

# **OPERATING INSTRUCTIONS**

## **SORVALL<sup>®</sup> RC-28S SUPRASPEED<sup>®</sup> CENTRIFUGE**

**Du Pont Company  
Sorvall<sup>®</sup> Instruments  
Wilmington, Delaware 19898  
U.S.A.**

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**Sorvall<sup>®</sup> Centrifuges**



PN 59154-1  
Issued August 1989

This manual is a guide for use of the

**SORVALL® RC-28S Supraspeed® Centrifuge**

Data herein has been verified and validated and is believed adequate for the intended use of the centrifuge. If the centrifuge or procedures are used for purposes over and above the capabilities specified herein, confirmation of their validity and suitability should be obtained, otherwise Du Pont does not guarantee results and assumes no obligation or liability. This publication is not a license to operate under, nor a recommendation to infringe upon, any process patents.

NOTES, CAUTIONS, and WARNINGS within the text of this manual are used to emphasize important and critical instructions:

**WARNING:** A 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:** A Caution informs the operator of an unsafe practice that could result in damage of equipment.

**NOTE:** A Note highlights essential information.

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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.**

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## WARNING

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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 or rotor failure occurs during centrifugation, in which case 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.

Never use any material capable of producing flammable or explosive vapors.

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

Always reduce (derate) rotor speed whenever:

- the rotor speed/temperature combination exceeds the solubility of the gradient material and would cause it to precipitate;
- rotor compartment load exceeds the maximum allowable compartment load specified (check this whenever average fluid density is greater than 1.2 g/ml). See Chapter 4, Operation.

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

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## CAUTION

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Do not run or precool a rotor at the critical speed, as this will have a detrimental effect on centrifuge component life. See Table 4-1, Rotor Information.

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

Do not operate centrifuge without rotor properly installed: rotor cover must be on and locked in place, and the rotor locked to the centrifuge drive. 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. Du Pont is not responsible for incorrect installation.

Always maintain the centrifuge in the recommended manner. See Chapter 7, Maintenance.

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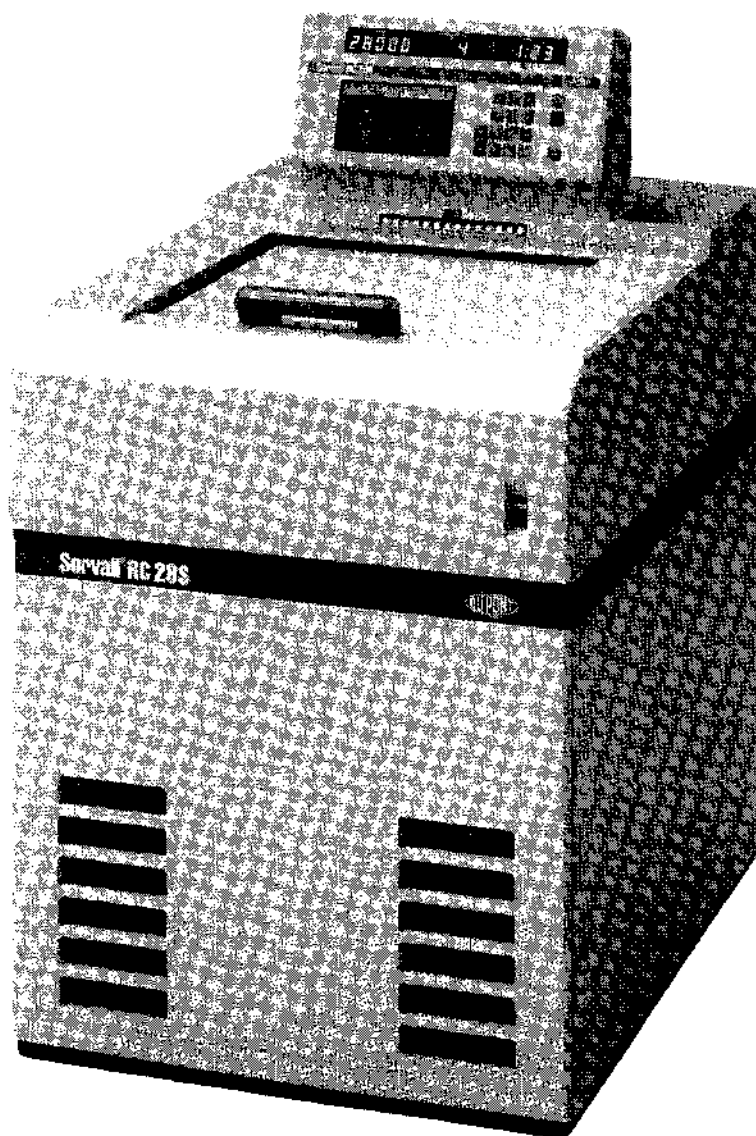


Figure 1-1. SORVALL® RC-28S *Supraspeed*® Centrifuge

# Chapter 1

## DESCRIPTION

This manual provides you with the information you need to install, operate and maintain your SORVALL® RC-28S **Supraspeed®** Centrifuge. If you encounter any problem concerning either operation or maintenance that is not covered in the manual, please telephone Du Pont for assistance. In the United States, call toll free (800) 551-2121. Outside the United States, contact the distributor or agent for SORVALL® Products.

### General Description

The Sorvall® RC-28S **Supraspeed®** Centrifuge defines a new class of centrifuge that brings an unparalleled level of performance to centrifugation. Created from the latest design technology, it incorporates usability, dependability, and safety with an extremely versatile speed range to set a new standard in value. When used with a Sorvall® **Supraspeed®** rotor, the RC-28S can reach a top speed of 28 000 rpm with a maximum g force of 100 095. At 100 095 x g you can perform applications in the RC-28S that previously required an ultracentrifuge. In addition to the **Supraspeed®** rotors designed for use with the RC-28S, the RC-28S accepts all Sorvall® superspeed rotors, increasing its usefulness by making it capable of a wide range of applications.

The centrifuge is microcomputer controlled and designed to be user friendly. It can be operated using basic parameters only or you can decide to use its special features. Because of this versatility and its user-friendliness, it can easily be operated by inexperienced persons learning centrifugation methods or by experienced persons experimenting with new methods.

The brushless dc drive which offers the optimum in centrifuge drive performance is one distinct feature of the RC-28S. Other features of the centrifuge are: automatic rotor recognition; programmability; RCF and  $\int \omega^2 dt$  control; slow start and slow stop control for sample reorientation; overtemperature control; a control panel lock to prevent run parameters from being changed; and a built-in calculator that can be used to perform centrifugation calculations, including conversions between RCF and speed, time and  $\int \omega^2 dt$ , or the calculation of K factors and run times when conversion of published run parameters is desired.

The centrifuge also has extensive diagnostic routines that allow the user to identify system malfunctions and perform maintenance and repair procedures.

For more on the features of the RC-28S, plus more on the centrifuge drive and other systems, read the table on the next two pages and the descriptive paragraphs that follow the table.



## Centrifuge Specifications

### Rotor Management

SPIN-RIGHT® Rotor Management System automatically recognizes installed Sorvall® rotor when chamber door is closed. Prevents operation of rotors above their maximum speed. Primary function of the system is to provide an added margin of safety during operation; however it is effective only when it is operated as intended. Any misuse of the system, as with any other centrifuge system or feature, could result in unsafe operation.

### Rotor Speed

#### **Set Speed:**

from 100 rpm to 28 000 rpm in increments of 10

#### **Speed Control:**

±10 rpm from 0-2000 rpm;  
±0.5 % above 2000 rpm.

#### **Speed Displayed:**

digital readout during a run of actual speed

### Rotor Temperature

#### **Set Temperature:**

from -20°C to +40°C<sup>1</sup>

#### **Overtemperature:**

automatic or settable from 0°C to 45°C

#### **Temperature Control:**

±1°C from 2°C to 40°C

#### **Temperature Displayed:**

digital readout during a run of actual temperature in 1° increments

### Time

#### **Set Time:**

one minute to 99 hours and 99 minutes; can select HOLD for continuous operation

### Time (continued)

#### **Time Displayed:**

digital readout indicates remaining time for a timed run or elapsed time for continuous run

### Vacuum

Rotary vane pump system.

#### **Chamber pressure:**

< 15 millibars (1.5 kPa)

### Ambient Temperature Range

from 15°C to 38°C<sup>2</sup>

### Dimensions:

Width: 70 cm (27.5 in)

Height: 93 cm (36.5 in)

to top deck

123 cm (48.5 in)

to top of control panel

Depth: 103 cm (40.5 in)

#### **Clearances:**

15 cm (6 in) required on left side of centrifuge

### Net Mass

385 kg (850 lbs)

### Electrical Requirements

Can be supplied for use on the following single phase power sources

200 V, 60 Hz, 30 A    200 V, 50 Hz, 30 A

208 V, 60 Hz, 30 A<sup>3</sup>    220 V, 50 Hz, 30 A

230 V, 60 Hz, 30 A<sup>3</sup>    240 V, 50 Hz, 30 A

#### **Receptacle:**

power cord fits Hubbell receptacle No. 9330 or equivalent

<sup>1</sup> Temperature range with power ON but no run in process (standby) is from -10°C to +30°C.

<sup>2</sup> The centrifuge will operate at ambient temperatures up to 38°C, but refrigeration system performance will be less than optimal above 25°C.

<sup>3</sup> CSA Certification applied for.

## Centrifuge Features

**High Performance Drive**

A brushless dc direct drive system designed for longer motor life and greater reliability; provides high torque; fast acceleration; and smooth, precise speed control. No brushes means less maintenance. Controlled by dual microprocessors with accurate speed control during acceleration and a Positive Action Brake system that provides controlled braking from set speed all the way to 0 rpm. Includes Sorvall® Gyro-Action Self-Centering System that permits "eye balancing" of tubes. Imbalance detector protects against damage from gross imbalance conditions. Accepts all Sorvall® Superspeed and **Supraspeed®** rotors.

**Automatic Rotor Recognition**

SPIN-RIGHT® Rotor Management System automatically recognizes installed Sorvall® rotor when chamber door is closed. Provides optimal instrument control. Prohibits operation of a rotor above its maximum speed. Primary function of the system is to provide an added margin of safety during operation; however, it is effective only when it is operated as intended. Any misuse of the system, as with any other centrifuge system or feature, can result in unsafe operation.

**Precise Temperature Control**

A high-capacity, highly efficient refrigeration system that combines heating and cooling. The combined heating and cooling provides temperature control from 2°C to 40°C and eliminates the need to defrost the chamber. Temperature sensor is mounted away from the chamber wall to further improve accuracy of rotor temperature measurement. Automatic sample temperature protection; maximum temperature will be set automatically or can be entered manually. Convenient precooling of rotors.

**Vacuum**

Allows Sorvall® **Supraspeed®** rotors to be operated at speeds up to 28 000 rpm. Automatically activated when required.

**RCF Run**

RCF can be chosen in place of a speed to control run. Allows RCF to be reproduced from run to run and rotor to rotor. Accepts values up to 100 095 x g, depending on the rotor used.

**Slow Start / Slow Stop**

Automatic control of acceleration and deceleration to and from transition speed; provides optimal reorientation conditions which prevent disturbance of gradient or pellet. Optimal times to and from transition speed are automatically determined for identified rotor or can be manually selected; transition speed can even be changed if desired. Flexibility of control means you can duplicate a slow start/slow stop run done in any other centrifuge.

**Zonal Run**

Allows operation with the chamber door open to dynamically load a Sorvall® TZ-28 Zonal Rotor. Loading speed selection from 1300 rpm to 2500 rpm. A key number is required for zonal operation.

 **$\int \omega^2 dt$  Run**

A built-in integrator that provides exact run-to-run reproducibility by controlling the accumulating  $\int \omega^2 dt$ . The accumulating value is displayed during the run.

**Control Panel Lock**

Locks the control panel to prevent run conditions from being changed without the operator knowing. A key number is required to lock and unlock the control panel.

**Centrifuge Features**

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**Programmability**

Records run settings in memory. Once recorded, programs can be recalled to allow duplication of run. Up to 20 programs can be recorded. A key number is required to save a program to prevent unauthorized changes; however, programs can be recalled without a key number.

**Calculator**

A built-in calculator that performs basic centrifugation calculations: RCF, Speed, Time,  $\int \omega^2 dt$ , K Factor, and pelleting time. Can be used to convert run conditions from rotor to rotor.

**Security Key Number**

A four digit security number that is required to access protected data and some diagnostics. Also required to activate Zonal, Program Save, and the Lock. Centrifuge is supplied with one factory-set number, but you can program multiple numbers for greater security and multiple users.

**Advanced Diagnostics**

Built-in diagnostic routines include several levels of electronic troubleshooting aids that allow you to diagnose problems if they occur. Also used to perform limited maintenance procedures and centrifuge updates.

**Rotor Chamber**

The stainless steel rotor chamber is epoxy coated and free of wall sensors making it durable and easy to clean. Chamber seal is located in the door rather than in the top of the chamber; minimizes accumulation of dirt on the seal which improves the seal. The door seal can easily be removed for cleaning. The sliding chamber door retracts which makes the chamber easy to access and solves door clearance problems.

**Size**

The RC-28S is narrower than most superspeed and ultraspeed centrifuges. Requires less floor space.

**Operator's Guide**

Readily accessible operating instructions and aids that pull out from under the control panel. Includes convenient Program Log records and rotor specifications.

**Serviceability & Technical Support**

Extensive diagnostics and easy to access components make the RC-28S easy to service. Complete product literature available plus a toll free number to call for technical assistance.

## System Descriptions

### Drive System

The RC-28S drive system uses state-of-the-art brushless dc motor technology that offers the optimum in centrifuge drive performance.

A brushless dc motor uses an electronic commutator in place of a mechanical commutator, which eliminates brushes and the maintenance problems associated with them, plus it eliminates the speed and current limitations of a mechanical commutator. The high torque of the dc motor results in faster acceleration and braking, while the high efficiency means less power consumption and less heat. Less heat in the motor means that the drive runs cooler which eliminates the need for any auxiliary means of motor cooling, such as Freon® or water.

The motor used is inherently non-cogging which ensures the smoothest acceleration and deceleration possible. Cogging is typical of induction and brush type motors and can cause sample disturbance during acceleration and deceleration.

The RC-28S drive system is controlled by dual microprocessors allowing extremely accurate speed control during acceleration and deceleration and eliminating overshoot of set speed. The accuracy of the speed control results in smoother slow start and slow stop, plus positive action braking from set speed to 0 rpm. The microprocessors operate independent of each other to constantly monitor various centrifuge functions and, as an added safety factor, they maintain constant internal communication with each other to test and evaluate the performance of the other. The many tests that are performed routinely throughout operation determine if any preset limitations are exceeded; any failure detected will cause immediate shutdown by the processor detecting the problem. In addition, the centrifuge will shut down if communication fails between the processors or in the unlikely event both processors fail.

