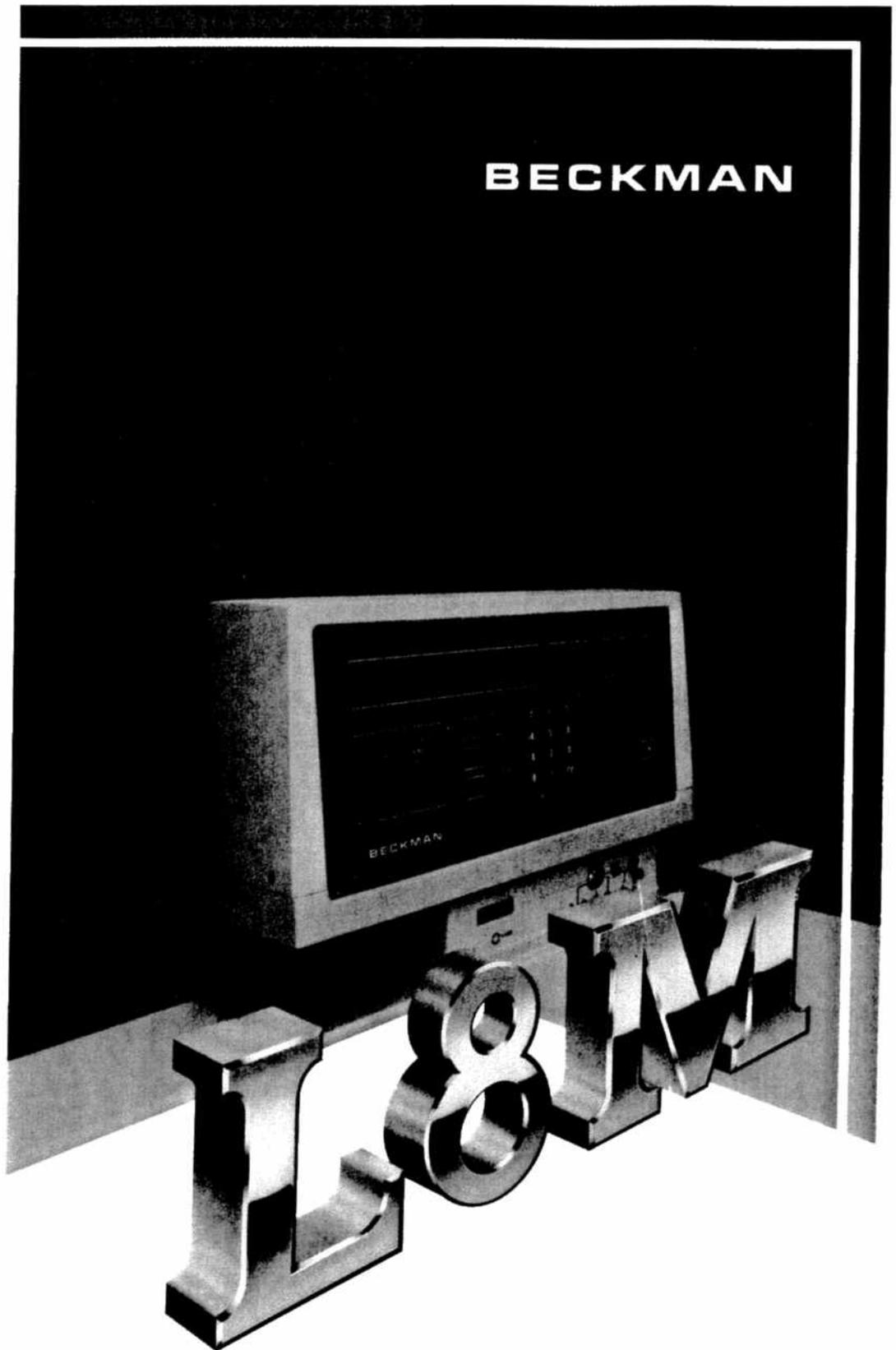


The Model L8-70M

BECKMAN



Safety Reminder

This page summarizes cautionary information basic to the safe operation of the L8M. However, it is strongly recommended that the user read the entire manual carefully before attempting to operate the instrument.

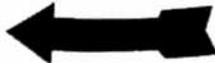
- The Model L8M Ultracentrifuge is not designed for use with materials capable of developing flammable or explosive vapors. Such materials should not be handled or stored near the instrument.
- Spills may generate aerosols. Pathogenic, toxic, or radioactive materials should not be used in this instrument unless all necessary safety precautions are taken.
- The door safety interlock is defeated up to 3000 rpm when the key interlock is in the ZONAL position.
- Maintenance other than that contained in this manual should be performed only by trained, qualified personnel.
- Turn the POWER off and disconnect the instrument from the main power source before performing any maintenance that requires the removal of an instrument panel.
- Do not place containers holding liquid on or near the chamber door. If they spill, liquid may get into the instrument and damage electrical or mechanical components.
- Under no circumstance should any effort be made to slow or stop rotation by hand-braking the rotor.

270-340784

DANGER!
HIGH VOLTAGE
DANGER!
HAUTE TENSION!
ACHTUNG!
HOCHSPANNUNG!
¡PELIGRO!
ALTA TENSION!
270-340784 Printed in U.S.A.

270-338831

CAUTION
HOT
DO NOT TOUCH
270-338831
MADE AND PRINTED IN U.S.A.



Labels shown here are attached to the Model L8M. Replacement labels will be provided free of charge by writing to Beckman Instruments, Marketing Department, Box 10200, Palo Alto, California 94304.

270-558261-A

CAUTION

 BOARD ASSEMBLIES WITH RED EDGE MARKING ARE SUBJECT TO DAMAGE BY STATIC ELECTRICITY
270-558261-A
PRINTED IN U.S.A.

270-340816-A

CAUTION	ATTENTION!
DO NOT PERFORM ANY MAINTENANCE ON THIS EQUIPMENT WITHOUT FIRST DISCONNECTING FROM MAIN POWER SOURCE.	N'EFFECTUER AUCUNE INTERVENTION DE MAINTENANCE SUR CETTE MACHINE SANS LA DECONNECTER DE LA SOURCE D'ALIMENTATION ELECTRIQUE.
VORSICHT!	¡ATENCIÓN!
VOR INSTANDHALTUNGSARBEITEN. GERÄT VOM NETZ TRENNEN.	NO REALIZAR NINGUNA OPERACION DE MANTENIMIENTO EN ESTE APARATO SIN DESCONECTARLE DE LA RED.

270-232292

CAUTION	PRECAUCION
EXCESSIVE LEAKAGE CURRENT ENSURE PROPER GROUNDING.	POSIBLES DERIVACIONES ASEGURE UNA BUENA TIERRA.
ATTENTION	VORSICHT
COURANT DE FUITE ELEVE FOURNIR UNE MISE A LA TERRE EFFICACE.	HOHER LECKSTROM GUTE ERDUNG SICHERSTELLEN.

270-232292 Printed in U.S.A.

270-231879

CAUTION	VORSICHT!
USE SAFETY GOGGLES WHEN SERVICING REFRIGERATION SYSTEM.	SCHUTZBRILLE ERFORDERLICH BEI WARTUNGSARBEITEN AN DER KOHLANLAGE.
ATTENTION!	¡ATENCIÓN!
PORTER DES LUNETTES DE SECURITE POUR REPARER LE SYSTEME DE REFRIGERATION.	USE GAFAS DE SEGURIDAD DURANTE LAS REPARACIONES DEL SISTEMA DE REFRIGERACION.

270-340786-A

CAUTION

- DO NOT REMOVE THIS PANEL.
- NO USER-SERVICEABLE PARTS INSIDE.
- ELECTRICAL SHOCK HAZARD.
- REFER SERVICING TO QUALIFIED SERVICE PERSONNEL.

ATTENTION!

- NE PAS ENLEVER CE PANNEAU.
- PAS DE PIÈCES REPARABLES PAR L'UTILISATEUR A L'INTERIEUR.
- RISQUE DE SECOURS ELECTRIQUE.
- S'ADRESSER POUR LES REPARATIONS DE CET INSTRUMENT AUX TECHNICIENS QUALIFIES DE BECKMAN.

VORSICHT!

- DIESE DECKPLATTE NICHT ABNEHMEN.
- ENTHÄLT KEINE TEILE DIE VOM GEBRAUCHER GEWARTET WERDEN KÖNNEN.
- ELEKTROISIERUNGSGEFAHR.
- WARTUNG NUR DURCH QUALIFIZIERTES BECKMAN-PERSONAL.

¡PRECAUCIÓN!

- NO quite ESTE PANEL.
- NO HAY PARTES QUE EL UTILIZADOR PUEDA REPARAR EN EL INTERIOR.
- PELIGRO DE ELECTROCHOQUE.
- REFERIA LOS SERVICIOS DE REPARACION A PERSONAL COMPETENTE DE BECKMAN.

270-340785-B

CAUTION

1. READ MANUAL BEFORE SERVICING.
2. DISCONNECT POWER BEFORE UNDERTAKING REPAIR OR MAINTENANCE.
3. ELECTRICAL OR REFRIGERATION SERVICING TO BE PERFORMED BY QUALIFIED PERSONNEL ONLY.
4. REPLACE ALL ACCESS COVERS BEFORE OPERATING MACHINE.
5. USE BECKMAN APPROVED PARTS ONLY.

ATTENTION!

1. LIRE LE MANUEL D'INSTRUCTIONS AVANT ENTRETIEN OU REPARATION.
2. COUPER LE COURANT AVANT D'ENTREPRENDRE DES REPARATIONS OU DES TRAVAUX D'ENTRETIEN.
3. SEUL UN PERSONNEL QUALIFIE PEUT PROCEDER A L'ENTRETIEN OU AUX REPARATIONS DE L'APPAREILLAGE ELECTRIQUE OU DE REFRIGERATION.
4. REMETTRE EN PLACE TOUS LES PANNEAUX D'ACCES AVANT DE FAIRE FONCTIONNER LA MACHINE.
5. N'EMPLOYER QUE DES PIECES AGREEES PAR BECKMAN.

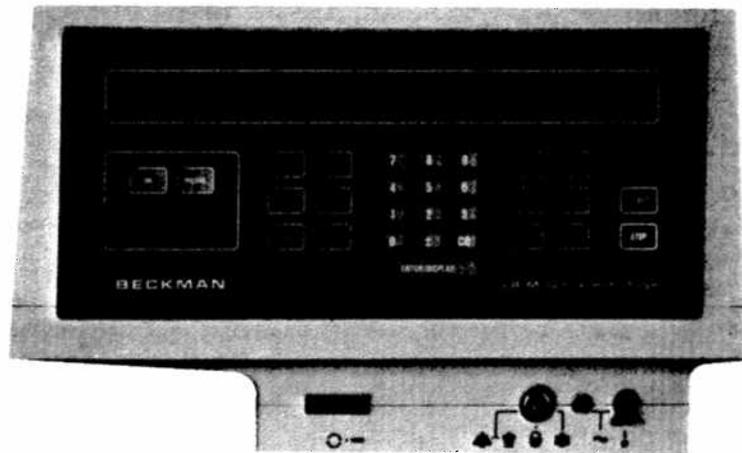
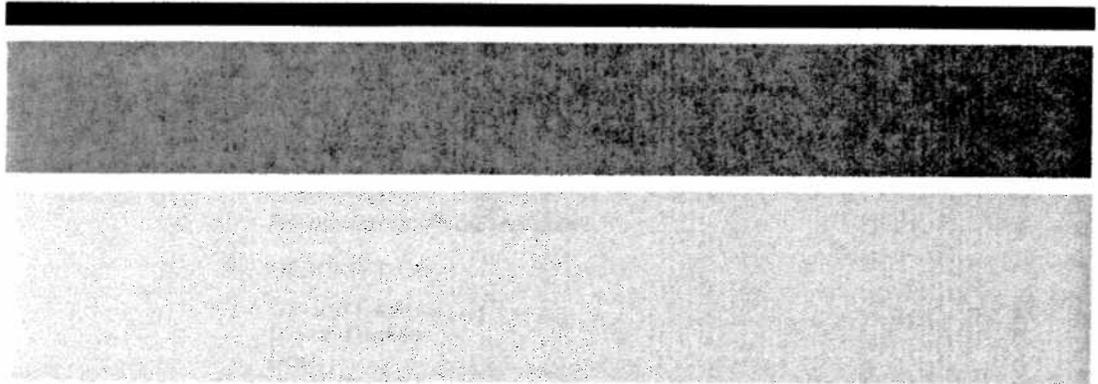
VORSICHT

1. VOR WARTUNGSARBEITEN GEBRAUCHSANWEISUNG LESEN.
2. VOR DURCHFÜHRUNG VON REPARATUR ODER WARTUNGSARBEITEN NETZSTROMER ZIEHEN.
3. ELEKTRIK UND KÜHLUNG DARB NUR VON FACHPERSONAL GEWARTET WERDEN.
4. VOR ERNEUTER INBETRIEBNAHME ALLE ENTFERNTEN ABDECKUNGEN WIEDER ANBRINGEN.
5. NUR VON BECKMAN GENEHMIGTE TEILE VERWENDEN.

PRECAUCION

1. LEA EL MANUAL ANTES DE SERVICIO DE MANTENIMIENTO O REPARACION.
2. DESCONECTE LA ENERGIA ELECTRICA ANTES DE EMPRENDER LAS REPARACIONES O EL MANTENIMIENTO.
3. SOLO EL PERSONAL COMPETENTE DEBE EFECTUAR LOS SERVICIOS DE MANTENIMIENTO O DE REPARACION ELECTRICOS O DE REFRIGERACION.
4. VUELVA A COLOCAR TODAS LAS CUBIERTAS DE ACCESO ANTES DE OPERAR LA MAQUINA.
5. UTILICE UNICAMENTE PIEZAS DE REPUESTO APROBADAS POR BECKMAN.

BECKMAN



The Model L8-70M Preparative Ultracentrifuge

Instruction Manual

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Introduction

The Model L8M is a microprocessor-controlled preparative ultracentrifuge, used to generate centrifugal forces for the separation of particles. The Model L8M can be used with any of Beckman's family of ultracentrifuge rotors (except the Type 15 rotor, and Type 35 and Type 42.1 rotors with serial numbers 1299 or lower).

