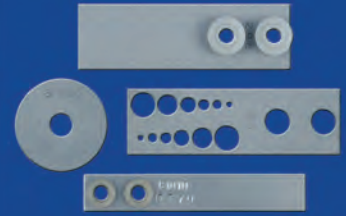
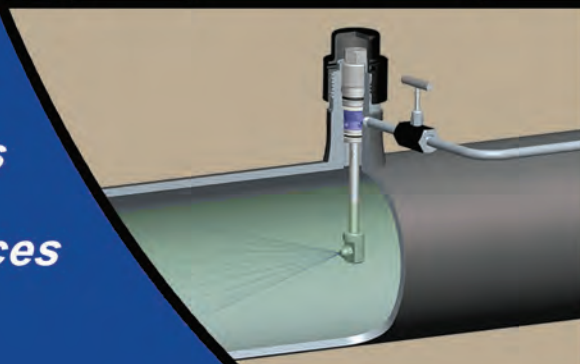


Metal Samples[®]



Corrosion Monitoring Products
Materials Evaluation Supplies
Precision Machining Services





Metal Samples is a division of Alabama Specialty Products, Inc. (ASPI) and works in association with other divisions of ASPI to provide you with a wide range of products and services.



- Corrosion Monitoring Products
- Materials Evaluation Products



- Laser Fabrication Services
- Precision Machining Services



- Advanced Laser Services
- Custom Systems



- Tissue Slicing Products

For more information on our company divisions, visit our corporate web site at:
www.alspi.com

About Metal Samples

Metal Samples specializes in manufacturing products for corrosion monitoring & materials evaluation and in providing precision machining services. Since 1980 we have supplied products and services to nuclear, medical, aerospace, chemical processing, water treating, and petroleum industries around the world.



From the beginning, founder Don Johnson's goal has been to operate this business based on Christian principles. With blessings from God, Metal Samples has grown to include over 200 employees and continues to develop new products and technologies to meet the growing needs of our customers.

Home Office:

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 Phone: (256) 358-4202
 Fax: (256) 358-4515

Houston Sales Office:

6327 Teal Mist Lane
 Fulshear, TX 77441
 Phone: (832) 451-6825

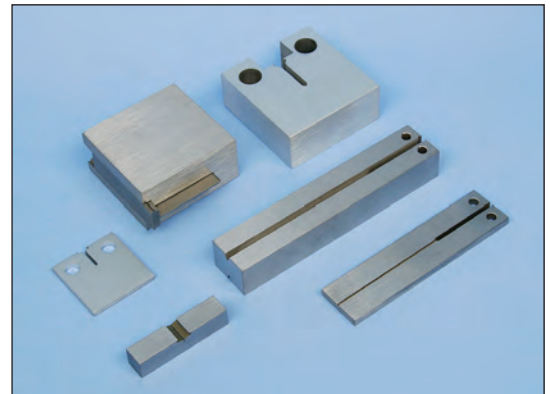
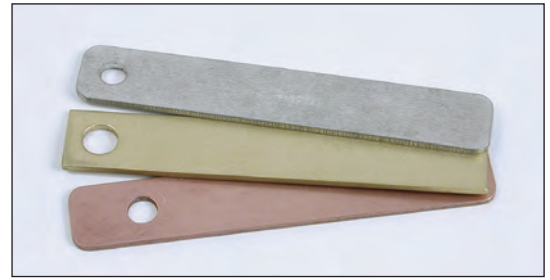
E-mail: msc@alspi.com
Web site: www.metalsamples.com



Scan code for digital copy of our catalogs.

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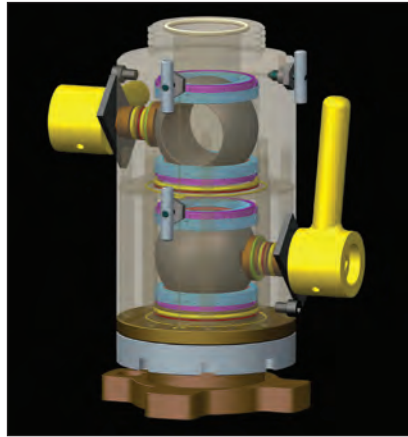
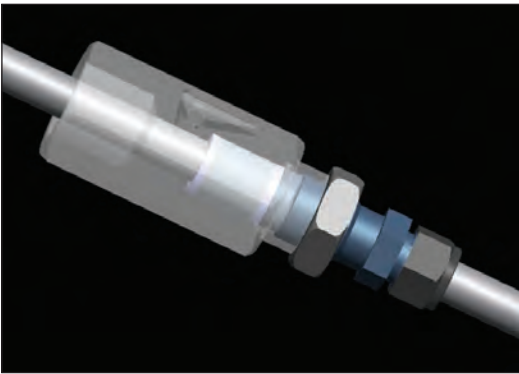


Terms & Delivery Services

- Terms - Net 30 days (subject to credit approval)
 - Minimum order inside USA - \$100.00
 - Minimum order outside USA - \$300.00
 - Overnight delivery available for many stock items
 - Orders outside the USA subject to additional charges
 - VISA™, MASTERCARD™, and AMERICAN EXPRESS™ accepted.
- (Full terms & conditions at www.metalsamples.com.)

Engineering / Design / CAD

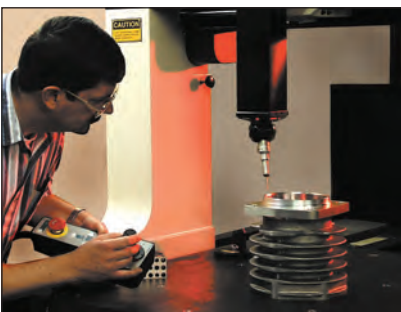
Our CAD department uses the latest in computer-aided drafting and design technology, including 3-D modeling software. Our engineering team has experience in corrosion, aerospace, electrical, mechanical, manufacturing, and materials engineering. These engineering capabilities, coupled with our machining expertise, allow us to help our customers find solutions to their specific application needs.



Quality Assurance (ISO 9001)

We emphasize high standards when it comes to the quality of your parts. To ensure the finished product will meet our customers approval, we maintain advanced training for personnel, procurement of state-of-the-art inspection equipment, and constant upgrading in our quality control area.

Our quality assurance begins with the receipt of raw materials and is adhered to throughout the manufacturing process until the final product is shipped. Technicians use high-tech inspection equipment to check the accuracy of your parts. Our quality assurance program is ISO 9001 certified, guaranteeing the highest quality on all of your orders.



Precision Machining Services

Metal Samples uses a wide variety of CNC and conventional machining equipment to offer you a one stop source for all of your manufacturing needs.

We have gained extensive experience in machining materials of all kinds, including exotic and difficult alloys such as Titanium, Nickel, Zirconium, Uranium, Molybdenum, and Rhenium.

Our machining services include:

- Laser cutting and welding
- Press brake services
- EDM services
- CNC milling, Turning
- Punching, Forming
- Laser cladding
- CNC screw machining
- Tube cutting and bending
- Waterjet cutting
- Precision plasma cutting
- Robotic welding
- Grinding, Drilling
- Powder coating
- Electropolishing
- Heat-treating, Anodizing
- Prototype fabrication

Screw Machining Services



Our CNC Swiss-type screw machines allow turning of long length to diameter ratios. These bar-fed machines allow complete automatic manufacturing of turned components with multiple features in a single operation, eliminating the need for many secondary operations.



Capabilities include milling, slotting, cross drilling and tapping, knurling, and threading.

Milling Services

Our vertical 4-axis CNC milling centers, coupled with a Pro-Engineer offline programming system, are able to machine with ball end tooling, using four axes simultaneously to produce very complex contours in a variety of materials. These machines are also capable of performing standard milling functions such as drilling, tapping, slotting, etc.

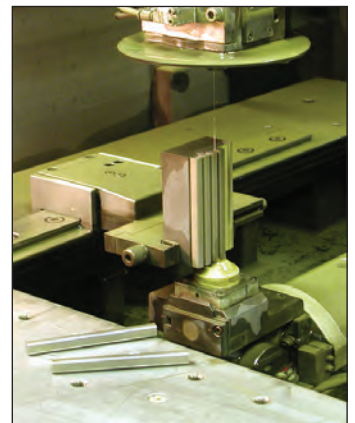


EDM Services

Our electrical discharge machining (EDM) department features the latest in technologically advanced equipment, including auto threading, 4-axis cutting, submerged machining, anti-electrolysis power supply, and small wire capabilities. Our sinker machines can EDM parts spherically and helically at the same time.



These machines are used to hold exceptionally tight tolerances on exotic and other difficult-to-machine materials. They can cut material thicknesses up to 20 inches and produce finishes of 12-15 RMS on steel and 8-9 RMS on carbide.



Punch Press Services

For rapid punching operations, we use our punch presses which can hold various sheet sizes and can punch pieces as thick as 5/16" on mild steels.

Our punch press department houses several machines, including automated CNC presses with sheet loaders.



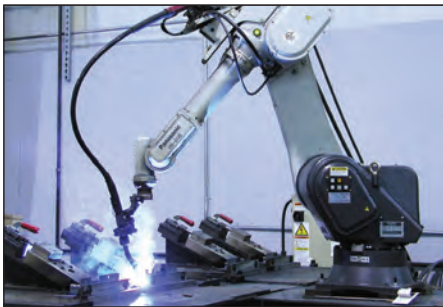
Press Brake Services

Our press brakes enable accurate bending and forming on materials, with capacity up to 220 tons and lengths up to 14 feet.

Among our many press brakes is a robotic system that allows for greater repeatability than could be obtained with conventional hand-fed machines.

Grinding Services

We provide complete precision grinding services with a variety of surface conditions, ranging from mill finishes to mirror-like finishes of 1 to 2 RMS. Capabilities include *surface, double-disc vertical and horizontal, centerless, and thread grinding*. Forms and profiles in single-run or large quantity orders can be ground cost effectively.



Robotic & Conventional Welding Services

Our welding department uses robotic welding systems which provide precise gas metal arc welds (GMAW) in repetitive motion applications. These systems are ideal for the automated run of repeat, large quantity parts.

We also have conventional welding stations (MIG & TIG) with a skilled team of welders dedicated to meet your welding needs.

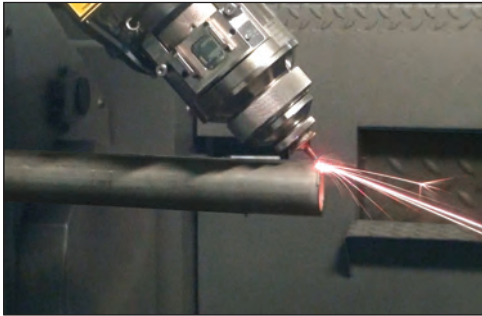
Waterjet Cutting Services

For thick plate cutting we use a combination waterjet / precision plasma cutting system. The waterjet provides tighter tolerances and allows for more intricate shape cutting, while the plasma provides greater speeds for less critical cuts.



Laser Sheet Cutting Services

Our laser systems allow rapid cutting speeds, versatility, and tight tolerances (held to $\pm .005$ " depending on material and thickness). If customers need revisions to their parts, laser cutting programs can be adjusted "on the fly", unlike the time consuming, expensive costs involved with setting up new tools and dies. Our systems can handle sheets up to 6' x 11' with typical cutting thickness up to 3/4" on carbon steel and 3/8" on stainless.



Laser Tube Cutting Services

We offer laser tube cutting services for processing round, square, rectangular, flat oval, and virtually any other type of tubing. Our laser tube cutters enable us to cut slots and holes in round tubing with diameters up to 8.625" and square tubing with side dimensions up to 8".

Laser Welding Services

Our CO₂, Nd:YAG, and fiber laser systems provide capabilities for laser welding that open up many different configurations and innovative joint designs which were previously unachievable with conventional welding methods. Laser welding is particularly useful in the welding of dissimilar metals.



Laser Marking / Etching Services

Our laser systems allow us to mark/etch carbon steel, stainless steel, aluminum, copper, mirror-finished stainless and plastics. These laser systems are capable of marking/etching different font letters, numbers, shapes, lines, barcodes, QR codes and logos with adjustable depth and darkness.



Material Inventory

Metal Samples stocks the largest variety of materials in the world. Exotic and conventional alloys are stocked in a number of forms, including bar, pipe, plate, rod, sheet, wire, and castings. Storing these materials in-house helps us expedite customer orders more effectively.



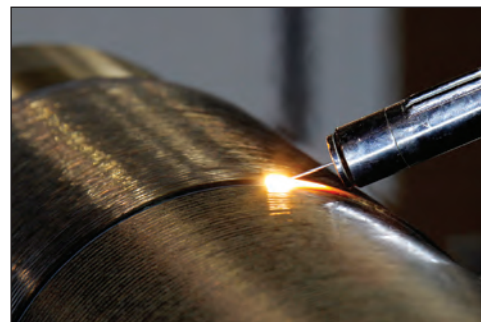
Laser Cladding Services

Through our sister company, Alabama Laser, we provide laser cladding services, using lasers to deposit a layer of material onto a substrate by way of powder or wire.



Hydraulic shaft clad for corrosion resistance

Laser cladding is emerging as a strategic technique for repairing damaged components and improving surface protection properties for better wear or corrosion resistance.



Hot wire laser cladding

Laser cladding provides minimal dilution and a small heat affected zone when compared to conventional welding. Laser cladding provides a metallurgical bond between the base material and the substrate unlike a thermal spray process where the bond is mechanical.



*Flanges (stainless steel) clad with Alloy 625 to enhance erosion / corrosion resistance
(Left: before machining, Right: after machining)*

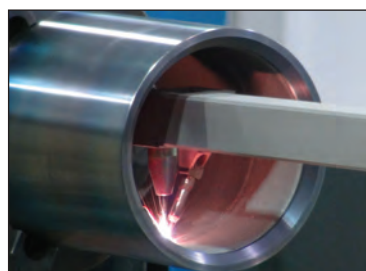
Code Stamp Certified:

- ASME - S & U Stamps
- NBIC - R Stamp

Our latest laser cladding system gives us the added capability of 5-axis motion to add material (either powder or wire) to existing parts for repair or modification. This gives us greater flexibility to work with many different geometries.



Boiler tubes (alloy steel) clad with Alloy 622



I.D. laser cladding for downhole tools



Repairing damaged areas to oil & gas seat

For more information on laser cladding or any of our other laser services, visit www.alabamalaser.com.

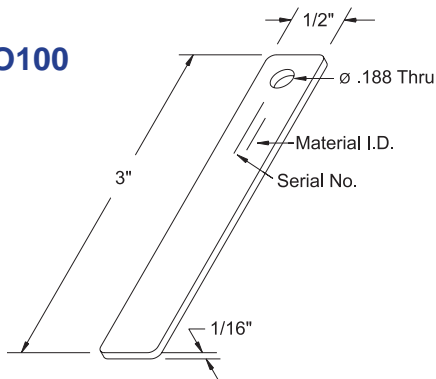
Corrosion Coupons

Accurate monitoring of corrosion rates in any environment is critical when viewed in terms of the maintenance and repair costs associated with corrosion and material failure. Test coupons provide an inexpensive means of on-line monitoring that will allow you to effectively measure the corrosivity within your system. By observing the mils-per-year corrosion rate of an exposed coupon, valuable information can be provided regarding the material's life expectancy.