### SPIN-RIGHT® Rotor Management System

The Sorvall® RC-28S SPIN-RIGHT® Rotor Management System automatically insures optimal control of the selected speed and temperature parameters and prevents the inadvertent setting of a speed beyond the capability of a given Sorvall® rotor. The Sorvall® rotor installed in the chamber is recognized through an ultrasonic scanning device that is activated when the chamber door is closed. The rotor identity is then displayed in the SET display of the control panel.

The primary function of the rotor management system is to provide an added margin of safety during operation. This system is effective only when it is operated as intended. Any misuse of the system, as with any other centrifuge system or feature, can result in unsafe operation.

### Refrigeration System

The refrigeration system consists of: a stainless steel evaporator that acts as the rotor chamber, a 2-hp hermetically sealed compressor, an air-cooled condenser, and the suction-capillary tube assembly. A hot gas bypass circuit allows for quiet, non-cycling

compressor operation as well as improved temperature control and frost-free operation. The refrigeration system is factory charged with Freon® 502.

The desired run temperature is entered on the control panel and is maintained by the system electronics which cycles the hot gas circuit as required. If desired, a maximum temperature can be entered on the control panel; if a value is not entered manually, the maximum temperature will default to +5°C above set temperature. Any failure causing the temperature to exceed the maximum setting will result in the termination of the run and a corresponding message will be displayed on the control panel to alert the operator.

### **Vacuum System**

The vacuum system includes a direct drive vacuum pump, an air-inlet solenoid (bleed) valve, mist eliminator, the evaporator chamber, and interconnecting tubes and fittings. Reduced rotor chamber pressure is sensed by a Pirani convection gauge located at the pump inlet manifold and monitored by the machine control microprocessor. When activated, this system provides a vacuum level between 1 and 15 millibars.

The vacuum system is automatically activated only when the set speed is higher than the top air speed of one of the Sorvall® **Supraspeed®** rotors designed specifically for use with the RC-28S.

In the event of a vacuum loss or insufficient vacuum, a message will appear in the control panel SET display to notify the operator. In an emergency, such as a power failure, when sample recovery is desirable, the chamber door can be opened manually (see Chapter 7 for procedure).

## Chapter 2

# INSTALLATION

This chapter contains instructions to prepare your Sorvall® RC-28S for operation.

### Inspection

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

Check the parts received with the centrifuge against the shipping list; if any parts are missing, contact Du Pont (see back cover).

### Location

Locate the centrifuge on a level floor. To permit free air circulation, the location must allow space for the size of the centrifuge (figure 2-1), plus an additional 15 cm (6 inch) space on the left side of the centrifuge. Free air circulation is very important for the centrifuge to function properly.

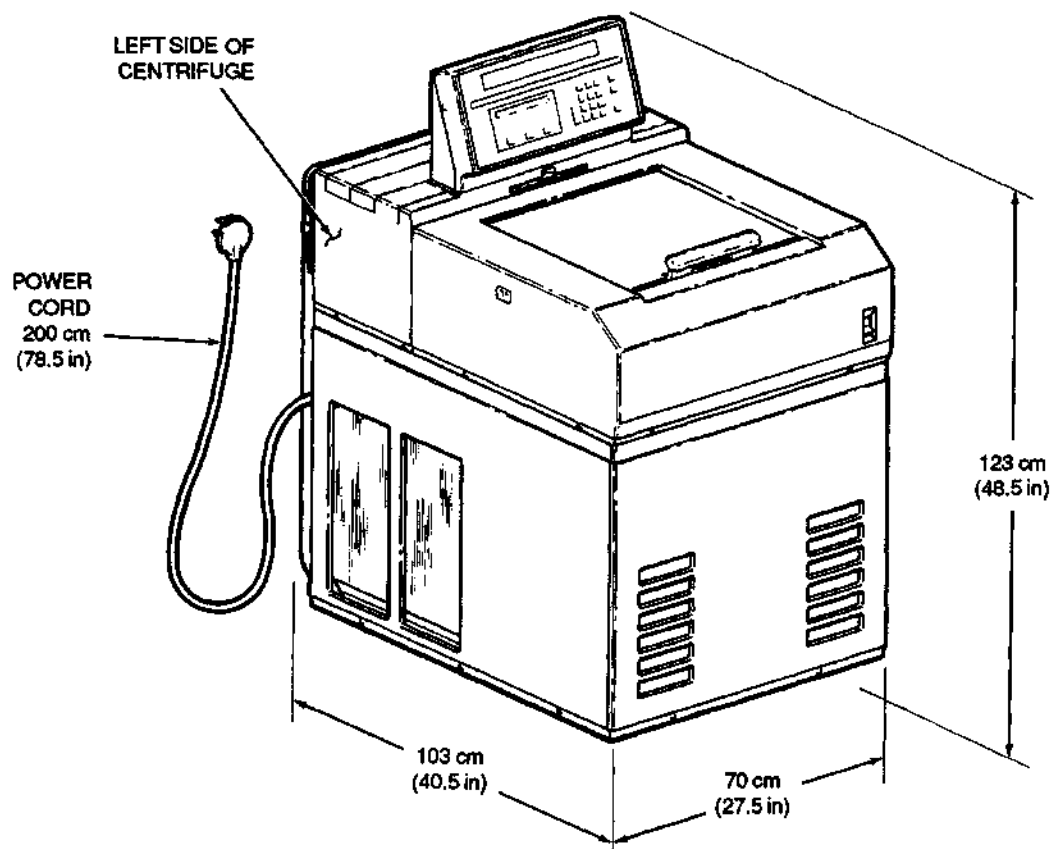


Figure 2-1. Centrifuge Dimensions

## Ambient Temperature

An ambient temperature range of 15°C to 38°C must be maintained. If the inlet air temperature is above 25°C, the centrifuge will not maintain low temperatures at high speeds.

## Leveling

### WARNING

The front stabilizers must be used as explained below to lift the casters off the floor; this will help minimize centrifuge movement in the event of a rotor failure.

When the centrifuge is situated at its operating location, lower and secure the front locking stabilizers. Lower the two locking stabilizers by hand until they are finger tight against the floor. Then use the 9/16 inch (14 mm) wrench supplied with the centrifuge to rotate each stabilizer an additional 2 1/2 turns. This will raise the front casters about 3 mm (1/8 inch) off the floor and level the centrifuge (based on level floor).

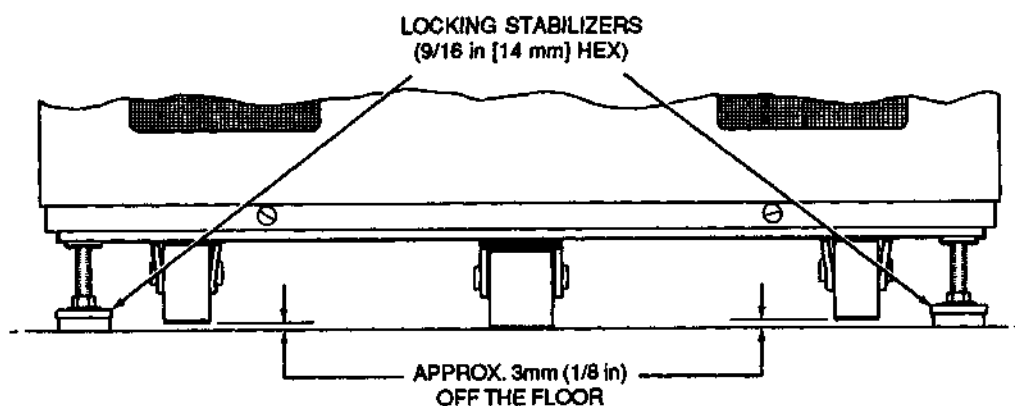


Figure 2-2. Leveling Adjustment

## Electrical

Your centrifuge was ordered for a specific single phase power source (preferably regulated). The nameplate on the back panel of the centrifuge tells which one of the following classifications you ordered:

200 V, 60 Hz, 30 A  
208 V, 60 Hz, 30 A\*  
230 V, 60 Hz, 30 A\*

200 V, 50 Hz, 30 A  
220 V, 50 Hz, 30 A  
240 V, 50 Hz, 30 A

If the line voltage varies  $\pm 10\%$  of its nominal value, you may notice variations in the performance of the centrifuge. If the line voltage exceeds this tolerance, it may damage the centrifuge.

\* CSA Certification applied for.

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**CAUTION**

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

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The centrifuge is equipped with a 3-wire power cord with a 3-prong cap, including ground connection, to fit Hubbell receptacle No. 9330 or equivalent.

To connect the centrifuge to a voltage other than what is specified on the nameplate, the centrifuge will have to be rewired and the power cord may have to be replaced. In this case, contact Du Pont to have a Service Representative do the rewiring.

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



## Chapter 3

# CONTROLS

This chapter provides:

- a detailed description of the RC-28S controls;
- a brief description of the built-in calculator; and
- a brief description of the diagnostic routines.

For step-by-step operating instructions see Chapter 4, and for further information on the calculator and the diagnostics, see Chapters 5 and 6.

### NOTE

A convenient Operator's Guide containing simplified instructions is located under the centrifuge control console.

## Control Panel

The RC-28S is easy to use. All commands are entered from the convenient keypad on the control panel and the set and run parameters are visible in the displays. All selected parameters can be locked to prevent changes to run settings. Figure 3-1 on the next page shows the RC-28S control panel and gives a brief description of the keys and displays. A complete description follows the illustration.

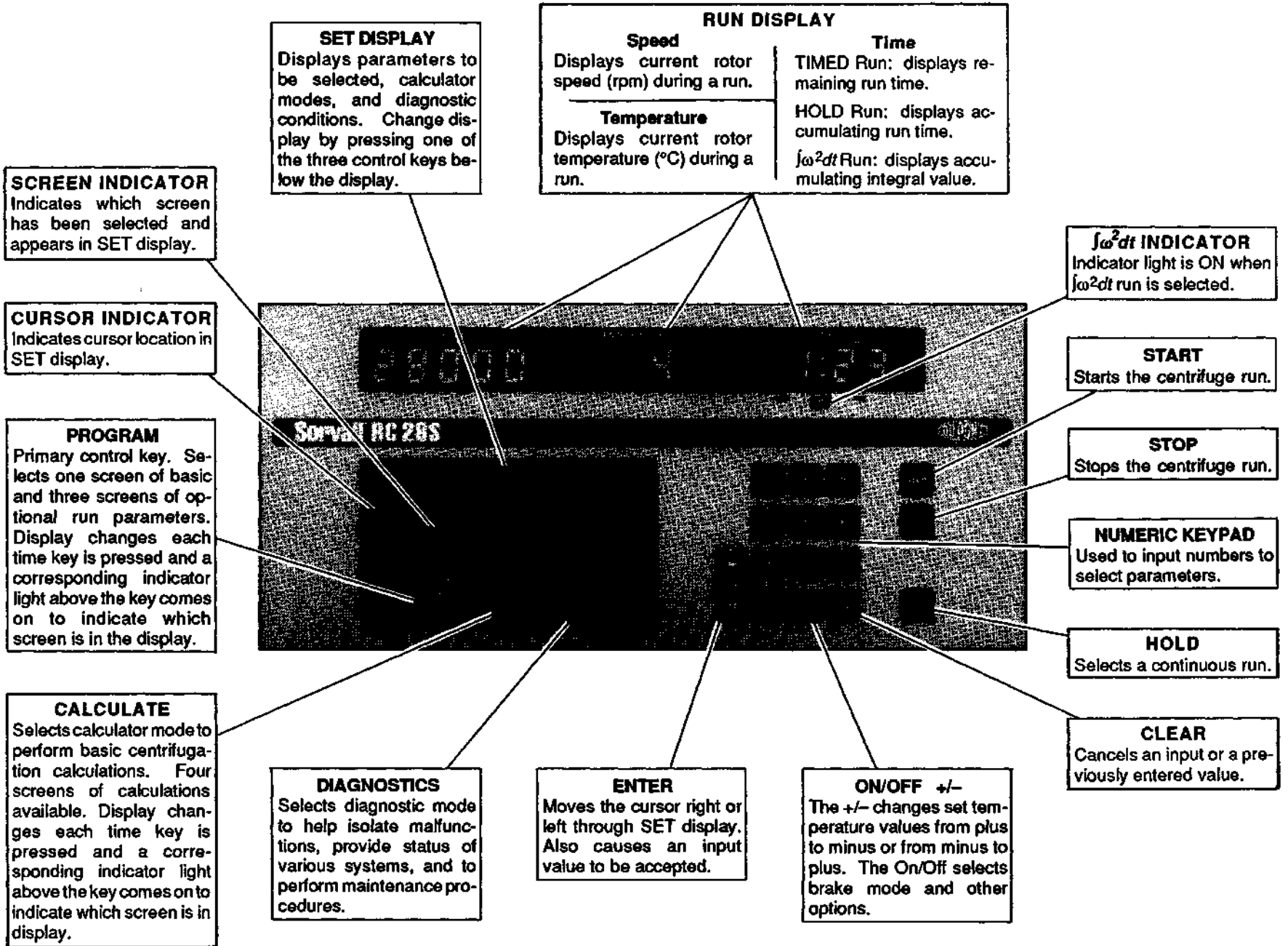
### Set Display

The SET display is the lower display that changes by pressing the PROGRAM, CALCULATE or DIAGNOSTICS key to show various screens of parameters or operations. A cursor in the SET display indicates the field where the next input character will appear. Lights below the display indicate the position of the cursor.

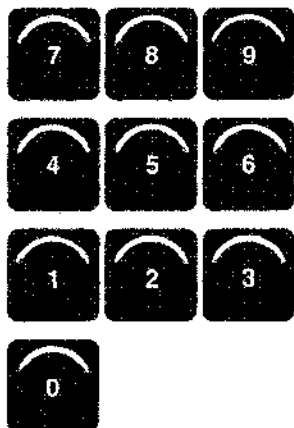
### Run Display

The RUN display includes the three upper displays that show actual speed, temperature, and time or  $\int \omega^2 dt$  during a run.

Figure 3-1. Control Panel



## Description of Display & Key Functions



The numeric keypad is used to input numbers from 0 to 9 to select parameter values.



The ENTER keys cause an input value to be accepted, plus they cause the cursor to move to the right or to the left through the SET display.



On/Off is used to select options. When pressed, the word On or Off will appear in the appropriate field of the SET display. The +/- is used only to change the temperature value from positive to negative or negative to positive.



Cancels an input or a previously entered value. When the key is pressed, the entry is set to zero (0) and a new value can be input. When pressed again, the previously entered value is restored.



Starts the centrifuge run.



Stops the centrifuge run.



Selects a continuous run. The word Hold will appear in the Hr:Min field of the SET display and all zeros will be in the RUN display. As soon as START is pressed, the timer will start and the Time field of the RUN display will show accumulating run time.

## Program Key Functions & Display Screens

PROGRAM



Selects four screens of standard and optional centrifugation conditions. The screens are labeled 1, 2, 3, and 4 and have corresponding lights above the key that come on to indicate which screen you have accessed. Each time the key is pressed, the SET display will change to the next screen.

The four PROGRAM key screens are illustrated below showing the available parameters and operations. A description of the fields in each screen follows.

