Black Eagle Hose
Construction & Overview

Polyflex Black Eagle hoses are designed for oilfield applications. For each application different demands need to be considered regarding:

Composition of fluids
Short term pressure fluctuations
Safety requirements and standards
Temperatures and pressures
Static and dynamic loads

Thermoplastic Core Tube

The essential requirement for a hose is to contain and transmit a fluid or gas. The core tube of a thermoplastic hose is therefore in direct contact with that medium. The selection of the core tube material depends on fluid cobartibility, service temperature, and diffusion rate under operating conditions. The available materials are:

- Polyamide (PA11): It is used in high-performance applications for oil and gas, flexible pipes and control fluid umbilicals. It can operate within a wide range of working temperatures (-40°C up to +70°C), has a high dimensional stability and is low in density.
- Fluoropolymer designed for use in chemical injection systems at high temperature levels, the tubing shows low permeation rates and an excellent chemical resistance. Proven to handle methanol at 100°C and 15,000* psi working pressure.

Thermoplastic core tubes are manufactured with an extremly smooth and clean inner surface. This provides minimum flow resistance and minimum pressure drop in service.

Spiral Wire Reinforcement

Our reinforcement allows flexibility in service without compromising fluid transfer. Various layers of high tensile strength steel wires are used to achieve the best combination of pressure resistance, flexibility, and volumetric expansion. The basic function of the cover is to protect the wire reinforcement from very demanding environment. This could be decomposive media like seawater or extreme abrasion of the cover.

ColorGard™ Cover

ColorGard™ is an extra thick dual layer Polyurethan sheath: a red inner layer and a black or golden outer layer. It offers both an abration resistant extra thick over for long service life and acts as an additional safety feature. This concept is a visual early warning system for detection of excessive abrasion. This feature avoids possible injuries and reduction of downtime by anticipating failure.

Table of Contents PFDE-ES28, Rev. U: Handling, Maintenance, Inspection, Repair

Black Eagle Hose Assemblies

Table of Contents PFDE-ES28, Rev. U: Handling, Maintenance, Inspection, Repair

Black Eagle Hose Assemblies

PFDE-ES28, Rev. U: Handling, Maintenance, Inspection, Repair

Black Eagle Hose Assemblies

Instructions for handling, maintenance, inspection and repair of Parker Polyflex BLACK EAGLE hoses and assemblies.

1. Scope

This engineering standard is focused mainly on larger bore - long length Parker Polyflex multispiral wire reinforced hoses used in well service operations. It is also relevant for shorter length hose assembly applications such as chemical injection, stimulation, cementing, flexible and testing lines. It provides information on recommended practices for handling, maintenance, inspection, and repair of hose assemblies.

Deployed as single line hoses or used in bundles, Parker Polyflex multispiral wire reinforced hoses are available in sizes from 3/16" to 3" inside diameter and working pressures up to 1035 bar / 15000 psi and continuous lengths greater than 3000 m depending on size.

Hose can be self-supporting, clamped, supported by a guide wire or strengthened with an additional tensile reinforcement.

Parker Polyflex have certified several specialized testing facilities and their personnel to assemble, inspect, test and repair hose assemblies. Hose management is an essential part of the service they provide.

SAE J1273, ISO 17165-2, API RP 17B and ISO 13628 are excellent documents providing general guidelines for selection, routing, fabrication, installation, replacement, maintenance, and storage of hose and hose assemblies. Together with Parker Polyflex field experience, they provide the basis for the recommendations included in this engineering standard.

2. Hose Features

Parker Polyflex Oil & Gas multispiral wire reinforced hoses have been used for over 30 years in both onshore and offshore applications. They are proven to be tough, easy to handle, lightweight compared with alternatives and offer excellent chemical resistance, integral external collapse, ozone and microbiological resistance.

In extreme, abrasive applications, Polyflex offers an additional extra thick ColorGard™ sheath incorporating a dual color "early warning" safety feature.

2.1 Design Life

Parker Polyflex large bore hoses are designed for prolonged service life. The prerequisite for this design life is that the hoses are used within the operating limits, stated in the hose specification sheets. These limits include, but are not limited to working pressure, number of pressure cycles, temperature range and bending radius.

In order to ensure a long service life, Parker Polyflex incorporates a combination of raw material suppliers testing and data, fatigue testing, accelerated and specialized testing into the design of the hoses.

Obviously, due to many other factors, affecting the service life, it is not possible to predict or guarantee service life of each individual hose assembly.

These factors may include, but are not limited to mechanical loads (bending, torsion, tensile loads), frequent changes of temperature within the specified range, improper handling and storage, chemical attack, abrasive fluids, hose damage etc.

3. Storage

Hoses and hose assemblies should be stored, wherever possible, empty and protected from the elements in a stress-free condition either straight, in a coil, or on a drum. The inside diameter of the coil or drum should not be less than two times the minimum bend radius. If a hose assembly has been used with chemicals, it shall be flushed with water before putting it to storage (see also P.5.4).

Example: hose with minimum bend radius 800 mm; minimum size of drum core/belly should be 2 × 800mm = 1.6m.

The fittings should be capped to prevent ingress of dirt or other contamination and any exposed threads protected from damage.

Storage of hoses and hose assemblies should take into account potential exposure to corrosive liquids, rodents, insects, UV light and high temperatures. Storage temperatures should be in the range of hose operating temperatures.

PFDE-ES28, Rev. U: Handling, Maintenance, Inspection, Repair

Black Eagle Hose Assemblies

4. Handling

4.1 Personnel

Only trained personnel shall handle and connect hose assemblies.

Incorrect handling will seriously reduce the lifetime of the hose and could cause dramatic failure. The use of wire rope or chains directly against the outer cover should be avoided, and the routing of the assembly should ensure the hose is never bent below its minimum bend radius or twisted. Special attention should be paid to the area at the back of the fitting.

4.2 Spooling and Reeling

When reeling long length hose onto a drum it is essential to minimize the tension on the hose. Proof testing of a "stretched" hose while on the drum can cause premature failure of the hose or damage to the drum.

When operating from a vessel it is recommended that the hose is pressurized during the subsea deployment and retrieving operation. This recommendation is based on the fact that during these operations the hose is always subjected to tensile force, at least due to its own weight. Tensile forces will result in hose elongation and possible deformation.

This is significantly reduced by pressurizing the hose, especially important if it is planned to proof test the hose assembly while coiled on a drum or winch. Deployment and retrieving pressures up to 200 bar had been found to be sufficient but this depends on the hose type and local safety regulations. For recommendations of pressure / load values, see Appendix 2.

When re-spooling a long length assembly, the pay-off and take-up drums should be in line and a minimum of 10m apart. Depending on how the hose was delivered or re-spooled, the hose shall be spooled from either the top of the pay-off drum onto the top of the take-up drum or from bottom to bottom.

See Fig. 1 and Fig. 2. These recommendations minimize the possibility of inducing twist into the hose.

When re-spooling a new hose that has a polyurethane cover, it is recommended to lubricate the hose cover with soapy water or other suitable lubricant so the hose will traverse more easily and position itself correctly onto the take-up drum/winch.

See Fig. 1

It is also recommended, when deploying the hose though a moon pool or over the side of a vessel, to align the hose routing in the same manner.

See Fig. 2

Note: When first supplied, the layline printed on the hose is normally straight and visible. Twisting of the layline is an early indication of poor alignment or high tensile loading.

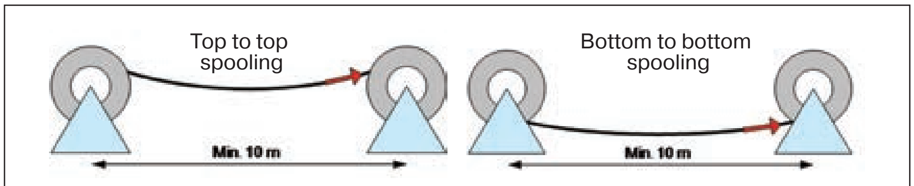


Fig. 1 Hose respooling

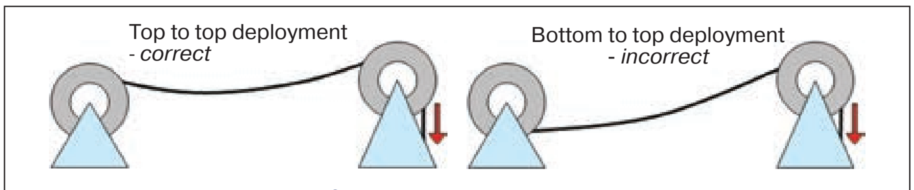


Fig. 2 Hose deployment

PFDE-ES28, Rev. U: Handling, Maintenance, Inspection, Repair

Black Eagle Hose Assemblies

5. Possible Causes of Premature Failure and Suggested Preventative Measures

5.1 Bending the hose below the minimum bend radius

This is most likely to occur if the end fitting is not supported during lifting, a support sling wrongly positioned, or the hose being pulled around a tight corner. It is important that hose should not be bent close to the end fittings. The straight section should be at least two times the outside diameter of the hose before it starts to bend.

Bend restrictors, lifting clamps and containment grips are useful accessories that help to reduce this type of handling problem.

5.2 Damage of the Hose Cover

Polyflex ColorGard™ extra thick, dual color cover significantly reduces the risk of exposing the reinforcing wires. If the outer black cover has been abraded to the point that the “early warning” red inner cover can be seen, but the wire reinforcement has not been exposed, the assembly is still fit for use but shall be scheduled for inspection. Alternatively, a repair according to section 7.1.1 may be considered.

