# RC-12BP
User´s Manual


PN 77203 - 2

Thermo SCIENTIFIC

# OPERATING INSTRUCTIONS

## SORVALL® *RC12BP*™

### *High-Capacity Lowspeed Refrigerated Centrifuge*

**Thermo Scientific**
**Asheville, North Carolina**
**U.S.A.**

SORVALL®

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This manual is a guide to the use of the

# *SORVALL® RC12BP™*
# *High-Capacity Lowspeed Refrigerated Centrifuge*

Information herein has been verified and is believed adequate for the intended use of the centrifuge. Because failure to follow the recommendations set forth in this manual could produce personal injury or property damage, always follow the recommendations set forth herein. Thermo Scientific does not guarantee results and assumes no obligation for the performance of centrifuges or other products that are not used in accordance with the instructions provided. This publication is not a license to operate under, nor a recommendation to infringe upon, any process patents.

Publications prior to the Issue Date of this manual may not contain data in apparent conflict with that provided herein. Please consider all data in this manual to be the most current.

***WARNING***, ***CAUTION***, and ***NOTE*** within the text of this manual are used to emphasize important and critical instructions.

> ***WARNING*** informs the operator of a hazard or an unsafe practice that could result in personal injury, affect the operator's health, or contaminate the environment.
>
> ***CAUTION*** informs the operator of an unsafe practice that could result in damage of equipment.
>
> ***NOTE*** highlights essential information.

***WARNING*** and ***CAUTION*** are accompanied by a hazard symbol  and appear in the left sidebar near the information they correspond to.

# *Important Safety Information*

**Certain potentially dangerous conditions are inherent to the use of all centrifuges. To ensure safe operation of this centrifuge, anyone using it should be aware of all safe practices and take all precautions described below and throughout this manual.**

### *WARNING*

When using radioactive, toxic, or pathogenic materials, be aware of all characteristics of the materials and the hazards associated with them in the event leakage occurs during centrifugation. If leakage does occur, neither the centrifuge nor the rotor can protect you from particles dispersed in the air. To protect yourself, we recommend additional precautions be taken to prevent exposure to these materials, e.g., use of controlled ventilation or isolation areas.

Always be aware of the possibility of contamination when using radioactive, toxic, or pathogenic materials. Take all necessary precautions and use appropriate decontamination procedures if exposure occurs.

In the future, if biocontainment products are added, the use of sealed rotors, buckets, and/or sample containers will offer increased protection from contamination during routine operation. However, these items will not guarantee protection from accidents resulting from damage to the rotor or buckets. Do run hazardous materials in the centrifuge unless placed in a biohazard enclosed and operated using all appropriate safety precautions.

Never use any materials capable of producing flammable or explosive vapors, or creating extreme exothermic reactions.

Use SORVALL® rotors only. Use of another manufacturer's rotor can cause rotor failure which could result in personal injury or centrifuge damage.

Never exceed the maximum rated speed of the installed rotor; to do so can cause rotor failure.

Always reduce (derate) rotor speed as instructed in this manual whenever:

- the rotor speed/temperature combination exceeds the solubility of the gradient material and causes it to precipitate.
- the compartment load exceeds the maximum allowable compartment load specified. See Chapter 4, page 4-14.

Failure to reduce rotor speed under these conditions can cause rotor failure.

Centrifuges routinely deal with high energy levels and could move suddenly in the unlikely event of rotor failure. During centrifuge operation, never lean on or move the centrifuge, keep the surrounding area clear of objects (including all hazardous materials), and do not work on top of or next to the centrifuge.

Do not attempt to open the chamber door when the rotor is spinning; never override or otherwise disable any of the safety systems of the centrifuge.

### *CAUTION*

Do not run or precool/preheat a rotor at the critical speed, as this will have a detrimental effect on centrifuge component life. See Chapter 4, Rotor Temperature Equilibration, page 4-13.

Do not operate the centrifuge with a rotor out of balance. To do so can cause damage to the centrifuge drive assembly.

Do not operate centrifuge without a rotor properly installed and locked to the drive, and the rotor cover (if any) must be properly installed. See rotor instruction manual.

Locate the centrifuge on a level floor to avoid rotor imbalance during operation.

The centrifuge can be damaged if connected to the wrong voltage. Check the voltage before plugging the centrifuge into a power source. Thermo is not responsible for incorrect installation.

Always maintain the centrifuge in the recommended manner. See Chapter 5, Maintenance.

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# Chapter 1: INTRODUCTION & DESCRIPTION

This manual contains information required to operate and maintain the SORVALL® *RC12*BP™ High-Capacity Lowspeed Refrigerated Centrifuge. If you require additional information regarding operation or maintenance, please contact Thermo for assistance. In the United States, call toll-free 1-800-522-7746. Outside the United States, contact your local representative for SORVALL® products.

## Centrifuge Description

The SORVALL® *RC12*BP™ is a microprocessor controlled, high-capacity lowspeed refrigerated centrifuge designed for use in regulated environments (such as those found in blood banking, biotechnology, or pharmaceutical arenas). The control panel, designed to be easy to use and easy to clean, allows simple input through a positive-feedback keypad with visual verification of set parameters and current run conditions. The control panel also prompts users for correct entry and displays user messages. The control panel introduces automation of quality control runs, an optional computer interface package enables automatic, on-line, quality control run and production run data logging.

The *RC12*BP™ operates at speeds* up to 4700 rpm, and is capable of producing relative centrifugal force up to 7333*g*. It uses a balanced, high-torque brushless dc motor designed to deliver optimal performance with smooth, quiet operation over its full speed range, with long bearing life. Advanced capabilities of this motor offer precise control of acceleration and deceleration, regardless of rotor load, for exceptional run reproducibility. Directly connected to the motor is a heavy-duty gyro-action drive with a square spindle that accepts the SORVALL® H-12000 high-capacity swinging bucket rotor. A viewing port in the chamber door permits speed confirmation using an optical tachometer.

Precise temperature control is made possible by a refrigeration system that is capable of delivering both cooling and heating. The high-capacity system is charged with environmentally-friendly CFC-free refrigerant. The microprocessor-controlled system consists of a low-temperature evaporator, a hermetically-sealed thermally-protected compressor, and a fan-cooled finned condenser.

* Speed in revolutions per minute (rpm) is related to angular velocity, $\omega$, according to the following:

$$\omega = (\text{rpm})\left(\frac{2\pi}{60}\right) = (\text{rpm})\ (0.10472)$$

Where $\omega$ = rad/s. All further references in this manual to speed will be designated as rpm.

The *RC12*BP™ has the following safety features: a protective armor plate steel guard within the cabinet; automatic shutoff of the drive motor for overspeed protection; circuit breakers on the main power and the control panel circuits; and a door interlock which prevents starting the drive while the chamber door is open, or opening the door while the rotor is in motion.

Figure 1-1 identifies and locates parts of the *RC12*BP™.

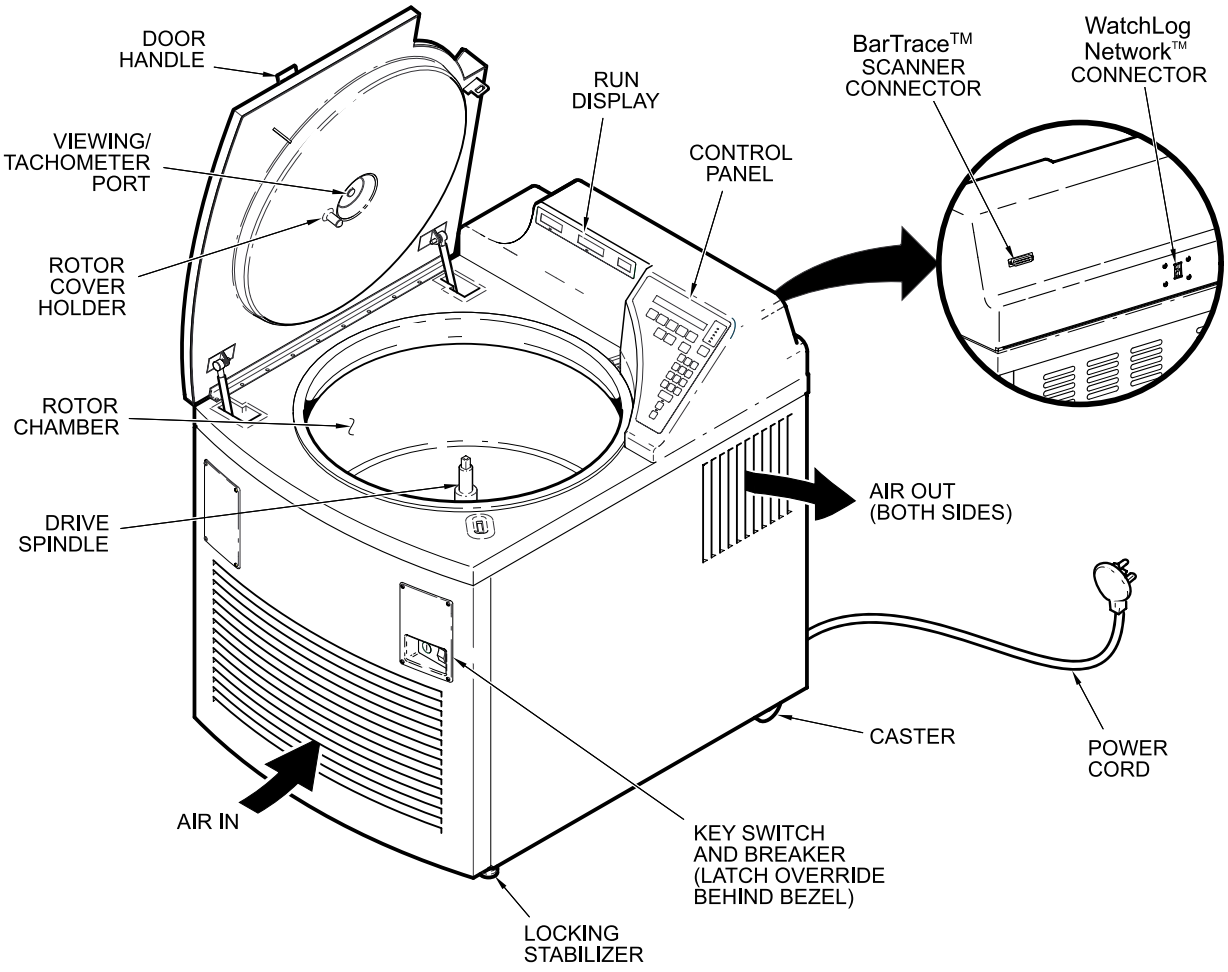



*Figure 1-1. Parts Location and Identification*

Specific *RC12*BP™ features include:

- An optional Network Computer Interface Package, which includes WatchLog Network™ software, allows automatic computerized logging of centrifuge QC RUN and production run data via RS485/RS232 communication hardware.

- QC RUN feature allows simple, automatic speed/temperature verification (optional Computer Interface Package required to record and print run data).

- A user-friendly, easy to clean control panel with an interactive backlit LCD SET display that prompts appropriate input and displays advisory messages, option selection indicators, and a separate, large LED RUN display for across-the-room viewing.

- Programming capability allows saving (to a battery backed-up memory) up to 9 sets of run parameters plus 6 step run sequences, allowing simple recall and error-free run reproducibility. The SAVE RUN sequence alerts users before overwriting programs, to eliminate inadvertent loss. A convenient RECALL key allows access to saved parameters for selection or reference.

- STEP RUN capability allows the linking-together of up to three sets of run parameters to automatically perform innovative step run protocols. The step run sequences may be saved in program memory for future use.

- KEYPAD LOCK, a 3-position keyswitch with a removable key, that is designed to limit control panel access. Besides allowing full functionality, the keyswitch can be set so that run parameters cannot be changed, or so that only parameters from saved programs may be run – in either case, greatly reducing the chance for operator error or unauthorized changes.

- Run duration controlled by TIME (minutes:seconds), by HOLD (for continuous runs), or by Accumulated Centrifugal Effect™ (ACE). Because rotor load differences, fluctuations in voltage, or slight mechanical differences affect how quickly centrifuges reach set speed, ACE calculates the effect of speed in relation to time, and adjusts run duration to account for differences in acceleration, thereby improving separation consistency and run reproducibility – run after run, from centrifuge to centrifuge.

- Rotor SPEED controlled by RPM (revolutions per minute), or by the RCF (relative centrifugal force, or *g*-force).

- SLOW START chooses gentle acceleration from 0 to 250 rpm (at 250 rpm, acceleration transitions to the normal, maximum rate), with the slow start rate defined by the selection of one of ten different acceleration profiles.

- SLOW STOP chooses gentle deceleration from 500 to 0 rpm (normal braking from set speed transitions to a more gradual rate at 500 rpm), with the rate defined by selection of one of ten different braking profiles.

***NOTE*** Selecting BRAKE OFF will affect SLOW STOP.

- BRAKE OFF deactivates normal braking for a coasting stop from a user-specified transition speed.
- Automatic sample temperature calculation considers the run speed, run time, set temperature and measured chamber temperature to estimate and maintain sample temperature.
- Automatic self-test performed by the microcomputer each time the centrifuge power is turned on, to ensure proper performance.
- Automatic diagnostics, so that if a system malfunction occurs, a message appears in the SET display to alert you of the condition.

## Centrifuge Specifications

| | |
|---|---|
| Speed | |
| Maximum Selectable Speed | 4700 rpm |
| Maximum Relative Centrifugal Force | 7333 *g* |
| Speed Control Accuracy | ±1% or 20 rpm, whichever is greater |
| Time | |
| Maximum Selectable Time | 99 minutes, 99 seconds (or HOLD for indefinite length of time, timed up to 300:00) |
| Maximum Selectable ACE (Accumulated Centrifugal Effect™) | $9.99 \times 10^{30}$ ($\int\omega^2 dt$, input as 9.99e30) |
| Temperature | |
| Temperature Selection Range | –10°C to 40°C |
| Temperature Control Accuracy | sample temperature controlled within 2°C of set temperature* |
| Overtemperature Alert | Maximum allowable temperature settable to within 2°C of set temp |
| Maximum Noise Level | < 65 dB** |
| Maximum Average Heat Output | 5.3 kW |

* With sample, rotor, and chamber temperatures equal to SET temperature at the start of the run, or, during a run, after those components reach equilibrium. Control range is reduced if run speed/ run time/set temperature/ambient temperature variables combine to create an extreme condition beyond the temperature control system capacity.

