.

NOTES TO THE READER
SOME RULES AND CONDITIONS

1. **Processing Techniques**: It is stressed that these policies and procedures are for development of recommended ratings for thermoplastics piping materials or pipe based on test data from good quality pipes (extruded or molded) made by specific processing techniques. These recommended ratings may or may not be valid for products made by differing processing techniques.

2. **Definitions and Acronyms:** Definitions and Acronyms are shown in the next section. The terminology of this report is in accordance with the definitions given in ASTM Standards D883, "Standard Definition of Terms Relating to Plastics," and F412, "Standard Terminology Relating to Plastic Piping Systems".

3. **Adjusting Recommended Ratings for Application-Specific Environments:** HDB/PDB/MRS/SDB recommended ratings issued by PPI are for conditions equivalent to those under which the test data were obtained, e.g., constant pressure, temperature and specific test environment. Various industry standards or regulations provide appropriate design factors or design coefficients to calculate the corresponding maximum allowable operating pressure for the piping system used in the desired application. Under some conditions, such as pressure cycling, higher temperature, more aggressive environment, or handling and installation quality, all of which may significantly reduce pipe durability, a more conservative design factor or design coefficient should be chosen. More information on design factors and design coefficients is given in PPI TR-9, "Recommended Design Factors and Design Coefficients for Pressure Applications of Thermoplastic Pipe Materials". ***Sustained pressure testing at elevated temperatures used to obtain these ratings may not be sufficient to fully evaluate either the thermal or oxidative stability performance of thermoplastic materials or pipe.***

4. **Product Standards:** An HDB/PBD/SDB/MRS recommended rating has been shown, through both scientific procedures and historical experience, to be a useful indicator of the relative long-term strength of a thermoplastic material when tested under the conditions set out in test method ASTM D2837 or ISO 9080. The performance of a material (or a piping product made with that material) under actual conditions of installation and use is dependent upon a number of other factors and conditions, which are not addressed in this report. These other factors and conditions are properly governed by the relevant product standard. The usefulness and adequacy of an HDB/PDB/SDB/MRS as an indicator of the strength of a material or pipe for use in any particular application is reflected in its incorporation in the applicable product standard, along with other appropriate performance parameters for the product and its component material. The appropriateness of an HDB/PDB/SDB/MRS for a specific application is also determined by the decision of a private or governmental entity to adopt such a standard as part of its own requirements for the product. The term "50-year strength value," as used in ASTM D2837, is a mathematical extrapolation that is useful in the context of developing an HDB. It does not necessarily constitute a representation that any material with such a value will perform under actual use conditions for that period of time.

5. **Sunlight (UV) Exposure:** These policies do not take into consideration the adequacy of a plastic composition's protection against sunlight exposure. Manufacturers may include in plastic pipe compositions suitable ingredients for the protection of properties against possible degradation by sunlight radiation during normal storage and use. The user should insure that sufficient protection has been incorporated into the selected piping composition should the application involve extended sunlight exposure during storage and/or use.

6. **Recommended Ratings are Formulation Specific:** Each HDB/PDB/SDB/MRS issued by PPI is specific to that particular thermoplastic piping material formulation, including the procedure for mixing, which is represented by the data submitted to the HSB. Any changes in the mixing procedure, in the formulation, or in its ingredients, outside those permitted in TR-3 are considered to result in a new composition, which may have different long-term strength properties. The listed HDB/PDB/SDB/MRS does not apply to this new composition, unless the changes have been made, or validated, in accordance with one or more of the policies presented in this report; or have been ruled upon by the HSB as acceptable based on information provided to the HSB.

7. **Resin Changes:** An inherent assumption in the development of these policies and procedures is that the commercial pipe resin will be of equivalent chemical and molecular composition, insofar as these parameters influence long-term strength and durability, to the resin used in the composition on which the original long-term data supplied to PPI were obtained. Any modification of the resin composition is considered to result in a different material from the one on which the original listings were based. The Chairman of the HSB should be notified of such modifications and the applicable policy followed to maintain the listing. In the case of a change in manufacturing location of the resin used in a listed compound, the Chairman of the HSB should be notified and any applicable policy followed to maintain the listing. Also, in the case of any deviation or circumstance not covered by a specific policy, a disposition will have to be made by the HSB in consultation with the manufacturer.

8. **Disclaimer:** While every effort has been made by the Plastics Pipe Institute to assure that these policies are sound, reasonable and prudent, PPI expressly disclaims any guarantee or warranty regarding their application. Each manufacturer who lists compositions in accordance with the procedures in TR-3 does so voluntarily and with the express agreement that PPI assumes no liability in regard to the listed compositions, and that the manufacturer will hold PPI harmless from any claims or liability arising in connection with its listed pipe compositions.

9. **Manufacturer's Responsibility:** The manufacturer is responsible to insure that his product is continually manufactured in such a manner as to maintain the long-term strength and durability consistent with the long-term data supplied to the HSB. In the case of a deviation or circumstance not covered by a specific policy, a disposition will have to be made by the HSB in consultation with the manufacturer.

10. **Adoption of Policies and Procedures**: These policies and procedures have been adopted using standard letter ballot methods.

11. **Interpretations:** Questions pertaining to the interpretation of any policies in this report should be referred to the Chairman of the HSB, Plastics Pipe Institute, 105 Decker Court, Suite 825, Irving, TX 75063.

12. **Maximum Temperature for Listings:** The maximum temperature for which PPI will list an HDB/PDB/SDB/MRS for a material in accordance with the policies and procedures in TR-3 is 200°F (93°C). PPI listing for temperatures above 200°F may be requested as a "Special Case" (see note 13) for consideration by the HSB.

13. **Special Case Listings:** The policies and procedures in TR-3 are intended to cover HDB/PDB/SDB/MRS listings for most thermoplastic piping materials. PPI recognizes there may be unusual cases, issues or circumstances that are not covered in TR-3, and that may justify an exception to the standard policies. To allow manufacturers an opportunity to have their material(s) listed by PPI when this occurs, the HSB has provided a "Special Case" system. The manufacturer may present its "Case" to the HSB at one of their two annual meetings, usually in February and August, using the approved "**Checklist for HSB Submissions**" form in TR-3 Appendix A.1. All information provided to HSB in these special cases will be made available for review only by HSB members and PPI staff, and will be held by them in strict confidence, in accordance with PPI's written confidentiality procedures (available from the HSB Chairman). There is a PPI fee for each

special case. You must contact the HSB Chairman well in advance of each meeting to arrange for your special case. A completed HSB submission form **must** be received at least two (2) weeks prior to the HSB meeting to permit HSB consideration at that meeting.

Definitions and Acronyms

ANSI	American National Standards Institute 1430 Broadway New York, NY 10018
API	American Petroleum Institute 211 North Ervay Suite 1700 Dallas, TX 75201
ASTM	American Society for Testing and Materials 100 Barr Harbor Drive West Conshohocken, PA 19428
AWWA	American Water Works Association 6666 West Quincy Avenue Denver, CO 80235
CSA	CSA, International 178Rexdale Boulevard Etobicoke, Ontario CANADA M9W 1R3
HSB	Hydrostatic Stress Board c/o Plastics Pipe Institute, Inc. 105 Decker Court, Suite 825 Irving, TX 75062
ISO	International Organization of Standardization Central Secretariat Geneva, Switzerland USA Contact: American National Standards Institute 1430 Broadway New York, NY 10018
NSF	NSF International 789 Dixboro Road Ann Arbor, MI 48113-0140 P. O. Box 5059 2600 GB Delft, Netherlands
PPI	Plastics Pipe Institute, Inc. 105 Decker Court, Suite 825 Irving, TX 75062

Brittle	A failure mode which exhibits no visible (to the naked eye) material deformation (stretching, elongation, or necking down) in the area of the break.
Composite pipe	Pipe consisting of two or more different materials arranged with specific functional purpose to serve as pipe.
CRS θ,t	The Categorized Required Strength, CRS θ,t, is the categorized lower prediction limit (LPL) of the long-term hydrostatic strength at a temperature (θ) and a time (t) as determined in accordance with ISO 9080 and ISO 12162. CRS θ,t **,** at 20°C and 50 years equals MRS.
Dependent Listing	A separate listing of a formulation that has previously been established as an independent listing under another owner's designation. Refer to Part D.3 of TR-3.
Ductile	A failure mode which exhibits material deformation (stretching, elongation, or necking down) in the area of the break.
E-X	The data level of an experimental grade listing where 'X' is the number of the grade level. e.g.: E-2 covers data out to at least 2,000 hours, E-8 covers data out to at least 8,000 hours, etc.
Experimental Grade (E)	A PPI HSB recommended rating that is valid for a limited duration, given to those materials covered by data that do not yet comply with the full requirements of the Standard Grade, but satisfy the applicable minimum preliminary data requirements that are detailed in TR-3. **The owner of an experimental listing must understand there is a potential risk in commercial sale of an experimental product in case it does not meet all the TR-3 requirements for a standard grade.**
HDB	The term HDB (Hydrostatic Design Basis) refers to the categorized long-term hydrostatic strength (LTHS) in the circumferential or hoop direction, for a given set of end use conditions, as established by ASTM Test Method D 2837, "Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials." Hydrostatic Design Basis (HDB) – one of a series of established stress values (specified in Test Method D 2837) for a plastic compound obtained by categorizing the long-term hydrostatic strength determined in accordance with ASTM Method D 2837.
Independent listing	A listing that has been established by a formulation owner under the provisions of Part A of TR-3.
LCL Ratio	The ratio of $\frac{LCL}{LTHS}$ expressed as a percentage. This ratio is a measure of the amount of scatter in the data and must be at least 85%.
LCL	Lower Confidence Limit - The lowest value of the LTHS, based on a statistical analysis of the regression data that can be expected at 100,000 hours.
LTHS	Long-term hydrostatic strength - the estimated tensile stress in the wall of the pipe in the circumferential orientation that when applied continuously will cause failure of the pipe at 100,000 hours. This is the intercept of the stress regression line with the 100,000-h coordinate.

MRP

Minimum Required Pressure – one of a series of established pressure values for a plastic piping component (multilayer pipe, fitting, valve, etc.) obtained by categorizing the long-term hydrostatic pressure strength in accordance with ISO 9080.

MRS

The term MRS (Minimum Required Strength) refers to the categorized long-term hydrostatic strength in the circumferential, or hoop direction, for a given set of end use conditions, as established by ISO 9080, "Determination of Long-Term Hydrostatic Strength of Thermoplastic Materials in Pipe form by Extrapolation." Minimum Required Strength – one of a series of established stress values for a plastic compound obtained by categorizing the long-term hydrostatic strength determined by hydrostatic testing in accordance with ISO 9080 and ISO 12162.

Multilayer pipe

Multilayer is a type of composite

TYPE 1: A pressure rated pipe having more than one layer (bonded together) in which at least 60% of the wall thickness is polymeric material that has an HDB (Hydrostatic Design Basis) or MRS (Minimum Required Strength), from which the pressure rating of the pipe is determined.

DISCUSSION: An example of this is coextruded plastic pipe with an outer layer for barrier or color purposes. If this outer layer has the same HDB/MRS as the bulk wall, the entire wall thickness is used for pressure calculations; if not, only the bulk wall that has an HDB/MRS rating is used for pressure calculations.

TYPE 2: A pressure rated pipe having more than one layer (bonded together) where at least 60% of the wall thickness is polymeric material, where the pipe pressure rating is determined by pipe size and pipe wall construction, and this pipe rating is listed by a PDB (Pressure Design Basis) or MRP (Minimum Required Pressure).

DISCUSSION: An example of this is PEX/AL/PEX pipe.

TYPE 3: non-pressure rated pipe comprising more than one layer in which at least 60% of the wall thickness is polymeric material.

NOTE: the different layer(s) of multilayer pipe may provide color, barrier, stiffness or other properties according to the intended application.

