# Instructions For Use

## SW 28 and SW 28.1
## Swinging-Bucket Rotors

For Use in Beckman Coulter Class H, R, and S
Preparative Ultracentrifuges

PN L5-TB-069PJ
August 2022

Beckman Coulter, Inc.
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BECKMAN COULTER

**SW 28 and SW 28.1 Swinging-Bucket Rotors**
PN L5-TB-069PJ (August 2022)



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Glossary of Symbols is available at beckman.com/techdocs (PN C24689).

*May be covered by one or more pat. - see www.beckman.com/patents*

Original Instructions

# Revision History

*This document applies to the latest and higher versions. When a subsequent version changes the information in this document, a new issue will be released to the Beckman Coulter website. For updates, go to www.beckman.com/techdocs and download the latest version of the manual or system help for your instrument.*

**Issue PG, 10/2018**
Changes or additions were made to:
- Table 2, Beckman Coulter Tubes and Accessories for the SW 28 Rotor
- Table 3, Beckman Coulter Tubes and Accessories for the SW 28.1 Rotor
- Certified Free Tubes
- Sterile Tubes
- Sterilization and Disinfection

**Issue PH, 9/2021**
Changes or additions were made to:
- Preparation and Use

**Issue PJ, 8/2022**
Changes or additions were made to:
- Table 2, Beckman Coulter Tubes and Accessories for the SW 28 Rotor

***Note:*** *Changes that are part of the most recent revision are indicated in text by a bar in the margin of the amended page.*

# Safety Notice

Read all product manuals and consult with Beckman Coulter-trained personnel before attempting to use this equipment. Do not attempt to perform any procedure before carefully reading all instructions. Always follow product labeling and manufacturer's recommendations. If in doubt as to how to proceed in any situation, contact your Beckman Coulter Representative.

## Alerts for Warning, Caution, and Note

**⚠ WARNING**

**WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.**

**⚠ CAUTION**

**CAUTION indicates a potentially hazardous situation, which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.**

**NOTE** NOTE is used to call attention to notable information that should be followed during installation, use, or servicing of this equipment.

## Safety Information for the SW 28 and SW 28.1 Rotors

Handle body fluids with care because they can transmit disease. No known test offers complete assurance that such fluids are free of micro-organisms. Some of the most virulent—Hepatitis (B and C) viruses, HIV (I–V), atypical mycobacteria, and certain systemic fungi—further emphasize the need for aerosol protection. Handle other infectious samples according to good laboratory procedures and methods to prevent spread of disease. Because spills may generate aerosols, observe proper safety precautions for aerosol containment. Do not run toxic, pathogenic, or radioactive materials in these rotors without taking appropriate safety precautions. Biosafe containment should be used when Risk Group II materials (as identified in the World Health Organization *Laboratory Biosafety Manual*) are handled; materials of a higher group require more than one level of protection.

The rotors and accessories are not designed for use with materials capable of developing flammable or explosive vapors. Do not centrifuge such materials in nor handle or store them near the centrifuge

Although rotor components and accessories made by other manufacturers may fit in the SW 28 and SW 28.1 rotors, their safety in these rotors cannot be ascertained by Beckman Coulter. Use of other manufacturers' components or accessories in these rotors may void the rotor warranty and should be prohibited by your laboratory safety officer. Only the components and accessories listed in this publication should be used in these rotors.

Hook all six buckets, loaded or empty, to the rotor for every run. Make sure that filled containers are loaded symmetrically into the rotor and that opposing tubes are filled to the same level with liquid of the same density. Make sure that buckets containing Quick-Seal tubes have the proper floating spacers inserted (if applicable) before installing the bucket cap.

If disassembly reveals evidence of leakage, you should assume that some fluid escaped the rotor. Apply appropriate decontamination procedures to the centrifuge and accessories.

Never exceed the maximum rated speed of the rotor and labware in use. Refer to the section on *Run Speeds*, and derate the run speed as appropriate.

Do not use sharp tools on the rotor that could cause scratches in the rotor surface. Corrosion begins in scratches and may open fissures in the rotor with continued use.

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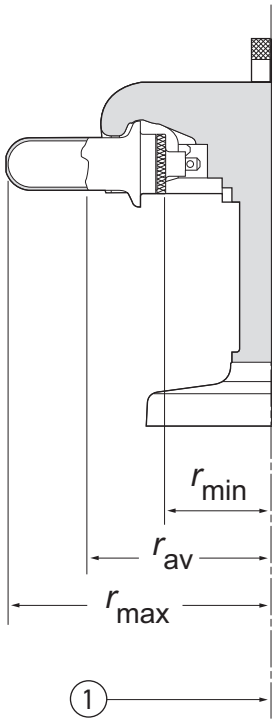
# SW 28 and SW 28.1 Swinging-Bucket Rotors

## Specifications for the SW 28 Rotor

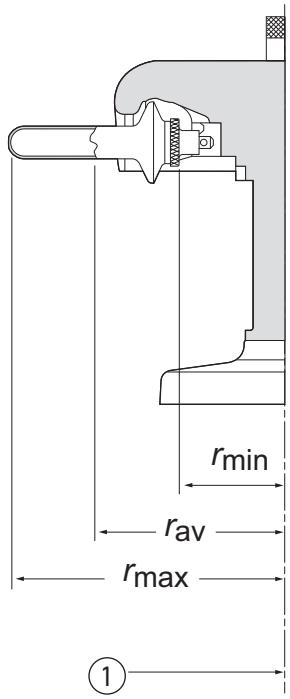



**1.** Axis of Rotation

| | |
|---|---|
| Maximum speed | 28,000 RPM |
| Density rating at maximum speed | 1.2 g/mL |
| Relative Centrifugal Field[a] at maximum speed | |
| At $r_{max}$ (161.0 mm) | 141,000 × *g* |
| At $r_{av}$ (118.2 mm) | 104,000 × *g* |
| At $r_{min}$ (75.3 mm) | 66,100 × *g* |
| *k* factor at maximum speed | 246 |
| *k* factor at maximum speed (5 to 20% sucrose gradient; 5°C) | |
| When particle density = 1.3 g/mL | 680 |
| When particle density = 1.5 g/mL | 622 |
| When particle density = 1.7 g/mL | 600 |
| Conditions requiring speed reductions | see *Run Speeds* |
| Number of buckets | 6 |
| Available tubes | see Table 2 |
| Nominal tube dimensions (largest tube) | 25 × 89 mm |
| Nominal tube capacity (largest tube) | 38.5 mL |
| Nominal rotor capacity | 231 mL |
| Approximate acceleration time to maximum speed (rotor fully loaded) | 4 to 5 min |
| Approximate deceleration time from maximum speed (rotor fully loaded | 4 to 5 min |
| Weight of fully loaded rotor | 5.9 kg (13 lb) |
| Rotor material | aluminum body; titanium buckets |

a. 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 = $r\omega^2/g$ — where *r* is the radius in millimeters, $\omega$ is the angular velocity in radians per second (2 π RPM /60), and *g* is the standard acceleration of gravity (9807 mm/s$^2$). After substitution: RCF = 1.12*r* (RPM/1000)$^2$

# Specifications for the SW 28.1 Rotor

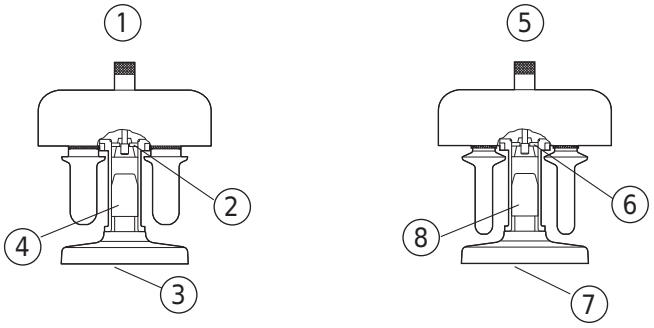



**1.** Axis of Rotation

| | |
|---|---|
| Maximum speed | 28,000 RPM |
| Density rating at maximum speed | 1.2 g/mL |
| Relative Centrifugal Field[a] at maximum speed | |
| At $r_{max}$ (171.3 mm) | 150,000 × *g* |
| At $r_{av}$ (122.1 mm) | 107,000 × *g* |
| At $r_{min}$ (72.9 mm) | 64,000 × *g* |
| *k* factor at maximum speed | 276 |
| *k* factor at maximum speed (5 to 20% sucrose gradient; 5°C) | |
| When particle density = 1.3 g/mL | 757 |
| When particle density = 1.5 g/mL | 694 |
| When particle density = 1.7 g/mL | 668 |
| Conditions requiring speed reductions | see *Run Speeds* |
| Number of buckets | 6 |
| Available tubes | see Table 3 |
| Nominal tube dimensions (largest tube) | 16 × 102 mm |
| Nominal tube capacity (largest tube) | 17 mL |
| Nominal rotor capacity | 102 mL |
| Approximate acceleration time to maximum speed (rotor fully loaded) | 4 to 5 min |
| Approximate deceleration time from maximum speed (rotor fully loaded | 4 to 5 min |
| Weight of fully loaded rotor | 5.8 kg (12.8 lb) |
| Rotor material | aluminum body; titanium buckets |

a. 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 = $r\omega^2/g$ — where $r$ is the radius in millimeters, ω is the angular velocity in radians per second (2 π RPM /60), and $g$ is the standard acceleration of gravity (9807 mm/s$^2$). After substitution: RCF = 1.12$r$ (RPM/1000)$^2$

# Description




1. SW 28 Rotor
2. Drive Pins
3. Rotor Stand (332400)
4. Adapter
5. SW 28.1 Rotor
6. Drive Pins
7. Rotor Stand (332400)
8. Adapter

*Beckman Coulter SW 28 and SW 28.1 rotors are manufactured in a facility that maintains certifications to both ISO 9001:2008 and ISO 13485:2003. They are for use with the specified Beckman Coulter ultracentrifuges. The rotors were developed, manufactured, and tested for safety and reliability as part of a Beckman Coulter ultracentrifuge/rotor system. Their safety or reliability cannot be assured if used in an ultracentrifuge not of Beckman Coulter's manufacture or in a Beckman Coulter ultracentrifuge that has been modified without Beckman Coulter's approval.*

The SW 28 and SW 28.1 are swinging-bucket rotors designed to centrifuge up to six tubes each. Used in Beckman Coulter class H, R, and S preparative ultracentrifuges, these rotors develop centrifugal forces for the separation of subcellular particles and viruses in density gradients. The rotors have a common rotor body with buckets that can be used interchangeably (see *Rotor Preparation*). Bucket and rotor body positions are numbered for operator convenience.

The SW 30 and SW 30.1 rotor buckets can be used on the SW 28/SW 28.1 rotor body as well. *However, the reverse is not true.* The matrix in Table 1 indicates interchangeability of rotor buckets between the SW 30 series, SW 28 series, and the older SW 27 series of rotors.

**Table 1** Rotor Bucket Interchangeability

| Buckets | May be used with rotors | | | | | |
|---|---|---|---|---|---|---|
| | **SW 30.1** | **SW 30** | **SW 28.1** | **SW 28** | **SW 27.1** | **SW 27** |
| SW 30 and SW 30.1 | Yes | Yes | Yes | Yes | No | No |
| SW 28 and SW 28.1 | No | No | Yes | Yes | No | No |
| SW 27 and SW 27.1 | No | No | No | No | Yes | Yes |

The rotor body and bucket caps are made of aluminum, anodized for corrosion resistance. The buckets are made of titanium, finished with clear polyurethane paint. Each bucket and cap assembly hooks into grooves on the rotor body. Bucket and rotor body positions are numbered for operator convenience. O-rings, made of Buna N rubber, between each bucket and bucket cap maintain atmospheric pressure inside the buckets during centrifugation. Drive pins in the rotor drive hole prevent the rotor from slipping on the centrifuge drive hub during acceleration and deceleration.

For overspeed protection, a Beckman Coulter ultracentrifuge equipped with a photoelectric detector will monitor the overspeed disk on the adapter bottom and shut down the run if a speed exceeding the maximum allowable run speed is detected.

See the Warranty at the back of this manual for warranty information.

# Preparation and Use

*Specific information about the SW 28 and SW 28.1 rotors is given here. Information common to these and other rotors is contained in Rotors and Tubes for Preparative Ultracentrifuges* (publication LR-IM-24), *which should be used together with this manual for complete rotor and accessory operation. Publication LR-IM-24 (on a CD) is included in the literature package with this rotor manual.*

**NOTE** Although rotor components and accessories made by other manufacturers may fit in the SW 28 and SW 28.1 rotors, their safety in these rotors cannot be ascertained by Beckman Coulter. Use of other manufacturers' components or accessories in these rotors may void the rotor warranty and should be prohibited by your laboratory safety officer. Only the components and accessories listed in this publication should be used in these rotors.

**NOTE** The use of a HEPA filter on the Optima XPN instruments can increase vacuum pull-down times during normal operation. The vacuum system can be warmed up prior to any scheduled run to reduce pull-down time. This warm up can be accomplished by closing the chamber door, setting the run temperature and manually starting the vacuum system several hours prior to making the scheduled run.

## Prerun Safety Checks

*Read the Safety Notice section at the front of this manual before using the rotor.*

1 Make sure that the rotor, buckets, and caps are clean and show no signs of corrosion or cracking.

2 Make sure that the rotor is equipped with the correct overspeed disk.

If the disk is missing or damaged, replace it according to the instructions in *Rotors and Tubes.*


3 Verify that the tubes and bottles being used are listed in Table 2 or Table 3.

**4** Check the chemical compatibilities of all materials used (refer to *Chemical Resistances,* publication IN-175).

## Rotor Preparation

*For runs at other than room temperature refrigerate or warm the rotor beforehand for fast equilibration.*

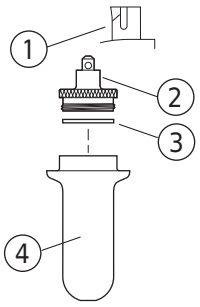
**NOTE** Place the rotor on the rotor stand (332400) when it is not in the centrifuge. Take care to protect the overspeed disk from damage when handling the rotor.

**1** Load the filled containers into the buckets (see page 8 for tube and accessory information).

Complete loading by placing the correct floating spacers (if required) over the tubes.

**2** Ensure that bucket O-rings are lightly but evenly coated with silicone vacuum grease.

Do not run a bucket without an O-ring, as the bucket will leak.




1. Hanger
2. Cap
3. O-ring 812715 (SW 28)
   815472 (SW 28.1)
4. Bucket

**3** Be sure that metal threads in the bucket caps are clean and lightly but evenly lubricated with Spinkote lubricant (306812).

**a.** Match bucket caps with numbered buckets and screw them down manually until tight.

**4** Hook the buckets to the rotor by inserting the bucket pins into the grooves on the rotor body.

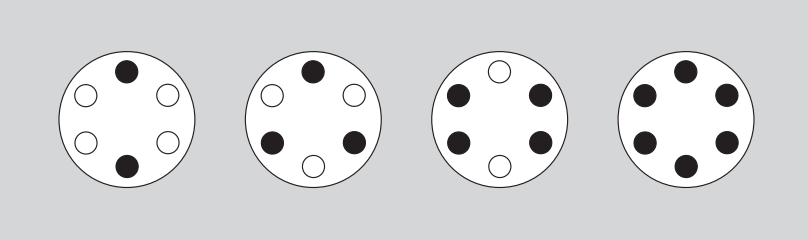
**a.** Swing each bucket back and forth slightly to ensure proper installation; the buckets should move freely.

*Six buckets must be installed, whether loaded or empty.*

**b.** If fewer than six tubes are being run, they must be arranged symmetrically in the rotor (see Figure 1).

Opposing tubes must be filled to the same level with liquid of the same density.

**Figure 1** Arranging Tubes in the Rotor.



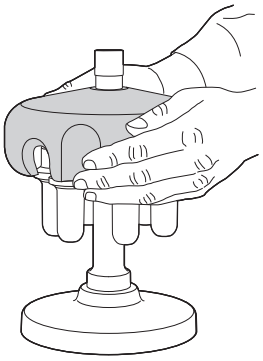
**NOTE** Two, three, four, or six tubes can be centrifuged per run if they are arranged in the rotor as shown. All buckets must be attached to the rotor, whether loaded or empty.