### PROGRAM DISPLAY SCREENS

1	Rotor	Speed	Hr:Min	Temp/Max	Brake
2	RCF	Slow-Start	Slow-Stop	Zonal/Speed	
3	w2dt	Time-out	Total	Lock	
4	PROGRAM>	Recall#	Save#		

## PROGRAM



## Program Key Functions & Display Screens

### Screen 1

Rotor	Speed	Hr:Min	Temp/Max	Brake
F-28/13	28000	0:90	+ 4 +9	On

When the "1" indicator light above the PROGRAM key is on, the SET display screen will include the basic run parameters: rotor identification, speed, time, temperature, and brake. All parameters, except rotor identification, can be changed during a run.

Following is a description of each field in this screen.

Rotor	Speed	Hr:Min	Temp/Max	Brake
-------	-------	--------	----------	-------

The SPIN-RIGHT® Rotor Management System automatically recognizes the installed Sorvall® rotor to provide temperature compensation, top speed limit, speed control, and RCF calculation. When the chamber door is closed, the rotor name will appear in the display. Whenever the chamber door is open, the word NONE will appear in the display unless the Lock is on, in which case the rotor name will stay in the display.

The rotor identification cannot be changed after START has been pressed.

Rotor	Speed	Hr:Min	Temp/Max	Brake
-------	-------	--------	----------	-------

Centrifugation speed is selected by entering a value from 100 to 28 000 rpm in increments of 10 rpm. If a speed value greater than the maximum allowable speed of the installed rotor is entered, all digits in the Speed field will flash indicating an erroneous entry. In this case, clear the entry and make a valid entry.

### NOTE

If an RCF value is selected to control the run, the speed required to achieve the chosen RCF value will automatically be calculated and displayed in this field.

The speed setting can be changed after a run has been started by returning to the Speed field and entering a new value.

Rotor	Speed	Hr:Min	Temp/Max	Brake
-------	-------	--------	----------	-------

Centrifugation time can be set from one minute to 99 hours and 99 minutes. Values are displayed exactly as entered; for example, if you input 90, it will be displayed 0:90 which represents one hour and 30 minutes run time. The same run time of one hour and 30 minutes can be selected by entering 130; this will be displayed as 1:30.

## Program Key Functions & Display Screens

PROGRAM



As soon as an entry is made, the entered value will appear in the RUN display. The timer will begin when START is pressed and the RUN display value will count down from set value to zero to show remaining run time. If HOLD is selected, the word HOLD will appear in the SET display and the RUN display value will begin at zero (0) and will show accumulating run time. When operating in the Zonal mode, the timer will begin after the rotor has been loaded and the chamber door closed. Time can be changed after the run has started by returning to the Hr:Min field and entering a new value.

### NOTE

If the integrator is On, the run will end when the selected integral value has accumulated. During a run, the RUN display will show the accumulating integral value and the SET display will show accumulating run time in the Hr:Min field. The integrator cannot be turned Off (or On) after a run has been started.

During a timed run with no preselected integral value, the accumulating integral value will be displayed in the  $\omega^2dt$  Total field of Screen 3.

Rotor	Speed	Hr:Min	Temp/Max	Brake
-------	-------	--------	----------	-------

There are two rotor temperature settings. The first one, Temp, selects desired centrifugation temperature; the other, Max, selects the sample overtemperature protection limit.

Centrifugation temperature can be set from -20°C to +40°C in increments of 1°C. Acceptable Max temperature values are from 0°C to +45°C. If a Max temperature value is not entered, the value will default to 5°C above the Temp value (unless Temp value is -6°C or lower in which case the Max temperature will always default to 0°C).

### NOTE

If the temperature shown in RUN display is 5°C or more above entered Temp value (shown in the SET display), Max temperature will remain 3°C above indicated temperature and will decrease as rotor cools until it is 5° above set Temp value or at 0°C.

Max temperature can be changed by moving the cursor to Max and entering the desired value, however, it must be at least 2° above set Temp value. For best operation, the Max temperature setting should not be changed from the default value until the rotor has cooled to the selected temperature.

Rotor	Speed	Hr:Min	Temp/Max	Brake
-------	-------	--------	----------	-------

Press On/Off to turn the brake on or off. The word On or Off will appear in the Brake field to indicate choice.

PROGRAM



## Program Key Functions & Display Screens

When the brake is Off, the rotor will coast from set speed to zero rpm at the end of the run. If a slow stop has been selected, the rotor will coast to the transition speed, then continue to decelerate at the controlled rate. When the Brake is On, the rotor will brake from set speed to zero rpm at the end of a run; if a slow stop has also been selected, the rotor will brake to transition speed, then continue to decelerate at the controlled rate.

Screen 2	RCF	Slow-Start	Slow-Stop	Zonal/Speed
	100095	On Auto	On Auto	Off 1500

To access, press PROGRAM until the "2" indicator light above the key is lit. The SET display will include the following fields: RCF, Slow Start, Slow Stop and Zonal.

RCF	Slow-Start	Slow-Stop	Zonal/Speed
-----	------------	-----------	-------------

The RCF field is used to: (1) display calculated RCF value for the identified rotor and the set run speed prior to a run and to display actual RCF value during a run; or (2) to set the centrifuge to operate at a given g force. When an RCF value is selected to control the run, the speed required to achieve it will automatically be calculated and displayed in the Speed field of Screen 1.

During a run, the RCF (at  $r_{max}$  of the identified rotor) at actual speed is always displayed in this field whether the run is programmed for speed or g force. At the end of a run, the value zero will remain in this field until the chamber door is opened. When the door is opened, the display will change back to show the RCF value for the set speed.

RCF	Slow-Start	Slow-Stop	Zonal/Speed
-----	------------	-----------	-------------

To select a slow start, move the cursor to Slow-Start and press On/Off; the display will show "On Auto". Auto is the optimal rate automatically calculated to have the installed rotor accelerate to transition speed in approximately 2 minutes. When the run is started, a message will appear in the SET display to indicate that a slow start is in progress. When the rotor reaches transition speed, the message in the display will go out and the rotor will accelerate to set speed at the maximum rate. The length of time for acceleration from 0 rpm to transition speed can be changed by positioning the cursor under "Auto" and entering the number of minutes (from 1 to 30) that you want for acceleration. Once Slow-Start has been turned On, it will remain On until it is turned Off. When Slow-Start is Off, the rotor will accelerate from 0 rpm to set speed at the maximum rate.

### NOTE

The preset transition speed (approximately 300 rpm for S-20 rotor and approximately 800 rpm for all other rotors) can be changed. See Chapter 6.

## Program Key Functions & Display Screens

PROGRAM



RCF **Slow-Start** Slow-Stop Zonal/Speed

To select a slow stop, move the cursor to Slow-Stop and press the On/Off key; the display will show "On Auto". When On, the rotor will decelerate from set speed to transition speed at the rate controlled by the brake setting. When the rotor reaches transition speed, a message will appear in the SET display to indicate that a slow stop has been initiated and the rotor will decelerate at a rate that will take it approximately 3 minutes to reach 0 rpm. This rate of deceleration from transition speed to 0 rpm is automatically calculated for the rotor in use. The rate of deceleration can be changed by positioning the cursor under "Auto" and entering the number of minutes (from 1 to 30) desired for deceleration. Once Slow-Stop has been turned On, it will remain On until turned Off. When Slow-Stop is Off, the rotor will decelerate at the rate controlled by the brake setting from set speed to 0 rpm.

### NOTE

The preset transition speed (approximately 300 rpm for S-20 rotor and approximately 800 rpm for all other rotors) can be changed. See Chapter 6.

RCF **Slow-Start** Slow-Stop **Zonal/Speed**

Used to select the Zonal mode of operation when dynamically loading a sample and/or gradient into the Sorvall® TZ-28 Rotor. A Key# is required to activate the Zonal mode.

When the Key# is entered and accepted, the word On appears in the display and the cursor moves to Speed. Enter the Zonal loading speed from 1300 to 2500 rpm (in increments of 10 rpm). When the chamber door is closed and START is pressed, the rotor will accelerate to the Zonal speed, at which time the chamber door can be opened and the sample/gradient loaded. After the sample and gradient are loaded, close the chamber door and the rotor will accelerate to the run speed selected in Screen 1 (the maximum Zonal run speed is 20 000 rpm).

At the end of the run, Zonal will turn Off automatically; therefore, each Zonal run requires this option be turned On and the Key# entered.

Zonal cannot be stored in program memory; the zonal speed can be saved, but the option must be turned On before the run.

### Screen 3

w2dt	Time-out	Total	Lock
On	1.97e07	5.20e07	On

This screen includes w<sup>2</sup>dt and Lock. To access, press PROGRAM until the "3" indicator light above the key is lit.

## PROGRAM



## Program Key Functions & Display Screens

w2dt Time-out	Total	Lock
---------------	-------	------

The  $\int \omega^2 dt$  option is used to program a run to end at a desired integral value rather than a time value. Press On/Off to turn the **w2dt** on. The  $\int \omega^2 dt$  values from the previous run will automatically be displayed: Time-out is the value at the start of deceleration, and Total is the value at 0 rpm, which includes deceleration. Press **(ENTER >)** or **(START)** to accept the Time-out value and begin the run. To change the Time-out value, first enter a three digit (X.XX) coefficient value (the decimal point will automatically be placed), then a two digit exponent value. Press **(START)** to begin the run.

During an integrator run, the RUN display will show accumulating integral value and the SET display will show selected Time-out integral value and the Total accumulating value. During a timed run, the SET display shows the accumulating value and the Time-out value at the beginning of deceleration.

The integrator cannot be turned On or Off after a run has been started.

w2dt Time-out	Total	Lock
---------------	-------	------

This feature locks all set run conditions (including options) so they cannot be changed until unlocked. The Lock is activated by pressing On/Off and entering the proper Key#. Once run conditions have been locked in, the cursor will only appear in the Lock field and in all calculator screens. To unlock, press On/Off again and enter the Key#.

The lock cannot be stored in program memory.

<b>Screen 4</b>	PROGRAM>	Recall#	Save#	
		1	1	Saved

Run conditions are stored in program memory and recalled from memory to control centrifuge operation. A Key# must be entered to save a new program; however, a program can be recalled without the Key#. A total of 20 programs can be stored and a different Key# can be assigned to each program, if desired (see Chapter 6).

To access, press PROGRAM until the "4" indicator light above the key is lit.

PROGRAM>	Recall#	Save#		
----------	---------	-------	--	--

Used to recall an established program. Position the cursor in this field and enter the assigned program number (from 1 to 20). The recorded program parameters will automatically appear in Screen 1 of the SET display. Press START to begin the run.



## Program Key Functions & Display Screens

PROGRAM



```
PROGRAM> Recall# Save#
```

Used to save all set run conditions except Zonal and Lock. Position the cursor in this field and enter a number from 1 to 20. The display will prompt you to enter Key#. When the Key# is entered and accepted, the display shows "Saved" and the assigned program number appears in the Save# and Recall# fields. The number that was input becomes the assigned program number that will be used to recall the program. If the incorrect Key# is entered, the display will show "Not Saved"; in which case, the program number must be reentered, then the correct Key#. If all program numbers have been used, a new program can be stored over an existing program. In this case, the number assigned is stored for the new program and the old program is automatically deleted from memory.

CALCULATE



## Calculate Key Functions & Display Screens

The CALCULATE key is used to perform basic centrifugation calculations, including RCF, speed, run time,  $\int \omega^2 dt$  and K Factor. The four calculator screens are pictured below. See Chapter 5 for instructions on how to use the calculator.

- 1 

```
CALC> Rotor Speed RCF Time w2dt
```
- 2 

```
CALC> r(cm) Speed RCF
```
- 3 

```
CALC> Speed Rmax Rmin K-Factor
```
- 4 

```
CALC> K-Factor1 Time1 K-Factor2 Time2
```

DIAGNOSTICS



## Diagnostics Key Functions & Display Screens

DIAGNOSTICS is used to monitor system operation, view system accumulators, perform user diagnostic routines, install new rotors and software, troubleshoot, and calibrate replacement subassemblies. See Chapter 6 for examples of display screens and instructions on the use of this key.

- 1 

```
Fault Door System
```
- 2 

```
User-1 User-2 Maint-1 Install
```
- 3 

```
Maint-2 Calib Serv-1 Serv-2
```

# Chapter 4

## OPERATION

This chapter provides:

- step-by-step operating instructions for the normal and zonal modes of operation; RCF and  $\int \omega^2 dt$  operation; programmed runs; slow start and slow stop; and HOLD runs;
- a description of the control panel lock and the Key# code;
- a precool/preheat procedure to equilibrate rotor and chamber temperature; and
- a Rotor Information Chart.

### Understanding the Centrifuge Controls

It is recommended that you read the description of the controls in Chapter 3 before using the centrifuge for the first time. You probably won't use all of the controls right away, but reading Chapter 3 will give you information that will be helpful in understanding the displays and how the control keys function, and it will help you become familiar with all features of the centrifuge. As you use the centrifuge, continue to refer to Chapter 3 whenever additional information is needed.

### Turning the Centrifuge On

The power ON/OFF switch is placed in the upper right hand corner of the front cabinet panel. The microprocessor automatically runs a diagnostic test everytime the centrifuge is turned on. If an error is found, a display message will appear in the SET display on the control panel. If no error is found, the run parameters will appear in the display indicating that the centrifuge is ready for operation.

### Normal Run

A normal run is one that is controlled by time with selected run temperature and run speed parameters and the brake set on or off. These parameters are selected in the first screen of the **(PROGRAM)** key.

Prior to performing the run, prepare and install the rotor according to the instructions in the rotor manual. To ensure that the sample, rotor, and chamber temperatures are at equilibrium at the start of the run, follow the precool/preheat procedure on page 4-12.

---

**WARNING**

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When loading the rotor, be sure not to exceed the maximum compartment mass of the rotor (see Table 4-1, Rotor Information). 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, page 4-12). Failure to do so can cause rotor failure which could result in personal injury and/or centrifuge damage.

---

**To perform the run:**

1. Turn the centrifuge power ON.

**NOTE**

For best run conditions and prolonged centrifuge life, the rotor chamber should be dry at the start of a run. Before installing the rotor, wipe chamber dry with a clean cloth or papertowel.

2. Open chamber door *all the way* and install rotor. Close chamber door.

---

**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.

3. The "1" light above the **PROGRAM** key should be on. If not, press **PROGRAM** until it is.

The name of the installed rotor will appear in the display and the cursor will be positioned in the **Speed** field.

**NOTE**

If using an S-20/17 or S-20/20 rotor ONLY: Press **ENTER <** to move the cursor to the **Rotor** field and input 18 for S-20/17 or 17 for S-20/20; otherwise the rotor will be recognized as an S-20/36. Press **ENTER >**.

4. Input desired run parameters: **Speed**, **Hr:Min**, and **Temp/Max**. Press **ENTER >** after each input.

Max temperature will automatically default to 5°C above set run temperature; if desired, enter a different value. For a continuous run, press **HOLD**.

5. Press **on/off** to make **Brake** selection. The word **On** or **Off** will appear in the display to indicate selection made.

