

# Integrator's Reference Guide Thermo Scientific HyClone Single-Use Bioreactor

*For use in biopharmaceutical applications*



**Integrator's Reference Guide**  
**Thermo Scientific HyClone**  
**Single-Use Bioreactor (S.U.B.)**  
UG011 Rev 1

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**NOTE:** The drawings used throughout this document are representative only and may change. Please refer to your Equipment Turn-Over Package (ETP) for your applicable drawings. ▲

We have taken precautions to ensure this manual is accurate and complete. Nevertheless, readers should remain alert to the possibility of errors and omissions. If any of the information in this manual seems incorrect, contact Thermo Fisher Scientific for advice before proceeding. This information, including product specifications, is subject to change without notice. Because of this, please take caution if extracting information from this User's Guide for use in other documentation as it will be updated with future revisions. Please contact Thermo Scientific HyClone products technical support for the current revision.

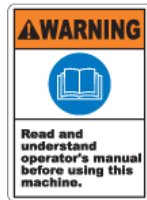
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## Warnings and Safety



### **Warning: Read and understand operator's manual before using this equipment.**

Thermo Scientific HyClone Single-Use Bioreactor is designed to be operated under traditional mammalian cell culture conditions. A general understanding of bioreactor systems and their operation is important prior to using the system for the first time. ▲

- Read and understand user's manual before operating
- Failure to do so could result in injury



### **Warning: Hazardous voltage inside**

#### **Disconnect power before opening. Service by trained personnel only.**

**Consult manual.** Electrical components are designed into and required for the proper function of the Single-Use Bioreactor (S.U.B.) The mixer motor, motor controller, resistive heater jacket and control panel all have electrical components. ▲

- Risk of electrical shock and injury
- There is potential for static charge build-up during mixing and set-up of BPCs



### **Warning: Entanglement hazard**

Rotating parts can cause injury. Keep hands away from moving parts. ▲

### **Warning: Hot surface. Do not touch.**

The heating jacket is designed to heat the outer vessel wall. Normal operating conditions generate heat and could create hot surfaces. ▲

- Hot surface inside
- Contact with surfaces may cause burns
- Do not touch while in operation



### **Warning: Burst Hazard**

Under normal operating conditions the S.U.B. BPC chamber is under slight pressure. Normal passive venting prevents any excess of pressure building up within the chamber. Chamber pressure and inlet line pressure should be monitored for proper settings. ▲

- Contents under pressure
- Do not exceed 0.5 psi (0.03 bar) BPC pressure
- Do not exceed 5 psi (0.34 bar) inlet pressure
- Assure vent filter is properly positioned and working properly

## Protective Earthing

### Environmental Conditions

Protective earthing must be verified prior to plugging the S.U.B. into any electrical outlet. Ensure the receptacle is properly earth grounded.

- Operating: 17°C to 27°C; 20% to 80% relative humidity, non-condensing
- Storage: -25°C to 65°C
- Installation category II (over voltage) in accordance with IEC 664
- Altitude Limit: 2,000 meters

### Water Jacket Vessel Information

The Water Jacket S.U.B. has been designed to be operated with water as the heat transfer medium with temperatures not exceeding 60°C (140°F) under less than 150 psi (1 MPa) operating pressure.

**NOTE:** The S.U.B. BPC operating limits for temperature are 5 to 40°C and an internal pressure of less than 0.5 psi. The water jacket is not classified as a pressure vessel and is not required to be registered, inspected and stamped with the Code U symbol per section U-1(c)2(f) of the ASME Boiler and Pressure Vessel Code [operating with water as the heat transfer medium, temperature not exceeding 99°C (210°F) under less than 300 psi (2 MPa)]. In Europe, to conform to the Pressure Equipment Directive 97/23/EC (PED), all S.U.B. jacketed systems should be operated at 75 psi or less. However, if operating conditions require usage outside of the above recommended parameters, a stamped jacket can be obtained for an additional fee.

# Section 1 Initial Installation Instructions

## Hardware Shipment and Setup

The Single-Use Bioreactor hardware is shipped directly from the manufacturer and will arrive crated. For unpacking instructions and detailed contents of the crate, please refer to the instructions specific to the S.U.B. volume. Be sure to follow the unpacking instructions provided and retain all packaging materials.

## 50 L, 100 L, 250 L and 500 L Hardware Uncrating

The S.U.B. hardware should arrive with the following items:

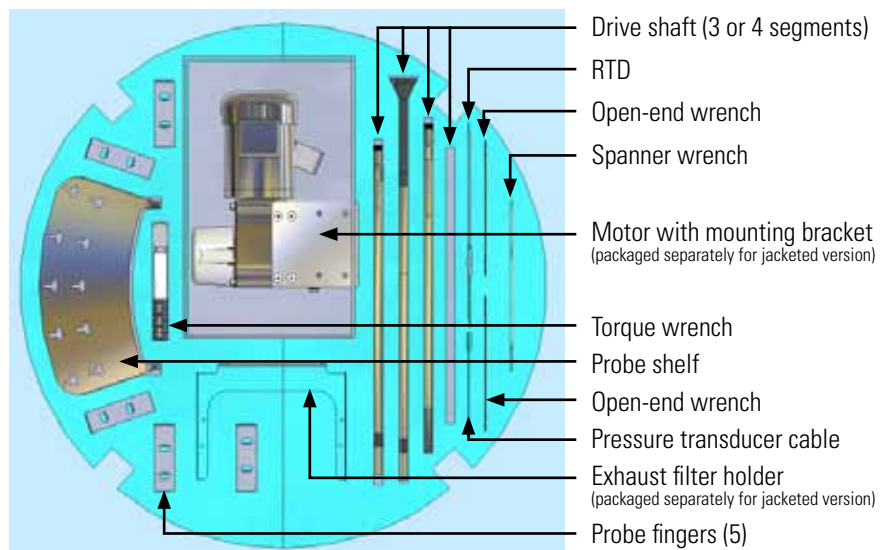
- Outer support container (platform, tank and control panel)
  - Drive shaft, RTD, probe shelf and brackets (4) and standard tool set (spanner wrench and torque wrench)
  - ETP - located on CD provided with hardware
1. Remove crate lid first
  2. Remove side wall(s)
  3. Remove the tie-down straps
  4. Remove any/all blocks on crate floor
  5. Remove S.U.B. carefully using forklift/manually by lifting via the bottom of the cart frame, not the casters
  6. Ensure no damage occurred during shipping

Contact your Sales Representative immediately if damage has occurred.

## 1000 L Hardware Uncrating

The S.U.B. hardware should arrive with the following items:

- Outer support container (platform, tank and control panel) - main shipping container
- Motor (boxed) - located inside tank
- Drive shaft, RTD, pressure transducer cable, probe shelf and brackets (5), and standard tool set (4 pieces) - items are located in the foam packaging within the tank (Figure 1.6)
- ETP - located on CD provided with hardware.



**Figure 1.6.** Foam packaging configuration for 1000 L S.U.B.



## Motor Mounting (1000 L)

Please reference the following instructions to mount the S.U.B. motor for first time setup or if the unit is to be transported. **NOTE:** Ensure S.U.B. is in final location as overall height with motor mounted is greater than 82" and may not fit through standard door frames. Mounting of the motor requires two persons; please exercise caution when working in elevated positions. References to figures are shown in parentheses following each step.

1. Remove the protective shipping bracket above the control panel (four 3/8" bolts) and store in original crate. Keep the 3/8" bolts for use in mounting the motor to the tank.
2. Attach the motor with mounting plate to the outside of the tank above the load cell summing block and control panel (Figure 1.7 or 1.8) using four (qty 4) 3/8"-16 x 1" fasteners from step 1 above. **NOTE:** The bottom two bolts are also used to mount the tool bracket on the Water Jacket 1000 L S.U.B. as shown in Figure 1.8.
3. Attach the motor lead to the control panel quick connect (Figure 1.9 or 1.10).



**Figure 1.7.** Electric Resistive Heater



**Figure 1.8.** Water Jacket



**Figure 1.9.** Electric Resistive Heater



**Figure 1.10.** Water Jacket

## Additional Items for Installation (1000 L)

1. **Resistive Heated S.U.B.:** Attach the exhaust filter bracket (fingers facing toward tank center) to the top strap of the tank (if looking at the control panel, use the strap on the left side) using the two 1/4 - 20 x 1/2" button head fasteners (use 5/32" hex wrench) located on the strap (Figure 1.11). Exact position of the bracket can be adjusted once the BPC is loaded. For elevated vent filters, mount the adapter piece and the extended filter bracket (Figure 1.14).
2. **Jacketed S.U.B.:** Mount bracket base first; loosen the three button head fasteners allow 1/4" of space between head and plate. Align the fasteners to the key-hole cut outs in the tank and slide to bottom. Tighten fasteners to lock the plate in position (Figure 1.12). The swivel arm of the upper bracket can then be placed into the lower receiver. Final position of the bracket can be adjusted once the BPC is loaded (Figure 1.13). Alternatively, an extended height dual filter bracket can be installed for elevated vent filters (Figure 1.14).



**Figure 1.11.** Electric Resistive Heater (mounting standard vent holder)



**Figure 1.12.** Water Jacket (mounting base assembly)

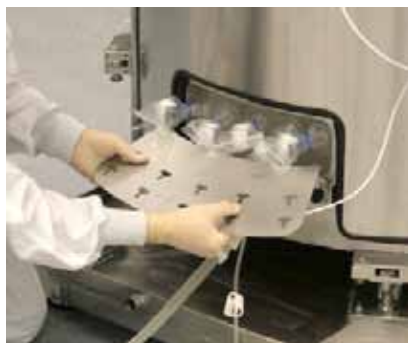


**Figure 1.13.** Water Jacket (mounting standard vent holder)



**Figure 1.14.** Extended Dual Vent Filter Bracket in use

3. Attach the probe shelf across the lower probe access cutout by inserting the two tabs into the slots (Figure 1.15 and 1.17) and hand tightening the knobs (Figure 1.16 and 1.18).