## Operation

*For low-temperature runs, precool the rotor in the centrifuge or in a refrigerator before use—especially before short runs—to ensure that the rotor reaches the set temperature. A suggested precooling cycle is a minimum of 30 minutes at 2000 RPM at the required temperature.*

1 To install the rotor, carefully lift it up off the rotor stand with both hands—do not lift the rotor by the adapter—and place it on the drive hub.

**a.** Slowly turn the rotor to the right (clockwise) to make sure that the rotor is seated properly on the hub.



**⚠ CAUTION**

**Remove the zonal support band from the ultracentrifuges so equipped before operating these rotors.**

2 Refer to the centrifuge instruction manual for additional operating instructions.

**NOTE** Some gradients may degrade when run time exceeds 8 hours.

3 For additional operating information, see the following:

- *Run Times*, page 15, for using *k* factors to adjust run durations.
- *Run Speeds*, page 15, for information about speed limitations.
- *Selecting CsCl Gradients*, page 22, for methods to avoid CsCl precipitation during centrifugation.

## Removal and Sample Recovery

**⚠ CAUTION**

**Risk of contamination. If disassembly reveals evidence of leakage, you should assume that some fluid escaped the rotor. Apply appropriate decontamination procedures to the centrifuge and accessories.**

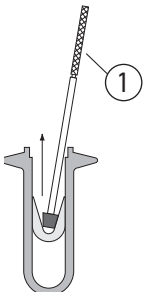
1 Remove the rotor from the centrifuge by lifting it straight up and off the drive hub.

2 Set the rotor on the rotor stand and carefully remove the buckets.

3 Remove the bucket caps and use the appropriate removal tool (listed in the *Supply List*) to remove the spacers and tubes.

**a.** If floating spacers were used, remove them with the threaded end of the floating spacer removal tool (338765).

**NOTE** If the conical-shaped adapters that support *k*onical tubes are difficult to remove after centrifugation, an extractor tool (354468) is available to facilitate removal.




**1.** Extractor Tool (354468)
While pressing the rubber tip against the adapter wall, pull the tube and adapter up and out of the cavity.

## Tubes and Accessories

The SW 28 rotor uses tubes and accessories listed in Table 2; the SW 28.1 rotor uses tubes and accessories listed in Table 3. Be sure to use only those items listed, and to observe the maximum speed limits shown. Refer to Appendix A in *Rotors and Tubes for Preparative Ultracentrifuges* (publication LR-IM-24) for information on the chemical resistances of tube and accessory materials.

**Table 2** Beckman Coulter Tubes and Accessories for the SW 28 Rotor[a]

| Tube | | | Required Accessory | | |
|---|---|---|---|---|---|
| **Dimensions/ Nominal Volume** | **Description** | **Part Number** | **Description** | **Part Number** | **Max Speed/ RCF/*k* factor** |
| 25 × 89 mm 38.5 mL | Certified Free & Sterile Ultra-Clear Open-Top | C14292 Carton of 48 (8 packs of 6) | none | — | 28,000 RPM 141,000 × *g* 246 |
| | Certified Free Ultra-Clear Open-Top | C13926 (pkg/50) | | | |
| | Standard Ultra-Clear Open-Top | 344058 (pkg/50) | | | |
| 25 × 89 mm 38.5 mL | Certified Free & Sterile Polypropylene Open-Top | C14301 Carton of 48 (8 packs of 6) | none | — | 28,000 RPM 141,000 × *g* 246 |
| | Certified Free Polypropylene Open-Top | C14285 (pkg/50) | | | |
| | Standard Polypropylene Open-Top | 326823 (pkg/50) | | | |

**Table 2** Beckman Coulter Tubes and Accessories for the SW 28 Rotor[a] *(Continued)*

| Tube | | | Required Accessory | | |
|---|---|---|---|---|---|
| **Dimensions/ Nominal Volume** | **Description** | **Part Number** | **Description** | **Part Number** | **Max Speed/ RCF/*k* factor** |
| 26 × 77 mm 29.9 mL | polypropylene OptiSeal bell-top[b] | 361625 (pkg/56) | polyetherimide (PEI) spacer | 392833 | 28,000 RPM 141,000 × *g* 246 |
| 25 × 89 mm 32 mL | thickwall polypropylene open-top | 355642 (pkg/25) | none | — | 28,000 RPM 141,000 × *g* 241 |
| 25 × 89 mm 32 mL | thickwall polycarbonate open-top | 355631 (pkg/25) | none | — | 28,000 RPM 141,000 × *g* 246 |
| 25 × 83 mm 33 mL | polypropylene Quick-Seal bell-top | 344623 (pkg/50) | polyphenylene oxide (PPO) floating spacer | 355536 | 28,000 RPM 141,000 × *g* 233 |
| 25 × 89 mm 30 mL | Certified Free & Sterile *k*onical Polypropylene Open-Top | C14307 Carton of 48 (8 packs of 6) | adapter | 358156 (pkg/6) | 28,000 RPM 139,000 × *g* 240 |
| | Certified Free *k*onical Polypropylene Open-Top | C14291 (pkg/50) | | | |
| | Standard Polypropylene *k*onical | 358126 (pkg/50) | | | |
| 25 × 76 mm 25 mL | *k*onical polypropylene open-top | 358125 (pkg/50) | adapter | 358156 (pkg/6) | 28,000 RPM 139,000 × *g* 190 |
| 25 × 83 mm 28 mL | *k*onical polypropylene Quick-Seal bell-top | 358651 (pkg/50) | adapter | 358156 | 28,000 RPM 139,000 × *g* 226 |
| | | | polyphenylene oxide (PPO) floating spacer | 355536 | |
| 25 × 64 mm 27 mL | polypropylene Quick-Seal bell-top | 343665 (pkg/50) | polyphenylene oxide (PPO) floating spacer | 355536 | 28,000 RPM 134,000 × *g* 180 |

**Table 2** Beckman Coulter Tubes and Accessories for the SW 28 Rotor[a] *(Continued)*

| Tube | | | Required Accessory | | |
|---|---|---|---|---|---|
| **Dimensions/ Nominal Volume** | **Description** | **Part Number** | **Description** | **Part Number** | **Max Speed/ RCF/*k* factor** |
| 25 × 38 mm 15 mL | polypropylene Quick-Seal bell-top | 343664 (pkg/50) | polyphenylene oxide (PPO) floating spacer | 355536 | 28,000 RPM 141,000 × *g* 92 |
| 25 × 38 mm 8.5 mL | *k*onical polypropylene Quick-Seal bell-top | 358652 (pkg/50) | adapter | 358156 (pkg/6) | 28,000 RPM 139,000 × *g* 84 |
| | | | polyphenylene oxide (PPO) floating spacer | 355536 | |
| 25 × 76 mm 23 mL | konical polypropylene Quick-Seal bell-top | 358654 (pkg/50) | adapter | 358156 | 28,000 RPM 139,000 × *g* 178 |
| | | | polyphenylene oxide (PPO) floating spacer | 355536 | |

a. Use only the items listed here..

b. Disposable plastic plugs included.

**Table 3** Beckman Coulter Tubes and Accessories for the SW 28.1 Rotor[a]

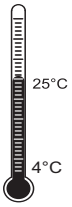
| Tube | | | Required Accessory | | |
|---|---|---|---|---|---|
| **Dimensions/ Nominal Volume/** | **Description** | **Part Number** | **Description** | **Part Number** | **Max Speed/ RCF/*k* factor** |
| 16 × 102 mm 18 mL | polypropylene Quick-Seal bell-top | 356291 (pkg/50) | polyphenylene oxide (PPO) floating spacer | 355579 | 28,000 RPM 150,000 × *g* 229 |
| 16 × 102 mm 17 mL | Certified Free & Sterile Ultra-Clear Open-Top | C14297 Carton of 48 (8 packs of 6) | none | — | 28,000 RPM 150,000 × *g* 275 |
| | Certified Free Ultra-Clear Open-Top | C14281 (pkg/50) | | | |
| | Standard Ultra-Clear Open-Top | 344061 (pkg/50) | | | |

**Table 3** Beckman Coulter Tubes and Accessories for the SW 28.1 Rotor[a] *(Continued)*

| Tube | | | Required Accessory | | |
|---|---|---|---|---|---|
| **Dimensions/ Nominal Volume/** | **Description** | **Part Number** | **Description** | **Part Number** | **Max Speed/ RCF/*k* factor** |
| 16 × 96 mm 17 mL | polypropylene open-top | 337986 (pkg/50) | none | — | 28,000 RPM 150,000 × *g* 275 |
| 16 × 93 mm 14.5 mL | *k*onical polypropylene open-top | 358123 (pkg/50) | adapter | 358155 | 28,000 RPM 148,000 × *g* 271 |
| 16 × 102 mm 12.5 mL | *k*onical polypropylene Quick-Seal bell-top | 358653 (pkg/50) | adapter | 358155 | 28,000 RPM 148,000 × *g* 235 |
| | | | polyphenylene oxide (PPO) floating spacer | 355579 | |
| 16 × 67 mm 10 mL | polypropylene Quick-Seal bell-top | 344622 (pkg/50) | polyphenylene oxide (PPO) floating spacer | 355579 | 28,000 RPM 150,000 × *g* 154 |
| 16 × 57 mm 8 mL | polypropylene Quick-Seal bell-top | 344621 (pkg/50) | polyphenylene oxide (PPO) floating spacer | 355579 | 28,000 RPM 150,000 × *g* 117 |
| 16 × 44 mm 6.3 mL | polypropylene Quick-Seal bell-top | 345830 (pkg/50) | polyphenylene oxide (PPO) floating spacer | 355579 | 28,000 RPM 150,000 × *g* 90 |
| 16 × 38 mm 4.2 mL | polypropylene Quick-Seal bell-top | 356562 (pkg/50) | polyphenylene oxide (PPO) floating spacer | 355579 | 28,000 RPM 150,000 × *g* 63 |

a. Use only the items listed here..

## Temperature Limits



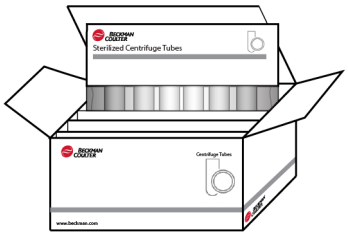

- Plastic tubes have been centrifuge tested for use at temperatures between 2 and 25°C. For centrifugation at other temperatures, pretest tubes under anticipated run conditions.
- If plastic containers are frozen before use, make sure that they are thawed to at least 2°C prior to centrifugation.

## Certified Free Tubes


Based on Sample
Results Below
Detectable Limit

Certified free tubes are lot traceable to testing that confirms the absence of endotoxin, DNase, RNase, and human & mouse DNA below a detectable limit.

## Sterile Tubes




Sterile tubes are sterilized via ethylene oxide in compliance with ISO 11135:2014. Cartons include several peel packages, each containing a typical run quantity of tubes per the tube details in Table 2 and Table 3. Packaging meets requirements of ISO11607:2006.

## OptiSeal Tubes

OptiSeal tubes come with plastic plugs and can be quickly and easily prepared for use. With the tube spacer in place, the *g* force during centrifugation ensures a tight, reliable seal that protects your samples.

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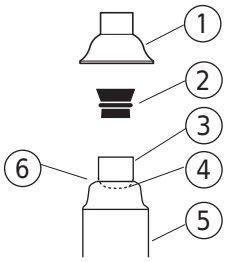
1 Place the tubes in the rack and fill each tube to the base of the stem, leaving no fluid in the stem.

Overfilling the tube can cause spillage when the plug is inserted or can compromise seal integrity.

However, too much air can cause excessive tube deformation, disrupting gradients and sample bands.




1. Spacer
2. Plug
3. Stem
4. Meniscus
5. Tube
6. Base of Stem

**2** Refer to *Using OptiSeal Tubes* (publication IN-189), included in each box of tubes, for detailed information on the use and care of OptiSeal tubes.

## Quick-Seal Tubes

Quick-Seal tubes must be sealed prior to centrifugation. These tubes are heat sealed and do not need caps; however, spacers are required on top of the tubes when they are loaded into the rotor buckets.

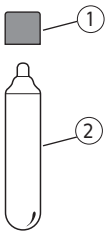
**1** Fill Quick-Seal tubes leaving a *small* bubble of air at the base of the neck.

Do not leave a large air space—too much air can cause excessive tube deformation.

**2** Some of the tubes listed in Table 2 and Table 3 are part of the *g*-Max system, which uses a combination of small bell-top Quick-Seal tubes and floating spacers (also called *g*-Max spacers).

This means that you can run the shorter tubes listed in Table 2 and Table 3 in the SW 28 and SW 28.1 rotors without reduction in *g* force.

For detailed information on the *g*-Max system see publication DS-709B.



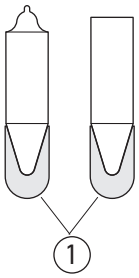

1. *g*-Max Spacer
2. Bell-top Tube

**3** Refer to *Rotors and Tubes for Preparative Ultracentrifuges* (publication LR-IM-24) for detailed information on the use and care of Quick-Seal tubes.

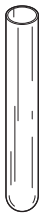
Quick-Seal tubes are disposable and should be discarded after a single use.

### *k*onical Tubes

Polypropylene konical tubes, used to optimize pelleting separations, have a conical tip that concentrates the pellet in the narrow end of the tube. The narrow bottom also reduces the tube's nominal volume and minimizes gradient material requirement. The konical tubes come in both open-top and Quick-Seal tube designs. Conical cavity adapters hold the tubes in the rotor buckets




1. Adapters



### Polypropylene and Ultra-Clear Open-Top Tubes

Polypropylene and Ultra-Clear open-top tubes should be filled as full as possible (2 or 3 mm from the tube top) for tube support. If necessary, float mineral oil (or some other low-density, immiscible liquid) on top of the tube contents to fill the tube to its maximum volume. (Do not use an oil overlay in Ultra-Clear tubes.) All opposing tubes for a run must be filled to the same level with liquid of the same density.

## Run Times

The *k* factor of the rotor is a measure of the rotor's pelleting efficiency. (Beckman Coulter has calculated the *k* factors for all of its preparative rotors at maximum rated speed and using full tubes.) The *k* factor is calculated from the formula

$$k = \frac{\ln(r_{max}/r_{min})}{\omega^2} \times \frac{10^{13}}{3600} \quad \text{EQ 1}$$

where ω is the angular velocity of the rotor in radians per second (ω = 0.105 × RPM), $r_{max}$ is the maximum radius, and $r_{min}$ is the minimum radius.

After substitution:

$$k = \frac{(2.533 \times 10^{11})\ln(r_{max}/r_{min})}{RPM^2} \quad \text{EQ 2}$$

Use the *k* factor in the following equation to estimate the run time *t* (in hours) required to pellet particles of known sedimentation coefficient *s* (in Svedberg units, *S*).

$$t = \frac{k}{s} \quad \text{EQ 3}$$

Run times can be estimated for centrifugation at less than maximum speed by adjusting the *k* factor as follows:

$$k_{adj} = k\left(\frac{28,000}{\text{actual run speed}}\right)^2 \quad \text{EQ 4}$$

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:

$$\frac{t_a}{t_b} = \frac{k_a}{k_b} \quad \text{EQ 5}$$

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

## Run Speeds

The centrifugal force at a given radius in a rotor is a function of 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, the samples are subjected to the same force. The RCF at a number of rotor speeds is provided in Table 4.

Do not select rotational speeds in excess of 28,000 RPM. In addition, speeds must be reduced under the following circumstances:

1. If nonprecipitating solutions more dense than 1.2 g/mL are centrifuged, reduce the maximum allowable run speed according to the following equation:

$$\text{reduced maximum speed} = (28{,}000\ \text{RPM}) \sqrt{\frac{1.2\ \text{g/mL}}{\rho}} \qquad \text{EQ 6}$$

   where ρ is he density of the tube contents. This speed reduction will protect the rotor from excessive stresses due to the added tube load.