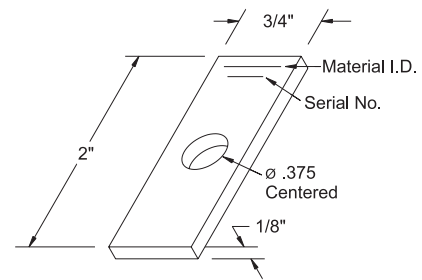
Metal Samples can make coupons in any size, shape, or material you need. Coupons can be stenciled with alloy and sequence numbers for proper identification. Mill test reports, identifying element compositions of materials used, are provided on all orders. The following coupons are four of the most commonly used in corrosion testing.

P/N CO100



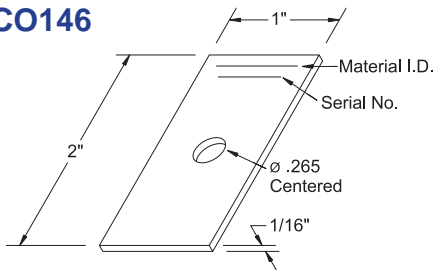
Shape	Rectangular
Finish	Double disc or glass bead
Identification	Stenciled (alloy, sequence)
Surface Area	3.38 in ²

P/N CO131



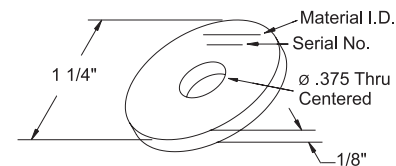
Shape	Rectangular
Finish	120 grit, glass bead, or mill
Identification	Stenciled (alloy, heat no., sequence)
Surface Area	3.47 in ²

P/N CO146



Shape	Rectangular
Finish	Glass bead or mill
Identification	Stenciled (alloy, sequence)
Surface Area	4.26 in ²

P/N CO220



Shape	Circular
Finish	120 grit, glass bead, or mill
Identification	Stenciled (alloy, sequence)
Surface Area	2.72 in ²

Finishes

- **Mill** - finished as produced from mill.
- **Glass Bead** - blasted with fine glass beads to remove mill scale.
- **120 Grit** - fine finish using a 120 grit belt. Commonly used in corrosion tests, such as pitting studies, where smooth surface finish is desired. Finishes up to 600 grit (extremely fine) can be provided.
- **Double Disc Ground** - extra fine finish using an abrasive disc that leaves minimal residue. Excellent for studies where surface finish is critical. Can produce 16-32 RMS finishes on common steels and 8 RMS on carbide steels.

Coupon Ordering and Services Available

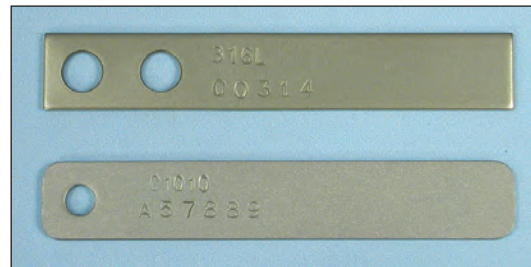
When placing your order for coupons, be ready to provide the sales person with information regarding the type of material you are testing, the size coupons required, surface finish desired, and if applicable, mounting hole size and location. The following options are available:

- Manufacturing on time and material basis
- Samples mounted on test racks and ready for installation
- Preweighing - coupons are cleaned, preweighed on an electronic scale, and individually packaged
- Weight log charts provided
- Non-standard coupons
- Coupon measuring
- Heat-treating, sensitizing, hot dip galvanizing
- Manufacturing from your material if requested
- Coupons made to specific requirements for mounting hole locations, coupon welding, stressing, and packaging
- Plating - nickel, nickel cadmium, cadmium, chrome, silver, gold, and others upon request
- Electro-polishing, hard facing
- Non-metallic coatings
- Anodizing and alonizing

Standard Coupons

Flat Coupons

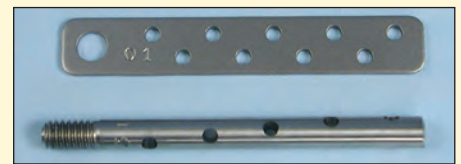
P/N	Size	Hole	Hole Location	Area Sq. In.
CO100	1/2" x 3" x 1/16"	3/16"	1/4" fr. end	3.38
CO101	1" x 2" x 1/16"	3/16"	1/4" fr. end	4.32
CO102	1/2" x 3" x 1/16"	9/64"	1/8" fr. end	3.41
CO103	1/2" x 3" x 1/16"	1/4"	1/4" fr. end	3.34
CO104	1/2" x 3" x 1/16"	(2) 1/4"	1/2" fr. ea. end	3.24
CO105	1/2" x 3" x 1/16"	3/16"	1/2" fr. end	3.38
CO106	1/2" x 3" x 1/16"	1/4"	1/2" fr. end	3.34
CO115	1/2" x 3" x 1/16"	1/4"	1/4" fr. end	3.37
CO117	3/8" x 3" x 1/16"	9/64"	1/8" fr. end	2.64
CO118	1/2" x 3" x 1/16"	(2) 1/4"	1/4" & 3/4" end	3.24
CO120	3/8" x 3" x 1/16"	(2) 1/4"	1/4" & 3/4" end	2.48



Scale coupons (or deposition coupons) provide a qualitative measure of relative deposition rates in industrial water and manufacturing process systems.

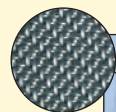
P/N CO115 (flat)

P/N ES209
(cylindrical)



The coupons listed above are made from a variety of materials (see Alloys list).

Mesh bio film coupons are used for quantification or identification of microorganisms.

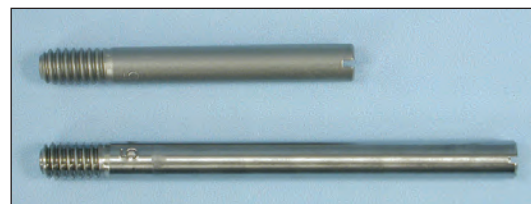


P/N COJ36



Cylindrical Coupons

P/N	Size	Thread	Slot	Area Sq. In.
ES200	1/4" Ø x 2 1/2"	1/4"-20 x 3/8"	1/16"	1.96
ES201	1/4" Ø x 2"	1/4"-20 x 3/8"	1/16"	1.57
ES202	1/4" Ø x 3"	1/4"-20 x 3/8"	1/16"	2.45
ES204	1/4" Ø x 1 1/2"	1/4"-20 x 3/8"	1/16"	1.18
ES209*	1/4" Ø x 3"	1/4"-20 x 3/8"	1/16"	



* ES209 has five 1/8" diameter scale holes.

Coupon Holders

Fixed (Pipe Plug) Coupon Holders

Metal Samples carries a variety of standard pipe plug coupon holders for flat and cylindrical specimens. We can design and make these assemblies to meet your specifications for size and material requirements.

Pipe Plug Assemblies for Flat Coupons

P/N	Plug Size	3" (Std.) Stem	Used with Coupon P/N
RC12E*100036	3/4" NPT	Nylon	CO102, CO117
RC13E*100036	1" NPT	Nylon	CO102, CO117
RC12Q*100036	3/4" NPT	Teflon®	CO102, CO117
RC13Q*100036	1" NPT	Teflon®	CO102, CO117
RC12E*010036	3/4" NPT	Nylon	CO100, CO103, CO115
RC13E*010036	1" NPT	Nylon	CO100, CO103, CO115
RC12Q*010036	3/4" NPT	Teflon®	CO100, CO103, CO115
RC13Q*010036	1" NPT	Teflon®	CO100, CO103, CO115
RC12E*030036	3/4" NPT	Nylon	CO118, CO120
RC13E*030036	1" NPT	Nylon	CO118, CO120
RC12Q*030036	3/4" NPT	Teflon®	CO118, CO120
RC13Q*030036	1" NPT	Teflon®	CO118, CO120
RC12E*090036	3/4" NPT	Nylon	CO105, CO106
RC13E*090036	1" NPT	Nylon	CO105, CO106
RC12Q*090036	3/4" NPT	Teflon®	CO105, CO106
RC13Q*090036	1" NPT	Teflon®	CO105, CO106
RC11E*010036	1/2" NPT	Nylon	CO100, CO103, CO115

* Add "3" to part number for Carbon Steel or "C" for PVC plug.
 (Example: Carbon Steel 3/4" pipe plug Nylon stem = RC12E3100036.)

Pipe Plug Assemblies for Cylindrical Coupons

P/N	Carbon Steel Plug	Insert	# of Coupons
PA2080709413	2" NPT	Nylon	8
PA2080783413	2" NPT	Teflon®	8
RC11E3040000	1/2" NPT	Nylon	1
RC12E3040000	3/4" NPT	Nylon	1
RC13E3040000	1" NPT	Nylon	1

All of these holders are used with ES2 series coupons.

Bypass Piping Systems

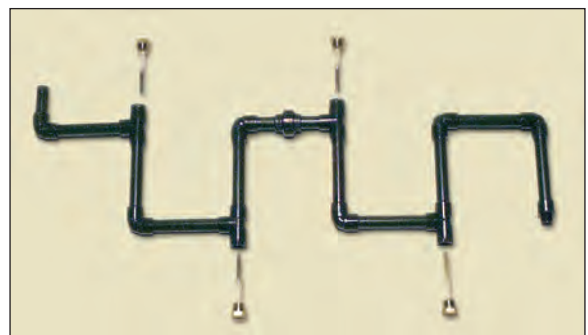
We provide conventional or custom-designed bypass systems for on-line corrosion monitoring. Commonly used in the industrial water treatment industry to determine the corrosive properties of potable or cooling water, these systems are available in PVC, carbon and stainless steels, and other materials.

Bypass systems are easily installed to your existing piping. Normally, all you need is a 1" NPT male fitting on which to attach the bypass. Standard bypass systems come equipped with 4 pipe plug assemblies, 4 pre-weighted mild steel coupons, and a 5-gpm flow control valve.



Bottle Cap Coupon Holder Assemblies

used with Schott bottles with a DIN GL 45 thread.



Adjustable Coupon Holders

Low Pressure or **Hand Insertable** systems can be used for pressures up to 125 psi. This assembly is commonly used in the water treating industry for coupon insertion through a full port valve. An example of this is in a municipal water pumping station, where leakage during withdrawal of the test coupon would not be critical.



Retractable Coupon Holders

Packing Gland systems are used in more demanding environments, where ratings up to 1,500 psi are required and leakage is prohibited. These systems do not require line (process) shutdown to insert or withdraw coupons. The assembly is used for coupon insertion through at least a 1" full port valve. A safety chain is provided to prevent accidental ejection.

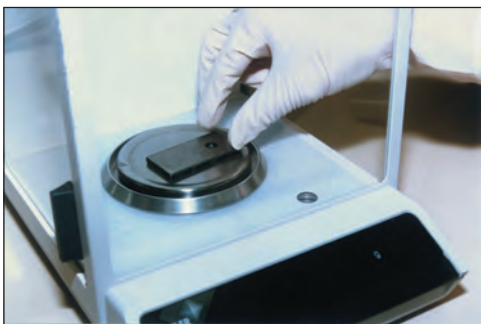
Retrievable Coupon Holders

These coupon holders are used with High Pressure Access Systems where pressure ratings up to 3,600 psi are required.

For more information, visit our website at www.metalsamples.com.



Post Exposure Coupon Analysis



Metal Samples offers post exposure coupon analysis. Our trained technicians will perform weight loss analysis and determine mils per year (MPY) corrosion rates of your exposed test samples. We are in adherence to ASTM-G1 specifications for cleaning and analyzing coupons.

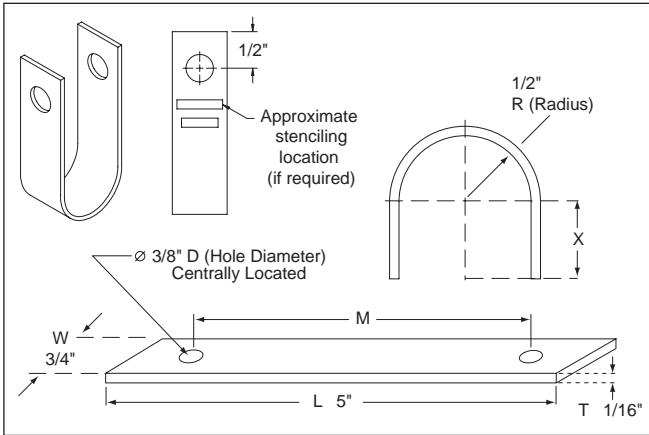
When using this service, ensure that initial coupon weights, exposure dates, and locations are recorded for each sample. This information can be recorded on the front of a VCI coupon storage bag.

Optional services include pit depth measurement and photos of the coupons before and after analysis. For additional information on post exposure coupon analysis see "Coupon Evaluation after Exposure" on page 36.

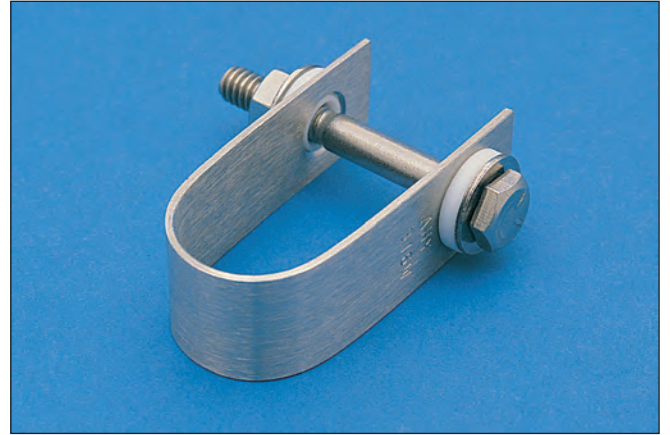
Stressed Coupons

Stress corrosion cracking occurs when tensile stress combines with a corrosive environment to attack a material. Testing for this type of corrosion is critical in storage tanks, pressure piping, and vessels commonly used in chemical processing plants and petrochemical refineries. Metal Samples can make your stressed samples in accordance with all ASTM standards including G30, G38, G39, and G58 or to your custom specifications.