**Figure 1.15.** Electric Resistive Heater



**Figure 1.16.** Electric Resistive Heater



**Figure 1.17.** Water Jacket



**Figure 1.18.** Water Jacket

## 2000 L Hardware Uncrating

1. Remove top cover.



**Figure 1.18**

2. Remove small side cover.



**Figure 1.19**

3. Remove both long side covers.



**Figure 1.20**



4. While in the horizontal position, remove both boxes (miscellaneous tools kit & motor assembly) and the packaging material. If this step is missed, both boxes can be removed through the large access door when the tank is vertical.



**Figure 1.21**



**Figure 1.22**



**Figure 1.23**



**Figure 1.24**

5. Using either a fork lift or overhead crane, the unit needs to be tipped from horizontal to vertical. Ensure all straps are secure before proceeding. Below are descriptions of both the forklift and overhead crane methods.

## **Forklift Method (Preferred)**

The next step is to lift the crate up. You will need about 10 feet of ceiling height above the crate. Lift the crate to vertical using the two eye bolts on the crate end with a 1" nylon, 2 leg sling with sling hooks, part # 8864T821 McMaster-Carr or equivalent. Also use a 2" wide by 2' long web sling (3360T571) and a web sling shackle with screw pin (35505T3).

Part Number	Description	Vendor
8864T821	1" nylon double leg sling with hooks	McMaster-Carr
3360T571	2" wide x 2' long web sling	McMaster-Carr
35505T3	Shackle for 2" web	McMaster-Carr

**Table 1.4.** Recommended Lift Kit

Remove forks from forklift to keep them from damaging tank. Using eyebolts on crate, attach slings to forklift. While lifting the crate, the forklift will need to move forward at the same time to avoid the bottom of the crate sliding back.



**Figure 1.25**

## Overhead Crane Method

In most cases, the overhead crane is free floating on the I-beam to which they are mounted, so for this method to work, two lifts need to be used. Use the same kit, as defined in table 1, and choke strap. This choke strap needs to be wrapped around the bottom base, as shown, and hooked up to the second lift, as in the picture below. Both lifts are raised to get the crate off the floor, but the eye bolt side will be raised higher, as shown. The strap side will then be lowered simultaneously as the eyebolt side is raised, until the crate is vertical.



**Figure 1.26**

## Uncrating Continued

6. Remove straps from around the tank. Be careful with the bag lift (hoist) while doing this to make sure it doesn't fall. Remove the bag lift during this same step.



**Figure 1.27**

7. Remove bag lift arms from bottom of crate.
8. Remove lag bolts from the feet of the S.U.B. unit.



**Figure 1.28**

9. Lift the tank out of the crate, using either a fork lift or an overhead crane.
10. Remove all packaging materials and prepare for assembly.



**Figure 1.29**



**Figure 1.30**



**NOTE:** This information is primarily directed toward third party firms performing integration services.

## 2000 L Hardware Crating

1. The crate will come assembled from the manufacturer, so the top (cover), two long sides (covers) and the end (cover) need to be detached and available. The two remaining sides, small base (pallet) and long base (pallet), remain together in an “L” shape, as shown.



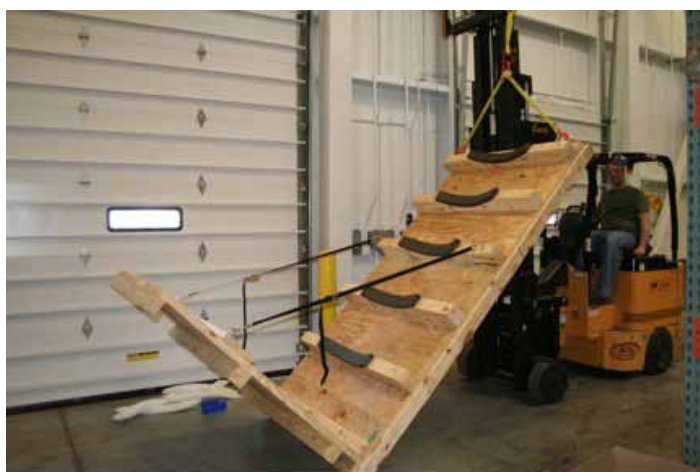
**Figure 1.31**

2. Attach two 8' tie downs, as shown. They need to be installed firmly to keep the long base from putting a lot of pressure at the corner joint after it gets tipped up.



**Figure 1.32**

3. The next step is to lift the crate up. You will need about 10 feet of ceiling height above the crate. Lift the crate to vertical using the two eye bolts on the end with a 1" nylon, 2 leg sling with sling hooks, part # 8864T821 McMaster-Carr or equivalent. Also use a 2" wide by 2' long web sling (3360T571) and a web sling shackle with screw pin (35505T3). Remove forks for convenience and to avoid damaging the crate. Refer to Table 1.4 for the recommended lift kit.



**Figure 1.33**

4. The 2000 L S.U.B. can be moved in two different ways: 1) a fork lift at the base, and 2) using the two eye bolts located at the top of the S.U.B. itself.



**Figure 1.34**

If moving the S.U.B. using a forklift, ensure that the summing block is tipped up and moved out of the way of the fork tines. Also ensure that a strap secures the tank to the fork lift for security.



**Figure 1.35**

5. The sparge plate inside the tank needs to be bubble wrapped and tied down.



**Figure 1.36**



**Figure 1.37**

6. The tank needs to be wrapped completely with bubble wrap, followed by stretch wrap. Fittings up to the tee of the jacket need to be removed (as shown in Figure 1.38)
7. We recommend positioning the tank using a fork lift underneath the base, but the option of using the tank eye bolts is available for overhead cranes.



**Figure 1.38**

8. Orient tank as shown. If necessary, locating boards can be removed and positioned to fit the feet. Also, straps may need to be loosened to let the tank pass through.



**Figure 1.39**



**Figure 1.40**



**Figure 1.41**



9. Install 12' straps around the tank, using the eyebolts provided. Use strips of foam underneath the straps to further protect the tank.



**Figure 1.42**

10. Ensure all straps are secure and tight.
11. To tip the tank down using a fork lift, the forks must first be removed. This will keep them from damaging the tank. We also recommend the same set up as mentioned before lifting the crate up vertically. The fork lift needs to pull the crate back and lower it simultaneously to lay the crate/S.U.B. system down.



**Figure 1.43**



**Figure 1.44**



**Figure 1.45**



**Figure 1.46**



**Figure 1.47**

12. With the tank secured in a horizontal position, each foot needs to have one lag screw, 3/8" x 4", installed to keep the base from putting a side load on the load cells during shipment. Ensure the lag screws go into the 4x4 underneath the feet.



**Figure 1.48**



**Figure 1.49**



**Figure 1.50**



**Figure 1.51**

13. **Bag Lift:** Remove the spider arm from the bag lift. Bubble wrap both pieces and finish with stretch wrap (Figure 1.51).



14. Attach bag lift frame to bottom of the small base using a cloth strap (1585T22) and steel wire buckles (1958T85). You will need to staple the cloth straps to the plywood base and tension them with the wire buckles.
15. Remove straps and place bag lift assembly next to tank and resting on the cradles with the small arm in vertical position. Ensure the control box on the beam leaves enough clearance for the side of the crate to be installed. Once in place, strap the bag lift down using the same cloth strapping, staples and ring buckles.



**Figure 1.52**



**Figure 1.53**



**Figure 1.54**



16. Re-install tank straps, but add dense card board and/or thick foam between the buckle and the tank.
17. Lay ½" dense foam along bottom inside of tank for kneeling and access to the end of the tank to prevent damaging stainless finish. Insert miscellaneous parts box first, followed by the motor assembly box. Tip them upright, as shown, and run ratchet strap from eyebolt to eyebolt going through the bottom sensor port access to the hanging tab access holes. Place high density cardboard and thick foam in between strap and all sharp corners before tensioning strap.



**Figure 1.55**



**Figure 1.56**



**Figure 1.57**



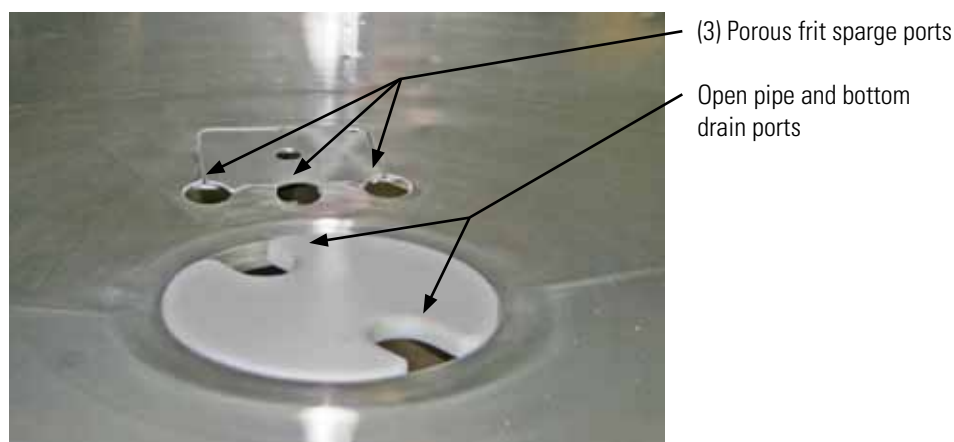
**Figure 1.58**

18. Double check all straps are properly tensioned and all points where straps cross sharp corners are properly padded.
19. Install both long sides
20. Install end cover.
21. Install top cover.
22. Paint and/or mark on all sides to "Open top cover first and read instructions before proceeding to unpack crate."

## 2000 L S.U.B. Assembly Instructions

### Tank Bottom

The tank bottom has two main access cut-out plates, one for the open pipe sparge and the bottom drain (harvest) ports and the other for three porous frit sparge ports (Figure 1.59).



**Figure 1.59**

Place the white plastic (Delrin) circular plate with two slots in the center recessed hole (Figure 1.59). The frit sparge tube port access rectangular plate is shown at the top of the Figure 1.59. This access plate is secured on one corner to let it rotate out of the way during installation of the disposable S.U.B. The stud may be tightened down for shipping to keep the plate from bouncing. To do this, unscrew the nylock nut underneath the plate about an inch (Figure 1.60). This will give the mechanism enough space to lift and rotate out of the way.



**Figure 1.60**

## Motor Mounting

The tank motor will need to be installed. When unpacking the motor assembly, note that the bolts and washers will already be in the aluminum block that will mount to the tank (Figure 1.61).

Use these bolts to mount the aluminum block to the stainless tank (Figure 1.62).



