Fittings, Materials and Tubing Guide

Instrumentation Products

aerospace
climate control
electromechanical
filtration
fluid & gas handling
hydraulics
pneumatics
process control
sealing & shielding

ENGINEERING YOUR SUCCESS.

Contents

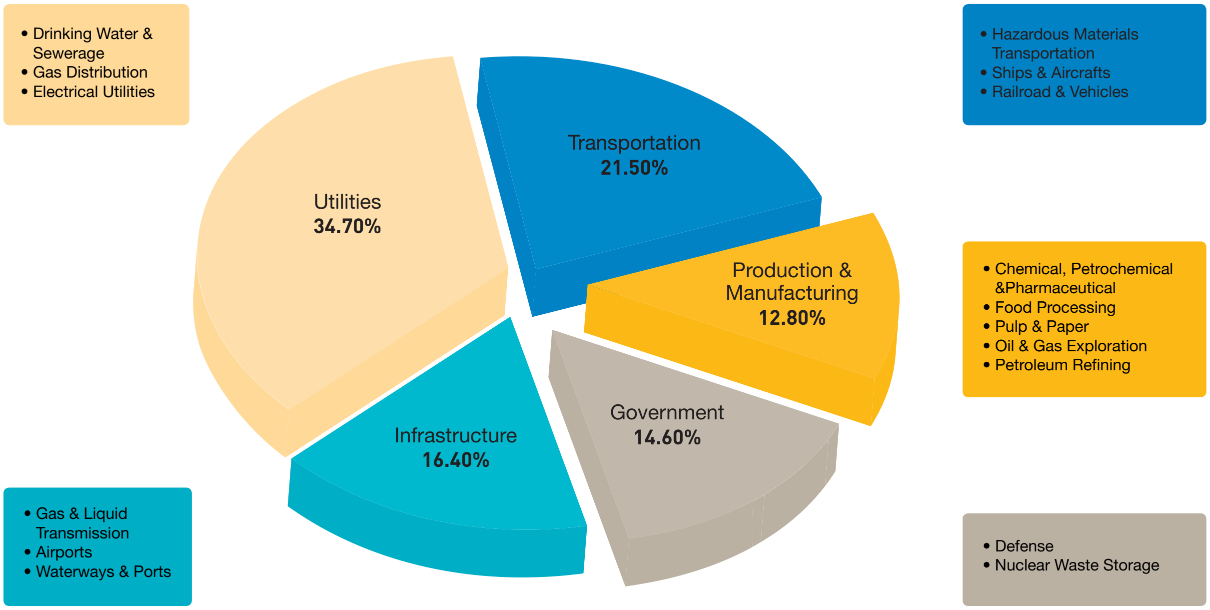
For the customers & markets that we serve, Corrosion represents the difference between trouble-free operation and costly downtime.

What is Corrosion?
According to NACE, Corrosion is the deterioration of a substance, usually a metal, or its properties because of a reaction with its environment.

The Problem of Corrosion
Direct and indirect economic losses derived from corrosion include the following:

- Replacement of damaged equipment
- Overdesign to allow for corrosion
- Preventive maintenance
- Shutdown due to corrosion failure
- Loss or contamination of the product being produced (i.e. food industry)
- Efficiency decrease. For example, corrosion products lower the heat transfer rate in heat exchangers
- Failure of adjacent equipment
- Health and safety. Loss of natural resources, pollution or even human lives.

Cost of Corrosion
According to a nationwide report conducted in the USA, the cost of corrosion accounted for a total of $276 billion per year. The specific industrial sectors and associated cost were broken down as follows:



Using the right materials and processes can help to beat corrosion problems throughout the industries we serve.

Uniform Corrosion
Uniform or general corrosion is the most classical form of corrosion, but is not always the most important in terms of cost or safety.

The consequences of uniform corrosion are a decrease in metal thickness per unit time or a more or less uniform deposit of these corrosion products in the surface of the metal.

Uniform corrosion can be limited or prevented by an appropriate choice of material or modification of the medium among other solutions.

Galvanic Corrosion
Galvanic corrosion can be defined simply as being the effect resulting from the contact between two different materials in a conducting corrosive environment.

In many cases, galvanic corrosion may result in quick deterioration of the least corrosion resistant material, and can lead to fatal failure.

Common methods of minimising and preventing galvanic corrosion are choosing material combinations in which the constituents are all made from the same material or different materials as close as possible in the corresponding galvanic series, avoiding an unfavourable surface area ratio, using protective coatings, or controlling the aggressiveness of the environment.

> **LESSON:** Do not mix tube and fitting or valve alloys wherever possible.

Galvanic reaction created by mixing different body & nut materials.

Crevice Corrosion
Crevice corrosion is an electrochemical oxidation-reduction process, which occurs within localized volumes of stagnant solution trapped in pockets, corners or beneath a shield (seal, deposit of sand, gasket or fastener, for instance).

Crevice corrosion is highly accelerated if chlorine, sulphide or bromide ions are present in the electrolyte solution. Once a crevice is initiated, even the most benign atmospheric environments can become extremely aggressive. Crevice corrosion is considered much more dangerous than uniform corrosion as the corrosion rate can be up to 100 times higher.

Crevice corrosion is encountered particularly in alloys which owe their resistance to the stability of a passive film. A classic example is stainless steel in the presence of moderate to high concentrations of chlorine ions.

Crevice corrosion can be limited or prevented by using welds rather than bolted or riveted joints, designing installations with a proper draining system and avoiding stagnant areas, using solid and high quality seals or controlling the severity of the electrolyte.

Crevice corrosion between the tube/tube trap interface.

Pitting Corrosion
Pitting is characterised by the localised attack in the form of deep and narrow holes that can penetrate inwards extremely rapidly, while the rest of the surface remains intact. A component can be perforated in a few days with no appreciable loss in weight on the structure as a whole.

Pitting corrosion is most aggressive in solutions containing chloride, bromide or hypochlorite ions. The presence of sulphides and H_2S is also detrimental to this type of attack. The stainless steels are particularly sensitive to pitting corrosion in seawater environments.

Pitting corrosion can be reduced or prevented by choosing the most appropriate material for the service conditions, avoiding stagnant zones and deposits, reducing the aggressiveness of the medium or using cathodic protection.

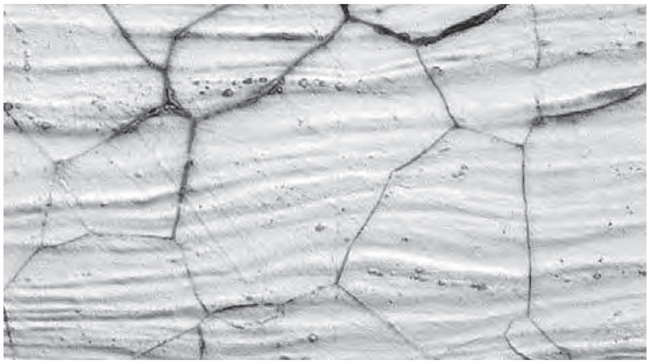
> **LESSON:** Every batch of Parker 6Mo steel is tested for Pitting Corrosion as per the ASTM G48 standard.

Intergranular Corrosion
Intergranular corrosion is a form of attack that progresses preferentially along the grain boundaries paths and can cause the catastrophic failure of the equipment, especially in the presence of tensile stress. Under certain conditions, the grain boundaries can undergo marked localized attack while the rest of the material remains unaffected. The alloy disintegrates and loses its mechanical properties. This type of corrosion is due either to the presence of impurities in the boundaries, or to local enrichment or depletion of one or more alloying elements.

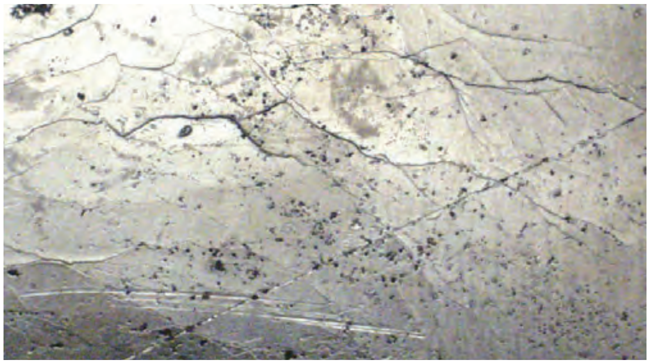
Many alloys can suffer from intergranular attack, but the most common example is the intergranular corrosion of austenitic stainless steels, related to chromium carbide depletion in the vicinity of the boundaries, during a "sensitising" heat treatment or thermal cycle.

Intergranular corrosion can be prevented by selecting the right material, avoiding low cost equipment where the material is likely to have impurities and poor heat treatment, using low carbon or stabilised grades if welding or applying post-weld heat treatments correctly.

> LESSON: Our stainless steel is capable of passing the intergranular corrosion test as per the ASTM A262 Practice.



Intergranular Corrosion – HAZ Area – Stainless Steel Weld in Seawater Environment

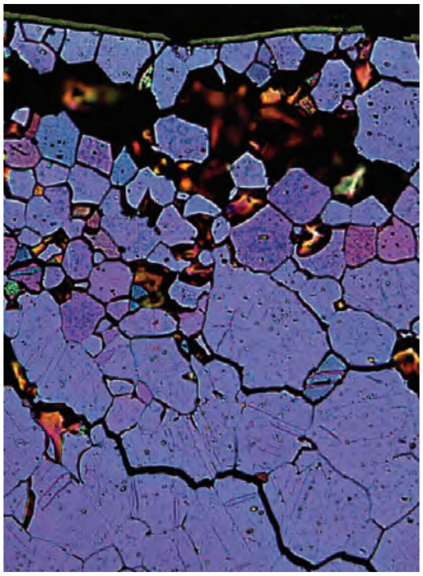


Stress Corrosion Cracking Stainless Steel in Seawater Environment

Stress Corrosion Cracking
Stress corrosion cracking (SCC) is a process involving the initiation of cracks and their propagation, possibly up to complete failure of a component, due to the combined action of tensile mechanical loading and a corrosive medium. The time necessary for a part to fail by SCC can vary from a few minutes to several years.

