

# OPERATION MANUAL

## OM2438

Revision 6



## Centra-MP4

### Centrifuge

Cat. No. 2437 -- For 100/120/220/240 VAC, 50/60 Hz

## Centra-MP4R

### Refrigerated Centrifuge

Cat. No. 2438 -- For 100/120/220/240 VAC, 50/60 Hz

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# Table Of Contents

1 INTRODUCTION .....	2
2 INSTALLATION .....	3
2.1 Receiving the Unit .....	3
2.2 Site Preparation .....	3
Clearance Envelope .....	3
2.3 Power Configuration .....	3
Voltage .....	4
Line Frequency .....	4
Power Cord .....	4
2.4 Moving the Unit .....	5
2.5 The Front Panel .....	5
3 OPERATION .....	8
3.1 Rotor and Accessories .....	8
Rotor Balance .....	9
Vibration .....	9
Rotor Installation .....	10
Rotor Removal .....	11
Adding Rotors .....	11
Deleting Rotors .....	11
3.2 Starting and Stopping a Run .....	11
Manual Operation .....	12
Momentary Mode .....	12
Hold Mode .....	12
Timing Mode .....	13
3.3 Stored Programs .....	13
Locking Programs .....	13
Recall Program .....	13
Add/Change Program .....	13
3.4 Centra MP4R Refrigeration .....	14
Rapid Condition .....	14
3.5 Warning Messages and Error Codes .....	15
4 APPLICATIONS .....	17
Corrosive Solvents .....	17
4.1 Speed and Force Tables .....	18
4.2 Derating Tables .....	25
Dense Samples .....	25
244 Rotor .....	25
4.3 Chemical Resistance Table .....	27
4.4 Decontamination Table .....	28
4.5 RCF Nomograph .....	29
5 MAINTENANCE .....	30
5.1 Cleaning .....	30
Corrosion .....	31
Storage .....	31
Decontamination .....	31
5.2 Cover Interlock Bypass .....	32
5.3 Calibration .....	32
5.4 Brush Replacement .....	33
5.5 Table of Spare Parts .....	34
5.6 Warranty .....	34
5.7 Condition of Returned Equipment .....	35
5.8 Fuses Not Replaceable By The Operator .....	35
6 SPECIFICATIONS .....	36

# 1 INTRODUCTION

The Centra MP4 and Centra MP4R are high-speed, multi-purpose centrifuges used in medical, industrial, and scientific laboratories. These bench-top units can achieve centrifugal forces of up to 16,750xg (using the 852 rotor), and speeds up to 14,000 rpm (using the 817 rotor). The Centra MP4R provides refrigerated temperature control.

Both units accommodate a wide variety of rotors, including angle, swinging bucket, and fixed horizontal designs. They can process tubes, bottles, microplates, microcapillary tubes, cytological slide carriers, and microsample tubes. The units can centrifuge up to 1 liter of fluid in a single operation.

An easy-to-use front panel provides many versatile modes of operation: manual and pre-programmed operation, momentary spin, indefinite spin (hold mode), and a Rapid Condition (MP4R Only) function for pre-cooling or pre-warming the rotor and sample chamber. You can select gentle acceleration and deceleration rates to maintain samples with density gradients. In addition, rotor number entry allows direct G-force control through automatic calculation of RCF. With the MP4R, you can select any chamber temperature down to -5°C. Repeat runs with precisely the same temperature, speed, and time settings may be achieved at the touch of a button.

The internal microprocessor simplifies operation, ensures repeatable results for continued success, and alerts operators when periodic maintenance is due.

A fail-safe cover interlock ensures that the cover is closed before a run can begin, and prevents the cover from opening until the rotor has slowed to a safe speed, even if the power fails. The rugged steel cabinet and rigid construction provide quiet operation and long-term reliability. A run automatically aborts at a safe, low speed if the rotor is unbalanced.

Both units are easily configured to many different AC power sources, have CSA certification, and are designed to meet requirements for UL listing, IEC 1010, British Standard 4402 and other international standards.

# 2 INSTALLATION

## 2.1 Receiving the Unit

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IEC ships the centrifuge in a carton that protects it from shipping hazards. Follow the unpacking instructions on the carton. Be sure to complete the postage-paid warranty card and return it to IEC.

## 2.2 Site Preparation

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The Specifications in Section 6 of this manual give the dimensions of the unit. Provide clearance of 8 cm (3 inches) on each side of the unit for ventilation. Place the unit on a clean and dry surface to ensure that the suction feet grip the surface firmly. Clear the area beneath the unit of debris and loose materials such as paper.

### Clearance Envelope

International Electrotechnical Commission standard 1010 part 2-20 limits the permitted movement of a laboratory centrifuge to 300mm in the event of a disruption. The user should therefore mark the clearance envelope boundary around the centrifuge, or laboratory management procedures should require that no person or any hazardous materials are within such a boundary while the centrifuge is operating.

The surface must be level to ensure quiet, vibration-free operation. A rigid, stable location is important since an improperly-loaded unit can vibrate or even move.

## 2.3 Power Configuration

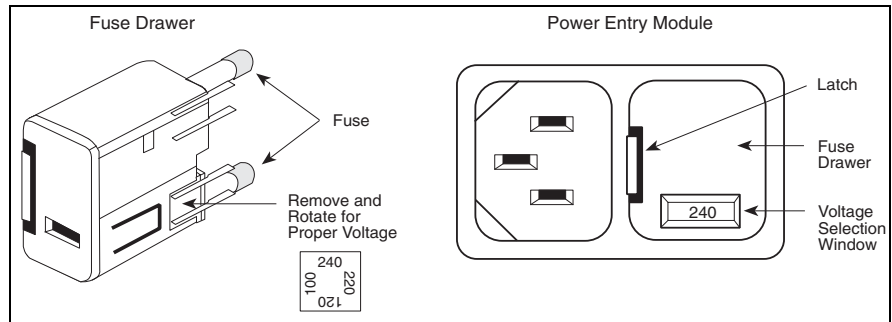
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The Centra-MP4R and Centra-MP4 use AC power at 100, 120, 220, or 240 Volts (nominal), at 50 or 60 Hz. The unit is shipped without fuses installed and must be configured for power at your site. **Do not plug in the centrifuge until you have configured it correctly.** For best results, the centrifuges should be used on a dedicated line. Variations in line voltage or frequency will affect the unit's speed and other characteristics. Less than nominal line voltage may prevent the centrifuge from reaching maximum published specifications of speed and/or temperature. Also, power line voltage at some locations may sag when the refrigeration system turns on.

**Caution: configuring the centrifuge incorrectly will void your warranty.**

## Voltage

Locate the power entry module on the lower left side of the unit (Figure 2-1). On the right side of this module is the fuse drawer (Figure 2-2). A small latch on the left holds the drawer in place. Press the latch and slide the drawer out. When removing the fuse drawer, be careful that the fuses do not fall out.



If the number visible in the window differs from the voltage at your site, remove the square insert, rotate it, and insert it so that the correct voltage is displayed through the window. (100, 120, 220, or 240 Volts. See Section 6 Specifications for operable voltage ranges.)

Install appropriate fuses for the voltage at your site as follows:  
For 100/120 V, install the two 16 A fuses. (IEC Part No. 50058)  
For 220/240 V, install the two 6.3 A fuses. (IEC Part No. 9946)  
Ensuring that the fuses are securely in place, reinstall the fuse drawer in the side of the centrifuge.

## Line Frequency

(Centra-MP4R Only). Locate the 50Hz/60Hz switch to the right of the power receptacle. Adjust this switch with a tool(screwdriver) to match the frequency at the site.

## Power Cord

The unit requires a grounded power supply (3-prong power outlet). If your facility does not have properly-grounded power outlets, arrange for proper grounding.

IEC provides two power cords with each Centra-MP4R and Centra-MP4. One is suitable for North America and Japan. The second has bare wires at one end for attachment of other types of plugs.

**Caution: Do not remove the grounding pin from the centrifuge power cord. Do not use the bare wired power cord to attach a power plug that does not have a grounding pin.**

When using the power cord with bare wires, install any required plug and attach the cord to the receptacle on the lower left side of the centrifuge. Plug into the power outlet.