** Measured 3 feet from the front panel at a height of four feet using an H-12000 rotor at its top speed of 4700 rpm.

| | |
|---|---|
| Weight (uncrated, without rotor) | 517 kg (1139 lb) |
| Dimensions | |
| Width | 83.8 cm (33 inch) |
| Depth | 106.7 cm (42 inch) |
| Height, top of control console | 112.8 cm (44.4 inch) |
| Length, power cord (minimum) | 244 cm (96 inch) |
| Other | |
| Depth, back of door to back panel | 21.8 cm (8.6 inch) |
| Height, top of open door | 170.4 cm (67.1 inch) |
| Height, rotor installation lift-over | 90.2 cm (35.5 inch) |
| Diameter, chamber opening | 66.8 cm (26.3 inch) |
| Supply Power Requirements | |
| Supply Configurations (AC) | 200 V, 60 Hz, 1Ø<br>208 V, 60 Hz, 1Ø<br>220 V, 60 Hz, 1Ø<br>230 V, 60 Hz, 1Ø<br>240 V, 60 Hz, 1Ø<br>200 V, 50 Hz, 1Ø<br>220 V, 50 Hz, 1Ø<br>230 V, 50 Hz, 1Ø (CE)<br>230 V, 50 Hz, 3Ø (CE)<br>240 V, 50 Hz, 1Ø |
| Recommended Supply Current | |
| Single Phase | 50 A |
| Polyphase | 32 A/phase |
| Supply Power Receptacle | |
| Standard | NEMA 6-50R |
| 230 V, 50 Hz, 1Ø | CEE-17 (63A, 2-pole and earth, 1Ø) |
| 230 V, 50 Hz, 3Ø | CEE-17 (32A, 3-pole neutral and earth, 3Ø) |

## Parts Supplied

Parts supplied with your *RC12*BP™ Centrifuge include:

| | |
|---|---|
| 77203 | Operating Instructions Manual, *RC12*BP™ |
| 77204 | Condensed Operating Instructions, *RC12*BP™ |
| 56418 | Program Log Pad, *RC3*BP™ & *RC12*BP™ |
| 68025 | Wrench, Open-End, 9/16-inch |
| 22001 | Preinstallation Kit (supplied separately) |

Refer to Table 4-1 (on page 4-2), for rotor information. For more information, refer to a current SORVALL® Product Guide, or contact Thermo or your local representative for SORVALL® products.

## *Optional Computer Interface Package*

An optional Network Computer Interface Package (Catalog No. 77017 for 100-120Vac; Catalog No. 77018 for 200-240Vac) is available for use of the QC RUN feature and automatic run data logging. The requirements for the user-supplied computer are:

A dedicated (one per 16 centrifuges) IBM®-compatible computer with Pentium® processor running at 75 MHz (or faster) with an available serial communications port. The computer must have at least 100MB of free hard drive space, and be running Microsoft® Windows® V3.1 or 3.11 with at least 8MB RAM, Windows 95® with at least 16MB RAM, or Windows NT® V4.0 with at least 16MB RAM. The computer requires a monitor, keyboard, mouse, and printer with Windows®-compatible driver.

**NOTE** A dedicated, directly connected computer is required; WatchLog Network™ software will not operate correctly as a network server-based application. Also, running other software applications, accessories or utilities while WatchLog Network™ is in use is not advised.

The *RC12*BP™ Centrifuge is compatible with WatchLog Network™ systems (revisions below 2.0 require a software upgrade), but is not compatible with older WatchLog™ software.

# Chapter 2: INSTALLATION

This chapter contains instructions to prepare the SORVALL® *RC12*BP™ centrifuge for operation.

## Inspection

1. When you receive your centrifuge, carefully inspect it for any signs of shipping damage. If you find damage, report it immediately to the transportation company and file a damage claim, then notify Thermo.

2. Check the parts received against the shipping list; if any parts are missing, contact Thermo (see back cover).

3. Remove all packing material, and remove any remaining items from inside the rotor chamber (where this manual was).

## Electrical Requirements

**NOTE** The centrifuge should be connected to an Overvoltage Category II circuit, and should have a means of power interruption at a remote location.

The *RC12*BP™ has specific power requirements and must be connected to the correct supply for proper performance. The nameplate on the back panel of the cabinet specify a voltage and frequency corresponding to one of the following AC supplies:

| | |
|---|---|
| 200 V, 50 Hz, 50 A, single Ø | 200 V, 60 Hz, 50 A, single Ø |
| 220 V, 50 Hz, 50 A, single Ø | 208 V, 60 Hz, 50 A, single Ø |
| 230 V, 50 Hz, 50 A, single Ø | 220 V, 60 Hz, 50 A, single Ø |
| 230 V, 50 Hz, 32 A/P, poly Ø | 230 V, 60 Hz, 50 A, single Ø |
| 240 V, 50 Hz, 50 A, single Ø | 240 V, 60 Hz, 50 A, single Ø |

The supply voltage should be checked with a voltmeter, then you should verify that the voltage indicated on the nameplate on the back panel is in agreement with the measured line voltage.

If the measured line voltage is not within 10% of the voltage specified on the nameplate, do not connect the power cord and operate the centrifuge or damage to the centrifuge may result. Contact Thermo or your local representative of SORVALL® products to see if the centrifuge can be modified for your voltage. The centrifuge system includes a ground wire with 50 A circuit protector on each positive power lead.

**CAUTION**

The centrifuge can be damaged if it is connected to the wrong voltage. Check the voltage listed on the nameplate, and measure the voltage at the power source before plugging in the power cord. Thermo is not responsible for incorrect installation.

Single phase *RC12*BP™ Centrifuges are equipped with a three-wire cord with three-prong connector to fit a NEMA 6-50P (50A, 2-pole and earth, 1Ø) receptacle, or, on 230V 50Hz centrifuges, a CEE-17 (63A, 2-pole and earth, 1Ø) receptacle. 230V 50Hz *polyphase RC12*BP™ Centrifuges are equipped with a four-wire cord with five-pin connector to fit a CEE-17 (32A, 3-pole, neutral and earth, 3Ø) receptacle. This cord may be changed to meet local electrical code requirements; the green and yellow wire is the ground and must be connected to the centrifuge frame.

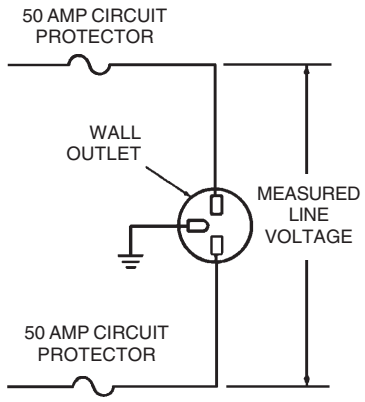



*Figure 2-1. RC12BP™ Electrical Requirements*

# Location

**NOTE** The *RC12*BP™ is to be installed in a Pollution Degree 2 environment at an altitude not exceeding 2000 meters (6560 feet), and is a Class A product not intended for home use (operation in a domestic environment could cause radio interference).

**CAUTION**

Locate the centrifuge on a level floor to avoid rotor imbalance during operation.

Locate the *RC12*BP™ on a level floor. For the centrifuge to function properly, ambient temperature and air circulation are very important. To ensure free air circulation, the centrifuge must be positioned so that no air vents are blocked, allowing for its physical size (see figure 2-2) plus an additional 15 cm (6 inches) on each side, and a minimum of 5 cm (2 inches) behind the centrifuge (10 cm [4 inches] or more is desired).

Ambient air temperature at the centrifuge air inlets must be between 5°C to 40°C (41°F to 104°F), with relative humidity ≤90% non-condensing, for the centrifuge to operate. Ideal ambient temperature to meet all performance specifications is between 20°C to 35°C (68°F to 95°F), therefore, avoid areas near heat sources (for example, heating pipes and radiators). Also, avoid close grouping of centrifuges or other heat-producing laboratory equipment. Generally, the cooler the location, the better the operating conditions will be for the centrifuge.

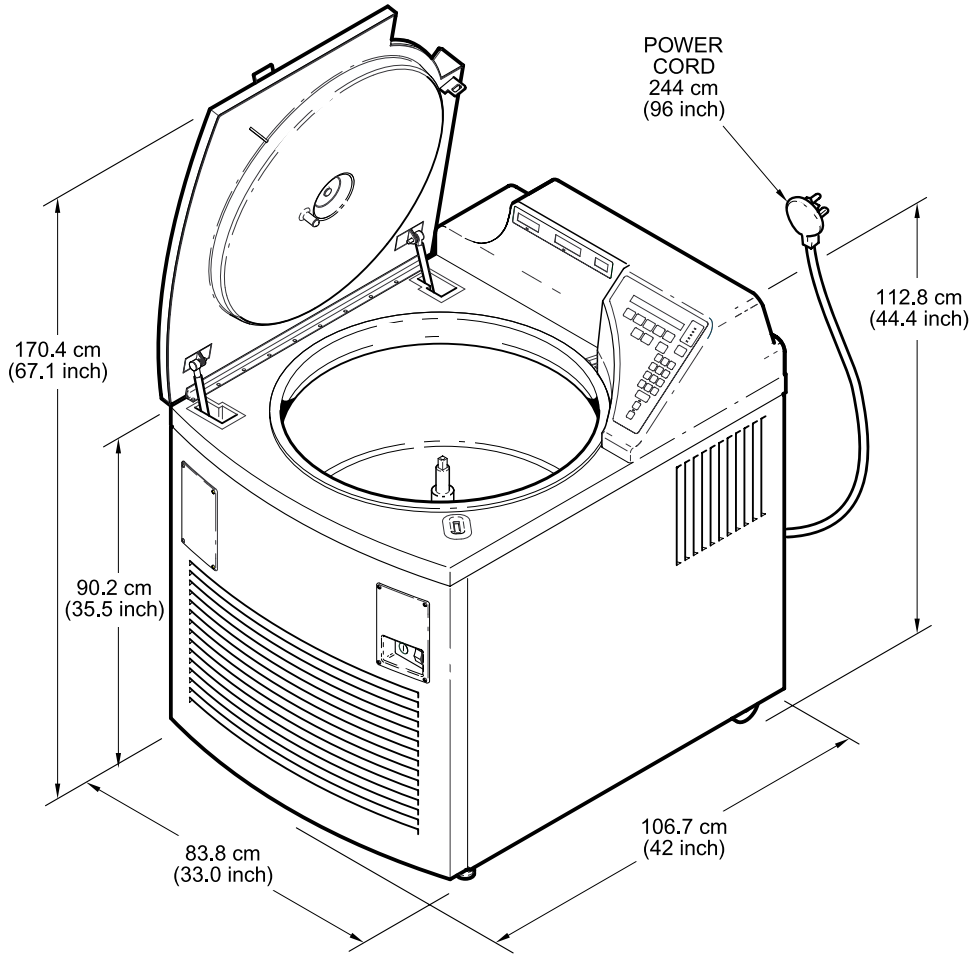



*Figure 2-2. Centrifuge Dimensions*

# Installation

A Preinstallation Kit (Catalog No. 22001) is supplied for UL/CE compliance. Install the Preinstallation Kit according to instructions supplied with the kit.

To install the *RC12*BP™:

1. Position the *RC12*BP™ in an operating location that satisfies the criteria specified in the previous *Location* paragraph. With the Preinstallation Kit installed, the operating location is so that the two tabs (under the front edge of the centrifuge) are flush against and aligned with the preinstalled hold-down brackets.

2. Secure the centrifuge to the brackets by installing a shackle and a locking bolt (supplied with the kit) through each tab/hold-down bracket eyelet and tightening.

**C A U T I O N**

The locking stabilizers must be used as explained to lift the front caster off the floor. The centrifuge can be damaged if it is operated when the stabilizers are not properly adjusted. After adjusting the stabilizers, make sure that the centrifuge is reasonably level, and that it does not rock on three of the four support points.

3. By hand, lower the two locking stabilizers in the front of the centrifuge until they lightly contact the floor. Use the 9/16-inch wrench (supplied with the centrifuge) to rotate each stabilizer an additional two revolutions. This will raise the front caster about 3 mm (1/8 inch) off the floor. Check that the centrifuge does not rock on its four support points, the two front stabilizers and the two rear casters (see figure 2-3). ***Read the CAUTION.***

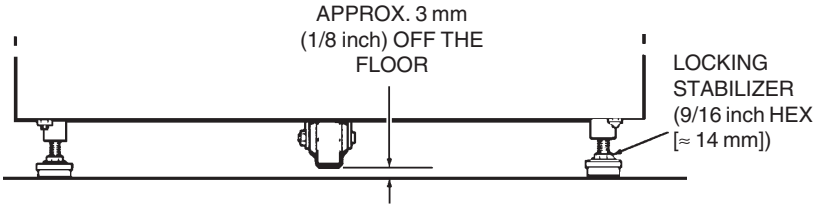



*Figure 2-3. Front Locking Stabilizer Adjustment*

4. Be sure the POWER switch is set to "O", then plug in the centrifuge power cord.

5. *Optional:* To be certain the centrifuge is working properly, turn to the Customer Control Inspection paragraph located in Chapter 5, Maintenance, and perform the procedures listed under Speed Control, Timer, and Temperature Control.

***NOTE*** If the centrifuge is to be connected with the optional Network Computer Interface Package for automatic quality control and run logging capability, Thermo or a local representative for SORVALL® products will install the package components as described in the WatchLog Network™ User's Manual (supplied in the package).

After the *RC12*BP™ satisfies the inspection/performance criteria, it can be considered ready for use.

# Chapter 3: CONTROLS, DISPLAYS and INDICATORS

The *RC12*BP™ controls, displays and indicators have been designed for ease of use – the control panel (figure 3-1) allows entry with visual verification of set parameters and current conditions, prompts action if an entry is inappropriate (remains blinking), and communicates status with user messages. An optional Computer Interface Package allows for automatic, on-line logging of quality control and daily run data.