**Figure 1.61**



**Figure 1.62**

## Tank Tool Kit

The tool holder is installed just behind the motor with two socket button head screws, nuts and washers. There is enough room to hold the nuts and washers inside the tank motor mount. Install tools and shaft as shown.



**Figure 1.63**

## Bag Hoist Assembly

The bag hoist assembly is mounted on the side and top of the tank (Figure 1.64).



**Figure 1.64**

First remove the eye bolt where the bag lift is going to be mounted. To aid in assembly, a slot is provided on the tank for a finger of the bag lift to fit into to hold the bottom of the bag lift next to the tank (Figure 1.65). The bag lift also has a hook that engages the top lip of the tank (Figure 1.66). Once bag lift is in position, use the eye-bolt to mount it securely to the top of the tank (Figure 1.66).



**Figure 1.65**



**Figure 1.66**

## Electrical Box Mount and Assembly

The electrical box assembly can be mounted in two different locations on the base (Figure 1.67 and Figure 1.68).



**Figure 1.67**



**Figure 1.68**

Two of the three base feet have two mounting holes for the electrical box stand (Figure 1.69). Once the stand is in place, the electrical box has a plate mounted on the back that matches up to the stand. The top of the stand has two threaded holes that will line up with the plate. Use two socket button head screws to secure the electrical box plate to the stand.



**Figure 1.69**



**Figure 1.70**



## Condenser System

For Condenser set up and use, please refer to the Single-Use Bioreactor User's Guide, Section 2.4, beginning on page 78.

### Filter Bracket and Assembly (only required if Condenser System not used)

When a Condenser system is not used, dual filters and filter heaters must be employed. The filter bracket is set up by sliding the mounts up to the collar on the shaft. To do this, loosen the black clamps around the shaft and then tighten back up when in position. The base clamp will mount to the top of the tank by setting the clamp base on the SUB with the clamp knobs facing out. Screw these knobs in to secure the clamp assembly to the tank. The recommended position for the filter bracket base is 1-2 feet left of the mixer motor.



**Figure 1.71**

### External E-Stop Assembly

The purpose of the external e-stop is to provide quick access to an e-stop while working upon the ladder (Figure 1.72). It is mounted on the top lip of the tank (recommended directly above the electrical box) and the cord is plugged into the side of the electrical box (Figure 1.73).



**Figure 1.72**



**Figure 1.73**

## Harsh Mount Display

A harsh mount display can be mounted on top of the electrical box stand (Figure 1.74). The two mounting holes on top match the bolt pattern of the Harsh Mount Display (Figure 1.75).



**Figure 1.74**



**Figure 1.75**

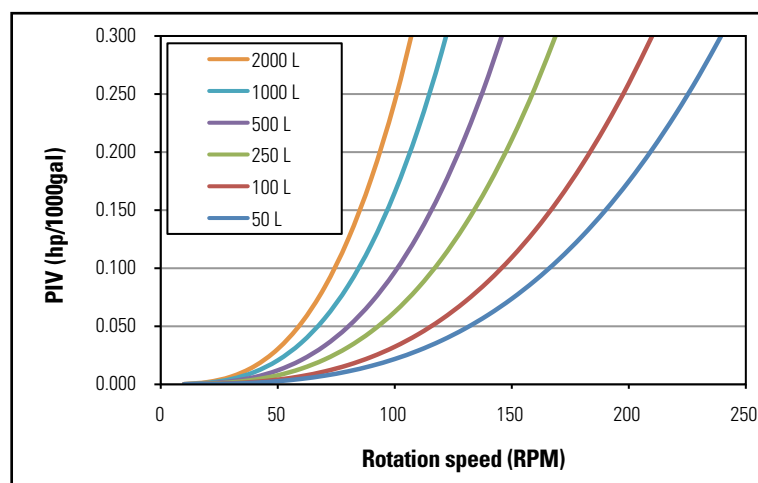
## Section 2 Functional Specifications

### 2.1 S.U.B. – Technical Operating Parameters (Dual Sparge Standard Product Line)

Functional performance of the S.U.B. depends largely upon the amount of agitation used to mix the S.U.B. and can have a direct influence upon cell growth performance of the system (due to parameters of shear, mixing time, and heat/mass transfer). All S.U.B. hardware systems have oversized mixer motors with gear reductions and a removable rigid shaft – typically the mixer speed for each system must be scaled based upon the size of the impeller and the liquid volume being mixed. Larger impellers will transfer more power to the liquid for a given rotational speed and because the design uses an angled mixer shaft instead of baffles, all systems will begin to vortex if the impeller is operated at excessive speed. Excessive vortexing will reduce the performance of the S.U.B. and can damage the drive shaft or impeller assembly (particularly in the larger scale 1000 and 2000 L systems). Therefore it is imperative that the mixer not be operated above nominal speed without the tank being filled to near full working volume. During drain operation, the mixing should be discontinued once the tank volume is below half the rated working volume. Systems with integrated controllers that employ safety interlocks with the agitation system will provide the highest system reliability; this should include deactivating agitation when the vessel is below half the rated working volume and limit the mixer speed ranges as listed in the matrix below.

### Recommended Mixer Speed Settings

Recommended mixer speed settings for all S.U.B.s are based upon a scaled Power Input to Volume (PIV) ratio of 0.1 hp/1000 gallons (assuming the impeller has a power number,  $N_p = 2.01$ ). These “nominal” mixer speeds are recommended as the process development starting point for performing suspension type animal cell culture.



**Graph 2.1** S.U.B. Mixing Power Input to Volume Estimations: (Simulation assumes the system is fill to rated working volume with water and Power Number ( $N_p$ ) =2.07)



## Standard Range Mixer Speed

Standard range mixer speed for all S.U.B.s is listed in Table 2.1. The mixer of the S.U.B. can be operated within this range of agitation speeds with fluid volumes anywhere from 50 to 110% of the rated working volume. In general, it is recommended as good practice to reduce the mixer speed of the impeller as the batch volume decreases in order to avoid excess shear and vortexing. The high end of this range represents 0.2 hp/1000 gallons in the 50-1000 L systems and 0.1 hp/1000 gallons in the 2000 L.

## Extended Range Mixer Speed

Extended range mixer speeds are the maximum recommended speeds for use with the S.U.B. but are to be used only under controlled conditions (meeting the following criteria). An interlock between the bioreactor controller and the reactor vessel is required to ensure reliable operation – in this case the standard range of mixer speeds cannot be exceeded unless the vessel is at 90% of working volume or greater. Load cells or a means to monitor batch volume should be the parameter interlock defined as 90-110% of the rated working volume. The upper end of this range represents 0.25 hp/1000 gallons in the 50-1000 L S.U.B. and 0.2 hp/1000 gallons in the 2000 L S.U.B.

	Nominal Setting (100% Working Volume)	Standard Range (50-110% Working Volume)		Extended Range (90-110% Working Volume Only)	
S.U.B. Size	Recommended Mixer Speed	Mixer Speed	VFD Settings (P24 and P39)	Mixer Speed	VFD Settings (P24 and P39)
50 L	169 rpm	30-213 rpm	72 Hz	20-230 rpm	77.5 Hz
100 L	146 rpm	30-183 rpm	61.7 Hz	20-197 rpm	66.4 Hz
250 L	118 rpm	30-150 rpm	63.2 Hz	20-161 rpm	67.9 Hz
500 L	100 rpm	30-128 rpm	21.6 Hz	20-138 rpm	23.3 Hz
1000 L	87 rpm	20-110 rpm	55.6 Hz	20-118 rpm	60.4 Hz
2000 L	75 rpm	20-75 rpm	37.8 Hz	20-95 rpm	47.9 Hz

**Table 2.1** Agitation and Specification Matrix (NOTE: The recommended VFD settings will scale the analog output of the VFD according to mixer speed listed (typically 0-10 VDC).

## Recommended Batch Temperature Setting

Recommended batch temperature setting is specified for growing most animal culture cultures, typically 37°C. However, specific applications will vary and the set point can be adjusted within the standard batch temperature range. Batch (process) temperature calibration should be verified on-site to ensure accuracy. See S.U.B. Facility Requirements Table for more information on the TCU specifications for water jacketed systems.

S.U.B. Size	Recommended Batch Volume Range	Recommended Batch Temperature Setting (100% WV)	Standard Batch Temperature Range
50 L	25-55 L	37°C	5-40°C
100 L	50-110 L	37°C	5-40°C
250 L	125-275 L	37°C	5-40°C
500 L	250-550 L	37°C	5-40°C
1000 L	500-1100 L	37°C	5-40°C
2000 L	1000-2200 L	37°C	5-40°C

**Table 2.2** Temperature Specification Matrix

## Standard Batch Temperature Range

Standard batch temperature range defines the temperature settings that are acceptable for use with the single use S.U.B. BPC (see Table 2..2). Resistive heated hardware cannot be actively cooled below room temperature; the jacketed systems can be operated down to batch temperatures of 5°C. The maximum recommended upper batch temperature for either system type is 40°C. Elevating the batch temperature beyond 40°C is not recommended as this reduces system reliability or may irreparably damage the S.U.B. BPC.

## Sparging, Off-gassing, and Backpressure Specification

Proper gas management in the S.U.B. should be a conservative balance between providing good mass transfer while managing bubble shear force, foaming, and internal BPC back pressure. Flow rates approaching or exceeding the suggested maximum values will likely necessitate the use of antifoam additives in the media.

S.U.B. Size	Micro Sparge Flow Rate Setting (at 100% working volume)		Macro Sparge Flow Rates (at 100% working volume)		Overlay Sparge Flow Rates		Off-Gassing Flow Rates		SUB-BPC Internal Pressure – Not to Exceed	
	Suggested Maximum	Rated Maximum	Suggested Maximum	Rated Maximum	Suggested Maximum	Rated Maximum	Suggested Maximum	Rated Maximum	Suggested Maximum	Rated Maximum
50 L	0.5 lpm	25 lpm	2 lpm	25 lpm	5 lpm	25 lpm	10 lpm	25 lpm	<0.1 psi	0.5 psi
100 L	1 lpm	25 lpm	4 lpm	25 lpm	5 lpm	25 lpm	10 lpm	25 lpm	<0.1 psi	0.5 psi
250 L	2 lpm	25 lpm	6 lpm	25 lpm	5 lpm	25 lpm	10 lpm	25 lpm	<0.1 psi	0.5 psi
500 L	4 lpm	55 lpm	8 lpm	65 lpm	10 lpm	25 lpm	25 lpm	50 lpm	<0.1 psi	0.5 psi
1000 L	8 lpm	55 lpm	10 lpm	65 lpm	10 lpm	50 lpm	25 lpm	50 lpm	<0.1 psi	0.5 psi
2000 L	16 lpm	70 lpm	12 lpm	65 lpm	50 lpm	100 lpm	50 lpm	100 lpm	<0.1 psi	0.5 psi

**Table 2.3** Sparging, Off-gassing, and Backpressure Specification Matrix

### Micro Sparge Setting

The suggested setting is based upon experience of providing good oxygen transfer without excessive shear, coalescing, or foam generation.