PDB

The term PDB (Pressure Design Basis) refers to the categorized long-term pressure strength for multilayer pipes or other complex piping components, as established by ASTM Test Method D 2837, "Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials." Pressure Design Basis – one of a series of established pressure values for a plastic piping component (multilayer pipe, fitting, valve, etc.) obtained by categorizing the long-term hydrostatic pressure strength determined in accordance with an industry test method that uses linear regression analysis. Although ASTM D 2837 does not use "pressure values", the PPI Hydrostatic Stress Board uses the principles of

	ASTM D2837 in plotting log pressure vs. log time to determine a "long-term hydrostatic pressure strength" and the resulting "Pressure Design Basis" for multilayer pipe that is listed in PPI TR-4.
PHR	Parts by weight of a specified ingredient per hundred parts by weight of the base resin.
PR	Pressure Rating – the estimated maximum pressure that the medium in the pipe can exert continuously with a high degree of certainty that failure of the pipe will not occur. PR = 2 (HDB) x (design factor) / (SDR-1), SDR = Standard Dimension Ratio = Average outside diameter / minimum wall thickness Or PR = (PDB) (design factor)
Private Listing	Manufacturer's listing that is held privately within PPI and is not published in PPI TR-4.
SDB	Strength Design Basis – one of a series of established stress values (specified in Test Method D 2837) for a plastic molding compound obtained by categorizing the long-term strength determined in accordance with ASTM Test Method F 2018. The term SDB (Strength Design Basis) refers to the categorized long-term strength for a plastic molding compound obtained by ASTM F 2018, "Standard Test Method for Time-to - Failure of Plastics Using Plane Strain Tensile Specimens." NOTE: The SDB is used only for a material intended for molding applications. The SDB shall not be used for pipe applications.
Standard Grade (S)	A PPI HSB recommended rating that is valid for a five year period, given to those materials that comply with the full data requirements of TR-3.
Substantiation	A requirement of ASTM D 2513 for PE materials to show that extrapolation of the 73°F stress regression curve is linear to the 438,000-hour intercept.
Thermoplastic	A plastic that repeatedly can be softened by heating and hardened by cooling through a temperature range characteristic of the plastic, and that in the softened state can be shaped by flow into articles by molding or extrusion.
TR	Technical Report
TR-X	A PPI Technical Report where 'X' is the number of the report. e.g.: TR-3/2002 is the 2002 edition of TR-3, *"Policies and Procedures for Developing Hydrostatic Design Basis (HDB), Pressure Design Basis (PDB) and Minimum Required Strengths (MRS) Ratings for Thermoplastic Piping Materials or Pipe".*

UCL	Upper Confidence Limit - The highest value of the LTHS, based on a statistical analysis of the regression data that can be expected at 100,000 h.
UV	Ultra-Violet radiation from solar exposure.
Validation	The process of ensuring that, for those materials that exhibit a transition from ductile to brittle failure mode, this transition occurs after 100,000 h at the rated temperature.

Common Plastics Abbreviations

CPVC	Chlorinated Poly (vinyl chloride)
PA	Polyamide (aka nylon)
PB	Polybutylene
PE	Polyethylene
PEX	Crosslinked polyethylene
PFA	Perfluoro (alkoxy alkane)
POM	Polyoxymethylene (aka polyacetal)
PP	Polypropylene
PVC	Poly (vinyl chloride)
PVDF	Poly (vinylidene difluoride)

SECTION I

MATERIALS WITH PPI RECOMMENDED HYDROSTATIC DESIGN BASIS (HDB), MAXIMUM HYDROSTATIC DESIGN STRESS (HDS) OR STRENGTH DESIGN BASIS (SDB) ESTABLISHED IN ACCORDANCE WITH PPI TR-3 (ASTM D 2837).

PART A - MATERIALS EVALUATED FROM DATA DEVELOPED ON EXTRUDED PIPE SPECIMENS (HDB) – THESE MATERIALS MAY BE USED FOR EITHER EXTRUDED PIPE OR MOLDING APPLICATIONS

The tables that follow present PPI recommended HDB's in effect on the date of issue of this report. Information on subsequently listed materials may be obtained by contacting the Plastics Pipe Institute. Each table has been divided into dependent listings and independent listings. A resin manufacturer or pipe manufacturer may have an independent listing in which they provide all the stress rupture data required by TR-3. A resin manufacturer may transfer their listing to the pipe manufacturer using the protocol in TR-3. In this case, the pipe manufacturer has a dependent listing.

The listings of HDB's have been sub grouped in accordance with the material's standard pipe material designation code. In this designation system, which is widely used by major national product standards, the plastic is identified by its standard abbreviated terminology in accordance with ASTM D 1600, "Standard Terminology Relating to Abbreviations, Acronyms, and Codes for Terms Relating to Plastics", followed by a four or five digit number. The first two or three digits, as the case may be, code the material's ASTM classification (short-term properties) in accordance with the appropriate ASTM standard specification for that material. The last two digits of this number represent the PPI recommended HDS at 73°F (23°C) divided by one hundred. Three examples of this pipe material designation code are as follows:

- CPVC 4120 is a chlorinated polyvinyl chloride (the CPVC abbreviation is in accordance with ASTM D 1600) classified as Type 4, Grade 1 (in accordance with ASTM F 441) which has a 2,000 psi maximum recommended HDS utilizing a 0.5 design factor at 73°F (23°C) for water.

- POM 21110 is a polyoxymethylene (the POM abbreviation is in accordance with ASTM D 1600) classified as Group 2, Class 1, Grade 1 (in accordance with ASTM D 4181) which has a 1,000 psi maximum recommended HDS utilizing a 0.5 design factor at 73°F (23°C) for water.

- PE 3408 is a polyethylene (the PE abbreviation is in accordance with ASTM D 1600) classified as a grade PE 34 with a density cell class of 3 and a slow crack growth cell class of 4 (in accordance with ASTM D 3350). It has an 800-psi maximum recommended HDS utilizing a 0.5 design factor at 73° F (23°C) for water.

The standard pipe material designation codes covered by this report are:

Pipe Material Designation Code	Maximum HDS at 73^{0}F (23^{0}C) psi	HDB at 73^{0}F (23^{0}C) psi	ASTM Specification
	Polyvinyl Chloride (PVC)		
PVC 1120	2,000	4000	D 1785
PVC 2116	1,600	3150	"
	Chlorinated Polyvinyl Chloride (CPVC)		
CPVC 4120	2,000	4000	F 441
	Polyethylene (PE)		
PE 1404	400	800	D 3350
PE 2406	630	1250	"
PE 2708	800	1250	"
PE 3408	800	1600	"
PE 3608	800	1600	"
PE 3708	800	1600	"
PE 3710	1000	1600	"
PE 4608	800	1600	"
PE 4708	800	1600	"
PE 4710	1000	1600	"
	Crosslinked Polyethylene (PEX)		
PEX 0006	630	1250	F 876
PEX 1006	630	1250	"
PEX 3006	630	1250	"
PEX 5006	630	1250	"
PEX 5206	630	1250	"
PEX 0008	800	1600	"
PEX 1008	800	1600	"
	Polyacetal (Polyoxymethylene - POM)		
POM 21110	1,000	2000	D 4181
	Polyvinylidene Fluoride (PVDF)		
PVDF 2016	1600	3150	D 3222
PVDF 2020	2000	4000	"
PVDF 2025	2500	5000	"
	Polyamide (PA)		
PA 32312	1250	2500	D 6779
PA 32316	1600	3150	"
PA 42316	1600	3150	"

TABLE I.A.1 - PVC 1120 MATERIALS[1]

The following materials carry a recommended HDB of 4,000 psi and a maximum recommended HDS of 2,000 psi at 73°F (23°C) for water.

1. Pipe Listings Dependent on PPI Generic Range Composition

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Atkore International	CPC 1	73	4000	S	12/30/2021
Atkore International	RL H2O	73	4000	S	12/31/2018
Axiall LLC	Axiall / Georgia Gulf 3152 Gray 434	73	4000	S	12/30/2020
Axiall LLC	Axiall / Georgia Gulf 3350 White 125	73	4000	S	12/31/2021
Charlotte Pipe	CP-110-P	73	4000	S	12/31/2021
Cresline Plastic Pipe Company	CRESLINE 7802	73	4000	S	12/31/2021
Diamond Plastics	DPC B-1	73	4000	S	12/31/2021
Diamond Plastics	DPC B-2	73	4000	S	12/31/2021
Diamond Plastics	DPC B-3	73	4000	S	12/31/2021
Diamond Plastics	DPC-ST1	73	4000	S	12/31/2021
Durman Esquivel	DURECO 7N	73	4000	S	12/31/2021
Futura Industrial	COMHIDC900VIR	73F	4000	S	12/31/2021
IPEX Technologies Inc	S907	73	4000	S	12/31/2021
JM Manufacturing dba JM Eagle	JM SERIES 30	73	4000	S	12/31/2021
JM Manufacturing dba JM Eagle	JMR90	73	4000	S	12/31/2021
K-Bin Inc	KBD-4000	73F	4000	S	12/30/2021
National Pipe and Plastics	N/O	73	4000	S*	12/30/2021
National Pipe and Plastics	NATIONAL 1185	73	4000	S	12/31/2021
North American Pipe Co.	N. AMERICAN M	73	4000	S	12/31/2021
North American Pipe Co.	NORTH AMERICAN M	73	4000	S	12/30/2021
Northern Pipe Products	NPP301R	73	4000	S	12/31/2021
Pipelife Jet Stream, Inc	JS 21085	73	4000	S	12/30/2021
Pipelife Jet Stream, Inc	PL101-OM	73	4000	S	12/31/2021
PolyOne	GEON E 1353	73	4000	S	12/30/2021
PolyOne	GEON E 1354	73	4000	S	12/30/2021
PolyOne	GEON E 1356	73	4000	S	12/31/2019
Royal Pipe Systems	ROYAL NSF PW	73	4000	S	12/31/2021
Sanderson Pipe Corporation	PP1	73	4000	S	12/31/2021
Sekisui Industrial Piping Co.	ESLON SCH80 PVC Pipe	73	4000	S	12/30/2019
Shoreline Plastics	SLP 1	73	4000	S	12/30/2019
Silver-Line Plastics	SL-1000	73	4000	S	12/31/2021
Texas United Pipe	U-G-1	73F	4000	S	12/31/2021
Vinylplex Inc	VPX	73F	4000	S	12/31/2021
Vinyltech Corporation	V1	73F	4000	S	12/31/2021
Vulcan Plastics	S-203	73F	4000	S	12/31/2021

2. Independent Listings – PVC 1120

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Axiall LLC	Axiall / Georgia Gulf 3152 White125	73	4000	S	12/31/2020
Axiall LLC	Axiall / Georgia Gulf 3401 White 125	73F	4000	S	12/31/2020
Axiall LLC	Axiall / Georgia Gulf 3450 White125	73	4000	S	12/31/2020
Axiall LLC	Axiall / Georgia Gulf CM-2	73	4000	S	12/31/2020
IPEX Technologies Inc	S1007	73	4000	S	12/31/2021
JM Manufacturing dba JM Eagle	JM SERIES 90	73	4000	S	12/31/2021
North American Pipe Co.	NAPCO-30A	73	4000	S	12/31/2021
North American Pipe Co.	NAPCO-B4	73	4000	S	12/31/2019
North American Pipe Co.	NAPCO-B5	73F	4000	S	12/31/2020
Omya North America	Omya PVC 1120 Range Formulation	73	4000	S	12/31/2021
Plastics Pipe Institute	PPI - PVC 1120 Range Formulation	73F	4000	S	12/31/2021

TABLE I.A.3 - CPVC MATERIALS[1]

CPVC 4120 MATERIALS - These materials carry a recommended HDB of 4,000 psi and a maximum recommended HDS of 2,000 psi at 73°F (23°C) for water.

1. Dependent Listings – CPVC 4120

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Axiall LLC	PROTHERM 4303 GRAY 165	73	4000	S	12/30/2021
		180	1250	E-10	12/30/2021
		180	1000	S	12/30/2021
Axiall LLC	PROTHERM 4303 ORANGE 25	73	4000	S	12/30/2021
		180	1250	E-10	12/30/2021
		180	1000	S	12/30/2021
Axiall LLC	PROTHERM 4303 TAN 01	73	4000	S	12/30/2021
		180	1250	E-10	12/30/2021
		180	1000	S	12/30/2021
Axiall LLC	PROTHERM 4305 GRAY 165	73	4000	S	12/30/2021
		180	1250	E-6	12/30/2021
		180	1000	S	12/30/2021
PolyOne	Geon EC900 Tan 3189	73	4000	S	12/30/2021
		180	1250	E-10	12/30/2021
		180	1000	S	12/30/2021
PolyOne	Geon EC920 Tan 3189	73	4000	S	12/30/2021
		180	1250	E-6	12/30/2021
		180	1000	S	12/30/2021
PolyOne	Geon EC950 Gray 2777	73	4000	S	12/31/2019
		180	1000	S	12/31/2019
Spears Manufacturing	Spears SP2300	73	4000	S	12/30/2021
		180	1250	E-10	12/30/2021
		180	1000	S	12/30/2021
Spears Manufacturing	Spears SP2400	73	4000	S	12/30/2021
		180	1250	E-6	12/30/2021
		180	1000	S	12/30/2021

NOTE1: CPVC 4120 represents the material designation.