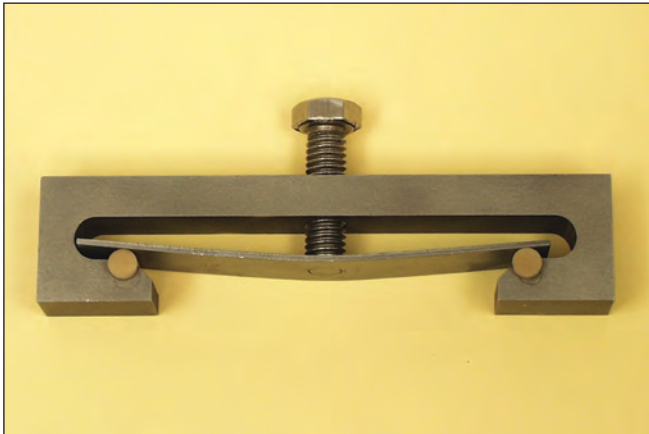
P/N CS502 - ASTM G30



P/N CS502W (Welded) - ASTM G58



**P/N TF2445
3-Point Bent Beam Assembly - ASTM G39**



**P/N TF2404 Stressing Frame
with P/N TF2447 4-Point Bent
Beam Assembly - ASTM G39**



**P/N CO303
Twist Specimen**



**P/N CS500
Tear Drop**

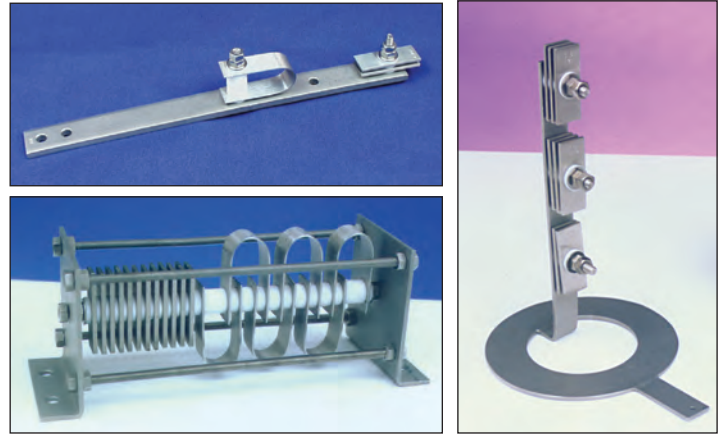


**P/N CS513
"C" Ring - ASTM G38**



Test Racks

Metal Samples offers test racks used to mount coupons and secure them directly to operating equipment or within a process system. Test racks make it easy to evaluate how corrosion would effect differing alloys and material finishes under identical conditions. Rack usage helps eliminate coupon loss which might occur if samples were individually placed in a process flow.



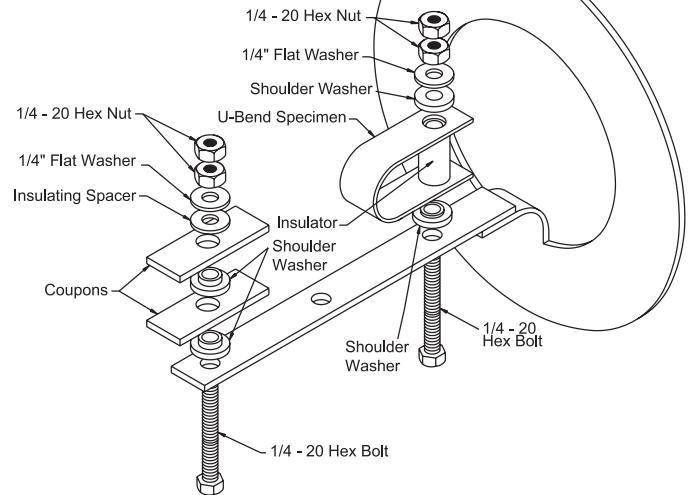
Racks can be fabricated to meet your requirements for material and size. Typical racks are flat bar racks, spool racks, and pipeline insertion racks. Other racks include angle bar racks and outdoor exposure racks. A variety of insulators, washers, and spacers used to isolate coupons can also be ordered separately.

Guidelines for Supporting Specimens

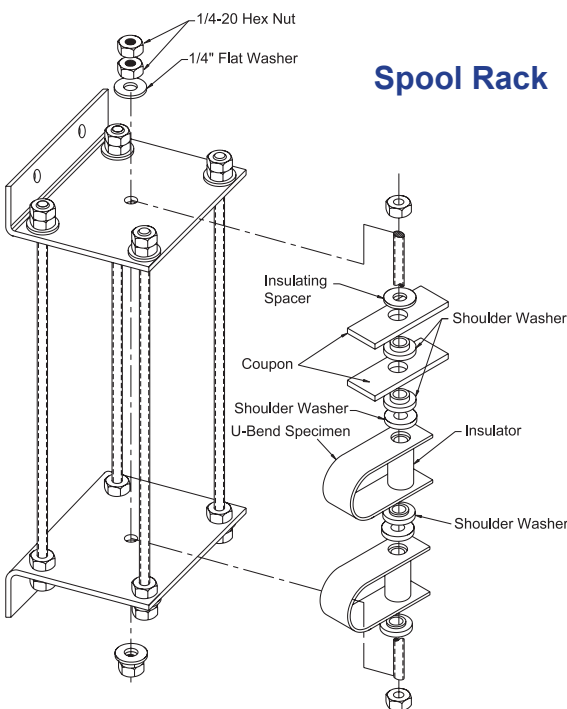
Corrosive behavior of materials subjected to immersion, partial immersion, or vapor phase can have great variance. For this reason, specimens to be tested should be properly positioned. There are several important points to be considered when supporting specimens for exposure:

- Each specimen location should be identified by sketch and recorded.
- The corrosive media should have access to the coupons.
- The test rack should have adequate corrosion resistance to endure the test.
- Specimens should be electrically isolated from other metals unless galvanic effects are being studied.
- Specimens should be located in easily accessible areas.

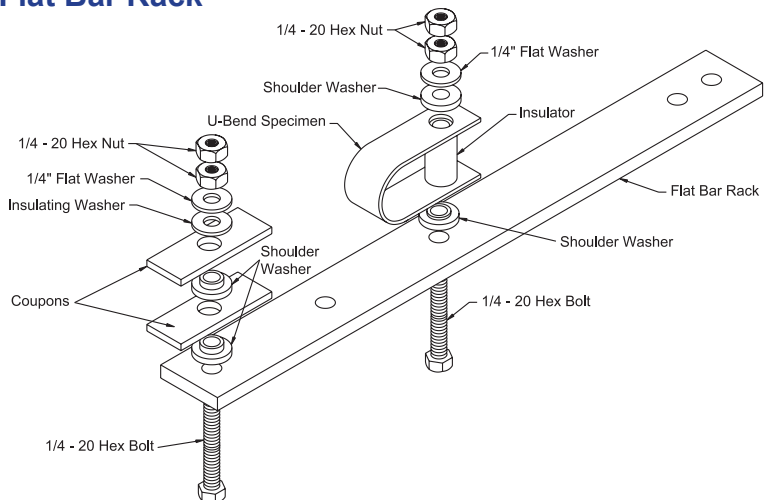
Pipeline Insertion Rack



Spool Rack



Flat Bar Rack



Insulators, Washers, & Spacers

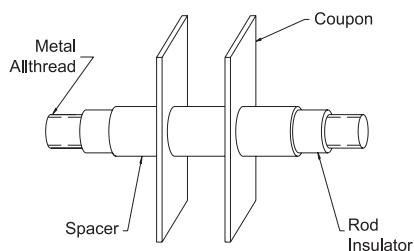
Metal Samples makes a variety of insulators, washers, and spacers used to isolate test specimens. We also make insulator kits (P/N KR5102) that contain an assortment of washers, screws, nuts, and stems. These kits are designed for field use when a variety of insulators are needed. The chart shown here is a general guide to material applications. Call for recommendations on use in hazardous or severe environments.

Material vs. Environment

Material	Acids		Alkalies		Organic Solvents	Water Absorption % 24 hrs.	Oxygen and Ozone	High Vacuum	Ionizing Radiation	Temperature Resistance		Tensile Strength lb/in
	Weak	Strong	Weak	Strong						High	Low	
Fluorocarbons TFE	Inert	Inert	Inert	Inert	Inert	0.0	Inert	-	P	550	G-275	2,500
Nylon	G	A	R	R	R	1.5	SA	-	F	300	G-70	10,000
Polyethylene (low density)	R	A-O	R	R	G	0.15	A	F	F	140	G-80	2,000
Polyethylene (high density)	R	A-O	R	R	G	0.1	A	F	G	160	G-100	4,000
Polypropylene	R	A-O	R	R	R	0.01	A	F	G	300	P	5,000
Rigid polyvinyl chloride	R	R	R	R	A	0.10	R	-	P	150	P	6,000
Phenolics	SA	A	SA	A	SA	0.6	-	-	G	400	L	7,500
Zirconia ceramics	R	R	R	R	R	0.0	R	-	-	-	-	-
Alumina ceramics	R	R	R	R	R	0.0	R	-	-	3180	-	-

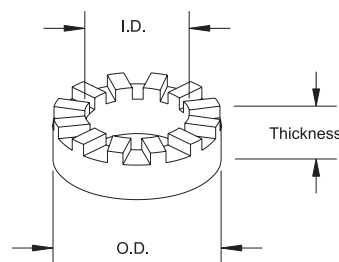
R = Resistance A = Attacked SA = Slight Attack A-O = Attacked by Oxidizing Acids G = Good F = Fair P = Poor L = Little Change

Rod Insulators



Material	P/N	OD (inches)	ID (inches)
Teflon®	04783002180015	.218	.188
	04783002960025	.296	.250
	04783003750062	.375	.250
	04783004060078	.406	.250
	04783004370093	.437	.250
	04783004370031	.437	.375
	04783005000062	.500	.375
	04783006250125	.625	.375
	04783006250078	.625	.470
04783008750162	.875	.550	

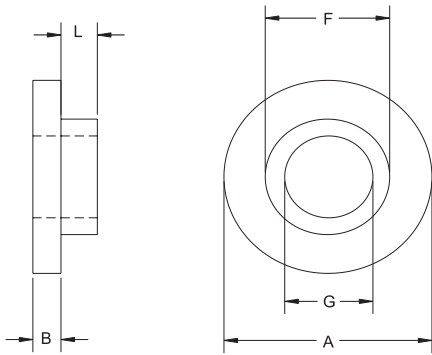
Crevice Washers



Material	P/N	Dimensions (inches)			# of Slots
		ID	OD	Thickness	
Teflon®	CW1900783	.391	.625	.250	12
	CW1902783	.265	.625	.250	12
	CW1904783	.265	.625	.100	12
Ceramic	CW1902473	.265	.625	.250	12

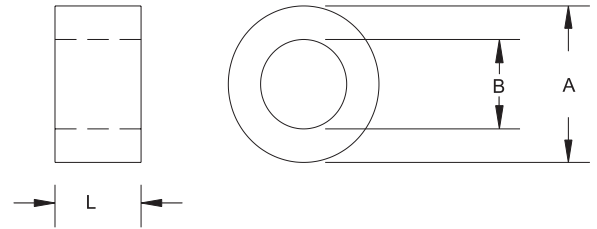
Contact our sales department for the availability of insulators, washers, and spacers not listed.

Shoulder Washers



Material	P/N	Dimensions (inches)				
		L	A	B	G	F
Ceramic	SW1402473	.050	.375	.090	.193	.250
	SW1425473	.050	.625	.125	.250	.375
TFE Glass	SW1439785	.109	.625	.094	.250	.313
Teflon®	SW1400783	.109	.625	.109	.250	.313
	SW1402783	.063	.375	.063	.188	.250
	SW1403783	.125	.625	.438	.250	.406
	SW1406783	.234	.625	.109	.250	.375
	SW1407783	.109	.625	.109	.250	.375
	SW1413783	.063	.656	.500	.250	.406
	SW1418783	.125	.641	.500	.359	.453
	SW1419783	.109	.625	.188	.250	.375
	SW1420783	.188	.625	.109	.250	.375
	SW1421783	.125	.438	.063	.188	.297
	SW1423783	.055	.625	.500	.250	.531
	SW1424783	.063	.750	.250	.250	.500
	SW1425783	.050	.625	.109	.250	.375
	SW1426783	.050	.625	.313	.250	.375
	SW1427783	.313	.500	.063	.203	.313
Nylon	SW1443709	.125	.375	.031	.188	.250
	SW1427709	.313	.500	.063	.203	.313
	SW1444709	.047	.375	.094	.188	.250

Spacers & Flat Washers



Material	P/N	Dimensions (inches)		
		L	A	B
Teflon®	ST1200783	.500	.375	.250
	ST1202783	.250	.375	.250
	ST1203783	.188	.375	.250
	ST1204783	.250	.625	.250
	ST1205783	.750	.500	.359
	ST1206783	.500	.500	.344
	ST1207783	.500	.625	.375
	ST1208783	.250	.625	.406
	ST1209783	.625	.625	.375
	ST1214783	.375	.625	.375
	ST1219783	.750	.750	.500
	ST1221783	.375	.500	.375
	ST1225783	.375	.625	.500
	ST1226783	1.00	.625	.265
	ST1231783	.125	.422	.363
	ST1232783	.375	.375	.250
	ST1253783	.062	.500	.250
	ST1254783	.062	.625	.250
	ST1255783	.125	.500	.125
	ST1256783	.188	.445	.188
Nylon	09709E1000-FW0000	.047	.438	.203
	ST1240709	.062	.375	.203
	ST1239709	.062	.375	.250
	ST1230709	.125	.500	.313
	09709E2500-FW0000	.094	.500	.250
Ceramic	ST1220473	.250	.500	.375
	ST1240473	.062	.375	.188
	ST1247473	.500	1.00	.560
	ST1248473	.125	.600	.394
	ST1249473	.125	.625	.250

Fasteners

We make a variety of fasteners in almost any material required, including:

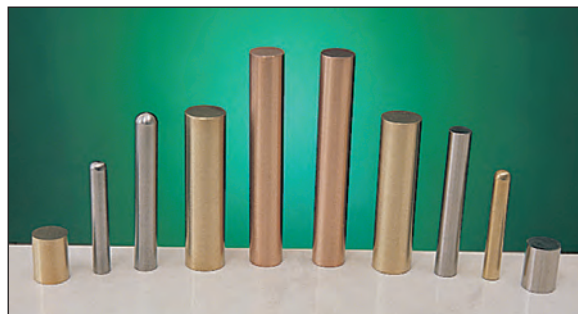
- Brass
- 304
- 316
- Teflon®
- Nylon
- Tantalum
- HASTELLOY® C-276
- Carpenter® 20Cb3
- HASTELLOY® B-2
- Titanium
- INCONEL® alloy 600



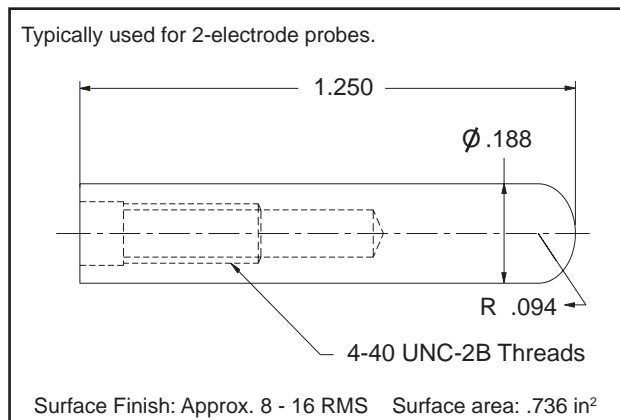
Teflon® is a registered trademark of DuPont. HASTELLOY® is a registered trademark of Haynes International, Inc. INCONEL® alloy 600 is a registered trademark of Special Metals. Carpenter® 20Cb3 is a registered trademark of Carpenter Technologies.

