5100

Low Pressure Reactors

Operating Instruction Manual



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PREFACE

Scope

These instructions describe the installation, operation and maintenance of Series 5100 Fixed Head Bench Top Reactors offered in six sizes from 160 mL to 1.5 L with glass and/or metal cylinders. They cover the basic steps to be followed for installing these reactors and describe the function of all standard components. They are intended to be used in conjunction with several related instruction sheets listed on the previous page. This information describes several components which are common to most pressure reaction equipment, and includes safety precautions and other related information applicable to all reaction laboratories. The users should study all of these instructions carefully before starting to use these vessels so that they will fully understand the capabilities and limitations of the equipment.

Related Instructions

The following publications are also available to further your understanding of this instrument and its component parts:

No.	Description of Instructions
201M	*Limited Warranty*
230M	*Safety Precautions for operating Pressure Reaction Equipment*
231M	*Safety Rupture Discs*
234M	*Magnetic Drives*
323M	*Pressure Relief Valves*
548M	*4848 Reactor Controllers*
549M	*4848 Controller CD-ROM*
553M	*A2110E Motor Controller*
FX004	*Health & Safety Assurance Certification*

Intended Usage

This system has been designed for use as a low pressure reactor system. It has been designed, built, and tested to strict physical and electrical standards. However, it is the user's responsibility to install and operate it in conformance with local pressure and electrical codes.

If the instrument is used in a manner not specified by Company, the protection provided by the equipment may be impaired.

Safety Information

To avoid electrical shock, always:

1. Use a properly grounded electrical outlet of correct voltage and current handling capability.
2. Ensure that the equipment is connected to electrical service according to local national electrical codes. Failure to properly connect may create a fire or shock hazard.
3. For continued protection against possible hazard, replace fuses with same type and rating of fuse.
4. Disconnect from the power supply before maintenance or servicing.

To avoid personal injury:

1. Do not use in the presence of flammable or combustible materials; fire or explosion may result. This device contains components which may ignite such material.
2. Refer servicing to qualified personnel.

General Specifications

Electrical Ratings

Controller ratings are found in the Operating Instructions for the controller supplied with your reactor and on the controller data plate.

Before connecting a controller to an electrical outlet, the user must be certain that the electrical outlet has an earth ground connection and that the line, load and other characteristics of the installation do not exceed the following limits:

Voltage: Fluctuations in the line voltage should not exceed 10% of the rated nominal voltage shown on the data plate.

Frequency: Controllers can be operated from either a 50 or 60 Hertz power supply without affecting their operation or calibration.

Current: The total current drawn should not exceed the rating shown on the data plate on the controller by more than 10 percent.

Thermocouple: Unless otherwise specified, all Series 4848 Controllers operate with a Type J (iron–constantan) thermocouple. The total resistance of the thermocouple and the lead wires should not exceed 100 ohms. If the resistance of the thermocouple circuit is higher, it will reduce the sensitivity of the control system.

Explanation of Symbols

II	On position, full power heater switch
I	On position, half power heater switch
O	Off Position
~	Alternating Current (AC)
	This **CAUTION** symbol may be present on the Product Instrumentation and literature. If present on the product, the user must consult the appropriate part of the accompanying product literature for more information.
	This **CAUTION** symbol indicates that the surface may be hot.
	**Protective Earth (PE) terminal**. Provided for connection of the Protective Earth (green or green/yellow) supply system conductor.

Environmental Conditions

This instrument is intended to be used indoors.

Operating: 15 °C to 35 °C; maximum relative humidity of 80% non-condensing.

Installation Category II (over voltage) in accordance with IEC 664.

Pollution degree 2 in accordance with IEC 664.

Altitude Limit: 2,000 meters.



CAUTION!
Do not use in hazardous atmospheres.

Unpack Carefully

Unpack the equipment carefully and check all the parts against the packing list. If shipping damage is discovered, report it immediately to the delivering carriers. Examine the components closely for any loose parts or shipping damage and be sure to check all layers of packing materials thoroughly so as not to overlook any parts which might otherwise be discarded.

Provisions for Lifting and Carrying

The Series 5100 Fixed Head Bench Top Reactors and its components are very heavy. Before moving ensure all cables are disconnected. Use proper and safe lifting techniques when installing or moving the Series 5100 Fixed Head Bench Top Reactors and/ or its components.

Cleaning & Maintenance

Periodic cleaning may be performed on the exterior surfaces of the controller with a lightly dampened cloth containing mild soap solution. All power should be disconnected and the power cord should be unplugged when cleaning the instrument.

There are no user serviceable parts inside the product other than what is specifically called out and discussed in this manual. Advanced troubleshooting instructions beyond the scope of this manual can be obtained by calling Company in order to determine which part(s) may need to be replaced or serviced.



Ensure that any hot surfaces have had adequate time to cool before cleaning or maintaining the reactor and/or its components.

Users Responsibility

All reactors and pressure vessels are designed and manufactured with great care to assure safe operation when used within their prescribed temperature and pressure limits.

But... the basic responsibility for safety when using this equipment rests entirely with the user; who must:

1. **Select a reactor or pressure vessel** that has the capability, pressure rating, corrosion resistance, and design features that are suitable for its intended use. Company engineers will be glad to discuss available equipment and material options with prospective users, but the final responsibility for selecting a reactor or pressure vessel that will perform to the user's satisfaction in any particular reaction or test must rest with the user.

   In exercising the responsibility for the selection of pressure equipment, the prospective user is often faced with the choice between over- or under-designed equipment. The hazards introduced by under-designed pressure vessels are readily apparent, but the penalties that must be paid for over-designed apparatus are often overlooked. Recognizing these criteria, eactors and pressure vessels are offered in several different styles, each designed for convenient use in daily operation within certain temperature and pressure limits, using gaskets, closures, and other elements carefully selected for safe operation within the limits specified for that design. But in order to preserve the validity of these designs, all temperature and pressure limits must be observed, and no attempt should be made to increase these limits by making alterations or by substituting components which are not recommended by Company.

2. **Install and operate** the equipment within a suitable barricade, if required, with appropriate safety accessories and in full compliance with local safety codes and rules.

   All standard pressure vessels are provided with either a suitable relief device or a means to attach one (typically in the form of a plugged opening). When a pressure vessel is delivered without a pressure venting device, it is the customer's responsibility to provide pressure relief in order to protect the operator and the equipment from destructive high pressures. If you need more information or need help in selecting a proper relief device, please contact Company.

3. **Establish training procedures** to ensure that any person handling the equipment knows how to use it properly.

4. **Maintain the equipment** in good condition and establish procedures for periodic testing to be sure the vessel remains structurally sound.

INSTALLATION

Pressure and Temperature Limits

The maximum working conditions for vessels are stamped on the cylinder. No attempt should be made to increase these limits by making alterations or by substituting components which are not recommended by the Company. It must also be understood that lower pressure and temperature limits may be required for modified reactors and for vessels made of special alloys. Limits for such vessels will be determined by the physical characteristics of the vessel material and will be prescribed on an individual basis.

Working temperatures up to 225 °C are permissible in reactors equipped with fluoroelastomer (FKM) O-ring seals, such as Viton®. The higher the operating temperature above 200 °C, the shorter the life of the O-ring will be. Perfluoroelastomer (FFKM) O-ring seals such as Kalrez® have a broad chemical resistance. Unfortunately, they are very expensive and will generally be reserved for unique applications. Ethylene propylene (EP) O-rings can be used to 170 °C and are recommended for applications where solvents such as ammonia and amines which will rapidly destroy fluoroelastomer O-rings.

The maximum working pressure and temperature for any vessel is governed by the design of the vessel and the strength of the material from which it is constructed. There is also a close relationship between working pressure and temperature since the strength of any material will normally fall off as the temperature is increased. Temperature and pressure limits are also affected by the physical properties and temperature limits of the gaskets and seals used in the vessel, and by any valves, gages or other fittings attached to the vessel. Obviously, the safe operating pressure of any system can be no higher than that of its lowest rated component.

All reactors show the maximum safe operating pressure and temperature imprinted on the cylinder. The working pressure and temperature in these 160 mL to 1.5 L reactors must not exceed the following maximum limits:

Pressure and Temperature Limits

Vessel Material	Maximum Pressure	Maximum Temperature
Glass	150 psi	225 °C
T316 SS	1000 psi	225 °C

Assemble the Reactor

These reactors require at least 10 inches of workspace from walls or flammable materials on a sturdy bench, table, or floor in a well ventilated area with convenient access to an electric outlet, running water, and a drain. If the tabletop is not heat resistant it would be ideal to provide an insulated pad on which to set the vessel when it is hot.

Review the following instructions first, prior to assembling the reactor.

1. Set the stand in the workspace.



Bolt the stand to a workbench or to the floor using the holes in the base plate.

Place the head assembly in the stand. Make sure the O-ring that seals the head and the cylinder together is installed in the head groove.

Two types of glass cylinders can be used with this apparatus (jacketed and non-jacketed) If a jacketed cylinder is being used, remove the jacket connection hoses, if present. A pair of split rings, with thumbscrews, is used to join the head and the cylinder flanges. The split rings are lined at the bottom with plastic cushions that eliminate metal against glass contact that could result in dangerous point loading on the glass. Examine the plastic cushions carefully. If they are cracked or otherwise appear damaged, they should be replaced.



CAUTION! Take care when handling the glass cylinder. If any of the pressure or load bearing surfaces become chipped or scratched, the pressure rating of the cylinder will be compromised.

If a metal cylinder is also being used with this apparatus, note that the split rings differ from those provided for a glass cylinder. Split rings intended for sealing a metal cylinder to a metal head should not be used with glass cylinders. A clasp system on both ends of the split rings is used to ensure proper alignment when assembled. Before using the split rings to mate the head and the cylinder, make sure the three thumbscrews on each half ring are backed off so that the end of the screw is flush with the inside of the split ring. Both sets of split rings feature thumb screws to be installed finger-tight.

Carefully bring the flange of the glass cylinder in contact with underside of the reactor head. A lab jack / cork support is provided for 1.0 and 1.5 liter glass reactors. When using the lab jack, bring the cylinder flush with the O-ring in the head, ensuring no stress is put on the glass. Align the major OD of the head with the OD of the cylinder flange. If a jacketed cylinder is being used, orient the cylinder so that the jacket connections are oriented to either side. Hold the cylinder carefully at the bottom with one hand, slide one of the half split rings onto the head/cylinder flanges, and rotate/slide around the head/cylinder flanges until the latches are facing you. Use one hand to steady this half split ring to the head/cylinder flanges as you attach the other half split ring from the front. Secure the latches. If using a lab jack, now lower it so that cylinder hangs freely.

At this point, the glass cylinder will be held in place loosely and can be rotated for proper orientation if needed. Tighten the six thumb screws two at a time, 180 degrees apart in a criss-cross pattern rather than progressively around the circle until finger-tight and the head flange is flush with the top of the cylinder flange. Do not over-tighten.



CAUTION! Never use tools, such as pliers, to tighten the thumbscrews. Excessive loading on the cylinder flange can compromise the pressure rating of the cylinder.



CAUTION! Before applying pressure to the reactor, install the transparent Lexan safety shield onto the front of the reactor stand. Failure to do so can result in serious injury if the cylinder should break under pressure.

To remove the cylinder from the head, follow the above procedure in the reverse order. If a jacketed cylinder is being used, drain and disconnect the jacket hoses first.

2. Set the Controller near the reactor, leaving a space of at least six inches between the controller and the base of the reactor so that the controller will not be unduly affected by radiant heat. Connect the reactor to the controller using information contained in its Instruction Manual 548M or follow the steps below.

Labeled connections are provided on the rear panel of the controller.



Cooling Only:

The **Cooling** output connector is to be used only with Company cooling solenoid valve assemblies supplied with the appropriate cooling power cord.



Heating Only:

The **Heating** output connector is to be used only with Company heater assemblies supplied with the appropriate heater power cord.