2. Independent Listings – CPVC 4120

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Axiall LLC	PROTHERM 4345 Gray 165	73	4000	S	12/31/2020
		180	1000	S	12/31/2020
Axiall LLC	PROTHERM 4345 Orange 25	73	4000	S	12/31/2020
		180	1000	S	12/31/2020
Axiall LLC	PROTHERM 4345 Tan 01	73	4000	S	12/31/2020
		180	1000	S	12/31/2020
Axiall LLC	PROTHERM 4353 Gray 165	73	4000	S	12/31/2020
		180	1000	S	12/31/2020

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Axiall LLC	PROTHERM 4353 Orange 25	73	4000	S	12/31/2020
		180	1000	S	12/31/2020
Kaneka North America LLC	KANEKA KNK-5003	73	4000	S	12/31/2021
		180	1250	E-10	12/31/2021
		180	1000	S	12/31/2021
Kaneka North America LLC	KANEKA KNK-5005	73	4000	S	12/31/2021
		180	1250	E-6	12/31/2021
		180	1000	S	12/31/2021
Kaneka North America LLC	KANEKA KNK-5007	73	4000	S	12/31/2021
		180	1000	S	12/31/2021
Kaneka North America LLC	KNK-5003 Almond	73F	4000	S	12/31/2021
		180F	1250	E-10	12/31/2021
		180F	1000	S	12/31/2021
KEM ONE	LUCALOR PEY 792	73	4000	S	12/31/2019
		180	1000	S	12/31/2019
KEM ONE	LUCALOR PEY 795	73	4000	S	12/31/2019
		180	1000	S	12/31/2019
Lubrizol Advanced Materials	TEMPRITE 3105 TAN 309	73	4000	S	12/31/2022
		180	1000	S	12/31/2022
Lubrizol Advanced Materials	TempRite 3107 Blue 470	73F	4000	S	12/31/2019
		180F	1000	S	12/31/2019
Lubrizol Advanced Materials	TEMPRITE 3107 PURPLE 795	73	4000	S	12/31/2022
		180	1000	S	12/31/2022
Lubrizol Advanced Materials	TEMPRITE 3107 TAN 309	73	4000	S	12/31/2022
		180	1000	S	12/31/2022
Lubrizol Advanced Materials	TEMPRITE 3115 TAN 309	73	4000	S	12/31/2020
		180	1250	S	12/31/2020
Lubrizol Advanced Materials	TEMPRITE 3118 GRAY 245	73	4000	S	12/31/2022
		180	1000	S	12/31/2022
Lubrizol Advanced Materials	TEMPRITE 3120 GRAY 245	73	4000	S	12/31/2019
		180	1000	S	12/31/2019
Lubrizol Advanced Materials	TEMPRITE 3135 BLUE 470	73	4000	S	12/31/2020
		180	1250	S	12/31/2020
Lubrizol Advanced Materials	TEMPRITE 3140 GRAY 245	73	4000	S	12/31/2021
		180	1250	S	12/31/2021
Lubrizol Advanced Materials	TempRite 3215 Blue 470	73F	4000	S	12/31/2019
		180F	1000	S	12/31/2019
Lubrizol Advanced Materials	TEMPRITE 3215 TAN 309	73	4000	S	12/31/2019
		180	1000	S	12/31/2019
Lubrizol Advanced Materials	TEMPRITE 88610 TAN 309	73	4000	S	12/31/2018
		180	1000	S	12/31/2018
Lubrizol Advanced Materials	TEMPRITE 88615 TAN 309	73	4000	S	12/31/2019
		180	1000	S	12/31/2019
Lubrizol Advanced Materials	TEMPRITE 88620 TAN 309	73	4000	S	12/31/2020
		180	1000	S	12/31/2020
Lubrizol Advanced Materials	TEMPRITE 88628 GRAY 245A	73	4000	S	12/31/2018
		180	1000	S	12/31/2018
Lubrizol Advanced Materials	TEMPRITE 88628 TAN 309A	73	4000	S	12/31/2018
		180	1000	S	12/31/2018

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Lubrizol Advanced Materials	TEMPRITE 88708	73	4000	S	12/31/2022
		180	1000	S	12/31/2022
Lubrizol Advanced Materials	TEMPRITE 88709	73	4000	S	12/31/2022
		180	1000	S	12/31/2022
Lubrizol Advanced Materials	TEMPRITE 88738 ORANGE 734	73	4000	S	12/31/2022
		180	1250	S	12/31/2022
Lubrizol Advanced Materials	TEMPRITE 88756 BLUE 470	73	4000	S	12/31/2022
		180	1000	S	12/31/2022
Spears Manufacturing	Spears SP2500 Gray	73	4000	S	12/31/2022
		180	1000	S	12/31/2022
Spears Manufacturing	Spears SP2500 Orange	73	4000	S	12/31/2022
		180	1000	S	12/31/2022
Spears Manufacturing	Spears SP2500 Tan	73	4000	S	12/31/2022
		180	1000	S	12/31/2022
Spears Manufacturing	Spears SP2600 Gray	73	4000	S	12/31/2022
		180	1000	S	12/31/2022
Spears Manufacturing	Spears SP2600 Orange	73	4000	S	12/31/2022
		180	1000	S	12/31/2022

NOTE1: CPVC 4120 represents the material designation.

2. Independent Listings – CPVC 4122

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Lubrizol Advanced Materials	TempRite 88616 Gray 245	73	4500	S	12/31/2021
		180	1250	S	12/31/2021
Lubrizol Advanced Materials	TempRite 88616 Tan 309	73	4500	S	12/31/2021
		180	1250	S	12/31/2021

NOTE1: CPVC 4122 represents the material designation.

2. Independent Listings – CPVC 23447-20

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Lubrizol Advanced Materials	TempRite 3214 Gray 245	73F	4000	E-2	12/31/2018
		180F	1000	E-2	12/31/2018

NOTE1:Â CPVC 23447 represents the cell classification per ASTM D1784-11.

2. Independent Listings – CPVC 23447-22

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Lubrizol Advanced Materials	TempRite 89307 GRAY 245	73	4500	S	12/31/2022
		180	1250	E-16	12/31/2022
Lubrizol Advanced Materials	TempRite 89307 TAN 309	73	4500	S	12/31/2022
		180	1250	E-16	12/31/2022

NOTE1: CPVC 23447 represents the cell classification per ASTM D1784-11.

2. Independent Listings – CPVC 23448-20

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Lubrizol Advanced Materials	TempRite 88619 Tan 309	73F	4000	S	12/31/2022
		180F	1250	S	12/31/2022
Lubrizol Advanced Materials	TEMPRITE 88631 Tan 311	73F	4500	E-2	6/30/2018
		180F	1250	E-2	6/30/2018
Lubrizol Advanced Materials	TEMPRITE 88632 Tan 311	73F	4500	E-2	6/30/2018
		180F	1250	E-2	6/30/2018

NOTE1: CPVC 23448 represents the cell classification per ASTM D1784-11.

2. Independent Listings – CPVC 24448-20

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Lubrizol Advanced Materials	TempRite 88148 Blue 480	73F	4000	E-2	12/31/2022
		180F	1250	E-2	12/31/2022

NOTE1: CPVC 24448 represents the cell classification per ASTM D1784-11.

TABLE I.A.4 - PE 1404 MATERIALS[1]

The following materials carry a recommended HDB of 800 psi and a maximum recommended HDS of 400 psi at 73°F (23°C) for water.

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Dow Chemical Company	DFDA 6080 BK 1404	73	800	S	12/31/2022

TABLE I.A.6. - PE 2708 MATERIALS[1]

The following materials carry a recommended HDB of 1250 psi and qualify for a 0.63 design factor to establish a maximum recommended HDS of 800 psi at 73°F (23°C) for water. These materials also meet the requirements for a PE 2406 as per ASTM D3350-02a. (*) - Indicates the material meets policy in TR-3 and ASTM D2837/D2513 requirement for substantiation. Stress rupture data confirm that the 73°F (23°C) regression is linear to 50 years.

1. Dependent Listings – PE 2708

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Bow Plumbing Group	Bow OxyPE-RT	73	1250	S*	12/31/2022
		180	630	S	12/31/2022
Centennial Plastics	PE2708 CenGas	73F	1250	S*	12/30/2021
		140F	1000	S	12/30/2021
Charter Plastics	3902/2240Y	73	1250	S*	12/31/2019
		140F	800	S	12/31/2019
Charter Plastics	DGDA-2420 YL	73	1250	S*	12/31/2022
		140	1000	S	12/31/2022
Charter Plastics	TR418Q/M358Y3	73F	1250	S*	12/31/2022
		140F	800	S	12/31/2022
Cresline Plastic Pipe Company	Cresline PE Yellow	73	1250	S*	12/30/2021
		140	1000	S	12/30/2021
Duraline Corporation	PolyPipe Y-20-A	73F	1250	S*	12/31/2022
		140F	800	S	12/31/2022
Duraline Corporation	PolyPipe Y-20-B	73F	1250	S*	12/31/2021
		140F	1000	S	12/31/2021
Duraline Corporation	PolyPipe Y-20-C	73	1250	S*	12/31/2022
		140	1000	S	12/31/2022
Duraline Corporation	PolyPipe Y-20-D	73	1250	S*	12/31/2019
		140F	800	S	12/31/2019
International Pipe	IPG	73F	1250	S*	12/31/2021
		140F	1000	S	12/31/2021
JM Manufacturing dba JM Eagle	JM Eagle MDPE UAC2000	73	1250	S*	12/31/2022
		140	1000	S	12/31/2022
JM Manufacturing dba JM Eagle	J-M MDPE GAS PIPE-1	73F	1250	S*	12/31/2021
		140F	1000	S	12/31/2021
Oil Creek Plastics	HEATFLEX	73	1250	S*	12/31/2022
		180	630	S	12/31/2022
Oil Creek Plastics	OCP-188	73F	1250	S*	12/31/2021
		140F	1000	S	12/31/2021
Oil Creek Plastics	OCP-2420	73	1250	S*	12/31/2022
		140	1000	S	12/31/2022
Performance Pipe Division	PP/TR418	73F	1250	S*	12/31/2022
		140F	800	S	12/31/2022
Performance Pipe Division	PP/TR418BK	73F	1250	S*	12/31/2022
		140F	800	S	12/31/2022
Pipeline Plastics, LLC	PLP-C2	73F	1250	S*	12/31/2021
		140F	1000	S	12/31/2021

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Pipeline Plastics, LLC	PLP-D2	73F	1250	S*	12/31/2022
		140F	800	S	12/31/2022
Polytubes 2009, Inc.	PT-D242	73	1250	S*	12/31/2022
		140	1000	S	12/31/2022
Polytubes 2009, Inc.	PT-I27	73F	1250	S*	12/30/2021
		140F	1000	S	12/30/2021
Silver-Line Plastics	GAS	73	1250	S*	3/29/2018
		140	1000	S	3/29/2018
Uponor Infra Ltd	WEHOGAS	73F	1250	S*	12/31/2022
		140F	800	S	12/31/2022
Uponor Infra Ltd	Wehogas 2420	73	1250	S*	12/31/2022
		140	1000	S	12/31/2022
Uponor Infra Ltd	Wehogas K38-20-160	73F	1250	S*	12/30/2021
		140F	1000	S	12/30/2021
Valencia Pipe Company	HOME-FLEX Underground	73F	1250	S*	12/30/2021
		140F	1000	S	12/30/2021
Valencia Pipe Company	HOME-FLEX Underground 2	73F	1250	S*	12/31/2021
		140F	1000	S	12/31/2021
Versaprofiles Products Inc	Versapipe Gas PE2708BM-HMF	73F	1250	S*	12/31/2021
		140F	1000	S	12/31/2021