If the hose cover is damaged to the extent that the reinforcing wires are exposed, localized corrosion of the wires could occur causing a progressive reduction in burst pressure, and ultimately failure.

If used subsea, a damaged cover will allow water to ingress into the carcass of the hose and could cause the corrosion of the wire reinforcement and/or collapse of the core tube.

It is strongly recommended to immediately remove from service any hose assembly with exposed wires. See also section 7.1.2 for details. A Parker Polyflex specialized testing facility should be contacted and the procedure described in section 6.5.1 shall be followed.

5.3 Kinked, Crushed or Twisted Hose

If a visible distortion of the hose occurred (kinked, crushed, twisted) it will have an impact on the function and lifetime of the hose. Reduction of burst pressure and external collapse pressure could result in a sudden failure of the hose assembly. This distortion can be caused by a high tensile load or other factors.

Maintaining pressure in the hose will significantly reduce the risk of such distortion occurring.

5.4 Chemical Attack or Ageing of the Core Tube

The use of chemicals at differing concentrations and/or temperatures can have a major effect on the life of a hose assembly and may cause dramatic hose failure. It is important to reference the chemical compatibility chart in the appendix of this document and keep the temperatures and concentrations within the specified limits.

Note: It is critical that the hose is thoroughly flushed with water after each use.

If the hose is not flushed, the concentration of the fluid that is left in the assembly can increase and cause localized failure of the core tube.

5.5 Damage or Corrosion of the End Fitting

Incorrect handling or insufficient flushing after use could result in damage or corrosion of the end fitting. This will make connection difficult, probably cause leakage, and could result in sudden failure of the connection.

5.6 Flow Rates

Depending on the abrasive properties of the fluid, high flow rates can result in erosion in the core tube or in the bore of the end fitting.

The maximum recommended flow rate is 15 m/sec, although much higher rates have been used short term with non-abrasive fluids. Do note possible temperature increase because of high flow velocities.

Note: The condition of the core tube and end fittings are checked as part of inspection (see 6.2).

PFDE-ES28, Rev. U: Handling, Maintenance, Inspection, Repair
Black Eagle Hose Assemblies

6. Inspection Guidelines

6.1 General

Hoses and hose assemblies have a limited lifetime and if they are not properly maintained, they could fail in service, causing expensive damages of property, unnecessary downtimes, release of hazardous substances and personnel injuries.

Properly planned inspections, preventive actions and timely hose replacements are highly recommended to ensure safety and are less expensive than replacements or repairs of hose assemblies after a failure.

Parker is recommending inspection and re-testing of Black Eagle Hoses on a regular basis.

6.2 Frequencies and Levels of Inspection

The table below represents the general Parker recommendation. However, due to huge variances in operating conditions in various applications, the final responsibility to define proper inspection intervals and amount of inspection is within the hose assembly owner/user.

Some factors, which could be taken into account while defining inspection intervals and amount of inspection, are listed below:

- Operating pressures
- Operating temperatures
- Operating times
- Service fluid type, density & viscosity
- PH levels, Chloride content
- Concentration of acids (i.e.HCL, ...)
- Flow rates (fluids, gas)
- Sand content (erosion monitoring) or other abrasive materials
- Additional stress levels (i.e. tensile loads)

It is also recommended to review these operating parameters in order to best evaluate the condition of a used Black Eagle hose assembly.

The history of each assembly should be logged showing the results of previous inspections and any repairs.

Recommended Frequencies of Inspection

Pre- and post-job	Every 6 months or during installation/ removal	Every 2 years See 6.3.
See 6.3.	Level 1, see 6.4	Level 2, see 6.5

6.3.1 Routine In-Field Pre Job Maintenance, Inspection and Testing

The operator shall visually inspect the hose assembly before every job. If any of the following conditions are found the hose shall be removed from service and scheduled for Level 1 inspection.

- Damage to the outer cover which exposes the reinforcing wires.
- Kinked, crushed, or twisted hose.
- Reduction in the outside diameter of the hose.
- Blistered, soft, degraded, or loose outer cover.
- Cracked, damaged, or badly corroded fittings.

If in doubt, contact the original supplier or a Parker Polyflex specialized testing facility for advice.

Regular in-field pressure testing, (normally required after attaching connectors prior to hose deployment), should be restricted to a test pressure of 1.1 × actual operating pressure, or the maximum stated working pressure of the hose assembly. Test duration should be 15 minutes. Preferably use water for pressure testing. The hose shall be monitored during the test and observed for signs of leakage in the hose and fittings, any bulging of the hose body, twisting or any abnormal distortion.

Prior to all pressure testing it must be ensured that all air is purged out of the hose. Failure to do so may result in core tube failure. To control that all air is removed it is sufficient to observe that the fluid flow leaving the hose is steady and constant for minimum of 5 minutes without any air bubbles or pulsations.

PFDE-ES28, Rev. U: Handling, Maintenance, Inspection, Repair

Black Eagle Hose Assemblies

6. Inspection Guidelines (cont.)

6.3.2 Routine in-field Post Job Maintenance, Inspection and testing

On completion of each operation both inside and outside hose surfaces should be flushed / cleaned with sufficient clean water to ensure that all chemicals or residues are fully removed from the hose assembly.

The operator shall visually inspect the hose assembly during every recovery. If any of the following conditions are found the assembly shall be removed from service and scheduled for Level 1 inspection.

- Damage to the outer cover which exposes the reinforcing wires.
- Kinked, crushed, or twisted hose.
- Reduction in the outside diameter of the hose.
- Blistered, soft, degraded, or loose outer cover.
- Cracked, damaged, or badly corroded fittings.

If in doubt, contact the original supplier or a Parker Polyflex specialized testing facility for advice.

6.4 Level 1 - On Site Inspection by User

The Black Eagle hose assembly shall be inspected on site by highly skilled users, who have experience and knowledge in using Black Eagle hoses. All observations should be noted and logged.

- Visual inspection
- Hose core tube inspection with borescope
- Hydrostatic pressure test

6.4.1 Level 1 Visual Inspection

For this purpose, the hose assembly should be cleaned inside and outside with water to remove oily traces, dirt, etc. for good viewing results.

The outer cover of the hose body shall be visually inspected for signs of leakage, excessive wear, looseness, kinks, bubbles, bulges, abrasion or cuts. The back side of a bend restrictor (if used) and the hose area behind the fitting should be checked for signs of over-bending/ kinking. The end fittings shall be checked for any signs of leakage, cracks and far advanced corrosion.

See 7.1 for possible hose repairs.

6.4.2 Level 1 - Hose Core Tube Inspection With a Borescope

A suitable video scope equipment is required to inspect the hose core tube and the inside surface of the fittings. Inspect the cleaned hose core tube for color change, cracks, blisters or erosion. Hoses that have been exposed to pressurized gases should be inspected thoroughly to determine, if the integrity of the liner has been breached or the liner has collapsed. If bulges, blisters, punctures or any other damage of the core tube is detected, the hose shall be removed from service and be replaced.

Some Parker Polyflex hoses have a special feature of ColorGard™ core tube. With black inside layer and yellow outside one, damage to core tube becomes visible.

If the hose core tube is damaged to the extent that yellow layer is exposed, hose shall be removed from service.

6.4.3 Level 1 - Hydrostatic Pressure Test

See 6.3.1 for details.

PFDE-ES28, Rev. U: Handling, Maintenance, Inspection, Repair

Black Eagle Hose Assemblies

6.5 Level 2 - Inspection/Recertification by a Parker Certified Facility

To be able to perform "Level 2" inspections and re-certifications of Black Eagle hose assemblies, dedicated equipment, personnel and expertise is required. Parker Polyflex have trained and certified specialized facilities and their personnel to assemble, inspect, test, repair and recertify hose assemblies. Their equipment includes:

- Inspection equipment (i.e. videoscopic camera)
- Manufacturing equipment (i.e. a suitable crimper with enough crimping force, die sets, gauges)
- High volume filling pumps for preparing pressure tests
- Testing equipment/ pressure test unit with the possibility to record pressure test graphs
- Safe testing chamber

Hose management is an essential part of the service they provide.

If necessary, the Black Eagle hose assemblies shall be decommissioned from the installation and returned to Parker Polyflex or a certified facility.

Level 2 inspections shall be conducted, if possible, during a regular equipment shutdown.

After completion of Level 2 inspection, customer will receive detailed report of the findings, including recommended actions:

- Repair (see 8.1)
- Recertification (see 8.2)
- Scrapping

6.5.1 Customer Pre-dispatch procedure before returning a hose assembly for Level 2 Inspection

- The object is to make sure the hose assembly can be safely handled and the condition of the assembly will justify the transportation and inspection costs.
- The chosen inspection facility should be contacted if doubtful about any of the points below.
- Check and record assembly serial number (send information to test facility).
- Assembly must be free of chemical residues inside and outside. (could result in refusal to handle returned assembly)
- Report on any findings out of section 6.3.1
- Method of transport, size and weight. (Long length hose assemblies on drums or reels may require special handling equipment such as drums and re-spooling machinery).
- Customer will receive a budget price for inspection based on the information given by the end user.