Note: *Do not make connections to a Variac, Powerstat or the like to attempt to control the heating output. The heavy inductive load on the primary side of such devices can destroy the internal sold state relay located in the 4848 Controller.*



Motor Only:

3. The support and heater are shipped fully assembled. The heater raises and lowers on its support rod to permit the vessel or cylinder to be removed. Lower the heater, open the hinged retainer on the front of the support and slide the vessel into its support. Fixed head vessels have a square lip which fits into a matching groove in the support plate. Removable vessels are supported by the split rings which rest on top of the support plate. The stirrer drive connector lifts by rotating and lifting the knob above the belt guard. The universal joint contains a cross pin that slips into the groove on top of the magnetic drive.

4. Connect the heater cord from the heater into the heater socket on the rear panel of the Series 4848 Reactor Controller.

5. Plug the motor cord into the motor socket on the rear of the controller.

Secure the clamp on the motor cord with the provided screw next to the motor socket for safety purposes.

6. Connect the thermocouple extension wire to both the thermocouple and to the controller in the "Primary Temp Input" position on the rear panel. Insert the thermocouple into thermowell.

7. Connect leads from accessory packages such as tachometer, pressure transducer and high temp cut-off to the designated positions on the back panel of the 4848 Controller.

8. Connect cooling water to internal cooling coil if installed.

9. Connect cooling water to the magnetic stirrer. See Instruction Manual 234M.

10. Connect tubing to the rupture disc outlet and run to a safely vented area. See Instruction Manual 231M.

11. Note the voltage requirement on the controller identification label on the back panel, and then plug the power cord into an appropriate outlet. Power for these reactors should be drawn from a 3-slot, grounded outlet capable of carrying up to the full current rating of the system.

12. Using the switch on the Reactor Controller, turn on the motor for a short run to check the stirrer drive system.

This apparatus includes a safety shield which should be used at all times. A relief valve pre-set to either 145 psi (CE certified) or 150 psi is also provided as a safety precaution to prevent over-pressurizing the glass cylinder - this also should be used at all times. Should this relief valve be inadvertently removed, the glass vessel could be over-pressurized, resulting in an explosion. The safety shield has been designed to withstand the force of this explosion. However, in the event of an explosion, some glass fragments will exhaust through the vertical slots provided in the back of the shield for the hoses.

Assembling & Connecting the Circulator Jacket Hoses

CAUTION! If a jacketed vessel is being used, the compression fittings should be pre-assembled onto the insulated hoses before attaching them to the cylinder. Failure to do so or tightening any of the compression fittings while the hoses are attached to the cylinder will likely cause the jacket nipple to break off.

Once the hoses are fixed at one end, they tend to have a preferred orientation. The following hose assembly procedure will minimize any side loading by the hoses against the jacket connection nipples.

Attach the hoses to the circulating bath first and route them through the openings at the rear of the reactor stand. Note that lower left connection is the jacket inlet. This should be connected to the circulator pump discharge. Elbows are used on the cylinder end to route the insulated hoses down and then out the rear of the stand. With the hose in its free state and not being twisted or rotated, tighten the elbows to the hoses in a manner that orients the open end of the elbow in line with the jacket nipple. This minimizes any side loading of the hose against the nipple.

Slide the brown plastic nut onto the nipple adapter so that the flange with the O-ring groove is recessed inside the nut. Tighten the tube stub onto the elbow. Place the O-ring in the groove of each of the assembled adapters and then screw the hose adapter onto the jacket nipple. **Tighten firmly, by hand only! No pliers!**

Draining the Jacket

To drain the jacket, first lower the temperature of the jacket circulating fluid to 60 °C or less.

> ***Note:*** *Oil, used as the circulating fluid, drains much faster when it is hot.*

Turn off the circulator and loosen the hose connection at the top of the jacket. This will allow air to enter the jacket and cause to fluid to drain back into the circulator. When the draining is complete, both hoses can be disconnected from the jacket. The ends of the hoses should be supported at a level higher than that of the circulator bath to prevent siphoning and fluid loss.

IDENTIFY THE VALVES

Gas Inlet Valve

The gas inlet valve is easily identified when the vessel is open by noting that it is connected to a dip tube which extends to a point near the bottom of the vessel cylinder. This is an angle valve with an attached fitting which provides a socket for attaching the A495HC pressure hose furnished with the reactor.

Gas Release Valve

The gas release valve is connected to the gage adapter on vessels with volumes of 160 – 600 mL. The gas release valve is installed in a port by itself on 1 L & 1.5 L vessels. These ports do not have a threaded connection on the underside of the head; they are always open to the gas phase of the reactor.

Liquid Sampling Valve

The liquid sampling valve is attached to the same fitting as the gas inlet valve and connected to a common dip tube. With this arrangement, incoming gas is always introduced below the surface of the liquid and the operator is provided with a means for clearing the dip tube to be sure that any sample taken during a run will be representative of the charge. This can be done by opening the upper gas inlet valve momentarily to allow the inlet gas to force any liquid in the dip tube back into the reactor before withdrawing a sample from the sampling valve.

Relief Valve

The relief valve is connected to the gage adapter and is pre-set to either 145 psi (CE certified) or 150 psi to ensure that the glass cylinder is not overcharged. When using a metal cylinder, a plug is provided so that the relief valve can be removed (due to higher pressure rating of metal cylinder).

OTHER VESSEL HEAD FITTINGS

Safety Rupture Disc

There is a safety rupture disc attached to the head which is intended to rupture and release the pressure before it reaches a dangerous level. A metal tag wired to the safety head identifies the burst pressure at room temperature for that particular disc. A similar tag is furnished with each replacement disc. This tag must remain with the apparatus at all times so that both present and future operators will be aware of the disc rating. Users should read the discussion of rupture discs given in the Instruction Sheet No. 231M for a complete description of the characteristics of rupture discs and the precautions to be observed when operating pressure equipment protected by this type of safety device. The disc is rated for 1000 psi and should remain installed for both glass and metal cylinders.

Pressure Gage

A pressure gage, typically 200 psi gage for glass cylinders and 1000 psi gage for metal cylinders includes a T316 Stainless Steel Bourdon tube. It is mounted on the head using attachment fittings similar to those used for the inlet/sampling valve assembly.

Type J Thermocouple

A Type J thermocouple in a 1/8" diameter stainless steel sheath is furnished with the reactor. Insert this thermocouple into the head thermowell and connect it to the thermocouple socket on the rear panel of the reactor controller using the extension wire furnished with the reactor.

See Page 30 for drawing of head fittings and valves.

ACCESSORIES

Air Motor

Variable stirring speeds from 100 to 2000 rpm with no spark hazard can be obtained by replacing the standard motor with an air motor. This motor operates on compressed air which must be supplied at 40 psig minimum pressure with at least 10CFM available at that pressure. It is furnished with a speed control valve and oiler, all assembled on a mounting bracket.

To operate reactors equipped with an air motor, mount the drive system firmly on the support stand and connect the air hose to a compressed air line. Fill the oiler with SAE 10 oil and adjust the oiler to feed one drop per minute into the air stream. For long continuous runs at high speeds, the oiling rate should be increased to three drops per minute. If the motor becomes sluggish, flush it with a non-flammable solvent in a well-ventilated area. Disconnect the air line and muffler and pour a small amount of solvent into the inlet port. Rotate the shaft by hand in both directions for a few minutes; then connect the air line and run the motor until there is no further trace of solvent in the exhaust. If the muffler felts are dirty, wash them in solvent or replace them. Relubricate the motor with a squirt of oil into the chamber and reassemble. If it becomes necessary to disassemble the motor to replace the vanes, follow directions given in the instruction sheet published by the Gast Manufacturing Corp., Benton Harbor, Michigan.

Spare Parts Kit

Company can furnish spare parts kits for these reactors which will provide a reserve supply of parts and tools sufficient to handle most normal replacements and emergency repairs during a year of heavy usage.

These kits contain replacement gaskets, packing, O-rings, shafts, bearings, and rupture discs. They can be ordered from any Dealer or direct from the Company. The order must specify the reactor size and indicate type of rupture disc, stirrer drive and whether it has a flat-gasket or O-ring closure.

Mantle Heaters

Mantle heaters with high temperature fabric heating mantles housed in sturdy aluminum shells can be provided for any plain (non-jacketed) cylinder. These heaters are designed to provide uniform heat distribution to the walls and bottoms of these vessels. They are attached to a support rod with a spring steel clamp and arranged so that they can be raised or lowered on the rod as desired. Each mantle must always be used with the vessel of the size for which it was designed, and must always be fully attached to the vessel before heat is turned on. Similarly, a short vessel must never be heated in a deep mantle. Without full contact with a vessel wall, a mantle will overheat and burn out.

Variable Speed Electric Motor

Reactors are normally equipped with a DC variable speed motor supplied and controlled through the Series A2110E or 4848 Controllers. Instructions for connecting and operating these motors are included in the controller's instruction manual No. 553M or 548M. This motor is installed in a drive system designed to produce stirring speeds from 0 to 1700 rpm.

Cooling Loop

Each 5100 Reactor has a single loop cooling coil installed in the vessel (except the 160 & 215 mL units). A slow, continuous flow of cold water through a cooling loop proves a very effective means for controlling temperature overshoot in these reactors, particularly when operating at temperatures below 150 °C. Water flow through the loop can be controlled automatically using a solenoid valve in the cold water line, with the solenoid connected to the cooling socket on the rear panel of the 4848 Reactor Controller. With this arrangement, cold water will be admitted to the cooling loop whenever the controller calls for cooling.

HOW TO USE THE VESSEL

Gas Connections

Gas connections are dependent on applications. For general usage, use the pressure hose furnished with the reactor. Screw the Type "A" coned pressure fitting into the adapter attached to the gas inlet valve and tighten the compression nut firmly. Do not use any thread dope on the coned fining. The A495HC pressure hose is made of reinforced Nylon which can be used for all noncorrosive gases at pressures up to 2500 psig. For operations involving corrosive gases, this hose should be replaced with an A490HC hose which has a PTFE lining and a braided stainless steel outer covering. Both of these hoses have the same fittings. An A506HC all metal hose is also available in stainless steel and other corrosion resistant materials.

Pressurizing the Vessel

Check all valves carefully before admitting gas into the system. The liquid sampling valve must remain closed throughout the charging procedure. The gas release valve must also be closed unless the vessel is to be purged, or unless there is to be a continuous flow through the reactor during a run. Always make certain that the pressure in the gas tank is greater than the pressure in the vessel; otherwise, liquid will be forced out of the vessel and into the gas tank when the inlet valve is opened. If there is any possibility that the tank pressure might not be high enough to force gas into the reactor, install a one-way check valve (optional) in the gas line to prevent any reverse flow. With the inlet valve open and the flow control valve on the gas tank closed, open the main valve on the gas tank only about one-quarter turn; then use the flow control valve or the valve on a pressure regulator to control the flow of gas into the vessel. After the desired pressure has been reached, close the tank valves and the vessel inlet valve and disconnect the hose at the vessel end.

Do Not Overfill the Vessel

Always watch the pressure gage closely when admitting gas so as not to exceed the maximum working limit. Remember that any subsequent increase in temperature will raise the pressure. Also, be sure that the amount of liquid placed in the vessel is carefully controlled.

As a general rule, the liquid charge should not exceed two-thirds of the capacity of the cylinder. Too much liquid in the vessel can lead to development of dangerous pressures if sufficient space is not provided for expansion when the liquid is heated. This hazard is explained in greater detail in a warning statement included in the Instruction Manual No. 230M.

Releasing Pressure

Use the gas release valve to reduce the pressure in the vessel if the reactor is accidentally overcharged when filling. Use this valve also to release any excess pressure during a run and to exhaust the vessel at the end of a run. If the discharge gases are flammable or toxic, discharge to an exhaust hood or to any other safe release point.