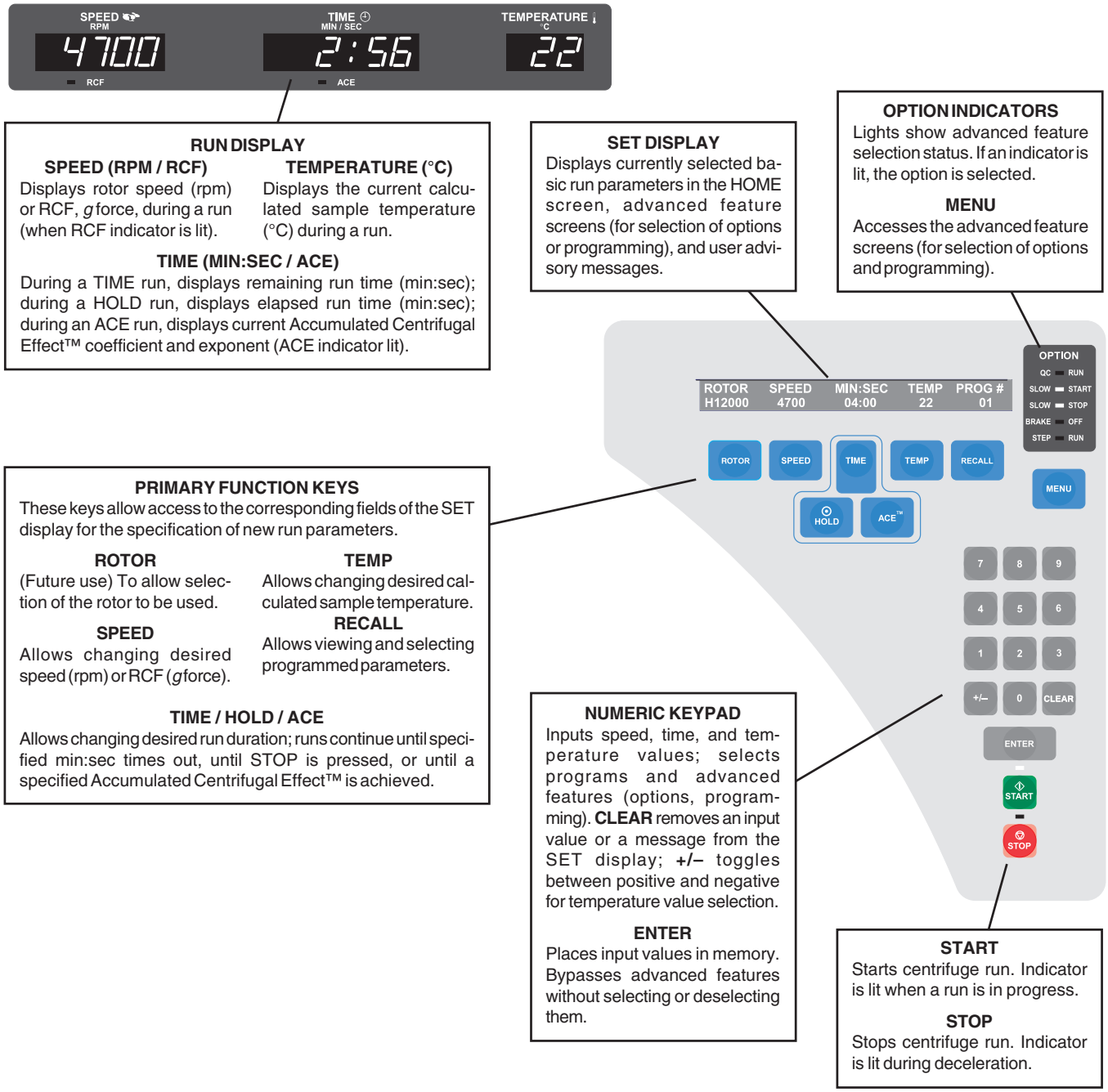
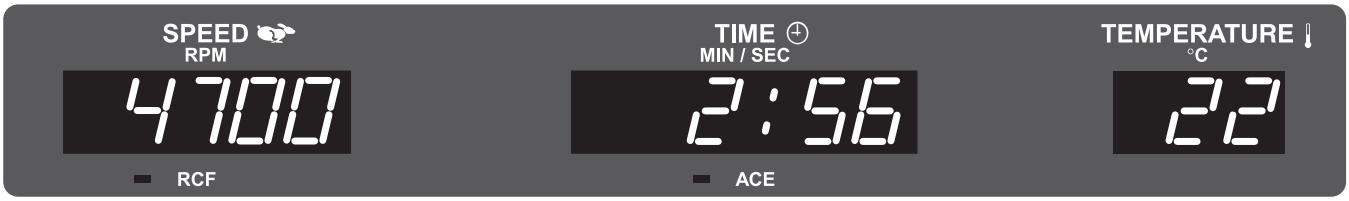



*Figure 3-1. Control Panel and Displays*

## *RUN Display*




The RUN display is to the left of the control panel, and is comprised of three fields of large red LEDs that indicate the current measured/ calculated conditions during a run:

- The run SPEED (RPM/RCF) field indicates either the current measured rotor speed (in rpm) or, if RCF is selected (RCF indicator lit), the relative centrifugal force (or *g*-force) that is currently being generated at the maximum radius of the selected rotor. The rpm values are rounded to 10s above 200 rpm. At run completion (zero speed, after the door has been unlocked) the display will show the word "End" until the door is opened.

- The run TIME (MIN:SEC/ACE) field indicates:
  - If controlled by TIME, the display counts down from set time, showing the time remaining (in minutes and seconds) until the run terminates and deceleration begins,
  - If controlled by HOLD (indicated in the control panel SET display), the display during a run counts up, showing the time elapsed (expressed in minutes and seconds, up to a maximum of 300:00) since START was pressed, or
  - If controlled by ACE (Accumulated Centrifugal Effect™, ACE indicator lit), the RUN display shows the current calculated ACE value ($\int\omega^2 dt$). When the set ACE value is reached, the run terminates and decelerates to a stop. The displayed value continues to calculate the centrifugal effect during deceleration to zero to show total accumulation.

### *Monitoring run duration in alternative terms*

During a run, if an alternative run duration key is pressed once (for example, pressing TIME during an ACE run), the RUN display will change to show an accumulating value in terms of the newly selected method. The SET display and ACE indicator will not change, but will continue to show the control method and value that was in effect when START was pressed. Run duration will be controlled by the SET display value, regardless of the alternative value showing in the RUN display. If that same alternative key is pressed a second time, the SET display will change to show a flashing value (from the previous run) expressed in that control method – entry will change duration control to that method and the RUN display will continue counting based on the new entry. Pressing START resets the run.

Between runs, the RUN display shows the previous run duration value, viewable in each control mode:

– TIME shows the MIN:SEC value at termination (the SET display shows the last TIME input value).

– HOLD shows the MIN:SEC value after deceleration to zero.

– After an ACE controlled run, ACE shows the total ACE value after deceleration to 0 (the SET display shows the termination value). If the previous run was not controlled by ACE, pressing ACE shows the ACE value at termination (the SET display shows the last ACE input value).

- The run TEMPERATURE (°C) field indicates the current calculated sample temperature in degrees Celsius, based on rotor selected, rotor speed, run time, set temperature, and measured temperature (the calculation assumes that the sample temperature, rotor temperature, and SET temperature are all equal at the start of the run).

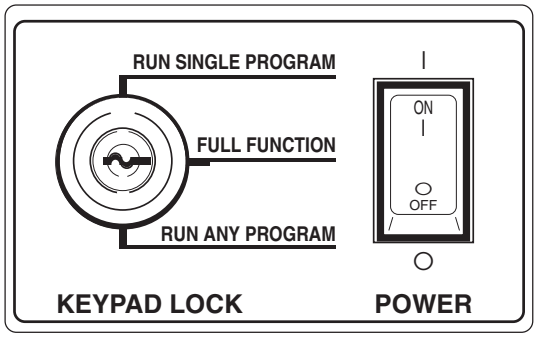
## SET Display


The SET display is a 2-line LCD array located at the top of the control panel. The SET display is used to input and display basic run parameters, to select options or other advanced features, and to display advisory messages. The display's contents are referred to in this manual as a ***screen***; for example, the *HOME screen* (described below) displays basic run parameters that correspond to the (Primary Function) keys below the display.

- The ***HOME screen*** (pictured above) displays currently selected values for the basic run parameters: ROTOR, SPEED/RCF, TIMED/HOLD/ACE, DEG C and, if displaying a recalled program, PROG #. The HOME screen appears in the SET display after the centrifuge power has been set ON and the diagnostic test has been completed. In addition, if MENU is pressed to access the options screens, pressing MENU again will return the HOME screen to the display.

The SET display is the primary interactive screen on the control panel, and has a role in all aspects of centrifuge use. Following is a detailed description of all HOME Screen fields as they relate to the Primary Function Key functionality, followed by option selection screens and advanced feature functionality. At the end of this chapter is a listing of the SET Display advisory messages, what they mean, and recommended action.

## *Main POWER and KEYPAD LOCK*




The Main POWER and KEYPAD LOCK panel is located away from the control console, in the top-right corner of the front cabinet panel.

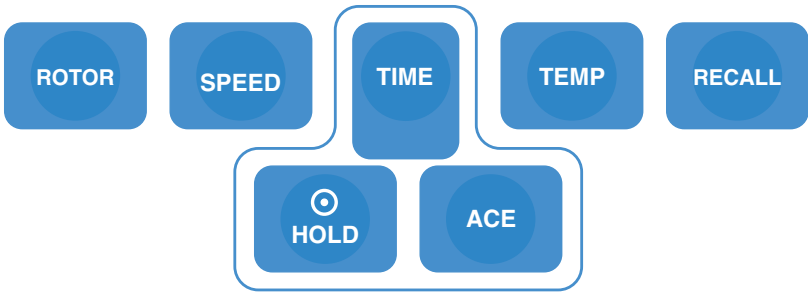
The POWER I/O (ON/OFF) switch is a 50-amp circuit breaker that turns the centrifuge ON and OFF by connecting or disconnecting the main supply power from all system circuitry.

The KEYPAD LOCK can be used to limit control panel function. It uses a 3-position keyswitch with a key that is removable in any of the 3 positions. Functionality is as follows:

- The middle position, FULL FUNCTION, allows use of all keys and features, without restriction;
- The upper position, RUN SINGLE PROGRAM, minimizes functionality so that set parameters cannot be changed (START, STOP, and CLEAR are the only active keys);
- The lower position, RUN ANY PROGRAM, makes it so that users may only perform runs using run parameters recalled from program memory (only RECALL, the numeric keypad including ENTER and CLEAR, START and STOP are active).

Use of the KEYPAD LOCK may offer a considerable advantage, improving process control by reducing the possibility for operator error, as well as restricting unauthorized run parameter or program memory changes.

## Primary Function Keys and HOME Screen Fields




The Primary Function Keys are the keys below the SET display. Each key is positioned below a corresponding field in the HOME screen, allowing simple, direct access to basic run parameter controls:

**ROTOR** (reserved for future use) would be pressed to specify a different rotor than the one shown in the SET display, which would be necessary if the rotor or bucket/carrier system installed in the centrifuge were to change. *Because there is only one rotor that is compatible with the centrifuge at this time, the ROTOR key presently has no function*. As future rotors are added, they will be listed by rotor name, and the ROTOR key would be pressed to scroll through the compatible rotors for selection. Correct identification of an installed rotor is required to establish set SPEED limits, correctly calculate RCF, and accurately control sample temperature. If a rotor is able to use buckets/carriers with different maximum radii, each configuration will be listed for selection, to calculate the different RCF. The ROTOR key is not active when a run is in progress.

***NOTE*** In the future (only after new rotors have been added), ensure that the installed rotor is correctly identified by changing the SET rotor name immediately after changing the installed rotor.

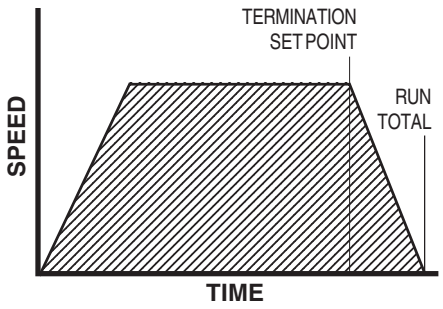
**SPEED** is pressed to specify a different rotor speed in revolutions per minute (rpm) or relative centrifugal force (RCF, also known as *g*-force) than the value shown in the SET display. Speed is selectable from 150 to 4700 rpm (the maximum rated speed for the H-12000 rotor), or as an equivalent RCF calculated at the maximum radius of the rotor (rotor geometry only). Changing from rpm to RCF or RCF to rpm is done by repeatedly pressing SPEED: pressing once causes the value to flash so a change can be made in the existing mode, pressing again changes to the other mode and displays a value equivalent to the previous, pressing again causes that value to flash so a change can be made, and so on. An entered value will continue to flash (prompting input) when it is out of range for the rotor. The formula used to calculate RCF is:

$$RCF = 11.17 \times \text{radius in cm} \times \left(\frac{rpm}{1000}\right)^2$$

***NOTE*** When changing mode, rpm/RCF values may appear a digit or two off from the original set value. The centrifuge translates set RCF values to rpm whole numbers for speed control purposes, then calculates that rpm whole number to the closest RCF value. There is no cause for concern; speed control accuracy is not compromised, and the slight value difference will not affect the run.

The run duration (from start to termination, when deceleration begins) setting or control method is changed by pressing one of the three grouped Primary Function keys:

- **TIME** is pressed to specify a length of time (minutes and seconds, to a maximum of 99:99) from run start to termination. In the RUN display, minutes and seconds begin counting down from the input value when START is pressed. The run terminates and deceleration begins when the timer reaches zero.
- **HOLD** is pressed to specify a continuous run which, once started, runs until STOP is pressed (terminating the run and initiating deceleration). During a continuous run, HOLD will be in the SET display, and the time elapsed from when START was pressed will appear in the RUN display. The timer will accumulate up to 300 minutes – if a run continues beyond that, displayed run time will no longer reflect elapsed time, but will remain fixed at 300:00. Whenever it is possible for such an extended run to occur, an external timing method is recommended.
- **ACE** is pressed to specify an Accumulated Centrifugal Effect™ value. When ACE control is selected, the centrifuge calculates the effect of speed in relation to time (the shaded area in the illustration at left), adjusting run duration to account for acceleration variation. This variation can be attributed to rotor load/configuration differences (affecting inertia), fluctuations in line voltage (affecting motor power), or slight mechanical differences including normal wear. When START is pressed, the realized ACE value begins to accumulate in the RUN display. The run will terminate and deceleration will begin when the specified ACE value (expressed as $\int\omega^2 dt$*, controllable up to $9.99 \times 10^{30}$ [displayed as 9.99e30]) is reached. After termination, the RUN display will continue to accumulate until the rotor stops – this run total is for reference; care should be taken not to confuse the RUN display's final accumulation with the controlling input/timeout value, found in the SET display. Compared to control by time, ACE selection provides a more advanced and relevant form of run duration control, thereby improving separation consistency, run reproducibility, and dependability of results.




**Accumulated Centrifugal Effect™**
***calculating the area under the curve***

* The integral value can be calculated deriving the following formula:

$$\int w^2 dt = w^2 \int dt = \omega^2 \Delta t$$

Where: $\Delta t$ = Change in time (seconds)

and $\omega^2$ = Angular speed
= $2\pi$ [n/60]
n = Speed (rpm)

During a run, to view in an alternative duration control mode (for example, to monitor accumulating TIME when an ACE run is in progress), press one of the other two duration control keys once – this changes the RUN display to show an accumulating value in that alternative mode without altering the way duration is controlled. In this viewing condition, the SET display field header does not change, nor will the status of the ACE indicator (both continuing to indicate the set control mode), but the SET value will change to show the last value entered in the alternative mode. If you press the same key a second time, the run will then change to that control method, using the value that was in the SET display as the controlling value until a different one is entered. Pressing START resets the run.