This instrument features the Ultra-Smooth variable-frequency induction drive; dual-program memory; dual-purpose digital displays; touch switches; a numerical keypad; programmed operation; and 9 acceleration and 10 deceleration profiles.

Digital displays indicate vacuum level, rotor speed, rotor temperature, run time remaining or elapsed, and accumulated centrifugal effect ($\omega^2 t$). The actual operating conditions of the instrument are displayed unless either the unit is in the input mode or **ENTER/DISPLAY** is pressed, in which case the selected values for the run are shown for 5 seconds.

Touch switches operate with light finger pressure. An audible beep and green LEDs (light-emitting diodes) signal when each switch is activated. The LEDs also signal when the instrument reaches set values during the run.

Manual, automatic, and programmed operation are available in the L8M. In *manual* operation, all individual run conditions are entered by the operator before beginning the run. In *automatic* operation, a run can be repeated in sequence without having to reenter the run parameters. *Programmed* operation permits the exact duplication of runs at any time, using a Memory-Pac™ programmable storage module.

Dual program permits the entry of *two* sets of run conditions, which are then carried out in sequence. This feature is particularly useful for delayed-start runs.

The L8M provides 9 slow acceleration profiles for greater protection of the gradient and sample-to-gradient interface and 10 slow deceleration profiles for integrity of the separation.

An optional feature of the instrument is the RS 232C Interface Accessory. Detailed information is supplied with this accessory.

Diagnostic messages and audible signals are provided to alert you of incorrect data entry or conditions that may need attention.

The following sections describe major instrument components and provide detailed instructions on the operation and care of the L8M. Read the manual carefully, using the foldout illustration at the back to locate specific components, displays or switches.

Specifications



CONTROL CHARACTERISTICS

Speed

- Set speed 1000 to 70 000 rpm
- Speed control Actual rotor speed will be within 20 rpm of the set speed.
- Speed display Digital readout indicates actual rotor speed (rpm) in increments of 100 rpm at speeds above 1000 rpm and 10 rpm at speeds below 1000 rpm.

Rotor Temperature

- Set temperature 0 to 45°C
- Maximum temperature Settable to 50°C
- Temperature control (after equilibration) ±1°C of set temperature
- Temperature display Digital readout indicates actual rotor temperature ±1°C.

Time

- Set time Up to 99 h 59 min; HOLD for longer runs
- Time display Digital readout indicates time remaining for timed runs and time elapsed for HOLD runs.
- Computed time In the $\omega^2 t$ mode, with speed and $\omega^2 t$ entered, the instrument automatically computes a value for equivalent time.

$\omega^2 t$ Integrator

- Set $\omega^2 t$ Up to 9.99×10^{14} radians squared per second
- $\omega^2 t$ display Digital readout indicates accumulated $\omega^2 t$ to three significant figures and exponential notation. Can be used to terminate a run at a preselected value.
- Computed $\omega^2 t$ In the TIME mode, with speed and time entered, the instrument will automatically compute a value for equivalent $\omega^2 t$.

Acceleration Select from 9 acceleration profiles, or maximum acceleration from 0 rpm to set speed.

Deceleration Select from 10 deceleration profiles, or maximum deceleration from set speed to 0 rpm.

Operation Manual, automatic, or programmed; key interlock selects normal, zonal, or locked operation.

Dry Cycle Used to dry out a damp chamber.

OPERATIONAL FEATURES

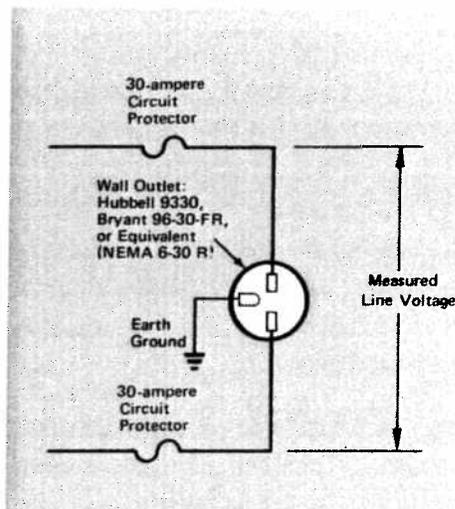
Message	Condition
CF	Oil supply to seal assembly of the CF-32 Ti rotor is low
DOOR	Chamber door not properly closed; door lock malfunction
DP	Diffusion pump exceeds temperature limits; oil low
DRIV	Drive overheating
DRY	While in DRY CYCLE, inappropriate command given
DSK1	Unacceptable overspeed disk signal
DSK2	Invalid information during low-speed check
ERRR	Operator error in data entry
IMBL	Imbalanced rotor
LOCK	While in a locked operation, power turned on or STOP pressed
MPAC	Memory-Pac module damaged, missing, or inserted incorrectly
MXTP	Excessive rotor temperature
NOTM	Temperature control system malfunctioning
OIL	Flow of drive oil impeded
PWR	Loss of power occurred while main circuit breaker on
SPED	Excessive rotor speed
TACH	Unacceptable tachometer signal
VAC	Loss of chamber vacuum
ZONL	Key in zonal position
Revolutions Counter	Accumulates number of rotor revolutions in thousands of revolutions
Barrier Ring	41-mm (1.63-in.) heat-treated steel alloy armor ring surrounded by a 13-mm (0.50-in.) steel vacuum chamber to provide full protection for the operator
Door	17-mm (0.67-in.) high-strength structural steel
Vacuum	Diffusion pump in series with a mechanical pump reduces chamber pressure to below 5 microns (0.665 Pa).
RS 232C Accessory	Optional RS 232C Interface Kit available
Dual Program	Permits entry of two sets of run conditions, which are then carried out in sequence.
Memory-Pac™ Module	Programmable storage module, which holds one or two sets of run conditions; permits the exact duplication of runs
Instrument Classification	H

Preinstallation Requirements

CAUTION

Do not attempt to install this instrument. The purchase price of this instrument includes installation by Beckman personnel. Installation by anyone other than authorized Beckman personnel invalidates any warranty covering the instrument.

Preinstallation requirements have been sent prior to shipment of the instrument. The following information is provided in case the ultracentrifuge must be relocated. Contact your Beckman Field Service Representative to adjust and level the instrument if it must be moved. The pads, which are affixed to the floor under each leveling leg at installation, prevent possible rotation of the instrument in the event of a rotor mishap. They must be reanchored if the instrument is moved.



ELECTRICAL REQUIREMENTS

The Model L8M instruments require nominal 208 to 240 Vac power, fused for 30 A, 60 or 50 Hz. A 1.8-m (6-ft) power cord with plug is attached to 60-Hz instruments. A 1.6-m (5 $\frac{1}{3}$ -ft) power cord on the 50-Hz instruments is not equipped with a plug, so both a receptacle and a plug complying with local electrical codes must be procured.

WATER REQUIREMENTS (for optional water-cooled drive only)

The L8M Ultracentrifuge may be ordered with an optional water-cooled drive. These units require clean (water hardness of 80 ppm maximum, and pH of 6 to 10), cool water at a flow rate of at least 1.9 liters (0.50 gal) per minute, measured at the drain line. This flow rate requires that the cooling water pressure be at least 140 kPa (20 psig). These instruments are shipped with 1.3-m (4 $\frac{1}{3}$ -ft) inlet and outlet lines attached. Each line is equipped with a $\frac{1}{4}$ -in. female flare fitting. The user must provide a manual valve with a $\frac{1}{4}$ -in. male flare fitting, and the drain may be either open or provided with a $\frac{1}{4}$ -in. male flare fitting.

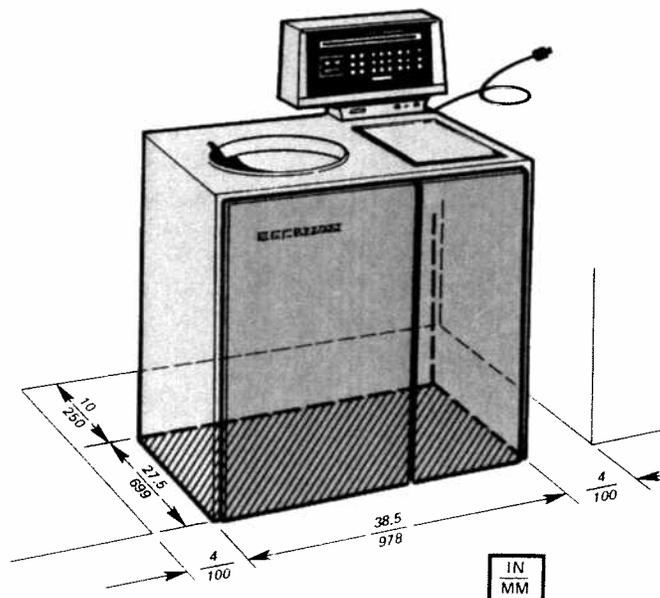
MAXIMUM HEAT DISSIPATION into the room
(measured for L8-80M)

2.17 kW (7400 Btu/h) refrigerated drive
1.52 kW (5200 Btu/h) water-cooled drive

Physical Data

Weight	558 kg (1230 lb)
Height	1295 mm (51 in.)
Width	978 mm (38.5 in.)
Depth	699 mm (27.5 in.)
Clearances	100 mm (4 in.) sides; 250 mm (10 in.) rear
Nominal Power	208/240 Vac, 60 Hz; 220 Vac, 50 Hz; single phase
Fusing	30-A circuit breaker (on/off)
Finish	Mylar* or coated polyester on control panel; urethane paint on top surface; general purpose paint on other surfaces
Refrigerant	R 12 (dichlorodifluoromethane)

Locate the instrument in a clean, safe, uncluttered environment. Observe the rear and side clearances, as sufficient air ventilation is required. The Model L8M will operate within specifications in a laboratory with ambient temperature ranging from 15 to 40°C.



*A registered trademark of E.I. du Pont de Nemours & Company.

Description

The Model L8M Preparative Ultracentrifuge, classified H, is used to generate centrifugal forces for the separation of particles. The Model L8M can be used with any of Beckman's family of ultracentrifuge rotors (except the Type 15 rotor). This section describes the control panel and major instrument components.

CONTROL PANEL

Run conditions are entered using the touch switches on the control panel. These conditions include SPEED and TEMPERATURE, and TIME, HOLD, or $\omega^2 t$. VACUUM is activated automatically when **START** is pressed, or can be turned on beforehand. Slow ACCEL and DECEL profiles, DUAL PROGRAM, DRY CYCLE, PROGRAMMED OPERATION, and Stop-Parameter Recall are special features that may be selected (Figure 1).

Audio and visual signals assist in correctly setting the run conditions. An audible beep and green light-emitting diodes (LEDs) signal when each switch has been activated. During the run, blinking LEDs signal which functions are progressing toward set conditions. When the instrument reaches these set values, the LEDs stop blinking and remain on for the duration of the run.

Diagnostic messages appear on the control panel to assist the user in proper operation of the instrument. These messages are described in TROUBLESHOOTING.

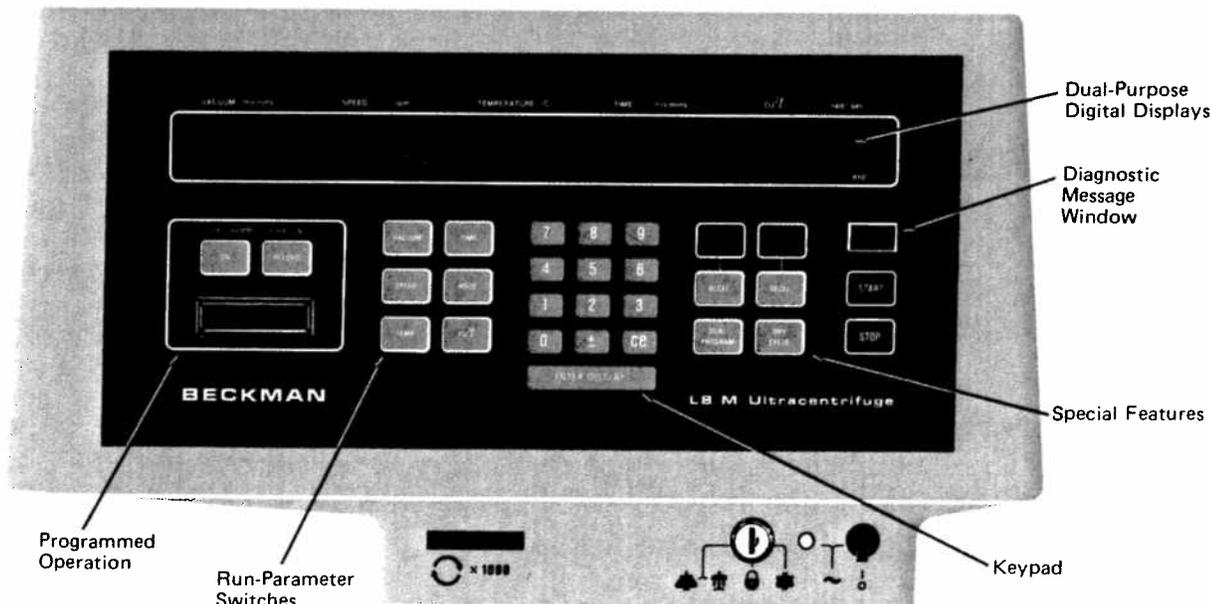
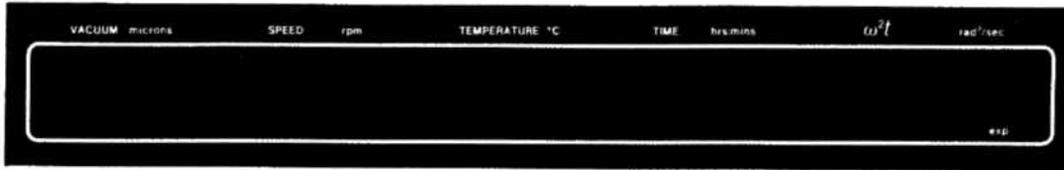


Figure 1. L8M Control Panel

DIGITAL DISPLAYS



Dual-purpose digital displays indicate chamber vacuum, rotor speed, rotor temperature, run time remaining or elapsed, and accumulated $\omega^2 t$. The actual (real-time) operating conditions of the instrument are displayed unless the unit is in the input mode or **ENTER/DISPLAY** is pressed, when the set values (those selected by the operator) are shown for 5 seconds. After 5 seconds, the displays return to real-time conditions. (The set values are retained in memory until new values are entered or the power is turned off.)

