4560

Mini Bench Top Reactors

Operating Instruction Manual



PREFACE 3

Scope 3
Related Instructions 3
Intended Usage 3
Safety Information 3
General Specifications 3
Explanation of Symbols 4
Environmental Conditions 4
Unpack Carefully 4
Provisions for Lifting and Carrying 4
Cleaning & Maintenance 4
User's Responsibility 5

FIXED HEAD OR REMOVABLE HEAD DESIGN 6

Fixed Head or Removable Head Vessel Design 6
Flat PTFE Gasket or Self Sealing O-ring Closure 6

INSTALLATION 7

Pressure and Temperature Limits 7
Assemble the Reactor 8

IDENTIFY THE VALVES 9

Gas Inlet Valve 9
Gas Release Valve 9
Liquid Sampling Valve 9

OTHER VESSEL HEAD FITTINGS 9

Safety Rupture Disc 9
Type J Thermocouple 10
Pressure Gage 10
Liners 10
Spare Parts Kit 10
Air Motor 10

HEATERS 11

Heater Precautions 11
Band Heater 11
Heating Mantle 11
Aluminum Block Heater 11
Optional Heater Accessories 11

HOW TO USE THE VESSEL 12

Removable Vessels 12
Fixed Head Vessels 12

MAINTENANCE 14

General Maintenance Notes 14
Periodic Pressure Tests 15
Technical Support 15

4560 SERIES REACTION VESSEL PARTS LIST 16

Standard Vessel Fittings 16
High Temperature Vessel Fittings 21
Overarm Parts List 24

STAND AND MOTOR DRAWINGS 25

Reactor Support Stand with Fixed Head and 1/8 hp Stirrer Drive Motor 25
Reactor Support Stand with Moveable Vessel and 1/4 hp Stirrer Drive Motor 26
Air Motor Option 27

PREFACE

Scope

These instructions describe the installation, operation and maintenance of Series 4560 Mini Bench Top Reactors offered in sizes from 100 mL to 600 mL. They cover the basic steps to be followed when installing these reactors and describe the function of all standard components. They are intended to be used in conjunction with several related instructions. This information describes several components that 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 included to further your understanding of this instrument and its component parts:

No.	Description
201M	*Limited Warranty*
230M	*Safety Precautions to be observed when operating Pressure Reaction Equipment*
231M	*Operating Instructions for Safety Rupture Discs*
234M	*Operating and Maintenance Instructions for Magnetic Drives*
323M	*Operating Instructions for Pressure Relief Valves*
548M	*Operating Instructions for 4848 Reactor Controllers*
FX004	*Health & Safety Assurance Certification*

Intended Usage

This system has been designed for use as a high 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 this equipment is used in a manner beyond its intended usage, 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.

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.



Caution!
Do not use in hazardous atmospheres.

Operating: 15 °C to 40 °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.

Storage: -25 °C to 65 °C; 10% to 85% relative humidity.

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. The vessel, motor, heater, and reactor controller may be packed separately for convenience in shipping, but these parts are easily reassembled. 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

Before moving ensure all cables are disconnected. Use proper and safe lifting techniques when installing or moving the 4560 Reactor 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.

User's 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 a 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, reactors 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.

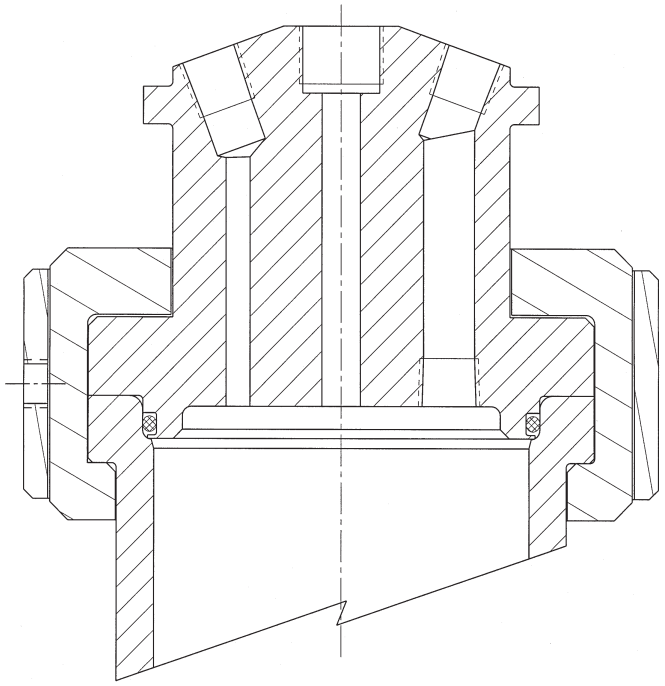
   All standard pressure vessels are provided with either suitable relief device or a means to attach one (typically in the form of a plugged opening). When a pressure vessel is delivered without a pressure venting device, it is the customer's responsibility to provide pressure relief in order to protect 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.

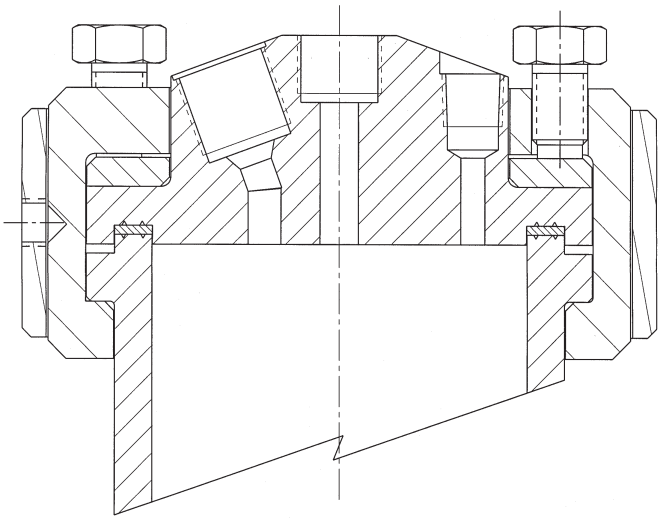
4. **Maintain the equipment** in good condition and establish procedures for periodic testing to be sure the vessel remains structurally sound.

FIXED HEAD OR REMOVABLE HEAD DESIGN

Series 4560 Mini Reactors are furnished with two structural options in addition to the size, pressure range, stirrer motor, controller and similar options. These are:



Fixed Head with O-ring



Moveable Head with Flat Gasket

Fixed Head or Removable Head Vessel Design

In the fixed head design, the head of the vessel may remain fixed in the reactor support stand. All attachments to the head, gas and liquid feed and discharge lines, cooling water, vapor take-off and condenser, thermocouple, and any electrical leads can remain permanently in place. The reactor is opened by removing the cover clamp sections and lowering the cylinder away from the head.

In the removable vessel design, the entire vessel must be removed from the support stand for charging, product recovery, and cleaning.

There is no difference in the pressure or temperature limits or basic operating instructions based upon the fixed head or movable vessel options. There are differences in the design of the stand components which adapt the vessels to the support system.

Flat PTFE Gasket or Self Sealing O-ring Closure

The flat gasket is held in a recess in the vessel head and a machine pilot on the cylinder closes the recess to completely contain the gasket. The split ring closure used with this gasket has six cap screws which must be tightened to develop the loading on the gasket.

The self sealing design features an O-ring retained in a groove on the vessel head. This design is self sealing and the split ring used with this sealing system does not require nor have the cap screws used with the flat gasket.

Maximum temperatures of a given system are dependant upon the material of construction and type of seal. Other accessories may limit operating temperature. The flat PTFE gasket can be used to operating temperatures as high as 350 °C. The flat flexible graphite gasket can be used to operating temperatures as high as 500 °C. The maximum temperature of the vessels equipped with O-ring seals depends upon the material used for the O-ring. The most common material is a fluoroelastomer (FKM) which has a 225 °C maximum operating temperature limit.

INSTALLATION

Pressure and Temperature Limits

The working pressure and temperature at which any reactor or pressure vessel can be used will depend upon the design of the vessel and the materials used in its construction. Since all materials lose strength at elevated temperatures, any pressure rating must be stated in terms of the temperature at which it applies. The standard material of construction for Company is Type 316 Stainless Steel.

Limits for vessels made of other materials and for other operating temperatures can be obtained from Customer Service. No attempt should be made to increase these limits by making alterations or by substituting components that 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 vessels will be determined by the physical characteristics of the vessel material and will be prescribed on an individual basis.

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. 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. An accompanied restricted operating limit tag and/or supplemental manual is given when a component of the system limits the operation below the imprinted valves.

Working temperatures up to 225 °C are permissible in Mini Reactors equipped with fluoroelastomer (FKM) O-ring seals. The higher the operating temperature above 200 °C, the shorter the life of the O-ring will be. Perfluoroelastomer (FFKM) O-ring seals have a broad chemical resistance and can be used to temperatures up to 300 °C. 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 such as ethers, ammonia and amines which will rapidly destroy fluoroelastomer O-rings.