***NOTE*** If you change the duration control mode to TIME during a run, time will begin to count down from the set value the moment the change is made (unless the run was previously controlled by time and you are returning, in which case the run resumes counting from the value that was remaining when TIME was exited). If you change to ACE control, the last-set ACE value that is displayed the moment the change is made will control termination, so that if you change to ACE when the run has already exceeded the value, the run will terminate immediately.

Between runs, the RUN display shows the previous run duration values, viewable in each control mode. Pressing TIME shows the MIN:SEC value at termination (the SET display shows the last TIME input value). HOLD shows the total MIN:SEC value after deceleration to zero. After an ACE controlled run, ACE shows the total ACE value after deceleration to zero (the termination value is in the SET display). If the previous run was not controlled by ACE, pressing ACE shows the ACE value at termination (the SET display shows the last ACE input value). *Always be sure of the control method and value before pressing START.*

**TEMP** is pressed to change desired calculated sample temperature (°C, settable from –10 to 40) that is controlled by the centrifuge during a run. The centrifuge automatically considers the rotor selected, rotor speed, run time, set temperature, and measured temperature to calculate and maintain sample temperature during the run. The calculation assumes that the sample temperature, rotor temperature, and SET temperature are all equal at the start of the run (as they must be any time that temperature control is critical).

**RECALL** is pressed to access program memory. Saved parameters are recalled by inputting a specific program number. By pressing START, you begin a run using the run parameters displayed. Also, programs can easily be recalled and modified to create new run parameters without fear of damaging the original program, because information that is saved in memory cannot be overwritten by using the RECALL key (modifying or replacing a program is reserved for the SELECT SAVE RUN option under the MENU key).

## *MENU Key and OPTIONS*


The MENU key accesses advanced feature options listed above it, plus other features such as saving parameters to memory. After pressing MENU, pressing 1 accesses a secondary screen to view or enter values, plus confirm option selection; pressing 0 deselects options; pressing ENTER steps through options without changing selections or settings, and on secondary screens, enters values to select the option. Pressing MENU again exits the options and returns to the HOME screen without entering/selecting a flashing value. Automatic logging of QC RUN and daily run data is possible using WatchLog Network™ software (packaged with the optional network computer interface package) on a dedicated computer.

- QC RUN allows simple, automatic quality control run speed/temperature verification when used with the optional computer interface package. The QC RUN feature will run and document the data from each set of parameters that has been saved in program memory.

  When QC RUN is selected, the SET screen will prompt you to prepare for the run and press START to begin – the centrifuge will start running program number 1, and systematically run each program in-order through program number 9. While the QC RUN is in progress, the parameters of the program that is running will be in the SET display. At the end of each program, the data from that segment of the QC RUN sequence will be written to the QC RUN log. If STOP is pressed while a QC RUN is in progress, the data collected up through the last program completed before termination will be logged (data from the program that was in progress will be logged and labelled incomplete). If a system fault occurs while a QC RUN is in progress (other than a computer failure, disabling WatchLog Network™), the data would be logged as if STOP was pressed, and a fault type will be recorded.

If, during the QC RUN, an observed RUN display temperature is not within ±2°C of SET temperature (as could be the case when there is a significant temperature change with a short run), the centrifuge will continue to repeat that step of the QC RUN sequence until the observed temperature is within range. The data will not be logged until the programmed run is completed successfully, at which time the centrifuge will move on to the next set of programmed parameters.

***NOTE*** If you plan on using the QC RUN feature, consider the following as you save runs to program memory:

- QC RUN programs should not use HOLD.
- Programs with factory default settings of SPEED=400 rpm, TIME=00:00, and TEMP=40 will be ignored in the QC RUN sequence.
- Although you may choose otherwise, to minimize the time it takes to perform a QC RUN, we recommend the following: Starting with program 1, save runs to program memory in order – sorted first by temperature (highest first), then, if there is more than one run at a single temperature, by speed (lowest first).

***FOR EXAMPLE :***
The programs at right are listed in correct order for using QC RUN; PROG # 5 (with factory default settings) will be ignored by the centrifuge when performing the run (program values shown are for example purposes only, actual set parameters will vary).

| ROTOR | SPEED | TIMED | DEG C | PROG # |
|---|---|---|---|---|
| H12000 | 2900 | 04:00 | 22 | 1 |
| H12000 | 4000 | 03:00 | 22 | 2 |
| H12000 | 3300 | 03:45 | 4 | 3 |
| H12000 | 4700 | 05:30 | 4 | 4 |
| H12000 | 400 | 00:00 | 40 | 5 |

While the QC RUN sequence is in progress, the centrifuge will output (to a connected computer) the observed speed and temperature along with the SET speed and temperature for automatic data logging and simple performance verification.

- SLOW START chooses gentle acceleration from 0 to 250 rpm (acceleration transitions to the normal, maximum rate at 250 rpm), with the slow start rate defined by selection of one of ten different acceleration profiles. The profiles are numbered for ease of selection, with number 1 being the slowest, most gradual rate, and each successive rate being incrementally faster up to number 10.

- SLOW STOP chooses gentle deceleration from 500 to 0 rpm (normal deceleration braking from set speed transitions to the more gradual rate at 500 rpm), with the rate defined by selection of one of ten different deceleration profiles. The profiles are numbered for ease of selection, with number 1 being the slowest, most gradual rate, and each successive rate incorporating incrementally more braking up to number 10. Particularly when

establishing blood bank protocols, for optimized braking with minimal resuspension, we recommend starting at setting 5 and adjusting up or down as needed. Selection of BRAKE OFF will have an affect on SLOW STOP *(see the NOTE under BRAKE OFF).*

- BRAKE OFF deactivates normal deceleration braking for a coasting stop from any specified speed (in rpm) between 4700 and 0. BRAKE OFF transition speed is set independently of set run speed, and is not affected by changes to set run speed. If the transition speed is set higher than the set run speed, at run termination, the centrifuge will coast to a stop from set speed.

***NOTE*** If SLOW STOP and BRAKE OFF are both selected:

  – If the BRAKE OFF transition speed is set to 500 rpm or higher, the SLOW STOP selection will be ignored.

  – If the BRAKE OFF transition speed is set below 500 rpm, the centrifuge will decelerate with full braking to 500, transition to the specified SLOW STOP rate, then change to a coasting stop when the specified BRAKE OFF transition speed is reached.

- CHANGE OVERTEMPERATURE LIMIT allows changing the maximum allowable sample temperature to establish a new overtemperature offset value. The centrifuge calculates the difference between the set and the maximum temperatures, and retains that value as an offset to apply to future runs, until it is changed. The retained offset will apply to any normal (manual-entry) runs as well as to any recalled program runs (specific overtemperature limit settings cannot be saved in run programs). ***See the EXAMPLE at left.***

***EXAMPLE:***
If you have a set temperature of 22 and set the maximum temperature to 24, an overtemperature alert will occur if the calculated sample temperature reaches 25. If the set temperature is then changed to 4, the maximum temperature setting will automatically change to 6, based on the previously calculated offset value.

  During a run, if the calculated sample temperature in the RUN display goes above the maximum allowable sample temperature, a SAMPLE TEMPERATURE OVER LIMIT message will appear in the SET display, and an alarm will sound. This may indicate a condition requiring simple corrective action, or it could indicate a refrigeration problem (see "SAMPLE TEMPERATURE OVER LIMIT" on page 3-16).

  This overtemperature alert is not activated and a precool mode begins if the RUN display temperature is more than 2°C over the SET value when START is pressed, or when a temperature change between programs occurs in a STEP RUN. In each case, a SAMPLE OVERTEMP – PRE-COOLING message will appear and an alarm will sound. Pressing CLEAR removes the message and shuts off the alarm, allowing the run to continue as a precool run (P-COOL replaces DEG C as the field header in the SET display during precool mode). A precool mode is automatic during a QC RUN; the message and alarm are disabled, and the program is repeated until temperature is within 2° of set.

- CHANGE UNDERTEMPERATURE LIMIT allows changing the minimum allowable sample temperature to establish a new undertemperature offset value. The centrifuge calculates the difference between the set and the minimum temperatures, and retains that value as an offset to apply to future runs, until it is changed. The retained offset will apply to any normal (manual-entry) runs as well as to any recalled program runs (specific undertemperature limit settings cannot be saved in run programs). ***See the EXAMPLE at left.***

  ***EXAMPLE:***
  If you have a set temperature of 22 and set the minimum temperature to 20, an undertemperature alert will occur if the calculated sample temperature goes down to 19. If the set temperature is then changed to 4, the minimum temperature setting will automatically change to 2, based on the previously established offset value.

  During a run, if the calculated sample temperature in the RUN display goes below the minimum allowable sample temperature, a SAMPLE TEMPERATURE UNDER LIMIT message will appear in the SET display, and an alarm will sound. This may indicate a condition requiring simple corrective action, or it could indicate a refrigeration problem (see "SAMPLE TEMPERATURE UNDER LIMIT" on page 3-16).

  This undertemperature alert is not activated and a preheat mode begins if the RUN display temperature is more than 2°C under the SET value when START is pressed, or when a temperature change between programs occurs in a STEP RUN. In each case, a SAMPLE UNDERTEMP – PRE-HEATING message will appear and an alarm will sound. Pressing CLEAR removes the message and shuts off the alarm, allowing the run to continue as a preheat run (P-HEAT replaces DEG C as the field header in the SET display during preheat mode). A preheat mode is automatic during a QC RUN; the message and alarm are disabled, and the program is repeated until temperature is within 2° of set.

- STEP RUN allows the linking-together of up to three sets of programmed run parameters to automatically perform step run protocols. When step run is selected, the specified programs must specify the same rotor at similar temperatures. Step runs can be saved to program memory (program numbers 10-15) for simple recall in future use (see SAVE RUN below).

- SAVE RUN allows pre-programming of up to 15 different sets of run parameters (9 standard runs, and 6 step runs) for simple recall and error-free run reproducibility. In addition to basic parameters, all option selections and settings (excluding rotor name, overtemperature limit, and undertemperature limit) will also be saved to program memory. To eliminate inadvertent loss of existing programs, the save run sequence alerts users before overwriting. The convenient RECALL key allows browsing through existing programs for selection or reference.

**NOTE** If you plan to use the QC RUN feature, specific guidelines should be considered when saving parameters to memory (see QC RUN on page 3-8).

## *Numeric Keypad*


The Numeric Keypad is used to input speed, time, and temperature values into the HOME screen and to select the advanced features. The ENTER key enters newly inputted speed, time, temperature, and RCF values into memory; it also allows you to bypass options in the OPTIONS sequence without selecting or deselecting them. The CLEAR key sets a blinking value to zero in the SET display, clears entry errors or fault messages, and if the barcoding accessory is used and the door is open, deletes barcode data input after the last run was completed (keypad lock must be set to FULL FUNCTION). The +/– key is used to toggle between positive (+) and negative (–) temperature values.

## START and STOP Keys


The green START key is used to start the centrifuge run. When the START key is pressed, the green LED status indicator on the key will blink until the rotor begins to spin (which could take up to 20 seconds if SLOW START is selected). Once the rotor starts spinning, the light on the key will remain ON through run termination (during deceleration) until the rotor stops spinning and door unlocks. Pressing START when a run is in progress resets run duration.

The red STOP key is used to terminate a run. When stop is pressed (or whenever a run terminates and deceleration begins), the red LED status indicator light on the key will be ON, and will remain ON until the rotor stops spinning and door unlocks. When that happens, the indicator light is turned OFF, and "End" will appear in the RUN Temperature display to prompt the user to open the chamber door and remove sample.

***NOTE*** The START and STOP keys are usable only when the HOME screen is in the SET display. If any other screen is in the display, the keys are disabled.

## SET Display Advisory Messages

When the *RC12*BP™ detects a system fault or a situation requiring operator action, an advisory message appears in the SET display and an alarm will sound to alert the operator. In most cases, pressing CLEAR shuts off the alarm and removes the message from the display (if not, in almost all other cases, turning the main POWER switch OFF and back ON will do so). The messages can be divided into two types, Problem Conditions and Terminal Conditions. Possible messages are listed here by message type, sorted alphabetically, with a description of the condition and the appropriate action.

### Problem Conditions

Problem Condition messages alert the user to a situation that will not terminate a run in progress (except for ROTOR IMBALANCE, NO ROTOR, or POWER FAILURE), but may prevent a run from starting. In many cases, a Problem Condition will force action to be taken, but can be remedied by the user.

DOOR MUST BE OPENED BETWEEN RUNS

START was pressed, but the chamber door had not been opened since the previous run ("End" will remain in the RUN Temperature display until the door has been opened). The centrifuge will not start. Open the door (if you had not accessed the chamber since the last run, remove previous sample and reload the rotor), then close the door and press START. If the message reappears when START is pressed, it indicates a door switch failure – remove all sample from the rotor, unplug the centrifuge and contact Thermo Service.

DOOR OPEN – RUN NOT STARTED

START was pressed, but the centrifuge did not detect that the chamber door was closed. The centrifuge will not start. Close the chamber door and press START. If the message then appears when the door is closed, it indicates a door switch failure. In that case, remove all sample from the rotor, then unplug the centrifuge and contact Thermo Service.

MEMORY FAILURE – CONTACT SERVICE

A memory problem was discovered during the centrifuge startup routine. All run information that had been saved to program memory has been lost and overwritten with SPEED=400 rpm, TIME=00:00, DEG C=40, Options OFF.

A MEMORY FAILURE fault could indicate a processing problem, but typically means that the battery has gone dead. Press CLEAR, turn the main power switch OFF and back ON to see if the fault recurs, then contact Thermo Service. Until the condition is repaired, the centrifuge will not communicate to WatchLog Network™ (logging run data will not occur), but the centrifuge should still be operational. If programmed operation is desired, resave the run parameters, but leave the main power switch ON until the condition is repaired, so that saved programs are not lost.

### NO ROTOR DETECTED

When START was pressed, a rapid increase in rpm was detected (that could occur if no rotor was installed), and the run was terminated immediately. After the door unlocks, install a rotor and restart the run. (In future use, if rotors are added: If a rotor was installed, check to be sure that it was correctly identified in the SET display. If not, either change the rotor or change the setting so that they match, then restart the run.) If a correctly identified rotor *was* installed, it indicates either that the drive shaft is damaged or that a tachometer problem exists. Remove all sample from the rotor, unplug the centrifuge and contact Thermo Service. (WatchLog Network™ record: NO ROTOR.)

