

# 10L Fermentor Vessel

Model 3  
*'The Fat Boy'*

November 2008  
Bryan Krantz

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# NOTES ON REVISIONS

**Overview of New 10 L Design.** A.k.a the 'Fat boy.' To increase the volume capacity, a 10 L fermentor vessel was designed. The following new parts were added to allow for the increase in volume: larger mixing propeller (P/N 68), SS adapter strap to fermentor base (P/N 69), headplate (P/N 70), baffle fins (P/N 71) and support (P/N 72), custom glass 200 mm 10 L vessel (P/N 73), large o-ring for 200 mm Duran flange (P/N 77), and a SS Duran flange clamp (P/N 78). The corresponding parts used exclusively in the 5 L model were supersized. For convenience in reading about past revisions of these parts prior to their supersizing, here is the part cross-list:

<b>5L P/N</b>	<b>10L P/N</b>	<b>DESCRIPTION</b>
7	68	Mixing propeller
38	69	Adapter strap
44	70	Headplate
59	71	Baffle fin
60	72	Baffle fin support
45	73	Glass vessel
48	77	Big Duran flange o-ring
51	78	Duran flange clamp

Basically, the rest of the parts in the version are identical to those in Model 2 (the 5 L).

## REVISION NOTES FOR MODEL 2 (5 L MODEL)

### REVISION 1.0

Found a custom glass fabrication company, Chemglass, to produce the 150 mm Duran flange flat bottom vessel (P/N 45).

### REVISION 2.0

**Bearing housing.** Due to the formation of leaks around the 1/4"-20 bolts in the bearing housing, I re-designed the bearing housing (P/N 5) to include face sealing o-rings around each mounting bolt (P/N 15). The mounting bolts (P/N 15) were changed from 1/4 "-20 thread to #10-32 thread (McMaster P/N 92314A835). P/N 14 was added back as a Viton O-ring (size Dash 008, McMaster P/N 9464K13) for these #10-32 bolts. Also P/N 13, the Viton O-ring 1.125" I.D., was changed to Dash 024 size (McMaster P/N 9464K78). As a result, the clearance holes for the mounting bolts between the headplate and the bearing housing on the headplate (P/N 44) were reduced from 17/64" to 13/64" for the smaller sized #10-32 fasteners.

**Sparger.** While little stress has been observed after repeated autoclaving of the vessel in the Ultem 1000 (polyetherimide, PEI) parts, the sparger (P/N 25) from Upchurch Scientific (Upchurch P/N A-227A), which is composed of KEL-F, PEEK, and Tefzel and a stainless steel (SS) frit, tended to separate at the junction between the SS frit and the KEL-F body. Thus a one-piece SS sparger was sought to replace the part from Upchurch. McMaster has an alternative sparger (McMaster P/N 4402K52), which is typically used as an exhaust muffler or filter and is type 316 SS. This new sparger will be P/N 53. Also a coupler to the sparge tube is required to adapt the 1/4" NPT male end of the sparger to the 1/4" O.D. SS tubing. This coupler from Swagelok (Swagelok P/N SS-400-7-4) will be P/N 54. I deleted P/N 24, which is the older style sparger tube.

**Temperature probe.** To simplify the insertion of the temperature probe into the fermentor vessel, an autoclave-in-place solution was found at Omega. Furthermore, fewer SS tube fittings required for Omega P/N CPSS-14U-12-NHX, which is type 304 stainless steel, uses a standard ceramic plug style for a Type T thermocouple, has an ungrounded junction, and is 1/4" diameter by 12" long. This new autoclavable probe will be P/N 55. The previous solution, P/N 27, was a dead-ended 1/4" tube was removed along with P/N 23, which was the cap to seal off the end of the old temperature probe tube.

**Replacement O-rings for SAE/ORB fittings.** Previously the O-ring seals for SAE ORB ports (P/N's 42 & 43) were given for seals made of viton. Swagelok makes replacement o-rings made out of their FKM fluorocarbon material. These alternative P/N's were added. From my experience the viton seals are a little firmer and the Swagelok FKM material seems a little bit nicer for the plug ports especially, which are opened and closed frequently.

**Binding Strap Fastener.** Changed P/N 32 from 1/2" long to 7/16" long to allow for smaller width adapter straps (P/N 38) to be used.

**Vent Filter.** Added an autoclavable vent filter from Pall Life Sciences (P/N 4251) listed here as project P/N 56. The filter is supplied by VWR Scientific.

**SS Baffle Assembly.** Added a design for a SS baffle, requiring P/N's 59-63. Parts 59 and 60 are cold rolled type 304 SS, and they are attached via the #5 screw size SS fasteners (P/N's 61-63 from McMaster-Carr).

### REVISION 2.1

**Glass vessel.** Really ~4.8 L. Note Chemglass added an o-ring groove on the glass, which is not in the specification. So it is a good idea to emphasize that you do not want that groove, since one exists on the headplate. On the other hand, the o-ring groove in the headplate could be removed in a future revision.

**Autoclave cap.** Rev. 2 of the cap design (see P/N 46) was created so that blind #8-32 tapped holes (0.25" dp) were added on the outside of the cap. A handle & knob assembly (Assembly J) will help in removing the tight cap after autoclaving, including a SS female #8-32 threaded standoff (McMaster P/N 91125A459), a plastic phenolic knob (McMaster P/N 5838K21) machined with a counterbored clearance for an #8 socket head cap screw, and SS fasteners (P/Ns 65 to 67). The SS locking shaft collar (P/N 16) has #6-32 socket head cap screws that rub in some cases with the inside of the autoclave cap. The initial cheap solution is to use low profile screws (McMaster P/N 93615A215). Though a future revision of the cap could simply open up the cavity from 1" to 1.1".

## REVISION 2.2

**Mixing Propeller.** The plastic body on the prior version of the mixing propeller (P/N 7) disintegrated after treatment with cleaning solutions like dilute NaOH. Also autoclaving may have contributed to the damage, especially at high pH. The simple solution was to make the propeller body with type 304 SS as shown in Rev. 2 of the part.

**Glass vessel.** Solution to the unwanted o-ring groove problem. Chemglass added an o-ring groove on the glass, which is not in the specification. Discovered that if the o-ring groove is there that you can fill the groove with autoclavable silicone RTV compound. I bought a 3-oz. tube of heat resistant silicone RTV sealant (Dow Corning No. 736) from McMaster-Carr (P/N 74515A32). The temperature range for the sealant is -85° to +500° F.

**Autoclave cap.** Rev. 3 of P/N 46, Bearing Housing Sealing Cap for Autoclaving. Found that the handles, which screwed into the autoclave cap via blind, #8-32-threaded holes, caused the cap to crack and split. Likely the cracking was due to differential heat expansion of the plastic against the metal screws (see Rev. 2 for the previous design). So I changed the design to have a clearance for a #8-32 threaded rod to connect the handle ends to. This solution has lasted about 50 autoclave cycles with little sign of failure. I replaced P/N 64 with a SS Ø.75" Diameter Ball Knob (McMaster-Carr (P/N 96415K81) instead of the phenolic one; the prior knob was more expensive and harder to machine. I replaced P/N 67 with #8-32 threaded rod 2-½" long from McMaster-Carr (P/N 95412A882); the rod is needed to connect the handles together through the autoclave cap. A small piece of 1/8" I.D. silicone rubber tubing (McMaster-Carr P/N 51135K73) about 0.12" long was added as a part (P/N 74); it is sandwiched between the standoff and the side of the autoclave cap (see Assembly J for details.) An optional step in assembly of the cap is to use a threadlock (added as P/N 75), such as Loctite No. 272 high-temperature threadlock from McMaster Carr (P/N 91458A65).

**Bearing Housing Assembly.** A special note for pressing the bearings onto the agitator shaft was added as Assembly K. The assembly requires an industrial press.

**Adapter strap.** P/N 39 attaches the fermentor vessel to the base drive unit. New version, Rev. 3, includes glands for Dash 010 Viton o-rings (McMaster-Carr P/N 9464K15) around the clearance for the ¼"-20 cap screws; the o-rings were added as P/N 76. They prevent stress on the headplate and surface cracking. Fortunately, without these the surface cracking was minimal, but with the o-ring revision, they look great after 50+ autoclave cycles.

# REVISION NOTES FOR MODEL 1 (OLD 4L MODEL)

## MODEL 1 REVISION 1.1

The vessel height on Wilmad Labglass' website is incorrectly listed as 13 ¼"; however, the true dimension is 14 ¼". Affected parts were subsequently altered:

- (1) P/N 37 was changed to a 4" long threaded stud (now McMaster P/N 95412A558).
- (2) P/N 35, the compression spring, was changed to McMaster P/N 1986K15.
- (3) The sparger tubes (P/N's 24 and 28) and cooling coil (P/N 29) dimensions were each increased.
- (4) A new part (P/N 41) was added which is a shorter PEEK bushing (1/4" tall).

Updates were made to all affected drawings of Parts (1, 24, 28, 29, 41) as well as Assemblies A and G.

## MODEL 1 REVISION 1.2

The previous vendor for P/N 10 (McMaster-Carr) has been replaced by SDP-SI (P/N A 7X 1-1216A), because the latter vendor makes the precision drive shaft in unhardened 303 SS which can be readily drilled and is already cut to the correct length (16").

Viton O-ring seals for SAE ORB ports (P/N's 42 & 43) were added.

Appendices 1-4 were created. App. 1 provides dimensions for the counterbore required for the SAE ORB ports. App. 2 describes the difference between NF and UNF thread. App. 3 gives information about temperature ratings of lubricants (see bearing specs P/N 6). App. 4 gives material specifications for the plastic, Ultem – Polyetherimide, used to construct the headplate, baseplate, bearing housing and propeller.

## MODEL 1 REVISION 1.3

On P/N 7, mixing propeller: (1) Enlarge screw size to #8 as #6 screws are too easily sheared. (2) Change stock thickness for paddles from 0.08" to 0.062" because of stock shape availability problems at McMaster-Carr (P/N 9085K11). Subsequently P/N 8 & 9 were updated to reflect the change.

The hole diameter for the set pin in the agitator shaft P/N 10 was a #29 drill (0.136"), but now from my experience this is a little loose (right at the upper tolerance). A 3.3 mm drill (0.130" - the tap drill for M4) is on the lower end of the tolerance and works better. Otherwise you have to search through a bag of set pins to find the appropriate size.

P/N 5, the bearing housing, was revised. The small o-rings, P/N 14 were eliminated, since they were redundant to seals around the ¼-20 bolts (P/N 15). The o-ring gland (for o-ring, P/N 13, dash-216) was modified to correctly reflect the specifications of a static face seal. The top of the bearing housing was modified to accept a sealing cap for autoclaving (P/N 46). The Sealing Cap is a new part that has been added to prevent bacteriophage contamination following autoclaving. Often in well sealed bearing assemblies, air is drawn into the vessel during cooling through the bearing shaft.

P/N 46, the Bearing Housing Sealing Cap for Autoclaving, has been added as a new part (see above). P/N 47 was subsequently added as the o-ring seal for the Autoclave cap.

P/N's 49 & 50 were added SAE/MS ORB plugs to seal additional open ports on the headplate (P/N 4). P/N 52, Flexible Silicone Tubing, was added.

Revisions to Assembly A were made to reflect the above changes.

# PARTS

PLAN PART #	DESCRIPTION	MATERIAL	MANUFACTURER	MANUFACTURER PART #	SUPPLIER	SUPPLIER PART #
5	Custom Bearing Housing	Polyetherimide (Ultem 1000)	GE Plastics	N/A	McMaster-Carr	(2.5" diameter x 3" disc) 7662K14
6	ABEC 3 Grade 0.375" Bore Diameter Double Shielded Flanged Bearing (0.8750" O.D.) Mil-G-23827A – Grease (rated -94 to 304 °F)	440C Stainless Steel	N/A	N/A	SDP-SI	A 7Y55-FSS8737M
8	#8-32 Flat Head Phillips Machine Screw 1/4" Lg.	18-8 Stainless Steel	N/A	N/A	McMaster-Carr	91771A190
9	#8-32 set screw 1/4" length	18-8 Stainless Steel	N/A	N/A	McMaster-Carr	92311A190
10	Custom Precision Ground Agitator Shaft (Ø 0.375" x 16" lg.)	303 Stainless Steel	N/A	N/A	SDP-SI	A 7X 1-1216A
11	Coiled Spring Pin for Agitator Shaft (Ø 0.125" x 0.75")	420 Stainless Steel	N/A	N/A	McMaster-Carr	93740A215
12	PEEK Bushing For Bearing Housing	PEEK	N/A	N/A	McMaster-Carr	6621K19
13	Large Viton O-ring for Custom Bearing Housing (Dash 024)	Viton	N/A	N/A	McMaster-Carr	9464K78
14	Small Face Seal O-Rings For Bearing Housing #10-32 Screws (Dash 008)	Viton	N/A	N/A	McMaster-Carr	9464K13



PLAN PART #	DESCRIPTION	MATERIAL	MANUFACTURER	MANUFACTURER PART #	SUPPLIER	SUPPLIER PART #
15	#10-32 Thd. 18-8 SS Hex Head Machine Screw, 1-1/4" Lg.	18-8 Stainless Steel	N/A	N/A	McMaster-Carr	92314A835
16	Locking Shaft Collar	303 Stainless Steel	N/A	N/A	McMaster-Carr	6436K33
17	SS Ferrule Set for 1/4" Tubing	316 Stainless Steel	Swagelok	SS-400-SET	Oakland Valve & Fitting	SS-400-SET
18	Teflon Ferrule Set for 1/4" Tubing	Teflon	Swagelok	T-400-SET	Oakland Valve & Fitting	T-400-SET
19	Stainless Steel Male SAE/MS O-Ring Boss to 1/4" Swage Tube Adapter	316 Stainless Steel	Swagelok	SS-400-1-6ST-BT	Oakland Valve & Fitting	SS-400-1-6ST-BT
20	SS Plug Valve with 1/4" Swage Fittings	316 Stainless Steel	Swagelok	SS-4P4T-M1	Oakland Valve & Fitting	SS-4P4T-M1
21	1/4" Tube Stem to Barb Connector	316 Stainless Steel	Swagelok	SS-4-HC-A-401	Oakland Valve & Fitting	SS-4-HC-A-401
22	Quick Connect Stem to 1/4" Swage	316 Stainless Steel	Swagelok	SS-QC4-S-400	Oakland Valve & Fitting	SS-QC4-S-400
26	Harvest Tube	316 Stainless Steel	N/A	N/A	McMaster-Carr	1/4" SS Tube 89895K722

PLAN PART #	DESCRIPTION	MATERIAL	MANUFACTURER	MANUFACTURER PART #	SUPPLIER	SUPPLIER PART #
28	Sparge Tube for Sparger	316 Stainless Steel	N/A	N/A	McMaster-Carr	¼" SS Tube 89785K51
29	Cooling Coil	316 Stainless Steel	N/A	N/A	McMaster-Carr	¼" SS Tube 89785K51
32	¼"-20 x 7/16" Socket Head Cap Screw	Stainless Steel	N/A	N/A	McMaster-Carr	92196A536
39	Quick Connect Body to ¼" Tube	316 Stainless Steel	Swagelok	SS-QC4-B-400	Oakland Valve & Fitting	SS-QC4-B-400
40	¼" Swage Port Connector	316 Stainless Steel	Swagelok	SS-401-PC	Oakland Valve & Fitting	SS-401-PC
41	Short PEEK Bushing	PEEK	N/A	N/A	McMaster-Carr	6621K17
42	Viton O-ring for SAE ORB Fitting (3/4"-16) Dash-908 OR	Viton	N/A	N/A	McMaster-Carr	9752K118
42	90 Durometer Fluorocarbon FKM O-ring for SAE ORB Fitting (3/4"-16) Dash-908)	90 Durometer Fluorocarbon FKM	Swagelok	VI9-OR-0908	Oakland Valve & Fitting	VI9-OR-0908
43	Viton O-ring for SAE ORB Fitting (9/16"-18) Dash-906)	Viton	N/A	N/A	McMaster-Carr	9752K116

PLAN PART #	DESCRIPTION	MATERIAL	MANUFACTURER	MANUFACTURER PART #	SUPPLIER	SUPPLIER PART #
43	90 Durometer Fluorocarbon FKM O-ring for SAE ORB Fitting (9/16"-18) Dash-906)	90 Durometer Fluorocarbon FKM	Swagelok	VI9-OR-0906	Oakland Valve & Fitting	VI9-OR-0906
46	Bearing Housing Sealing Cap for Autoclaving	Polyetherimide (Ultem 1000)	GE Plastics	N/A	McMaster-Carr	Rod 2" Dia. 12" Lg. 8686K81
47	Sealing Cap O-ring (Dash 029)	Viton	N/A	N/A	McMaster-Carr	9464K291
49	SS 9/16"-18 SAE ORB Plug	316 Stainless Steel	Swagelok	SS-SS-6-PST	Oakland Valve & Fitting	SS-SS-6-PST
50	SS 3/4"-16 SAE ORB Plug	316 Stainless Steel	Swagelok	SS-SS-8-PST	Oakland Valve & Fitting	SS-SS-8-PST
52	1/4" Flexible Silicone Tubing	Silicone	N/A	N/A	McMaster-Carr	3184K1
53	SS Sparger with 1/4" NPT Male Thread	316 Stainless Steel	N/A	N/A	McMaster-Carr	4402K52
54	SS Coupler 1/4" NPT Female x 1/4" tube compression fitting	316 Stainless Steel	Swagelok	SS-400-7-4	Oakland Valve & Fitting	SS-400-7-4
55	Autoclavable SS Temperature Probe 1/4" O.D. Type T (Ungrounded)	304 Stainless Steel	Omega Engineering Inc.	CPSS-14U-12-NHX	Omega Engineering Inc.	CPSS-14U-12-NHX

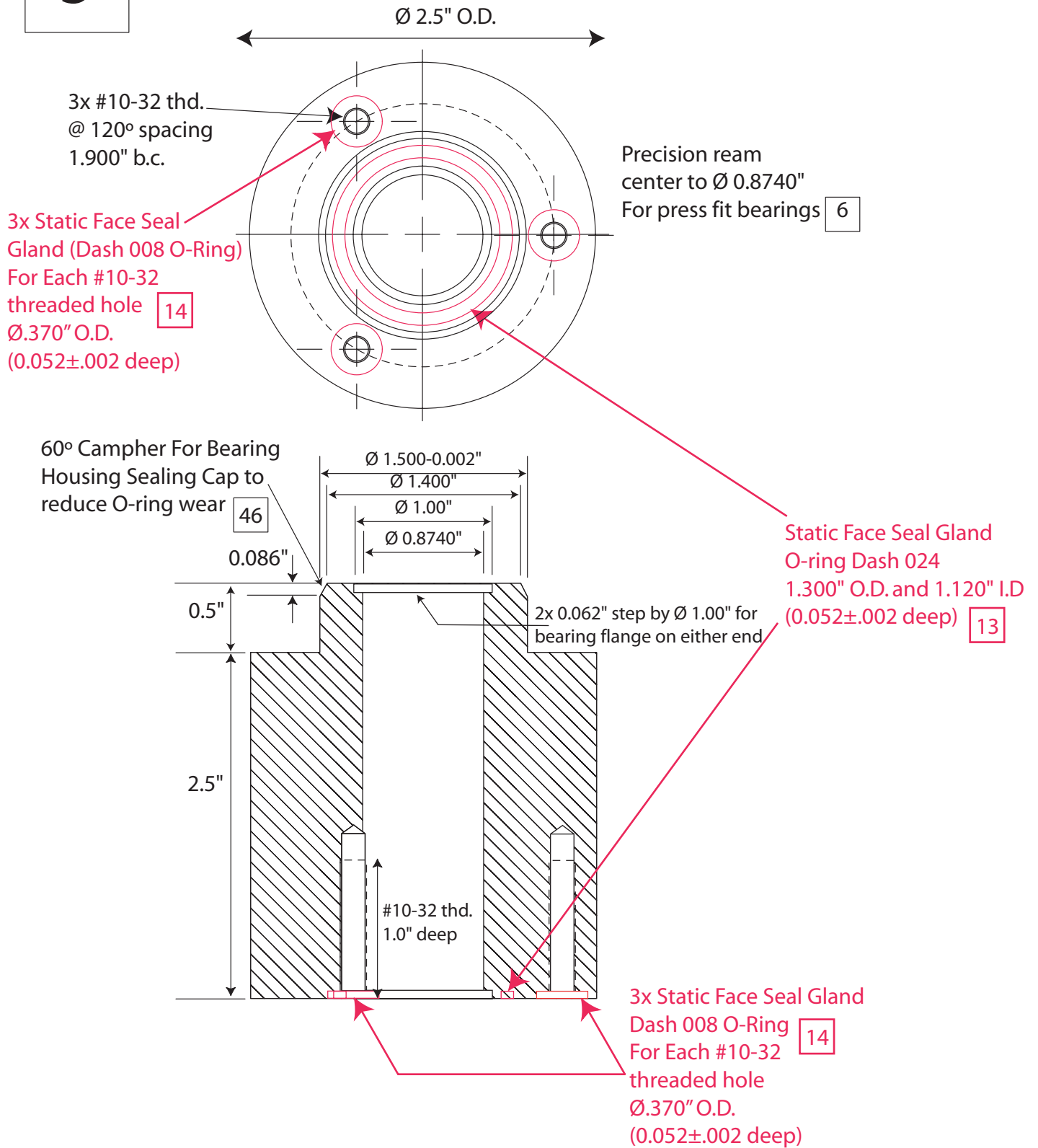
PLAN PART #	DESCRIPTION	MATERIAL	MANUFACTURER	MANUFACTURER PART #	SUPPLIER	SUPPLIER PART #
56	Vent filter with hose barbs (Pall P/N 4251)	PFTE Membrane with Polypropylene Body	Pall Life Sciences	4251	Fisher Scientific	09-730-241A
57	Dow Corning Molykote Synthetic Grease 44 Multipurpose, 5.3-Ounce Tube, Nlgi #2	Molykote Synthetic Grease 44	Dow Corning	44M	McMaster-Carr	1252K23
58	Dow Corning Hi-Vacuum Silica Synthetic Grease 5.3-Ounce Tube	Hi-Vacuum Silica Synthetic Grease	Dow Corning	976V	McMaster-Carr	2966K52
61	Button Head Socket Cap Screw #5-40 Thread, 1/4" Length	Type 18-8 SS	N/A	N/A	McMaster-Carr	92949A131
62	Machine Screw Nut #5-40 Screw Size, 5/16" Width, 7/64" Height	Type 18-8 SS	N/A	N/A	McMaster-Carr	91841A006
63	External-Tooth Lock Washer #5 Screw Size	Type 420 SS	N/A	N/A	McMaster-Carr	98438A215
64	SS Ø.75" Diameter Ball Knob	Type 316 SS	N/A	N/A	McMaster-Carr	96415K81
65	18-8 SS Standoff with Female #8-32 Thread 1/4" OD x 1" lg.	Type 18-8 SS	N/A	N/A	McMaster-Carr	91125A459
66	18-8 SS #8-32 Set Screw 5/8" lg.	Type 18-8 SS	N/A	N/A	McMaster-Carr	92311A196