After you have selected the above parameters, the SET display should look similar to the example below:

Rotor	Speed	Hr:Min	Temp/Max	Brake
F-28/13	28000	0:90	+ 4 + 9	On

6. Select **Slow-Start** and/or **Slow-Stop** if desired (see below).
7. Press **(START)**.

Any of the run parameters, except rotor identification, can be changed while a run is in process.

The rotor will accelerate to the set run speed and remain there for the selected length of time then decelerate to a stop. To end a run in HOLD or before the selected run time has elapsed, press **(STOP)**.

### NOTE

Integral value can be checked anytime during a timed run by pressing **(PROGRAM)** until **w2dt** is in the display ("3" indicator light on). The accumulating  $\int \omega^2 dt$  value will be in the **Total** field.

To do another run with the same parameters: prepare rotor and install it in the centrifuge, then close chamber door and press **(START)**. All entered parameters remain until a change is made.

## Slow Start/Slow Stop

Slow Start and Slow Stop are used to prevent gradient disturbance during acceleration and deceleration. When they are on, the rotor will accelerate or decelerate to or from transition speed at a controlled rate that is slower than normal (transition speed is preset at approximately 800 rpm for all rotors except the S-20, which is preset at approximately 300 rpm; preset transition speed can be changed, if desired - see Chapter 6). The length of time for the acceleration/deceleration phase will automatically default to the optimal time for identified rotor; or, if desired, time (from 1 to 30 minutes) can be entered manually.

### NOTE

If Slow Start or Slow Stop are on, they will remain on for future runs until turned off.

1. Follow Steps 1 through 5 for a Normal run (page 4-2).
2. Press **(PROGRAM)**. The "2" indicator light above the key will light.

#### To select Slow Start:

1. Press **(ENTER >)** to move cursor to **Slow-Start**.
2. Press **(on off)**.
3. To accept the "Auto" time for acceleration and begin the run, press **(START)**.

RCF	Slow-Start	Slow-Stop	Zonal/Speed
100095	On	Auto	Off 1500

To change the length of time for acceleration from 0 to transition speed, press **(ENTER >)** to move cursor to **Auto** and input desired number of minutes (from 1 to 30). If a slow stop is desired (see page 4-5); if not, press **(START)** to begin the run.

**Table 4-1. Rotor Information****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.

ROTOR	CODE #	MAX SPEED (rpm)	CRITICAL SPEED (rpm)	MAX RCF	K FACTOR <sup>1</sup>	MAX COMPART-MENT MASS	rMAX (cm)	rMIN (cm)
SV-288	1	20 000	1200	40 301	210	50.0 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	4201	780.0 g	15.13	3.93
SA 600	4	16 500	1200	39 411	792	115.0 g	12.96	5.52
SS-34	5	20 000	1350	47 807	750	115.0 g	10.70	3.26
SE-12	6	21 000	1700	45 959	513	30.0 g	9.33	3.81
HB-4	7	13 000	1200	27 579	1678	250.0 g	14.61	4.75
HS-4	8	7000	1000	9425	4487	1035.0 g	17.22	7.21
SM-24	9	20 000	1300	49 460 <sup>2</sup>	457 <sup>2</sup>	27.0 g	11.07 <sup>2</sup>	5.37 <sup>2</sup>
GSA	10	13 000	900	27 504	2019	580.0 g	14.57	3.77
TZ-28	11	20 000	1000	42 535	605	1620.0 g	9.52	3.65
SH-MT	12	13 730 <sup>3</sup>	1600	19 140 <sup>3</sup>	656 <sup>3</sup>	36.4 g	9.09 <sup>3</sup>	5.57 <sup>3</sup>
SH-80	13	20 000	1650	45 394	399	78.0 g	10.16	5.40
F-28/13	14	28 000	1300	100 095	143	23.0 g	11.43	7.34
F-28/36	15	28 000	1300	100 095	198	66.0 g	11.43	6.18
S-20/36	16	20 000	400	71 934	466	156.6 g	16.10	7.70
S-20/20	17	20 000	400	58 083	299	115.1 g	13.00	8.10
S-20/17	18	20 000	400	74 168	573	130.1 g	16.60	6.70
SS-34/KSB-R	19	20 000	1350	47 807	750	115.0 g	10.70	3.26
TZ-28/GK	20	19 000	1000	38 388	671	1620.0 g	9.52	3.65

<sup>1</sup> With maximum allowable volume at maximum speed.

<sup>2</sup> Outer row

<sup>3</sup> Maximum speed of rotor is 20 000 rpm; actual maximum speed depends on tubes. Values given are typical for 1.5 ml microtubes.

As soon as (START) is pressed, the **\*\*\* Slow Start In Progress \*\*\*** message will appear in the SET display and will remain there until the rotor has accelerated to approximately 20 rpm.

**To select Slow Stop:**

1. Press (ENTER >) to move cursor to **Slow-Stop**.
2. Press (on off).
3. To accept the "Auto" rate of deceleration and begin the run, press (START).

RCF	Slow-Start	Slow-Stop	Zonal/Speed
100095	On	Auto	Off 1500

To change the length of time for deceleration from transition speed to 0 rpm, press (ENTER >) to move cursor to **Auto** and input desired number of minutes (from 1 to 30). To begin run, press (START).

During deceleration, the **\*\*\* Slow Stop In Progress \*\*\*** message will appear in the SET display as soon as the rotor reaches transition speed; the message will remain in the display until the rotor stops spinning.

**RCF Run**

The centrifuge can be set to operate at a given g force rather than speed. When you know the RCF (g force) you want applied to the particles during centrifugation, you can use this feature to select the value. The run speed required for the set RCF value will automatically be calculated.

**To perform an RCF Run:**

1. Load and balance the rotor according to the instructions in the rotor manual. To ensure that the rotor and chamber temperatures are at equilibrium, follow the precool/preheat procedure on page 4-12.

---

**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.

Do not exceed maximum compartment mass of the rotor (see Table 4-1, Rotor Information). 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, page 4-12). Failure to do so can cause rotor failure which could result in personal injury and/or centrifuge damage.

---

2. Turn the centrifuge power ON.

**NOTE**

For best run conditions, the rotor chamber should be dry at the start of a run. Before installing a rotor, wipe the chamber dry with a clean cloth or papertowel.

3. Open chamber door *all the way* and install rotor. Close chamber door.
4. The "1" light above the **PROGRAM** key should be on. If not, press **PROGRAM** until it is.

**NOTE**

If using an S-20/17 or S-20/20 rotor ONLY: Press **ENTER <** to move the cursor to the **Rotor** field and input 18 for an S-20/17 or 17 for an S-20/20; otherwise the rotor will be recognized as an S-20/36. Press **ENTER >**.

5. Input desired **Hrs/Min** and **Temp/Max** values. Press **ENTER >** after each input. (Speed is not entered because run speed will automatically be calculated and set when the RCF value is entered.)

Max temperature will automatically default to 5°C above set run temperature; if desired, enter a different value. For a continuous run, press **HOLD**.

6. Press **on off** to make **Brake** selection. The word **On** or **Off** will appear in the display to indicate selection made.

7. Press **PROGRAM** again.

**RCF** will appear in the display with the cursor positioned in the **RCF** field and the "2" light above the **PROGRAM** key will be on.

8. Input desired **RCF** value (for  $r_{max}$  of the installed rotor). Press **ENTER >**.

The display should look similar to the example below.

RCF	Slow-Start	Slow-Stop	Zonal/Speed
93100	Off	Off	Off 1500

9. Press **START**.

The rotor will accelerate to the speed required to achieve the set RCF value and remain there for the selected length of time or until **STOP** is pressed, then decelerate to a stop.

**Key# Code**

The Key# is a security number that must be entered in order to access Zonal, Program Save, the control panel Lock, and some Diagnostic routines. Whenever you attempt to use these features, the display will prompt you to enter the Key#.

A different number can be assigned to each of the features that require a Key#, including a different number for each of the 20 programs saved. There is also a System Access Key# that allows access to any of the fields that require a Key#, except for some Diagnostic routines. The centrifuge is shipped with the System Access Key# 1234. This is the only number assigned when you receive the centrifuge. For the procedures to change the System Access number or to assign Key#s to the various features, see Chapter 6.

## Zonal Run

Zonal operation allows you to operate the centrifuge with the door open at speeds from 1300 rpm to 2500 rpm. This is used with a Sorvall® TZ-28 Zonal Rotor to dynamically load gradient and sample. A Key# is required to access Zonal mode.

Assemble the rotor according to the procedure in the rotor instruction manual. To ensure that rotor and chamber temperatures are at equilibrium at the start of the run, follow the precool/preheat procedure on page 4-12.

### To perform the run:

1. Turn the centrifuge power ON.
2. Open chamber door all the way and install rotor. Close chamber door.
3. The "1" light above the **PROGRAM** key should be on. If not, press **PROGRAM** until it is.
4. Input desired run parameters: **Speed**, **Hr:Min** and **Temp/Max**. Press **ENTER** after each input.

### NOTE

Maximum speed in the Zonal Mode is 20 000 rpm.

Max temperature will automatically default to 5°C above set run temperature; if desired, enter a different value. For a continuous run, press **HOLD**.

5. Press **on off** to make **Brake** selection. The word **On** or **Off** will appear in the display to indicate selection made.
6. Press **PROGRAM** until the "2" light above the key is on and **Zonal/Speed** appears in the display.

### NOTE

It is best to use a slow start and slow stop when doing gradient separations in the TZ-28 Rotor (see Slow Start/Slow Stop, page 4-3).

7. Select **Slow-Start** and/or **Slow-Stop** if desired.
8. Press **ENTER** to move the cursor to **Zonal/Speed**. Press **on off**. The display will prompt you to enter **Key#** (page 4-6).
9. Input **Key#** and press **ENTER**. When the Key# has been accepted, the word **On** will appear in the display indicating that the centrifuge will operate in the Zonal mode.



10. Input the desired loading speed (from 1300 rpm to 2500 rpm in increments of 10). Press **ENTER**.

At this point, the display should look similar to the following:

RCF	Slow-Start	Slow-Stop	Zonal/Speed
42535	Off	Off	On 1500

11. Press **START**.

When rotor reaches selected loading speed, the **\*\*\* Rotor at Zonal Speed> Load \*\*\*** message will appear in the display indicating that the door can be opened.

---

### WARNING

---

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

---

12. Open chamber door and load the sample/gradient according to the instructions in the rotor manual. When loading is complete, disconnect and remove any equipment that was used to load it.

---

### WARNING

---

When loading the sample and gradient, be sure not to exceed maximum compartment mass specified for the rotor (see Table 4-1, Rotor Information). If maximum compartment mass is exceeded, operating 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.

---

13. Close the chamber door. The timer will begin and the rotor will accelerate to the set run speed and remain there for the selected run time. At the end of the run, the rotor will decelerate to 0 rpm and the Zonal function will turn off automatically.

## Hold Run

A Hold run is a run that will continue until **STOP** is pressed. All parameters except time are entered as described for the type of run you will perform.

### To select Hold:

Press **HOLD**. Hold will appear in the **Hr:Min** field of the SET display. While the run is in process, the RUN display will show the accumulating time.

### To end a HOLD run:

Press **STOP**. The rotor will begin to decelerate and the run will end.

**To change a HOLD run to a timed run:**

Press **(HOLD)**. The key is a toggle switch so pressing it while in HOLD will return the centrifuge to a timed condition. The last entered time value will appear in the **[Hr:Min]** field of the SET display and the RUN display will show the remaining time.

**NOTE**

When the centrifuge returns to a timed condition, the computer will account for the length of time the centrifuge was in HOLD. Therefore, if the last entered time value had already elapsed when the HOLD key was pressed again, the RUN display will show zeros (0.00) and the rotor will begin to decelerate.

**To enter a new time value and cancel the accumulated HOLD time:**

Enter the new time value. The **[Hr:Min]** field of the SET display will show the new set time, and the RUN display will change to countdown from the newly entered value. The length of time the centrifuge was in HOLD has no effect on the new set time.

 **$\int \omega^2 dt$  Run**

An  $\int \omega^2 dt$  run allows you to set the centrifuge to end a run when a desired integral value is reached.

**To perform an  $\int \omega^2 dt$  run:**

1. Load and balance rotor according to instructions in the rotor manual. To ensure that the rotor and chamber temperatures are at equilibrium, follow the precool/preheat procedure on page 4-12.

---

**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.

Do not exceed maximum compartment mass of the rotor (see Table 4-1, Rotor Information). 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, page 4-12. Failure to do so can cause rotor failure which could result in personal injury and/or centrifuge damage.

---

2. Turn the centrifuge power ON.

**NOTE**

For best run conditions, the rotor chamber should be dry at the start of a run. Before installing a rotor, wipe the chamber dry with a clean cloth or papertowel.

3. Open chamber door *all the way* and install rotor. Close chamber door.
4. The "1" light above the **PROGRAM** key should be on. If it is not, press **PROGRAM** until it is.

**NOTE**

If using an S-20/17 or S-20/20 rotor ONLY: Press **ENTER**  $\leftarrow$  to move the cursor to the **Rotor** field and input 18 for an S-20/17 or 17 for an S-20/20; otherwise the rotor will be recognized as an S-20/36. Press **ENTER**  $\rightarrow$ .

5. Input desired **Speed** and press **ENTER**  $\rightarrow$  twice to move the cursor to **Temp/Max**. (Time is not entered since the run will end when the integral value has accumulated.)
6. Input desired **Temp/Max** values. Press **ENTER**  $\rightarrow$  after each input.
7. Press **on off** to make **Brake** selection. The word **On** or **Off** will appear in the display to indicate the selection made.
8. Press **PROGRAM** until the "3" light above the key is lit and **w2dt** appears in the display. The word **On** or **Off** will appear in the **w2dt** field with the integral values from the previous run displayed next to it. See example below.

**NOTE**

**Time-out** is the  $\int \omega^2 dt$  value from the previous run at the start of deceleration.  
**Total** is the  $\int \omega^2 dt$  value from the previous run at 0 rpm, which includes the deceleration time.

w2dt	Time-out	Total	Lock
On	1.94e07	5.20e07	Off

9. If Off, press **on off** to turn On.
10. To use the **Time-out** value, press **START**. To change the **Time-out** value, press **ENTER**  $\rightarrow$  and enter a new value: first a three digit (X.XX) coefficient value, then a two digit exponent value. Press **START**.

The rotor will accelerate to the set speed and remain there until the integral value has accumulated.

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

**Programmed Run**

The RC-28S memory will store up to 20 programs. Each program saves a set of run parameters that can be recalled by entering the assigned program number (from 1 to 20) and pressing **START**.

A Key# must be entered in order to store a new program or to make a change to an existing program; however, a stored program can be recalled without the Key#. A different Key# can be assigned to each program, if desired; see Chapter 6 for procedure.

### Program Save

1. Enter all desired run parameters.

#### NOTE

Program Save will not store if the control panel Lock is on; also, Program Save will not turn Zonal On.