### POWER FAILURE – RUN RESTARTED

A momentary power failure occurred during the run, and the rotor speed was still within 200 rpm of SET speed when the power was restored. The automatic restart feature resumed the run in progress. (WatchLog Network™ does not document this occurrence.)

### POWER FAILURE – RUN TERMINATED

A power failure occurred during the run, and the rotor speed was not within 200 rpm of SET speed when power was restored, disabling automatic restart. The run in progress was terminated. (If power is restored before zero speed, WatchLog Network™ record: POWER FAIL. If power is restored after zero speed, there will be no record of the run.)

### ROTOR IMBALANCE – BALANCE ROTOR

Excessive rotor vibration was detected; the run in progress was terminated. Rebalance the rotor according to directions in the rotor instruction manual, then restart the run. WatchLog Network™ record: IMBALANCE.)

### SAMPLE OVERTEMP – PRE-COOLING

The RUN display temperature was more than 2°C above the SET temperature either when START was pressed, or during a STEP RUN at a moment when the programmed SET temperature changed. Press CLEAR to continue the run as a Precool run, or press STOP to terminate the run to remove sample before precooling the chamber to SET temperature. During a Precool run, P-COOL replaces the DEG C field header in the SET display until RUN temperature is within 2°C of SET value.

### SAMPLE TEMPERATURE OVER LIMIT

During a run, when the pre-cool feature was not active (see SAMPLE OVERTEMP – PRE-COOLING, above), the RUN display temperature went above the maximum allowable (overtemperature limit) setting. Check all possible causes:

a. SET temperature too low for rotor/speed combination,

b. overtemperature limit too close to the SET temperature (see page 3-10, CH

c. ambient air temperature at the centrifuge inlet > 35°C,

d. centrifuge air inlet blocked or proper clearance not observed (see page 2-2, Location).

Check all possible causes before contacting Thermo Service. (WatchLog Network™ record: OVERTEMP.)

### SAMPLE TEMPERATURE UNDER LIMIT

During a run, when the preheat feature was not active (see SAMPLE UNDERTEMP – PRE-HEATING below), the RUN display temperature went below the minimum allowable (undertemperature limit) setting. The limit setting may be too close to the SET temperature (see page 3-11, CHANGE UNDERTEMPERATURE LIMIT) – try setting a lower undertemperature limit. If the problem persists, there may be a refrigeration system problem. Contact Thermo Service. (WatchLog Network™ record: TEMP. UNDER LIMIT.)

### SAMPLE UNDERTEMP – PRE-HEATING

The RUN display temperature was more than 2°C below the SET temperature either when START was pressed, or during a STEP RUN at a moment when the programmed SET temperature changed. Press CLEAR to continue the run as a Preheat run, or press STOP to terminate the run to remove sample before preheating the chamber to SET temperature. During a Preheat run, P-HEAT replaces the DEG C field header in the SET display until RUN temperature is within 2°C of SET value.

THE SET SPEED EXCEEDS ROTOR MAX - ENTER A LOWER SET SPEED

(Future use, if rotors are added.) START was pressed, but the centrifuge detected a set SPEED value that was too high for the SET rotor. The centrifuge will not start. This can occur if you change the SET rotor, but the SET speed is too high for the newly specified rotor, or if you recall a program that was saved based on the use of a different, higher-speed rotor. Make sure the SET rotor specified is the installed rotor, then enter an rpm or RCF value that does not exceed the maximum allowable for the rotor, or install and specify a different rotor, and press START.

THE SET SPEED EXCEEDS ROTOR MAX - RUN TERMINATED

(Future use, if rotors are added.) This can occur when a QC RUN or STEP RUN is in progress, and a program is encountered that has a higher set speed than the maximum speed of the SET rotor (indicating that the program was saved based on the use of a different, higher-speed rotor). The SET rotor cannot be used with the programs as saved. Make sure the SET rotor is installed, change to an acceptable rotor or review and change the programs saved before reattempting. (WatchLog Network™ record: SET SPEED.)

THE SET TIME = 0:00 - ENTER A VALID TIME

START was pressed with a set run duration value of zero. The centrifuge will not start. Press one of the three run duration control keys (TIME/HOLD/ACE), input a value, then press START.

## *Terminal Conditions*

Terminal Condition messages alert the user to a serious fault condition. Runs are disallowed or terminated. These conditions typically cannot be remedied by the user; the centrifuge should be removed from service until it is repaired by Thermo Service.

**ALternate TACH FAILURE**

During a run, the primary tachometer signal was indicating 2000 rpm or more while the secondary tachometer signal was indicating 0 rpm. Wait for the rotor to stop spinning (this could take as long as 30 minutes), then use the mechanical override to remove all sample from the rotor, unplug the centrifuge and contact Thermo Service. ***Read the WARNING***. (WatchLog Network™ record: TACH FAULT.)

**AIR TEMP SENSOR FAILURE**

The chamber air temperature sensor indicated either an open circuit, or a temperature above 45°C. The fault indicates a sensor failure or a refrigeration system problem. After the rotor stops and the chamber door is opened, note if the chamber is warm – if so, the rotor may be too hot to touch. Unplug the centrifuge and contact Thermo Service. (WatchLog Network™ record: AIR SENSOR.)

**COMPRESSOR FAILURE**

While the refrigeration compressor was working to cool, the chamber air temperature sensor detected an increase of 10°C or more from when the compressor first turned on. The fault indicates a refrigeration system problem. After the rotor stops and the chamber door is opened, note if the chamber is warm – if so, the rotor may be too hot to touch. Unplug the centrifuge and contact Thermo Service. (WatchLog Network™ record: COMPRESSOR.)

**COMPRESSOR SOLENOID FAILURE**

While the refrigeration compressor was working to heat, the chamber air temperature sensor detected a decrease of 10°C or more from when the compressor first turned on. The fault indicates a refrigeration solenoid/valve problem. Unplug the centrifuge and contact Thermo Service. (WatchLog Network™ record: COMP. SOLENOID.)

***W A R N I N G***

**Do not open the chamber door when the rotor is spinning**. In the event of a tachometer failure (or any failure where RUN speed does not register), the brake will not operate and the rotor will coast to a stop – from high speed, deceleration to 0 could take as long as 30 minutes. Before using the mechanical override to open the chamber door, use the viewing port in the door to make sure that the rotor has stopped spinning. Opening a chamber door when a rotor is spinning exposes hazardous energy; contact with a spinning rotor could cause personal injury.

### CONDENSER PRESSURE TOO HIGH

The refrigeration system's high side pressure sensor indicated either an open circuit, or an internal pressure above 450 psi. The fault typically indicates a refrigeration system problem. Possible causes include:

- user repairable items such as ambient air temperature too high, centrifuge air inlet blocked or proper clearance not observed (see page 2-2, Location);
- Thermo Service repairable items such as a blocked condenser, condenser fan failure, system overcharge, or pressure sensor malfunction.

Check user repairable causes before unplugging the centrifuge and contacting Thermo Service. (WatchLog Network™ record: COMPRESSOR.)

### DOOR CLOSED SWITCH FAILURE

A run was in progress when the door closed switch opened, indicating a circuit failure. Remove all sample from the rotor after it stops, then unplug the centrifuge and contact Thermo Service. (WatchLog Network™ record: DOOR.)

### DOOR LOCK SWITCH FAILURE

A run was in progress when the door lock switch opened, indicating a circuit failure. Remove all sample from the rotor after it stops, then unplug the centrifuge and contact Thermo Service. (WatchLog Network™ record: DOOR.)

### DOOR LOCK SWITCH SHORTED

At run completion, the door lock switch did not open, indicating a circuit failure. The interlock motor is de-energized; another run will not start. Remove all sample from the rotor, then unplug the centrifuge and contact Thermo Service.

### DOOR NOT LOCKED – CONTACT SERVICE

After START was pressed, the door lock switch did not close, indicating a circuit failure. The run will not start and the interlock motor is de-energized. Remove all sample from the rotor, unplug the centrifuge and contact Thermo Service.

### DRIVE BOX FAULT

The microcomputer detected that the drive box was not responding, possibly indicating an error internal to the drive box electronics, or a brake resistor overheat condition. Wait for the rotor to stop spinning (this could take as long as 30 minutes), then use the mechanical override to remove all sample from the rotor, unplug the centrifuge and contact Thermo Service. ***Read the WARNING on page 3-18.*** (WatchLog Network™ record: DRIVE.)

DRIVE FAULT AT START-UP

After START was pressed, the microcomputer detected that the tachometer was not responding as power was applied to the drive motor, without any indication of a drive fault. May indicate a motor problem or, if it occurs at same time as Tach Fault, a tachometer problem. Wait for the rotor to stop spinning (this could take a few minutes), then use the mechanical override to remove all sample from the rotor, unplug the centrifuge and contact Thermo Service. ***Read the WARNING on page 3-18***. (WatchLog Network™ record: DRIVE.)

DRIVE FAULT DETECTED – CALL SERVICE

The microcomputer detected either that the drive motor was not responding, or that the tachometer circuit failed. Wait for the rotor to stop spinning (this could take as long as 30 minutes), then use the mechanical override to remove all sample from the rotor, unplug the centrifuge and contact Thermo Service. ***Read the WARNING on page 3-18***. (WatchLog Network™ record: DRIVE.)

DRIVE FAULT DURING BRAKING

After run termination while the rotor is decelerating and the drive was working to reverse, either the drive box stopped responding or a speed increase was detected. Wait for the rotor to stop spinning (this could take as long as 30 minutes), then use the mechanical override to remove all sample from the rotor, unplug the centrifuge and contact Thermo Service. ***Read the WARNING on page 3-18***. (WatchLog Network™ record: DRIVE.)

FLOOR TEMP SENSOR FAILURE

The chamber floor temperature sensor has indicated either a temperature above 55°C, or an open circuit. The fault indicates a sensor failure or a refrigeration problem. After the rotor stops and the chamber door is opened, note if the chamber is warm – if so, the rotor may be too hot to touch. Unplug the centrifuge and contact Thermo Service. (WatchLog Network™ record: FLOOR SENSOR.)

MOTOR CURRENT FEEDBACK FAULT

The microprocessor has detected that the feedback current returning from the drive motor was improbable based on the current sent to the motor. The fault indicates a motor/drive box, power supply, or tachometer problem. Wait for the rotor to stop spinning (this could take as long as 30 minutes), then use the mechanical override to remove all sample from the rotor, unplug the centrifuge and contact Thermo Service. ***Read the WARNING on page 3-18***. (WatchLog Network™ record: DRIVE.)

MOTOR OVERHEAT DETECTED - CALL SERVICE

Indicates that high motor temperature has tripped its thermal switch, or that the motor temp circuit is otherwise open. Wait for the rotor to stop spinning, remove all sample from the rotor, unplug the centrifuge and contact Thermo Service. (WatchLog Network™ record: MOTOR SENSOR.)

ROTOR OVER MAX SPEED – CONTACT SERVICE

Speed was more than 200 rpm higher than the rotor's maximum rated speed, indicating improper speed control or a faulty tachometer circuit. Wait for the rotor to stop spinning (this could take as long as 30 minutes), then use the mechanical override to remove all sample from the rotor, unplug the centrifuge and contact Thermo Service. ***Read the WARNING on page 3-18***. (WatchLog Network™ record: ROTOR OVERSPEED.)

SHUNT OVERHEAT DETECTED - CALL SERVICE

Indicates that high brake resistor temperature has tripped its thermal switch (indicating that the resistor was energized when it should not have been), or that the brake circuit is otherwise open. Wait for the rotor to stop spinning, remove sample from the rotor, unplug the centrifuge and contact Thermo Service. (WatchLog Network™ record: SHUNT OVERDRIVE.)

TACH FAULT DETECTED – CALL SERVICE

During a run, the tachometer signal was lost, indicating that the tachometer circuit has failed, or that the drive shaft is damaged. Wait for the rotor to stop spinning (this could take as long as 30 minutes), then use the mechanical override to remove all sample from the rotor, unplug the centrifuge and contact Thermo Service. ***Read the WARNING on page 3-18***. (WatchLog Network™ record: TACH FAULT.)

UNEXPECTED ISR – CALL SERVICE

The microprocessor has detected erroneous information or encountered a processing problem. The run in progress may or may not be terminated; the controls and displays might lock-up. Turn the main power switch OFF and back ON. If the fault recurs, turn the main power switch OFF. Wait for the rotor to stop spinning (this could take as long as 30 minutes), then use the mechanical override to remove sample from the rotor, unplug the centrifuge and contact Thermo Service. ***Read the WARNING on page 3-18***. (WatchLog Network™ may not record: UNEXPECTED ISR.)

# Chapter 4: OPERATION

This chapter provides the operating procedures for the *RC12*BP™ Centrifuge.

**NOTE** Before turning on the *RC12*BP™ for the first time, be sure it is properly installed (see Chapter 2, Installation). Before using the *RC12*BP™ for the first time, we recommend that you read all WARNINGS and CAUTIONS, as well as Chapter 3 to familiarize yourself with the centrifuge controls and features.

## Turning the Centrifuge ON

To turn the *RC12*BP™ ON, find the main POWER switch, located on a small recessed panel in the upper right corner of the front cabinet panel, then rock the POWER switch up to the "I" (ON) position – watch the control panel LEDs to be sure that all segments light.

**NOTE** If any LED segments do not light, note which ones and contact a local Thermo Service Representative. Continued operation when the centrifuge is unable to display all run information correctly could mislead an unaware observer.

During start-up (in addition to lighting all LEDs), the centrifuge microprocessor performs a short diagnostic routine and the SET display will appear as follows:


If an error is detected, an error message will appear in the SET display. If no error is found, the SET display will automatically display the HOME screen that was displayed when the centrifuge was turned OFF. All OPTIONS selections will also be the same as when the centrifuge was turned OFF.

**NOTE** Do not attempt to open the door unless End is in the SPEED display. Doing so when the interlock is to be moving could cause the interlock to bind, requiring cycling the main POWER switch several times.

# Rotor Installation, Loading and Balancing

**W A R N I N G**

If maximum compartment mass is exceeded, the maximum speed must be lowered (see Reducing Speed for Rotor Compartment Loads in Excess of Design Mass, page 4-14). Failure to do so can cause rotor failure which could result in personal injury or centrifuge damage.

Install, load, and balance the rotor according to the instructions given in the rotor instruction manual.

## Table 4-1. ROTOR INFORMATION

| Rotor | Maximum Speed (rpm) | Maximum RCF (*g*-force)[1] | Maximum Compartment Mass (grams)[2] | Balance Margin (grams) | Critical Speed (rpm) | Biohazard Containment Available |
|---|---|---|---|---|---|---|
| **SWINGING BUCKET** | | | | | | |
| H-12000 | 4700 | 7333 | 4726[3] | 50 | 400 | no |

1 Values reflect the centrifuge's calculation rounding, are based on the rotor's maximum radius, and do not consider any tube, bottle or adapter geometry.