2. Independent Listings – PE 2708

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Borealis AG	BorSafe ME3440	73	1250	S	12/31/2021
Borealis AG	BorSafe ME3441	73	1250	S	12/31/2021
Borealis AG	BorSafe ME3444	73	1250	S	12/31/2021
Chevron Phillips Chemical	MARLEX TR-418P8D	73F	1250	S*	12/31/2022
		140F	800	S	12/31/2022
Dow Chemical Company	CONTINUUM DGDA 2420 YL	73	1250	S*	12/31/2022
		140	1000	S	12/31/2022
Dow Chemical Company	CONTINUUM DGDA-2420 YL2	73F	1250	S*	12/31/2021
		140F	1000	S	12/31/2021
Dow Chemical Company	DOWLEX 2344	73	1250	S*	12/31/2022
		180	630	S	12/31/2022
Formosa Plastics Corporation, U.S.A.	HP3902/MDYC-303	73	1250	S*	12/31/2019
		140F	800	S	12/31/2019
Formosa Plastics Corporation, U.S.A.	HP3902/PO2107	73	1250	S*	12/31/2019
		140F	800	S	12/31/2019
Formosa Plastics Corporation, U.S.A.	HP3902/PO2240	73	1250	S*	12/31/2019
		140F	800	S	12/31/2019
INEOS Olefins & Polymers USA	K38-20-123	73	1250	S*	12/31/2019
		140	800	S	12/31/2019
INEOS Olefins & Polymers USA	K38-20-160	73F	1250	S*	12/31/2021
		140F	1000	S	12/31/2021
Performance Pipe Division	PP/K38	73	1250	S*	12/30/2021
		140	1000	S	12/30/2021

2. Independent Listings – PE 3408

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
INEOS Olefins & Polymers USA	K44-24-123	73	1600	S	12/31/2021
		140	630	S	12/31/2021

TABLE I.A.8. - PE 3608 MATERIALS[1]

The following materials carry a recommended HDB of 1600 psi and a maximum recommended HDS of 800 psi at 73°F (23°C) for water. These materials also meet the requirements for a PE 3408 as per ASTM D3350-02a. (*) - Indicates the material meets policy in TR-3 and ASTM D2837/D2513 requirement for substantiation. Stress rupture data confirm that the 73°F (23°C) regression is linear to 50 years.

1. Dependent Listings – PE 3608

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Advanced Drainage Systems	PolyFlex (1)	73	1600	S*	12/31/2021
		140	800	S	12/31/2021
Advanced Drainage Systems	PolyFlex (2)	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
Advanced Drainage Systems	PolyFlex (3)	73	1600	S*	12/31/2018
Centennial Plastics	PE3408 CENFUSE	73	1600	S*	12/30/2021
		140	800	S	12/30/2021
Centennial Plastics	PE3408 CENFUSE (1)	73	1600	S*	12/30/2019
		140	800	S	12/30/2019
Co-Ex Pipe Co.	CO-FLEX-IN	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
Endot Industries	ENDOT EIC-80	73	1600	S*	12/31/2019
		140	800	S	12/31/2019
IPEX Inc.	HDPE Water Pressure Pipe	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
JM Manufacturing dba JM Eagle	J-M PE PRESSURE PIPE-4	73	1600	S*	12/31/2019
		140	800	S	12/31/2019
Poly Technology	Poly Technology	73	1600	S*	12/30/2021
		140	800	S	12/30/2021
Polytubes 2009, Inc.	PT-I36	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
Polytubes 2009, Inc.	PT-I38	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
Shawcor Composite Pipe Division	GP36-D	73	1600	S*	12/31/2019
		140	800	S	12/31/2019
Trinus Pipes & Tubes Ltd.	TR-6	73	1600	S*	12/30/2019
		140	800	S	12/30/2019
Trinus Pipes & Tubes Ltd.	Trinus TR-8	73	1600	S*	12/30/2019
		140	800	S	12/30/2019
Uponor Infra Ltd	SCLAIRPIPE K44-06-123	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
Uponor Infra Ltd	SCLAIRPIPE K44-15-123	73	1600	S*	12/30/2021
		140	800	S	12/30/2021
Versaprofiles Products Inc	Versapipe HD80 BK	73	1600	S*	12/30/2021
		140	800	S	12/30/2021
Versaprofiles Products Inc	Versapipe HD80 BL	73	1600	S*	12/30/2018

2. Independent Listings – PE 3608

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Dow Chemical Company	DGDB 2480 BK	73	1600	S*	12/31/2019
		140	800	S	12/31/2019
Dow Chemical Company	DGDB 2480 NT	73	1600	S	12/31/2019
Formosa Plastics Corporation, U.S.A.	HP4401/AS4642	73	1600	S*	12/31/2019
		140	800	S	12/31/2019
Formosa Plastics Corporation, U.S.A.	HP4401/MDPE-535-42	73	1600	S*	12/31/2019
		140	800	S	12/31/2019
Formosa Plastics Corporation, U.S.A.	HP4401/PO2107	73	1600	S*	12/31/2019
		140	800	S	12/31/2019
Formosa Plastics Corporation, U.S.A.	HP4401/PO2116	73	1600	S*	12/31/2019
		140	800	S	12/31/2019
INEOS Olefins & Polymers USA	K44-06-123	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
INEOS Olefins & Polymers USA	K44-08-123	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
INEOS Olefins & Polymers USA	K44-15-122	73	1600	S	12/31/2019
INEOS Olefins & Polymers USA	K44-15-123	73	1600	S*	12/31/2021
		140	800	S	12/31/2021
INEOS Olefins & Polymers USA	K44-15-186	73	1600	S*	12/31/2018

2. Independent Listings – PE 3708

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Borealis AG	BorSafe HE3470-LS	73	1250	S	12/31/2021

TABLE I.A.11- PE 4608 MATERIALS[1]

The following materials carry a recommended HDB of 1600 psi and a maximum recommended HDS of 800 psi at 73° (23°C) for water. These materials also meet the requirements for PE 3408 as per ASTM D3350-02a. (*) – Indicates the material meets policy in TR-3 and ASTM D2837/D2513 requirement for substantiation. Stress rupture data confirm that the 73° (23°C) regression is linear to 50 years.

1. Dependent Listings – PE 4608

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Advanced Drainage Systems	Polyflex (5)	73	1600	S*	12/31/2019
		140	1000	S	12/31/2019
Advanced Drainage Systems	Polyflex (7)	73	1600	S	12/31/2021
Flying W Plastics	FL 110	73	1600	S*	12/31/2019
		140	1000	S	12/31/2019
Plasson USA	IPF L5008-Black	73	1600	S*	12/31/2019
		140	1000	S	12/31/2019

2. Independent Listings – PE 4608

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Equistar Chemicals, LP	ALATHON L5008 Black	73	1600	S*	12/31/2019
		140	1000	S	12/31/2019
Equistar Chemicals, LP	ALATHON L5008U-Blue	73	1600	S	12/31/2021
Equistar Chemicals, LP	ALATHON L5008U-Lavender	73	1600	S	12/31/2021

TABLE I.A.13 - PE 4710 MATERIALS[1]

The following materials carry a recommended HDB of 1600 psi and qualify for a 0.63 design factor to establish a maximum recommended HDS of 1000 psi at 73°F (23°C) for water. These materials also meet the requirements for a PE 3408 as per ASTM D3350-02a. (*) - Indicates the material meets policy in TR-3 and ASTM D2837/D2513 requirement for substantiation. Stress rupture data confirm that the 73°F (23°C) regression is linear to 50 years.

1. Dependent Listings – PE 4710

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Advanced Drainage Systems	ADS PolyFlex 4710 (1)	73F	1600	S*	12/30/2021
		140F	1000	S	12/30/2021
Advanced Drainage Systems	ADS PolyFlex 4710 (2)	73	1600	S*	12/31/2019
		140	1000	S	12/31/2019
Advanced Drainage Systems	ADS PolyFlex 4710 (3)	73	1600	S*	12/30/2021
		140	1000	S	12/30/2021
Advanced Drainage Systems	ADS PolyFlex 4710 (4)	73	1600	E-10*	6/30/2018
		140	1000	E-4	6/30/2018
Advanced Drainage Systems	ADS PolyFlex 4710 (5)	73	1600	S*	12/30/2018
		140	1000	S	12/30/2018
Advanced Drainage Systems	ADS PolyFlex 4710 (6)	73F	1600	S*	12/30/2019
		140F	1000	S	12/30/2019
Advanced Drainage Systems	ADS PolyFlex 4710 (7)	73F	1600	E-10*	6/30/2018
		140F	1000	E-10	6/30/2018
Advanced Drainage Systems	ADS PolyFlex 4710 (8)	73F	1600	E-6*	6/30/2018
		140F	1000	E-10	6/30/2018
Advanced Drainage Systems	ADS PolyFlex 4710 (9)	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
AEP Pipe Systems	AEP ELECTR-O-FUZE UI	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
Blue Diamond Industries	BDID-4710	73	1600	S*	12/30/2020
		140	1000	S	12/30/2020
Blue Diamond Industries	BDII 4710	73	1600	S*	12/30/2021
		140	1000	S	12/30/2021
CB Supplies Ltd	Bruiser	73	1600	S*	12/31/2019
		140	1000	S	12/31/2019
CB Supplies Ltd	CanPERT	73F	1600	S*	12/30/2020
		180F	800	S	12/30/2020
Centennial Plastics	PE4710 CENFUSE	73	1600	S*	12/30/2021
		140	1000	S	12/30/2021

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Centennial Plastics	PE4710 CenFuse (1)	73	1600	S*	12/30/2019
		140	1000	S	12/30/2019
Centennial Plastics	PE4710 CENFUSE (3)	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
Charter Plastics	A2490/F0092	73	1600	S*	12/30/2020
		140	1000	S	12/30/2020
Charter Plastics	BLUE ICE	73F	1600	S*	12/30/2021
		140F	1000	S	12/30/2021
Charter Plastics	Charter Black L-1 HDPE	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
Charter Plastics	Charter Plastics E6210A/PO2107	73	1600	S*	3/17/2019
		140	1000	S	3/17/2019
Charter Plastics	FPE6210A/MD53542	73F	1600	S*	12/30/2019
Charter Plastics	H525/2107	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
Charter Plastics	TRB-432 BK	73	1600	S*	12/31/2020
		140	1000	S	12/31/2020
Co-Ex Pipe Co.	CO-FLEX-IN-121	73	1600	S*	12/31/2021
		140	1000	S	12/31/2021
Co-Ex Pipe Co.	CO-FLEX-LB	73	1600	S*	12/30/2019
		140	1000	S	12/30/2019
Co-Ex Pipe Co.	CO-FLEX-LB2	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
Co-Ex Pipe Co.	CO-FLEX-SAS	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
Cresline Plastic Pipe Company	Cresline HD	73	1600	S*	12/30/2021
		140	1000	S	12/30/2021
Cresline Plastic Pipe Company	Cresline HD-F	73F	1600	S*	12/30/2019
		140F	1000	S	12/30/2019
Duraline Corporation	PolyPipe B-50-G	73	1600	S*	12/31/2021
		140	1000	S	12/31/2021
Duraline Corporation	PolyPipe B-50-H	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
Duraline Corporation	PolyPipe B-50-J	73	1600	S*	12/31/2020
		140	1000	S	12/31/2020
Duraline Corporation	PolyPipe G-50-A	73	1600	S*	12/31/2019
		140	800	S	12/31/2019
Endot Industries	END-100	73F	1600	S*	12/30/2021
		140F	1000	S	12/30/2021
Endot Industries	ENDOT EID-100	73	1600	S*	12/30/2020
		140	1000	S	12/30/2020
Endot Industries	ENDOT EID-80	73	1600	S*	12/31/2019
		140	1000	S	12/31/2019
Extrumex	Tuberia Extrupak PE4710	73	1600	S*	12/30/2019
		140	1000	S	12/30/2019
Fluidos Industriales Mexicanos, SA de CV	TUBERIA TKP TIPO II PE 4710	73	1600	S*	12/31/2018
		140	1000	S	12/31/2018
Fluidos Industriales Mexicanos, SA de CV	TUBERIA TKP TIPO II PE4710 REFLEX	73	1600	S*	12/31/2019
		140	1000	S	12/31/2019