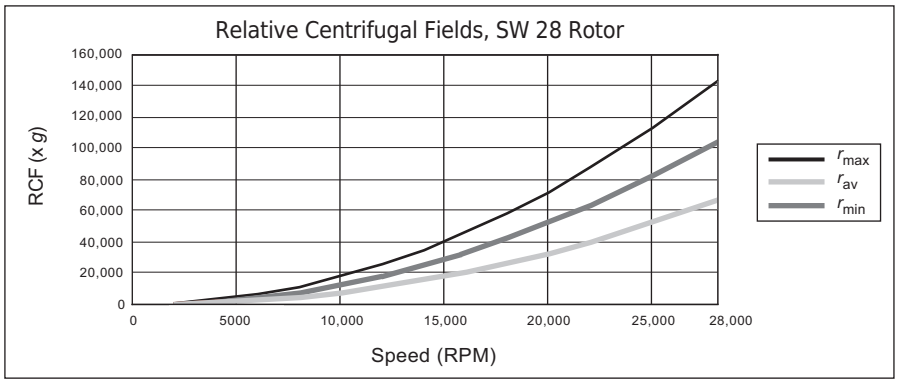
2. *Further speed limits must be imposed* when CsCl or other self-forming-gradient salts are centrifuged, as equation (6) does not predict concentration limits/speeds that are required to prevent precipitation of salt crystals. Solid CsCl has a density of 4 g/mL, and if precipitated during centrifugation may cause rotor failure. Figure 2 through Figure 5, together with the description and examples below, show how to reduce run speeds when using CsCl gradients.

**Table 4** Relative Centrifugal Fields for the SW 28 and SW 28.1 Rotors[a]

| SW 28 Rotor | | | |
|---|---|---|---|
| Rotor Speed (RPM) | Relative Centrifugal Field (× *g*) | | |
| | At $r_{max}$ (161 mm) | At $r_{av}$ (118.2 mm) | At $r_{min}$ (75.3 mm) |
| 28,000 | 141,000 | 104,000 | 66,100 |
| 25,000 | 113,000 | 82,700 | 52,700 |
| 22,000 | 87,300 | 64,100 | 40,800 |
| 20,000 | 72,100 | 53,000 | 33,700 |
| 18,000 | 58,400 | 42,900 | 27,300 |
| 16,000 | 46,200 | 33,900 | 21,600 |
| 14,000 | 35,300 | 26,000 | 16,500 |
| 12,000 | 26,000 | 19,100 | 12,100 |
| 10,000 | 18,000 | 13,200 | 8430 |
| 8000 | 11,500 | 8470 | 6400 |
| 6000 | 6490 | 4770 | 3040 |
| 4000 | 2880 | 2120 | 1350 |
| 2000 | 721 | 530 | 337 |

| SW 28.1 Rotor | | | |
|---|---|---|---|
| Rotor Speed (RPM) | Relative Centrifugal Field (× *g*) | | |
| | At $r_{max}$ (171.3 mm) | At $r_{av}$ (122.1 mm) | At $r_{min}$ (72.9 mm) |
| 28,000 | 150,000 | 107,000 | 64,000 |
| 25,000 | 120,000 | 85,500 | 51,000 |
| 22,000 | 92,900 | 66,200 | 39,500 |
| 20,000 | 76,700 | 54,700 | 32,700 |
| 18,000 | 62,200 | 44,300 | 26,500 |
| 16,000 | 49,100 | 35,000 | 20,900 |
| 14,000 | 37,600 | 26,800 | 16,000 |
| 12,000 | 27,600 | 19,700 | 11,800 |
| 10,000 | 19,200 | 13,700 | 8170 |
| 8000 | 12,300 | 8750 | 5230 |
| 6000 | 6900 | 4920 | 2940 |
| 4000 | 3070 | 2190 | 1310 |
| 2000 | 767 | 547 | 327 |

a. Entries in this table are calculated from the formula RCF = 1.12*r* (RPM/1000)$^2$ and then rounded to three significant digits.


Relative Centrifugal Fields, SW 28 Rotor
RCF (x g)
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
0
5000
10,000
15,000
20,000
25,000
28,000
Speed (RPM)
$r_{max}$
$r_{av}$
$r_{min}$

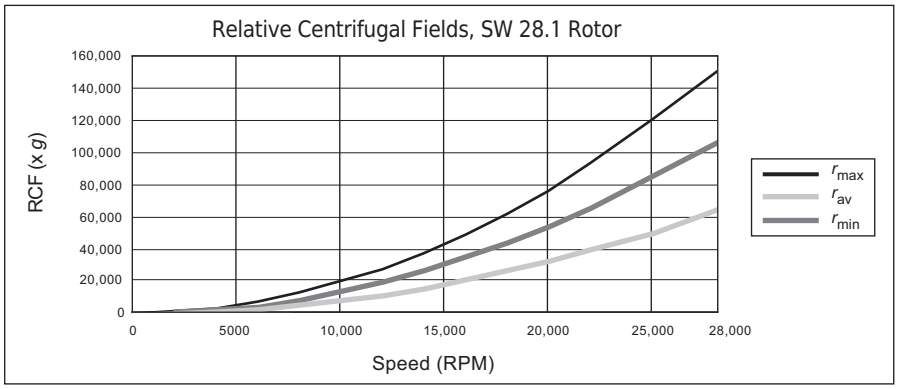
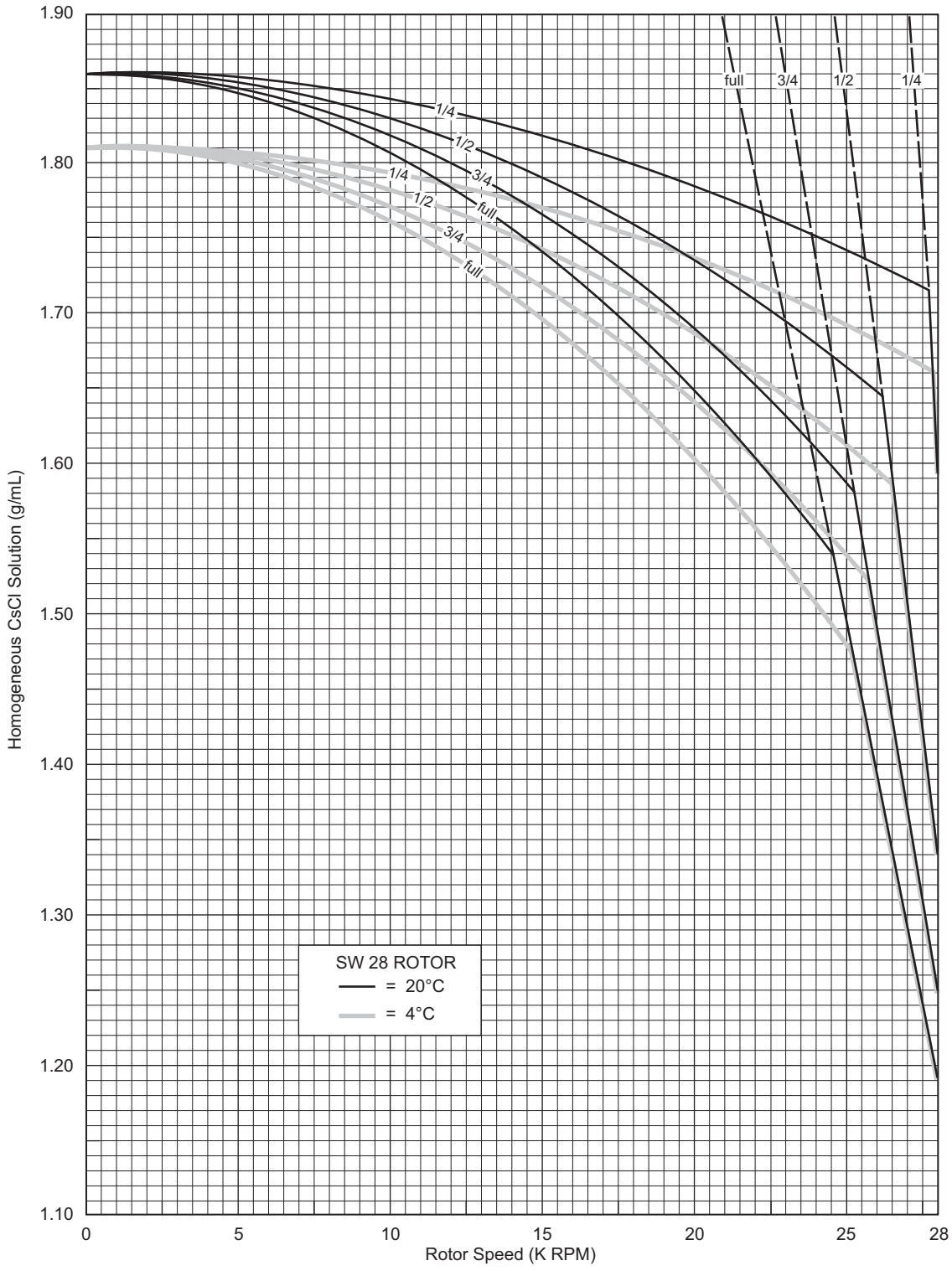
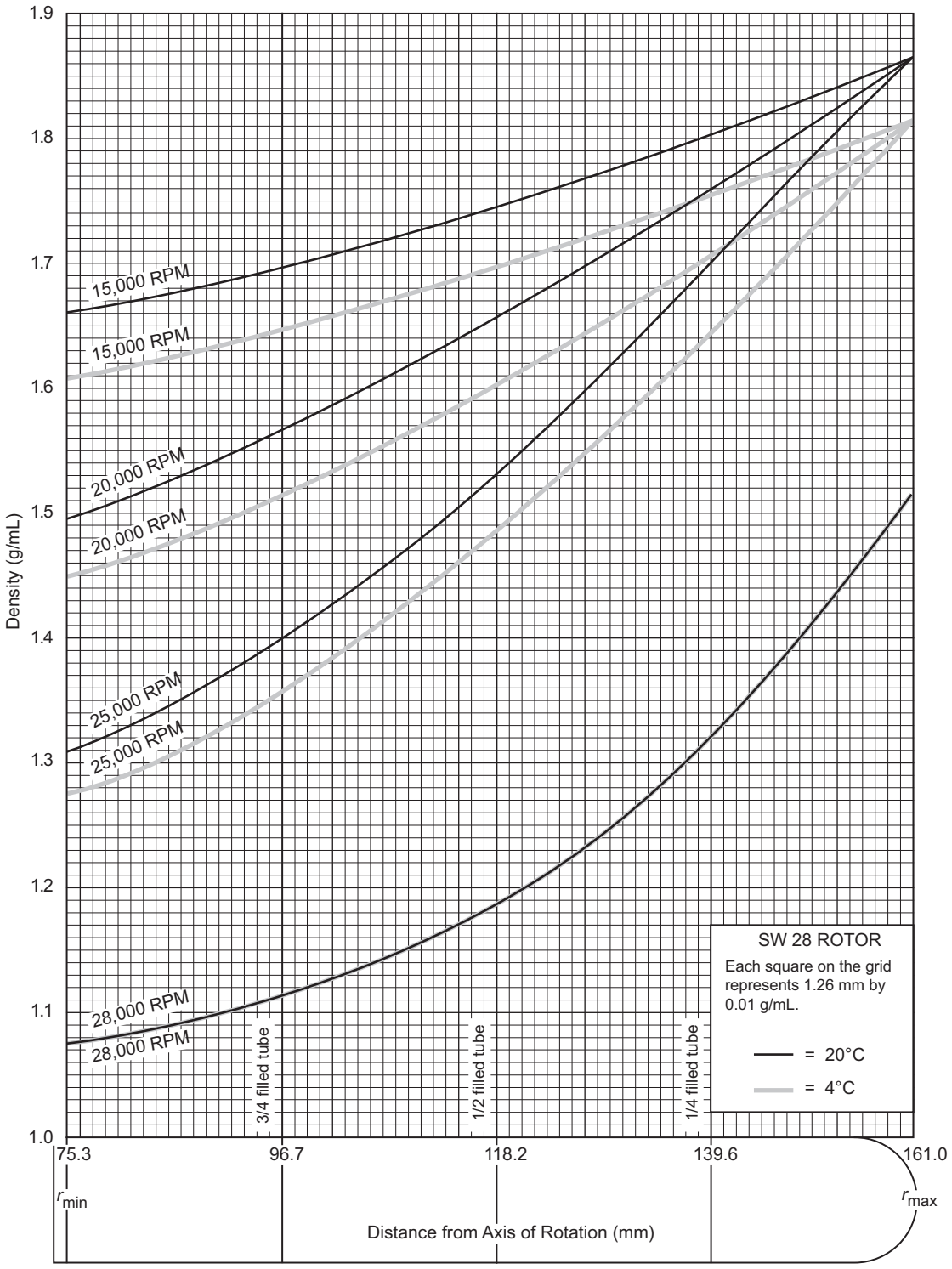

Relative Centrifugal Fields, SW 28.1 Rotor
RCF (x g)
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
0
5000
10,000
15,000
20,000
25,000
28,000
Speed (RPM)
$r_{max}$
$r_{av}$
$r_{min}$

**Figure 2** Precipitation Curves for the SW 28 Rotor*



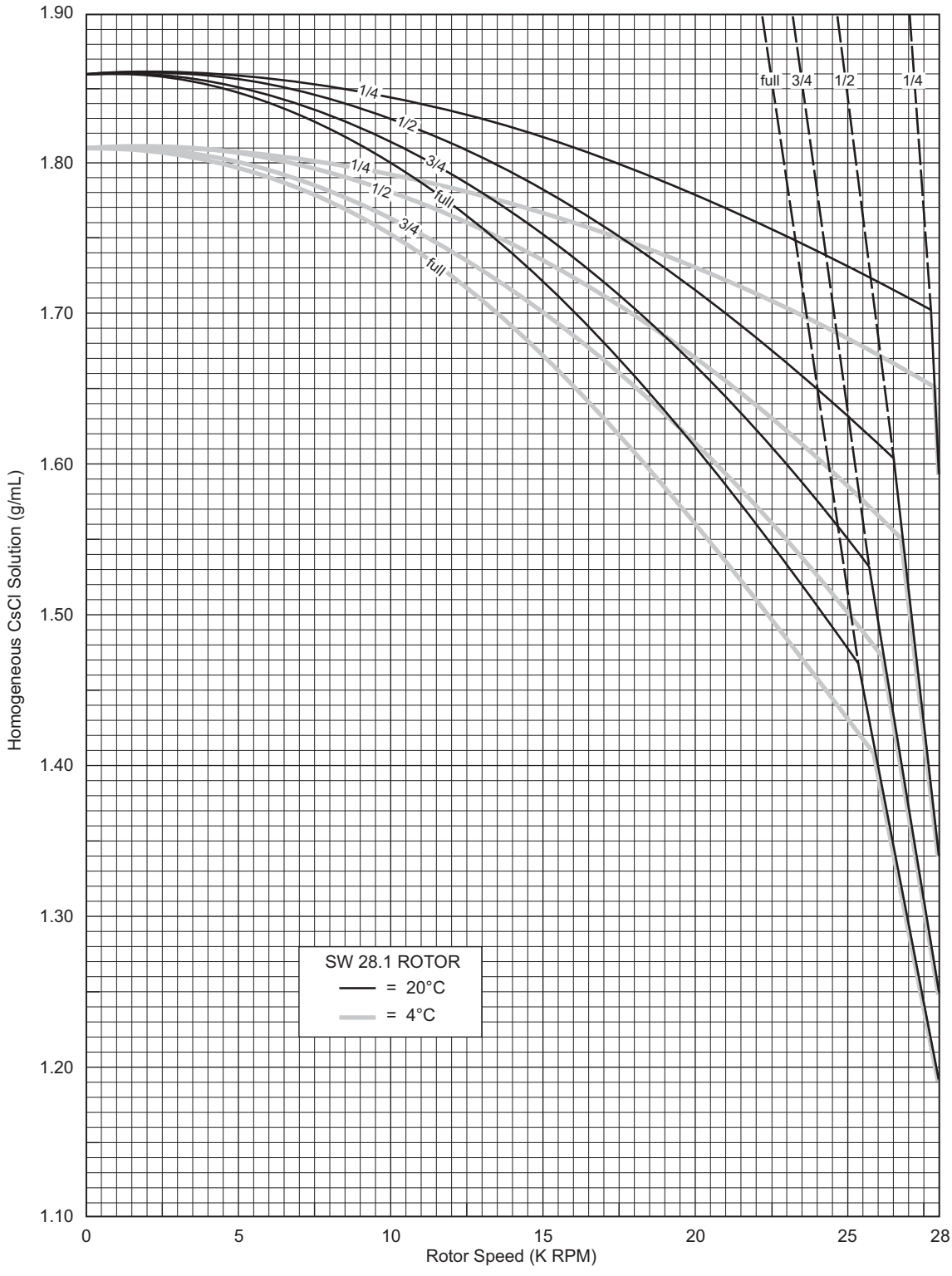

* Using speed and density combinations that intersect on or below the solid curves ensures that CsCl will not precipitate during centrifugation. Tube fill volumes are indicated on the curves. The dashed lines are a representation of EQ 6 and are shown here to illustrate the inability of that equation to prevent CsCl precipitation.