2 Maximum allowable at maximum speed (see Reducing Speed for Rotor Compartment Loads in Excess of Design Mass, page 4-13).

3 Value includes the mass of the bucket, adapter (if used), blood bags or bottle, and sample; value for contents only (not including the bucket) is 2160 grams.

# Normal Operation

***Read the Safety Information Page at the front of this manual.***

1 Check all OPTION LED indicators – if selection changes are required, press MENU, then press ENTER to access each option screen in succession (see figure 4-1 on page 4-7). As you step through each screen, you may select or deselect, and change or accept the previous setting. To check an existing selection setting (Slow Start/Stop rates, Brake Off speed, Overtemperature Limit or Step Run sequence), press 1 to display the option's secondary screen, then view the displayed value. When finished with all changes, press MENU to return to the HOME screen.

**NOTE** Do not attempt to open the door unless End is in the SPEED display. Doing so when the interlock is to be moving could cause the interlock to bind, requiring cycling the main POWER switch several times.

2. Prepare the rotor according to the rotor manual. Open the chamber door, wipe the chamber and drive spindle dry (if wet) and install the rotor, making sure the rotor is fully seated and locked to the drive spindle. Load the rotor, install its cover, and close the chamber door. (In future use, if new rotors have been added) make sure that the SET rotor specifies the installed rotor. If not, press ROTOR repeatedly until it does.

3. Check the settings in all other fields in the SET display – input changes to specific parameters as follows:

   a. If you require a change to the SPEED (rpm) or RCF (*g* force) field, press SPEED and input the desired value. Values in excess of the maximum for the specified rotor will not be accepted (the value will continue to blink). To change mode from rpm to RCF, or from RCF to rpm, press SPEED more than once; an equivalent value will be calculated (based on the maximum radius of the specified rotor) and displayed.

   b. If you require a change to the TIMED/HOLD/ACE field, press TIME, HOLD, or ACE to select a run duration control method and, if you did not select HOLD, input a desired termination value (in minutes and seconds up to 99:99, or in ACE up to 9.99e30 [$9.99 \times 10^{30}$]). *Always be sure of the control method and value before starting the run.*

   c. If you require a change to the DEG C field, press TEMP and input the desired sample temperature between –10 and 40°C.
   ***Read the sections regarding Temperature Control and Rotor Temperature Equilibration found on pages 4-11 and 4-12.***

4. If using WatchLog Network™ run logging software, be sure it is running, then press START (START indicator will blink, then stay lit once the rotor starts to spin).

The rotor will accelerate to the set run parameters, and continue until run termination. At termination, the STOP indicator will light and the rotor will decelerate to a stop. After it stops, START and STOP indicators will turn off, and "End" will appear in the RUN TEMP display and remain there until the door is opened.

**NOTE** Do not attempt to open the door unless End is in the SPEED display. Doing so when the interlock is to be moving could cause the interlock to bind, requiring cycling the main POWER switch several times.

# *Programmed Operation*

## *A. Storing Selections to Program Memory*

1. Establish all desired run parameters as explained in steps 1 and 3 of the previous section, Normal Operation.

***NOTE*** If you plan on using the QC RUN feature, consider the following as you save runs to program memory:

- QC RUN programs should not use HOLD.
- Programs with factory default settings of SPEED=400 rpm, TIME=00:00, and TEMP=40 will be ignored in the QC RUN sequence.
- Although you may choose otherwise, to minimize the time it takes to perform a QC RUN, we recommend the following: Starting with program 1, save runs to program memory in order – sorted first by temperature (highest first), then, if there is more than one run at a single temperature, by speed (lowest first).

***FOR EXAMPLE :***
The programs at right are listed in correct order for using QC RUN; PROG # 5 (with factory default settings) will be ignored by the centrifuge when performing the run (program values shown are for example purposes only, actual set parameters will vary).

| ROTOR | SPEED | TIMED | DEG C | PROG # |
|---|---|---|---|---|
| H12000 | 2900 | 04:00 | 22 | 1 |
| H12000 | 4000 | 03:00 | 22 | 2 |
| H12000 | 3800 | 03:45 | 4 | 3 |
| H12000 | 4700 | 05:30 | 4 | 4 |
| H12000 | 400 | 00:00 | 40 | 5 |

2. Press MENU to access the advanced features screens, then press ENTER (seven times after first accessing the advanced features) until the following screen is in the SET display:

```
SAVE TO PROGRAM MEMORY?
(1=YES, 0=NO; ENTER=DO NOT CHANGE)
```

3. Input 1. The following screen will appear in the SET display:

```
ENTER PROG  #.............: 00
 (SINGLE RUNS, 1-9; STEP RUNS, 10-15)
```

***NOTE*** Single-digit program numbers 1-9 are for storing sets of standard run parameters; double-digit program numbers 10-15 are for storing step-runs.

3. Input a program number, then press enter. The SET display will then return to the HOME screen, and that program number will appear in the PROG # field as confirmation:

| ROTOR | SPEED | TIMED | DEG C | PROG # |
|---|---|---|---|---|
| H12000 | 2900 | 04:00 | 22 | 1 |

Record saved information on the Program Log Pad (supplied).

***NOTE*** To prevent accidental erasure of established programs, if the entered program number has been previously assigned, the following message will appear:


To review stored programs before overwriting, refer to your Program Log Pad or press RECALL. If you press RECALL, you will have to go back and reestablish the run parameters before you can store them to memory.

## *B. Performing a Programmed Run*

***Read the Safety Information Page at the front of this manual.***

1. Press RECALL – the HOME screen will change to display a program number flashing in the PROG # field.

2. Input the desired program number, then press ENTER – the SET display and options indicators change to reflect the run parameters that were saved to that program number.

3. Prepare the rotor according to the rotor manual instructions.

4. Open the chamber door, wipe the chamber and drive spindle dry (if moisture is present), and install the rotor, making sure that the rotor is fully seated and locked to the drive spindle. Install the rotor cover, if any, then close the chamber door.

***NOTE*** Rotor names are not saved or recalled – (in future use, if new rotors have been added) be sure that the installed rotor is correct for the recalled program; make sure that the SET rotor identifies the installed rotor.

5. If using WatchLog Network™ run logging software, be sure it is running, then press START (START indicator will blink, then stay lit once the rotor starts to spin).

The rotor will accelerate according to the recalled parameters, and continue until run termination. At termination, the STOP indicator will light and the rotor will decelerate to a stop. After it stops, START and STOP indicators will turn off, and "End" will appear in the RUN TEMP display and remain there until the door is opened.

***NOTE*** Do not attempt to open the door unless End is in the SPEED display. Doing so when the interlock is to be moving could cause the interlock to bind, requiring cycling the main POWER switch several times.

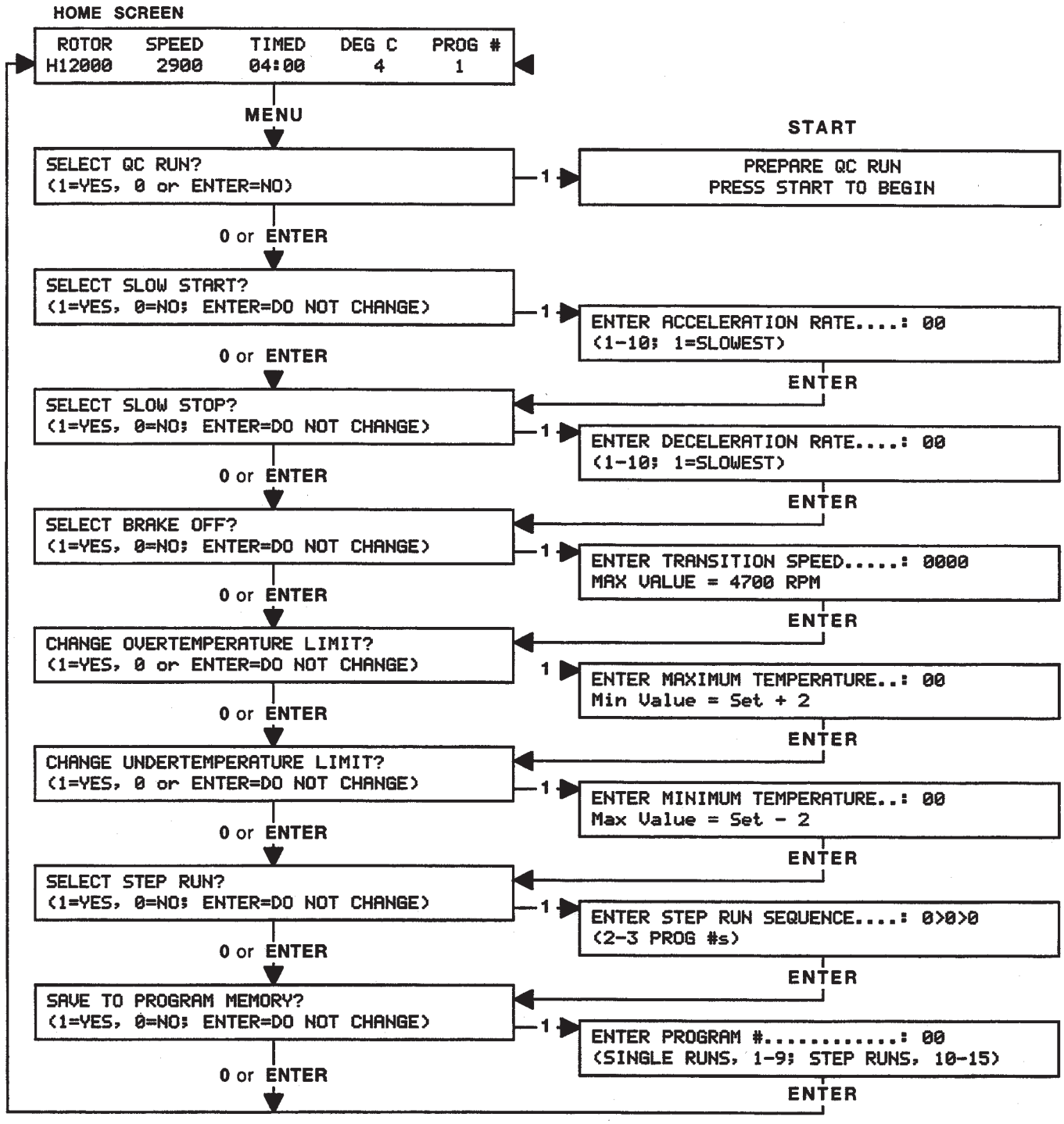
## *Using Advanced Features (Options)*

The advanced features of the *RC12*BP™ allow for: performing quality control runs, changing speed or time control ranges, changing acceleration/deceleration or overtemperature alert settings, linking-together programmed run parameters, and saving run parameters to program memory for simple recall. Detailed description of each of the advanced features can be found in Chapter 3.

Advanced feature selection is usually reflected by LED option status indicators – when a feature has been selected, the corresponding indicator will be lit (although specific settings for several features can only be checked by reselecting the feature in the options screens). If changes to advanced feature selection are required (other than to RPM/RCF or TIME/HOLD/ACE status, which are accessible through primary function keys), the features are accessed by pressing MENU and then pressing ENTER until the selection screen of the particular feature appears in the SET display.

Pressing ENTER steps through the options screen sequence without changing preexisting selection status (unless a new value is input). Selections are made by inputting 1 or 0, then entering any required setting values that may be prompted on a subsequent screen for that option.

After the last option in the options screen sequence (SAVE TO PROGRAM MEMORY?), the HOME screen will reappear in the SET display. If you wish to exit the sequence before that, MENU may be pressed at any time to return to the HOME screen.




***NOTE*** Pressing MENU again will return to the HOME SCREEN from anywhere in the advanced feature option screen sequence.

*Figure 4-1. Advanced Feature Option Screens*

Use specific options as follows:

```
SELECT QC RUN?
```

The QC RUN feature is considered usable only if the centrifuge is equipped with the optional computer interface package. The connected computer should have WatchLog Network™ software running before starting a QC RUN.

When QC RUN is selected, the SET screen will prompt you to prepare for the run and press START to begin. When START is pressed, the centrifuge will start with program number 1, and systematically step through each successive set of saved parameters until it has run every program saved to PROG # positions 1-9 (programs will be skipped if they are programmed to factory settings: SPEED=400 rpm, TIME=00:00, and TEMP=40). QC RUN data will automatically be recorded by the WatchLog Network™ software so that centrifuge performance with respect to the SET speed and temperature is documented, and can be verified.

***NOTE*** If you plan on using the QC RUN feature, consider the following as you save runs to program memory:

- QC RUN programs should not use HOLD.
- Programs with factory default settings of SPEED=400 rpm, TIME=00:00, and TEMP=40 will be ignored in the QC RUN sequence.
- Although you may choose otherwise, to minimize the time it takes to perform a QC RUN, we recommend the following: Starting with program 1, save runs to program memory in order – sorted first by temperature (highest first), then, if there is more than one run at a single temperature, by speed (lowest first).

***FOR EXAMPLE :***
The programs at right are listed in correct order for using QC RUN; PROG # 5 (with factory default settings) will be ignored by the centrifuge when performing the run (program values shown are for example purposes only, actual set parameters will vary).

| ROTOR | SPEED | TIMED | DEG C | PROG # |
|---|---|---|---|---|
| H12000 | 2300 | 04:00 | 22 | 1 |
| H12000 | 4000 | 08:00 | 22 | 2 |
| H12000 | 3800 | 03:45 | 4 | 3 |
| H12000 | 4700 | 05:30 | 4 | 4 |
| H12000 | 400 | 00:00 | 40 | 5 |

To select the QC RUN feature, press MENU, input 1, install the correct rotor, make sure WatchLog Network™ is running on the connected computer, and press START. The QC RUN sequence will begin, running program number 1, and the run status will be displayed on the WatchLog Network™ computer screen.

If, during a QC RUN, the observed RUN temperature is more than 2°C over SET temperature, the DEG C field in the SET display will change to P-COOL. If the temperature is not within 2°C as a program is completed, the centrifuge will automatically repeat that step of the QC sequence. That program will continue repeating until observed temperature is within 2°C.

As each program is completed, WatchLog Network™ will record the observed conditions from the completed program in the database. If STOP is pressed during the QC RUN sequence, WatchLog Network™ will record the data from the program running at the time STOP was pressed, but will label that data incomplete. After the rotor decelerates to zero and the door is opened, the QC RUN option will return to a deselected condition, and the LED status indicator will no longer be lit.


This screen allows you to select a starting rotor acceleration rate (to 250 rpm) that is more gentle than normal, maximum acceleration. If SLOW START is selected when START is pressed, the rotor will accelerate at a more gradual rate up to 250 rpm, then transition to normal, full acceleration to SET speed.