### Macro Sparge Setting

The suggested setting is based upon experience of providing good oxygen transfer with the benefit of providing CO<sub>2</sub> stripping and some improved control against foam generation.

### Overlay Sparge Setting

The amount of overlay allowed is best set by determining the balance of gas exhaust vent flow capacity still available, while keeping the internal back pressure of the S.U.B. BPC under safe operating conditions. Typical applications with the S.U.B. will not require the use of the overlay vent if the open pipe sparge is being used.

## Maximum Flow Ratings

Maximum flow ratings are based upon the physical and mechanical limitations of each sparger flow channel of the standard BPC assembly (flow restrictions related to filters, check valves, diffusers not to exceed a pressure drop of 10-psi). In practice it is expected that most users will not operate near these maximum ratings.

## Operating Pressure

Operating Pressure must be considered as part of developing a robust cell culture process and it is good practice to avoid conditions that will make the top of the S.U.B. BPC bag appear tight (>0.1 psi). Typically the exhaust vent filters will block over time, thus reduced capacity will increase pressure drop across the filter media as the run progresses. Vent filter heaters are recommended in order to flash condensate that may accumulate near or on the filter media. Maximum rated operating pressure is 0.5 psi; exceeding this increases drive shaft wear and may result in bursting the BPC (typically at a location above liquid level). Applications requiring large gas flow can use the Single-Use Bioreactor Condenser System to provide additional protection and reliability.

## Sparge Flow Meter Recommendations

Flow meters should be scaled for the proper vessel size depending upon the maximum or expected oxygen uptake rate (OUR) of the targeted cell line. It is common in many process development applications to use a modular control platform to manage multiple S.U.B. systems. In this case it is good practice to consolidate the S.U.B.s into scaled groupings (50-250 L, 500-1000 L, 2000 L for example) and in this case select the upper flow rate listed on the standard range for the largest system specified for the bioreactor work station (typically this is sufficient to provide both sparging flow rate accuracy and capacity).

S.U.B. Size	Air		Oxygen		Carbon Dioxide		Nitrogen (optional)	
	Recommended Setting:	Standard Range:	Recommended Setting:	Standard Range:	Recommended Setting:	Standard Range:	Recommended Setting:	Standard Range:
50 L	0.5 lpm	0-5 lpm	0.25 lpm	0-1 lpm	0.1 lpm	0-0.5 lpm	0.25 lpm	0-1 lpm
100 L	1 lpm	0-5 lpm	0.5 lpm	0-1 lpm	0.2 lpm	0-0.5 lpm	0.5 lpm	0-1 lpm
250 L	2.5 lpm	0-5 lpm	1.25 lpm	0-2 lpm	0.5 lpm	0-1 lpm	1.25 lpm	0-2 lpm
500 L	5 lpm	0-10 lpm	2.5 lpm	0-5 lpm	1 lpm	0-2 lpm	2.5 lpm	0-5 lpm
1000 L	8 lpm	0-15 lpm	4 lpm	0-5 lpm	1 lpm	0-2 lpm	2.5 lpm	0-5 lpm
2000 L	16 lpm	0-30 lpm	8 lpm	0-10 lpm	1 lpm	0-2 lpm	2.5 lpm	0-10 lpm

**Table 2.4** Sparge Flow Meter Recommendations

## S.U.B. (Water Jacket) - Facility Requirements and Specifications for Installation

Specifications for the S.U.B. with water jacket are listed below. The system heights are listed for overall installed height and the required overall height required for installing the drive shaft into the top mounted agitation drive system. Jacket temperature range specified is wider than the batch temperature range; this will allow the jacket to more efficiently transfer heat by allowing high temperature gradients between the batch and jacket temperatures during temperate shifts. Do not exceed a jacket temperature of 50°C for extended periods (batch temperatures above 40°C can lead to product damage and system failure). Jacket flow rate varies largely depending upon the style and size of pump used in the thermo-circulation system. For best results jacket inlet pressure and TCU thermal capacity should meet or exceed the recommendations listed.

S.U.B. Size	Power Requirements		System Weight		System Foot Print		System Height		Jacket Temperature Range		Jacket Supply Pressure		Minimum Recommended TCU Thermal Capacity	
	108-125 VAC	208-240 VAC	Dry	Wet	W	L	Overall	Req.	Low	High	Suggested	Range	Heat	Cool
50 L	10 W	10 W	285 lbs	395 lbs	23"	34"	52.5"	80"	2°C	50°C	60 psi	14-145 psi	0.5 kW	0.5 kW
100 L	10 W	10 W	372 lbs	592 lbs	29.5"	42"	56"	85"	2°C	50°C	60 psi	14-145 psi	1 kW	1 kW
250 L	10 W	10 W	440 lbs	991 lbs	26"	35"	60"	96"*	2°C	50°C	60 psi	14-145 psi	2.5 kW	2.5 kW
500 L	N/A	10 W	724 lbs	1826 lbs	39.25"	52.2"	70"	95"	2°C	50°C	60 psi	14-145 psi	5 kW	5 kW
1000 L	N/A	10 W	1138 lbs	3343 lbs	40"	48"	84"	120"*	2°C	50°C	60 psi	14-145 psi	10 kW	10 kW
2000 L	N/A	30 W	1800 lbs	6200 lbs	58.9"	63.7"	126.5"	132"	2°C	50°C	60 psi	14-145 psi	20 kW	20 kW

**Table 2.5** S.U.B. (Water Jacket) - Facility Requirements and Specifications for Installation

\*250 L S.U.B. w/ custom 2-piece agitation shaft (SH50177.41) requires 84"

\*1000 L S.U.B. w/ custom 4-piece agitation shaft (SH50177.39) requires 112"

Specifications for the S.U.B. with resistive heater blanket are listed below. The system heights are listed for overall installed height and also the required overall height required for installing the drive shaft into the top mounted agitation drive system. The jacket temperature range is limited to temperatures at or above ambient conditions. It is best practice to set up the system and operator process to reduce the likely hood of the S.U.B. being operated improperly (without the bag being loaded properly - filled to at least 50% of working volume before the heater is enabled). When integrating a bioreactor control system, an interlock between the heater and vessel load cells should be implemented to ensure the tank heater does not operate unless intended.

SUB	Power Requirements		System Weight		System Foot Print		System Height		System Temperature Range		Resistive Heater Capacity	
	108-125 VAC	208-240 VAC	Dry	Wet	W	L	Overall	Req.	Low	High	108-125 VAC	208-230 VAC
<b>50 L</b>	15 Amps	10 Amps			25.8"	36.1"	52.8"	80"	Ambient	40°C	0.4 kW	0.4 kW
<b>100 L</b>	15 Amps	10 Amps	372 lbs	592 lbs	29.5"	42"	56"	85"	Ambient	40°C	0.6 kW	0.6 kW
<b>250 L</b>	20 Amps	10 Amps	440 lbs	991 lbs	26"	35"	60"	96"*	Ambient	40°C	1.3 kW	1.3 kW
<b>500 L</b>	N/A	20 Amps	591 lbs	1693 lbs	39.3"	52.2"	77"	95"	Ambient	40°C	N/A	2.8 kW
<b>1000 L</b>	N/A	30 Amps	600 lbs	2805 lbs	40"	48"	84"	110"*	Ambient	40°C	N/A	5 kW

**Table 2.6** S.U.B. (Resistive Heater Blanket) - Specifications for Installation

\*250 L S.U.B. w/ custom 2-piece agitation shaft (SH50177.41) requires 84"

\*1000 L S.U.B. w/ custome 4-piece agitation shaft (SH50177.39) requires 112"

## Section 3 Product Information

### 2000 L Jacketed Volumetric Flow

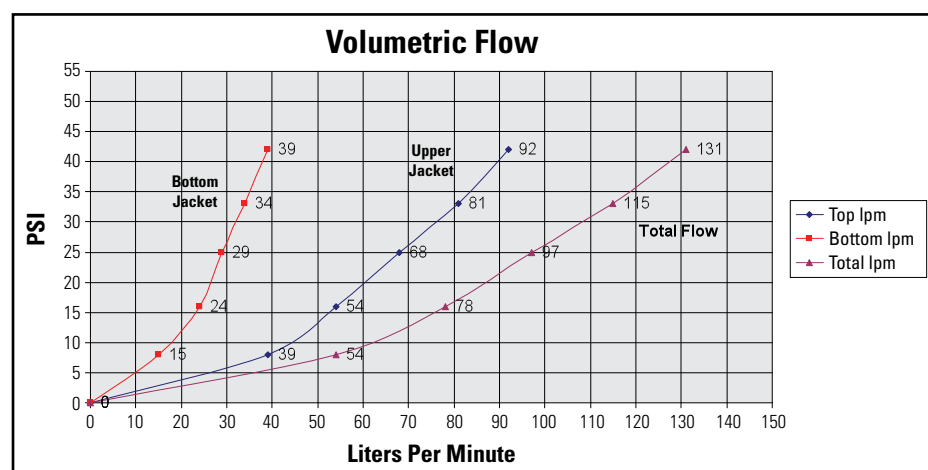
Tests were performed to demonstrate the flow rate performance and resulting pressure drop typical of the water jacket used on the 2000 L S.U.B. hardware system. Tests were conducted with a 2 hp centrifugal recirculation pump using water as the jacket circulation fluid. Valves, pressure gauges, and flow meters were used to regulate and record the results presented in Table 3.1. A typical inlet pressure of 60 psi resulted in a jacket flow rate of 115 lpm and a pressure drop of 33 psi. The piping of the jacket utilized the standard 1" quick connects and was tested using the preferred parallel flow path between the top and bottom jackets. This resulted in a flow distribution of 70% (top) and 30% (bottom) as seen in Graph 3.1.