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Flying W Plastics	IB210	73	1600	E-10*	12/31/2018
		140	1000	E-10	12/31/2018
Flying W Plastics	SS210	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
Flying W Plastics	SW210	73	1600	S*	12/31/2021
		140	1000	S	12/31/2021
Georg Fischer Central Plastics	DESIGN FLOW 347	73	1600	S	12/30/2020
		140	1000	S	12/30/2020
Georg Fischer Central Plastics	DESIGN FLOW 348	73	1600	S*	12/30/2020
		140	1000	S	12/30/2020
Georg Fischer Central Plastics	DESIGN FLOW 350	73	1600	S*	12/30/2020
		140	1000	S	12/30/2020
Georg Fischer Central Plastics	DESIGN FLOW 351	73	1600	S*	12/31/2018
		140	1000	S	12/31/2018
Georg Fischer Central Plastics	DESIGN FLOW 352	73	1600	S*	12/30/2020
		140	1000	S	12/30/2020
Georg Fischer Central Plastics	DESIGN FLOW 353	73	1600	S*	12/30/2021
		140	1000	S	12/30/2021
Hebei Quanen High-Tech Piping Company	JM Quanen PE 4710 Pressure Pipe	73	1600	S*	12/31/2019
		140	1000	S	12/31/2019
Improved Piping Products, Inc	IPP PE4710 BK	73	1600	S*	12/30/2020
		140	1000	S	12/30/2020
International Pipe	IPT	73	1600	S*	12/31/2021
		140	1000	S	12/31/2021
Interstate Plastic	INTERSTATE PE4710 DL 01	73	1600	S*	12/31/2021
		140	1000	S	12/31/2021
Interstate Plastic	Interstate PE4710 DL 02	73	1600	E-10*	12/31/2018
		140	1000	E-10	12/31/2018
IPEX Inc.	HDPE IF21	73	1600	S*	12/30/2021
		140	1000	S	12/30/2021
JM Manufacturing dba JM Eagle	JM EAGLE PE4710 TRB-437LS	73F	1600	S*	12/31/2022
		140F	1000	S	12/31/2022
JM Manufacturing dba JM Eagle	JM Eagle PE 4710 H525 BLACK	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
JM Manufacturing dba JM Eagle	JM Eagle PE 4710 HDPE Pressure Pipe	73	1600	S*	12/30/2020
		140	1000	S	12/30/2020
JM Manufacturing dba JM Eagle	JM Eagle PE 4710 HDPE Pressure Pipe 2	73F	1600	S*	12/30/2020
		140F	1000	S	12/30/2020
JM Manufacturing dba JM Eagle	JM Eagle PE 4710 HDPE Pressure Pipe 3	73	1600	S*	12/30/2020
		140	1000	S	12/30/2020
JM Manufacturing dba JM Eagle	JM Eagle PE 4710 HDPE Pressure Pipe 5	73	1600	S*	12/31/2018
		140	1000	S	12/31/2018
JM Manufacturing dba JM Eagle	JM Eagle PE4710 HD4985 BK	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
JM Manufacturing dba JM Eagle	JM EAGLE PE4710 L4904LS	73F	1600	S*	12/31/2022
		140F	1000	S	12/31/2022
JM Manufacturing dba JM Eagle	JM Eagle PE4710/PE100 Pressure Pipe 4	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
JM Manufacturing dba JM Eagle	JM Eagle Pure Core PE 4710	73	1600	E-10*	12/31/2018

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
		140	1000	E-10	12/31/2018
JM Manufacturing dba JM Eagle	JMEagle PURE CORE PE4710-2	73F	1600	S*	12/31/2021
		140F	1000	S	12/31/2021
JM Manufacturing dba JM Eagle	JMM PE 4710 Pressure Pipe	73	1600	S*	12/31/2021
		140	1000	S	12/31/2021
Muovitech Group North America	Muovitech 1	73	1600	S*	12/30/2019
		140	1000	S	12/30/2019
NuMex Plastics	NuMex PE4710 DL 01	73	1600	S*	12/31/2021
		140	1000	S	12/31/2021
NuMex Plastics	NuMex PE4710 DL 02	73	1600	E-10*	12/31/2018
		140	1000	E-10	12/31/2018
Oil Creek Plastics	Aqua-Jet 100A	73	1600	E-10*	6/30/2018
		140	1000	E-10	6/30/2018
Oil Creek Plastics	Aqua-Jet 100B	73F	1600	S*	12/30/2021
		140F	1000	S	12/30/2021
Oil Creek Plastics	Aqua-Jet 100C	73	1600	S*	12/30/2020
		140	1000	S	12/30/2020
Oil Creek Plastics	Aqua-Jet 121	73	1600	S*	12/31/2021
		140	1000	S	12/31/2021
Oil Creek Plastics	AQUA-PERT	73F	1600	S*	12/30/2020
		180F	800	S	12/30/2020
Performance Pipe Division	PP/9346 Grey	73	1600	S*	12/31/2019
		140	800	S	12/31/2019
Performance Pipe Division	PP/DOW 2399 BK	73F	1600	S*	12/31/2020
		180F	800	S	12/31/2020
Performance Pipe Division	PP/DOW 2490	73	1600	S*	12/30/2020
		140	1000	S	12/30/2020
Performance Pipe Division	PP/DOW 2490 BL	73	1600	S*	12/30/2021
		140	1000	S	12/30/2021
Performance Pipe Division	PP/DOW 2499	73F	1600	S*	12/30/2020
		180F	800	S	12/30/2020
Performance Pipe Division	PP/DOW 2499 BK	73F	1600	S*	12/30/2020
		180F	800	S	12/30/2020
Performance Pipe Division	PP/Dow 2502	73	1600	S*	12/31/2018
		140	1000	S	12/31/2018
Performance Pipe Division	PP/Dow2482	73	1600	S*	12/30/2020
		140	1000	S	12/30/2020
Performance Pipe Division	PP/Dow2492	73	1600	S*	12/30/2020
		140	1000	S	12/30/2020
Performance Pipe Division	PP/H516HP BK	73	1600	S*	12/30/2020
		140	1000	S	12/30/2020
Performance Pipe Division	PP/H516LS BK	73F	1600	S*	12/31/2022
		140F	1000	S	12/31/2022
Performance Pipe Division	PP/H525	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
Performance Pipe Division	PP/H525 Grey	73	1600	S*	12/30/2019
		140	1000	S	12/30/2019
Performance Pipe Division	PP/HD4985 BK	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Performance Pipe Division	PP/L4904	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
Performance Pipe Division	PP/TUB 121	73	1600	S*	12/31/2021
		140	1000	S	12/31/2021
Pipeline Plastics, LLC	PLP B-1	73	1600	S*	12/31/2019
		140	1000	S	12/31/2019
Pipeline Plastics, LLC	PLP B-2	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
Pipeline Plastics, LLC	PLP B-4	73F	1600	S*	12/30/2021
		140F	1000	S	12/30/2021
Pipeline Plastics, LLC	PLP C-1	73	1600	S*	12/31/2021
		140	1000	S	12/31/2021
Pipeline Plastics, LLC	PLP D-3	73F	1600	S*	12/31/2022
		140F	1000	S	12/31/2022
Pipeline Plastics, LLC	PLP G-1	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
Pipeline Plastics, LLC	PLP-B3	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
Plasson USA	IPF DGDA-2490 BL	73	1600	S*	12/30/2021
		140	1000	S	12/30/2021
Plasson USA	IPF L4904-Black	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
Plasson USA	IPF TRB-432 BK	73	1600	S*	12/31/2020
		140	1000	S	12/31/2020
Plasson USA	IPF TRB-437LS BK	73F	1600	S*	12/31/2022
		140F	1000	S	12/31/2022
Policonductos S.A. de C.V.	PLC PE-4710 D1	73	1600	S*	12/31/2019
		140	1000	S	12/31/2019
Policonductos S.A. de C.V.	PLC PE-4710 LS D2	73	1600	S*	12/31/2018
		140	1000	S	12/31/2018
Poly Technology	Poly Technology 4710	73	1600	S*	12/30/2021
		140	1000	S	12/30/2021
Poly Technology	Poly Technology 4710 Blue	73	1600	E-10*	12/31/2018
		140	1000	E-10	12/31/2018
Poly Technology	POLY TECHNOLOGY-EQ/BLUE	73F	1600	S*	12/30/2022
		140F	1000	S	12/30/2022
Polytubes 2009, Inc.	PT D247	73	1600	S*	12/30/2020
		140	1000	S	12/30/2020
Polytubes 2009, Inc.	PT D347	73	1600	S*	12/30/2018
		140	1000	S	12/30/2018
Polytubes 2009, Inc.	PT D47	73	1600	S*	12/30/2020
		140	1000	S	12/30/2020
Polytubes 2009, Inc.	PT-l47	73	1600	S*	12/30/2021
		140	1000	S	12/30/2021
Shawcor Composite Pipe Division	GP-47D	73	1600	S*	12/30/2020
		140	1000	S	12/30/2020
Shawcor Composite Pipe Division	GPD2-4710	73	1600	S*	12/31/2020
		140	1000	S	12/31/2020
Shawcor Composite Pipe Division	GPD3-100	73	1600	S*	12/31/2021

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
		140	1000	S	12/31/2021
Shawcor Composite Pipe Division	GPRT	73F	1600	S*	12/30/2020
		180F	800	S	12/30/2020
Silver-Line Plastics	SL 47 121	73	1600	S*	12/31/2021
		140	1000	S	12/31/2021
Silver-Line Plastics	Ultra Pure	73	1600	E-10*	12/31/2018
		140	1000	E-10	12/31/2018
Teel Plastics, Inc.	PE4710 Pressure Pipe	73	1600	S*	12/31/2021
		140	1000	S	12/31/2021
Trinus Pipes & Tubes Ltd.	Trinus TR-4	73	1600	S*	12/30/2020
		140	1000	S	12/30/2020
Trinus Pipes & Tubes Ltd.	Trinus TR-7	73F	1600	S*	6/24/2021
		140F	1000	S	6/24/2021
Union Pipes Industry	UPI/HE 3490-LS	73	1600	S*	12/30/2020
		140	1000	S	12/30/2020
United Poly Systems	UPS7473-1	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
United Poly Systems	UPS7473-3	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
United Poly Systems	UPS7473-4	73F	1600	S*	12/30/2019
United Poly Systems	UPS7473-6	73	1600	S*	12/30/2019
		140	1000	S	12/30/2019
United Poly Systems	UPS7473-7	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
United Poly Systems	UPS7473-8	73	1600	S*	12/31/2020
		140	1000	S	12/31/2020
United Poly Systems	USP 7473-5	73	1600	S*	12/30/2018
		140	1000	S	12/30/2018
Uponor Infra Ltd	SCLAIRPIPE DGDA-2490 BK 100	73	1600	S*	12/30/2020
		140	1000	S	12/30/2020
Uponor Infra Ltd	Sclairpipe DGDC-2482 BK	73	1600	S*	12/30/2020
		140	1000	S	12/30/2020
Uponor Infra Ltd	Sclairpipe HD4985	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
Uponor Infra Ltd	SCLAIRPIPE L4904-Black	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
Uponor Infra Ltd	Sclairpipe TUB121	73F	1600	S*	12/30/2021
		140F	1000	S	12/30/2021
Versaprofiles Products Inc	Versapipe Gas PE4710-HMF	73F	1600	S*	12/31/2022
		140F	1000	S	12/31/2022
Versaprofiles Products Inc	Versapipe HD100 BK	73	1600	S*	12/30/2021
		140	1000	S	12/30/2021
Versaprofiles Products Inc	Versapipe HD100 BL	73	1600	E-10*	12/31/2018
		140	1000	E-10	12/31/2018
Viega LLC	Viega PE A-Black	73	1600	S*	12/31/2019
		140	1000	S	12/31/2019
WL Plastics	WL Plastics A1	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
WL Plastics	WL Plastics C1	73	1600	S*	12/31/2022

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
		140	1000	S	12/31/2022
WL Plastics	WL Plastics C3	73	1600	S*	12/31/2020
		140	1000	S	12/31/2020
WL Plastics	WL Plastics C4	73F	1600	S*	12/31/2022
		140F	1000	S	12/31/2022
WL Plastics	WL Plastics E2	73	1600	S*	12/30/2019
		140	1000	S	12/30/2019
WL Plastics	WL Plastics E3	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
WL Plastics	WL Plastics E4	73F	1600	S*	12/31/2021
		140F	1000	S	12/31/2021
WL Plastics	WL Plastics S5	73	1600	S*	12/30/2021
		140	1000	S	12/30/2021