6.5.2 Level 2 - Recommended Inspection Amount

- Safety inspection, condition of assembly as received.
  - Check for chemical residue inside and outside (may require flushing or cleaning).
  - Assembly serial number (check assembly history including previous repairs).
- External inspection
- Internal inspection
- Inspection report

6.5.3 Level 2 -External Inspection

- Damage to the outer cover (abrasion, incorrect routing)
- Exposed reinforcing wires. (damaged outer cover)
- Kinked, crushed, or twisted hose. (high tensile loading, incorrect routing)
- Reduction in the outside diameter of the hose (high tensile loading with no pressure)
- Blistered, soft, degraded, or loose outer cover. (chemical attack, leaking fitting, permeation or high temperature)
- Cracked, damaged, or badly corroded fittings (chemical attack, poor handling, old hose assembly)
- Damage or wear on fitting threads (poor handling, old hose assembly)
- Condition of containment grips / clamps. (abrasion, frayed wires, distortion)

PFDE-ES28, Rev. U: Handling, Maintenance, Inspection, Repair

Black Eagle Hose Assemblies

6.5.4 Level 2 - Internal Inspection

Internal inspection will be done with a borescope.

- Check for damage to bore of fittings, cracks, severe abrasion and corrosion.
- Check for damages, bulges, cracks and blisters of core tube at the back of fittings (critical area).
- Scope maximum length of the core tube possible. Recommended minimum is 10 m both sides.
- Hose assemblies shorter than 20 m should be scoped on the complete length.
- Look for uneven surface (sign of wire fatigue, abrasion, chemical attack).

6.5.5 Level 2 - Inspection Report

The testing facility will advise on the overall condition of the hose and end connections.

Customer will receive detailed report of the findings, including recommended actions:

- Repair (see 7.1)
- Recertification (see 7.2)
- Scrapping

7 Procedure for Repair and Recertification

7.1 Repair

It is recommended, that all repairs are done by certified specialized testing facilities. Some repairs (see examples in following pages) could be done in field. Be sure to maintain safety requirements.

7.1.1 Twisted Hose, Hose with the Reduced O.D., Flattened Hose

A hose with signs of twisting or deformation will need to be unreeled, as straight as possible, from the winch/drum in a safe environment and pressurized to working pressure for at least 1 hour and then pressure released. The hose shall be re-inspected to see if the hose has returned to its "untwisted, undistorted" original shape. If so, the hose should be again pressurized before rewinding back onto the winch/drum. Any sections of hose still misshapen should be cut out of the assembly.

7.1.2 Hose with Cover Damage

- No reinforcement wires exposed.

Temporary solution, the damaged area can be cleaned and protected by wrapping with a strong adhesive "duct / riggers" tape. If abraded to the point where the red ColorGard is visible, the damaged area should be thoroughly cleaned with mild solvent, a thin plastic sheet wrapped around the hose to form a mould. A two pack polyurethane mixture can then be poured into the mould and allowed to set. Remove mould after the polyurethane is set. Also, a repair procedure according to Appendix 3 might be applied.

- Reinforcement wires exposed.

It is strongly recommended to remove the hose assembly from service immediately. Any ingress of water into hose carcass will initiate corrosion of the reinforcement wire. It is difficult to estimate the rate of corrosion. At best, the hose could function for months, at worst, possibly less than one week. It is also possible that the core tube could have collapsed if the external pressure acting within the carcass is greater than internal pressure within the hose.

In any case, the lifetime of the hose assembly will be significantly reduced, and the hose assembly shall be immediately scheduled for inspection at certified specialized testing facility.

Decision to further use a hose assembly with exposed wire shall be based on a proof pressure test for 1.1× maximum working pressure of the hose assembly. This test shall be conducted prior to every further job.

Repair of such a hose assembly is possible, but it will include cutting out the section of the hose, where the wires have been subjected to water. Obviously, this will require new fittings to be crimped and hose assembly to be proof pressure tested. Procedure for proof pressure testing in this case is specified in the assembly instructions for the appropriate hose type.

After successfully passing pressure test, hose assembly shall be permanently marked with the new recertification date (see 7.2).

The testing facility will recommend if the condition of the hose warrants the cost of assembling new fittings, joining the lengths together and proof testing.

PFDE-ES28, Rev. U: Handling, Maintenance, Inspection, Repair

Black Eagle Hose Assemblies

7 Procedure for Repair and Recertification (cont.)

7.1.3 Fitting Re-ending

In case of fitting damage or hose damage near fitting (usually due to kinking) it is allowed to cut off the fitting and replace it by a new one. This can be done by Parker certified facilities only and will require pressure test at 1.5 x maximum working pressure of hose assembly. Recommended testing time = 15 minutes.

7.2 Recertification

Recertification shall include Level 2 inspection acc. to section 6.5.2 and a hydrostatic pressure test.

Unless otherwise agreed between customer and test facility, test conditions are:

- Test pressure = 1.5× maximum working pressure of hose assembly. Allow for at least 30 minutes stabilization time before starting recording pressure decay.
- Pressure hold time = 1 hour
- Pressure decrease of maximum 5% is allowed.

To avoid hose damage due to excessive pressurizations, it is recommended to limit the number of pressure tests to 1.5 x maximum working pressure to 20 for the lifetime of the hose assembly. This may include pressure testing during recertification as well as pressure testing after fitting re-ending.

After successfully passing pressure test, hose assembly shall be permanently marked with the word RECERT plus the consecutive number of recertification. i.e. "RECERT-3" and recertification date.

It is recommended to keep the number of recertifications limited to 10 times.

8 Parker Certified Distributors/ Service Addresses

The below listed companies have been certified by Parker Polyflex to manufacture, inspect and re-certify Black Eagle hose assemblies:

- Abdex Industries WA, 49A Sustainable Avenue, Bibra Lake, WA 6163, Australia, +61 89418 3044
- Beattie Industrial Ltd., Div. of Newfoundland Offshore, 1345 Topsail Road, PO Box 8398, A1B 3N7Paradise, NF, Canada, +1 (709) 782-2623
- Flexiflo Corp., PO Box 18532, Jebel Ali Free Zone, Dubai, United Arab Emirates, +971 4 8838131
- Fluid Control Service AS, Ljosheimsvegen 1, 4050 Sola, Norway, +47 51 64 49 50
- Active Service AS, Sjøkrigsskoleveien 15, 5165 Laksevåg, Norway, +47 55 94 22 50
- Hydrafit AS, Bleivassvegen 30F, 5347 Ågotnes, Norway, +47 56 12 67 00
- *Hydrasun Group Ltd., Gateway Business Park, Moss Road, Aberdeen AB12 3GQ, United Kingdom, +44 1224 618618 (24 Hrs.)
- Mento AS, PO.Box 44, Kontinentalveien 22, 4098 Tananger, Norway, +47 51 64 86 00
- Norwesco Industries (1983) Ltd., 6908L - 6th Street S.E., Calgary AB, T2H 2K4, Canada, +1 403 258 3883
- *Parker Hannifin Manufacturing Germany GmbH & Co. KG - FLUID CONNECTORS GROUP - POLYMER HOSE
- DIVISION EUROPE - An der Tuchbleiche 4 - 68623 Lampertheim, Germany, + 49 (0) 6256 81-0
- Parker Hannifin Corporation, Parflex Division, 11151 Cash Road, Stafford, TX 77477, USA, +1 281 566 450

Note: * only these facilities are currently certified to re-end 3" Black Eagle hoses. Level 2 inspection, pressure testing and recertification of all sizes can be done by all above listed facilities.

PFDE-ES28, Rev. U: Handling, Maintenance, Inspection, Repair

Appendix 1: Chemical Resistance Chart

The below chart contains chemical resistance information for Polyamide 11 (Nylon 11), Fluoropolymer and Proprietary Material used on Nautilus 20 hose. These are the most common core tube materials used for Parker Polyflex oil & gas hoses.

Please refer to the technical datasheets for more detailed information.

Rating Codes

Abbreviation	Status	Description
E	Excellent	Good to excellent. Little or no swelling, tensile or surface change. Preferred choice.
A	Good	Good to excellent. Little or no swelling, tensile or surface change. Limitations with temperature and type of fluid.
B	Limited	Marginal or conditional. Noticeable effects but not necessary indicating lack of serviceability. Further testing is suggested for specific application. Very long-term effects.
X	Unsatisfactory	Poor or unsatisfactory. Not recommended without extensive and realistic testing.
-		Indicates that this was not tested.
*	Swelling	Increase of volume of material, due to absorption of a solvent.

Material Code for Hose Core Tubes

Abbreviation	Material
N	Polyamide
M	Co-extruded tube with fluoropolymer inner liner
POM	Polyoxymethylene

Notes on the Chemical Resistance Table

- The chemical resistance table is a simpified rating tabulation based on immersion tests. Higher temperatures tend to reduce ratings. Since final selection depends on pressure, fluid, ambient temperature and many other factors not known to Parker Hannifin, no performance guarantee is expressed or implied.
- The indications do not imply any compliance with standards and regulations and do not refer to possible changes of color, taste or smell.
- Some hose applications must take into account legal and insurance regulations. The chemical resistance indicated does not express or imply approval by certain institutions.
- Chemical resistance does not imply low permeation rates. For gas applications, refer to Gas Permeability of Plastics (pg. A-8). Note that hoses with coextruded core tube with fluoropolymer inner liner are not recommended for gas applications.
- For fluids, not listed or for advice on particular applications, please contact Parker Hannifin, Polyflex Division in Lampertheim, Germany.