**Warning: The power cord(s) provided with the unit is correctly rated for the highest current demand. This power cord should not be interchanged with cords from equipment with lower current demand. Exchange of power cords between equipment may create a fire hazard.**

## 2.4 Moving the Unit

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Suction cups adhere the unit to the work surface and keep it from moving. This is a safety feature. To move the unit to another location, use an object such as a tongue depressor under each suction cup. Lift up an edge of each suction cup and insert the object far enough to break the vacuum seal of that cup. When all four cups are disengaged, the unit can be easily lifted. When the unit is in its new location, ensure that the suction cups are operating properly again. Be sure the new location is appropriate (see Section 2.2).

The voltage and frequency settings may need to be changed at the new location. Check carefully that the unit is configured for the correct voltage and frequency. If necessary follow the instructions in Section 2.3.

## 2.5 The Front Panel

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The On/Off key must be On to enable use of the front panel. This key controls power to the refrigeration system (MP4R) and the display. The unit displays the chamber temperature whenever the unit is plugged in. The On/Off key is inoperative during a run; to shut off the refrigeration system, first stop the run by pressing the STOP key.

The front panel contains numeric displays labeled °C (MP4R only), RPM/RCF, ROTOR/RADIUS, and MINUTES. Normally, the numeric displays indicate actual readings of temperature, rotor speed, and the elapsed time of, or time remaining in, the run. The display instead indicates the desired settings for the run:

- (1) whenever the up and down arrow keys are used,
- (2) briefly at the start of a run, and
- (3) briefly after the unit is switched on.

When the display shows actual readings, the numbers are bright; when the display shows desired settings, the numbers are dim.



The number under this symbol represents temperature in whole degrees Celsius, from -5° C through 45° C (Model MP4R, only).



The number under this symbol represents the rotor speed in RPM or the Relative Centrifugal Force (RCF) in xg.

**RPM**  
**RCF**



This key toggles between RPM and RCF. When RPM is selected, the speed indicator displays revolutions per minute. When RCF is selected, the speed indicator displays relative centrifugal force, and the rotor/radius indicator displays either the rotor number or the rotor radius. RCF is only indicated when a rotor number has been selected in the rotor/radius display.



The number under this symbol displays time. Times of less than 10 minutes are displayed as [mm:ss]. Times of 10 minutes or longer are displayed as minutes. Time can be set up to 360 minutes. In the hold mode, times up to 999 minutes will be displayed. Times greater than 999 minutes are displayed by alternately flashing hours, shown as H[hh], and minutes past the displayed hours, shown as [mm].



The arrow keys beneath each display are used to view or change the desired settings for temperature (MP4R only), rpm/rcf, rotor/radius, or time. The first time the key is pressed, the numeric display simply switches from actual readings to desired settings, without changing the desired settings. When pressed again, the selected setting increases or decreases once for each press. If the key is held in, the setting changes continuously until the key is released. The longer it is held in, the more rapidly the setting changes. Usually, the key is held in to approach a desired setting, then pressed repeatedly to select the exact setting. Three seconds after the arrow key is released, the display returns to the actual readings.



This key starts a run. The run is governed by the desired settings shown on the numeric display. The associated green light blinks until the rotor approaches the desired run speed. Then the light stays on until the end of the run.



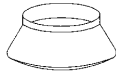
This key stops the run. (A run will also stop automatically when the desired time has elapsed.) The associated red light blinks as the rotor decelerates. (It also blinks if an error occurs; see Section 3.5.) When the run ends, the light stays on.



This key unlocks the cover. This key is inoperative if a run is in progress; pressing it does not stop the run. The cover will not unlock until the rotor speed is less than 100 RPM. The associated yellow light is on whenever the cover is open. A run cannot be started when the cover is open.



This key saves the currently displayed desired settings as stored program 0 through 9 (see Section 3.3). The numeric display above it shows the stored program number or other mode of operation (see Section 3.2). The numeric displays can also display warning or error messages (see Section 3.5).



The rotor/radius display indicates either the selected rotor number or the rotor radius in centimeters. This display illuminates when the rotor is selected. The applicable IEC rotor numbers are supplied in the memory, along with their maximum radius in centimeters. The key under rotor/radius toggles between the two. To select a rotor number, toggle to ROTOR and press an arrow key under the rotor display. To change the radius, toggle to RADIUS, and press an arrow key under the rotor display. Note that the radius cannot be changed to a radius larger than the maximum radius for that rotor. The display changes back to rotor number after three seconds.

Gentle acceleration and braking can be selected when centrifuging delicate samples. The gentle settings avoid mixing of density gradients or breakup of pellets.



This key controls rotor acceleration up to 400 RPM. If the yellow light over the rabbit is lit, then full acceleration is selected. If the yellow light over the turtle is lit, then slow acceleration is selected. Slow acceleration takes from 15 to 35 seconds to achieve 400 RPM, depending on the rotor and its contents.



This key controls rotor braking. If the yellow light over the rabbit is lit, full braking is selected. If the yellow light over the turtle is lit, slow braking is selected. (This means the rotor will coast down from 600 RPM.) If both lights are out, all braking is disabled; the rotor will coast from operating speed to a stop.



# 3 OPERATION

## 3.1 Rotor and Accessories

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A balanced load is essential with all centrifuges. An unbalanced load produces vibration and can damage the unit. A 2 gram load imbalance, at a speed of 4600 RPM, imparts force equivalent to 9.1 kg at rest (20 pounds). Therefore, always ensure that the rotor is loaded symmetrically with a full complement of accessories, and a full (or paired) set of tubes. Tube adapters should also be installed symmetrically.

IEC rotors are dynamically balanced at the factory. IEC matches removable parts (trunnion rings, shields, buckets and carriers) to within 1 gram and stamps the weight on each piece. Check these markings whenever you interchange parts, to ensure that opposite parts are matched. Ensure that the total weight of samples and removable parts loaded in opposing positions are equal in weight to within 1 gram. The position numbers, present on many rotors and adapters, identify opposing tube positions.

To obtain good dynamic balance, the opposite loads must not only be equal in mass, but must also have the same center of gravity. Opposing containers must be alike in shape, thickness, and distribution of glass or plastic. This is especially important for large containers.

Tubes loaded into swinging bucket rotors must be symmetric around the axis of rotation. Verify this by rotating the entire rotor 180° by hand: the loads should be in the same apparent positions (not in the mirror image). In addition, the loads within each bucket must also be symmetric around the bucket's pivot axis. Verify this by ensuring that each bucket is loaded so that it does not tilt from the vertical when the rotor is at rest. Maintaining balance within each bucket ensures that the bucket and the tubes swing out to horizontal when the rotor reaches operating speed, applying centrifugal force toward the bottom of the tubes. Failure to achieve full swing-out causes vibration and premature wear of both the rotor and the motor.

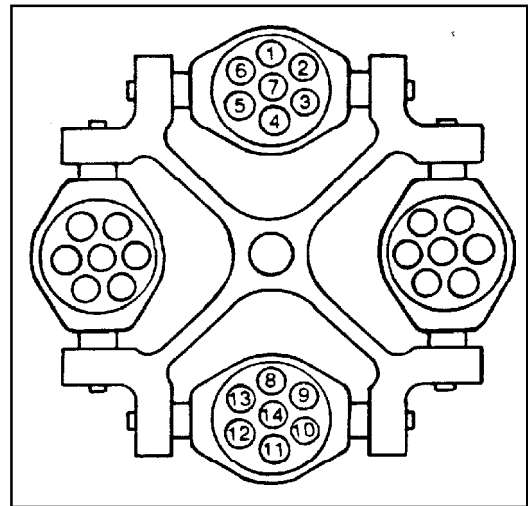
Samples of like (similar) specific gravities may be processed in the same run provided the samples of the same type are balanced around the rotor as though they were the only pairs in the rotor.