DOOR

The door is made of 17-mm (0.67-in.) high-strength structural steel. It can be unlocked only by using the door handle, and opened only if the power is on and the vacuum is off. Open-door operation up to 3000 rpm is permitted for ZONAL operation.

ROTOR CHAMBER

The rotor chamber is heavy aluminum, coated with a chemically resistant epoxy finish. The rotor drive spindle, radiometer, and photoelectric devices are visible in the bottom of the chamber (Figure 2).

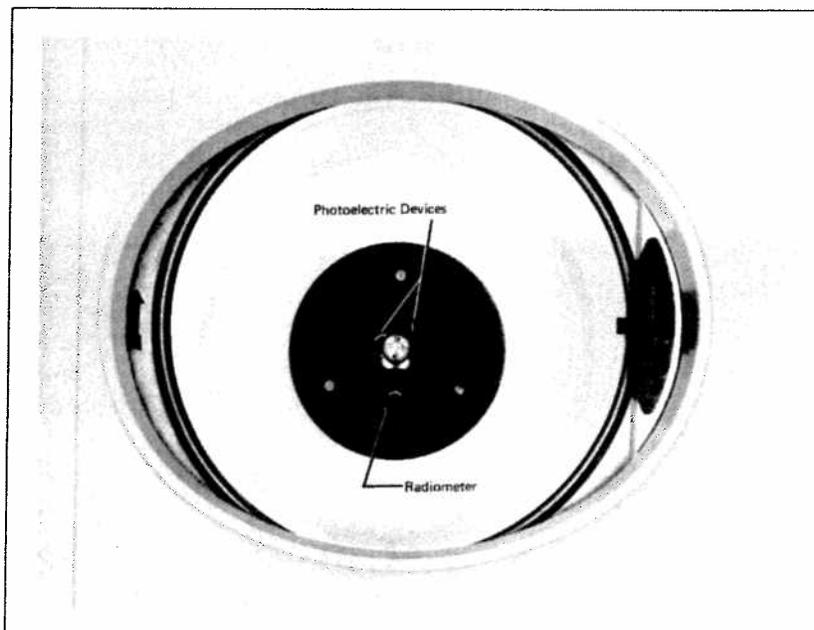


Figure 2. The Rotor Chamber

TEMPERATURE SENSING

The temperature of the rotor is continuously monitored by an infrared radiometer in the bottom of the rotor chamber (see Figure 2). The sensor functions when good vacuum (< 100 microns) is attained. Actual rotor temperature, after equilibration, is controlled to within 1° of the set run

temperature. Peak to peak fluctuations of rotor temperature will be within 0.3° (see Figure 3). The digital temperature readout will be within 1° of the actual rotor temperature.

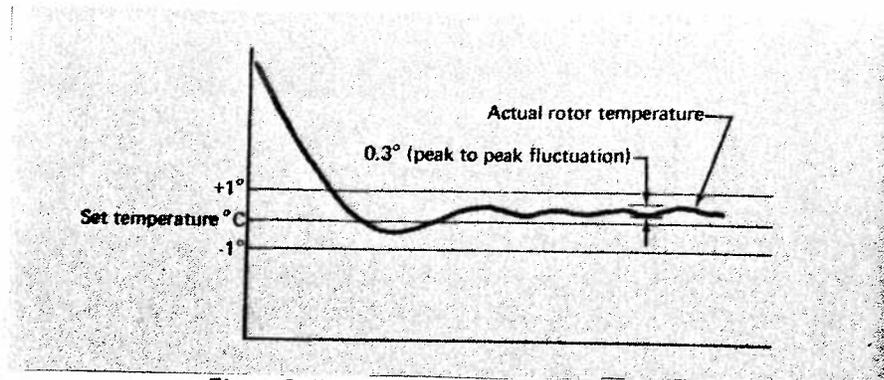


Figure 3. Temperature Control Diagram

OVERSPEED SYSTEM

The overspeed system is a safety feature, which checks the rotor at both low and high speeds to ensure that the rotor does not exceed its maximum allowable speed. This system includes photoelectric devices in the rotor chamber next to the drive hub (Figure 2) and an overspeed disk on the rotor bottom (Figure 4). The appropriate disk must be correctly installed on the rotor for the instrument to operate. Individual rotor bulletins provide information on the correct overspeed disks for each rotor.

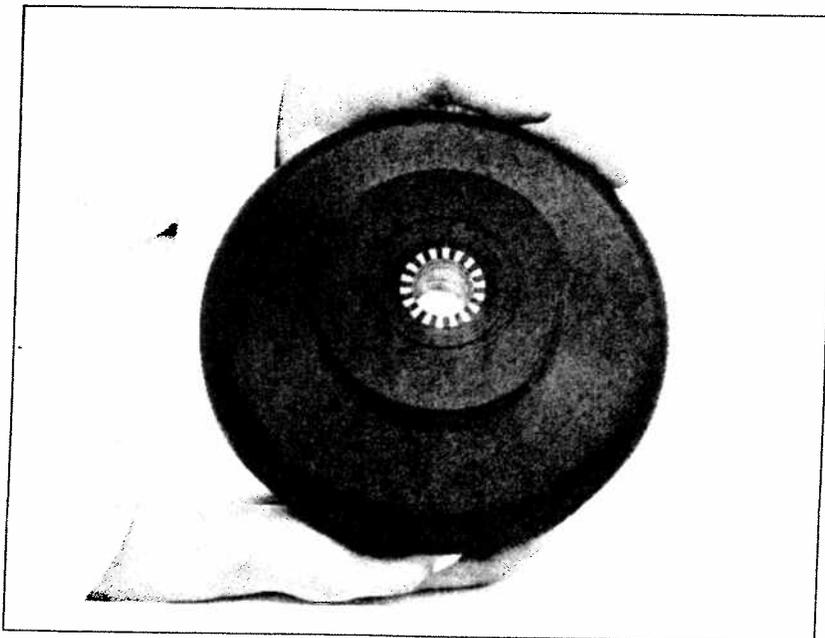


Figure 4. Rotor with Overspeed Disk Attached

The overspeed disk has alternating light and dark sectors (Figure 4). As the rotor spins, the passage of reflecting and nonreflecting sectors over the photoelectric device generates a series of pulses that are detected by the electronic circuitry.

Description

Low-Speed Check

At 1000 rpm, the disk is checked. If the *set* speed is greater than the maximum speed permitted by the disk, the diagnostic message **■■■■** will appear and the SPEED display will begin to flash. The instrument corrects the error and the rotor accelerates to the disk's permitted maximum speed. The run continues uninterrupted. When **[ENTER/DISPLAY]** is pressed, *the corrected speed rather than the original incorrect speed appears in the display.*

High-Speed Check

A high-speed check of the overspeed system occurs during the run to ensure that the rotor does not exceed set speed.

DRIVE

The Model L8M uses the Ultra-Smooth direct drive, induction motor system. The system is frequency-controlled, eliminating the need for motor brushes. Because the rotating shaft, or spindle, is attached directly to the motor, no gears are necessary. The absence of gears and motor brushes results in ultra-smooth, quiet performance. The entire drive is integrated into a vacuum envelope and, thus, does not require an oil-bushing vacuum seal or external oil reservoir. The drive is freon or water cooled.

The L8M induction motor system provides faster acceleration and deceleration of the rotor than previous models. Also, it is extremely accurate: actual rotor speed is within 20 rpm of the set speed.

VACUUM SYSTEM

The instrument uses a diffusion pump in series with a mechanical vacuum pump to reduce chamber pressure to below 5 microns (0.665 Pa). The diffusion pump is automatically activated when chamber pressure reaches about 750 microns.

REFRIGERATION

The refrigeration compressor is activated when the main power circuit breaker is turned on, but there is no cooling effect in the chamber until the door is closed and the vacuum pump is turned on (unless ZONAL operation has been selected). Operating temperatures can be set between 0 and 45°C.

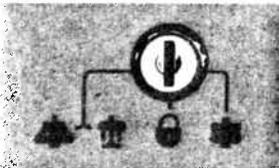
Operation

This section explains how to use the control panel (including the power switch and key positions) to operate the instrument. Use the foldout illustration at the back of the manual to locate displays and switches. Remember, the Ultra-Smooth drive should not be operated without a rotor, so do not press [START] unless a rotor is installed on the drive.



POWER

The main POWER switch controls primary power to the instrument. Power must be on before the chamber door can be opened. Do not use the POWER switch to abort a run; press [STOP] instead.



KEY POSITIONS

Use the key interlock switch to select NORMAL, LOCKED, or ZONAL modes. Insert the key, with teeth facing downward. The teeth will face in the direction of the selected key position (Figure 5).

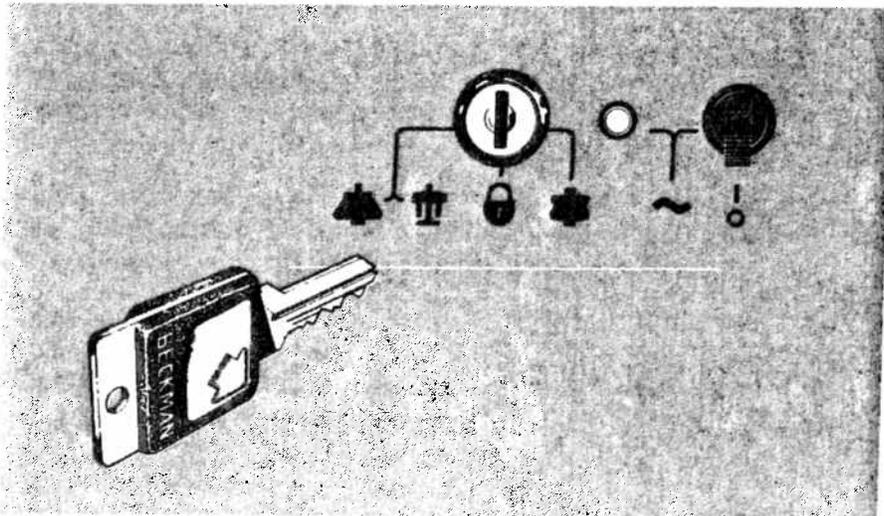


Figure 5. Insertion of Key into the Instrument

CAUTION

In case of a shutdown diagnostic, be sure to keep the power ON until the rotor has stopped. Turning it off disables certain protective features of the software. In the case of a TACH diagnostic, wait an hour before proceeding with the instructions under TROUBLESHOOTING.

Operation



NORMAL

Turn the key clockwise to the  position for routine closed-door centrifugation. (The key may be removed while in this position.)



LOCKED

Turn the key vertically to the  position for operation according to the values *presently* in the instrument. (In DUAL PROGRAM, both programs will be run in sequence.) The key can be removed from the instrument while in this position.



ZONAL

Turn the key counterclockwise to the  position for runs in which the rotor is loaded and unloaded while it is spinning. The key cannot be removed while in this position. (Read the warning information under ZONAL OPERATION before beginning the run.)



KEYPAD

Use the keypad for the numerical entry of set values. There are keys for digits 0 through 9 as well as for \pm (plus or minus)¹ and **ce** (clear entry), and an **ENTER/DISPLAY** switch.

To enter set values, press the keys in the desired sequence.

Example: To key in 2 hours and 30 minutes, press **2** **3** **0** in that order.

Also, use the numerical keys to enter slow ACCEL and DECEL profile numbers and programs 1 and 2 in DUAL PROGRAM.

ce

Clear Entry Key

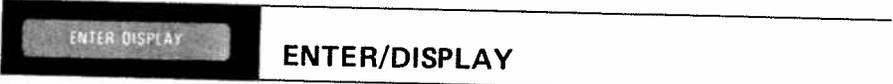
The clear entry key operates only after a run-parameter switch is activated (that is, the instrument is in the input mode).

- Press **ce** *once* to clear a numerical entry; "0" will flash in the display. Reenter the correct numbers.

Example: You want to enter 10:00 as your set time; however, you press **1** **0** **5** **0** by mistake. Press **ce** *once*. The display will flash "0000." Reenter **1** **0** **0** **0** in that order.

¹ The \pm key is only used by Beckman Field Service Representatives when servicing the instrument.

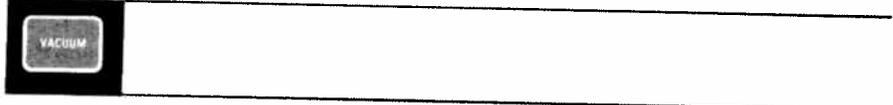
- Press **ce** twice in succession to exit from the input mode. The LED on the switch goes out. The associated display stops flashing and returns to real-time conditions. The switch is no longer activated.
- Press **ce** once to clear the **ERRR** diagnostic message.



- Press **ENTER/DISPLAY** to enter set values into memory. Unacceptable numbers (for example, 90 000 rpm) are indicated by the **ERRR** diagnostic and will not be accepted. The display must be cleared by pressing **ce**, and the correct numbers entered.
- Press **ENTER/DISPLAY** at any time to display set values for 5 seconds.
- After a run, press **ENTER/DISPLAY** and **STOP** to display the run conditions that existed when the rotor began to decelerate. This command is called Stop-Parameter Recall. These *recall* values are retained in memory until a new run is started, or the power is turned off.

NOTE: **ENTER/DISPLAY** must be the last switch pressed before pressing **START** to begin the run.

BASIC RUN PARAMETERS



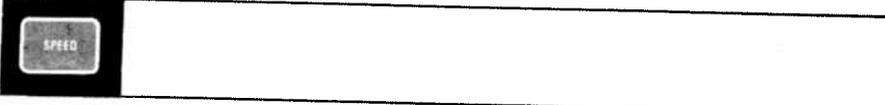
The vacuum system is activated automatically when you press **START** to begin a run. To turn the vacuum on before pressing **START** :

1. Close the chamber door.
2. Press **VACUUM**. "-- --" (three bars) appear in the display. When the chamber vacuum reaches 900 microns, the display will begin to show values decrementally in microns (see Table 1).