**Figure 3** CsCl Gradients at Equilibrium for the SW 28 Rotor*



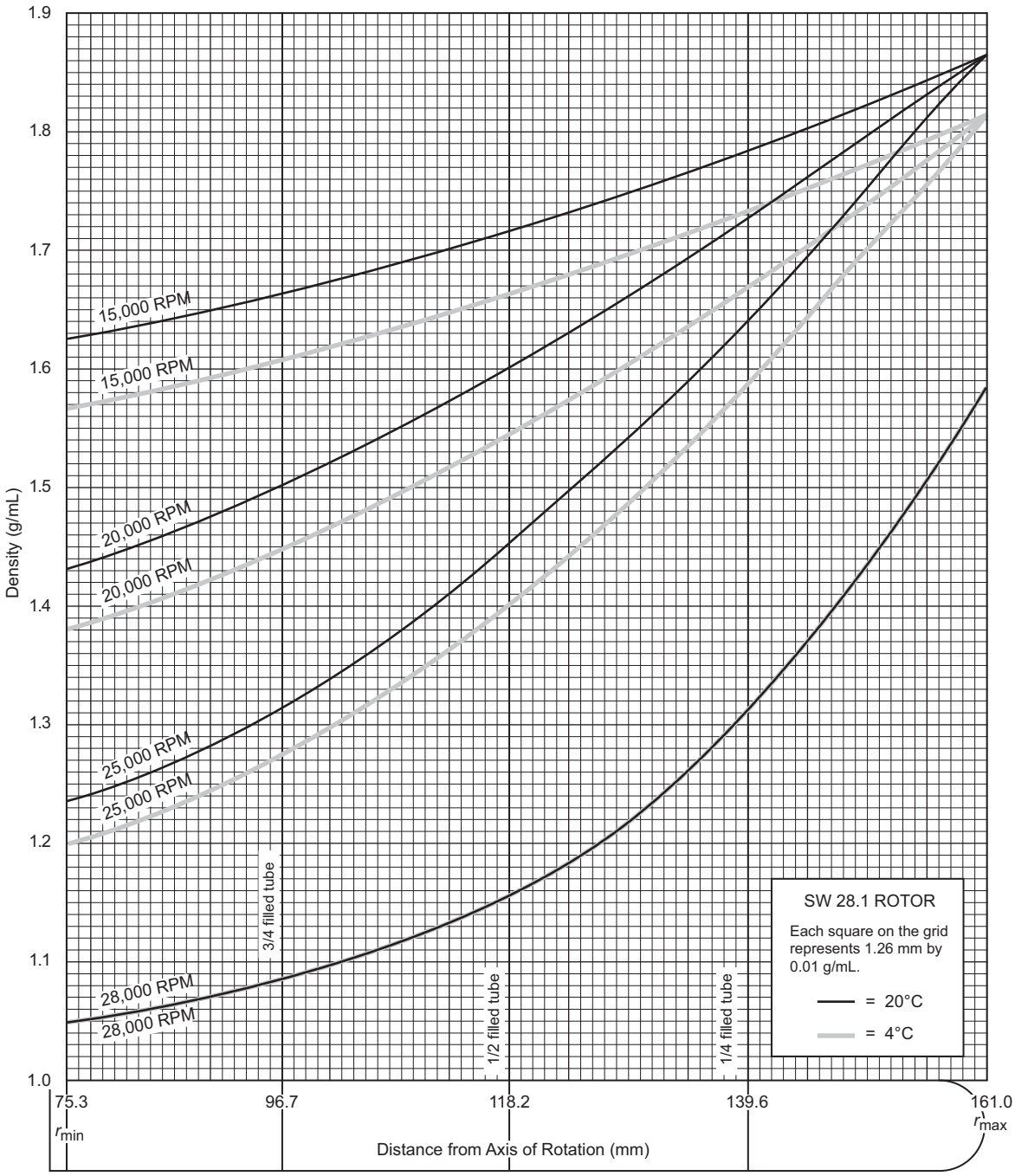

* Centrifugation of homogeneous CsCl solutions at maximum allowable speeds (from Figure 2) results in gradients presented here.

**Figure 4** Precipitation Curves for the SW 28.1 Rotor*




* Using speed and density combinations that intersect on or below the solid curves ensures that CsCl will not precipitate during centrifugation. Tube fill volumes are indicated on the curves. The dashed line are a representation of EQ 6 and are shown here to illustrate the inability of that equation to prevent CsCl precipitation.

**Figure 5** CsCl Gradients at Equilibrium for the SW 28.1 Rotor*




* Centrifugation of homogeneous CsCl solutions at maximum allowable speeds (from Figure 4) results in gradients presented here.

## Selecting CsCl Gradients

Rotor speed is used to control the slope of a CsCl density gradient, and must be limited to prevent CsCl precipitation during centrifugation. Speed and density combinations that intersect on or below the curves in Figure 2 (for the SW 28 rotor) and in Figure 4 (for the SW 28.1 rotor) ensure that CsCl will not precipitate during centrifugation in these rotors. Curves are provided at two temperatures: 20°C (black curves) and 4°C (gray curves). Curves in Figure 2 through Figure 5 are provided up to the maximum speed of the rotor

**NOTE** The curves in Figure 2 through Figure 5 are for solutions of CsCl salt dissolved in distilled water only. If other salts are present in significant concentrations, the overall CsCl concentration may need to be reduced.

The reference curves shown in Figures Figure 3 and Figure 5 show gradient distribution at equilibrium. Each curve in Figure 3 is within the density limits allowed for the SW 28 rotor; each curve in Figure 5 is within the density limits allowed for the SW 28.1 rotor. Each curve was generated for a single run speed using the maximum allowable homogeneous CsCl densities (one for each fill level) that avoid precipitation at that speed. (The gradients in Figure 3 and Figure 5 can be generated from step or linear gradients, or from homogeneous solutions. But the total amount of CsCl in solution must be equivalent to a homogeneous solution corresponding to the concentrations specified in Figure 3 and Figure 5.) Figure 3 and Figure 5 can also be used to approximate the banding positions of sample particles. Curves not shown may be interpolated.

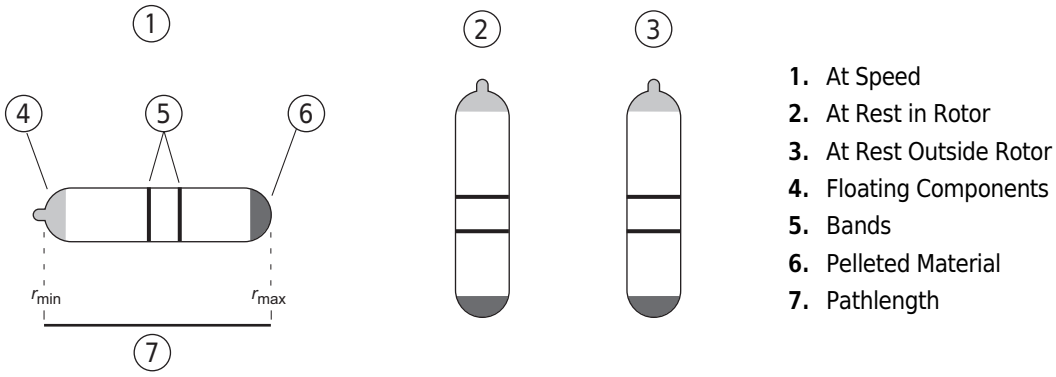
## Adjusting Fill Volumes

Figure 2 through Figure 5 show that several fill volumes are possible in a tube. If a thinwall tube is partially filled with gradient solution, float mineral oil (or some other low-density, immiscible liquid) on top of the tube contents to fill the tube to its maximum volume. (Do not use an oil overlay in Ultra-Clear tubes.) Note that for a given CsCl density, as the fill level decreases the maximum allowable speed increases. Partial filling may be desirable when there is little sample or when you wish to shorten the run time.

For example, in the SW 28 rotor, a *quarter-filled* tube of 1.67-g/mL homogeneous CsCl solution at 4°C may be centrifuged at 26,000 RPM (see Figure 2). The segment of the 26,000 RPM curve (Figure 3) from the quarter-filled line to $r_{max}$ (the tube bottom) represents this gradient. The same solution in a *half-filled* tube may be centrifuged no faster than 20,000 RPM, and 17,000 RPM in a *three-quarter-filled* tube. A tube full of the 1.67-g/mL CsCl solution may be centrifuged no faster than 15,000 RPM. Curves not shown in the figures may be interpolated.

## Typical Examples for Determining CsCl Run Parameters

**Example A:**
Starting with a homogeneous CsCl solution density of 1.33 g/mL and approximate particle buoyant densities of 1.30 and 1.35 g/mL, at 20°C, where will particles band at equilibrium in the SW 28 rotor?




1. At Speed
2. At Rest in Rotor
3. At Rest Outside Rotor
4. Floating Components
5. Bands
6. Pelleted Material
7. Pathlength

**1** In Figure 2, find the curve that corresponds to the required run temperature (20°C) and fill volume (one-half full).

The maximum allowable rotor speed is determined from the point where this curve intersects the homogeneous CsCl density (28,000 RPM).

**2** In Figure 3, sketch a horizontal line corresponding to each particle's buoyant density.

**3** Mark the point in Figure 3 where each particle density intersects the curve corresponding to the selected run speed and temperature.

Particles will band at these locations across the tube diameter at equilibrium during centrifugation.

In this example, particles will band about 145 and 151 mm from the axis of rotation, about 6 mm of centerband-to-centerband separation.

To determine interband volume in milliliters, use the following equation:

$$V = \pi r^2 h \qquad \text{EQ 7}$$

where *r* is the tube radius in centimeters and h is the interband separation in centimeters

**Example B:**
Knowing particle buoyant densities (for example, 1.55 and 1.50 g/mL), how do you achieve good separation in the SW 28 rotor.

**1** In Figure 3, sketch in a horizontal line corresponding to each particle's buoyant density.

2 Select the curve at the desired temperature (4°C) and tube volume (full) that gives the best particle separation.

3 Note the run speed along the selected curve (20,000 RPM).

4 From Figure 2, select the maximum homogeneous CsCl density (in this case, 1.56 g/mL) that corresponds to the temperature and run speed established above.

These parameters will provide the particle-banding pattern selected in Step 2.

In this example, particles will band about 110 and 122 mm from the axis of rotation (about 12 mm apart).

## Use of a CsCl Cushion

Some separations incorporate the use of cushions of CsCl. A common example is the isolation of total RNA. In this example, one-fourth of the total tube volume is filled with a cushion of 5.7 M CsCl (1.71 g/mL). A solution containing a tissue homogenate in a guanidinium thiocyanate buffer is layered over the CsCl solution.

Maximum run speeds must take into account the increased density of the solution as well as the use of the CsCl precipitation curves.

**NOTE** Run speeds obtained using average densities are approximate.

**Example C:**
Using SW 28 rotor.

1 Parameters

- Cushion:1.71 g/mL density CsCl (5.7 M)
- Cushion volume:9.6 mL (1/4 total volume)
- Overlay:1.2 g/mL density homogenate/buffer
- Overlay Volume:28.9 mL (3/4 total volume)
- Average Density:1.33 g/mL
- Temperature:20°C

2 First, use the square root deration formula:

$$\text{RPM} = 28{,}000 \sqrt{\frac{1.2\ \text{g/mL}}{1.33\ \text{g/mL}}} = 28{,}000\ (0.95) = 26{,}600$$

3 Next, use the CsCl curves for quarter-filled tubes (at 20°C) in Figure 3 to determine that the maximum run speed for the SW 28 with a quarter volume of 1.71 g/mL CsCl is 27,500 RPM.

4 Choosing the lower of the two speeds gives a maximum run speed of 26,600 RPM.

**Example D:**

1 All parameters are as listed in Example C with the exception of temperature.

Temperature: 4°C

2 As in Example C, the square root deration curve gives a maximum speed of 26,600 RPM.

3 The CsCl curves for quarter-filled tubes at 4°C in Figure 3 show that the maximum run speed for the SW 28 with a quarter volume of 1.71 g/mL CsCl is 24,000 RPM.

4 Choosing the lower of the two speeds gives a maximum run speed of 24,000 RPM.

# Care and Maintenance

## Maintenance

**NOTE** Do not use sharp tools on the rotor that could cause scratches in the rotor surface. Corrosion begins in scratches and may open fissures in the rotor with continued use.

1 Frequently check the bucket O-rings for signs of wear.

**a.** Replace O-rings every 6 months, or whenever worn or damaged.

**b.** Keep the O-rings lightly coated with silicone vacuum grease (335148)

Replacement instructions are in *Rotors and Tubes*.

2 Before every run, lubricate the bucket cap threads with a thin, even coat of Spinkote lubricant (306812).

**3** Refer to *Chemical Resistances* (IN-175) for the chemical compatibilities of rotor and accessory materials.

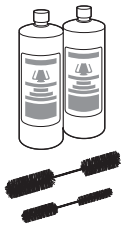
Your Beckman Coulter representative provides contact with the Field Rotor Inspection Program and the rotor repair center.

## Cleaning

*Wash the rotor and rotor components immediately if salts or other corrosive materials are used or if spillage has occurred. Do not allow corrosive materials to dry on the rotor.*

Under normal use, wash the rotor frequently (at least weekly) to prevent buildup of residues.

**1** Wash the rotor buckets, O-rings, and caps in a mild detergent, such as Solution 555, that won't damage the rotor.



Dilute the detergent with water (10 parts water to 1 part detergent).

**NOTE** Do not immerse the rotor body in water, since the hanger mechanism is difficult to dry and can rust.

The Rotor Cleaning Kit contains two plastic-coated brushes and two quarts of Solution 555 (339555) for use with rotors and accessories.

**2** Wash the rotor body with a sponge or cloth dampened with a mild detergent, such as Solution 555.

Dilute the detergent with water (10 parts water to 1 part detergent).

**3** Rinse the cleaned rotor and components with distilled water.

**4** Air-dry the rotor and lid upside down.

*Do not use acetone to dry the rotor.*

**5** Clean metal threads frequently to prevent buildup of residues and ensure adequate closure.

**a.** Use a brush and concentrated Solution 555.

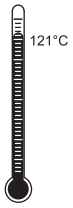
**b.** Dilute the detergent with water (10 parts water to 1 part detergent).

**c.** Rinse and dry thoroughly, then lubricate lightly but evenly with Spinkote to coat all threads.

## Decontamination

If the rotor or other components are contaminated with toxic, radioactive, or pathogenic materials, follow appropriate decontamination procedures as outlined by your laboratory safety officer. Refer to *Chemical Resistances* (IN-175) to select solutions that will not damage the rotor and accessory materials.

## Sterilization and Disinfection




- The rotor and all rotor components, except those made of polyphenylene oxide (PPO), can be autoclaved at 121°C for up to an hour. Remove the plugs from the rotor and place the rotor, plugs, and spacers in the autoclave upside down.

**⚠ CAUTION**

**Risk of personal injury or equipment damage. Ethanol is a flammability hazard. Do not use it in or near operating ultracentrifuges.**

- Ethanol (70%) or hydrogen peroxide (6%) may be used on all rotor components, including those made of plastic. Bleach (sodium hypochlorite) may be used, but may cause discoloration of anodized surfaces. Use the minimum immersion time for each solution, per laboratory standards.

While Beckman Coulter has tested these methods and found that they do not damage the rotor or components, no guarantee of sterility or disinfection is expressed or implied. When sterilization or disinfection is a concern, consult your laboratory safety officer regarding proper methods to use.

Where sterilization is critical in your application, consider using Beckman Coulter Certified Free & Sterilized Tubes. For tubes not available in the sterilized option, refer to *Use and Care of Centrifuge Tubes and Bottles* (publication IN-192) included in each box of tubes or bottles for sterilization and disinfection procedures. *Quick-Seal, Ultra-Clear, and thinwall open-top tubes are disposable and should be discarded after a single use.*

## Storage

When it is not in use, store the rotor and buckets in a dry environment (not in the instrument). Remove the bucket caps to allow air circulation so that moisture will not collect in the buckets.

# Returning a Rotor

Before returning a rotor or accessory for any reason, prior permission must be obtained from Beckman Coulter, Inc. A return authorization form is necessary and may be obtained from your local Beckman Coulter office. The return form should contain the following information:

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

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

Use the address label printed on the return form when mailing the rotor and/or accessories.

