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SS-34 @ 6500 RPM'S FOR
30 MIN'S.

SORVALL®

SN#: 10207105
SS-34 @ 19,000 RPM'S FOR
30 MIN'S.
installed Rm 220 02/20/04

SORVALL®
RC-5C PLUS

OPERATING INSTRUCTIONS

Kendro
Laboratory Products

PN 74559-5

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OPERATING INSTRUCTIONS

SORVALL® RC-5C PLUS

Superspeed Centrifuge

Kendro Laboratory Products
Newtown, Connecticut
U.S.A.

SORVALL®

Kendro Laboratory Products

PN 74559-5
Issued February 2000

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This manual is a guide for use of the

SORVALL® RC-5C PLUS Superspeed 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. Kendro 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 curent.

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.

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

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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

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

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. In the event of a tube failure, a rotor without a biocontainment seal cannot protect you from particles dispersed into the air; if a rotor fails, the centrifuge cannot protect you from particles dispersed into the air. To protect yourself, we recommend additional precautions be taken to prevent exposure to these materials, for example, 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.

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

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, Operation.

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

CAUTION

Do not operate or precool a rotor at the critical speed, as this will have a detrimental effect on centrifuge component life. See Appendix, Rotor Information Table, for critical speeds of rotors.

Do not operate the centrifuge with the rotor out of balance. Operating the rotor out of balance can cause damage to the centrifuge drive assembly.

Do not operate the centrifuge unless the rotor is properly seated on the drive spindle and locked in place. See the rotor instruction manual.

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

The centrifuge can be damaged if it is connected to the wrong voltage. Check the voltage before plugging the centrifuge into a power source. Kendro is not responsible for incorrect installation. See Chapter 2.

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

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Chapter 1: INTRODUCTION & DESCRIPTION

This manual provides you with the information you will need to operate and maintain your SORVALL® RC-5C PLUS Superspeed Centrifuge. If you encounter any problem concerning either operation or maintenance that is not covered in the manual, please contact our Marketing Technical Group for assistance. In the United States, call toll free (800) 522 SPIN (800 522-7746). Outside the United States, contact your local distributor or agent for SORVALL® products.

Centrifuge Description

The RC-5C PLUS is a high-speed (to 21 000 rpm) centrifuge used to separate substances of different densities at controlled temperatures. Some of the outstanding features of the RC-5C PLUS are:

- Relative Centrifugal Force (RCF) calculator. It allows you to calculate RCF before a run and display it at any time during a run.
- Automatic temperature compensation for all SORVALL® superspeed rotors.
- Integrator ($\int \omega^2 dt$). It 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 and after a timed run.
- Automatic rate-controlled slow start and slow stop.
- Refrigeration system charged with SUVA® refrigerant, one of Kendro's CFC-replacement coolants.
- Durable motor brushes with increased life.
- Automatic diagnostic indicators that alert you of a system malfunction, plus other indicators that let you know the system status.
- 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.

The centrifuge can be operated in several modes or a combination of modes. Run conditions are selected by setting the switches on the front control panel, and then actual run conditions are continuously displayed during operation by easy-to-read displays. For your

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protection, system interlocks will keep the centrifuge from starting and will automatically terminate a run in progress if a system malfunctions.

The RC-5C PLUS has the same drive system and the same high-capacity refrigeration system as earlier SORVALL® superspeed centrifuges. The drive system has a directly coupled, fan-cooled series universal motor that provides smooth, quiet operation at all speeds. The motor is controlled by a saturable reactor that is, in turn, controlled by the system electronics that respond to the run parameters you select. The gyro-action self-centering drive spindle allows you to balance the centrifuge tubes by "eye" rather than by weighing them. The refrigeration system is a low temperature, hermetically-sealed unit that consists of a compressor, a condenser, an evaporator/rotor chamber, and all interconnecting tubing. During operation, the refrigeration system will maintain selected temperatures within the range specified for the centrifuge.

The RC-5C PLUS accepts the SORVALL® superspeed rotors listed in the Rotor Information Table in the Appendix, which includes all the rotors compatible with earlier floor-model, superspeed centrifuges.

Refer to figure 1-1 to identify the parts of the RC-5C PLUS.