Electrodes

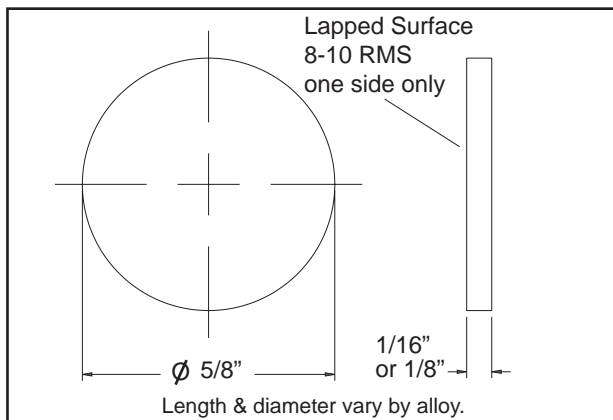
Metal Samples provides electrodes compatible with our various probes and instruments, as well as those of most other major manufacturers. Other electrodes not shown here are also available. Electrodes are made from a variety of materials (see Alloys list).



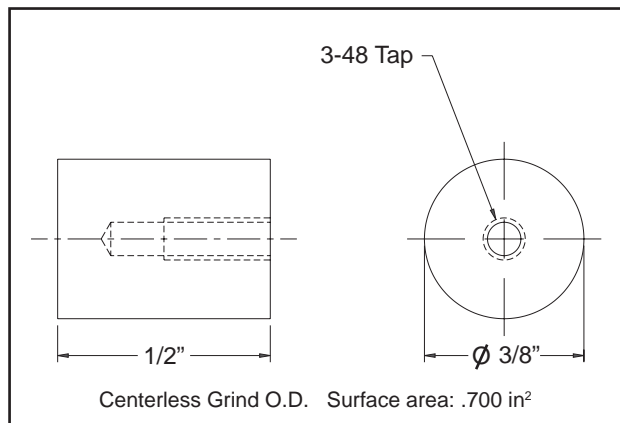
P/N EL400



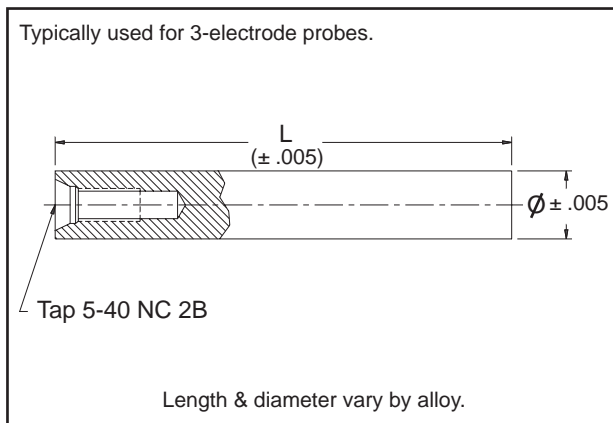
P/N EL405



P/N EL410

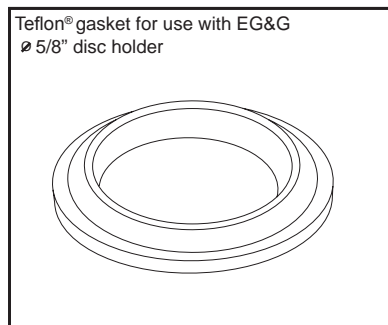


P/N EL412

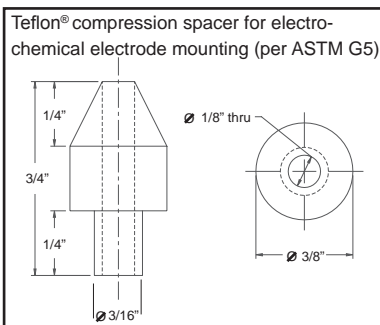


Gaskets Commonly used with Electro-Chemical Apparatus

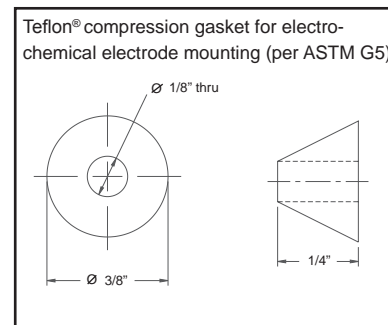
P/N MI2616



P/N MI2604



P/N MI2605



Alloys

UNS	Material	Density (g/cm ³)
Aluminum & Aluminum Alloys		
A03190	Al 319	2.79
A03191	Al 319.1	
A03192	Al 319.2	
A03330	Al 333	
A03331	Al 333.1	2.70
A03550	Al 355	2.71
A03552	Al 355.2	2.68
A03561	Al 356.1	
A03562	Al 356.2	2.68
A03600	Al 360	
A03800	Al 380	
A03900	Al 390	
A04432	Al 443.2	
A05142	Al 514.2	
A05352	Al 535.2	
A07720	Al 772.0	
A91100	Al 1100	2.71
A91145	Al 1145	
A92011	Al 2011	2.82
A92014	Al 2014	2.80
A92017	Al 2017	
A92024	Al 2024	2.77
	Al 2024 ALCLAD	
A92036	Al 2036	
A92090	Al 2090	
A92219	Al 2219	
A93003	Al 3003	2.73
A93004	Al 3004	
A94043	Al 4043	
A95005	Al 5005	2.70
A95050	Al 5050	2.69
A95052	Al 5052	2.68
A95083	Al 5083	2.66
A95086	Al 5086	2.65
A95154	Al 5154	2.66
A95182	Al 5182	
A95254	Al 5254	
A95257	Al 5257	
A95454	Al 5454	2.68
A95456	Al 5456	2.66
A95652	Al 5652	
A96061	Al 6061	2.70
A96063	Al 6063	2.70
A97039	Al 7039	
A97050	Al 7050	
A97075	Al 7075	2.80
	Al 7075 ALCLAD	
A97178	Al 7178	2.82

UNS	Material	Density (g/cm ³)
Copper & Copper Alloys		
C10100	CDA 101 OFE	8.89
C10200	CDA 102 OFE	8.89
C10300	CDA 103	8.89
C11000	CDA 110 ETP	8.89
C11400	CDA 114 STP	8.91
C12200	CDA 122 DHP	8.94
C15100	CDA 151	
C17200	CDA 172	8.23
C17300	CDA 173	
C18200	CDA 182	
C19400	CDA 194 HSM	8.78
C19500	CDA 195	
C22000	CDA 220 Com. Bronze	8.80
C23000	CDA 230 Red Brass	8.75
C26000	CDA 260 Cartridge Br.	8.53
C26800	CDA 268 Yellow Brass	8.47
C27200	CDA 272	
C27400	CDA 274	
C28000	CDA 280 Muntz Metal	8.39
C31600	CDA 316 Leaded Bronze	8.83
C33000	CDA 330	
C34500	CDA 345	
C35300	CDA 353	
C36000	CDA 360 FC Brass	8.49
C36500	CDA 365	
C44300	CDA 443 Admiralty Br.	8.52
C46400	CDA 464 Naval Brass	8.41
C48500	CDA 485 Leaded Naval	8.44
C51000	CDA 510 Phos. Bronze	8.86
C51900	CDA 519	
C52100	CDA 521	
C61000	CDA 610	
C61300	CDA 613	8.50
C61400	CDA 614 Al Bronze D	8.45
C62300	CDA 623	
C62400	CDA 624	
C62500	CDA 625	
C63000	CDA 630 Ni Al Bronze	7.58
C63200	CDA 632	
C64200	CDA 642 Al Bronze	7.69
C65100	CDA 651	
C65500	CDA 655 High Silicon	8.52
C67300	CDA 673	
C67500	CDA 675 Mn Bronze A	8.63
C68700	CDA 687 Al Brass	8.33
C70600	CDA 706 (90/10)	8.94
C71000	CDA 710 (80/20)	8.94
C71500	CDA 715 (70/30)	8.94
C72200	CDA 722	
C75200	CDA 752	
C83600	CDA 836	8.80
C83800	CDA 838	
C84400	CDA 844	
C84500	CDA 845	

UNS	Material	Density (g/cm ³)
Copper & Copper Alloys (cont'd)		
C85200	CDA 852	
C85400	CDA 854 Leaded Yellow	8.45
C85700	CDA 857	
C86200	CDA 862	
C86300	CDA 863 Mn Bronze	7.70
C86400	CDA 864	
C87500	CDA 875	
C90300	CDA 903 Tin Bronze	8.80
C90500	CDA 905	8.73
C90700	CDA 907	8.80
C91600	CDA 916	
C92200	CDA 922	8.64
C92700	CDA 927	8.80
C93200	CDA 932	8.91
C93700	CDA 937	8.95
C94400	CDA 944	
C95300	CDA 953	
C95400	CDA 954 Al Bronze 9L	7.45
C95500	CDA 955	8.20
C95800	CDA 958	8.80
C96200	CDA 962	8.94
C96400	CDA 964	8.94
C97800	CDA 978	8.86
Carbon & Alloy Steels		
G10050	C1005	
G10080	C1008	7.85
G10090	C1009	
G10100	C1010 Mild Steel	7.87
G10150	C1015 Mild Steel	7.87
G10180	C1018 Mild Steel	7.87
G10200	C1020 Mild Steel	7.87
G10260	C1026 Mild Steel	7.87
G10350	C1035	
G10400	C1040	
G10420	C1042	
G10450	C1045	7.84
G10500	C1050	7.84
G10600	C1060	
G10740	C1074	
G10750	C1075	
	C1076	
G10800	C1080	
G10950	C1095	
G11170	C1117	
	C11L17	
G11370	C1137	
G11410	C1141	
G11440	C1144	
G12144	C12L14	
G12150	C1215	
	C15830	
G41300	C4130	7.85
	C4130X	7.85

All alloys are subject to availability. For alloys not listed here, please contact our sales department. Densities listed are for general reference only.

UNS	Material	Density (g/cm ³)	UNS	Material	Density (g/cm ³)	UNS	Material	Density (g/cm ³)
Carbon & Alloy Steels (cont'd)			Carbon & Alloy Steels (cont'd)			Heat & Corrosion Resistant Steels Including Stainless Steels (cont'd)		
G41400	C4130MOD C4140 Alloy Steel C4140C C4140D C41L40 C41L50	7.85	K12542	A202 Gr B		S30300	302 HQ 303 303 (P-70)	7.90
G41420	C4142		K12766	A508 Class 2		S30323	303Se	
G41500	C4150 C4330V		K13050	A350 Lf 5		S30400	304	7.94
G43400	C4340 Alloy Steel C4340A C4340B	7.84	K13502	A508 CL1		S30403	304L	7.94
G52986	C52100		K20747	A710 Gr A		S30409	304H 304 .25%B 304 1%B	
G86200	C8620		K21590	A182 F22 (2¼ Cr, 1 Mo)	7.86	S30451	304N	
G86300	C8630		K24728	A355 Gr A		S30453	304LN	
G87400	C8740		K31820	HY80		S30800	308	8.00
G93106	C9310		K32018	A203 Gr E		S30883	308L	
K01200	A179	7.85	K32045	HY100 HY130		S30900	309	7.98
K01201	A192		K41545	A387 F5		S30908	309S	8.00
K01800	A516 Gr 55 A213		K42544	A182 F5a (5 Cr, 1/2 Mo)	7.78	S31000	310	7.98
K01807	A214	7.86	K81340	A553 A569 A606 A610 A611	7.87	S31008	310S	7.98
K02100	A516 Gr 60	7.83	K90941	A182 F9 (9 Cr, 1 Mo)	7.67	S31009	310H	
K02303	A572 Gr 50		N08705	HP HP50		S31603	316 / 316L 316LM	7.98
K02400	A537 CL1		K91283	HP 9-4-30		S31653	316LN	
K02401	A515 Gr 60 / A283 Gr C	7.83	K92890	Nimark 250 A120 A366		S31700	317	7.98
K02504	A53 Gr A	7.84	S50300	A182 F7	7.78	S31703	317L	7.98
K02600	A36	7.85	S50200	A387 Gr 5 Manganese Steel		S31725	317LM	7.98
K02700	A516 Gr 70	7.83	K44220	300M		S31753	317LN 317LNMo	7.90 7.98
K02801	A285 Gr C	7.84	Coated, Plated or Special Conditioned Steels			S32100	321	7.90
K03000	A500 Gr B		Aluminized Steel			S32900	329	7.98
K03005	A53 Gr B	7.87	Chrome Plated Steel			N08330	330	8.03
K03006	A333 Gr 6 / A106 Gr B	7.84	Galvanized Steel			N06333	333	8.24
K03009	A350 Lf 1		Terne Steel			S34700	347	8.03
K03101	A515 G 70	7.83	Tin Plated Carbon Steel			S34800	348	
K03300	A455		Tin Plated Steel			S40300	403	7.70
K02707	A210 Gr A1		Heat & Corrosion Resistant Steels Including Stainless Steel			S40500	405	7.80
K03501	A210 Gr C		S13800	13-8 PH Mo		406A1		
K03502	A181 Gr 2		S15500	15-5 PH	7.80	406A2		
K03506	A266 CL 2		S15700	15-7 PH Mo 15B30	7.80	406A4		
K11430	A588 Gr A/Cor-Ten B	7.83	S17400	17-4 PH	7.80	S40900	409	7.64
K11510	A242 Type1/Cor-Ten A	7.89	S17700	17-7 PH	7.80	S41000	410	7.70
K11547	A213 T2		K14675	17-22A		S41008	410S	
K11572	A182 F11(1¼Cr, ½Mo)	7.86	K23015	17-22AS 18SR		S41600	416	7.70
K11597	A213 T11 A513		S16100	CROLOY 16-1		S41800	418	
K11662	A514 Gr D		S20100	201L	7.94	S42000	420	7.70
K11757	A387 F12	7.87	S20300	203		S42020	420F	
K11789	A387 F11		S30100	301	7.90	S42200	422	
K11804	A656 Gr 80 A694 Gr 52		S30200	302	7.94	S43000	430	7.72
K11820	A204 Gr A		Coated, Plated or Special Conditioned Steels			S43036	430Ti	
K11856	A514 Gr A		Aluminized Steel			S43100	431	7.73
K12020	A204 Gr B		Chrome Plated Steel			S43700	437	
K12022	A302 Gr B		Galvanized Steel			S43035	439	7.64
K12023	A209 T1a		Terne Steel			S44002	440A	7.70
K12045	A541		Tin Plated Carbon Steel			S44004	440C	7.70
K12521	A533 Gr A		Tin Plated Steel			S44100	441	

All alloys are subject to availability. For alloys not listed here, please contact our sales department. Densities listed are for general reference only.