**Caution:** **DO NOT exceed maximum rated speed for each rotor/ accessory combination. Maximum rated speeds can be found in Section 4.1 Speed And Force Tables.**

## Rotor Balance

For example, load tubes in the following manner:

1. Load four tubes.  
Positions 3, 6, 10, 13  
or 2,5,9,12  
or 1,4,8,11
2. Load six tubes.  
Positions 6,7,3,13,14,10  
or 5,7,2,12,14,9  
or 1,7,4,8,14,11
3. Load an odd number of tubes. **Not recommended**  
(unless a dummy tube is used for balance.)



## Vibration

All centrifuges have critical speeds at which vibration occurs. As the speed increases beyond the critical speed vibration will cease. This inherent condition also occurs during deceleration. An imbalanced load intensifies these critical vibrations. **Do not operate this centrifuge continuously at observed critical speeds.**

## Rotor Installation

**To install a rotor**, line up the keyway (slot) in the rotor with the key in the shaft. Lower the rotor straight onto the shaft. A correctly aligned rotor will slide down far enough that the shaft protrudes through the top of the rotor. Secure the locking nut onto the shaft using the wrench provided.

**Caution:** Failure to securely tighten the rotor retaining nut against the rotor **WITH THE WRENCH PROVIDED** will result in the rotor coming off the shaft.

The 851, 852 and 853 rotors require an IEC Part No. 50036 hub adapter. Use the wide rotor locking nut to secure the rotor to the tapered hub adapter. For easiest use, leave the rotor and hub adapter secured together when installing and removing. Use the locking nut to secure the hub adapter to the shaft, and tighten with a coin or tool.

**Caution:** Never remove the key from the shaft in order to use a non-standard rotor; equipment failure can result.

### **Rotor Removal**

**To remove a rotor**, first remove any sample tubes, shields, buckets and other accessories from the rotor. Unscrew and remove the locking nut. If the rotor is difficult to remove, place the locking nut back on the shaft and finger tighten it. Unscrew it one turn. Grasp the rotor with one hand and pull upward on it while tapping the locking nut with the locking wrench. The opposing force should free the rotor to be lifted from the shaft.

### **Adding Rotors**

As new rotors are released by IEC, the rotor number and radius can be added to the rotor menu. To do so, press the hidden key located behind the "C" in IEC. Prog x.x will appear. Press RPM arrows until "rotor Add" appears. Press the file key and "Rotor" will appear next to the Rotor/Radius display. Press an arrow key under the rotor display to select the new rotor number. Press the file key. "Radius" appears. Use arrow keys to select maximum radius. Press file key again. "RPM" will be illuminated. Use the RPM arrow key to select the maximum RPM for the rotor. Push file again. Unit beeps three times to acknowledge addition of rotor. Press "C" in IEC to return to normal operation. Note: Up to five rotors may be added to memory. When the rotor memory is full, the unit displays "FUL" under the rotor symbol.

### **Deleting Rotors**

Push "C" in IEC. Use RPM arrows to scroll to "rotor Add." Use the time arrows to select "dEL" instead of "Add." Press file key. "Rotor" appears. Use rotor arrows to select rotor to be deleted. Press file key to delete. Unit beeps three times to acknowledge deletion of rotor.

## **3.2 Starting and Stopping a Run**

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Read Section 2.5 for a general description of the front panel. The desired settings displayed on the front panel always govern the operation of the unit. The number or symbol displayed above the word PROGRAM describes the operating mode of the unit. It is important that the unit be in the correct mode for the desired operation.

The digits and symbols, which appear above the word PROGRAM when the arrow keys are pressed, can be one of the following:

blank The unit is in **manual operation**.

0-9 The unit is under control of the **stored program** with the number shown.

H The unit is set to **hold mode**, in which it runs until you stop it.

- The unit is set for a **momentary spin**.

C The unit is set to **Rapid Condition**, a special program discussed in Section 3.4.

The display indicates the parameters last selected for each PROGRAM mode of operation.

**Manual Operation** For manual operation, set the mode so that the display above the word PROGRAM is blank. Select a desired temperature (MP4R only), speed/g-force, run time, acceleration mode, and deceleration mode. To start the spin, press the Start key. The spin stops automatically at the end of the desired interval. A run can also be stopped manually by pressing the STOP key.

During a manual operation, the MINUTES display counts down and displays the time remaining in the current spin.

The run time specified begins either when the START key is pressed, or when the rotor reaches 95% of set speed (see TIMING MODE). When the elapsed time reaches this desired setting, deceleration begins. That is, the run time does not include deceleration time.

The settings can be changed during a manual run. These changes affect the run in progress. If the time setting is changed during a run, the unit adjusts the displayed count-down timer so that your revised setting will be the total time of the run. If the new time selected is less than the elapsed time, the run will end.

The unit's mode (PROGRAM) cannot be changed during a spin.

**Momentary Mode** Momentary spin is useful for easily separated samples, for simultaneous mixing of samples, and to deposit condensate droplets at the bottom of the tube.

For momentary spin, set the mode so that a dash "-" appears above the word PROGRAM. The dash also appears above MINUTES because there is no programmed time in a momentary spin. Select temperature (MP4R only), speed/g-force, acceleration mode, and deceleration mode, as for manual operation.

Press and hold the START key. The run starts when you press the key and ends when you release the key. In this mode you can perform very quick separations or protocols.

During a momentary spin, the unit displays actual values, not desired settings. The MINUTES display counts upward and displays the elapsed time since you pressed the START key.

**Hold Mode** For hold mode (operation without time limit), set the mode so that H appears above the word PROGRAM. The H also appears above MINUTES because hold mode does not have a programmed time.

Select temperature (MP4R only), speed/g-force, acceleration mode, and deceleration mode, as for manual operation. Press and release the START key. The run starts when you press the key and stops only when you press the STOP key. Hold mode is like manual operation, except that the time setting is not used. During a run in hold mode, the MINUTES display counts upward and displays the elapsed time of the spin. See Section 2.5 for more information on the MINUTES display operation.

## Timing Mode

Two timing modes are available on these units:

ACC, for the set time to start counting down at the beginning of acceleration; that is, when the start key is pressed. The unit is originally set to this mode.

SPd, for the set time to start counting down when the rotor has reached 95% of set speed. Display will alternately display set time and SPd until counting begins.

To select a timing mode, press the TIME down arrow key , and scroll below zero. ACC or SPd will appear. Press and release the TIME down arrow key to choose the desired mode. After three seconds, or after pressing the FILE or START key, the display will return to the last selected run time provided the up arrow key has not been pressed.

The timing mode is stored along with the other parameters when a program is saved. If a saved program has been recalled, altered, and not re-saved, the timing mode will revert back to the previous mode when recalled.

## 3.3 Stored Programs

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The Centra-MP4 series has an internal memory capable of holding 10 sets of run parameters. Each set, or program, is stored and can be recalled by selecting a program number (0 - 9). Programs are retained in memory even if the power is turned off. When necessary, a program can be modified for a particular run or changed permanently. You cannot change the unit's program, rotor/radius, or timing modes during a spin.

### Locking Programs

Programs can be locked from the program lock in the special function menu. Press the "C" in IEC. Use RPM arrows to scroll until "Loc P" is displayed. Use the program arrow keys to select the program to be locked. Pressing the following keys in the following order will lock or unlock a program: Start, Stop, Cover Open, Stop, Start and File (Save). The display will alternate between the program number and an "L" indicating that the values of the program are locked and cannot be changed.

### Recall Program

Press a program arrow key to select the appropriate program number. The programmed run parameters will be displayed and will become the set parameters. To begin this run, simply press START.

### Add/Change Program

Select a program number with the program arrow keys. The current program parameters will appear on the display. Modify the desired parameters using the parameter arrow keys, or the ACCEL or BRAKE switches. To make the changes permanent, press the PROGRAM SAVE (file folder) key. The program number will stop flashing, and the new program will be displayed and will remain in memory until further changes are made. To make changes temporary, press START without pressing the PROGRAM SAVE (file folder) key. The program display goes blank to indicate that the values are now stored in the manual program and the instrument is not operating from the program mode at this time. As long as the PROGRAM SAVE (file folder) key is not pressed, the original program remains unchanged.