Pressure Vessel and Temperature Limits

In the standard pressure and temperature setup, the system must not exceed the following:

Vessel Material	Maximum Pressure	Maximum Temperature
T316SS	3000 psig (207 bar) [200 bar for CE orders]	350 °C PTFE Flat Gasket
T316SS	3000 psig (207 bar) [200 bar for CE orders]	225 °C FKM O-Ring
T316SS	3000 psig (207 bar) [200 bar for CE orders]	300 °C FFKM O-Ring

In the high pressure/high temperature setup, the system must not exceed the following:

Vessel Material	Maximum Pressure	Maximum Temperature
T316SS (HT)	2000 psig (138 bar)	500 °C Flexible Graphite Flat Gasket

Assemble the Reactor

These reactors require at least 10 sq. ft. of workspace in a well-ventilated area with convenient access to an electric outlet, running water, air and a drain.

1. Set the stand in the workspace.

   Bolt the stand to the bench top using the holes in the base plate.

2. 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 the support plate adapter. 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. There is a bracket at the back of the area where the split ring rests. The thumb screw on the drop band which encircles the split ring closure should fit into the slot on this bracket. This will keep the vessel from rotating when stirring viscous reactions. It may be necessary to reposition the drop band if the gage does not face forward when the thumb screw is in the slot.

3. Set the Reactor 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:

The Motor output connector is to be used only with Company motor assemblies supplied with the appropriate motor power cord.

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 and extension wire to both the thermocouple and to the controller in the "Primary Temp Input" position on the rear panel. Insert the thermocouple in the 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 the magnetic drive. See Instruction Manual No. 234M.

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

10. Note the voltage and amperage requirement stamped on the controller data plate, and then plug the power cord into an appropriate outlet. Power for these reactors should be drawn from a grounded outlet capable of carrying up to the full current rating of the reactor.

11. If an electric stirrer motor is supplied, turn the speed control knob fully counterclockwise on the Reactor Controller, turn on the motor switch and slightly increase the speed for a short run to check the stirrer drive system but do not turn on the heater, put heater toggle switch in center position (OFF). There must always be a vessel in the heater when it is turned on, and the vessel and heater sizes must match. If the heater is operated without proper size vessel in contact with the heater, the heater may overheat and fail.

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 cylinder. With this arrangement, incoming gas is always introduced below the surface of the liquid. This valve includes a coupling with an "A" socket connection for attachment of the pressure hose.

Gas Release Valve

The gas release valve is typically connected to a side opening on the gage adapter. Gas released from this valve will be drawn from the top of the reactor.

Liquid Sampling Valve

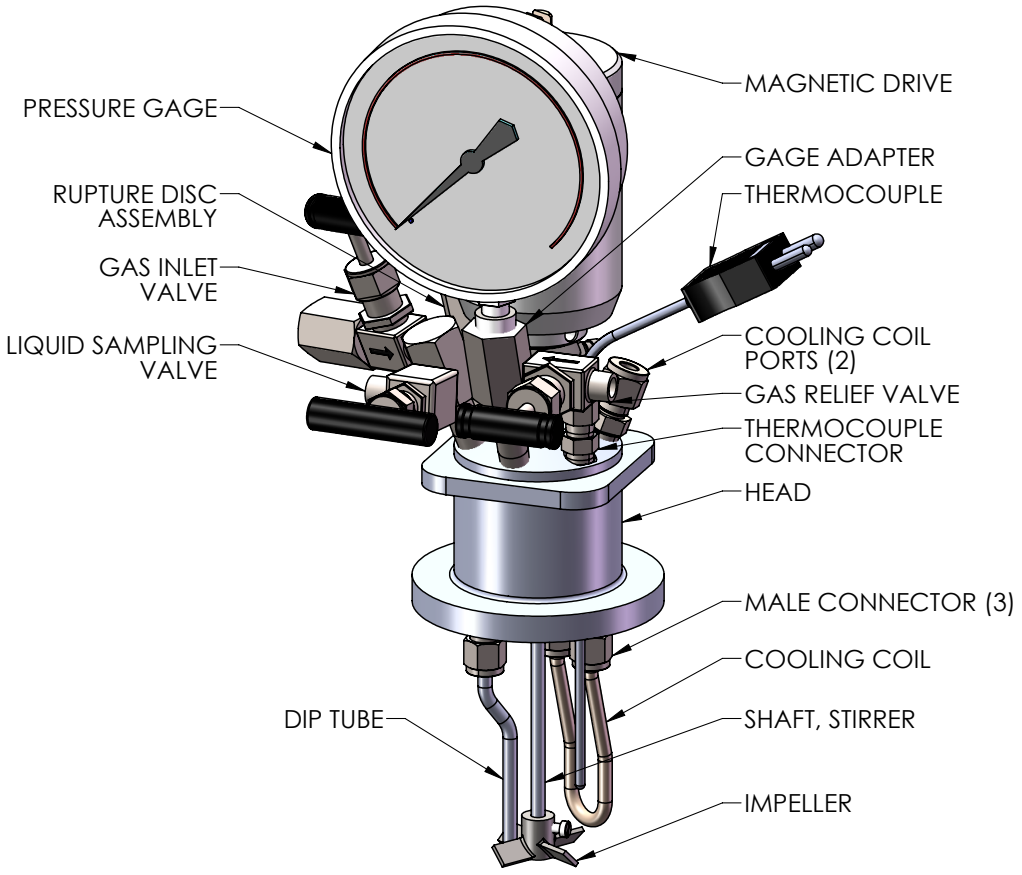
The liquid sampling valve is attached to the same fitting as the gas inlet valve and connected to the same dip tube. This provides the operator with a means for clearing the dip tube to be sure that any sample taken during a run will be representative of the charge. This can be done by opening the upper 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.

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 Operating Instruction 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.

A typical pre-bulged disc can be used to 90% of the rating on the tag. For additional protection, the user should install an adequate and safe venting system for removing any toxic, flammable or volatile materials which would be released if the rupture disc should burst. A connector for attaching 3/8" OD tubing to the discharge port of the rupture disc is provided for this purpose.



Fixed Head Shown (Standard Temperature)

Type J Thermocouple

A Type J Thermocouple in a 1/8" diameter stainless steel sheath is installed in each reactor. In reactors made of alloys other than stainless steel, the stainless thermocouple is installed in a thermowell made of the same alloy as the vessel. Connect the thermocouple to the socket on the rear panel of the reactor controller using the A470E2 extension wire furnished with the reactor.

Pressure Gage

The pressure gage furnished with this reactor has a T316 stainless steel Bourdon tube. Gages are furnished in a variety of ranges to meet individual needs. Typically, the gage and the rupture disc are furnished as matched ranges. For applications where a gage is selected with a range under 1000 psi, a relief valve is added and set to protect the gage. A 1000 psi rupture disc is installed as the fail-safe vessel protection.

For highly corrosive applications where the vapor phase might corrode the stainless Bourdon tube, offers isolator assemblies in a variety of materials. These isolators with their internal piston isolate the vapors from the gage.Accessories

Liners

Glass or PTFE liners can be furnished to fit most reactors. These liners slide into the cylinder. Although they will not keep corrosive vapors from reaching the surfaces of the cylinder and head, they make it much easier to add and remove liquid reactants, and they give some protection to the cylinder when working with corrosive solutions. It must be noted, however, that adding a PTFE liner will slow the heat transfer rate into the vessel, and it may be necessary to adjust the temperature control method to prevent overheating.

Liner Part Numbers

Fits ID	Cylinder Size	Glass Liner	PTFE Liner
2.06"	100 mL	762HC7	762HC7HA
2.5"	160 mL	762HC8	762HC8HA
2.5"	300 mL	762HC	762HC4HA
2.5"	450 mL	762HC2	762HC5HA
2.5"	600 mL	762HC3	762HC6HA

Spare Parts Kit

Spare parts kits are available for these reactors. The kits will provide a reserve supply of parts and tools sufficient to handle most normal replacements and emergency repairs during a year of heavy usage.

The kits contain small perishable items required for continuous operation including gaskets, bushings, rupture discs and seals. 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. It is most advantageous to provide the complete vessel number from the head or cylinder.

Air Motor

Variable speeds from 100 to 2000 rpm with no spark hazard can be obtained by replacing the standard motor with an A1393HC air motor assembly. This motor operates on compressed air which must be supplied at 40 psig minimum pressure with at least 10 CFM 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 assembly firmly on the stand and connect the air hose to a compressed air line. For best torque and speed control the piping to the motor should be at least 1/4" IPS or larger. 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.

Re-lubricate 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 the directions given in the instruction sheet published by the Gast Manufacturing Corporation, Benton Harbor, Michigan.

(See Page 27 for drawing and parts callout)

HEATERS

Heater Precautions

Caution!
Improper usage of heaters may result in premature heater failure. Failure from improper usage is not covered by the Limited Warranty.