The total fluid volume of the top and bottom jacket is approximately 32.4 L (upper jacket 29 L, bottom jacket 3.5 L) .

The total area of the top and bottom jacket is approximately 7759.7 in<sup>2</sup> (upper jacket 6832.7 in<sup>2</sup>, bottom jacket 927 in<sup>2</sup>).

2000 L JACKETED	Tank Inlet	Tank Outlet	Pressure Drop	Total	Bottom	Side	Bottom Jacket Flow Distribution
	42 psi	42 psi	0 psi	0 lpm	0 lpm	0 lpm	0
	45 psi	37 psi	8 psi	54 lpm	15 lpm	39 lpm	28%
	50 psi	34 psi	16 psi	78 lpm	24 lpm	54 lpm	31%
	55 psi	30 psi	25 psi	97 lpm	29 lpm	68 lpm	30%
	60 psi	27 psi	33 psi	115 lpm	34 lpm	81 lpm	30%
	65 psi	23 psi	42 psi	131 lpm	39 lpm	92 lpm	30%

**Table 3.1.** 2000 L Jacketed Volumetric Flow at Specific PSI with Head Pressure Shown



**Graph 3.1.** 2000 L Jacketed Volumetric Flow at Specific PSI, Minus Head Pressure

## Section 4 Troubleshooting

<b>Symptom</b>	Single-Use Bioreactor will not operate.
<b>Remedy</b>	<p>Check power supply.</p> <ul style="list-style-type: none"><li>• Verify main electrical plug connection at wall outlet, verify position of main power disconnect, and verify position of Emergency Stop switch.</li><li>• Verify condition of main electrical circuit breaker of facility. If protection breaker has been tripped, determine fault condition. The condition may exist where other electrical systems are requiring current loads beyond those allowed by the breaker. S.U.B. system should be placed on its own electrical circuit.</li><li>• Disconnect main power cord. Inspect electrical circuit breakers and fuses inside the electrical enclosure of the S.U.B. controller. Determine fault condition by visual inspection. If fault condition can not be determined by visual inspection, contact manufacturer.</li></ul>
<b>Symptom</b>	Single-Use Bioreactor temperature is below target or slow to respond.
<b>Remedy</b>	<p>Check temperature controller and sensor.</p> <ul style="list-style-type: none"><li>• Verify the temperature probe (RTD) is not loose and has been fully inserted into the S.U.B. BPC thermo-well.</li><li>• Verify thermo-well has been filled with sufficient glycerol to aid in heat transfer.</li><li>• Verify that temperature controller is enabled. Indicator light (green LED labeled–C1) will illuminate when temperature controller is cycling heater to maintain target temperature.</li><li>• Verify mixer is operating, safety interlock will not allow heaters to warm without the mixer in operation.</li><li>• Verify system is filled with sufficient volume of fluid. There must be enough volume of media (minimum volume) in S.U.B. BPC to provide contact with the bag (add more media if BPC is not touching heater area).</li></ul>

<b>Symptom</b>	Mixer controller does not respond to user inputs.
<b>Remedy</b>	<p>Allow speed to stabilize before using key-pad interface.</p> <ul style="list-style-type: none"> <li>• Rapidly adjusting speed control in an excessive manner may require several seconds for speed stabilization.</li> <li>• Wait ten seconds and then attempt to adjust speed at key-pad interface.</li> <li>• Users should verify the position of the input select switch of the VFD. If the toggle switch is not in the middle position, the controller will not be able to receive control inputs from the control keypad on the front panel.</li> </ul>
<b>Symptom</b>	Dissolved Oxygen (DO) readings are low or slow to respond.
<b>Remedy</b>	<p>Check physical condition of the DO probe, calibration of the DO probe, flow rate of gas into S.U.B.</p> <ul style="list-style-type: none"> <li>• DO probes require routine maintenance; replace damaged probe or membrane.</li> <li>• Verify DO probe calibration relative to set-points of zero and span.</li> <li>• Inspect line sets connected to direct spargers for restriction (closed tubing clamp, pinched line, low supply pressure).</li> </ul>
<b>Symptom</b>	Direct membrane sparge does not seem to be working although gas is present.
<b>Remedy</b>	<p>Allow sparge membrane to purge.</p> <ul style="list-style-type: none"> <li>• If the S.U.B. is filled with liquid and allowed to sit idle for extended periods of time without gas being supplied to the sparge, liquid can accumulate between the membrane and check valve. Various media additives may restrict the membrane temporarily. Several minutes of gas pressure being supplied to the sparge should purge the membrane, allowing it to function properly.</li> <li>• Certain operating conditions can create situations when the sparge membrane may become restricted due to insufficient line pressure from the bioreactor controller gas feed line. Increasing the flow rate to 1 liter per minute, or momentarily raising the pressure regulator outlet pressure to 5 psi (0.34 bar) may alleviate the problem. Alternatively, several seconds at this higher pressure will allow the membrane to purge pores that may be blocked due to the presence of accumulated liquid.</li> </ul>



<b>Symptom</b>	DO readings are erratic or unstable.
<b>Remedy</b>	<p>Adjust bioreactor controller to suite the volume of the S.U.B. system.</p> <ul style="list-style-type: none"><li>• Many different parameters can effect the ability of a bioreactor controller to effectively maintain a target setpoint during process control. Modern controllers utilize computer algorithms to adjust targeted parameters, the most common technique is that of tunable controller that uses variables of PID. Tuning these PID values to the specific characteristics of the system dynamics will in most cases stabilize process parameters to an acceptable level. It is recommended that S.U.B. users consult the user manual of the particular bioreactor controller being used.</li><li>• A grounding reference to the media can be created by using a grounding lead between the tank and the body of the stainless steel DO probe or to the stainless steel connector (if present) on the sample line of the S.U.B BPC.</li></ul>
<b>Symptom</b>	Most traditional systems utilize a condenser or exhaust vent heater to help manage condensate; is this necessary for the S.U.B.?
<b>Remedy</b>	Extensive testing has found that an exhaust heater or a condenser is not typically required under normal operating conditions for S.U.B.s 500 L or smaller. However more demanding applications may warrant an exhaust vent heater which is available from your sales rep.
<b>Symptom</b>	I typically use level sensors to control volume and feed rate or supplement during a bioreactor run; how would I do this with the S.U.B.?
<b>Remedy</b>	<p>Use load cells or a scale to control volumes based upon weight.</p> <ul style="list-style-type: none"><li>• The S.U.B. is not equipped with level sensors. However, the S.U.B. can be setup to allow supplement feeds and volumes to be managed by weight. Please refer to Section 3 for skid dimensions for sizing of scales.</li></ul>

## **Symptom**

pH levels are questionable or out of range.

## **Remedy**

Verify calibration of probe, utilize either media or gas buffers.

- pH levels can be managed in a similar manner to conventional bioreactors once calibration of the probe is verified by use of an off-line sample. Carbon dioxide gas sparged through the media or headspace, biocarbonate levels in the media, and the addition of liquid titrant solutions all serve to manage the pH balance of the bioreactor environment. See Section 2.5 - Probe Assembly instructions for more information on probe calibration.
- A grounding reference to the media can be created by using a grounding lead between the tank and the body of the stainless steel DO probe or to the stainless steel connector (if present) on the sample line of the S.U.B BPC.

## **Symptom**

S.U.B. BPC seems overly tight or overpressure.

## **Remedy**

Verify bag is venting and inspect for cause of overpressure.

- Reduce inlet gas flow rate of overlay and direct sparge.
- Inspect exhaust filter for restriction or blockage.
- Excessive foaming should be avoided for several reasons. If foam levels are allowed to reach the exhaust filter, the filter will become restricted resulting in excessive internal pressure within the confines of the S.U.B. This may cause product failure and impending burst of the S.U.B. BPC.

## **Symptom**

Noise emitted from the BPC mixer assembly.

## **Remedy**

No action required.

- The bearing port assembly supplied with the S.U.B. is an important component in maintaining a sterile environment during cell growth. The special seals used in the S.U.B. may generate some noise during operation, particularly after the first day of operation. This noise may vary in intensity and frequency but generally has no significant effect upon performance or overall durability of the S.U.B. BPC during the intended life of the product.

## Symptom

We forgot to introduce the pH and DO probes prior to media fill; can we still make a sterile connection under these conditions?

## Remedy

Yes, as long as the clamps were closed on the Kleenpak Connector probe ports before liquid fill.

- The Kleenpak connectors must be dry to make the connection of the probe assemblies. When media is already present in the S.U.B., follow the probe insertion procedures as outlined in Section 2.5: Probe Assembly. Some fluid may enter the bellows when the probe is inserted into a BPC already filled with media.

## Symptom

I am not familiar with the use of the Pall Kleenpak Connectors and am concerned about making connections. What can I do to ensure a successful connection using this system?

## Remedy

Familiarize yourself with the Pall Kleenpak Connector instructions found in Section 2.7 before beginning.

- When a connection is being made, visually evaluate the status of the four locking external clips and verify they are tightly secured (the snap should be audible for all four clips when pressing the connectors together). Always make sure the four locking clips are fully engaged for the male/female connection before removing the paper strips.
- A common cause for a leaky Kleenpak is an error in the final step of seating the tapered barrels of the male/female connector. There are a series of concentric rings inside the male connector (0.3" in front of the black O-ring) Visually verify that the four internal clips are on the last set of rings. Using both hands place connector flanges between index fingers and thumbs and squeeze until properly seated.