## 3.4 Centra MP4R Refrigeration

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Whenever the cover is closed and the unit is switched ON, the unit applies refrigeration to the rotor chamber as necessary to cool it to the currently displayed temperature setting. However, using the keyboard so that a cold temperature is momentarily displayed (for example, stepping through the stored programs) does not activate refrigeration.

If a temperature higher than ambient is specified, the unit does not heat the rotor chamber except through the normal heating effect of the equipment (i.e. air friction and motor heat).

If the rotor chamber is not at the temperature specified, it does not abort the spin. However, if the rotor chamber differs by 5°C or more from the specified temperature at the start of a run, the unit sounds an audible alarm (see Section 3.5). The °C display switches between the actual and programmed temperature until the two temperatures come within 5°C. This shows the reason for the alarm. Press the STOP key if the run should not continue at the actual temperature.

The unit is not designed for use as a refrigerator. The natural fanning action of the rotating horizontal and fixed angle rotors serves to maintain a uniform temperature distribution inside the chamber. Therefore, at zero RPM, there is no correlation between set and actual chamber temperatures.

Any frost or condensation that forms in the rotor chamber should be removed by allowing it to melt and removing it with a sponge or cloth. When the centrifuge is not in use, turn it off or leave the cover open (disabling refrigeration).

### **Rapid Condition (MP4R Only)**

When the chamber temperature is above the set temperature, RAPID CONDITION will run a rotor at 500 rpm to increase air circulation in the chamber to quickly cool the chamber to the set point. When the chamber temperature is below the set temperature, RAPID CONDITION will run the rotor at 3400 rpm to warm the chamber to the set temperature. When the temperature has been reached a three beep signal will sound and the rotor will brake to rest. (Some smaller rotors may not be able to warm the chamber to the higher temperature settings.) To select this program, press the PROGRAM arrow keys until a 'C' appears in the PROGRAM display. Select the desired temperature, install a rotor, and press the START key.

## 3.5 Warning Messages and Error Codes

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The **beeper** sounds in these situations:

- o Briefly whenever a key is pressed.
- o Three times at the start and at the end of a spin.
- o On the Centra-MP4R for 2 seconds if the START key is pressed and the rotor chamber is more than 5° C warmer or cooler than your desired temperature setting (see Section 3.4).
- o Seven times when a warning occurs (see below).

**Warning Messages** appear in place of the numeric displays in the following cases:

bAL	This appears during a run if the rotor is unbalanced. The rotor brakes to a stop and the run ends. The cover must be opened to reset this warning. Verify that a balanced load is installed. Inspect the rotor and rearrange tubes or add additional, inactive tubes to balance the rotor.
HEAd	This appears if you start a run without loading a rotor into the chamber. The run ends. The cover must be opened to reset this warning.
LId	This appears briefly if you press the Start key but the cover is not closed. Closing the cover resets the warning.
PFAIL	This appears at the end of a run that is interrupted by a power failure. Opening the cover resets this warning.
bruSh	This appears at the end of every run if it is time to replace the brushes. To reset the warning and replace the brushes, see Section 5.4.
LInE LO/Hi	This appears as soon as power is applied to the unit if the line voltage does not match the voltage configuration. It can only be cleared by unplugging the unit and reconfiguring it properly (see Section 2.3).

**Warning Messages during a spin.** The “bAL”, “LId”, and “PFAIL” messages can occur during a spin. In this case, the rotor brakes to a stop and the run ends.

**Error Codes** require factory-authorized maintenance. A typical error means the internal microprocessor has detected impermissible readings or a failure elsewhere in the unit. An error number appears on the front panel. Tell the service personnel which number appeared when you report the problem.



- Error 001: No Tachometer  
Tachometer signals were not present during run. The rotor is stopped under full brake. To open cover unplug and reinstall the power cord.
- Error 002: Overspeed  
Speed is 500 RPM or more over set and rotor is not decelerating, for more than one second or actual rotor speed is over 14,500 RPM. The rotor will coast to a stop.
- Error 003: Runaway  
During stopping, rotor has not been decelerating for 8 seconds, or when at standby, rotor speed exceeds 600 RPM. The rotor coasts to a stop.
- Error 004: Refrigeration Failure (Centra MP4R only)  
The unit displays this code if the measured temperature exceeds 45°C at any time during the run. The rotor will be stopped under programmed deceleration.
- Error 005: Fail-safe Time-out  
Independent circuitry on the circuit board has sensed a lack of activity from the control microprocessor. All power outputs disabled (including motor, compressor, fans, latch solenoid, etc.).
- Error 006: COP Watchdog/Op-Code Trap  
The microprocessor itself has sensed a lack of activity from the program that controls the centrifuge. The rotor coasts to a stop.
- Error 007: Stack Error  
The microprocessor itself has sensed a lack of activity from the program that controls the centrifuge. The rotor coasts to a stop.
- Error 008: COP Watchdog Not Enabled  
Microprocessor COP watch dog feature is not enabled. The rotor coasts to a stop.
- Error 009: Undefined Interrupt  
Microprocessor was interrupted by an undefined source. The rotor coasts to a stop.

## 4 APPLICATIONS

This section describes the use of specific rotors and accessories. More detailed information is often shipped with the rotor or accessory itself. This section contains five reference tables:

- o Speed and Force Tables
- o Derating Table for Dense Samples
- o Chemical Resistance Table
- o Decontamination Table
- o Nomograph

**Relative centrifugal force** (RCF or G-force) at a given speed varies with the rotor, and with the length of the sample tube, because the distance of the tube's tip from the center of rotation is different. The Speed and Force Tables indicate the maximum speed and RCF the Centra MP4 and the Centra MP4R can achieve with various rotor/accessory combinations. The Derating Table specifies reductions in maximum RPM when spinning samples with specific gravity above 1.2.

Misapplication of any tube can cause tube rupture. To avoid this, compare the G forces specified in the Speed and Force Table with the ratings for the tubes you are using. If the tubes are not rated for the force the centrifuge will apply, reduce the speed to the G-force listed for your tubes.

**Corrosive Solvents** Your IEC centrifuge is made of materials designed to resist attack from most laboratory chemicals. The interior of the rotor chamber is stainless steel. Rotors and accessories placed in the chamber are made of a variety of materials, including aluminum and polypropylene. The Chemical Resistance Table shows the suitability of each material with different classes of reagents.

Section 5.1 describes how to clean and remove corrosion from the chamber, rotors, and accessories. Follow these instructions, and clean spills promptly, to minimize the effect of corrosive chemicals and to avoid expensive repairs.

## 4.1. Speed and Force Tables

---

<b>ROTOR 215 4-Place Horizontal Swinging Bucket</b>						
No. of Places	Tube Volume (ml)	Trunnion/ Shield or Carrier	Maximum Speed (rpm)	Max RCF (xg)	Max Radius (cm)	O.D. x Length (mm) Common Tube Size
4	80	366/365	4600	3500	14.8	38x118
4	50	325/320**	4600	3300	14.0	30x116
4	50	350/323**	4300	3200	15.2	Falcon/Corning Conical
4	10	310/356	4900	3550	13.2	17.2x113
8	50	326/320	4100	2675	14.2	30x116
12	10	355/356	4100	2475	13.2	17.2x112
12	10	366/1013	4600	3025	12.8	16.5x107 16x75;100 Vacutainer
16	5-7	366/1018	4700	3150	12.8	14.2x103 13x75;100 Vacutainer
20	3-5	366/369	5200	3350	11.1	12.6x83 10;12x75
4	3	1024	2050	500	10.6	1"x3" Microscope Slide

**\*\* Order Adapter 1106 And 571 Cushion To Spin 15ml Falcon/Corning Conical Tubes**

<b>ROTOR 221 6-Place Horizontal Swinging Bucket</b>						
No. of Places	Tube Volume (ml)	Shield	Maximum Speed (rpm)	Max RCF (xg)	Max Radius (cm)	O.D. x Length (mm)
6	10	356	5000	3625	13.0	17.2x102
6	15	303	4500	3300	14.6	17.2x119