1. **Heater Size.** Each heater must always be used with a vessel of the size for which it was designed, and it must always be fully attached to the vessel before heat is turned on.
2. **Hygroscopic Insulating materials.** Insulating materials used in high temperature heating elements are very hygroscopic. Though thoroughly tested, it cannot be assumed that all electrical safety requirements are met in the first thirty minutes of heating.
3. **Avoid spillage.** Liquids can penetrate or absorb into the heater's insulating material potentially damaging or greatly decreasing the life of the heater.
4. **Slow Heating.** In some applications it is prudent to heat the reactor slowly to avoid issues primarily related to thermal lag. Heaters are typically made of materials with very low thermal mass. When heated at high power, with 100% output, the heating elements can temporarily operate above their maximum design temperature greatly reducing the life of the heating element(s). The rate of heating can be controlled by starting on low power or by running a Ramp program.

Band Heater

The 100 and 160 mL models are offered with a high watt density band heater, which is to be clamped directly onto the cylinder. After the vessel has been placed in its holder, slide the heater onto the cylinder and tighten the clamping screw that projects from the aluminum housing.

Caution!
Band heaters must be securely clamped to the reactor before use to avoid damage to the heater.

Heating Mantle

The 300, 450 and 600 mL Mini Reactors are standard equipped with heating mantles housed in sturdy aluminum shells. Standard Mini Reactor systems utilize a glass fiber heater and high temperature Mini Reactor systems utilize a higher wattage ceramic fiber heater. These mantles are specifically sized to provide uniform heat distribution to the walls and bottoms of these vessels. They are attached to the support rod with a clamp, arranged so that they can be raised or lowered on the rod as desired.

Caution!
For glass fiber and molded ceramic heaters, discontinue use if there is any damage to the heater that results in exposure of the heating element.

Aluminum Block Heater

Alternately the 300, 450 and 600 mL Reactor systems can be heated with an aluminum block heater which features integrated cooling.

Optional Heater Accessories

Heaters are offered with optional thermowell port to accommodate the A511E bayonet style thermocouple, an open bottom to accommodate a cylinder bottom drain valve, and/or the quick connect mounting style for conveniently changing heater size.

HOW TO USE THE VESSEL

Removable Vessels

Always remove removable vessels from the support stand before attempting to open or close them.

To open the Vessel

Open the gas release valve to discharge any internal pressure. For the bolted closure, loosen the six cap screws in the split ring sections. Loosen the cone pointed screw in the outer band and lower the band to rest on the table. The ring sections can now be removed, and the head with all attached fittings is free to be lifted from the cylinder. Handle the head carefully so as not to damage the stirring shaft and other internals when they are outside of the cylinder.

Before Closing the Vessel

Examine the head gasket or o-ring carefully to be sure that it is in good condition. After considerable use, some of the PTFE gasket may extrude into a thin, ragged edge around the inside and outside diameters. This does not necessarily mean that the gasket must be replaced, but the extruded portion should be removed with a sharp knife. Examine the mating surfaces on the cylinder and head to be sure they are clean and free from burrs; then set the head on the cylinder.

Sealing Vessels with PTFE Gaskets

Initially tighten the cap screws to 15 ft-lbs then increase to 20-25 ft-lbs. Tightening should proceed in a criss-cross pattern rather than progressively around the circle. Let the vessel stand for about five minutes after the initial tightening; then tighten the cap screws again. This will compensate for any tendency of the PTFE gasket to flow under the loading pressure.

Sealing with Flexible Graphite Gaskets

Initially tighten the cap screws to 15 ft-lbs then increase to 20-25 ft-lbs. Tightening should proceed in a criss-cross pattern rather than progressively around the circle.

Flexible graphite gaskets tend to be somewhat flakey. To extend the useful life of these gaskets, first rough up the sealing surface of the cylinder with 120 grit sand paper to ensure the gasket remains in the head groove and does not stick to the cylinder. Secondly, coat both sealing surfaces with a silicone lubricant. This process will aid in compressing the gasket so it does not break apart after one use.

Recommended Bolt Torque		
PTFE or Flexible Graphite	0-3000 psig (0-207 bar)	20-25 ft-lbs

O-ring Closures

The split rings used with an o-ring seal do not include any compression bolts.

With the easy close split ring, the o-ring is attached to the pilot on the underside of the head. When closing the vessel, set the head on the cylinder and press down on the head until the bottom of the head meets with the cylinder flange. Then install the two split ring halves and attach the outer drop band.

Fixed Head Vessels

Fixed head vessels are opened and closed with the same procedure used for removable vessels except that they are opened and closed with the head in place. Before opening the vessel lower the heater and swing it well to the side so that it will not be damaged by any materials that drip from the vessel as it is opened. When closing the vessel always hold the cylinder until both split ring sections are in place to lock the cylinder to the head.

> ***Note:*** *The following steps are common to both head configurations.*

Gas Connections

For a gas connection to the vessel, use the A495HC pressure hose furnished with the reactor. Attach the hose to a pressure regulator or flow control valve on a commercial gas cylinder using PTFE tape or other thread sealant on the 1/8" NPT male nipple and on the 1/4" NPT bushing, if used. Then 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 or tape on the coned fitting. The A495HC pressure hose is made of reinforced Nylon which can be used for all non-corrosive gases at pressures up to 2500 psig. For operations involving corrosive gases, this hose should be replaced with an A490HC hose (optional) which has a PTFE lining and a braided stainless steel outer covering. These hoses have the same fittings as in the A495HC.

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.

Internal Cooling Loop
Each Mini Reactor (except the 100 and 160 mL sizes) has a single loop cooling coil installed in the vessel with compression fittings on the head for connecting 1/4" copper or plastic tubing to the loop. (Special 1/8" OD spiral coils can be furnished for 100 mL & 160 mL if required. Due to internal space limitations these coils are attached with male connectors on the top side of the head thereby making the coil captive.) 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, and connected to the cooling socket on the rear panel of the Reactor controller. With this arrangement, cold water will be admitted to the cooling loop whenever the controller calls for cooling.

If internal cooling is not desired, the cooling loop can be removed and the opening in the head can be closed with No. 79HW, 1/8" NPT plugs. Optionally, other 1/8" NPT threaded fittings can also be installed in the coil openings.

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. A light coating of thread lubricant, such as High Temperature Anti-Seize Lubricant (424HC2), applied to the straight threads and to the nose of coned adapter will help to obtain a tight joint. PTFE tape should be used only on all tapered (NPT) threads not NPS straight threads.

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.

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 a mild soap solution. All electrical power should be disconnected when cleaning.

9. Routinely inspect cap screws on split ring closure for lubrication and cleanliness. It is important to clean and lubricate periodically so that the required torque is achieved when tightening the bolts.

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 1/4" IPS or larger. Fill the oiler with SAE 10 oil and adjust the oiler feed to 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 is dirty, replace it. Re-lubricate the motor with a squirt of oil into the chamber and reassemble.

11. If servicing assistance is needed, contact Company directly at the address shown on the back of these instructions.

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 Company 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.

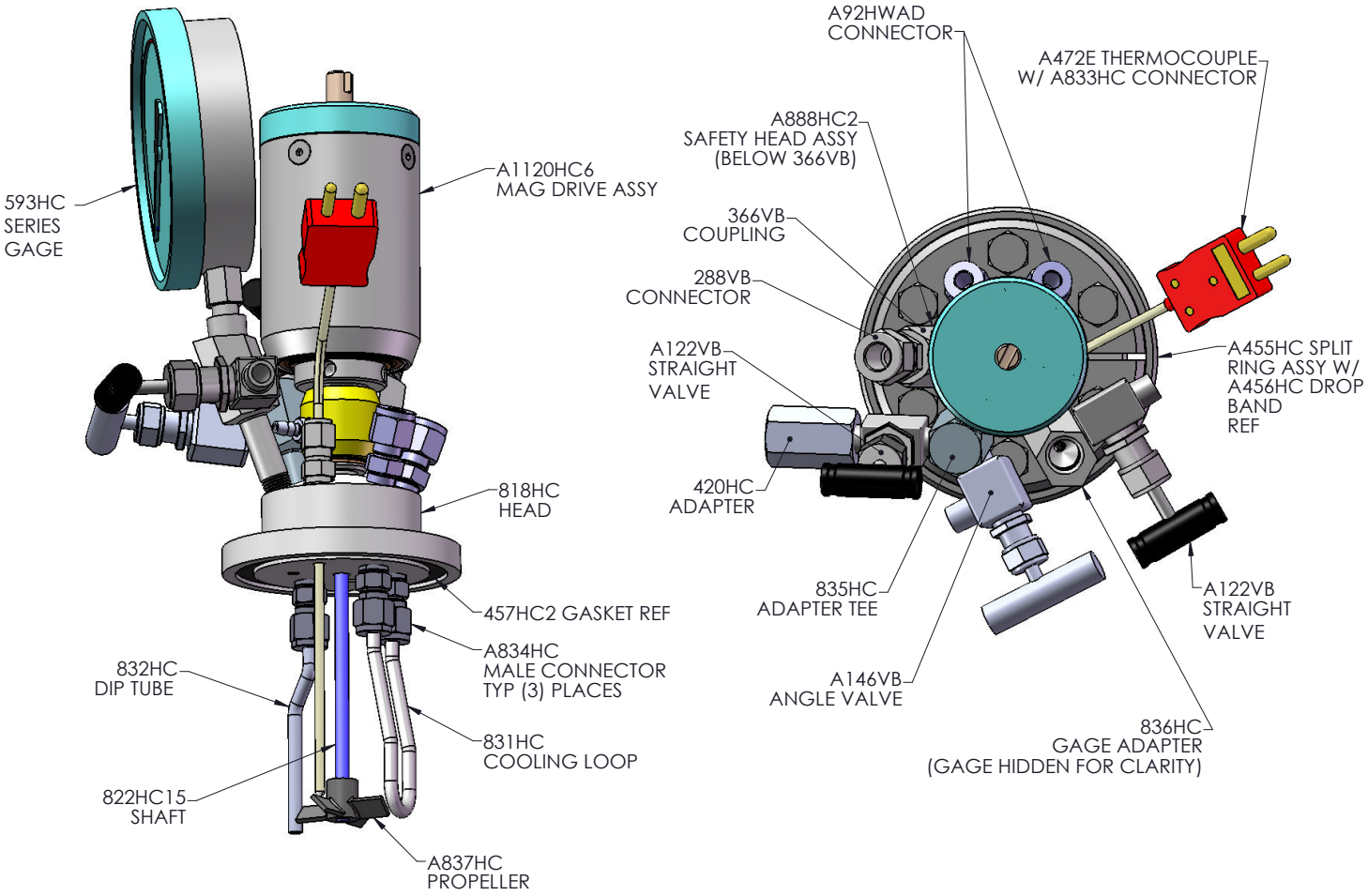
Each operating instruction manual binder includes a customized Parts List that contains a list of the parts in the major components of your Reactor. Do not discard this Parts List. You should use this parts list for reordering consumable and replacement parts to ensure that you order the correct items for your reactor system.