Customers located outside the United States should contact their local Beckman Coulter office.

# Supply List

See the Beckman Coulter *Ultracentrifuge Rotors, Tubes & Accessories* catalog (BR-8101, available at www.beckman.com), call Beckman Coulter Customer Service at 1-800-742-2345 (U.S.A. or Canada), or contact your local Beckman Coulter office for detailed information on ordering parts and supplies. For your convenience, a partial list is given below.

## Replacement Rotor Parts

| Description | Part Number |
|---|---|
| SW 28 rotor assembly | 342207 |
| SW 28 buckets (set of 6, with caps and O-rings) | 342217 |
| SW 28 bucket O-ring | 812715 |
| SW 28.1 rotor assembly | 342216 |
| SW 28.1 buckets (set of 6, with caps and O-rings) | 342212 |
| SW 28.1 bucket O-ring | 815472 |

| Description | Part Number |
|---|---|
| Rotor stand | 332400 |
| Overspeed disk (28,000 RPM) | 342211 |

## Other

**NOTE** For MSDS information, go to the Beckman Coulter website at www.beckman.com.

| Description | Part Number |
|---|---|
| Tubes and accessories | see Table 2 and Table 3 |
| Bucket holder rack | 331186 |
| Quick-Seal Cordless Tube Topper kit, 60 Hz | 358312 |
| Quick-Seal Cordless Tube Topper kit, 50 Hz (Europe) | 358313 |
| Quick-Seal Cordless Tube Topper kit, 50 Hz (Great Britain) | 358314 |
| Quick-Seal Cordless Tube Topper kit, 50 Hz (Australia) | 358315 |
| Quick-Seal Cordless Tube Topper kit, 50 Hz (Canada) | 367803 |
| Tube racks for the Tube Topper<br>for 16-mm diameter tubes<br>for 38-mm diameter tubes | <br>348123<br>348124 |
| Floating spacer removal tool | 338765 |
| Tube removal tool (Quick-Seal tubes) | 361668 |
| Extractor tool (*k*onical tube adapters) | 354468 |
| Spinkote lubricant (2 oz) | 306812 |
| Silicone vacuum grease (1 oz) | 335148 |
| Rotor Cleaning Kit | 339558 |
| Solution 555 (1 qt) | 339555 |
| Rotor cleaning brush | 339379 |
| Centering tool (for overspeed disk replacement) | 331325 |

# Beckman Coulter, Inc.
# Ultracentrifuge Rotor Warranty

All Beckman Coulter ultracentrifuge Fixed Angle, Vertical Tube, Near Vertical Tube, Swinging Bucket, and Airfuge rotors are warranted against defects in materials or workmanship for the time periods indicated below, subject to the Warranty Conditions stated below.

| | |
|---|---|
| Preparative Ultracentrifuge Rotors | 5 years — No Proration |
| Analytical Ultracentrifuge Rotors | 5 years — No Proration |
| ML and TL Series Ultracentrifuge Rotors | 5 years — No Proration |
| Airfuge Ultracentrifuge Rotors | 1 year — No Proration |

For Zonal, Continuous Flow, Component Test, and Rock Core Ultracentrifuge Rotors, see separate warranty.

1. This warranty is valid for the time periods indicated above from the date of shipment to the original Buyer by Beckman Coulter or an authorized Beckman Coulter representative.
2. This warranty extends only to the original Buyer and may not be assigned or extended to a third person without written consent of Beckman Coulter.
3. This warranty covers the Beckman Coulter Centrifuge Systems only (including but not limited to the centrifuge, rotor, and accessories) and Beckman Coulter shall not be liable for damage to or loss of the user's sample, non-Beckman Coulter tubes, adapters, or other rotor contents.
4. This warranty is void if the Beckman Coulter Centrifuge System is determined by Beckman Coulter to have been operated or maintained in a manner contrary to the instructions in the operator's manual(s) for the Beckman Coulter Centrifuge System components in use. This includes but is not limited to operator misuse, abuse, or negligence regarding indicated maintenance procedures, centrifuge and rotor classification requirements, proper speed reduction for the high density of certain fluids, tubes, and tube caps, speed reduction for precipitating gradient materials, and speed reduction for high-temperature operation.
5. 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.
6. This warranty does not cover the failure of a Beckman Coulter rotor in a centrifuge not of Beckman Coulter manufacture, or if the rotor is used in a Beckman Coulter centrifuge that has been modified without the written permission of Beckman Coulter, or is used with carriers, buckets, belts, or other devices not of Beckman Coulter manufacture.
7. Rotor parts subject to wear, including but not limited to rotor O-rings, VTi, NVT, TLV, MLN, and TLN rotor tube cavity plugs and gaskets, tubing, tools, optical overspeed disks, bearings, seals, and lubrication are excluded from this warranty and should be frequently inspected and replaced if they become worn or damaged.
8. Keeping a rotor log is not mandatory, but may be desirable for maintenance of good laboratory practices.

### Repair and Replacement Policies

1. If a Beckman Coulter rotor is determined by Beckman Coulter to be defective, Beckman Coulter will repair or replace it, subject to the Warranty Conditions. A replacement rotor will be warranted for the time remaining on the original rotor's warranty.
2. If a Beckman Coulter centrifuge is damaged due to a failure of a rotor covered by this warranty, Beckman Coulter will supply free of charge (i) all centrifuge parts required for repair (except the drive unit, which will be replaced at the then current price less a credit determined by the total number of revolutions or years completed, provided that such a unit was manufactured or rebuilt by Beckman Coulter), and (ii) if the centrifuge is currently covered by a Beckman Coulter warranty or Full Service Agreement, all labor necessary for repair of the centrifuge.
3. If a Beckman Coulter rotor covered by this warranty is damaged due to a malfunction of a Beckman Coulter ultracentrifuge covered by an Ultracentrifuge System Service Agreement, Beckman Coulter will repair or replace the rotor free of charge.
4. If a Beckman Coulter rotor covered by this warranty is damaged due to a failure of a Beckman Coulter tube, bottle, tube cap, spacer, or adapter, covered under the Conditions of this Warranty, Beckman Coulter will repair or replace the rotor and repair the instrument as per the conditions in policy point (2) above, and the replacement policy.
5. Damage to a Beckman Coulter rotor or instrument due to the failure or malfunction of a non-Beckman Coulter tube, bottle, tube cap, spacer, or adapter is not covered under this warranty, although Beckman Coulter will assist in seeking compensation under the manufacturer's warranty.

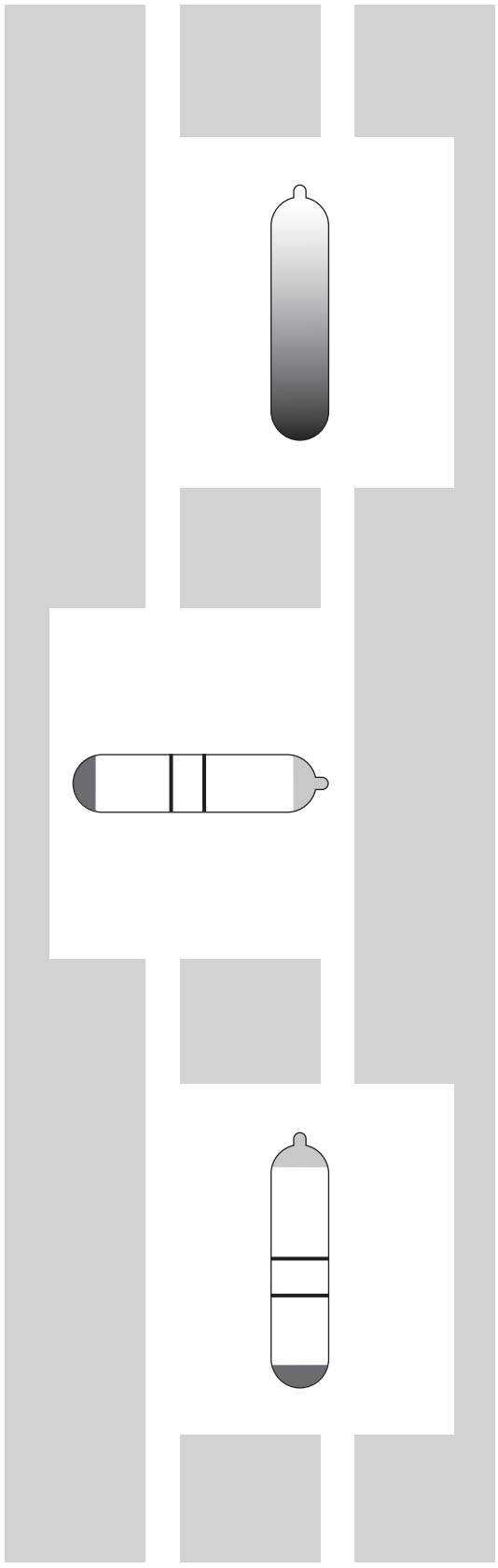
### Disclaimer

IT IS EXPRESSLY AGREED THAT THE ABOVE WARRANTY SHALL BE IN LIEU OF ALL WARRANTIES OF FITNESS AND OF THE WARRANTY OF MERCHANTABILITY AND BECKMAN COULTER, INC. 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.

### Factory Rotor Inspection Service

Beckman Coulter, Inc., will provide free mechanical and metallurgical inspection in Indianapolis, Indiana, USA, of any Beckman Coulter rotor at the request of the user. (Shipping charges to Beckman Coulter are the responsibility of the user.) Rotors will be inspected in the user's laboratory if the centrifuge in which they are used is covered by an appropriate Beckman Coulter Service Agreement. Contact your local Beckman Coulter office for details of service coverage or cost.

Before shipping, contact the nearest Beckman Coulter Sales and Service office and request a Returned Goods Authorization (RGA) form and packaging instructions. Please include the complete rotor assembly, with buckets, lid, handle, tube cavity caps, etc. A SIGNED STATEMENT THAT THE ROTOR AND ACCESSORIES ARE NON-RADIOACTIVE, NON-PATHOGENIC, NON-TOXIC, AND OTHERWISE SAFE TO SHIP AND HANDLE IS REQUIRED.



# Related Documents

**Rotors and Tubes for Preparative Ultracentrifuges (LR-IM-24)**

- Rotors
- Tubes, Bottles, and Accessories
- Using Tubes, Bottles, and Accessories
- Using Fixed-Angle Rotors
- Using Swinging-Bucket Rotors
- Using Vertical-Tube and Near-Vertical Tube Rotors
- Care and Maintenance
- Chemical Resistances for Beckman Coulter Centrifugation Products
- Use of the w2t Integrator
- The Use of Cesium Chloride Curves
- Gradient Materials
- References
- Glossary

Available in electronic pdf by request.

**Rotors and Tubes CD (369668)**

- Rotors and Tubes for Tabletop Preparative Ultracentrifuges
- Rotors and Tubes for J2, J6, Avanti J Series Centrifuges
- Rotors and Tubes for Preparative Ultracentrifuges
- Rotor Safety Bulletin
- Chemical Resistances for Beckman Coulter Centrifugation Products

Included with shipment of instrument.

**Additional References**

- Chemical Resistances for Beckman Coulter Centrifugation Products (IN-175)
- Beckman Coulter Ultracentrifuge Rotors, Tubes & Accessories catalog (BR-8101)
- Using OptiSeal Tubes (IN-189)
- Use and Care of Centrifuge Tubes and Bottles (IN-192)

Available in hard copy or electronic pdf by request, also available at www.beckman.com.

**Data Sheets**

- *g*-Max System: Short Pathlengths in High Force Fields (DS-709B)

Available at www.beckman.com

**www.beckman.com**

BECKMAN COULTER

# Instructions For Use

## SW 55 Ti
## Swinging-Bucket Rotor

For Use in Beckman Coulter Class H, R, and S
Preparative Ultracentrifuges

PN L5-TB-062ME
October 2018

Beckman Coulter, Inc.
250 S. Kraemer Blvd.
Brea, CA 92821 U.S.A.

BECKMAN COULTER

**SW 55 Ti Swinging-Bucket Rotor**
L5-TB-062ME (October 2018)



**Contact Us**
If you have any questions, contact our Customer Support Center.

- Worldwide, find us via our website at www.beckman.com/support/technical
- In the USA and Canada, call us at 1-800-369-0333.
- Outside of the USA and Canada, contact your local Beckman Coulter Representative.

Find us on the World Wide Web at:
**www.beckman.com**

EC REP

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Glossary of Symbols is available at beckman.com/techdocs (PN C24689).

Original Instructions

# Revision History

*This document applies to the latest and higher versions. When a subsequent version changes the information in this document, a new issue will be released to the Beckman Coulter website. For updates, go to www.beckman.com/techdocs and download the latest version of the manual or system help for your instrument.*

**Issue ME, 10/2018**

Changes or additions were made to:

- Certified Free Tubes
- Sterile Tubes
- Table 1, Available Tubes and Bottles for the Type 50.2 Ti Rotor. Use only the items listed here and observe fill volumes and maximum run speeds.
- Sterilization and Disinfection

***Note:*** *Changes that are part of the most recent revision are indicated in text by a bar in the margin of the amended page.*

# Safety Notice

**Read all product manuals and consult with Beckman Coulter-trained personnel before attempting to use this equipment. Do not attempt to perform any procedure before carefully reading all instructions. Always follow product labeling and manufacturer's recommendations. If in doubt as to how to proceed in any situation, contact your Beckman Coulter Representative.**

## Alerts for Warning, Caution, and Note

**⚠ WARNING**

**WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.**

**⚠ CAUTION**

**CAUTION indicates a potentially hazardous situation, which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.**

**NOTE** NOTE is used to call attention to notable information that should be followed during installation, use, or servicing of this equipment.

## Safety Information for the SW 55 Ti Rotor

Handle body fluids with care because they can transmit disease. No known test offers complete assurance that such fluids are free of micro-organisms. Some of the most virulent—Hepatitis (B and C) viruses, HIV (I–V), atypical mycobacteria, and certain systemic fungi—further emphasize the need for aerosol protection. Handle other infectious samples according to good laboratory procedures and methods to prevent spread of disease. Because spills may generate aerosols, observe proper safety precautions for aerosol containment. Do not run toxic, pathogenic, or radioactive materials in this rotor without taking appropriate safety precautions. Biosafe containment should be used when Risk Group II materials (as identified in the World Health Organization *Laboratory Biosafety Manual*) are handled; materials of a higher group require more than one level of protection.

The rotor and accessories are not designed for use with materials capable of developing flammable or explosive vapors. Do not centrifuge such materials in nor handle or store them near the ultracentrifuge.

Although rotor components and accessories made by other manufacturers may fit in the SW 55 Ti rotor, their safety in this rotor cannot be ascertained by Beckman Coulter. Use of other manufacturers' components or accessories in the SW 55 Ti rotor may void the rotor warranty and should be prohibited by your laboratory safety officer. Only the components and accessories listed in this publication should be used in this rotor.

Hook all six buckets, loaded or empty, to the rotor for every run. Make sure that filled containers are loaded symmetrically into the rotor and that opposing tubes are filled to the same level with liquid of the same density. Make sure that buckets containing Quick-Seal tubes have the proper floating spacers inserted (if applicable) before installing the bucket cap.

If disassembly reveals evidence of leakage, you should assume that some fluid escaped the rotor. Apply appropriate decontamination procedures to the centrifuge and accessories.

Never exceed the maximum rated speed of the rotor and labware in use. Refer to the section on *Run Speeds*, and derate the run speed as appropriate.

Do not use sharp tools on the rotor that could cause scratches in the rotor surface. Corrosion begins in scratches and may open fissures in the rotor with continued use.

