RC-3C Plus
User´s Manual

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PN 55559 - 7

Thermo SCIENTIFIC

OPERATING INSTRUCTIONS

SORVALL® RC-3C PLUS

General Purpose Automatic Refrigerated Centrifuge

Thermo Scientific
Asheville, North Carolina
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SORVALL®

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This manual is a guide for use of the

SORVALL® RC-3C PLUS General Purpose Automatic Refrigerated Centrifuge

Data 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 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 contain data in apparent conflict with that provided herein. Please consider all data in this manual to be the most current.

NOTE, ***CAUTION***, and ***WARNING*** 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.

CAUTION and ***WARNING*** 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.

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 not run hazardous materials in the centrifuge unless placed in a biohazard enclosure 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 4-12.

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/Chamber Temperature Equilibration, page 4-1.

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. Thermoo is not responsible for incorrect installation.

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

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Chapter 1: DESCRIPTION

This manual provides you with the information you will need to install, operate and maintain your SORVALL® RC-3C PLUS General Purpose Automatic Refrigerated Centrifuge. If you require additional information regarding operation or maintenance, please contact Thermo for assistance. In the United States, call Thermo toll-free 1-800-522-7746; outside the United States, contact the nearest Thermo office (see back cover) or your local representative for SORVALL® products. SORVALL® product information is available on our internet web site at ***http://www.thermo.com*** or ***http://www.thermo.de.***

Centrifuge Description

The RC-3C PLUS is a large capacity, versatile, quiet, and reliable centrifuge for low speed (to 6000 rpm) work designed to meet the needs of research and clinical laboratories, blood banks, and plasmapheresis centers.

The centrifuge system has a fan-cooled brushless dc motor with automatic programmed acceleration and braking. The high-torque motor is balanced to ensure smooth, quiet operation over its full speed range and to promote long life for the bearings. A gyro-action drive with a square spindle drive shaft accepts a variety of SORVALL® rotors. A clear acrylic viewing port located in the center of the chamber door permits calibration of rotor speed with a stroboscope.

Temperature control is handled by a refrigeration system charged with environmentally-friendly CFC-free refrigerant. The refrigeration system consists of a low-temperature condensing unit with a twin cylinder, hermetically-sealed power assembly (motor and compressor), a finned condenser and two fans.

The centrifuge includes the following safety features: protective, armor plate steel guard within the cabinet; automatic shut-off of the drive motor for overspeed protection and of the refrigeration motor to prevent damage from overheating; electrical circuit breakers on the main power and the control panel circuits; operating controls which may be changed during operation without damage to the centrifuge; and a door interlock which prevents opening the chamber door while the rotor is in motion and/or starting of the rotor drive while the door is open.

Specifications and features of the RC-3C PLUS are described on the next two pages.

Centrifuge Specifications

Temperature
- Chamber Temperature Controlled within 2°C of Set Temperature[1] ..... from 0°C to 30°C

Maximum Operating Speed[2]
- (Controlled within 1% of Set Speed or ± 20 rpm, whichever is greater) .... 6000 rpm[3]

Dimensions:
- Width ..... 76.2 cm (30 inch)
- Height ..... 94 cm (37 inch) to top deck
- ..... 120.6 cm (47.5 inch) to top of control panel
- Depth ..... 101.6 cm (40 inch)
- Rotor Chamber Diameter ..... 58.4 cm (23 inch)

Electrical Requirements:
- Supply Configurations (AC) ..... 200 V, 50 Hz, 1Ø
  200 V, 60 Hz, 1Ø
  208 V, 60 Hz, 1Ø
  220 V, 50 Hz, 1Ø
  220 V, 60 Hz, 1Ø
  230 V, 60 Hz, 1Ø
  230 V, 50 Hz, 1Ø (CE)
  230 V, 50 Hz, 3Ø (CE)
  240 V, 50 Hz, 1Ø
- Recommended Supply Current
  - 230V, 50 Hz, 1 Ø (rated 24 A) ..... 32 A
  - 230V, 50 Hz, 3 Ø (rated 18 A) ..... 32 A/phase
  - Other configurations (rated 24 A) .. 30 A
- Supply Power Receptacle
  - 230 V, 50 Hz, 1Ø ..... CEE-17 (32A, 2-pole and earth, 1Ø)
  - 230 V, 50 Hz, 3Ø ..... CEE-17 (32A, 3-pole, neutral and earth, 3Ø)
  - All other configurations ..... NEMA 6-30R

Maximum Noise Level ..... ≤ 58 dB[4]

Average Operating Heat Output ..... 3.2 kW (11 000 BTU/h)

Mass (uncrated, without rotor) ..... 303.5 kg (669 lbs)

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1 With the sample, rotor, and chamber temperatures equal to SET temperature at the start of the run, or, during a run, after those components have reached equilibrium. Control range is reduced if variables combine to create an extreme condition beyond the temperature control system capacity.

2 Maximum speed is dependent on line voltage and rotor used.

3 Speed in revolutions per minute (rpm) is related to angular velocity, ω, according to the following:

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

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

4 The maximum noise output using an H6000A Rotor at 5000 rpm, measured 6 feet from the front panel at a height of 3 feet.

Centrifuge Features

- Programmed operation which automatically establishes pre-recorded run conditions and completely controls centrifuge operation.

- Relative Centrifugal Force (RCF) values can be calculated prior to a run and can be displayed during a run, except during programmed operation.

- Automatic temperature compensation for a variety of SORVALL® Centrifuge rotors.

- $\int \omega^2 dt$ integrator that can be used either as a control or a display or both. When used as a control, the centrifuge will shut down based on a preselected integral value rather than a preselected time and when used as a display, the accumulated integral value will be displayed during a timed run.

- Automatic rate-controlled slow start/stop can be selected.

- Multiple stopping rates available for the H-2000B, H-4000, H-6000A, HBB-6, HLR-6, and HBB-12 Rotors.

- Automatic diagnostic indicators that alert you of a system malfunction should one occur, plus advisory messages that come on to call your attention to a system status that requires correction (for example, ENTRY ERROR) or to serve as a reminder that certain run conditions have been selected (for example, HOLD).

- Automatic self-test routine by the microcomputer; every time the centrifuge is started the microcomputer will go through a routine check to ensure its proper performance.

Chapter 2: INSTALLATION

This chapter contains instructions to prepare the SORVALL® RC-3C PLUS 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

The RC-3C PLUS has specific power requirements and must be connected to the correct supply power for proper performance. The centrifuge requires a dedicated 30-Amp supply circuit (both 230 V, 50 Hz configurations require a 32-Amp per phase supply circuit). The centrifuge system includes a power cord with ground wire, and the main ON/OFF POWER switch is a 30 A circuit breaker for each positive and neutral input power lead.

The nameplate on the back panel of the cabinet specifies one of the following AC supplies:

200 V, 50 Hz, 24 A, single Ø	200 V, 60 Hz, 24 A, single Ø
220 V, 50 Hz, 24 A, single Ø	208 V, 60 Hz, 24 A, single Ø
230 V, 50 Hz, 24 A, single Ø	220 V, 60 Hz, 24 A, single Ø
230 V, 50 Hz, 18 A/P, poly Ø	230 V, 60 Hz, 24 A, single Ø
240 V, 50 Hz, 24 A, single Ø	

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.

Before plugging-in the centrifuge power cord, supply voltage should be checked with a voltmeter to verify that the voltage listed on the nameplate on the back panel agrees with the measured line voltage. If 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 determine if the centrifuge can be modified for your voltage.

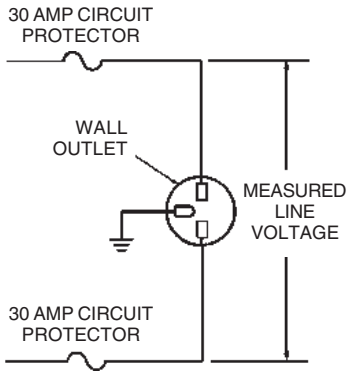


Figure 2-1. RC-3C PLUS Electrical Requirements

Single phase RC-3C PLUS Centrifuges are equipped with a three-wire cord with three-prong connector to fit a NEMA 6-30P receptacle, or, on 230V 50Hz centrifuges, an IEC 60309-type 3-pin receptacle (32A, 2-pole and earth). 230V 50Hz *polyphase* RC-3C PLUS Centrifuges are equipped with a four-wire cord with five-pin connector to fit an IEC 60309-type 5-pin receptacle (32 A, 3-pole, neutral and earth). 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.

The main ON/OFF POWER switch is a 30-Amp circuit breaker; however, for emergency disconnect purposes, we recommend a separate means of power interruption in a remote location.

Location

CAUTION

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

Locate the RC-3C PLUS on a level floor. Ambient temperature and air circulation are important for the centrifuge to function properly.

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) above the opening on top of the backpack, and on both sides of the centrifuge.

For safety, personnel should know that centrifuges routinely deal with high energy levels and could move suddenly in the unlikely event of a rotor failure. Laboratory management procedures should require that no person or any hazardous materials are within a “clearance envelope” boundary of 300 mm (12 inches) from the centrifuge while it is operating. During centrifuge operation, personnel should be instructed not to lean on or move the centrifuge, not to stay within the clearance envelope longer than necessary for operational reasons, and not to deposit potentially hazardous materials within the clearance envelope.