After selecting the SLOW START option, entering 1-10 selects one of ten available starting rates, with 1 being the slowest acceleration, and each successive setting incrementally faster, up to a setting of 10. After SLOW START selections are completed, SELECT SLOW STOP? will appear in the display.


This screen allows you to select a slow stop deceleration rate (from 500 rpm) that is more gentle than a normal, full braking stop. If SLOW STOP is selected, at run termination the rotor will decelerate under full braking to 500 rpm, then transition to a more gradual deceleration rate to stop. After selecting the SLOW STOP option, entering 1-10 selects one of ten available stopping rates. Entering 1 selects the slowest rate, and each successive setting incorporates incrementally more braking up to a setting of 10. Particularly when establishing blood bank protocols, for optimized braking with minimal resuspension, we recommend starting at setting 5 and adjusting up or down as needed. After SLOW STOP selections are completed, SELECT BRAKE OFF? will appear in the display. Selection of BRAKE OFF will have an affect on SLOW STOP *(see the NOTE under SELECT BRAKE OFF?).*

SELECT BRAKE OFF?

This screen allows you to select a speed (in rpm) at which, after termination, deceleration will transition from braking to a coasting stop. The amount of time it takes for the rotor to stop depends on the transition speed, windage and inertia of the rotor. BRAKE OFF transition speed is set independently of set run speed, and is not affected by changes to set run speed. If the transition speed is set higher than the set run speed, at run termination, the centrifuge will coast to a stop from set speed. After selection, CHANGE OVERTEMPERATURE LIMIT? will appear in the display.

***NOTE*** If SLOW STOP and BRAKE OFF are both selected:

- If the BRAKE OFF transition speed is set to 500 rpm or higher, the SLOW STOP selection will be ignored.
- If the BRAKE OFF transition speed is set below 500 rpm, the centrifuge will decelerate with full braking to 500, transition to the specified SLOW STOP rate, then change to a coasting stop when the specified BRAKE OFF transition speed is reached.

CHANGE OVERTEMPERATURE LIMIT?

The *RC12*BP™ has sample overtemperature protection that alerts the user if the calculated sample temperature in the RUN display exceeds SET temperature by more than a specified amount. CHANGE OVERTEMPERATURE LIMIT allows you to specify a maximum allowable sample temperature as it relates to the current SET temperature, to create a new overtemperature offset value that will be applied to future changes to set temperature. The overtemperature limit cannot be set below 2°C over the SET temperature. The offset value will be retained until overwritten. (See CHANGE OVERTEMPERATURE LIMIT on page 3-10 for more information.)

The *RC12*BP™ also has an automatic precool feature, and this overtemperature alert feature is disabled when precooling is in progress. The precool feature sounds an alarm and "SAMPLE OVERTEMP – PRE-COOLING" appears in the SET display if the calculated sample temperature in the RUN display is more than 2°C above the SET temperature, either when START is pressed, or during a STEP RUN, when a new program's SET temperature is more than 2°C lower than the RUN temperature. When CLEAR is pressed, the DEG C field in the SET display will change to P-COOL, which will remain in the display until the RUN temperature comes into range, or the run terminates.

After selection, CHANGE UNDERTEMPERATURE LIMIT? will appear in the display.

CHANGE UNDERTEMPERATURE LIMIT?

The *RC12*BP™ has sample undertemperature protection that will alert the user if the calculated sample temperature in the RUN display is below SET temperature by more than a specified amount. CHANGE UNDERTEMPERATURE LIMIT allows you to specify a minimum allowable sample temperature as it relates to the current SET temperature, to create a new undertemperature offset value that will be applied to future changes to set temperature. The undertemperature limit cannot be set higher than 2°C below the SET temperature. The offset value will be retained until overwritten. (See CHANGE UNDER-TEMPERATURE LIMIT on page 3-11 for more information.)

The *RC12*BP™ also has an automatic preheat feature, and this undertemperature limit feature is disabled when preheating is in progress. The preheat feature sounds an alarm and "SAMPLE UNDERTEMP – PRE-HEATING" appears in the SET display if the calculated sample temperature in the RUN display is more than 2°C below the SET temperature, either when START is pressed, or during a STEP RUN, when a new program's SET temperature is more than 2°C higher than the RUN temperature. When CLEAR is pressed, the DEG C field in the SET display will change to P-HEAT, which will remain in the display until the RUN temperature comes into range, or until the run terminates.

After selection, SELECT STEP RUN? will appear in the display.

SELECT STEP RUN?

This screen allows you to link together up to three sets of run parameters from program memory to create a step run. If the desired parameters have not been entered into memory, you must save each desired set of parameters to memory before continuing with step run creation.

To create a step run, input a program number 1-9 for the first portion of the step run. The SET screen will prompt for another number, input a program number 1-9 for the second portion of the step run. The SET screen will prompt for another number, and you can either press ENTER (if you are creating a two-stage step run), or input a program number 1-9 for the third portion of your run.

***NOTE*** (In future use, if new rotors have been added) when step run is selected, the specified programs should all use the same rotor.

So that runs are not inadvertently corrupted, whenever STEP RUN has been selected (indicator lit), changes to run parameters will be ignored unless STEP RUN is deselected before START is pressed. Because of this, the only changes that could be made without deselecting would be if a different step run was recalled from program memory (program numbers 10-15).

After STEP RUN selection, SAVE TO PROGRAM MEMORY? will appear in the display. For future use, step runs may be saved to program memory, and can occupy program number 10-15.


This screen allows pre-programming of up to 15 different sets of run parameters (9 standard runs, and 6 step runs) for simple recall and error-free run reproducibility of frequently used protocols. To eliminate inadvertent loss of existing programs, the storage sequence alerts users before overwriting. The convenient RECALL key allows browsing through existing programs for selection or reference.

**NOTE** If you plan to use the QC RUN feature, specific guidelines should be considered when saving parameters to memory (see QC RUN on page 3-8).

To save a run, all run parameter selections should be made before selecting this option. After SAVE TO PROGRAM MEMORY selection and assignment of a program number, the SET display will return to the HOME screen. See Programmed Operation on page 4-4.

## Temperature Control

The *RC12*BP™ controls calculated sample temperature during a run based on the rotor selected, rotor speed, run time, SET temperature and measured chamber temperature. The complex calculation the centrifuge performs must assume, however, that the sample and the rotor are at SET temperature at the start of the run. The centrifuge makes precise calculated adjustments to control temperature of equilibrated components; the control adjustments will not precisely compensate for the error introduced if a rotor or its contents are not at SET temperature at the start of a run (although, eventually, components will equilibrate and control will be appropriate).

**NOTE** When temperature control is critical, the sample, SET temperature, rotor (body, buckets, adapters, and cover), and rotor chamber should all be at the same temperature when START is pressed.

To equilibrate rotor temperature before operation, either store the rotor in a controlled temperature environment (such as refrigerator or cold room), or precool/preheat the rotor in the centrifuge chamber, until the rotor is the same temperature as the sample and the required SET temperature.

Temperature control needs can vary with the application. In many cases, the *RC12*BP™ Centrifuge will be used to run large volumes of sample for short amounts of time. Over the course of a short run, if all components have been equilibrated, it would be difficult to significantly change the sample temperature – even if the centrifuge's temperature control performance was reduced.

## Rotor Temperature Equilibration

To equilibrate the rotor temperature in the centrifuge chamber:

1. Install the rotor in the rotor chamber, place empty buckets in all positions, and install the rotor cover.

2. Close the chamber door.

3. Turn off all options (access with MENU key).

4. (Future use, if rotors are added) Check to be sure that the correct rotor name is in the ROTOR field of the SET display – if not, press ROTOR until it is.

5. Press SPEED. If you are precooling the rotor, input 1500 rpm; if you are preheating the rotor, input the rotor's maximum rated speed (the maximum rated speed of an H-12000 rotor is 4700 rpm).

6. Press HOLD to select a continuous run.

7. Press TEMP and enter the desired rotor temperature.

8. Press START to begin rotor temperature equilibration. The centrifuge will alert you that a sample overtemperature or undertemperature condition exists, and that pre-cooling or pre-heating is taking place – press CLEAR.

9. Monitor progress of the value in the RUN TEMPERATURE display, and note the time when the displayed RUN temperature reaches the SET temperature. From when it does, allow the run to continue for an additional 30 minutes, then press STOP.

## Running Hazardous Material

**WARNING**

If using pathogenic, toxic, or otherwise hazardous materials in the *RC12*BP™, we recommend that the centrifuge be located in a biohazard safety enclosure and operated with all appropriate safety precautions.

The *RC12*BP™ Centrifuge is designed with a refrigeration system that operates independently of the laboratory environment. Because the centrifuge chamber is not designed for biocontainment, some vapors or aerosols released from uncapped, leaking or broken tubes may leak from the chamber during operation. Once a run is completed and the chamber door is opened, the vapors or aerosols which have concentrated in the chamber will be released into the laboratory area. For this reason, when materials which are pathogenic, toxic, or otherwise hazardous in nature are to be run, the centrifuge should be located in a biohazard safety enclosure and operated with all appropriate safety precautions. ***Read the WARNING regarding hazardous materials found on the Safety Information Page in the front of this manual.***

Use appropriate decontamination procedures should exposure to any hazardous material occur. See Chapter 5 for the procedure to follow if a centrifuge or rotor that has been used with a hazardous material must be serviced by Thermo personnel or returned to our service facilities for repair.

## Reducing Speed for Rotor Compartment Loads in Excess of Design Mass

There is a maximum allowable compartment mass established for each centrifuge rotor (see Rotor Information Table on page 4-2). To prevent rotor failure, the total contents of any compartment, including specimen, tubes or bottles, cover, and any adapters or bucket liner (future rotors, if added, may also include the mass of the bucket), must not exceed the maximum allowable compartment mass unless rotor speed is reduced proportionately.

Strict adherence to the maximum allowable compartment mass or reduced speed (see below) is required to prevent rotor failure. ***Read the WARNING on the Safety Information Page in front of this manual.***

If the actual compartment mass (total contents as explained above) is more than that specified for the rotor, the reduced speed can be determined by using the following formula:

$$\text{Reduced Speed (rpm)} = \text{Maximum Rotor Speed (rpm)} \times \sqrt{\frac{\text{Maximum Compartment Mass}}{\text{Actual Compartment Mass}}}$$

# Chapter 5: MAINTENANCE

This section describes routine maintenance procedures that should be performed on a regular basis. As the user, it is your responsibility to make certain that these activities are followed when necessary. To keep your centrifuge in good working condition and ensure accurate test results, we recommend that you have the centrifuge serviced annually by a Thermo Service Representative or other Thermo-qualified service personnel. If further service is needed, contact Thermo Service or your local representative for SORVALL® products.

**WARNING**

There are no user-serviceable items inside the centrifuge. Because of the high voltages in the centrifuge, anyone who is not properly trained in electronics must not test or repair the electrical circuits.

| MAINTENANCE ACTIVITY | FREQUENCY |
|---|---|
| Inspect for general cleanliness | Once a week |
| Clean the rotor chamber | As required and immediately after a spill |
| Wash the drive spindle | When the rotor is removed |
| Clean the cabinet panels | As required and after a spill |
| Defrost the rotor chamber | When ice buildup occurs |
| Check the door gas springs and brackets | Once a month |
| Check speed, timer, and temperature controls | Twice a year or as procedures dictate |
| Have the motor/gyro inspected, ground continuity tested, the condenser cleaned, the latch inspected, and the imbalance detector checked. | Once a year when centrifuge is serviced |

**WARNING**

If hazardous materials have been processed in the centrifuge, observe all necessary precautions when cleaning or servicing the centrifuge to avoid contamination.

## Inspection and Cleaning

### a. Inspection

Inspect the centrifuge each week for encrusted biological deposits, and general cleanliness.

**CAUTION**

Before using any cleaning or decontamination methods other than those recommended by Thermo, users should check with Thermo or the local representative of SORVALL® products that the proposed method will not damage the equipment.

### b. Cleaning

#### Rotor Chamber

The rotor chamber should be kept clean and, if condensation builds up, should be wiped dry to maintain efficient temperature control. When necessary, the rotor chamber may be washed using a mild, nonalkaline detergent such as dishwashing liquid. Rinse with water and dry with a soft absorbent cloth.

**CAUTION**

Chlorides are extremely harmful to aluminum alloy rotors and can cause stress corrosion cracking. Therefore, if chlorides are used to disinfect the chamber, be sure to rinse the chamber thoroughly with water to remove all of the chloride cleanser.

Use 70% ethanol to disinfect the rotor chamber or a 2% glutaraldehyde solution to sterilize it. For general radioactive decontamination, use a solution of equal parts of 70% ethanol, water, and 10% SDS. Follow with ethanol rinses, then deionized water rinses. Dry with a soft absorbent cloth. Dispose of wash solution in proper radioactive waste containers. ***Read the CAUTION.***

In normal operation, it is not unusual for moisture in the air to condense on the cool walls of the rotor chamber, so that the chamber must be wiped dry. When the chamber gets colder, frost can collect on the chamber walls and, as it builds up, act as an insulator between the chamber air and the refrigerant. If frost collects on the chamber walls, you should periodically defrost the chamber to maintain efficient cooling. To defrost the chamber, remove the rotor, close the chamber door, and change the SET temperature to 25. When the displayed RUN temperature reaches 20, open the door and wipe all parts of the chamber dry. Then wipe the rotor dry, reinstall it, close the chamber door and enter a desired SET temperature.

### Drive Spindle

Wipe the spindle with a soft cloth before a rotor is installed to reduce the chance of the rotor sticking to the spindle. If necessary, to remove deposits, the spindle may be washed with warm water; make sure it is wiped dry before installing the rotor.

### Cabinet

The enameled cabinet panels may be cleaned with a household wax cleaner. A mild, nonalkaline detergent and water may be used to clean the top deck and the chamber door.

### Door Gas Springs

**WARNING**

The door gas springs must be checked periodically for proper functioning. If gas pressure is not sufficient the door will not stay open and possible injury could result.

Monthly, check that the two door gas springs are functioning properly by opening the chamber door and making sure it remains open. The gas springs counterbalance the weight of the door and hold it in the open position. Also, check that the connecting ends of each gas spring and the brackets they are connected to have not developed cracks. If the chamber door will not stay in the open position, or a gas spring or bracket is cracked, contact your local Service Representative.

## Lubrication

All components are prelubricated and require no further lubrication. The refrigeration unit is hermetically sealed and the ball bearings in the gyro-action drive assembly and the centrifuge motor are permanently lubricated.

# Customer Control Inspection

To keep your centrifuge in good working condition and ensure accurate and consistent results, we recommend that you use the following procedures to check the speed control, timer control and temperature control at least twice a year or more often as your procedures dictate.