This kind of attack normally occurs in media that are little or non-aggressive towards the metal or alloy concerned in the absence of tensile loading. This form of corrosion is of a paramount importance and represents a permanent risk in numerous industrial installations, in terms of both the safety and economic consequences involved. No commercial alloy is fully immune to SCC.

Stress corrosion can be avoided by selecting materials that are not susceptible in the specific corrosion environment and minimised by stress relieving or annealing after fabrication and welding, avoiding surface machining stresses and controlling the corrosive environment.



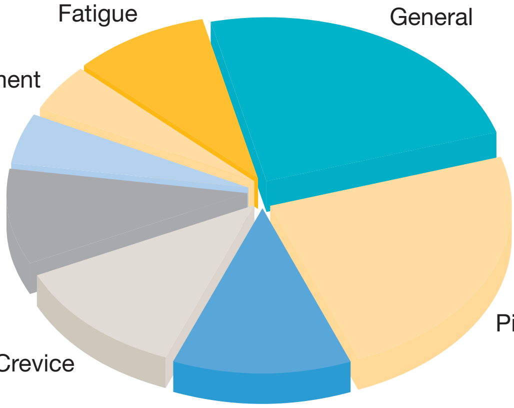
> LESSON: Do not take shortcuts. Select the best material for a safer & more cost effective application.

The Facts

Some of the most popular factors that can have a significant influence in terms of corrosion are listed below:

- **Materials Selection:**
  - Environment
  - Mechanical Properties
  - Availability of Design &
  - Test Data
  - Cost
  - Availability
  - Maintainability
  - Compatibility with other components
  - Reliability
  - Appearance
- **Process Parameters:**
  - Media Chemistry
  - Temperature
  - Velocity
  - Pressure
- **Construction Parameters:**
  - Drainage, Welding, etc.
- **Dissimilar Metals**
- **Crevices**
- **Corrosion Allowance**
- **Operating Lifetime**
- **Maintenance & Inspection Requirements**

Some Figures About Corrosion
The industrial importance of localized corrosion problems has been revealed in many reports. The following pie chart summarizes the findings of 363 corrosion failure cases investigated in a major chemical processing company. The importance of pitting comes second, just after general corrosion and before stress corrosion cracking which is often also initiated by pitting.



Sour Gas Service and NACE MR0175

Hydrogen sulphide (H2S) is a colourless, flammable, and extremely hazardous gas. It occurs naturally in crude petroleum, natural gas, and hot springs. In addition, hydrogen sulphide is produced by bacterial breakdown of organic materials and human and animal wastes (for instance, sewage systems). Industrial activities that can produce the gas include petroleum/natural gas drilling and refining, wastewater treatment, coke ovens, tanneries, and paper mills. Hydrogen sulphide can also exist as a liquid compressed gas.

When dissolved in water, H2S forms a weak acid which is extremely corrosive, especially in the case of steel where the corrosion products of iron, sulphide and atomic hydrogen can penetrate the steel and embrittle it. Under the influence of applied stresses, cracking can develop in a very short time and result in failure of the equipment and potential human and environmental loss. This type of failure is known as sulphide stress corrosion cracking (SSCC) and there are many cases in history that account for this type of failure.

NACE MR 0175/ISO 15156 is a Materials Standard issued by the National Association of Corrosion Engineers. It aims to assess the suitability of materials for oilfield equipment where sulphide stress corrosion cracking may be a risk in hydrogen sulphide (sour) environments. This 3-part document gives requirements and recommendations for the selection and qualification of carbon and low-alloy steels, corrosion-resistant alloys, and other alloys for service in equipment used in oil and natural gas production and natural gas treatment plants in H2S-containing environments, whose failure could pose a risk to the health and safety of the public and personnel or to the environment. It can be applied to help to avoid costly corrosion damage to the equipment itself.

Parker Instrumentation can offer all the range of materials compliant to the metallurgical requirements of NACE MR0175 in selected ranges. For more information, please contact us.

The Solution

Corrosion control does not just happen. It must be planned.
We can help you find the best solution for your application.

As the worldwide search for oil and gas, power generation or chemical production is turning to more challenging applications an increasing number of situations are being encountered where corrosive production environments and products are present. Many of these cases often involve significant amounts of hydrogen sulphide, carbon dioxide, brine or hazardous chemicals among others, where their high corrosivity along with the wrong decisions made during the design stage have often lead to fatal failure and invaluable human, environmental and economic loss. In most cases, these situations could have been avoided by properly analysing the specific operating parameters and designing the most suitable equipment.

In addition, other factors such high pressures and temperatures or severe environments are on demand. Requirements for higher production rates or more complex processes along with climate change and new environmental regulations can complicate the material selection process and ultimately the performance and integrity of the application. Under these circumstances materials can offer a valid and cost effective alternative to conventional methods of corrosion control.

The material selection process can sometimes become complex, usually involving multiple factors like high strength requirements, operating temperature, high corrosion resistance, availability and cost.

Material Compatibility

The most important consideration in the selection of suitable tubing for any application is the compatibility of the tubing material with the media to be contained.

Consideration should also be given to the maximum and minimum operating temperatures for the different tubing materials.

Due to thermal expansion characteristics and chemical stability, Parker instrument fittings are designed to work on like materials.

The practice of mixing materials is strongly discouraged.
In general, dissimilar materials in contact may be susceptible to galvanic corrosion.

Further, different materials have different levels of hardness, and can adversely affect a successful seal on the tubing.

Materials Range for Corrosion Control

Our experienced credentials in materials selection are the results of years of expertise in successful applications worldwide.

Materials Range
Parker offers the most extensive range of alloys in the market. The range varies from conventional steels to high nickel alloys and titanium for the most demanding applications. The table below depicts the standard range of materials per product family. Other alloys might be offered on request.

	A-LOK® Fittings	MPI™ Fittings	CPI™ Fittings	Phastite® Fittings	Valves	Manifolds	Flanged Products
Brass	Yes	No	Yes	No	Yes	No	No
Carbon Steel	No	No	Yes	No	Yes	No	Yes
Stainless Steel 316/316L	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Duplex Steel	No	No	No	No	Yes	Yes	Yes
Superduplex Steel	No	No	No	No	No	Yes	Yes
Super austenitic 6Mo	Yes	No	Yes	No	Yes	Yes	Yes
Monel 400	Yes	No	Yes	No	Yes	Yes	Yes
Alloy 825	Yes	No	No	No	Yes	Yes	Yes
Alloy 625	Yes	No	No	No	Yes	Yes	Yes
Alloy C-276	Yes	No	Yes	No	Yes	Yes	Yes
Titanium	Yes	No	Yes	No	Yes	Yes	Yes

Parameters To Be Considered in the Materials Selection Process

The main parameters to be considered when selecting any equipment are:

- Operating conditions, including temperature, pressure and media contained
- Environment
- Legislation and Internal Regulations
- Cost
- Availability
- Lead time
- Expected life time of the equipment
- Safety

In terms of materials, the selection criteria normally translate into some of the following parameters:

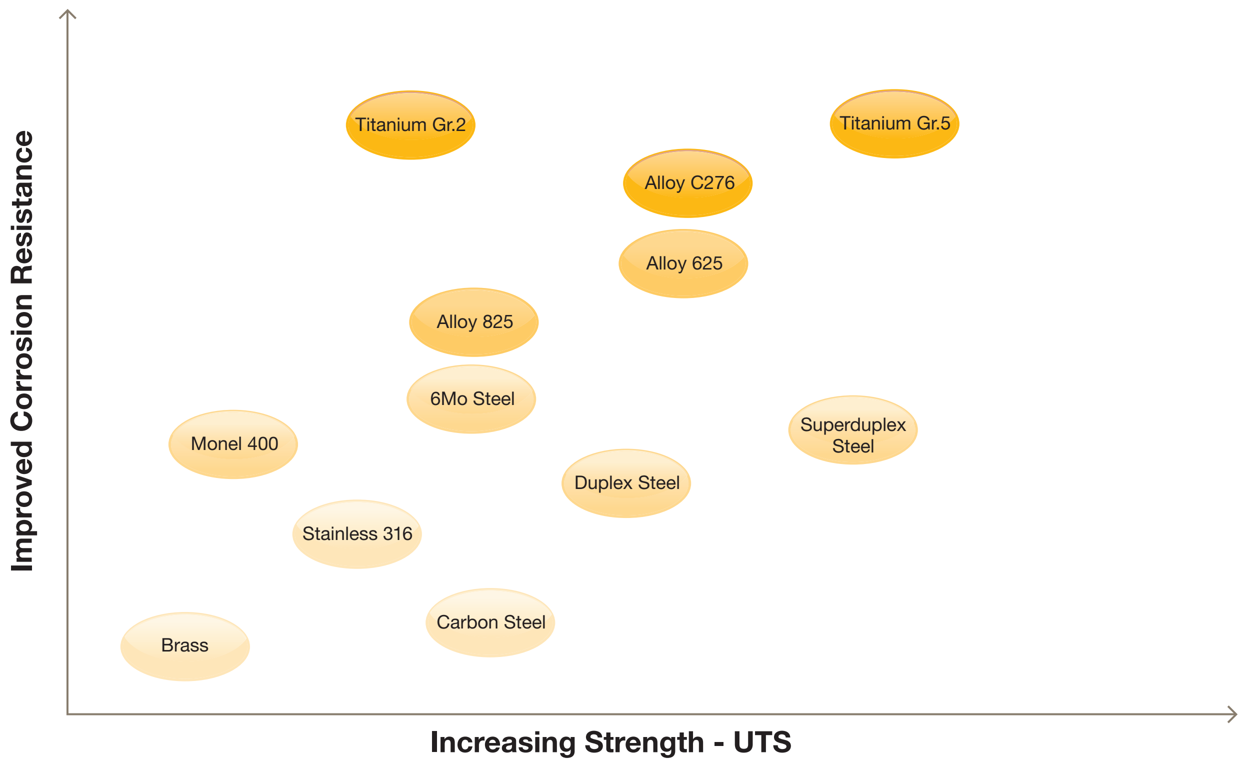
- Mechanical properties
- Corrosion resistance to media and environment
- Temperature operating range
- Cost
- Availability on request