4560 SERIES REACTION VESSEL PARTS LIST

Standard Vessel Fittings

(3000 psig/ 350°C)

Vessel Closure and Standard Internal Parts



Consult the itemized list for your reactor, provided along with this manual. For purpose of reactor identification the following abbreviation codes are used:

RV -	Removable Vessel	FH -	Fixed Head
FG -	Flat Gasket Seal	OR -	O-ring Seal
SS -	T316 only	SP -	Special Alloy
MD -	Magnetic Drive		
FMD -	Footless Magnetic Drive		

* For parts made from alternate materials use the codes shown below as a suffix to the standard part number.

CM -	Alloy 400	CC -	Alloy 20Cb3
CT -	Alloy 600	CA -	Titanium G2 or G4
CG -	Alloy b-2	CH -	Alloy C-276
CX -	Zirconium		

Cylinders*

Part No.	Description	Code
452HC8	Cylinder, 100 mL	FG
2342HC4	Cylinder, 100 mL	OR
452HC9	Cylinder, 160 mL	FG
2342HC5	Cylinder, 160 mL	OR
452HC	Cylinder, 300 mL	FG
2342HC	Cylinder, 300 mL	OR
452HC2	Cylinder, 450 mL	FG
2342HC2	Cylinder, 450 mL	OR
452HC3	Cylinder, 600 mL	FG
2342HC3	Cylinder, 600 mL	OR

** For Special Fittings*

Magnetic Stirrer

Part No.	Description
A1120HC6	Magnetic Stirrer, 16in-lb
A2140HC2	Footless Magnetic Stirrer, 16 in-lb
A2685HC	Cooling Sleeve
827HC	O-ring
2714HC	Hose connector

See manual 234M for a full list of magnetic stirrers and parts.

Heads for A1120HC6 Magnetic Stirrer*

Part No.	Description	Code
818HC	Head, for thermocouple	RV FG
818HC2*	Head, for thermowell	RV FG
2201HC	Head, for thermocouple	FH FG
2201HC2*	Head, for thermowell	FH FG
2340HC	Head, for thermocouple	RV OR
2340HC*	Head, for thermowell	RV OR
2343HC	Head, for thermocouple	FH OR
2343HC2*	Head, for thermowell	FH OR

Heads for A2140HC2 Footless Magnetic Stirrer*

Part No.	Description	Code
818HC39	Head, for thermocouple	RV FG
818HC40*	Head, for thermowell	RV FG
2201HC5	Head, for thermocouple	FH FG
2201HC6*	Head, for thermowell	FH FG
2340HC5	Head, for thermocouple	RV OR
2340HC6*	Head, for thermowell	RV OR
2343HC5	Head, for thermocouple	FH OR
2343HC6*	Head, for thermowell	FH OR

Gaskets & Seals

Part No.	Description	Code
457HC2	Head Gasket, PTFE	FG
457HC3KL	Head Gasket, Flexible Graphite	FG
2341HCJV	O-ring FKM	OR
2341HCJK	O-ring FFKM	OR
48HC	Gasket, silver; A1120HC	
48HCFG	Gasket, gold plated; A1120HC	
2142HC	Gasket, silver; A2140HC	
2142HCFG	Gasket, gold plated; A2140HC	
2142HC2KL	Gasket, graphite; A2140HC	

** For Special Fittings*

Split Rings and Accessories

Part No.	Description	Code
A455HC	Split Ring Assembly w/ bolts	RV FG
454HC	Comp. Ring, Head Drop Band	RV FG
A456HC	Drop Band w/ screw	RV FG
A2205HC	S/R, 6 bolt, Captive Comp. Ring	FH FG
232HCFDE	9/16" Hex Comp bolt, GR-B7	RV FG
232HCF3DE	7/16" Hex Comp bolt, GR-B7	FH FG
2195HC	Split ring, quick close	OR
372HC2	Wrench, 9/16"	RV FG
3646HC	Wrench, 7/16" S/R	FH FG
3646HC2	Wrench, 7/16" Short	FH FG

Dip Tubes

Part No.	Description	Code
832HC	Dip Tube for 300 mL	SS
832HC4*	Dip Tube with nut, 300 mL	SP
832HC2	Dip Tube, 450 mL	SS
832HC5*	Dip Tube with nut, 450 mL	SP
832HC3	Dip Tube, 600 mL	SS
832HC6*	Dip Tube with nut, 600 mL	SP
832HC19*	Dip Tube with nut, 100/160 mL	SS / SP

Male Connectors

Part No.	Description	Code
A833HC	Male Connector, 1/8NPTM x 1/8T, (Thermocouple)	SS
A834HC	Male Connector, 1/8NPTM x 3/16T, (SS dip tube)	SS
A92HW*	Male Connector, 1/8NPTM x 1/4T, (Special mate diptube)	SS / SP
A138CA	Male Connector, 1/8NPTM x 1/4T, TW, (thermowell)	SP

Cooling Loop

Part No.	Description	Code
831HC13	Cooling Coil, Spiral for 100 mL	
831HC	Cooling Loop for 300 mL	SS
831HC6*	Cooling Loop for 300 mL	SP
831HC2	Cooling Loop for 450 mL	SS
831HC7*	Cooling Loop for 450 mL	SP
831HC3	Cooling Loop for 600 mL	SS
831HC8*	Cooling Loop for 600 mL	SP
A92HW*	Internal Connector, cooling loop*	
*217VB**	*Nut for A92HW* ¼" T*	
*218VB**	*Ferrule for A92HW* ¼" T*	

Thermocouple/Thermowell

Part No.	Description	Code
A833HC	Male Conn, 1/8" NPT(M) × 1/8" T for Thermocouple	
A138CA	Male Conn, 1/8" NPT(M) × 1/4" T for thermowell	
A1453HC	Thermowell, 1/4"OD	
A472E	Thermocouple, Grounded 300mL Type J, 7-1/2	TC
A472E2	Thermocouple, Grounded 450mL Type J, 9-1/2	TC
A472E3	Thermocouple, Grounded 600mL Type J, 11-1/2	TC
A472E4	Thermocouple, Grounded 100/160mL Type J, 5-1/2	TC
A490E	Thermocouple, Dual Grounded, 7-1/2, 1/8"OD	TC
A490E2	Thermocouple, Dual Grounded 9-1/2	TC
A490E3	Thermocouple, Dual Grounded 11-1/2	TC
213VBAD	Nut 1/8" T	TC
214VBAD	Ferrule 1/8" T	TC
217VBAD	Nut 1/4" T	TW
218VBAD	Ferrule 1/4" T	TW

Specify volume & head style (fixed or movable)

Stirrer Support Bracket

Part No.	Description	Code
A1260HC	Stirrer Bracket without bushing	SS
A1260HC2*	Stirrer Bracket without bushing	SP
1261HC	Stirrer Bracket Bushing, PTFE graphite	
1261HC2KF	Stirrer Bracket Bushing, graphite	