2. Independent Listings – PE 4710

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Borealis AG	BorSafe HE3490-LS	73	1600	S	12/31/2021
Borealis AG	BorSafe HE3490-LS-H	73	1600	E-10*	6/30/2018
		140	1000	E-10	6/30/2018
Borouge Pte Ltd	BorSafe HE3490-LS	73	1600	S*	12/31/2020
		140	1000	S	12/31/2020
Chevron Phillips Chemical	MARLEX H516HP BK	73	1600	S*	12/31/2020
		140	1000	S	12/31/2020
Chevron Phillips Chemical	MARLEX H516HPY	73	1600	S*	12/31/2020
		140	1000	S	12/31/2020
Chevron Phillips Chemical	MARLEX H525 BK	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
Chevron Phillips Chemical	MARLEX TRB-432 BK	73	1600	S*	12/31/2020
		140	1000	S	12/31/2020
Chevron Phillips Chemical	Marlex TRB-437LS BK	73F	1600	S*	12/31/2022
		140F	1000	S	12/31/2022
Dow Chemical Company	CONTINUUM DGDA 2490 BK	73	1600	S*	12/31/2020
		140	1000	S	12/31/2020
Dow Chemical Company	CONTINUUM DGDA 2490 BL	73F	1600	S*	12/31/2021
		140F	1000	S	12/31/2021
Dow Chemical Company	CONTINUUM DGDA 2490 GN	73F	1600	S*	12/31/2021
		140F	1000	S	12/31/2021
Dow Chemical Company	CONTINUUM DGDA 2490 NT	73	1600	E-10*	6/30/2018
		140	1000	E-10	6/30/2018
Dow Chemical Company	CONTINUUM DGDA 2490 YL	73F	1600	S*	12/31/2021
		140F	1000	S	12/31/2021
Dow Chemical Company	CONTINUUM DGDA 2490 YL2	73F	1600	S*	12/31/2022
		140F	1000	S	12/31/2022
Dow Chemical Company	CONTINUUM DGDA 2492 BK	73	1600	S*	12/31/2020
		140	1000	S	12/31/2020
Dow Chemical Company	CONTINUUM DGDA 2493 BK	73F	1600	S*	12/31/2020
		140F	1000	S	12/31/2020
Dow Chemical Company	CONTINUUM DGDA 2502 BK	73	1600	S*	12/31/2018
		140	1000	S	12/31/2018
Dow Chemical Company	CONTINUUM DGDA-2490 GY	73F	1600	S*	12/31/2021
		140F	1000	S	12/31/2021
Dow Chemical Company	CONTINUUM DGDA-2490 LV	73F	1600	S*	12/31/2021
		140F	1000	S	12/31/2021
Dow Chemical Company	CONTINUUM DGDC 2480 BK	73	1600	S*	12/31/2019
		140	1000	S	12/31/2019
Dow Chemical Company	CONTINUUM DGDC 2482 BK	73	1600	S*	12/31/2020
		140	1000	S	12/31/2020
Dow Chemical Company	CONTINUUM DGDD 2480 BK	73	1600	S*	12/31/2019
		140	1000	S	12/31/2019
Dow Chemical Company	HYPERTHERM 2399 BK	73F	1600	S*	12/31/2020
		180F	800	S	12/31/2020
Dow Chemical Company	HYPERTHERM 2399 NT	73F	1600	S*	12/31/2020

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
		180F	800	S	12/31/2020
Dow Chemical Company	INTREPID 2499 BK	73F	1600	S*	12/31/2020
		180F	800	S	12/31/2020
Dow Chemical Company	INTREPID 2499 NT	73F	1600	S*	12/31/2020
		180F	800	S	12/31/2020
Equistar Chemicals, LP	ALATHON L4904 Black	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
Equistar Chemicals, LP	ALATHON L4904 Grey	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
Equistar Chemicals, LP	ALATHON L4904LS-Black	73F	1600	S*	12/31/2022
		140F	1000	S	12/31/2022
Equistar Chemicals, LP	ALATHON L5008HP Black	73	1600	S*	12/31/2019
		140	1000	S	12/31/2019
Equistar Chemicals, LP	ALATHON L5008HP Blue	73F	1600	S*	12/31/2022
		140F	1000	S	12/31/2022
Equistar Chemicals, LP	L4904 Readymade	73F	1600	S*	12/31/2022
		140F	1000	S	12/31/2022
Formosa Plastics Corporation, U.S.A.	E6210A/MD53542	73F	1600	S*	12/31/2019
		140F	1000	S	12/31/2019
Formosa Plastics Corporation, U.S.A.	E6210A/PO2107	73	1600	S*	12/31/2018
		140	1000	S	12/31/2018
Formosa Plastics Corporation, U.S.A.	E6210C BLK	73F	1600	S*	12/31/2018
		140F	1000	S	12/31/2018
INEOS Olefins & Polymers USA	TUB 121	73	1600	S*	12/31/2021
		140	1000	S	12/31/2021
INEOS Olefins & Polymers USA	TUB 124	73	1600	E-10*	12/31/2018
		140	1000	E-10	12/31/2018
INEOS Olefins & Polymers USA	TUB121N NATURAL	73F	1600	E-10*	6/30/2018
		140F	1000	E-10	6/30/2018
INEOS Olefins & Polymers USA	TUB122 YELLOW	73	1600	E-10*	6/30/2018
		140	1000	E-10	6/30/2018
INEOS Olefins & Polymers USA	TUB127 Lavender	73F	1600	E-10*	6/30/2018
		140F	1000	E-10	6/30/2018
Sasol Chemicals North America, LLC	HD 4985 BK	73	1600	S*	12/31/2022
		140	1000	S	12/31/2022
Saudi Arabian Basic Corp. (SABIC)	P6006N	73	1600	S*	12/31/2019
		140	1000	S	12/31/2019
Saudi Arabian Basic Corp. (SABIC)	P6006N / IPBK010A	73	1600	S*	12/31/2019
		140	1000	S	12/31/2019
Saudi Arabian Basic Corp. (SABIC)	P6006N / PE-535-42	73	1600	S*	12/31/2019
		140	1000	S	12/31/2019

TABLE I.A.14A - PEX 0006 MATERIALS[1]

The following materials carry a recommended HDB of 1,250 psi and a maximum recommended HDS of 630 psi at 73°F (23°C) for water.The first digit is for chlorine resistance tested in accordance with ASTM F 2023. A digit “0” indicates it does not meet this requirement or it has not been tested.

1. Dependent Listings – PEX 0006

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Uponor	hePEXplus	73	1250	S	12/30/2021
		180	800	S	12/30/2021
		200	630	S	12/30/2021

2. Independent Listings – PEX 0006

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Golan Plastic Products	PEXGOL-F	73F	1250	E-6	12/31/2018
		140F	630	E-6	12/31/2018
Golan Plastic Products	PEXGOL-FB	73F	1250	E-16	12/31/2018
		200F	630	E-16	12/31/2018
Kafrit NA Ltd	TA 1108 HD/TABOREX TA 2114 HD (natural)	73	1250	S	12/31/2021
		180	800	S	12/31/2021
Mercury Plastics Inc	MERFLEXPEX -1	73	1250	S	12/31/2019
		180	800	S	12/31/2019
		200	630	S	12/31/2019
Roth Industries	ROTH PEX	73	1250	S	12/31/2021
		180	800	S	12/31/2021
		200	630	S	12/31/2021
Safelink Systems	MR PEX	73	1250	S	12/31/2019
		180	800	S	12/31/2019
		200	630	S	12/31/2019
Uponor	AQUAPEX PLUS	73	1250	S	12/31/2021
		180	800	S	12/31/2021
		200	630	S	12/31/2021
Uponor	hePEX	73	1250	S	12/31/2021
		180	800	S	12/31/2021
		200	630	S	12/31/2021
Viega LLC	ProFlex	73	1250	S	12/31/2022
		180	800	S	12/31/2022
		200	630	S	12/31/2022
Viega LLC	ProFlex (black)	73	1250	S	12/31/2022
		180	800	S	12/31/2022
		200	630	S	12/31/2022
Viega LLC	ProFlex (natural)	73	1250	S	12/31/2021
		180	800	S	12/31/2021
		200	630	S	12/31/2021
Viega LLC	ViegaPEX	73F	1250	S	12/31/2021
		200F	630	S	12/31/2021
Viega LLC	ViegaPEX (black)	73F	1250	S	12/31/2021
		200F	630	S	12/31/2021
Viega LLC	ViegaPEX (natural)	73F	1250	S	12/31/2021
		200F	630	S	12/31/2021

TABLE I.A.14B - PEX 1006 MATERIALS[1]

The following materials carry a recommended HDB of 1,250 psi and a maximum recommended HDS of 630 psi at 73°F (23°C) for water.The first digit is for chlorine resistance tested in accordance with ASTM F 2023. A digit “1” indicates the PEX tubing has been tested and meets the F 876 requirement for minimum chlorine resistance at the end use condition of 25% at 140°F (60°C) and 75% at 73°F (23°C). A digit “0” indicates it does not meet this requirement or it has not been tested.

1. Dependent Listings – PEX 1006

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Silver-Line Plastics	Sil-O-PEX	73	1250	S	12/31/2019
		180	800	S	12/31/2019
		200	630	S	12/31/2019
Viega LLC	A-1001LT	73	1250	S	12/30/2020
		180	800	S	12/30/2020
		200	630	S	12/30/2020
Viega LLC	A-PEX EXTRA	73	1250	S	12/31/2019
		180	800	S	12/31/2019
		200	630	S	12/31/2019

2. Independent Listings – PEX 1006

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Golan Plastic Products	PEXGOL	73F	1250	S	12/31/2022
		180F	800	E-16	12/31/2022

2. Independent Listings – PEX 3006

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
REHAU Inc	REHAU RAUPEX	73	1250	S	12/31/2019
		180	800	S	12/31/2019
		200	630	S	12/31/2019

2. Independent Listings – PEX 3206

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
REHAU Inc	REHAU RAUPEX Oxygen Barrier	73	1250	S	12/31/2019
		180	800	S	12/31/2019
		200	630	S	12/31/2019

2. Independent Listings – PEX 3306

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
REHAU Inc	REHAU Municipex	73	1250	S	12/31/2019
		180	800	S	12/31/2019
		200	630	S	12/31/2019
REHAU Inc	REHAU RAUGEO	73F	1250	S	7/31/2020
		180F	800	S	7/31/2020
		200F	630	S	7/31/2020
REHAU Inc	REHAU RAUPEX Red/White/Blue UV-Shield	73	1250	S	12/31/2019
		180	800	S	12/31/2019
		200	630	S	12/31/2019

TABLE I.A.14D.1 - PEX 5006 MATERIALS[1]

The following materials carry a recommended HDB of 1,250 psi and a maximum recommended HDS of 630 psi at 73°F (23°C) for water.The first digit is for chlorine resistance tested in accordance with ASTM F 2023. A digit “5” indicates the PEX tubing has been tested and meets the F 876 requirement for minimum chlorine resistance at the end use condition of 100% at 140°F (60°C).