Although the mechanism of corrosion is highly complex the actual control of the majority of corrosion reactions can be effected by the application of relatively simple concepts. Indeed, the Committee on Corrosion and Protection concluded that 'better dissemination of existing knowledge' was the most important single factor that would be fundamental in decreasing the enormous cost of corrosion in the UK.*

* Report of the Committee on Corrosion and Protection, Department of Trade and Industry, H.M.S.O. (1971)

Materials Quick Selection Guide for General Industrial Applications

The following table classifies our materials range in terms of mechanical strength and general corrosion resistance, and aims to be a generic tool and guidance at an early stage of the design. The values given to the specific parameters are not absolute and should be used as a reference only. Each application needs to be evaluated carefully and individually as the rules below might not apply at all times.



* For instrumentation applications

Cost Considerations

Think of the equipment replacement cost, depreciation, re-qualification of the new systems, downtime or low production rates, fines or human and environmental loss. Avoid low cost equipment. Investing in a more expensive material today could be a cheaper and trouble-free solution in the medium and long term.

Parker Hannifin carried out Stress Corrosion Cracking Testing as per ASTM G36 conducted by an independent party and its aim was to determine the time to failure of the 6Mo super austenitic steel (UNS S31254) and the conventional 316/L stainless steel (UNS S31600/03) in exactly the same conditions. Results showed that the 6Mo grade took over 3 times more to fail than the 316 grade.

In service applications, those results translate into a life expectancy of 6Mo three times longer than that of 316 in the same given conditions, **reducing leakage and downtime and increasing safety by over 60%.**

Example of a typical installation and associated life cycle cost:

		Materials Selection A: Stainless Steel 316	Materials Selection B: Superaustenitic 6Mo
Initial Installation	8,000 meters of 1/2" x 0.065" tubing	$7/m	$23/m
	1,500 Fittings 1/2" x straight shapes	$15/unit	$40/unit
	Design Parameter	5 Years Life	15 Years Life
After 5 Years	Tubing & Fitting Replacement**	Tube: $7/m Fitting: $15/unit	$0
	MHR Labour Cost	40 MHR per 300 meters	$0
		$80 labour/hour	$0
After 10 Years	Tubing & Fitting Replacement**	Tube: $7/ft Fitting: $15/unit	$0
	MHR Labour Cost	40 MHR per 300 meters	$0
		$80 labour/hour	$0
TOTAL		$406,380	$244,000

** Figures exclude material cost increase

40% cheaper

Check List of Design Parameters

Here are some basic guidelines based on our extensive knowledge and experience in applications worldwide:

- Think about cost effectiveness, safety and reliability
- A cheap option today usually translates into high cost of ownership tomorrow
- Do not mix tube and fitting/ valve alloys whenever Possible
- Use 6Mo for high pitting/ crevice corrosion performance
- Use Super Duplex for its tensile strength
- Use our range of exotic materials for demanding applications and NACE compliance

Let us help you select the best solution for your application. Start thinking **smarter, faster, cleaner** and **safer.**

For a successful and prolonged corrosion-free service, make sure the following parameters are checked during the design stage:

✓	Operating conditions, including temperature, pressure and media contained
✓	Environment
✓	Legislation and Internal Regulations
✓	Cost
✓	Availability
✓	Lead time
✓	Expected life time of the equipment
✓	Safety

Specify Parker Grade Tube

In any instrumentation application, one of the first steps to ensuring safety and reliability is to select the right tubing for your process.

Parker's instrument tube fittings have been designed to work in a wide variety of applications that demand the utmost in product performance.

Although Parker's Instrument tube fittings have been engineered and manufactured to consistently provide this level of reliability, no systems integrity is complete without considering the critical link, **tubing.**

Whilst it is the responsibility of the system designer/user to ensure the correct specification of materials and tube to ensure system integrity, this brochure is intended as a guide to assist the designer in properly selecting and ordering quality tubing and details the compatibility of selected tubing with Parker fittings.

Proper tube selection and installation, we believe, are key ingredients in building leak-free reliable tubing systems.

The following parameters should be considered when designing a leak-free system and ordering tubing for use with Parker tube fittings:

- Tubing Hardness
- Tubing Wall Thickness
- Tubing Surface Finish
- Material Compatibility

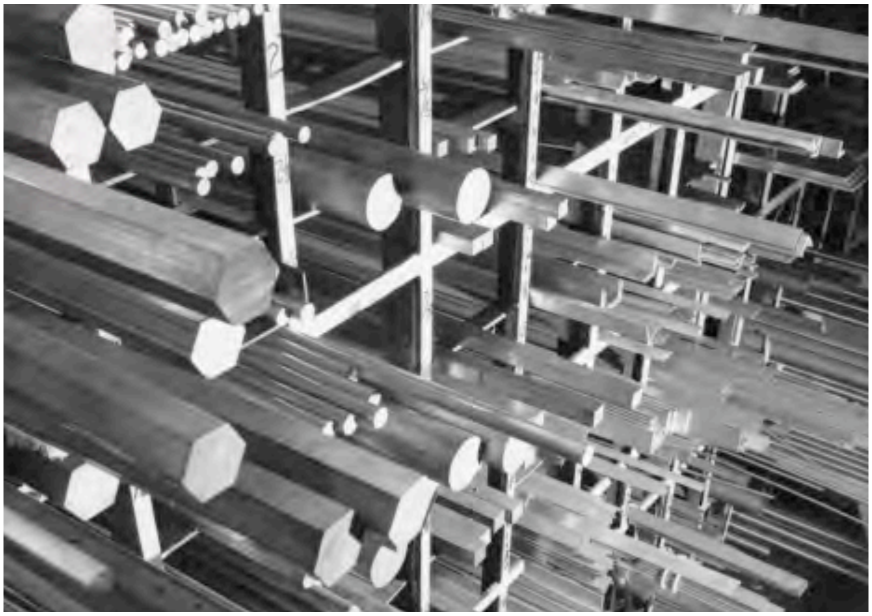
Tubing Hardness: Remember Parker Instrumentation Tube Fittings are designed to work within specific hardness ranges. Fittings are designed so the differential hardness between tube and fitting are optimum for a reliable and trouble-free operation. For specific values of our alloy portfolio and to understand the compatibility of a selected tubing with our ALOK/CPI fittings, refer to the allowable pressure working tables (1-14), on pages 22-31. As a general rule, tubing must be suitable for bending and flaring.

Tube Wall Thickness: Proper wall thickness is necessary to accommodate accepted safety factors relative to desired working pressures.

Tube Surface Finish: As best practice, it is fundamental to control the tubing finish and straightness.

Always select tubing free of visible draw marks or surface scratches. If possible, cut off any undesirable sections. These 'deep' scratches can cause leaks when attempting to seal low-density gases such as argon, nitrogen, or helium. In addition, tubing shall be reasonably straight and ends must be smooth and free of burrs or any other imperfections.

* For materials not covered in this brochure, please contact us directly.



Picture of a low cost product. Corrosion damage created by a low quality hardening process applied to the back ferrule

Tube Part Numbers

Listed below are some of our popular tubing requirements, we also can supply Super Duplex, 625, 825 and Titanium tube