2. Press **PROGRAM** until the "4" indicator light above the key is lit.
3. Press **ENTER** to move the cursor to **Save#** and input a number from 1 to 20. Press **ENTER**.
4. Input **Key#** (page 4-6). Press **ENTER** to store program. Press **START** to begin the run.

PROGRAM>	Recall#	Save#	
	1	1	Saved

5. Record program number and run parameters in the Program Log Record (located in back of the Operator's Guide under the centrifuge control panel).

#### NOTE

Program Recall will not turn Zonal On, but it will set loading speed and all other parameters.

### Program Recall

To recall a program:

1. Press **PROGRAM** until the "4" indicator light above the key is lit.
2. Input assigned program number (from 1 to 20). Press **START**.

All prerecorded run parameters will automatically be established to control centrifuge operation. The displays will change to show the set run parameters for the selected program.

### Control Panel Lock

The control panel Lock will lock all set run conditions (including options) so they cannot be changed until unlocked.

To lock or unlock set run conditions:

1. Press **PROGRAM** until the "3" indicator light above the key is lit.

2. Press **ENTER** to move the cursor to **Lock**.
3. Press **on off** and input **Key#** (page 4-6). Press **ENTER**.

After run conditions have been locked in, the cursor will only appear in the **Lock** field and in all calculator screens.

## Precool/Preheat

The following precool/preheat procedure is recommended to ensure that the rotor and the chamber temperatures are at equilibrium at the start of a run.

1. Open chamber door and install rotor. Close chamber door.
2. Press **PROGRAM** until the "1" light above the key is lit.
3. Input **Speed** of 2000 rpm. Press **ENTER**.
4. Press **HOLD**, then press **ENTER**.
5. Input desired **Temp**. Press **ENTER**.
6. Press **START**. The rotor/chamber should achieve temperature in approximately 30 minutes.

## 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 4-1, Rotor Information). To prevent rotor failure, the total contents of any compartment, including specimen, tubes, covers, and adapters (if used), must not exceed the figure given in Table 4-1 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. **Observe 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.

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

## Chapter 5

# CALCULATOR

The RC-28S calculator allows you to perform basic centrifugation calculations to help determine run conditions necessary to provide desired separation results.

Four screens of calculator functions are available. When you enter the CALCULATE mode, the values displayed in Screens 1, 2 and 3 are calculated from the data entered in the first three screens of the PROGRAM mode. To do calculations for a different rotor, enter the rotor code number (see Table 4-1, Rotor Information) in **Rotor** field of CALCULATE Screen 1. The values displayed in Screen 4 (if any) are from the previous calculation in that screen.

### CALCULATOR DISPLAY SCREENS

1	CALC> Rotor Speed RCF Time $\omega^2dt$
2	CALC> r(cm) Speed RCF
3	CALC> Speed Rmax Rmin K-Factor
4	CALC> K-Factor1 Time1 K-Factor2 Time2

#### Screen 1 CALC> Rotor Speed RCF Time $\omega^2dt$

Use to calculate SPEED, RCF (at  $r_{max}$ ), TIME, and  $\omega^2dt$ . To access, press **CALCULATE** until the "1" indicator light above the key is on. Enter rotor code number (see Rotor Information Chart) in the **Rotor** field.

##### To calculate SPEED from RCF:

1. Position cursor in **RCF** field and input RCF value.
2. Press **ENTER**. The calculated speed will be displayed.

##### To calculate RCF (at $r_{max}$ ) from SPEED:

1. Position cursor in **Speed** field and input speed.
2. Press **ENTER**. The calculated RCF value will be displayed.

##### To calculate estimated run TIME from $\omega^2dt$ and SPEED: \*

1. Position cursor in **Speed** field and input speed.
2. Press **ENTER** to move cursor to  **$\omega^2dt$**  and input  $\omega^2dt$  value.
3. Press **ENTER**. The calculated run time will be displayed.

##### To calculate estimated $\omega^2dt$ from SPEED and TIME: \*

1. Position cursor in **Speed** field and input speed.
2. Press **ENTER** to move cursor to **Time** and input time.
3. Press **ENTER**. The estimated integral value will be displayed.

\* It is not possible to exactly calculate Time from  $\omega^2dt$  or  $\omega^2dt$  from Time. These calculations are meant to give an approximate value to help you save time.

## Calculator Use

### Screen 2 CALC> r(cm) Speed RCF

Use to calculate RCF or SPEED at a rotor radius other than the maximum. To access, press **CALCULATE** until the "2" indicator light is on. The values in the display are from Screen 1 of the **CALCULATE** key.

**To calculate SPEED from RCF at a radius other than  $r_{max}$ :**

1. Position cursor in r(cm) field and input radius.
2. Press **ENTER** to move cursor to RCF and input RCF.
3. Press **ENTER**. The calculated speed will be displayed.

**To calculate RCF from SPEED at a radius other than  $r_{max}$ :**

1. Position cursor in r(cm) field and input the radius.
2. Press **ENTER** and input Speed.
3. Press **ENTER**. The calculated RCF value will be displayed.

### Screen 3 CALC> Speed Rmax Rmin K-Factor

Use to calculate K Factor. To access, press **CALCULATE** until the "3" indicator light above the key is on. The values in the display are from Screen 1 of the **CALCULATE** key.

**To calculate K Factor at a particular speed using  $r_{min}$  and  $r_{max}$  displayed:**

1. Position cursor in Speed field and input desired speed.
2. Press **ENTER**. The calculated K Factor will be displayed.

**To calculate K Factor using an  $r_{min}$  or  $r_{max}$  other than what is displayed:**

1. Verify speed and change if desired.
2. Move cursor to Rmax and/or Rmin field and input radius value.
3. Press **ENTER**. K Factor will be calculated and displayed.

### Screen 4 CALC> K-Factor1 Time1 K-Factor2 Time2

Use primarily for pelleting runs to convert centrifugation time from one rotor (Rotor-1) to another rotor (Rotor-2). To do so, you need to know the K Factor at desired run speed for both rotors.

**To calculate:**

1. Press **CALCULATE** until the "4" indicator light above the key is on.
2. Input K Factor of Rotor-1. Press **ENTER**.
3. Input run time from Rotor-1 in Time1 field. Press **ENTER**.
4. Input K Factor of Rotor-2 in K-Factor2 field. Press **ENTER**. The run time calculated for Rotor-2 will be displayed in Time2 field.

\* K Factor (the rotor clearing factor) is a function of sample path length (distance between  $r_{min}$  and  $r_{max}$ ) and rotor speed. The lower the K Factor value, the faster a given centrifugation protocol can be completed. Protocols can be converted from one rotor to another if K Factors are known for both rotors.

## Chapter 6

# TROUBLESHOOTING and DIAGNOSTICS

This chapter provides:

- a description of SET display messages;
- DIAGNOSTICS information;
- the procedure to assign or change Key#'s; and
- the procedure to change the Slow Start/Slow Stop transition speed.

### Display Messages

The RC-28S has a number of display messages that can appear in the SET display on the control panel. These messages notify you of an operating condition or a centrifuge fault that, in most cases, requires attention or demands action.

Following is a list of the SET display messages, along with the probable cause (in bold print) and the corrective action.

<b>*** Check Installed Rotor ***</b>
--------------------------------------

**The rotor management system did not recognize the installed rotor.**

Possible causes are:

- 1. the rotor management system was not properly activated;**
  - 2. the installed rotor is not intended for use in the RC-28S;**
  - 3. a rotor code was manually input that is incorrect for the installed rotor; or**
  - 4. rotor/rotor lid not properly installed.**
1. To reactivate rotor management system, open the chamber door all the way and close it again slowly.
  2. If the installed rotor is not meant for use in this centrifuge, remove it and install one that is (see Table 4-1, Rotor Information).

---

#### 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.

---

3. Install rotor to match selected rotor code; or, if the rotor you want is installed, clear the message by opening and closing the chamber door. The rotor management system will automatically recognize the installed rotor.
4. Properly install rotor/rotor lid; refer to rotor instruction manual.



**\*\*\* Close Chamber Door \*\*\***

**The chamber door was not completely closed when the (START) key was pressed.**

Close the chamber door all the way and press (START); it may be necessary to open the door all the way first, then close it.

**\*\*\* Fault> Press DIAGNOSTICS \*\*\***

**Centrifuge malfunction.**

Press (DIAGNOSTICS) to shut off alarm and select DIAGNOSTIC mode. See Diagnostics (page 6-5) for more information.

**\*\*\* Install Rotor \*\*\***

**There was no rotor installed when the chamber door was closed and (START) was pressed.**

Open the chamber door and install a rotor. Close the door and press (START).

**\*\*\* Open Chamber Door \*\*\***

**Run has ended.**

Open chamber door and remove rotor.

**\*\*\* Power Outage> Run Interrupted \*\*\***

**A power outage occurred during the run. The run resumed when power was restored.**

No corrective action required. Press (PROGRAM) to clear message.

**\*\*\* Power Outage> Run Terminated \*\*\***

**A power outage occurred during the run. Run terminated because speed and/or temperature significantly varied from set parameters.**

Restart run.

**\*\*\* Recalled Rotor Not Installed \*\*\***

A program was recalled that requires a rotor different than the one installed in the chamber.

Install the correct rotor for the program recalled, or verify that you used the correct program number.

**\*\*\* Release Door Handle \*\*\***

Indicates that you tried to open the door before the door latch had released.

Release the door handle and wait until the message clears, then open the door. If the problem does not clear, the door latch solenoid may be defective.

**\*\*\* Replace NOVRAM Battery Soon \*\*\***

Battery for the centrifuge memory is low and must be replaced. (Average battery life is from 5 to 10 years.)

Call for Service to replace battery.

**\*\*\* Rotor at Zonal Speed> Load \*\*\***

Zonal run is in process and rotor is at selected loading speed.

Open chamber door and load sample/gradient. Close chamber door.

**\*\*\* Rotor Imbalance \*\*\***

Excessive rotor imbalance; run terminated.

Remove the rotor and balance it according to the instructions in the rotor manual, then install rotor and restart the run.

**\*\*\* Rotor Overtemperature \*\*\***

Run terminated because display temperature is higher than selected **Max** temperature. Possible causes are: (1) selected **Max** temperature set below displayed temperature; (2) rotor not precooled; (3) selected **Max** temperature too low for the rotor/speed combination; (4) high ambient temperature; or (5) condenser inlet blocked.

Check possible causes: (1) if **Max** temperature was manually set lower than display temperature, run will terminate when **(START)** is pressed; wait until actual temperature cools to **Max** temperature setting and restart run or set a higher **Max** temperature and press **(START)** to restart run; (2) if rotor was not precooled, precool

it according to procedure on page 4-12; (3) acceptable rotor/speed/temperature combinations vary depending on rotor used; in some cases, if temperature is set lower than +2°C, rotor temperature may not be attainable at set speed; to achieve temperature, set a lower speed; (4) check ambient temperature: it should be between 15°C and 25°C for optimal performance; will operate at temperatures up to 38°C but performance will be less than optimal; (5) check for 6 inch clearance on left side of centrifuge; clean condenser (to clean the condenser, see Chapter 7). If problem does not clear, there may be a refrigeration system malfunction. See DIAGNOSTICS.

**\*\*\* Secure Rotor Properly \*\*\***

**The rotor is not properly locked on the centrifuge drive.**

Open the chamber door and tighten rotor locking knob(s); if the rotor has two knobs, tighten the larger one first. Close chamber door and press **START**.

**\*\*\* Self Test in Progress \*\*\***

**A diagnostic test of all centrifuge systems. This is done once every 24 hours that the centrifuge power is ON.**

No corrective action required.

**\*\*\* Slow Start in Progress \*\*\***

**Indicates that a Slow-Start was selected and initiated.**

Message will clear automatically when rotor has accelerated to transition speed; no corrective action.

**\*\*\* Slow Stop in Progress \*\*\***

**Indicates that a Slow-Stop was selected and initiated.**

Message appears when the rotor has decelerated to transition speed. It will clear as soon as the rotor has stopped spinning; no corrective action.

**\*\*\* Tach Failure> Rotor Spinning \*\*\***

**Tachometer has failed. Run is terminating, but the rotor is still spinning, even though RUN display may indicate 0 rpm. The chamber door cannot be opened until the rotor has come to a complete stop.**

Wait until the **\*\*\* Open Chamber Door \*\*\*** message appears in the display, then open the chamber door and remove the rotor. Call for Service.

\*\*\* Time to Service Vacuum Pump \*\*\*

Twenty or less vacuum runs remain before vacuum pump oil must be changed.

Change vacuum pump oil as soon as possible (see Chapter 7).

\*\* Turn DIAGNOSTICS Off Before Start \*\*

The DIAGNOSTIC mode was exited with one of the fields turned on; centrifuge will not start.

Press **DIAGNOSTICS** twice. Press **on off** to turn the field off. Input **Q** and press **ENTER**. Press **PROGRAM** to exit DIAGNOSTICS and start run.

\*\*\* Vacuum Pump Must Be Serviced \*\*\*

Vacuum will not operate until vacuum pump oil is changed. Centrifuge will not start if set speed is higher than the top air speed\* of the installed Sorvall® Supraspeed® rotor.

Change vacuum pump oil (see Chapter 7).

\* Top air speed is equal to maximum speed of the rotor in an RC-5C Centrifuge. See rotor instruction manual.

## Diagnostics

### General

The DIAGNOSTIC information provided in this manual is intended to help you understand the basics of the DIAGNOSTIC mode and to teach you to perform routine tasks that require the use of DIAGNOSTICS. Common tasks done using the DIAGNOSTIC mode include assigning Key#,s, changing the vacuum pump oil and the slow start/slow stop transition speed, identifying system faults, and troubleshooting. Other routines are available in DIAGNOSTICS that are designed for use by qualified service personnel only, therefore, instructions for their use are not included in this manual. For information regarding use of the service routines, it is best to call Du Pont for assistance.

The illustrations below are representative of the three DIAGNOSTIC screens. (Screen 4 is currently not used.)

1	Fault Door System 1 of 2			
2	User-1 Off	User-2 Off	Maint-1 Off	Install Off
3	Maint-2 Off	Calib Off	Serv-1 Off	Serv-2 Off

Following is an explanation of how to enter and move around in the DIAGNOSTIC mode.

## Screen 1, Faults

Screen 1 identifies faults and gives specific causes for them. When a fault occurs, **\*\*\* Fault> Press DIAGNOSTICS \*\*\*** will appear in the SET display, an alarm will beep, and the cursor indicator lights beneath the display will move from left to right. The alarm will sound every minute until **DIAGNOSTICS** is pressed and the fault is cleared.