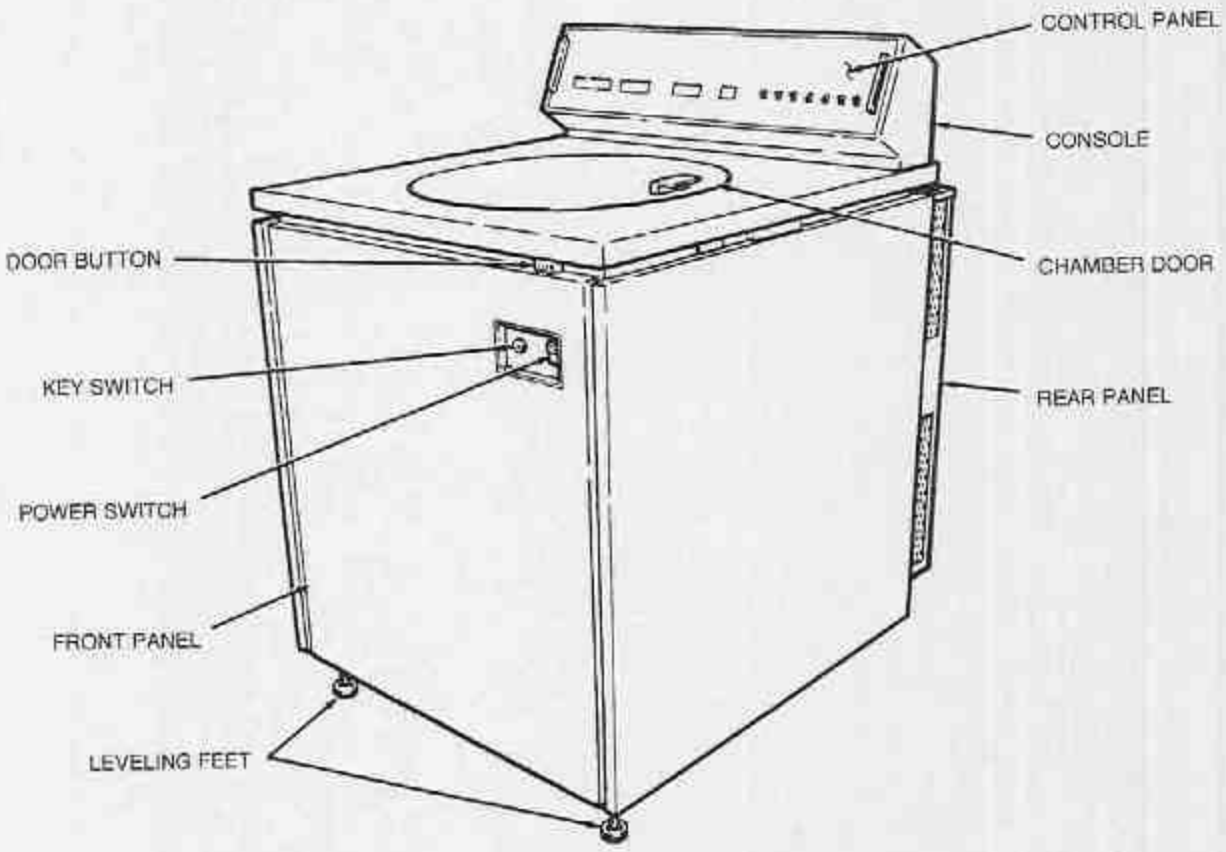


Figure 1-1 Centrifuge Parts Location and Identification

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Centrifuge Specifications

Run Speed[1]	
Speed Selection Range (rpm)	50 to 21 000
Speed Control Accuracy	±1% or 100 rpm, whichever is greater
Maximum Relative Centrifugal Force	51 070 *g*
Run Temperature	
Temperature Selection Range	–20 to +40°C
Temperature Control Range	+2 to +40°C[2,3]
Temperature Control Accuracy	±1°C[3,4]
Run Time Selection Range	0 to 99 hr, 59 min or Hold
Ambient Temperature Range	+15 to +38°C[3]
Mass (Weight)	308 kg (680 lb)
Dimensions	
Width	76 cm (30 in)
Height to top of control console	114 cm (45 in)
Depth	99 cm (39 in)
Electrical Requirements	
Input Power (single phase, 30 A)	240 V, 50 Hz 230 V, 60 Hz 220 V, 50 Hz 208 V, 60 Hz 200 V, 60 Hz
Input Power (polyphase, 30 A)	220 V, 50 Hz
Receptacle (for NEMA 6-30P grounded plug that is supplied)	NEMA 6-30R
Noise Level	<62 dB[5]
Heat Output	4 kW[6] (13 500 Btu/h[6])

1 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.

2 May vary at very low speeds (below approximately 2000 rpm).
3 The centrifuge will operate at ambient temperatures up to 38°C, but refrigeration system performance may be less than optimal above 25°C.
4 After the centrifuge system has reached equilibrium.
5 For the SS-34 rotor at 20 000 rpm.
6 For the SS-34 rotor spinning 20 000 rpm at 4°C, after it has reached equilibrium. Other rotors, speeds, and temperatures cause the heat output to vary.

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Centrifuge Accessories

The following accessories are provided with the centrifuge:

Catalog No.	Description
74567	Condensed Operating Instructions
74559	Instruction Manual
68025	9/16-inch Wrench
91499	NORMAL/ZONAL Key
12284	Motor Brush Replacement Kit

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Chapter 2: INSTALLATION

After you receive your centrifuge, inspect it for damage before using it. The RC-5C PLUS centrifuge must be installed in a location that meets all of the location and electrical requirements that are specified below. Installation instructions are on page 2-2.

Inspection

As soon as you receive your RC-5C PLUS you should carefully inspect it for any shipping damage that may have occurred. If you find any damage, please report it immediately to the transportation company and file a damage claim, then notify Kendro. If any parts are missing, contact one of the Kendro district offices or the local representative of SORVALL® products. You will find a list of offices on the back cover of this manual.

Location Requirements

The location of the centrifuge should be carefully considered because free air circulation is very important for the centrifuge to function properly. To allow adequate air circulation, locate the centrifuge in an area that will allow 10 cm (4 in) clearance between the wall and the sides of the centrifuge and has an ambient temperature within 15°C to 38°C. If the ambient air temperature is above 25°C, the centrifuge may not maintain low temperatures at high speeds.

When the centrifuge is situated at its operating location, install it as specified later in this chapter.

Electrical Requirements

CAUTION

The centrifuge can be damaged if it is connected to the wrong voltage. Check the voltage before plugging the centrifuge into any power source. Kendro is not responsible for improper installation.

The appropriate single-phase power source must be available to plug the centrifuge into. Check the nameplate on the back panel of the centrifuge to determine the electrical configuration of your centrifuge, which is one of the following:

240 V, 50 Hz, 30 A*
230 V, 60 Hz, 30 A*
220 V, 50 Hz, 30 A*
208 V, 60 Hz, 30 A*
200 V, 60 Hz, 30 A*
208 V, 60 Hz, 50 A*
230 V, 60 Hz, 50 A*

* CSA and UL approval is applied for.

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To connect the centrifuge to a voltage other than what is specified on the nameplate (including polyphase), it will have to be rewired and its power cord may have to be replaced. Contact Kendro to have a Field Service Engineer do the rewiring.

The centrifuge is equipped with a 3-wire power cord with a 3-prong grounded plug (NEMA 6-30P) that fits NEMA receptacle 6-30R or equivalent. (Centrifuges shipped to Canada have CSA approval and are supplied with a power cord to fit a NEMA 6-50R receptacle or equivalent.) For connection to other receptacles, the power cord may have to be replaced. Follow local electrical codes.

CAUTION

The centrifuge can be damaged if it is connected to a line voltage that varies more than ±10% of its nominal value. Check the voltage before plugging the centrifuge into any power source. Kendro is not responsible for improper installation.

If the line voltage varies by more than ±10% of its nominal value, it may damage the centrifuge. ***Read the CAUTION.***

The main power ON/OFF switch is a 30 A circuit breaker; therefore, a separate line disconnect switch is not needed unless required by local codes.

Installation

To install the centrifuge:

1. *If you are installing a new centrifuge,* remove any packaging.
2. Roll centrifuge into position. Open the chamber door by following the emergency sample recovery procedure in Chapter 5.
3. Install a rotor WITHOUT its lid. Place a level on the center hub of the rotor.

CAUTION

The centrifuge can be seriously damaged if it is operated when it is not level.

4. Turn the two front feet with the 9/16-inch wrench provided until they bear weight. Alternately turn the feet with the wrench to raise or lower the feet until the centrifuge is level. Remove the level. ***Read the CAUTION.***
5. Plug the centrifuge into the appropriate electrical outlet.

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Chapter 3: CONTROLS, DISPLAYS & INDICATORS

This chapter describes the RC-5C PLUS centrifuge controls, displays, and indicators and includes their locations and functions.

Controls, Displays, & Indicators

The RC-5C PLUS control switches are used to select desired run parameters and, during a run, digital displays indicate actual run conditions, such as estimated sample temperature, rotor speed, remaining or elapsed run time or accumulated integral value. Indicators light up, 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.

Refer to figure 3-1 for the location of the controls, displays, and indicators described in this chapter.

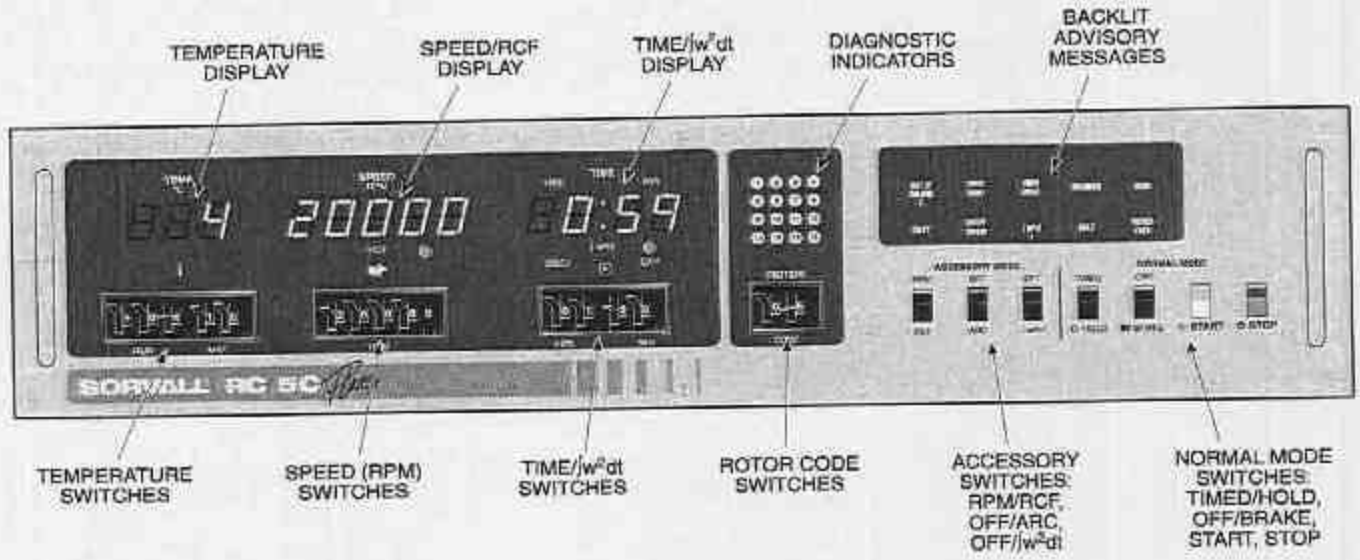
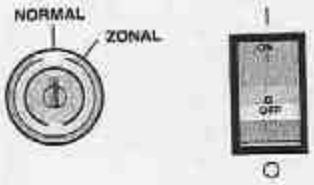