Description	Unit of Measure	Material	Parker IPDE Part	Description	Unit of Measure	Material	Parker IPDE Part
1/4” OD x .028”	MT	316/316L	TUBE-316-1/4 OD X .028	6mm OD x 1.0	MT	316/316L	TUBE-316-6MMOD X 1.0
1/4” OD x .035”	MT	316/316L	TUBE-316-1/4 OD X .035	6mm OD x 1.5	MT	316/316L	TUBE-316-6MMOD X 1.5
1/4” OD x .049”	MT	316/316L	TUBE-316-1/4 OD X .049	8mm OD x 1.0	MT	316/316L	TUBE-316-8MMOD X 1.0
1/4” OD x .065”	MT	316/316L	TUBE-316-1/4 OD X .065	8mm OD x 1.5	MT	316/316L	TUBE-316-8MMOD X 1.5
5/16” OD x 0.035”	MT	316/316L	TUBE-316-5/16 OD X .035	10mm OD x 1.0	MT	316/316L	TUBE-316-10MMOD X 1.0
5/16” OD x 0.049”	MT	316/316L	TUBE-316-5/16 OD X .049	10mm OD x 1.5	MT	316/316L	TUBE-316-10MMOD X 1.5
5/16” OD x 0.065	MT	316/316L	TUBE-316-5/16 OD X .065	10mm OD x 2.0	MT	316/316L	TUBE-316-10MMOD X 2.0
3/8” OD x .028”	MT	316/316L	TUBE-316-3/8 OD X .028	12mm OD x 1.0	MT	316/316L	TUBE-316-12MMOD X 1.0
3/8” OD x .035”	MT	316/316L	TUBE-316-3/8 OD X .035	12mm OD x 1.5	MT	316/316L	TUBE-316-12MMOD X 1.5
3/8” OD x .049”	MT	316/316L	TUBE-316-3/8 OD X .049	12mm OD x 2.0	MT	316/316L	TUBE-316-12MMOD X 2.0
3/8” OD x .065”	MT	316/316L	TUBE-316-3/8 OD X .065	16mm OD x 1.0	MT	316/316L	TUBE-316-16MMOD X 1.0
1/2” OD x .035”	MT	316/316L	TUBE-316-1/2 OD X .035	16mm OD x 1.5	MT	316/316L	TUBE-316-16MMOD X 1.5
1/2” OD x .049”	MT	316/316L	TUBE-316-1/2 OD X .049	16mm OD x 2.0	MT	316/316L	TUBE-316-16MMOD X 2.0
1/2” OD x .065”	MT	316/316L	TUBE-316-1/2 OD X .065	18mm OD x 1.0	MT	316/316L	TUBE-316-18MMOD X 1.0
1/2” OD x .083”	MT	316/316L	TUBE-316-1/2 OD X .083	18mm OD x 1.5	MT	316/316L	TUBE-316-18MMOD X 1.5
5/8” OD x 0.035”	MT	316/316L	TUBE-316-5/8 OD X .035	18mm OD x 2.0	MT	316/316L	TUBE-316-18MMOD X 2.0
5/8” OD x .049”	MT	316/316L	TUBE-316-5/8 OD X .049	20mm OD x 2.0	MT	316/316L	TUBE-316-20MMOD X 2.0
5/8” OD x .065”	MT	316/316L	TUBE-316-5/8 OD X .065	22mm OD x 2.0	MT	316/316L	TUBE-316-22MMOD X 2.0
5/8” OD x .083	MT	316/316L	TUBE-316-5/8 OD X .083	25mm OD x 2.0	MT	316/316L	TUBE-316-25MMOD X 2.0
5/8” OD x 0.095	MT	316/316L	TUBE-316-5/8 OD X .095	25mm OD x 2.5	MT	316/316L	TUBE-316-25MMOD X 2.5
5/8” OD x 0.120	MT	316/316L	TUBE-316-5/8 OD X .120	1/4” OD x 0.36”	MT	6Mo	TUBE-6MO-1/4 OD X 0.036
3/4” OD x 0.035	MT	316/316L	TUBE-316-3/4 OD X .035	1/2” OD x 0.49”	MT	6Mo	TUBE-6MO-1/2 OD X 0.049
3/4” OD x .049”	MT	316/316L	TUBE-316-3/4 OD X .049	1/2” OD x 0.65”	MT	6Mo	TUBE-6MO-1/2 OD X .065
3/4” OD x .065”	MT	316/316L	TUBE-316-3/4 OD X .065	3/8” OD x 0.49”	MT	6Mo	TUBE-6MO-3/8 OD X 0.049
3/4” OD x 0.083”	MT	316/316L	TUBE-316-3/4 OD X .083	3/8” OD x 0.65”	MT	6Mo	TUBE-6MO-3/8 OD X .065
3/4” OD x 0.095”	MT	316/316L	TUBE-316-3/4 OD X .095	1” OD x .125”	MT	6Mo	TUBE-6MO-1 OD X .125
3/4” OD x 0.109”	MT	316/316L	TUBE-316-3/4 OD X .109	6mm OD x 1.0	MT	6Mo	TUBE-6MO-6MMOD X 1.0
3/4” OD x 0.120”	MT	316/316L	TUBE-316-3/4 OD X .120	8mm OD x 1.0	MT	6Mo	TUBE-6MO-8MMOD X 1.0
7/8” OD x 0.049”	MT	316/316L	TUBE-316-7/8”OD X .049”	10mm OD x 1.0	MT	6Mo	TUBE-6MO-10MMOD X 1.0
7/8” OD x 0.065”	MT	316/316L	TUBE-316-7/8”OD X .065”	10mm OD x 1.5	MT	6Mo	TUBE-6MO-10MMOD X 1.5
7/8” OD x 0.083”	MT	316/316L	TUBE-316-7/8”OD X .083”	12mm OD x 1.5	MT	6Mo	TUBE-6MO-12MMOD X 1.5
7/8” OD x 0.109”	MT	316/316L	TUBE-316-7/8”OD X .109”	20mm OD x 2.0	MT	6Mo	TUBE-6MO-20MMOD X 2.0
1” OD x 0.035”	MT	316/316L	TUBE-316-1 OD X .035	25mm OD x 2.0	MT	6Mo	TUBE-6MO-25MMOD X 2.0
1” OD x 0.049”	MT	316/316L	TUBE-316-1 OD X .049	1/4” OD x 0.65”	MT	Monel 400	TUBE-M400-1/4 X .065
1” OD x 0.065	MT	316/316L	TUBE-316-1 OD X .065	1/2” OD x 0.48”	MT	Monel 400	TUBE-M400-1/2 OD X .048
1” OD x .083”	MT	316/316L	TUBE-316-1 OD X .083	1/2” OD x 0.83	MT	Monel 400	TUBE-M400-1/2 OD X .083
1” OD X 0.095”	MT	316/316L	TUBE-316-1 OD X .095	12mm x 1.5	MT	Monel 400	TUBE-M400-12MM X 1.5
1” OD X 0.109”	MT	316/316L	TUBE-316-1 OD X .109				

*Note: Non Std sizes are on an inquiry by inquiry basis

Training

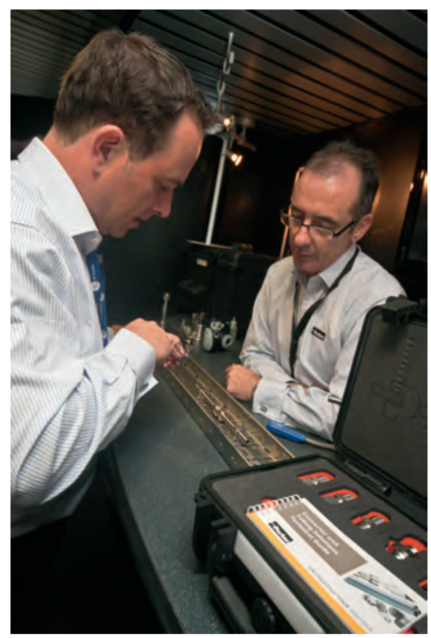
The Right Tube + The Right Fitting + A Parker Trained Fitter = A High Integrity Solution

IPDE is pleased to announce the arrival and running of its new Small Bore Expert (SBEx) courses.
The course has been developed as an upgrade and replacement to our industry leading Safety at Work Programme, provide material that is relevant to your engineers on site.

Some of the advantages over our existing programme are:

- Greater knowledge of small bore tubing systems
- Increased product familiarity
- Increased skills and confidence in dealing with small bore systems

The benefits that your nominated trainer can pass on to your engineers are:
- Increased understanding of their own systems and installation practices
- Improvements in the safety and integrity of their small bore tubing systems
- Overall asset integrity improvement



What does the Trainer get?
- 5 days of training, including:
- A comprehensive kit including:
- Spanners
- Tube benders
- Tube cutter
- De-burrer
- Vice grips
- Fittings samples
- Promotional clothing
- License fee

This will be the only licensed and certified training course that we will allow to be run with our support.
What else do you get?
- Access to the only certified IPDE training course

Each individual fittings package incorporates summarized installation instructions which are adequate for most circumstances. However, it is strongly recommended that attention is given to the contents of the Parker Instrument Tube Fitting Installation Mini A-lok book and attendance to the Parker Certified Installer SBEx 'Small Bore Expert' Training is also highly beneficial and would be further recommended.

SBEx Parker SAFETY TRAINING

Our Materials Statement

Our primary philosophy is to build reliable, efficient, cost-effective equipment for the intended service. We always strive for the best quality in the designs we produce, the materials we select and manufacturing processes we apply. All our materials come from the most prestigious mills in Europe and North America, and are fully traceable to the source of origin and mercury and radioactive free. We want to add value to every component we create and make all the applications we serve **smarter, faster, cleaner** and **safer.**

Due to their versatility, reliability and excellent corrosion resistance, the set of alloys and equipment that we offer usually meet all the demands in markets, including the oil and gas, chemical and petrochemical processing, pollution control, marine engineering, power generation, or pulp and paper among others.

However, the unique requirements of some of the projects often demand special approaches. Parker Instrumentation understand those needs and has the technical knowledge and experience to help our customers to find the better solutions for their applications and meet even the most challenging demands.

Together, we can create innovative solutions that ensure your success

Gas Service

Special care must be taken when selecting tubing for gas service. In order to achieve a gas-tight seal, ferrules in instrument fittings must seal any surface imperfections.

This is accomplished by the ferrules penetrating the surface of the tubing. Penetration can only be achieved if the tubing provides radial resistance and if the tubing material is softer than the ferrules.

Thick walled tubing helps to provide resistance. Tables 1-14 (stainless to titanium pressure charts on pages 22 to 31) indicate the minimum acceptable wall thickness for various materials in gas service.

The ratings coloured in dark blue indicate combinations of diameter and wall thickness which are not suitable for gas service.

Acceptable tubing hardness for general applications is listed in Tables 1-14. For most services, particularly in larger diameters and thicknesses, better results can be obtained by using tubing well below this maximum hardness.

For example, a desirable hardness of 80 HRB is suitable for stainless steel. The maximum allowed is 90 HRB.

Tubing Handling & Preparation

After tubing has been properly selected and ordered, careful handling is important.
From the receiving dock to point of installation, special attention is necessary to prevent scratching, burring and other injurious damage occurring to the tube.