When **DIAGNOSTICS** is pressed, descriptive fault information will appear in the display. The fault information is arranged in two groups: first, general faults (e.g., Refrigeration System, Vacuum System); second, specific cause(s) for the fault (e.g., Compressor Failure, Vacuum Release Failure). As soon as **DIAGNOSTICS** is pressed, the first general fault description will appear in the display with an indication of how many general faults have occurred (e.g., Fault 1 of 1, Fault 1 of 2, etc.). The example below shows that two general faults occurred, the first being in the Door System.

```
Fault   Door System
 1 of 2
```

Press **ENTER**. When you do, the fault information in the display will change to show a specific cause for the fault along with a string of binary numbers. Each "1" in the string of binary numbers represents a separate cause for the fault. If there is more than one "1", press **ENTER** again and the cursor will move to the next "1" and the display will show another cause for the fault.

```
Fault   Door Not Locked
 1 of 2  0001000100000000
```

Continue to press **ENTER** until all causes have been displayed and cursor has returned to the **Fault** field. If there was more than one general fault (i.e., Fault 1 of 2, Fault 1 of 3), when the cursor returns to the Fault field, the display will automatically change to show the next general fault; for example:

```
Fault   Vacuum System
 2 of 2
```

Continue to press **ENTER** until all faults have been displayed and the SET display screen again includes the first general fault (e.g., Fault 1 of 2, Door System).

## NOTE

As you move through the fault screens, be sure to make a note of each fault displayed; this information will be required to help Service personnel troubleshoot the problem.

After all faults have been identified and written down, press **STOP** to clear **\*\*\* Fault> Press DIAGNOSTICS \*\*\*** message from the display. If the message does not clear when **STOP** is pressed, turn the centrifuge power OFF then back ON to clear the message. Call for Service; when you call, let Service know which faults were displayed.

**Screen 2**

Screen 2 is used to monitor system operation; install new software; add new rotors; and perform some maintenance routines, such as assigning Key#'s (procedure on page 6-9), changing slow start/slow stop transition speed (procedure on page 6-12), and changing the vacuum pump oil (page 7-4).

Table 6-1 describes what each field is used for and what authorization (Key#) is required to access the field.

**Table 6-1. Screen 2 Fields, DIAGNOSTICS**

Field	Purpose	Authorization Required
<b>Screen 2</b>	<b>User-1    User-2    Maint-1    Install</b>	
User-1	To monitor state of system operation, such as vacuum level and air temperature.	None
User-2	To perform user diagnostic routines, such as entering Key#s and changing vacuum oil.	System Key#
Maint-1	To view system accumulators.	None
Install	To install software and add new rotors.	System Key#

To enter Screen 2, press **DIAGNOSTICS** until the "2" indicator light above the key is lit. Position the cursor under the field you want to use and press **on off**. Enter Key#, if necessary, then enter the selection number that corresponds to the desired operation (Table 6-2) and press **ENTER >**. Press **on off** to turn selection on.

To exit DIAGNOSTICS, press **on off** to turn selection off, enter selection number **0** and press **ENTER >**.

**Table 6-2. DIAGNOSTICS, Screen 2, Operations**

Selection #	Operation	Selection #	Operation
<b>USER-1</b>		<b>USER-1 (continued)</b>	
1	Vacuum Level (mbar)	16	Tachometer Frequency
2	Ctrlr Samp Temp (deg C)	17	Slow Transition Speed
3	Samp Temp Offset (deg C)	18	Vacuum Transition Speed
4	Air Temp (deg C)	19	Imbalance Threshold
5	Base Temp (deg C)	20	Drive Relay
6	Jumper Temp (deg C)	21	Rail Enable
7	Winding Temp (deg C)	22	Rail Setting (V)
8	Measured Rotor Inertia	23	Rail Volt Sense
9	Door Home Microswitch	24	Brake Enable
10	Door X Position	25	Brake Setting (%)
11	Door Closed Switch	26	Drive Enable (Ctrlr)
12	Door Lock Sensor	27	Drive Enable (Host)
13	URR ID 1st/2nd	28	Bridge Enabled (Yes/No)
14	URR Y Value	29	Bridge Chop (Half/Full)
15	Motor Direction	30	Bridge Setting (Amps)

continued

**Table 6-2. DIAGNOSTICS, Screen 2, Operations (continued)**

Selection #	Operation	Selection #	Operation
<b>USER-1 (continued)</b>		<b>MAINT-1</b>	
31	Bridge Current Sense (A)	1	Serial Number (Year)
32	HES Offset	2	Serial Number (Unit)
33	Host State	3	Hours of System on Time
34	NovRAM (U2) Battery OK?	4	Hours on Drive
35	NovRAM (U4) Battery OK?	5	Number of Drive Cycles
36	Min Vac Level (mbar)	6	Hours on Vacuum Pump
37	Max Vac Level (mbar)	7	Hours Since Oil Change
38	Raw Air Temp (deg C)	8	Number of Vacuum Cycles
39	Min Air Temp (deg C)	9	Cycles Since Oil Change
40	Max Air Temp (deg C)	10	Drive Revs (*10^6)
41	Raw Base Temp (deg C)	11	w2dt (mantissa) on Drive
42	Max Base Temp (deg C)	12	w2dt (exponent) on Drive
43	Raw Jumper Temp (deg C)	13	Number of URR Cycles
44	Min Jumper Temp (deg C)	14	Successful URR Cycles
45	Max Jumper Temp (deg C)	15	No Match URR Cycles
46	Raw Winding Temp (deg C)	16	Failed URR Cycles
47	Max Winding Temp (deg C)	17	Loose Lid URR Cycles
<b>USER-2</b>		18	Mismatched URR Cycles
1	System Access Key#	19	Runs Ending with Faults
2	Zonal Access Key#	20	Last General Faults
3	Lock Access Key#	21	Prior General Faults
4	Program (1-20) Key#	22	Controller ROM Version
5	Slow Transition Speed	23	Host ROM (U5) Version
6	Press On for Oil Change	24	Host ROM (U8) Version
7	LCID Display Test	<b>INSTALL</b>	
8	Vacuum System Override	1	Install Rotor
9	Remote Baud Rate	2	Install NovRAM
10	Clear Faults	3	Install ROM (U5)

### Screen 3

Screen 3 is used for calibration and advanced troubleshooting and repair. Table 6-3 lists the fields in Screen 3 and describes their purpose. All of the fields in this screen are for use by Du Pont or other Service Personnel only.

**Table 6-3. Screen 3 Fields, DIAGNOSTICS**

Field	Purpose	Authorization Required
<b>Screen 3</b>	<b>Maint-2    Calib    Serv-1    Serv-2</b>	
<b>Maint-2</b>	To access diagnostic routines available to DuPont personnel only.	No access
<b>Calib</b>	To calibrate replacement subassemblies.	Service Personnel
<b>Serv-1</b>	To monitor system status for advanced troubleshooting.	Service Personnel
<b>Serv-2</b>	To access diagnostic routines for advanced troubleshooting and repair.	Service Personnel

## How to Assign or Change a Key#

The centrifuge is shipped with a factory-set System Access Key# of "1234" that will allow access to most fields that require a Key# (Screen 3 Service Diagnostics cannot be accessed by the System Access Key#).

If desired, you can change the System Access Key# and you can set different Key#s for various features, such as: the control panel Lock, Zonal, and up to twenty different Program Save Key#s. All Key#s must consist of four digits or less.

### NOTE

Record all Key#s and keep them in a place where they will not be lost. If Key#s are lost, call Du Pont for assistance.

### System Access Key#

To change the System Access Key#:

1. Press **DIAGNOSTICS** until the "2" indicator light above the key is on and the display looks as follows:

User-1	User-2	Maint-1	Install
Off	Off	Off	Off

2. Press **ENTER** to move the cursor to **User-2**.
3. Press **on/off**. The display will prompt you to enter a Key#:

User-1	User-2	Maint-1	Install
Off	Key#	Off	Off

4. Input current **System Access Key#** and press **ENTER**; display will look as follows:

User-2 (Override)	Press 0 or On to Exit
0	Off

5. Input **1** in the **User-2** field and press **ENTER**; cursor moves to **(Override)**.

User-2 (Override)	System Access Key#	
1	Off	1234 ←

CURRENT SYSTEM ACCESS KEY#

6. Press **on/off** to turn **(Override)** on, then press **ENTER**.
7. Input the new **System Access Key#** (four digits or less). Press **ENTER**.

User-2 (Override)	System Access Key#	
1	On	4444 ←

EXAMPLE OF NEW SYSTEM ACCESS KEY#

8. Press **on/off** to turn **(Override)** off and press **ENTER**.



9. Record the new System Access Key#.

### NOTE

To change other Key#s (i.e., Zonal, Lock, or Program), go to Step 1 of the appropriate procedure that follows; do **not** repeat Steps 1 through 4 of the System Access Key# procedure.

If you are not going to assign or change other Key#s, exit DIAGNOSTICS by performing steps 10 & 11 below.

10. Input 0 in User-2 field and press **ENTER**. The display will change back to:

User-1	User-2	Maint-1	Install
Off	Off	Off	Off

11. Press **PROGRAM** to exit DIAGNOSTICS.

### Zonal and Lock Access Key#s

Follow Steps 1 through 4 of System Access Key# procedure, then:

1. To change the Zonal Key#, input 2 in the User-2 field; or to change the Lock Key# input 3 in the User-2 field. The display will change:

User-2 (Ovride) Zonal Access Key#		
2	Off	1234

or

User-2 (Ovride) Lock Access Key#		
3	Off	1234

CURRENT  
ACCESS  
KEY#S

2. Press **ENTER**; the cursor will move to (Ovride).
3. Press **on off** to turn (Ovride) on.
4. Press **ENTER** and input the new Key# (four digits or less). Press **ENTER**.

User-2 (Ovride) Lock Access Key#		
3	On	2222

EXAMPLE OF  
NEW LOCK KEY#

5. Press **on off** to turn (Ovride) off.
6. Press **ENTER** to move cursor to User-2 field.

**NOTE**

To assign or change Program Key#s, go to Step 1 of the following procedure, but do **not** repeat Steps 1 through 4 of the System Access Key# procedure. If you are not going to assign Program Key#s, do steps 7 and 8 to exit DIAGNOSTICS.

7. Input 0 in **User-2** and press **(ENTER >)**. The display will change back to:

User-1	User-2	Maint-1	Install
Off	Off	Off	Off

8. Press **(PROGRAM)** to exit DIAGNOSTICS.

9. Record new Key#.

**Program Key#(s)**

A Key# is required to save a program and to make changes to an existing program, but it is not required to recall a program.

A different Key# can be assigned to each of the 20 possible programs, if desired.

Follow Steps 1 through 4 of the System Access Key# procedure, then:

1. Input 4 in the **User-2** field and press **(ENTER >)**.

User-2 ( Task ) Program(1-20) Key#
4 Off

2. Press **(on off)** to turn **( Task )** on; display changes:

User-2 ( Task ) Enter Program Number
4 On 0

3. Press **(ENTER >)** and input the desired program number (1-20). Press **(ENTER >)** again.

User-2 ( Task ) Key# for Program #01	CURRENT KEY# FOR PROGRAM 1
4 On 1234 ←	

4. Press **(ENTER >)** and input the Key# (four digits or less) that you want assigned to the program (Program #01 is in the example above and below).

User-2 ( Task ) Key# for Program #01	EXAMPLE OF NEW KEY# FOR PROGRAM 1
4 On 3333 ←	

5. Press **(ENTER >)**; cursor moves to **( Task )**. Press **(on off)** to turn **( Task )** off.

**NOTE**

To assign or change Key#s for other Programs, repeat steps 2 through 5.

- Press **(ENTER >)** to move cursor to **User-2** field. Input **0** and press **(ENTER >)**. The display will change back to:

User-1	User-2	Maint-1	Install
Off	Off	Off	Off

- Press **(PROGRAM)** to exit DIAGNOSTICS.
- Record new Key#s.

## How to Change Slow Start/Slow Stop Transition Speed

The slow start/slow stop transition speed is approximately 800 rpm for all rotors except the S-20 rotor, which has a transition speed of approximately 300 rpm; and the GS-3 rotor, which has a transition speed of approximately 650 rpm.

Transition speed can be changed to any speed from 100 rpm to 1000 rpm (the selected speed will be rounded to the nearest number that is divisible by 4). When the transition speed is changed, it will affect the next run only (unless stored in a program); at the end of the run, it will automatically change back to the default speed of 800 rpm (300 rpm for the S-20 or 650 rpm for the GS-3). Anytime you want a run with a transition speed other than the default speed, you must change it prior to the run or store the transition speed as part of a saved program.

Prepare and install the rotor according to the instructions in the rotor manual. Close chamber door and select other desired run parameters, then change transition speed:

- Press **(DIAGNOSTICS)** until the "2" indicator light above the key is on and the display looks as follows:

User-1	User-2	Maint-1	Install
Off	Off	Off	Off

- Press **(ENTER >)** to move the cursor to **User-2**.
- Press **(on off)**. The display will prompt you to enter a **Key#**.
- Input the **System Access Key#** and press **(ENTER >)**.

User-2 (Ovride)	Press 0 or On to Exit
0	Off

- Input **5** in the **User-2** field and press **(ENTER >)**.

User-2 (Ovride)	Slow Transition Speed
5	Off 800

- Press **(on off)** to turn **(Ovride)** on, then press **(ENTER >)** to move cursor to **Slow Transition Speed**.

7. Input desired transition speed (from 100 rpm to 1000 rpm).




---

**CAUTION**

---

Do not set transition speed at the critical speed ( $\pm 100$  rpm) of the rotor (see Table 4-1, Rotor Information, for critical speed). Slow start in the critical speed range can have a detrimental effect on centrifuge components.

---

8. Press **ENTER** ; when you do, the cursor will move to **<Ovr-ide>**. Press **on off** to turn **<Ovr-ide>** off.
9. Press **ENTER**  and the cursor will move to **User-2**.
10. Input **0** in **User-2** and press **ENTER** . The display will change back to:

User-1	User-2	Maint-1	Install
Off	Off	Off	Off

11. Press **PROGRAM** to exit DIAGNOSTICS.
12. Press **START** to begin run.

**NOTE**

If the chamber door is opened after the transition speed has been changed, the transition speed will automatically change back to the default speed.

# Chapter 7

## MAINTENANCE

This chapter describes routine maintenance procedures that are to be performed by the user. Any further maintenance should be performed by a DuPont Service Representative or other qualified service personnel.

### WARNING

Because the high voltage electrical circuits in this centrifuge can cause severe electrical shock, untrained personnel must not attempt procedures that are not included in this manual. Failure to comply with this warning can result in personal injury.

If hazardous materials have been processed in the centrifuge, take all necessary precautions when cleaning or servicing the centrifuge to avoid personal exposure to contaminants.

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

The following is a suggested maintenance schedule.

**Table 7-1. Maintenance Schedule**

Maintenance	Frequency
Clean the rotor chamber	Daily or immediately after a spill
Wash the tapered spindle	Once a week
Clean cabinet panels	Once a month
Clean the control panel	Once a month
Clean condenser coils	Check monthly; clean as required
Clean air inlet louvers	Check monthly; clean as required
Clean and inspect door seal	Once a month or whenever vacuum performance is poor
Change vacuum pump oil and mist eliminator filter	Once a year or when the message *** Time to Service Vacuum Pump *** appears in the SET display.
Test RUN display lights and control panel indicators	Once a year or whenever numbers displayed seem erroneous.

## Cleaning

### Rotor Chamber

The rotor chamber should be kept clean and wiped dry routinely to maintain efficient cooling. Wash the chamber with a mild 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 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.

