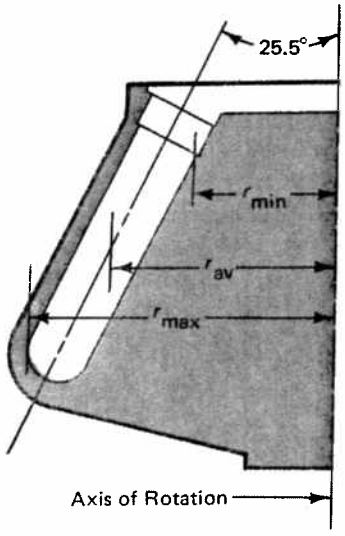
L5-TB-031H
September 1988

BECKMAN

INSTRUCTIONS FOR USING THE TYPE 75 Ti ROTOR
In Beckman Class H, R, and Certain F and G Preparative Ultracentrifuges



SPECIFICATIONS

Maximum speed	75 000 rpm
Density rating at full speed	1.2 g/mL
Relative Centrifugal Field* at maximum speed	
At r_{max} (79.7 mm)	502 000 x *g*
At r_{av} (58.3 mm)	367 000 x *g*
At r_{min} (36.9 mm)	232 000 x *g*
k factor at maximum speed	35
Number of tube cavities	8
Available tubes	see Tables 1 and 2
Nominal dimensions of largest tube	$^5/_8$ x 3 in. (16 x 76 mm)
Nominal tube capacity	13.5 mL
Nominal rotor capacity	108 mL
Approximate acceleration time to maximum speed (rotor fully loaded) in an L8M ultracentrifuge	9 min
Approximate deceleration time from maximum speed (rotor fully loaded) in an L8M ultracentrifuge	$5^1/_2$ min
Weight of fully loaded rotor	5.9 kg (13 lb)
Rotor material	titanium

*Relative Centrifugal Field (RCF) is the ratio of the centrifugal acceleration at a specified radius and speed ($r\omega^2$) to the standard acceleration of gravity (*g*) according to the following formula:

$$RCF = \frac{r\omega^2}{g}$$

where *r* is the radius in millimeters, ω is the angular velocity of radians per second ($2\pi RPM/60$), and *g* is the standard acceleration of gravity (9807 mm/s^2). After substitution:

$$RCF = 1.12r\left(\frac{RPM}{1000}\right)^2$$

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DESCRIPTION

The Type 75 Ti titanium fixed angle rotor, rated for 75 000 rpm, holds up to eight 5/8 x 3-in. tubes at a 25.5-degree angle from the axis of rotation. Used in Beckman class F (Model L2-50 and L3's), G (Model L3's only), H, and R preparative ultracentrifuges, the rotor develops centrifugal forces that can separate very small particles. The rotor is also useful for banding plasmid DNA in sedimentation-equilibrium experiments using cesium chloride gradients. Up to 108 mL of gradient and sample volume can be centrifuged per run.

The exterior surface of the rotor is finished with black urethane paint for optimal temperature control. The titanium lid is finished with red urethane paint to indicate that the rotor is a high-performance rotor. The aluminum handle is red anodized. The rotor is heavy enough to be engaged by the drive spindle without the aid of drive pins. The O-rings in the handle and lid are made of Buna N and maintain atmospheric pressure in the rotor during centrifugation. An overspeed disk is attached to the rotor bottom as part of the photoelectric overspeed detection system. The Type 75 Ti rotor is warranted at 75 000 rpm for 5000 runs, 10 000 hours of centrifugation, or five years, whichever occurs first (see the Warranty).

OPERATION

> **NOTE:** Specific information about the Type 75 Ti rotor is given here. Information common to this and other rotors is contained in the Rotors and Tubes Manual, LR-IM, which should be used together with this bulletin for complete rotor and accessory operation.

TUBES AND BOTTLES

Tubes and bottles that may be used in the Type 75 Ti rotor are listed in Tables 1 and 2. Be sure to observe the maximum speed limits shown.

Polyallomer and polycarbonate containers should not be centrifuged below 2°C. Do not freeze polyallomer tubes before centrifugation, as they may become brittle and crack. Polyallomer and polycarbonate containers may be centrifuged at temperatures above 25°C, but they should be pretested under anticipated run conditions. Ultra-Clear™ tubes have been tested for use at temperatures between 4 and 20°C. For centrifugation at other temperatures, pretest these tubes as well. Stainless steel tubes can be centrifuged at any temperature. Thinwall capped tubes should be filled as full as possible to prevent tube collapse during centrifugation. Cap O-rings or gaskets should be dry and free from lubricant during assembly. Thickwall plastic tubes are used partially filled (at least half filled) without tube caps. Do not overfill capless tubes. Polycarbonate bottles

may be centrifuged completely filled, or if desired, partially filled with at least 5 mL. (If filled below maximum volume, 60 000 rpm is the maximum speed—see Table 1.) Refer to the Rotors and Tubes Manual for more detailed information on filling tubes and bottles.