<b>ROTOR 224 Horizontal Swinging Bucket with Cat. No. 3224 Cups</b>						
No. of Places	Tube Volume (ml)	Adapter Number	Maximum Speed (rpm)	Max RCF (xg)	Max Radius (cm)	O.D. x Length (mm) Common Tube Size
4	250	----	4400	3310	15.3	IEC 2050, 2051
4	175	----	4400	3270	15.1	Falcon 2076 w/2090 cushion
4	80	7221	4400	3180	14.7	38.1x111
4	50	7231	4400	3180	14.7	Falcon/Corning Conical
12	30	7223	4400	3180	14.7	IEC 2047, 2055, 2802
16	15	7230	4400	3180	15.1	Falcon/Corning Conical
28	15	7224	4400	3180	14.7	16.2x100
28	10-15	7225	4400	3180	14.7	13;16x75;100 Vacutainer/HG
40	7	7236	4400	3180	14.7	13x100 Vacutainer
48	3-5	7226	4400	3180	14.7	12x75; 10x75
40	3	7228	4400	3180	14.7	10x50
40	1.5	7228	4400	2970	13.7	1.5 Microtube

<b>ROTOR 244 2-Place (Tray) Horizontal Microplate</b>						
No. of Places	Tube Volume (ml)	Carrier	Maximum Speed (rpm)	Max RCF (xg)	Max Radius (cm)	O.D. x Length (mm)
2	----	49852	4,000*	1800	10.0	86x128 (96 well) Array Racks

\*See Derating Table For 244 Rotor

<b>ROTOR 794 4-Place Fixed Horizontal</b>						
No. of Places	Tube Volume (ml)	Tray Insert	Maximum Speed (rpm)	Max RCF (xg)	Max Radius (cm)	O.D. x Length (mm)
40	.25-.4	5914	11,000	8,120	4.7-6.0	6.0x46 Microtubes
40	1.5-2	5912	11,000	8,120	6.0	11.0x39 Microtubes

<b>ROTOR 796 6-Place Fixed Horizontal</b>						
No. of Places	Tube Volume (ml)	Tray Insert	Maximum Speed (rpm)	Max RCF (xg)	Max Radius (cm)	O.D. x Length (mm)
60	.25-.4	5914	9000	6350	5.7-7.0	6.0x46 Microtubes
60	1.5-2	5912	9000	6350	7.0	11.0x39 Microtubes

<b>ROTOR 801 6-Place Fixed Angle 45°</b>						
No. of Places	Tube Volume (ml)	Shield	Maximum Speed (rpm)	Max RCF (xg)	Max Radius (cm)	O.D. x Length (mm)
6	50	305	5200	3650	12.1	30x133 Falcon/Corning Conical*
6	50	320	6500	5100	10.8	30x116 Corning 8300-50

\*With IEC 315 Conical Cushion

<b>ROTOR 803 6-Place Fixed Angle 45°</b>						
No. of Places	Tube Volume (ml)	Shield	Maximum Speed (rpm)	Max RCF (xg)	Max Radius (cm)	O.D. x Length (mm)
6	10	356	8300	7850	10.2	17.2x88
6	15	303	7400	6850	11.2	17.2x102
6	19	302	6300	5600	12.6	17.2x122

<b>ROTOR 804S 4-Place Fixed Angle 45° with 323 Sealed Dome Shield</b>						
No. of Places	Tube Volume (ml)	Shield	Maximum Speed (rpm)	Max RCF (xg)	Max Radius (cm)	O.D. x Length (mm)
4	50	323*	7200	6675	11.5	Falcon/Corning Conical

\*Order Adapter 1106 And 571 Cushion To Spin 15 MI Falcon/Corning Conical Tubes

<b>ROTOR 809 12-Place Fixed Angle 45°</b>						
No. of Places	Tube Volume (ml)	Shield	Maximum Speed (rpm)	Max RCF (xg)	Max Radius (cm)	O.D. x Length (mm)
12	10	356	7500	6425	10.2	17.2x88
12	15	303	6500	5300	11.2	17.2x102
12	19	302	5500	4250	12.6	17.2x122

<b>ROTOR 815 24-Place Fixed Angle 33°</b>						
No. of Places	Tube Volume (ml)	Shield	Maximum Speed (rpm)	Max RCF (xg)	Max Radius (cm)	O.D. x Length (mm)
24	10	356	6500	5250/4300	11.1/9.1	17.2x88
24	15	303	5500	4050/3375	12/10	17.2x102
24	19	302	5000	3625/3075	13/11	17.2x122 Falcon/Corning Conical

<b>ROTOR 816 8-Place Fixed Angle 33°</b>						
No. of Places	Tube Volume (ml)	Shield	Maximum Speed (rpm)	Max RCF (xg)	Max Radius (cm)	O.D. x Length (mm)
8	50	320	6300	5200	11.7	30x115 Corning 8300-50
8	50	305	5600	4500	12.8	30x134 Falcon/Corning Conical*

\*With IEC 315 Conical Cushion

<b>ROTOR 818 12-Place Fixed Angle 35°</b>						
No. of Places	Tube Volume (ml)	Adapter	Maximum Speed (rpm)	Max RCF (xg)	Max Radius (cm)	O.D. x Length (mm)
12	5	----	13,400	15,050	7.5	12x80 IEC 2804, 2840
12	1.5-2	5762	13,400	11,050	5.5	11x66
12	B-D/.5	5761	13,400	11850/10050	5.9/5.0	8x66
12	.4/.25	5760	13,400	11850/10050	5.9/5.0	6x66

<b>ROTOR 819 10-Place Fixed Angle 35°</b>						
No. of Places	Tube Volume (ml)	Adapter Number	Maximum Speed (rpm)	Max RCF (xg)	Max Radius (cm)	O.D. x Length (mm)
10	10	----	13,400	15,250	7.6	16.1x85IEC2046,2067,2801,2850
10	5	5986	13,400	14,850	7.4	12.1x85
10	4	5987	13,400	14,650	7.3	10.9x90IEC2804,2840,2841,2852
10	1	5989	13,400	14,450	7.2	6.1x52 Corning 9820-6

<b>ROTOR 836 6-Place Fixed Angle 30°</b>						
No. of Places	Tube Volume (ml)	Adapter Number	Maximum Speed (rpm)	Max RCF (xg)	Max Radius (cm)	O.D. x Length (mm)
6	30	----	13,400	15,050	7.5	25.8x100 IEC 2047,2055,2802
6	15	5965	13,400	14,450	7.2	16.1x109
6	5	5966	13,400	14,050	7.0	12.1x112
6	3	5967	13,400	13,650	6.8	10.9x95

<b>ROTOR 841 12-Place Fixed Angle 45°</b>						
No. of Places	Tube Volume (ml)	Adapter Number	Maximum Speed (rpm)	Max RCF (xg)	Max Radius (cm)	O.D. x Length (mm)
12	1.5-2	----	14,000	12,700	5.8	11x39
12	B-D	5763	14,000	12,925	5.9	B-D Microtainer Tubes
12	.5	5763	14,000	10,750	4.9	8x66
12	.4	5764	14,000	12,700	5.8	6x46
12	.25	5764	14,000	9850	4.5	6x46

<b>ROTOR 851(651)++ 24-Place Fixed Angle 45°</b>						
No. of Places	Tube Volume (ml)	Adapter Number	Maximum Speed (rpm)	Max RCF (xg)	Max Radius (cm)	O.D. x Length (mm)
24	1.5	----	13,200	16,250	8.35	11x45
24	B-D	5763	13,200	16,450	8.45	B-D Microtainer Tubes
24	.5	5763	13,200	14,500	7.45	8x32
24	.4	5764	13,200	16,250	8.35	6x50
24	.25	5764	13,200	14,100	7.25	6x32

**++50036 Hub Adapter Required**

<b>ROTOR 852(652)++ 48-Place Fixed Angle 45°</b>						
No. of Places	Tube Volume (ml)	Adapter Number	Maximum Speed (rpm)	Max RCF (xg)	Max Radius (cm)	O.D. x Length (mm)
48	.5	----	13,200	15,575*	8.0*	8x32
				14,600**	7.5**	
24	B-D	5763	13,200	16,750*	8.6*	B-D Microtainer Tubes