When the run begins, the rotor will not accelerate past 3000 rpm until the vacuum reaches 750 microns. At that time, the rotor accelerates to set speed. The vacuum LED stops blinking and remains on until the vacuum is released at the end of the run. (If the rotor delays too long, consult TROUBLESHOOTING.)

To vent the chamber, press **VACUUM**. The instrument will accept the command only when the rotor speed is 3000 rpm or lower. The chamber door can be opened *only* when the vacuum has been completely vented and the rotor is at rest (except in the ZONAL mode).

Should the vacuum deteriorate during a run, the diagnostic message **VAC** will appear on the control panel and the rotor will brake to a stop. Consult TROUBLESHOOTING.



The **SPEED** display indicates the actual speed of the rotor or, in the input mode, the set speed in revolutions per minute. The real-time display shows speeds above 1000 rpm in increments of 100 (example: 45 700 rpm) and speeds below 1000 rpm in increments of 10 (example: 680 rpm).

Table 1. Chamber Pressure. Values are displayed decrementally on the control panel.

VACUUM Display (microns)
900
800
750*
700
600
500
450
400
350
300
250
200
150†
100
90
80
70
60
50
40
30
25
20
15
10
9
8
7
6
5
4
3
2
1

*Rotor does not accelerate past 3000 rpm until 750 microns reached.
 † DRY CYCLE completed.

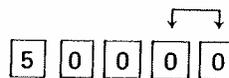
Operation

Speed may be set between 1000 rpm and the instrument's maximum speed. In the input mode, the last two digits of the SPEED display are fixed as zeros and cannot be changed by keypad entries.

To enter speed:

1. Press **SPEED**. The SPEED display will flash.
2. Press the numerical keys to enter the desired speed.

Example: To enter 50 000 rpm, press **5 0 0** in that order. Remember, the last two digits are fixed as zeros, so it is unnecessary to enter them.



3. Check the SPEED display. If the entry is incorrect, press **ce**, and reenter the correct digits.
4. Press either the next run-parameter switch or **ENTER/DISPLAY**. If you have entered a speed below 1000 rpm (other than 0 rpm in a delayed-start run) or above the instrument's maximum speed, **ERRR** will flash on the control panel. Press **ce** and reenter an acceptable value. Press the next switch or **ENTER/DISPLAY**.

During the run, the rotor's overspeed disk is checked at 1000 rpm. If the set speed is greater than that allowed by the overspeed disk, **ERRR** will appear and the SPEED display will flash. The run will continue uninterrupted, but the rotor will accelerate only to the maximum speed permitted by the disk. To clear the diagnostic, press **SPEED** and **ENTER/DISPLAY**. The maximum rotor speed is the new set speed.

To change the set speed so that it is *lower* than the rotor's maximum speed, press **SPEED**, **ce**, the correct numerical digits, and **ENTER/DISPLAY**.

Remember that the rotor will not accelerate beyond 3000 rpm until a sufficient vacuum is achieved. When the vacuum reaches about 750 microns, the rotor accelerates to set speed.

The set speed can be changed at any time (except when the key is in the  position) by pressing **SPEED**, the correct numerical digits, and **ENTER/DISPLAY**. The rotor will promptly accelerate or decelerate to the new set speed.

If during the run the rotor exceeds its maximum allowable speed, the diagnostic message **SPED** will appear on the control panel. Consult TROUBLESHOOTING.



The TEMPERATURE display indicates the *actual* rotor temperature or, in the input mode, the *set* temperature. The run temperature can be set from 0 to 45°C. If no value is entered, the instrument automatically selects 25°C as the run temperature. Maximum rotor temperature can be set from 5 to 50°C; however, it must always be set at least 5° above the set run temperature. If no maximum temperature is entered, the instrument automatically selects 50°C. Should the set temperature be increased at any time, the maximum temperature will be automatically increased as well, if necessary, to maintain the 5° difference.

To enter rotor temperature:

1. Press **TEMP**. The TEMPERATURE display will flash.
2. Press the numerical keys to enter the desired temperature.

Example: To enter 23°C, press **2** **3** in that order.

3. Check the TEMPERATURE display. If the entry is incorrect, press **ce**, and reenter the correct digits.
4. If you do not wish to enter MAX TEMP, press the next run-parameter switch or **ENTER/DISPLAY**.

To enter MAX TEMP:

1. Press **TEMP** a second time. A green LED, reading MAX, will appear to the left of the TEMP switch.
2. Press the numerical keys to enter the desired MAX TEMP.
3. Check to make sure that the entry is correct. Press the next run-parameter switch or **ENTER/DISPLAY**.

The set temperature and/or maximum temperature can be changed at any time (except during a locked operation), by repeating the steps above. The rotor temperature will be adjusted accordingly.

If the rotor exceeds the set maximum temperature, the diagnostic message **MXTM** will flash on the control panel. To clear this diagnostic, reset the MAX TEMP to a temperature higher than the actual rotor temperature. For low-temperature runs, you may have to wait to set the MAX TEMP until after the rotor has reached set temperature. If the temperature control system is malfunctioning, the diagnostic **NOTM** will appear. Consult TROUBLESHOOTING.

RUN-DURATION MODES

The duration of a run depends on which mode (TIME, HOLD, or $\omega^2 t$) you select. What appears in the TIME display also depends on the mode selected. The run-duration mode can be changed at any time by pressing the appropriate switch and entering the new value, except when the instrument is in a locked operation.



In the TIME mode, the TIME display indicates the time *remaining*, in hours and minutes. (When **ENTER/DISPLAY** is pressed, the *set* time is displayed.) The run time can be set for up to 99 hours and 59 minutes.

To enter run time:

1. Press **TIME**. The TIME display will flash.
2. Press the numerical keys to enter the desired time.

Example: To enter a run time of 12 hours and 30 minutes, press **1** **2** **3** **0** in that order.

3. Check the TIME display. If the entry is incorrect, press **ce** and reenter the correct digits.
4. Press the next run-parameter switch or **ENTER/DISPLAY**.

The TIME display begins counting down when the rotor begins to turn in a NORMAL operation (or when the chamber door is closed after the rotor has been loaded in a ZONAL operation). The display shows the time remaining; when the TIME display reaches zero, the rotor decelerates to end the run.

When speed *and* time have been entered, the instrument will automatically compute an approximate value for equivalent $\omega^2 t$. When you press **ENTER/DISPLAY**, this computed value will be displayed. Otherwise, in the TIME mode, the $\omega^2 t$ display remains blank (see Figure 6).



Use HOLD as the run-duration mode for continuous operation.

To select HOLD:

1. Press **HOLD**. The word "HOLD" will appear in the TIME display.
2. Press the next run-parameter switch or **ENTER/DISPLAY**.

During the run, the TIME display indicates the time that has *elapsed* since the rotor began to turn in a NORMAL operation (or when the chamber door was closed after the rotor was loaded in a ZONAL operation). The run will continue until you press **STOP**; time will continue to accumulate in the display until the rotor stops. The instrument does not compute a value for $\omega^2 t$ in the HOLD mode (see Figure 6).



The sedimentation that occurs during acceleration and deceleration can be a significant contribution to the total centrifugal effect of a run. In such cases, the value of $\omega^2 t$ represents a better measure of centrifugal effect than do the speed and time values, and $\omega^2 t$ is the desired run-duration mode.

The $\omega^2 t$ display indicates the accumulated centrifugal effect in radians squared per second, to three significant figures and exponential notation. $\omega^2 t$ can be set for up to 9.99×10^{14} radians squared per second. The integrator accumulates $\omega^2 t$ during the run. Deceleration begins when the preset value is reached. The integrator then *continues* to accumulate $\omega^2 t$ until the rotor comes to rest. The value displayed at that time represents the *total centrifugal effect* on the sample.

To select $\omega^2 t$:

1. Press **$\omega^2 t$** . The $\omega^2 t$ display will flash.
2. Press the numerical keys to enter the desired value.

Example: To enter 3.24×10^{12} , press **3 2 4 1 2** in that order.

3. Check the $\omega^2 t$ display. If the entry is incorrect, press **ce** and reenter the correct digits.
4. Press the next run-parameter switch or **ENTER/DISPLAY**.

When speed *and* $\omega^2 t$ have been entered, the instrument will automatically compute a value for TIME (approximate length of the run; see Figure 6). Three bars will appear in the display if the computed value exceeds the display limits.

The $\omega^2 t$ display begins accumulating when **START** is pressed and stops when the rotor comes to rest. Press **ENTER/DISPLAY** and **STOP** sequentially to show the values that existed when the rotor began its deceleration. These *recall values* will be retained in the memory until a new run is started, or the power is turned off. (To duplicate a run, select $\omega^2 t$ as the run-duration mode and enter the $\omega^2 t$ recall value into the display.)

Accumulated $\omega^2 t$ automatically returns to zero when **START** is pressed to begin the next run.

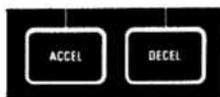
In a dual program, however, if $\omega^2 t$ is the run mode, the value set in program 2 will be the final accumulated value at the end of the run. $\omega^2 t$ *does not* return to zero at the end of program 1.

	(set)	Set Speed	Set Time	(computed)
TIME	(real-time)	Actual Speed	Time Remaining	
	(stop-parameter recall)	Actual Speed	Time Remaining	Accumulated $\omega^2 t$
	(set)	Set Speed	"HOLD"	
HOLD	(real-time)	Actual Speed	Time Elapsed	
	(stop-parameter recall)	Actual Speed	Time Elapsed	Accumulated $\omega^2 t$
	(set)	Set Speed	(computed)	Set $\omega^2 t$
$\omega^2 t$	(real-time)	Actual Speed		Accumulated $\omega^2 t$
	(stop-parameter recall)	Actual Speed	Time Elapsed	Accumulated $\omega^2 t$

Figure 6. Displayed Values for TIME, HOLD, and $\omega^2 t$ Modes. Set values are those that are selected by the operator. These are displayed in the input mode or when **ENTER/DISPLAY** is pressed. Real-time values are the actual operating conditions of the instrument. "Computed" values are those that the instrument automatically computes after the other two set values have been entered. (No value is computed in the HOLD mode.) The stop-parameter recall values indicate the conditions existing in the instrument when the rotor begins to decelerate.

Operation

RUN MODIFIERS



The L8M provides 9 slow acceleration profiles to protect the sample and the sample-to-gradient interface and 10 slow deceleration profiles to maintain sample separation.

Table 2 lists the two sets of profiles by keypad number. The rotor speeds listed under ACCELERATION indicate the speed at which the rotor *completes* its slow acceleration and begins its maximum acceleration to set speed. The times (in minutes and seconds) indicate how long it takes for the rotor to accelerate from zero to that speed (170, 350, or 500 rpm).

The rotor speeds listed under DECELERATION in Table 2 indicate the speed at which the rotor *begins its slow deceleration*. (Until that point the rotor has been decelerating with full dynamic braking.) The times (in minutes and seconds) indicate how long it takes the rotor to decelerate from 500, 350, or 170 to 0 rpm. For a stop without the brake from any speed, select deceleration profile 0. (The time it will take for the rotor to come to rest depends on the speed at which deceleration begins and the rotor being used.)

Figure 7 is a diagrammatic view of the slow acceleration and deceleration curves.

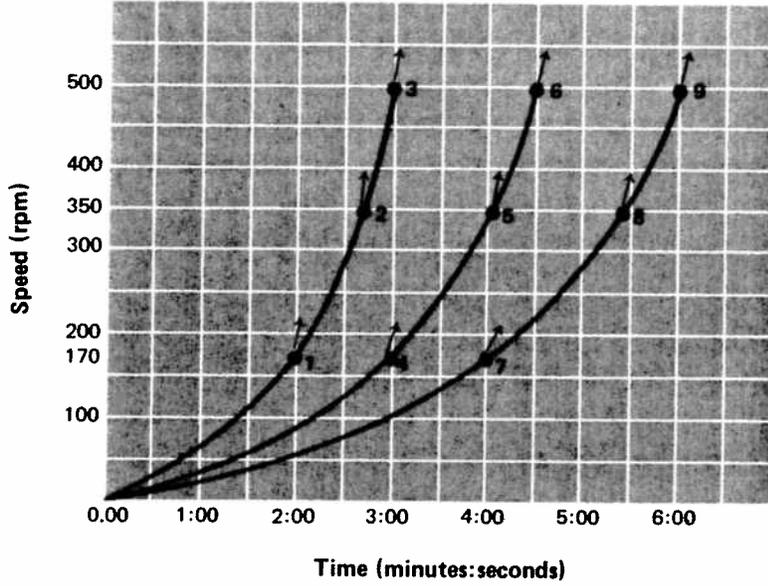
Table 2. Slow Acceleration and Deceleration Profiles

ACCELERATION		
1	170 [†]	2:00
2	350	2:40
3	500	3:00
4	170 [†]	3:00
5	350	4:00
6	500	4:30
7	170 [†]	4:00
8	350	5:20
9	500	6:00
DECELERATION		
1	170 [†]	2:00
2	350	2:40
3	500	3:00
4	170 [†]	3:00
5	350	4:00
6	500	4:30
7	170 [†]	4:00
8	350	5:20
9	500	6:00
0	deceleration from any speed to zero without brake	

*Rotor speeds under Acceleration indicate the point at which the rotor begins its maximum acceleration to set speed. Speeds under Deceleration indicate the point at which slow deceleration begins.

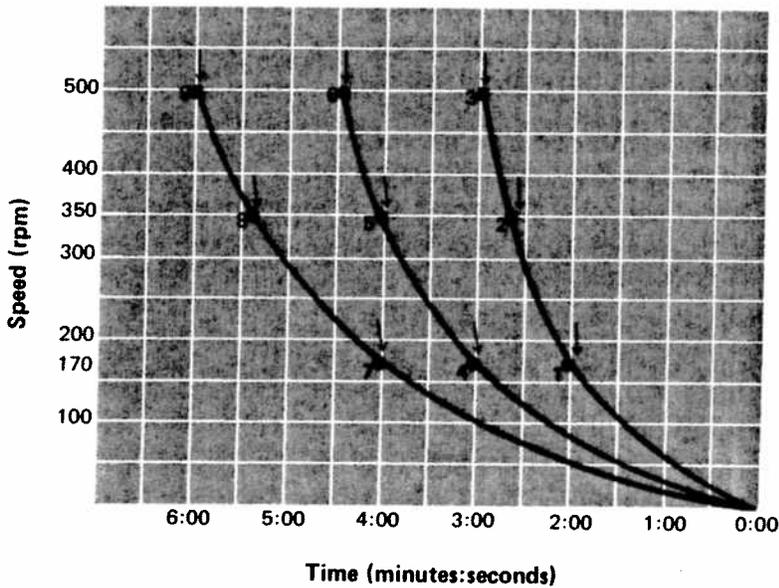
[†]When using swinging bucket rotors SW 41 Ti, SW 40 Ti, SW 28.1, SW 28, SW 27.1, SW 27, SW 25.2, and SW 25.1, select 170 rpm only.