The high-strength titanium caps must be used with maximum-diameter thinwall Ultra-Clear and polyallomer tubes. Red silicone O-rings are used in caps for Ultra-Clear, and black Buna N O-rings for polyallomer tubes. Torque the cap nut to 90 to 100 inch-pounds (10 to 11 N•m), using a torque wrench (see Supply List) while the capped tube is held in the tube-cap vise. Required tools for small tubes used with adapters are detailed in the Rotors and Tubes Manual.

Quick-Seal® tubes should be filled leaving a small air space at the neck of the tube (refer to publications IN-163 and IN-181). Install a spacer over each sealed Quick-Seal tube in the rotor cavity.

Table 1. Available Tubes ($^5/_8$ x 3-in.) for the Type 75 Ti Rotor

Description	Part Number	Required Accessory		Nominal Fill Volume (mL)	Maximum Speed (rpm)
		Description	Part Number		
Thinwall Ultra-Clear polyallomer	344085 326814	titanium cap*	341968	13.5	75 000
Quick-Seal Ultra-Clear polyallomer	344322 342413	aluminum spacer	342695	13.5	75 000
Thickwall polyallomer polycarbonate	355640 355603	none	—	8	30 000 50 000†
Polycarbonate bottle assembly	355603 355651 (bottle only)	Noryl‡ cap	355604	10.4**	65 000

*Use red silicone O-rings with Ultra-Clear tubes; use black Buna N O-rings with polyallomer tubes.

†Recommended speed. These tubes may be centrifuged at 75 000 rpm for 6 hours or at 65 000 rpm for 8 hours.

‡A registered trademark of General Electric.

**For lower fill volumes (minimum of 5 mL) centrifuge at 60 000 rpm.

CAUTION

Use only the caps listed in the table. In particular, the high-strength titanium caps have been specially designed for use with thinwall Ultra-Clear and polyallomer tubes 344085 and 326814, respectively. DO NOT use aluminum caps with these tubes. Be sure all caps are in good condition before use.

Table 2. Small Tubes and Accessories for the Type 75 Ti Rotor.
Only tubes and caps listed here or in Table 1 should be run in this rotor.

Dimensions and Volume	Description	Part Number	Required Cap	Required Adapter/ Floating Spacer*	Maximum Speed (rpm) and RCF	*k* Factor
5/8 x 2 5/8 in. (16 x 67 mm) 10 mL	Quick-Seal polyallomer	344622	none	none†	75 000 rpm 502 000 x *g*	32
1/2 x 2 1/2 in. (13 x 64 mm) 6.5 mL	Ultra-Clear	344088	303113 or 346256‡	303313	50 000 rpm 206 000 x *g*	66
	polyallomer	326820	303313 or 346256‡			
	stainless steel	301099	••			
1/2 x 2 1/2 in. (13 x 64 mm) 4 mL	thinwall polyallomer	355644	none	303313	50 000 rpm 206 000 x *g*	66
	thickwall polycarbonate	355645¶	none			
5/8 x 1 3/4 in. (16 x 45 mm) 6.3 mL	Quick-Seal polyallomer	345830	none	345828*	75 000 rpm 502 000 x *g*	22
5/8 x 1 1/2 in. (16 x 32 mm) 4.2 mL	Quick-Seal polyallomer	356562	none	345828*	75 000 rpm 502 000 x *g*	16
1/2 x 1 5/8 in. (13 x 41 mm) 4 mL	Ultra-Clear	344093	303113 or 346256‡	303402	45 000 rpm 146 000 x *g*	64
1/2 x 1 1/4 in. (13 x 32 mm) 3 mL	Ultra-Clear	344092	303113 or 346256‡	303401	45 000 rpm 135 000 x *g*	55
5/16 x 1 5/16 in. (8 x 49 mm) 2 mL	Ultra-Clear	344091	303724	303376	40 000 rpm 134 000 x *g*	69

* Floating spacer, part of the *g*-Max system of tube support, are made of Noryl, a registered trademark of General Electric.

† Use spacer, part number 344676, on top of this Quick-Seal tube.

‡ Use the 344672 neoprene gasket and 346246 stem.

•• Use part number 305022, 303113, or 346256.

¶ 50 000 rpm is the recommended speed. This tube, however, may be centrifuged at 65 000 rpm for 8 hours.