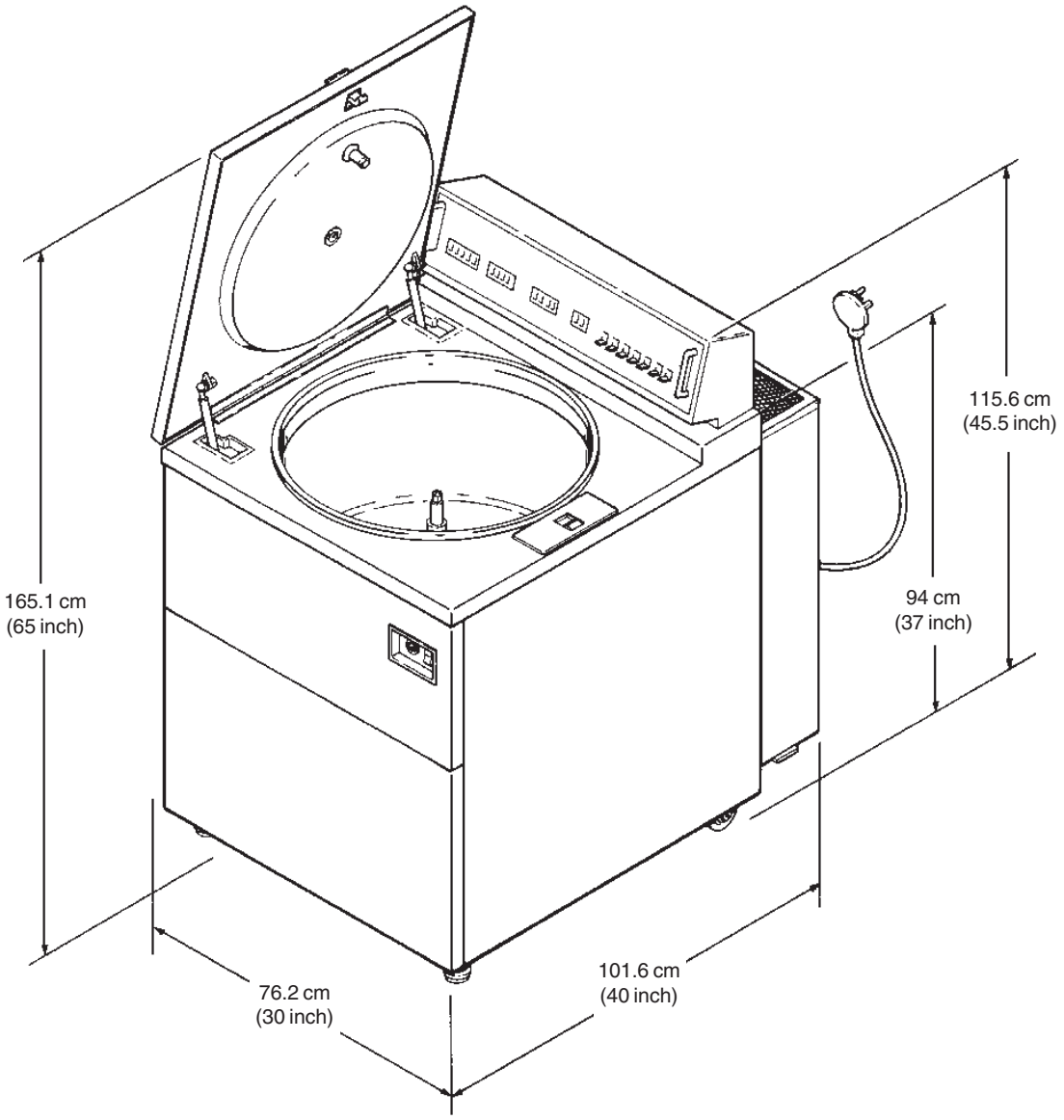


Figure 2-2. Centrifuge Dimensions

Environment

Ambient air temperature at the centrifuge air inlets must be between 15°C to 38°C (59°F to 100°F), with relative humidity ≤90%, for the centrifuge to operate. Ideal ambient temperature is between 20°C to 30°C (68°F to 86°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.

The centrifuge is intended for use in 1) a Pollution Degree 2 Environment, 2) an installation category II supply circuit, and 3) at a maximum altitude of 2000 meters.

Installation

A Preinstallation Kit (Catalog No. 22001) is supplied for UL/CSA/CE compliance. Install the Preinstallation Kit according to instructions supplied with the kit. To install the RC-3C PLUS :

1. Position the RC-3C PLUS 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.

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.***

CAUTION

To prevent rotor imbalance conditions: after adjusting the locking stabilizers, make sure the centrifuge is reasonably level, and does not rock on three of the four support points.

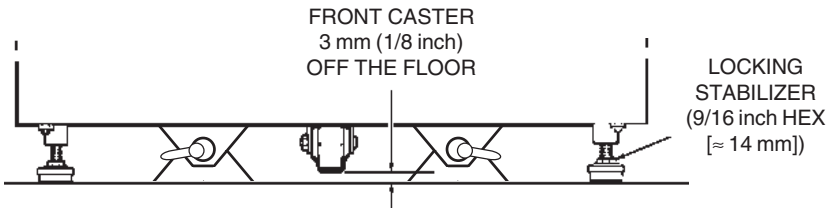


Figure 2-3. Front Locking Stabilizer Adjustment

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

5. Set the main POWER switch is set to "O" (OFF), then perform a test run to verify centrifuge performance.

   Optional: For detailed steps to perform an operational quality inspection, refer to *Customer Control Inspection* in Chapter 5, Maintenance, and perform the procedures listed under Speed Control, Timer, and Temperature Control.

After the RC-3C PLUS satisfies the inspection/performance criteria, it can be considered ready for use.

Chapter 3: CONTROLS, INDICATORS and DISPLAYS

The RC-3C PLUS control switches are used to select desired run conditions and during a run digital displays indicate actual run conditions, such as calculated sample temperature, rotor speed, remaining or elapsed run time or accumulated integral value. Indicator lights come on, as required, to show that you have selected certain run conditions (for example, HOLD or $\int\omega^2 dt$) or to let you know when the centrifuge is not functioning properly.

The information contained in this section describes the function of each RC-3C PLUS control and explains the meaning of all displays and indicators; the illustration below shows their location.

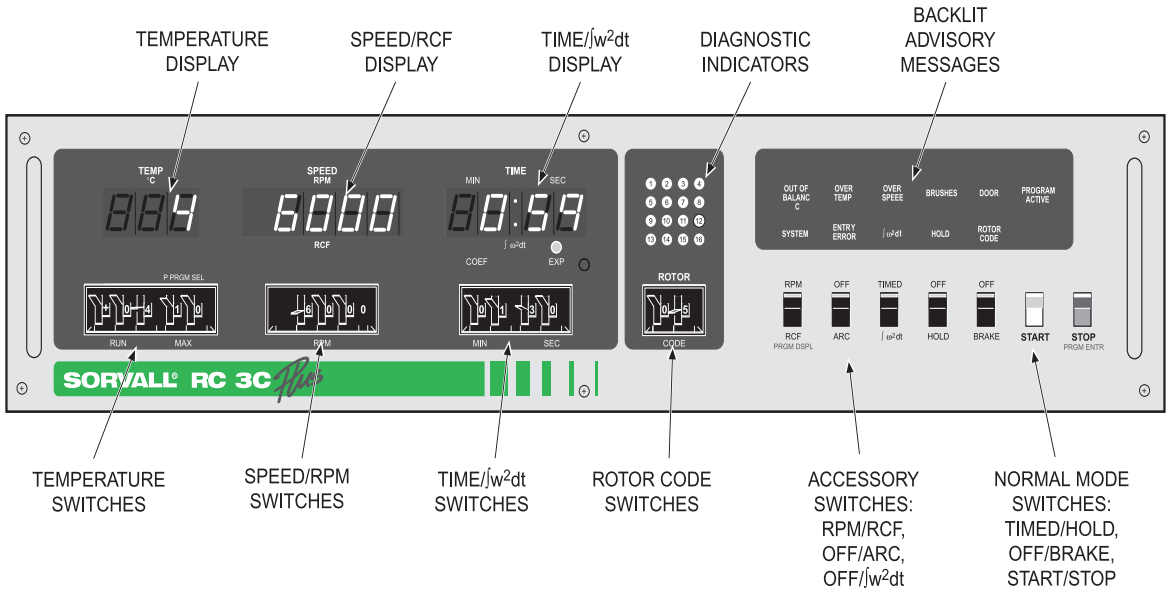
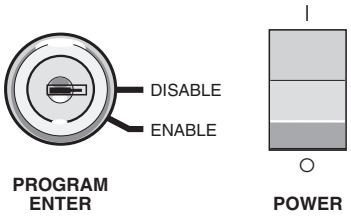


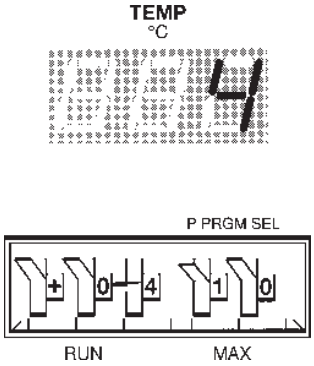
Figure 3-1. RC-3C PLUS Controls, Indicators, and Displays

KEY Switch and POWER Switch



These switches are located in the upper right corner of the front cabinet panel. The key switch is set using the key supplied with the centrifuge; the setting of this switch enables or disables the PROGRAM ENTER function. The power switch (30 A circuit breaker) is an ON/OFF toggle switch that, when set to "I", applies power to the centrifuge.