Figure 3-1. RC-5C PLUS Control Panel

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Key Switch and Power Switch

The key switch and power switch are located in the upper right-hand corner of the front cabinet panel. The key switch is set using the key that is supplied with the centrifuge; the position of this switch determines the mode of centrifuge operation. The key should be kept in the NORMAL position unless you need to dynamically load the TZ-28 zonal rotor. The power switch (30 A circuit breaker) is an ON/OFF toggle switch that, when set to ON, applies power to the centrifuge.

Temperature Switches and Display

The temperature display indicates estimated sample temperature.

The RUN temperature switch is used to set desired sample temperature. The MAX temperature switch is used to set the overtemperature, which is the maximum permissible sample temperature. (If the sample temperature exceeds this limit, the centrifuge will shut off and the OVERTEMP message will light.)

Speed Switches, Display, & Indicator

The Speed/RCF display indicates rotor speed in rpm (revolutions per minute) or RCF (relative centrifugal force, commonly referred to as *g* force) when the RPM/RCF switch is pressed to RCF.

The indicator below the display lights when the RPM/RCF switch is pressed to RCF.

The RPM switches are used to set the desired run speed.

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Time/$\int\omega^2 dt$ Switches, Display, & Indicator

The Time/$\int\omega^2 dt$ display shows one of the following values during a run: (1) accumulated run time if the TIMED/HOLD switch is set to HOLD, (2) remaining run time if the TIMED/HOLD switch is set to TIMED and the OFF/$\int\omega^2 dt$ switch is set to OFF, or (3) accumulated integral value if the OFF/$\int\omega^2 dt$ switch is set to $\int\omega^2 dt$. Time values are displayed in hours and minutes and integral values are displayed as a coefficient and an exponent (for example, 15 20 means 1.5×10^{20}).

The indicator below the display will light if the OFF/$\int\omega^2 dt$ switch is set to $\int\omega^2 dt$.

The Time/$\int\omega^2 dt$ switches are used to select either the desired length of run time (hours and minutes) or the desired integral value (coefficient and exponent), depending on the setting of the OFF/$\int\omega^2 dt$ switch when the START switch is pressed. The centrifuge will shut off when the preselected value is achieved, provided the TIMED/HOLD switch is set to TIMED (if the switch is set to HOLD, the run will continue until STOP is pressed).

Rotor Code Switches

The code number of the rotor in use must be set on these switches for proper automatic temperature compensation, speed control, and RCF calculation. 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.

TIMED/HOLD Switch

The setting of this switch determines how the run will end:

- If the TIMED/HOLD switch is set at TIMED when the START switch is pressed, the run will end when the preselected length of time has elapsed or the preselected integral value has accumulated, depending on the setting of the OFF/$\int\omega^2 dt$ switch.

- If set at HOLD when the START switch is pressed, the run will continue until you press the STOP switch. If the setting is changed from TIMED to HOLD during a run, the run will not end until you press the STOP switch.

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OFF/BRAKE Switch

When the OFF/BRAKE switch is set to BRAKE, the rotor will brake (rather than coast) all the way from set speed to 0 rpm at the end of the run, unless the OFF/ARC switch is set to ARC; if this is the case, the rotor will brake from set speed to 700 rpm, then continue to decelerate to 0 rpm at a controlled rate.

When the OFF/BRAKE switch is set to OFF the rotor will coast all the way from set speed to 0 rpm at the end of the run, unless the ARC is on; if this is the case it will coast to 700 rpm, then continue to decelerate at the controlled rate.

START Switch

The START switch starts the run when is it pressed.

STOP Switch

The STOP switch ends the run when it is pressed.

RPM/RCF Switch

This switch is normally set to RPM, which causes the SPEED display to show rotor speed. When pressed down to RCF during a run, the SPEED display numbers will change from the current rotor speed to the current relative centrifugal force (RCF, commonly referred to as *g* 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 RPM/RCF switch is released, the display will change back to show rotor speed.

This switch can also be used to calculate RCF values before a run has been started (see Chapter 4).

OFF/ARC Switch

When the OFF/ARC switch is set to ARC it causes an automatic rate-controlled slow start from 0 rpm to 500 rpm and a slow stop from 700 rpm to 0 rpm. The setting of the OFF/BRAKE switch will determine the rate of deceleration from set speed down to 700 rpm—if it is set to OFF, the rotor will coast from set speed to 700 rpm; if it is set to BRAKE, the rotor will brake from set speed to 700 rpm.

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 down to 0 rpm in accordance with the setting of the OFF/BRAKE switch.

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

- If the OFF/$\int\omega^2 dt$ switch is set to $\int\omega^2 dt$ and the TIMED/HOLD switch is set at TIMED 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.

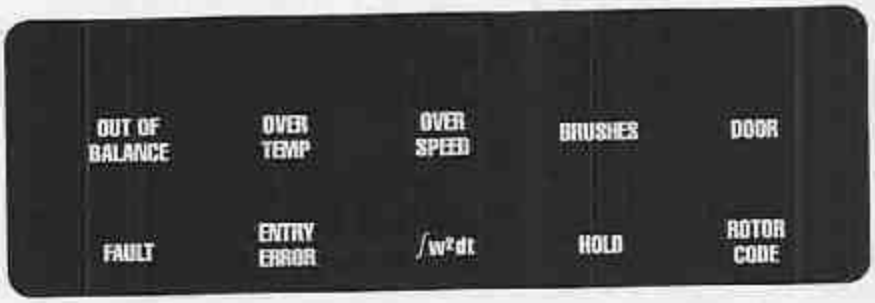
- If the OFF/$\int\omega^2 dt$ switch is set to $\int\omega^2 dt$ and the TIMED/HOLD switch is set at HOLD when the START switch is pressed, the TIME display will show accumulated run time and the run will continue until you press the STOP switch. However, the setting on the switches has been interpreted as an integral value rather than time; therefore, if you change the setting of the TIMED/HOLD switch to TIMED during the run, the display will change to show accumulated integral value and the run will end when the set value is reached.

- If the OFF/$\int\omega^2 dt$ switch is set to OFF when the START switch is pressed, the centrifuge will operate in either a timed mode or a continuous run (HOLD) mode, depending on the setting of the TIMED/HOLD switch. The TIME display will show either remaining run time (TIMED) or accumulated run time (HOLD). During a TIMED run, the accumulated integral value can be displayed by changing the setting of this switch to $\int\omega^2 dt$ (the run will still be controlled by time, not integral). Even though the run is controlled by time, the integral value accumulates from the time the START switch is pressed until the rotor decelerates to 0 rpm at the end of the run.