ACCELERATION CURVES



(Arrows indicate the point from which the rotor begins maximum acceleration to set speed. Numbers indicate which key to press to select that profile.)

DECELERATION CURVES



(Arrows indicate the point at which the rotor begins slow deceleration. Numbers indicate which key to press to select that profile.)

Figure 7. Slow Acceleration and Deceleration Curves. The rotor accelerates and decelerates very smoothly; however, the digits in the SPEED display may vary slightly at speeds below 50 rpm.

Operation

To enter slow ACCEL:

1. Press **ACCEL**. The ACCEL display will flash.
2. Press the numerical key that matches the desired ACCEL profile. The number will appear in the display above the ACCEL switch.
3. Check the ACCEL display. If the number is incorrect, press **ce** and reenter the correct digit.
4. Press the next run-parameter switch or **ENTER/DISPLAY**.

To enter slow DECEL:

1. Press **DECEL**. The DECEL display will flash.
2. Press the numerical key that matches the desired DECEL profile. The number will appear in the display above the DECEL switch.
3. Check the DECEL display. If the number is incorrect, press **ce** and reenter the correct digit.
4. Press the next run-parameter switch or **ENTER/DISPLAY**.

To select a stop without the brake *during deceleration*, press **DECEL**, **0**, **ENTER/DISPLAY**, and **STOP**. The brake is released immediately and the rotor decelerates to a stop.

NOTE: Profile 0 cannot be selected, however, if another slow DECEL profile has already been entered because the slow DECEL switch cannot be reactivated once the rotor begins to brake.

To exit from slow ACCEL or DECEL *while in the input mode*, press **ce** twice. The display will clear and the LED on the switch will go out.

To exit from slow ACCEL during the run, *while the instrument is operating in that mode*, press **ENTER/DISPLAY** and **START**. Slow ACCEL is immediately negated and the rotor promptly accelerates to set speed.

To exit from slow DECEL, *while the instrument is in that mode*, press **STOP**. The rotor will immediately decelerate with full braking power to a stop. Remember, once the instrument is in slow ACCEL or DECEL during the run, you cannot change the profile number because the switch is inactivated. You can only exit from the mode entirely by following the instructions above.

If neither slow ACCEL or DECEL is selected, the instrument automatically accelerates or decelerates at maximum rates during the run.

Figure 8 is a schematic of typical acceleration and deceleration profiles for NORMAL and ZONAL operations in a single run.

START AND STOP



Press **START** to begin a run. The green LED above the switch indicates that the rotor is accelerating or at full speed. (For repeat runs and runs in the locked operation, press **ENTER/DISPLAY** and **START**.)

NOTE: To begin a run, **ENTER/DISPLAY** must always be the last switch pressed before pressing **START**. Further, **START** must be pressed within the 5-second period when set values are being displayed. If you wait beyond the 5 seconds, the **START** switch will not be activated. If this happens, press **ENTER/DISPLAY** and **START** again to begin the run.

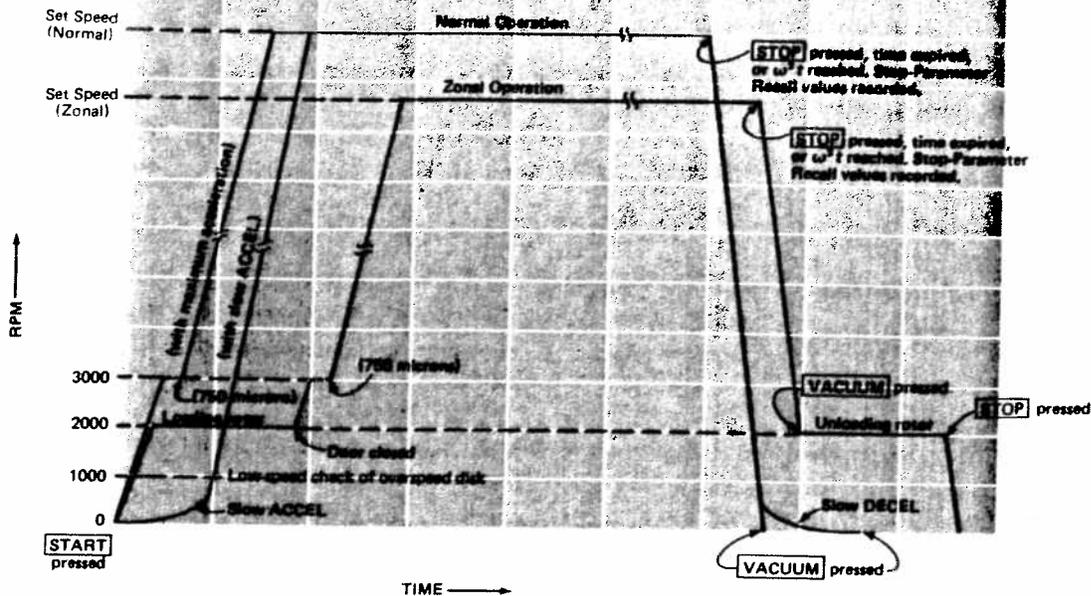
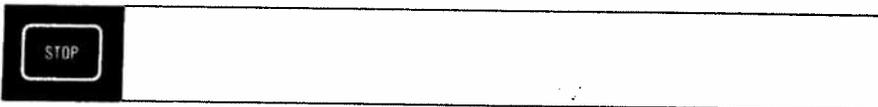


Figure 8. Typical Acceleration and Deceleration Profiles for a Single Run



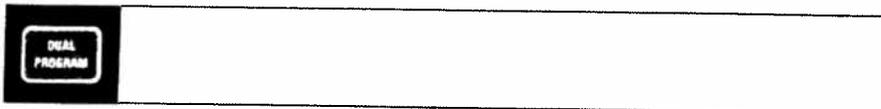
Press **STOP** to terminate a run. The green LED below the switch will blink to indicate that the rotor is decelerating. The LED will go out when the rotor comes to rest.

After a run, press **ENTER/DISPLAY** and **STOP** to display the actual values that existed when the rotor began its deceleration. These "recall" values are retained in memory until a new run is started or the power is turned off.

If you press **STOP** during a locked operation, the diagnostic message **LOCK** will flash and the rotor will decelerate to a stop. To clear the diagnostic or restart the run, first turn the key to ; then proceed according to directions under **LOCKED** operation.

NOTE: The **STOP** switch is always active and can be pressed at any time to terminate a run.

SPECIAL FEATURES



Dual program permits the entry of two sets of run conditions, which are then carried out in sequence. This feature is especially useful for delayed-start runs. For example, if you want to complete a 10-hour run at 8 am, you can establish program 1 as a zero-speed run to be completed at 10 pm. Program 2 will start at that time and finish at 8 am the following day.

Operation

To enter program 1:

1. Press **DUAL PROGRAM**, **1**, and **ENTER/DISPLAY**. The "1" to the left of the DUAL PROGRAM switch indicates that you are entering the first set of run conditions.
2. Enter the desired run conditions as described earlier.
3. Press **ENTER/DISPLAY**. (Do not press **START** yet.)

To enter program 2:

4. Press **DUAL PROGRAM**, **2**, and **ENTER/DISPLAY**. A "2" will appear to the left of the DUAL PROGRAM switch.
5. Enter the second set of run conditions.
6. Press **ENTER/DISPLAY** and **START**.

When you press **START**, program 1 will begin automatically. During the run, the number of the program in progress remains on. To review either or both sets of run conditions in dual program at any time, press **DUAL PROGRAM** and the appropriate program number. The set values for that program will be displayed and the program number will flash in its display.

To exit from this review mode, *first be certain the program number being displayed matches the number of the program in progress.* Then press **ENTER/DISPLAY**.

Example: Program 1 is running. You wish to review the set values in program 2. Press **DUAL PROGRAM**, then **2**. After reviewing the displayed values, press **1**, then **ENTER/DISPLAY**. If you merely press **ENTER/DISPLAY**, the instrument will switch into program 2.

To exit from DUAL PROGRAM entirely, press **DUAL PROGRAM** twice in succession.

Special care must be taken to prepare rotors for use in delayed-start runs. To prevent tube evacuation while the rotor is at zero speed under vacuum conditions, do the following:

1. When using swinging bucket rotors, check that the bucket O-rings or gaskets are in good condition. Then lubricate them with silicone vacuum grease. Apply a light coat of Spinkote™ lubricant to the cap threads.
2. When using fixed angle rotors, lubricate the metal threads with Spinkote lubricant. Check that the O-rings in the lid and handle are in good condition; then lubricate them with silicone vacuum grease. This is particularly important when using uncapped tubes in the run.

It is important that evaporation does not occur while the rotor is at zero speed because it can lead to tube collapse or rotor imbalance during the second part of the run.

Figure 9 is a schematic of typical acceleration and deceleration profiles for dual program runs.

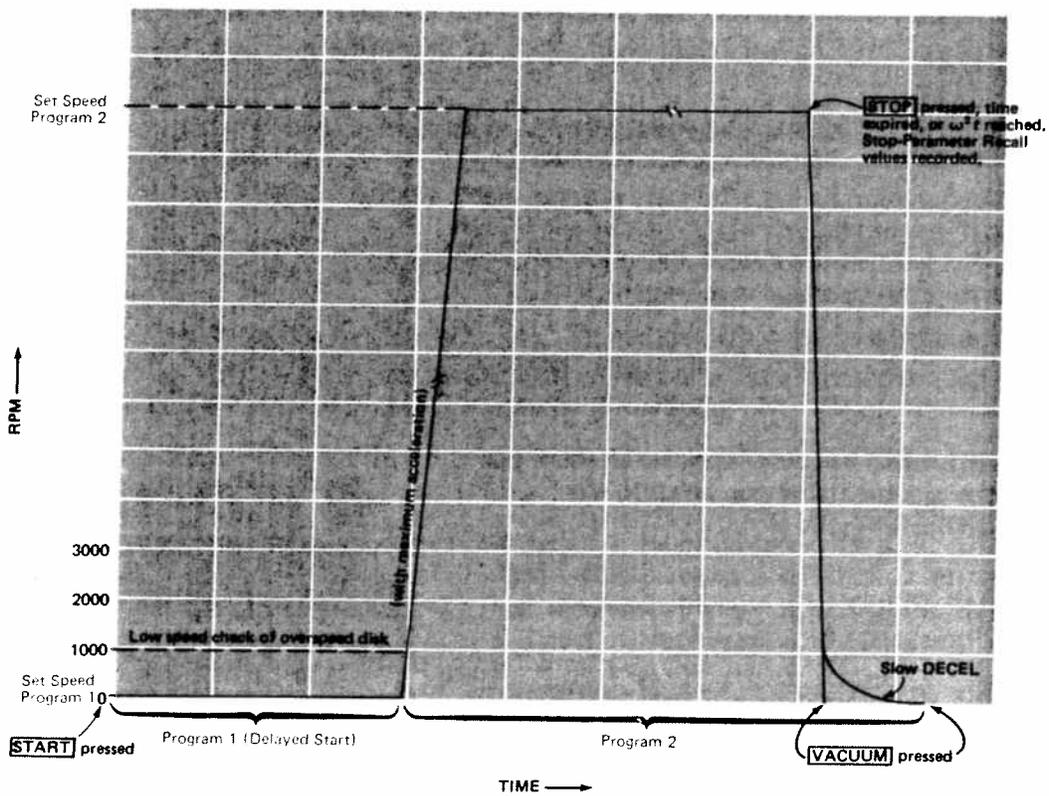
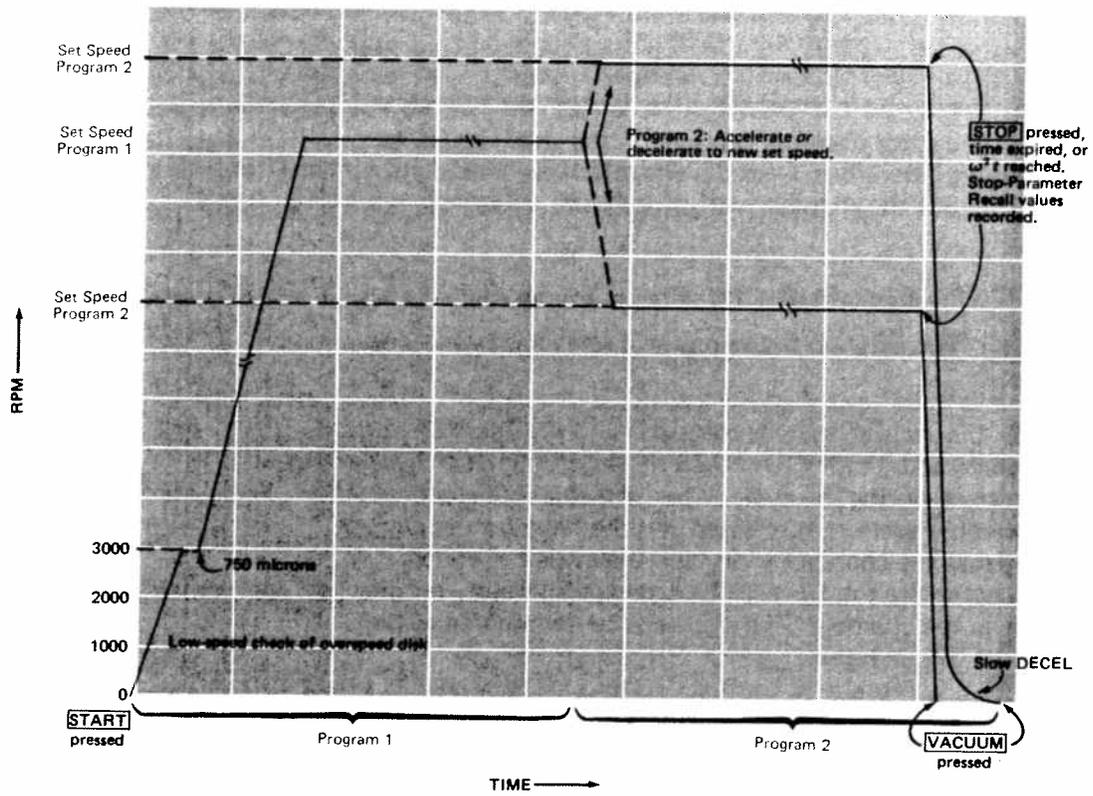


Figure 9. Typical Acceleration and Deceleration Profiles for Dual Program Runs

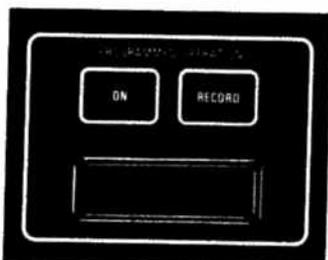
Operation



Excessive moisture in the rotor chamber can extend the time needed to achieve a proper vacuum. Therefore, keep the chamber door closed between runs, and wipe out the chamber with a dry cloth. If necessary, use the dry cycle.