The *g*-Max™ system uses a combination of short bell-top Quick-Seal tubes (see Table 2) and floating spacers (also referred to as *g*-Max spacers). This provides an advantage over using conventional sleeve-type adapters, in which the tubes are no longer at the maximum radius, resulting in a reduction of *g* force. In the *g*-Max system, floating spacers sit on top of the Quick-Seal tubes—thus, there is no reduction of radial distance and, therefore, no reduction of *g* force. Further, adapters cannot be run at maximum speed. Finally, the shorter pathlength of the tubes permits faster run times for gradient or pelleting separations. For more information on the *g*-Max system, see publication DS-709.

ROTOR PREPARATION

Before using the rotor, make certain the 24-sector overspeed disk is properly attached to the rotor bottom. Be sure the threads in the rotor assembly are well lubricated with Spinkote™ lubricant, and the O-rings are thinly coated with silicone vacuum grease. For runs at temperatures other than room temperature, always refrigerate or warm the rotor beforehand, since titanium is a poor conductor of heat. Tubes placed opposite each other in the rotor should be filled to the same level with the same density liquid. Two, four, six, or eight tubes can be centrifuged per run, if they are arranged symmetrically as shown in Figure 1.

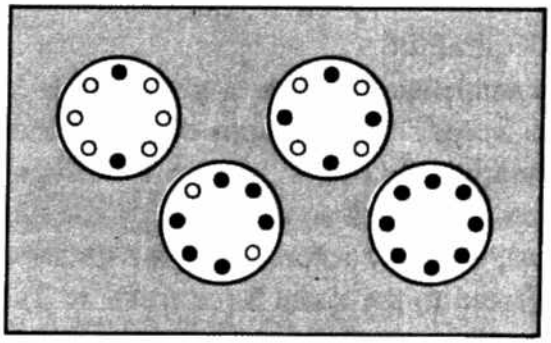

Figure 1. Arranging Tubes in the Rotor. Two, four, six, or eight tubes can be centrifuged per run, if they are arranged in the rotor as shown.

In Model L2-50 ultracentrifuges, use the stabilizer level "40" for the Type 75 Ti rotor.

NOTE: Consult the appropriate instrument instruction manual for ultracentrifuge operation.

RUN TIMES

The *k* factor of the rotor (35 at maximum speed) is a measure of the rotor's relative pelleting efficiency. Use the *k* factor in the following equations to estimate the run time *t* (in hours) required to pellet particles of known sedimentation coefficient *s* (in Svedberg units).

$$t = \frac{k}{s} \qquad (1)$$

Run times at less than maximum speed can be estimated by using the k factors in Table 3 or by adjusting the k factor as follows:

$$k = 35\left(\frac{75\ 000\ \text{rpm}}{\text{actual run speed}}\right)^2 \quad (2)$$

Run times can also be estimated from data established in prior experiments if the k factor of the previous rotor is known. For any two rotors a and b:

$$\frac{t_a}{t_b} = \frac{k_a}{k_b} \quad (3)$$

where the k factors have been adjusted for the actual run speed used.

Equilibrium sedimentation run times should not be calculated using k factors. Cesium chloride gradients, for example, generally require overnight centrifugation for full tubes. Tubes partially filled with gradient solution will required less time for equilibration. Centrifugation at speeds slower than 45 000 rpm will require longer run times for good particle resolution.

RUN SPEEDS

The centrifugal force at a given radius in a rotor is a function of the rotor speed. Comparisons of forces between different rotors are made by comparing the rotors' relative centrifugal fields (RCF). When rotational speed is selected so that identical samples are subjected to the same RCF in two different rotors, one may describe the samples as having been subjected to the same force (refer to Table 3). Speeds may not be selected in excess of those provided in Tables 1 and 2 for a particular tube. In addition, rotor speeds may need to be reduced when centrifuging high density solutions or salts that may precipitate (e.g., CsCl).

For centrifuging nonprecipitating solutions of density greater than 1.2 g/mL in this rotor, use the following square-root reduction formula to determine the allowable rotor speed.

$$\text{reduced speed} = 75\ 000\ \text{rpm}\sqrt{\frac{1.2\ \text{g/mL}}{\text{density of tube contents}}} \quad (4)$$

This speed reduction will protect the rotor from excessive stresses due to the added load.

When CsCl or other self-forming-gradient salt is centrifuged, the square-root formula above will not usually guard against the precipitation of salt crystals. Precipitation will alter the density distribution of the gradient, and therefore the sample separation. Figures 2 and 3, together with the

description and examples below, show how to reduce rotor speed when using CsCl gradients in sedimentation-equilibrium experiments.

Table 3. Relative Centrifugal Fields. Entries in this table are calculated from the formula RCF = 1.12 r (RPM/1000)² and then rounded to three significant digits.