- At the end of any TIMED run (but before the START switch is pressed again), the integral recall value for the run can be displayed by changing the OFF/$\int\omega^2 dt$ switch to $\int\omega^2 dt$. If you know the integral recall value of a particular run, you can then duplicate the run by selecting the integrator mode and setting the switches for the integral value (see Integrator Mode in Chapter 4).

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Backlit Advisory Messages



The RC-5C PLUS has ten operator advisory messages on the control panel. These messages are backlit; 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

Indicates 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.

OVERTEMP

Indicates 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:

- run temperature setting may be too low for the rotor/speed combination; check rotor instruction manual to verify temperature setting,
- room ambient temperature is above 25°C, or
- inadequate air circulation (see Location Requirements, page 2-1).

Check each of these possible causes before notifying your Kendro Field Service Engineer of the problem.

OVERSPEED

Indicates the detected speed is greater than 22 000 rpm and run in progress terminated. If the ENTRY ERROR message is also lit, see page 4-11 for possible cause. Otherwise, notify your Kendro Field Service Engineer of the overspeed condition.

BRUSHES

Warns that the drive motor commutator brushes are worn and should be replaced within the next eight hours of operation. If a run is in progress when the light comes on, the run can be completed, but the brushes should be replaced before starting the next run. Continued operation with worn brushes can damage the centrifuge drive motor.

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DOOR
Indicates one of the following:

- Pressed START with the centrifuge chamber door open and the key switch set to NORMAL. The centrifuge will not start. Close the chamber door and start the centrifuge.

- Rotor speed is above 1500 rpm with the chamber door open and the key switch set to ZONAL. Run in progress terminated. Notify Kendro Field Service Engineer.

- Rotor is spinning with the chamber door open and the key switch set to NORMAL. Run in progress terminated. Notify Kendro Field Service Engineer.

FAULT
Blinks on and off whenever a diagnostic indicator lights up; the indicator represents a condition that has caused the run to end (diagnostic indicators number 1-8) See Diagnostic Indicators later in the chapter.

ENTRY ERROR
Lights when a wrong entry has been made on one of the control settings. See page 4-11 for a list of possible entry errors.

$\int\omega^2 dt$
Indicates that you have selected the integral ($\int w^2 dt$) mode; the setting on the TIME switches is interpreted as an integral value rather than a time.

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

ROTOR CODE
Blinks 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 4-1).

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Diagnostic Indicators



These indicators, numbered 1 through 16, help troubleshoot a problem when the centrifuge is not operating properly. When any of the indicators light, it means a problem exists that is affecting the operation of the centrifuge. Each indicator 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 indicators, only twelve (1-12) are currently being used; the other four are there for future use, if needed. 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 your Kendro Field Service Engineer.

2 PROGRAM FAILURE
Notify Kendro Field Service Engineer.

3 MEMORY SYSTEM FAILURE
Notify Kendro Field Service Engineer.

4 DRIVE SYSTEM FAILURE
Notify Kendro Field Service Engineer.

5 OVERCURRENT
The motor exceeded the preset current limit. Restart the run. If the light comes on again, notify your Kendro Field Service Engineer.

6 NO ROTOR
The microcomputer has detected a sudden and sustained increase in rpm, because there was no rotor installed when the START switch was pressed. The centrifuge ran for a few seconds then shut off. Install a rotor and restart the run.

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

8 TEMPERATURE SENSOR FAILURE
Chamber air temperature sensor has failed. Notify your Kendro Field Service Engineer.

9 TEMPERATURE SENSOR FAILURE
Chamber wall temperature sensor has failed. Notify your Kendro Field Service Engineer.

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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 your Kendro Field Service Engineer.

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 your Kendro Field Service Engineer.

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 message is lit, check all control settings. If the condition persists, notify your Kendro Field Service Engineer.

13 NOT USED

14 NOT USED

15 NOT USED

16 NOT USED

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Chapter 4: OPERATION

This chapter provides step-by-step instructions on how to set the centrifuge power ON, open the chamber door, and perform a run in the normal mode. It also describes the rate control, zonal, and integrator modes of operation and how to precool the rotor.

The chapter contains supplementary information on how to calculate relative centrifugal force (RCF); how to do a test run for low speed and low temperature operation; and what will cause an ENTRY ERROR. The controls and displays referred to in this chapter are described in detail in Chapter 3.

Setting the Centrifuge Power ON

The centrifuge power ON/OFF switch is located on the front panel, below the control panel. Press the top of the switch to set the centrifuge power ON.

Opening the Chamber Door

Press the door release button located under the top deck (see figure 1-2) to release the door latch and open the chamber door.

WARNING

When loading the rotor, be sure not to exceed the maximum compartment mass of the rotor (see the Rotor Information Table in the Appendix). If maximum compartment mass is exceeded, the maximum operating speed must be lowered (see Reducing Speed for Rotor Compartment loads in Excess of Design Mass later in this chapter). Failure to do so can cause rotor failure, which could result in centrifuge damage and personal injury.

CAUTION

Failure to load and install the rotor in accordance with the rotor instruction manual could result in damage to the centrifuge. The rotor cover must be on and locked in place and the rotor must be locked to the drive spindle.

Normal Mode Operation

The normal mode of operation should be used for most RC-5C PLUS centrifuge runs. (EXCEPTIONS: To slowly accelerate or decelerate fragile gradients or samples, see Rate Control [ARC] Operation. To dynamically load a zonal rotor, see Zonal Mode Operation. To control a run with the integrator, see Integrator Mode Operation.)

To perform a normal centrifuge run, the centrifuge power must be set ON and a rotor must be loaded and installed according to the instructions in the rotor manual ***(read the WARNING and the CAUTION)***. If the sample temperature during the centrifuge run is critical, we recommend that you precool the rotor and chamber as described on page 4-7 before beginning this procedure.

NOTE The controls and displays referred to in this procedure are defined in Chapter 3.

If the ENTRY ERROR message lights at any time during this procedure, refer to page 4-11 for possible causes.

1. Set the main power switch to ON.

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2. Set the RUN and MAX temperature switches to the desired run temperature and maximum temperature. The MAX temperature setting should be for a value that is at least 5°C higher than the RUN temperature setting.

NOTE For optimal temperature control at RUN temperatures below ambient, both the rotor and the rotor chamber should be at the desired RUN temperature before the run is started. If the rotor was precooled in the centrifuge, the chamber will already be at the desired temperature. If the rotor was precooled by some other means, you should wait until the temperature display indicates the desired RUN temperature before starting the run. The run will not start as long as the displayed temperature is greater than the MAX temperature setting.

3. Set the key switch on the front panel to NORMAL.

4. Open the chamber door.

5. If applicable, make sure the rotor cover is installed and, for fixed-angle rotors, secured.

6. Place the rotor on the drive spindle and lock it in place by turning the rotor locking knob counterclockwise.

7. Close the chamber door.

8. Set the ROTOR CODE switches for the proper ROTOR CODE number (see Table 4-1). Close the chamber door.

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

10. Make sure the OFF/$\int\omega^2 dt$ switch is set to OFF.

11. Set the TIMED/HOLD switch:

    - For a timed run, set the switch to TIMED, then set the HRS and MIN switches for the desired length of run time.

    - For a continuous run, set the switch to HOLD (the setting on the HRS and MIN switches is ignored). When HOLD is selected, the HOLD message indicator light will come on.