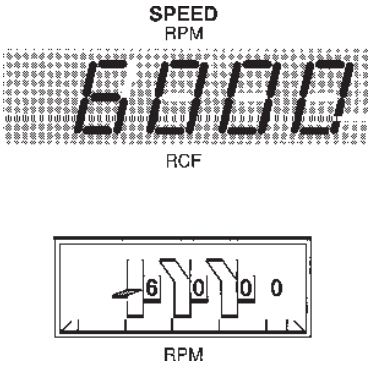
TEMPERATURE



During a run, the temperature display indicates calculated sample temperature. If a programmed run is in operation and the PRGM DSPL switch is pressed, the display will change to show the prerecorded set RUN temperature for the selected program; as soon as the switch is released, the display changes back to actual temperature.

The RUN temperature switch is used to set desired sample temperature. The P PRGM SEL/MAX temperature switch is used either to set the maximum permissible sample temperature (if the sample temperature exceeds this limit, the centrifuge will shut off and the OVERTEMP light will come on) or to select one of the ten programmed runs when set to P0 through P9. During a programmed run, the MAX temperature value will default to the prerecorded set RUN temperature plus seven degrees centigrade.

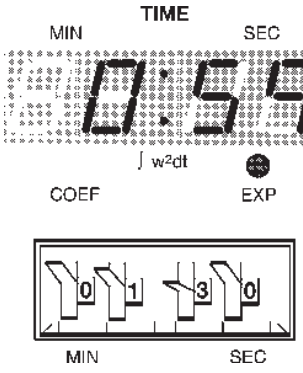
SPEED



During a run, this display indicates actual rotor speed in rpm (revolutions per minute). If the RPM/RCF switch is pressed to RCF during a run, the display will show RCF (relative centrifugal force) value; if this switch is pressed to PRGM DSPL during a programmed run, the display will show the prerecorded set RUN speed for the selected program.

The RPM switches are used to set desired run speed.

TIME



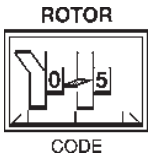
This display shows one of the following values during a run: (1) accumulated run time if the OFF/HOLD switch is set to HOLD, (2) remaining run time if the OFF/HOLD switch is set to OFF and the TIMED/$\int\omega^2 dt$ switch is set to TIMED, or (3) accumulated integral value if the TIMED/$\int\omega^2 dt$ switch is set to $\int\omega^2 dt$. The time values are displayed in minutes and seconds and the integral value is displayed as a coefficient and an exponent (for example, 15 20 means 1.5×10^{20}). If a programmed run is in operation and the PRGM DSPL switch is pressed, the display will change to show the prerecorded set value for the selected program.

The indicator light below the display will come on if the TIMED/$\int\omega^2 dt$ switch is set to $\int\omega^2 dt$, meaning that the display is showing

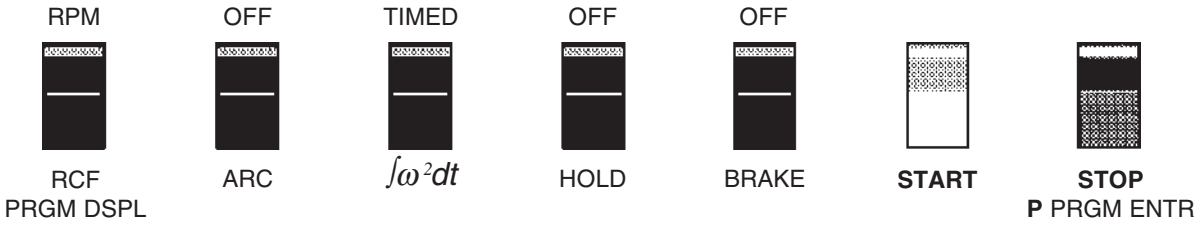
TIME (continued)

an integral value.
The switches are used to select either the desired length of run time in minutes and seconds or the desired integral value, depending on the setting of the TIMED/$\int\omega^2 dt$ switch when the START switch is pressed. The centrifuge will shut off when either preselected value is achieved, provided the OFF/HOLD switch is set at OFF.

ROTOR CODE



The code number of the rotor in use must be set on these switches for proper automatic temperature compensation, acceleration/deceleration rates, and RCF calculation (if multiple rotor codes are available for a particular rotor [rotor codes 1–29], the selection sets braking rate. At the beginning of each run, the ROTOR CODE message light will flash on and off to remind you to enter the proper code number.



RPM/RCF Switch/PROGRAM DISPLAY Switch

This switch is normally set at RPM, in which case the SPEED display will show rotor speed. During a non-programmed run, if the switch is pressed to RCF, the SPEED display numbers will change from the current rotor speed to the current relative centrifugal force value. To be sure that the RCF value is correct, make sure the proper rotor code number is set on the ROTOR CODE switches. When the switch is released, the display will change back to show rotor speed.

During programmed operation, if the switch is pressed to PRGM DSPL (program display), all displays will show the prerecorded set run values for the selected program; when the switch is released, all displays will change back to actual values.

This switch can also be used to calculate RCF values before a run has been started (see Chapter 4, page 4-10, RCF Calculation for instructions).

OFF/ARC Switch

If set to ARC this switch selects an automatic rate-controlled slow start from 0 to 250 rpm before normal full acceleration is established. Also, depending on other settings, selection of ARC will cause a controlled slow stop from 500 to 0 rpm.

The position of the OFF/BRAKE switch and the ROTOR CODE setting determines if selected ARC controls slow stop at the end of a run — if the OFF/BRAKE switch is set to OFF, the rotor will *coast* from set speed to 0 rpm; if it is set to BRAKE and the ROTOR CODE is set to 30 or above, the rotor will *brake* from set speed to 500 rpm, then continue to decelerate to a stop at the controlled slow stop rate. For rotors using ROTOR CODE settings 01 through 29, ARC has no effect on stopping because the braking/stopping rate is controlled by the ROTOR CODE set.

If the OFF/ARC switch is set to OFF, the rotor will accelerate to set speed at the normal rate, then it will decelerate from set speed to 0 rpm depending on the position of the OFF/BRAKE switch and the ROTOR CODE setting).

Because the rate at which a rotor is decelerated is automatically determined by the ROTOR CODE setting, it is always important that the correct ROTOR CODE number is set.

TIMED/$\int\omega^2 dt$ Switch

- If set to TIMED and the OFF/HOLD switch is set to OFF when the START switch is pressed, the TIME display will show remaining run time (in minutes and seconds), and the run will end when the preselected length of time has elapsed.

- If set to $\int\omega^2 dt$ and the OFF/HOLD switch is set to OFF when the START switch is pressed, the TIME display will show accumulated integral value during the run and the run will end when the preselected integral value has accumulated. The integral value begins to accumulate after the rotor starts spinning and stops accumulating when the rotor has decelerated to 0 rpm at the end of the run.

- Accumulated integral value can be displayed during any TIMED run by changing the switch to $\int\omega^2 dt$ without affecting how the run will end (i.e., it will still end when the preselected amount of time has elapsed). At the end of any TIMED run — before the START switch is pressed again — the $\omega^2 dt$ recall value at timeout of the previous run can be displayed by changing this switch to $\int\omega^2 dt$. Knowing the $\omega^2 dt$ recall value of a particular run will allow you to duplicate that run by selecting the $\int\omega^2 dt$ mode and setting the switches for that integral value.

- If this switch is set to $\int w^2 dt$ and the OFF/HOLD switch is set to HOLD when START is pressed, the TIME display will show accumulated run time (in minutes and seconds) and the run will continue until the STOP switch is pressed. However, the setting on the switches has been interpreted as an integral value rather than time; therefore, if you change the setting of the OFF/HOLD switch to OFF during the run, the TIME display will change to show accumulated integral value and the run will end when the set value is reached. (If the set value has already accumulated when the switch setting is changed, the run will end immediately.)

OFF/HOLD Switch

If set at HOLD when the START switch is pressed or changed from OFF to HOLD during a run, the run will continue until the STOP switch is pressed. The setting of this switch will override the setting of the TIMED/$\int \omega^2 dt$ switch.

OFF/BRAKE Switch

When this switch is set to BRAKE, the rotor will *brake* (rather than *coast*) as it decelerates from set speed. The rate at which a rotor can ***safely*** be decelerated depends on rotor inertia, and varies from rotor to rotor. The ROTOR CODE setting automatically establishes a safe braking rate for each rotor.

NOTE It is particularly important that the correct ROTOR CODE number is set when BRAKE is selected.