Rotor Speed (rpm)	Relative Centrifugal Field (x g)			*k* Factor*
	At r_{max} (79.7 mm)	At r_{av} (58.3 mm)	At r_{min} (36.9 mm)	
75 000	502 000	367 000	232 000	35
70 000	437 000	320 000	203 000	40
65 000	377 000	276 000	175 000	46
60 000	321 000	235 000	149 000	54
55 000	270 000	198 000	125 000	64
50 000	223 000	163 000	103 000	78
45 000	181 000	132 000	83 700	96
40 000	143 000	104 000	66 100	122
35 000	109 000	80 000	50 600	159
30 000	80 300	58 800	37 200	217

*Calculated for all Beckman preparative rotors as a measure of the rotor's pelleting efficiency in water at 20°C.

SELECTING CsCl GRADIENTS

NOTE: The curves in Figures 2 and 3 are for solutions of CsCl salt only. If other salts are present in significant concentrations, the overall CsCl concentration must be reduced. This prevents precipitation of salts concentrated at the tube bottom.

Rotor speed is used to control the slope of a CsCl density gradient, and must be limited to prevent precipitation of CsCl during centrifugation. Speed and density combinations that intersect on or below the curves in Figure 2 ensure that CsCl will not precipitate during centrifugation of the Type 75 Ti rotor. Curves are provided at two temperatures, 20°C (black curves) and 4°C (gray curves). Note that for a given initial homogeneous CsCl solution density, the maximum allowable run speed increases as the fill volume of solution in the tube decreases. The curves in Figure 3 show gradient profiles at equilibrium. Each curve was generated for a single run speed using the maximum allowable homogeneous CsCl densities (one for each fill volume) that avoid precipitation at that speed and temperature.[1] Figure 3 can be used to approximate the banding positions of sample particles. In general, lower run speeds provide better resolution, but will require longer run times to achieve particle equilibration.

[1]The gradients in Figure 3 can be generated from step or linear gradients, or from homogeneous solutions.

Solutions can be centrifuged faster (therefore for shorter run times) when a tube is partially filled with gradient and sample. (For centrifuging thin-wall tubes, fill the remainder of the tube with a low-density, immiscible liquid, such as mineral oil.[2]) For example, a *full* tube of a 1.54 g/mL homogeneous CsCl solution can be centrifuged no faster than 50 000 rpm at 20°C (from Figure 2). Figure 3 presents the gradient profile, from 1.315 g/mL at the meniscus to 1.86 g/mL at the tube bottom. The same solution in a 3/4-filled tube can be centrifuged at 20°C at 55 000 rpm. Interpolation of Figure 3 between the 50 000 and the 60 000 rpm curves to the 3/4-filled level gives the 55 000 rpm curve. The same solution in a 1/2-filled tube can be centrifuged at 62 000 rpm, and in a 1/4-filled tube at 75 000 rpm. Note that the 75 000 rpm curve in Figure 3 is identical for 4 and 20°C. The 1/4-filled volume at 75 000 rpm yields a gradient distribution of 1.36 to 1.765 g/mL at the tube bottom.

TYPICAL EXAMPLES FOR DETERMINING CsCl PARAMETERS

Example A: Starting with a homogeneous CsCl solution density (e.g., 1.55 g/mL) and approximate particle densities (e.g., 1.53 and 1.60 g/mL), where will particles band?

1. In Figure 2 find the curve that corresponds to the desired run temperature (4°C) and tube fill volume (3/4-filled). The maximum allowable rotor speed is determined from the point where this curve intersects the homogeneous CsCl density (50 000 rpm).
2. In Figure 3, sketch in a horizontal line corresponding to each particle density.
3. Mark the point where each density intersects the curve corresponding to the selected speed and temperature.
4. Particles will band at these points along the tube axis.

In this example, particles band at about 62 and 67 mm from the axis of rotation. When the tube is held upright, there will be about 12 mm of interband separation $\left(d_{up} = \frac{d\theta}{\sin\theta}\right)$. About 16 hours of centrifugation is required for particle equilibration. If a full tube is used instead of a 3/4-filled tube, the maximum allowable speed for a 1.55 g/mL solution is 45 000 rpm and about 20 hours of centrifugation will be required. Interpolation of Figure 3 will give the gradient profile.

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[2]Do not use an oil overlay in the Ultra-Clear tubes.

Example B: Knowing particle densities (e.g., 1.55 and 1.50 g/mL), how do you achieve the best separation?

1. In Figure 3, sketch in a horizontal line corresponding to each particle density.
2. Select the curve at the desired temperature (e.g., 20°C) and tube volume (e.g., full) that gives the best particle separation.[3]
3. Note the speed indicated along the curve (50 000 rpm).
4. From Figure 2, determine the maximum allowable homogeneous CsCl density (1.54 g/mL) that corresponds to the the selected run parameters (temperature, run speed, and fill volume). These parameters will provide the particle separation selected in Step 2.