12. Set the OFF/BRAKE switch to the desired setting (refer to Chapter 3). Set the OFF/ARC switch to OFF.

13. Press the START switch. (The ROTOR CODE advisory message will blink for a few seconds as a reminder to set the proper ROTOR CODE number.)

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Table 4-1. Rotor Codes

Rotor Code	Rotor	Rotor Code	Rotor
1	SV-288	16	S-20/36
2	SV-80	17	S-20/20
3	GS-3	18	S-20/17
4	SA-600	22	F-16/250
5	SS-34	23	HB-6
6	SE-12	24	F-28/50
7	HB-4	25	F-20/MICRO
8	HS-4	26	SA-300
9	SM-24	27	SLA-1000
10	GSA	28	SLA-1500
11	TZ-28	29	SH-3000
12	SH-MT	30	SLA-3000
13	SH-80	32	SLA-600TC
14	F-28/13	33	SLC-4000
15	F-28/36		

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

If you want to see the accumulated integral value anytime during a TIMED run, change the setting of the OFF/$\int\omega^2 dt$ 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.

CAUTION

You should remove the rotor from the centrifuge as soon as it stops to avoid any possibility of the samples freezing.

14. After the rotor has come to a stop and the door has unlatched, open the chamber door and remove the rotor. ***Read the CAUTION.***

NOTE We recommend keeping the chamber door closed after the rotor has been removed to inhibit the formation of condensation on the chamber walls.

The run can be repeated with the same parameters by installing the rotor, closing the chamber door, and pressing START. The selected speed, time, and temperature are retained from previous run.

Rate Control (ARC) Operation

The automatic rate control (ARC) accessory provides a slow, controlled acceleration from 0 to 500 rpm and a slow, controlled deceleration from 700 to 0 rpm. The ARC should be used when centrifuging gradients or fragile pellets. To do a rate-controlled run, follow the Normal Mode Operation procedure, except set the OFF/ARC switch to ARC in Step 12 to activate the rate control.

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WARNING

When loading the rotor, be sure not to exceed the maximum compartment mass of the rotor (see the Rotor Information Table in the Appendix). If maximum compartment mass is exceeded, the maximum operating speed must be lowered (see Reducing Speed for Rotor Compartment loads in Excess of Design Mass later in this chapter). Failure to do so can cause rotor failure, which could result in centrifuge damage and personal injury.

CAUTION

Failure to load and install the rotor in accordance with the rotor instruction manual could result in damage to the centrifuge. The rotor cover must be on and locked in place and the rotor must be locked to the drive spindle.

CAUTION

Do not operate the rotor at its critical speed (see the Rotor Information Table in the Appendix).

Zonal Mode Operation

The zonal mode of operation must be used when dynamically loading the gradient and sample into a SORVALL® TZ-28 Zonal Rotor. When the zonal mode is activated, the centrifuge will accelerate to a low speed for rotor loading and when loading is complete, accelerate to the set run speed.

Preparation for Loading

Assemble the TZ-28 rotor according to the instructions in the rotor instruction manual, then:

NOTE If desired, precool the rotor in the centrifuge according to the procedure on page 4-7.

Read the WARNING and the CAUTION.

1. Set the main power switch to ON.
2. Set the key switch on the front panel to ZONAL.
3. Press the door release button, and open the chamber door.
4. Install the rotor as instructed in the rotor manual. Set the ROTOR CODE switch to 11.
5. Set the RPM switch to the desired loading speed, which must be between 50 and 1400 rpm (1400 rpm is the recommended speed). ***Read the CAUTION.***
6. Set the OFF/$\int\omega^2 dt$ switch to OFF.
7. Set the RUN and MAX temperature switches to the desired run temperature and maximum temperature. The MAX temperature setting should be for a value that is at least 5°C higher than the RUN temperature setting.

NOTE For optimal temperature control at RUN temperatures below ambient, both the rotor and the rotor chamber should be at the desired RUN temperature before the run is started. If the rotor was precooled in the centrifuge, the chamber will already be at the desired temperature. If the rotor was precooled by some other means, you should wait until the temperature display indicates the desired RUN temperature before starting the run. The run will not start as long as the displayed temperature is greater than the MAX temperature setting.

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9. Set the TIMED/HOLD switch:

   - For a timed run, set the switch to TIMED, then set the HRS and MIN switches for the desired length of run time. The timer will start as soon as you press the START switch; therefore, include the time it will take to load the rotor in the run time you select.

   - For a continuous run, set the switch to HOLD (the setting on the HRS and MIN switches is ignored). When HOLD is selected, the HOLD message indicator light will come on.

10. Set the OFF/BRAKE switch to the desired setting (refer to Chapter 3). If the rotor already has the gradient in it, set the OFF/ARC switch to ARC to activate the rate control; it the rotor is empty, set the switch to OFF.

Loading

WARNING

When operating the centrifuge with the chamber door open and the rotor spinning, remove any articles that could fall into the rotor chamber (for example, jewelry, necktie, objects in shirt pockets). Tie back long hair and roll up shirt sleeves.

1. Press the START switch. (The ROTOR CODE advisory message will blink for a few seconds as a reminder to set the proper ROTOR CODE number.)

NOTE The timer will start as soon as you press the START switch; therefore, include the time it will take to load the rotor in the run time you select.

2. Wait for the rotor to reach the selected loading speed, then load the rotor according to the instructions in the rotor instruction manual. When the rotor is loaded, disconnect any equipment that was used to load it.

3. Close the chamber door.

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

5. Set the OFF/ARC switch to ARC so there will be a rate-controlled slow stop at the end of the run (see Rate Control [ARC] Operation).

Acceleration and Deceleration

CAUTION

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

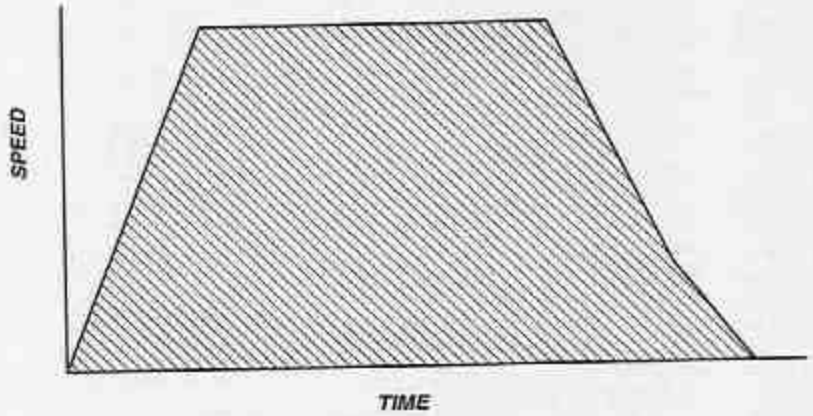
After you have closed the chamber door and set the run speed, the rotor will accelerate to the set speed, run for the selected length of time, then decelerate to a stop. If the run was in the HOLD mode, press the STOP switch to end the run; as soon as you press the STOP switch the rotor will begin to decelerate.

NOTE The accumulated integral value can be displayed during a run the same as for a NORMAL run.

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Integrator Mode Operation

The integrator mode can be used in place of the timer to control the length of the centrifuge run. The integral value ($\int\omega^2 dt$) represents the actual centrifuge force generated by the rotor accumulated over time.



$\int\omega^2 dt = [(\text{rpm}/60)(2)]^2 (t_2\text{-}t_1)$

$(t_2\text{-}t_1)$ = time in seconds

Figure 4-1. Integral Value

$\int\omega^2 dt$ is the integral value. The integral value is the area under the curve (as represented by the grey area in the drawing above). The larger the integral value, the more total centrifugal force (time and *g* force) applied to the sample. The use of the integrator will compensate for changes in rotor load and other factors that may change the rate acceleration in the RC-5C PLUS. For a more detailed explanation of the advantages of using the integrator, contact the SORVALL® Applications Laboratory.