Note: 450 mL and 600 mL only

Stirrer Shafts for A1120HC6 Magnetic Stirrer*

Part No.	Description	Code
822HC15	Shaft, 300 mL, 5.81"	RV MD
822HC30	Shaft, 300 mL, 6.42"	FH MD
822HC16	Shaft, 450 mL, 7.81"	RV MD
822HC31	Shaft, 450 mL, 8.92"	FH MD
822HC17	Shaft, 600 mL, 9.81"	RV MD
822HC32	Shaft, 600 mL, 10.92"	FH MD
822HC18	Shaft, 100 mL, 3.88"	RV MD
822HC33	Shaft, 100 mL, 4.99"	FH MD
822HC18	Shaft, 160 mL, 3.88"	RV MD
822HC33	Shaft, 160 mL, 4.99"	FH MD

Stirrer Shafts for A2140HC2 Footless Magnetic Stirrer

Part No.	Description	Code
2141HC	Shaft, 300 mL, 7.93"	RV FMD
2141HC7	Shaft, 300 mL, 9.05"	FH FMD
2141HC2	Shaft, 450 mL, 9.93"	RV FMD
2141HC8	Shaft, 450 mL, 11.05"	FH FMD
2141HC3	Shaft, 600 mL, 11.93"	RV FMD
2141HC9	Shaft, 600 mL, 13.05"	FH FMD
2141HC46	Shaft, 100/160 mL, 5.93"	RV FMD
2141HC50	Shaft, 100/160 mL, 7.05"	FH FMD

Impellers*

Part No.	Description	Code
A2148HC	Impeller with screw, for 2141HC series shafts	FMD
A837HC	Impeller with screw, for 822HC series shafts	MD

Gas Entrainment Upper Shaft

Part No.	Description	Code
2027HC	2.83" Shaft, upper	MV MD
2027HC3	3.94" Shaft, upper	FH MD

Gas Entrainment Lower Shaft

Part No.	Description	Code
2028HC5	3.04" Shaft, 300 mL	MD
2141HC1	8.16" Shaft, 300 mL	FH FMD
2141HC15	7.11" Shaft, 300 mL	MV FMD
2028HC6	4.04" Shaft, 450 mL	MD
2141HC12	9.72" Shaft, 450 mL	FH FMD
2141HC16	8.61" Shaft, 450 mL	MV FMD
2028HC7	5.54" Shaft, 600 mL	MD
2141HC13	11.22" Shaft, 600 mL	FH FMD
2141HC17	10.11" Shaft, 600 mL	MV FMD
2028HC8	1.18" Shaft, 100/160 mL	MD
2141HC14	6.85" Shaft, 100/160 mL	FH FMD
2141HC18	5.73" Shaft, 100/160 mL	MV FMD

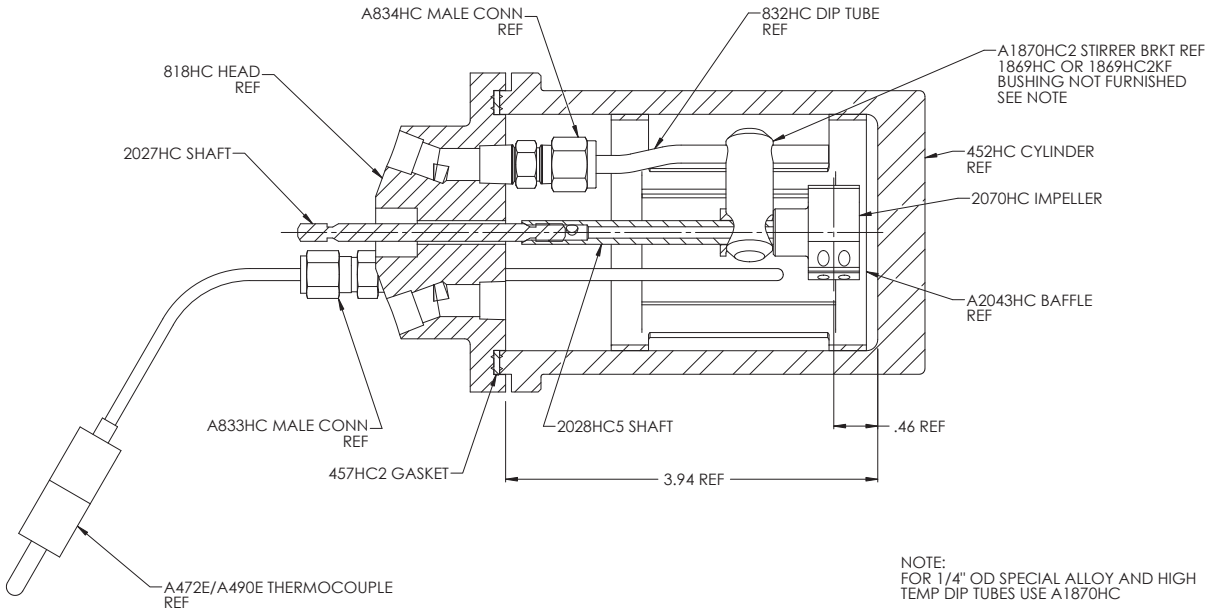
Gas Entrainment Impeller

Part No.	Description
2027HC	GE Impeller, 300/450/600 mL
2027HC2	GE Impeller, 100/160 mL

** For Special Fittings*

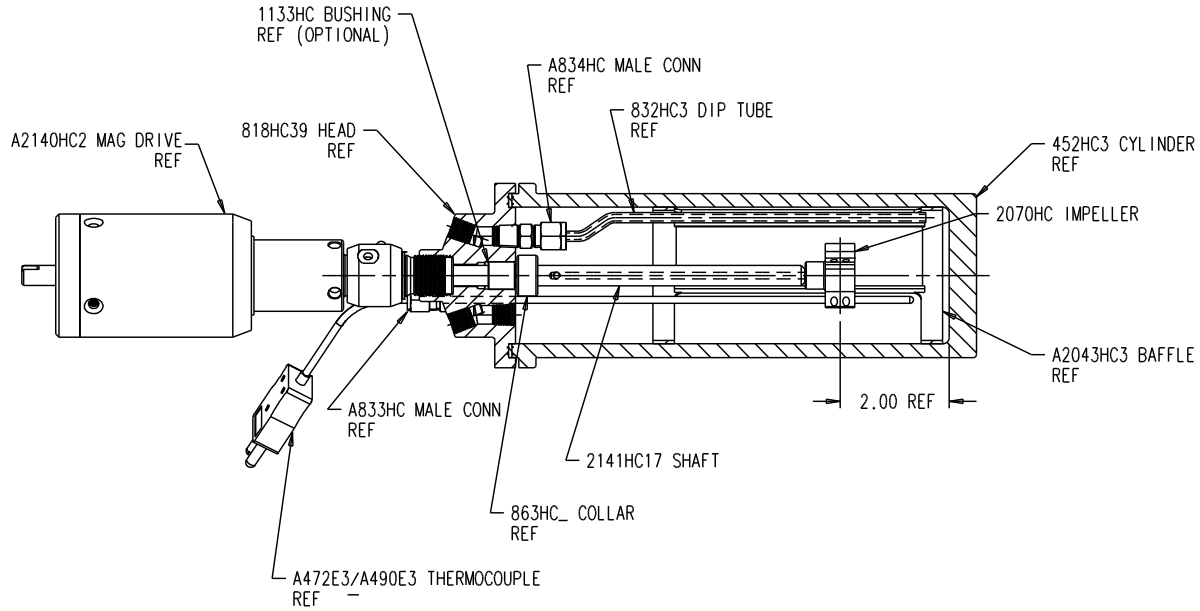
4561 Gas Entrainment Assembly

300mL Removable Vessel



4563 Gas Entrainment Assembly

600mL Removable Vessel



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
A122VB	Needle Valve T316 1/8 NPTM

Gages

Part No.	Description
593HCP1AD	Pressure Gage, 3-1/2", 100 psi/bar
593HCP2AD	Pressure Gage, 3-1/2", 200 psi/bar
593HCP6AD	Pressure Gage, 3-1/2", 600 psi/bar
593HCPD	Pressure Gage, 3-1/2", 1000 psi/bar
593HCPF	Pressure Gage, 3-1/2", 2000 psi/bar
593HCPG	Pressure Gage, 3-1/2", 3000 psi/bar