In this example, particles will band at about 55 and 60 mm from the axis of rotation (i.e., 5 mm apart). When the tube is held upright, there will be about 10 mm of interband separation. If a full tube is run, about 20 hours of centrifugation will be required to achieve equilibration. For a shorter run time (about 16 hours of centrifugation), use a 3/4-filled tube of a 1.595 g/mL homogeneous CsCl solution at 50 000 rpm to achieve the same particle separation.

MAINTENANCE

Routinely inspect the overspeed disk. If it is scratched, damaged, or missing, replace it according to the instructions in the Rotors and Tubes Manual. Do not use sharp tools on the rotor. Store the rotor in a dry environment (not in the instrument) with the lid removed.

Silicone vacuum grease should be routinely applied to the O-rings in the lid and handle. Replace the O-rings about twice a year or whenever worn or damaged. Keep the threads of the rotor assembly well lubricated with Spinkote lubricant. Refer to the Rotors and Tubes Manual for the chemical resistances of rotor and tube materials. Your Beckman Representative provides contact with the Field Rotor Inspection Program and the rotor repair center.

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[3] To improve band position, change fill level, temperature, or rotor speed; or reduce the homogeneous CsCl density so that a low-speed curve in Figure 3 is translated down into the density range of interest.

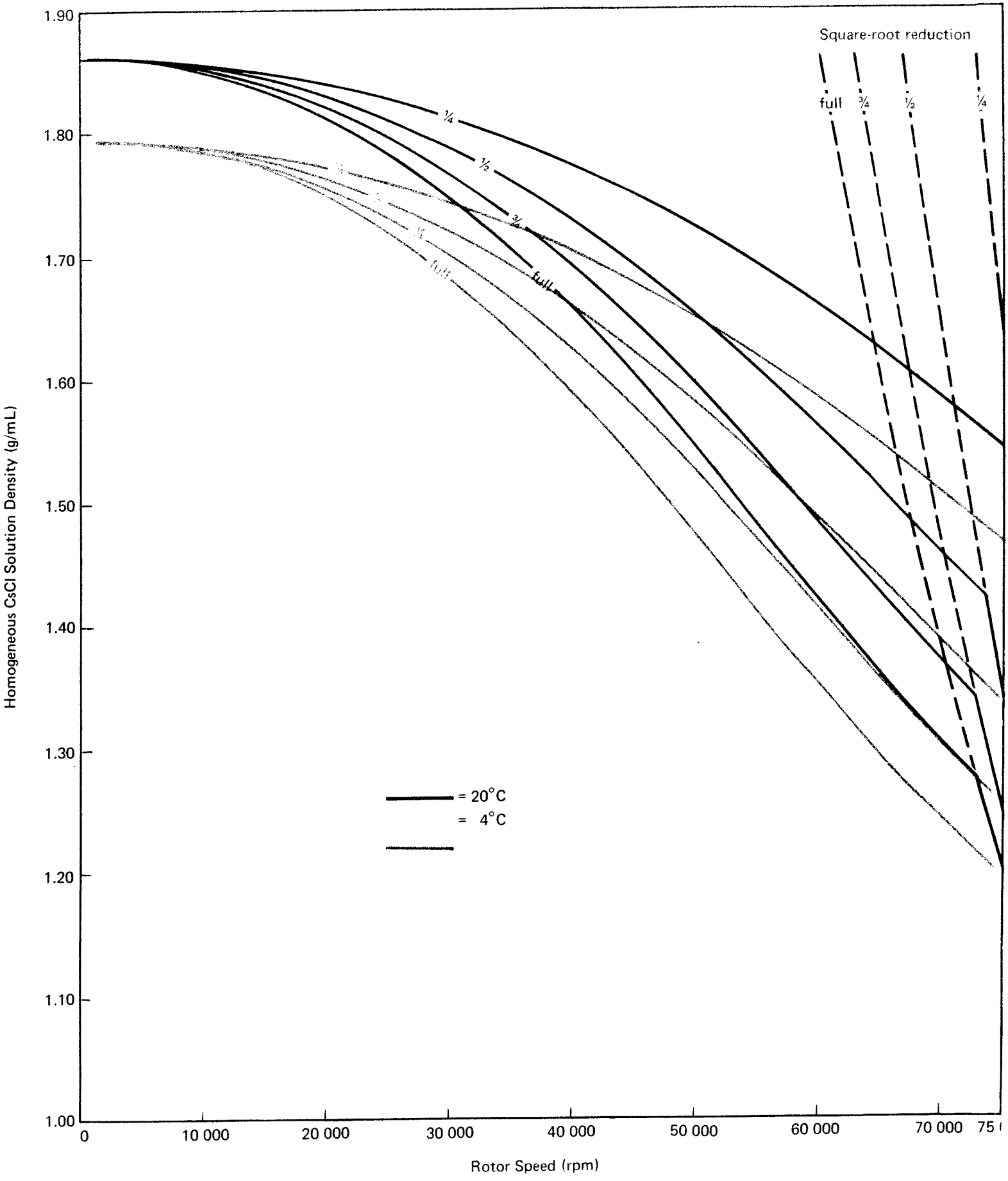

Figure 2. Precipitation Curves. Using combinations of CsCl densities and rotor speeds that intersect on or below the curves ensures that CsCl will not precipitate during centrifugation.