PLAN PART #	DESCRIPTION	MATERIAL	MANUFACTURER	MANUFACTURER PART #	SUPPLIER	SUPPLIER PART #
67	18-8 SS #8-32 Threaded Rod 2-½ " lg.	Type 18-8 SS	N/A	N/A	McMaster-Carr	95412A882
68	10L Custom mixing propeller	Type 304 SS	N/A	N/A	McMaster-Carr	(SS Bar 0.75"x0.75"x12") 89415K291 (SS Strip 0.075"x1"x36") 1421T21
69	SS Custom Adapter Straps for 10 L to Fermentor Apparatus	Type 304 SS	N/A	N/A	McMaster-Carr	1.25" x 0.25" bar stock 8992K453
70	Custom Headplate for 200 mm Duran Flange Clamp	Polyetherimide (Ultem 1000)	GE Plastics	N/A	McMaster-Carr OR Modern Plastics	0.5" stock sheet
71	SS Baffle Fin	Type 304 SS	N/A	N/A	McMaster-Carr	12" x 12" x 0.06" sheet 8983K42
72	SS Baffle Fin Support	SS	N/A	N/A	McMaster-Carr	(SS Strip 0.075"x1"x36") 1421T21
73	Custom Glass 10 L Flat Bottom 200 mm Duran Flange Fermentor Vessel	Borosilicate Glass	Chemglass	Custom Glass	Chemglass	Custom Glass
74	1/8" I.D. silicone rubber tubing	Silicone Rubber	N/A	N/A	McMaster-Carr	51135K73
75	Loctite No. 272 high- temperature threadlock	Threadlock	N/A	N/A	McMaster-Carr	91458A65

PLAN PART #	DESCRIPTION	MATERIAL	MANUFACTURER	MANUFACTURER PART #	SUPPLIER	SUPPLIER PART #
76	O-rings Dash 010 for Custom Adapter Strap	Viton	N/A	N/A	McMaster-Carr	9464K15
77	Silicone O-ring for 200 mm Duran Flange Clamp Dash 371	Silicone	N/A	N/A	McMaster-Carr	9396K335
78	200 mm Duran Flange Clamp	SS	Chemglass	CG-141-05	Chemglass	CG-141-05

5

# Custom Bearing Housing, Rev. 3



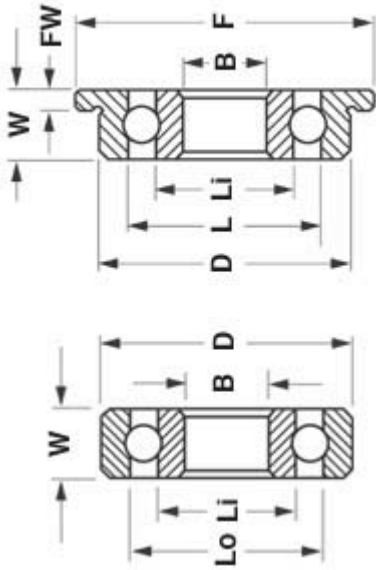
Material: Polyetherimide (Ultem)  
Stock Shape: Disc 2-1/2" Diameter, 3" Thick  
Supplier: McMaster-Carr  
Part #: 7662K14

6

# 0.375" Bore Double Shielded Flanged Bearing

Part Number	B Bore Size Inch	D Outside Dia. Inch	Bearing Type	Material/quality	Lubrication	W Overall Width	Dynamic Load lbs	Static Load lbs	FW Flange Width (0 = None)	F Flange Dia. (0 = None)
A 7Y55-FSS8737M	0.3750"	0.8750"	Flanged - Double Shield	440C Stainless / ABEC 3	Mil-G-23827A - Grease	0.2810	569	273	0.0620	0.969

A 7Y55-FSS8737M    0.3750"    0.8750"    Flanged - Double Shield    440C Stainless / ABEC 3    Mil-G-23827A - Grease    0.2810    569    273    0.0620    0.969

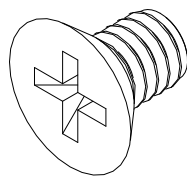
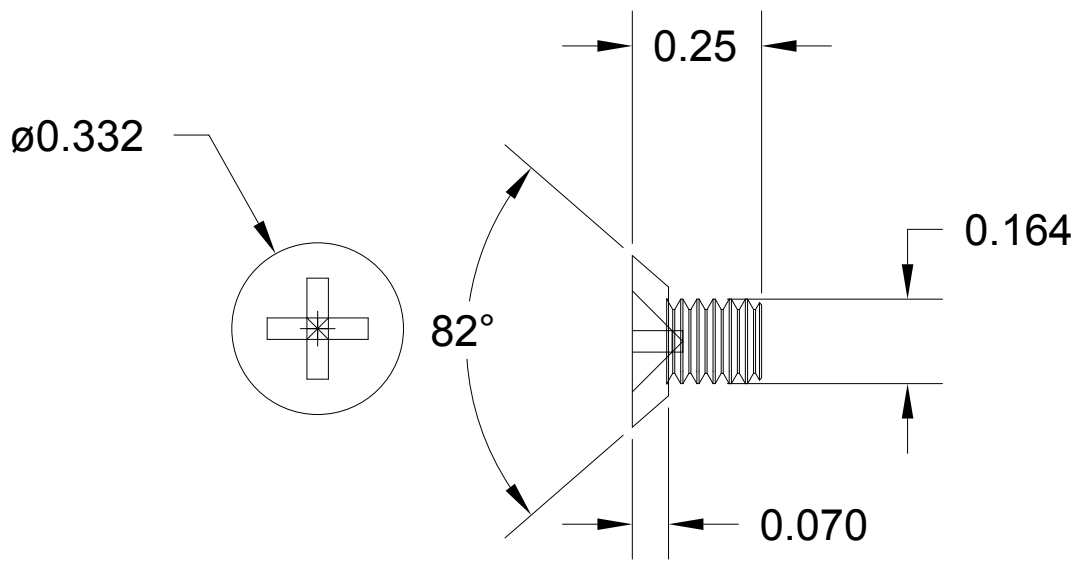


Material: 440C Stainless Steel  
 Manufacturer: Unknown  
 Manufacturer Part #: Unknown  
 Supplier: Sdp-si  
 Supplier Part #: A 7Y55-FSS8737M



8

#8-32 Flat Head Phillips Machine Screw 1/4" Lg.



Material: 18-8 Stainless Steel  
Supplier: McMaster-Carr  
Part#: 91771A190

9

## #8-32 x 1/4" Set Screw



**Material**

18-8 Stainless Steel

**Screw Style**

Standard Socket

**Point**

Cup

**System of Measurement**

Inch

**Thread Size** #8-32

**Length** 1/4"

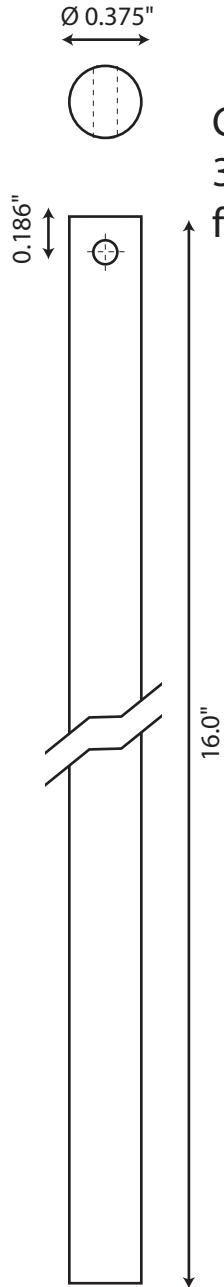
Material: 18-8 Stainless Steel

Supplier: McMaster-Carr

Part #: 92311A190

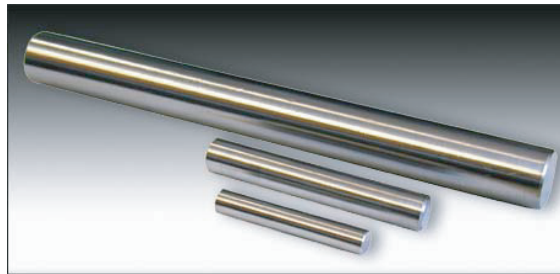
10

# Custom Precision Ground Agitator Shaft (Ø 0.375")



Customize with  
3.3mm drill ( $\text{Ø } 0.130''$ )  
for  $1/8''$  coiled spring pin [11](#)

$.37500(+.000/-0.0002)''$  Dia., 16" Long, 303 Stainless Steel Shaft



## Product Details

**Part Number** A 7X 1-1216A

**Unit** Inch

**Shaft Dia.** 0.3750"

**Shaft Dia. Tolerance**  $(+.000/-0.0002)''$

**Length** 16"

**Material** 303 Stainless Steel

**Condition** UnHardened

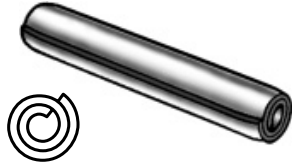
**Finish** 10 Microinch

**Straightness** 0.0010 in / in

Material: 303 Stainless Steel  
Supplier: SDP-SI  
Part #: A 7X 1-1216A

# 11

## Coiled Spring Pin for Agitator Shaft (Ø 0.125" x 0.75")



Nominal Diameter		1/16	5/64	3/32	1/8	5/32	3/16	7/32	1/4	5/16	3/8
Standard Duty Actual Dia.	Min.	.067	.083	.099	.131	.163	.196	.228	.260	.324	.388
	Max.	.072	.088	.105	.138	.171	.205	.238	.271	.337	.403
Heavy Duty Actual Dia.	Min.	—	—	.098	.130	—	.194	—	.258	.322	—
	Max.	—	—	.103	.136	—	.202	—	.268	.334	—
Double Shear Strength, lbs.	Standard Duty Type 420 SS & Plain Steel	300	475	700	1250	1925	2800	3800	5000	7700	11,200
	Heavy Duty Type 420 SS & Plain Steel	—	—	1000	2100	—	4400	—	7700	11,500	—

Wound in a spiral for superior flexibility, these pins fit snugly in out-of-round holes. They accommodate wider hole tolerances plus absorb shock and vibration better than standard spring pins. Ends are chamfered (beveled) for easy insertion.

Material: 420 Stainless Steel  
 Type: Standard Duty  
 Supplier: McMaster-Carr  
 Part #: 93740A215

# 12

## Long PEEK Bushing

### Nonmetallic Sleeve and Flanged Bearings



Sleeve

Flanged

**VespeI**—Offers all the advantages of Teflon plus a wider temp. range. They're precision machined and require no external lubrication.

**PEEK**—Strong chemical compatibility and large load capacity make this an economical alternative to VespeI.

They offer excellent high-temp. performance and maintain high P max, V max, and PV max values. Ideal for high-pressure steam applications and other applications demanding tight tolerances.

**Rulon**—A self-lubricating, filled PTFE material that does not absorb water. *Rulon LR* is inert to most chemicals. *Rulon J* offers the lowest coefficient of friction of any reinforced PTFE material. Ideal for start/stop applications. *Rulon 641* is nontoxic. Excellent for food and medical applications. FDA compliant.

**Nylon**—Gives abrasion resistance and self-lubrication at a low cost. Package quantity is 5.

**MDS-Filled Nylon**—The strong, rigid qualities of nylon combined with wear-resistant, self-lubricating molybdenum disulfide (MDS). They dampen vibration and handle most chemicals.

**UHMW**—Ultra-high molecular weight polyethylene is USDA and FDA compliant. Suitable for direct contact with food and pharmaceuticals. Ideal for wet, corrosive environments.

For Shaft Dia. and OD Tolerance			Length Tolerance	
For Shaft Dia.	For Shaft Dia. Tolerance	OD Tolerance	For Shaft Dia.	Length Tolerance
<b>VespeI</b>			<b>VespeI</b>	
All	+0.000 to 0.001	+0.000 to 0.001	All	±0.005
<b>PEEK</b>			<b>PEEK</b>	
$\frac{3}{16}$ to $\frac{1}{4}$	+0.003 to -0.000	+0.003 to 0.000	$\frac{3}{16}$ to $\frac{1}{4}$	±0.008
$\frac{5}{16}$ to $\frac{3}{8}$	+0.004 to -0.000	+0.004 to 0.000	$\frac{5}{16}$ to $\frac{3}{8}$	±0.010
$\frac{1}{2}$ to $\frac{5}{8}$	+0.005 to -0.000	+0.005 to 0.000	$\frac{1}{2}$ to $\frac{5}{8}$	±0.013
$\frac{3}{4}$ to 1	+0.006 to -0.000	+0.006 to 0.000	$\frac{3}{4}$ to 1	±0.015
$1\frac{1}{2}$ to 2	+0.007 to -0.000	+0.007 to 0.000	$1\frac{1}{2}$ to 2	±0.018
2	+0.008 to -0.000	+0.008 to 0.000	<b>Rulon LR, J, and 641</b>	
<b>Rulon LR, J, and 641</b>			All	
All	+0.002 to 0.000	+0.002 to 0.000	All	±0.005
<b>Nylon</b>			<b>Nylon</b>	
$\frac{3}{16}$ to $\frac{1}{2}$	±0.002	±0.002	All	±0.010
$\frac{5}{8}$ to 1	±0.003	±0.003	<b>MDS-Filled Nylon</b>	
<b>MDS-Filled Nylon</b>			<b>MDS-Filled Nylon</b>	
All	Press-fit	Press-fit	$\frac{1}{8}$ to $\frac{3}{8}$	+0 to 0.0087
<b>UHMW</b>			<b>UHMW</b>	
$\frac{1}{8}$ to $\frac{1}{2}$	+0.002 to +0.010	+0.003 to +0.006	$\frac{7}{16}$ to $\frac{5}{8}$	+0 to 0.0106
$\frac{5}{8}$ to 1	+0.004 to +0.015	+0.004 to +0.008	$\frac{3}{4}$ to 1	+0 to 0.013
$1\frac{1}{8}$ to $1\frac{1}{2}$	+0.006 to +0.020	+0.004 to +0.008	$1\frac{1}{4}$ to 2	+0 to 0.015
<input type="checkbox"/> Tolerance is not rated; bearings conform to shaft dia.			All	

Bearing Material	Temperature Range	For Shaft Hardness	P max	V max	PV max
VespeI	400° to +550° F	Hard	4,900	3,000	300,000
PEEK	150° to +485° F	Soft and up	6,000	600	100,000
Rulon LR	400° to +550° F	Hard	1,000	400	10,000
Rulon J	400° to +550° F	Soft and up	750	400	7,500
Rulon 641	400° to +550° F	Soft and up	1,000	400	10,000
Nylon	20° to +250° F	Medium and up	400	360	3,000
MDS-Filled Nylon	40° to +200° F	Hard	2,000	200	2,700
UHMW	100° to +180° F	Medium and up	1,000	100	3,000

Sleeve Bearings

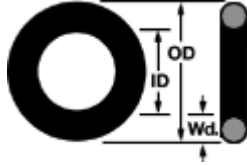
$\frac{3}{8}$ " I.D.  
 $1\frac{5}{32}$ " O.D.  
 $\frac{3}{4}$ " Long



Material: PEEK  
 Stock Part: Sleeve  
 Supplier: McMaster  
 Part #: 6621K19

13

## Large O-ring for Custom Bearing Housing (Dash 024)



McMaster Part Number: [9464K78](#)

\$9.39 per Pack of 50

SAE Specification

SAE J200

AS568A Dash Number

024

Type

O-Ring

Cross Section Shape

Round

System of Measurement

Inch

Width

1/16"

Actual Width

.070"

Inside Diameter

1-1/8"

Actual Inside Diameter

1.114"

Outside Diameter

1-1/4"

Actual Outside Diameter

1.254"

Material

Viton

Viton Type

Standard

Durometer

Hard

Durometer Shore

Shore A: 75

Temperature Range

-15° to +400°F

Color

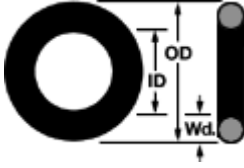
Black

Specifications Met

Society of Automotive Engineers (SAE)

14

Small Face Seal O-Rings For Bearing Housing #10-32  
Screws (Dash 008)



McMaster P/N: [9464K13](#)

SAE Specification

AS568A Dash Number

Type

Cross Section Shape

System of Measurement

Width

Actual Width

Inside Diameter

Actual Inside Diameter

Outside Diameter

Actual Outside Diameter

Material

Viton Type

Durometer

Durometer Shore

Temperature Range

Color

Specifications Met

\$6.03 per Pack of 100

SAE J200

008

O-Ring

Round

Inch

1/16"

.070"

3/16"

.176"

5/16"

.316"

Viton

Standard

Hard

Shore A: 75

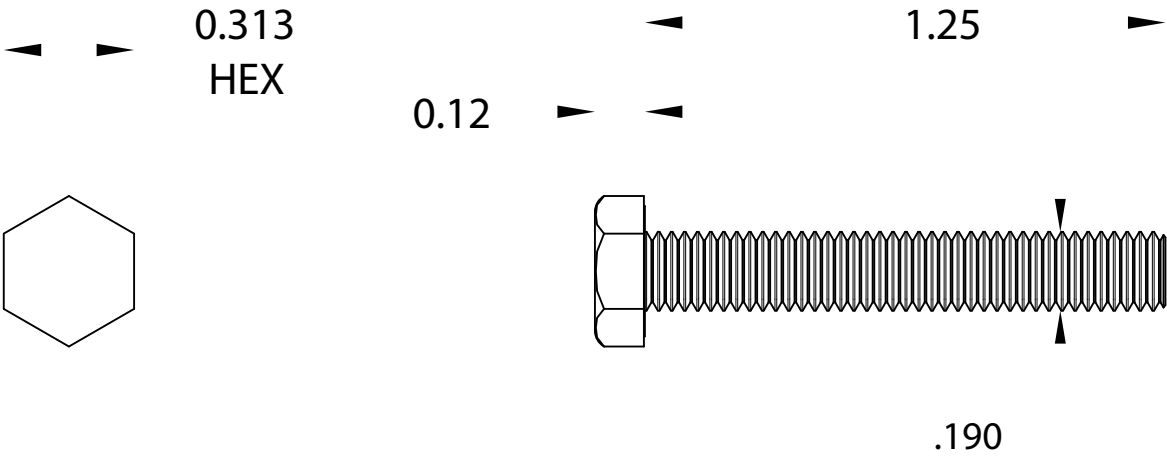
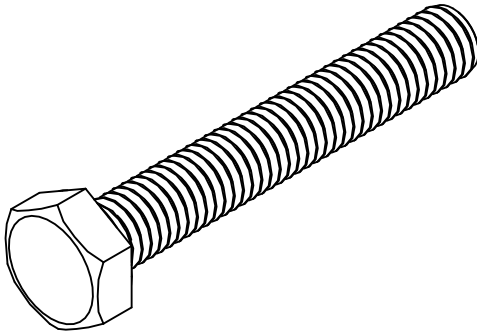
-15° to +400°F

Black

Society of Automotive Engineers (SAE)

15

# #10-32 Hex Head SS Bolt



18-8 Stainless Steel Hex  
Head Machine Screw 10-32  
Thread, 1-1/4" Length  
P/N: 92314A835  
McMaster-Carr Supply Company



# 16

## Locking Shaft Collar



Part Number 6436K33

\$5.59 Each

<b>Type</b>		Two-Piece Clamp-On Shaft Collars
<b>System of Measurement</b>	Inch	
<b>Bore Size</b>		3/8"
<b>Outside Diameter</b>		7/8"
<b>Width</b>		3/8"
<b>Material</b>		Type 303 Stainless Steel
<b>Width Tolerance</b>		+.003" to -.01"
<b>Set/Cap Screw Size</b>		6-32 x 7/16"
<b>Set/Cap Screw Material</b>		18-8 Austentic Stainless Steel

Material: 303 SS  
Stock Part: Locking Shaft Collar  
Supplier: McMaster  
Part #: 6436K33

# 17

## SS Ferrule Set for 1/4" Tubing



### Front Ferrule

- Over 1 in. and over 25 mm stainless steel ferrules are PFA coated. To order silver-plated front ferrules, add **-BL** as a suffix to the basic ordering number.

Tube OD	Basic Ordering Number
1/16	-103-1
1/8	-203-1
3/16	-303-1
1/4	-403-1
5/16	-503-1
3/8	-603-1
1/2	-813-1
5/8	-1013-1
3/4	-1213-1
7/8	-1413-1
1	-1613-1
1 1/4	-2003-1 <input type="checkbox"/>
1 1/2	-2403-1 <input type="checkbox"/>
2	-3203-1 <input type="checkbox"/>

Tube OD	Basic Ordering Number
Dimensions, mm	
2	-2M3-1
3	-3M3-1
4	-4M3-1
6	-6M3-1
8	-8M3-1
10	-10M3-1
12	-12M3-1
14	-14M3-1
15	-15M3-1
16	-16M3-1
18	-18M3-1
20	-20M3-1
22	-22M3-1
25	-25M3-1
28	-28M3-1 <input type="checkbox"/>
30	-30M3-1 <input type="checkbox"/>
32	-32M3-1 <input type="checkbox"/>
38	-38M3-1 <input type="checkbox"/>
50	-50M3-1 <input type="checkbox"/>



### Back Ferrule

- Over 1 in. and over 25 mm stainless steel ferrules are PFA coated. To order back ferrules without PFA coating, add **-WC** as a suffix to the basic ordering number.

Tube OD	Basic Ordering Number
1/16	-104-1
1/8	-204-1
3/16	-304-1
1/4	-404-1
5/16	-504-1
3/8	-604-1
1/2	-814-1
5/8	-1014-1
3/4	-1214-1
7/8	-1414-1
1	-1614-1
1 1/4	-2004-1
1 1/2	-2404-1
2	-3204-1

Tube OD	Basic Ordering Number
Dimensions, mm	
2	-2M4-1
3	-3M4-1
4	-4M4-1
6	-6M4-1
8	-8M4-1
10	-10M4-1
12	-12M4-1
14	-14M4-1
15	-15M4-1
16	-16M4-1
18	-18M4-1
20	-20M4-1
22	-22M4-1
25	-25M4-1
28	-28M4-1
30	-30M4-1
32	-32M4-1
38	-38M4-1
50	-50M4-1

Note: When ordering a set of front and back ferrules, order using dash **-SET** suffix.

**Material: 316 SS**

**Supplier: Swagelock**

**Part #: SS-400-SET**

# 18

# Teflon Ferrule Set for 1/4" Tubing



## Front Ferrule

- Over 1 in. and over 25 mm stainless steel ferrules are PFA coated. To order silver-plated front ferrules, add **-BL** as a suffix to the basic ordering number.

Tube OD	Basic Ordering Number
1/16	-103-1
1/8	-203-1
3/16	-303-1
1/4	-403-1
5/16	-503-1
3/8	-603-1
1/2	-813-1
5/8	-1013-1
3/4	-1213-1
7/8	-1413-1
1	-1613-1
1 1/4	-2003-1 <input type="checkbox"/>
1 1/2	-2403-1 <input type="checkbox"/>
2	-3203-1 <input type="checkbox"/>

Tube OD	Basic Ordering Number
Dimensions, mm	
2	-2M3-1
3	-3M3-1
4	-4M3-1
6	-6M3-1
8	-8M3-1
10	-10M3-1
12	-12M3-1
14	-14M3-1
15	-15M3-1
16	-16M3-1
18	-18M3-1
20	-20M3-1
22	-22M3-1
25	-25M3-1
28	-28M3-1 <input type="checkbox"/>
30	-30M3-1 <input type="checkbox"/>
32	-32M3-1 <input type="checkbox"/>
38	-38M3-1 <input type="checkbox"/>
50	-50M3-1 <input type="checkbox"/>



## Back Ferrule

- Over 1 in. and over 25 mm stainless steel ferrules are PFA coated. To order back ferrules without PFA coating, add **-WC** as a suffix to the basic ordering number.

Tube OD	Basic Ordering Number
1/16	-104-1
1/8	-204-1
3/16	-304-1
1/4	-404-1
5/16	-504-1
3/8	-604-1
1/2	-814-1
5/8	-1014-1
3/4	-1214-1
7/8	-1414-1
1	-1614-1
1 1/4	-2004-1
1 1/2	-2404-1
2	-3204-1

Tube OD	Basic Ordering Number
Dimensions, mm	
2	-2M4-1
3	-3M4-1
4	-4M4-1
6	-6M4-1
8	-8M4-1
10	-10M4-1
12	-12M4-1
14	-14M4-1
15	-15M4-1
16	-16M4-1
18	-18M4-1
20	-20M4-1
22	-22M4-1
25	-25M4-1
28	-28M4-1
30	-30M4-1
32	-32M4-1
38	-38M4-1
50	-50M4-1

Note: When ordering a set of front and back ferrules, order using dash **-SET** suffix.