Withdrawing Liquid Samples

Liquid samples may be withdrawn from the sampling valve attached to the same adapter as the gas inlet valve whenever the vessel is pressurized. Always close the inlet valve before withdrawing a liquid sample and open the sampling valve cautiously because liquid will be discharged with considerable force. Be particularly careful if the temperature of the sample is above its boiling point at atmospheric pressure. If so, it will "flash" and be lost as soon as it is released from the vessel. This problem can be avoided by connecting an optional 4351 Sample Collection Vessel to the sampling valve to collect the liquid into an appropriate receiver. The addition of a small amount of gas can be used to clear the dip tube between liquid samples so that the next sample drawn through the tube will truly be representative of the mixture.

Initial Operating Test

Read all operating instructions carefully so as to be well acquainted with the correct procedures for handling the vessel and for operating the controller and other accessories. An initial operating test should be made, with only water, to check the apparatus before starting the first experimental runs. For this initial test, fill the cylinder not more than half full of water and run the temperature up to 150 ° C while checking the apparatus for leaks and observing the performance of the reactor controller.

MAINTENANCE

General Maintenance Notes

1. Periodically inspect all electrical wiring and pressure connections for excessive corrosion. Suspect parts should be replaced by components only supplied by Company.

2. Always use appropriate wrenches on all fittings and valves. Never use pliers or pipe wrenches.

3. Head and cylinder service fixtures are available for convenience and protection of components during maintenance of your reactor.

4. To reinstall straight thread (NPS) fittings to the head, screw the gage or valves firmly into the adapter. Run the bushing onto the threaded stem as far as it will go. Screw this assembly into the head until the nose of the adapter is seated; then back it off until the valve or gage is facing in the desired direction (no more than one full turn). Hold the fitting firmly in place and close the joint by tightening the bushing. This connection can be made and broken repeatedly without destroying the sealing surfaces. A light coating of thread lubricant, such as High Temperature Anti-Seize Lubricant, applied to the straight threads and to the nose of the adapter will help to obtain a tight joint.

   Note: *PTFE tape should not be used on this joint.*

5. NPT (National Pipe Taper) threads should not be disassembled any more than necessary. It will become increasingly difficult to maintain a tight seal with these tapered threads if the joint is made and broken repeatedly. Grafoil tape or PTFE tape (if temp allows) should be used on all NPT threads.

6. Do not use oil or anti-seize lubricant on threads or fittings if the vessel is to be used with oxygen.

7. If your vessel is equipped with a loose compression ring be sure that it is in place on the head before attaching any head fittings. The compression ring cannot be installed after fittings have been screwed into the head.

8. Clean all threads and gas passages thoroughly and remove all tape fragments when overhauling a vessel. An ultrasonic bath is excellent for cleaning metal parts, but do not place a thermocouple probe, pressure gage, face seals or ball bearings in an ultrasonic bath. Periodic cleaning may be performed on the exterior surfaces of the reactor stand with a lightly dampened cloth containing mild soap solution. All power should be disconnected when cleaning.

9. Routinely inspect cap screws on split ring closure for lubrication and cleanliness. These screws should not be allowed to dry because the threads will seize. Regularly apply High Temperature Anti-Seize Lubricant (No. 424HC2) before this happens.

10. To operate reactors equipped with an air motor, connect air hose to a compressed air line. For best torque and speed control the piping to the motor should be at least 3/8" IPS or larger. Fill the oiler with SAE 10 oil and adjust the oiler feed one drop per minute into the air stream. For long continuous runs at high speeds the oiling rate should be increased to three drops per minute. If the motor becomes sluggish, flush it with a non-flammable solvent in a well ventilated area.

    Disconnect the air line and muffler and pour a small amount of solvent into the inlet port. Rotate the shaft by hand in both directions for a few minutes; then connect the air line and run the motor until there is not further trace of solvent in the exhaust. If the muffler is dirty, replace it. Re-lubricate the motor with a squirt of oil into the chamber and reassemble.

Periodic Pressure Tests

Each cylinder used in a stirred reactor is tested under hydrostatic pressure to the higher of 1.43 times the rated working pressure at room temperature or 1.30 times the rated working pressure corrected for temperature before it is released from the factory. Micrometer caliper measurements are taken during this test to check the deflection of the walls under pressure. Excessive deflection or failure of the metal to resume its original dimensions after pressure is released indicates that a cylinder is potentially unsafe and it will be rejected. Similar tests should be made at regular intervals during the life of each cylinder, and particularly whenever the user suspects that the equipment has been over-stressed or damaged.

Some laboratories maintain hydraulic test facilities and make it a rule that all pressure vessels must be tested at regular intervals. Records are kept of deflections at specific test pressures so that any increase in deflection becomes a warning that the metal has lost strength. Any cylinder that fails to return to its original dimensions after application of the prescribed hydrostatic test should be discarded as unsafe for further use.

Users who do not have pressure test facilities can return any pressure vessel to the factory for hydrostatic testing and overhaul. This should be done whenever the metal shows excessive damage from corrosion or whenever an over-pressure or other unusual occurrence raises any safety questions.

To return a vessel for repair, contact Company for a return authorization number (RMA).

An order or letter of instructions should be mailed to the same address, as no repair work will be started without specific instructions and a Health & Safety Assurance Certification form (FX004) signed by a responsible user.

Technical Support

Company strives to provide our customers with world class support. When contacting for technical support, please provide the complete serial number etched on the side or the bottom of the vessel cylinder. Serial numbers are a long string of letters and numbers. See highlighted text in figure below for an example of a complete serial number.

PARTS LIST

*Note: Special material internal parts (not T316) will have a suffix designating the material:

CH - Alloy C-276 CA - Titanium CB - Alloy Cb-20
CG - Alloy B-2 CX - Zirconium HZ - PTFE coated T316

(I.e.- a 300 mL Alloy C-276 dip tube would be 832HC31CH)

Cylinders*

Model No.	Size	Material	Plain	Jacketed
5101	300 mL	Glass	2525HC	2525HC11
	300 mL	Metal	2630HC	2630HC11
5102	450 mL	Glass	2525HC2	2525HC12
	450 mL	Metal	2630HC2	2630HC12
5103	600 mL	Glass	2525HC3	2525HC13
	600 mL	Metal	2630HC3	2630HC13
5104	160 mL / 215 mL	Glass	2525HC4 (160 mL)	2525HC14 (215 mL)
	160 mL / 215 mL	Metal	2630HC4 (160 mL)	2630HC14 (215 mL)
5111	1000 mL	Glass	2825HC	2825HC11
	1000 mL	Metal	2910HC3	2910HC13
5112	1500 mL	Glass	2825HC2	2825HC12
	1500 mL	Metal	2910HC4	2910HC14

Heads*

Part No.	Description
2635HC3	Head for 160 mL - 600 mL
2635HC4	Head for 160 mL - 600 mL, footless mag drive
2915HC2	Head for 1000 mL - 1500 mL
2915HC3	Head for 1000 mL - 1500 mL, footless mag drive

Internal Fittings*

Thermowell and Thermocouple

Part No.	Description
For 160 mL - 600 mL:	
217VBAD	Replacement nut for thermowell
218VBAD	Replacement ferrule set for thermowell
A1453HC	Thermowell, 1/4" OD, T316, 12" L (cut to length)

Thermowell and Thermocouple (Continued)

Part No.	Description
2943HCHZ	Thermowell, 300 mL, PTFE coated T316, 6.86" length
2943HC2HZ	Thermowell, 450 mL, PTFE coated T316, 8.86" length
2943HC3HZ	Thermowell, 600 mL, PTFE coated T316, 10.86" length
2943HC4HZ	Thermowell, 160 mL, PTFE coated T316, 4.73" length
2943HC5HZ	Thermowell, 215 mL, PTFE coated T316, 5.43" length
A472E	Thermocouple, type-J, 7 ½", grounded
A472E2	Thermocouple, type-J, 9 ½", grounded
A472E3	Thermocouple, type-J, 11 ½", grounded
A472E4	Thermocouple, type-J, 5 ½", grounded
A490E	Dual thermocouple, type-J, 7 ½"
A490E2	Dual thermocouple, type-J, 9 ½"
A490E3	Dual thermocouple, type-J, 11 ½"

Thermowell and Thermocouple (Continued)

Part No.	Description
For 1000 mL - 1500 mL:	
48HC	Gasket for thermowell, Silver
48HCFG	Gasket for thermowell, Gold plated Silver
265HC7	Thermowell, 1000 mL, T316
265HC7HZ	Thermowell, 1000 mL, PTFE coated T316
265HC27	Thermowell, 1500 mL, T316
265HC27HZ	Thermowell, 1500 mL, PTFE coated T316
A472E2	Thermocouple, type-J, 1000 mL, grounded
A472E3	Thermocouple, type-J, 1500 mL, grounded

Male Connectors

Part No.	Description
A92HWAD	Male connector, 1/4T x 1/8"NPT for dip tube and cooling loop
A138CA	Male connector, 1/4T x 1/8"NPT for thermowell

Dip Tubes

Part No.	Description
832HC35	Dip tube, 160 mL, T316, .75" length
832HC35HZ	Dip tube, 160 mL, PTFE coated, T316
832HC36	Dip tube, 215 mL, 1.46" length
832HC36HZ	Dip tube, 215 mL, 1.46" length, PTFE coated, T316
832HC31	Dip tube, 300 mL, T316
832HC31HZ	Dip tube, 300 mL, PTFE coated, T316
832HC32	Dip tube, 450 mL, T316
832HC32HZ	Dip tube, 450 mL, PTFE coated, T316
832HC33	Dip tube, 600 mL, T316
832HC33HZ	Dip tube, 600 mL, PTFE coated, T316
686HC19	Dip tube, 1000 mL, T316
686HC19HZ	Dip tube, 1000 mL, PTFE coated, T316
686HC20	Dip tube, 1500 mL, T316
686HC20HZ	Dip tube, 1500 mL, PTFE coated, T316

Cooling Loop

Part No.	Description
831HC6	Cooling loop, 300 mL, T316
831HC6HZ	Cooling loop, 300 mL, PTFE coated T316
831HC7	Cooling loop, 450 mL, T316
831HC7HZ	Cooling loop, 450 mL, PTFE coated T316
831HC8	Cooling loop, 600 mL, T316
831HC8HZ	Cooling loop, 600 mL, PTFE coated T316
2930HC3	Cooling loop, 1000 mL, T316
2930HC3HZ	Cooling loop, 1000 mL, PTFE coated T316
2930HC4	Cooling loop, 1500 mL, T316
2930HC4HZ	Cooling loop, 1500 mL, PTFE coated T316

Gaskets and Seals

Part No.	Description
For 160 mL - 1500 mL:	
48HC	Gasket for mag drive, Silver
48HCFG	Gasket for mag drive, Gold plated Silver
48HCKL	Gasket for mag drive, Graphite
2142HC	Gasket, Silver for footless mag drive
2142HC2KL	Gasket, Graphite for footless mag drive
For 160 mL - 600 mL:	
2632HCJV	Head seal O-ring, FKM
2632HCJK	Head seal O-ring, FFKM
2632HCJE	Head seal O-ring, EP
2632HCJB	Head seal O-ring, NBR
For 1000 mL - 1500 mL:	
2913HCJV	Head seal O-ring, FKM
2913HCJK	Head seal O-ring, FFKM
2913HCJE	Head seal O-ring, EP