This is especially important for gas service. Low-density gases such as helium and argon cannot be sealed with damaged tubing.

Make certain not to drag tubing across any surfaces such as truck beds, shelves, or storage racks, the floor and (or) ground of any plant/ construction site. This is important for tubing of all materials. Besides scratching, improper handling can create out-of-round tubing.

Out-of-round tubing will not fit the I.D. of the ferrule(s) or the fitting body bore properly and will cause leakage.

Tube end preparation is also essential in assuring trouble-free systems. Some important points to consider are:

- Always Handling the Tubing carefully
- Cutting Tube End with either a tube cutter or hacksaw
- Deburring the tube end
- Cleaning the tube end

Tubing Ordering Suggestions:

Tubing for use with Parker instrument fittings must be carefully ordered to ensure adequate quality for good performance. Each purchase order must specify the material nominal outside diameter, and wall thickness. Ordering to ASTM specifications ensures that the tubing will be dimensionally, physically, and chemically within strict limits. Also, more stringent requirements may be added by the user. All tubing should be ordered free of scratches and suitable for bending and flaring.

Example:

A purchase order meeting the above criteria would read as follows:

“1/2 x 0.049 tubing in 316 stainless steel, seamless, as per ASTM A-269. Fully annealed, with hardness of 80 HRB or less. Must be suitable for bending and flaring; surface scratches, and imperfections are not permissible.”

Allowable Pressure Working Tables

System Pressure
The system operating pressure is another important factor in determining the type, and more importantly, the size of tubing to be used. In general, high pressure installations require stronger materials. Heavy walled softer tubing such may be used if chemical compatibility exists with the media. However, the higher strength of materials such as Alloy 625 permits the use of thinner tubes without reducing the ultimate rating of the system. In any event, tube fitting assemblies should never be pressurized beyond the recommended working pressure.

The following tables (1-14) list by material, the maximum suggested working pressure of various tubing sizes in combination with Parker A-LOK®/CPI™ fittings. Acceptable tubing diameters and wall thicknesses are those for which a rating is listed. Combinations, which do not have a pressure rating, are currently not recommended for use with instrument fittings. For higher pressures, see the Parker **Medium-Pressure Fittings or Phastite Fittings Range**.

Table 15 lists the de-rating factors which should be applied to the working pressures listed in Tables 1-14 for elevated temperature conditions. Simply locate the correct factor in Table 15 and multiply this by the appropriate value in Tables 1-14 for elevated temperature working pressure.

Table 15		Elevated Temperature Rating Factors						
Temperature		Tubing Material						
˚F	˚C	Stainless 316/316L*	6Mo	Alloy 400	Alloy 625	Alloy 825	Alloy C276	Titanium Gr. 2
100	38	1	1	1	1	1	1	1
200	93	1	1	0.88	0.93	0.92	0.91	0.87
300	149	1	0.95	0.81	0.88	0.87	0.84	0.72
400	204	0.97	0.9	0.79	0.85	0.83	0.78	0.62
500	260	0.9	0.87	0.79	0.82	0.79	0.73	0.53
600	315	0.85	0.86	0.79	0.79	0.76	0.69	0.45
700	371	0.82	0.84	0.78	0.77	0.74	0.65	--
800	426	0.8	--	0.76	0.75	0.73	0.63	--
900	482	0.78	--	0.43	0.74	--	0.61	--
1000	537	0.77	--	--	0.73	--	0.6	--
1100	593	0.62	--	--	0.73	--	--	--
1200	649	0.37	--	--	0.72	--	--	--

*** Dual-certified grades such as 316/316L, meet the minimum chemistry and the mechanical properties of both alloy grades.**

Example:
Tubing Type 316 stainless steel seamless, 1/2 in. x 0.049 in. wall at 100 ˚F

- The allowable working pressure at room temperature (up to 100 ˚F) is 2800 psi (Refer to Table 1)
- The elevated temperature factor for 316 stainless steel is 0.77 at 1000 ˚F (Refer to Table 15)
- The allowable working pressure for 316 stainless steel tubing ½ in. x 0.049 in. wall at 1000 ˚F is then:
  2800 psi x 0.77 = 2156 psi

The figures and tables included are for reference purposes only. Applicable codes and industry practices should be always considered when designing pressure systems.

- All working pressures have been calculated following the recommendations contained within ASME B31.3, Chemical Plant and Petroleum Refinery Piping Code, and ASME B31.1, Power Piping, and have been proven as accurate by extensive product testing. The calculation utilises an allowable stress figure that incorporates a 4:1 factor of safety.
- All calculations are based on maximum outside diameter and minimum wall thickness.
- All working pressures are applicable at ambient (72˚F or 22˚C) temperature.

NB.
All Parker A-LOK®/CPI™ tube fittings are designed such that successful assembly is achieved under most circumstances with 1 ¼ turns of the nut being applied from finger tight. For high pressure gaseous services or other critically severe service, consideration should be given to the utilization of a high pressure make up being 1 ½ turns of the nut from finger tight.

Certain combinations of tube and fitting may also benefit from other techniques to aid assembly such as utilization of a pre setting tool. Guidelines are given within the following tables and again we recommend attention to the Parker Instrument Tube Fitting Installation Manual and to the SBEX 'Small Bore Expert' training.
See page 15 for further details

Pipe Pressure Ratings

NPT / BSPT Pipe Size	BRASS			
	Male		Female	
	Straight[a]	Shape[b]	Straight[a]	Shape[b]
1/16	6000	5500	4500	3800
1/8	5600	5000	4000	2900
1/4	4100	4100	4300	3000
3/8	4000	4000	3500	2700
1/2	3900	3100	3600	2500
3/4	3800	3400	3000	2000
1	2700	2700	3100	2300
1-1/4	2000	2000	2300	1900
1-1/2	1800	1800	2100	1700
2	1600	1600	2000	1500

NPT / BSPT Pipe Size	STAINLESS STEEL			
	Male		Female	
	Straight[a]	Shape[b]	Straight[a]	Shape[b]
1/16	10000	9500	7500	7000
1/8	9100	9100	6400	5500
1/4	7500	7500	6600	5600
3/8	7200	7200	5300	5000
1/2	6600	5800	5200	4500
3/4	6400	6400	4300	3500
1	4600	4600	4500	3900
1-1/4	3500	3500	3500	3100
1-1/2	2900	2900	3200	2500
2	2600	2600	2700	2300

NPT / BSPT Pipe Size	CARBON STEEL			
	Male		Female	
	Straight[a]	Shape[b]	Straight[a]	Shape[b]
1/16	10500	10100	8000	7500
1/8	9700	9700	6800	5900
1/4	8000	8000	7000	6000
3/8	7600	7600	5600	5300
1/2	7000	6200	5500	4800
3/4	6800	6800	4600	3700
1	4900	4900	4800	4200
1-1/4	3700	3700	3700	3300
1-1/2	3100	3100	3400	2600
2	2800	2800	2800	2400

Notes:

a. Fittings manufactured from bar stock.
b. Fittings manufactured from forgings.
c. Material of construction in accordance with Parker Catalog 4230/4233, Table 1.
d. Pressure ratings for fittings with both tube and pipe ends are rated to the lower pressure.

Brass

Brass is a metal alloy of Copper and Zinc. Small additions of other alloying elements are added to modify the properties so that the resulting material is fit for a given purpose.

Brasses are medium strength engineering materials, comparable to high strength structural steels and some stainless steels and aluminium alloys. In the softened or annealed condition brasses are ductile and strong but when hardened by cold working their strength increases markedly. Brass has excellent machinability.

While brass may be less corrosion resistant than other copper alloys, its performance is quite adequate for many applications. However, brass tarnishes. Exposed to the atmosphere, it quickly forms a brown or gray-green protective corrosion film. Under certain conditions, brass can also dezincify. Dezincification is associated with submerged or stagnant exposure conditions, often in acidic media. Under atmospheric exposure, this form of corrosion is usually limited to superficial attack.

Typical applications include:

- Valves, pumps, shafts, fittings, and fasteners.
- Heat Exchangers Tubes
- Automotive Industry
- Marine Engineering
- Piping

Refer to page 9 for product availability.

Typical Composition Grade 2	
Element	**Weight (%)**
Copper	60.0 to 63.0
Load	2.5 to 3.7
Iron	0.35 max
Zinc	Remainder

Typical Specifications	
Product	**Standard**
Bar	ASTM B16
UNS No.	C36000

Carbon Steel

Carbon steel, also called plain carbon steel, is a malleable, iron-based metal containing carbon, small amounts of manganese, and other elements that are inherently present. It is the most widely used engineering material, and accounts for approximately 85%, of the annual steel production worldwide.

Despite its relatively limited corrosion resistance, carbon steel is still used in large tonnages in numerous industrial applications.

Typical applications of Carbon Steel are:

- Pipeline Systems
- Mining
- Metal Processing Equipment
- Transportation
- Fossil Fuel Power Plants
- Petroleum Production & Refining

Refer to page 9 for product availability.

Typical Composition ASTM A105	
Element	**Weight (%)**
Carbon	0.35 max
Manganese	28.0 to 34.0
Copper	0.4 max
Nickel	0.4 max
Chromium	0.3 max
Molybdenum	0.12 max
Vanadium	0.08 max

Typical Composition ASTM A105 LF2	
Element	**Weight (%)**
Carbon	0.3 max
Manganese	0.6 to 1.35
Copper	0.4 max
Nickel	0.4 max
Chromium	0.3 max
Molybdenum	0.12 max
Columbium	0.02 max
Vanadium	0.08 max

Typical Specifications	
Product	**Standard**
Bar	ASTM A696
Forging	ASTM A105 ASTM A350 LF2
Other	NACE MR0175 NACE MR0103

Stainless Steel 316/316L

Stainless Steels 316/316L are austenitic grades and two of the most used alloys in a variety of industrial applications. The molybdenum addition gives this grade good resistance to general corrosion and provides increased strength at elevated temperatures. The austenitic structure also gives these grades excellent toughness, even at cryogenic temperatures. Grade 316L, the low carbon version of 316, minimizes harmful carbide precipitation due to welding.