# Contents

# Illustrations

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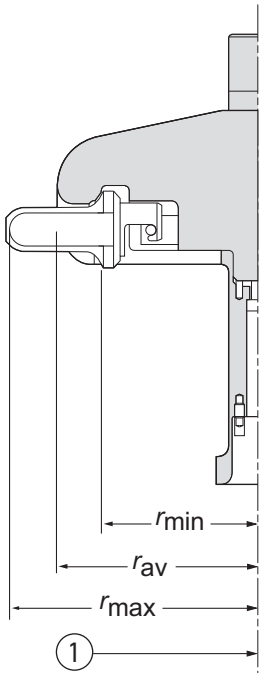
## Tables

# SW 55 Ti
# Swinging-Bucket Rotor

## Specifications



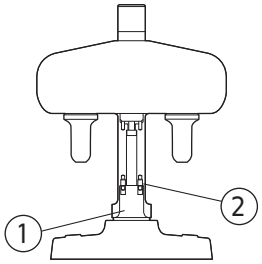

1. **Axis of Rotation**

| | |
|---|---|
| Maximum speed | 55,000 RPM |
| Density rating at maximum speed | 1.2 g/mL |
| Relative Centrifugal Field[a] at maximum speed | |
| At $r_{max}$ (108.5 mm) | 368,000 × *g* |
| At $r_{av}$ (84.6 mm) | 287,000 × *g* |
| At $r_{min}$ (60.8 mm) | 206,000 × *g* |
| *k* factor at maximum speed | 48 |
| *k* factor at maximum speed (5 to 20% sucrose gradient; 5°C) | |
| When particle density = 1.3 g/mL | 135 |
| When particle density = 1.5 g/mL | 123 |
| When particle density = 1.7 g/mL | 118 |
| Conditions requiring speed reductions | see *Run Speeds* |
| Number of buckets | 6 |
| Available tubes | see Table 1 |
| Nominal tube dimensions (largest tube) | 13 × 51 mm |
| Nominal tube capacity (largest tube) | 5 mL |
| Nominal rotor capacity | 30 mL |
| Approximate acceleration time to maximum speed (fully loaded)[b] | 3½ min |
| Approximate deceleration time from maximum speed (fully loaded)[b] | 3½ min |
| Weight of fully loaded rotor | 5 kg (11 lb) |
| Rotor material | titanium |

a. 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 = $r\omega^2/g$ — where *r* is the radius in millimeters, $\omega$ is the angular velocity in radians per second (2 π RPM /60), and *g* is the standard acceleration of gravity (9807 mm/s$^2$). After substitution: RCF = $1.12r\ (RPM/1000)^2$

b. Time may vary depending on which instrument is used.

# Description




1. Adapter
2. Drive Pins

*The Beckman Coulter SW 55 Ti rotors are manufactured in a facility that maintains certifications to both ISO* 9001:2008 and ISO 13485:2003. They are for use in the specified Beckman Coulter ultracentrifuges.

The SW 55 Ti is a swinging bucket rotor designed to centrifuge up to six tubes. Used in Beckman Coulter class H, R, and S preparative ultracentrifuges, the rotor develops centrifugal forces for the separation and purification of small particles. Typical applications include separation of DNA, RNA, proteins, and subcellular particles in density gradients, and banding RNA- containing viruses in sedimentation equilibrium studies. Approximate sample volume per tube is 0.2 mL, with a gradient volume of about 4.8 mL.

The rotor body and buckets are made of titanium and finished with polyurethane paint; the rotor body is black and the buckets are red. *Do not interchange these red buckets with the SW 50.1 Ti black buckets.* A solid-film lubricant (grey in color) is applied to the bucket flange to improve the seating of the bucket into the rotor pocket. Bucket caps are anodized aluminum. The bucket and cap assemblies hook over the crossbar of the rotor hanger mechanism. O-rings, made of Buna N rubber, between each bucket and bucket cap maintain atmospheric pressure inside the buckets during centrifugation.

Drive pins in the rotor bottom prevent the rotor from slipping on the ultracentrifuge drive hub during acceleration and deceleration. Two indentations on the sides of the rotor adapter indicate their location.

For overspeed protection, a Beckman Coulter ultracentrifuge equipped with a photoelectric detector will monitor the overspeed disk on the adapter bottom and shut down the run if a speed exceeding the maximum allowable speed is detected.

See the Warranty at the back of this manual for warranty information.

# Preparation and Use

*Specific information about the SW 55 Ti rotor is given here. Information common to this and other rotors is contained in Rotors and Tubes for Preparative Ultracentrifuges* (publication LR-IM-24), *which should be used together with this manual for complete rotor and accessory operation. Publication LR-IM-24 is included in the literature package with this rotor manual.*

**NOTE** Although rotor components and accessories made by other manufacturers may fit in the SW 55 Ti rotor, their safety in this rotor cannot be ascertained by Beckman Coulter. Use of other manufacturers' components or accessories in the SW 55 Ti rotor may void the rotor warranty and should be prohibited by your laboratory safety officer. Only the components and accessories listed in this publication should be used in this rotor.

## Prerun Safety Checks

*Read the Safety Notice section at the front of this manual before using the rotor.*

1 Make sure that the rotor, buckets, and bucket caps are clean and show no signs of corrosion or cracking.

2 Make sure that the rotor is equipped with the correct overspeed disk.

**a.** If the disk is missing or damaged, replace it according to the instructions in *Rotors and Tubes*.


3 Verify that the tubes and accessories being used are listed in Table 1.

4 Check the chemical compatibilities of all materials used.

Refer to *Chemical Resistances* (publication IN-175), included in the *Rotors and Tubes* CD.

## Rotor Preparation

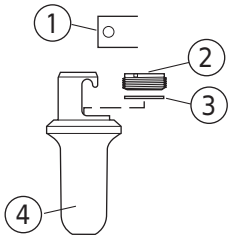
*For runs at other than room temperature refrigerate or warm the rotor beforehand for fast equilibration.*

**1** Load the filled containers into the buckets (see page 6 for tube and accessory information).

Complete loading by placing the correct floating spacers (if required) over the tubes.

**2** Ensure that bucket O-rings are lightly but evenly coated with silicone vacuum grease (335148).

Do not run a bucket without an O-ring, as the bucket will leak.




1. Hanger
2. Cap
3. O-Ring
4. Bucket

**3** Be sure that metal threads in the bucket caps are clean and lightly but evenly lubricated with Spinkote lubricant (306812).

**a.** Match numbered buckets to numbered caps.

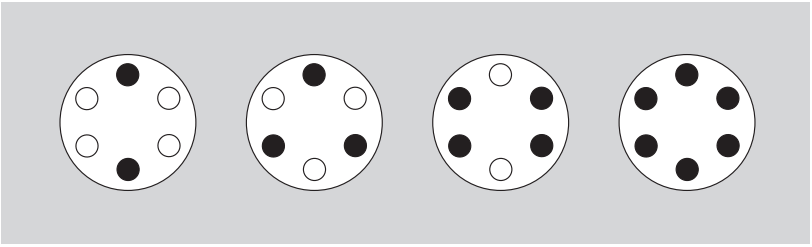
**b.** Put bucket caps on the buckets and screw the caps into the buckets until there is metal-to-metal contact.

**4** Hook all buckets, loaded or empty, to the rotor.

If fewer than six tubes are being run, they must be arranged symmetrically in the rotor (see Figure 1).

Opposing tubes must be filled to the same level with liquid of the same density.

**Figure 1** Arranging Tubes in the Rotor.



**NOTE** Two, three, four, or six tubes can be centrifuged per run if they are arranged in the rotor as shown. All buckets must be attached to the rotor, whether loaded or empty.

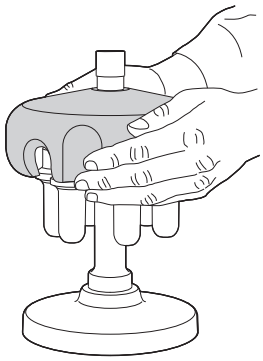
## Operation

Refer to *Rotors and Tubes for Preparative Ultracentrifuges* (publication LR-IM-24) for information on installing swinging bucket rotors.

1 To install the rotor, carefully lift it with both hands—*do not lift the rotor by the adapter*—and place it on the drive hub.

Make sure that the rotor pins are perpendicular to the drive hub pins.

The pins must not rest on top of each other; turn the rotor to the right (clockwise) by hand to check for proper installation.



2 Refer to the instrument instruction manual for ultracentrifuge operation.

3 For additional operating information, see the following:

- *Run Times*, page 10, for using *k* factors to adjust run durations.
- *Run Speeds*, page 11, for information about speed limitations.
- *Selecting CsCl Gradients*, page 15, for methods to avoid CsCl precipitation during centrifugation.

## Removal and Sample Recovery

**⚠ CAUTION**

**Risk of contamination. If disassembly reveals evidence of leakage, you should assume that some fluid escaped the rotor. Apply appropriate decontamination procedures to the ultracentrifuge and accessories.**

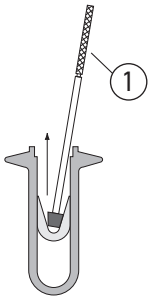
1 Remove the rotor from the ultracentrifuge by lifting it straight up and off the drive hub.

**2** Set the rotor on the rotor stand and carefully remove the buckets.

**3** Remove the bucket caps and use the appropriate removal tool (listed in the *Supply List*) to remove the spacers and tubes.

If floating spacers were used, remove them with the threaded end of the floating spacer removal tool (338765).

**NOTE** If the conical-shaped adapters that support *k*onical tubes are difficult to remove after centrifugation, an extractor tool (354468) is available to facilitate removal.




1. Extractor Tool (354468)
   While pressing the rubber tip against the adapter wall, pull the tube and adapter up and out of the cavity.

## Tubes and Accessories

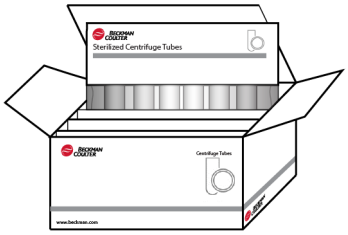
The SW 55 Ti rotor uses tubes and accessories listed in Table 1. Be sure to use only those items listed, and to observe the maximum speed limits shown. Refer to *Chemical Resistances* (IN-175) for information on the chemical compatibilities of tube and accessory materials.

### Certified Free Tubes


Based on Sample Results Below Detectable Limit

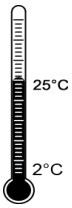
Certified free tubes are lot traceable to testing that confirms the absence of endotoxin, DNase, RNase, and human & mouse DNA below a detectable limit.

## Sterile Tubes




Sterile tubes are sterilized via ethylene oxide in compliance with ISO 11135:2014. Cartons include several peel packages, each containing a typical run quantity of tubes per the tube details in Table 1. Packaging meets requirements of ISO11607:2006.

## Temperature Limits




- Plastic tubes have been centrifuge tested for use at temperatures between 2 and 25°C. For centrifugation at other temperatures, pretest tubes under anticipated run conditions.
- If plastic containers are frozen before use, make sure that they are thawed to at least 2°C prior to centrifugation.
- Stainless steel tubes can be centrifuged at any temperature.

## OptiSeal Tubes

OptiSeal tubes come with plastic plugs and can be quickly and easily prepared for use. With the tube spacer in place, the *g* force during centrifugation ensures a tight, reliable seal that protects your samples

**Table 1** Available Tubes for the SW 55 Ti Rotor[a]

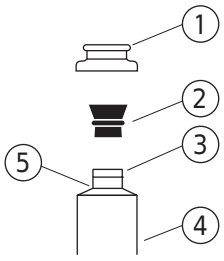
| Tube | | | Required Accessory | | Max Speed/RCF/ *k* factor |
|---|---|---|---|---|---|
| **Dimensions/ Nominal Volume** | **Description** | **Part Number** | **Description** | **Part Number** | |
| 13 × 51 mm 5 mL | Certified Free & Sterile Ultra-Clear Open-Top | C14295 Carton of 48 (8 packs of 6) | none | — | 55,000 RPM 368,000 × *g* 48 |
| | Certified Free Ultra-Clear Open-Top | C14279 (pkg/50) | | | |
| | Standard Ultra-Clear Open Top | 344057 (pkg/50) | | | |
| 13 × 51 mm 5 mL | thinwall polypropylene | 326819 (pkg/50) | none | — | 55,000 RPM 368,000 × *g* 48 |

**Table 1** Available Tubes for the SW 55 Ti Rotor[a] *(Continued)*

| Tube | | | Required Accessory | | Max Speed/RCF/ *k* factor |
|---|---|---|---|---|---|
| **Dimensions/ Nominal Volume** | **Description** | **Part Number** | **Description** | **Part Number** | |
| 13 × 51 mm<br>3 mL | *k*onical open-top polypropylene | 358119<br>(pkg/50) | adapter | 358153 | 55,000 RPM<br>368,000 × *g*<br>48 |
| 13 × 51 mm<br>3.2 mL | Quick-Seal *k*onical polypropylene | 358647<br>(pkg/50) | adapter | 358153 | 55,000 RPM<br>368,000 × *g*<br>48 |
| | | | Polyphenylene oxide (PPO) floating spacer | 355535 | |
| 13 × 51 mm<br>3.5 mL | thickwall polypropylene | 349623<br>(pkg/25) | none | — | 55,000 RPM<br>368,000 × *g*<br>48 |
| 13 × 25 mm<br>2 mL | Quick-Seal polypropylene | 345829<br>(pkg/50) | Polyphenylene oxide (PPO) floating spacer | 355535 | 55,000 RPM<br>368,000 × *g*<br>29 |
| 13 × 51 mm<br>3.5 mL | thickwall polycarbonate | 349622<br>(pkg/25) | none | — | 55,000 RPM<br>368,000 × *g*<br>48 |
| 5 × 41 mm<br>0.8 mL | Ultra-Clear | 344090<br>(pkg/50) | adapter | 356860 | 48,000 RPM<br>269,000 × *g*<br>64 |
| | | | | 305527 | 25,000 RPM<br>73,200 × *g*<br>209 |

a. Use only the items listed here..

1 Place the tubes in the rack and fill each tube to the base of the stem, leaving no fluid in the stem. Overfilling the tube can cause spillage when the plug is inserted or compromise seal integrity. However, too much air can cause excessive tube deformation, disrupting gradients and sample bands.




1. Spacer
2. Plug
3. Stem
4. Tube
5. Base of Stem

**2** Refer to *Using OptiSeal Tubes* (publication IN-189) included in each box of tubes, for detailed information on the use and care of OptiSeal tubes.

## Quick-Seal Tubes

Quick-Seal tubes must be sealed prior to centrifugation. These tubes are heat sealed and do not need caps; however, spacers are required on top of the tubes when they are loaded into the rotor buckets.

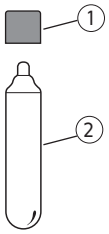
**1** Fill Quick-Seal tubes leaving a *small* bubble of air at the base of the neck.

Do not leave a large air space—too much air can cause excessive tube deformation.

**2** Some of the Quick-Seal tubes listed in Table 1 are part of the *g*-Max system, which uses a combination of small bell-top Quick-Seal tubes and floating spacers (also called *g*-Max spacers).

This means that you can run the shorter tubes listed in Table 1 in the SW 55 Ti rotor without reduction in *g* force.

For detailed information on the *g*-Max system see publication DS-709B.



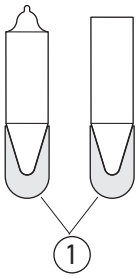

1. *g*-Max Spacer
2. Bell-top Tube

**3** Refer to *Rotors and Tubes for Preparative Ultracentrifuges* (publication LR-IM-24) for detailed information on the use and care of Quick-Seal tubes.

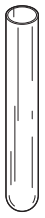
Quick-Seal tubes are disposable and should be discarded after a single use.

## *k*onical Tubes

Polypropylene konical tubes, used to optimize pelleting separations, have a conical tip that concentrates the pellet in the narrow end of the tube. The narrow bottom also reduces the tube's nominal volume and minimizes gradient material requirement. The konical tubes come in both open-top and Quick-Seal tube designs. Conical cavity adapters hold the tubes in the rotor buckets.




**1.** Adapters



### Thinwall Tubes

Thinwall polypropylene and Ultra-Clear open-top tubes should be filled as full as possible (2 or 3 mm from the tube top) for tube support. If necessary, float mineral oil (or some other low-density, immiscible liquid) on top of the tube contents to fill the tube to its maximum volume. (Do not use an oil overlay in Ultra-Clear tubes.) All opposing tubes for a run must be filled to the same level with liquid of the same density.

### Thickwall Tubes

Thickwall polypropylene and polycarbonate tubes can be run partially filled (at least half filled) with or without caps, but all opposing tubes for a run must be filled to the same level with liquid of the same density. Do not overfill capless tubes; be sure to note the reductions in fill volume and run speed shown in Table 1.

## Run Times

The *k* factor of the rotor is a measure of the rotor's pelleting efficiency. (Beckman Coulter has calculated the *k* factors for all of its preparative rotors at maximum rated speed and using full tubes.) The *k* factor is calculated from the formula

$$k = \frac{\ln(r_{max}/r_{min})}{\omega^2} \times \frac{10^{13}}{3600} \quad \textbf{EQ 1}$$

where ω is the angular velocity of the rotor in radians per second (ω = 0.105 × RPM), $r_{max}$ is the maximum radius, and $r_{min}$ is the minimum radius.