Heaters

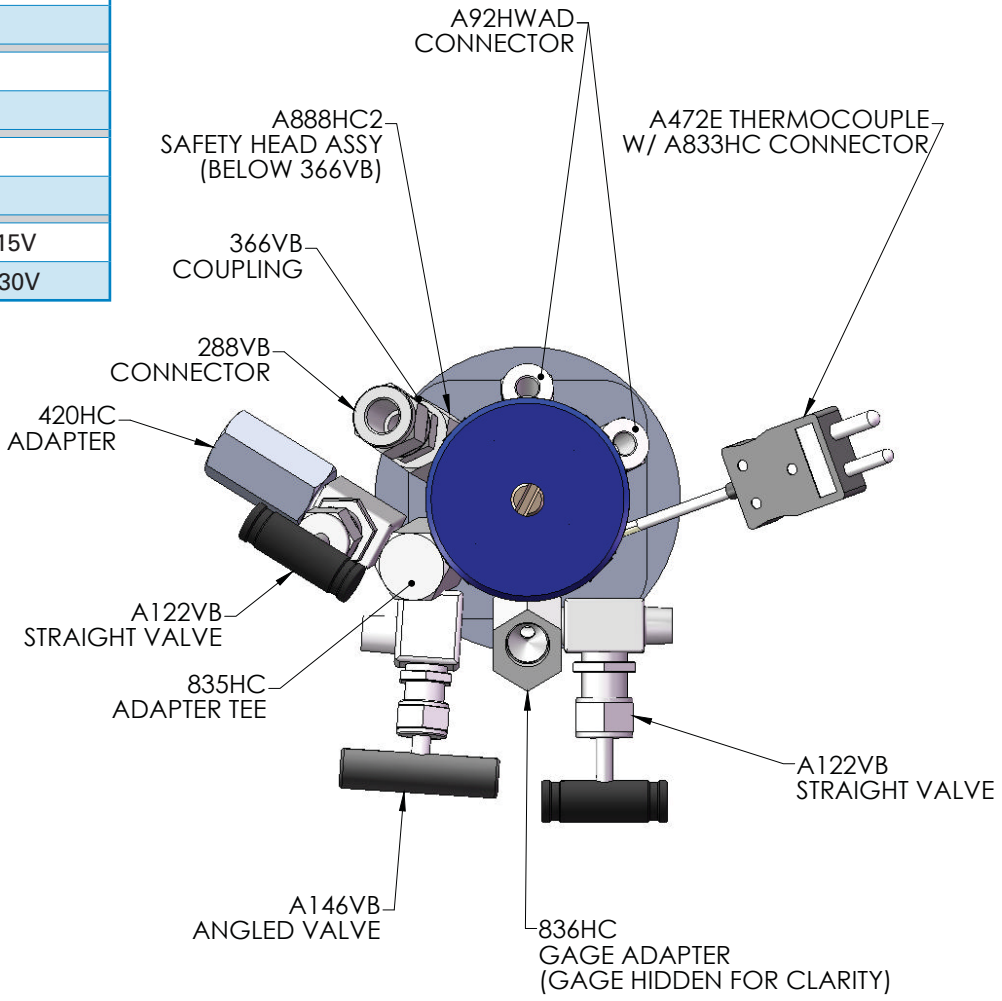
Part No.	Description
A2230HCEB	Heater, 300 mL, 115V
A2230HCEE	Heater, 300 mL, 230V
A2230HC2EB	Heater, 450 mL, 115V
A2230HC2EE	Heater, 450 mL, 230V
A2230HC3EB	Heater, 600 mL, 115V
A2230HC3EE	Heater, 600 mL, 230V
A2235HCEB	Heater, 100/160 mL, 115V
A2235HCEE	Heater, 100/160 mL, 230V

External Fittings

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

Rupture Disc Assembly

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



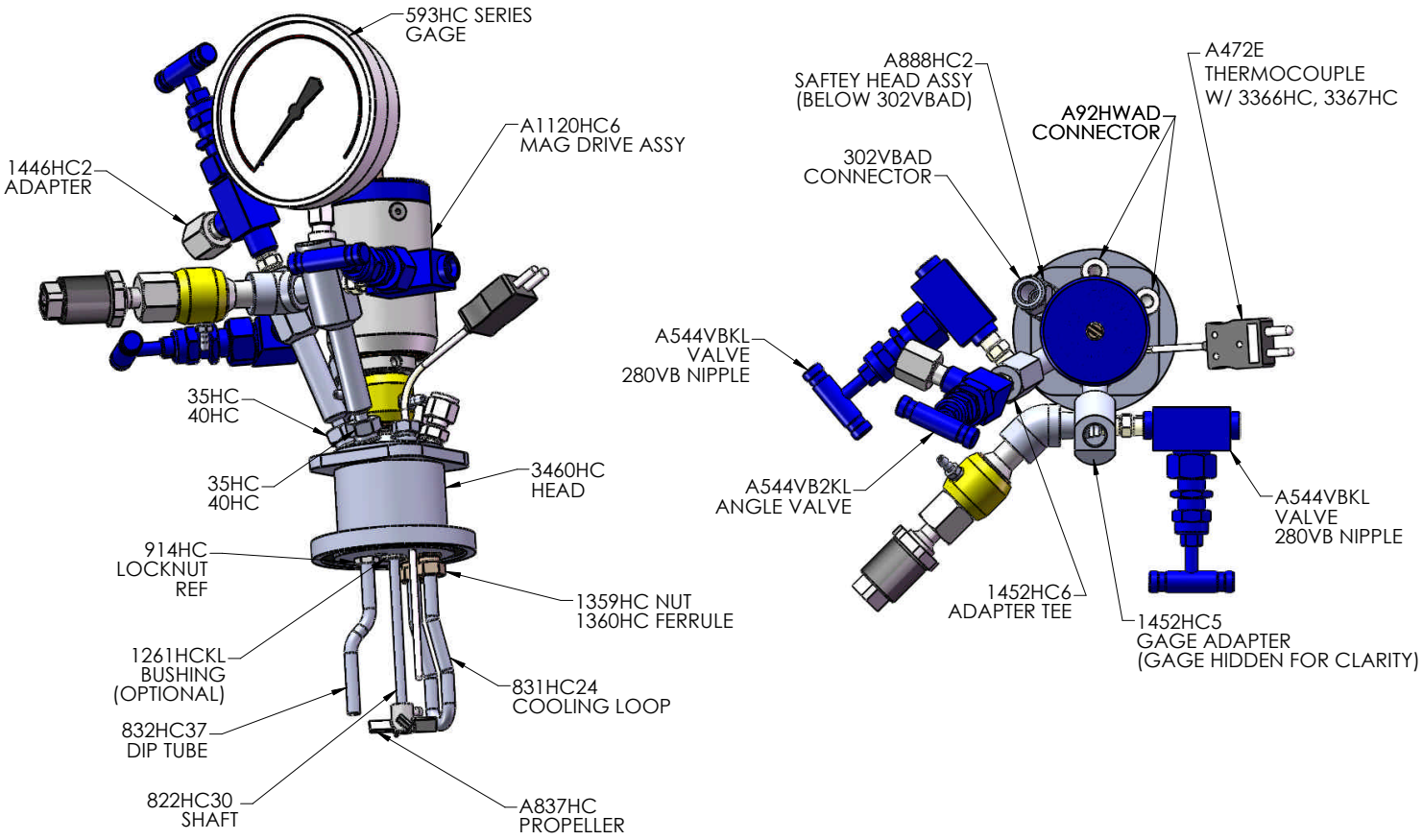
** For Special Fittings*

4560 SERIES REACTION VESSEL PARTS LIST

High Temperature Vessel Fittings

(2000 psig/500°C)

Vessel Closure and Standard Internal Parts



**Special Materials*

Consult the itemized list for your reactor, provided along with this manual. For purpose of reactor identification the following abbreviation codes are used:

RV -	Removable Vessel	FH -	Fixed Head
FG -	Flat Gasket Seal	SP -	Special Alloy
SS -	T316 only	MD -	Magnetic Drive
FMD -	Footless Magnetic Drive		

* For parts made from alternate materials use the codes shown below as a suffix to the standard part number.

CM -	Alloy 400	CC -	Alloy 20Cb3
CT -	Alloy 600	CA -	Titanium G2 or G4
CG -	Alloy b-2	CH -	Alloy C-276
CX -	Zirconium		

Cylinders*

Part No.	Description	Code
452HC	Cylinder, 300 mL	FG
452HC2	Cylinder, 450 mL	FG
452HC3	Cylinder, 600 mL	FG

Heads*

Part No.	Description	
3619HC	Head, for thermocouple	RVMD
3619HC*	Head, for thermowell	RVMD
3460HC*	Head, for thermocouple	FHMD
3460HC2*	Head, for thermowell	FHMD
3460HC3	Head, for thermocouple	FHFMD

** For Special Fittings*

Gaskets*

Part No.	Description	Code
457HC3KL	Head Gasket, Flexible Graphite	RV FG
48HC	Gasket, silver; A1120HC	RV FG
48HCFG	Gasket, gold plated; A1120HC	FH FG
2142HC	Gasket, silver; A2140HC	FH FG

Closure*

Part No.	Description	Code
A455HC7	Split Ring Assembly with bolts	RV
454HC	Compression Ring, Head	RV
A456HC	Drop Band	RV
A2205HC3	Split Ring Assembly with compression ring & bolts	FH
372HC2	Wrench, 9/16"	RV
3646HC	Wrench, 7/16"	FH
3646HC2	Wrench, 7/16" short	FH
3647HC	Torque adapter, 3/8 drive x 7/16	RV FH
1368HC	Torque wrench, 3/8 drive	RV FH

Dip Tubes*

Part No.	Description	Code
832HC37	Dip Tube for 300 mL	
832HC38	Dip Tube, 450 mL	
832HC39	Dip Tube, 600 mL	

Cooling Loop*

Part No.	Description	Code
831HC24	Cooling Loop for 300 mL	
831HC25	Cooling Loop for 450 mL	
831HC26	Cooling Loop for 600 mL	
1359HC*	Nut, 1/4" Tube Seal	
1360HC*	Ferrule, 1/4" Tube Seal	

Stirrer Support Bracket

Part No.	Description	Code
A1260HC2*	Stirrer Bracket without bushing	
1261HC2KF	Stirrer Bracket Bushing	

Note: *450 mL and 600 mL only*

Thermowell*

Part No.	Description	Code
A1453HC*	Thermowell (specify reactor volume & head style when ordering)	

Magnetic Stirrer

Part No.	Description
A1120HC6	Magnetic Stirrer, 16in-lb
A2140HC2	Footless Magnetic Stirrer, 16 in-lb
A2685HC	Cooling Sleeve Assembly
827HC	O-ring
2714HC	Hose connector

See manual 234M for a full list of magnetic stirrers and parts.