It is common for 316 and 316L to be stocked in 'Dual Certified' form. These items have chemical and mechanical properties complying with both 316 and 316L specifications.

The corrosion resistance of stainless steel grades 316/316L is excellent in a wide range of atmospheric environments and many corrosive media. However, it is subjected to pitting and crevice corrosion in warm chloride environments, as well as to stress corrosion cracking.

Initially developed for use in paper mills, 316/316L stainless steel is typically used in the following applications:

- Food processing equipment
- Brewery equipment
- Chemical and petrochemical equipment
- Laboratory equipment
- Boat fittings
- Chemical transportation containers
- Heat exchangers
- Nuts and bolts
- Springs
- Medical implants
- General Service Process Equipment

Typical Composition	
Element	**Weight (%)**
Carbon	0.03/0.08 max
Manganese	2.00 max
Chromium	16.0 to 18.0
Nickel	10.0 to 14.0
Molybdenum	2.0 to 3.0

Typical Specifications	
Product	**Standard**
Bar	ASTM A479 ASTM A276 EN 10088-3
Forging	ASTM A182
Casting	ASTM A351
Tube	ASTM A269 ASTM A213
Other	NACE MR0175
	NACE MR0103
UNS No.	S31600/S31603

Refer to page 9 for product availability.

Tubing Specification: High Quality, Fully Annealed, Stainless Steel Tubing to ASTM A269 Grade 316/316L UNS S31600/S31603. Recommended Tube Hardness 80 HRB. Maximum Permissible Hardness 90 HRB.

Table 1	316/316L Stainless Steel															Imperial
Tube O.D. Size	Wall Thickness, inches															
	0.010	0.012	0.014	0.016	0.020	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.120	0.134	0.156	0.188
1/16	5600	6900	8200	9500	12100	16800										
1/8						8600	10900									
3/16						5500	7000	10300								
1/4						4000	5100	7500	10300							
5/16							4100	5900	8100							
3/8							3300	4800	6600							
1/2							2600	3700	5100	6700						
5/8								3000	4000	5200	6100					
3/4								2400	3300	4300	5000	5800				
7/8								2100	2800	3600	4200	4900				
1									2400	3200	3700	4200	4700			
1 1/4										2500	2900	3300	3700	4100	4900	
1 1/2											2400	2700	3000	3400	4000	4500
2												2000	2200	2500	2900	3200

Working pressure is measured in 'psig'

Table 2	316/316L Stainless Steel									Metric
Tube O.D. Size	Wall Thickness, mm									
	0.8	1.0	1.2	1.5	1.8	2.0	2.2	2.5	2.8	3.0
3	720									
6	330	430	520	680						
8		310	380	490						
10		240	300	380	470					
12		200	240	310	380	430				
14		180	220	280	340	390	430			
15		170	200	260	320	360	400			
16			190	240	300	330	370	430		
18			170	210	260	290	330	380		
20			150	190	230	260	290	330	380	
22			140	170	210	230	260	300	340	
25					180	200	230	260	300	320

Working pressure is measured in 'bar'

- Not recommended for gas service
- Recommended for all services - standard assembly
- Recommended for all services - Use pre-assembly tool
- Recommended for all services - Use 'Hyferset' pre-assembly tool
- No data/Not recommended/No solution

Duplex Stainless Steel

Austenitic-Ferritic stainless steels, also called duplex stainless steels, were developed more than 70 years ago in Sweden for the paper industry in order to combat corrosion problems caused by chloride-bearing cooling waters and other aggressive chemical process fluids.

Due to the high content of chromium, nitrogen, and molybdenum, these steels offer good resistance to localised and uniform corrosion. The duplex microstructure contributes to the high mechanical strength, good abrasion, erosion and fatigue resistance. Duplex steels also possesses good weldability properties.

Typical applications of duplex stainless steel are:

- Pulp and paper industry
- Components for structural design
- Storage tanks
- Cargo tanks and pipe systems in chemical tankers
- Water heaters
- Flue-gas cleaning
- Heat exchangers

Refer to page 9 for product availability.

Typical Composition	
Element	**Weight (%)**
Carbon	0.03 max
Manganese	2.00 max
Chromium	21.0 to 23.0
Nickel	4.5 to 6.5
Molybdenum	2.5 to 3.5
Nitrogen	0.08 to 0.02

Typical Specifications	
Product	**Standard**
Bar	ASTM A479 ASTM A276
Forging	ASTM A182 F51
Tube	ASTM A789
Other	NACE MR0175 NACE MR0103
UNS No.	S31803

Super Duplex Stainless Steel

First used in the 1980s, Super-Duplex refers to highly alloyed, high performance Duplex stainless steel with a improved pitting and crevice corrosion resistance.

Super duplex steels were designed for specific applications where both high mechanical strength and good corrosion resistance are required.

Super Duplex Stainless Steel is noted for its high level of chromium, which gives the alloy excellent resistance to acid chlorides, acids, caustic solutions and other harsh environments.

Typical applications of super duplex stainless steel are:

- Desalination plants
- Heat exchangers
- Pollution control
- Pulp and Paper industry
- Tube & Pipe systems for petrochemical refineries
- Downhole

Typical Composition	
Element	**Weight (%)**
Carbon	0.03 max
Manganese	1.00 max
Chromium	24.0 to 26.0
Nickel	6.0 to 8.0
Molybdenum	3.0 to 4.0
Nitrogen	0.20 to 0.30
Copper	0.05 approx.

Typical Specifications	
Product	**Standard**
Bar	ASTM A479 ASTM A276
Forging	ASTM A182 F53/55
Tube	ASTM A789
Other	NACE MR0175 NACE MR0103
UNS No.	S32750/32760

Refer to page 9 for product availability.

Alloy 400

Alloy 400, also known as Monel™, is a nickel-copper alloy, resistant to sea water and steam at high temperatures as well as to salt and caustic solutions. The alloy possesses excellent corrosion resistance in a wide variety of media and is also characterized by good weldability and moderate to high strength.

The alloy has been used in a variety of applications. It has excellent resistance to rapidly flowing brackish water or seawater. It is particularly resistant to hydrochloric and hydrofluoric acids when they are de-aerated. Indeed, it is one of few metallic materials which can be used in contact with fluorine, hydrofluoric acid, hydrogen fluoride and their derivatives.
The alloy is widely used in the chemical, oil and marine industries. Good mechanical properties from sub-zero temperatures up to 1020 °F.

Typical applications include:

- Valves, pumps, shafts, fittings, and fasteners, especially in marine environment
- Chemical and hydrocarbon processing equipment
- Crude oil distillation towers
- Gasoline and freshwater tanks
- Seawater Handling Equipment

Typical Composition Grade 2	
Element	**Weight (%)**
Nickel	63.0 min
Copper	28.0 to 34.0
Iron	2.5 max
Manganese	2.0 max
Carbon	0.3 max

Typical Specifications	
Product	**Standard**
Bar	ASTM B164
Forging	ASTM B564
Tube	ASTM B165
Other	NACE MR0175 NACE MR0103
UNS No.	N04400

Refer to page 9 for product availability.

Tubing Specification: High Quality, Fully Annealed, Alloy 400 Tubing to ASTM B165 Grade UNS N04400.
Recommended Tube Hardness 70 HRB. Maximum Permissible Hardness 75 HRB.

Table 3			Alloy 400					Imperial
Tube O.D. Size	Wall Thickness, inches							
	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.12
1/8	8000	10400						
1/4	3700	4800	7000	9800				
5/16		3700	5400	7500				
3/8		3100	4400	6100				
1/2		2400	3500	4700	6200			
3/4			2200	3000	4000	4600	5400	
1				2200	2900	3400	3900	4300

Working pressure is measured in 'psig'

Table 4			Alloy 400					Metric
Tube O.D. Size	Wall Thickness, mm							
	0.8	1	1.2	1.5	2	2.5	2.8	3
3	670	890						
6	310	400	490	640				
8		290	350	460				
10		230	280	360				
12		190	230	290	400			
18			160	200	270			
20			140	180	240	310	350	
25				140	190	240	280	300

Working pressure is measured in 'bar'

Not recommended for gas service

Recommended for all services - standard assembly

No data/Not recommended/No solution

Super Austenitic 6Mo

Super austenitic stainless steel 6Mo is a high performance alloy designed specifically for added corrosion resistance. It has the same structure as the common austenitic alloys, and greater levels of elements such as chromium, nickel, molybdenum, copper, and nitrogen, which gives it enhanced strength and corrosion resistance.

6Mo is especially suited for high-chloride environments such as brackish water, seawater, pulp mill bleach plants, and other high-chloride process streams. It is often used as a replacement in critical components where alloy 316/316L has failed by pitting, crevice attack, or chloride stress corrosion cracking. In many applications, the super austenitic stainless steels have been found to be a technically suitable and much more cost-effective alternative than nickel-base alloys.

Typical Composition	
Element	**Weight (%)**
Carbon	0.02 max
Manganese	1.00 max
Chromium	19.5 to 20.5
Nickel	17.5 to 18.5
Molybdenum	6.0 to 6.5
Nitrogen	0.18 to 0.22
Copper	0.5 to 1.0

Typical Specifications	
Product	**Standard**
Bar	ASTM A479 ASTM A276
Forging	ASTM A182 F44
Tube	ASTM A269
Other	NACE MR0175
	NACE MR0103
UNS No.	S31254

Refer to page 9 for product availability.