Appendix 1: Chemical Resistance Chart for Black Eagle Hose

Chemical	Concentration	N				M	P		
		20°C (68°F)	40°C (104°F)	60°C (140°F)	90°C (194°F)	100°C (212°F)	23°C (73°F)	100°C (212°F)	150°C (302°F)
Acetaldehyde		A	B	X	X	A	A	A	—
Acetic Acid	5%	A	A	A	B	E	A	A	—
	10%	A	A	B	X	E	A	A	—
	50%	B	X	X	X	E	A	A(75°C)	—
Acetic Anhydride		B	X	X	X	E	—	—	—
Acetone	Pure	A	A	B	X	A	A	A	—
Acetylene		A	A	A	—	A	A	A	—
Air		A	A	A	A	A	A	A	A
Aluminium Sulfate	Saturated Solution	A	A	A	A	A	A	—	—
Ammonia	Liquid or Gas	A	A	A	X	A	A	A	A
Ammonium Chloride		A	A	A	—	A	A	A	—
Ammonium Hydroxide	Concentrated	A	A	A	A	A	A	A(80°C)	—
Ammonium Nitrate		A	A	A	A	A	A	A	—
Ammonium Sulfate	Saturated Solution	A	A	B	—	E	A	—	—
Amyl Acetate		A	A	A	B	A	A	A	—
Aniline		B*	X	X	X	E	A	B	—
Asphalt		A	A	A	A	A	A	—	—
Barium Chloride	Saturated Solution	A	A	A	A	A	A	—	—
Benzaldehyde		A	B	X	X	E	A	A(60°C)	—
Benzene		A	A*	B	X	E	A	A	—
Benzyl Alcohol		B	X	X	X	E	A	A(80°C)	—
Bleach		B	X	X	X	E	A	A	—
Bromine		X	X	X	X	B	X	X	X
Butane		A	A	A	A	A	A	—	—
Butyl Alcohol (Butanol)		A*	B	X	X	E	A	A	—
Calcium Arsenate		A	A	A	—	A	—	—	—
Calcium Bromide		A	A	A	B	—	—	—	—
Calcium Chloride	Saturated Solution	A	A	A	A	A	A	A	—
Calcium Nitrate		A	A	A	—	A	A	—	—
Camphor		A	—	—	—	A	A	—	—
Carbonated Water		A	A	A	A	A	—	—	—
Carbon Dioxide		A	A	A	A	A	A	—	—
Carbon Disulfide		A*	B*	B	X	A	A	A	—
Carbon Monoxide		A	A	A	A	A	A	A	A
Carbon Tetrachloride		X	X	X	X	A	A	A	—
Cement Slurries		A	A	A	—	A	—	—	—
Chlorinated Solvents		B	X	X	X	E	A	A/B	—
Chlorine		X	X	X	X	E	X	X	X
Chloroform		B	X	X	X	E	A	A	—
Chromic Acid		X	X	X	X	E	A	B(80°C)	—
Citric Acid	Saturated Solution	A	A	B	X	E	A	A	—
Copper Sulfate		A	A	A	A	A	A	A	—
Crude Oil		A	A	A	B	A	A	—	—
Cyclohexane		A	A	A	B	A	A	A	—
Cyclohaxanol		A	B	X	X	E	A	A	—
Cyclohexanone		A	B	X	X	E	A	A	—
Decalin		A	A	A	B	A	A	—	—
Diacetone Alcohol		A	A	B	X	E	—	—	—
Diammonium Phosphate		A	A	B	—	E	—	—	—
Dichloroethylene		B	X	X	X	E	—	—	—
Diesel		A	A	A	A	A	A	A	—
Diester Oils		A	A	A	B	A	—	—	—
Diethanolamine	20%	A	A*	A*	B	A	—	—	—
Diethyl Ether		A	—	—	—	E	A	A	—
Dioctyl Phosphate		A	A	A	B	—	—	—	—
Dioctyl Phthalate		A	A	A	B	A	A	—	—

PFDE-ES28, Rev. U: Handling, Maintenance, Inspection, Repair

Appendix 1: Chemical Resistance Chart

Chemical	Concentration	N				M	P		
		20°C (68°F)	40°C (104°F)	60°C (140°F)	90°C (194°F)	100°C (212°F)	23°C (73°F)	100°C (212°F)	150°C (302°F)
Ethanol	Pure	A*	B	B	X	E	A	A	—
Ethyl Acetate		A	A	A	—	A	A	A(50°C)	—
Ethylene Chlorhydrin		X	X	X	X	E	A	—	—
Ethylene Oxide		A	A	X	X	E	A	A(50°C)	—
Fatty Acid Esters		A	A	A	A	A	—	—	—
Fluorine		X	X	X	X	X	X	X	X
Formaldehyde	Technical	A	B	X	X	E	A	A	—
Formic Acid	10%	X	X	X	X	E	B	B	—
Freon		A	—	—	—	A	A	—	—
Furfuryl Alcohol		A	A*	B	X	E	A	A	—
Gas (Coal)		A	A	—	—	A	A	—	—
Gasoline (High Octane)		A	A	A*	—	A	A	A	—
Glucose		A	A	A	A	A	A	—	—
Glycerine	Pure	A	A	B	X	E	A	A	—
Heptane		A	A	A*	—	A	A	A	—
Hexane		A	A	A	A	A	A	A(60°C)	—
Hydraulic Fluid (petroleum base)		A	A	A	A	A	A	A	—
Hydraulic Fluid (phosphate ester base)		A	A	A	B	A	A	—	—
Hydraulic Fluid (water base)		A	A	A	A	A	—	—	—
Hydrochloric Acid	15%	A	B	X	X	E	A	A	—
	28%	X	X	X	X	E	A	A	—
	37%	X	X	X	X	A	A	—	—
Hydrofloric Acid	3%	A	B	X	X	E	B	—	—
Hydrogen		A	A	A	A	A	A	—	—
Hydrogen Peroxide	20%	A	B	—	—	E	A	A	—
Iron Trichloride	Saturated Solution	A	A	A	—	A	A	B	—
Isocyanates		B	X	X	X	E	—	—	—
Isooctane		A	A	A	A	A	A	—	—
Isopropyl Alcohol		A	B	X	X	E	A	A	—
Kerosene		A	A	A*	B	A	A	A(85°C)	—
Lactic Acid		A	A	A	B	E	A	A	—
LP Gas		A	A	A	A	E	—	—	—
Magnesium Chloride	50%	A	A	A	A	A	A	A	—
Mercury		A	A	A	A	A	A	A	—
Methane		A	A	A	A	E	A	A	A
Methanol	Pure	A	B	B*	X	E	A	A	—
Methyl Acetate		A	A	A	—	A	A	—	—
Methyl Bromide		A	X	X	X	E	A	—	—
Methyl-Cellosolve		A	A	A	X	A	—	—	—
Methyl Chloride		A	X	X	X	E	A	—	—
Methylene Chloride		X	X	X	X	A	A	—	—
Methyl Ethyl Ketone (MEK)		A	A	B	X	—	A	A(80°C)	X(200°C)
Methyl Isobutyl Ketone		A	A	B	X	E	A	—	—
Methyl Sulfate		A	B	—	—	E	—	—	—
Monochlorobenzene		B	X	X	X	A	A	A(75°C)	—
Monoethylene Glycol (MEG) Ethane-1, 2-diol		A	A	A*	X	E	A	A	B(200°C)
Naphta		A	A	A	—	A	A	A	—
Naphthalene		A	A	A	B	A	A	A	—
Natural Gas		A	A	A	A	E	A	—	—
Nitric Acid		X	X	X	X	A	X	X	X
Nitrobenzene		B	X	X	X	A	A	B(80°C)	—
Nitrogen Gas		A	A	A	A	E	A	—	—
Oils Refined		A	A	A	B	A	A	A	—

PFDE-ES28, Rev. U: Handling, Maintenance, Inspection, Repair

Appendix 1: Chemical Resistance Chart for Black Eagle Hose

Chemical	Concentration	N				M	P		
		20°C (68°F)	40°C (104°F)	60°C (140°F)	90°C (194°F)	100°C (212°F)	23°C (73°F)	100°C (212°F)	150°C (302°F)
Oleic Acid		A	A	A	B	A	A	A	—
Oxalic Acid		A	A	B	X	E	A	A	—
Oxygen Gas		A	A	B	X	A	A	—	—
Ozone		B	X	X	X	E	A	B	—
Perchloric Acid		B	X	X	X	B	A	A	—
Perchloroethylene		B	X	X	X	E	A	A	—
Petroleum Ether		X	X	X	X	E	A	A(80°C)	—
Phenols		A	A	A	B	E	B	X	X
Phosphoric Acid	50%	A	B	X	X	E	A	A	A
Picric Acid		B	X	X	X	E	A	A	—
Potassium Carbonate		A	A	B	X	E	A	—	—
Potassium Chloride		A	A	B	X	E	A	A	—
Potassium Hydroxide	50%	A	B	X	X	E	A	A(80°C)	—
Potassium Nitrate		A*	B*	X	X	E	A	A	—
Potassium Permanganate	5%	X	X	X	X	E	A	A(60°C)	—
Potassium Sulfate		A	A	A	A	A	A	A	—
Propane		A	A	A	A	A	A	—	—
Propylene Glycol		A	B	X	X	A	A	—	—
Pyridine	Pure	B	X	X	X	E	A	A(80°C)	—
Sea Water		A	A	A	A	A	A	A	—
Sodium Borate		A	A	A	—	A	A	—	—
Sodium Carbonate	Saturated Solution	A	A	B	X	E	A	A(80°C)	—
Sodium Chloride	Saturated Solution	A	A	A	A	A	A	A	—
Sodium Hydroxide	50%	A	B	X	X	E	A	A	A
Sodium Hypochlorite	Concentrated	B	X	X	X	E	A	—	—
	Dilute Commercial	A	B	X	X	E	A	A	—
Sodium Sulfide		A	A	B	—	E	A	A	—
Stearic Acid		A	A	A	B	A	A	—	—
Stearin		A	B	B	—	E	—	—	—
Styrene Monomer		A	A*	—	—	E	A	—	—
Sulphur Dioxide		B	X	X	X	A	A	A	A
Sulphur Hexafluoride Gas		A	A	A	A	A	A	—	—
Sulphuric Acid	1%	A	B	B	X	A	A	—	—
	10%	A	B	X	X	A	A	B(80°C)	—
Sulphuric Anhydride		B	X	X	X	E	A	—	—
Tartaric Acid		A	A	A	B	A	A	A	—
Tetrahydrofuran (THF)		A	A	B	X	E	A	B	—
Toluene		A	A*	B	B	E	A	A	—
Tributyl Phosphate		A	A	A	B	A	A	—	—
Trichloroethane		B	X	X	X	E	A	A(75°C)	—
Trichloroethylene		B	X	X	X	E	A	A(80°C)	—
Tricresyl Phosphate		A	A	A	B	A	B	—	—
Triphenyl Phosphate		A	A	B	—	A	—	—	—
Trisodium Phosphate		A	A	A	A	A	—	—	—
Turpentine		A	A	B	—	A	A	—	—
Urea		A	A	B	B	E	A	A	—
Uric Acid		A	A	A	B	A	A	—	—
Water		A	A	A	A	A	A	A	—
Water Glycols e.g. Oceanic HW fluids a)Transaqua HT/HT2 b)Brayco Micronic SV fluids a) registered trademark of MacDermid Group b) registered trademark of Castrol		A	A	A	B	A	A	A	—
Xylene		A	A*	B	B	E	A	B/X	—
Zinc Bromide		A	A	A	—	—	—	—	—
Zinc Chloride		A	A	B	X	E	A	A(80°C)	—