Selecting BRAKE establishes maximum safe braking from set speed, but the stopping rate (from 500 to 0 rpm) can be adjusted by the ROTOR CODE setting or by ARC selection:

- For rotors using ROTOR CODE settings 01–29 (H-2000B, H-4000, H-6000A, HBB-6, HLR-6, or HBB-12 rotors), the ten rotor codes that are available each establish a different stopping rate (lower is slower, see page 4-9, Braking Rate Selection). Selecting ARC will enable slow start, but will have no affect on stopping rates established by rotor codes 01–29.

- For rotors using ROTOR CODE settings 30 and above, setting the OFF/ARC switch to OFF establishes full braking to 0 rpm, but setting the OFF/ARC to ARC selects a slower controlled stopping rate from 500 to 0 rpm. Selecting ARC also enables slow start for all rotor codes.

When the OFF/BRAKE switch is set to OFF the rotor will *coast* from set speed to 0 rpm at the end of the run.

START Switch

When pressed, will start the run.

STOP Switch/PROGRAM ENTER Switch

If pressed while a run is in progress, the run will stop.

If the centrifuge is in STANDBY, the key switch set to ENABLE, and the P PRGM SEL switch is set to one of ten program file numbers from P0 through P9 when this switch is pressed to PRGM ENTR, all run parameters set on the control panel will be recorded in program memory under the selected file number.

Backlit Advisory Messages

The RC-3C PLUS has ten operator advisory messages on the control panel. These messages are backlit, meaning that each message lights only when the condition that it represents exists. The meaning of each message is given below, along with the corrective action.

OUT OF BALANCE

Excessive rotor imbalance. Run in progress terminated. Remove the rotor and balance it according to the directions in the rotor instruction manual, then restart the run.

OVER TEMP

Run terminated because the chamber temperature exceeded the desired maximum run temperature selected on the MAX temperature switch. Some problems that could cause this are:

1. temperature setting may be too low for the rotor/speed combination; check rotor instruction manual to verify temperature setting,

2. room ambient temperature is above 35°C, or

3. condenser inlet is blocked (see page 2-2, Location).

Check each of these possible causes before notifying the Thermo Service Representative of the problem.

OVER SPEED

The detected speed is higher than 6200 rpm and run in progress terminated. If the ENTRY ERROR light is also on, see page 4-11 for possible cause. If the ENTRY ERROR light is not on, notify Thermo Service Representative of the OVER SPEED condition.

DOOR

Attempt to start the centrifuge with the chamber door open. The centrifuge will not start. Close the chamber door and start the centrifuge.

SYSTEM

Flashes on and off whenever a diagnostic light is lit that represents a condition that has caused the run to end (that is, numbers 1-4 and 6-8). See DIAGNOSTICS.

ENTRY ERROR

When this message is lit it means that a wrong entry has been made on one of the control settings. See page 4-11 for a list of possible entry errors.

$\int\omega^2 dt$

A reminder that you have selected the integrator ($\int\omega^2 dt$) mode, meaning that the setting on the TIME switches have been interpreted as an integral value rather than time.

HOLD

Indicates that the OFF/HOLD switch is set at HOLD and the run will continue until you press the STOP switch.

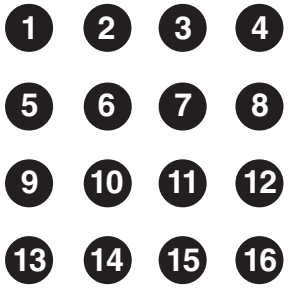
ROTOR CODE

Flashes on and off for a few seconds at the beginning of each run as a reminder to enter the proper ROTOR CODE number (see table on page 4-2).

PROGRAM ACTIVE

Indicates that the centrifuge is operating in programmed mode.

DIAGNOSTICS



Diagnostic lights, numbered 1 through 16, help troubleshoot a problem when the centrifuge is not operating properly. When any of the lights come on, it means a problem exists that is affecting the operation of the centrifuge. Each light represents a different problem; some problems will cause the centrifuge to shut off, others will not, depending on the seriousness of the problem. Of the sixteen lights, only eleven (1-4 and 6-12) are currently used; the other five (5 and 13-16) are inactive and reserved for future use. The meaning of each light is given below, along with the corrective action.

1 CONTROL SYSTEM FAILURE. Turn the main power off and back on, then restart the run. If the light comes on again, notify Thermo Service Representative.

2 PROGRAM FAILURE. Notify Thermo Service Representative.

3 MEMORY SYSTEM FAILURE. Notify Thermo Service Representative.

4 DRIVE SYSTEM FAILURE. Notify Thermo Service Representative.

5 NOT USED

6 NO ROTOR. The microcomputer has detected a sudden and sustained increase in rpm, meaning that no rotor was installed when the START switch was pressed. The centrifuge ran for a few seconds then shut off. Install a rotor and restart the run. If centrifuge will not restart, notify your Thermo Service Representative.

7 REFRIGERATION SYSTEM FAILURE. There was no apparent drop in chamber temperature thirty seconds after the refrigeration system started to cool. Notify Thermo Service Representative.

8 TEMPERATURE SENSOR FAILURE. Chamber air temperature sensor has failed. Notify Thermo Service Representative.

9 TEMPERATURE SENSOR FAILURE. Chamber wall temperature sensor has failed. Notify Thermo Service Representative.

10 COMPUTER SYSTEM FAILURE. The computer has received erroneous information. The condition will clear and the light will go out if the problem is momentary. If the condition persists, notify Thermo Service Representative.

11 TACHOMETER ERROR. The computer has detected changes in rpm that are beyond the normal range, indicating that the tachometer input frequency is unstable. The condition will clear and the light will go out if the problem is momentary. If the condition persists, notify Thermo Service Representative.

12 REGISTER OVERFLOW. This problem could be momentary; if it is, the condition will clear and the light will go out. Also, a wrong entry on one of the control switches may cause this light to come on — if the ENTRY ERROR light is on, check all control settings. If the condition persists, notify Thermo Service Representative.

13 **14** **15** **16** NOT USED

Chapter 4: OPERATION

This chapter provides the operating procedures for the RC-3C PLUS Centrifuge.

NOTE Before using the RC-3C PLUS for the first time, be sure it is properly installed (see Chapter 2, Installation). In addition, we recommend that you read all WARNINGS and CAUTIONS, as well as Chapter 3 to familiarize yourself with the centrifuge controls and features.

Rotor/Chamber Temperature Equilibration

To ensure proper temperature control, the sample, SET temperature, rotor (body, buckets, adapters, and cover), and rotor chamber should all be at the same temperature when START is pressed. The rotor should be equilibrated before operation, either in the centrifuge or in a refrigerator or cold room. To preequibrate the rotor and chamber:

1. Install the empty rotor in the chamber, place empty buckets (if applicable) in all positions, and the rotor cover, if any.
2. Close the chamber door.
3. Set the POWER switch to "**I**" (ON).
4. Set the TEMP °C RUN switches to the desired temperature, and set the MAX switches to at least 5 degrees above either the RUN setting or the TEMP °C display.
5. Set the SPEED RPM switches: if cooling, set switches to 1500; if heating, set a value that is approximately 70% of the maximum rated speed of the selected rotor.
6. Set ROTOR CODE switches to a proper ROTOR CODE number (see Table on page 4-2). If multiple rotor codes are available for the installed rotor (rotor codes 01–29), set the switches to the highest number (09, 19, or 29).
7. Set the OFF/ARC switch to OFF.
8. Set the OFF/HOLD switch to HOLD.
9. Press the START switch to begin temperature equilibration. Monitor progress of the value in the TEMP °C display, and note the time when the displayed temperature reaches the set RUN temperature. From the time it does, allow the run to continue for an additional 30 minutes, then press STOP.

WARNING

When loading the rotor, be sure not to exceed the maximum compartment mass of the rotor (see table). 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 4-12). Failure to do so can cause rotor failure which could result in personal injury and/or centrifuge damage.

Rotor Installation, Loading and Balancing

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

Rotor Information

Rotor	Rotor Capacity (places x ml)	ROTOR CODE Number [1]	Maximum Speed (rpm)	Maximum RCF (*g*-force) [3]	Maximum Compartment Mass (grams) [4]	Balance Margin (grams)	Critical Speed (rpm)
SWINGING BUCKET							
H-6000A	6 x 1000	20–29 [2]	5000	7277	2575	10	450
HBB-6	6 place	20–29 [2]	5000	7129	2800	10	450
HLR-6	6 place	20–29 [2]	5000	7205	2800	10	450
H-6000A M (with microplates)	6 x 2 std. 96-well	20–29 [2]	5000	5186	462 [5]	10	450
H-2000B	8 place	01–09 [2]	2800	2297	750 [5]	10	800
H-2000B M (with microplates)	8 x 2 std. 96-well	01–09 [2]	2800	1822	290 [5]	10	800
HL-2B	2 place	30	3300	2024	2000	5	700
HBB-12	6 place	20–29 [2]	2900	2462	3820	25	500
H-4000	4 x 1000	10–19 [2]	5250	7121	2575	10	450
HB-4 [6]	4 x 50	33	6000	5903	250	10	1100
HS-4 [6]	4 place [7]	34	6000	6929	1035	10	1000
FIXED-ANGLE							
LA/S-400	8 x 50	37	6000	5646	90	10	1000
LAC-6000	6 x 1000	37 [8]	6000	7890	1500	25	450
SS-34 [6]	8 x 50	31	6000	4303	115	5	1140
SA-600 [6]	12 x 50	32	6000	5211	115	5	950
SM-24 [6]	24 x 16	35	6000	4451 [9]	27	5	1100
SE-12 [6]	12 x 14	36	6000	3752	30	5	1100

1 ROTOR CODE number "00" allows runs without automatic temperature or speed compensation. The maximum speed at this setting is 6000 and the maximum RCF value is 1021 (defined for a rotor radius of 2.54 cm [1 in]).