Typical applications of this alloy are:

- Seawater Handling Equipment
- Pulp Mill Bleach Systems
- Tall Oil Distillation Columns and Equipment
- Chemical Processing Equipment
- Food Processing Equipment
- Desalination Equipment
- Flue Gas Desulfurization Scrubbers
- Oil and Gas Production Equipment

Why selecting Steel 6Mo grade over Steel 316 grade?

- For all those applications which involve moderate to high chloride presence.
- For those applications in which 316 has failed or is likely to fail due to pitting, crevice or induced stress corrosion cracking.
- For those applications that require compliance to NACE standards and the existing 316 range can not meet such demand.
- For NACE equipment in processes over 60 °C, where 316 is not permitted.

Parker Hannifin carried out Stress Corrosion Cracking Testing as per ASTM G48 conducted by an independent party that determined the time to failure of 6Mo to be 3 times higher of that of 316. In service applications, those results translate into a life expectancy of 6Mo three times longer than that of 316 in the same given conditions, reducing leakage and downtime and increasing safety by over 60%.

Why selecting Steel 6Mo grade over Super duplex grades?

- Choose 6Mo for improved corrosion resistance and super duplex for increased strength. The higher strength of super duplex grades can make this material more susceptible to stress corrosion cracking under certain conditions.
- For those applications that are likely to suffer from pitting corrosion. The pitting resistance given by the PREN or Pitting Resistance Equivalent Number is higher for 6Mo than for its super duplex counterparts.

6Mo is one of our best-seller materials. It has been successfully used in a wide range of applications in the North Sea, Middle East, Mexico Gulf or Australia. Typical applications cover offshore platforms, heat exchangers or desalination plants.

Tubing Specification: High Quality, Fully Annealed, Super Stainless Steel Tubing to ASTM A269/A213 Grade UNS S31254.
Recommended Tube Hardness 80 HRB. Maximum Permissible Hardness 90 HRB.

Table 5			6Mo				Imperial
Tube O.D. Size	Wall Thickness, inches						
	0.02	0.028	0.035	0.049	0.065	0.083	0.095
1/16							
1/8	7100	10500					
3/16		6700	8600				
1/4		4900	6300	10000			
5/16			4900	7100			
3/8			4000	5800	8000		
1/2			3200	4600	6200		
5/8				3600	4900		
3/4				3000	4000	5200	
7/8				2500	3400	4400	
1					2900	3800	4400

Working pressure is measured in ‘psig’

Table 6				6Mo				Metric
Tube O.D. Size	Wall Thickness, mm							
	0.8	1	1.2	1.5	1.8	2	2.2	2.5
3	550							
6	410	520	680					
8		380	470					
10		300	370	470				
12		250	300	380	470			
14			270	340	420			
15			250	320	390			
16			230	300	360			
18			210	260	320	360		
20			180	230	290	320		
22				210	260	290	320	
25					220	250	280	320

Working pressure is measured in ‘bar’

- Not recommended for gas service (light blue)
- Recommended for all services - standard assembly (green)
- Recommended for all services - Use pre-assembly tool (grey)
- Recommended for all services - Use ‘Hyferset’ pre-assembly tool (yellow)
- No data/Not recommended/No solution (white)

Alloy 825

Alloy 825 is a nickel-iron-chromium alloy with additions of molybdenum, copper, and titanium. The alloy is designed to provide exceptional resistance to many corrosive environments. Alloy 825 is resistant to corrosion in many acids and alkalis under both oxidising and reducing conditions, including sulphuric, sulphurous, phosphoric, nitric and organic acids, alkalis such as sodium or potassium hydroxide, and aqueous chloride solutions. High nickel content gives the alloy virtual immunity to stress corrosion cracking and good resistance to pitting and crevice.

Alloy 825 is a versatile general engineering alloy that exhibits good mechanical properties at both room and elevated temperatures (over 1000 °F).

Typical applications include:

- Chemical processing
- Pollution control
- Oil and gas recovery
- Acid production
- Nuclear fuel reprocessing

Typical Composition	
Element	**Weight (%)**
Carbon	0.05 max
Manganese	1.00 max
Chromium	19.5 to 23.5
Nickel	38.0 to 46.0
Molybdenum	2.5 to 3.5
Iron	22.0 min
Titanium	0.06 to 1.2
Aluminium	0.2 max
Copper	0.5 to 3.0

Typical Specifications	
Product	**Standard**
Bar	ASTM B425
Forging	ASTM B564
Tube	ASTM B423
Other	NACE MR0175 NACE MR0103
UNS No.	N08825

Refer to page 9 for product availability.

Tubing Specification: High Quality, Fully Annealed, Alloy 825 Tubing to ASTM B163 or B423 Grade UNS N08825. Recommended Tube Hardness 80 HRB. Maximum Permissible Hardness 90 HRB.

Table 7	Alloy 825		Imperial	
Tube O.D. Size	Wall Thickness, inches			
	0.035	0.049	0.065	0.083
1/4	5400	8700	11100	
3/8	3500	5500	7600	
1/2	2700	4300	5900	

Working pressure is measured in 'psig'

Table 8	Alloy 825			Metric	
Tube O.D. Size	Wall Thickness, mm				
	0.8	1	1.2	1.5	2
6	260	450	610	730	
10		260	350	440	
12		210	280	360	

Working pressure is measured in 'bar'

- Not recommended for gas service
- Recommended for all services - standard assembly
- Recommended for all services - Use pre-assembly tool
- No data/Not recommended/No solution

Alloy 625

This alloy has outstanding resistance to pitting and crevice corrosion as well as good resistance to intergranular attack. It also is almost totally resistant to chloride-induced stress corrosion cracking. With these properties the alloy has extremely high resistance to attack by a wide range of media and environments including nitric, phosphoric, sulphuric and hydrochloric acids, as well as alkalis and organic acids in both oxidising and reducing conditions. Alloy 625 has virtually no corrosive attack in marine and industrial atmospheres with extremely good resistance to seawater, even at elevated temperatures.

It is an excellent choice for applications that require high corrosion-fatigue strength or high tensile strength applications, creep and rupture strength and weldability.

Typical applications include:

- Sour Gas Service
- Engine exhaust systems
- Fuel and Hydraulic Lines
- Distillation columns and chemical transfer lines
- Nuclear water reactors

Alloy 625 is one of our best seller materials. It is one of the preferred alloy in a wide range of sour gas applications.

Typical Composition	
Element	**Weight (%)**
Carbon	0.1 max
Manganese	0.5 max
Chromium	20.0 to 23.0
Nickel	58.0 min
Molybdenum	8.0 to 10.0
Iron	5.0 max
Columbium + Tantalum	3.15 to 4.15
Titanium	0.4 max
Aluminium	0.4 max
Cobalt	1.0 max

Typical Specifications	
Product	**Standard**
Bar	ASTM B446
Forging	ASTM B564
Tube	ASTM B444
Other	NACE MR0175 NACE MR0103
UNS No.	N06625

Refer to page 9 for product availability.

Tubing Specification: High Quality, Fully Annealed, Alloy 625 Tubing to ASTM B444 Grade 2 UNS N06625. Recommended Tube Hardness 85 HRB. Maximum Permissible Hardness 93 HRB.

Table 9	Alloy 625		
Tube O.D. Size	**Wall Thickness, inches**		
	0.035	**0.049**	**0.065**
1/4	6800		
3/8	4400	6400	8700
1/2		5000	6800
3/4			4400

Working pressure is measured in 'psig'

Table 10	Alloy 625			Metric	
Tube O.D. Size	**Wall Thickness, mm**				
	0.8	**1**	**1.2**	**1.5**	**1.8**
6	440	570			
10	260	330	400	510	630
12			330	420	

Working pressure is measured in 'bar'

- Recommended for all services - standard assembly (green)
- Recommended for all services - Use pre-assembly tool (grey)
- Recommended for all services - Use 'Hyferset' pre-assembly tool (yellow)
- No data/Not recommended/No solution (white)

Alloy C276

Alloy C-276 is known for its excellent resistance to a wide variety of chemical process environments, including strong oxidizers such as ferric and cupric chlorides, hot contaminated media, chlorine, formic and acetic acids, acetic anhydride, and seawater and brine solutions. Alloy C-276 alloy has excellent resistance to pitting and to stress-corrosion cracking. It is also one of the few materials that withstands the corrosive effects of wet chlorine gas, hypochlorite, and chlorine dioxide. Alloy C-276 can resist the formation of grain boundary precipitates in the weld heat-affected zone, making it also a common candidate for most chemical and petrochemical processing applications in the as-welded condition.

This alloy might be used in any environment that requires resistance to heat and corrosion but where the mechanical properties of the metal must be retained.

Typical applications include:

- Chemical processing
- Air Pollution control
- Pulp and Paper Production
- Marine Engineering
- Waste Treatment

Refer to page 9 for product availability.

Typical Composition	
Element	**Weight (%)**
Carbon	0.01 max
Manganese	1.00 max
Chromium	14.5 to 16.5
Nickel	51.0 min
Molybdenum	15.0 to 17.0
Iron	4.0 to 7.0
Tungsten	3.0 to 4.5
Cobalt	2.5 max
Vanadium	0.35 max

Typical Specifications	
Product	**Standard**
Bar	ASTM B574
Forging	ASTM B564
Tube	ASTM B622
Other	NACE MR0175 NACE MR0103
UNS No.	N10276

Tubing Specification: High Quality, Fully Annealed, Alloy C276 Tubing to ASTM B622 Grade UNS N10276. Recommended Tube Hardness 85 HRB. Maximum Permissible Hardness 93 HRB.