The RC-5C PLUS allows you to obtain the integral value generated during a normally timed run by pressing the OFF/$\int\omega^2 dt$ switch to $\int\omega^2 dt$ when the run has stopped (see Integral Recall). The integral value can then be used to control subsequent centrifuge runs.

This procedure specifies how to set up a run to be controlled by an integral value. Prepare the rotor according to the instructions in the rotor instruction manual, then follow the instructions below.

NOTE If desired, precool the rotor in the centrifuge according to the procedure on page 4-7.

1. Follow Steps 1 through 9 and Step 12 in Normal Mode Operation to install a rotor, set run temperature and speed, and set brake. To use the rate control, see Rate Control (ARC) Operation. ***Follow all WARNINGS and CAUTIONS.***

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

3. Set the TIMED/HOLD switch to TIMED, then set the COEF and EXP switches for the desired integral value (for example, 15 20 means 1.5×10^{20}).

NOTE The TIMED/HOLD switch should never be set at HOLD during an $\int\omega^2 dt$ run; if it is, the display will show accumulated run time, and the run will not end until you press the STOP switch.

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

CAUTION

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

NOTE The setting of the OFF/$\int\omega^2 dt$ switch can be changed to OFF any time during a run to have the display (TIME) show the length of time that has elapsed since the run was started (the numbers in the display will change to represent hours and minutes 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.

Integral Recall

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

Rotor Precool

CAUTION

Failure to load and install the rotor in accordance with the rotor instruction manual could damage the centrifuge. The rotor cover must be on and locked in place and the rotor must be locked to the drive spindle.

If you plan to run a temperature-sensitive sample in the RC-5C PLUS centrifuge, we recommend that you precool the rotor and the centrifuge before loading the sample. This will ensure that the rotor and chamber temperatures are at equilibrium at the start of the run.

1. Set the centrifuge power ON and open the chamber door.

2. Install the empty rotor (with cover installed, if applicable). Lock it to the drive spindle by turning the rotor locking screw counterclockwise. Close the chamber door.

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3. Set a run speed of 2000 rpm.
4. Set the TIMED/HOLD switch to HOLD.
5. Set the RUN temperature switch for desired run temperature.
6. Set the MAX temperature switch for a value higher than the temperature displayed to avoid an overtemperature condition.
7. Set all other controls as you would for a normal mode run.
8. Press the START switch. The rotor will accelerate to 2000 rpm and quickly cool to the selected run temperature. It will typically take the rotor 30 minutes to cool, but the actual time will vary depending on the rotor weight and rotor material.

   When the displayed temperature equals the run temperature setting, stop the run.
9. After the rotor has come to a stop, open the chamber door and remove the rotor lid. Place the samples in the rotor and balance the load as specified in the rotor instruction manual.
10. Re-secure the rotor lid. Lock the rotor to the drive spindle. Close the chamber door.
11. Perform the desired centrifuge run.

Reducing Speed for Loads in Excess of Design Mass

There is a maximum allowable compartment mass established for each rotor (see the Rotor Information Table in the Appendix or the individual rotor manual). To prevent rotor failure, the total contents of any compartment, including specimen, tubes, sealing assembly, and adapters (if used), must not exceed the specified maximum compartment mass unless rotor speed is reduced proportionately.

WARNING

Failure to reduce rotor speed when compartment load exceeds maximum allowable compartment load can lead to rotor failure.

Strict adherence to the maximum allowable compartment mass or reduced rotor speed is required to prevent rotor failure. ***Read the WARNING.***

If the maximum compartment mass is greater than the value specified for the rotor, use the following formula to determine the reduced rotor speed that is required:

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

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RCF Calculation

The RCF accessory is used to calculate relative centrifuge force (RCF) values.

The accessory allows you to quickly determine the speed at which you must run a particular rotor to achieve a desired RCF value. To calculate the speed at a particular RCF:

1. Turn the main power ON but do not start the centrifuge; the rotor must be at 0 rpm to calculate the speed that corresponds to a particular RCF.

2. Set the ROTOR CODE switches for the code number of the rotor you will use. (Rotor codes are given in Table 4-1.)

NOTE The RCF values calculated for the SM-24 Rotor (code number 09) are the values for the outer row of the rotor.

3. Hold the RPM/RCF switch down to RCF.

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

NOTE If the ENTRY ERROR advisory message lights, you have the speed switches set for a value higher than the maximum speed of the identified rotor. Make sure the correct rotor or rotor code is selected.

The RCF accessory can also be used to view the RCF at a particular speed. Press the RPM/RCF switch down to view the RCF value (it will appear in the SPEED display). The RCF will correspond to the speed set on the RPM switches when rotor is at rest or to the actual speed (shown in the SPEED display) when a run is in progress.

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Test Run for Low Speed and Low Temperature Operation

If the centrifuge is operated at a speed less than 2000 rpm and a temperature 2°C or less, the refrigeration system may have difficulty maintaining the indicated sample temperature within 1°C of the set temperature. This condition may cause the sample to freeze; therefore, when the speed and temperature are set below the values given above, 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 rotor speed and sample temperature are this low because each speed/temperature/rotor combination may give different results.

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

NOTE The dispensable 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 centigrade 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°C differential. To obtain the +2°C sample temperature you should reset the set RUN temperature switches to +6°C. (Setting the higher temperature would prevent the sample from freezing.)

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Entry Errors

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

- 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 at least 5°C higher than the RUN temperature setting.
- The RPM switches are set for a speed below 50 rpm. The system will default to a 50 rpm setting. Change the speed setting.
- The RPM switches are set at or above 105% of the maximum speed of the identified rotor. Check the ROTOR CODE setting to make sure you have selected the proper code number and check the speed setting to make sure it is within range for the rotor.
- The TIMED/HOLD switch is set at TIMED, the OFF/$\int\omega^2 dt$ switch is set at OFF, and the TIME (HRS and MIN) switches are set at zero. The run will not start.
- The TIMED/HOLD switch is set at TIMED, the OFF/$\int\omega^2 dt$ switch is set at $\int\omega^2 dt$, and the COEF switch is set at zero. The run will not start.
- The ROTOR CODE switches are set at a number that is not used (see Table 4-1 for numbers that are used); the control values will default to those for a ROTOR CODE setting of "00".

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Chapter 5: CARE and MAINTENANCE

This chapter describes routine maintenance procedures. It also includes cleaning and decontamination recommendations and the Service Decontamination Policy. As the user, it is your responsibility to make certain these procedures and recommendations are followed. 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 speed control, timer, temperature control, and rotor imbalance checked by a Kendro Field Service Engineer or other qualified service personnel periodically, because they may need to be recalibrated. If further service is needed, contact your Kendro Field Service Engineer.

Maintenance

To gain the most in safety, performance, and useful life from your centrifuge, it is necessary to properly maintain it. Proper maintenance is a simple and inexpensive way to help prevent major failures. In addition to the maintenance described below, a Kendro service contract, which includes a yearly Preventive Maintenance visit, is recommended to keep your centrifuge in good condition.

Table 5-1 provides a suggested maintenance schedule.