---

### CAUTION

---

Chlorides are extremely harmful to aluminum alloy rotors and can cause stress corrosion cracking. Therefore, do not use chlorides to disinfect the chamber.

---

### 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 Noryl® cabinet panels with a household wax cleaner. Use a mild *nonalkaline* detergent and water to clean the top deck and the chamber door.

### Control Panel

To clean the control panel, spray a small amount of a mild cleaning liquid (such as window cleaner) on a clean cloth and wipe the panel clean. DO NOT spray cleaners directly on the control panel.

### Door Seal

The chamber door seal should be cleaned once a month. If the seal is not kept clean, it can result in an insufficient vacuum level during a vacuum run.

#### To clean the seal:

1. Open the chamber door all the way. Using a #1 phillips (or Reed-Prince) screwdriver, loosen the quarter-turn fastener (turn counterclockwise) on the front edge of the door (figure 7-1, view 1).
2. Close the chamber door halfway, then locate the hole in the center of the tray assembly, underneath the door (figure 7-1, view 2). Insert your fingers approximately 13mm (1/2 inch) into the hole and pull forward on the silver seal tray until the hole is visible. Continue pulling tray out while pushing back on the door handle until the door is fully open and the seal tray assembly is separated from the door. Remove the sealing assembly.

3. Inspect the top and bottom perimeter of the seal for signs of cracks, tears, or abrasions. If damaged, replace the door seal assembly, Catalog No. 59235.
4. Wash the centrifuge deck and both sides of the door seal and tray with a mild *nonalkaline* laboratory detergent and rinse well.
5. With the door fully open, carefully engage both corners of the tray in the door tracks, then slide the seal tray assembly back into the door. Secure it in place with the quarter-turn fastener.

---

**WARNING**

---

Do not operate the centrifuge without the seal tray assembly in place. The assembly is part of the centrifuge containment system, which provides protection in the event of a rotor failure.

---

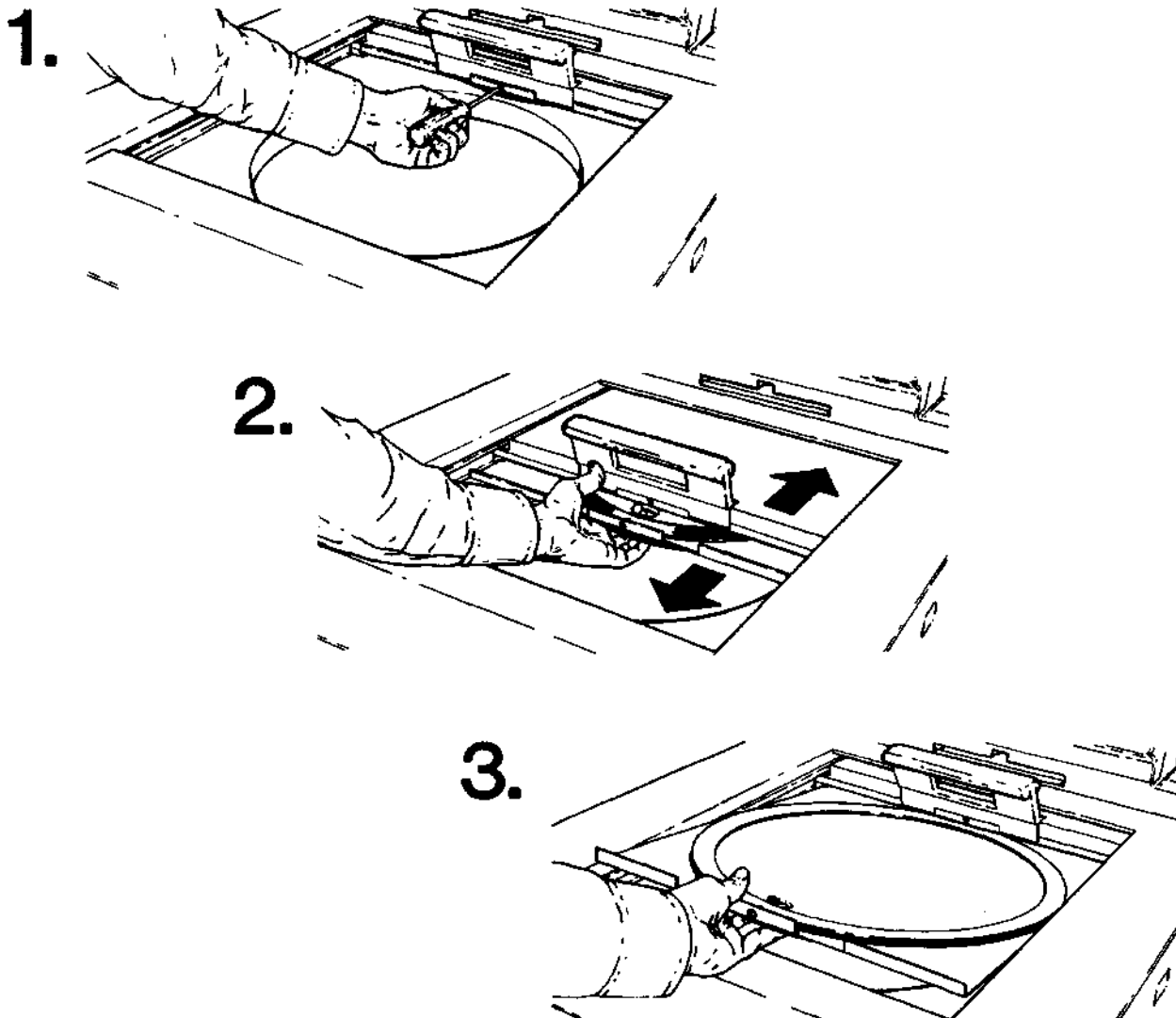


Figure 7-1. Door Seal Removal

### Refrigeration System Condenser

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

### Air Louvers

To allow proper air flow through the centrifuge, the air louvers on the front cabinet panel should be kept free of dust and dirt. Clean the louvers with a brush or a vacuum cleaner as needed.

## 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.

Vacuum pump oil must be changed whenever the **\*\*\* Time to Service Vacuum Pump \*\*\*** message appears in the SET display or once a year, whichever occurs first.

## Changing the Vacuum Pump Oil & Mist Eliminator Filter

The most common cause of vacuum pump failure or poor performance is contaminated oil. To ensure the efficiency of the vacuum system operation, the vacuum pump oil must be changed whenever the **\*\*\* Time to Service Vacuum Pump \*\*\*** message appears in the SET display or once a year, whichever occurs first.

The **\*\*\* Time to Service Vacuum Pump \*\*\*** message will appear in the SET display on the control panel to warn you that twenty or less vacuum runs\* remain before the vacuum will not operate. The oil should be changed as soon as possible after this message appears. If the oil is not changed before the twenty vacuum runs are up, the **\*\*\* Vacuum Pump Must Be Serviced \*\*\*** message will appear in the display when you attempt to start the twenty-first vacuum run and an interlock will prevent further vacuum operation until the oil is changed.

A DuPont Oil Change Kit, Catalog No.12870, is required for this procedure. The kit includes the items needed to change the oil: a bottle of vacuum pump oil, a mist eliminator filter, a plastic exhaust port blocking tube, a piece of tape, and a funnel.

### NOTE

If you are not using the DuPont Oil Change Kit, you must use oil that meets the same specifications as the oil supplied in the kit. The specifications for the oil are given in the Appendix of this manual with a list of additional items required.

\* A vacuum run occurs when a Sorvall® Supraspeed® rotor is operated above its maximum air speed. Maximum air speed is equal to maximum speed of the rotor in an RC-5C Centrifuge. See rotor instruction manual.



Refer to Figure 7-2 for parts location and change the vacuum pump oil:

### NOTE

It is best to change the oil while it is warm, since it is less viscous when warm and will pump out easier.

1. Turn the centrifuge power ON and open the chamber door.
2. Peel the back off the piece of tape supplied in the Oil Change Kit, then stick the tape over the left-hand inlet port to *completely* seal the port.
3. Turn the two fasteners at the bottom of the lower front cabinet panel. Pull bottom of panel out, then down, and remove panel from centrifuge.
4. Remove right access panel from behind control console by pressing in on end of panel and lifting up. If necessary, strike end of panel lightly to pop panel off.

### WARNING

Leave chamber door open while access panel is off. This is necessary to avoid the possibility of pinching your hand and fingers between the door and the door track behind the console.

5. Loosen knob on cap of mist eliminator. Then, remove cap and knob assembly.
6. Remove mist eliminator filter and screen. Discard filter and keep the screen.
7. Install the exhaust port blocking tube (supplied in the kit) on the stem of the mist eliminator. Reinstall the cap and knob assembly and tighten it: turn the knob two full turns after you first feel resistance.
8. Remove entire length of vacuum pump drain line from channel in front access panel.
9. Remove drain line tubing clamp, then securely position end of drain line in a waste bottle having a capacity of one liter or more.

### NOTE

Make sure the drain line tubing is not kinked, particularly near the top of the access panel and where it was crushed by the tube clamp.

10. Turn the vacuum pump on:

- a. Press **DIAGNOSTICS** until the "2" indicator light above the key is on and **User-2** appears in the display.

User-1	User-2	Maint-1	Install
Off	Off	Off	Off

- b. Press **ENTER** to move the cursor to **User-2**. Press **on/off**; the display will prompt you to enter a Key#:

User-1	User-2	Maint-1	Install
Off	Key#	Off	Off

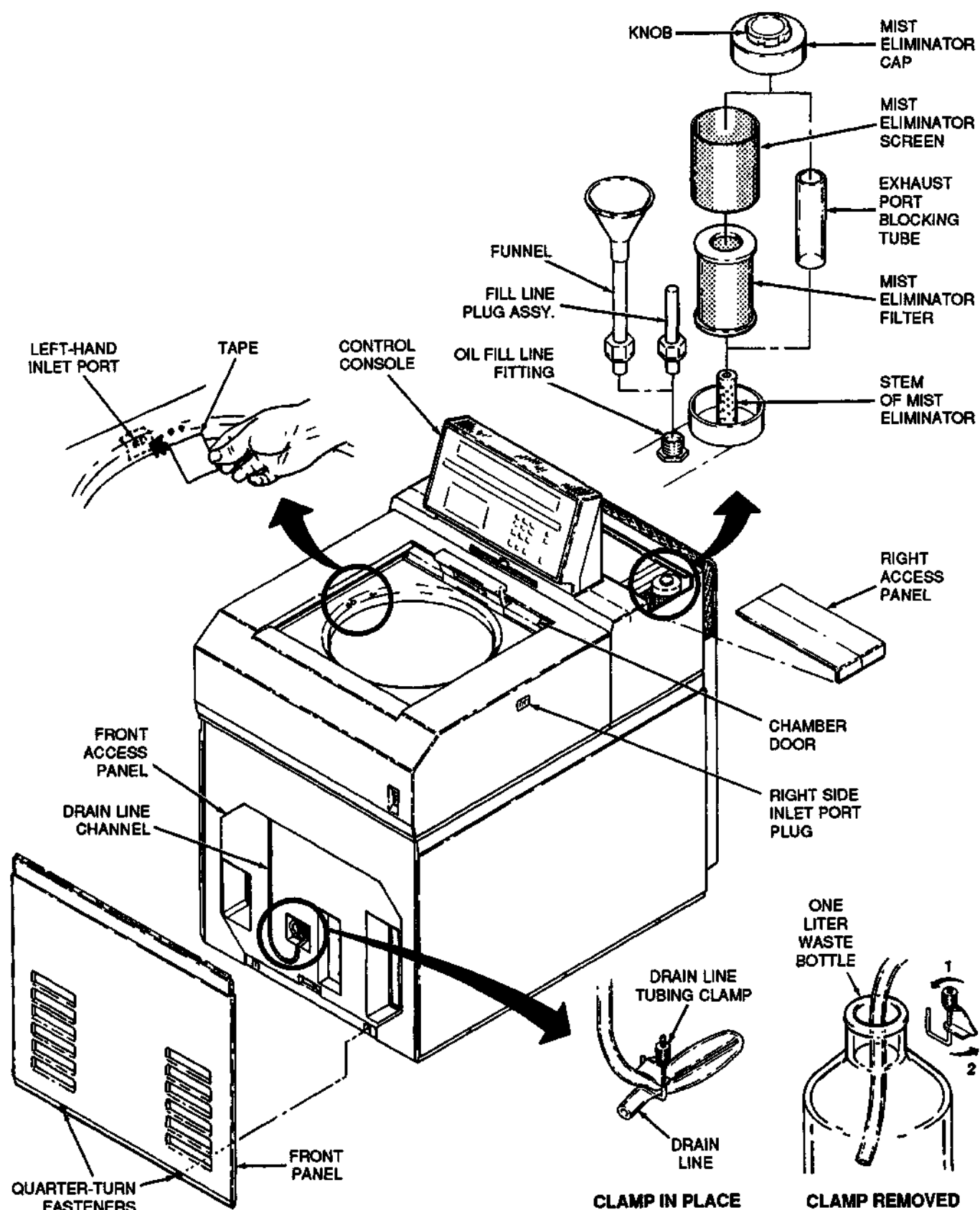


Figure 7-2. Oil Change Parts Identification

- c. Input the System Access Key# and press **(ENTER ▷)**.

```
User-2 (Ovride) Press 0 or On to Exit
  0      Off
```

- d. Input **6** and press **(ENTER ▷)**.

```
User-2 ( Task ) Press On for Oil Change
  6      Off
```

- e. Press **(on off)** and press **(ENTER ▷)**.

```
User-2 ( Task ) Enter 1 to Run PUMP
  6      On      0
```

- f. Input **1** and press **(ENTER ▷)**.

```
User-2 ( Task ) Enter 0 When Empty
  6      On
```

### NOTE

If vacuum pump turns off within 30 seconds after it is first turned on, check to make sure the piece of tape inside chamber completely seals inlet port and that the inlet port plug on left side of centrifuge is firmly in place.

11. Run the pump until air comes through the drain line and froth begins to appear in the waste container; this indicates that the pump is empty. Immediately press **(ENTER ▷)**, input **0** and press **(ENTER ▷)** again to turn pump OFF and avoid damaging the pump.

---

### CAUTION

---

Do not run the pump after it is empty. To do so can damage the pump.

---

### NOTE

The pump will turn off automatically after 4 minutes. If the pump is not empty after the 4 minutes, press **(ENTER ▷)**, input **1** and press **(ENTER ▷)** again to continue running the pump.

12. Press **(on off)** to turn **( Task )** off.
13. Press **(ENTER ▷)** to move the cursor under **User-2**. Input **0** and press **(ENTER ▷)**.
14. Press **(PROGRAM)** to exit DIAGNOSTICS.
15. Wipe oil from drain line tubing and clamp.
16. Position tubing clamp in place on drain line. Close clamp and tighten it securely to seal the drain line. Store the line back in the front access panel.
17. Unscrew the knob on the mist eliminator cap and remove cap and knob assembly.