2 Multiple ROTOR CODE numbers allow selection of various braking rates from 500 rpm to 0 rpm (page 4-9, Braking Rate Selection).

3 Values are based on the rotor's maximum radius, and do not consider any tube, bottle, microplate, or adapter geometry.

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

5 Bucket/carrier contents only; value listed does not include the mass of the bucket or carrier.

6 Requires use of spindle adapter, Catalog Number 55222.

7 Accepts buckets or multicarriers; maximum volume depends on which buckets or carriers are used.

8 Rotor code 37 was established for the LA/S-400 rotor, but may be used for the LAC-6000 rotor. If running an LAC-6000 with rotor code 37, do not use the RCF function –values indicated will not reflect the rotor. Also, in most cases, automatic temperature control will not be correct; perform test runs at the desired speed/time to determine an appropriate temperature setting to maintain sample at the desired temperature.

9 Outer row.

Normal Operating Procedure

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

To keep your centrifuge in good working condition and ensure accurate test results, we recommend that you check the speed control, timer, and temperature control twice a year following the procedures given in Chapter 5, Customer Control Inspection, page 5-2.

WARNING

Make sure the rotor compartment mass does not exceed the maximum allowable mass given in table on page 4-2. If the maximum compartment mass is exceeded, the operating speed must be lowered according to the instructions given on page 4-12. Failure to do so can cause the rotor to fail with subsequent damage to the centrifuge.

Prepare the rotor according to the instructions in the rotor instruction manual, then follow the instructions below.

1. Set the main power switch to "I".
2. Set the RUN and MAX temperature switches to the desired setting. The MAX temperature setting should be for a value that is at least 5°C higher than the RUN temperature setting. (If the MAX temperature switch is set to P0 through P9, the centrifuge will automatically establish all run conditions of the selected program; this switch must be set for a value from 0 to 49 during a non-programmed run.)

NOTE For optimum temperature conditions, both the rotor and the rotor chamber should be at the desired **RUN** temperature before the run is started. If a significant temperature change is needed, equilibrate temperatures before proceeding (see Rotor/ Chamber Temperature Equilibration on page 4-1). If a minor change is needed, after you have set the **RUN** temperature, wait until the TEMP °C display indicates set **RUN** temperature before proceeding.

3. Open the chamber door.
4. Install a rotor (precooled, if necessary) and set the ROTOR CODE switch for the proper ROTOR CODE number (see table on page 4-2). Close the chamber door.

CAUTION

Do not operate the centrifuge without a rotor in place on the drive spindle; to do so can damage the centrifuge drive.

5. Set the RPM switches for the desired run speed.
6. Set the TIMED/$\int\omega^2 dt$ switch to TIMED.
7. Set the OFF/HOLD switch: For a timed run, set the switch to OFF, then set the MINS and SEC switches for the desired length of run time. For a continuous run, set the switch to HOLD (the setting on the MINS and SEC switches is unimportant). When HOLD is selected, the HOLD message indicator light will come on.
8. Set the OFF/BRAKE switch and the OFF/ARC switch to desired setting.

NOTE If the **OFF/ARC** switch is set to **ARC**, the timer begins to count down as soon as the **START** switch is pressed. Therefore, for short runs, it will be necessary to compensate for the slow start ramp up to the desired run speed. This can be done by either adding time to the total run time or by using the $\int\omega^2 dt$ function.

9. Press the START switch. (The ROTOR CODE message indicator light will flash for a few seconds as a reminder to set the proper ROTOR CODE number.)

NOTE If you want to see the accumulated integral value during a **TIMED** run, change the setting of the **TIMED/$\int\omega^2 dt$** switch to $\int\omega^2 dt$. As long as you change the setting of this switch after the **START** switch is pressed it will not have any affect on how the run will end - the run will still end when the preselected time has elapsed.

$\omega^2 dt$ RECALL - At the end of a **TIMED** run, you can recall the integral value at timeout by changing the setting of the **TIMED/$\int\omega^2 dt$** switch to $\int\omega^2 dt$. (This must be done before another run is started or before the power is turned off.) The integral value can then be used to duplicate the run by setting the recalled value on the **COEF** and **EXP** switches and selecting the $\int\omega^2 dt$ mode.

To end a run in **HOLD** or before the selected run time has elapsed, press the **STOP** switch. Read the CAUTION.

CAUTION

If you end a run by pressing the **STOP** switch, remove the rotor from the centrifuge as soon as it stops to avoid any possibility of the samples freezing.

Braking Rate Selection

When BRAKE is selected, multiple ROTOR CODE numbers assigned to the H-2000B, H-4000, H-6000A, HBB-6, HLR-6, and HBB-12 Rotors (rotor codes 1–29) allow you to modify the braking rate. Depending on the ROTOR CODE selected, the stopping rate (500 to 0 rpm) will vary; the higher the ROTOR CODE number, the sooner the rotor will stop. For other rotors (rotor codes 30 and above), braking rate can be modified by selection of ARC.

$\int\omega^2 dt$ RECALL

At the end of any TIMED run you can recall the integral value at timeout and use this value in the $\int\omega^2 dt$ mode to duplicate the run. When the rotor has stopped, change the setting of the TIMED/$\int\omega^2 dt$ and the $\omega^2 dt$ value will appear in the display. The value must be recalled before another run is started or before the main power is turned off.

$\int\omega^2 dt$ Operating Procedure

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

WARNING

Make sure the rotor compartment mass does not exceed the maximum allowable mass given in table on page 4-2. If the maximum compartment mass is exceeded, the operating speed must be lowered according to the instructions given on page 4-12. Failure to do so can cause the rotor to fail with subsequent damage to the centrifuge.

Prepare the rotor according to the instructions in the rotor instruction manual, then follow the instructions below.

1. Set the main power switch to "I".

2. Set the RUN and MAX temperature switches to the desired setting. The MAX temperature setting should be at least 5°C higher than the RUN temperature setting. (If the MAX temperature switch is set to P0 through P9, the centrifuge will automatically establish all run conditions of the selected program; this switch must be set for a value from 0 to 49 during a non-programmed run.)

NOTE For optimum temperature conditions, both the rotor and the rotor chamber should be at the desired **RUN** temperature before the run is started. If a significant temperature change is needed, equilibrate temperatures before proceeding (see Rotor/ Chamber Temperature Equilibration on page 4-1). If a minor change is needed, after you have set the **RUN** temperature, wait until the TEMP °C display indicates set **RUN** temperature before proceeding.

3. Open the chamber door.

CAUTION

Do not operate the centrifuge without a rotor in place on the drive spindle; to do so can damage the centrifuge drive.

4. Install a rotor (precooled, if necessary) and set the ROTOR CODE switch for the proper ROTOR CODE number (see table on page 4-2). Close the chamber door.

5. Set the RPM switches for the desired run speed.

6. Set the TIMED/$\int\omega^2 dt$ switch to $\int\omega^2 dt$.

7. Set the OFF/HOLD switch to OFF, then set the COEF and EXP switches for the desired integral value.

NOTE If the **OFF/HOLD** switch is set at **HOLD** during an $\int\omega^2 dt$ run, the display will show accumulated run time and the run will not end until you press the **STOP** switch.

8. Set the OFF/BRAKE switch and the OFF/ARC switch to the desired setting.

9. Press the START switch. The $\int\omega^2 dt$ indicator light on the control panel will come on. (The ROTOR CODE message indicator light will flash for a few seconds as a reminder to set the proper ROTOR CODE number.)

NOTE The setting of the **TIMED/$\int\omega^2 dt$** switch can be changed to **TIMED** anytime during a run to have the display (**TIME**) show the length of time that has elapsed since the run was started (that is, the numbers in the display will change to represent minutes and seconds instead of the integral value). The run will still terminate when the preselected integral value has accumulated.

To end a run before the selected integral value has accumulated, press the **STOP** switch. Read the CAUTION.

CAUTION

If you end a run by pressing the **STOP** switch, remove the rotor from the centrifuge as soon as it stops to avoid any possibility of the samples freezing.

Programmed Operating Procedure

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

In programmed operation, all operating modes and run parameters are recalled from the program memory file of the selected program. (Instructions for storing a program are given on page 4-8, Program Enter.)

WARNING

Make sure the rotor compartment mass does not exceed the maximum allowable mass given in table given on page 4-2. If the maximum compartment mass is exceeded, the operating speed must be lowered according to the instructions given on page 4-12. Failure to do so can cause the rotor to fail with subsequent damage to the centrifuge.

To perform a programmed run, prepare the rotor according to the instructions in the rotor manual, then proceed as follows:

1. Set the main power switch to "I".

2. Set the **P** PRGM SELECT switches for the file number (P0 - P9) of the desired programmed run. The PROGRAM ACTIVE light will come on, indicating that the run parameters (control setpoints) are being taken from the program memory file (of selected program) and not from control panel switches. Prerecorded set run conditions can be displayed by pressing the PROGRAM DISPLAY switch (see page 4-9, Program Display).