Alloys Listed by Trademark

UNS	Material	Density (g/cm ³)
Allegheny Ludlum Corporation		
	316LXN TM	8.03
S31725	317LX TM	8.03
S31726	317LXN TM	8.03
N08367	AL-6XN [®]	8.06
	AL-6XN Plus TM	
N08904	AL-904L TM	7.95
S15500	AL 15-5 TM	
S15700	AL 15-7 TM	
S17400	AL 17-4 TM	
S17700	AL 17-7 TM	
N08020	AL 20 TM	8.08
S32003	AL 2003 TM	7.78
	AL 22-3 TM	
S44735	AL 29-4C [®]	7.65
S20400	AL 30 TM	
S24000	AL 33 TM	7.84
K93600	AL 36 TM	
	AL 42 TM	
	AL 45 TM	
S20910	AL 50 TM	7.95
N14052	AL 52 TM	
N02200	AL 200 TM	8.90
N02201	AL 201 TM	8.90
S20153	AL 201LN TM	7.86
	AL 216 TM	
S21904	AL 219 TM	7.85
S31803	AL 2205 TM	7.88
S32550	AL 255 TM	7.72
N10276	AL 276 TM	8.90
	AL 304DA TM	7.86
	AL 310L TM	
N08800	AL 332 TM	8.03
	AL 344 TM	
N04400	AL 400 TM	8.83
	AL 403 TM	
	AL 409Cb TM	7.76
S40930	AL 409HP TM	7.76
	AL 410 TM	7.65
	AL 410HC TM	
	AL 418 TM Special	7.86
	AL 420 TM	7.73
	AL 425 Mod TM	7.72
	AL 433 TM	7.75
	AL 436S TM	7.75
S43035	AL 439HP TM	
	AL 440A TM	7.74
	AL 440C TM	
	AL 441 TM	7.71
	AL 441HP TM	
	AL 467 TM	
	AL 468 TM	
K94800	AL 4750 TM	
N06600	AL 600 TM	8.42
N06601	AL 601 TM	8.05
	AL 610 TM	
	AL 611 TM	

UNS	Material	Density (g/cm ³)
Allegheny Ludlum Corp. (cont'd)		
N06625	AL 625 TM	8.44
N08800	AL 800 TM	8.03
N08810	AL 800H TM	8.03
N08811	AL 800AT TM	8.03
N08825	AL 825 TM	8.13
K91470	ALFA I TM	7.38
K91470	ALFA II TM	7.34
N06625	ALTEMP [®] 625	8.44
N07718	ALTEMP [®] 718	8.19
S66286	ALTEMP [®] A-286	7.92
N06002	ALTEMP [®] HX	8.22
S35000	AM 350 TM	7.81
S35500	AM 355 TM	7.91
	AM 362 TM	
	AM 363 TM	
S44627	E-BRITE 26-1 [®]	7.67
N08700	JS 700 TM	7.95
K91470	Ohmaloy [®] 30	
K91470	Ohmaloy [®] 40	
K94760	Sealmet [®] 4	
	Sealmet [®] 485	
	Silectron [®]	
Carpenter Technology Corp.		
N08020	20Cb3 [®]	8.08
N08024	20Mo4 [®]	8.11
N08026	20Mo6 [®]	8.13
N20910	22 Cr-13 Ni-5 Mn	7.88
S28200	18-18 PLUS [®]	7.88
S45000	Custom 450 [®]	7.75
S45500	Custom 455 [®]	7.76
N07716	Custom 625 PLUS [®]	8.40
S32950	7 Mo PLUS [®]	7.75
N07031	PYROMET [®] 31	7.99
S30430	Custom Flo 302 HQ	7.92
S30300	Project 70 [®] Type 303	7.83
N06600	PYROMET [®] 600	8.43
R30605	L605	9.20
S66286	CONSUMET [®] A286	7.92
	HyMu "77"	
	HyMu "80" [®]	8.74
	High Permability "45"	
	High Permability "49" [®]	8.18
	NI MARK [®] 250	8.02
	Temp. Compensator "30"	8.70
	Temp. Compensator "32"	8.12
K93601	Carpenter Invar "36" [®]	8.05
K94610	KOVAR [®]	8.36
K94100	Glass Sealing "42"	8.12
N14052	Glass Sealing "52"	

UNS	Material	Density (g/cm ³)
Deloro Stellite Inc.		
	Deloro [®] alloy #30	
	Deloro alloy #40	8.20
	Deloro alloy #50	
	Delchrome [®] alloy W	
	Delchrome alloy #90	
	Delchrome alloy #93	
	Nistelle [®] alloy B-2C	
	Nistelle alloy C-4C	
	Nistelle alloy X	
	NoCo TM 02	
	Stellite [®] alloy #3	8.69
R30404	Stellite alloy #4	8.73
R30006	Stellite alloy #6	8.46
R30016	STELLITE 6B (Wrought Alloy)	
	STELLITE 6K (Wrought Alloy)	
R30012	Stellite alloy #12	
	Stellite alloy #19	
R30021	Stellite alloy #21	
	Stellite alloy #25	
R30031	Stellite alloy #31	
	Stellite alloy #33	
	Stellite alloy #100	
	Stellite alloy #250	
R31001	Stellite alloy Star J	
	Stellite alloy #703	
	Stellite alloy #706	
	Stellite alloy #712	
	Stellite alloy #720	
	Tribaloy [®] T-400	8.99
	Tribaloy [®] T-700	8.72
	Tribaloy T-745	
	Tribaloy T-800	8.64
	Tribaloy T-900	
Delta Centrifugal Corp. (Cast Steels)		
	A436 Type 1; Type 2; Type 3	
	A439 D2; A439 D3	
	B407	
J91150	CA 15	
	CA 40; CA40F	
J91540	CA6NM	
	CB7Cu-1; CB7Cu-2	
J93370	CD4MCu	
	CF3; CF3M; CG3M	
	CF8; CF8M; CG8M; CF8C	
	CF10SMnN	
	CF16Fa	
J93790	CG6MMN	
J95150	CN7M	
	CW6MC	
	CW12MW	
	CY40	
N02100	CZ100	
	HD; HE; HF; HH; HK; HT	

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UNS	Material	Density (g/cm ³)
Delta Centrifugal Corp. (cont'd)		
	M25S	
	M30C; M30H	
	M35-1	
	N12M	
C96400	70-30 CuNi	
C96200	90-10 CuNi	
C83600	85-5-5-5	
C85700	Naval Brass	
C86500	65K Mn Brz	
C86300	100K Mn Brz	
C90300	Navy G	
C92200	Navy M	
C92300	Leaded Tin Brz	
C93200	660 Brz	
C95400	9C AL Brz	
C95500	9D AL Brz	
Flowserve		
N30107	Durco CW6M (Chlorimet 3)	9.00
J92600	Durco CF8	7.76
J92900	Durco CF8M	7.76
N30007	Durco N-7M (Chlorimet 2)	9.22
J93370	Durco CD-4MCu	
J93900	Durcomet 5	7.85
N24135	Durco M35	8.65
	Durichlor 51	7.06
N08007	Durimet 20 (CN-7M)	7.96
	Duriod 7101	
	Duriod 7107	
	Duriod 7201	
	Duriod 7301	
Haynes International		
N10675	HASTELLOY B-3 [®] alloy	9.20
N06455	HASTELLOY C-4 alloy	8.60
N06022	HASTELLOY C-22 [®] alloy	8.60
N10276	HASTELLOY C-276 alloy	8.80
N06200	HASTELLOY C-2000 [®]	8.50
N06030	HASTELLOY G-30 [®] alloy	8.22
N10004	HASTELLOY W alloy	9.00
N06002	HASTELLOY X alloy	8.23
N08320	HASTELLOY 20MOD	
	HAYNES 6B alloy	
R30605	HAYNES 25 alloy	9.13
	HAYNES 75 alloy	
R30188	HAYNES 188 alloy	8.98
N07214	HAYNES 214 [™] alloy	8.05
N06230	HAYNES 230 [™] alloy	8.83
	HAYNES 242 [™] alloy	9.06
N07263	HAYNES 263 alloy	8.37
R30556	HAYNES 556 [™] alloy	8.23
	HAYNES 617 alloy	8.36
N06625	HAYNES 625 alloy	8.45
N07718	HAYNES 718 alloy	8.23
	HAYNES D-205 [™] alloy	
N12160	HAYNES [®] HR-160 [®] alloy	8.01
N08120	HAYNES HR-120 [®] alloy	8.07

UNS	Material	Density (g/cm ³)
Haynes International (cont'd)		
N07041	HAYNES R-41 alloy	8.25
	HAYNES Ti-3Al-2.5V	
N07750	HAYNES X-750 alloy	8.25
N10362	HYBRID-BC1 [®] alloy	8.83
R30155	MULTIMET [®] alloy	8.19
R31233	ULTIMET [®] alloy	8.47
N07001	Waspaloy alloy	8.20
Kubota Metal Corporation		
	KCR13C	
	KCR13CA	
	KCR13CB	
	KCR12N	
	KCR20N	
	KCR8NA	
	KCR8NB	
	KCR8NC	
	KCR8NMB	
	KCR8NMC	
	KCRD183	
	KCRD283	
Outokumpu		
S31803	Avesta 2205	7.80
S30415	Avesta 153MA	
S30815	Avesta 253MA	
S31254	Avesta 254SMO	8.00
S32654	Avesta 654SMO	8.00
S31726	317LMN	8.00
	34LN	
RMI Titanium		
R50250	Ti Gr 1	4.52
R50400	Ti Gr 2	4.52
R50550	Ti Gr 3	4.52
R50700	Ti Gr 4	
R56400	Ti Gr 5	4.44
R52400	Ti Gr 7	4.52
R56320	Ti Gr 9	4.52
R52250	Ti Gr 11	4.52
R53400	Ti Gr 12	4.43
R52402	Ti Gr 16	4.52
R58640	Beta C Ti (ST)	4.82
	Beta C Ti (STA)	4.82

UNS	Material	Density (g/cm ³)
Rolled Alloys		
	RA17-4	
	RA188	
S30815	RA 253 MA [®]	7.80
S35315	RA 353 MA [®]	
S30908	RA309	7.89
S30909	RA309H	
S31008	RA310	7.86
S31009	RA310H	
S32100	RA321	
N08330	RA330 [®]	7.94
N06333	RA333 [®]	8.14
S44600	RA446	7.47
	RA62	
S30615	RA85H [®]	7.59
N08811	RA800H/AT	
N08825	RA825	
N06600	RA600	8.47
N06601	RA601	8.11
	RA625	
	RA718	
S32205	RA2205	
S32760	Zeron 100 [®]	7.84
Sandusky International Inc.		
	Alloy 86	7.78
	Alloy EPV	7.78
	1N Bronze	9.02
Sandvik Steel		
G10550	11L - (AISI 1055)	
	13C	
G10740	15LM - (AISI 1074)	
	15N2/15N2C	
G10950	20C - (AISI 1095)	
	9H574	
	15W12C1	
S42000	6C27 - (AISI 420)	
	7C27Mo2	
	12C27; 12C27 Mod.	
	13C26	
	19C27	
S30403	3R12 - (AISI 304L)	
S30200	12R10 - (AISI 302)	
S30100	12R11 - (AISI 301)	
S30100	11R51 - (AISI 301)	
	9RU10 - (AISI 631)	
	13RM19	
S32750	SAF 2507	8.00
Special Metals		
N02200	Nickel 200	8.89
N02201	Nickel 201	8.89
N02205	Nickel 205	8.89
	Nickel 212	
N02270	Nickel 270	

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UNS	Material	Density (g/cm ³)
Special Metals (cont'd)		
	BRIGHTRAY [®] alloy 35	8.30
N06004	BRIGHTRAY [®] alloy B	8.30
N06003	BRIGHTRAY [®] alloy C	8.30
	BRIGHTRAY [®] alloy F	8.30
N06003	BRIGHTRAY [®] alloy S	8.30
	Electroformed Nickel	
N03301	DURANICKEL [®] alloy 301 FERRY [®] alloy	8.19
	INCOCLAD [®] 671/800HT [®]	
N08020	INCOLOY [®] alloy 020	8.08
N08028	INCOLOY [®] alloy 028	8.03
N08926	INCOLOY [®] alloy 25-6MO	8.20
N08330	INCOLOY [®] alloy 330	8.08
N08800	INCOLOY [®] alloy 800	7.94
N08810	INCOLOY [®] alloy 800H	7.94
N08811	INCOLOY [®] alloy 800HT	7.94
S35045	INCOLOY [®] alloy 803	7.86
N08825	INCOLOY [®] alloy 825	8.14
	INCOLOY [®] alloy 840	7.83
S35135	INCOLOY [®] alloy 864 TM	8.02
N19903	INCOLOY [®] alloy 903	8.30
N09908	INCOLOY [®] alloy 908	
N19909	INCOLOY [®] alloy 909	8.30
N09925	INCOLOY [®] alloy 925 TM	8.08
S66286	INCOLOY [®] alloy A-286	7.94
	INCOLOY [®] alloy DS	7.86
S67956	INCOLOY [®] alloy MA956	7.25
N06950	INCONEL [®] alloy 050	8.39
N06600	INCONEL [®] alloy 600	8.47
N06601	INCONEL [®] alloy 601	8.11
	INCONEL [®] alloy 601GC	8.11
N06617	INCONEL [®] alloy 617	8.36
N06022	INCONEL [®] alloy 622	8.61
N06625	INCONEL [®] alloy 625	8.44
	INCONEL [®] alloy 625LCF	8.44
N06686	INCONEL [®] alloy 686	8.73
N06690	INCONEL [®] alloy 690	8.19
N09706	INCONEL [®] alloy 706	8.05
N07718	INCONEL [®] alloy 718	8.19
N07719	INCONEL [®] alloy 718SPF TM	
N07725	INCONEL [®] alloy 725 TM	8.30
N07750	INCONEL [®] alloy X-750	8.28
N07751	INCONEL [®] alloy 751	8.22
N07754	INCONEL [®] alloy MA754	8.55
	INCONEL [®] alloy MA758	8.55
R30783	INCONEL [®] alloy 783	
N10276	INCONEL [®] alloy C-276	8.89
N06985	INCONEL [®] alloy G-3	8.14
N06002	INCONEL [®] alloy HX	8.22
	INCOTHERM TM alloy TC	
	INCOTHERM TM alloy TG	
	KOTHERM [®] alloy KP	
	KOTHERM [®] alloy KN	
N04400	MONEL [®] alloy 400	8.80
N04405	MONEL [®] alloy R-405	8.80
N05500	MONEL [®] alloy K-500	8.44
K93600	NILO [®] alloy 36	8.11
	NILO [®] alloy 365	