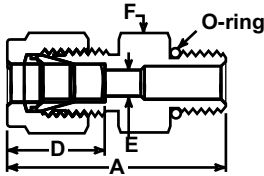
**Material: Teflon**

**Supplier: Swagelock**

**Part #: T-400-SET**

# 19

## Stainless Steel Male SAE/MS O-ring Boss to 1/4" Swage Tube Adapter



Tube OD	SAE/MS Thread Size	Basic Ordering Number	Dimensions			
			A	D	E	F Flat
1/8	5/16-24	-200-1-2ST	1.18	0.50	0.09	7/16
	7/16-20	-200-1-4ST	1.24			9/16
	9/16-18	-200-1-6ST	1.31			11/16
1/4	7/16-20	-400-1-4ST	1.34	0.60	0.19	9/16
	9/16-18	-400-1-6ST	1.40			11/16
	3/4-16	-400-1-8ST	1.48			7/8
	7/8-14	-400-1-10ST	1.60			1
5/16	1/2-20	-500-1-5ST	1.37	0.64	0.25	5/8
3/8	7/16-20	-600-1-4ST	1.40	0.66	0.18	5/8
	9/16-18	-600-1-6ST	1.46			11/16
	3/4-16	-600-1-8ST	1.54			7/8
	7/8-14	-600-1-10ST	1.66			1
1/2	9/16-18	-810-1-6ST	1.54	0.90	0.28	13/16
	3/4-16	-810-1-8ST	1.65			7/8
	7/8-14	-810-1-10ST	1.77			1
	1 1/16-12	-810-1-12ST	1.93			1 1/4
5/8	3/4-16	-1010-1-8ST	1.65	0.96	0.42	15/16
	7/8-14	-1010-1-10ST	1.78			1
3/4	3/4-16	-1210-1-8ST	1.81	0.96	0.42	1 1/16
	1 1/16-12	-1210-1-12ST	1.93			1 1/4
7/8	1 3/16-12	-1410-1-14ST	1.93	1.02	0.72	1 3/8
1	1 1/16-12	-1610-1-12ST	2.10	1.23	0.66	1 3/8
		-1610-1-16ST	2.14			1 1/2
1 1/4	1 5/8-12	-2000-1-20ST	2.69	1.62	1.09	1 7/8
1 1/2	1 7/8-12	-2400-1-24ST	3.06	1.97	1.34	2 1/8
2	2 1/2-12	-3200-1-32ST	4.00	2.66	1.81	2 3/4

The E dimension is the minimum opening. These fittings may have a larger opening at the pipe/straight thread end.

Note: Dash -BT designates that the through hole 'E' is bored through. To the same O.D. as the tube fitting.

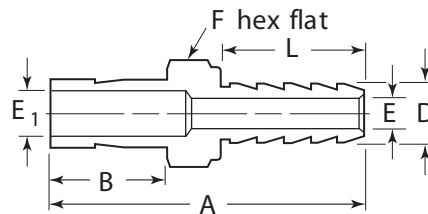
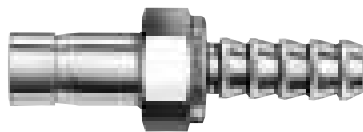
Material: 316 Stainless Steel  
 Manufacturer: Swagelok  
 Supplier: Cambridge Valve & Fitting  
 Part #: SS-400-1-6ST-BT

20

# SS Plug Valve with 1/4" Swage Fittings

PART NO. SS-4P4T-M1		
CUSTOMER DRAWING	DRAWN BY RCR	TITLE P4T SERIES PLUG VALVE
	APPROVED BY RDT	PART NO. SS-4P4T-M1
- DRAWING NOT TO SCALE. - DIMENSIONS ARE INCHES NEXT TO (MILLIMETERS). - DRAWING IS SUBJECT TO CHANGE WITHOUT NOTICE.		02-14-02
		02-14-02

## Tube Adapter



Hose ID in.	Tube Size in.	Basic Ordering Number	Dimensions, in.						
			A	B	D	E	E <sub>1</sub>	F	L
1/8	1/8	-2-HC-A-201	1.36	0.54	0.15	0.08	0.09	5/16	0.40
	1/4	-2-HC-A-401	1.46	0.64			0.19	3/8	
1/4	1/4	-4-HC-A-401	1.85	0.64	0.30	0.19	0.19	7/16	0.79
	3/8	-4-HC-A-601	1.91	0.70			0.28		
	6 mm	-4-HC-A-6MTA	1.88	0.64			0.18		
5/16	1/4	-5-HC-A-401	1.93	0.64	0.37	0.19	0.19	7/16	0.87
3/8	1/4	-6-HC-A-401	1.93	0.64	0.45	0.30	0.17	9/16	0.87
	3/8	-6-HC-A-601	1.99	0.70			0.28	9/16	
	1/2	-6-HC-A-811	2.25	0.96			0.39	5/8	
1/2	3/8	-8-HC-A-601	2.06	0.70	0.60	0.38	0.28	11/16	0.94
	1/2	-8-HC-A-811	2.32	0.96			0.39	11/16	
3/4	3/4	-12-HC-A-1211	2.49	1.02	0.90	0.63	0.59	1 3/16	1.05
1	1	-16-HC-A-1611	3.02	1.30	1.20	0.88	0.80	1 3/8	1.19

Swagelok tube adapters are to be used only with Swagelok tube fittings manufactured by Swagelok Company.

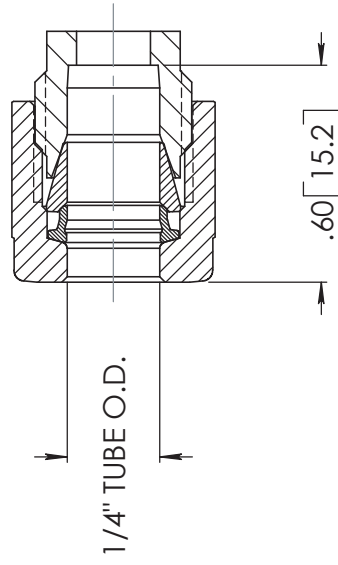
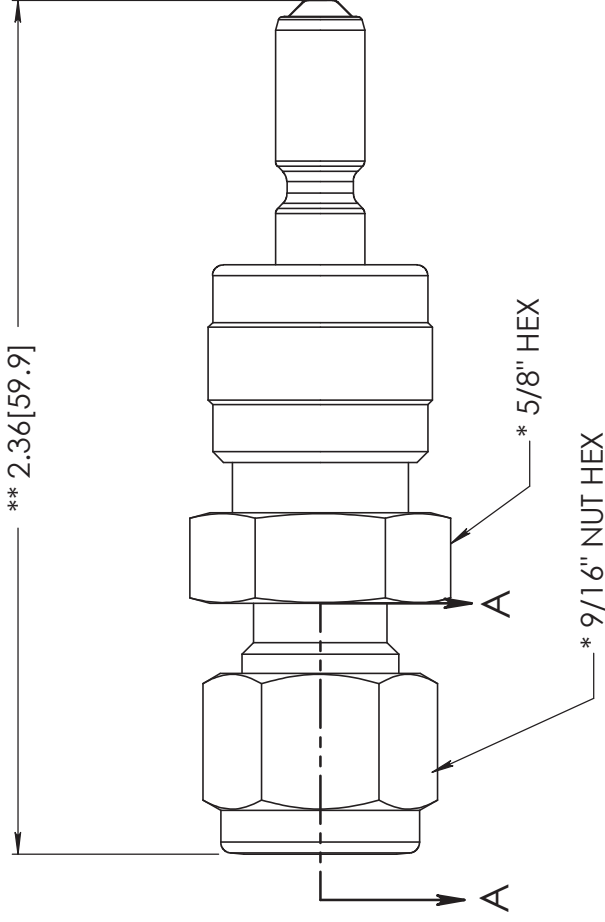
**Material: 316 Stainless Steel**

**Supplier: Swagelok**

**Part #'s: SS-4-HC-A-401 (1/4" x 1/4" barb I.D.)**

PART NO. SS-QC4-S-400

# 22 Quick Connect Stem to 1/4" Swage



NOTE(S):  
1) \*DIMENSIONS ARE ACROSS HEX FLATS.  
2) \*\*ARE TYPICAL FINGER-TIGHT DIMENSIONS.

CUSTOMER DRAWING



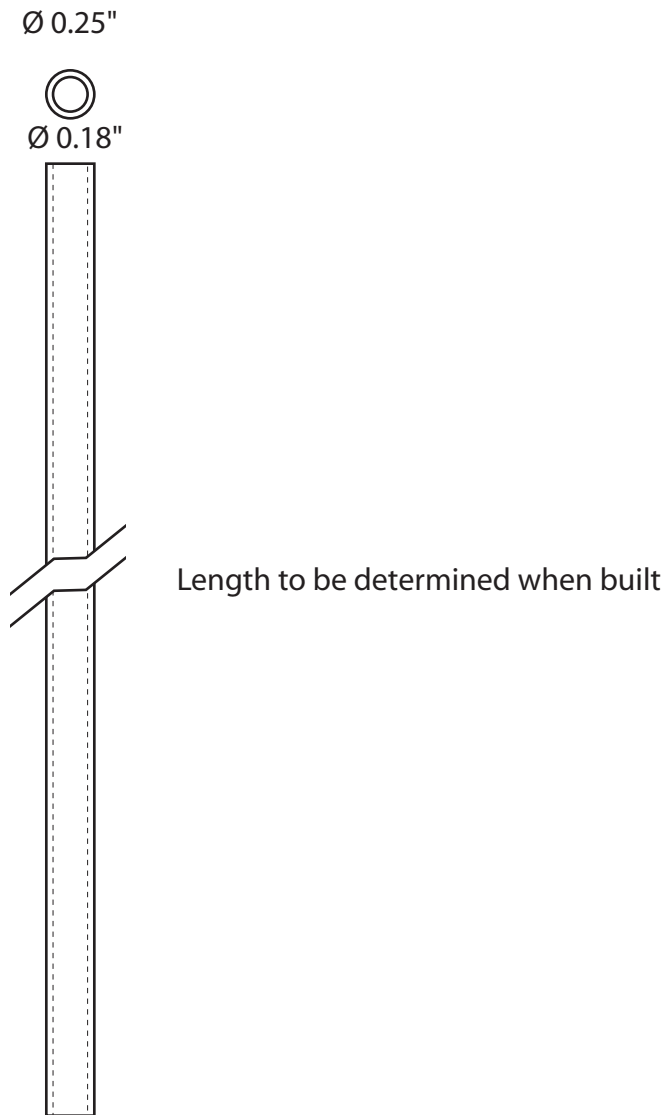
- DRAWING NOT TO SCALE.  
- DIMENSIONS ARE INCHES NEXT TO [MILLIMETERS].  
- DRAWING IS SUBJECT TO CHANGE WITHOUT NOTICE.

DRAWN BY  
CMD 07-30-03  
APPROVED BY  
RDT 07-31-03

TITLE  
1/4" QC SESO STEM  
PART NO. SS-QC4-S-400

26

# Harvest Tube

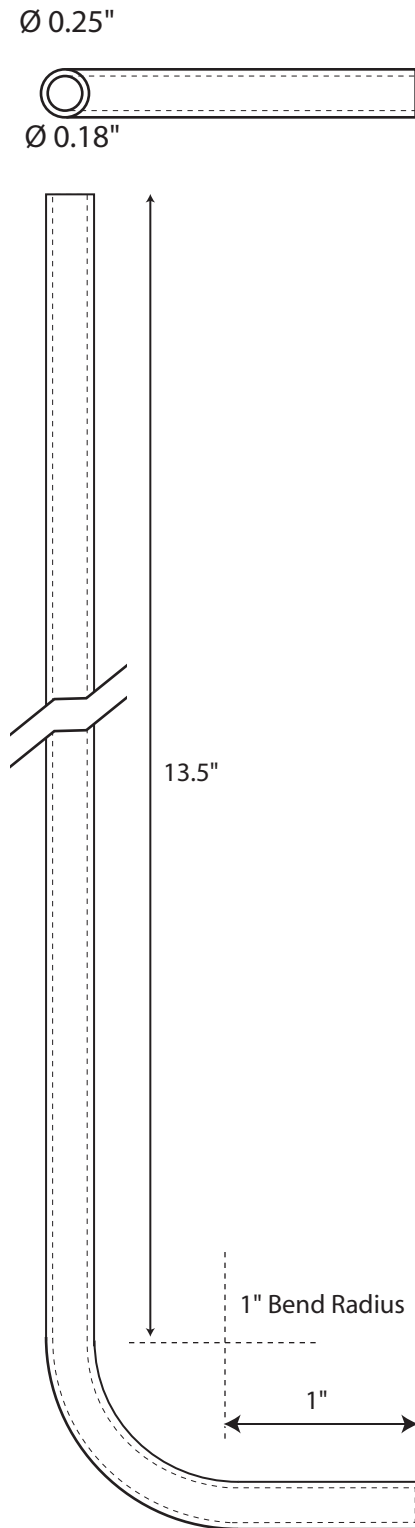


Material: 316 Stainless Steel  
Stock shape: Tube seamless 1/4" diameter 0.035" wall  
Supplier: McMaster-Carr  
Part #: 89785K51



28

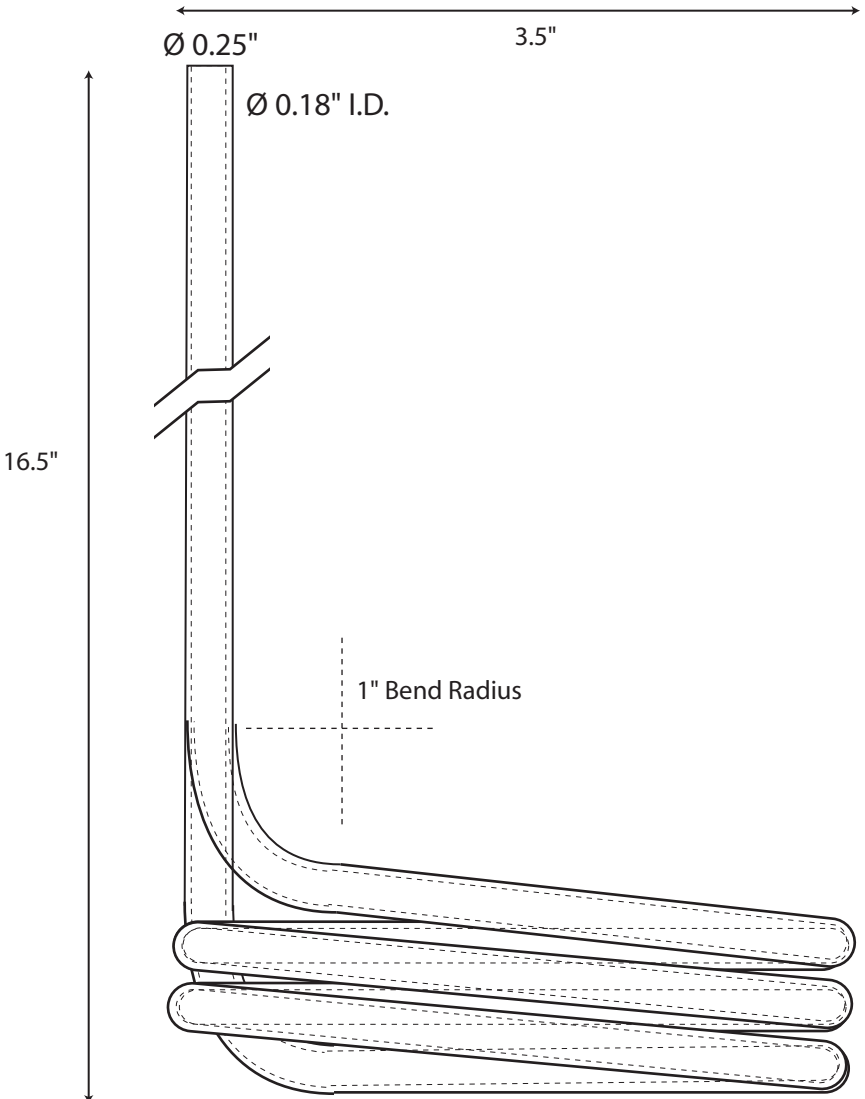
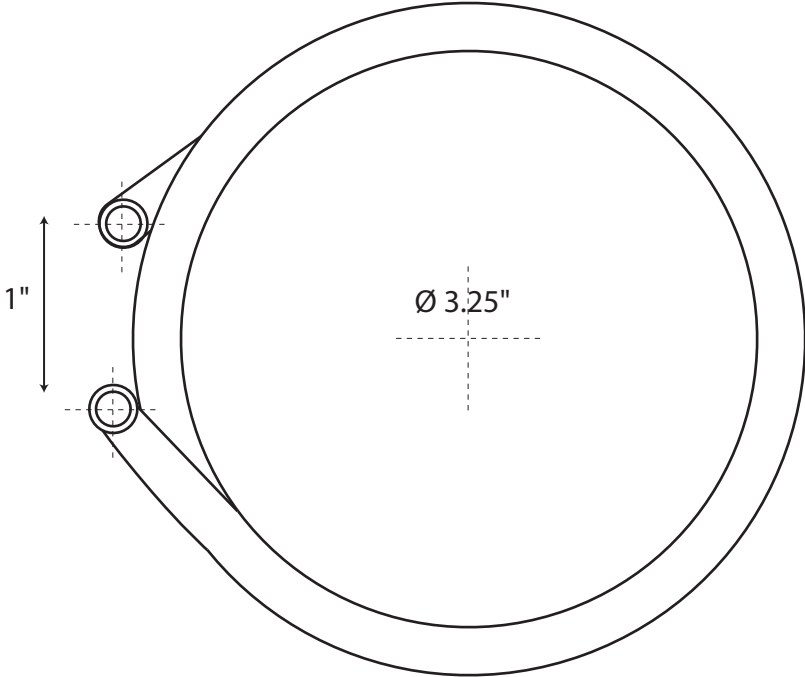
# Sparge Tube for Sparger



Material: 316 Stainless Steel  
Stock shape: Tube seamless 1/4" diameter 0.035" wall  
Supplier: McMaster-Carr  
Part #: 89785K51

# 29

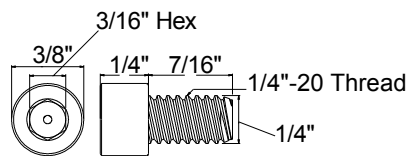
## Cooling Coil



Material: 316 Stainless Steel  
Stock shape: Tube seamless 1/4" diameter  
0.035" wall  
Supplier: McMaster-Carr  
Part #: 89785K51

32

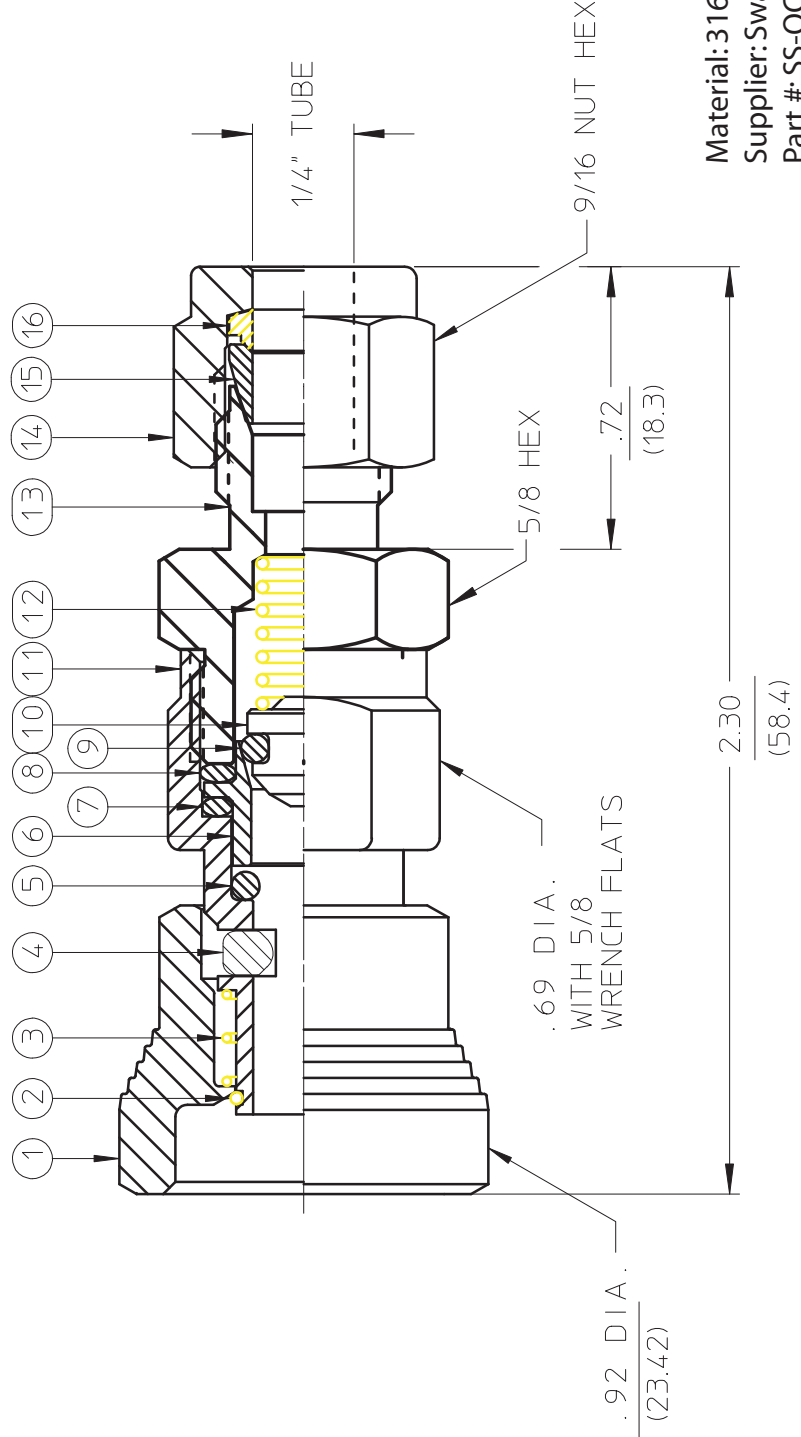
# 1/4"-20 Socket Head Cap Screw x 7/16" Long



1/4"-20 Socket Head Cap Screw x 7/16" Long  
Material: Type 18-8 Stainless Steel  
Supplier: McMaster-Carr  
Supplier P/N: 92196A536

# 39 Quick Connect Body To 1/4" Tube

ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	BODY SLEEVE	9	BODY VALVE SEAL O-RING
2	SNAP RING	10	BODY VALVE
3	BODY SLEEVE SPRING	11	HOUSING
4	LOCKING DOGS	12	BODY VALVE SPRING
5	STEM SEAL O-RING	13	BODY ADAPTER
6	INSERT	14	NUT
7	INSERT SEAL O-RING	15	FRONT FERRULE
8	INSERT SEAL O-RING	16	REAR FERRULE



Material: 316 Stainless Steel  
 Supplier: Swagelok  
 Part #: SS-QC4-B-400

CUSTOMER DRAWING



- DRAWING NOT TO SCALE.  
 - DIMENSIONS ARE INCHES OVER (MILLIMETERS).  
 - DRAWING IS SUBJECT TO CHANGE WITHOUT NOTICE.