PFDE-ES28, Rev. U: Handling, Maintenance, Inspection, Repair

Appendix 2: Data for Tensile Loading and Weights of Black Eagle Hoses

Note that all below values of tensile forces include the own weight of the hoses.

The values below have been established based on lab testing (tensile test followed by impulse testing) of short hose assemblies. At the tensile forces stated below the hoses will not elongate more than 30% at the area of highest load (topside). Pressurized hose can take higher tensile load, it will elongate less.

2448N-32V80	Pressure (bar)	0	100	300 and above
	Max. tensile force (kN)	30	50	100
2580N-32V80	Pressure (bar)	0	100	300 and above
	Max. tensile force (kN)	30	50	100
2648N-32V80	Pressure (bar)	0	100	300 and above
	Max. tensile force (kN)	30	50	100
2240N-48V80	Pressure (bar)	0	100 and above	
	Max. tensile force (kN)	30	50	
2440N-48V80	Pressure (bar)	0	100	300 and above
	Max. tensile force (kN)	600	100	200
2640N-48V80	Pressure (bar)	0	100	300 and above
	Max. tensile force (kN)	60	100	200

The table below shows examples.

Hose Part No.	Hose I.D.		Hose O.D.		Hose Weight			
					In Air		In Water	
					Empty	Full of Water	Empty	Full of Water
	inch	mm	inch	mm	(kg/m)	kg/m)	kg/m)	(kg/m)
2448N-32V80	2	50.5	3.16	80.5	8.5	10.5	3.3	5.3
2580N-32V80	2	50.5	3.32	84.5	9.4	11.5	3.7	5.7
2648N-32V80	2	50.5	3.32	84.5	12.1	14.1	6.2	8.1
2240N-48V80	3	75.0	4.48	114.0	11.5	16.0	1.1	5.6
2440N-48V80	3	75.0	4.80	122.0	18.7	23.2	6.7	11.3

1st Example: No pressure. 1000 m length of 2580N-32V80 shall be deployed. Hose weight in water, full of water, 5,7 kg/m × 1000 m = 5700 kg. Maximum tensile force is 30 kN, therefore a 1000 m length is too heavy to deploy in these conditions.

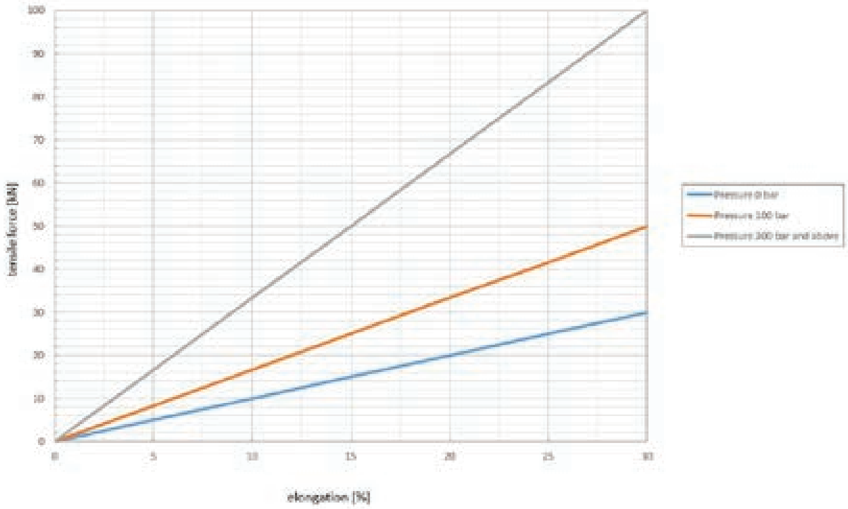
2nd Example: Pressure 300 bar. 1500 m length of 2580N-32V80 shall be deployed. Hose weight in water, full of water, 5,7 kg/m × 850 m = 8550 kg. Maximum tensile force is 100 kN, so a 1500 m length of 2580N-32V80 is okay to deploy when pressurized at 300 bar, and an additional weight of 10000-8550=1450 kg may be added.

The following maximum tensile force over elongation plots indicate which maximum elongation will locally occur at a specific maximum tensile force is 20 kN, so a 300 m length of 2240N-48V80 is OK to deploy when pressurized at 100 bar, and an additional weight of 2000-1680 = 320 kg may be added.

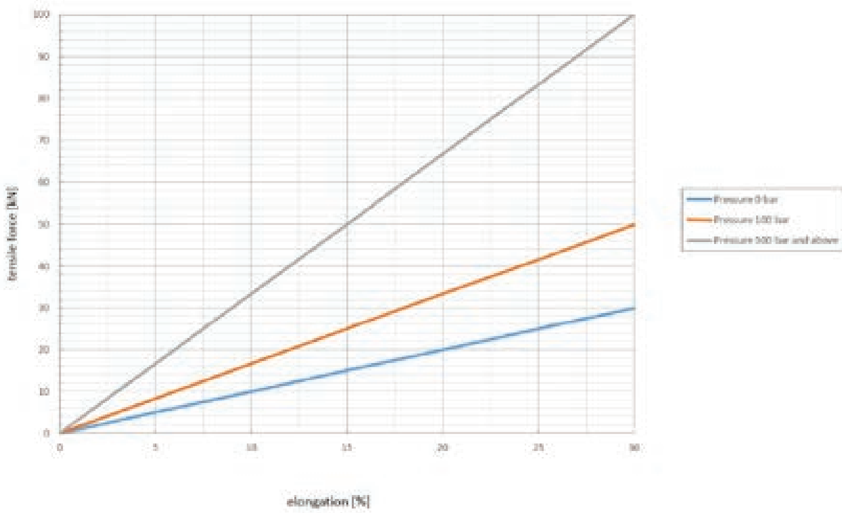
PFDE-ES28, Rev. U: Handling, Maintenance, Inspection, Repair