18. Remove exhaust port blocking tube from the stem of the mist eliminator. Do not install mist eliminator filter yet.
19. Unscrew the nut from the oil fill line fitting (located in front of the mist eliminator) and remove the fill line plug assembly.
20. Insert the funnel (supplied in the kit) in the oil fill line fitting. Make sure the funnel is in as far as it will go, then secure it in place by tightening the locking nut.
21. Open the bottle of oil and *slowly* pour entire contents (675 ml) into funnel, being careful not to overflow the oil in the funnel.
22. Properly dispose of the collected waste oil.

---

**WARNING**

---

Disposal of the waste oil must conform to all local, state, and federal standards.

---

23. Loosen the locking nut on the funnel and remove the funnel.
24. Reinstall the fill line plug assembly in the oil fill line fitting as far as it will go and tighten the nut; the nut should be finger tight.
25. Position the new mist eliminator filter in place, then install the mist eliminator screen over the filter.
26. Install mist eliminator cap and knob assembly over the mist eliminator screen, making sure screen is fully seated inside cap; tighten the assembly in place by turning the knob on the cap.
27. Reinstall the access panel behind the control console.
28. Reinstall the front cabinet panel.
29. Remove piece of tape from inside the chamber. The centrifuge is ready for use.

## Emergency Sample Recovery

---

**WARNING**

---

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

---

### **a. Nonvacuum Runs**

Wait until the rotor has coasted to a stop. When the rotor stops, insert a straightened paperclip in the door interlock override hole and push down (figure 7-3). Open chamber door.

### **b. Vacuum Runs**

If a power failure occurs, vacuum will not release automatically and you will not be able to open the chamber door. The chamber will maintain a partial vacuum and the rotor will safely coast to a stop. The vacuum must then be released manually.

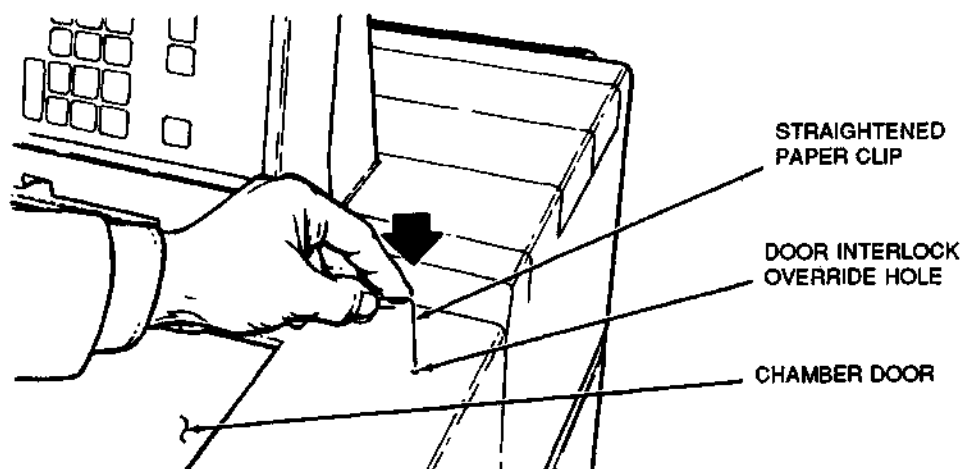


Figure 7-3. Door Interlock Override

**To release vacuum:**

1. Wait until the rotor has coasted to a stop, then turn the power switch OFF.
2. When the rotor stops, unplug the centrifuge.
3. Locate the vacuum release solenoid valve (figure 7-4). Insert a screwdriver through the grille on left side of back panel, and turn vacuum release screw fully clockwise (approximately 4 to 5 turns). Air will begin to enter chamber.

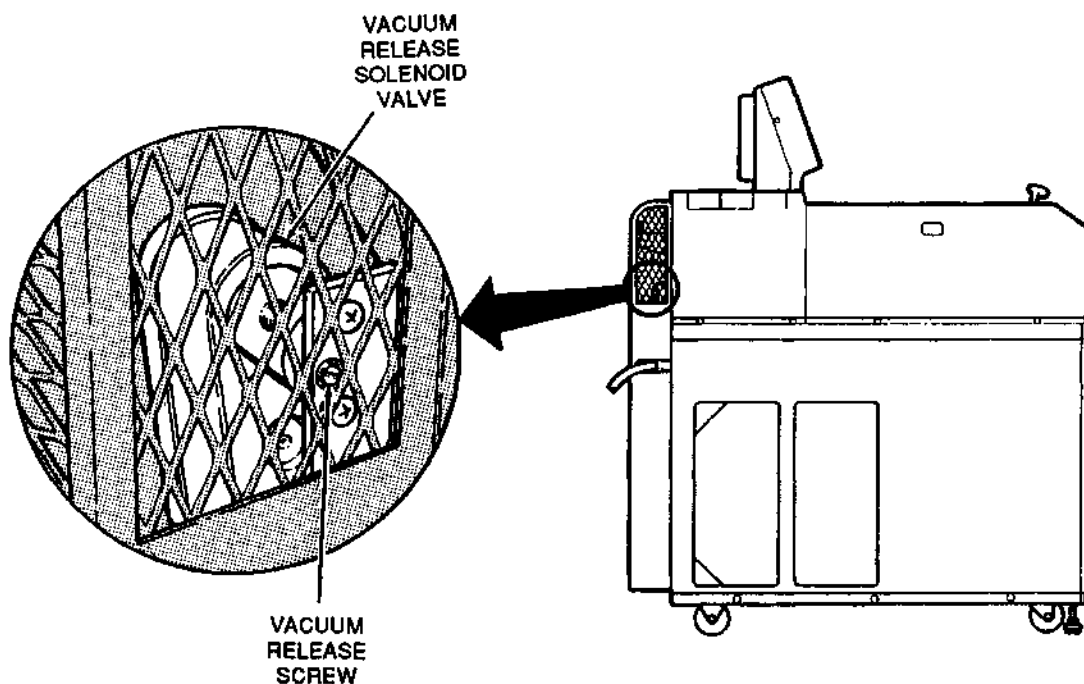


Figure 7-4. Vacuum Release Solenoid Valve Location

4. When the air in the chamber has reached atmospheric pressure (hissing noise will stop), turn the vacuum release solenoid valve screw fully counterclockwise.
5. Insert a straightened paperclip in the door interlock override hole (figure 7-3). Open door.

## Test of RUN Display Lights & Control Panel Indicators

Periodically test the control panel RUN display and indicators to verify that the lights are functional:

1. Turn the centrifuge power ON.
2. Press **DIAGNOSTICS** until the "2" indicator light above the key is on and the display looks as follows:

User-1	User-2	Maint-1	Install
Off	Off	Off	Off

3. Press **ENTER** to move the cursor to **User-2**.
4. Press **on off**. The display will prompt you to enter a **Key#**.
5. Input the System Access Key# and press **ENTER**.

User-2 (Ovride) Press 0 or On to Exit	
0	Off

6. Input 7 in the **User-2** field and press **ENTER**.

User-2 (Ovride) LCID Display Test		
7	Off	8

7. Press **on off**.

When **on off** is pressed:

- the number "8" will light in each space across the RUN display;
- all indicator lights on the control panel will come on;
- the minus temperature symbol will light in the RUN display; and
- the cursor indicator lights will all come on.

If a number other than "8" appears in the display or if any of the other lights do not come on, call for Service.

8. Press **on off**.
9. Press **ENTER**.

10. Input **Q** under **User-2** and press **(ENTER >)**. The display will change back to:

User-1	User-2	Maint-1	Install
Off	Off	Off	Off

11. Press **(PROGRAM)** to exit DIAGNOSTICS.

## Parts Ordering Information

To order replacement parts: in the United States, telephone toll-free (800) 551-2121. Outside the United States, contact local distributor or agent. Be sure to provide a description of the part, centrifuge model, and centrifuge serial number.

## Service Decontamination Policy

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### WARNING

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

---

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

- Clean the centrifuge and/or rotor to be serviced of all encrusted material and decontaminate it prior to servicing by the DuPont representative. There must be no radioactivity detectable by survey equipment.
- Complete and attach Decontamination Information Certificate (Sorvall® Products Form No. IPDP-59 or E53603) to the centrifuge or rotor.

If a centrifuge or rotor to be serviced does not have a Decontamination Information Certificate attached and, in DuPont's opinion presents a potential radioactive or biological hazard, the DuPont representative will not service the equipment until proper decontamination and certification is complete. If DuPont 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 the disposition of equipment. Disposition costs will be borne by the sender.

Decontamination Information Certificates are included with these instructions. Additional certificates are available from the local Technical or Service Representative. In the event these certificates are not available, a written statement certifying that the

unit has been properly decontaminated and outlining the procedures used will be acceptable.

**NOTE**

The Service Representative will note on a 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.



## **Vacuum Pump Oil Specifications**

---

If you are not using Du Pont Oil Change Kit (Cat. No. 12870) when changing the vacuum pump oil, you must use oil that meets the specifications below.

### **Oil Specifications:**

Molecular distilled general purpose hydrocarbon mechanical pump fluid, 675 ml.

Ultimate pressure @ 25°C:	6 x 10 <sup>-5</sup> Torr
Viscosity @ 38°C:	375 SUS 80 CST
Specific Gravity @ 22°C:	0.88
Flash Point:	251°C
Fire Point:	279°C
Auto Ignition:	449°C

These properties are typical of Cambridge Mill Products #VB-X.

### **Also Required:**

Mist Eliminator Filter, Technolab #ED5-IL

Plastic Tape, minimum width 50 mm (2 inch); 3M #471 or equivalent

## WARRANTY

E. I. du Pont de Nemours and Company makes no warranty of any kind, expressed or implied, except as stated in this warranty policy.



The Sorvall® RC-28S **Supraspeed**® Centrifuge is warranted to be free from defects in material and workmanship for a period of one year from the date of delivery. Du Pont 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.

Du Pont 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. DU PONT 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.

## Glossary

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<b>Cursor</b>	A movable indicator in the SET display screens that shows position for data entry.
<b>Default Value</b>	The choice made by the computer system when no explicit choice is made by the operator.
<b>Display Message</b>	A message that appears in the display that prompts the operator to perform a specific operation or informs the operator of an operating condition.
<b>Enter</b>	To transfer an input to the computer by pressing either the right <b>ENTER</b>  or the left <b>ENTER</b>  cursor key.
<b>Entry</b>	An input that has been transferred to the computer.
<b>Fault</b>	A centrifuge malfunction.
<b>Fault Message</b>	Message produced by the computer program that indicates a fault has occurred.
<b>Field</b>	One item of information within a screen; cursor must be positioned in field to make an entry.
<b>Input</b>	The data to be transferred to the computer by pressing the keypad.
<b>Integrator</b>	Keeps track of the accumulating centrifugal effect during a run, including acceleration and deceleration.
<b>K Factor</b>	A value used to estimate run time at a specific speed to move particles in suspension (assumes at 20°C) from the $r_{min}$ of the rotor to $r_{max}$ of the rotor. The lower the K Factor, the more efficient the rotor is in sedimenting particles.
<b>Key Number</b>	A security number that provides user authorization to access protected data.
<b>RCF</b>	(g force) The force applied to a suspension of particles during centrifugation relative to the force that the earth's gravity would have on them.
<b>Run Display</b>	The upper display on the control panel which shows actual time, $\int \omega^2 dt$ , temperature, and speed values.
<b>Screen</b>	A group of fields visible in the SET display selected by pressing either the PROGRAM, CALCULATE, or DIAGNOSTICS key.
<b>Set Display</b>	The lower display on the control panel that changes according to the screen selected.
<b>Transition Speed</b>	The speed at which the rotor changes from slow acceleration or deceleration to maximum acceleration or deceleration when Slow Start or Slow Stop is used.

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- Warranty. *See Appendix*
- Zonal Field, 3-7
- Zonal Run, 1-3, 3-7, 4-7

## PROGRAM LOG

**PROGRAM #** \_\_\_\_\_ **Date** \_\_\_\_\_

**Operator** \_\_\_\_\_

**Rotor** \_\_\_\_\_ **Speed** \_\_\_\_\_

**Hr** \_\_\_\_\_ **Min** \_\_\_\_\_ **Temp** \_\_\_\_\_ °C

**Brake** ☐ ON ☐ OFF **Zonal\* Speed** \_\_\_\_\_

**RCF** \_\_\_\_\_  **$\int \omega^2 dt$**  \_\_\_\_\_

**Slow Start** ☐ ON ☐ OFF **Rate** \_\_\_\_\_

**Slow Stop** ☐ ON ☐ OFF **Rate** \_\_\_\_\_

**Notes** \_\_\_\_\_

\* PROGRAM RECALL will not turn ZONAL On, but it will set speed & other parameters.

## PROGRAM LOG

PROGRAM # \_\_\_\_\_ Date \_\_\_\_\_

Operator \_\_\_\_\_

Rotor \_\_\_\_\_ Speed \_\_\_\_\_

Hr \_\_\_\_\_ Min \_\_\_\_\_ Temp \_\_\_\_\_ °C

Brake ☐ ON ☐ OFF Zonal\* Speed \_\_\_\_\_

RCF \_\_\_\_\_  $\int \omega^2 dt$  \_\_\_\_\_

Slow Start ☐ ON ☐ OFF Rate \_\_\_\_\_

Slow Stop ☐ ON ☐ OFF Rate \_\_\_\_\_

Notes \_\_\_\_\_

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## PROGRAM LOG

**PROGRAM #** \_\_\_\_\_ **Date** \_\_\_\_\_

**Operator** \_\_\_\_\_

**Rotor** \_\_\_\_\_ **Speed** \_\_\_\_\_

**Hr** \_\_\_\_\_ **Min** \_\_\_\_\_ **Temp** \_\_\_\_\_ °C

**Brake** ☐ ON ☐ OFF **Zonal\* Speed** \_\_\_\_\_

**RCF** \_\_\_\_\_  **$\omega^2 \cdot dt$**  \_\_\_\_\_

**Slow Start** ☐ ON ☐ OFF **Rate** \_\_\_\_\_

**Slow Stop** ☐ ON ☐ OFF **Rate** \_\_\_\_\_

**Notes** \_\_\_\_\_

\* PROGRAM RECALL will not turn ZONAL On, but it will set speed & other parameters.

## DECONTAMINATION CERTIFICATE

Instructions on the reverse of this card must be completed before field service or the return of the instrument or part to the Du Pont/Sorvall service facility.

NAME _____	DEPARTMENT _____
INSTITUTION _____	ADDRESS _____
CITY _____	STATE _____ ZIP _____
INSTRUMENT _____	SERIAL NUMBER _____
ROTOR _____	SERIAL NUMBER _____
PART _____	PART NUMBER _____
CONTAMINATE USED _____	
DECONTAMINATION CERTIFIED BY _____	
DATE DECONTAMINATED _____	

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## INSTRUCTIONS

When an instrument that has been used with radioactive or pathogenic material requires servicing by Du Pont personnel either at the customer's laboratory or at Du Pont 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 (Sorvall Instruments Form No. IPDP-59) 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, the instrument or part 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, 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 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

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.

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