1. Close the chamber door.
2. Press **DRY CYCLE**. The LED on the switch will remain on while the cycle is in progress.

In the DRY CYCLE, the vacuum system comes on and the chamber heats to 50°C. The VACUUM and TEMPERATURE displays indicate actual chamber pressure and temperature during the cycle. When the chamber reaches 150 microns, the chamber vacuum is released and the temperature control turns off, indicating that the chamber is dry and the cycle has ended. The time needed to complete the DRY CYCLE depends directly on the amount of moisture in the chamber. The cycle can be terminated at any time by pressing **DRY CYCLE** again.



MEMORY-PAC™ PROGRAM MODULE

The Memory-Pac program module is a solid-state programmable storage unit, designed to hold one or two sets of run conditions (Figure 10). Use of the Memory-Pac permits the exact duplication of runs quickly and efficiently with minimal operator involvement.

To record a single run on the Memory-Pac module:

1. Turn the power ON. (If there is a rotor in the chamber, it must be at rest.)
2. Remove the black protective cover from the Memory-Pac module. Insert the module (label side up) into the PROGRAMMED OPERATION slot.
3. Enter the desired run conditions (such as SPEED, TEMP, MAX TEMP; TIME, HOLD, or $\omega^2 t$, etc.) to define a complete run. Press **ENTER/DISPLAY**.
4. Press **RECORD**, then **ENTER/DISPLAY**. The program values will be displayed for 5 seconds while the module is programmed. The module can then be removed and the run conditions marked on the label. (Pencilled notations are recommended as they are easier to change.) To begin the run now, press **ENTER/DISPLAY** and **START**.

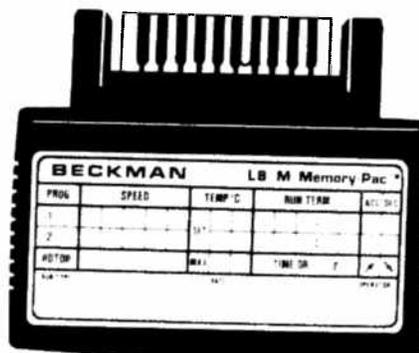


Figure 10. The Memory-Pac Module

The set values remain in the instrument memory until you change them or turn off the power. Changes may be made during the run without affecting the Memory-Pac module. To make changes on the module itself, see *Modifying the Program on the Module*, below.

To record a dual program on the Memory-Pac module:

1. Turn the power ON. (If there is a rotor in the chamber, it must be at rest.)
2. Insert a Memory-Pac module (label side up) into the PROGRAMMED OPERATION slot.

Program 1

3. Press **DUAL PROGRAM**, **1**, and **ENTER/DISPLAY**. The "1" to the left of the DUAL PROGRAM switch indicates that you are entering the first set of run conditions.
4. Enter the desired run conditions.
5. Press **ENTER/DISPLAY**.

Program 2

6. Press **DUAL PROGRAM**, **2**, and **ENTER/DISPLAY**. The "2" appears in its display.
7. Enter the second set of run conditions. Press **ENTER/DISPLAY**.
8. Press **RECORD**, then **ENTER/DISPLAY** twice in succession. Both programs are entered in sequence. (Values for program 2 will be visible in the display for 5 seconds.) The Memory-Pac may be removed and the two sets of run conditions marked on the label. To begin program 1 now, press **ENTER/DISPLAY** and **START**.

Both sets of run conditions will remain in memory until you change them or turn off the power. Changes can be made during the run without affecting the Memory-Pac itself.

To operate the instrument using information from the Memory-Pac see RUN PROCEDURE: Programmed Operation, below.

Modifying the Program on the Module

To modify the program on the Memory-Pac module itself, make sure the power is on and the rotor is at rest. Then follow these steps.

1. Insert the Memory-Pac module into the PROGRAMMED OPERATION slot, label side up.
2. Press **ON** and **ENTER/DISPLAY**. This transfers the information for a single run or program 1 of a dual program into the instrument. Press **ENTER/DISPLAY** a second time if a dual program is being run, to transfer the information for program 2 into the instrument. (The values on the Memory-Pac will be displayed for 5 seconds.)
3. Press **DUAL PROGRAM**, **1**, and **ENTER/DISPLAY** to return to program 1.
4. Press the run-parameter switch to be changed and key in the new values. After completing the changes, press **ENTER/DISPLAY**.

Operation

5. To make changes in program 2, press **DUAL PROGRAM**, **2**, and **ENTER/DISPLAY**. Enter the new values as desired and then press **ENTER/DISPLAY**. (If no changes are to be made in program 2, skip this step.)
6. Press **RECORD**, then **ENTER/DISPLAY** twice. Both sets of run conditions are reprogrammed onto the Memory-Pac module.
7. To begin the run now, press **ENTER/DISPLAY** and **START**.

After removing the program module from the instrument, mark the changes on the label for future use.

If the Memory-Pac module is inserted incorrectly (label side down), or is damaged or defective, **IMPAC** will flash on the control panel. Check or replace the module. Press **ce** to clear the diagnostic; then proceed with the programmed operation.

RUN PROCEDURE

The Model L8M is classified H, and all Beckman ultracentrifuge rotors (except the Type 15 rotor, and Type 35 and Type 42.1 rotors with serial numbers 1299 or lower) can be used in this instrument. Power must be on before the chamber door can be opened. Make certain that the rotor has the appropriate overspeed disk—undamaged and correctly installed. For fast temperature equilibration, refrigerate or warm the rotor to the desired temperature before a run. (Wipe off any condensation on the rotor before placing it in the chamber to speed up chamber evacuation.)

NORMAL (Standard) OPERATION

Manual

1. Turn the POWER switch ON. Open the chamber door and install the rotor; close the chamber door.
2. Turn the key clockwise to the   position.
3. Enter the run conditions (VACUUM, SPEED, TEMP, MAX TEMP; and TIME, HOLD, or $\omega^2 t$) as desired.
4. Select slow ACCEL and/or DECEL profiles if desired.
5. Press **ENTER/DISPLAY** and **START**. (Unless otherwise directed, the vacuum and brake are selected automatically.)

Press **STOP** to terminate a run in the HOLD mode. Runs in the timed or $\omega^2 t$ modes will terminate automatically. After the rotor has stopped, press **VACUUM** to vent the chamber.

Automatic

To repeat the same run in sequence, just press **ENTER/DISPLAY** and **START**. There is no need to reenter any of the run conditions unless you wish to make a change.

Programmed

1. Turn the POWER switch ON. Open the chamber door and install the rotor. Close the chamber door.
2. Turn the key clockwise to the   position.
3. Insert the preprogrammed Memory-Pac module, label side up, into the PROGRAMMED OPERATION slot.

4. Press **ON** and **ENTER/DISPLAY**. This transfers the information for a single run or program 1 of a dual program into the instrument. Press **ENTER/DISPLAY** a second time if a dual program is being run, to transfer the information for program 2 into the instrument.
5. Press **ENTER/DISPLAY** and **START**. (In dual program, when **START** is pressed, the instrument automatically begins with program 1.)
6. Remove the Memory-Pac module if desired.
7. At the end of the run(s), press **VACUUM** to vent the chamber.

Manual Override During a Programmed Operation

Any of the run conditions can be changed while a programmed run is in progress. However, such changes affect only the current run—they do not change the information on the Memory-Pac itself.

To change a run condition during a programmed run:

1. Press the specific run-parameter switch to be changed (for example, TEMP).
2. Use the numerical keys to enter the new value.
3. Press **ENTER/DISPLAY**.

The command has been entered and the instrument will make the change or changes accordingly. The LED on the **ON** switch goes out, indicating that the instrument is no longer operating from the instructions on the Memory-Pac module.

LOCKED OPERATION

To ensure that run conditions are not changed during centrifugation, use the locked operation.

1. Enter the desired run conditions, with the key in the  position.
2. Press **ENTER/DISPLAY** and **START**. Turn the key to the  (vertical) position and then remove it.

To use the locked operation in a ZONAL run, follow steps 1 through 9 under ZONAL OPERATION below before turning the key to the  position. The key must be returned to the  position, however, before the rotor begins to decelerate. This is to ensure that the instrument will complete the run in the zonal mode.

VACUUM, **ENTER/DISPLAY**, **START**, and **STOP** are the only functional switches on the control panel during a locked operation. Run conditions cannot be changed nor diagnostic messages cleared until the key is reinserted and turned to .

If you press **STOP** during a locked operation, the diagnostic **LOCK** will flash and the rotor will decelerate to a stop. To clear the diagnostic or restart the run, turn the key to  and press **ENTER/DISPLAY** and **START**.

If the key is in the  position when the power is turned on, the diagnostic message **LOCK** will flash. Turn the key to  to clear the diagnostic.

Operation

ZONAL OPERATION

WARNING

In ZONAL operation, the operator is unavoidably exposed to rotating machinery. For safety, the operator must be properly instructed and qualified. Guard against accidentally dropping objects (pens, pencils, screwdrivers, reagent containers) into the chamber. Loose lab coats, neckties, scarves, and long necklaces should not be worn.

Manual

Loading

1. Precool the rotor.
2. Turn the POWER switch ON.
3. Turn the key counterclockwise to the  position. This permits open-door operation up to 3000 rpm.
4. Prepare the rotor assembly. Install it and the rotor and anticondensation shields according to instructions in the zonal rotor instruction manual (ZR-IM).
5. Set the run conditions (SPEED, TEMP, MAX TEMP; and TIME, HOLD, or $\omega^2 t$) as desired. In the TIME and $\omega^2 t$ modes, the instrument does not begin counting until the chamber door is closed, after the rotor is loaded.
6. Press **ENTER/DISPLAY** and **START**. The LED above the **START** switch flashes until the rotor accelerates to 2000 rpm.
7. Load the rotor.
8. Disconnect the seal assembly and cap the rotor.

NOTE: **ZONAL** will appear on the control panel to indicate that the key is in the ZONAL position.

Acceleration

9. Close the chamber door. The vacuum system will come on automatically, and in the TIME or $\omega^2 t$ mode, the instrument will begin counting. The rotor will accelerate to 3000 rpm and hold until the proper vacuum is achieved before it accelerates to set speed.

Deceleration

10. The rotor will decelerate to 2000 rpm when the run is terminated (TIME runs out, $\omega^2 t$ reaches preset value, or the **STOP** switch is pressed).

NOTE: If you wish to abort a ZONAL run in progress, turn the key to  and then press **STOP**.

11. When the SPEED display indicates that the rotor is spinning at 2000 rpm, release the chamber vacuum by pressing **VACUUM**. Open the chamber door.

Unloading

12. Unload the rotor according to the instructions in the zonal rotor instruction manual. Press **STOP** after unloading.

Programmed

1. Precool the rotor.
2. Turn the POWER switch ON.
3. Turn the key counterclockwise to the  position.
4. Prepare the rotor assembly. Install it and the rotor and anticondensation shields according to instructions in the zonal rotor instruction manual.
5. Insert a preprogrammed Memory-Pac module, label side up.
6. Press **ON** and **ENTER/DISPLAY** to transfer the information from the Memory-Pac to the instrument.
7. Press **ENTER/DISPLAY** and **START**.
8. Load the rotor, disconnect the seal assembly, cap the rotor, and follow the directions above regarding acceleration, deceleration, and unloading of the rotor in ZONAL operation.

POINTS TO REMEMBER ABOUT THE MODEL L8M

Never operate the drive without a rotor.

Moisture in the rotor chamber will retard achieving a proper vacuum and can lengthen centrifuge run times. Follow these steps to keep the chamber clean and dry.

- Always keep the chamber door closed between runs. If left open, moisture will condense on the chamber walls—particularly after cold runs.
- Wipe off the chamber walls and the rotor with a clean, dry, lint-free cloth before placing the rotor into the chamber.
- Use the DRY CYCLE when necessary.

POINTS TO REMEMBER ABOUT A ROTOR

- Consult the appropriate rotor bulletin for specifications and complete instructions on using the rotor. Refer to the rotor bulletin or the Rotors and Tubes Manual (LR-IM) for information on the care and cleaning of rotors and accessories.
- Do not run a rotor without the appropriate overspeed disk—the one for the rated speed of the rotor—correctly installed. Any substitution can completely negate this important safety system and invalidate the warranty.
- For fast temperature equilibration, refrigerate or warm the rotor to the desired temperature before the run.

Troubleshooting

IN CASE OF POWER FAILURE DURING THE RUN

If facility power fails only momentarily, the L8M will resume operation when power is restored. The cautionary message **PWR** will flash on the control panel to indicate that a power outage has occurred. If the power failure lasts for 15 minutes or more, the diagnostic message **DRV** may flash on the control panel when power is restored. There will be a delay of 3 to 5 minutes until the drive has cooled before the run can be restarted.

CAUTION

Implement the following procedure only when absolutely necessary.