UNS	Material	Density (g/cm ³)
Special Metals (cont'd)		
K94100	NILO [®] alloy 42	8.11
	NILO [®] alloy 475	
K94800	NILO [®] alloy 48	8.11
K94610	NILO [®] alloy K	8.16
	NILOMAG [®] alloy 77	8.77
N06075	NIMONIC [®] alloy 75	8.36
N07080	NIMONIC [®] alloy 80A	8.19
	NIMONIC [®] alloy 86	
N07090	NIMONIC [®] alloy 90	8.19
	NIMONIC [®] alloy 101	
	NIMONIC [®] alloy 105	8.01
	NIMONIC [®] alloy 115	
N07263	NIMONIC [®] alloy 263	8.36
N09901	NIMONIC [®] alloy 901	8.14
	NIMONIC [®] alloy PE16	
	NIMONIC [®] alloy PK33	
	NIOOTHERM [®] alloy NP	
	NIOOTHERM [®] alloy NN	
N09902	NI-SPAN-C [®] alloy 902	8.11
	RESISTOHM [®] alloy 30	
	RESISTOHM [®] alloy 40	
N06604	RESISTOHM [®] alloy 60	
	RESISTOHM [®] alloy 70	
	RESISTOHM [®] alloy 80	
	RESISTOHM [®] alloy 125	
	RESISTOHM [®] alloy 135	
	RESISTOHM [®] alloy 140	
	RESISTOHM [®] alloy 145	
	RESISTOHM [®] alloy Y	
K92890	UDIMAR [®] alloy 250	
K93120	UDIMAR [®] alloy 300	
S13800	UDIMET [®] alloy 13-8Mo	
R30188	UDIMET [®] alloy 188	
N07500	UDIMET [®] alloy 500	
	UDIMET [®] alloy 520	
R30605	UDIMET [®] alloy 605	
	UDIMET [®] alloy 700	
	UDIMET [®] alloy 720	
N09979	UDIMET [®] alloy D-979	
N07041	UDIMET [®] alloy R41	
Stainless Foundry & Engineering, Inc.		
	ILLIUM 98	
	ILLIUM 98HF	
	ILLIUM B	
	ILLIUM G	
	ILLIUM P	
	ILLIUM PD	
Teledyne Allvac		
N06110	Allvac [®] Allcorr [®]	8.33
N13017	Allvac [®] Astroloy	7.91
N07041	Allvac [®] Rene 41	8.24
N07001	Allvac [®] Waspaloy TM	8.19
R56320	Allvac [®] 3-2.5	4.48
R54520	Allvac [®] 5-2.5	4.45

UNS	Material	Density (g/cm ³)
Teledyne Allvac (cont'd)		
R54620	Allvac [®] 6-2-4-2	4.54
R56260	Allvac [®] 6-2-4-6	4.65
R56400	Allvac [®] 6-4	4.43
R56402	Allvac [®] 6-4 ELI	4.48
R56620	Allvac [®] 6-6-2	4.54
R56700	Allvac [®] 6-7	4.51
R54810	Allvac [®] 8-1-1	4.31
R50250	Allvac [®] 30, Ti CP-1	4.51
R30035	Allvac [®] 35N	8.41
R50400	Allvac [®] 40, Ti CP-2	4.51
R50550	Allvac [®] 50, Ti CP-3	4.51
R50700	Allvac [®] 70, Ti CP-4	4.51
R58650	Allvac [®] Ti-17	4.65
R52400	Allvac [®] Grade 7	4.51
R53400	Allvac [®] Grade 12	4.51
R58153	Allvac [®] Grade 15-3-3-3	4.76
R58640	Allvac [®] 38-644	4.81
N08330	Allvac [®] 330	8.00
	Allvac [®] 520	8.22
N09706	Allvac [®] 706	8.08
N07718	Allvac [®] 718-OP [®]	8.19
	Allvac [®] 720	8.08
N07252	Allvac [®] M-252	8.24
T11350	Allvac [®] M-50	7.78
S66286	Nickelvac [®] A-286	7.92
N06022	Nickelvac [®] C 22	8.02
N10276	Nickelvac [®] C-276	8.89
N10665	Nickelvac [®] H-B-2	9.22
N06002	Nickelvac [®] H-X	8.22
N05500	Nickelvac [®] K-500	8.47
R31537	Nickelvac [®] TJA-1537 TM	8.30
N08020	Nickelvac [®] 23	8.06
N07080	Nickelvac [®] 80 A	8.16
N04400	Nickelvac [®] 400	8.83
N06600	Nickelvac [®] 600	8.41
N06601	Nickelvac [®] 601	8.05
	Nickelvac [®] 606	8.36
N06625	Nickelvac [®] 625	8.44
N06690	Nickelvac [®] 690	8.13
N08800	Nickelvac [®] 800	7.94
N08810	Nickelvac [®] 800-H	7.94
N08825	Nickelvac [®] 825	8.14
N09901	Nickelvac [®] 901	8.22
N07263	Nickelvac [®] C-263	8.35
N10276	Nickelvac [®] HC-276	8.94
N10003	Nickelvac [®] H-N	8.77
N10004	Nickelvac [®] H-W	8.99
R30605	Nickelvac [®] L-605	9.22
N07090	Nickelvac [®] N-90	8.11
S31600	Nickelvac [®] R-26	8.19
N07722	Nickelvac [®] W-722	8.24
N07750	Nickelvac [®] X-750	8.30
N07751	Nickelvac [®] X-751	8.24
S20910	Nickelvac [®] XM-19	7.86
S31675	REX 734 TM	7.89
S41800	Vasco Greek Ascology	7.86
K91238	Vasco [®] 9-4-30	7.83
G43400	Vasco [®] 4340	7.83

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UNS	Material	Density (g/cm ³)
Teledyne Allvac (cont'd)		
G93106	Vasco [®] 9310	7.86
	Vasco [®] X-2M	7.75
K24728	Vasco [®] D6AC	7.78
S64152	Vasco [®] Jethete M152	7.75
T20811	VascoJet [®] 1000	7.75
K92890	Vascomax [®] C-250	8.00
K93120	Vascomax [®] C-300	8.00
	Vascomax [®] C-350	8.08
	Vascomax [®] T-200	8.00
	Vascomax [®] T-250	8.00
Timken Latrobe		
R30035	MP35N	8.41
R30159	MP159	8.36
S44004	440C	7.75
S42700	BG42	7.75
S64152	Jethete M152	7.75
	410Cb	7.77
S15500	15-5 PH	7.81
S17400	17-4 PH	7.75
S13800	PH 13-8 Mo	7.76
	440N-DUR	7.67
	CSS-42L™	7.89
	420 Stainless	7.64
	422 Stainless	7.77
ThyssenKrupp VDM		
N08926	Cronifer 1925hMo	8.10
N08031	Nicrofer 3127hMo	8.10
N08020	Nicrofer 3620Nb	8.05
N06985	Nicrofer 4823hMo	8.30
N10276	Nicrofer 5716hMoW	8.89
N06059	Nicrofer 5923hMo	8.80
R20033	Nicrofer 3033	7.90
N06025	Nicrofer 6025HT	7.90
N06045	Nicrofer 45TM	8.00
N10629	Nimofer 6629	9.20
N10665	Nimofer 6928	9.20
Usinor Industeel		
	4003	
	Abroclad	
	Creusabro ACR	
	Creusabro [®] 4000	
	Creusabro [®] 8000	
	Creusabro [®] M	
	CLC 18.9 (H)	
	CLC 18.9 L	
	CLC 18.10 L	
	CLC 18.10 Ti	
	CLC 18.10 Nb	
	CLC 18.10 N	
	CLC 18.10 LN	
	CLC 18.12.4 LN	
	CLC 18.14.3 L	

UNS	Material	Density (g/cm ³)
Usinor Industeel (cont'd)		
	CLC 18.15.4 L	
	CLC 17.12.2 (H)	
	CLC 17.12.2 L	
	CLC 17.12.2 Ti	
	CLC 17.12.2 Nb	
	CLC 17.12.3 L	
	CLC 17.13.3	
	CLC 17.13.3 LN	
	CLC 17.13.5 LN	
	FAST 17.12.2.2	
	FAST 18.10	
	FAST 17.12.3	
	Fora 250 bc	
	Fora 360 bc	
	Fora 400 bc	
	Fora 500	
	M 200	
	M 250	
	M 300	
	NUCL 18.10	
	NUCL 18.10 Nb	
	NUCL 18.10 B	
	NUCL 167 SPH	
	SIRIUS S12	
	SIRIUS S15	
	SIRIUS 309 (S)	
	SIRIUS 310 (S)	
	SIRIUS 314	
	SIRIUS 800 (H)	
	SIRIUS 600	
	Soleil A2	
	Soleil A4	
	Soleil B2	
	Soleil B3	
	Soleil B4	
	Soleil C5	
	SP 300	
	SP 400	
	SP 400 S	
R50250	Titanium	
	UR 16	
	UR 35N - 2304	
	UR 45N - 2205	
	UR 45N Mo - 2205 Mo	
	UR 45N - 2306 Mo	
	UR 47N - SAF 2507	
	UR 51	
	UR 52N - 2507 Cu	
	UR 65	
	UR 76N	
	UR 625	
	UR 825	
	UR B6 (N)	
	UR B25	
	UR B26	
	UR B28	
	UR B46	
	UR B66	

UNS	Material	Density (g/cm ³)
Usinor Industeel (cont'd)		
	UREA 25.22.2	
	UREA 316 L mod	
	Virgo 39	
	Virgo 17.4 PH	
	Virgo 15.5 PH	
R60001	Zirconium	
Waukesha Foundry Inc.		
	3 WM	8.85
	23 BIWM	8.58
	54C	8.58
	88 WM	8.58
	119 WM	8.58
	EM-27	7.75
	HC250	8.02

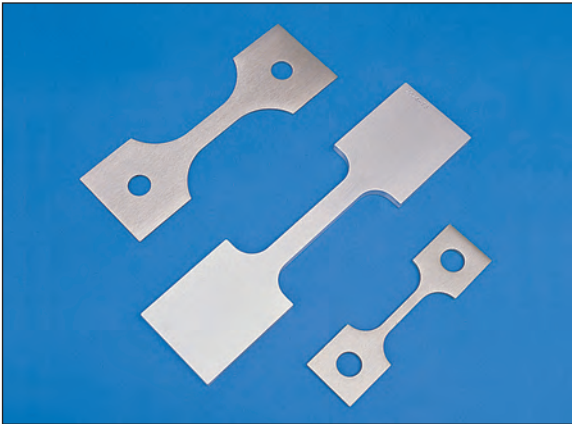
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Mechanical Test Specimens

Mechanical test specimens are used to evaluate the physical characteristics of materials. Assessing the strength, ductility, and hardness of an alloy gives the engineer valuable information in determining the best materials for use in industrial applications. Metal Samples machines tensile and fracture mechanics test specimens to ASTM specifications or to your requirements. Specimens in a wide variety of sizes and materials are available.

Tensile Specimens

Flat Tensile Specimens

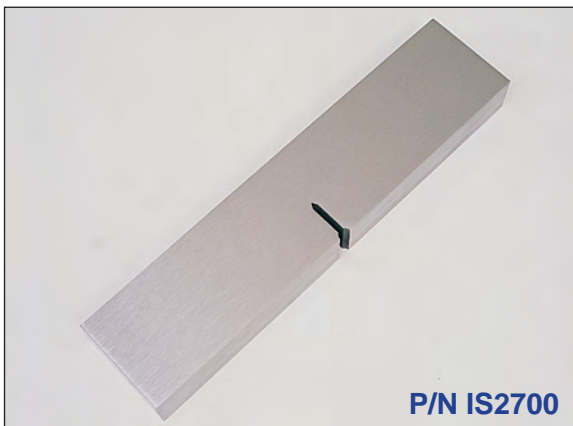


Round Tensile Specimens

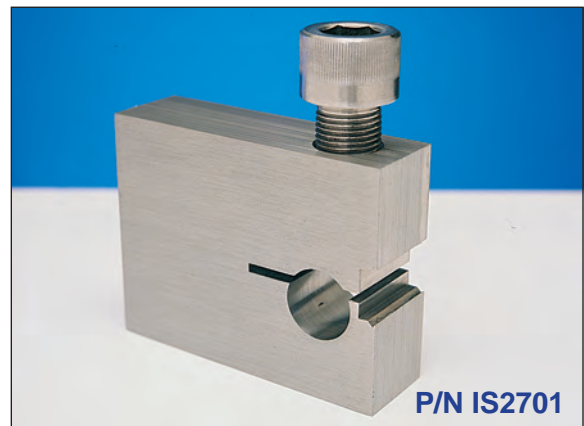


Fracture Mechanics Specimens

Charpy



Wedge Open Load



Compact Tension



Double Cantilevered Beam



Reference Assortment Kits

Metal Samples has selected some commonly used metals for non-destructive testing. Reference Assortment Kits can be very useful in performing the **Chemical Spot Test**. This test method is based on electrographic extraction of metal atoms from a surface and can be verified by testing on a known alloy. An additional use of these kits is to check the element content of an alloy by examining the color intensity of a chemical spot in comparison to a standard. The reagent chemicals can be tested on a metal standard to ensure the shelf life of the chemical has not been exceeded.

Another non-destructive evaluation that utilizes metal standards is the **Thermoelectric Alloy Separators Test**. This test measures the “EMF” generated by a heat junction of dissimilar metals. The magnitude of the “EMF” is a function of the metal’s chemistry and physical characteristics.

Reference Kit No. KR5100 contains 44 different alloys and Reference Kit No. KR5101 contains 54 different alloys. Additional slots are provided with the kit to expand the selection of alloys to meet your specific requirements. The chemical analysis of each alloy in the kit has been tabulated from mill test reports and certified chemical analyses. These test results are recorded on an analysis sheet that accompanies the assortment. Alloy specimen sizes can be either 1" x 2" x 1/16" or 1" x 2" x 1/8". The alloy specimens have a glass bead blasted finish.