Stirrer Shaft and Impellers

Part No.	Description
For 160 mL - 600 mL:	
A837HC	Propeller, turbine, T316
A837HC5HZ	Propeller, turbine, PTFE coated T316
822HC33	Stirrer shaft, 160 mL, T316, 4.99" length
822HC33HZ	Stirrer shaft, 160 mL, PTFE coated T316, 4.99" length
822HC44	Stirrer shaft, 215 mL, T316, 5.69" length
822HC44HZ	Stirrer shaft, 215 mL, PTFE coated T316, 5.69" length
822HC30	Stirrer shaft, 300 mL, T316, 6.92" length
822HC30HZ	Stirrer shaft, 300 mL, PTFE coated T316, 6.92" length
822HC31	Stirrer shaft, 450 mL, T316, 8.92" length
822HC31HZ	Stirrer shaft, 450 mL, PTFE coated T316, 8.92" length
822HC32	Stirrer shaft, 600 mL, T316, 10.92" length
822HC32HZ	Stirrer shaft, 600 mL, PTFE coated T316, 10.92" length
2070HC	Gas Entrainment impeller, 300 mL - 600 mL, T316
2070HCHZ	Gas Entrainment impeller, 300 mL - 600 mL, PTFE coated
2070HC2	Gas Entrainment impeller, 160 mL, T316
2070HC2HZ	Gas Entrainment impeller, 160 mL, PTFE coated T316
2027HC3	Gas Entrainment upper shaft, T316
2028HC5	Gas Entrainment shaft, 300 mL, T316
2028HC5HZ	Gas Entrainment shaft, 300 mL, PTFE coated T316
2028HC6	Gas Entrainment shaft, 450 mL, T316
2028HC6HZ	Gas Entrainment shaft, 450 mL, PTFE coated T316
2028HC7	Gas Entrainment shaft, 600 mL, T316
2028HC7HZ	Gas Entrainment shaft, 600 mL, PTFE coated T316
2028HC8	Gas Entrainment shaft, 160 mL, T316

Stirrer Shaft and Impellers (Continued)

Part No.	Description
For 1000 mL - 1500 mL:	
352HC9	Upper shaft, 1000 mL - 1500 mL, T316
A358HC5	Propeller, turbine, 1000 mL - 1500 mL, T316
A358HC8	Propeller, turbine, 1000 mL - 1500 mL, PTFE coated T316
A2044HC	Gas Entrainment shaft/impeller, 1000 mL, T316
A2044HCHZ	Gas Entrainment shaft/impeller, 1000 mL, PTFE coated T316
A2044HC3	Gas Entrainment shaft/impeller, 1500 mL, T316
A2044HC3HZ	Gas Entrainment shaft/impeller, 1500 mL, PTFE coated T316
A449HC	Lower shaft with coupling, 1000 mL, T316
A449HCHZ	Lower shaft with coupling, 1000 mL, PTFE coated T316
A449HC22	Lower shaft with coupling, 1500 mL, T316
A449HC22HZ	Lower shaft with coupling, 1500 mL, PTFE coated T316

Stirrer Support Bracket

Part No.	Description
For 450 mL - 600 mL:	
A1260HC2	Stirrer bracket, for cooling loop, T316
A1260HC5HZ	Stirrer bracket, PTFE coated T316
A1872HC	Stirrer bracket, for 265HC style thermowell
1261HC	Bushing for stirrer bracket, PTFE
For 1000 mL - 1500 mL:	
A1404HC2	Stirrer bracket, for thermowell, T316
A1404HC3HZ	Stirrer bracket, PTFE coated T316
299HC	Bushing for stirrer bracket, PTFE

External Fittings

Part No.	Description
366VBD	Hex Coupling, 1/4 NPTF
288VBAD	Male Connector, 3/8" T-1/4" NPTM
A92HWAD	Male Connector 1/8 NPTMx1/4T (T316SS for top of cooling loop)
79HW*	Plug, Hex Head 1/8" NPTM
835HC	Adapter, two 1/8" NPT(F) side ports
A122VB	Needle Valve T316 1/8 NPTM
A146VB	Angle Valve T316 1/8 NPTM-M
420HC	Adapter, T303 A Skt × 1/8 NPTF
208HC10	Adapter, T316 2-1/8 NPTF Valve
260HC2	Valve extension

Rupture Disc Assembly

See manual 231M for a full list of safety rupture discs.

Part No.	Description
A888HC2	Rupture disc assembly
49HC2	Orifice cone
527HC	Orifice ring
433HC4	Safety head outlet

Magnetic Drive Parts

See manual 234M for a full list of Magnetic Drives.

Part No.	Description
Parts For A1120HC9 Drive	
264AC4	Pin spanner wrench
264AC5	Face spanner wrench
1132HC	Thrust washer, pk of 2
1133HC	Bushings, pk of 3
1137HCHA	PTFE O-ring
48HC	Silver gasket
1138HC	Upper snap ring
1138HC2	Lower snap ring
1139HC	Ball bearings, pk of 2
2714HC	Nipples for cooling sleeve
827HC	Cooling sleeve O-rings
1144HC	Wave spring

Split Rings

Part No.	Description
For 160 mL - 600 mL:	
A2526HC	Split ring, glass and glass jacketed cylinder
A2735HC	Split ring, metal cylinder
2524HC	Spacer, Ultem, for A2526HC split ring
2524HCHA	Spacer, PTFE, for A2526HC split ring
For 1000 mL - 1500 mL:	
A2916HC	Split ring, glass cylinder
A2912HC2	Split ring, metal cylinder
2914HC	Spacer, Ultem, for A2916HC split ring
2914HCHA	Spacer, PTFE, for A2916HC split ring

Gage Assembly

Part No.	Description
836HC	Gage adapter, 1/4" NPT(F) top x 1/8" NPT(F) side port
836HC6	Gage adapter, 1/4" NPT(F) top x 1/8" NPT(F) + two 1/4" NPT(F) side ports
836HC7	Gage adapter, 1/4" NPT(F) top, one 1/8" + 1/4" NPT(F) side ports (std)
208HC15	Gage adapter, angled 2 1/4" NPTF
209HC4	Adapter bushing, 1/2" NPS T303
A122VB	Needle Valve T316 1/8 NPTM
414VBAD	Elbow, 1/4" NPT(M) x 1/4" NPT(F)

Pressure Gages

Part No.	Description
2633HCP10AD	Gage, 3-1/2", 1000 psi, back MT
2633HCP20AD	Gage, 3-1/2", 2000 psi, back MT
2633HCP30AD	Gage, 3-1/2", 3000 psi, back MT
2633HCP50AD	Gage, 3-1/2", 5000 psi, back MT
2633HCP75AD	Gage, 3-1/2", 7500 psi, back MT
2633HCP3YB	Gage, 30"/300 psi back MT
2633HCP1AD	Gage, 3-1/2", 100 psi, back MTG
2633HCP2AD	Gage, 3-1/2", 200 psi, back MTG
2633HCP6AD	Gage, 3-1/2", 600 psi, back MTG

Accessories

Part No.	Description
424HC2	High temperature thread lubricant, 1oz tube
A495HC	Gas inlet hose assembly, 6-ft, 2500 psi, Nylon
JP0025TB06	Neoprene tubing, 1/4"OD, for cooling water
TX31SK	5/16 socket screw key
2925HC	Lab Jack (for 1000 mL - 1500 mL glass cylinders)
A2995HC	Hose assembly for circulator consists of the following parts:
A2650HC	Hose Assembly
221VBAD	Nut
222VBAD	Ferrule
277VBAD	Union fitting
275VBAD	Male connector, 3/8T x 3/8 NPTM
2648HC2	Cap for hose end
2649HC	Tube adapter

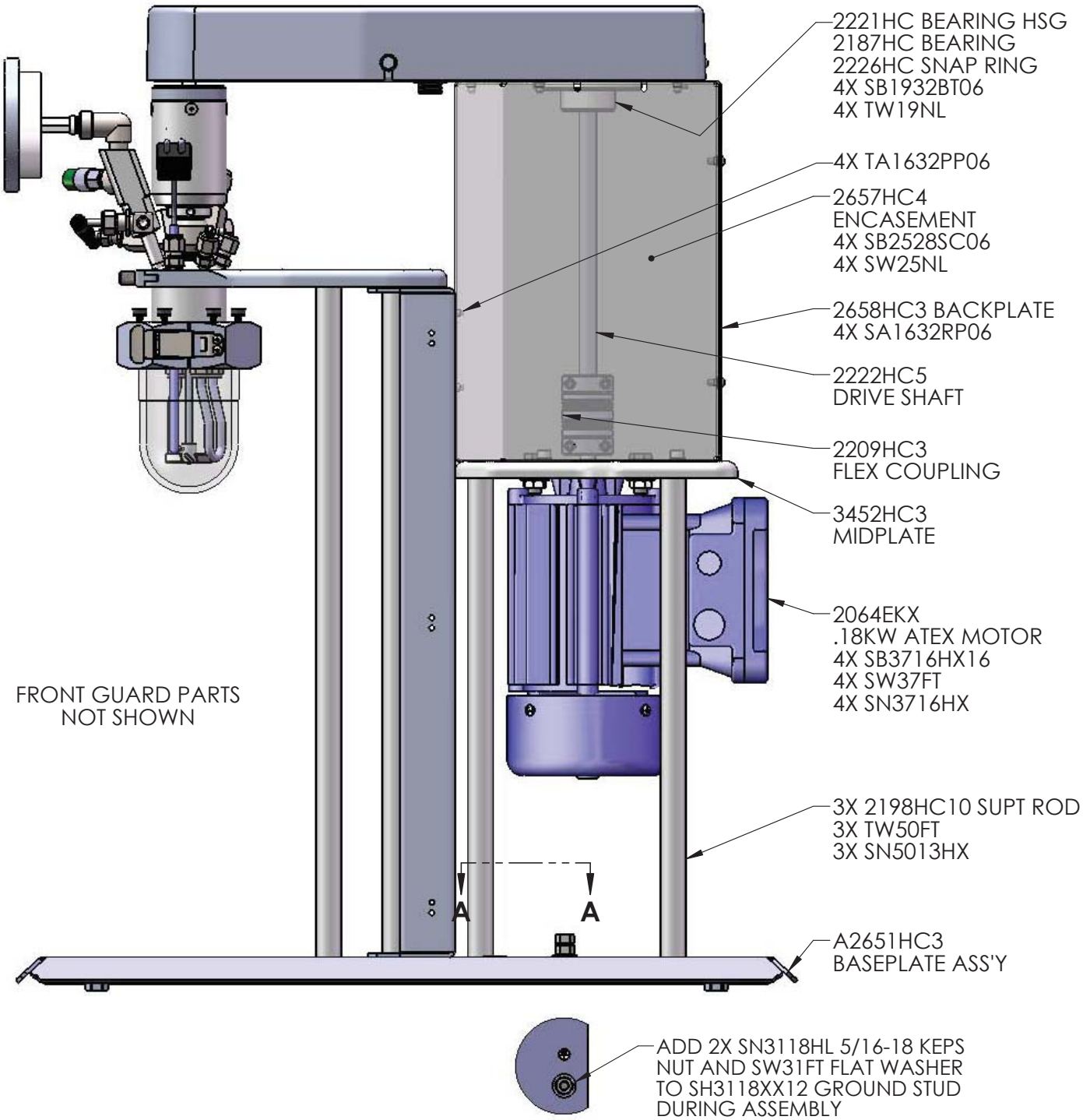
Heaters

Part No.	Description
For 160 mL - 600 mL:	
A2230HCEB	Electric heater, 300 mL metal or glass cylinder, 115V
A2230HCEE	Electric heater, 300 mL metal or glass cylinder, 230V
A2230HC2EB	Electric heater, 450 mL metal or glass cylinder, 115V
A2230HC2EE	Electric heater, 450 mL metal or glass cylinder, 230V
A2230HC3EB	Electric heater, 600 mL metal or glass cylinder, 115V
A2230HC3EE	Electric heater, 600 mL metal or glass cylinder, 230V
A2230HC4EB	Electric heater, 160 mL metal cylinder, 115V
A2230HC4EE	Electric heater, 160 mL metal cylinder, 230V
A2230HC16EB	Electric heater, 160 mL glass cylinder, 115V
A2230HC16EE	Electric heater, 160 mL glass cylinder, 230V
For 1000 mL - 1500 mL:	
A2945HCEB	Electric heater, 1000 mL metal cylinder, 115V
A2945HCEE	Electric heater, 1000 mL metal cylinder, 230V
A2945HC2EB	Electric heater, 1500 mL metal cylinder, 115V
A2945HC2EE	Electric heater, 1500 mL metal cylinder, 230V
A2944HCEB	Electric heater, 1000 mL glass cylinder, 115V
A2944HCEE	Electric heater, 1000 mL glass cylinder, 230V
A2944HC2EB	Electric heater, 1500 mL glass cylinder, 115V
A2944HC2EE	Electric heater, 1500 mL glass cylinder, 230V