**\*Outer Row \*\*Inner Row ++50036 Hub Adapter Required**

<b>ROTOR 853(653)++ 40-Place Fixed Angle 45°</b>						
No. of Places	Tube Volume (ml)	Adapter Number	Maximum Speed (rpm)	Max RCF (xg)	Max Radius (cm)	O.D. x Length (mm)
40	.4	----	13,200	16,350	8.4	6x50
40	.25	----	13,200	14,600	7.5	6x32
40	.8	----	13,200	16,500	8.5	6x50

**++50036 Hub Adapter Required**



<b>ROTOR 854 4-Place Fixed Angle 20°</b>						
No. of Places	Tube Volume (ml)	Adapter Number	Maximum Speed (rpm)	Max RCF (xg)	Max Radius (cm)	O.D. x Length (mm)
4	50	----	12,900	14,000	7.53	28.4x106 IEC1630,2048,2053,2997
4	30	7243	12,900	13,400	7.2	25.4x93 IEC 2047,2055,2802
4	30	Corning 8445-AO	12,200	12,100	7.2	Corning 8445-30
4	25	Corning 8446-AO	12,200	12,100	7.2	Corning 8446-25

## 4.2 Derating Tables

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### Dense Samples

The Speed and Force Table lists the maximum speed for each rotor/adaptor combination in the Centra-MP4/R. These speeds are guaranteed only with samples whose specific gravity is not greater than:

1.2 for swinging bucket rotors

1.5 for fixed angle rotors

For denser samples, the maximum guaranteed speed is reduced (derated) by a factor from the table below:

#### Derating Factor for:

Specific Gravity	Swinging Bucket	Fixed Angle
1.2	1.	1.
1.3	.960	1.
1.4	.925	1.
1.5	.894	1.
1.6	.866	.967
1.7	.839	.939
1.8	.816	.912
1.9	.794	.888
2.0	.774	.866
2.1	.755	.844
2.2	.738	.825
2.3	.721	.807
2.4	.707	.790
2.5	.692	.774
2.6	.678	.758
2.7	.666	.744
2.8	.654	.731
2.9	.642	.719
3.0	.632	.707

**Example.** An angle rotor rated for 10,000 RPM, used with samples with a specific gravity of 1.6, cannot spin faster than (10,000 x .967 =) 9,670 RPM.

**Specific gravities greater than 3.0.** This table is based on the formula:

$$\sqrt{s_0/s_a}$$

...where  $s_0$  is the maximum specific gravity allowed before derating (1.2 or 1.5, depending on the type of rotor), and  $s_a$  is the actual specific gravity of the sample in question. You can use the same formula to compute derating factors for specific gravities greater than 3.0.

**Caution:** Do not exceed the rated speed. Higher speeds will impose unnecessary wear on the centrifuge and can cause ROTOR FAILURE.

### 244 Rotor

The 244 rotor is designed for centrifugation of multi-well microplates. The weight of the loaded microplates must be equally distributed between the rotor's two carriers. The maximum rated speed for the 244 rotor when each of the carriers is loaded with 280 grams (total load of 560 grams) is 4000 rpm in the MP4/R.

**Caution:** For loads greater than 280 grams (weight of microplate and sample) per carrier, maximum speed must be DERATED (according to the following table) to avoid ROTOR FAILURE.

**Derating Table for 244 Rotor**

Load per carrier	Max. Speed
280 grams	4000 rpm
300 grams	3600 rpm
320 grams	3300 rpm
340 grams	3000 rpm
360 grams	2800 rpm
380 grams	2600 rpm
400 grams	2400 rpm
450 grams	1900 rpm
500 grams	1400 rpm
600 grams	800 rpm
Greater than 600 grams	Do Not Use

### 4.3 Chemical Resistance Table

	Plastic										Metal					Other			
	PA	PC	PE	PP	PU	NL	DN	CN	NN	PS	TI	SS	AL	MB	MG	RR	BN	VN	PF
Acids, dilute or weak	E	E	E	E	G	E	F	N	F	E	G	G	F	F	N	F	E	E	E
Acids*, strong or conc.	E	N	E	E	F	N	N	N	N	F	N	N	N	N	N	N	F	G	N
Alcohols, aliphatic	E	G	E	E	F	E	E	E	N	E	E	E	E	F	E	E	G	E	
Aldehydes	G	F	G	G	G	G	G	G	F	N	E	E	E	E	E	E	N	E	E
Bases	E	N	E	E	N	G	N	G	F	E	E	E	E	E	E	G	G	N	N
Esters	G	N	G	G	N	E	G	G	E	N	E	E	E	E	E	N	N	N	E
Hydrocarbons, aliphatic	G	F	G	G	E	N	E	E	E	N	E	E	E	E	E	N	E	E	E
Hydrocarbons, aromatic	F	N	G	F	N	N	E	E	E	N	E	E	E	E	E	N	N	E	E
Hydrocarbons, halogenated	F	N	F	F	N	N	G	E	G	N	E	E	E	E	N	N	N	F	E
Ketones	G	N	G	G	N	N	E	E	E	N	E	G	G	G	E	N	N	N	E
Oxidizing Agents, strong	F	N	F	F	N	N	N	N	N	N	E	F	N	N	N	N	F	E	E
Salts	E	E	E	E	E	E	E	E	E	E	E	F	F	F	N	E	E	E	E

\* For Oxidizing Acids, see "Oxidizing Agents, strong".

PA - POLYALLOMER	TI - TITANIUM
PC - POLYCARBONATE	SS - STAINLESS STEEL
PE - POLYETHYLENE	AL - ALUMINUM
PP - POLYPROPYLENE	MB - MANGANESE BRONZE
PU - POLYURETHANE	MG - MAGNESIUM
NL - MODIFIED PHENYLENE OXIDE (NORYL)	RR - RUBBER
DN - ACETAL HOMOPOLYMER (DELFIN)	BN - BUNA-N
CN - ACETAL COPOLYMER (CELCON)	VN - VITON
NN - NYLON	PF - PHENOLIC FIBER
PS - POLYSTYRENE	

#### Classification of Resistance

E=Excellent  
 G=Good  
 F=Fair  
 N=Not Recommended

## 4.4 Decontamination Table

Compatible Processes For Decontamination																				
Sterilization Methods	Plastic										Metal					Other				
	PA	PC	PE	PP	PU	NL	DN	CN	NN	PS	TI	SS	AL	MB	MG	RR	BN	VN	PF	PT
<b>Mechanical</b>																				
Autoclave*	S	M	U	S	M	U	S	S	S	U	S	S	S	S	S	S	S	M	S	M
Ethylene Oxide Gas	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	U	U	S	S	S
Dry Heat 160°C@2Hrs.	U	U	U	U	U	U	U	U	U	U	S	S	U	S	S	U	U	U	U	U
<b>Chemical</b>																				
Ethanol	S	S	S	S	U	S	S	S	U	M	S	S	S	S	S	S	S	S	S	S
40% Formalin	S	S	S	S	U	S	S	S	S	U	S	S	S	S	S	S	U	S	S	S
Methanol	S	M	S	S	M	S	S	S	U	M	S	S	S	S	S	S	S	U	S	S
2-Propanol	S	S	S	S	M	S	S	S	U	S	S	S	S	S	M	S	S	S	S	S
5% Sodium Hypochlorite**	S	S	S	S	U	S	U	U	U	S	S	M	U	U	U	S	U	S	S	M
3% Hydrogen Peroxide	S	S	S	S	S	S	M	S	U	S	S	S	S	S	U	S	S	S	S	M
100% Hydrogen Peroxide	S	S	S	S	S	U	U	U	U	S	S	S	S	S	S	U	U	S	S	U
5% Phenol Solution	M	U	U	S	U	U	M	M	U	M	M	M	M	M	M	M	U	S	S	U

PA - POLYALLOMER  
 PC - POLYCARBONATE  
 PE - POLYETHYLENE  
 PP - POLYPROPYLENE  
 PU - POLYURETHANE  
 NL - MODIFIED PHENYLENE OXIDE (NORYR)  
 DN - ACETAL HOMOPOLYMER (DELRIN)  
 CN - ACETAL COPOLYMER (CELCON)  
 NN - NYLON  
 PS - POLYSTYRENE