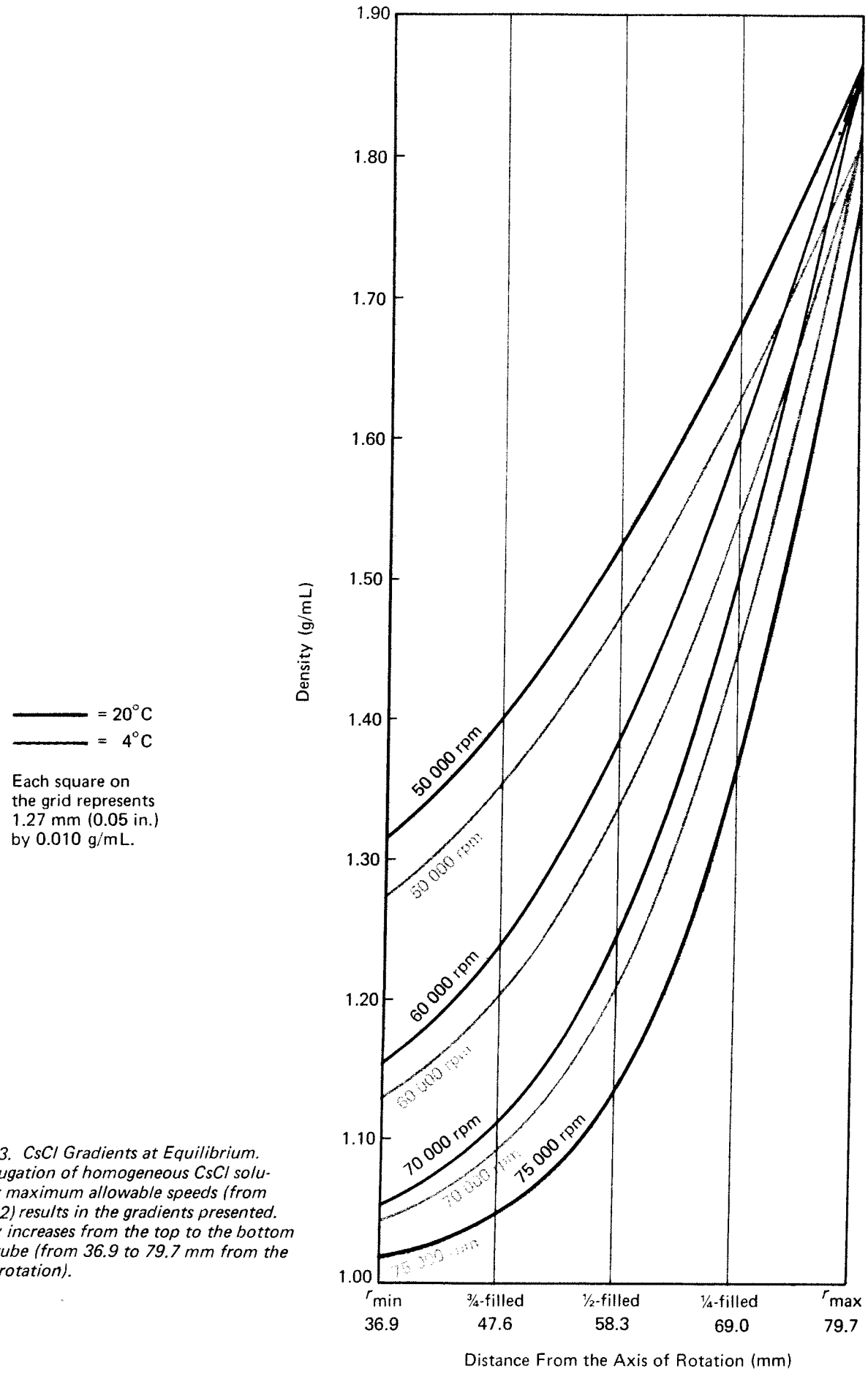

Figure 3. CsCl Gradients at Equilibrium. Centrifugation of homogeneous CsCl solutions at maximum allowable speeds (from Figure 2) results in the gradients presented. Density increases from the top to the bottom of the tube (from 36.9 to 79.7 mm from the axis of rotation).