DRAWN BY	CO	DATE	11-6-98
APPROVED BY	DJK	DATE	11-11-98

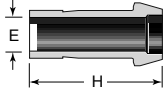
TITLE	SS-QC4 BODY
PART NO.	SS-QC4-B-400

# 40

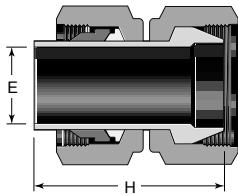
## 1/4" Swage Port Connector

### Port Connectors

#### 1 in. / 25 mm and under



#### Over 1 in. / 25mm



Tube OD	Basic Ordering Number	Dimensions	
		E	H
1/16	-101-PC	0.03	0.54
1/8	-201-PC	0.08	0.88
1/4	-401-PC	0.17	0.98
5/16	-501-PC	0.22	1.02
3/8	-601-PC	0.27	1.05
1/2	-811-PC	0.37	1.43
5/8	-1011-PC	0.47	1.49
3/4	-1211-PC	0.58	1.49
1	-1611-PC	0.80	1.94
1 1/4	-2000-PC	1.02	2.72
1 1/2	-2400-PC	1.25	3.31
2	-3200-PC	1.72	4.56

Tube OD	Basic Ordering Number	Dimensions	
		E	H
<i>Dimensions, mm</i>			
3	-3M1-PC	1.9	22.2
6	-6M1-PC	4.1	25.0
8	-8M1-PC	5.6	26.0
10	-10M1-PC	7.1	27.1
12	-12M1-PC	8.8	36.2
15	-15M1-PC	11.2	37.8
16	-16M1-PC	12.0	37.8
18	-18M1-PC	13.9	37.8
20	-20M1-PC	15.5	39.4
25	-25M1-PC	19.9	49.3
28	-28M0-PC	22.5	63.5
30	-30M0-PC	24.3	67.6
32	-32M0-PC	26.5	69.7
38	-38M0-PC	31.6	81.9

Furnished with nuts and preswaged ferrules.

Material: 316 Stainless Steel  
 Manufacturer: Swagelok  
 Supplier: Cambridge Valve & Fitting  
 Part #: SS-401-PC

# 41

## Short PEEK Bushing

### Nonmetallic Sleeve and Flanged Bearings



Sleeve

Flanged

**VespeI**—Offers all the advantages of Teflon plus a wider temp. range. They're precision machined and require no external lubrication.

**PEEK**—Strong chemical compatibility and large load capacity make this an economical alternative to VespeI.

They offer excellent high-temp. performance and maintain high P max, V max, and PV max values. Ideal for high-pressure steam applications and other applications demanding tight tolerances.

**Rulon**—A self-lubricating, filled PTFE material that does not absorb water. *Rulon LR* is inert to most chemicals. *Rulon J* offers the lowest coefficient of friction of any reinforced PTFE material. Ideal for start/stop applications. *Rulon 641* is nontoxic. Excellent for food and medical applications. FDA compliant.

**Nylon**—Gives abrasion resistance and self-lubrication at a low cost. Package quantity is 5.

**MDS-Filled Nylon**—The strong, rigid qualities of nylon combined with wear-resistant, self-lubricating molybdenum disulfide (MDS). They dampen vibration and handle most chemicals.

**UHMW**—Ultra-high molecular weight polyethylene is USDA and FDA compliant. Suitable for direct contact with food and pharmaceuticals. Ideal for wet, corrosive environments.

For Shaft Dia. and OD Tolerance			Length Tolerance	
For Shaft Dia.	For Shaft Dia. Tolerance	OD Tolerance	For Shaft Dia.	Length Tolerance
<b>VespeI</b>				
All	+0.000 to 0.001	+0.000 to 0.001	All	±0.005
<b>PEEK</b>				
$\frac{3}{16}$ to $\frac{1}{4}$	+0.003 to -0.000	+0.003 to 0.000	$\frac{3}{16}$ to $\frac{1}{4}$	±0.008
$\frac{5}{16}$ to $\frac{3}{8}$	+0.004 to -0.000	+0.004 to 0.000	$\frac{5}{16}$ to $\frac{3}{8}$	±0.010
$\frac{1}{2}$ to $\frac{5}{8}$	+0.005 to -0.000	+0.005 to 0.000	$\frac{1}{2}$ to $\frac{5}{8}$	±0.013
$\frac{3}{4}$ to 1	+0.006 to -0.000	+0.006 to 0.000	$\frac{3}{4}$ to 1	±0.015
$1\frac{1}{2}$ to 2	+0.007 to -0.000	+0.007 to 0.000	$1\frac{1}{2}$ to 2	±0.018
2	+0.008 to -0.000	+0.008 to 0.000	<b>Rulon LR, J, and 641</b>	
All	+0.002 to 0.000	+0.002 to 0.000	All	±0.005
<b>Nylon</b>				
All	±0.002	±0.002	All	±0.010
$\frac{3}{16}$ to $\frac{1}{2}$	±0.003	±0.003	<b>MDS-Filled Nylon</b>	
$\frac{5}{8}$ to 1	±0.003	±0.003	$\frac{1}{8}$ to $\frac{3}{8}$	+0 to 0.0087
<b>MDS-Filled Nylon</b>				
All	Press-fit	Press-fit	$\frac{7}{16}$ to $\frac{5}{8}$	+0 to 0.0106
<b>UHMW</b>				
$\frac{1}{8}$ to $\frac{1}{2}$	+0.002 to +0.010	+0.003 to +0.006	$\frac{3}{4}$ to 1	+0 to 0.013
$\frac{5}{8}$ to 1	+0.004 to +0.015	+0.004 to +0.008	$1\frac{1}{4}$ to 2	+0 to 0.015
$1\frac{1}{2}$ to $1\frac{1}{2}$	+0.006 to +0.020	+0.004 to +0.008	All	±0.005

□ Tolerance is not rated; bearings conform to shaft dia.

Bearing Material	Temperature Range	For Shaft Hardness	P max	V max	PV max
VespeI	□400° to +550° F	Hard	4,900	3,000	300,000
PEEK	□150° to +485° F	Soft and up	6,000	600	100,000
Rulon LR	□400° to +550° F	Hard	1,000	400	10,000
Rulon J	□400° to +550° F	Soft and up	750	400	7,500
Rulon 641	□400° to +550° F	Soft and up	1,000	400	10,000
Nylon	□20° to +250° F	Medium and up	400	360	3,000
MDS-Filled Nylon	□40° to +200° F	Hard	2,000	200	2,700
UHMW	□100° to +180° F	Medium and up	1,000	100	3,000

#### Sleeve Bearings

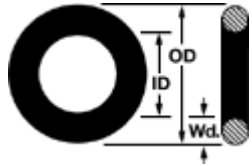
□  
 $\frac{3}{8}$ " I.D.  
 $1\frac{5}{32}$ " O.D.  
 $\frac{1}{4}$ " Long



Material: PEEK  
 Stock Part: Sleeve  
 Supplier: McMaster  
 Part #: 6621K17

42

# O-ring for SAE ORB Fitting (3/4"-16) Dash 908



Part Number 9752K118

\$4.69 per Pack of 25

**System of Measurement**

Inch

**AS568A Dash Number**

908

**Inside Diameter**

.644"

**Outside Diameter**

.818"

**Width**

.087"

**Type**

Viton for Boss Tube Fittings

**Durometer**

Shore A: 90

**Operating Temperature Range**

-15° to +400°F

**Color**

black

**Package Quantity**

25

Material:Viton

Dash:908

Supplier:McMaster

Part #:9752K118

**P/N:** VI9-OR-0908

**Description:** 90 Durometer Fluorocarbon FKM O-ring for Fittings with SAE/MS Straight Threads, Uniform Size 908



**Dash Size:** 908

**Fitting:** SAE ORB 3/4"-16 Thread

Material: FKM Fluorocarbon

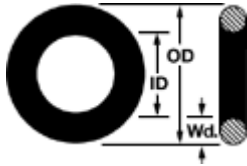
**Material:** Fluorocarbon

Dash:908

Manufacturer :Swagelok

Supplier:Cambridge Valve & Fitting

Part #: VI9-OR-0908

**43****O-ring for SAE ORB Fitting (9/16"-18) Dash 906**

Part Number 9752K116

\$3.49 per Pack of 25

**System of Measurement**

Inch

**AS568A Dash Number**

906

**Inside Diameter**

.468"

**Outside Diameter**

.624"

**Width**

0.078"

**Type**

Viton for Boss Tube Fittings

**Durometer**

Shore A: 90

**Operating Temperature Range**

-15° to +400°F

**Color**

black

**Package Quantity**

25

Material:Viton

Dash:906

Supplier:McMaster

Part #:9752K116

**P/N:** VI9-OR-0906**Description:** 90 Durometer Fluorocarbon FKM O-ring for Fittings with SAE/MS Straight Threads, Uniform Size 906**Dash Size:** 906**Fitting:** SAE ORB 9/16"-18 Thread**Material:** Fluorocarbon

Material: FKM Fluorocarbon

Dash: 906

Manufacturer: Swagelok

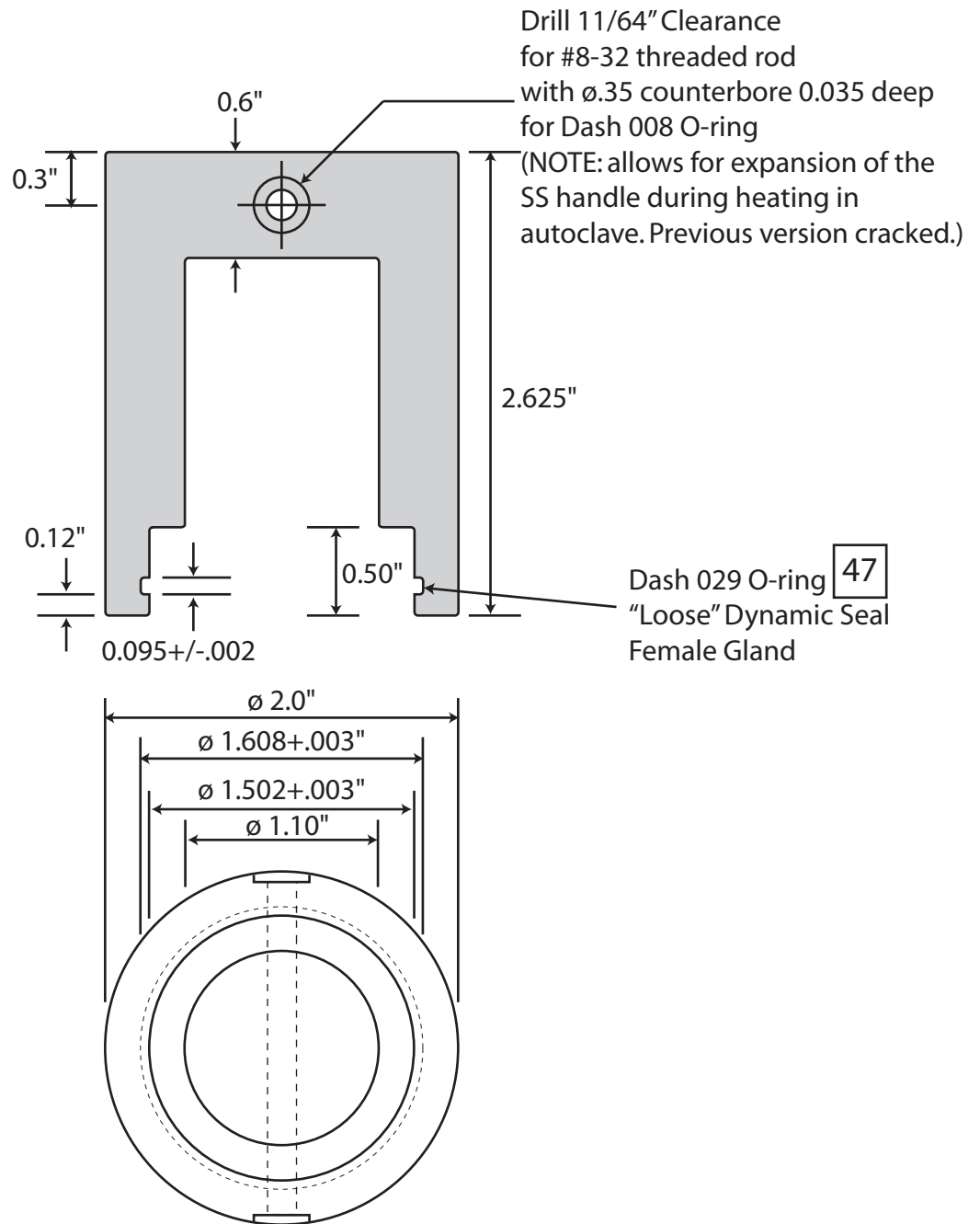
Supplier: Cambridge Valve &amp; Fitting

Part #: VI9-OR-0906



46

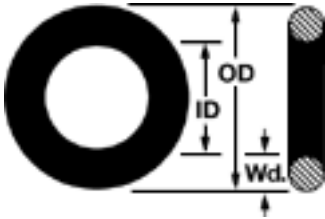
# Bearing Housing Sealing Cap for Autoclaving, Rev. 3



Material: Polyetherimide (Ultem)  
Stock Shape: Rod 2" Dia., 12" Lg.  
Supplier: McMaster-Carr  
Part #: 8686K81

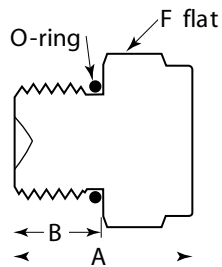
47

# Sealing Cap O-ring



<b>System of Measurement</b>	Inch
<b>AS568A Dash Number</b>	029
<b>Inside Diameter</b>	1-1/2"
<b>Outside Diameter</b>	1-5/8"
<b>Width</b>	1/16"
<b>Type</b>	Viton
<b>Durometer</b>	Shore A: 75
<b>Operating Temperature Range</b>	-31° to +400°F
<b>Color</b>	Black
<b>Package Quantity</b>	25

Material: Viton  
Stock Shape: Dash 029  
Supplier: McMaster-Carr  
Part #: 9464K291

**49****SS 9/16"-18 SAE ORB Plug**

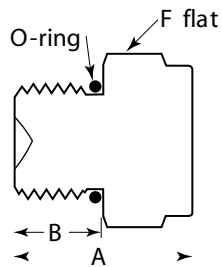
Thread Size in.	Basic Ordering Number	Dimensions, in. (mm)		F in.	O-ring Uniform Size
		A	B		
7/16-20	-4-PST	0.76 (19.3)	0.36 (9.1)	9/16	-904
9/16-18	-6-PST	0.82 (20.8)	0.39 (9.9)	11/16	-906
3/4-16	-8-PST	0.89 (22.6)	0.44 (11.2)	7/8	-908
1 1/16-12	-12-PST	1.12 (28.4)	0.59 (15.0)	1 1/4	-912
1 5/16-12	-16-PST	1.18 (30.0)		1 1/2	-916

O-ring material is 90 durometer fluorocarbon FKM.

For O-ring see P/N 43.

Material: 316 SS  
 Manufacturer: Swagelock  
 Supplier: Cambridge Valve & Fitting  
 Part#: SS-6-PST

# 50 SS 3/4"-16 SAE ORB Plug



Thread Size in.	Basic Ordering Number	Dimensions, in. (mm)		F in.	O-ring Uniform Size
		A	B		
7/16-20	-4-PST	0.76 (19.3)	0.36 (9.1)	9/16	-904
9/16-18	-6-PST	0.82 (20.8)	0.39 (9.9)	11/16	-906
3/4-16	-8-PST	0.89 (22.6)	0.44 (11.2)	7/8	-908
1 1/16-12	-12-PST	1.12 (28.4)	0.59 (15.0)	1 1/4	-912
1 5/16-12	-16-PST	1.18 (30.0)		1 1/2	-916

O-ring material is 90 durometer fluorocarbon FKM.

For O-ring see P/N 42.

Material: 316 SS  
 Manufacturer: Swagelock  
 Supplier: Cambridge Valve & Fitting  
 Part#: SS-8-PST

## 1/4" Flexible Silicone Tubing

### Thick Wall Silicone Rubber Tubing

- Temperature Range: -60° to +400° F
- Color: Semi-clear (translucent) white
- Durometer, Shore A: 65
- Tensile Strength: 1150 psi
- Elongation: 375%
- Sterilization: Steam (autoclave)
- Material Meets: FDA (food and beverage) and 3A (dairy)
- Fittings: Barbed (see pages 111-118)



Thick walls and the resilience of synthetic silicone rubber make this tubing crush resistant. Ideal for outdoor applications, it stays flexible over a wide range of temperatures and resists weathering and ozone. Use for air, water, chemical, food, beverage, and dairy lines. Peroxide used in the forming (curing) process.

Material: Silicone Rubber  
Supplier: McMaster-Carr  
Part #: 3184K1

53

## SS Sparger with 1/4" NPT Male Thread

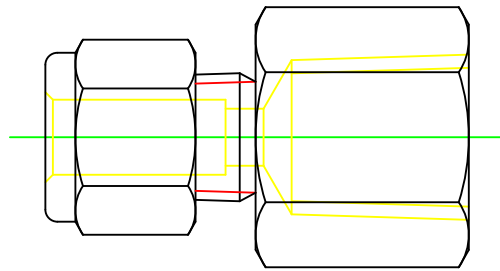


- Maximum Pressure: 125 psi
  - Maximum Temperature: 300° F
    - Filtration: 40 microns
- Connection: NPT Male

Material: 316 Stainless Steel  
Supplier: McMaster-Carr  
P/N: 4402K52

54

SS Coupler 1/4" NPT Female x 1/4" tube compression fitting



Type 316 Stainless Steel  
1/4" tube x 1/4" NPT Female  
Manufacturer: Swagelok  
P/N: SS-400-7-4

## Autoclavable SS Temperature Probe 1/4" O.D. Type T (Ungrounded)

### High Temperature Quick Disconnect Thermocouples

#### Standard Dimensions



ANSI color code shown  
To order IEC color code see omega.com

MEETS OR EXCEEDS SPECIAL LIMITS OF ERROR (SLE) AND EN 60584-2: Tolerance Class 1

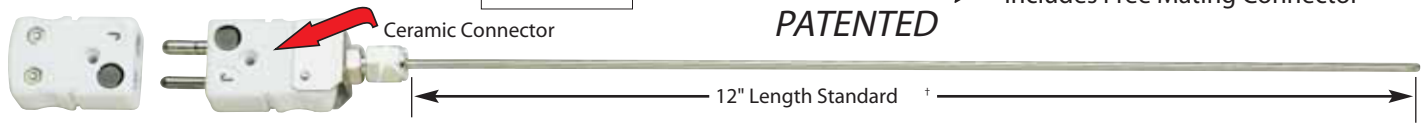


Available! Type-N with Inconel Sheath Consult Sales

The Write-On Window is a trademark of OMEGA Engineering, Inc.

- ✓ Features SHX or NHX Type Ceramic Connector Rated to 650°C (1200°F)
- ✓ 304, 310, 316, 321 SS, Inconel or Super OMEGA CLAD ° XL Sheath
- ✓ Tube Clamp Included for Extra Strength for Standard Size
- ✓ Includes Free Mating Connector

**PATENTED**



#### Standard Dimension, Standard Size

**ALL MODELS AVAILABLE FOR FAST DELIVERY!**

Alloy/ANSI Color Code	Sheath Dia. (inch)	Model Number		Model Number		Model Number		Price/Add'l 12"
		Grounded Junction	Price	Ungrounded Junction	Price	Exposed Junction	Price	
COPPER-	1/16	CPSS-116G-12-NHX	\$36.50	CPSS-116U-12-NHX	\$38.50	CPSS-116E-12-NHX	\$36.50	\$1.55
CONSTANTAN	1/8	CPSS-18G-12-NHX	36.50	CPSS-18U-12-NHX	38.50	CPSS-18E-12-NHX	36.50	2.50
304 SS	T 3/16	CPSS-316G-12-NHX	37.50	CPSS-316U-12-NHX	39.50	CPSS-316E-12-NHX	37.50	3.15
Sheath		1/4	CPSS-14G-12-NHX	40.50	CPSS-14U-12-NHX	42.50	CPSS-14E-12-NHX	40.50

**Type T, Std. Connector Size, 1/4" Probe**  
**Material: 304 Stainless Steel with Ceramic Connector**  
**Supplier: Omega Engineering, Inc.**  
**P/N: CPSS-14U-12-NHX**



**56****Vent filter (Pall Life Sciences P/N 4251)****Acro 50 Vent Device****2x Stepped Hose Barbs 6.4 – 12.7 mm (1/4 – 1/2 in.) diameter****PTFE Membrane with Polypropylene Support****0.2 µm Filter****Flow rate at 0.2 bar (20 kPa, 3 psi): 8 L/min****Autoclavable if desired at 121 – 123 °C (for 30 minutes)**

Effective Filtration Area:	19.6 cm <sup>2</sup>
Maximum Operating Temperature:	130°C (266°F)
Maximum Operating Pressure:	4.1 bar (60 psi) at ambient temperature
Diameter:	7.3 cm (2 <sup>7</sup> / <sub>8</sub> " )
Overall Length:	8.2 cm (3 <sup>7</sup> / <sub>32</sub> " )

**Materials: Polypropylene body with PTFE membrane****Manufacturer: Pall Life Sciences****Manufacturer P/N: 4251****Supplier: Fisher Scientific****Supplier P/N: 09-730-241A****Package Size: 18**

57

## Dow Corning Molykote Synthetic Grease 44M

**DOW CORNING**



Silicone fluid base oil keeps this grease stable over a wide temperature range in harsh environments.

No. 44 high-temperature grease maintains its viscosity at high temperatures better than the grease above.