If the power failure lasts for several hours or continues for an indefinite period, it may be necessary to retrieve the sample from the rotor. (A rotor decelerating without the brake in a vacuum may take hours to come to a complete stop.) **DISCONNECT THE POWER CORD**, remove the front panel and **LISTEN CAREFULLY**. Touch the drive housing (Figure 11) to see if it is vibrating, and listen again. *Do not proceed while any sound or vibration is emitted from the drive.*

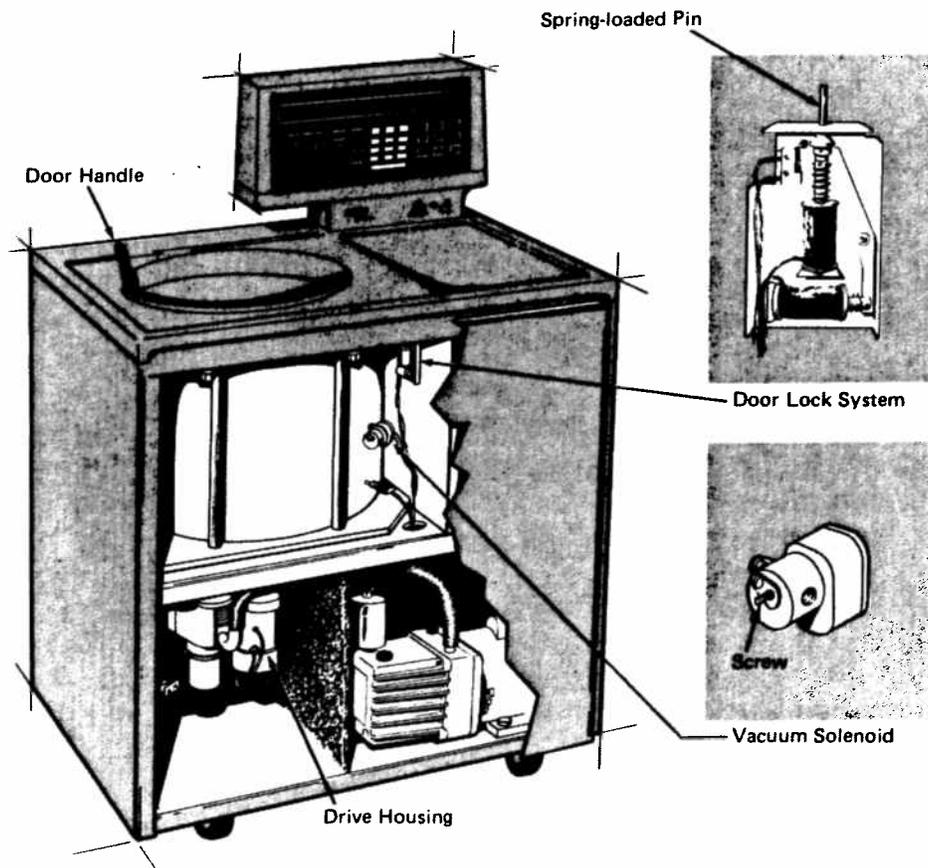


Figure 11. The Drive Housing. Check it for evidence of vibration.

Troubleshooting

Release chamber vacuum by turning the screw on the vacuum solenoid valve until you hear air rushing into the chamber. (If a whining noise is heard, close the valve and wait a little longer—**THE ROTOR IS STILL SPINNING.**) Return the screw to its closed position after the vacuum is vented. Compress the spring on the horizontal solenoid (see the insert in Figure 11). Then pull the spring-loaded pin on the door lock down while pulling back on the door handle to open the chamber door. If the rotor is still spinning, close the door and wait. The drive is particularly quiet and may emit no audible sounds below 5000 rpm.

WARNING

Under no circumstances should an effort be made to slow or stop rotation by hand-braking the rotor.

DIAGNOSTIC MESSAGES

In the event of certain abnormal conditions, a diagnostic message (see Figure 12) will flash on the control panel. Consult the Diagnostic Messages Chart below to determine the nature of the condition and the recommended action.

A number of diagnostic messages indicate "shutdown" conditions, which cause the rotor to decelerate to a stop. The diagnostic and the LED below **STOP** flash, accompanied by an intermittent beep, which continues for 10 seconds. (To silence the beep, press **STOP**.) The LED continues to flash until the rotor comes to a stop, and the diagnostic remains until the condition is corrected.

CAUTION

In the case of a shutdown diagnostic, be sure to keep the power ON until the rotor has stopped. Turning it off disables certain protective features of the software. *In the case of a **TACH** diagnostic, wait an hour before proceeding with the instructions given in the chart below.*

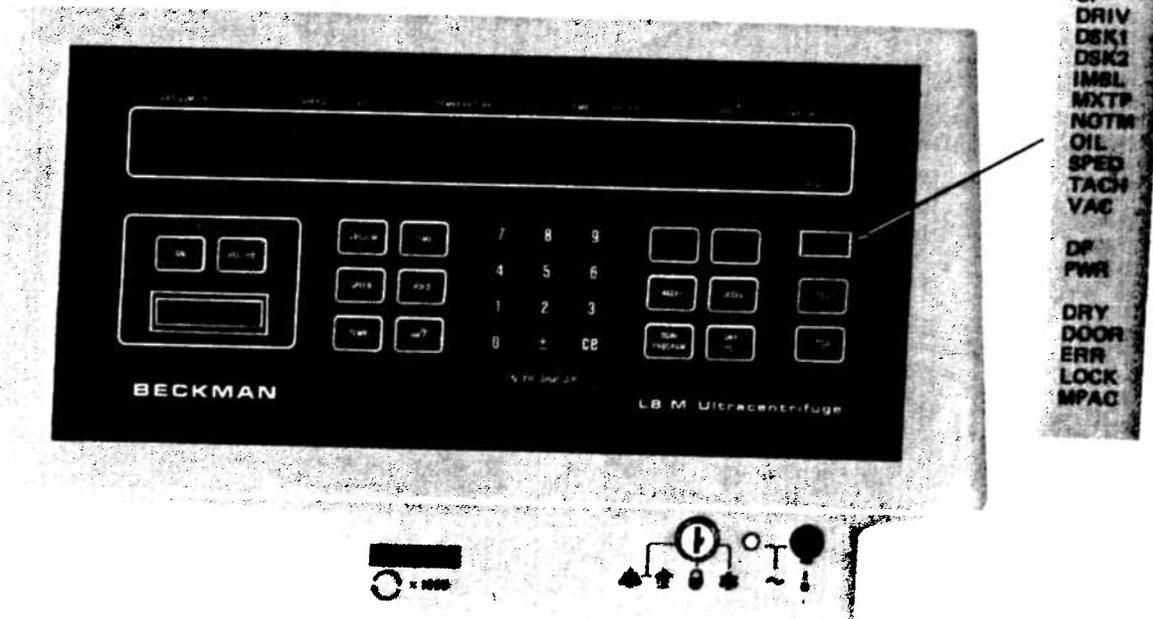


Figure 12. Control Panel Showing Diagnostic Message Display

To *recall* the actual (real-time) values that existed in the instrument when the rotor began to decelerate, press **ENTER/DISPLAY** and **STOP**. These values will be displayed for 5 seconds and will remain in memory until the power is turned off or a new run is started.

Two "cautionary" diagnostic messages (**DP** and **PWR**) are informational, to alert you of conditions that may need attention. These are also accompanied by an intermittent beep, which lasts for 10 seconds. The rotor does not decelerate, and the run in progress may be completed without interruption. However, you should investigate the condition when the run is finished.

Status messages include **DOOR**, **DRY**, **ERR**, **LOCK**, and **MPAQ**. See the chart for instructions on correcting these conditions.

If a condition cannot be corrected, contact your Beckman Field Service Representative for assistance.



Troubleshooting

DIAGNOSTIC MESSAGES CHART

To recall the operating conditions that existed when the rotor began to decelerate, press **ENTER/DISPLAY** and **STOP**. These values will remain in memory until the power is turned off or a new run is started.

Diagnostic Message	Condition	STOP Mode, Possible Causes and Recommended Action
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Shutdown Conditions*

In the following conditions, allow the rotor to come to a complete stop before investigating the problem. Correct the condition if possible. Press **ENTER/DISPLAY** and **START** only if you have corrected the problem.

DSK1	Unacceptable overspeed disk signal.	<i>Deceleration with brake.</i> The rotor has a missing or damaged overspeed disk. Consult the Rotors and Tubes Manual for instructions on installing a new overspeed disk.
DSK2	Invalid information during low-speed disk check.	<i>Deceleration with brake.</i> See DSK1 above.
IMBL	Imbalanced rotor.	<i>Deceleration with brake.</i> Usually occurs when the rotor is spinning below 1000 rpm. The rotor is not balanced. Check for proper placement of buckets and tubes.
VAC	Loss of chamber vacuum.	<i>Deceleration with brake.</i> Chamber pressure goes above 750 microns for more than a minute while the rotor speed is above 3000 rpm. There has been sample leakage or the vacuum system is malfunctioning. In the latter case, call your Beckman Field Service Representative. If sample leakage has occurred, clean the rotor and the chamber. (Follow normal precautions if pathogenic or radioactive materials are involved.) If the vacuum pump oil is low or contaminated, it should be changed (see MAINTENANCE).

For the following shutdown conditions, try to clear the diagnostic by pressing **ENTER/DISPLAY** and **START**. If the diagnostic persists, correct the condition according to the instructions below. Then press **ENTER/DISPLAY** and **START** to restart the run. If the rotor is still spinning when the condition is corrected, pressing these two switches permits *resuming* the run in progress rather than restarting it from the beginning.

*Intermittent beep, which continues for 10 seconds, accompanies flashing diagnostic message. (To silence the beep, press **STOP**.) The LED below **STOP** flashes as long as the rotor is decelerating. The diagnostic message flashes until the condition is corrected.

Troubleshooting

Diagnostic Message	Condition	STOP Mode. Possible Causes and Recommended Action
CF	Interruption of oil supply to the seal assembly of the CF-32 Ti rotor.	<i>Deceleration with brake.</i> Check to make sure that the safety plug for the CF-32 Ti rotor is inserted. Check the oil that is used to lubricate the upper bearing of the CF-32 Ti rotor. If low, fill the reservoir to the level indicated on the sight glass.
DRIV	The drive has overheated.	<i>Deceleration without brake.</i> In the case of water-cooled drives, check that the water supply is turned on. The flow of cooling water may be off or too slow. In refrigerated units, check that condenser fins are clean and unobstructed. Check to see if there has been a power outage during the run. If there is no obvious cause for the overheating, contact your Beckman Field Service Representative.
MXTM	Excessive rotor temperature.	<i>Deceleration with brake.</i> The rotor temperature has exceeded the set MAX TEMP. Poor vacuum can cause overheating. If chamber pressure is still greater than 50 microns after 10 minutes, there may be excessive moisture in the chamber or the vacuum system may be malfunctioning (see VAC).
TACH	Unacceptable tachometer signal.	<i>Deceleration without brake.</i> WAIT AN HOUR BEFORE ATTEMPTING TO CLEAR THE DIAGNOSTIC. Call your Beckman Field Service Representative.

In the following shutdown conditions, press **ENTER/DISPLAY** and **START**. If the condition persists the diagnostic will continue to flash. Call your Beckman Field Service Representative for assistance.

DOOR	Door lock malfunction during centrifugation.	<i>Deceleration with brake.</i> No operator solution.
NOTM	Temperature control system is malfunctioning.	<i>Deceleration without brake.</i> No operator solution.
OIL	Flow of drive oil impeded.	<i>Deceleration without brake.</i> No operator solution.
SPED	Excessive rotor speed.	<i>Deceleration without brake.</i> No operator solution.

Troubleshooting

Diagnostic Message	Condition	STOP Mode, Possible Causes and Recommended Action
<i>Cautionary</i> DP	Diffusion pump too warm.	Diffusion pump oil is probably getting low. Call your Beckman Field Service Representative to replenish it. (You may complete the run in progress while in this condition.)
PWR	Loss of power while the main circuit breaker is on.	There has been a power outage during the run. Check your run conditions and sample, if necessary, as the loss of power may have affected the quality of the run.
<i>Status</i> DRY	In DRY CYCLE	While in DRY CYCLE, inappropriate command given. Instrument will not recognize START during this cycle.
DOOR	Chamber door not properly closed.	Close door properly if in NORMAL operation. For ZONAL operation, make sure that key is positioned correctly. Check the chamber O-ring and clean if necessary.
ERRR	Operator error in data entry.	Unacceptable information entered. Instrument will not accept command. Clear the entry to remove the diagnostic. During the low-speed check of the disk, set speed is greater than maximum speed permitted by the overspeed disk. The SPEED display flashes and the rotor accelerates only to the maximum speed permitted by the disk. The run continues uninterrupted at the correct speed. To clear ERRR , press SPEED and ENTER/DISPLAY .
LOCK	STOP pressed while in locked operation or power turned on while key is in the position.	Turn key to  position to cancel message. Return to  position for locked operation.
MPAC	Memory-Pac module is inserted incorrectly, is damaged, or is missing.	Insert the module correctly. Replace if damaged or defective. Press CE to clear the diagnostic.
<i>Service</i> TEST	Special built-in test diagnostic.	Permits automatic cycling of the instrument based on current run conditions entered in the instrument. To clear the diagnostic, press ENTER/DISPLAY and START while the rotor is at rest.

Should other diagnostic messages appear, or if you cannot correct a condition, call your Beckman Field Service Representative for assistance.

Maintenance

INSTRUMENT CARE

The following procedures should be performed routinely. For maintenance not covered in this manual, contact your Beckman Field Service Representative. Diagnostic messages are covered under TROUBLESHOOTING.

WARNING

Maintenance that requires the removal of instrument panels will involve exposure to electrical and mechanical hazards. **TURN THE POWER SWITCH OFF AND DISCONNECT THE INSTRUMENT FROM THE MAIN POWER SOURCE.**

CLEANING

All instrument surfaces can be kept clean by washing with a mild detergent solution such as Solution 555TM. The top working surface is finished with urethane paint; the sides are finished with general purpose paint. Both can be disinfected with 70% ethanol² in the event of contamination. The control panel is coated with a Mylar finish. Use only a mild detergent solution on the control panel.