PRODUCT FEATURES & PART IDENTIFICATION

5100 Stand

Mini Stand (160 mL - 600 mL)

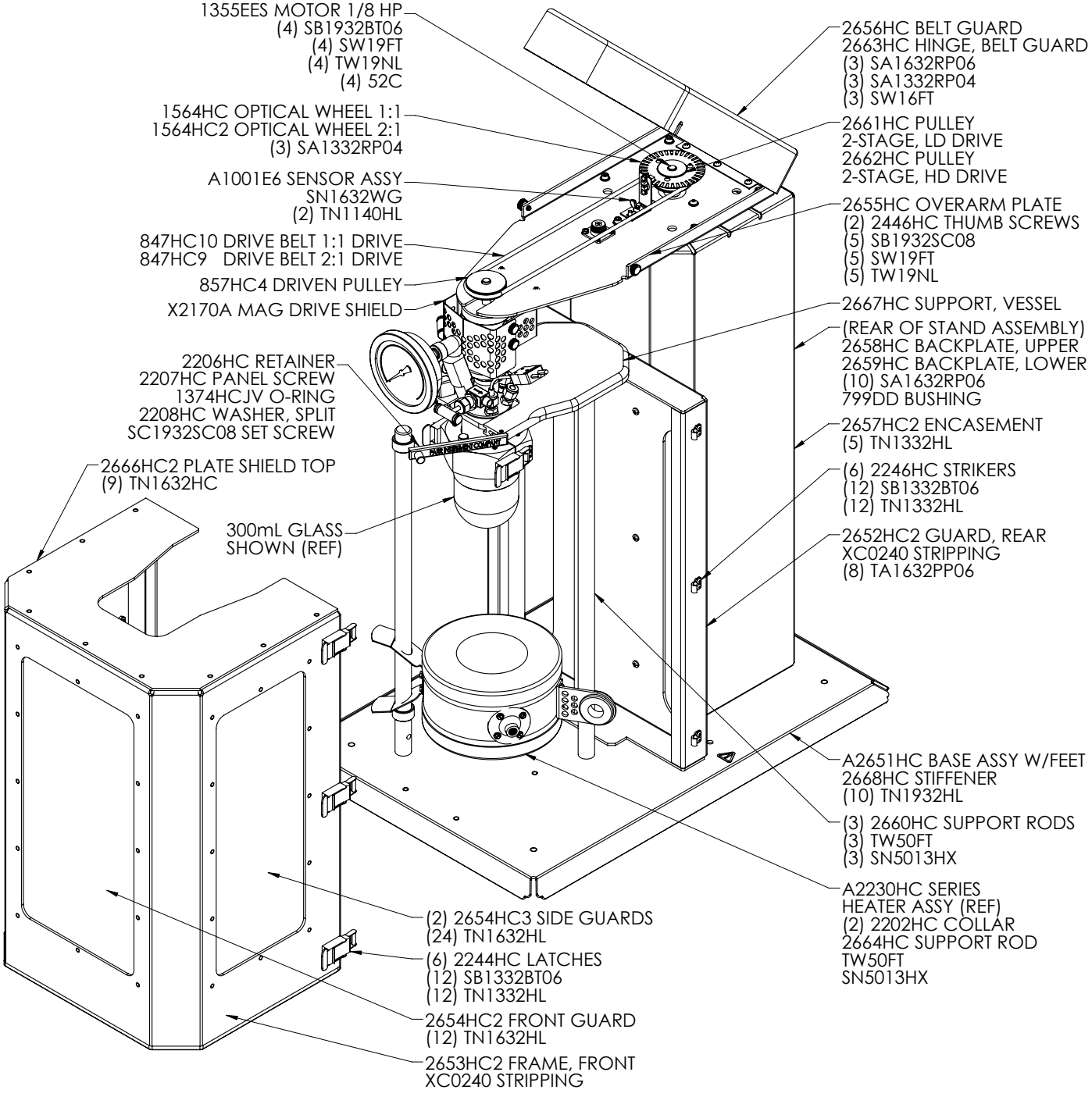


SECTION A-A

NOTE: LITER STANDS (LARGER) CAN BE CONVERTED TO ACCEPT MINI VESSEL ASSEMBLIES. MINI STANDS ARE FOR MINI VESSEL ASSEMBLIES ONLY.