NOTE The setting of the **P PRGM SELECT** switches should not be changed after a run has been started. If the setting is changed from one program number to another program number after the **START** switch has been pressed, the **ENTRY ERROR** light will come on and the run will continue with the parameters of the first program selected. If the setting is changed from a program number to a **MAX** temperature value after the **START** switch has been pressed, the run will terminate.

For optimum temperature conditions, both the rotor and the rotor chamber should be at the desired **RUN** temperature before the run is started. If a significant temperature change is needed, equilibrate temperatures before proceeding (see Rotor/ Chamber Temperature Equilibration on page 4-1).

If a minor change is needed, after you have set the **RUN** temperature, wait until the TEMP °C display indicates set **RUN** temperature before proceeding.

3. Open the chamber door.

CAUTION
Do not operate the centrifuge without a rotor in place on the drive spindle; to do so can damage the centrifuge drive.

4. Install a rotor (precooled, if necessary). Close the chamber door.

NOTE Run Parameters: In programmed operation, the temperature, speed, and time/integral values, are automatically established as the prerecorded set values of the selected program. It is recommended that you verify these run parameters before starting the run by pressing the **PROGRAM DISPLAY** switch.

The function of the **OFF/ARC**, **OFF/BRAKE**, **TIMED/** $\int\omega^2 dt$ and **ROTOR CODE** switches during programmed operation is determined by their setting at the time the program was recorded. If required, refer to the Program Log Book to verify settings.

5. Set the OFF/HOLD switch:

   - if set to OFF, the run will end when the prerecorded run time has elapsed or when the prerecorded $\omega^2 dt$ value has accumulated;
   - if set to HOLD, the run will continue until the STOP switch is pressed (the prerecorded run time or $\omega^2 dt$ value will be overridden).

6. Press the START switch. (The ROTOR CODE message indicator light will flash for a few seconds.)

NOTE To display the accumulated integral value during a programmed run, set the **TIMED/**$\int\omega^2 dt$ switch to $\int\omega^2 dt$.

$\omega^2 dt$ RECALL - At the end of a **TIMED** run, the integral value at timeout can be recalled by setting the **TIMED/**$\int\omega^2 dt$ switch to $\int\omega^2 dt$; this must be done before another run is started or before the power is turned off. The recalled integral value can then be used to duplicate the run.

RUN TIME RECALL - At the end of an $\int\omega^2 dt$ run, the run time value (in minutes and seconds) can be displayed by setting the **TIMED/**$\int\omega^2 dt$ switch to **TIMED**; this must be done before another run is started or before the power is turned off.

To end a run in **HOLD** or before the selected run time has elapsed, press the **STOP** switch. Read the CAUTION.

CAUTION
If you end a run by pressing the **STOP** switch, remove the rotor from the centrifuge as soon as it stops to avoid any possibility of the samples freezing.

Program Enter

The RC-3C PLUS has 10 program files, numbered P0 through P9, in which run conditions can be stored for repeat runs.

To enter a new program:

1. Set the main power switch to "I".
2. Set the RUN temperature switch to the desired setting.
3. Set the **P** PRGM SEL (MAX temperature) switches to the desired program number (P0 to P9). The PROGRAM ACTIVE message will light.

NOTE The **MAX** temperature value for a programmed run will automatically be 7°C higher than the set **RUN** temperature, with two exceptions: if the **RUN** temperature is 44°C or higher, the **MAX** temperature will be 50°C; or, if the **RUN** temperature is -7°C or lower, the **MAX** temperature will be 0°C.

4. Set the RPM switches for the desired run speed.
5. Set the desired run time (MIN and SEC) or the desired integral value (COEF and EXP).
6. Set ROTOR CODE switch for the code number of rotor to be used (see table page 4-2).
7. Set the OFF/ARC switch, the OFF/BRAKE switch, and the TIMED/$\int\omega^2 dt$ switch to the desired setting.

NOTE If the **OFF/ARC** switch is set to **ARC**, the timer begins to count down as soon as the **START** switch is pressed. Therefore, for short runs, it will be necessary to compensate for the slow start ramp up to the desired run speed. This can be done by either adding time to the total run time or by using the $\int\omega^2 dt$ function.

The **OFF/HOLD** switch is not a programmable function. If this switch is set to **HOLD** during a programmed run, the run will continue beyond the set time or $\omega^2 dt$ value.

If the **ENTRY ERROR** message is lit, one of the control switch settings is incorrect and must be corrected before recording the program (page 4-10, Test Run for Low Temperature Operation).

8. Insert the key in PROGRAM ENTER key switch and turn it to the ENABLE position.

9. Press the PRGM ENTR (STOP) switch on the control panel to record the set run conditions.

NOTE To protect the program from unauthorized change, turn the key switch to **DISABLE** and remove the key; a program cannot be changed without the key inserted and set to **ENABLE**.

10. Press the PRGM DSPL switch to verify that the displayed values are the same as the set values.

11. Record the programmed control settings in the Program Log book supplied.

Program Display

To display programmed settings:

1. Set the **P** PRGM SEL switches to the desired program number; the PROGRAM ACTIVE message will light.

2. Press the PRGM DSPL switch; the programmed control settings will be displayed as follows:

   - TEMPERATURE display will show set run temperature,
   - SPEED display will show set run speed,
   - TIMED/$\int\omega^2 dt$ display will show set run time or set integral value; if the numbers displayed are a time value, the $\int\omega^2 dt$ indicator light will NOT be on and the displayed value will contain a colon; if the displayed numbers are an integral value, the $\int\omega^2 dt$ indicator light WILL be on and there will be a decimal point in the COEF value.

RCF Calculation

The RC-3C PLUS can calculate RCF (*g*-force) values. This feature allows you to quickly determine the speed you must run a particular rotor at to achieve a desired RCF value. To do so:

1. Turn the main power to "I" but do not start the centrifuge; the rotor must be at 0 rpm, and the centrifuge must not be in the programmed mode of operation.

2. Set the ROTOR CODE switches for the code number of the rotor you intend to use. (ROTOR CODE numbers are given in the table on page 4-2.)

NOTE RCF values calculated for the SM-24 Rotor (code number 35) are the values for the rotor's outer row.

3. Press and hold the RCF switch.

4. The SPEED display will show the RCF value (for the identified rotor) at the speed that is set on the RPM switches.

5. Adjust the speed (RPM switches) setting until the desired RCF value appears in the SPEED display; the speed set on the RPM switches is the speed you have to run that rotor at to achieve the displayed RCF.

Temperature Control

The RC-3C PLUS controls calculated sample temperature during a run based on the rotor selected, rotor speed, run time, set RUN temperature and measured chamber temperature. The complex calculation the centrifuge performs must assume, however, that the sample and the rotor are at set RUN temperature at the start of the run. If temperatures are not equilibrated, adjustments made by the centrifuge's control system may not be appropriate (although, over time, temperature control should come into range).

NOTE *When temperature control is critical*, the sample, set RUN temperature, rotor (body, buckets, adapters, and cover), and rotor chamber should all be at the same temperature when START is pressed. Also, remove the sample soon after a run has ended, so that it will not be affected if chamber temperature drops slightly when the rotor is no longer generating heat due to air friction.

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 (see page 4-1) until the rotor is the same temperature as the sample and required set RUN temperature.

Temperature control needs can vary with the application. In many cases, the RC-3C PLUS Centrifuge will be used to run large volumes of sample for short amounts of time. With such a run, if all components have been equilibrated, it would be difficult to significantly change sample temperature during the run – even if the centrifuge's temperature control performance was reduced.

Test Run for Low Temperature Operation

If the centrifuge is operated at a very low temperature, it may be difficult for the refrigeration system to maintain indicated sample temperature within 2°C of the set temperature. This condition may cause the sample to freeze; therefore, when the sample temperature you want is 2°C or colder, we recommend that you do a test run to determine a temperature setting that will achieve the results you want and prevent the sample from freezing. This test run procedure should be used for every run where the sample temperature is this low because each speed/temperature/rotor combination may give different results.

1. Prepare two tubes or bottles of dispensible fluid and place them in the rotor. Balance the rotor according to the instructions in the rotor instruction manual.

NOTE The dispensible fluid should have a freezing temperature well below the desired sample temperature.

2. Set the RUN temperature switch to the desired sample temperature.

3. Install the rotor in the centrifuge and run it for at least two hours at the speed for which the temperature setting is being determined.

4. Stop the centrifuge. Wait for the rotor to stop then immediately open the chamber door and measure the actual sample temperature using an immersible centrigrade thermometer.

5. Adjust the RUN temperature switches upward or downward according to the temperature differential between the measured temperature and the set RUN temperature.

   For example: If the measured sample temperature is -2°C and the set RUN temperature is +2°C there is a 4° differential. To obtain the +2°C sample temperature you should reset the set RUN temperature switches to +6°C. (In this particular case, this procedure would prevent the sample from freezing.)

Running Hazardous Material

WARNING

If using pathogenic, toxic, or otherwise hazardous materials in the RC-3C PLUS, we recommend that the centrifuge be located in a biohazard safety enclosure and operated with all appropriate safety precautions.