Appendix 2: Data for Tensile Loading and Weights of Polyflex Hoses

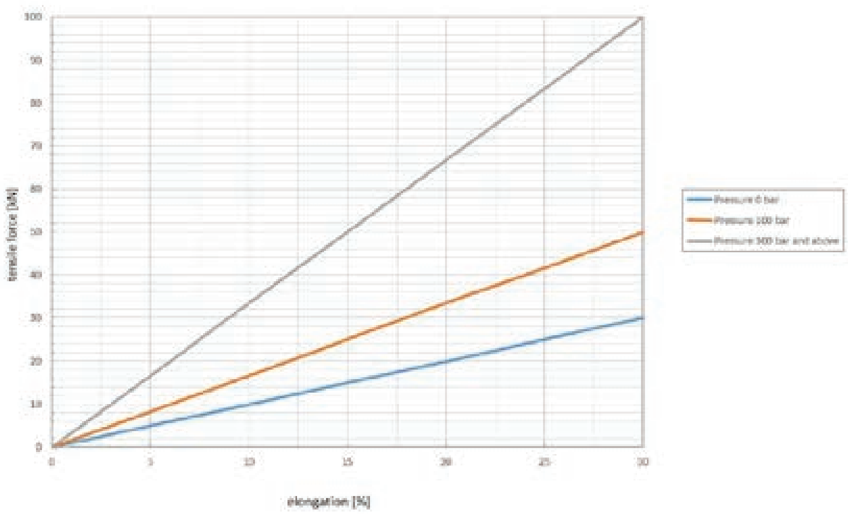
2448N-32V80



2580N-32V80

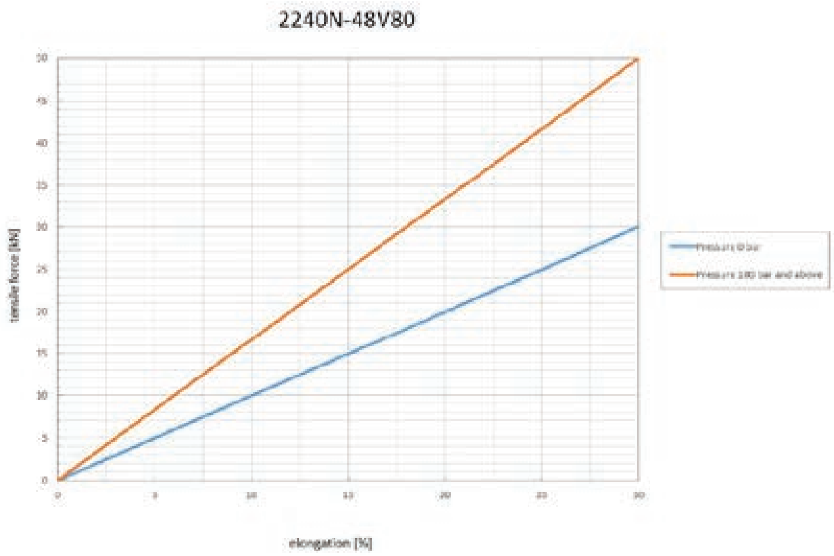


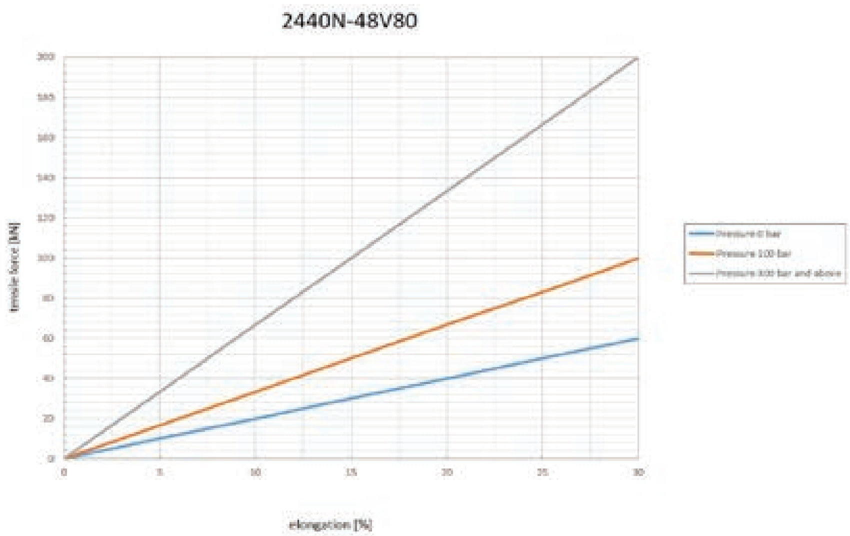
2648N-32V80

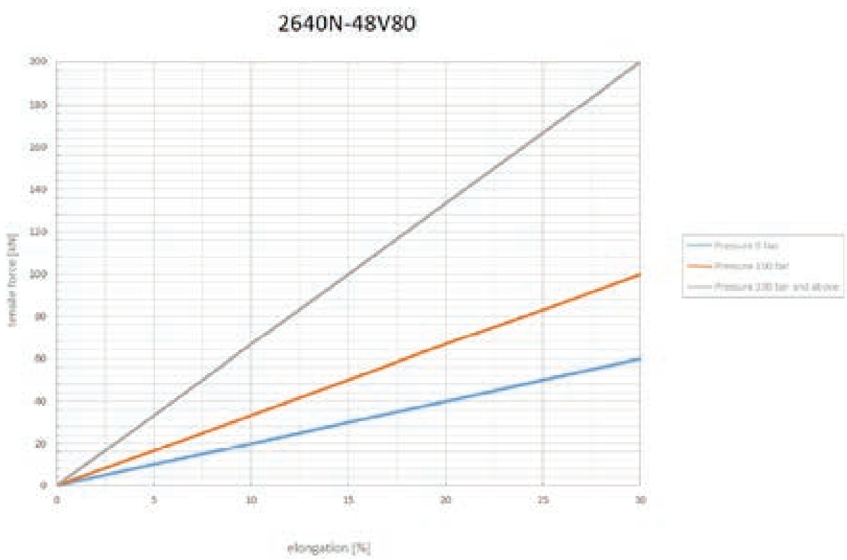


PFDE-ES28, Rev. U: Handling, Maintenance, Inspection, Repair

Appendix 2: Data for Tensile Loading and Weights of Polyflex Hoses







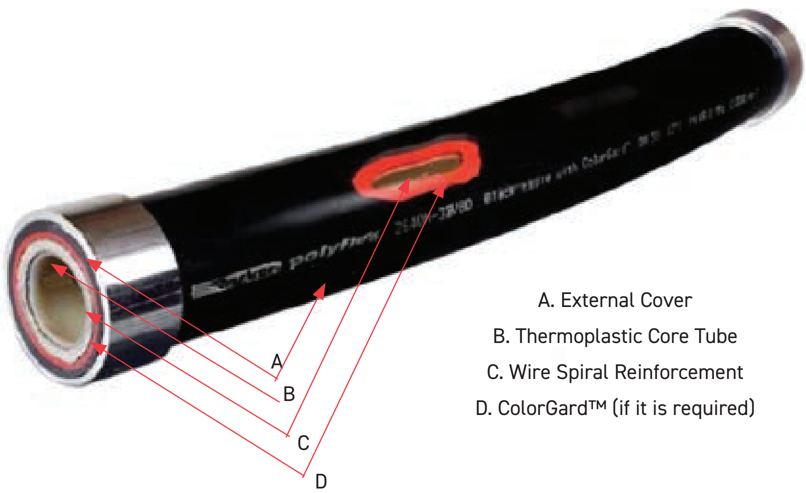
PFDE-ES28, Rev. U: Handling, Maintenance, Inspection, Repair

Appendix 3: Procedure for a repair of a local damage in the outer cover

1 Purpose

This engineering standard provides a recommended practice for repair of local outer cover damage on a Polyflex large bore hose. This instruction is valid for sizes 1-1/2" (DN 38) up to size 3" (DN 75) with ColorGard.

Polyflex large bore hoses are being increasingly used subsea, deployed as single line hoses. These hoses are therefore protected by a dual color outer cover, the extra thick ColorGard sheath (see picture):



2 Important Safety Notices

Before repairing a Polyflex hose, carefully read and fully understand the below instructions. Refer to section 7.2.1 to determine whether the repair is allowed.

Follow your local safety regulations and ensure that operators are equipped with appropriate protection. The repair of Polyflex hoses requires a safe use of a hot-air gun.

Incorrect handling may significantly reduce the lifetime of the hose and could cause dramatic failures.

PFDE-ES28, Rev. U: Handling, Maintenance, Inspection, Repair

Appendix 3: Procedure for a repair of a local damage in the outer cover

3 Preparation

Recommended equipment and materials:

- Original Polyflex thermoplastic filling material to enable a permanent and proper compound to the original outer cover of the hose
- Industrial hot-air gun (must be able to achieve min. 1200°F/650°C temperature) with a small and removable front nozzle to locally melt the filling material and the damaged area of the outer cover. A spoon, knife or a putty knife to locally press/ fill the melted material into the damaged area
- Enough cold water to cool down the heated hose immediately
- Grinding tool and sand paper (grain 60 80) to smoothen the repaired spot
- Optional: Anti splatter spray/ silicone spray for final polish after the finished repair

4 Repair Procedure

4. 1

Clean the defective spot with a lint-free cloth or with compressed air.

Do not use any cleaning detergent!

For the repair, the area must be dry and free of dirt and dust.

4. 2

Melt the damaged area with the hot-air gun at approx. 1112°F/600°C locally. Immediately when the material is melting, use a spoon or putty knife to press the melted material into the damaged area.

Cool the heated area immediately with cold water.

PFDE-ES28, Rev. U: Handling, Maintenance, Inspection, Repair

Appendix 3: Procedure for a repair of a local damage in the outer cover

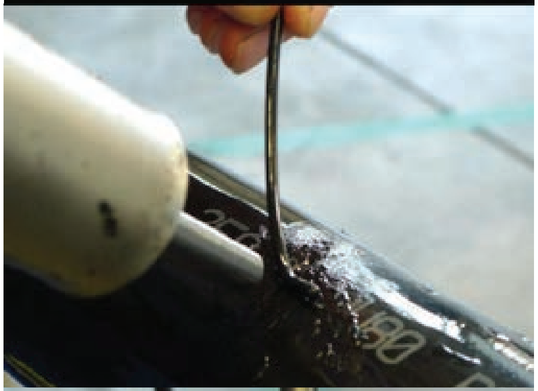
4 Repair Procedure (cont.)

4. 3

Visually check the melted area for any holes or remaining gaps.

4. 4

Fill open gaps with melted filling material.

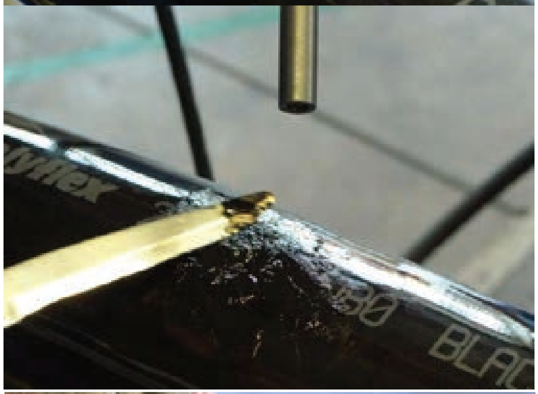


4. 5

Spackle the melted material into the gaps by using a putty knife or similar. Make sure that enough melted material is used for the repair.

ATTENTION:
DO NOT OVERHEAT THE HOSE

STOP HEATING IMMEDIATLY AFTER MATERIAL IS STARTING TO MELT!