CLEANING AND STERILIZATION

If salt solutions or other corrosive materials have been run, or if spillage has occurred, wash the rotor immediately. Do not allow corrosive materials to dry on the rotor. Use a mild detergent, such as Solution 555™ diluted 5 or 10 to 1 with water, and brushes that will not scratch the rotor. (Purchase the Rotor Cleaning Kit, which contains two quarts of Solution 555 and two brushes.) Thoroughly rinse the cleaned rotor with water and air-dry upside down.

Metal threads should be cleaned at least every six months, or more often if the rotor is used daily. Clean with a brush and concentrated Solution 555. Rinse and dry well, then lubricate with Spinkote.

If the rotor is contaminated with pathogenic or radioactive materials, appropriate decontamination procedures should be followed. Consult the Rotors and Tubes Manual to select a decontaminant that will not damage the rotor.

The rotor, including the O-rings, can be sterilized by autoclaving at 121°C for about one hour. Place the rotor in the autoclave upside down with the lid removed. All rotor components can be disinfected with 70% ethanol.[4]

RETURNING A ROTOR

Before returning a rotor or accessory for any reason, prior permission (a Returned Goods Authorization form) must be obtained from Spinco Division personnel. This form may be obtained from your local Sales Representative. It should contain the following information:

- serial number,
- a history of use (approximate frequency of use),
- the original purchase order number, billing number, and shipping number, if possible,
- the name and phone number of the person to be notified upon receipt of the rotor or accessory at the factory and
- the name and phone number of the person to be notified about repair costs, etc.

To protect our personnel, it is the customer's responsibility to ensure that the parts are free from pathogens and/or radioactivity. Sterilization and

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[4] Flammability hazard; do not use in or near operating ultracentrifuges.

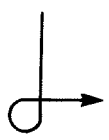
decontamination must be done before returning the parts. Smaller items (such as tubes, bottles, etc.) should be enclosed in a sealed plastic bag.

All parts must be accompanied by a note, plainly visible on the outside of the box or bag, stating that they are safe to handle and that they are not contaminated with pathogens or radioactivity. Failure to attach this notification will result in return or disposal of the items without review of the reported problem.

The rotor and/or accessories may then be mailed to:

Spinco Division
Beckman Instruments, Inc.
1050 Page Mill Road
Palo Alto, CA 94304

Attention: Returned Goods Clerk



SUPPLY LIST

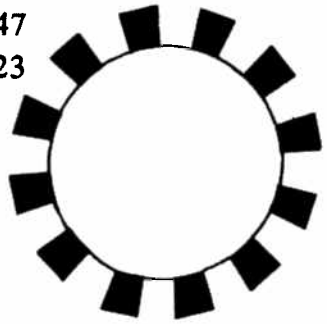
See the Rotors, Tubes, and Accessories catalog (PL-174) for detailed information on reordering supplies. For your convenience, a partial list is given below.

REPLACEMENT ROTOR SUPPLIES

Type 75 Ti rotor 334218
Tubes, bottles, caps, adapters and spacers .... see Tables 1 and 2
Overspeed disk (75 000 rpm) 334217
Rotor handle 335377
Lid O-ring 854524
Handle O-ring 010018

OTHER

Silicone vacuum grease 335148
Spinkote lubricant 306812
Rotor Cleaning Kit 339558
Tube-cap vise 305075
Tool kit 331202
  Tube removal tool 301875
  Torque wrench 858121
  Socket adapter 858122
  Socket for 3/4-in. (19-mm) nuts 858123
  Socket for 7/16-in. (11-mm) nuts 870432
Removal tool for polycarbonate bottles with Noryl caps ... 335381
Tube-Sealing Kit (60 Hz sealer) 342429
Tube-Sealing Kit (50 Hz sealer) 342424
Tube racks for Quick-Seal Tube Sealer
  5/8 x 3-in. tubes 342488
  5/8 x 2 5/8-in. tubes 344641
  5/8 x 1 3/4-in. tubes ..... 344641[5]
Tube Topper Kit (60 Hz) 348137
Tube Topper Kit (50 Hz) 349647
Tube rack for the Tube Topper 5/8-in. diameter tubes 348123



The 24-Sector Overspeed Disk

[5]Because of the short length of these tubes, insert the 345828 tube spacers upside down in the tube rack first. Then insert the tubes for sealing. To remove the spacers, turn the rack upside down.

WARRANTY FOR PREPARATIVE ULTRACENTRIFUGE ROTORS

Beckman Zonal, Continuous Flow, Swinging Bucket and Aluminum Fixed Angle Rotors are warranted subject to the conditions specified below against defects in materials or workmanship for 1000 runs, or 2500 hours of centrifugation, or five years, whichever occurs first, at any speed up to a maximum rpm (speed stamped on the rotor—properly reduced for certain fluid densities, high temperatures, tubes, tube caps, and adapters as described in the operator's manual for the rotor or Beckman ultracentrifuge in use). If, after 1000 runs or 2500 hours of centrifugation, the 5-year warranty period has not expired, the warranty is then extended for an additional 1000 runs, or for 2500 hours of centrifugation at any speed up to 90% of the maximum, or until the expiration of the 5-year period, whichever occurs first.