Table 5-1. Maintenance Schedule

Maintenance	Frequency
Clean the rotor chamber	Daily or immediately after a spill
Wash the tapered spindle	Once a week
Clean the cabinet panels	Once a month
Clean the condenser fins	Once every 1 to 3 months or whenever dust accumulates significantly
Check LEDs and indicators	Once a year or whenever displayed numbers seem erroneous
Replace the motor brushes	When BRUSHES advisory message lights up
Clean the motor exhaust filter	Each time the brushes are replaced

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WARNING

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

Cleaning and Decontamination

Rotor Chamber

The rotor chamber should be defrosted and cleaned periodically to maintain efficient cooling. To defrost the chamber, install a rotor, close the chamber door, set the RUN temperature switch for 25°C and set the MAX temperature switch for 30°C, then run the centrifuge until the frost melts. When defrosting is complete, wipe the chamber dry with a damp sponge or cloth.

CAUTION

Chlorides (for example, bleach solutions) are extremely harmful to aluminum alloy rotors and can cause stress corrosion cracking. Therefore, do not use chlorides to decontaminate the chamber.

Use 70% ethanol to disinfect the rotor chamber and the rubber door seal or a 2% glutaraldehyde solution to sterilize them, then follow with several deionized water rinses. For general radioactive decontamination, use a solution of equal parts 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 solutions in proper radioactive waste containers.

To prevent condensation from forming in the rotor chamber, keep the chamber door closed when the chamber is cold.

Tapered Drive Spindle

Wipe the drive spindle with a soft cloth each time a rotor is to be installed to reduce the chance of the rotor sticking. Once a week, wash the drive spindle with warm water.

Cabinet

Clean the cabinet panels, top deck, and chamber door with a mild, *nonalkaline* detergent and water. Do not use abrasive cleansers.

Refrigeration System Condenser Fins

WARNING

The condenser fins are very sharp. Use care when cleaning them to avoid personal injury.

To maintain the efficiency of the refrigeration system, keep the condenser fins (located in the rear of the centrifuge) free of dust and dirt (to access the condenser, remove the back panel). Clean the fins with a brush or a vacuum cleaner at one to three month intervals. The fins will bend easily; be very careful when cleaning them.

Lubrication

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

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LED & Indicator Test

Once a year or whenever displayed numbers seem erroneous, you should test the LED and indicators on the control panel to make sure they all work. If even one segment of an LED digit does not work, you could get an incorrect reading in the display.

Test the LEDs and indicators:

1. Set the main power OFF.
2. Set the ROTOR CODE switches to "00" (the setting of all other switches is irrelevant).
3. Set the main power ON. When you do, watch the control panel and make sure the displays and indicators light as follows:
   - the number 8 should light in each digit space across all of the displays,
   - the minus sign should light in the TEMP display,
   - all ten backlit advisory messages should light,
   - diagnostic indicators 1 through 12 should light,
   - the $\int\omega^2 dt$ indicator should light.

NOTE The RCF indicator will not light; to test this indicator, just press the RCF switch.

If any of the LEDs or indicators are not working, contact a Kendro Field Service Engineer to repair it.

Motor Brush Replacement

When the drive motor brushes need to be replaced, the BRUSHES advisory message on the control panel will light. The brushes can be used for approximately eight hours after the light comes on; therefore, if the light comes on while a run is in process, the centrifuge will continue to operate and the run can be completed. The brushes should be replaced before the next run is started. Continued operation with worn brushes can damage the centrifuge motor.

The catalog number to order replacement brushes is 12284; this includes two brushes plus installation instructions.

NOTE The motor exhaust filter should be washed with a mild detergent each time the brushes are replaced. See the brush replacement instructions.

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Parts Ordering Information

To order replacement parts: in the United States, telephone toll-free (800) 522-SPIN (800 522-7746). To order parts in other countries, refer to the list of contacts on the back of this manual. Be sure to provide a description of the part, centrifuge model, and centrifuge serial number.

Emergency Sample Recovery

WARNING

When the main power shuts off, the brake will not operate. Wait until the rotor stops (approximately 15 minutes) 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-5C PLUS chamber door will not unlatch. 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 door latch override button is recessed beneath the top deck to the left of the door button (see illustration). To open the chamber door, push the door latch override button with a pencil or similar object and—at the same time—push the door button. The chamber door will open.

NOTE The chamber door will not open if the door latch override button and door button are not pushed at the same time.

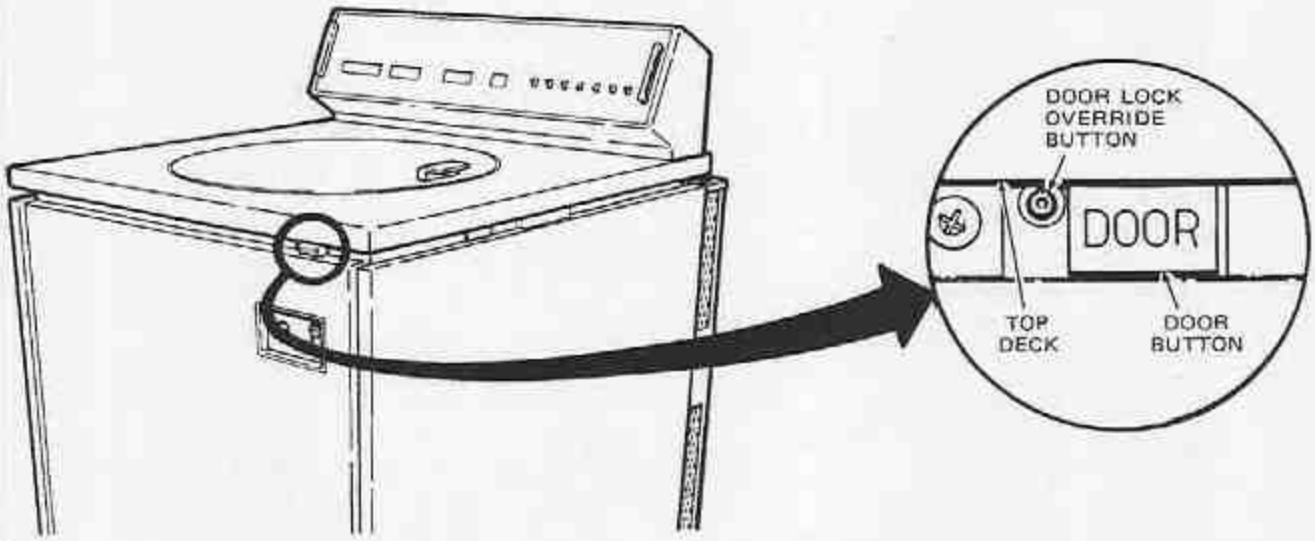


Figure 5-1. Door Latch Override Button Location

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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.

Service Decontamination Policy

If a centrifuge or rotor that has been used with radioactive or pathogenic material requires servicing by Kendro personnel, either at the customer's laboratory or at a Kendro 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 the Cleaning and Decontamination paragraph in this chapter) prior to servicing by the Kendro representative or returning it to the Kendro 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. Also, this instruction manual contains specific guidance about cleaning and decontamination methods appropriate for the product it describes.

   Clean and decontaminate your centrifuge and rotor as follows:

   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 cover is stuck, notify Kendro representative; be prepared with the name and nature of the sample so the Kendro Chemical Hazards Officer can decide whether to authorize the rotor's return to a Kendro facility.

   For superspeed centrifuges:

   1. Remove rotor from the rotor chamber.
   2. Decontaminate chamber door, rotor chamber, and drive spindle using appropriate method (see "Cleaning and Decontamination" on page 5-2).
   3. Remove all encrusted material from around the motor and drive assemblies.
   4. Remove, wash, and decontaminate the motor sealing gasket and pad.