The RC-3C PLUS 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 areosols 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 procedure to follow if a centrifuge or rotor that has been used with a hazardous material must be 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 Table on page 4-2). To prevent rotor failure, the total contents of any compartment, including specimen, tubes, cover, and adapters (if used), must not exceed the figure given in the table on page 4-2 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.***

The rotor speed is reduced in proportion to the square root of the ratio for the maximum allowable compartment mass to the actual compartment mass (including specimen, tubes, covers, and adapters). If the compartment mass is more than that specified for the rotor, the reduced speed can be determined by using the formula given below.

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

Entry Errors

Any of the following conditions will cause the ENTRY ERROR message to light.

1. The MAX temperature switch is set at or below the value set on the RUN temperature switch. In this case, the MAX temperature that the system will use is the RUN temperature plus seven degrees. Change the MAX temperature setting for a value higher than the RUN temperature setting.

2. The RPM switches are set for a speed below 50 rpm. The system will default to a 50 rpm setting. Change the speed setting.

3. The RPM switches are set at or above 102% of the maximum speed of the identified rotor. Check the ROTOR CODE setting to make sure you have selected a proper code number and check the speed setting.

4. The OFF/HOLD switch is set at OFF, the TIMED/$\int\omega^2 dt$ switch is set at TIMED, and the TIME (MINS and SEC) switches are set at zero. The run will not start.

5. The OFF/HOLD switch is set at OFF, the TIMED/$\int\omega^2 dt$ switch is set at $\int\omega^2 dt$, and the COEF switch is set at zero. The run will not start.

6. The ROTOR CODE switches are set at a number that is not used (that is, any number above 36); the control values will default to those for a ROTOR CODE setting of “00”.

7. The MAX temperature switch is set at a number from P0 through P9 during a non-programmed run, or the program number was changed during a programmed run.

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 procedures are followed when necessary. Also, to keep your centrifuge in good working condition and ensure accurate test results, we recommend that, in addition to these routine procedures, you have the temperature control and the rotor imbalance detector checked periodically by a Thermo Service Representative or other qualified service personnel because occasionally, these controls may need to be recalibrated. If further service is needed, contact Thermo or the nearest representative for SORVALL® products.

WARNING

Because of the high voltages in the centrifuge, anyone who is not properly trained in electronics must not test or repair the electrical circuits.

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 signs of wear, encrusted biological deposits, and general cleanliness.

b. Cleaning

Rotor Chamber

The rotor chamber should be kept clean and wiped routinely to maintain efficient cooling. Wash the rotor chamber with a mild, nonalkaline dishwashing liquid, then rinse and dry with a soft absorbent cloth.

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, 10% SDS, and water. Follow this with ethanol rinses then deionized water rinses. Dry with a soft absorbent cloth. Dispose of all wash solution in proper radioactive waste containers. ***Read the CAUTION.***

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.

Periodically defrost the rotor chamber to maintain efficient cooling; frost on the inner walls acts as an insulation between the chamber and the refrigerant. To defrost the chamber, install a rotor and close the chamber door. Set the RUN temperature switch for 30°C and set the MAX temperature switch for 40°C, then run the centrifuge until the frost melts (approximately 5 minutes). When the rotor comes to a complete stop, remove the rotor and wipe the chamber dry. The chamber can also be defrosted by leaving the chamber door open and the main power off until the frost melts; wipe chamber dry.

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. Periodically, wash the spindle with warm water.

Cabinet

Clean the enameled cabinet panels with a household wax cleaner. Use a mild, nonalkaline detergent and water to clean the top deck and the chamber door.

Refrigeration System

To maintain the efficiency of the refrigeration system, the air filter should be cleaned every three to six months (see page 5-4, Cleaning the Air Filter).

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.

Periodically 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 gas spring bracket is not cracked. If the chamber door will not stay in the open position or the gas spring bracket is cracked, contact your local Thermo 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 test results, we recommend that you check the speed control, timer and temperature at least twice a year following the procedures given on the next page.

If the bi-annual inspection reveals inaccurate results for any of these controls (that is, Speed Control, Timer, or Temperature), contact your local Thermo Service Representative for SORVALL® products or qualified service technician because occasionally, these controls need to be recalibrated.

Speed Control

1. Precool rotor and chamber if desired.

2. Prepare a sample of test fluid. Load and balance the rotor according to the instructions given in the individual rotor instruction manual.

3. Open the chamber door and install the rotor. Close the chamber door.

NOTE The chamber door must be closed to do this procedure.

4. Set the POWER switch to "I".

5. Set the run parameters: TEMP °C switches, SPEED switches, TIME switches, ROTOR CODE switches and OFF/ARC switch, to the desired settings for a normal run application.

6. Press the START switch. When the rotor has reached the preset rpm value, verify the RPM reading using a strobe tachometer following the instructions supplied with the tachometer. Check the rotor through the viewing port located in the center of the chamber door. The reading given by the strobe tachometer should be in agreement with the SPEED display (located on the front panel of the centrifuge) to ± 20 rpm or 1%, whichever is greater.

7. Repeat this procedure at any other speed ranges that are commonly used in your laboratory protocols.

Timer

1. Precool rotor and chamber if desired.

2. Prepare a sample of test fluid. Load and balance the rotor according to the instructions given in the individual rotor instruction manual.

3. Open the chamber door and install the rotor. Close the chamber door.

4. Set the POWER switch to "I".

5. Set the run parameters: TEMP °C switches, SPEED switches, TIME switches, ROTOR CODE switches and OFF/ARC switch, to the desired settings for a normal run application.

6. Press the START switch. Using a stopwatch, verify that the centrifuge shuts off when the preset time on the TIME display has elapsed (± 5%).

7. Repeat this procedure at any other time ranges that are commonly used in your laboratory protocols.

Temperature

1. Precool rotor and chamber.

2. Prepare a sample of test fluid. Load and balance the rotor according to the instructions given in the individual rotor instruction manual.

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

3. Open the chamber door and install the rotor. Close the chamber door.

4. Set the POWER switch to "I".

5. Set the run parameters: RUN TEMP °C switches, SPEED switches, ROTOR CODE switches and OFF/ARC switch, to the desired settings for a normal run application commonly used in your protocols. Set TIME switches to HOLD.

6. Press the START switch. The run duration should be long enough for the sample temperature to stabilize.

7. Once the temperture has stabilized, the temperature displayed on the control panel, should be within ±1°C of the run temperature that was set in step 5.

8. At the end of the run, wait for the rotor to stop spinning, then immediately open the chamber door and measure the actual sample temperature using a calibrated thermometer that is, Fluke 51 K/J or equivalent). The sample temperature should be within ±2°C of temperature displayed.

9. Repeat this procedure at any other speed ranges that are commonly used in your laboratory protocols.

Emergency Sample Recovery

WARNING

When the main power shuts off, the brake will not operate. Wait until the rotor stops spinning before using the mechanical override. Reaching into the rotor chamber before the rotor has stopped spinning could cause personal injury.

If the main power shuts off because of a power failure or a system malfunction while the rotor is spinning, the RC-3C PLUS chamber door will not open. A mechanical override is provided to allow sample recovery in the case of an emergency. This procedure should never be used routinely and is intended for emergency sample recovery only.

The mechanical door release lever is recessed in the back cabinet panel (see figure 5-1). To open the chamber door, push the door release lever with a pencil or similar object, then carefully lift the door latch and pull the door open.

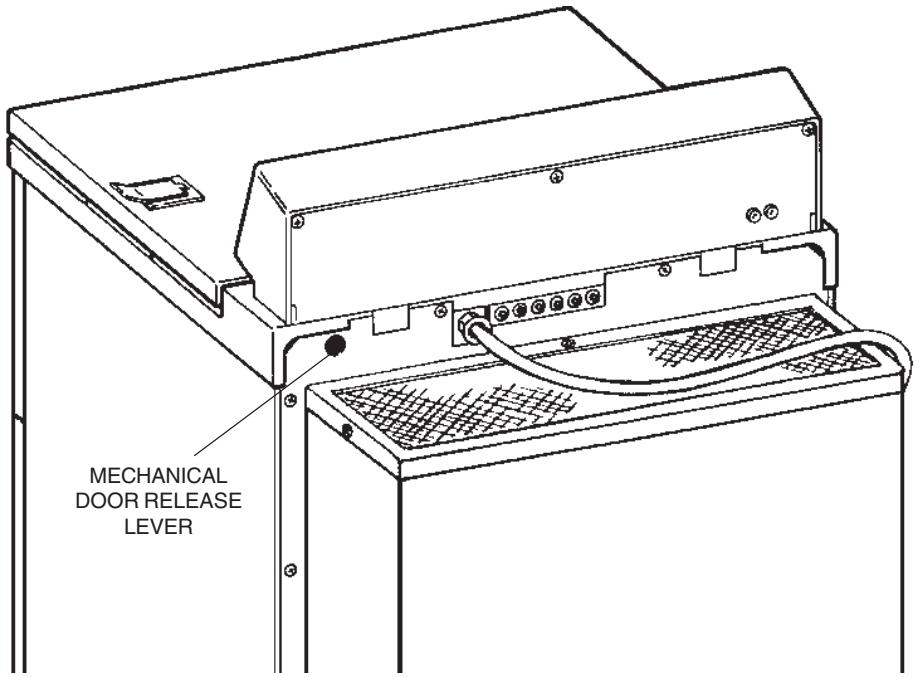


Figure 5-1. Location of Mechanical Door Release Lever

Cleaning the Air Filter

1. Unplug the centrifuge power cord.

2. Using a 9/16 wrench, raise the two locking stabilizers (this will lower the center caster). Then, roll the centrifuge to an area to access the bottom of backpack.