<b>Symptom</b>	We are not achieving the cell growth we expected in the S.U.B. while running under our normal bioreactor agitation and sparging rates. What should we do?
<b>Remedy</b>	<p>Reduce agitation and sparging rates.</p> <ul style="list-style-type: none"><li>• Often low cell viability and cell growth can be attributed to excessive sparging or agitation. It is recommended that users reduce their sparge rate compared to what they might use in a conventional bioreactor. Gas flow rates supplied as overlay should also be reduced as much as possible. Too much gas creates excess foam and higher shear conditions. Provide only the level of agitation needed: low viability and lysed cells, reduce agitation speed—cell aggregation and settling, increase agitation. Media formulation can also have a large affect on cell culture growth in the S.U.B. Surfactants such as Pluronic decrease shear and increase <math>k_L a</math>, but at a cost of increased foaming. Thermo Scientific can offer custom media especially for the S.U.B. and customer's specific cell line(s).</li></ul>
<b>Symptom</b>	Excessive foam in the bioreactor headspace.
<b>Remedy</b>	<p>Alter the liquid surface tension related to the culture media and/or sparge gas.</p> <ul style="list-style-type: none"><li>• A media supplement of antifoam can be used in the S.U.B. These serve to lower the surface tension of the media and will reduce the presence of foam.</li><li>• High sparge rates of air can result in the presence of excessive foam. Testing has shown that sparging with oxygen will typically result in dramatic reduction of foam in the headspace.</li></ul>

## Section 5 Ordering Information

This section covers the following information:

- 5.1 Ordering Information: Disposables (BPC)
- 5.2 Ordering Information: Hardware
- 5.3 Ordering Information: Accessories
- 5.4 Ordering Information: Partial Spare Parts List
- 5.5 Replacement and Spare Parts
- 5.6 Ordering Instructions
- 5.7 Ordering/Support Contact Information

## 5.1 Ordering Information

### Disposables

#### Standard BPC Products

Part Number	Description	Additional Information
SH30774.01	50 L S.U.B. BPC	Standard dual sparge bags featuring an open pipe sparge and a porous frit sparge. All S.U.B. BPCs provided gamma-sterilized.
SH30774.02	100 L S.U.B. BPC	
SH30774.03	250 L S.U.B. BPC	
SH30774.04	500 L S.U.B. BPC	
SH30774.05	1000 L S.U.B. BPC	
SH30774.07	2000 L S.U.B. BPC	
SH30774.08	2000 L S.U.B. BPC w/o condenser assembly	

#### Custom BPC Products

Category	Options/Capability	Remarks
<b>Tubing Type</b>	C Flex, platinum cured silicone, PVC, Pharmed®, PharmaPure®	More information in selection guide of BPC catalog
<b>Tubing Size</b>	Specific lengths of 1/8" ID to 1" ID	ID limitations due to port size
<b>Connectors</b>	Luers, CPC Quick Connects, SIP connectors, Triclamp, Kleenpak, Lynx®, SmartSite®, Clave®, Lynx steam thru, CPC Steam Thru, Gore steam valve, Gore Mini TC, BioQuate (GE), PAW SterilEnz®, end plug, etc.	Refer to selection guide in BPC catalog for further information by connection type. <b>Note:</b> Only option for probe port connections is Kleenpak.
<b>Kleenpak (i.e., probe) ports</b>	Additional ports: second row of 4 for 50 L to 250 L S.U.B.s; second row of 5 for 500 L and 1000 L S.U.B.s	
<b>Disposable sensors</b>	Pressure sensor: Pendotech for 50 L to 250 L S.U.B. (comes standard on 500 L and 1000 L) DO – Finesse DO and pH – PreSens Availability of various other disposable sensors currently pending.	
<b>Addition of ports/lines (other than 2nd row of probe ports)</b>	Limited engineer-to-order customization possible such as additional media lines and vent filter lines. Requires economic justification.	Dependent on location in bag and compatibility with hardware
<b>Port sizes</b>	Limited customization possible as engineer-to-order with justification.	Dependent on location in bag and fit with hardware (e.g., 1" ID port on harvest line)
<b>Re-arrangement of lines on existing ports</b>	Limited customization possible, e.g., moving sample/tempwell port to a probe tube port, or swapping overlay inlet line with supplement line.	Dependent on location in bag and fit with hardware
<b>Sparger</b>	Dual sparger (open pipe plus porous frit) standard. Can do an engineer-to-order for one or the other alone. Make-to-order bags will be built around standard dual sparger chamber.	
<b>Dip tube lines</b>	Limited customization possible. Suggested use through 1" port, so this is engineer-to-order. Otherwise must use ferrule approach.	Length cannot interfere with impeller and shaft. Typical is 10" or shorter.
<b>Overlay and Sparge Line Filters</b>	Can use disposable (capsule) filter other than standard hydrophobic vent filter with Emflon II.	
<b>Vent Filters</b>	Standard is Pall Kleenpak 0.2 micron exhaust vent filter.	<b>NOTE:</b> Vent filter heater configuration restricts options
<b>Vent Filter Tubing Length</b>	Extended filter height above the S.U.B. bag is make-to-order.	Must be compatible with a vent filter bracket option
<b>Filters on Media and Supplement Inlets</b>	Choice of filters for inlets used to sterile filter incoming media or supplements.	

## 5.2 Ordering Information

### Hardware Standard S.U.B. Products

50 L, 100 L, 250 L and 500 L S.U.B. Systems Include: 304 stainless steel outer support container with swivel caster platform, variable speed agitation controller, motor, drive assembly with shaft, PID temperature controller (resistive only), RTD sensor, integrated resistive heating element or jacket, probe shelf and standard tool set.

Part Number	Description
SV50171.01	50 L S.U.B., Electric Resistive Heater, US version (120 VAC)
SV50171.02	50 L S.U.B., Electric Resistive Heater, EU version (240 VAC)
SV50171.03	50 L S.U.B., Water Jacket, US version (120 VAC)
SV50171.04	50 L S.U.B., Water Jacket, EU version (240 VAC)

Part Number	Description
SV50197.01	100 L S.U.B., Electric Resistive Heater, US version (120 VAC)
SV50197.02	100 L S.U.B., Electric Resistive Heater, EU version (240 VAC)
SV50197.03	100 L S.U.B., Water Jacket, US version (120 VAC)
SV50197.04	100 L S.U.B., Water Jacket, EU version (240 VAC)

Part Number	Description
SV50172.01	250 L S.U.B., Electric Resistive Heater, US version (120 VAC)
SV50172.02	250 L S.U.B., Electric Resistive Heater, EU version (240 VAC)
SV50172.03	250 L S.U.B., Water Jacket, US version (120 VAC)
SV50172.04	250 L S.U.B., Water Jacket, EU version (240 VAC)

Part Number	Description
SV50200.02	500 L S.U.B., Electric Resistive Heater, US/EU version (208/240 VAC)
SV50200.04	500 L S.U.B., Water Jacket, US/EU version (208/240 VAC)



1000 L S.U.B. Systems Include: 304 stainless steel outer support container with swivel caster platform, variable speed agitation controller, motor, drive assembly with shaft, PID temperature controller, three load cells with summing block, display and wiring, RTD sensor, integrated resistive heating element, probe shelf, and standard tool set.

Part Number	Description
SV50174.01	1000 L S.U.B. Electric Resistive Heater, Modbus Plus Interface (240 VAC)
SV50174.02	1000 L S.U.B. Electric Resistive Heater, Allen-Bradley Interface (240 VAC)
SV50174.03	1000 L S.U.B. Electric Resistive Heater, Analog Output Interface (240 VAC)
SV50174.04	1000 L S.U.B. Electric Resistive Heater, Profibus Interface (240 VAC)
SV50174.05	1000 L S.U.B. Resistive Heater, DeviceNet Interface (240 VAC)

Part Number	Description
SV50174.11	1000 L S.U.B. Water Jacket, Modbus Plus Interface (240 VAC)
SV50174.12	1000 L S.U.B. Water Jacket, Allen-Bradley Interface (240 VAC)
SV50174.13	1000 L S.U.B. Water Jacket, Analog Output Interface (240 VAC)
SV50174.14	1000 L S.U.B. Water Jacket, Profibus Interface (240 VAC)
SV50174.15	1000 L S.U.B. Water Jacket, DeviceNet Interface (240 VAC)

2000 L S.U.B. Systems Include: 304 stainless steel outer support container, variable speed agitation controller, motor, drive assembly with four segment drive shaft, RTD sensor, integrated water jacket, three load cells with summing block/display, BPC pressure monitor, probe support system, and standard tool set.

Part Number	Description
SV50223.11	2000 L S.U.B. Water Jacket, Modbus Plus Interface (240 VAC)
SV50223.12	2000 L S.U.B. Water Jacket, Allen-Bradley Interface (240 VAC)
SV50223.13	2000 L S.U.B. Water Jacket, Analog Output Interface (240 VAC)
SV50223.14	2000 L S.U.B. Water Jacket, Profibus Interface (240 VAC)
SV50223.15	2000 L S.U.B. Water Jacket, DeviceNet Interface (240 VAC)

The S.U.B. Condenser System consists of a cart and brackets, a condenser (chill) plate, a peristaltic pump, and a temperature control unit (TCU, also referred to as a chiller).

Part Number	Description
SV50232.01	Complete Condenser System (120 V) including cart, chill plate and mounting post with filter brackets, TCU, and pump
SV50232.02	Complete Condenser System (240 V) including cart, chill plate and mounting post with filter brackets, TCU, and pump
SV50232.21	Condenser assembly including chill plate and mounting post with filter brackets (Option: Allowing two chill plates per systems)
SV50232.23	Thermoflex 900 TCU (115 VAC/60 Hz) with necessary plumbing
SV50232.24	Thermoflex 900 TCU (240 VAC/50 or 60 Hz) with necessary plumbing
SV50241.01	Thermo Scientific Masterflex Pump (115 VAC/50 or 60 Hz or 230 VAC/50 or 60 Hz)