Reference Kit No. KR5100

Contents:		
AL1100	I800H / HT	321
AL2024	I825	347
AL3003	M400	410
AL5052	20Cb3	416
AL5086	G3	420
AL6061	HC-276	430
CDA 110	HB-3	440C
CDA 260	Haynes 25	Ti Gr 2
CDA 360	17-4PH	F255
CDA 464	301	C1010
CDA 510	302	C4140
CDA 706	303	C4340
CDA 715	304L	Mg
I600	316L	Zinc
I625	317L	

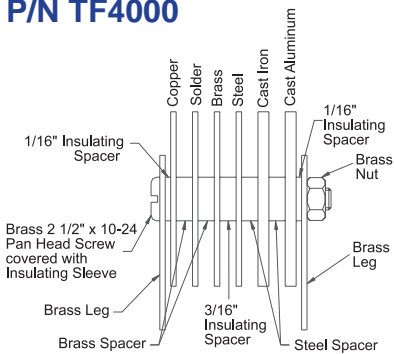
Reference Kit No. KR5101

Contents:		
AL1100	I800H / HT	317L
AL2024	I825	321
AL3003	M400	347
AL5086	20Cb3	410
AL6061	G3	430
AL7075	HC-276	904L
CDA 110	HB-3	F255
CDA 122	HX	Ti Gr 2
CDA 260	Haynes 25	Ti Gr 5
CDA 360	Al-6XN	Ti Gr 7
CDA 443	LDX2101	C1010
CDA 464	2205	C1020
CDA 706	301	1 1/4Cr 1/2Mo
CDA 715	302	2 1/4Cr 1Mo
N200	304L	5Cr 1/2Mo
I600	309S	9Cr 1Mo
I625	310S	C4140
IX750	316L	C4340

Test Apparatus

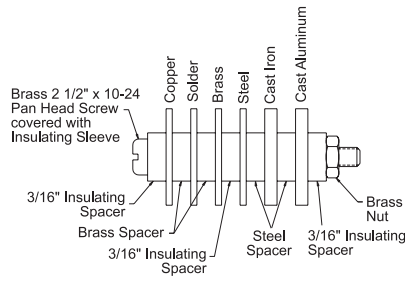
ASTM Engine Coolant Test Apparatus

P/N TF4000



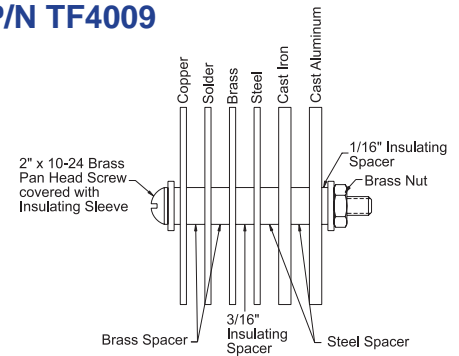
ASTM D1384 corrosion test bundle for testing engine coolants in glassware.

P/N TF4006



ASTM D2570 simulated service corrosion test bundle for testing engine coolants.

P/N TF4009



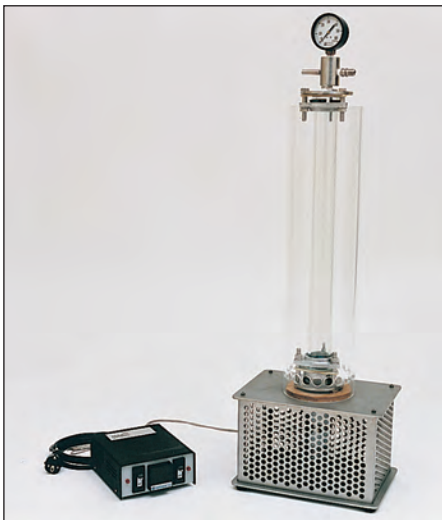
ASTM D2847 method for evaluation of engine coolants in actual vehicle service.

Engine Coolant Testing Parts

P/N	Description	P/N	Description
TF4000	D1384 Test Bundle	CO1464273504100*	Solder Coupon (30/70)
TF4006	D2570 Test Bundle	CO1464270504100	Brass Coupon (CDA260)
TF4009	D2847 Test Bundle	CO1463780504100	Steel Coupon (C1020)
TF4000A	Brass Leg	CO337B930504100	Grey Cast Iron Coupon (CL3500)
TF4000C	Insulating Sleeve (TFE)	CO3373130504100	Cast Aluminum Coupon (AL319)
TF4000D	Steel Spacer	ST1253783	1/16" Insulating Spacer (TFE)
TF4000E	Brass Spacer	09369E1024HN0000	10-24 Brass Nut
TF4000F	3/16" Insulating Spacer (TFE)	09369E1024PH2000	2" x 10-24 Brass Pan Head Screw
CO1464190504100	Copper Coupon (CDA110)	09369E1024PH2500	2 1/2" x 10-24 Brass Pan Head Screw

* Solder Coupon (30/70) is **solder coated brass**. Please specify if you require pure solder.

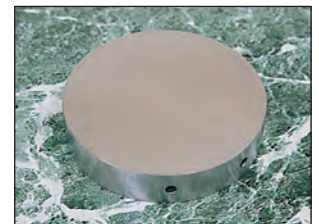
P/N TF2424 (Ford Test)



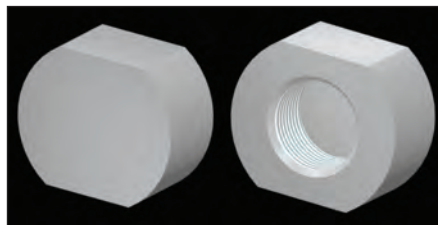
ASTM D4340 Heat Transfer Corrosion Assembly for evaluating the effectiveness of engine coolants in combating corrosion of aluminum casting alloys under heat transfer conditions. Available in 120V 60Hz or 240V 50Hz.

P/N TF4005

AL319 Cast Aluminum Specimen with two holes for thermocouple leads and a 600 grit finish on one side. Used in conjunction with P/N TF2424 in heat transfer corrosion testing. Other materials are available at your request.



P/N TF4012



ASTM G32 Vibratory Cavitation Erosion Test Buttons. These buttons are available in AL319 cast aluminum and grey cast iron.

Note: Metal Samples manufactures test apparatus in accordance with ASTM standards. Metal Samples does not conduct test procedures and therefore does not attempt to address testing considerations. Please consult ASTM standards for safety guidelines and additional information regarding testing procedures.

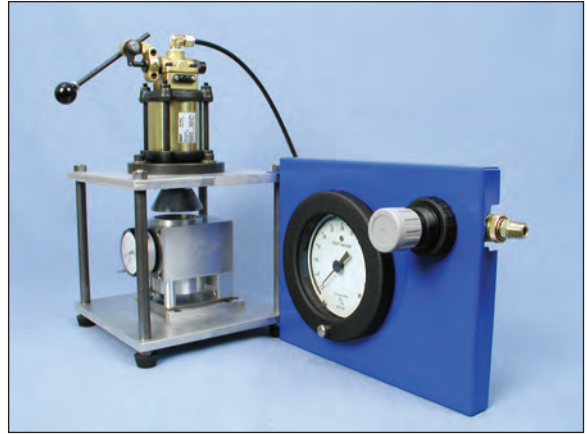
ASTM F-3 Test Apparatus

P/N TF2436



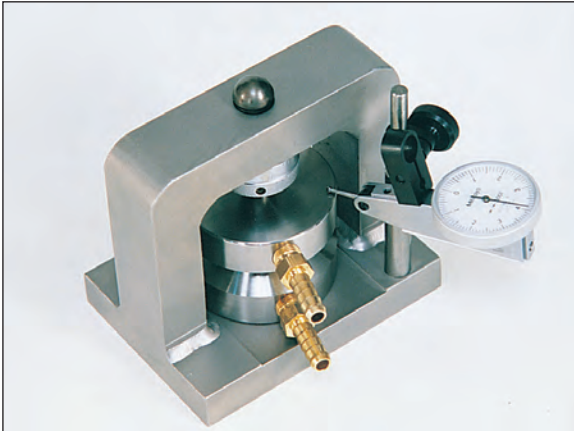
ASTM F36 Test Cell for compressibility and recovery of gasket materials. Fixture shipped partially assembled.

P/N TF2401



ASTM F36 Test Cell with Test Panel. This is the complete assembly for the ASTM F36 test method. Assembly is ready for attachment to pressure supply.

P/N TF2425



ASTM F37 (Method A) Test Cell is used to evaluate the fluid sealing properties of gasket materials.

P/N TF2402



ASTM F37 (Method A) Test Cell with Test Panel. This is the complete assembly for the ASTM F37 (A) test method. Assembly is ready for attachment to pressure supply.

P/N TF2421



ASTM F37 (Method B) Test Cell is used to evaluate the gas sealability of gasket materials. This test cell can also be used for evaluating liquid sealability.

P/N TF2403



ASTM F37 (Method B) Test Cell with Test Panel. This is the complete assembly for the ASTM F37 (B) test method. Assembly is ready for attachment to pressure supply.

P/N TF2406



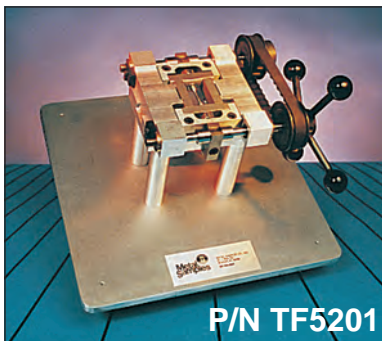
ASTM F38 Method B Test Apparatus includes all equipment necessary for Creep Relaxation testing. Yokes for the ASTM F607 Test apparatus are also available.

P/N	Description	Included with P/N TF406
FP5700	Upper Yoke	
FP5701	Lower Yoke	
FP5702	Dial Indicator	•
FP5703	Dowell Pins	
FP5704	Dial Indicator Adapter	•
FP5705	4140 Nut*	
FP5706	4140 Washer*	
FP5707	4140 Bolt*	
FP5708	4140 Platen (2)*	• (5 pair)
FP5713	Mounting Plate	•
FP5714	Custom Wrench	•
FP5760	Preconditioned & Calibrated Bolt, Nut, and Washer*	• (5 sets)

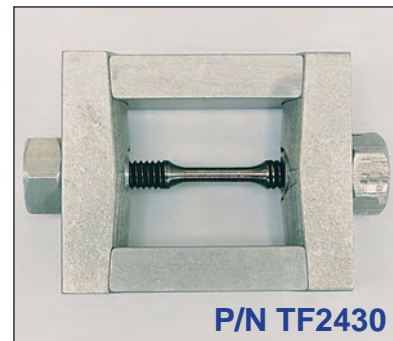
* High temperature INCONEL Alloy 718 available.

ASTM G49 Test Apparatus

The **ASTM G49 test fixture** is used to evaluate stress on a 1/8" round tensile specimen. The fixture is comprised of two assemblies, the **loading fixture (P/N TF5201)** and the **stress frame (P/N TF2430)**. The stress frame is purchased separately. The test specimen is not included.



P/N TF5201



P/N TF2430

Immersion Test Assembly

The TF2443 immersion test assembly (120V 60Hz) is used to determine the corrosivity of aqueous and non-aqueous liquid waste. The assembly is made in accordance with **NACE TM-01-69** and **EPA 11-10 of SW846** specifications. Metal Samples can supply the complete assembly as well as test specimens and replacement parts.



P/N TF2443

Fluid Sealing Pressure Gasket Assembly

P/N TF2408



This flanged, carbon steel, pressure gasket test fixture (TF2408) is used for evaluating fluid sealing properties. The fixture meets the Fluid Sealing Association's **FSA-NMG-2040** specifications. A stainless steel version of this fixture is also available.

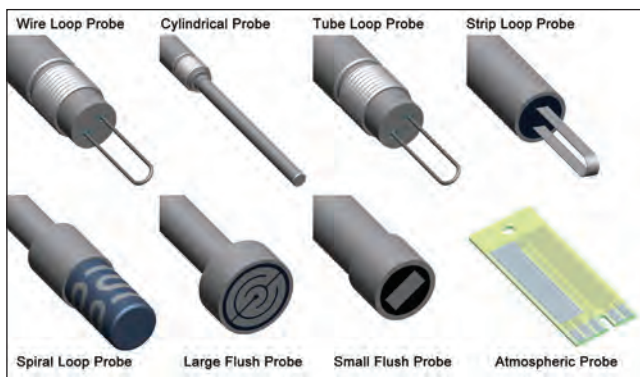
Corrosion Monitoring Systems

Unlike test coupons which must be removed from the process for evaluation, our on-line corrosion monitoring systems can provide corrosion rate determination while remaining within the process. Since these monitoring systems are made in-house at Metal Samples, we can offer rapid turnaround times and custom manufacturing to meet your requirements for temperature, pressure, and other conditions.

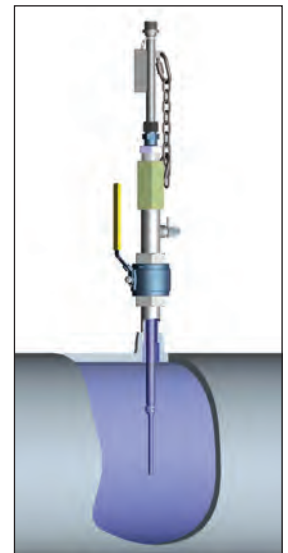
Probes

Electrical Resistance (ER) Probes

Electrical resistance (ER) probes are commonly used in petroleum, chemical processing, and other environments where on-line corrosion rate readings are required. ER probes can be used in conductive systems, as well as non-conductive environments such as oil, gas, atmosphere, and soil.



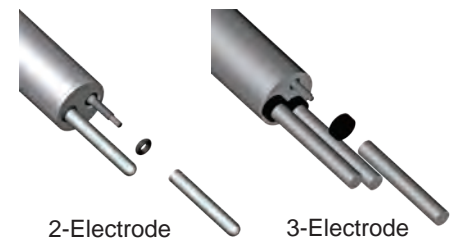
The operating principle is based on the change in resistance of the probe element as it is exposed to corrosive conditions. Element configurations include wire loop, tube loop, flush-mount, and cylindrical types, which can be made in a variety of materials and thicknesses.



Linear Polarization Resistance (LPR) Probes



Linear polarization resistance (LPR) probes are commonly used in the water treating industry and other environments where instantaneous, on-line corrosion rate readings are required. LPR probes are ideally suited to monitor corrosion trends within a system, such as monitoring of corrosion inhibitor effects.



LPR probes are used in conductive environments such as water or any electrolyte. The operating principle is based on measuring the flow of current between electrodes. LPR probes can be provided in both 2-electrode and 3-electrode styles. Electrodes can be provided in virtually any alloy required. (See Electrodes - page 16.)

Specialized Probes

In addition to our traditional ER and LPR line of probes, we also manufacture specialized probes such as bio-probes, sand (erosion) probes, hydrogen probes, corrosion under insulation (CUI) probes, and custom-made probes.



For more information on our corrosion monitoring probes, visit our website at www.metalsamples.com.

Instrumentation

Metal Samples offers a complete line of corrosion monitoring instrumentation to interpret both electrical resistance (ER) and linear polarization resistance (LPR) probes, and to be used in specialized monitoring.



ER & LPR Instrumentation

Digital, hand-held, menu-driven **corrosion meters** take probe measurements and store the data to be later downloaded to a computer for analysis.



Data loggers are used to continuously monitor probes in remote locations, automatically read the probes at selected intervals, and store the readings in memory.

Field **transmitters** transmit measurements to a receiver (such as a DCS or SCADA system). Wireless radio options are available to eliminate cable and conduit setup.



Our **high resolution** ER instruments provide faster response times than traditional ER instruments, obtaining corrosion rates in hours instead of days. Our high-res data loggers are certified intrinsically safe and offer data storage capacity of 16,000 readings per probe on 250 different probes, on-screen charting and USB data transfer. Our high-res transmitters can be direct-probe or remote mounted and are available in various communication protocols such as RS-485 Modbus and 4-20 mA.

Specialized Instrumentation

In addition to our ER and LPR instruments, we also carry a line of specialized instruments including hydrogen penetration monitoring systems, instruments for monitoring biofilm activity, and telemetry systems to allow remote monitoring of corrosion rates via the Internet from anywhere in the world.



For a complete list of our corrosion monitoring instruments, visit our website at www.metalsamples.com.