Stand for 5100

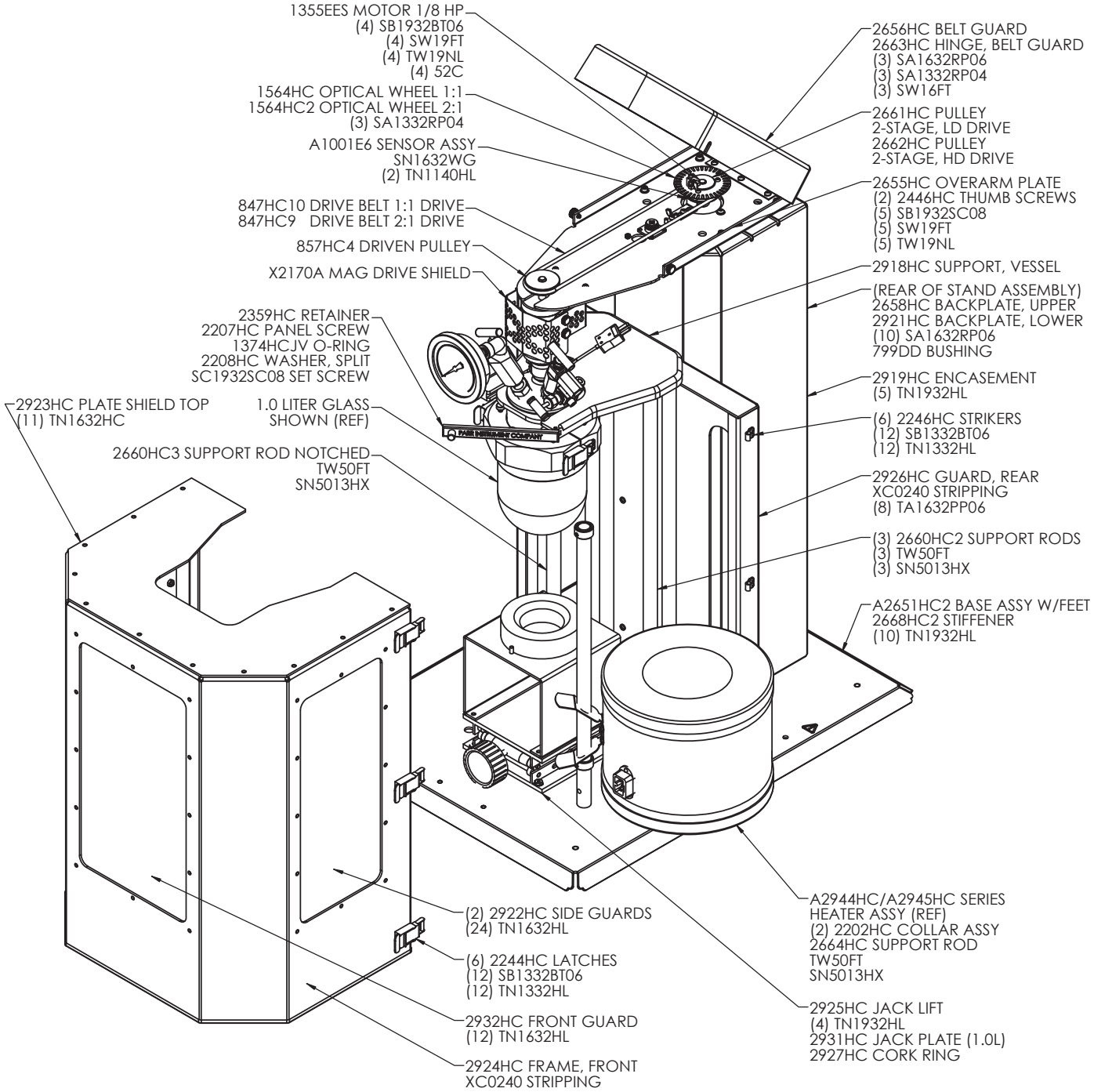
160 - 600 mL Vessels



5100 OVERALL DIMENSIONS OF APPARATUS: 16.50" WIDE X 23.50" DEEP X 29.57" TALL

Stand for 5110

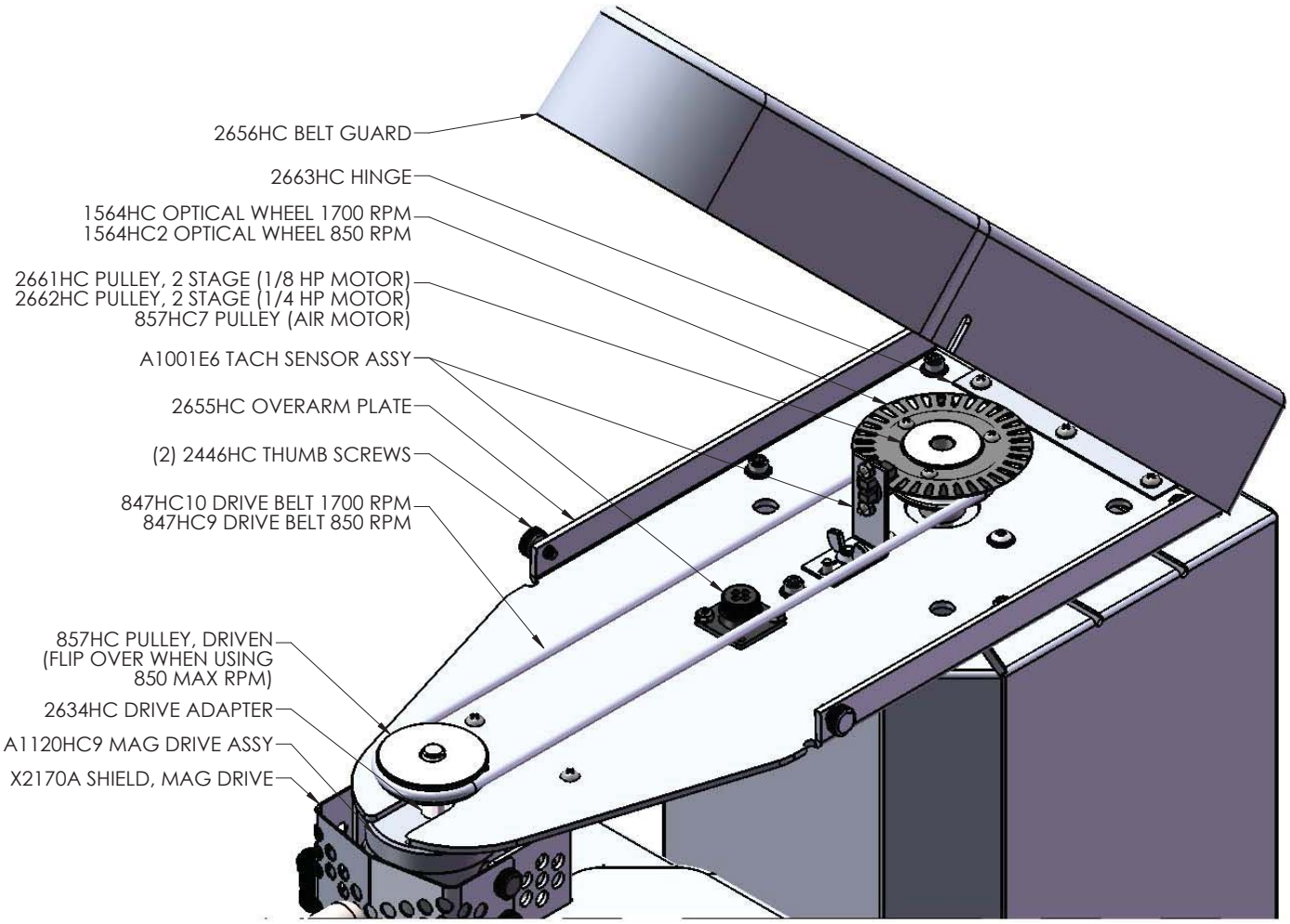
1 L and 1.5 L Vessels



5110 OVERALL DIMENSIONS OF APPARATUS: 20.38" WIDE X 26.00" DEEP X 32.57" TALL

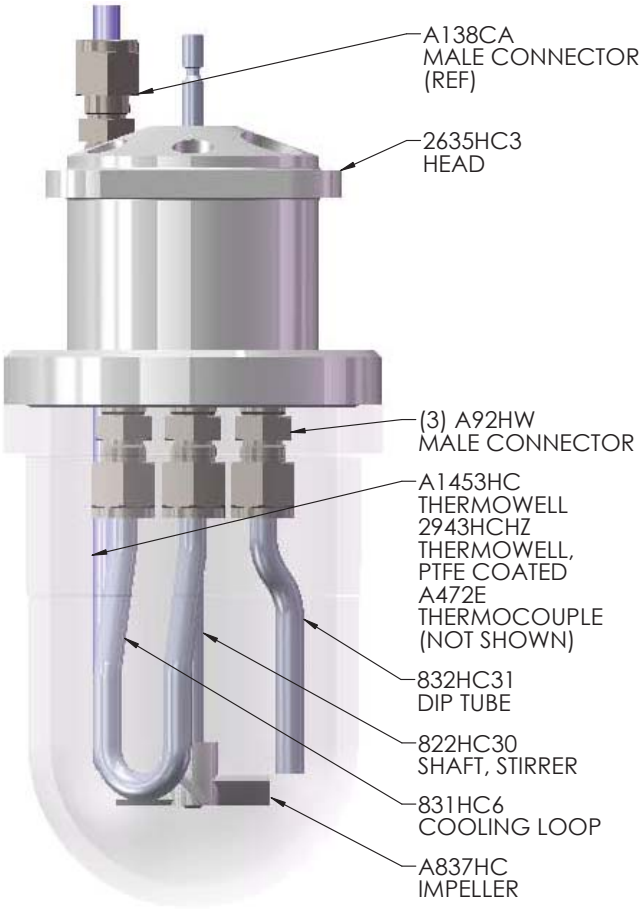
5100 Overarm

Overarm Components, Common For All 5100 Series Reactors

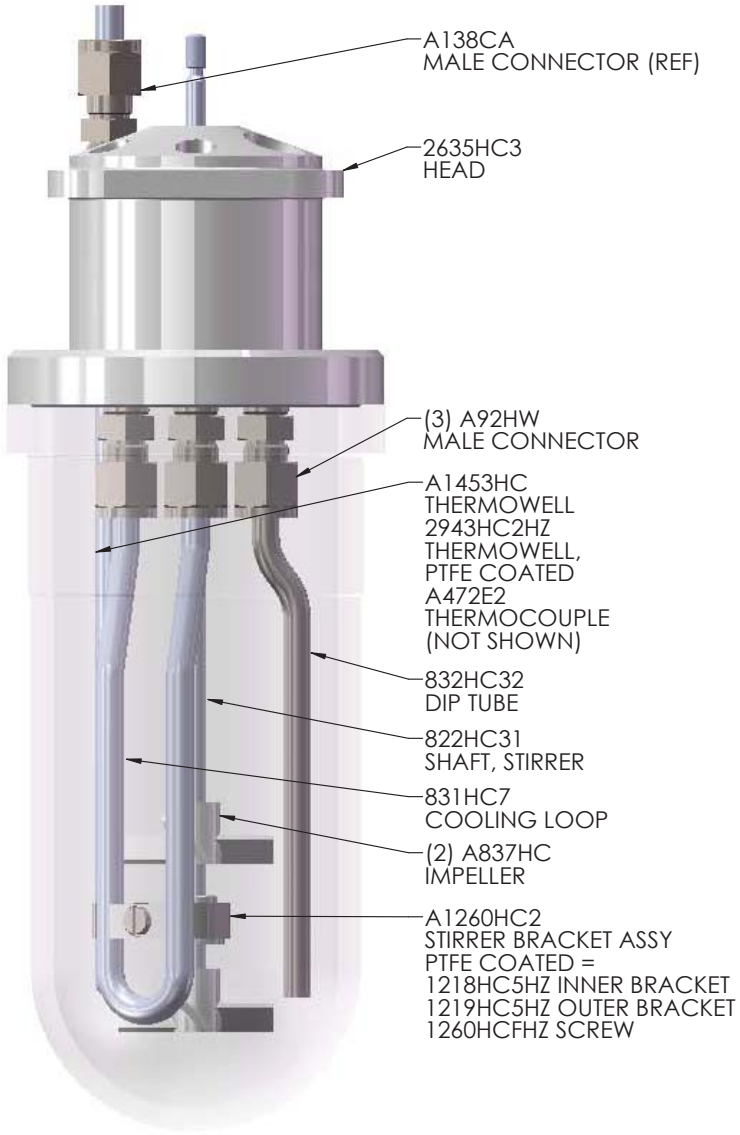


5100 Internals

300 mL - 450 mL Glass Vessels



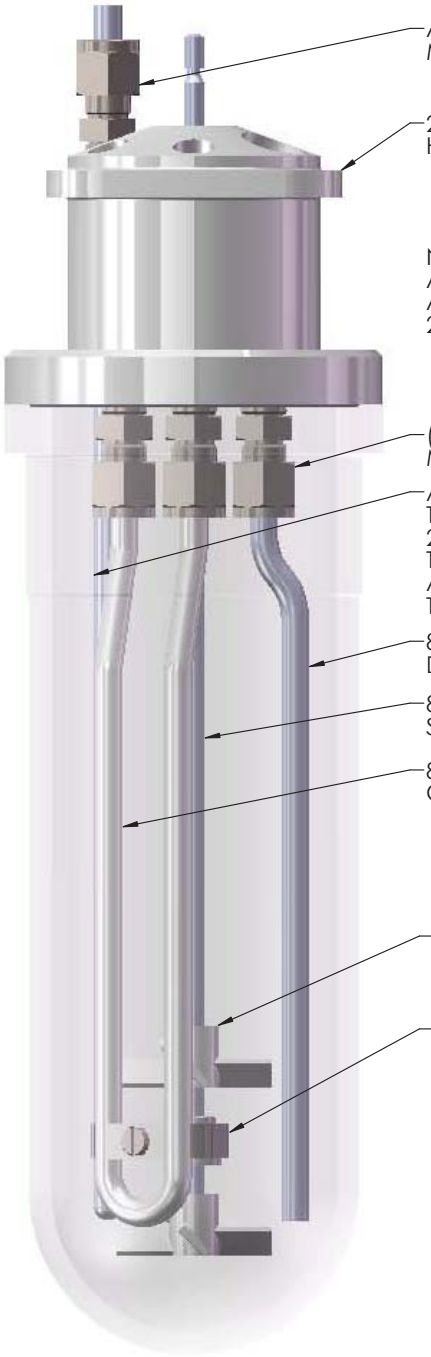
5101 300mL



5102 450mL

5100 Internals (continued)

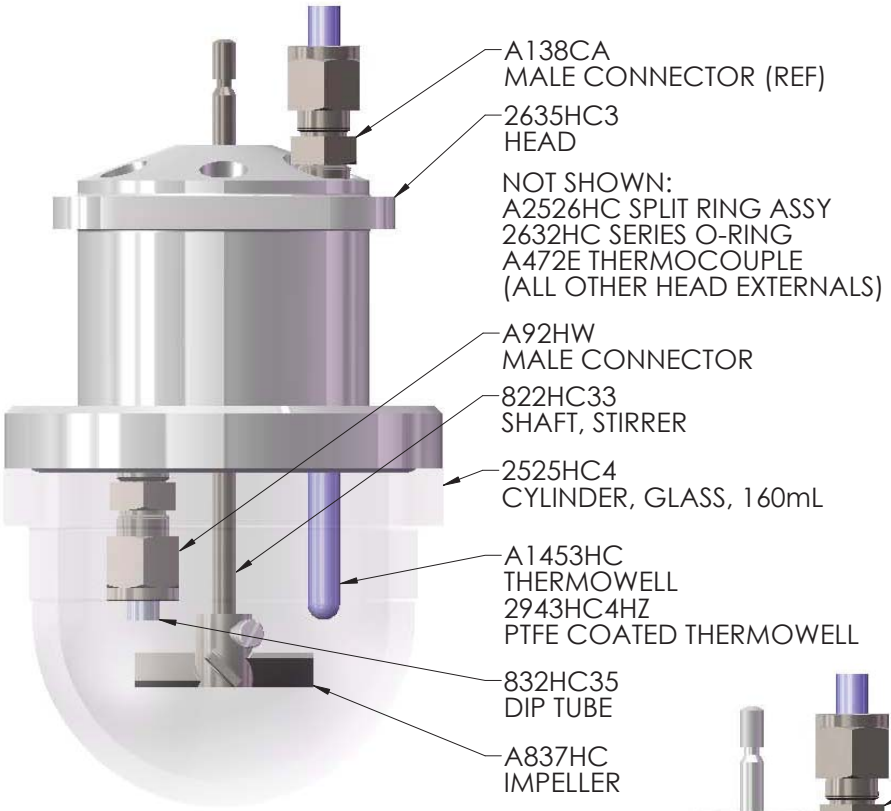
600 mL Glass Vessels



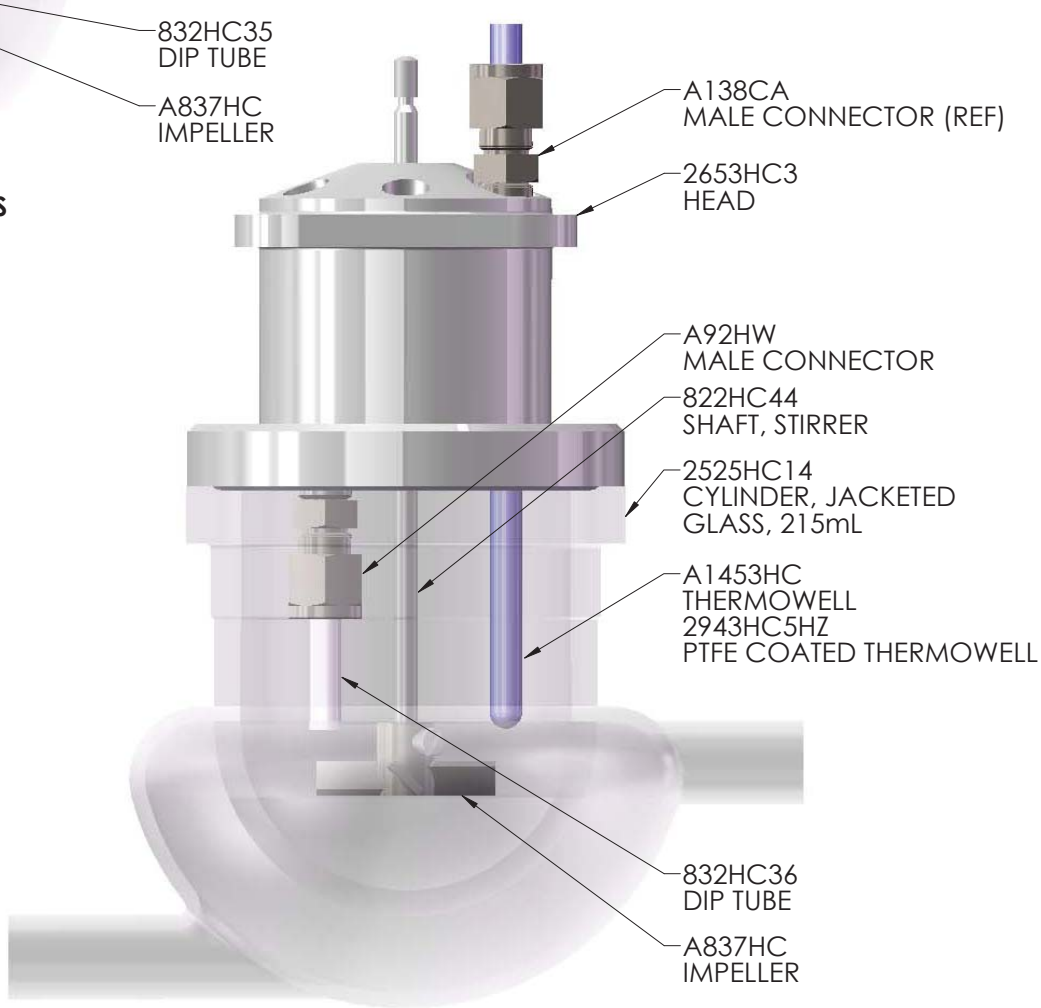
5103 600mL

5100 Internals (continued)

160 mL - 215 mL Glass Vessels



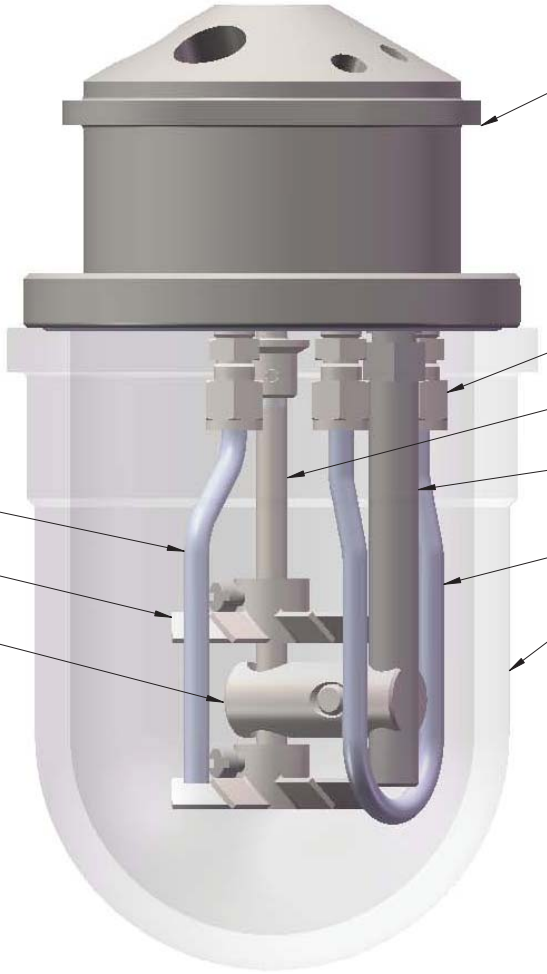
5104 160mL GLASS



5104 215mL GLASS JACKETED

5111 & 5112 Internals

1 L & 1.5 L Glass Vessels



2915HC SERIES HEAD

NOT SHOWN:
A2916HC SPLIT RING ASSY (FOR GLASS)