## 5.3 Ordering Information

### Accessories

Part Number	Description
SH30720.01	Bioreactor Probe Assembly (non-sterile)
SH30845.01	Sterile Sampling Manifold with luer lock (individual)
SH30845.02	Sterile Sampling Manifold with luer lock (10 count)
SV20664.01	Heavy Duty Tubing Clamp
SV20664.02	Heavy Duty Tubing Clamps (4 pack of SV20664.01)
SV20664.03	Heavy Duty Tubing Clamps (10 pack of SV20664.01)
SV20750.01	S.U.B. Temperature/Sample Port
SV50177.01	Autoclave Tray for Probe Kits (stainless steel)
SV50177.110	16 Pin communication cable (male end one end)
SV50177.111	2 Pin heater on/off cable for external control
SV50177.16	Elevated Single Filter Bracket Assembly for 50, 100 and 250 L
SV50177.17	Elevated Filter Bracket Assembly 25.5" for dual filters—fits all sizes except 1000 L jacketed S.U.B. and 2000 L S.U.B.
SV50177.20	Elevated Dual Filter Bracket for 1000 L jacketed S.U.B.
SV50177.21	Adapter piece for 1000 L resistive heater S.U.B. to enable use of SV50177.17
SV50177.23	Probe Hanger Clip (2000 L S.U.B. only)
SV50177.65	Frit Sparge Line Support
SV50191.01	Vent Filter Heater with programmable controller (100-120 VAC)
SV50191.01-09	Vent Filter Heater and Cord Options (For use with exhaust filters when not using condenser system.)
SV50191.02	Standard filter heater power cord for US/Japan, NEMA 5-15P w/6' lead (100-120 VAC)
SV50191.03	Vent Filter Heater with programmable controller (200-240 VAC)
SV50191.04	Custom filter heater power cord for use in UK, BS1363 w/10' lead (240 VAC)
SV50191.05	Custom filter heater power cord for use in Europe, CEE 7/7 w/12' lead (240 VAC)
SV50191.06	Custom Power Cord for US/Japan, NEMA 5-15P w/ 12' leads & GFCI (100-120 VAC)
SV50191.07	Custom Power Cord for UK, BS1363 w/ 12' leads & GFCI (240 VAC)
SV50191.08	Custom Power Cord for Europe, CEE 7/7 w/ 12' leads & GFCI (240 VAC)
SV50191.09	Custom Extension Cord for filter heater, for use between heater and controller, 10' (100-240VAC)
SV50191.10	Vent Filter Heater with RTD (two wire Pt-100), (100-120 VAC/17-24 W)
SV50191.11	NEMA rated Vent Heater w/ Programmable Controller (100-120VAC), power cord
SV50191.13	NEMA rated Vent Heater w/ Programmable Controller (200-240VAC), power cord
SV50191.16	NEMA rated Vent Heater w/ Programmable Controller (100-120VAC)
SV50191.17	NEMA rated Vent Heater w/ Programmable Controller (200-240VAC)
SV50191.18	NEMA rated Vent Heater w/ Programmable Controller (200-240VAC)
SV50191.19	NEMA rated Vent Heater w/ Programmable Controller (200-240VAC)
SV50193.10	250 L, 500 L Load Cell Kit - Analog load cells (3), display, choice of interface
SV50194.10	50 L, 100 L Load Cell Kit - Analog load cells (3), display, choice of interface
SV50244.01	Dual Filter Bracket for 2000 L S.U.B. tank (when not using condenser system). Accommodates two vent filter heater units.
SV50935.01	Mobile Stairs (2000 L S.U.B. only)

## 5.4 Ordering Information

### Partial Spare Parts List

Part Number	Description
SV50177.01	Probe Kit Autoclave Tray (SST w/Plastic Carry handle)
SV50177.02	Probe Holder, retains Probe Adapters in Closed Position (SST)
SV50177.03	Filter Bracket Assembly, 11", Single Filter (Anodized Aluminum)
SV50177.06	Motor Sleeve Cap-threaded (Anodized Aluminum)
SV50177.10	2" Open End Wrench (Anodized Aluminum)
SV50177.11	Torque Wrench-3/8" Drive-150 in-lbs (Plated Steel Construction)
SV50177.12	Stretch Hooks (Rubber w/SST hooks)
SV50177.15	Filter Bracket Assembly, 18", Single Filter (Anodized Aluminum)
SV50177.16	Filter Bracket Assembly, 24", Single Filter (Anodized Aluminum)
SV50177.17	Filter Bracket Assembly, 25.5", Dual Filter (Anodized Aluminum & SST)
SV50177.18	Filter Bracket, Dual Filter (SST) 1000 L Jacketed S.U.B.
SV50177.19	Filter Bracket, Dual Filter (SST), 1000 L Resistive S.U.B.
SV50177.20	Filter Bracket Assy, Dual Filter (SST), 1000L Jacketed S.U.B.
SV50177.34	Drive Shaft Assembly, 50 L S.U.B. (One (1) Piece Integrated Design) (Delrin/ Anodized Aluminum)
SV50177.35	Drive Shaft Assembly, 250 L S.U.B. (One (1) Piece Integrated Design) (Delrin/ Anodized Aluminum)
SV50177.36	Drive Shaft Assembly, 500 L S.U.B. (Two (2) Piece Integrated Design) (Delrin/ SST)
SV50177.38	Drive Shaft Assembly, 1000 L S.U.B. (Three (3) Piece Integrated Design) (Delrin/ SST)
SV50177.39	Drive Shaft Assembly, 1000 L S.U.B. (Four (4) Piece Integrated Design) (Delrin/ SST) (NON- Released Engineering Design)
SV50177.40	Drive Shaft Assembly, 250 L S.U.B. (One (1) Piece Integrated Design) (Delrin/ SST)
SV50177.41	Drive Shaft Assembly, 250 L S.U.B. (Two (2) Piece Integrated Design) (Delrin/ SST)
SV50177.65	Frit Sparge Line Support
SV50177.90	Safety Cap, Drive Shaft/Motor Assembly (Clear Lexan)
SV50177.110	Cable Assembly, 16 Pin, Main communication cable from S.U.B./S.U.M. to External Controller (Male one end)
SV50177.112	Cable Assembly, 16 Pin, Main communication cable from S.U.B./S.U.M. to External Controller (Male-2-Male)
SV50177.113	Cable Assembly, 16 Pin, Main communication cable from S.U.B./S.U.M. to External Controller (Male one end) (VFD & Temperature control only)
SV50177.114	Cable Assembly, 3 Pin, Pressure Alarm Relay cable from S.U.B./S.U.M. to External Controller (Male-2-Male)
SV50177.117	Cable Assembly, 4 Pin, TCU Communicaiton cable (Male one end)
SV50177.118	Cable Assembly, 4 Pin, Disposable pressure sensor communication cable w/Buccaneer QC Male & Female components.
SV50177.119	Cable Assembly, 16 Pin w/3 Pin RTD in-line QC pigtail, Main communication cable from S.U.B./S.U.M. to External Controller (Male one end & 3 Pin QC pigtail)
SV50177.124	1/4" Dia Neoprene Rubber Cord

## Partial Spare Parts List (Cont.)

Part Number	Description
SV50177.155	Drive Shaft Assembly, 2000 L S.U.B. (Four (4) Piece Integrated Design)
SV50177.160	Motor, 1/4HP, 208VAC, 3Ph, IP65, 10:1 Gear Reduction, 50 L, 100 L S.U.B.s
SV50177.161	Motor, 1/4HP, 208VAC, 3Ph, IP65, 12.5:1 Gear Reduction, 250 L S.U.B.
SV50177.162	Motor, 1/2HP, 208VAC, 3Ph, IP65, 15:1 Gear Reduction, 500 L, 1000 L S.U.B.s
SV50177.165	PressureMAT, Control Monitor, 1 Relay/1 Analog, 12-24VDC, 4 Watt
SV50177.166	PressureMAT, Control Monitor, 2 Relay/2 Analog (or 4 relays), 12-24VDC, 4 Watt
SV50177.170	Load Cell, 250 lbs (110 Kg), Set of 3 w/ Summing Block
SV50177.171	Load Cell, 500 lbs (220 Kg), Set of 3 w/ Summing Block
SV50177.172	Load Cell, 2150 lbs (550 Kg), Set of 3 w/ Summing Block
SV50177.173	Load Cell, 2500 lbs (1100 Kg), Set of 3 w/ Summing Block
SV50177.174	Load Cell, 5000 lbs (2200 Kg), Set of 3 w/ Summing Block
SV50177.187	Illuminated Switch, Green, 120VAC
SV50177.188	Illuminated Switch, Green, 240VAC
SV50177.189	Illuminated Light, Green, 6VDC
SV50177.193	Lamp, Green, 120VAC, Replacement for motor on/off switch
SV50177.194	Lamp, Green, 240VAC, Replacement for motor on/off switch
SV50177.208	Fuse, 10 Amp, 250VAC
SV50177.209	Fuse, 15 Amp, 250VAC
SV50177.222	Illuminated Knob, Green, Replacement for motor on/off switch
SV50177.232	RTD, PT100, 3 Wire, 60" w/o Quick Disconnect Connector (Refer to P/N TX-10289)
SV50177.233	RTD, PT100, 3 Wire, 120" w/o Quick Disconnect Connector (Refer to P/N TX-10324)
SV50177.234	RTD-Standard, PT100, 3 Wire, 60" With Quick Disconnect (Bulgin 3-pin) Connector (Refer to P/N TX-10289)
SV50177.235	Cable Assy, Disposable Sensor Fiber Optic, (DO Sensor, Green Body), Mates to SV20963 sensors
SV50177.236	Cable Assy, Disposable Sensor Fiber Optic, (PH Sensor, Blue Body), Mates to SV20963 sensors
SV50177.238	Pressure Transducer, Disposable, 12" length, QC w/4-Wire pigtail

## 5.5 Ordering Instructions

Disposable and hardware components for the Single-Use Bioreactor (S.U.B.) can be ordered directly from your sales representative for Thermo Scientific HyClone products. These items include all components that have part numbers beginning with the following two digits:

- SH
- SV

## 5.6 Ordering/Support Contact Information

### In the Americas and Asia:

Tel: +1 (435) 792 8000

Toll-free: +1 (800) HyClone

Or +1 (800) 492 5663

Fax: +1 (435) 792 8001

[www.thermoscientific.com/hyclone](http://www.thermoscientific.com/hyclone)

[Info@hyclone.com](mailto:Info@hyclone.com)

### In Europe:

Tel: +32 53 85 75 59

Fax: +32 53 85 74 31

[perbio.euromarketing@thermofisher.com](mailto:perbio.euromarketing@thermofisher.com)

[www.thermo.com/perbio](http://www.thermo.com/perbio)

## Technical Support

Technical support for the Single-Use Bioreactor is available through a variety of formats. Some or all of the following may be appropriate depending on individual experience and circumstances.

## Technical Service Hotline

Contact your Thermo Scientific HyClone sales representative for general product pricing, availability, delivery, order information and product complaints.

Call 1-800-HyClone (US) or 32 53 85 75 59 (EU) for direct and immediate response to overall product questions, and general product technical information (Technical Support). You can also contact our Tech Support by email at: [hyc.bpctechsupport@thermofisher.com](mailto:hyc.bpctechsupport@thermofisher.com).