Appearance: Reddish-brown

Base Oil: Silicone

Thickener: Lithium

Service Temperature [C]: 222

Temperature Range [C]: -40 to +200

Dropping Point [C]: 280

Material: Synthetic Grease (Lithium Soap, Silicone Oil)

Manufacturer: Dow Corning

Manufacturer P/N: 44M

Supplier: McMaster-Carr

Supplier P/N: 1252K23

58

## Dow Corning #976V Vacuum Grease



DOW CORNING

### Specifications for Dow Corning 976V Grease:

Specific Gravity at 25° C:	1.0 g/cc
Bleed after 24 hours at 199° C:	0.5% max.
Evaporation after 24 hours at 199° C:	2.0% max.
Solidification point:	-40° C/-40° F
Melting point:	None detected
Color:	Cream color to light gray or tan
Vapor pressure:	
at 150° C	1.2 x 10 <sup>-5</sup> torr
at 200° C	7 x 10 <sup>-4</sup> torr

Material: Hi-Vacuum Silica Synthetic Grease  
Manufacturer: Dow Corning  
Manufacturer P/N: 976V  
Supplier: McMaster-Carr  
Supplier P/N: 2966K52

# SS Fasteners for SS Baffle

61



18-8 Stainless Steel Button Head Socket Cap Screw #5-40 Thread, 1/4" Length  
Supplier: McMaster-Carr  
Supplier P/N: 92949A131

62



18-8 Stainless Steel Machine Screw Nut #5-40 Screw Size, 5/16" Width, 7/64" Height  
Supplier: McMaster-Carr  
Supplier P/N: 91841A006

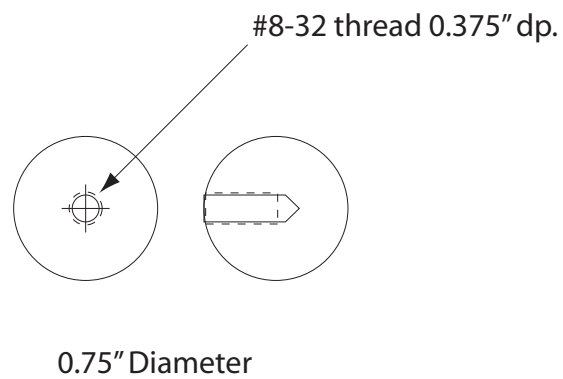
63



410 Stainless Steel External-Tooth Lock Washer #5 Screw Size, .129" Id, .285" Od, .014"  
Supplier: McMaster-Carr  
Supplier P/N: 98438A215

64

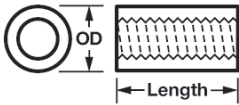
## SS Ø.75" Diameter Ball Knob



Part: Knob for Autoclave Cap Handle  
Stock Shape: Ø.75" Diameter Ball  
Material: Type 316 SS  
Supplier: McMaster-Carr  
Supplier P/N: 96415K81

# SS Hardware for Autoclave Cap, Rev. 1

65



18-8 SS Standoff with Female #8-32 Thread 1/4" OD x 1" lg.  
Supplier: McMaster-Carr  
Supplier P/N: 91125A459

66

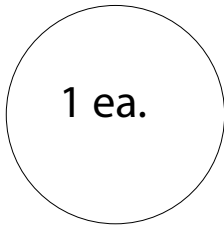


18-8 SS #8-32 Set Screw 5/8" lg.  
Supplier: McMaster-Carr  
Supplier P/N: 92311A196

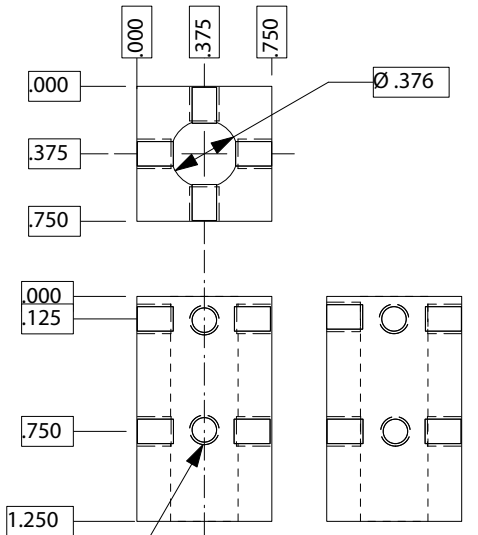
67



18-8 SS #8-32 Threaded Rod 2-1/2" lg.  
Supplier: McMaster-Carr  
Supplier P/N: 95412A882

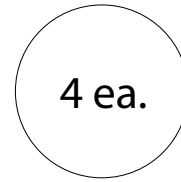


Propeller Shaft to Paddle Adapter

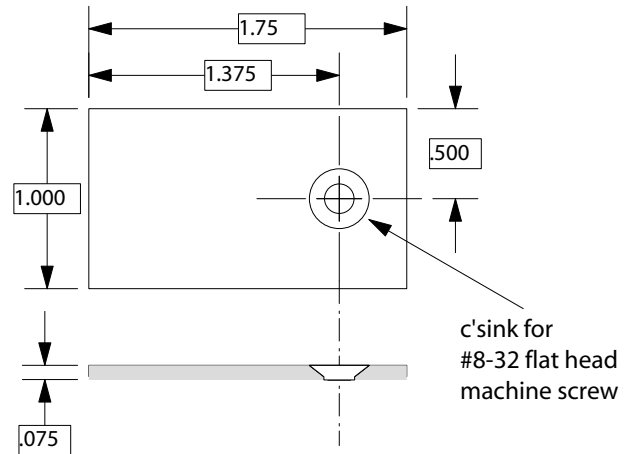


Drill #29,  
tap 8 places thru #8-32  
NOTE: needs c'sink for flat head screw.  
(See Paddle on right)

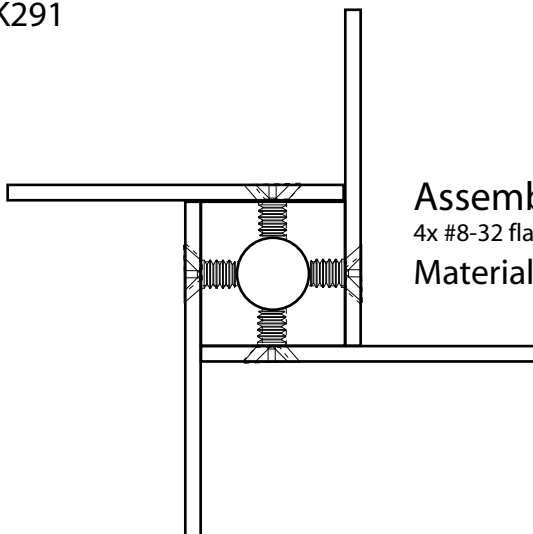
Material: Type 304 Stainless Steel  
Shape: Bar 0.75 × 0.75 × 12  
Supplier: McMaster-Carr  
P/N: 89415K291



Paddle



Material: 304 SS  
SS Strip 0.075"×1"×36"  
Supplier: McMaster-Carr  
Part #: 1421T21

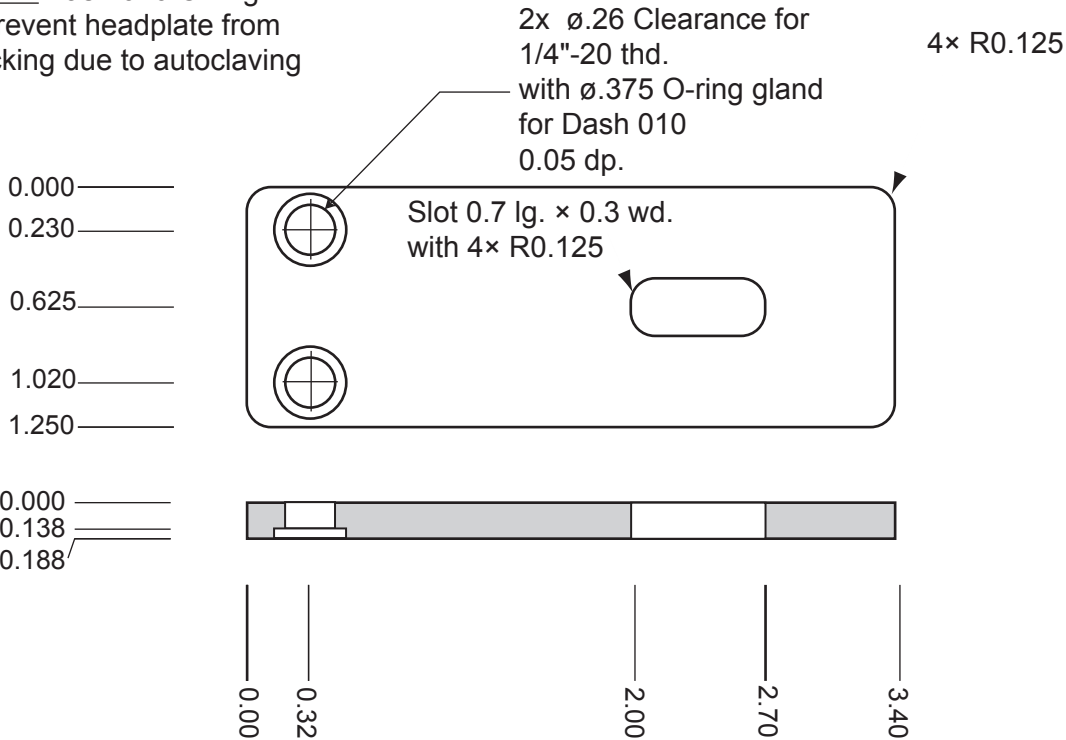


Assembly  
4x #8-32 flat head machine screws 0.25" long  
Material: 18-8 SS

# 69

## SS Adapter Straps to 10 L Fermentor Apparatus

**NOTE:** Dash 010 O-ring to prevent headplate from cracking due to autoclaving

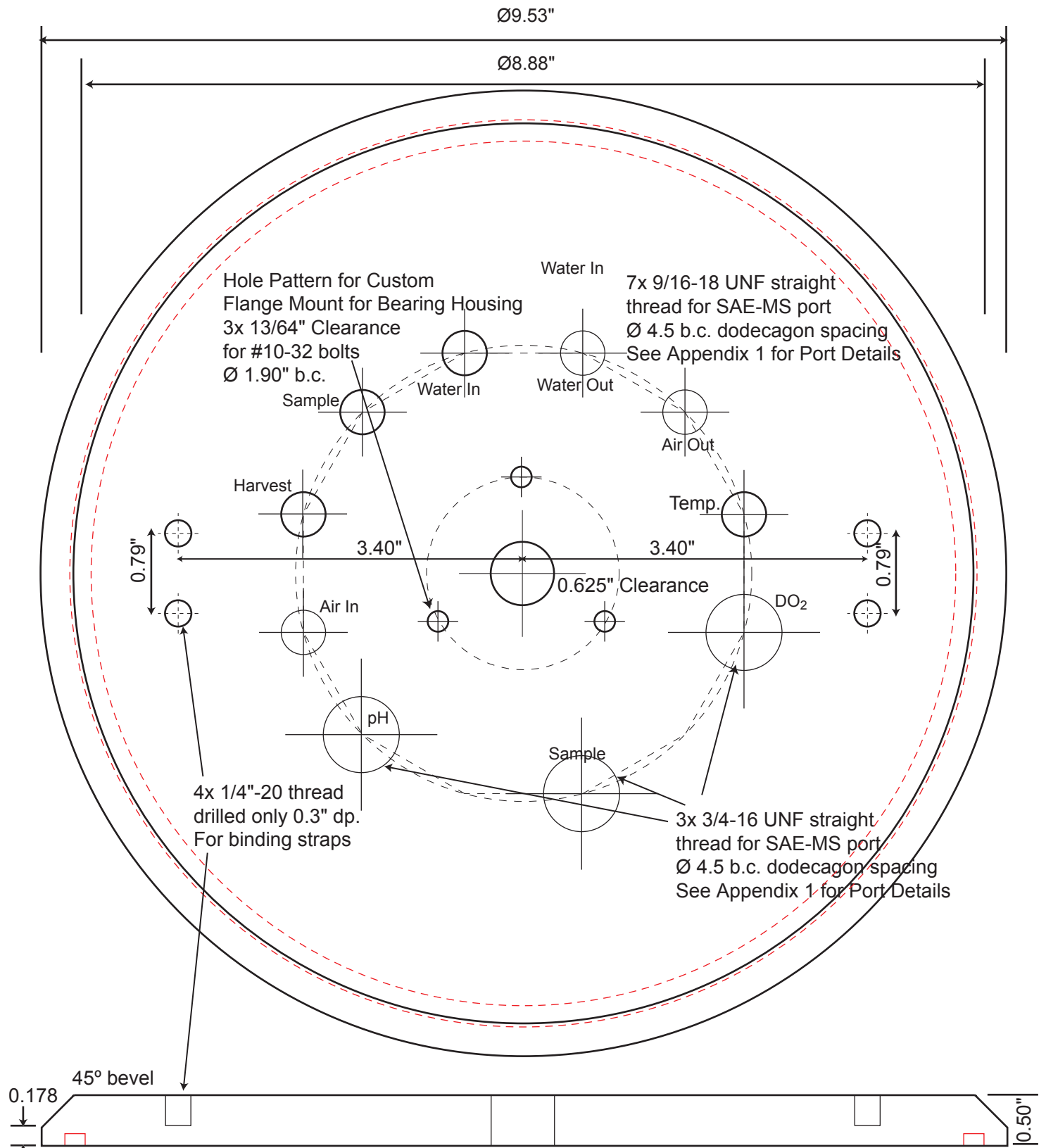


Material: 304 Stainless Steel  
Stock Shape: Bar  
Supplier: McMaster-Carr



70

# Custom Headplate for 200 mm Duran Flange Clamp, Rev. 1



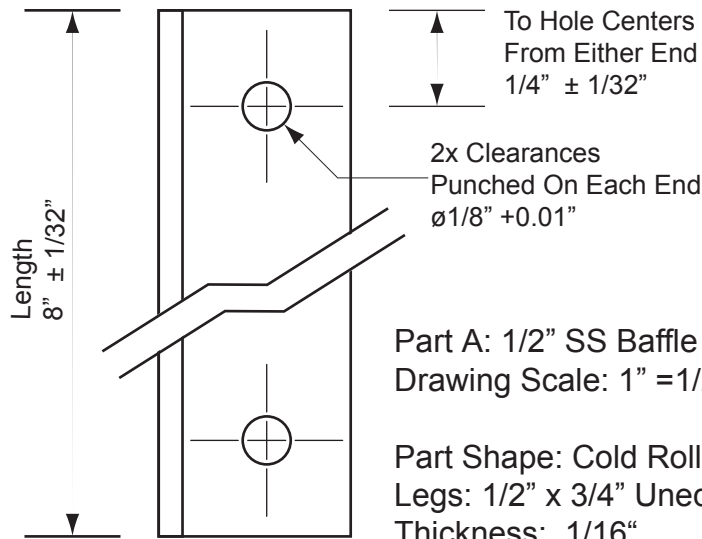
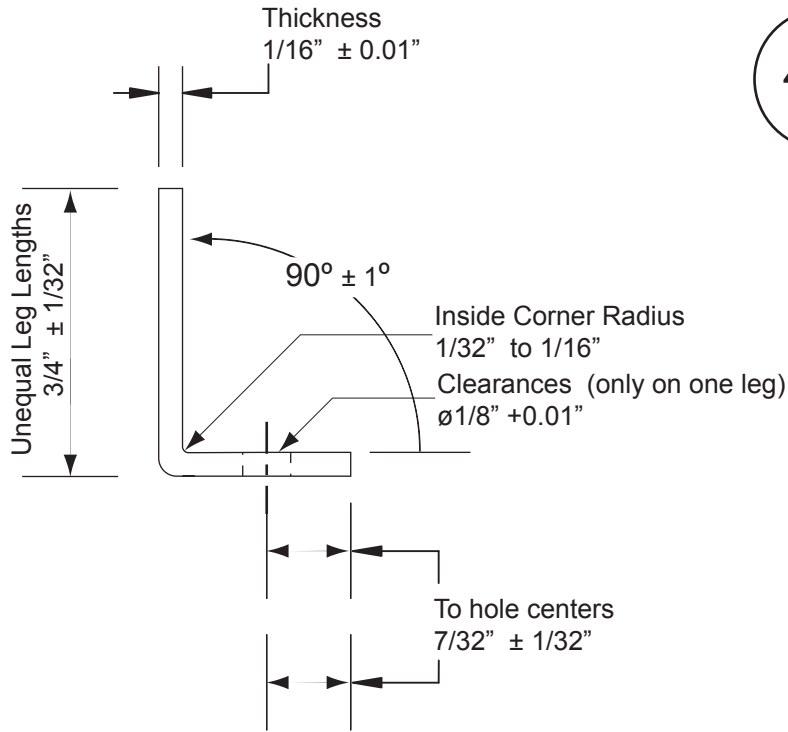
Static Face Seal Gland for O-ring Dash 371  
0.210" Width  
8.95" O.D. and 8.53" I.D.  
0.125" Dp.

Material: Polyetherimide (PEI)  
Stock Shape: 0.5" thick sheet  
Supplier: McMaster-Carr  
or Modern Plastics  
Scale: 0.75 = 1"

71

# 1/2" x 3/4" SS Baffle Fin for 10L Fermentor

4 ea.



Part A: 1/2" SS Baffle Fins  
Drawing Scale: 1" = 1/2"

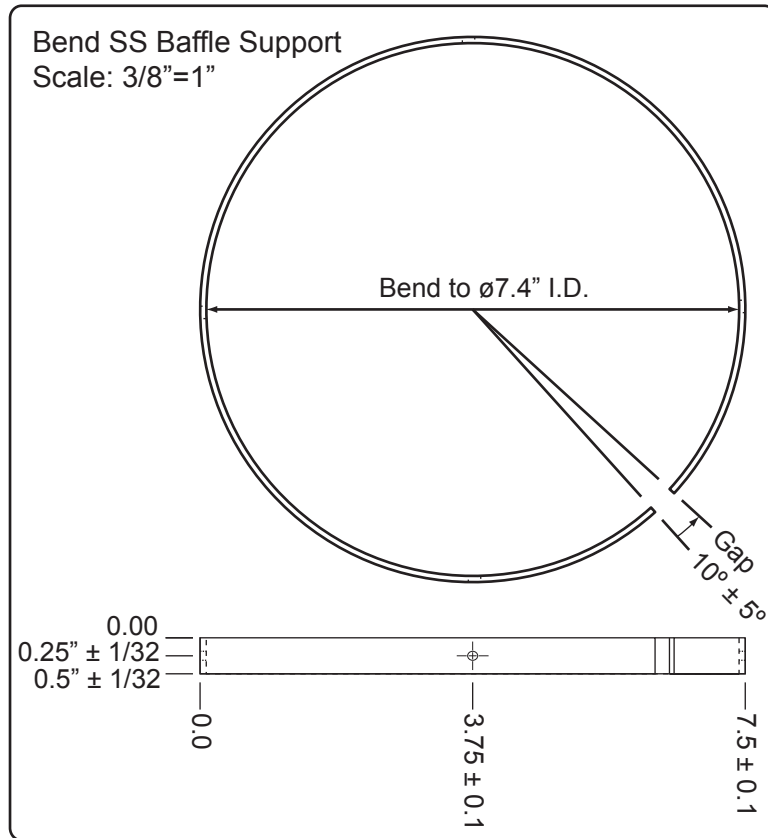
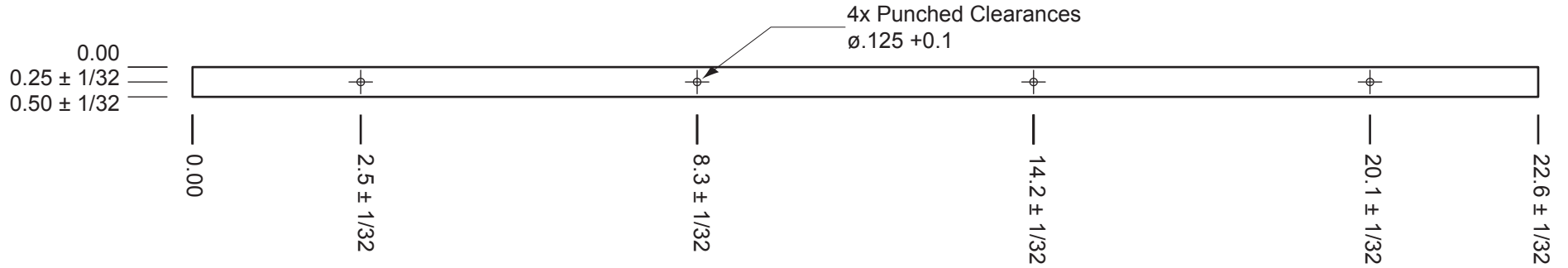
Part Shape: Cold Rolled 90° Angle  
Legs: 1/2" x 3/4" Unequal Legs (Approx. O.D.)  
Thickness: 1/16"  
Radius (Inside Corner): 1/32 to 1/16"  
Overall Part Length: 8"  
Qty: 4

Material: Type 304 SS  
Stock shape: Type 304 SS 12" x 12" x 0.06" sheet  
Finish: Unfinished, De-burred  
Supplier: McMaster-Carr  
P/N: 8983K42

72

# SS Baffle Fin Support for 10L

2 ea.



Part B: SS Baffle Fin Support  
Drawing Scale: 1" = 1/2"

Part Shape: Cold Rolled Circle  
Width: 1/2"  
Thickness: 1/16"  
Bending Radius: 2.75"

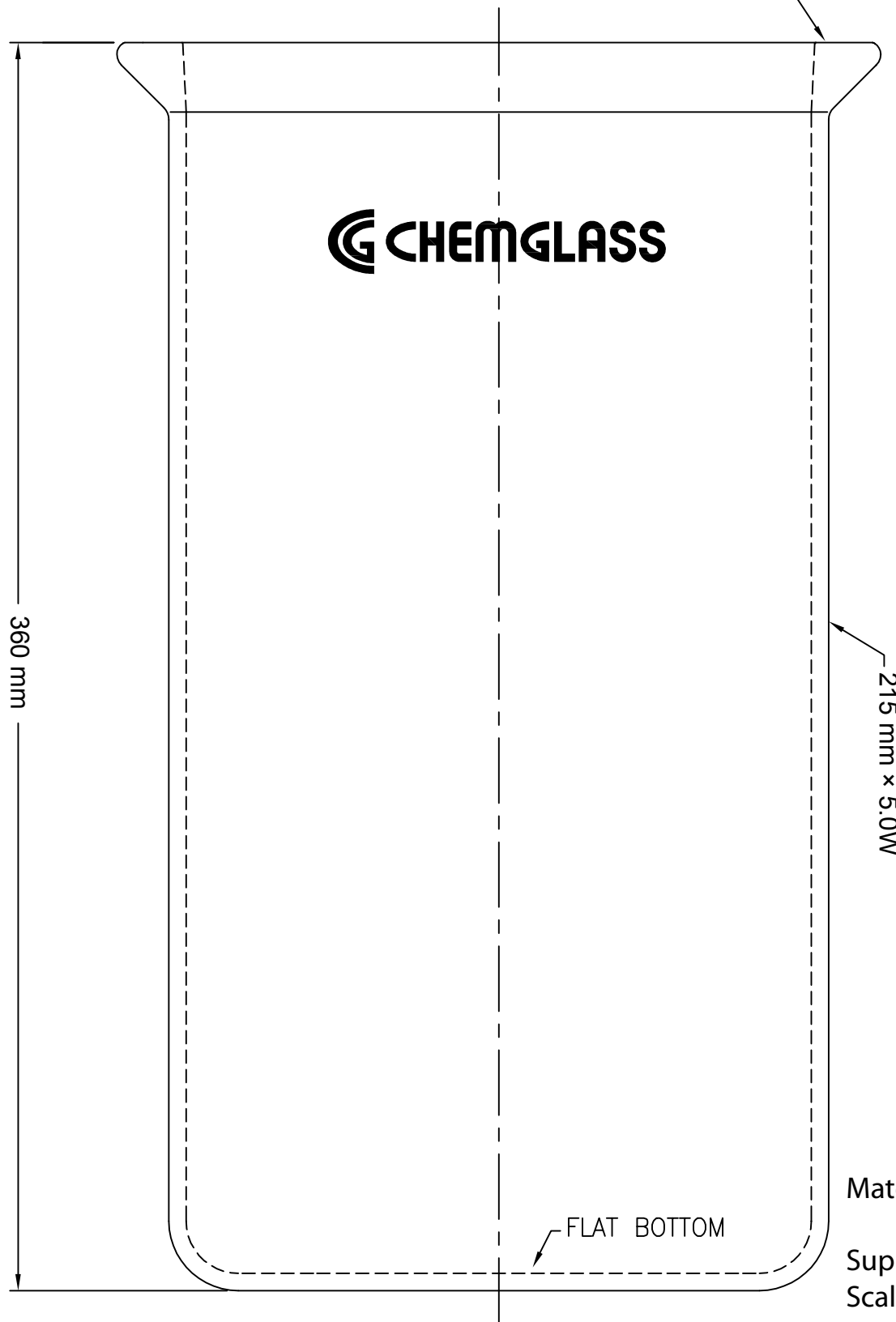
Material: Type 304 SS  
Finish: Unfinished, De-burred  
Stock Shape: 1/2" x 1/16" Strip  
Overall Part Length: 17"  
Qty: 2

Stock Shape: 1/2" x 0.06" Strip  
Supplier: McMaster-Carr  
Supplier P/N: 1421T11

73

# Custom Glass 10 L Flat Bottom Duran Flange Fermentor Vessel

NOTE: Reaction Kettle Flange, 200 mm Duran, **Flat Ground**  
CHEMGLASS P/N CG-148-05



Material: Borosilicate  
Glass  
Supplier: Chemglass  
Scale: 1 cm = 2 cm

**74**

# 1/8" I.D. Silicone Rubber Tubing



---

<b>Type</b>	<b>High-Temperature Silicone Rubber Firm Tubing</b>
<b>Material</b>	<b>Silicone</b>
<b>Shape</b>	<b>Single Line</b>
<b>Outside Dia.</b>	<b>1/4" (.25")</b>
<b>Inside Dia.</b>	<b>1/8" (.125")</b>
<b>Wall Thickness</b>	<b>1/16" (.0625")</b>
<b>Available Lengths</b>	<b>10, 25, 50, and 100 feet</b>
<b>Length Note</b>	<b>This tubing can stretch up to 2 times its length and still spring back to its original shape.</b>
<b>Reinforcement</b>	<b>Unreinforced</b>
<b>Color</b>	<b>Semi-Clear White</b>
<b>Maximum Pressure</b>	<b>20 psi @ 72° F</b>
<b>Operating Temperature Range</b>	<b>-94° to +392° F</b>
<b>Bend Radius</b>	<b>1/4" (.25")</b>
<b>Durometer</b>	<b>70A (Soft)</b>
<b>Tensile Strength</b>	<b>1,350 psi</b>
<b>For Use With</b>	<b>Air, Beverage, Food, Water</b>
<b>Sterilize With</b>	<b>Steam (autoclave)</b>
<b>Specifications Met</b>	<b>United States Food and Drug Administration (FDA)</b>
<b>FDA Specification</b>	<b>CFR21 177.2600</b>
<b>ASTM Specification</b>	<b>ASTM D2000 M7GE 707</b>
<b>Compatible Fittings</b>	<b>Barbed</b>

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Material: Silicone Rubber  
Shape: 1/8" I.D. by 1/4" O.D.  
Supplier: McMaster-Carr  
P/N 51135K73

75

# Loctite No. 272 High Temperature Threadlock



**Part Number: 91458A65**

**Loctite® Brand Threadlocker**

**Loctite®**

**Product Number** 272

**Loctite® Item**

**Number** 27240

**Package Size** 1.69 oz. (50 ml) bottle

**Color** Red

**Application Notes** Prevent threaded metal fasteners from loosening due to shock and vibration. Seals against fluid leakage and withstands most chemicals and environments. High strength for bolts up to 1-1/2" dia. in temperatures up to 450° F.