A2912HC SPLIT RING ASSY (FOR METAL)
2913HC SERIES O-RING
A472E2 THERMOCOUPLE (1.0L)
A472E3 THERMOCOUPLE (1.5L)

(3) A92HW
MALE CONNECTOR

A449HC STIRRER SHAFT ASSY (1.0L)
A449HC22 STIRRER SHAFT ASSY (1.5L)

265HC7 THERMOWELL (1.0L)
265HC27 THERMOWELL (1.5L)
48HC SERIES GASKET

686HC19 DIP TUBE (1.0L)
686HC20 DIP TUBE (1.5L)

2930HC3 COOLING LOOP (1.0L)
2930HC4 COOLING LOOP (1.5L)

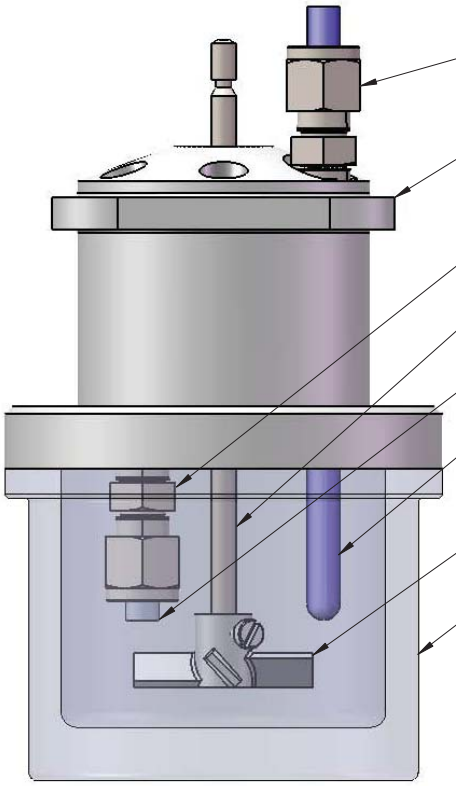
(2) A358HC5 PROPELLER ASSY

2825HC SERIES
GLASS CYLINDER (SHOWN)
2910HC SERIES
METAL CYLINDER (REF)

A1404HC2 STIRRER BRACKET ASSY
A1404HC3HZ = PTFE COATED

5100 Metal Vessels Internals

160 mL - 215 mL Vessels



A138CA
MALE CONNECTOR (REF)

2635HC3
HEAD

A92HW
MALE CONNECTOR

822HC33
SHAFT, STIRRER

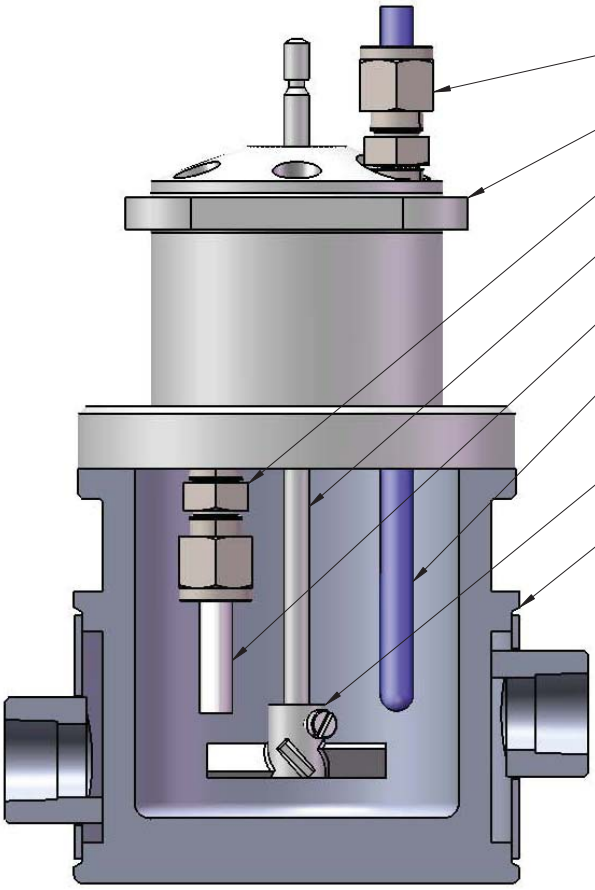
832HC35
DIP TUBE

A1453HC
THERMOWELL
2943HC4HZ = PTFE COATED

A837HC
IMPELLER

2630HC4
METAL CYLINDER 160mL

NOT SHOWN:
A2735HC SPLIT RING ASSY
2632HC SERIES O-RING
A472E THERMOCOUPLE



A138CA
MALE CONNECTOR (REF)