Table 11	Alloy C276			Imperial
Tube O.D. Size	**Wall Thickness, inches**			
	0.028	**0.035**	**0.049**	**0.065**
1/4	5500			
3/8		4500	6500	8900
1/2		3500	5100	6900
5/8		2800		

Working pressure is measured in 'psig'

Table 12	Alloy C276			Metric
Tube O.D. Size	**Wall Thickness, mm**			
	0.8	**1**	**1.2**	**1.5**
6	450	580		
10		330	410	520
12		270	330	430
15		230		

Working pressure is measured in 'bar'

- Not recommended for gas service
- Recommended for all services - standard assembly
- Recommended for all services - Use pre-assembly tool
- No data/Not recommended/No solution

Titanium Grade 2

Titanium is virtually immune to environmental attack. It withstands urban pollution, marine environments, the sulphur compounds of industrial areas and is failure-proof in even more aggressive environments. The uses for titanium in industry are growing faster than ever before as more and more engineers are discovering it can reduce lifecycle costs across a broad range of equipment and processes.
Titanium has an exceptionally high strength to weight ratio, allowing for lighter components or reduced wall thicknesses. Any remaining higher up front costs are almost always recouped in multiple due to increased production time and reduced maintenance.
Titanium forms a very tenacious surface oxide layer, which is an outstanding corrosion inhibitor. In many harsh environments it can outlast competing materials as much as 5 times longer. Lower failure rates translate to less downtime, reduced maintenance and total lower cost.

Typical applications include:

- Chemical processing
- Power Generation
- Aerospace and Defence
- Petrochemical Refineries
- Desalination Plants

Typical Composition Grade 2	
Element	**Weight (%)**
Nitrogen	0.03 max
Carbon	0.08 max
Hydrogen	0.015 max
Iron	0.3 max
Oxygen	0.25 max
Titanium	Remainder

Typical Composition Grade 5	
Element	**Weight (%)**
Nitrogen	0.05 max
Carbon	0.08 max
Hydrogen	0.015 max
Iron	0.4 max
Oxygen	0.2 max
Aluminium	5.5 to 6.75
Vanadium	3.5 to 4.5
Titanium	Remainder

Typical Specifications	
Product	**Standard**
Bar	ASTM B348
Plate	ASTM B265
Forging	ASTM B381
Tube	ASTM B338
Other	NACE MR0175
UNS No.	R50400/56400

Refer to page 9 for product availability.

Tubing Specification: High Quality, Fully Annealed, Titanium Tubing to ASTM B338 Grade 2 UNS R50400. Recommended Tube Hardness 75 HRB. Maximum Permissible Hardness 85 HRB.

Table 13	Titanium Grade 2			Imperial
Tube O.D. Size	Wall Thickness, inches			
	0.028	0.035	0.049	0.065
1/4	3300	4200	6200	
3/8		2700	4000	5400
1/2		2100	3100	

Working pressure is measured in 'psig'

Table 14	Titanium Grade 2			Metric
Tube O.D. Size	Wall Thickness, mm			
	0.8	1	1.2	1.5
6	280	350	440	
10		200	250	320
12		170	200	

Working pressure is measured in 'bar'

- Not recommended for gas service
- Recommended for all services - standard assembly
- Recommended for all services - Use pre-assembly tool
- No data/Not recommended/No solution

Suparcase™ for A-LOK® Back Ferrules

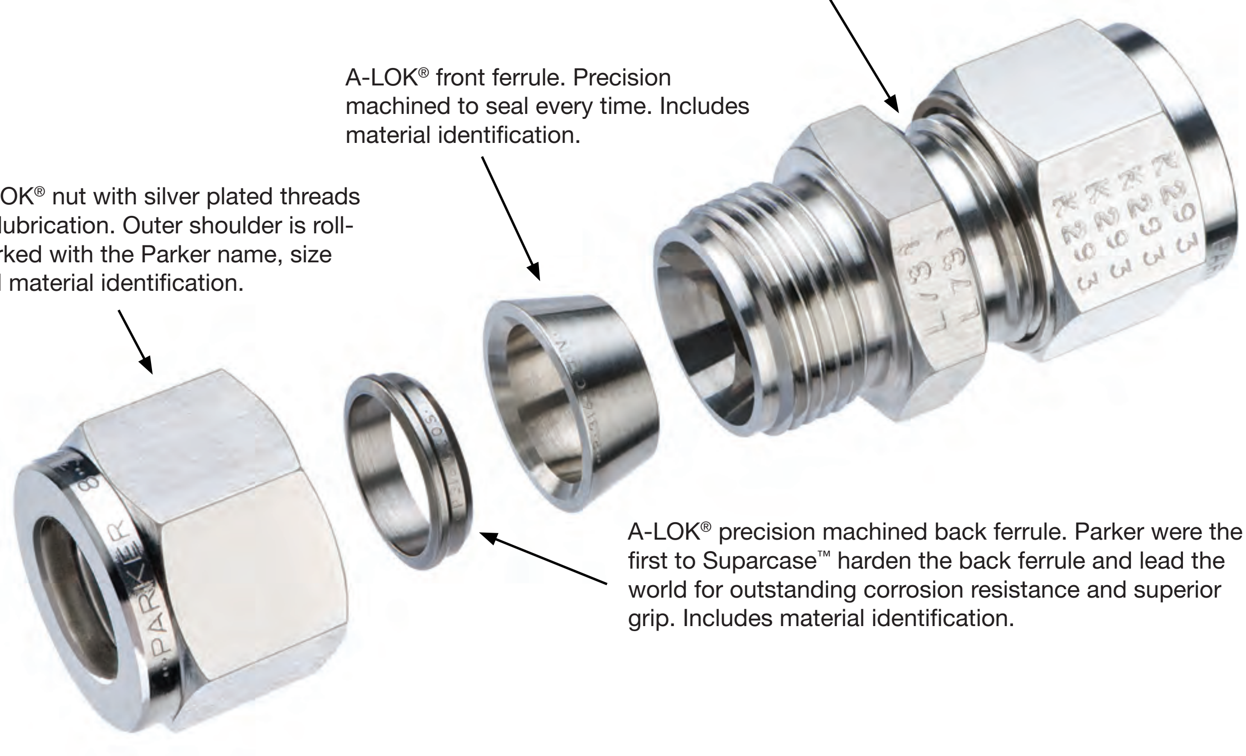
The first step in ensuring the integrity of any system is to choose the right materials for the job. That's why Parker supply fittings in a wide range of exotic materials for applications where corrosion is an issue, and where new, harder materials for tubing for high-integrity applications are being used.

The Suparcase™ PRINCIPLE

The Parker Suparcase™ surface treatment is an unique process that allows stainless steels and other alloys to be hardened without affecting, and even increasing, the corrosion resistance of the given materials. Parker has been using the proprietary Suparcase process to surface harden stainless steel ferrules for approximately 20 years. The process achieves a carbon supersaturated surface layer by altering the oxide passive layer on the surface of the stainless steel, without any detrimental effects.

Good Tube Grip = Harder Rear Ferrule = Smarter, Faster, Cleaner, Safer

- Suparcase™ process perfected by Parker gives the Differential Hardness
- Some competitor hardening process corrode (i.e. Nitride or Edge Hardening)
- Suparcase™ increases the corrosion resistance
- Suparcase™ is applied to all back ferrules, all sizes



A-LOK® body. Includes precision machined threads and burnished cones for enhanced sealing. Materials sourced only in Western Europe to ensure quality capable of performing in the most harsh process environments. Includes material & HCT identification.

A-LOK® front ferrule. Precision machined to seal every time. Includes material identification.

A-LOK® nut with silver plated threads for lubrication. Outer shoulder is roll-marked with the Parker name, size and material identification.

A-LOK® precision machined back ferrule. Parker were the first to Suparcase™ harden the back ferrule and lead the world for outstanding corrosion resistance and superior grip. Includes material identification.

Suparcase™ Advantages

The result is a thin surface region supersaturated with carbon in solid solution. This surface region has some unusual advantageous properties:

- **Improved Hardness**
  Hardness Test – Suparcased samples are at least 250% harder than their untreated counterparts.
- **Increased Fatigue Strength**
  Bending Test – Suparcased samples showed 50% increase in fatigue strength with respect to the same untreated samples under the same number of cycles.
- **No change in shape, size or colour**
- **Suparcase Layer does not crack or delaminate during forming**
- **Outstanding Wear and Erosion Resistance**
  Wear Test performed on a high pressure homogenizer made out of Stainless Steel 316 – The Suparcase™ samples increased the wear & erosion resistance by 13 times in air and by 10 times in seawater with respect to their untreated counterparts.
- **Exceptional Corrosion Resistance**
  ASTM G48 - Standard Test Methods for Pitting and Crevice Corrosion Resistance of Stainless Steels and Related Alloys by Use of Ferric Chloride Solution. Test Results on Type 316 Suparcased™ stainless steel:

Condition	ASTM G 48 Ferric Chloride Test Results
As-machined (Cold Worked)	6.1% weight loss
As-machined + Suparcase™	0.0% weight loss
Annealed + Suparcase™	**No corrosion**

Suparcased Rear Ferrule

Nitride hardened Rear Ferrule

ASTM G150 Critical Pitting Temperature. CPT measures the temperature at which pitting is likely to start:

Alloy	UNS Number	CPT Range - °C
316	S31600	0 - 30
317L	S31703	32 - 45
904L	N08904	30 - 55
316 Suparcase™	S31600	69 - 75
6Mo	S31254	70 - 90