4. 6

Cool down the area with cold water in order to avoid any heat damages of the hose.

PFDE-ES28, Rev. U: Handling, Maintenance, Inspection, Repair

Appendix 3: Procedure for a repair of a local damage in the outer cover

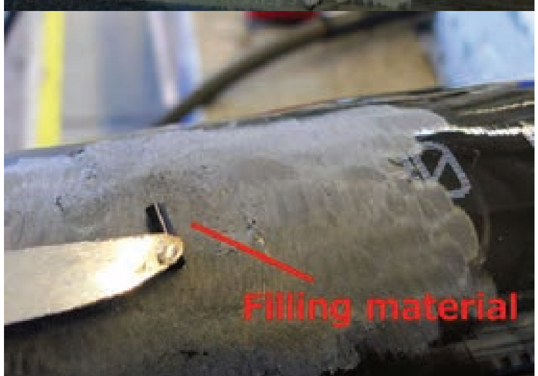
4 Repair Procedure (cont.)

4. 7

Remove excessive filling material by using a grinding tool. The grain of the tool / grinding paper should be approx. 60 - 80

4. 8

By grinding the repaired area, unfilled gaps might become visible. These gaps shall be filled by following step 4.4 to 4.7



PFDE-ES28, Rev. U: Handling, Maintenance, Inspection, Repair

Appendix 3: Procedure for a repair of a local damage in the outer cover

4 Repair Procedure (cont.)

4. 9

Remove excessive melted filling material with a grinding tool (see 4.7).

4.10

Final grinding by hand with sand paper (Grain = 60 - 80)

4.11

Final finish by locally heating up the repaired area.

ATTENTION:
DO NOT OVERHEAT THE HOSE

STOP HEATING IMMEDIATLY AFTER MATERIAL IS STARTING TO MELT!

Cool down immediately with cold water to avoid any overheating.

PFDE-ES28, Rev. U: Handling, Maintenance, Inspection, Repair

Appendix 3: Procedure for a repair of a local damage in the outer cover

4 Repair Procedure (cont.)

4. 12

Polish repaired outer cover by using Silicone spray or similar. (optional)

Appendix 4: Recommendations for use of Parker Polyflex Black Eagle hoses with gas and sour gas.

4. 1 Use of Black Eagle Hoses with Gas

Please refer to Hose Intro "Chemical compatibility table" (pg. A-108) for chemical compatibility of core tube materials with gases. However, good chemical compatibility is not the only parameter to consider for gas use. The other key parameter is permeability. Permeation could lead to different potential failure modes. One is hose cover blistering and another is core tube collapse due to rapid gas decompression and/or gas trapped under pressure between hose layers.

Permeability is defined as the ability of a substance to allow another substance to pass through it. For a circular tube, it is calculated per the below formula:

Permeability Coefficient

$$V = PW * A * T * P/S$$

V volume of gas, in cm^3, which diffuses through a 1mm thickness

PW permeability coefficient, $cm^3*mm/m^2*day*bar$, see table below

A is the area across which the gas diffuses, in m^2

S thickness of tube, in mm

T diffusion time, in days

p pressure difference across the plastic, in bar

Recommended Frequencies of Inspection

PW values for various gases, $cm^3*mm/m^2*d*bar$	N2	Air	O2	CO2	H2	He	CH4
PA11, methanol washed	5	7	21	60	130		6
PA12	9	13	43	105	900	500	14
POM	2	4	4	20	80		

- These guidance values are taken from literature. They are based on room temperature.
- Higher temperatures significantly increase permeation rates.
- Actual behavior may vary considerably because of variations in processing.

The below simplified estimation formula is a result of recalculations based on the typical core tube thickness and area of Polyflex hoses.

V=K PW*P

V volume of gas, in cm^3, which diffuses through a 1mm thickness

K recalculation coefficient for area and thickness, see next table

PW permeability coefficient, $cm^3*mm/m^2*day*bar$, see next table

P pressure difference across the tube, in bar K coefficients for hose sizes

PFDE-ES28, Rev. U: Handling, Maintenance, Inspection, Repair

Appendix 4: Recommendations for use of Parker Polyflex Black Eagle hoses with gas and sour gas.

4. 1 Use of Black Eagle Hoses with Gas (cont.)

Permeability Coefficient (cont.)

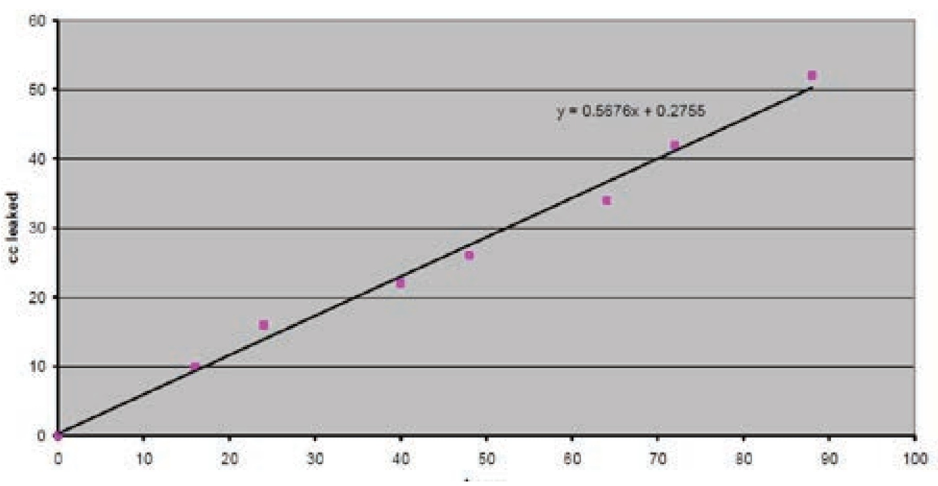
Permeation									
-04	-05	-06	-08	-12	-16	-20	-24	-32	48
0.017	0.019	0.02	0.027	0.035	0.040	0.044	0.048	0.053	0.048

Example: how much CH4 would permeate through core tube of a 2" hose at 10000 psi.

V=0.053*6*690=219.42 cm³ per core tube meter per day

As previously mentioned, all the calculated values can be used for estimation only Permeation coefficients are just literature values for lab conditions, permeation through hose cover is not considered

As an example, permeation of CH4 at 1 meter has been measured at 170 bar and ambient temperature and the result is represented on the below graph. The above calculation would result in a value of V=0,053*6*170=54,06 cm³ per core tube meter per day, which would mean 2,25 cm³ per hour, and only approx. 0,57 cm³ per hour have been measured.



Note that in all previous discussions gas which permeates through the core tube was mentioned. Obviously,there is one more barrier hose cover. If cover is pin-pricked, gas will easily go through it and no issues will occur. But pin-pricking is not acceptable for subsea service as the reinforcement wires will corrode. In addition,collapse resistance of hose would be compromised. For land based operations, all Parker Polyflex hoses may be pin-pricked.

Pin-pricking is not required on hoses with Colorgard. Performance of those hoses with gas has been confirmed by several tests. Test summary is provided below.

Without pin-pricking, gas will also have to permeate though the hose cover. The formula for calculation is the same as for core tube, only other permeability coefficients shall be used. Parker hoses are designed in the way that cover material has higher permeability coefficient compared to core tube, so more gas can permeate though the cover. In addition, area of permeation is larger. Thick cover is rigid enough to withstand any possible pressure build up in the hose annulus without building blisters.

PFDE-ES28, Rev. U: Handling, Maintenance, Inspection, Repair

Appendix 4: Recommendations for use of Parker Polyflex Black Eagle hoses with gas and sour gas.

4. 1 Use of Black Eagle Hoses with Gas (cont.)

Permeability Coefficient (cont.)

Hose Type	Test Description	Test Gas	Test Pressure and Temperature	Test Results
2640N-24V80	Pre-conditioning of hose: 24 hours soak in methanol at room temperature and atmospheric pressure. Pressurize with test gas mixture for 12 hours. Decompress at 20 bar/min. Leave for 1 hour. Repeat this pressure cycle two more times.	Gas mixture 97/3 CH_4/ CO_2	740 bar (10730 psi) at 25°C / 77°F	No signs of blistering or slitting and no decompression damage have been found on hose core tube at a magnification of X20.
2640N-24V80	Pressurize with test gas at 345 bar for 24 hours. Decompress at 70 bar/min. Leave for at least 12 hours. Repeat this pressure cycle two more times.	N_2	345 bar (5000 psi) at ambient temperature	No signs of blistering or slitting and no decompression damage have been found on hose cover at a magnification of X20.
2640N-32V80 2580N-32V80	Pressurize with test gas at 690 bar for 30 days and slowly decompress (decompression rate not noted). Pressure test with water 20 times at 1035 bar for 60 sec. Pressure test with water at 1035 bar for 1 hour. Pressurize with test gas at 690 bar for 47 days and slowly decompress (decompression rate not noted). Pressure test with water 20 times at 1035 bar for 60 sec. Pressure test with water at 1035 bar for 1 hour. Perform burst test.	Gas mixture 97/3/2 CH_4/CO_2/ H_2S water added to adjust system pH to 3.5- 3.8	690 bar (10000 psi) at 25°C / 77°F	No deterioration on cover have been found. After all testing, hose passed minimum burst press.
2440N-32V80 2448N-32V80	Pressurize with Nitrogen at 170 bar for 7 days. Then pressurize with Methane at 170 bar for 45 days.	N_2 and CH_4	170 bar (2465 psi) at ambient temperature	No leakages at connections and no ballooning of the cover. The bore inspection at about 910 hours revealed that the core tube was perfectly smooth and circular. Hose expands by about 0.6 to 0.8 mm upon inflation to 175 bar, but there is no creep in diameter thereafter. After decompression at the end of testing, it took around 6 hours to return to its original outside diameter.