3. From the left side of centrifuge, grasp the handle on the air filter assembly and pull downward (see figure 5-2). Remove the air filter assembly.

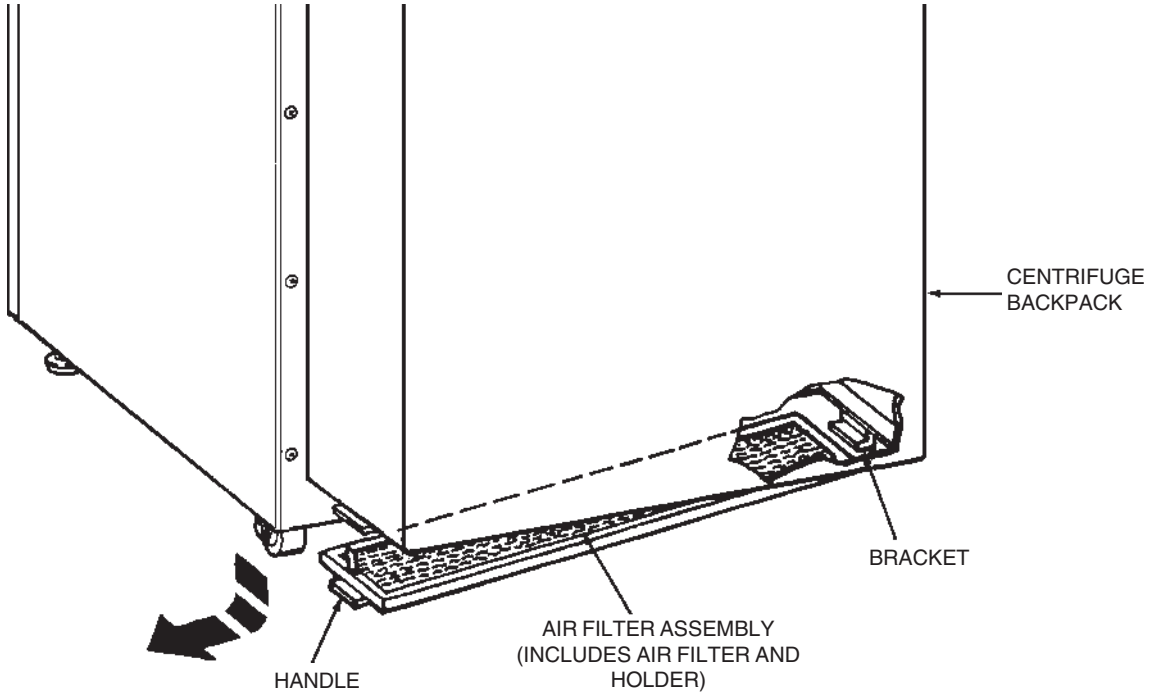


Figure 5-2. Air Filter Assembly Removal

4. Clean the air filter assembly by rinsing in warm water. If the air filter is being reinstalled proceed to step 6. However, if the air filter can no longer be cleaned by rinsing in warm water or if it is damaged, replace the air filter as described in step 5. The catalog number to order a replacement air filter is 55466.

5. Replace the air filter as follows:

   a. The air filter is slightly smaller than the air filter holder and is held in place by a small piece of foam at one end of the holder. Slide the air filter into the foam and the filter will "pop up" out of the holder. Discard the air filter.

   b. While holding one end of the new air filter (Cat. No. 55466) against the foam, lower the other end into the holder. The spring action of the foam will retract against the air filter and hold it in place.

6. Reinstall the air filter assembly making sure the right side of the assembly engages the small bracket on the backpack. Once the assembly is engaged, gently push upward to secure in place.

Circuit Breakers

The RC-3C PLUS has seven circuit breakers. The primary power circuit breaker is located on the front cabinet panel (POWER switch). Six circuit breakers are located on the rear console panel (as shown in figure 5-3). One 20A breaker protects the drive circuitry, one 20A breaker protects the refrigeration circuitry, and the remaining four 3A breakers protect the power supply.

If a circuit breaker trips, it can be reset by pushing the reset button on the breaker. Repeated tripping indicates a fault in the system, in which case you should contact a Thermo Service Representative.

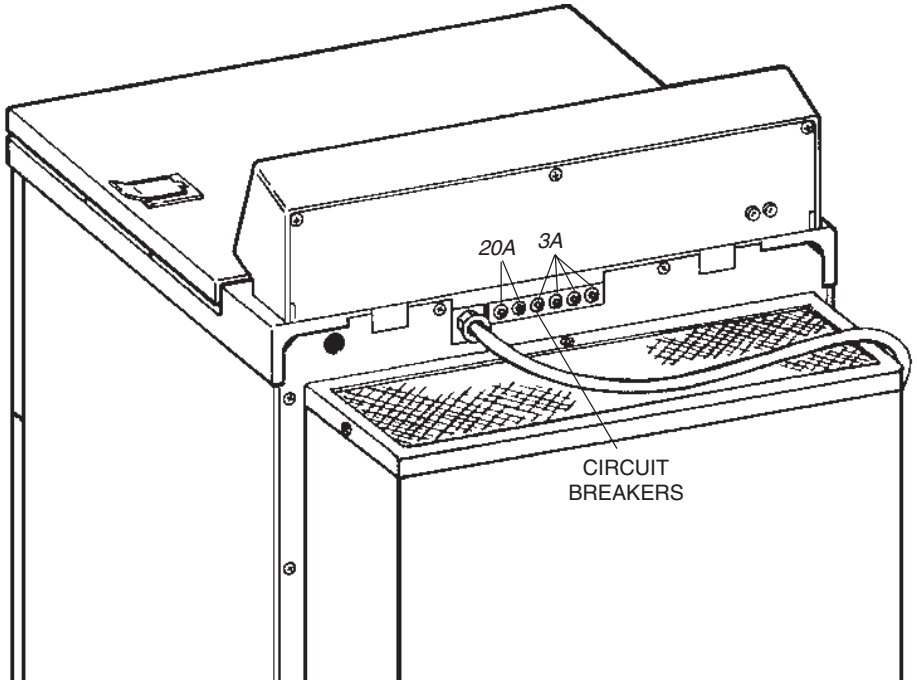


Figure 5-3. Location of Circuit Breakers

Parts Ordering Information

To order replacement parts, telephone toll-free 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 radiactive 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 equipment to be serviced of all encrusted material and decontaminate it (see Care and 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 Care and Maintenance Section of 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 lowspeed floor model centrifuges:
   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.

   Do not leave a loaded rotor locked inside a centrifuge that requires servicing. If, with a loaded rotor installed in the chamber, a centrifuge malfunction makes it so that the chamber door will not open by normal means, follow the Emergency Sample Recovery procedure found in your centrifuge operating instructions manual to gain access to the rotor.

2. Complete and attach Decontamination Information Certificate (in the back of your rotor or instrument manual) to the centrifuge or rotor before servicing.

   Decontamination Information Certificates are included with this book. Additional certificates are available from the local Thermo Representative or Field Service Engineer. In the event these certificates are not available, a signed, written statement certifying that the unit has been properly decontaminated, identifying what the contaminants were and outlining the decontamination procedures used will be acceptable.

NOTE The Field Service Engineer 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.

If a centrifuge or rotor to be serviced does not have a Decontamination Information Certificate attached and, in Thermo opinion presents a potential radioactive or biological hazard, the Thermo representative will not service the equipment until proper decontamination and certification is complete.

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

1. Contact your Thermo representative to obtain an Equipment Return Decontamination Form; be prepared with the name and serial number of the centrifuge or rotor and the repairs required.

2. Complete the Equipment Return Decontamination Form and return it to Thermo Upon receipt of a completed form, a Returned Material Authorization Number (RMA Number) will be issued to you.

CAUTION Do not ship or transport a centrifuge with a rotor installed on the drive spindle. If a centrifuge chamber door cannot be opened using conventional methods, refer to the Emergency Sample Recovery (mechanical override) instructions that are provided in your centrifuge operating manual.

3. With the RMA Number clearly marked on the outside of packaging, send the items to the address obtained from your Thermo representative.

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

If equipment is received at Thermo facilities without a valid RMA Number on the outside of the shipping container and a completed Equipment Return Decontamination Form on file, the equipment will be treated as a potential contamination hazard, and will not be serviced until decontamination certification has

been completed. The sender will be contacted for instructions regarding disposition of the equipment in question; all disposition costs will be borne by the sender. If contaminated equipment is received at Thermo facilities, both the carrier and appropriate authorities shall be notified.

APPENDIX

Warranty

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

The SORVALL® RC-3C PLUS 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.

Index

NOTES

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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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**

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In anderen Ländern:
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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