TI - TITANIUM  
 SS - STAINLESS STEEL  
 AL - ALUMINUM  
 MB - MANGANESE BRONZE  
 MG - MAGNESIUM  
 RR - RUBBER  
 BN - BUNA-N  
 VN - VITON  
 PF - PHENOLIC FIBER  
 PT - PAINTED SURFACES

\*Autoclaving  
 121°C 20 min. @  
 2 ATM (15 PSIG)

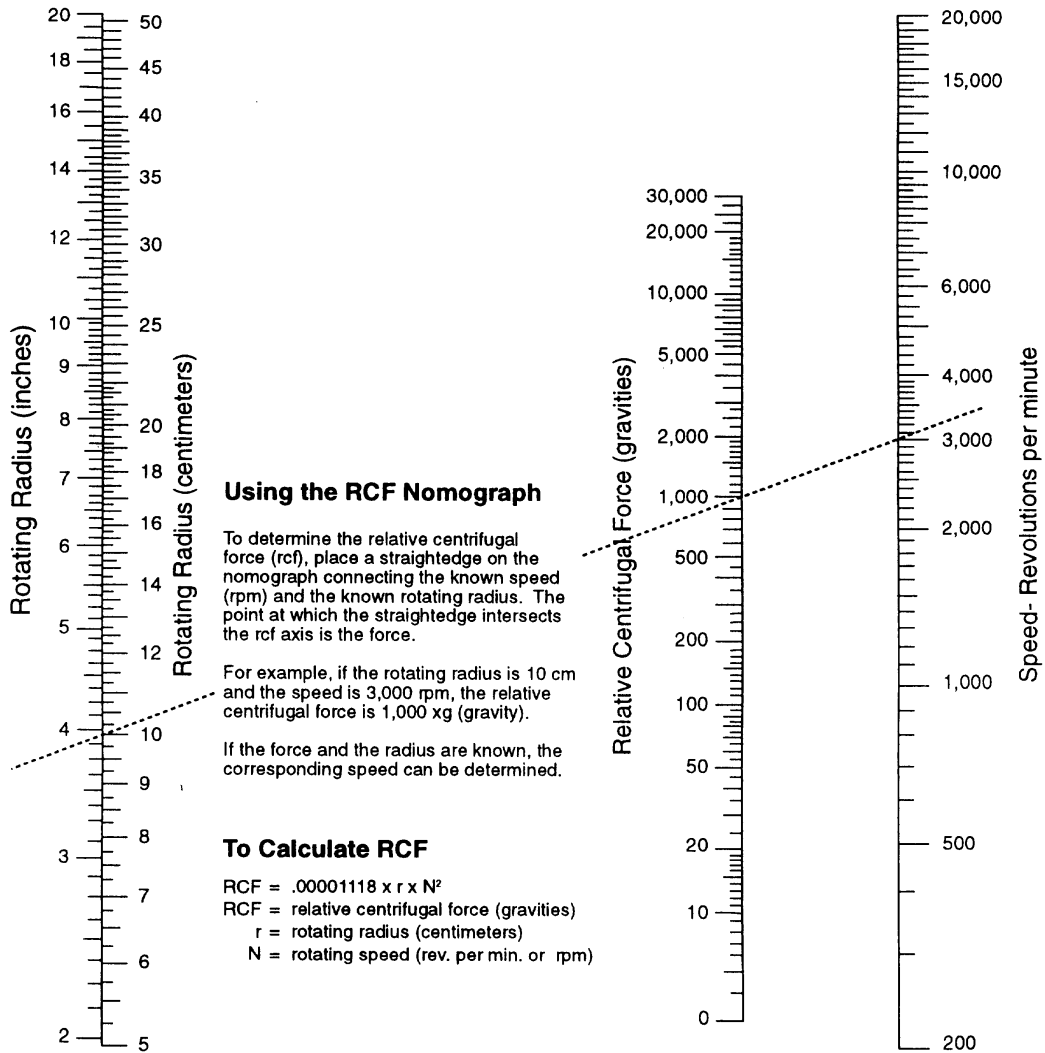
\*\*Household Bleach

S=SATISFACTORY  
 M=MARGINAL  
 U=UNSATISFACTORY

### WARNING:

This chart describes the material compatibility of various sterilization methods. It does not specify the adequacy of sterilization. Refer to section 4.3 Chemical Resistance Table for material compatibility during centrifugation.

## 4.5 RCF Nomograph



# 5 MAINTENANCE

## 5.1 Cleaning

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Keep your centrifuge clean to ensure good operation and to extend its life. Clean the entire sample chamber, rotor, and lid at the end of each workday, and also right after any spill.

To clean the sample chamber, use a damp sponge, warm water, and a mild liquid detergent suitable for washing dishes by hand, such as Ivory® liquid. Do not use caustic detergents or detergents that contain chlorine ions, since these attack metals. Remove stubborn stains with a plastic scrub pad. Do not use steel wool, wire brushes, abrasives, or sandpaper, since they create corrosion sites. Never pour water directly into the sample chamber. Scrub the rotor's tube cavities with a stiff test-tube brush that has end bristles and a non-metallic tip. After cleaning any part, dry it properly, preferably using a clean, absorbent towel.

If glass breakage occurs, remove all broken pieces immediately. Glass particles, if present in the chamber, will be ground into a fine grey dust during centrifugation. If glass breakage recurs it is recommended that all adapters and cushions be replaced. Particles of broken glass become imbedded in the plastic or rubber accessories. These particles can come in contact with new glass tubes, creating a pressure point which may result in recurring glass breakage.

**Cleaning swinging bucket rotors** is necessary to ensure that the buckets can pivot freely. Periodically manipulate each bucket; if you feel resistance or hear squeaking, lubricate all buckets with Bonded Lubricant Coating (BLC), IEC Part No. 7133. Use the following cleaning and lubrication procedure:

1. Wipe the old lubricant from all rotor pins and buckets with a soft, clean, lint-free cloth saturated with solvent such as trichloroethylene.
2. Clean the rotor and buckets as described above. The cleaning step is important because BLC only adheres to a clean surface. If you are unable to remove foreign matter in this way, contact an authorized IEC Service Representative.
3. Shake the bottle of BLC vigorously until all the gray sediment at the bottom of the bottle is dispersed.

4. Use the brush applicator cap to apply a light coating of BLC to the bucket slots only. Do not lubricate the pins. Lubricant will move around the pins during a spin.
5. Give the BLC 1 to 2 minutes to dry. Buff the bucket slots vigorously with a soft, clean, lint-free cloth. Continue until no more BLC rubs off onto the cloth. The surface will be a shiny, light gray.

**Corrosion** IEC manufactures and finishes rotors and structural accessories to give maximum resistance to corrosion. However, maximum equipment life requires that you continually inspect the rotor cavities for corrosion, especially after using chloride ion solutions, such as sodium chloride (saline), and sodium hypochlorite (household bleach). These solutions attack most metals. Clean the rotor, rotor chamber, and accessories (particularly the sample compartments and bucket cups) thoroughly after each such use. Inspect all surfaces under bright light for corrosion; small crevices will grow deeper and cause failure.

Replace the shaft, metal locking screw, rotor or accessories if they become badly corroded, cracked deformed or gouged.

If you see any corrosion, remove it immediately as follows:

1. Follow the cleaning procedure at the start of this section. Soak the part in the mild hand-dishwashing detergent. Scrub the part thoroughly with a stiff test-tube brush having end bristles and a non-metallic tip.
2. Soak the part again in clear warm water for at least an hour.
3. Rinse the part thoroughly in warm water first, then in distilled water.
4. Dry the part thoroughly with a clean, absorbent cloth.
5. If this procedure does not remove the corrosion, **discontinue use of the part.**

**Storage** Store parts on a soft surface to avoid damaging finished surfaces. Rotors and other parts should be clean and dry for storage. Store them open to the atmosphere, not in a plastic bag, so that any residual moisture will evaporate. The parts should face downward to avoid retaining moisture in the cavities.