Chamber

The rotor chamber is coated with epoxy resin paint and the chamber door O-ring is Buna N rubber. The chamber can be wiped clean with a cloth or washed with a mild detergent such as Solution 555.³ The O-ring should be cleaned with a tissue every 3 or 4 months. Replace the O-ring whenever it becomes worn or damaged. Lightly lubricate the O-ring with silicone vacuum grease before reinstalling it to ensure an optimal vacuum seal.

NOTE: Keep the chamber door closed between runs to prevent moisture and dirt from collecting inside. Wipe off the chamber walls with a dry cloth before each run and use the DRY cycle to collect condensation after each cold run.

Do not place containers holding liquid on or near the chamber door. If they spill, liquid may get into the instrument and damage electrical or mechanical components.

Refrigeration Condenser Fins

The fins on the refrigeration condenser (refer to the foldout illustration at the back of the manual) must be clean for efficient heat transfer. Use a vacuum cleaner or a damp cloth to clean the fins. Be careful, the fins are sharp.

² Flammability hazard. Do not use in or near operating ultracentrifuges.

³ Do not spray detergent into the chamber as it can cause shorting of the optical system.

Maintenance

CHANGING THE VACUUM PUMP OIL

The vacuum pump oil should be changed every 3 to 12 months, depending on use, or whenever the oil is cloudy (check by looking through the sight glass on the pump housing), indicating that it is contaminated. If the pump oil has been contaminated with radioactive or pathogenic materials, use the necessary safety precautions when changing it.

Remove the screws from the front panel, and remove the panel. Lift the vacuum pump out of the instrument (refer to illustration inside the foldout at the back of the manual), then disconnect its hose and power cord. Drain all of the oil by removing the drain plug (at end of pump housing). Remove the filler cap from the top of the reservoir and refill the pump with Direct-Drive Vacuum Pump Oil. Reinstall the pump.

SUPPLY LIST

Direct-drive vacuum pump oil	341661
Diffusion pump oil	330246
Vacuum grease, silicone	335148
Spinkote™ lubricant	306812
Solution 555™	339555
Radiometer cover.	330158
Chamber O-ring	801778
Centering tool for overspeed disk.	331325
Logbook for preparative ultracentrifuges	330049
Master rotor logbook	339587
Tube removal tool	301875
Tube-cap hex driver	841883
Tube-cap vise	305075
Memory-Pac program modules (2)	345573

Warranty for the Model L8M Preparative Ultracentrifuge

Subject to the exceptions and upon the conditions specified below, Beckman agrees to correct, either by repair, or, at its election, by replacement, any defects of material or workmanship which develop within one (1) year after delivery of the Model L8M Ultracentrifuge (the product), to the original Buyer by Beckman or by an authorized representative, provided that investigation and factory inspection by Beckman discloses that such defect developed under normal and proper use.

Some components and accessories by their nature are not intended to and will not function for as long as one (1) year. If any such component or accessory fails to give reasonable service for a reasonable period of time, Beckman will repair or, at its election, replace such component or accessory. What constitutes either reasonable service and a reasonable period of time shall be determined solely by Beckman.

Any product claimed to be defective must, if requested by Beckman, be returned to the factory, transportation charges prepaid, and will be returned to Buyer with the transportation charges collect unless the product is found to be defective in which case Beckman will pay all transportation charges.

Beckman makes no warranty concerning products or accessories not manufactured by it. In the event of failure of any such product or accessory, Beckman will give reasonable assistance to the Buyer in obtaining from the respective manufacturer whatever adjustment is reasonable in light of the manufacturer's own warranty.

Damage to the instrument while operating a rotor not of Beckman manufacture is not covered by warranty or service contract terms.

Beckman shall be released from all obligations under all warranties either expressed or implied, if the product covered hereby is repaired or modified by persons other than its own authorized service personnel, unless such repair is made by others who meet qualifications similar to those required of Beckman's service

personnel, or unless such repair in the sole opinion of Beckman is minor, or unless such modification is merely the installation of a new Beckman plug-in component for such product.

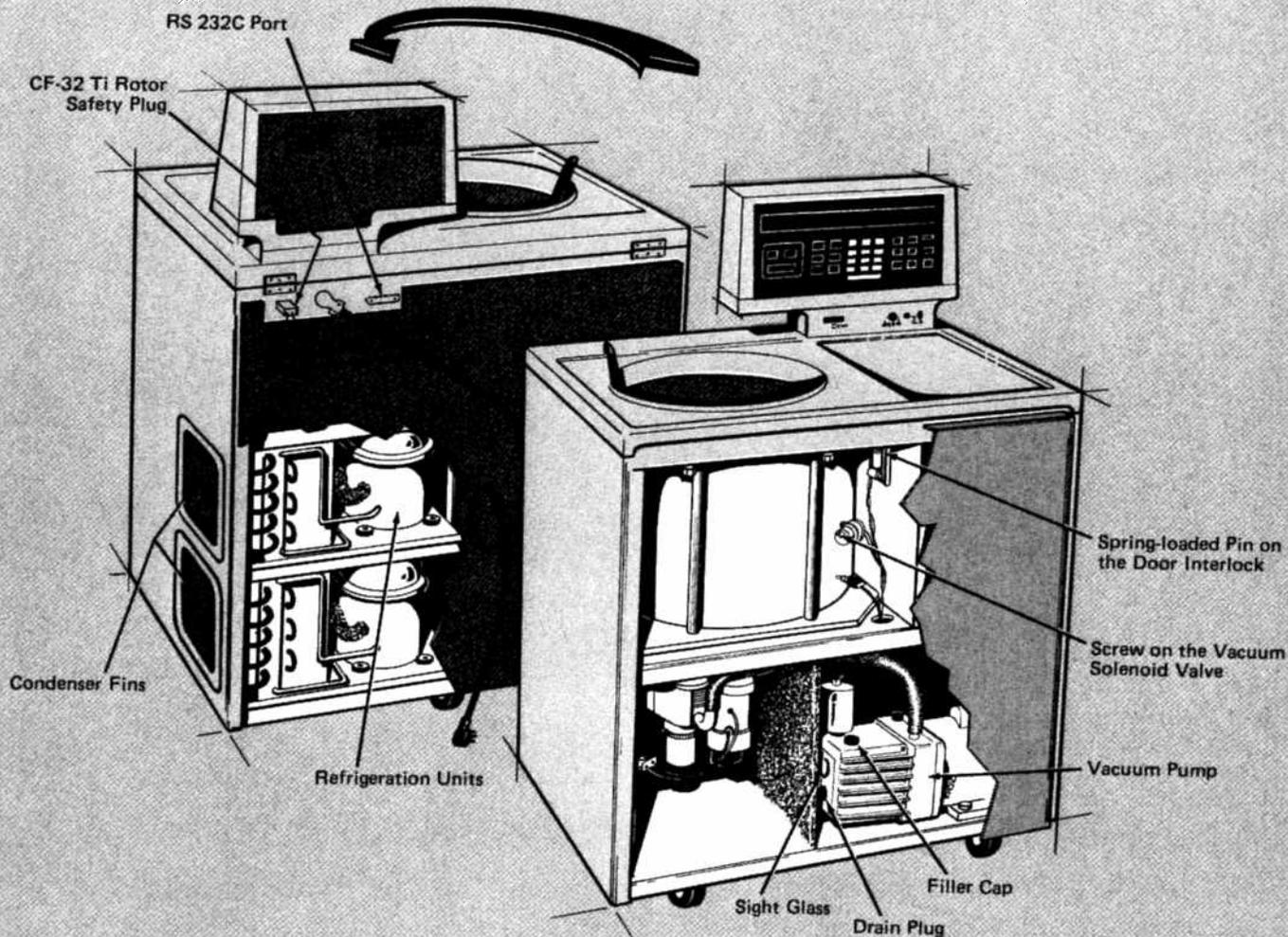
SPECIAL DRIVE WARRANTY

During the instrument's warranty period (one year) there will be no charge for drive replacement if the drive unit is installed, serviced, and operated in accordance with the following conditions.

1. The drive has been operated only within its rated speed and temperature ranges.
2. The drive unit has not been subjected to unequal loading, improper rotor installation, corrosion from material spilled onto the hub or accumulated in the chamber of the instrument.
3. The drive unit has not been disassembled, modified, or repaired, except by Beckman personnel or by a Service Representative authorized by Beckman.
4. The drive unit was installed by a Beckman Field Service Representative or other Service Representatives authorized by Beckman.
5. The instrument in which the drive unit has been used and operated, and its associated rotors, were manufactured by Beckman and serviced only by Beckman Field Service Representatives or other Service Representatives authorized by Beckman.

IT IS EXPRESSLY AGREED THAT THE ABOVE WARRANTY SHALL BE IN LIEU OF ALL WARRANTIES OF FITNESS AND OF THE WARRANTY OF MERCHANTABILITY AND THAT BECKMAN SHALL HAVE NO LIABILITY FOR SPECIAL OR CONSEQUENTIAL DAMAGES OF ANY KIND WHATSOEVER ARISING OUT OF THE MANUFACTURE, USE, SALE, HANDLING, REPAIR, MAINTENANCE, OR REPLACEMENT OF THE PRODUCT.

Use the logbook (p/n 330049) and the Master Rotor Logbook (p/n 339587) to keep an accurate record of the number of hours and the speed of each run for each rotor. This information will be required to derate the rotor and for warranty purposes.



Summary of Operating Steps for the Model L8M

NORMAL (Standard) OPERATION

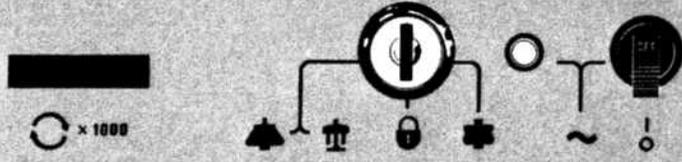
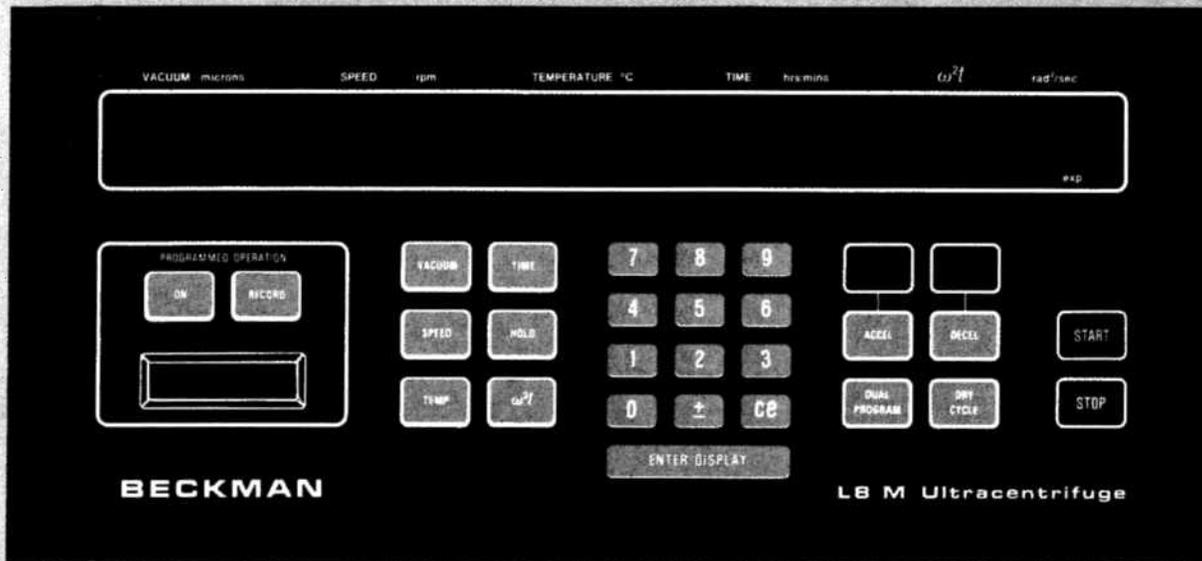
Make certain that the rotor has the appropriate over-speed disk—undamaged and correctly installed. For fast temperature equilibration, refrigerate or warm the rotor to the desired temperature before the run.

Turn the power ON. Open the chamber door, install the rotor, then close the chamber door. Turn the key clockwise to the  position.

MANUAL

To enter a single run:

1. Select the desired run conditions (SPEED, TEMP, MAX TEMP; and TIME, HOLD, or $\omega^2 t$).
2. Select slow ACCEL and/or DECEL profiles if desired.
3. Press **ENTER/DISPLAY** and **START**. (Unless otherwise directed, vacuum and brake are selected automatically.)



To enter a dual program:

Program 1

1. Press **DUAL PROGRAM**, **1**, and **ENTER/DISPLAY**.
2. Enter the first set of run conditions.
3. Press **ENTER/DISPLAY**.

Program 2

4. Press **DUAL PROGRAM**, **2**, and **ENTER/DISPLAY**.
5. Enter the second set of run conditions.
6. Press **ENTER/DISPLAY** and **START**. When you press **START**, program 1 will begin automatically. (Unless otherwise directed, vacuum and brake are selected automatically.)

AUTOMATIC

To repeat a run in sequence, just press **ENTER/DISPLAY** and **START**. There is no need to reenter any of the run conditions unless you wish to make a change.

PROGRAMMED

1. Insert the preprogrammed Memory-Pac™ module—label side up—into the PROGRAMMED OPERATION slot.

2. Press **ON** and **ENTER/DISPLAY** to transfer information for a single run or program 1 of a dual program into the instrument. Press **ENTER/DISPLAY** a second time to transfer the information for program 2 into the instrument.
3. Press **ENTER/DISPLAY** and **START**. (In dual program, when you press **START**, program 1 will begin automatically.)
4. Remove the Memory-Pac module if desired.

TO END THE RUN

Press **STOP** to terminate a run in the HOLD mode. Runs in the timed or ω^2t mode will terminate automatically. After the rotor has stopped, press **VACUUM** to vent the chamber. Open the chamber door, remove the rotor, then close the chamber door. Keep the door closed between runs.

ZONAL OPERATION

Assemble the zonal rotor according to the Zonal Rotor Instruction Manual (ZR-IM). Refer to the L8M instruction manual for ZONAL operation. Read the warning information carefully before beginning the run.