Stirrer Shafts for A1120HC6 Magnetic Stirrer*

Part No.	Description	Code
822HC15	Shaft, 300 mL, 5.81"	RV MD
822HC30	Shaft, 300 mL, 6.42"	FH MD
822HC16	Shaft, 450 mL, 7.81"	RV MD
822HC31	Shaft, 450 mL, 8.92"	FH MD
822HC17	Shaft, 600 mL, 9.81"	RV MD
822HC32	Shaft, 600 mL, 10.92"	FH MD

Stirrer Shafts for A2140HC2 Footless Magnetic Stirrer*

Part No.	Description	Code
2141HC	Shaft, 300 mL, 7.93"	RV FMD
2141HC7	Shaft, 300 mL, 9.05"	FH FMD
2141HC2	Shaft, 450 mL, 9.93"	RV FMD
2141HC8	Shaft, 450 mL, 11.05"	FH FMD
2141HC3	Shaft, 600 mL, 11.93"	RV FMD
2141HC9	Shaft, 600 mL, 13.05"	FH FMD

Impellers*

Part No.	Description	Code
A2148HC	Impeller with screw, for 2141HC series shafts	FMD
A837HC	Impeller with screw, for 822HC series shafts	MD

Gages

Part No.	Description
593HCP1AD	Pressure Gage, 3-1/2", 100 psi/bar
593HCP2AD	Pressure Gage, 3-1/2", 200 psi/bar
593HCP6AD	Pressure Gage, 3-1/2", 600 psi/bar
593HCPD	Pressure Gage, 3-1/2", 1000 psi/bar
593HCPF	Pressure Gage, 3-1/2", 2000 psi/bar
593HCPG	Pressure Gage, 3-1/2", 3000 psi/bar

** For Special Fittings*

Thermocouple/Thermowell

Part No.	Description	Code
A472E	Thermocouple, Grounded 300mL Type J, 7-1/2	TC
A472E2	Thermocouple, Grounded 450mL Type J, 9-1/2	TC
A472E3	Thermocouple, Grounded 600mL Type J, 11-1/2	TC
A472E4	Thermocouple, Grounded 100/160mL Type J, 5-1/2	TC
A490E	Thermocouple, Dual Grounded, 7-1/2, 1/8" OD	TC
A490E2	Thermocouple, Dual Grounded 9-1/2	TC
A490E3	Thermocouple, Dual Grounded 11-1/2	TC
3366HC	Nut, 1/8" Tube Seal	TC
3367HC	Ferrule, 1/8" Tube Seal	TC
1360HC	Ferrule SS, 1/4" Tube Seal	TW
1359HC	Nut, 1/4" T Seal	TW
A1453HC	Thermowell, 1/4" OD	

Specify volume & head style (fixed or movable)

External Fittings

Part No.	Description
A888HC2	Rupture disc assembly
49HC2	Orifice cone
527HC	Orifice ring
433HC4	Safety head outlet
A544VBKL	Valve, Straight 1/8" NPTF
A544VB2KL	Valve, Angled 1/8" NPTF
280VBAD	Nipple, 1/8" NPTM
A92HWAD	Male Connector 1/8 NPTMx1/4T (T316SS for top of cooling loop)
35HC	Compression Nut
40HC	Bushing
1452HC5	Gage Adapter
1452HC6	Valve Adapter
302VBAD	Female Conn, 38" Tube – 1/4" NPTF
1446HC2	Adapter, 'A' Cone F – 1/8" NPTM
424HC2	Anti-Seize Lubricant
79HW*	Plug, Hex Head 1/8" NPTM
94CAAD	Plug, Hex Head 1/4" NPTM

Rupture Disc Assembly

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

** For Special Fittings*

Overarm Parts List

Motor

Part No.	Description
1355EES	Motor VS/PM130VDC 1/8 HP
A1554EES	Motor VS/PM 130VDC 1/8 HP with EMC filter for CE
A1393HC	Air Motor
A388EEQ	Motor ¼ HP EXP VS 90 VDC
A388EER	Motor ¼ HP EXP VS 180 VDC
A388EES	Motor ¼ HP VS 90 VDC
A388EET	Motor ¼ HP VS 180 VDC

Driven Pulley Assembly

Part No.	Description
A2179HC	Driven Pulley Assembly includes:
839HC	Ball Bearing
841HC	Snap Ring, External .693"
842HC	Snap Ring, 1.804"
858HC2	Pulley, Driven
862HC	Support Hub
299HC2	Bushing, PTFE

Upper Drive Shafts

Part No.	Description
A2223HC	Upper Drive Shaft

Shaft Couplings

Part No.	Description
2075HC2	Shaft Coupling .38, Universal

Release Knobs

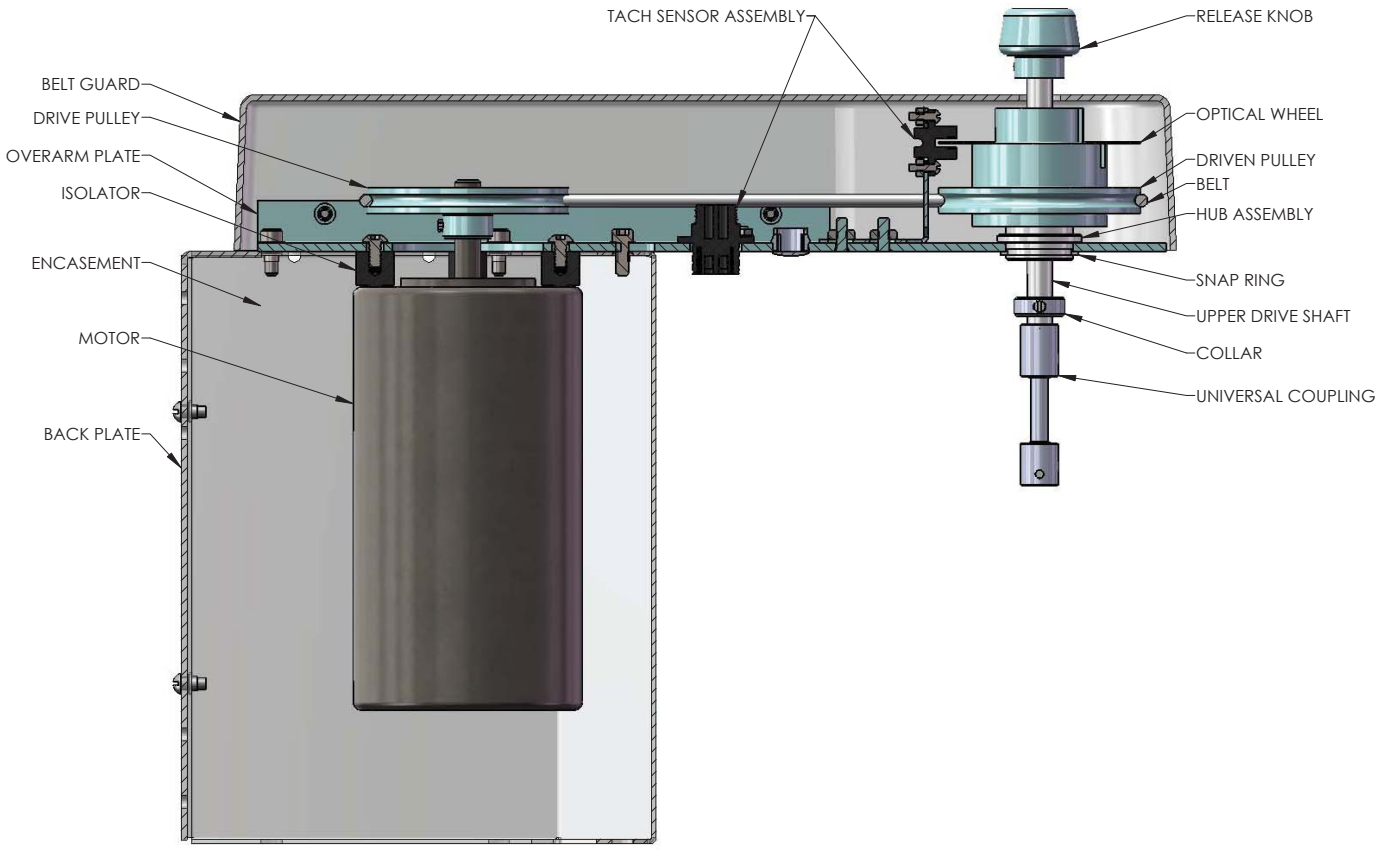
Part No.	Description
845HC2	Release Knob, .38 Shaft