The situation changes, however, if the hose is in subsea service. With external pressure applied, pressure difference across the cover becomes the limiting factor.

Gas permeating through core tube could stay in the hose annulus between core tube and cover and some pressure will build up there. Due to undefined volume of hose annulus of Polyflex hoses (this is related to hose design and manufacturing), it is not possible to calculate this pressure. And in case of quick hose depressurization this built-up pressure could lead to core tube collapse.

With a hose deployed down from a vessel, the situation becomes even more complicated. External pressure varies over the hose length. Lower part of the hose may have no gas permeation through cover, all gas which has passed through the core tube is creeping up through annulus and starts leaving the hose at the pressure balance point. In this case gas permeates through core tube on the whole length of hose but it permeates through cover only on the part length. Obviously, the volume of gas which needs to locally penetrate through cover is higher. This could lead to blisters on the cover. Quick retrieving of hose (which means external pressure change) could lead to the same phenomenon.

Parker Polyflex Black Eagle hoses have been used in gas applications for many years. Based on the lab testing and field experience, multiple number of parameters shall be considered. Therefore, design factor of min. 4:1 should be applied (max. operating pressure should not exceed 25% of minimum burst pressure of the hose). This is also required by ISO 7751. If possible, guards of hose whip restrictors shall be used. Please also refer to Parker Safety Guide 4400-B.1. (pg E-3)

PFDE-ES28, Rev. U: Handling, Maintenance, Inspection, Repair

Appendix 4: Recommendations for use of Parker Polyflex Black Eagle hoses with gas and sour gas.

4. 2 Use of Parker Polyflex hoses with sour gas.

Core tube of most of Parker Polyflex Black Eagle hoses is made from Polyamide 11. This material is perfectly resistant to Hydrogen sulfide. Only aqueous solutions which are acidic can lead to an acceleration of polymer degradation. Due to the low acidity and generally low partial pressures of Hydrogen sulfide in crude oil or natural gas this effect can be neglected.

Reinforcement wires are made of very high strength steel. Processing of these wires results in very small grain sizes which reduce the susceptibility of the material to cracking that can be caused by H2S. In addition, contact of wires with H2S is limited to the amount of gas which has permeated through the core tube. This amount is also very low due to low partial pressures. In addition, testing has been conducted: totally 77 days of exposure to 2% of wet H2S at 690 bar (resulting in partial pressure of 13,8 bar (200 psi)) and subsequent burst pressure test and SEM analysis of wires. Minimum burst pressure was achieved and in all the wire samples examined, there was no evidence of microcracks or intergranular fracture, nor was there any evidence of embrittlement.

More attention shall be put to hose fittings. They are in direct contact to fluids and can be subjected to H2S. Some limitations and requirements are listed in ISO 15156 parts 1 to 3 (former NACE MR0175). The usual question "are the fittings NACE compliant?" cannot always be answered with yes or no.

The original and subsequent editions of NACE Standard MR0175/ISO 15156 established limits of H2S partial pressure above which precautions against sulfide stress cracking (SSC) were always considered necessary. They also provided guidance for the selection and specification of SSC-resistant materials when the H2S thresholds were exceeded. In more recent editions, NACE MR0175 has also provided application limits for some corrosion resistant alloys, in terms of environmental composition and pH, temperature and H2S partial pressures.

In addition, requirements for different equipment may be also different.

The two important statements out of **NACE MR01175**/ISO 15156 shall be considered.

The behavior of metallic materials in H2S-containing environments is affected by complex interactions of parameters, including the following:

a) chemical composition, method of manufacture, product form, strength, hardness of the material and its local variations, amount of cold work, heat-treatment condition, microstructure, microstructural uniformity, grain size and cleanliness of the material;

b) H2S partial pressure or equivalent concentration in the water phase;

c) chloride ion concentration in the water phase;

d) acidity (pH) of the water phase;

e) presence of sulfur or other oxidants;

f) exposure to non-production fluids;

g) exposure temperature;

h) total tensile stress (applied plus residual);

i) exposure time.

Core tube of most of Parker Polyflex Black Eagle hoses is made from Polyamide 11. This material is perfectly resistant to Hydrogen sulfide. Only aqueous solutions which are acidic can lead to an acceleration of polymer degradation. Due to the low acidity and generally low partial pressures of Hydrogen sulfide in crude oil or natural gas this effect can be neglected.

WARNING — CRAs (corrosion-resistant alloys) and other alloys selected using ISO 15156 are resistant to cracking in defined H2S-containing environments in oil and gas production, but not necessarily immune to cracking under all service conditions. *It is the equipment users responsibility to select the CRAs and other alloys suitable for the intended service.* Below there is the list of Parker Polyflex hose fittings for some Black Eagle hoses and the information about use with H2S based on ISO 15156 requirements Hose fittings are not explicitly listed in ISO 15156.

Note that several fitting types with various materials may exist for the same hose.

PFDE-ES28, Rev. U: Handling, Maintenance, Inspection, Repair

Appendix 4: Recommendations for use of Parker Polyflex Black Eagle hoses with gas and sour gas.

4. 2 Use of Parker Polyflex hoses with sour gas. (cont.)

Hose Type	Fitting Series	Nipple Material	Shell Material	Maximum Temperature		Maximum Partial Pressure (pH2S)		Remarks
				°C	°F	kPa	psi	
2440N-20V80	1xxLX-	Duplex 2205	316 or 316Ti	232	450	10	1.5	Any combination of chloride concentration and in situ pH occurring in production environments is acceptable. If chloride concentration is less than 50 mg/l, no restrictions on pH2S and pH are set.
2640N-24V80	1xx5X-	Duplex 2205	Duplex 2205	232	450	10	1.5	Any combination of chloride concentration and in situ pH occurring in production environments is acceptable. If chloride concentration is less than 50 mg/l, no restrictions on pH2S and pH are set.
	6xx5X-	4340 Q&T	316 or 316Ti	-	-	0.3	0.05	Normally, no special precautions are required for the selection of steels for use under these conditions, nevertheless, highly susceptible steels can crack.
2640N-24V80	6xx5X-	Nitronic 50 (S20910)	316 or 316Ti	66	150	100	15	Any combination of chloride concentration and in situ pH occurring in production environments is acceptable.
2240N-32V10 2248N-32V10	1xxS6-	4340 Q&T	316 or 316Ti	-	-	0.3	0.05	Normally, no special precautions are required for the selection of steels for use under these conditions, nevertheless, highly susceptible steels can crack.
2449N-32V10	1xxS8-	4340 Q&T	316 or 316Ti	-	-	0.3	0.05	Normally, no special precautions are required for the selection of steels for use under these conditions, nevertheless, highly susceptible steels can crack.
2448N-32V80 2580N-32V80	1xxBL-	4340 Q&T	316 or 316Ti	-	-	0.3	0.05	Normally, no special precautions are required for the selection of steels for use under these conditions, nevertheless, highly susceptible steels can crack.
		Super Duplex S32750 or S32760	316 or 316Ti	-	-	10 to 20	1.5* to 3	Any combination of chloride concentration and in situ pH occurring in production environments is acceptable. If chloride concentration is less than 50 mg/l, no restrictions on pH2S and pH are set. * depending on chemical composition of individual material batch
	6xx5X-	4340 Q&T	316 or 316Ti	-	-	0.3	0.05	Normally, no special precautions are required for the selection of steels for use under these conditions, nevertheless, highly susceptible steels can crack.
		Nitronic 50 (S20910)	316 or 316Ti	66	150	100	15	Any combination of chloride concentration and in situ pH occurring in production environments is acceptable.
2648N-32V80	1xxCX-	4340 Q&T	316 or 316Ti	-	-	0.3	0.05	Normally, no special precautions are required for the selection of steels for use under these conditions, nevertheless, highly susceptible steels can crack.
		Inconel 718 (N07718)	316 or 316Ti	135	275	-	-	Any combination of hydrogen sulfide, chloride concentration, and in situ pH in production environments is acceptable.

*fittings out of this material has been manufactured till April 2021, they are still in field and some stock is available. Contact Parker for clarification if required.

PFDE-ES28, Rev. U: Handling, Maintenance, Inspection, Repair

Appendix 4: Recommendations for use of Parker Polyflex Black Eagle hoses with gas and sour gas.

4. 2 Use of Parker Polyflex hoses with sour gas. (cont.)

Hose Type	Fitting Series	Nipple Material	Shell Material	Maximum Temperature		Maximum Partial Pressure (pH_2S)		Remarks
				°C	°F	kPa	psi	
2240N-48V80 2440N-48V80 2640N-48V80	1XXTX- 1XXLX- 1XX5X-	4340 Q&T*	316 or 316Ti	-	-	0.3	0.05	Normally, no special precautions are required for the selection of steels for use under these conditions, nevertheless, highly susceptible steels can crack.
	1XXTX- 1XXLX- 1XX5X-	4140 Q&T, max. HRC22	316 or 316Ti	-	-	-	-	Normally, no special precautions are required.
2440N-48V80	1XXLX-	Inconel 625 (N06625)	316 or 316Ti	-	-	-	-	These materials have been used without restriction on temperature, pH2S, chloride concentration, or in situ pH in production environments. No limits on individual parameters are set, but some combinations of the values of these parameters might not be acceptable.

*fittings out of this material has been manufactured till April 2021, they are still in field and some stock is available. Contact Parker for clarification if required.