Material: Threadlock

Manufacturer: Loctite

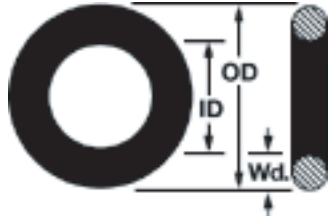
Manufacturer P/N: 272

Supplier: McMaster-Carr

Supplier P/N: 91458A65

**76**

# O-rings for Custom Custom Adapter Strap



<b>Part Number</b>	<b>9464K15</b>
<b>System of Measurement</b>	Inch
<b>AS568A Dash Number</b>	010
<b>Inside Diameter</b>	1/4"
<b>Outside Diameter</b>	3/8"
<b>Width</b>	1/16"
<b>Type</b>	Viton
<b>Durometer</b>	Shore A: 75
<b>Operating Temperature Range</b>	-31° to +400°F
<b>Color</b>	Black
<b>Package Quantity</b>	50

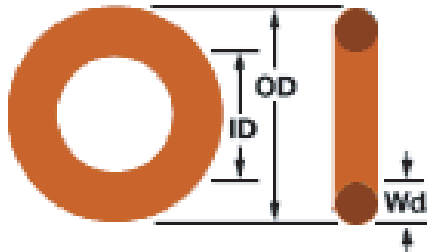
Viton (fluorocarbon) O-rings offer a wide spectrum of chemical compatibility and temperature-range adaptability. Use with petroleum products, diester lubricants, silicone fluids, solvents, and acids (except fuming nitric). They have good resistance to taking a set after compression and low gas permeability. Great for hard vacuum service. Not for use with acetates, methyl alcohol, ketones, brake fluids, hot water, and steam. Color is black.

Standard— Durometer is Shore A: 70-80. Temperature range is -31° to +400° F. Meet ASTM D2000 MGHK810A1-10B38EF31Z1. For Boss Tube Fittings— For SAE high-pressure, straight-thread fluid connection boss tube fittings. Durometer is Shore A: 85-95. Temperature range is -15° to +400° F. Meet ASTM D2000, SAE J200, and Aerospace Standard (AS) 568. Also Available: Other dash numbers for standard Shore A 70-80 durometer O-rings and boss O-rings in 70-80 Shore A. For other dash numbers for standard Shore A 70-80 durometer O-rings, please ask for 9464K342 and specify dash number. For boss O-rings in 70-80 Shore A, please ask for 9752K999 and specify dash number and durometer.

**Material: Viton**  
**Dash #: -010**  
**Supplier: McMaster-Carr**  
**Part #: 9464K15**

**77**

# O-ring for 200 mm Duran Flange Clamp



<b>Part Number:</b>	<b>9396K335</b>
<b>AS568A Dash Number</b>	<b>371</b>
<b>Type</b>	<b>O-Ring</b>
<b>O-Ring Type</b>	<b>Standard</b>
<b>Cross Section Shape</b>	<b>Round</b>
<b>Width</b>	<b>3/16"</b>
<b>Actual Width</b>	<b>.210"</b>
<b>Inside Diameter</b>	<b>8-1/2"</b>
<b>Actual Inside Diameter</b>	<b>8.475"</b>
<b>Outside Diameter</b>	<b>8-7/8"</b>
<b>Actual Outside Diameter</b>	<b>8.895"</b>
<b>Material</b>	<b>Silicone</b>
<b>Silicone Type</b>	<b>Standard</b>
<b>Durometer</b>	<b>Hard</b>
<b>Durometer Shore</b>	<b>Shore A: 70</b>
<b>Temperature Range</b>	<b>-65° to +450°F</b>
<b>Color</b>	<b>Red-Orange</b>
<b>Specifications Met</b>	<b>Food and Drug Administration (FDA)</b>
<b>FDA Specification</b>	<b>FDA Compliant</b>

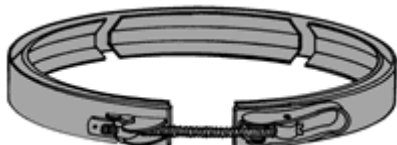
Material: Silicone  
Size: Dash 371  
Supplier: McMaster-Carr  
P/N: 9396K335 (for Silicone)



**78**

# SS 200 mm Duran Flange Clamp

CG-141

**Clamp for Duran® Reaction Flanges and Lids**

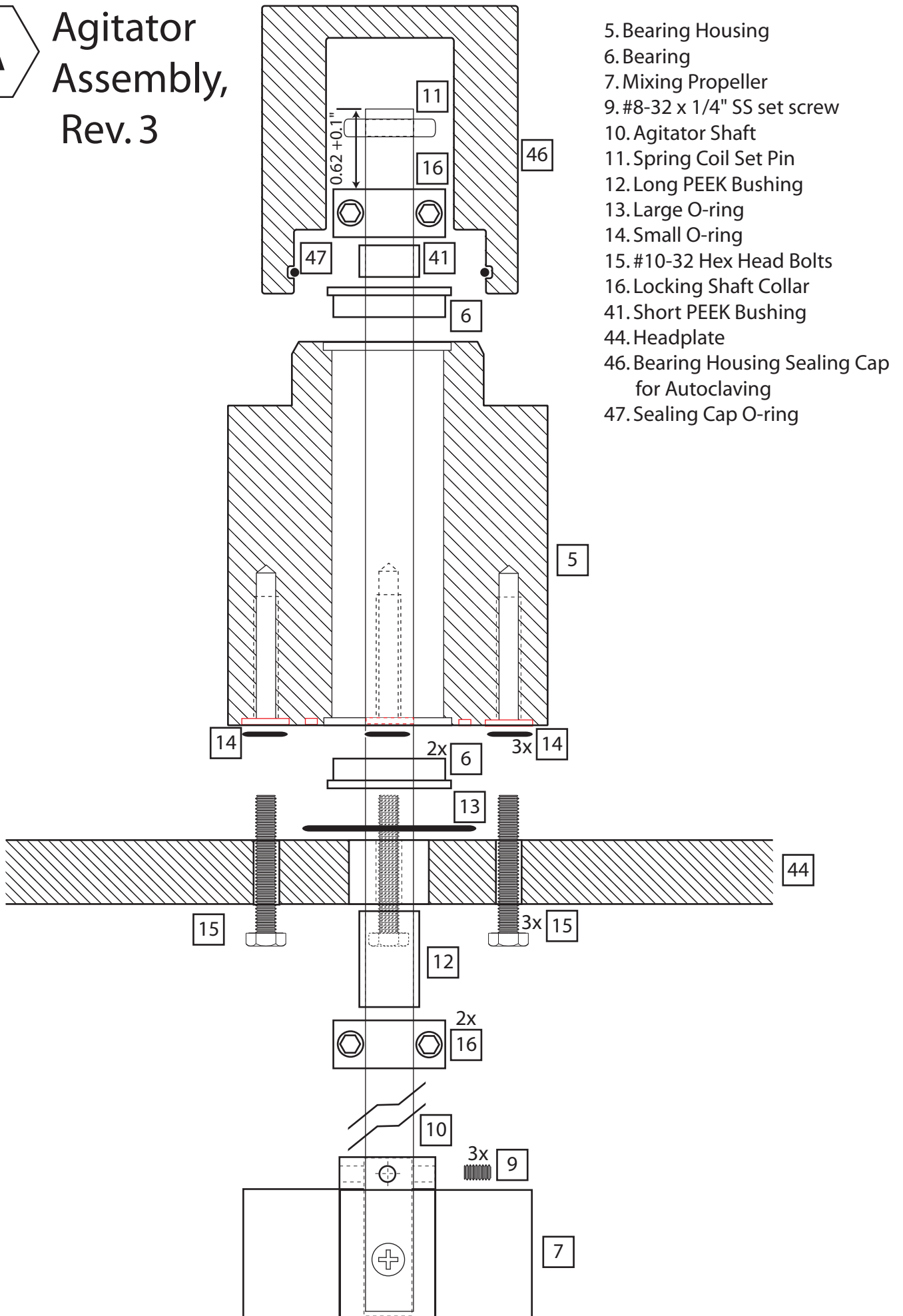
Made entirely from stainless steel, the clamp has three sections that firmly hold reaction vessel and lid together. Quick release mechanism has a screw adjustment for tension applied to the flange.

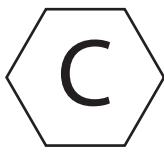
Item Number	Item Description	PQ	Price
CG-141-01	Clamp, Stainless Steel, Quick Release, 60mm Schott Duran Flange	EACH	\$54.64
CG-141-02	Clamp, Stainless Steel, Quick Release, 100mm Schott Duran Flange	EACH	\$70.45
CG-141-04	Clamp, Stainless Steel, Quick Release, 150mm Schott Duran Flange	EACH	\$84.40
CG-141-05	Clamp, Stainless Steel, Quick Release, 200mm Schott Duran Flange	EACH	\$95.10
CG-141-03	Clamp, Stainless Steel, Quick Release, 120mm Schott Duran Flange	EACH	\$83.00

Material: Stainless Steel  
Supplier: Chemglass  
Part #: CG-141-05

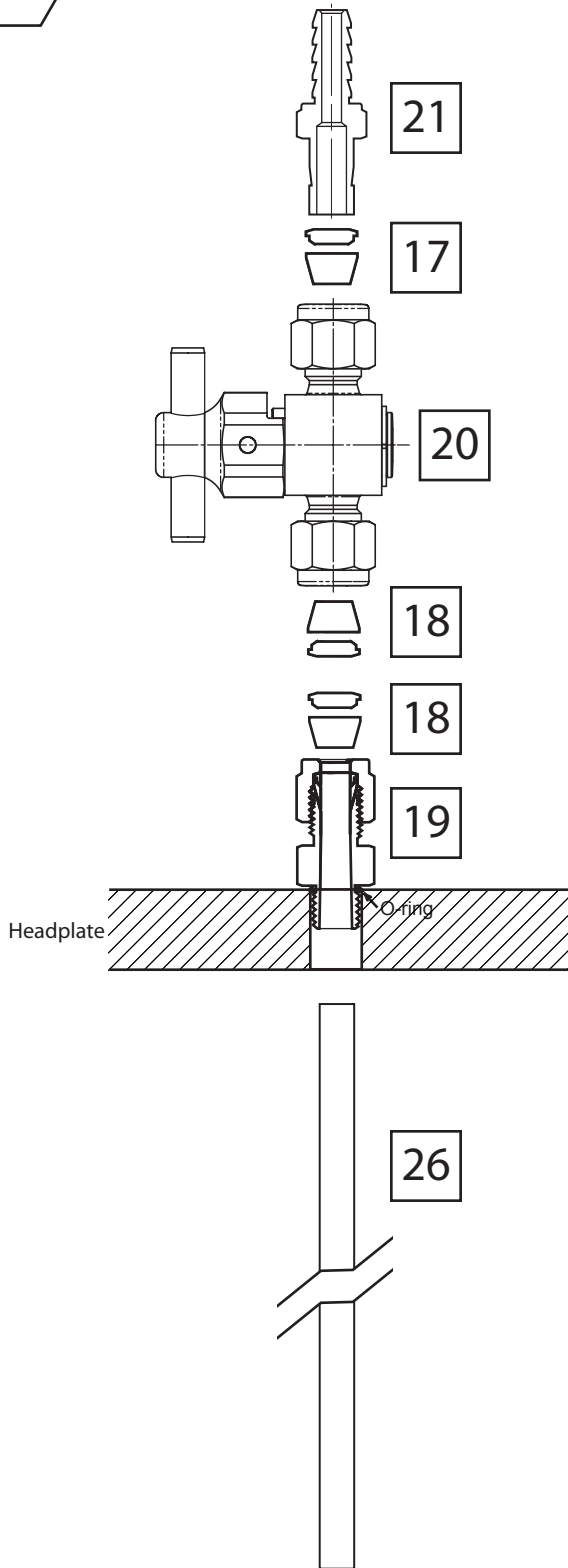
A

# Agitator Assembly, Rev. 3





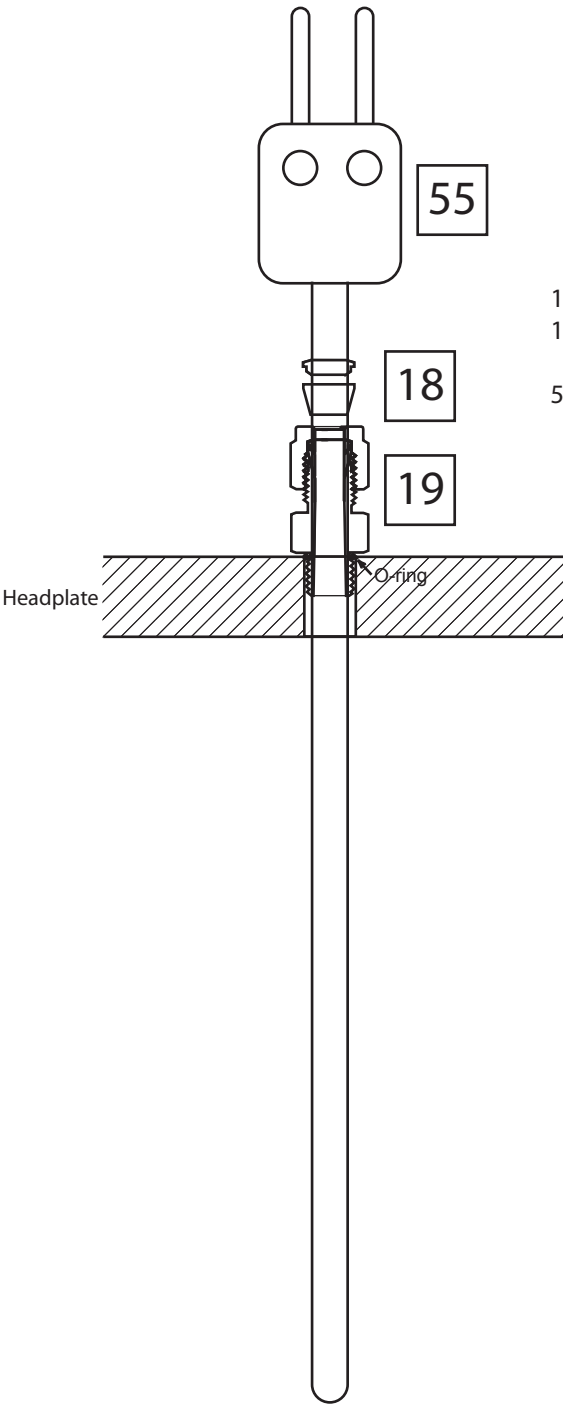
# Harvest Tube Assembly



- 17. SS Ferrule Set
- 18. Teflon Ferrule Set
- 19. SS 9/16-18 SAE/MS ORB to 1/4" Swage Adapter with Bored Through Option
- 20. SS Plug Valve with 1/4" Swage Fittings
- 21. SS 1/4" Barb for 1/4" I.D. flexible Tubing with 1/4" Swage Tube Adapter
- 26. Harvest Tube

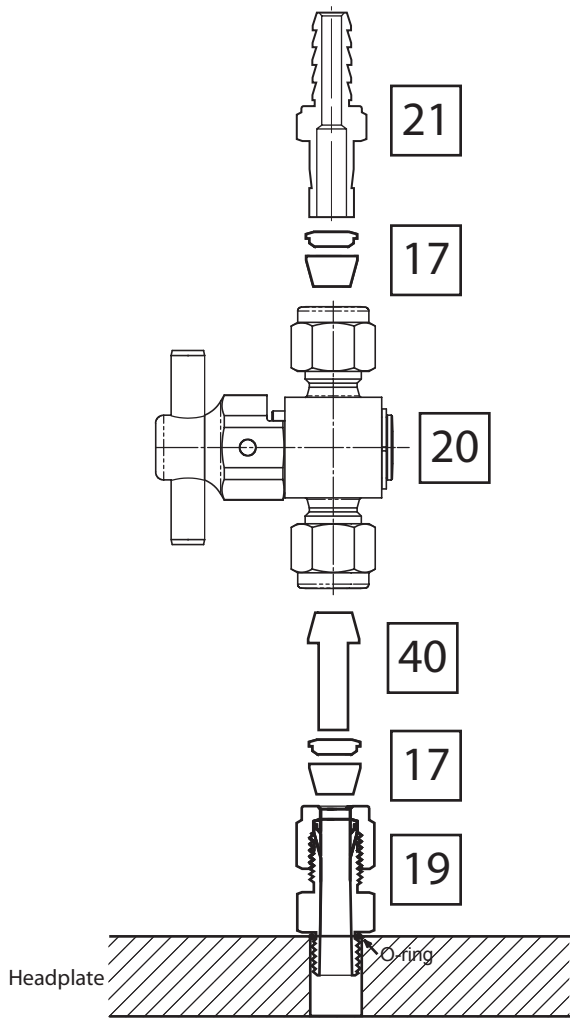


# Temperature Probe Tube Assembly, Rev. 2



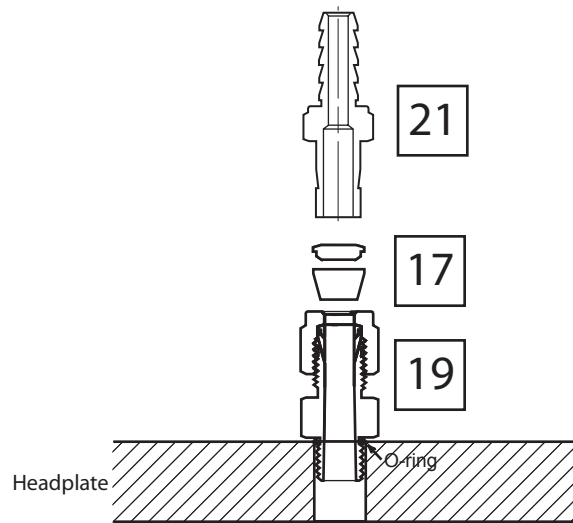
- 18. Teflon Ferrule Set
- 19. SS 9/16-18 SAE/MS ORB to 1/4" Swage Adapter with Bored Through Option
- 55. Temperature Probe (Ceramic Std. Conn. Type T, 1/4" SS Probe)

# E Air Out Assembly



Optional Configuration #1

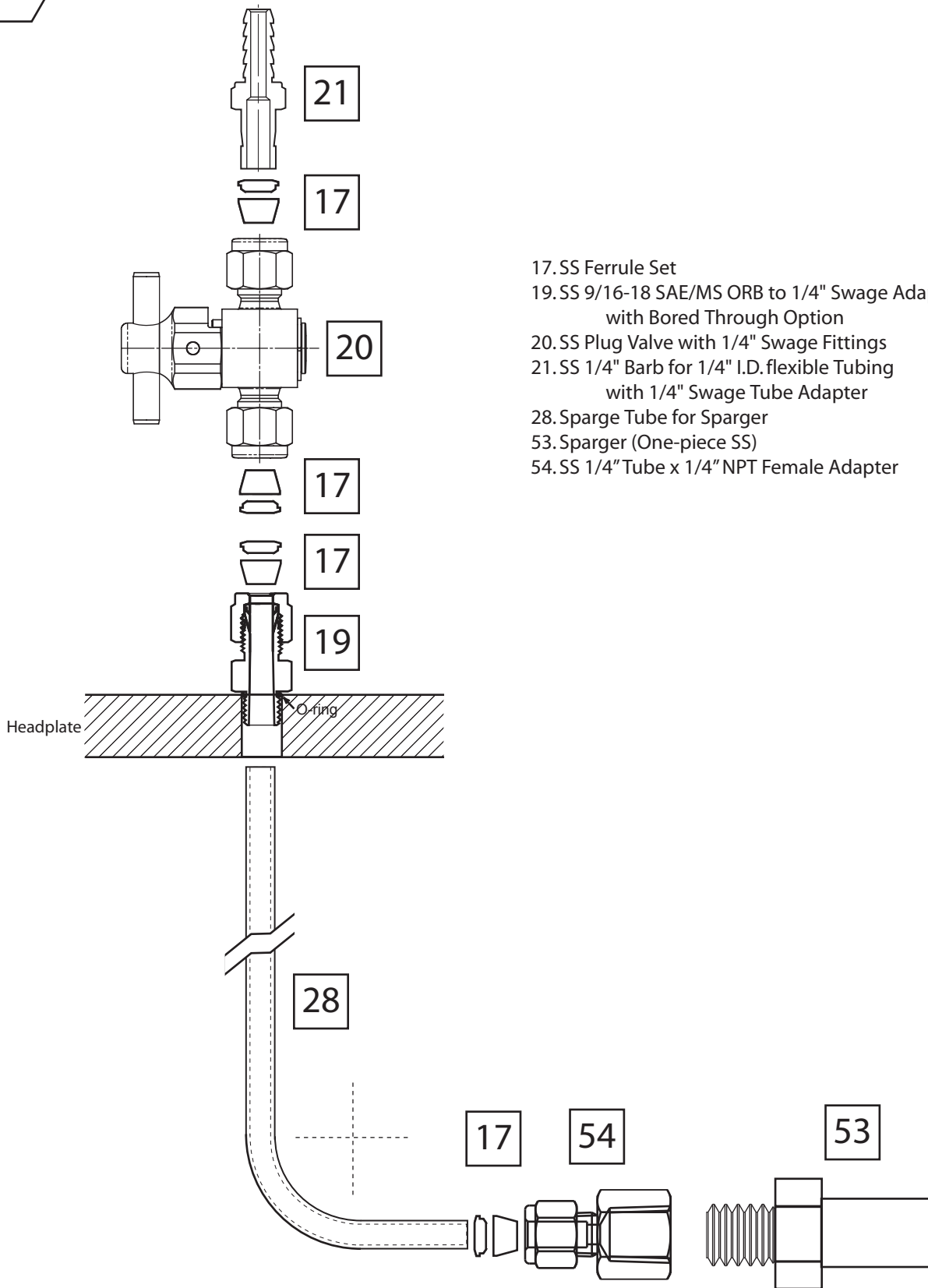
- 17. SS Ferrule Set
- 19. SS 9/16-18 SAE/MS ORB to 1/4" Swage Adapter
- 20. SS Plug Valve with 1/4" Swage Fittings
- 21. SS 1/4" Barb for 1/4" I.D. flexible Tubing with 1/4" Swage Tube Adapter
- 40 SS 1/4" Swage Port Connector