1. Dependent Listings – PEX 5006

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Bow Plumbing Group	BOWPEX-5 Natural	73	1250	S	12/30/2019
		180	800	S	12/30/2019
		200	630	S	12/30/2019
Bow Plumbing Group	Oxypex-1	73	1250	S	12/31/2022
		180	800	E-16	12/31/2022
IPEX Inc.	IPEX-P	73	1250	S	12/30/2020
		180	800	S	12/30/2020
		200	630	S	12/30/2020
Mueller Plastics Corporation	Mueller Polystream PEX	73F	1250	S	12/31/2019
		180F	800	S	12/31/2019
REHAU Inc	RAUPEX CL5 UV Shield	73F	1250	S	12/31/2019
		180F	800	S	12/31/2019
Rifeng Enterprise Co Ltd	RIFENG PEX	73	1250	S	12/30/2021
		180	800	S	12/30/2021

2. Independent Listings – PEX 5006

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Borealis AG	BorPEX HE1878E-C2	73	1250	S	12/31/2019
		180	800	S	12/31/2019
		200F	630	E-10	12/31/2019
Hyundai Engineering Plastics	Polylink XP650 (Natural)	73	1250	S	12/31/2022
		180	800	E-16	12/31/2022
Kafrit NA Ltd	TA 1108 HD/TA 2420 CL (Natural)	73	1250	S	12/31/2019
		180	800	S	12/31/2019
		200	630	S	12/31/2019
SACO AEI Polymers	PEXIDAN L/T	73	1250	S	12/31/2020
		180	800	S	12/31/2020
		200	630	S	12/31/2020
SACO AEI Polymers	PEXIDAN L/T Eclipse	73	1250	S	12/31/2019
		180	800	S	12/31/2019
		200	630	S	12/31/2019

TABLE I.A.14D.2 - PEX 5106 MATERIALS[1]

The following materials carry a recommended HDB of 1250 psi and a maximum recommended HDS of 630 psi at 73°F (23C) for water. The first digit is for chlorine resistance tested in accordance with ASTM F2023. A digit “5” indicates the PEX tubing has been tested and meets the F876 requirement for minimum chlorine resistance at the end use condition of 100% at 140°F (60°C). The second digit indicates the UV resistance as per ASTM F876. The digit “1” indicates a minimumÂ month UV exposure resistance.

1. Dependent Listings – PEX 5106

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
HeatLink Group	PureLink Plus	73	1250	S	12/30/2019
		180	800	S	12/30/2019
		200	630	S	12/30/2019
HeatLink Group	PureLink Reclaimed	73	1250	S	12/30/2019
		180	800	S	12/30/2019
HeatLink Group	SureLink	73	1250	S	12/30/2019
		180	800	S	12/30/2019

2. Independent Listings – PEX 5106

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Uponor	AQUAPEX	73	1250	S	12/31/2021
		180	800	S	12/31/2021
		200	630	S	12/31/2021

TABLE I.A.14D.4 - PEX 5306 MATERIALS[1]

The following materials carry a recommended HDB of 1250 psi and a maximum recommended HDS of 630 psi at 73°F (23°C) for water. The first digit is for chlorine resistance tested in accordance with ASTM F2023. A digit “5” indicates the PEX tubing has been tested and meets the F876 requirement for minimum chlorine resistance at the end use condition of 100% at 140°F (60°C). The second digit indicates the UV resistance as per ASTM F876. The digit “3” indicates a minimum 6 month UV exposure resistance.

1. Dependent Listings – PEX 5306

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Bow Plumbing Group	Superpex	73F	1250	S	12/30/2019
		180	800	S	12/30/2019
		200	630	S	12/30/2019

2. Independent Listings – PEX 5306

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Kafrit NA Ltd	TA 1108 HD/TA 2410 CL (Red)	73F	1250	S	12/31/2019
		180	800	S	12/31/2019
		200	630	S	12/31/2019
Kafrit NA Ltd	TA 1108 HD/TA 2411 CL (Blue)	73	1250	S	12/31/2019
		180	800	S	12/31/2019
		200	630	S	12/31/2019
Kafrit NA Ltd	TA 1108 HD/TA 2412 CL (White)	73F	1250	S	12/31/2019
		180	800	S	12/31/2019
		200	630	S	12/31/2019
Kafrit NA Ltd	TA 1108 HD/TA 2415 CL (White)	73F	1250	S	12/31/2019
		180	800	S	12/31/2019
		200	630	S	12/31/2019
Kafrit NA Ltd	TA 1108 HD/TA 2417 CL (Black)	73F	1250	S	12/31/2019
		180F	800	S	12/31/2019
		200F	630	S	12/31/2019
Kafrit NA Ltd	TA 1108 HD/TA 2418 CL (Red)	73F	1250	S	12/31/2019
		180F	800	S	12/31/2019
		200F	630	S	12/31/2019
Kafrit NA Ltd	TA 1108 HD/TA 2419 CL (White)	73F	1250	S	12/31/2019
		200F	630	S	12/31/2019
Kafrit NA Ltd	TA 1117 HD/ TA 2410 CL (Red)	73F	1250	S	12/31/2019
		180F	800	S	12/31/2019
		200F	630	S	12/31/2019
SACO AEI Polymers	PEXIDAN L/T Eclipse Black	73	1250	S	12/31/2019
		180	800	S	12/31/2019
		200	630	S	12/31/2019
SACO AEI Polymers	PEXIDAN L/T Eclipse Blue	73	1250	S	12/31/2019
		180	800	S	12/31/2019
		200	630	S	12/31/2019
SACO AEI Polymers	PEXIDAN L/T Eclipse Red	73	1250	S	12/31/2019
		180	800	S	12/31/2019
		200	630	S	12/31/2019
SACO AEI Polymers	PEXIDAN L/T Eclipse White	73	1250	S	12/31/2019
		180	800	S	12/31/2019
		200	630	S	12/31/2019
SACO AEI Polymers	PEXIDAN L/T-UV Blue	73F	1250	S	12/31/2019
		180F	800	S	12/31/2019
		200F	630	S	12/31/2019
SACO AEI Polymers	PEXIDAN L/T-UV Red	73	1250	S	12/31/2019
		180	800	S	12/31/2019
		200	630	S	12/31/2019
SACO AEI Polymers	PEXIDAN L/T-UV White	73	1250	S	12/31/2019
		180	800	S	12/31/2019
		200	630	S	12/31/2019

2. Independent Listings – PA 32312

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Arkema	Rilsan 11	73	2500	S	12/31/2019
		140	1600	S	12/31/2019
		180	1250	S	12/31/2019

2. Independent Listings – PA 32316

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Arkema	Rilsan R11P250 (BESHV)	73	3150	S	12/31/2019
		180	1600	S	12/31/2019

2. Independent Listings – PA 42316

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Evonik Degussa	VESTAMID PA12	73	3150	S	12/31/2019
		140	2000	S	12/31/2019
		180F	1600	E-10	12/31/2019
UBE America	UBESTA 3035	73	3150	S	12/31/2021
		140	2000	S	12/31/2021
		180	1600	S	12/31/2021

TABLE I.A.20 - PVDF 2020 MATERIALS[1]

The following materials carry a recommended HDB of 4000 psi and a maximum recommended HDS of 2000 psi at 73°F (23°C) for water.

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Arkema	KYNAR 1000	73	4000	S	12/31/2019
		200	1250	S	12/31/2019
Arkema	KYNAR 740	73	4000	S	12/31/2019
		200	1250	S	12/31/2019

TABLE I.A.21 - PVDF 2025 MATERIALS[1]

The following materials carry a recommended HDB of 5000 psi and a maximum recommended HDS of 2500 psi at 73°F (23°C) for water.

Company Name	Material Designation	Temp °F	HDB (psi)	Grade	Expiration Date
Solvay Specialty Polymers	SOLEF 1010	73	5000	S	12/31/2022
		248	1250	S	12/31/2022
		284	800	S	12/31/2022

SECTION I

PART B – THESE MATERIALS MAY BE USED FOR MOLDING APPLICATIONS ONLY

TABLE I.B.1

Materials with recommended hydrostatic design basis (HDB) at 73°F (23°C) that have been established in accordance with TR-3 using:

Molded Specimens

Company Name	Material Designation	Designation Code	Temp °F	HDB (psi)	Grade	Expiration Date
PolyOne	GEON 87431		73	4000	S	12/31/2021
PolyOne	GEON M1200/M3200		73	3200	S	12/31/2021

TABLE I.B.2

Materials with recommended hydrostatic design basis (HDB) at 73°F(23°C) that have been established in accordance with TR-3 using:

Extruded Pipe Specimens

Company Name	Material Designation	Designation Code	Temp °F	HDB (psi)	Grade	Expiration Date
Axiall LLC	Axiall / Georgia Gulf 6907 BLUE 83	Extruded Pipe for Molding	73	4000	S	12/31/2020
IPEX Technologies Inc	PVC E05	Extruded Pipe for Molding	73	4000	S	12/31/2019
IPEX Technologies Inc	PVC E05 Gray	Extruded Pipe for Molding	73F	4000	S	12/31/2021
IPEX Technologies Inc	PVC E05 White	Extruded Pipe for Molding	73F	4000	S	12/31/2021
Lubrizol Advanced Materials	TEMPRITE 3212 GRAY 245	Extruded Pipe for Molding	73	4000	S	12/31/2019
			180	1000	S	12/31/2019
Lubrizol Advanced Materials	TEMPRITE 3235 BLUE 470	Extruded Pipe for Molding	73	4000	S	12/31/2019
			180	1000	S	12/31/2019
Lubrizol Advanced Materials	TEMPRITE 88065 ORANGE 734	Extruded Pipe for Molding	73	4000	S	12/31/2019
			180	1000	S	12/31/2019
Lubrizol Advanced Materials	TempRite 88096 Tan 309	Extruded Pipe for Molding	73	4000	S	12/31/2020
			180	1000	S	12/31/2020

TABLE I.B.3

Materials with recommended strength design basis (SDB) at 73°F(23°C) that have been established in accordance with TR-3 using:

Molded Plaque Specimens

Company Name	Material Designation	Designation Code	Temp °F	SDB (psi)	Grade	Expiration Date
JM Manufacturing dba JM Eagle	UAC-MFPA1	PA 12116	73	3150	S	12/31/2019

SECTION II

PIPES WITH PPI RECOMMENDED PRESSURE DESIGN BASIS (PDB) AND MAXIMUM PRESSURE RATINGS (PR) ESTABLISHED IN ACCORDANCE WITH PPI TR-3 (ASTM D 2837).

This Section lists recommendations for the Pressure Design Basis (PDB) for composite pipes and pipes of multilayer construction consisting essentially of two layers of thermoplastic material that sandwich a thin layer of metallic reinforcement. Because the longer-term strength of pipes of such construction is determined not only by the properties of each of the materials used but also by the specific combination of materials and layer thicknesses, this Section differs from Section I in two important respects:

- The long-term strength recommendations are presented in terms of a *pressure design basis* (PDB) which represents the pipe's estimated long-term hydrostatic *pressure* strength; and
- Each PDB recommendation is specific to the particular wall construction and pipe diameter that are represented by the data upon which the PDB recommendation was established.

The PDB is the categorized estimated long-term hydrostatic pressure strength of a pipe. The procedures for the estimating of the long-term hydrostatic pressure strength, and for its categorization into preferred values, are the same as those used in Section I for the establishing of a material's hydrostatic design basis (HDB).

The *maximum* pipe pressure ratings (PR's) are obtained by multiplying the PDB by a 0.5 design factor. The design factor is intended to take into consideration all the variables and degree of safety involved on a particular application. The 0.5 value is without consideration to conditions such as aggressive environments, cyclic stressing, localized stress concentrations, and temperature fluctuations which were not present in the testing of the pipes but which could significantly affect long-term durability. Smaller design factors (effectively, larger safety factors) should be considered to compensate for conditions not adequately represented by the test protocol upon which the PDB's have been established. The pipe manufacturer, appropriate pipe standards and codes, and relevant technical information should be consulted for guidance.

The PDB's listed in this Section have been developed under the same PPI TR-3 protocol as is used for the establishing of the HDB's that are listed in Section I of this report. The use of this protocol, including the use of ASTM method D 2837, was deemed as appropriate for each of the listed pipe constructions because their pressure versus time-to-rupture behavior exhibits the same kind of regression with duration of loading as is exhibited by thermoplastic pipes of homogenous wall construction. The Hydrostatic Stress Board excludes wall constructions that cannot be evaluated and analyzed in accordance with ASTM D 2837 from consideration.

Experimental listings are also allowed.

There are indications that the long-term strength of a pipe of multilayer construction could be expressed as some function of the tensile strength properties and relative thickness of each of the separate material layers (Reference #1 and #2). Should this be confirmed for any of the listed material combinations, then the recommended strength for each such combination will be reported in terms of a material strength (i.e., and HDB), rather than a pipe strength (a PDB).

Reference #1 – Frank Furno, A New Concept in Plastics Piping, Proceedings of the Eleventh Plastic Fuel Gas Pipe Symposium (October 1989, San Francisco, CA), American Gas Association.

Reference #2 – Jeremy Bowman, The Influence of Time and Temperature on the Strength of Multilayered Pressure Pipe, Plastics Pipe VII Proceedings (September, 1992, Koningshof, The Netherlands) The Plastics and Rubber Institute.