High Pressure Access Systems



High pressure access systems are specialized piping arrangements which permit internal access to production plant vessels and pipework operating under full process conditions. The corrosion monitoring industry standard for such access systems is based on a 2-inch nominal bore design.

These systems are designed for the high pressures and temperatures found in the oil and gas, chemical processing, and petroleum industries where users are not prepared to shut down and depressurize process systems in order to remove or install corrosion monitoring devices.

The Access Fitting Assembly consists of three main components:



Protective Cover – designed to protect the external threads of the access fitting body.



Plug – the carrier for the installed device. Depending on the type of device being used, a solid plug or a hollow plug is selected. The plug assembly screws into the access fitting body and seals the bore of the fitting to contain line pressure.



Access Fitting Body – the specialized pipe fitting which is permanently attached to the process plant vessel or pipework.

Clad Access Fittings

Metal Samples offers Corrosion Resistant Alloy (CRA) seat fittings for our 2" high pressure access systems. Non CRA seat fitting bodies can be subject to galvanic corrosion over long periods of time. This problem can be corrected by cladding the seats of high pressure access fitting bodies with CRA materials. Normal CRA materials used are I625 or C276. This prevents localized corrosion of the seats and extends the life of the access fitting beyond the expectation of the pipeline thus removing the need for fitting replacement.



Hydraulic Access Fittings

Metal Samples offers Hydraulic Access Fittings as part of our Hydraulic Access System product line (hydraulic retrieval tools, service valves, fittings, plugs and covers). Hydraulic Access Systems allow installation, operation and maintenance of corrosion monitoring devices in processes under full operating pressures (up to 6,000 psi) and offer advantages over standard Mechanical Access Systems, including:

- absence of an internal thread, which eliminates the possibility of thread galling, as well as problems associated with debris in the threading
- shorter and lighter overall (using the hydraulic retriever tool)
- requires less operational clearance
- increased safety (no external moving parts, no telescoping action)
- increased simplicity of operation

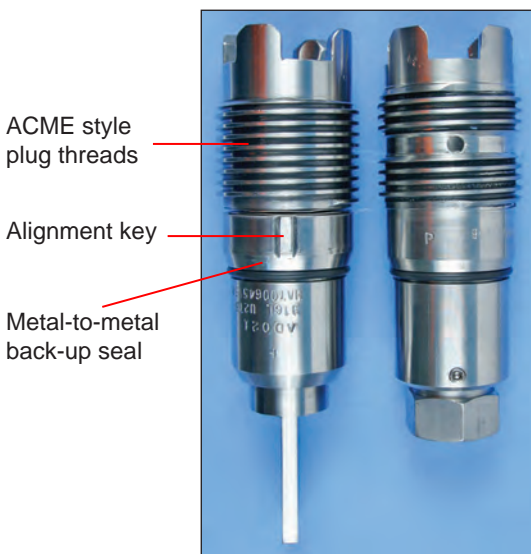


*Left: Cutaway of hydraulic access fitting showing inserted solid plug and plug retainers with hollow plug beside it.
Right: Hydraulic access fitting with cover beside it.*

MH Access Fittings

In addition to our standard HP Access System product line which is compatible and interchangeable with access fitting equipment produced by other major manufacturers, we also provide the MH Access System product line which is a proprietary design of Metal Samples. The MH Access System incorporates a number of unique and patented features which are an improvement to the generic HP System design:

- ACME style plug threads, reducing the risk of galling
- positive alignment grooves, allowing orientation of weight-loss coupons and injection quills
- a metal-to-metal back-up seal to prevent leakage



*Left: MH Solid Plug
Right: MH Hollow Plug*



Alignment groove Alignment key



Alignment key in groove

Retrieval Tool / Service Valve

When operated with a Retrieval Tool and Service Valve, high pressure access systems allow the installation and retrieval of corrosion monitoring coupon holders, probes, chemical injection equipment, and other devices to be carried out safely and without plant shutdown, at working pressures up to 3600 psi.

Hot Tap Tool

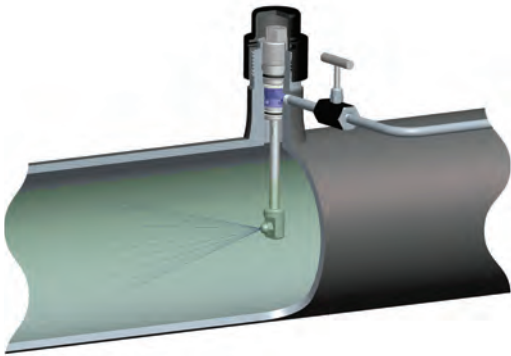
The Hot Tap Tool provides a safe and reliable method of hot tapping high pressure access fittings on pressurized pipelines or vessels. To tap a hole through the pipe wall, a service valve is installed on the fitting. The hot tap tool is mounted on the service valve and mated to a special cutter assembly installed in the access fitting. The drive screw on the hot tap tool puts pressure on the cutter as the tool shaft is rotated to cut through the pipe wall.



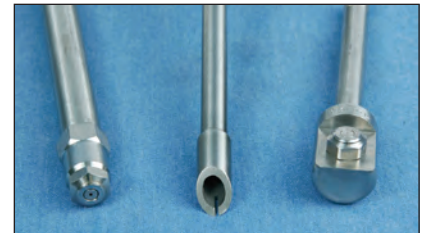
*Retrieval Tool with Service Valve (left)
& Hot Tap Tool with Service Valve (right)*

Injection & Sampling Systems

Injection systems are used to inject a wide range of chemicals into processes, including biocides, demulsifiers, corrosion inhibitors, oxygen scavengers, glycol, dewaxers, methanol, odorizers, and product additives.



Sampling systems are used to take samples of the process fluid or medium. Such samples are then analyzed in the laboratory for inhibitor concentration levels, the presence of metal ions, oxygen levels, scale forming compounds, and a wide range of process parameters.



Nozzle types

Easy Tool Retracting System

The Easy Tool Retracting System is used for the safe insertion or retraction of probes, coupon insertion systems, and chemical injection systems. The tool's patented design enables probes of various lengths to be inserted to various depths required.

With a weight of under 15 pounds and an overall length of 32" or 44", the Easy Tool is one of the lightest and shortest retracting tools available on the market. Metal Samples requires that an Easy Tool be used when working on systems with pressures over 150 psi.



For more information on the products listed above, visit our website at www.metalsamples.com.

Technical Information Regarding Corrosion Testing - By A. S. Krisher

Corrosion Testing, Why?

Corrosion tests are conducted for a number of reasons, some of which are:

1. To provide an insight into corrosion mechanisms.
2. To compare resistance of one alloy to another under standard conditions (in alloy development work for example).
3. As a quality control test for a given heat of alloy.
4. To provide a basis for estimating service life of process equipment.

The discussion which follows relates primarily to reason # 4, although the same principles apply in tests conducted for other reasons.

General Requirements for Coupon Tests

There are a number of "good practice" requirements which apply to all coupon testing.

1. The chemistry and processing history of the material in the coupon must be known.
2. The coupon must be positively identified, usually by code numbers stenciled into the specimen.
3. Data about the specific coupon test should be recorded in a permanent log book. Items which must be recorded are detailed information on the coupon (chemistry, mechanical properties, and processing history), dimensions of the coupon, initial weight of the coupon, and initial surface condition. Location, condition of exposure, and time of exposure must also be recorded.

Type of Tests

Data of value in estimating the probable service life of a piece of process equipment can be generated in a number of ways.

1. Operating Experience - The most reliable information is generated by actual operating experience with equipment in identical service. In a sense the equipment is being used as a large, complex, expensive coupon. This is a costly and slow testing method, especially when data on several materials is needed.
2. Model Equipment - Model equipment installed parallel with actual equipment or in a small scale (pilot plant) operation can generate information almost as reliable as full scale equipment. Care must be exercised to assure that important variables are adequately simulated.
3. Coupons - Field - Coupons exposed in operating equipment are widely used. Care must be taken to install the coupons so that they are exposed to the corrosive

conditions of interest.

4. Coupons - Laboratory - Coupons exposed to laboratory solutions from plant operations, or less reliable synthetic solutions which approximate the chemistry of plant streams, generate useful information if the tests are properly designed and conducted. Such tests allow study of the affect of changes in process chemistry on corrosion.
5. Instrumental Test Methods - Advanced methods, including electrical resistance and linear polarization scans, are valuable additions to corrosion testing methods. They can generate a continuous record of corrosion rate. They also can be used to gain insight into corrosion mechanisms. The precautions noted with regard to coupon tests also apply with these methods.

Surface Condition of Coupons

Surface condition for coupons is a subject of substantial debate. A typical vessel as installed in the plant will have large surface areas in original mill condition, smaller areas of weld heat-affected zone, and areas that have been ground during the fabrication process. It is possible to replicate all of these conditions on a coupon. However, in the interest of simplicity and consistency, it is fairly common to machine the coupon surface flat, leaving a standard ground surface as defined by the size grading of the grinding media. An example would be the "120 grit finish" achieved by grinding with a 120 grit belt. This leaves a flat surface with clearly detectable scratches, all in a consistent direction. Any deviation from this standard initial surface is attributable to the exposure in the environment. Any effect on corrosion due to the initial finish, or the as welded heat-affected zone finish, or the ground surface will be very temporary in a corrosive system.

It is also worth noting that if the surface condition (i.e., the mill finish) does provide an improved corrosion resistance over the metal without this surface condition, such a situation will have questionable reliability in an operating system. When this surface condition is damaged mechanically or chemically, the corrosion resistance will revert to that of the parent metal without the special surface treatment.

Coupon Mounting

Coupons should be mounted in such a way that they are securely held and are electrically isolated from contact with all other metals (except when the purpose of the test is to study galvanic corrosion). Mounting materials (brackets, bolts, etc.) and insulating materials should be selected to be fully resistant to the environment. Failure of any of these components will lead to loss of data or loss of electrical isolation.

Time of Test

In general, coupon tests should be run for a minimum of 1 week. In many cases, it will be worthwhile and desirable to evaluate the effect of time of exposure which can be done by means of a controlled interval test.

Economics of Corrosion Testing

Corrosion testing is not cheap. More specifically, materials for a field rack with ten coupons will cost about \$150 with 316 hardware or \$250 with Hastelloy C-276 hardware. If a field test program required ten such racks, the total cost would be \$1500 to \$2500 plus the direct costs (rack assembly, rack installation and removal, record keeping, evaluation, reporting, etc.) These costs should be evaluated in terms of the benefits derived from the information generated by the tests.

In today's process industry, direct maintenance costs associated with a premature corrosion failure usually run to (at least) tens of thousands of dollars, and frequently into the hundreds of thousands. The business losses associated with such failures can easily be ten times the direct maintenance costs.

Considered in this fashion, it seems evident that the expenses of corrosion coupon testing can be easily justified.

Coupon Evaluation after Exposure

At the end of the test, observations of the coupon before cleaning should be recorded (photographically if appropriate). Samples are cleaned by various means (detailed in appropriate specifications) to remove all deposits and corrosion products from the unreacted metal. After cleaning, the coupon is weighed again and the corrosion rate is calculated from the weight loss.

$$\text{Corrosion Rate (CR)} = \frac{\text{Weight loss (g)} * K}{\text{Alloy Density (g/cm}^3) * \text{Exposed Area (A)} * \text{Exposure Time (hr)}}$$

The constant can be varied to calculate the corrosion rate in various units:

Desired Corrosion Rate Unit (CR)	Area Unit (A)	K-Factor
mils/year (mpy)	in ²	5.34 x 10 ⁵
mils/year (mpy)	cm ²	3.45 x 10 ⁶
millimeters/year (mmy)	cm ²	8.75 x 10 ⁴

$$\text{Metal Loss (ML)} = \frac{\text{Weight loss (g)} * K}{\text{Alloy Density (g/cm}^3) * \text{Exposed Area (A)}}$$

Desired Metal Loss Unit (ML)	Area Unit (A)	K-Factor
mils	in ²	61.02
mils	cm ²	393.7
millimeters	cm ²	10.0

Note that this calculation yields an average rate, assuming perfectly even metal loss from all surfaces. Examine coupons under low power magnification and record evidence of localized attack. End grain attack, localized weld attack, intergranular corrosion, accelerated attack in stressed area (at the stenciled numbers), and localized attack associated with the mounting hardware should be noted if present. The depth of penetration of localized attack should be determined by means of microscopic examination or metallographic examination.

Advantages of Coupon Testing

Coupon tests are low in cost, simple to conduct, and allow the simultaneous evaluation of numerous materials and variations of a single material. Alloy chemistry variations and metallurgical variations (ie., the effect of heat treatment, microstructure, welding and stress) can be considered. Coupon tests are easily adapted to evaluate specific types of corrosion, such as crevice corrosion and galvanic corrosion.

Summary

Coupon testing remains a powerful tool in the corrosion engineer's tool kit. Intelligent and systematic use of this tool provides data which allows a knowledgeable and experienced engineer to make reliable predictions of field performance.

To Dig Deeper

There is a large body of literature dealing with corrosion coupon testing. The references listed below will serve as a useful introduction.

1. Ailor, W.H. Ed. Handbook on Corrosion Testing and Evaluation J. Wiley, 1971.
2. ASTM G1-81, "Preparing, Cleaning, and Evaluating Corrosion Test Specimens." *
3. ASTM G4-84, "Conducting Corrosion Coupon Tests in Plant Equipment." *
4. ASTM G-30.
5. ASTM G31-72, "Laboratory Immersion Corrosion Testing of Metals." *
6. ASTM G46-76, "Examination and Evaluation of Pitting Corrosion." *
7. ASTM G-58.
8. ASTM G78-83, "Crevice Corrosion Testing of Iron-Base and Nickel-Base Stainless Alloys in Seawater and Other Chloride Containing Aqueous Environments."

* American Society for Testing and Materials, Philadelphia, PA.

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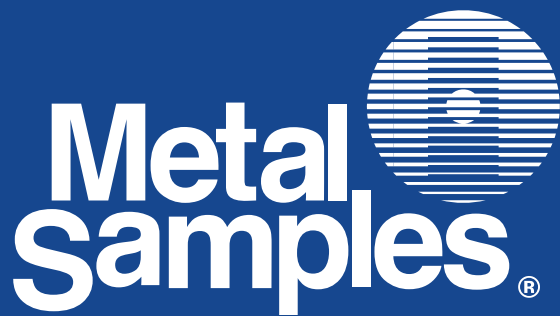
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Business Philosophy

Metal Samples, a division of Alabama Specialty Products, Inc., is committed to superior quality, quick delivery, fair pricing, and excellent service. With our rapidly-expanding physical plant, state-of-the-art equipment, ever-broadening product lines, dedicated research, and highly-skilled work force, we stand ready to meet your specific manufacturing needs.

However, it takes more than buildings, equipment, and personnel to produce excellence; it takes *esprit de corps*. That is why our company works energetically as a whole, realizing the significance of our motto, "May the beauty of the LORD our GOD be upon us and may He establish the work of our hands." Psalm 90:17.





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CATALOG XIII