Aluminum-Composite Rotors are warranted subject to the conditions specified below against defects in material or workmanship for 2500 runs, or 5000 hours of centrifugation, or five years, whichever occurs first, at any speed up to the maximum rpm (as defined above).

Titanium and Total Composite Fixed Angle and Vertical Tube Rotors are warranted subject to the conditions specified below against defects in material or workmanship for 5000 runs, or 10 000 hours of centrifugation, or five years, whichever occurs first, at any speed up to the maximum rpm (as defined above).

Replacement

A defective rotor will be replaced by Beckman at its then current list price less a credit based upon the number of actual runs or hours, as the case may be, up to the maximum number of warranted runs or hours, respectively specified herein. The Buyer shall not receive a credit unless and until the claimed defective rotor and an up-to-date rotor log book or other acceptable up-to-date history record of rotor use are returned to Beckman's Spinco Division at Palo Alto, California, or delivered to a Beckman Field Service Representative.

The replacement price (cost to Buyer) for the respective rotor shall be calculated as follows:

Beckman Zonal, Continuous Flow, Swinging Bucket and Aluminum Fixed Angle Rotors

Replacement Price

$$= \text{Current rotor list price} \times \frac{\text{RUNS}}{2000} \left(\text{or } \frac{\text{HOURS}}{5000}, \text{ whichever is greater}\right)$$

Aluminum-Composite Rotors

Replacement Price

$$= \text{Current rotor list price} \times \frac{\text{RUNS}}{2500} \left(\text{or } \frac{\text{HOURS}}{5000}, \text{ whichever is greater}\right)$$

Titanium and Total Composite Fixed Angle and Vertical Tube Rotors

Replacement Price

$$= \text{Current rotor list price} \times \frac{\text{RUNS}}{5000} \left(\text{or } \frac{\text{HOURS}}{10\,000}, \text{ whichever is greater}\right)$$

Conditions (as applicable)

1) This warranty is valid for five years from the date of shipment to the original buyer by Beckman or an authorized Beckman representative.

2) This warranty extends only to the original Buyer and may not be assigned or extended to a third person without the written consent of Beckman.

3) This warranty covers the rotor only and Beckman shall not be liable for damage to accessories or ancillary supplies including but not limited to (i) tubes, (ii) tube caps, (iii) tube adapters, (iv) rotor or tube contents, (v) bearings, (vi) seals, or (vii) O-rings.

4) This warranty is void if the rotor is (i) operated or maintained in a manner contrary to the instructions in the manual for the Beckman rotor or ultracentrifuge in use, (ii) used in a centrifuge not of Beckman manufacture, or (iii) used in a Beckman ultracentrifuge that has been modified without the written permission of Beckman, or (iv) used with carriers, belts, or other insert devices not of Beckman's manufacture.

5) Should a Beckman ultracentrifuge be damaged due to a failure of a rotor covered by this warranty, Beckman will supply free of charge (i) all ultracentrifuge parts required for repair (except the rotor drive unit which will be replaced at the then current price less a credit determined by the total number of revolutions completed, provided that such a unit was manufactured or rebuilt by Beckman), and (ii) if the ultracentrifuge is currently covered by a Beckman warranty or service agreement, all labor necessary for repair of the ultracentrifuge.

6) Rotor Bucket Sets purchased concurrently with or subsequent to the purchase of a Swinging Bucket Rotor are warranted only for a term co-extensive with that of the rotor for which the Bucket Sets are purchased.

7) Rotor cores and liners purchased concurrently with or subsequent to the purchase of a Zonal or Continuous Flow Rotor are warranted only for a term co-extensive with that of the rotor for which the cores and liners are purchased.

Disclaimer

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.

Field Rotor Inspection Service

Beckman Instruments, Inc., will provide inspection in Palo Alto of any rotor at the request of the user. Rotors will be inspected in the laboratory if the ultracentrifuge in which they are used is covered by an appropriate Beckman Service Agreement. Contact your local Beckman office for details of service coverage or cost. Upon receipt at the factory in Palo Alto, California, any Beckman rotor will be inspected by the Spinco Division Metallurgy Laboratory, whether the owner holds a Beckman Service Agreement or not. Before shipping a rotor, the owner should contact the nearest Beckman Sales and Service office and request a Returned Goods Authorization (RGA) form and packaging instructions. Rotor owners are urged to make use of this inspection service if they have any doubts about the condition of a rotor.

NOTE: When a rotor is returned to the factory for any reason, please include the complete rotor assembly, a history of runs and hours on the rotor, and a signed statement that the rotor is safe to handle (nonradioactive and pathogenically clean).

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