## Initial Setup and Operation

Appropriate technical support is available to assist in the initial setup and operation of each Single-Use Bioreactor system. Inquire at the time of purchase.

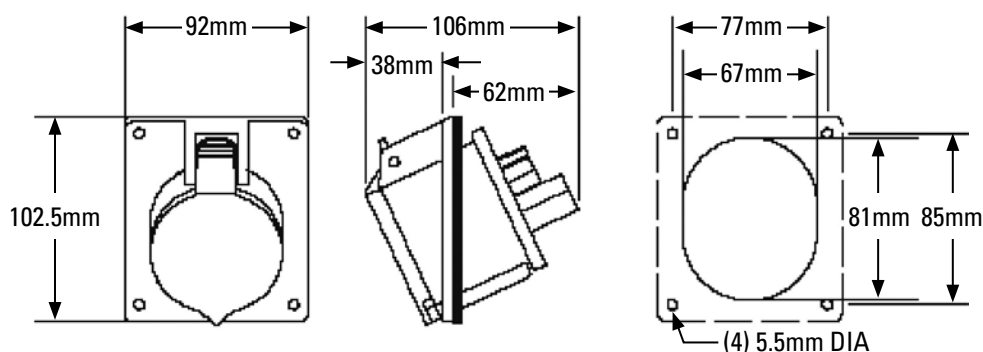
## Training

Training can be provided for startup and operation of the S.U.B. Contact your Thermo Scientific HyClone Products sales representative.



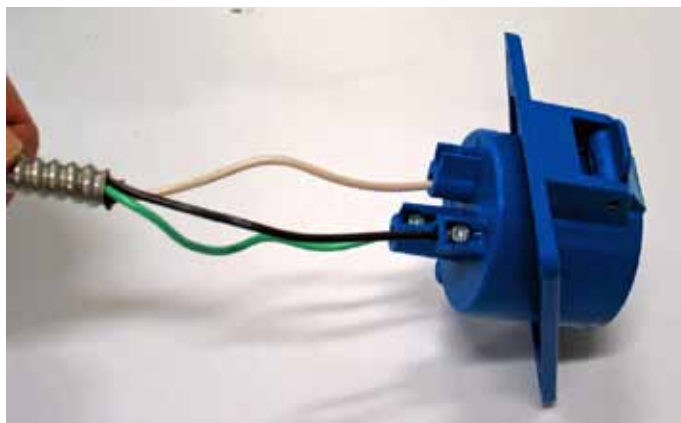
## Appendix A Installation of Female Electrical Receptacle

1. In order complete this installation the facility must be equipped with an electrical housing of sufficient size.
  - Typically in the U.S. the plug will require a 'two gang box' when using the adapter plate (supplied).
  - For installations outside the U.S. (an adapter plate is not supplied) it is recommended that an electrical panel be modified to accommodate the cutout dimensions as shown below.



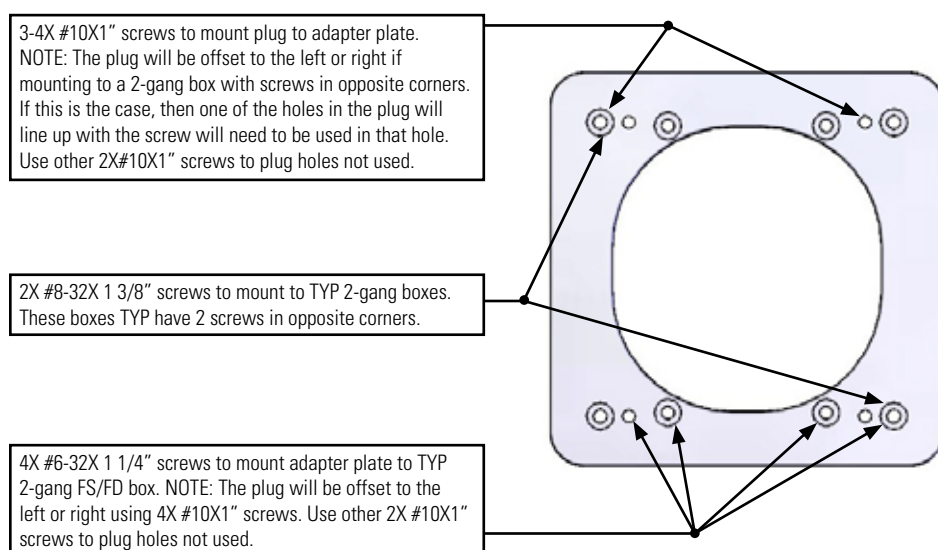
**Figure 1** Panel Cutout

2. Verify that electrical power has been disconnect and been locked out for safety
3. Verify the holes for mounting the receptacle housing are positioned properly.
  - Center to center of respective mounting positions is 3.35" (85mm) tall and 3.0" (77mm) wide.
4. Verify the condition of the three expose wire leads, strip back to new wire if needed.
5. Connect the wire leads using the screw terminals, paying strict attention to obtain the correct wiring position as it is labeled on the receptacle.
  - Green (ground)
  - White (common)
  - Black in the US, Blue in the EU (hot)



**Figure 2** Female Receptacle

6. If using the adapter mounting plate, secure it to the selected facility electrical housing as per drawing (Figure 3), otherwise proceed to step 7.



**Figure 3** Adapter Mounting Plate

7. Secure the electrical receptacle using four supplied screw fasteners.
8. Connect power back to the electrical circuit.
9. Test the circuit with multi-meter prior to making any connections to the electrical receptacle.

## Appendix B Calibration of the AC-Tech Variable Speed Drive

### Calibration of the AC-Tech variable speed drive (SCF/SCM Models)

If during the verification of the mixer speed calibration it was determined the displayed speed varied from the actual speed, please follow these steps to calibrate the drive:

1. Press 'M' on the speed controller menu.
2. If '000' appear, the menu is locked. To unlock the menu, hold the up arrow key and select '225' then press the menu key.
3. Use the arrow key to select 'P39' and then press 'M'.
4. Use the arrow keys to enter the correct value listed in the Table 3.1, then press 'M'. **NOTE:** The value may need to be adjusted +/- slightly to calibrate exactly.

S.U.B. VFD Parameters for RPM Calibration +/- 1 rpm			
S.U.B. Unit	Parameter	Value	Value derived from:
50 L (SCF/SCM models)	P39	178	Motor rating of 1780 rpm (60 Hz) with gear reduction of 10:1 -- $1780/10 = 178$
100 L (SCF/SCM models)	P39	178	Motor rating of 1780 rpm (60 Hz) with gear reduction of 10:1 -- $1780/12.5 = 178$
250 L (SCF/SCM models)	P39	142	Motor rating of 1780 rpm (60 Hz) with gear reduction of 12.5:1 -- $1780/12.5 = 142$
500 L (SCF/SCM models)	P39	356	Motor rating of 1780 rpm (60 Hz) with gear reduction of 5:1 -- $1780/5:1 = 356$
1000 L (SCF/SCM models)	P39	119	Motor rating of 1780 rpm (60 Hz) with gear reduction of 15:1 -- $1780/15 = 119$
2000 L (SCF/SCM models)	P39	119	Motor rating of 1780 rpm (60 Hz) with gear reduction of 15:1 -- $1780/15 = 119$

**Table 3.1.** VFD Parameters

5. The mixer output should now be scaled properly for the correct RPM displayed.

**NOTE:** For users who currently operate the S.U.B. and have not previously verified the calibration of the system, the current calibration of the system should be verified so an approximate operating RPM for any previous bioreactor runs can be documented and compared to the newly calibrated system. Users can then verify the parameters in the above table and change them if necessary. To confirm that the parameter change provides a calibration accuracy of +/- 1 RPM, conduct a final check of the calibration (refer to Section 2.2). ▲

## Appendix C Mettler Toledo Load Cell Calibration Instructions

### Load Cell Calibration Instructions for S.U.B. Hardware Systems using Mettler Toledo Panther Display

**NOTE:** Please refer to the instructions and reference material found in the Panther Terminal Technical Manual for specific procedures and trouble shooting methods.

Prior to reading these instructions confirm the following:

- The Panther Display, Load Cell summing block, and Load Cell transducers have been specified, installed and configured properly.
- The load cells transducer do not have the transport lock out nuts in place (the load cells must be ready for use prior to calibration).

**NOTE:** The calibration accuracy achieved cannot exceed the precision of the reference used for calibration.

- Field calibration is most often performed using calibrated reference weights or flow meter for volumetric mass reference.
- Factory trained technicians have the experience and tools necessary to provide the best system performance and reliability.
- IF IN DOUBT, CONTACT THE FACTORY SERVICE REPRESENTATIVE.

### Introduction

- Setup mode is accessed by pressing the “select” and “print” keys at the same time (these are the two outermost keys). See section 3 of the technical manual for further detail.
- Pressing “print” is equivalent to ENTER. Use this key to proceed through the sub-block numbers until you find the choice of interest.
- Press “select” to toggle the values of the selected sub-block
- The S.U.B. electrical schematic contains a table showing the sub-blocks that have changed from the default settings.

## Calibration

(Refer to technical manual section beginning on page 3-8):

1. Access the setup menu by pressing “select” and “print” simultaneously
2. Press “print” continually until sub-block 1.4 is displayed
3. Press “print” again until [CAL X] is displayed (this is the calibration mode)
4. Press “select” to toggle the value from “0” to “1” (this will enable the calibration mode)
5. Display will show “[E SCAL]” (indicating you should now empty the scale)
6. Once the scale is empty, press “enter” (this will establish the scale zero)
7. Display will show [15 CAL] and begin to count down to zero
8. If the scale is not completely steady it may fault showing [E SCALE]
9. If successful, the display will show [Add Ld]
10. Place test (calibration) weight on scale and press “ENTER”
11. Display will show [00000]. Now enter the value of test weight.
12. Once the value is entered, press “enter” (this will establish the scale span)
13. Display will show [15 CAL] and begin to count down to zero
14. Display will show [CAL d] meaning calibration is done
15. Exit setup mode if task is complete by pressing “CLEAR”
16. Display will show [CaL.OFF]. Then press “PRINT”
17. The Panther Display will return to normal operating mode

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