Optional Configuration #2

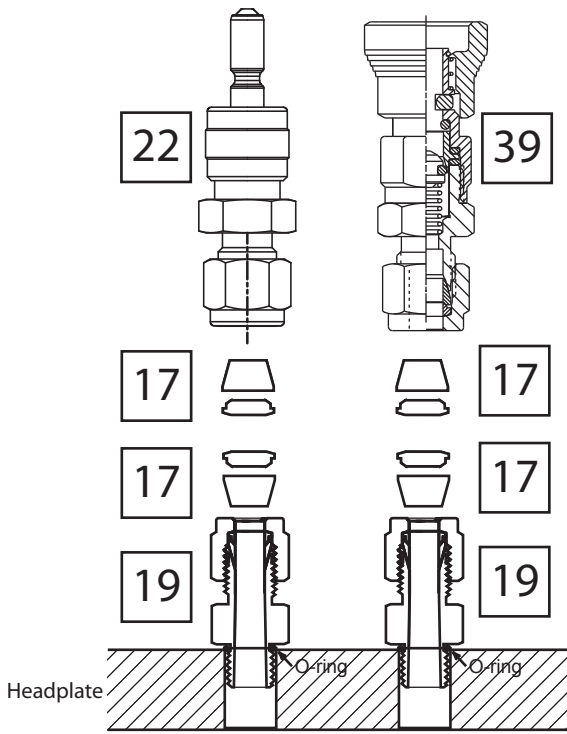
**F**

# Sparge Tube Assembly Style 2, Rev. 2

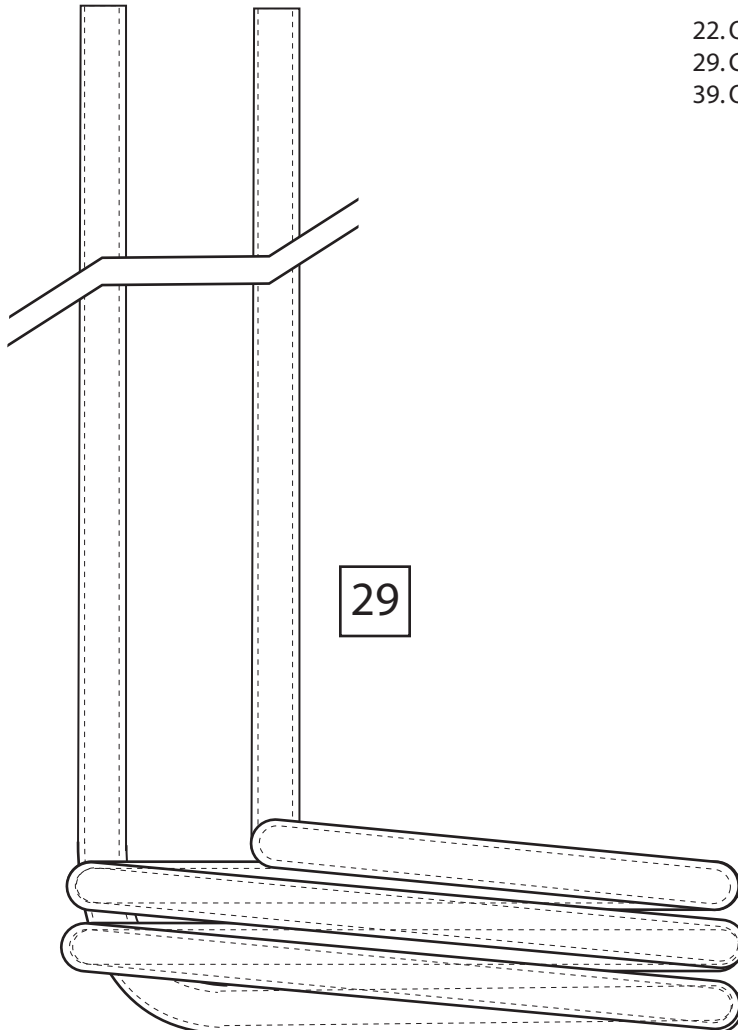


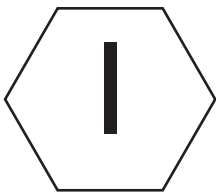


# Cooling Coil Assembly

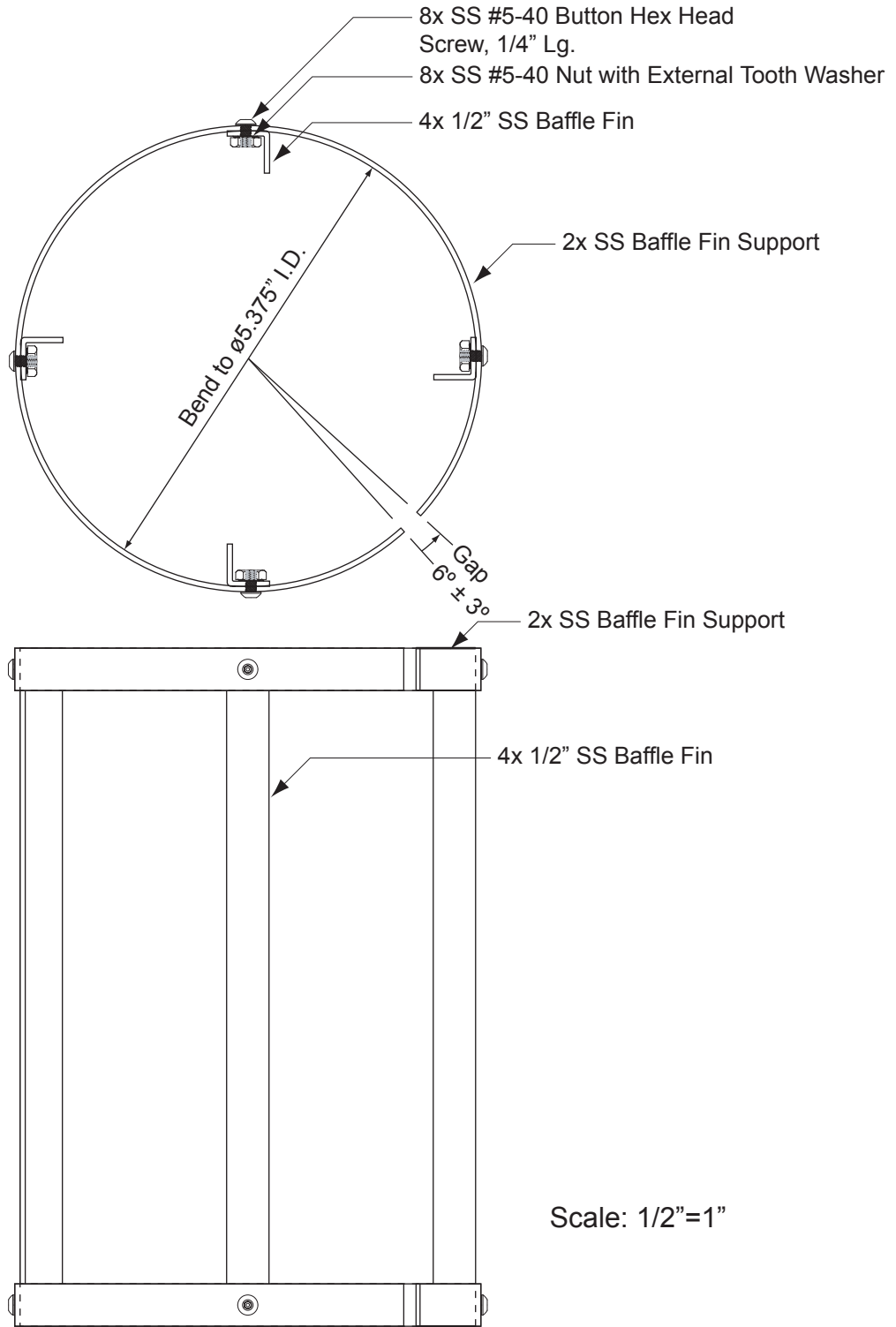


- 17. SS Ferrule Set
- 19. SS 9/16-18 SAE/MS ORB to 1/4" Swage Adapter
- 22. Quick Connect Stem to 1/4" Swage
- 29. Cooling Coil
- 39. Quick Connect Body to 1/4" Tube





# SS Baffle Assembly



Scale: 1/2"=1"

## Fasteners



18-8 Stainless Steel Button Head Socket Cap Screw #5-40 Thread, 1/4" Length  
Supplier: McMaster-Carr  
Supplier P/N: 92949A131

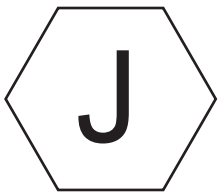


18-8 Stainless Steel Machine Screw Nut #5-40 Screw Size, 5/16" Width, 7/64" Height  
Supplier: McMaster-Carr  
Supplier P/N: 91841A006

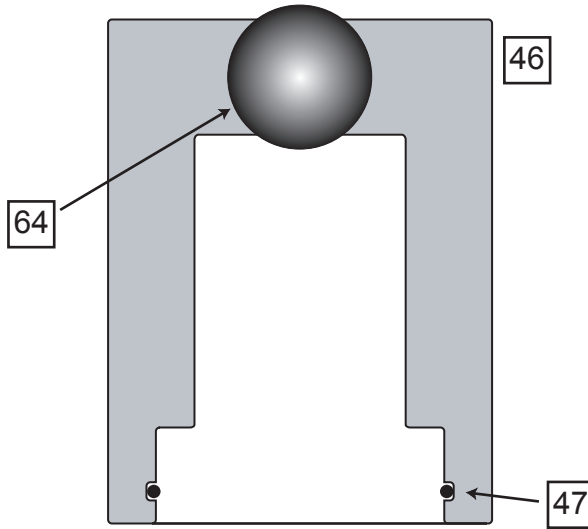


410 Stainless Steel External-Tooth Lock Washer #5 Screw Size, .129" Id, .285" Od, .014"  
Supplier: McMaster-Carr  
Supplier P/N: 98438A215

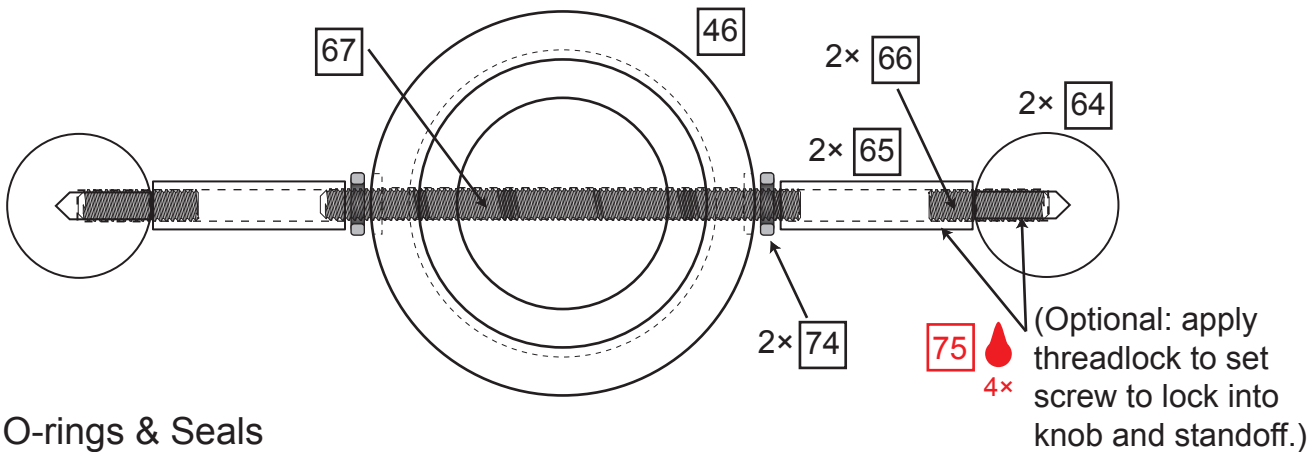




# Autoclave Cap with Handles, Rev. 1



- 46. Autoclave Cap, Rev. 3
- 47. Dash 029 Viton O-ring
- 64. SS Knob
- 65. SS Standoff
- 66. SS #8-32 Set Screw 5/8" lg.
- 67. SS #8-32 Threaded Rod 2-1/2" lg.
- 74. Piece of 1/8" I.D. Silicone Tubing
- 75. Loctite 272



## O-rings & Seals

47



Dash 029 Viton O-ring  
Supplier: McMaster-Carr  
Supplier P/N: 9464K291

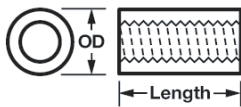
74



Silicone tubing (cut to length ~0.12" lg.)  
Supplier: McMaster-Carr  
Supplier P/N: 51135K73

## Fasteners

65



18-8 SS Standoff with Female #8-32 Thread 1/4" OD x 1" lg.  
Supplier: McMaster-Carr  
Supplier P/N: 91125A459

66



18-8 SS #8-32 Set Screw 5/8" lg.  
Supplier: McMaster-Carr  
Supplier P/N: 92311A196

67

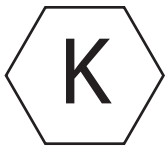


18-8 SS #8-32 Threaded Rod 2-1/2" lg.  
Supplier: McMaster-Carr  
Supplier P/N: 95412A882

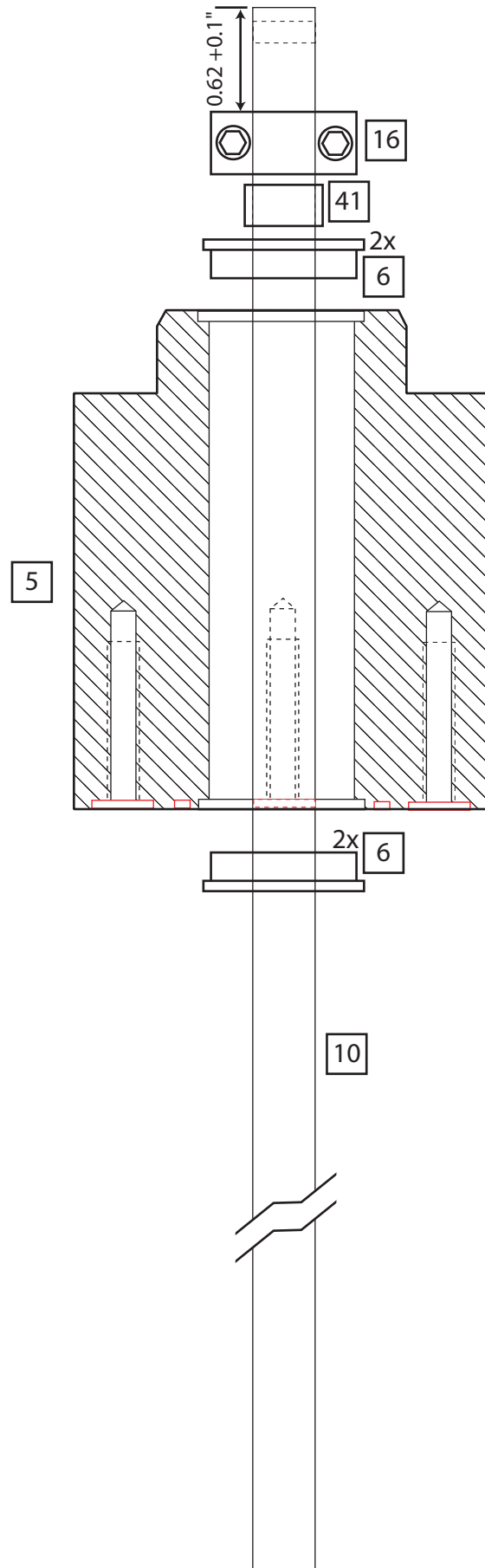
75



Loctite No. 272 High temperature threadlock  
Supplier: McMaster-Carr  
Supplier P/N: 91458A65



# Press Bearings into Housing



- 5. Bearing Housing
- 6. Bearing
- 10. Agitator Shaft
- 16. Locking Shaft Collar
- 41. Short PEEK Bushing

Press top and bottom bearings into housing such that top of the agitator shaft is 1.25" above the top of the bearing, which is 0.62" above the locking collar that rests on the PEEK bushing.

Grease the inside of bearing housing on the shaft above and below the two bearings with Dow Corning High Temp 44 Bearing Grease.

## BILLS OF MATERIALS

Chemglass Inc.  
3861 North Mill Road  
Vineland, NJ 08360  
1-800-843-1794  
1-800-922-4361 (fax)



[www.chemglass.com](http://www.chemglass.com)

[customer-service@chemglass.com](mailto:customer-service@chemglass.com)

[technical-service@chemglass.com](mailto:technical-service@chemglass.com)

Qty.	Project P/N	Chemglass P/N	Description
1 ea	73	Custom	Custom Flat Bottom Duran Flange Fermentor Vessel (Designed with technical service)
1 ea	78	CG-141-05	200 mm Duran Flange Clamp

## McMaster-Carr

Mail Address:  
P.O. Box 740100  
Atlanta, GA 30374-0100  
[atl.sales@mcmaster.com](mailto:atl.sales@mcmaster.com)

Sales Desk and Customer Service:  
Fax:  
[www.mcmaster.com](http://www.mcmaster.com)

# McMASTER-CARR®

Street Address:  
6100 Fulton Industrial Blvd.  
Atlanta, GA 30336-2852

(404) 346-7000  
(404) 629-6500  
(404) 349-9091

Qty.	Project P/N	McMaster P/N	Description
1 ea	5	7662K14	Polyetherimide (Ultem 1000) Ø2.5" Dia. x 3" Long Disc
1 pk of 100	8	91771A190	#8-32 Flat Head Phillips Machine Screw ¼" Lg. (Type 18-8 SS)
1 pk of 100	9	92311A190	#8-32 set screw ¼" length (Type 18-8 SS)
1 pk of 50	11	93740A215	Coiled Spring Pin (Ø.125" x 0.75")
1 ea	12	6621K19	PEEK Bushing (Ø.375" ID x 15/32" OD x 0.75" long)
1 pk of 50	13	9464K78	Viton O-ring (Dash 024)
1 pk of 100	14	9464K13	Viton O-Ring (Dash 008)
1 pk of 50	15	92314A835	#10-32 Thd. 18-8 SS Hex Head Machine Screw, 1-1/4" Lg.
2 ea	16	6436K33	Type 303 SS Locking Shaft Collar Ø.375"
1 ea (3')	26	89895K722	Type 304 SS Tube ¼" OD 0.21" ID, 0.02" Wall
1 ea (3')	28	89785K51	Type 304 SS Tube ¼" OD, .18" ID, .035" Wall
1 ea (6')	29	89785K51	Type 304 SS Tube ¼" OD, .18" ID, .035" Wall
1 pk of 100	32	92196A536	¼"-20 x 7/16" Socket Head Cap Screw (Type 18-8 SS)
1 ea	41	6621K17	PEEK Bushing (Ø.375" ID x 15/32" OD x 0.25" long)
1 pk of 25	42	9752K118	Viton O-ring for SAE ORB Fitting (3/4"-16)
1 pk of 25	43	9752K116	Viton O-ring for SAE ORB Fitting (9/16"-18)
1 ea (~2.5")	46	8686K81	Polyetherimide (Ultem 1000) Rod Ø 2" Dia. x 12" Lg.
1 pk of 25	47	9464K291	Viton O-ring (Dash 029)
10' lg.	52	3184K1	¼" ID x 7/16" OD x 3/32" Wall Flexible Silicone Tubing
1 ea	53	4402K52	SS Sparger with ¼" NPT Male Thread
1 ea	57	1252K23	Dow Corning Molykote Synthetic Grease 44 Multipurpose, 5.3-Ounce Tube, Nlgi #2
1 ea	58	2966K52	Dow Corning Hi-Vacuum Silica Synthetic Grease 5.3-Ounce Tube
1 pk of 100	61	92949A131	18-8 SS Button Head Socket Cap Screw #5-40 x ¼" lg.
1 pk of 100	62	91841A006	18-8 SS Nut #5-40 Screw Size, 5/16" Width, 7/64" Height
1 pk of 100	63	98438A215	410 SS External-Tooth Lock Washer #5 Screw Size
1 pk of 5	64	96415K81	Type 316 SS Ø.75" Diameter Ball
2 ea	65	91125A459	18-8 SS Standoff with Female #8-32 Thread 1/4" OD x 1" lg.
1 pk of 100	66	92311A196	18-8 SS #8-32 Set Screw 5/8" lg.
1 pk of 10	67	95412A882	18-8 SS #8-32 Threaded Rod 2-1/2" lg.
1 ea	68	89415K291	Type 304 SS Bar 0.75" x 0.75" x 12"
1 ea	68	1421T21	Type 304 SS Strip 0.075"x1"x36"
1 ea	69	8992K453	1.25" x 0.25" Type 304 SS bar stock
1 ea	70	8685K521	Polyetherimide (Ultem 1000) Sheet 1/2" Thick, 12" x 12" sq.
1 ea	71	8983K42	Type 304 SS 12" x 12" x 0.06" sheet
1 ea	72	1421T11	Type 304 SS Strip .060" Thick, 1" Width, 36" Length
1' lg.	74	51135K73	1/8" I.D. Silicone Rubber Tubing
1 ea	75	91458A65	Loctite No. 272 High-temperature Threadlock
1 pk of 100	76	9464K15	O-rings Dash 010 for Custom Adapter Strap
1 ea	77	9396K335	Silicone O-ring for 200 mm Duran Flange Clamp (Dash 371)

## Modern Plastics

Corporate Headquarters:  
678 Howard Avenue  
P.O. Box 3974  
Bridgeport, Connecticut 06605-0574

Toll-Free: 800-243-9696  
Phone: 203-333-3128  
Fax: 203-333-4625  
[www.modernplastics.com](http://www.modernplastics.com)

[customerservice@modernplastics.com](mailto:customerservice@modernplastics.com)



Qty.	Project P/N	Modern Plastics P/N	Description
1 ea	44	N/A	Polyetherimide (Ultem 1000) Natural Color, Sheet 0.500" Thick, 24" x 24" sq. (Cheaper source of stock material if more than one headplate will be made.)

OMEGA ENGINEERING INC.  
One Omega Drive  
Stamford, Connecticut 06907-0047  
P.O. Box 4047  
(800)-848-4286 or (203)-359-1660  
Fax: (203)-359-7700

 **OMEGA ENGINEERING, INC.**

[www.omega.com](http://www.omega.com)

[sales@omega.com](mailto:sales@omega.com)

[cservice@omega.com](mailto:cservice@omega.com)

Qty.	Project P/N	SDP/SI P/N	Description
1	55	CPSS-14U-12-NHX	Std-plug ceramic style, Type T, thermocouple 1/4" dia. 12" lg.

Stock Drive Products/  
Sterling Instrument (SDP/SI)



2101 Jericho Tpke  
Box 5416  
New Hyde Park, NY  
11042-5416

Phone: (516) 328-3300  
Fax : (516) 326-8827

[www.sdp-si.com](http://www.sdp-si.com)

[support@sdp-si.com](mailto:support@sdp-si.com)

Qty.	Project P/N	SDP/SI P/N	Description
2	6	A 7Y55-FSS8737M	ABEC 3 Grade 0.375" Bore Diameter Double Shielded Flanged Bearing (Ø.8750" O.D.)
1	10	A 7X 1-1216A	Precision Ground Agitator Shaft (Ø.375")

Swagelok

[www.swagelok.com](http://www.swagelok.com)



Distributor:

Oakland Valve & Fitting Co.