**Decontamination** Decontamination is called for if tube breakage occurs and infectious, pathogenic, or radioactive material is released into the unit. Some rotors totally contain the sample tubes. In this case, spillage is usually confined to the rotor. If so, it may be sufficient to decontaminate the rotor. The Decontamination Table lists the sensitivity of various materials to common sterilization procedures. When using a 1-to-10 dilution of household bleach (sodium hypochlorite) to decontaminate metal rotors or accessories, follow decontamination by the corrosion cleaning procedure given earlier, since chloride ions attack most metals.



Always decontaminate for the minimum recommended time. If you observe corrosion, remove it as described earlier, discontinue use of the method, and use an alternate decontamination procedure.

Sterilization of polypropylene rotors can be done by autoclaving. Remove any sample tubes before autoclaving, unless they are completely full of sample, or remove caps, stoppers, and other tube closures, before autoclaving to keep the tubes from collapsing under pressure. Autoclave the

rotor and accessories at 121° C @ 15 psig for 20 minutes. Do not stack polypropylene rotors during autoclaving. After the rotor is cool to the touch, do a normal cleaning operation as described above.

Repeated autoclaving will seriously degrade the performance of polycarbonate materials.

## 5.2 Cover Interlock Bypass

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If power fails, the cover remains locked. If you need to remove samples from the unit before power is restored, use the cover interlock bypass after the rotor has come to a stop.

Unplug the centrifuge. Locate a hidden plug just below the front panel. Use a screwdriver to remove this plug. Pull the attached cord to release the cover interlock. Reassemble the plug in the hole.

Do not perform this operation routinely. The centrifuge's cover interlock provides operator safety and allows the cover to be opened promptly whenever rotation has stopped.

## 5.3 Calibration

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The built-in, independent digital tachometer in your centrifuge is calibrated by IEC according to standards that are traceable to the U.S. National Institute of Standards and Technology (NIST). The built-in tachometer uses crystal standards that do not drift. Therefore, IEC recommends verifying the RPM indicator once every 24 months. This can be done easily using an optical tachometer through the clear plastic viewport in the lid. If this measurement indicates instrument tachometer failure, please notify IEC Technical Service.

## 5.4 Brush Replacement

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Brush replacement is required when brush length is 1/4 inch or less, or when the front panel displays "bruSh" at the end of a spin. The "bruSh" warning occurs every 700 hours of actual spin time. A set of replacement brushes is included with the centrifuge.

Open the cover and unplug the centrifuge. Unscrew the locking screw and remove the rotor and all accessories. Locate the rubber motor boot at the bottom of the rotor chamber. It is attached to the motor by a ring with 4 screws, and is fitted to the rotor chamber. Gently push the boot toward the motor shaft to separate it from the guard bowl. Locate and unscrew the two brush holder caps (protruding from both sides of the motor). **Take care not to drop the brush caps into the motor well!** Inside each cap is a brush assembly, consisting of a rectangular carbon brush, a spring, and a copper wire inside the spring. Remove and discard from both sides of the motor the entire assembly inside each cap. Replace them with the spares. The brush's rectangular shape keeps it from being inserted improperly. Screw the caps back in. Reinstall the motor boot assembly. Plug the centrifuge back into the power outlet.

**Order a new set of brushes; IEC Part No. 50433.**

The "bruSh" warning indication on the front panel must now be reset. To do so, follow this procedure:

1. Press the SPECIAL FUNCTIONS button located behind the "C" in IEC. The RPM display now shows one of a set of Special Functions. This menu is primarily used by service personnel.
2. Press either RPM arrow key until the RPM display shows "bruSh". The MINUTES display now shows the hours of brush life. At brush replacement, this number is 700 or over.
3. Press the File key to set the brush life back to 0, reflecting the installation of new brushes.
4. Press the SPECIAL FUNCTIONS button again to return the unit to normal operation.

## 5.5 Table of Spare Parts

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48407	Rotor Locking Screw
9946	Fuse 6.3 A, 200/240 V
50058	Fuse 16 A, 100/120 V
50433	Brushes, One Pair
50431	Brush Caps, One Pair
7133	BLC (Bonded Lubricant Coating)

## 5.6 Warranty

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IEC wants you to be satisfied with the quality of your Centra-MP4R or Centra-MP4 centrifuge. We warrantee your IEC centrifuge for one year and IEC rotors for seven years. We will repair or replace any of these products that fails, within this period from the date of its delivery, due to defects in material and workmanship, and we will ship you the repaired product or its replacement at our expense. You must use IEC approved accessories and genuine IEC spare parts. This warranty does not apply to any instrument that has been abused or repaired without authorization.

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. THE FOREGOING STATES 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. IEC WILL IN NO EVENT BE LIABLE FOR ANY SPECIAL OR CONSEQUENTIAL DAMAGES WHATSOEVER, AND OUR LIABILITY UNDER NO CIRCUMSTANCES WILL EXCEED THE PURCHASE PRICE FOR THE GOODS FOR WHICH LIABILITY IS CLAIMED.

## 5.7 Condition of Returned Equipment

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Before returning equipment to IEC, you must contact IEC or your dealer and receive a return goods authorization (RGA). **All returned units must be decontaminated, free of radioactivity, and free of hazardous and infectious materials.** The RGA paperwork includes a Certificate of Decontamination for you to sign indicating that you have performed these steps. IEC will not accept the shipment until this signed certificate is received.

You must prepay transportation to the service depot.

## 5.8 Fuses Not Replaceable By The Operator

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Four internal fuses are not replaceable by the operator. These fuses should only be replaced by qualified service personnel.

F1	2.5A	T	250V
F2	6.3A	T	250V
F3	2.0A	T	125V
F4	1.0A	T	125V

## 6 SPECIFICATIONS

Maximum Speed:	14,000 RPM (817 fixed angle rotor) 4,400 RPM (224 horizontal rotor)
Maximum Force:	16,750 xg (852 fixed angle rotor)
Maximum Number of Tubes:	60 x 1.5 ml (796 rotor)
Maximum Sample Volume:	1 liter (224 rotor)
Operator Controls:	
Chamber Temp.*:	-5° C to 40° C, by 1 C°
Rotation:	300 -14,000 RPM, by 100 RPM 1 - 100 xg, by 1 xg 101 xg and up, by 10 xg
Spin Duration:	0:01 through 0:59, by 1 second 1:00 through 4:45, by 15 seconds 5 through 360 min., by 1 min. Momentary operation mode Hold mode (indefinite duration) Timing mode
Repeatability:	
Temperature Control*:	+/- 1 C° in the range from +4° C to ambient
Rotation	to 10 RPM
Spin Timing	0.1 seconds
Motor:	Series-wound universal motor
Brake:	Automatic dynamic electric brake
Refrigeration System*:	Hermetic compressor (1/4 hp @ 60 Hz)
Refrigerant*:	HP-80, (5.8 oz.)
Fuses:	2x 16 A Slo-Blo (for 100 V/120 V) 2x 6.3A Slo-Blo (for 220V/240V)
Power Requirements	
Voltage:	User-configurable for: 100 V nominal ( 90-110 V) 120 V nominal (108-132 V) 220 V nominal (198-242 V) 240 V nominal (216-264 V)
Frequency:	50 Hz, 60 Hz
Current:	12 A Maximum (100 V/120 V) 6.5 A Maximum (220 V/240 V)
Heat Output:	950 BTU/hour typical (MP4R) 700 BTU/hour typical (MP4)

\* MP4R Only

Dimensions (MP4R)

Height: 85 cm (33.5 in) (with cover open)  
40 cm (15.5 in) (with cover closed)  
Width: 47 cm (18.5 in)  
Depth: 69 cm (27 in)  
Weight: 95 kg (210 lbs) (shipping weight)  
73 kg (160 lbs) (net weight)

Dimensions (MP4)

Height: 85 cm (33.5 in) (with cover open)  
40 cm (15.5 in) (with cover closed)  
Width: 47 cm (18.5 in)  
Depth: 53 cm (20.75 in)  
Weight: 73 kg (160 lbs) (shipping weight)  
50 kg (110 lbs) (net weight)

Sound Level: 65 dba

*Specifications Subject To Change Without Notice*