Drive Pulleys

Part No.	Description	Belt Part No.
857HC	Pulley 600 RPM	847HC8
857HC3	Pulley 800 RPM	847HC8
857HC4	Pulley 1000 RPM	847HC8
857HC5	Pulley 1700 RPM	847HC4
857HC7	Pulley, Air Motor	847HC8

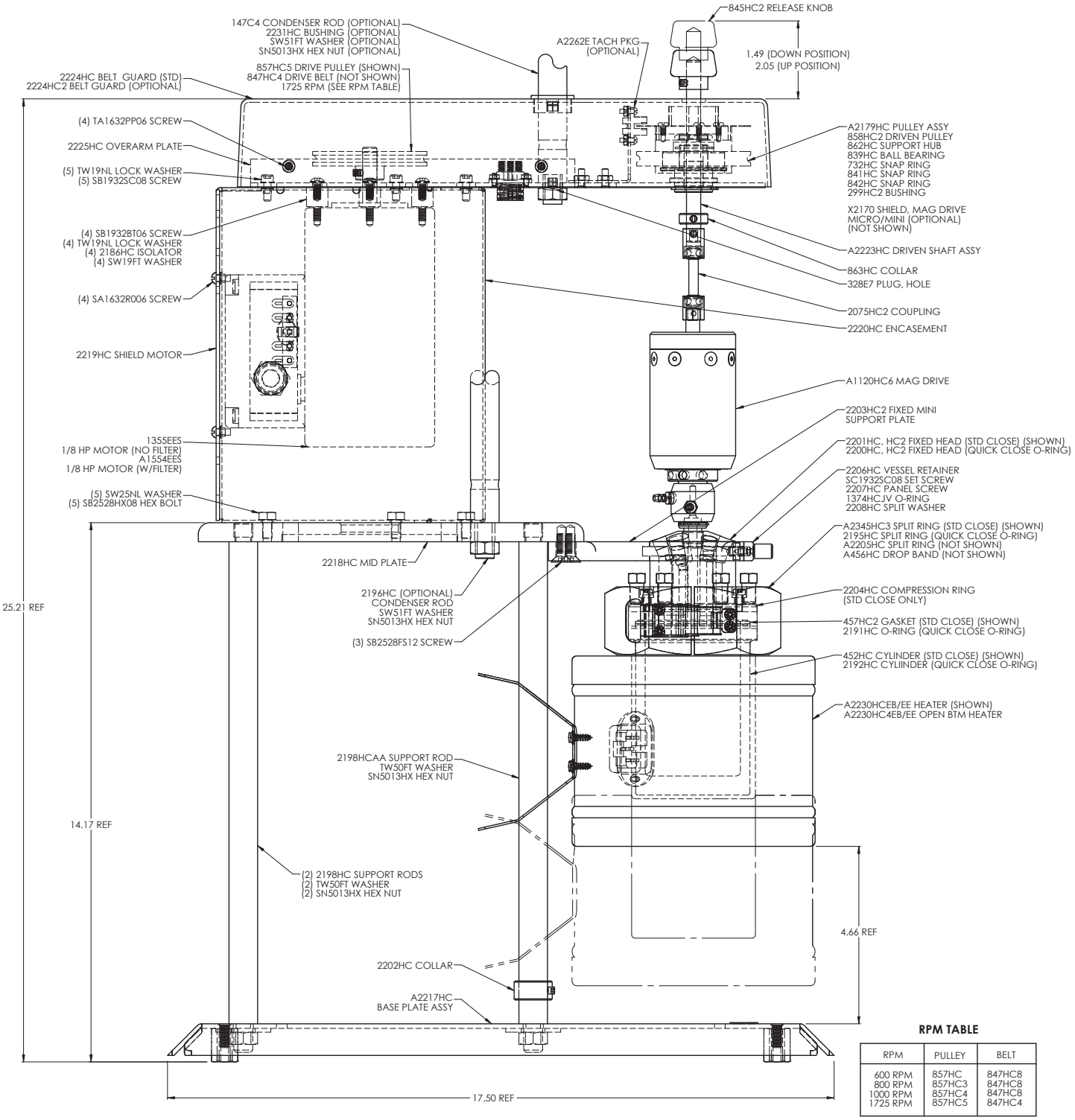
Optional Tach Parts

Part No.	Description
A1001E2	Tach Sensor Assembly (5.5"L)



STAND AND MOTOR DRAWINGS

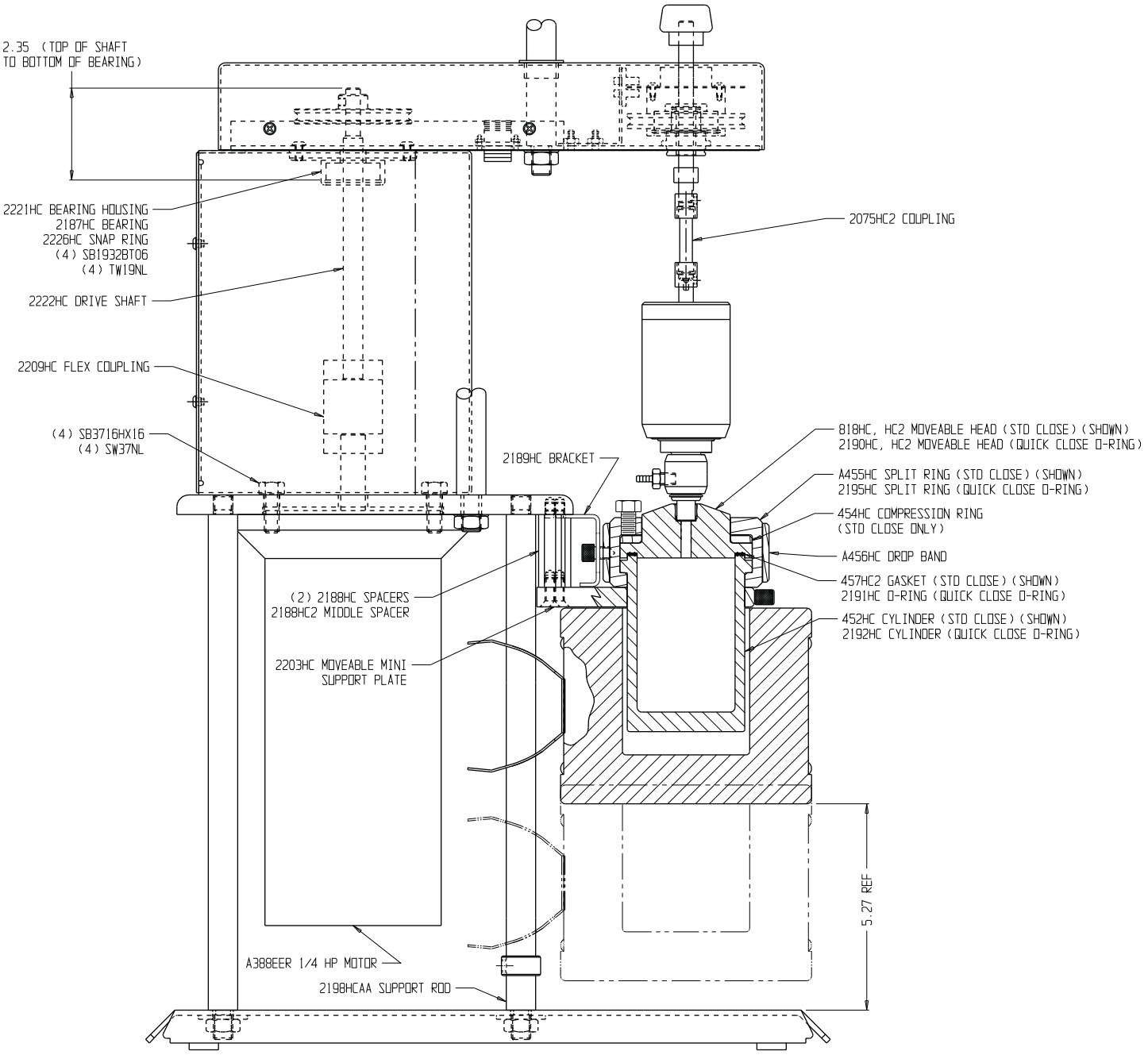
Reactor Support Stand with Fixed Head and 1/8 hp Stirrer Drive Motor



RPM TABLE

RPM	PULLEY	BELT
600 RPM	857HC	847HC8
800 RPM	857HC3	847HC8
1000 RPM	857HC4	847HC8
1725 RPM	857HC5	847HC4

Reactor Support Stand with Moveable Vessel and 1/4 hp Stirrer Drive Motor



Air Motor Option