2441 Sprig Court - Unit A

Concord, CA 94520-8509

Phone: 925-676-4100

Fax: 925-798-9833

Email: [info@Oakland.swagelok.com](mailto:info@Oakland.swagelok.com)

Website: [www.swagelok.com/oakland](http://www.swagelok.com/oakland)

Qty.	Project P/N	Swagelok P/N	Description
5 ea	17	SS-400-SET	SS Ferrule Set (1 Front Ferrule/1 Back Ferrule) for 1/4 in. Swagelok Tube Fitting
5 ea	18	T-400-SET	PTFE Ferrule Set (1 Front Ferrule/1 Back Ferrule) for 1/4 in. Swagelok Tube Fitting
5 ea	19	SS-400-1-6ST-BT	SS Swagelok Tube Fitting, Male Connector, 1/4 in. Tube OD x 9/16-18 Male SAE/MS Straight Thread (with Bored Through Option)
1 ea	19	SS-400-1-6ST	SS Swagelok Tube Fitting, Male Connector, 1/4 in. Tube OD x 9/16-18 Male SAE/MS Straight Thread
2 ea	20	SS-4P4T-M1	SS Quarter-Turn Instrument Plug Valve, 1/4 in. Swagelok Tube Fitting, 1.6 Cv, with SS Handle
3 ea	21	SS-4-HC-A-401	Stainless Steel Hose Connector, 1/4 in. Tube Adapter, 1/4 in. Hose ID
1 ea	22	SS-QC4-S-400	SS Instrumentation Quick-Connect Stem w/o Valve, 0.3 Cv, 1/4 in. Swagelok Tube Fitting
1 ea	39	SS-QC4-B-400	SS Instrumentation Quick-Connect Body, 0.2 Cv, 1/4 in. Swagelok Tube Fitting
1 ea	40	SS-401-PC	1/4" Tube Swage Port Connector
1 pk	42	VI9-OR-0908	90 Durometer Fluorocarbon FKM O-ring for Fittings with SAE/MS Straight Threads, Uniform Size 908
1 pk	43	VI9-OR-0906	90 Durometer Fluorocarbon FKM O-ring for Fittings with SAE/MS Straight Threads, Uniform Size 906
1 ea	49	SS-6-PST	Stainless Steel Pipe Fitting, Hex Head Plug, 9/16-18 Male SAE/MS Straight Thread
3 ea	50	SS-8-PST	Stainless Steel Pipe Fitting, Hex Head Plug, 3/4-16 Male SAE/MS Straight Thread
1 ea	54	SS-400-7-4	SS Coupler 1/4" NPT Female x 1/4" tube compression fitting



**Fisher Scientific**

**Customer Service** 800.766.7000  
**FAX** 800.926.1166  
**Scientific Customers** 800.766.7000  
**FAX** 800.926.1166

**Fisher Scientific**  
**2000 Park Lane Drive**  
**Pittsburgh, PA 15275**

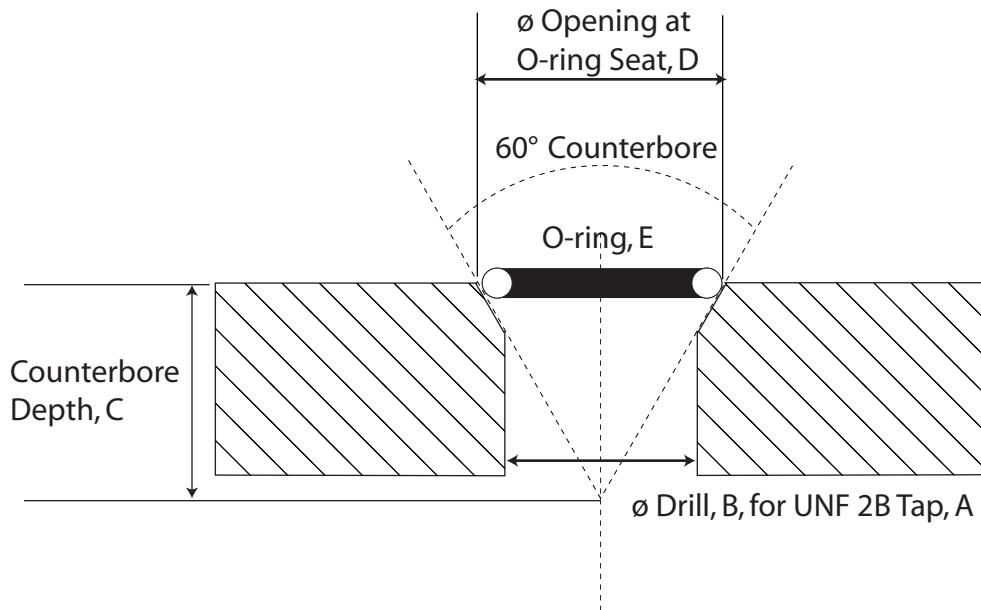


**ThermoFisher**  
**SCIENTIFIC**

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Qty.	Project P/N	Fisher P/N	Description
1 pk of 18	56	09-730-241A	PTFE Autoclavable Vent filter with hose barbs (Pall P/N 4251)

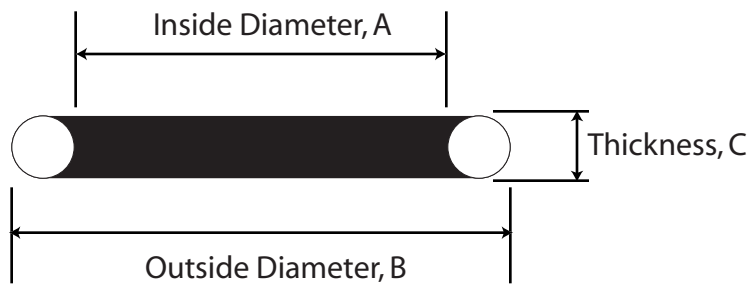
# Appendix 1: SAE ORB Port Detail



Note: This is not the rigorous standard for SAE ORB ports. However, it should be sufficient for low pressure sealing applications.

## KEY FOR SAE ORB Port

SAE Port Dash	UNF Thread A	Drill for Tap B	Counterbore Depth C	Opening Diameter at O-ring Seat D	O-ring Dash E
6	9/16"-18	1/2"	0.559"	0.645"	906
8	3/4"-16	11/16"	0.728"	0.840"	908

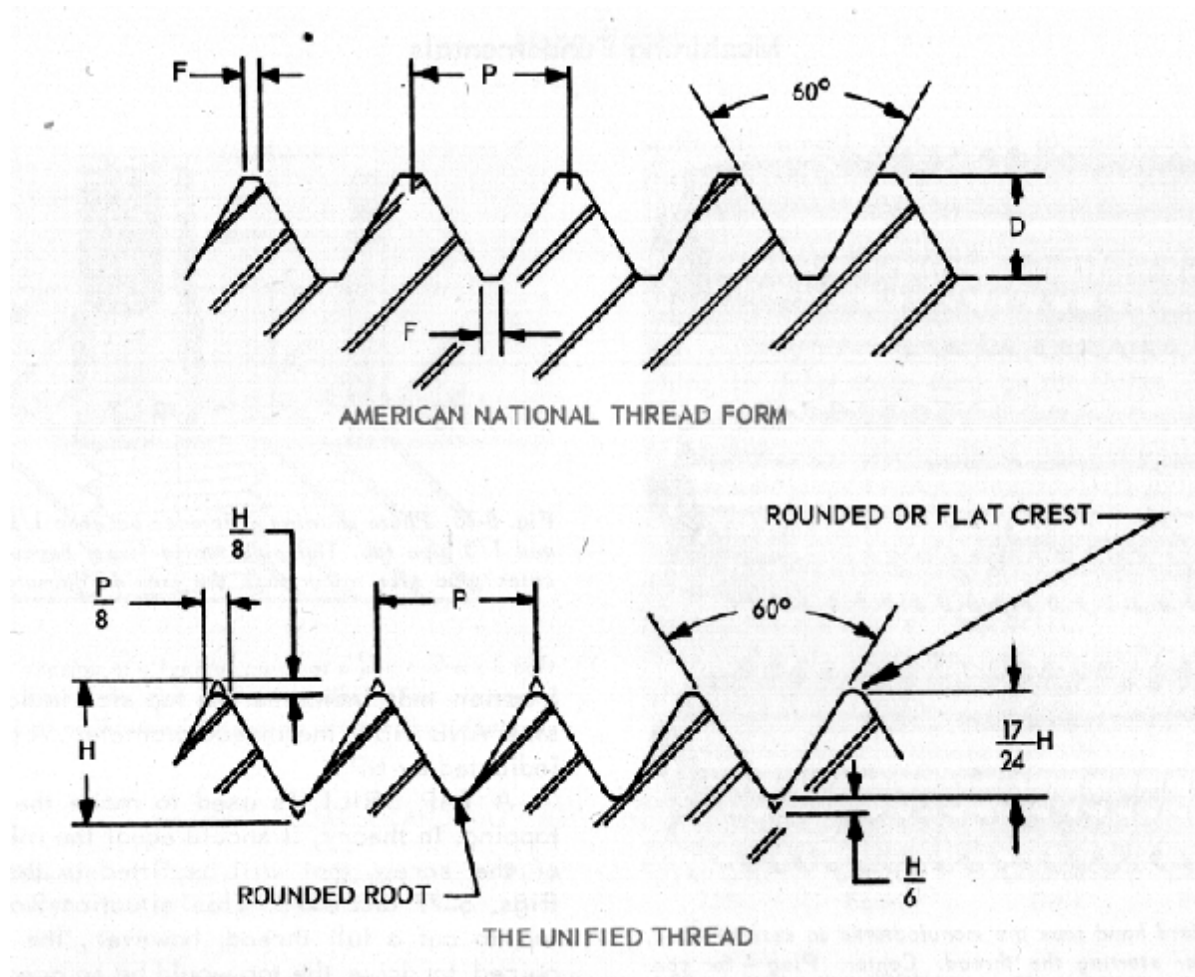


## KEY FOR SAE ORB O-rings

SAE Port Dash	O-ring Dash	P/N	Inside Diameter A	Outside Diameter B	Thickness C
6	906	43	0.468"	0.624"	0.078"
8	908	42	0.644"	0.818"	0.087"

# Appendix 2: National & Unified Thread Standards

The threads cut by taps and dies conform to a standard for the shape of the threads. Often it is the American National Standard in National Coarse (NC) or National Fine (NF). NC has fewer threads per inch than NF. NC is most common while NF is favored in precision assemblies. Also in common use is the Unified Thread System with UNC (coarse) and UNF (fine). The only difference between National and Unified threads is the shape of the root and crest. The threads in the two different standards will mate. Fasteners are designated by their diameter, number of threads per inch, and shape. For example, 1/4-20NC means 1/4 inch diameter, 20 threads per inch, and National Standard. Threads smaller than 1/4 inch are designated by number from 0 (smallest) to 12 (largest). To convert number to diameter multiply by 0.013 and add 0.060.



# Appendix 3:Mil-Spec Lubrication

Manufacturer	Lubricants	Operating temperature range		USA-specification
		in C	in F	
<b>GREASES</b>				
SHELL	ALVANIA RS	-25/+120	-13/+248	—
	AEROSHELL Gr. 6	-40/+120	-40/+248	MIL-G-7711A
	AEROSHELL Gr. 7	-70/+150	-94/+302	MIL-G-23827A
	AEROSHELL Gr. 15A	-70/+230	-94/+446	MIL-G-25013D
	AEROSHELL Gr. 16	-55/+200	-67/+392	MIL-G-25760A
EXXON (ESSO)	BEACON 325	-55/+120	-67/+248	MIL-G-3278A
	ANDOK C	-25/+120	-13/+248	—
	ANDOK B	-30/+110	-22/+230	MIL-G-18709A
KLUBER	ISOFLEX SUPER LDS 18	-60/+130	-76/+266	MIL-G-3278A/MIL-G-7118 A
	ISOFLEX LDS 18 SPEC. A	-60/+130	-76/+266	MIL-G-23827A/MIL-G-15793
	ISOFLEX ALLTIME SL 1	-70/+150	-94/+302	—
	ISOFLEX ALLTIME SL 2	-50/+150	-58/+302	—
	ISOFLEX NBU 15	-40/+130	-40/+266	MIL-G-7711A/MIL-G-25760
	ISOFLEX PDB38/CX1000	-70/+120	-94/+248	—
	ISOFLEX TOPAS NB 52	-60/+160	-76/+320	MIL-G-81322C
	UNISILICON TK44-N2 STABURAGS NBU 12	-60/+230 -35/+150	-76/+446 -31/+302	— —
MOBIL	MOBIL GREASE 28	-60/+75	-76/+347	MIL-G-81322A
CHEVRON	CHEVRON SRI 2	-30/+175	-22/+347	—
TEXACO	LOW TEMP EP	-70/+120	-94/+248	MIL-G-23827A
	UNITEMP Grease 500	-54/+177	-65/+350	—
DOW CORNING	DC 33	-70/+180	-94/+356	MIL-G-46886
	DC 44	-40/+200	-40/+392	MIL-G-15719A
DU PONT	KRYTOX 240 AB	-40/+227	-40/+440	MIL-G-38220
	KRYTOX 240 AC	-34/+288	-30/+550	MIL-G-27617A
GEN. ELECTRIC	VERSILUBE G300	-70/+230	-94/+446	—
<b>OILS</b>				
SHELL	AEROSHELLOL 3	-56/+115	-70/+240	MIL-L-7870A
	AEROSHELLOL 12	-60/+120	-76/+248	MIL-L-6085A
KLUBER	ISOFLEX PDP 38	-70/+120	-94/+248	MIL-L-6085A
DOW CORNING	DC 550 FLUID	-40/+230	-40/+446	

# Appendix 4: Ultem - Polyetherimide Material Specifications

**WESTLAKE**  
PLASTICS COMPANY

## Tempalux (polyetherimide)

An amorphous thermoplastic polyetherimide, stock shapes from ULTEM™ resin possess a combination of useful characteristics, including high strength at elevated temperatures, high modulus, and broad chemical resistance. Tempalux stock shapes are inherently flame resistant with low smoke emission. Tempalux stock shapes display property retention and resistance to environmental stress cracking when exposed to a wide variety of chemicals. The standard color of Tempalux stock shapes is light amber. Glass filled grades appear tan or greenish in color. Tempalux rod, slab, and tubular bar are air annealed for stress relief. The following physical property information is based on typical values of the base polyetherimide resin (PEI).

### Manufacturing Capabilities:

**Rod:** 1/4" to 8" diameter  
**Sheet:** .035" to 1/4" thick  
**Film (unfilled):** .001" to .029" thick  
**Slab:** 3/8" to 4" thick

### Colors/Grades:

Amber - unfilled  
Tan/Green - glass filled  
(custom colors available)

### Advantages of Tempalux:

- Inherent flame resistance
- Extremely low NBS smoke evolution
- Superior limiting oxygen index
- Exceptional tensile and flexural strength
- Broad chemical resistance
- UV stable
- FDA compliant

### Applications Include:

- Burn-in test sockets
  - Connectors
  - Automotive components
  - Valves, electrical fittings
- \*In addition to our standard capabilities, Westlake also has the ability to process custom resins in various sizes and colors with some exceptions.

	Units	ASTM Test	Unfilled	20% GF	30% GF
<b>Mechanical</b>					
Tensile Strength @yield	psi	D638	15,200	20,100	24,500
Tensile Strength @break	psi	D638	-	19,000	23,000
Tensile Modulus	psi	D638	430,000	1,000,000	1,300,000
Tensile Elongation @yield	%	D638	7.0	-	-
Tensile Elongation @break	%	D638	60.0	4.0	3.0
Flexural Strength @yield	psi	D790	22,000	30,000	33,000
Flexural Modulus	psi	D790	480,000	1,000,000	1,300,000
Compressive Strength @yield	psi	D695	21,900	28,700	30,700
Compressive Modulus	psi	D695	480,000	809,000	938,000
Izod Impact Strength					
Un-Notched	ft-lbs/in	D256	25.0	9.0	8.0
Notched @73°F	ft-lbs/in	D256	1.0	1.6	2.0
Hardness (R, M, Lor D)	Ñ	D7852 D2240	M109	M114	M114
<b>Thermal</b>					
Heat Deflection Temperature					
@66 psi	°F	D648	410	410	414
@264 psi	°F	D648	392	408	410
Coefficient of Thermal Expansion	in/in/°F	D696	3.1x10 <sup>-5</sup>	1.4x10 <sup>-5</sup>	1.1x10 <sup>-5</sup>
Flammability Rating - UL94	-	-	@.075" 5VA	@.016" V-0	@.016" V-0
Thermal Conductivity (BTU-in)/(hr-ft <sup>2</sup> -°F)		C177	1.53	1.70	1.80
Limiting Oxygen Index	%	D2863	47.0	50.0	50.0
<b>Electrical</b>					
Dielectric Strength	V/mil	D149	831	670	770
Dielectric Constant @1kHz	-	D150	3.15	3.50	3.70
Dissipation Factor @1kHz	-	D150	0.0013	0.0015	0.0015
Volume Resistivity	ohm-cm	D257	1.0x10 <sup>17</sup>	7x10 <sup>16</sup>	3x10 <sup>16</sup>
<b>Optical</b>					
Haze	%	D1746	-	-	-
Transparency	%	D1746	-	-	-
<b>Other</b>					
Specific Gravity	-	D792	1.27	1.42	1.51
Water Absorption @24 hours	%	D570	0.25	0.19	0.16

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Tempalux™ is the Registered Trademark of Westlake Plastics Co.



## ULTEM\*PEI

- High dielectric strength
- UL 94-V-0 rated with low smoke
- Available in glass-reinforced grades
- High strength and performs in continuous use to 340°F (170°C)

Ultem 1000 polyetherimide is an amorphous polymer offering high strength and excellent flame and heat resistance. It performs continuously to 340°F (170°C), making it ideal for high strength/ high heat applications, and those requiring consistent dielectric properties over a wide frequency range. It is hydrolysis resistant, highly resistant to acidic solutions and capable of withstanding repeated autoclaving cycles.

Ultem 2100, 2200 and 2300 are glass-reinforced versions (10, 20, and 30%, respectively) of Ultem 1000 which provide even greater rigidity and improved dimensional stability while maintaining many of the useful characteristics of basic Ultem. Ultem 1000 is FDA and USP Class VI compliant. FDA compliant colors of Ultem are also available on a custom basis.

Ultem commonly is machined into parts for reusable medical devices, analytical instrumentation, electrical/electronic insulators (including many semiconductor process components) and a variety of structural components requiring high strength and rigidity at elevated temperatures.

Port Plastics offers Ultem 1000 and Ultem 2300 as standard products, and will custom quote Ultem 2100, 2200 and specialty grades of Ultem.

### Proven Applications

#### Structural probes

Surgical probes machined from Ultem rod are autoclavable, and offer high strength and rigidity. *(Prior materials: Acetal, Polysulfone)*

#### Manifolds

In pharmaceutical process equipment, manifolds machined from Ultem plate offer resistance to hot chemical solutions and daily sanitizing. *(Prior material: Aluminum)*

#### Insulators

High frequency insulators used in microwave communications equipment are machined from Ultem stock shapes. *(Prior material: Ceramic)*

#### Clamps

High voltage and flame resistance of Ultem make it ideal for clamps used to connect printed circuit boards to video display units used in airplanes, tanks and ships. *(Prior material: Acetal)*

#### Engineering Notes:

Since Ultem is an amorphous material, selection of appropriate non-aromatic coolants during machining is important. Care must also be used in selecting adhesives and designing press fit components to avoid stress cracking.

Extruded	Rod	Disc	Plate	Tubular Bar	Other
Ultem* 1000 PEI	.125"- 6.0"	-	.250"-2.0" (A)	Quote on request	-
Ultem* 2300 PEI	.500"- 6.0"	-	.375"-2.0" (A)	-	-

Key: A = 12" wide x 24" long



# Ultem 1000 - Polyetherimide



		ULTEM 1000	ULTEM 2300
<b>MECHANICAL PROPERTIES</b>	<b>ASTM</b>	<b>VALUE</b>	<b>VALUE</b>
Specific Gravity	D792	1.28	1.51
Tensile Strength, psi	D638	16,500	17,000
Tensile Modulus, psi	D638	475,000	800,000
Elongation, %	D638	80	3
Flexural Strength, psi	D790	20,000	30,000
Flexural Modulus, psi	D790	500,000	900,000
Shear Strength, psi	D732	15,000	-
Compressive Strength, psi	D695, 10% Def.	22,000	32,000
Compressive Modulus, psi	D695	480,000	625,000
Hardness, Rockwell M	D785	112	114
Hardness, Rockwell R	D785	125	127
Izod Impact (Notched), ft-lb/in	D256 Type A	0.5	1
Coefficient of Friction, Dynamic	Dry vs. Steel,	0.42	-
Limiting PV, psi-fpm	PTM55010	1,875	1,000
k (wear) factor, 10-10in3-min/lb-ft-hr	PTM55010	999	999
<b>THERMAL PROPERTIES</b>			
Coefficient of Thermal Expansion,	E831 (TMA)	0.31	0.11
Deflection Temperature 264 psi, °F	D648	392	410
Tg-Glass Transition (Amorphous), °F	D3418	419	419
Continuous Service in Air (Max), °F	Without Load	340	340
Thermal Conductivity, BTU-in/hr-ft <sup>2</sup> -°F		0.9	-
<b>ELECTRICAL PROPERTIES</b>			
Dielectric Strength, Volts/mil	D149(2)	830	770
Volume Resistivity, Ohm-cm	D257	1E+15	1E+15
Dielectric Constant, 1 MHz	ASTM D150(2)	3.5	3.7
Dissipation Factor, 1 MHz	ASTM D150(2)	0.0013	0.0015
<b>CHEMICAL PROPERTIES</b>			
Water Absorption Immersion, %	24 hr	0.25	0.18
Water Absorption, %	Saturation	1.25	0.9
Acids, Weak (acetic, dilute HCl)		3	3
Acids, Strong (conc. HCl or sulfuric)		3	3
Alkalies, Weak (dilute NaOH)		2	2
Alkalies, Strong (conc. NaOH)		1	1
Hydrocarbons, Aromatic (toluene)		2	2
Hydrocarbons, Aliphatic (gasoline)		3	3
Ketones, Esters (acetone)		3	3
Ethers (diethyl ether, THF)		3	3
Chlorinated Solvents (methylene chloride)		1	1
Alcohols (methanol, anti-freeze)		3	3
Inorganic Salt Solutions (NaCl, KCl)		3	3
Continuous Sunlight		3	3
Steam		3	3
1= Unacceptable, 2= Limited Service, 3= Acceptable Service			
<b>COMPLIANCE</b>			
Flammability, UL94 (5=V-0; 4=V-1; 3=V-2; 1=HB) V-O UL94		5 (VO)	5 (VO)
FDA(1=Yes)		0 Compliant	0 Compliant
USDA(1=Yes)		0 Compliant	0 Compliant
NSF (1=Yes)		0 Compliant	0 Compliant
3A-Dairy (1=Yes)		0 Compliant	0 Compliant
Canada AG (1=Yes)		0 Compliant	0 Compliant
USPClass VI (1=Yes)		1 Not Compliant	1 Not Compliant

# Appendix 5: Swagelok O-rings for Fittings with SAE/MS Straight Threads (O-ring Boss, ORB)

Port Size, in.	Uniform Size Number	Ordering Number	Durometer
1/8	902	VI9-OR-0902	90
3/16	903	VI9-OR-0903	
1/4	904	VI9-OR-0904	
5/16	905	VI9-OR-0905	
3/8	906	VI9-OR-0906	
1/2	908	VI9-OR-0908	
5/8	910	VI9-OR-0910	
3/4	912	VI9-OR-0912	
7/8	914	VI9-OR-0914	
1	916	VI9-OR-0916	
1 1/4	920	VI9-OR-0920	
1 1/2	924	VI9-OR-0924	
2	932	VI9-OR-0932	