2635HC3
HEAD

A92HW
MALE CONNECTOR

822HC44
SHAFT, STIRRER

832HC36
DIP TUBE

A1453HC
THERMOWELL
2943HC5HZ = PTFE COATED

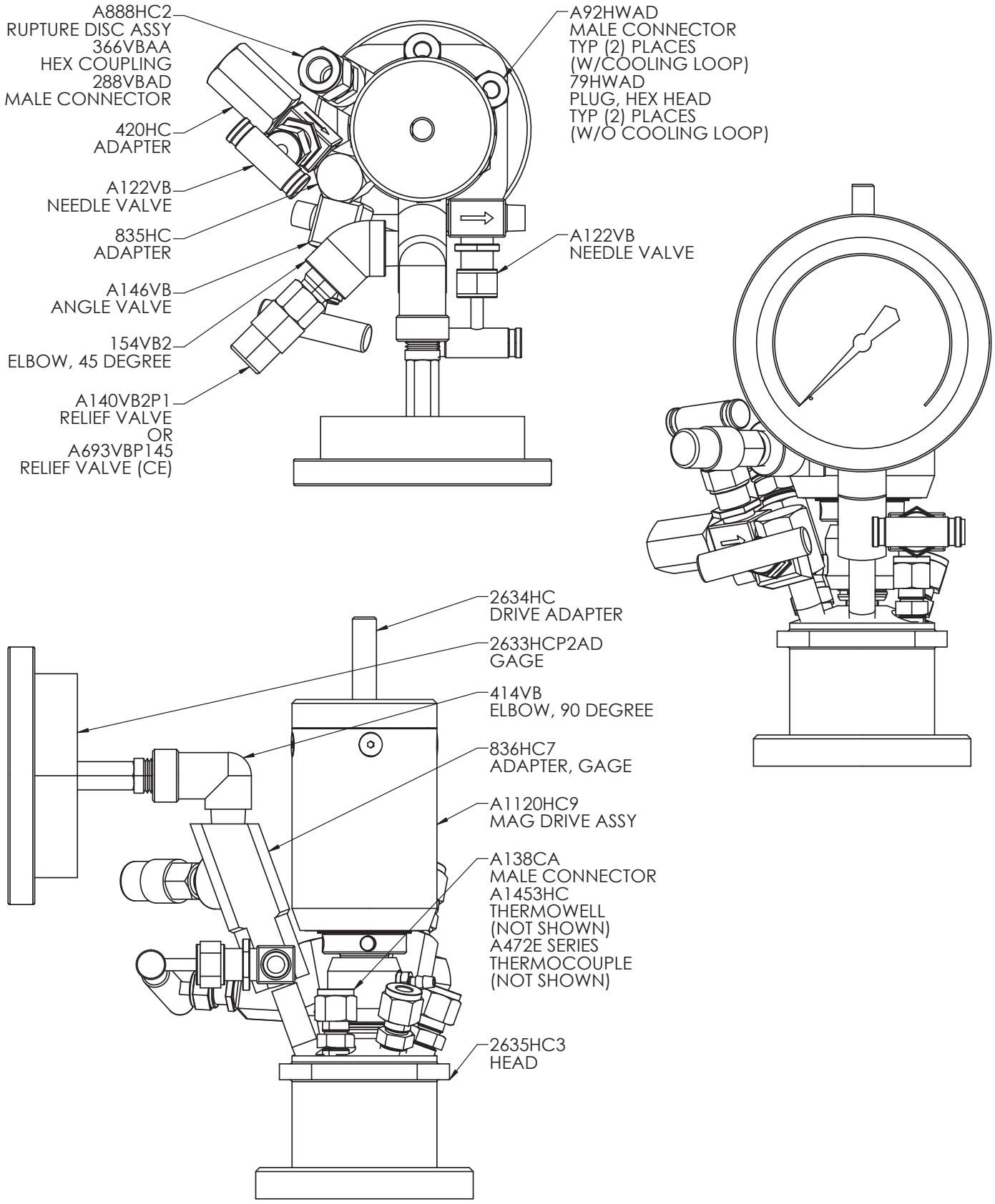
A837HC
IMPELLER

2630HC14
METAL JACKETED
CYLINDER, 215mL

NOT SHOWN:
A2735HC SPLIT RING ASSY
2632HC SERIES O-RING
A472E THERMOCOUPLE

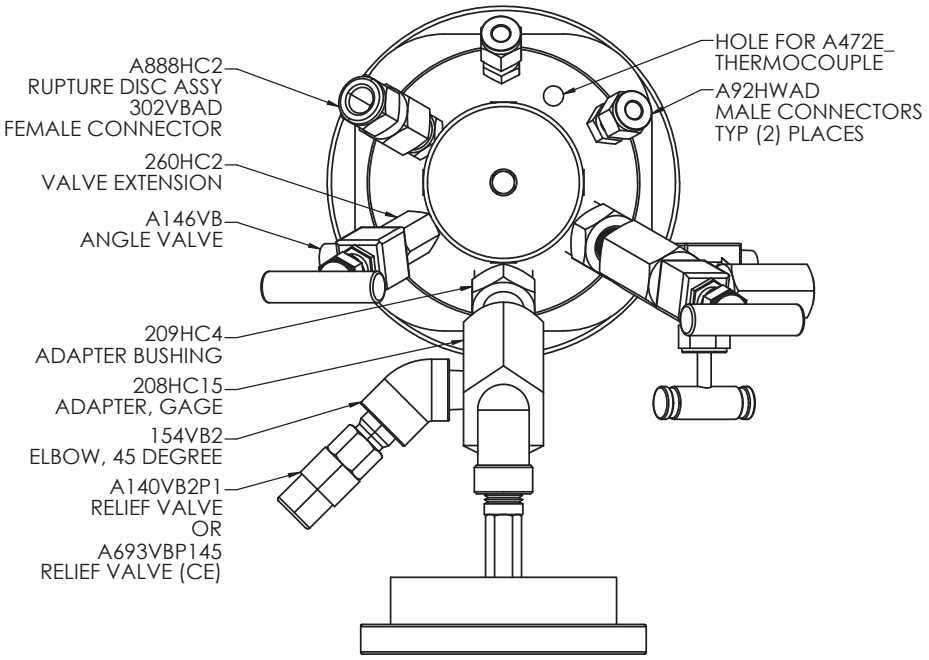
5100 Head Assembly

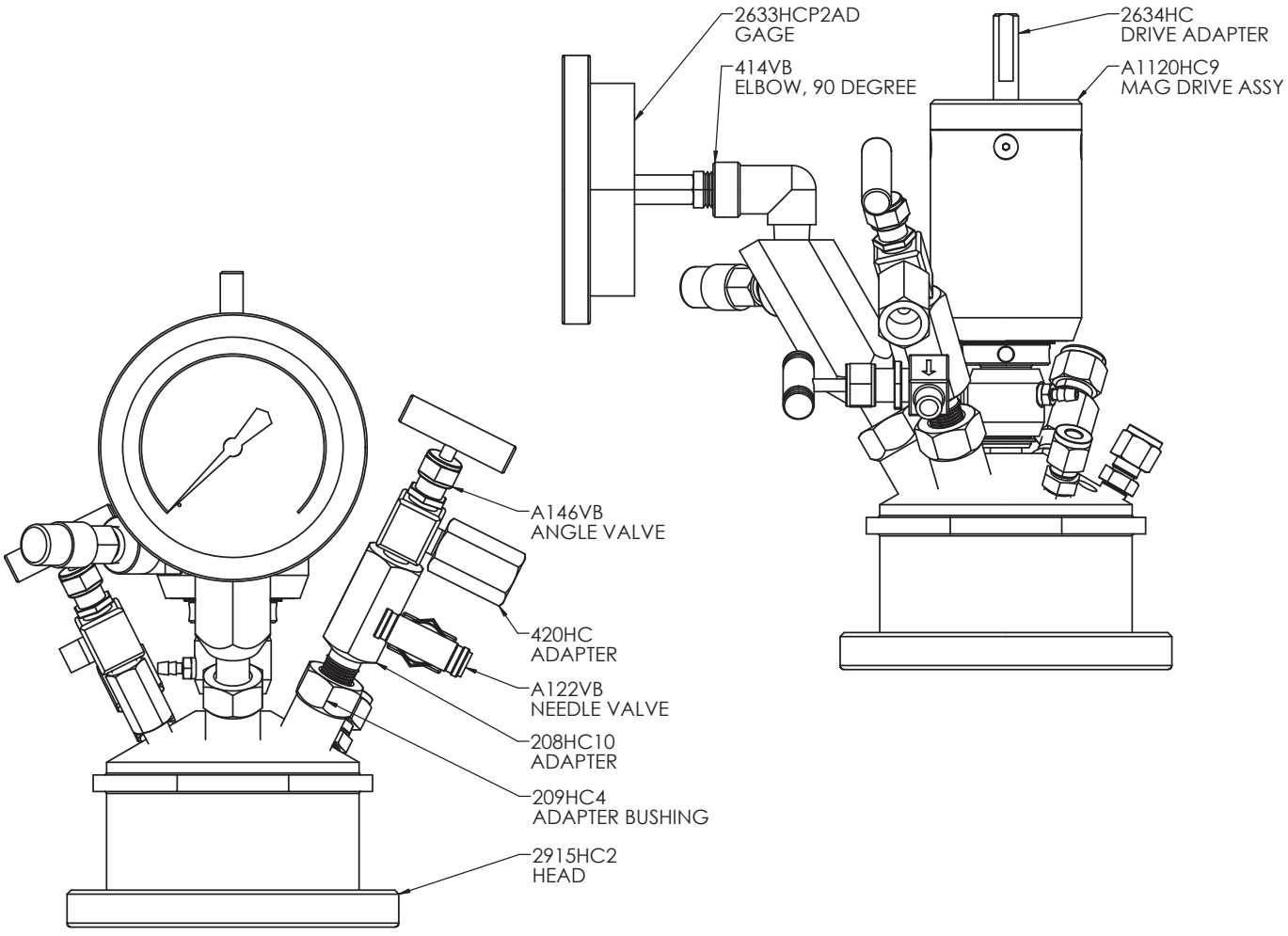
Head Assembly for 160 mL - 600 mL Vessels



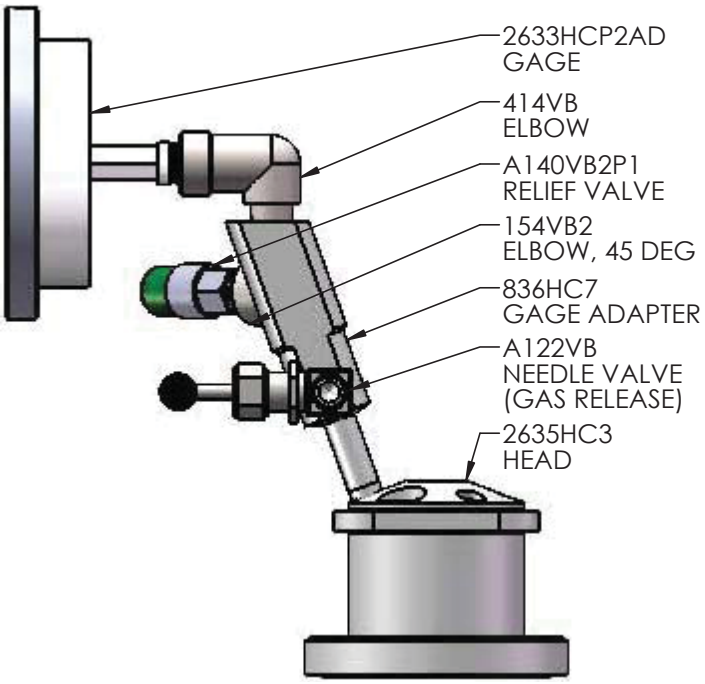
5110 Head Assembly

Head Assembly for 1 L & 1.5 Vessels

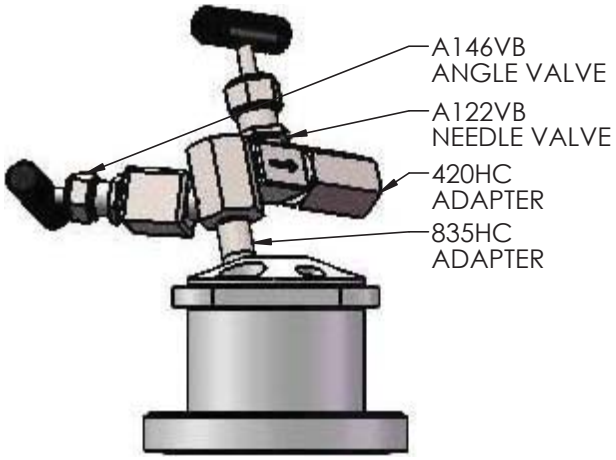




5100 Head Fittings and Valves

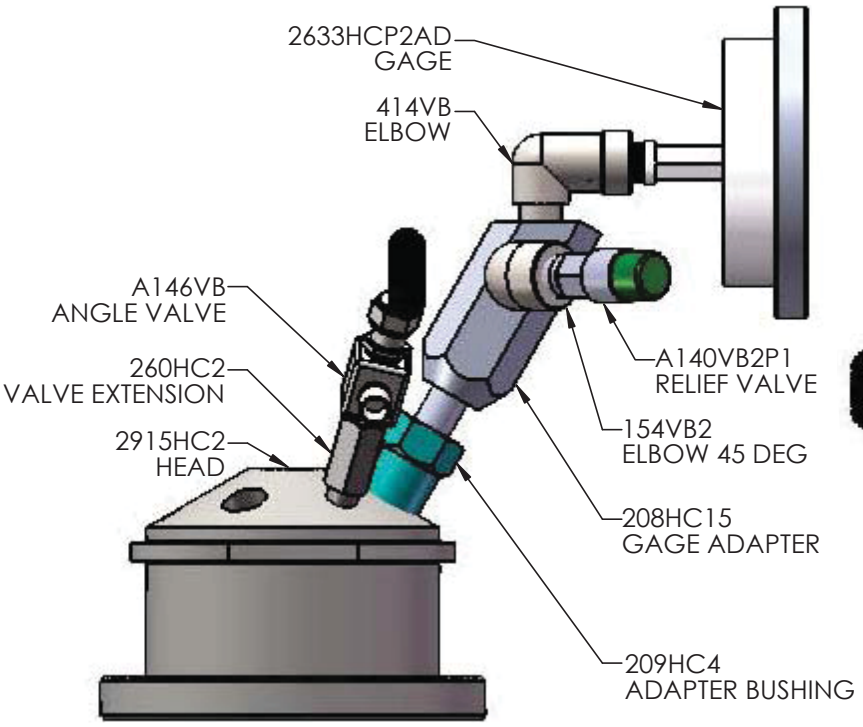


5100 GAGE ASSEMBLY / GAS RELIEF VALVE

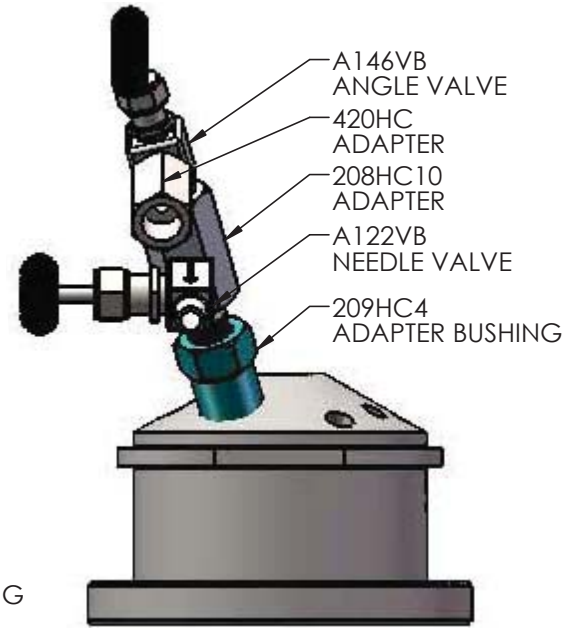


5100 GAS INLET / LIQUID SAMPLING VALVE

5110 Head Fittings and Valves



5110 GAGE ASSEMBLY / GAS RELIEF VALVE



5110 GAS INLET / LIQUID SAMPLING VALVES