After substitution:

$$k = \frac{(2.533 \times 10^{11})\ln(r_{max}/r_{min})}{RPM^2} \quad \textbf{EQ 2}$$

Use the *k* factor in the following equation to estimate the run time *t* (in hours) required to pellet particles of known sedimentation coefficient *s* (in Svedberg units, *S*).

$$t = \frac{k}{s} \quad \textbf{EQ 3}$$

Run times can be estimated for centrifugation at less than maximum speed by adjusting the *k* factor as follows:

$$k_{adj} = k \left( \frac{55,000}{\text{actual run speed}} \right)^2 \quad \text{EQ 4}$$

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:

$$\frac{t_a}{t_b} = \frac{k_a}{k_b} \quad \text{EQ 5}$$

## Run Speeds

The centrifugal force at a given radius in a rotor is a function of speed. Comparisons of forces between different rotors are made by comparing the rotors' relative centrifugal fields (RCF). When rotational speed is adjusted so that identical samples are subjected to the same RCF in two different rotors, the samples are subjected to the same force. The RCF at a number of rotor speeds is provided in Table 2.

Do not select rotational speeds in excess of 55,000 RPM. In addition, speeds must be reduced under the following circumstances:

1. If nonprecipitating solutions more dense than 1.2 g/mL are centrifuged, the maximum allowable run speed must be reduced according to the following equation:

$$\text{reduced maximum speed} = (55,000 \text{ RPM}) \sqrt{\frac{1.2 \text{ g/mL}}{\rho}} \quad \text{EQ 6}$$

   where ρ is he density of the tube contents. This speed reduction will protect the rotor from excessive stresses due to the added tube load.

2. *Further speed limits must be imposed* when CsCl or other self-forming-gradient salts are centrifuged, as equation (6) does not predict concentration limits/speeds that are required to avoid precipitation of salt crystals. Solid CsCl has a density of 4 g/mL, and if precipitated during centrifugation may cause rotor failure. Figure 2 and Figure 3, together with the description and examples below, show how to reduce run speeds when using CsCl gradients.

**Table 2** Relative Centrifugal Fields for the SW 55 Ti Rotor[a]

| Rotor Speed (RPM) | Relative Centrifugal Field (× *g*) | | | *k* Factor[b] |
|---|---|---|---|---|
| | At $r_{max}$ (108.5 mm) | At $r_{av}$ (84.6 mm) | At $r_{min}$ (60.8 mm) | |
| 55,000 | 368,000 | 287,000 | 206,000 | 48 |
| 50,000 | 304,000 | 237,000 | 170,000 | 59 |
| 45,000 | 246,000 | 192,000 | 138,000 | 72 |

**Table 2** Relative Centrifugal Fields for the SW 55 Ti Rotor[a]

| Rotor Speed (RPM) | Relative Centrifugal Field (× *g*) | | | *k* Factor[b] |
|---|---|---|---|---|
| | At $r_{max}$ (108.5 mm) | At $r_{av}$ (84.6 mm) | At $r_{min}$ (60.8 mm) | |
| 40,000 | 194,000 | 152,000 | 109,000 | 92 |
| 35,000 | 149,000 | 116,000 | 83,400 | 120 |
| 30,000 | 109,000 | 85,300 | 61,300 | 163 |
| 25,000 | 76,000 | 59,200 | 42,600 | 235 |
| 20,000 | 48,600 | 37,900 | 27,200 | 367 |
| 15,000 | 27,300 | 21,300 | 15,300 | 652 |
| 10,000 | 12,200 | 9,480 | 6,810 | 1,467 |

a. Entries in this table are calculated from the formula RCF = $1.12r\,(RPM/1000)^2$ and then rounded to three significant digits.

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

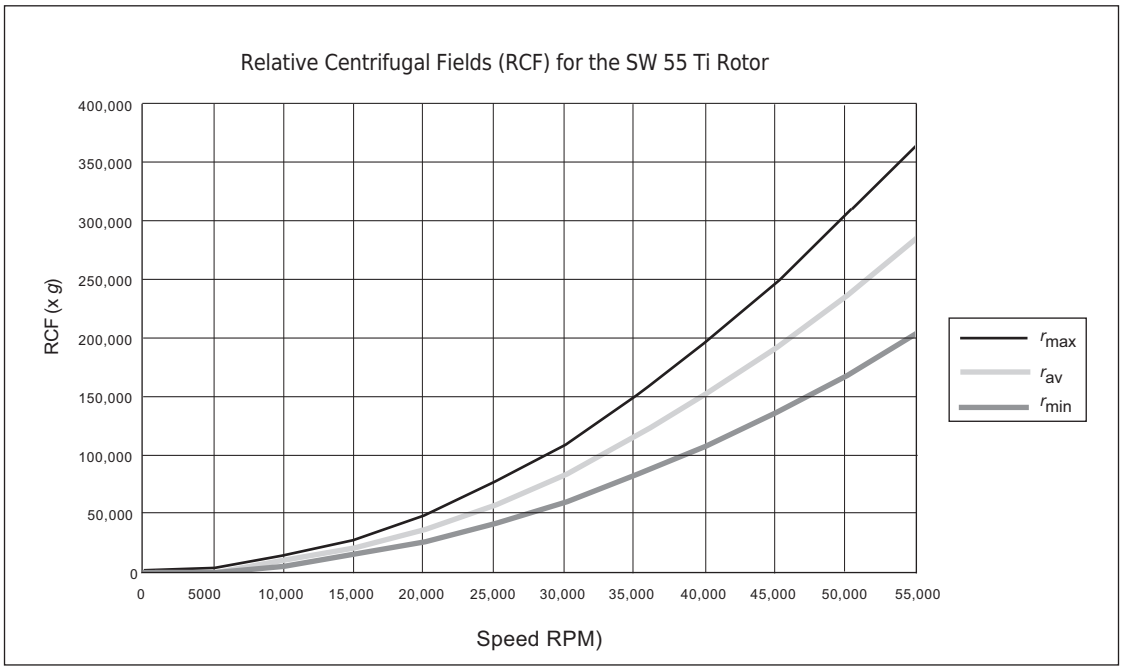
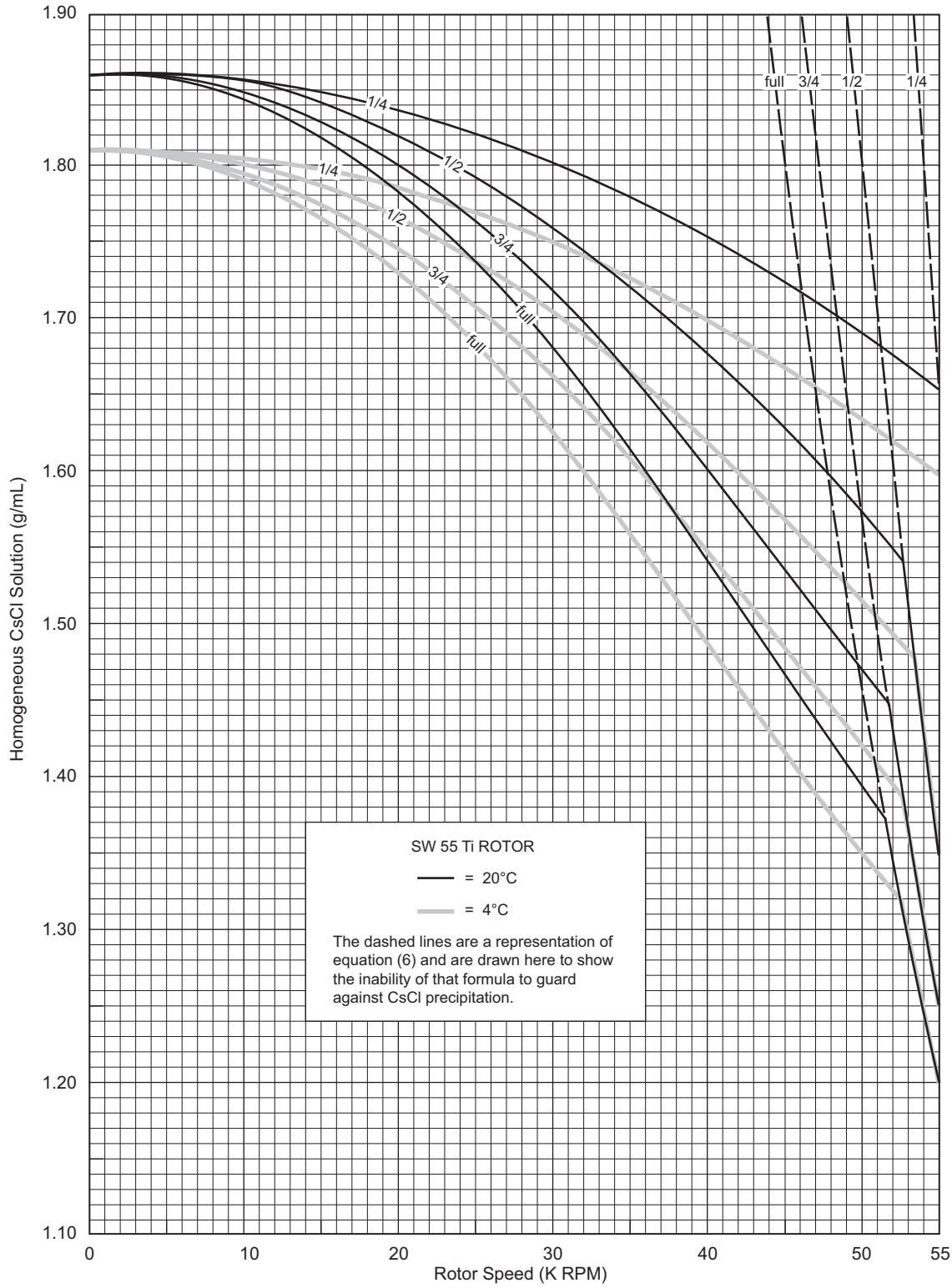
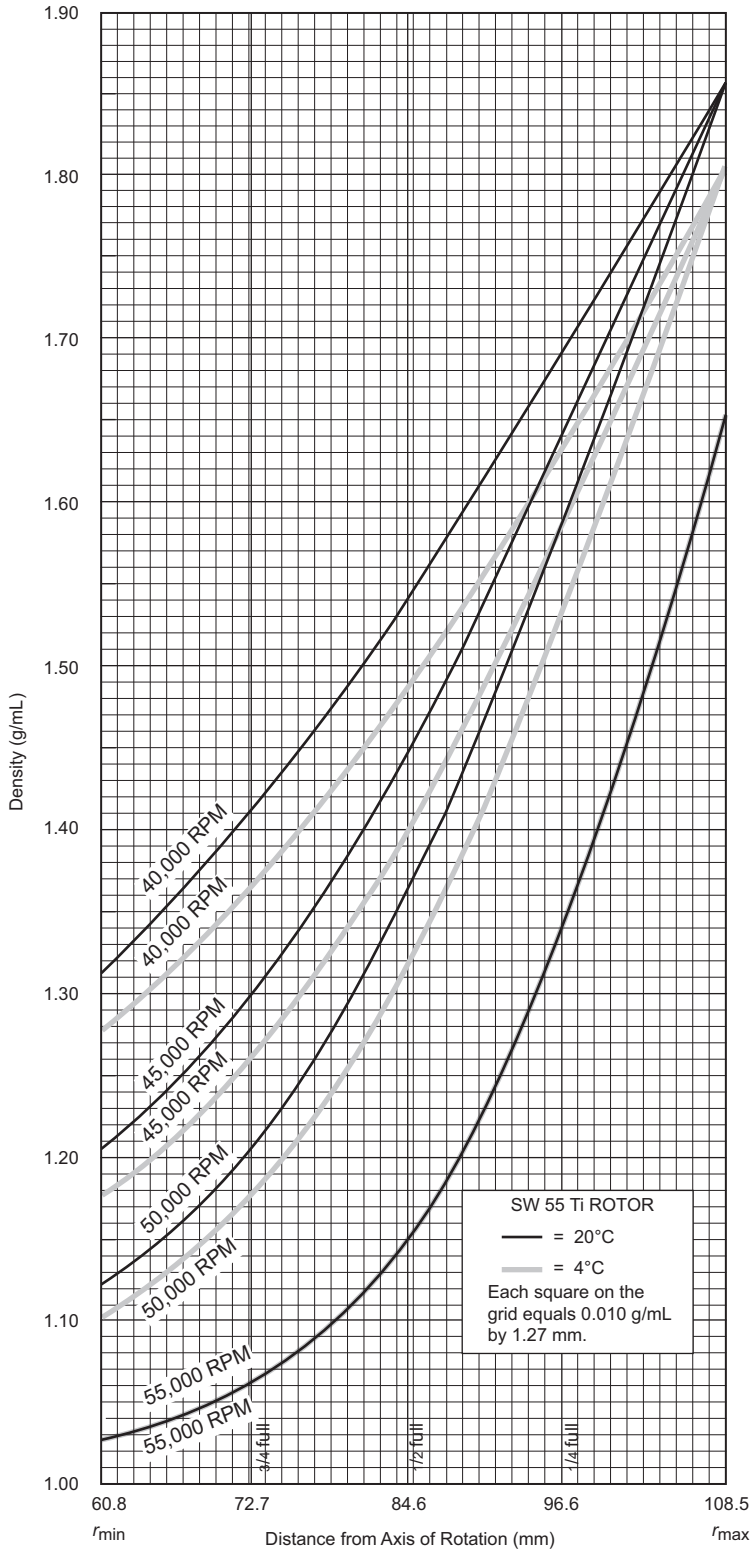


**Figure 2** Precipitation Curves for the SW 55 Ti Rotor*




* Using combinations of rotor speeds and homogeneous CsCl solution densities that intersect on or below these curves ensures that CsCl will not precipitate during centrifugation. The dashed lines are representations of EQ 6, and are shown here to illustrate the inability of that equation to predict CsCl precipitation.

**Figure 3** CsCl Gradients at Equilibrium for the SW 55 Ti Rotor*




* Centrifugation of homogeneous CsCl solutions at the maximum allowable speeds (from Figure 2) results in gradients presented here.

## Selecting CsCl Gradients

Rotor speed is used to control the slope of a CsCl density gradient, and must be limited so that CsCl precipitation is avoided. Speed and density combinations that intersect on or below the curves in Figure 3 ensure that CsCl will not precipitate during centrifugation in the SW 55 Ti rotor. Curves are provided at two temperatures: 20°C (black curves) and 4°C (gray curves). Curves in Figure 2 and Figure 3 are provided up to the maximum rated speed of the rotor.

**NOTE** The curves in Figure 2 and Figure 3 are for solutions of CsCl salt dissolved in distilled water only. If other salts are present in significant concentrations, the overall CsCl concentration may need to be reduced.

The reference curves in Figure 3 show gradient distribution at equilibrium. Each curve in Figure 3 is within the density limits allowed for the SW 55 Ti rotor: each curve was generated for a single run speed using the maximum allowable homogeneous CsCl densities (one for each fill level) that avoid precipitation at that speed. (The gradients in Figure 3 can be generated from step or linear gradients, or from homogeneous solutions. But the total amount of CsCl in solution must be equivalent to a homogeneous solution corresponding to the concentrations specified in Figure 3.) Figure 3 can also be used to approximate the banding positions of sample particles. Curves not shown in the figure may be interpolated.