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 Kendro facility. If Certificate is not available, attach a written statement verifying decontamination (what was contaminant and what decontamination method was used).

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

1. Contact your Kendro representative to obtain a Return Service Order Number (RSO No.); be prepared with the name and serial number of the centrifuge or rotor and the repairs required.

2. Send item(s) with the RSO No. clearly marked on the outside of packaging to the address obtained from your Kendro 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 a centrifuge or rotor to be serviced does not have a Decontamination Information Certificate attached and, in Kendro's opinion presents a potential radioactive or biological hazard, the Kendro representative will not service the equipment until proper decontamination and certification is complete. If Kendro 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 Representative or Field Service Engineer. 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 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.

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APPENDIX

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Warranty

Kendro Laboratory Products, L.P. makes no warranty of any kind, expressed or implied, except as stated in this warranty policy.

The SORVALL® RC-5C PLUS Superspeed Centrifuge is warranted to be free from defects in material and workmanship for a period of one year from the date of delivery. The compressor, condenser, evaporator and all interconnecting tubing are warranted to be free of defects in material and workmanship for a period of five years from the date of delivery. Kendro 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 apply to any damage to any instrument resulting from: normal wear and tear; misuse; abuse; use of electrical currents or circuits other than those specified on the plate affixed to the instrument; accident; negligence; failure to follow operating instructions; or use of any rotor other than a SORVALL® rotor intended for use in this instrument.

Kendro reserves the right to change, alter, modify, or improve any of its instruments without any obligation whatsoever 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. Kendro 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.

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Rotor Information Table

WARNING

The SORVALL® RC–5C PLUS can be used with SORVALL® rotors *only*. Use of another manufacturer's rotor can cause rotor failure which could result in personal injury and/or centrifuge damage.

ROTOR	CODE #	MAX SPEED (rpm)	CRITICAL SPEED (rpm)	MAX RCF	K FACTOR[1]	MAX COMPART-MENT MASS	RADIUS MAX (cm)	RADIUS MIN (cm)
SV-288	1	20 000	1200	40 301	210	50 g	9.02	6.47
SV-80	2	19 000	1050	40 968	97	6.4 g	10.16	8.84
GS-3	3	9000	750	13 689	4203	780 g	15.13	3.94
SA-600	4	16 500	950	39 412	747	115 g	12.96	5.52
SS-34	5	20 000	1140	47 808	714	115 g	10.70	3.27
SE-12	6	21 000	1100	45 959	335	30 g	9.33	3.81
HB-4	7	13 000	1100	27 712	1667	250 g	14.68	4.82
HS-4	8	7000	1000	9 430	3912	1035 g	17.23	7.22
SM-24	9	20 000	1100	49 461[2]	434[2]	27 g	11.07[2]	5.38[2]
GSA	10	13 000	900	27 485	2023	580 g	14.56	3.77
TZ-28	11	20 000	1000	42 580	612	1620 g	9.53	3.62
SH-MT	12	13 730[3]	1400	19 140[3]	656[3]	36 g	9.09[3]	5.57[3]
SH-80	13	20 000	700	45 395	400	78 g	10.16	5.40
F-28/13	14	19 500	1200	48 548	143	23 g	11.43	7.34
F-28/36	15	18 000	1200	41 366	198	66 g	11.43	6.18
S-20/36	16	8 000	350	11 510	508	156 g	16.10	7.21
S-20/20	17	12 000	350	20 798	369	115 g	12.93	7.21
S-20/17	18	8 000	350	11 860	598	130 g	16.59	6.45
SS-34/KSB	19	20 000	1140	47 808	——	115 g	10.70	——
TZ-28/GK	20	20 000	900	42 580	612	——	9.52	3.65
F-16/250	22	14 000	750	29 775	1295	420 g	13.60	3.67
HB-6	23	13 000	1000	27 617	1765	164 g	14.63	4.50
F-28/50	24	19 500	800	48 718	337	115 g	11.47	4.04
F-20/MICRO	25	20 000	1200	51 427	187	3.0 g	11.51	8.57
SA-300	26	21 000	1100	47 634	573	115 g	9.67	2.35
SLA-1000	27	16 500	800	35 793	1725	400 g	11.77	1.84

(continued)

1 With maximum allowable volume at maximum speed.
2 Outer row
3 Maximum speed of rotor is 20 000 rpm; actual maximum speed depends on tubes. Values given are typical for 1.5 ml microtubes.
4 Microplates
5 Will vary depending on number and size of microplates.

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Rotor Information Table (continued)

WARNING

The SORVALL® RC–5C PLUS can be used with SORVALL® rotors *only*. Use of another manufacturer's rotor can cause rotor failure which could result in personal injury and/or centrifuge damage.

ROTOR	CODE #	MAX SPEED (rpm)	CRITICAL SPEED (rpm)	MAX RCF	K FACTOR[1]	MAX COMPART-MENT MASS	RADIUS MAX (cm)	RADIUS MIN (cm)
SLA-1500	28	14 500	750	31 916	1475	420 g	13.59	3.66
SH-3000	29	4 350	900	3 919	8138	1805 g	18.54	9.11
SLA-3000	30	11 000	500	20 449	2364	780 g	15.13	3.94
SH-3000 (mp)[4]	31	4 350	900	3 175	3175[5]	987 g	15.02	—
SLA-600TC	32	12 500	820	25 656	913	74 g	14.70	7.99
SLC-4000	33	7 000	400	9 173	9 804	1500 g	16.76	2.51

1 With maximum allowable volume at maximum speed.
2 Outer row
3 Maximum speed of rotor is 20 000 rpm; actual maximum speed depends on tubes. Values given are typical for 1.5 ml microtubes.
4 Microplates
5 Will vary depending on number and size of microplates.

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Glossary

ARC Automatic Rate Control. An accessory mode that controls the acceleration and deceleration of a rotor to avoid gradient or pellet disturbance. Automatically sets the optimal acceleration and deceleration rate for each rotor.

HOLD A feature that selects a continuous run in place of a run controlled by time in hours and minutes; when it is selected, HOLD keeps (holds) the rotor at the selected run speed until STOP is pressed.

Integrator Mode An accessory mode that allows the user to control a run by an integral value rather than time in hours and minutes. The integral value represents the centrifuge force accumulated over time. The mode is activated by setting the OFF/$\int\omega^2 dt$ to $\int\omega^2 dt$.

Normal Mode The operation mode that is used to perform most centrifuge runs. The mode is activated by turning the key on the front panel to NORMAL and the OFF/ARC switch and the OFF/$\int\omega^2 dt$ switch to OFF.

Overtemperature The maximum estimated sample temperature (MAX) allowed during a centrifuge run; if the temperature in the display exceeds this value, the run will terminate.

RCF Relative Centrifugal Force. An accessory that calculates RCF. The force (*g* force) applied to a suspension of particles during centrifugation relative to the force that the earth's gravity would have on them. It is related to speed (rpm) by this equation: RCF = 11.17 x radius (in cm) x (rpm÷1000)^2.

Rotor Code The number assigned to each rotor model compatible with the centrifuge. The code determines how the centrifuge calculates RCF and controls speed and temperature for the rotor.

Zonal Mode An accessory mode that allows the user to dynamically load the SORVALL® TZ-28 Zonal Rotor. The mode is activated by turning the key on the front panel to ZONAL.

Abbreviations

A Ampere

ARC Automatic Rate Control

LED Light-Emitting Diode

RCF Relative Centrifuge Force (*g* force)

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