If any of these control checks reveal a control inaccuracy, contact Thermo Service or your local representative for SORVALL® Products to arrange to have a qualified service technician recalibrate the controls.

## Speed Controls

1. Prepare a sample of test fluid. Load and balance the rotor according to the instructions in the rotor manual.

2. Install the rotor in the chamber and close the chamber door.

3. If the RCF or SLOW START indicators are lit, press MENU, then press ENTER until the correct selection screen appears. Press 0 to deselect each option (indicator will turn OFF), then press MENU to return to the HOME screen.

4. Set the run parameters for a commonly used protocol, with SPEED controlled by rpm, and run duration set to HOLD.

5. Press START, wait for the SPEED value in the RUN display to reach the specified SET speed, then wait an additional 5 minutes for speed to stabilize.

6. Using an optical tachometer, check rotor speed through the viewing port in the center of the chamber door (in rpm, following instructions supplied with the tachometer).

The tachometer should indicate rpm equal to the SET value ±20 rpm or 1%, whichever is greater (2000 rpm and below, ±20 rpm; above 2000, ±1%). If necessary, repeat this procedure at other speeds that are commonly used in your protocols.

## Timer Controls

1. Prepare a sample of test fluid. Load and balance the rotor according to the instructions in the rotor manual.

2. Install the rotor in the chamber and close the chamber door.

3. Set the run parameters for a commonly used protocol, but set the run duration by TIME (MIN:SEC) to 13:30.

4. Press START. Using a stopwatch, begin timing precisely as the RUN TIME display counts down to 13:20; then stop timing precisely as the RUN TIME display counts down to 00:00.

The stopwatch should read between 13:15 to 13:25, representing 13:20 ±0.5% (4 seconds) plus an additional second to allow for cumulative human error. If necessary, repeat this procedure at other time ranges that are commonly used in your protocols.

## Temperature Controls

When verifying temperature control, all test run conditions (TEMP, SPEED, TIME, ROTOR and option selections) should match your required protocol(s). Before the run, it is important for the test fluid to be at the same volume and temperature as the actual sample, and for the SET temperature, the displayed RUN Temperature, and the temperature of all parts of the rotor assembly to match also (ideally, all rotor components would have been stored in the same controlled-temperature area overnight, but if that is not possible, you can precool or preheat the rotor as required).

1. Choosing a commonly used protocol with the longest run time, set the centrifuge run parameters.

2. Equilibrate the rotor chamber and the temperature of all rotor parts (include any tubes, bottles, or adapters to be used) to the desired sample temperature.

3. Make sure the rotor chamber is wiped dry, then install the rotor in the chamber and keep the chamber door closed until you load the rotor.

4. Prepare two equal loads of test fluid (similar in volume to normal run samples) equilibrated to the desired sample temperature – check the sample temperature using a calibrated thermometer (such as a Fluke 51 K/J or equivalent).

**NOTE** Test fluid must be compatible with aluminum and have a freezing point below the desired sample temperature.

5. Load and balance the rotor according to the instructions in the rotor manual, then close the chamber door.

6. Press START – during the run, the RUN display temperature should be within 2° of the SET display temperature.

7. After termination, immediately after the rotor stops and the door unlocks, open the chamber door and measure the sample temperature using the same calibrated thermometer that was used earlier.

The measured sample temperature should be within 2°C of SET temperature. If required, repeat this procedure at other speed/ temperature ranges commonly used in your run protocols.

If an out-of-range temperature is observed, re-equilibrate the chamber, rotor, and test fluid temperatures to match desired sample temperature, and repeat the test run.

## *Emergency Sample Recovery*

***W A R N I N G***

**Do not open the chamber door when the rotor is spinning**. In the event of a power failure (or any failure where RUN speed does not register), the brake will not operate and the rotor will coast to a stop – from high speed, deceleration to 0 could take as long as 30 minutes. Before using the mechanical override to open the chamber door, use the viewing port in the door to make sure that the rotor has stopped spinning. Opening a chamber door when a rotor is spinning exposes hazardous energy; contact with a spinning rotor could cause personal injury.

If a power failure (or malfunction that disables the door unlock function at zero speed) occurs while the rotor is spinning, a means to mechanically override the door interlock is provided to allow sample recovery. This procedure should never be used routinely, or while the rotor is spinning, and is intended for emergency sample recovery only. ***Read the WARNING.***

To perform the mechanical override (refer to Figure 5-1):

1. Turn the main power switch OFF, unplug the centrifuge, then use the viewing port and make sure the rotor has stopped spinning before proceeding.

2. Access the interlock motor, located behind the bezel that frames Main POWER switch and KEYPAD LOCK panel in the upper right side of the front cabinet panel. Remove the four screws that secure the bezel, then remove the bezel.

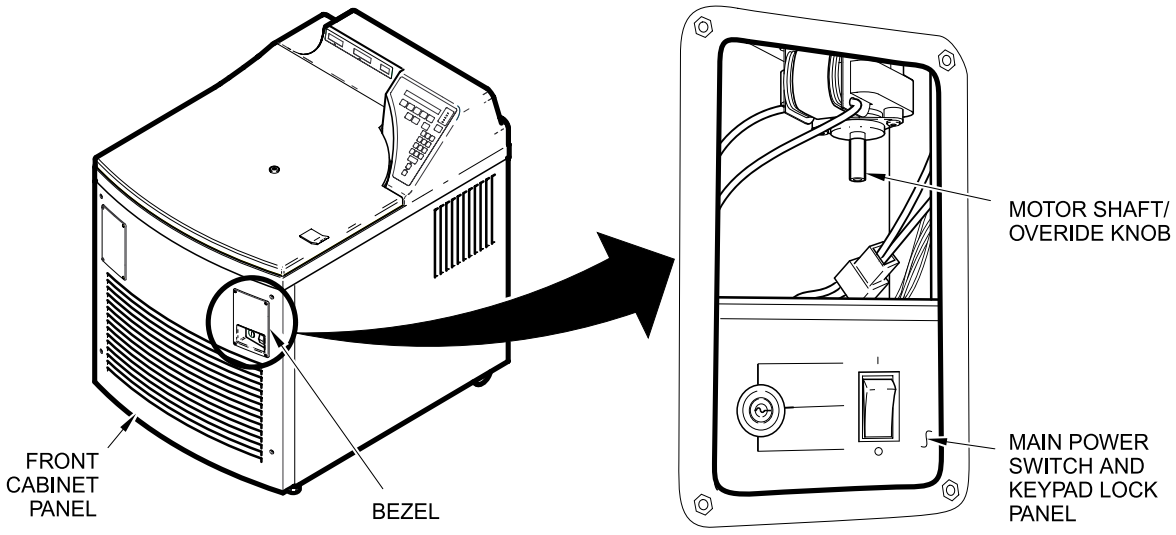



*Figure 5-1. Location of Mechanical Door Override*

3. Locate the interlock motor, then find the motor shaft/override knob extending down from the bottom of the motor casing (it is covered with a plastic sleeve). Spin the knob (in either direction) with your finger until the door interlock bar has been drawn back far enough to disengage the door latch brackets, so that the door can be opened using the latch handle.

4. Reinstall the bezel in the front cabinet panel, then plug-in the power cord.

## Parts Ordering Information

To order replacement parts, telephone toll free 1-800-522-7746 in the United States. Outside the United States, contact your local distributor or agent for SORVALL® products. Be sure to provide a description of the part plus the centrifuge model and serial number.

## Service Decontamination Policy

**WARNING**

Because of the characteristics of the samples likely to be processed in this centrifuge, biological or radioactive contamination may occur. Always be aware of this possibility, and take normal precautions. Use appropriate decontamination procedures should exposure occur.

If a centrifuge or rotor that has been used with radioactive or pathogenic material requires servicing by Thermo personnel, either at the customer's laboratory or at a Thermo facility, comply with the following procedure to ensure the safety of all personnel:

1. Clean the centrifuge or rotor to be serviced of all encrusted material and decontaminate it (see Maintenance Section of centrifuge or rotor instruction manual) prior to servicing by the Thermo representative or returning it to the Thermo facility. There must be no radioactivity detectable by survey equipment.

   The SORVALL® Product Guide contains descriptions of commonly used decontamination methods and a chart showing method compatibility with various materials. The centrifuge or rotor instruction manual contains specific guidance about cleaning and decontamination methods appropriate for the product it describes.

   Clean and decontaminate your centrifuge or rotor as follows:

   *For the centrifuge:*

   a. Remove rotor from the rotor chamber.
   b. Remove, wash, and decontaminate motor sealing gasket and pad.
   c. Decontaminate lid, rotor chamber, and drive using an appropriate method.
   d. Remove all encrusted material from around the motor and drive assemblies.

*For rotors:*

Remove tubes, bottles, and adapters from the rotor and decontaminate rotor using an appropriate method. If tubes or rotor caps are stuck in the rotor, or the rotor lid is stuck, notify Thermo representative; be prepared with the name and nature of the sample so the Thermo Chemical Hazards Officer can decide whether to authorize the rotor's return to a Thermo facility.

2. Complete and attach Decontamination Information Certificate (in the back of your rotor or instrument manual) to the centrifuge or rotor before servicing or return to Thermo facility. If Certificate is not available, attach a written statement verifying decontamination (what was contaminant and what decontamination method was used).

*If the centrifuge or rotor must be returned to a Thermo facility:*

1. Contact your Thermo representative to obtain a Return Service Order Number (RSO#); be prepared with the name and serial number of the centrifuge or rotor and the repairs required.

2. Send item(s) with the RSO# clearly marked on the outside of package to the address obtained from a Thermo representative.

***NOTE*** United States federal regulations require that parts and instruments *must* be decontaminated before being transported. Outside of the United States check local regulations.

If a centrifuge or rotor to be serviced does not have a Decontamination Information Certificate attached and, in Thermo's opinion presents a potential radioactive or biological hazard, the Thermo representative will not service the equipment until proper decontamination and certification is complete. If Thermo receives a centrifuge or rotor at its Service facilities which, in its opinion, is a radioactive or biological hazard, the sender will be contacted for instructions as to disposition of the equipment. Disposition costs will be borne by the sender.

Decontamination Information Certificates are included with these instructions. Additional certificates are available from the local Account or Service Representative. In the event these certificates are not available, a written statement certifying that the unit has been properly decontaminated and outlining the procedures used will be acceptable.

***NOTE*** The Service Representative will note on the Customer Service Repair Report if decontamination was required and, if so, what the contaminant was and what procedure was used. If no decontamination was required, it will be so stated.

# APPENDIX

# Warranty

Thermo Scientific makes no warranty of any kind, expressed or implied, except as stated in this warranty policy.

The SORVALL® *RC12*BP™ Centrifuge is warranted (subject to the conditions specified below and in the warranty clause of the Thermo terms and conditions of sale in effect at the time of sale) to be free from defects in material and workmanship for a period of one (1) year from the date of delivery. Thermo will repair or replace and return free of charge any part which is returned to its factory within said period, transportation prepaid by user, and which is found upon inspection to have been defective in materials or workmanship. This warranty does not include normal wear from use, it does not apply to any instrument or part which has been altered by anyone other than an employee of Thermo, nor to any instrument which has been damaged through accident, negligence, failure to follow operating instructions, the use of electric currents or circuits other than those specified on the plate affixed to the instrument, misuse or abuse.

Thermo reserves the right to change, alter, modify or improve any of its instruments without any obligation whatever to make corresponding changes to any instrument previously sold or shipped.

*The foregoing obligations are in lieu of all other obligations and liabilities including negligence and all warranties, of merchantability or otherwise, expressed or implied in fact or by law, and state our entire and exclusive liability and buyer's exclusive remedy for any claim or damages in connection with the sale or furnishing of goods or parts, their design, suitability for use, installation or operation. Thermo will in no event be liable for any special or consequential damages whatsoever, and our liability under no circumstances will exceed the contract price for the goods for which liability is claimed.*

# DECONTAMINATION INFORMATION CERTIFICATE

Complete and attach to equipment *BEFORE* servicing *(instructions on reverse)*

**PLEASE PRINT**

DECONTAMINATION CERTIFIED BY _____ TITLE/POSITION _____

PHONE _____ FAX _____ DEPARTMENT _____

INSTITUTION _____ ADDRESS _____

CITY _____ STATE _____ ZIP _____

INSTRUMENT _____ SERIAL NUMBER _____

ROTOR _____ SERIAL NUMBER _____

PART _____ PART NUMBER _____

HAZARDOUS CONTAMINANT(S) _____ DECONTAMINATION DATE _____

DECONTAMINATION METHOD(S) _____

DECONTAMINATION CERTIFIER'S SIGNATURE _____ DATE _____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# INSTRUCTIONS

When an instrument that has been used with radioactive, pathogenic, or otherwise hazardous materials requires servicing by Thermo personnel either at the customer's laboratory or at Thermo facilities, the following procedure must be complied with to insure safety of our personnel:

1. The instrument or part to be serviced shall be cleaned of all blood and other encrusted material and decontaminated prior to servicing by our representative. No radioactivity shall be detectable by survey equipment.

2. A Decontamination Information Certificate shall be completed and attached to the instrument or part.

If an instrument or part to be serviced does not have a Decontamination Information Certificate attached to it, and, in our opinion, presents a potential radioactive or biological hazard, our representative will not service the equipment until proper decontamination and certification has been completed. If an instrument is received at our Service facilities and, in our opinion, poses a radioactive or biological hazard, the sender will be contacted for instructions as to disposition of the equipment. Disposition costs will be borne by the sender.

Decontamination Information Certificates are included with these Operation Instructions. Additional certificates are available from your local technical or customer service representative. In the event these certificates are not available, a written statement certifying that the instrument or part has been properly decontaminated and outlining the procedures used will be acceptable.

*NOTE* Thermo Service representatives will indicate on a Customer Service Repair Report if decontamination was required, and if so, what the contaminate was and what procedure was used. If no decontamination was required, it should be so stated.

01/06


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01/06



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01/06

# WEEE Compliance

## Great Britain

**WEEE Compliance.** This product is required to comply with the European Union's Waste Electrical & Electronic Equipment (WEEE) Directive 2002/96EC. It is marked with the following symbol. Thermo Scientific has contracted with one or more recycling/disposal companies in each EU Member State, and this product should be disposed of or recycled through them. Further information on Thermo Scientific's compliance with these Directives, the recyclers in your country, and information on Thermo Scientific products which may assist the detection of substances subject to the RoHS Directive are available at **www.thermo.com/WEEERoHS**

## Deutschland

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## Italia

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Wenden Sie sich an Ihren örtlichen **SORVALL**®-vertreter.

*E-mail Technical Service Representative for **SORVALL**® brand products at techsupport.led.asheville@thermofisher.com*

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