TABLE II.A.1

Multi-layer/Composite pipes with recommended pressure design basis (PDB) that have been established in accordance with TR-3.

Company Name	Pipe Designation	Material Designation	Temp °F	PDB (psig)	Grade	Expiration Date
IPEX Inc.	PE/AL/PE	IPEX PE-AL-PE (1/2, 5/8, 3/4, 1")	73	400	S	12/31/2021
			140	200	S	12/31/2021
IPEX Inc.	PE/AL/PE	IPEX PE-AL-PE [PE-RT] (1/2, 5/8, 3/4, 1")	73	400	S	12/31/2021
			180	200	S	12/31/2021
Rifeng Enterprise Co Ltd	PEX/AL/PEX	RIFENG PEX-AL-PEX (1/2", 5/8", 3/4", 1")	73	500	S	12/31/2022
			200	250	S	12/31/2022
Westfalische Rohrwerke	PERT/AL/PERT	WRW PERT-AL-PERT (1/2", 5/8", 3/4", 1")	73	400	S	12/31/2022
			140	315	S	12/31/2022
			200	200	S	12/31/2022

SECTION III

MATERIALS WITH PPI RECOMMENDED MINIMUM REQUIRED STRENGTH (MRS) AND CATEGORIZED REQUIRED STRENGTH (CRS) ESTABLISHED IN ACCORDANCE WITH ISO 9080 AND ISO 12162.

For classification purposes, the MRS is determined using ISO 9080 and the ISO 12162 standard conditions of 20°C (68°F). The CRS (θ, t) is the Categorized Required Strength value of σ_{lpl} determined and categorized for the selected temperature (θ) and required time (t) in accordance with ISO 9080 using the 3 or 4 coefficient stress rupture/time equation. These CRS (θ, t) values are listed in Table III.B.1. This current listing approach is under review by the Hydrostatic Stress Board.

The reader is advised that the MRS and CRS(θ, t) values listed in TR-4 represent an approximation of the likelihood that pipe specimens produced from these materials will not fail when placed in service and utilized in conjunction with the appropriate design coefficients. HDB values as determined in accordance with TR-3 policies include a stress reduction factor (design factor) to arrive at a recommended HDS. MRS and CRS(θ, t) designations, as determined in accordance with ISO 9080, do not include any stress reduction factors (design coefficients) that are required prior to its application for an intended service. As such, it is the responsibility of the design engineer to determine the appropriate design coefficients for the particular application when using MRS and CRS(θ, t). The reader is advised to consult the owner of the material designation for specifics regarding interpretation or use of the MRS and CRS(θ, t) values listed in TR-4.

2. Independent Listings – PE 80

Company	Material	Temp °C	MRS (MPa)	Grade	Expiration Date
Borealis AG	BorSafe HE3470-LS	20	8	S	12/31/2021
Borealis AG	BorSafe ME3440	20	8	S	12/31/2021
Borealis AG	BorSafe ME3441	20	8	S	12/31/2021
Borealis AG	BorSafe ME3444	20	8	S	12/31/2021
Chevron Phillips Chemical	MARLEX H525 BK	20	8	S	12/31/2018
Chevron Phillips Chemical	MARLEX TR-418P8D	20	8	S	12/31/2022
Dow Chemical Company	CONTINUUM DGDA 2420 YL	20	8	S	12/31/2022
Dow Chemical Company	CONTINUUM DGDC 2480 BK	20	8	S	12/31/2019
Formosa Plastics Corporation, U.S.A.	HP3902 Y	20	8	S	12/31/2022
Formosa Plastics Corporation, U.S.A.	HP4401 BK	20	8	S	12/31/2022
INEOS Olefins & Polymers USA	K44-08-123	20	8	S	12/31/2021
INEOS Olefins & Polymers USA	K44-15-123	20	8	S	12/31/2021

TABLE III.A.2 - PE 100 MATERIALS

The following materials have a recommended MRS of 10.0 MPa (1450 psi) at 20°C (68°F).

1. Dependent Listings – PE 100

Company	Material	Temp °C	MRS (MPa)	Grade	Expiration Date
Charter Plastics	Charter Black L-1 HDPE	20	10	S	12/31/2022
Charter Plastics	TRB-432 BK	20	10	S	12/31/2020
Duraline Corporation	PolyPipe B-50-J	20	10	S	12/30/2020
Endot Industries	ENDOT EID-100	20	10	S	12/30/2020
Endot Industries	INE00B121	20	10	S	12/30/2020
Fluidos Industriales Mexicanos, SA de CV	TUBERIA TKP TIPO II PE PE-100	20	10	S	12/30/2021
Georg Fischer Central Plastics	DESIGN FLOW 352	20	10	S	12/31/2018
Georg Fischer Central Plastics	DESIGN FLOW 353	20	10	S	12/30/2020
Improved Piping Products, Inc	IPP PE4710 BK	20	10	S	12/30/2020
JM Manufacturing dba JM Eagle	JM Eagle PE 100 TUB 121	20	10	S	12/30/2020
JM Manufacturing dba JM Eagle	JM Eagle PE4710/PE100 Pressure Pipe 4	20	10	S	12/31/2022
JM Manufacturing dba JM Eagle	J-M PE PRESSURE PIPE	20	10	S	12/30/2020
Performance Pipe Division	PP/DOW 2490	20	10	S	12/30/2020
Performance Pipe Division	PP/Dow2492	20	10	S	12/30/2020
Performance Pipe Division	PP/H516HP BK	20	10	S	12/30/2020
Performance Pipe Division	PP/H516LS BK	20	10	S	12/31/2021
Performance Pipe Division	PP/TUB 121	20	10	S	12/30/2020
Policonductos S.A. de C.V.	PLC PE-100	20	10	S	12/31/2021
Polytubes 2009, Inc.	PT D2100	20	10	S	12/30/2020
Polytubes 2009, Inc.	PT-I100	20	10	S	12/30/2020
Shawcor Composite Pipe Division	GPD2-100	20	10	S	12/30/2020
Union Pipes Industry	UPI/HE 3490-LS	20	10	S	12/31/2018
Uponor Infra Ltd	SCLAIRPIPE DGDA-2490 BK 100	20	10	S	12/30/2020
Uponor Infra Ltd	Sclairpipe TUB121	20	10	S	12/30/2020
WL Plastics	WL Plastics C3	20	10	S	12/31/2020
WL Plastics	WL Plastics E3	20	10	S	12/31/2022
WL Plastics	WL Plastics S5	20	10	S	12/30/2020

2. Independent Listings – PE 100

Company	Material	Temp °C	MRS (MPa)	Grade	Expiration Date
Borealis AG	BorSafe HE3490-IM	20	10	S	12/31/2018
Borealis AG	BorSafe HE3490-LS	20	10	S	12/31/2021
Borouge Pte Ltd	BorSafe HE3490-LS	20	10	S	12/31/2018
Chevron Phillips Chemical	MARLEX H516HP BK	20	10	S	12/31/2020
Chevron Phillips Chemical	MARLEX TRB-432 BK	20	10	S	12/31/2020
Chevron Phillips Chemical	MARLEX TRB-432 NT	20	10	S	12/31/2021
Chevron Phillips Chemical	Marlex TRB-437LS BK	20	10	S	12/31/2021
Dow Chemical Company	CONTINUUM DGDA 2490 BK	20	10	S	12/31/2020
Dow Chemical Company	CONTINUUM DGDA 2492 BK	20	10	S	12/31/2020
Dow Chemical Company	CONTINUUM DGDA 2502 BK	20	10	S	12/31/2021
Equistar Chemicals, LP	ALATHON L4904 Black	20	10	S	12/31/2022
Equistar Chemicals, LP	L4904 Readymade	20	10	S	12/31/2022
Formosa Plastics Corporation, U.S.A.	E6210A-BK	20	10	S	12/31/2018
INEOS Olefins & Polymers USA	TUB 121	20	10	S	12/31/2020

2. Independent Listings – PA11 180

Company	Material	Temp °C	MRS (MPa)	Grade	Expiration Date
Arkema	Rilsan R11P250 (BESHV)	20	18	S	12/31/2019

2. Independent Listings – PA12 180

Company	Material	Temp °C	MRS (MPa)	Grade	Expiration Date
Evonik Degussa	VESTAMID NRG 2101	20	18	S	12/31/2020
UBE America	UBESTA 3035	20		S	12/31/2021
		20		S	12/31/2021

TABLE III.B.1 - CRS (Θ, T)

The CRS (θ, t) is the categorized value of the ISO 9080 LPL for a material at a temperature of T (°C) and a time of t years, using the extrapolation limits of ISO 9080. This current listing approach is under review by the Hydrostatic Stress Board.The reader is advised that the MRS and CRS(θ, t) values listed in TR-4 represent an approximation of the likelihood that pipe specimens produced from these materials will not fail when placed in service and utilized in conjunction with the appropriate design coefficients. HDB values as determined in accordance with TR-3 policies include a stress reduction factor (design factor) to arrive at a recommended HDS. MRS and CRS(θ, t) designations, as determined in accordance with ISO 9080, do not include any stress reduction factors (design coefficients) that are required prior to its application for an intended service. As such, it is the responsibility of the design engineer to determine the appropriate design coefficients for the particular application when using MRS and CRS(θ, t). The reader is advised to consult the owner of the material designation for specifics regarding interpretation or use of the MRS and CRS(θ, t) values listed in TR-4.

Company	Material	Temp °C	CRS (θ, t)	Grade	Expiration Date
Borealis AG	RA7050-GN	60	6.3	S	12/31/2022
		70	5.0	S	12/31/2022
Borealis AG	RA7050-grey	60	6.3	S	12/31/2022
		70	5.0	S	12/31/2022

APPENDIX

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APPENDIX

PPI Membership

Benefits

8 Reasons to Join the Plastics Pipe Institute

1. **Learn from the Experts – Your Industry Peers!**
   PPI offers unmatched opportunities to learn more about the plastics pipe industry from the experts in your industry – your peers. Learn about best practices, market opportunities, standardization issues, ongoing research and many other areas critical to your company's success.

2. **Input into Industry Positions**
   PPI is recognized as the industry voice before North American and international standards setting organizations, code writing bodies, municipalities and other regulatory agencies. And we regularly provide industry positions to these groups. Help us develop positions that will benefit your interests.

3. **Networking**
   Membership allows you participation in all PPI forums and meetings. At these events, you will meet and learn from your peers in the industry. Our membership includes material and additive suppliers, pipe manufacturers, equipment manufacturers and distributors, giving you access to the complete supply chain. PPI's Spring and Fall meetings are recognized throughout the industry as "must-attends" and are open to members only.

4. **Technical Credibility of PPI and the Use of the PPI Logo**
   PPI is recognized around the world as the technical expert on plastic piping issues. The use of our logos is available to members only, and provides unmatched credibility. Use the logo(s) on your literature, product packaging, website and business cards to show that you are part of the worldwide leader on plastic pipe issues.

5. **Links to Your Company from PPI's Website**
   We provide links to all of our members through our website www.plasticpipe.org. PPI has thousands of visitors monthly, all looking for suppliers of piping products, or information about products. We provide a link for them to quickly get to you.

6. **Services of PPI's Staff**
   Our technical, engineering and marketing staff are ready to answer your questions and help you grow your business. This knowledge base is available to members everyday, and is a benefit we encourage you to use. Call us today!

7. **Discounts on PPI Services & Products**
   PPI members get significant discounts on PPI's products and services, including literature, certification program fees and product listing fees. These products and services will help your business succeed – and at a discount!

8. **50 + Years of Experience**
   PPI was founded in 1950, and through responsible and credible leadership, has established itself as the technical and marketing leader of the industry before a wide variety of stakeholders. Today, PPI is the voice of the plastics piping industry.

About Pexgol:

Pexgol, a division of Golan Plastic Products, is the only worldwide manufacturer that specializes in large diameter, cross-linked polyethylene pipe systems, providing them to industrial, infrastructure, aquaculture and mining sectors throughout the world.

Pexgol Material: PE-Xa

Is a chemically unbreakable cross-connection between polyethylene chains. The result of this chemical reaction is the creation of a material which has extremely high structural integrity, combined with resistance to a wide variety of corrosive and weather conditions.

PEXGOL
X-LINKED PIPING SOLUTIONS

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