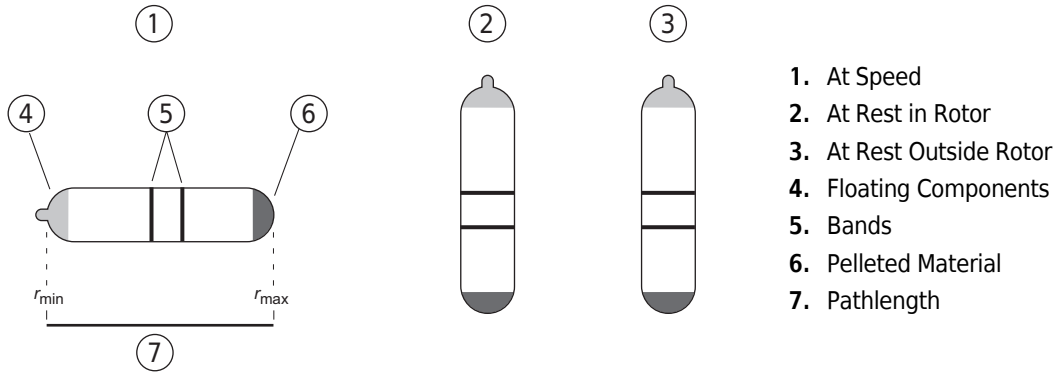
## Adjusting Fill Volumes

Figure 2 and Figure 3 show that several fill volumes are possible in a tube. If a thinwall tube is partially filled with gradient solution, float mineral oil (or some other low-density, immiscible liquid) on top of the tube contents to fill the tube to its maximum volume. (Do not use an oil overlay in Ultra-Clear tubes.) Note that for a given CsCl density, as the fill level decreases the maximum allowable speed increases. Partial filling may be desirable when there is little sample or when you wish to shorten the run time.

For example, a *quarter-filled* tube of 1.55-g/mL homogeneous CsCl solution at 4°C may be centrifuged at 52,000 RPM (see Figure 2). The segment of the 55,000-RPM curve (Figure 3) from the quarter-filled line to the tube bottom represents this gradient. The same solution in a *half-filled* tube may be centrifuged no faster than 47,000 RPM (curves not shown in the figure may be interpolated), and 40,000 RPM in a *three-quarter-filled* tube. A tube full of the 1.55-g/mL CsCl solution may be centrifuged no faster than 36,000 RPM.

## Typical Examples for Determining CsCl Run Parameters

**Example A:**
Starting with a homogeneous CsCl solution density of 1.39 g/mL and approximate particle buoyant densities of 1.39 and 1.45 g/mL, at 20°C, where will particles band at equilibrium?




**1** In Figure 2 find the curve that corresponds to the desired run temperature (20°C) and fill volume (full).

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's buoyant density.

**3** Mark the point in the figure where each particle density intersects the curve corresponding to the selected run speed and temperature.

Particles will band at these locations across the tube diameter at equilibrium during centrifugation.

In this example, particles will band about 86 and 90 mm from the axis of rotation, about 3.5 mm of centerband-to-centerband separation.

To determine interband volume in milliliters, use the following equation:

$$V = \pi r^2 h \qquad \text{EQ 7}$$

where *r* is the tube radius in centimeters and *h* is the interband separation in centimeters.

**Example B:**
Knowing particle buoyant densities (for example, 1.375 and 1.42 g/mL), how do you achieve good separation?

1. In Figure 3, sketch in a horizontal line corresponding to each particle's buoyant density.
2. Select the curve at the required temperature (4°C) and tube volume (full) that gives the best particle separation.
3. Note the run speed along the selected curve (40,000 RPM).
4. From Figure 2, select the maximum homogeneous CsCl density (in this case, 1.55 g/mL) that corresponds to the temperature and run speed established above.

   These parameters will provide the particle-banding pattern selected in Step 2.

In this example, particles will band at about 74 and 79 mm from the axis of rotation (about 5 mm apart).

# Care and Maintenance

## Maintenance

**NOTE** Do not use sharp tools on the rotor that could cause scratches in the rotor surface. Corrosion begins in scratches and may open fissures in the rotor with continued use.

1. Regularly inspect the overspeed disk on the bottom of the rotor adapter.

   If it is scratched, damaged, or missing, replace it.

   Replacement instructions are in *Rotors and Tubes for Preparative Ultracentrifuges* (publication LR-IM-24).
2. Frequently check the bucket O-rings (824412) for signs of wear. Keep O-rings lightly coated with silicone vacuum grease (335148).
   a. Replace gaskets every 6 months, or whenever worn or damaged.
   b. Keep the gaskets lightly coated with silicone vacuum grease.
3. Regularly lubricate the bucket cap threads with a thin, even coat of Spinkote lubricant before every run.

4 Refer to *Chemical Resistance*s (IN-175) for the chemical compatibilities of rotor and accessory materials.

Your Beckman Coulter representative provides contact with the Field Rotor Inspection Program and the rotor repair center.

## Cleaning

*Wash the rotor and rotor components immediately if salts or other corrosive materials are used or if spillage has occurred. Do not allow corrosive materials to dry on the rotor.*

Under normal use, wash the rotor frequently (at least weekly) to prevent buildup of residues.

1 Wash the rotor buckets, O-rings, and caps in a mild detergent, such as Solution 555, that won't damage the rotor.

Dilute the detergent with water (10 parts water to 1 part detergent.)

**NOTE** Do not immerse the rotor body in water, since the hanger mechanism is difficult to dry and can rust.

The Rotor Cleaning Kit contains two plastic-coated brushes and two quarts of Solution 555 (339555) for use with rotors and accessories.

2 Wash the rotor body with a sponge or cloth dampened with a mild detergent, such as Solution 555, diluted with water (10 parts water to 1 part detergent).

3 Rinse the cleaned rotor and components with distilled water.

4 Air-dry the rotor and lid upside down.

*Do not use acetone to dry the rotor.*

5 Clean metal threads frequently to prevent buildup of residues and ensure adequate closure.

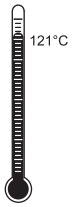
**a.** Use a brush and concentrated Solution 555.

**b.** Rinse and dry thoroughly, then lubricate lightly but evenly with Spinkote to coat all threads.

## Decontamination

If the rotor or other components are contaminated with toxic, radioactive, or pathogenic materials, follow appropriate decontamination procedures as outlined by your laboratory safety officer. Refer to *Chemical Resistances* (IN-175) to select solutions that will not damage the rotor and accessory materials.

## Sterilization and Disinfection




- The rotor and all rotor components, except those made of polyphenylene oxide (PPO), can be autoclaved at 121°C for up to an hour. Remove the plugs from the rotor and place the rotor, plugs, and spacers in the autoclave upside down.
- Ethanol (70%) or hydrogen peroxide (6%) may be used on all rotor components, including those made of plastic. Bleach (sodium hypochlorite) may be used, but may cause discoloration of anodized surfaces. Use the minimum immersion time for each solution, per laboratory standards.

**⚠ CAUTION**

**Risk of personal injury or equipment damage. Ethanol is a flammability hazard. Do not use it in or near operating ultracentrifuges.**

While Beckman Coulter has tested these methods and found that they do not damage the rotor or components, no guarantee of sterility or disinfection is expressed or implied. When sterilization or disinfection is a concern, consult your laboratory safety officer regarding proper methods to use.

Where sterilization is critical in your application, consider using Beckman Coulter Certified Free & Sterilized Tubes. For tubes not available in the sterilized option, refer to *Use and Care of Centrifuge Tubes and Bottles* (publication IN-192) included in each box of tubes or bottles for sterilization and disinfection procedures. *Quick-Seal, Ultra-Clear, and thinwall open-top tubes are disposable and should be discarded after a single use.*

## Storage

When it is not in use, store the rotor in a dry environment (not in the instrument) with the bucket caps removed to allow air circulation so moisture will not collect in the tube cavities.

# Returning a Rotor

Before returning a rotor or accessory for any reason, prior permission must be obtained from Beckman Coulter, Inc. An authorization form may be obtained from your local Beckman Coulter sales office. The form, entitled *Returned Material Authorization* (RMA) for United States returns or *Returned Goods Authorization* (RGA) for international returns, should contain the following information:

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

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

Use the address label printed on the RMA/RGA form when mailing the rotor and/or accessories.

Customers located outside the United States should contact their local Beckman Coulter office.

# Supply List

See the Beckman Coulter *Ultracentrifuge Rotors, Tubes & Accessories* catalog (BR-8101) available at www.beckman.com, or contact your local Beckman Coulter Representative for detailed information on ordering parts and supplies (customers in the U.S.A or Canada can call Beckman Coulter Customer Service at 1-800-742-2345). For your convenience, a partial list is given below.

## Replacement Rotor Parts

| Description | Part Number |
|---|---|
| SW 55 Ti rotor assembly | 342194 |
| Buckets (set of 6, with caps and O-rings) | 342199 |
| Bucket cap | 342190 |
| Bucket O-ring | 824412 |
| Overspeed disk (55,000 RPM) | 328896 |

| Description | Part Number |
|---|---|
| Rotor stand | 332400 |
| Bucket holder rack | 331313 |

## Other

**NOTE** For MSDS information, go to the Beckman Coulter website at www.beckman.com.

| Description | Part Number |
|---|---|
| Tubes and accessories | see Table 1 |
| OptiSeal tube rack | 361650 |
| Quick-Seal Cordless Tube Topper kit, 60 Hz | 358312 |
| Quick-Seal Cordless Tube Topper kit, 50 Hz (Europe) | 358313 |
| Quick-Seal Cordless Tube Topper kit, 50 Hz (Great Britain) | 358314 |
| Quick-Seal Cordless Tube Topper kit, 50 Hz (Australia) | 358315 |
| Quick-Seal Cordless Tube Topper kit, 50 Hz (Canada) | 367803 |
| Tube Topper rack (13-mm dia. tubes) | 348122 |
| Floating spacer removal tool | 338765 |
| Tube removal tool (Quick-Seal tubes) | 361668 |
| Extractor tool (konical tube adapters) | 354468 |
| Spinkote lubricant (2 oz) | 306812 |
| Silicone vacuum grease (1 oz) | 335148 |
| Rotor Cleaning Kit | 339558 |
| Solution 555 (1 qt) | 339555 |
| Rotor cleaning brush | 339379 |
| Centering tool (for overspeed disk replacement) | 331325 |

# Beckman Coulter, Inc.
# Ultracentrifuge Rotor Warranty

All Beckman Coulter ultracentrifuge Fixed Angle, Vertical Tube, Near Vertical Tube, Swinging Bucket, and Airfuge rotors are warranted against defects in materials or workmanship for the time periods indicated below, subject to the Warranty Conditions stated below.

| | |
|---|---|
| Preparative Ultracentrifuge Rotors | 5 years — No Proration |
| Analytical Ultracentrifuge Rotors | 5 years — No Proration |
| ML and TL Series Ultracentrifuge Rotors | 5 years — No Proration |
| Airfuge Ultracentrifuge Rotors | 1 year — No Proration |

For Zonal, Continuous Flow, Component Test, and Rock Core Ultracentrifuge Rotors, see separate warranty.

**Warranty Conditions (as applicable)**

1. This warranty is valid for the time periods indicated above from the date of shipment to the original Buyer by Beckman Coulter or an authorized Beckman Coulter representative.
2. Maintain one copy of this software for backup purposes (the backup copy shall be supplied by Beckman Coulter);
3. This warranty covers the Beckman Coulter Centrifuge Systems only (including but not limited to the centrifuge, rotor, and accessories) and Beckman Coulter shall not be liable for damage to or loss of the user's sample, non-Beckman Coulter tubes, adapters, or other rotor contents.
4. This warranty is void if the Beckman Coulter Centrifuge System is determined by Beckman Coulter to have been operated or maintained in a manner contrary to the instructions in the operator's manual(s) for the Beckman Coulter Centrifuge System components in use. This includes but is not limited to operator misuse, abuse, or negligence regarding indicated maintenance procedures, centrifuge and rotor classification requirements, proper speed reduction for the high density of certain fluids, tubes, and tube caps, speed reduction for precipitating gradient materials, and speed reduction for high-temperature operation.
5. 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.
6. This warranty does not cover the failure of a Beckman Coulter rotor in a centrifuge not of Beckman Coulter manufacture, or if the rotor is used in a Beckman Coulter centrifuge that has been modified without the written permission of Beckman Coulter, or is used with carriers, buckets, belts, or other devices not of Beckman Coulter manufacture.
7. Rotor parts subject to wear, including but not limited to rotor O-rings, VTi, NVT, TLV, MLN, and TLN rotor tube cavity plugs and gaskets, tubing, tools, optical overspeed disks, bearings, seals, and lubrication are excluded from this warranty and should be frequently inspected and replaced if they become worn or damaged.
8. Keeping a rotor log is not mandatory, but may be desirable for maintenance of good laboratory practices.

**Repair and Replacement Policies**

1. If a Beckman Coulter rotor is determined by Beckman Coulter to be defective, Beckman Coulter will repair or replace it, subject to the Warranty Conditions. A replacement rotor will be warranted for the time remaining on the original rotor's warranty.
2. If a Beckman Coulter centrifuge is damaged due to a failure of a rotor covered by this warranty, Beckman Coulter will supply free of charge (i) all centrifuge parts required for repair (except the drive unit, which will be replaced at the then current price less a credit determined by the total number of revolutions or years completed, provided that such a unit was manufactured or rebuilt by

Beckman Coulter), and (ii) if the centrifuge is currently covered by a Beckman Coulter warranty or Full Service Agreement, all labor necessary for repair of the centrifuge.

3. If a Beckman Coulter rotor covered by this warranty is damaged due to a malfunction of a Beckman Coulter ultracentrifuge covered by an Ultracentrifuge System Service Agreement, Beckman Coulter will repair or replace the rotor free of charge.
4. If a Beckman Coulter rotor covered by this warranty is damaged due to a failure of a Beckman Coulter tube, bottle, tube cap, spacer, or adapter, covered under the Conditions of this Warranty, Beckman Coulter will repair or replace the rotor and repair the instrument as per the conditions in policy point (2) above, and the replacement policy.
5. Damage to a Beckman Coulter rotor or instrument due to the failure or malfunction of a non-Beckman Coulter tube, bottle, tube cap, spacer, or adapter is not covered under this warranty, although Beckman Coulter will assist in seeking compensation under the manufacturer's warranty.

**Beckman Coulter will assist in seeking compensation under the manufacturer's warranty.**

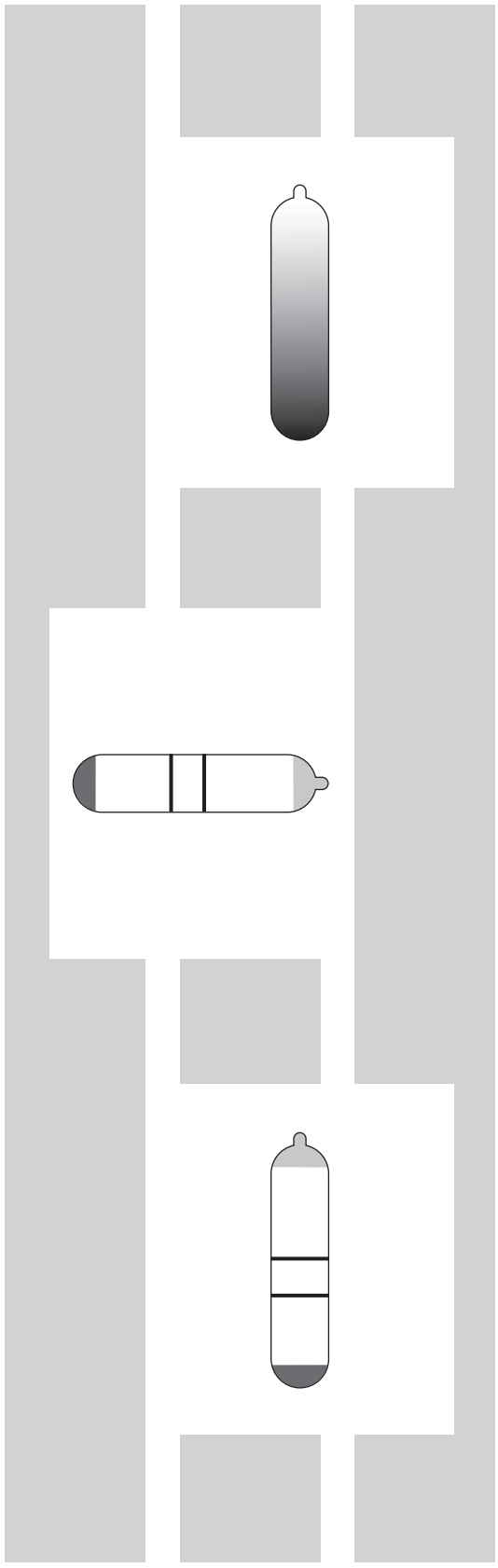
### Disclaimer

IT IS EXPRESSLY AGREED THAT THE ABOVE WARRANTY SHALL BE IN LIEU OF ALL WARRANTIES OF FITNESS AND OF THE WARRANTY OF MERCHANTABILITY AND BECKMAN COULTER, INC. 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.

### Factory Rotor Inspection Service

Beckman Coulter, Inc., will provide free mechanical and metallurgical inspection in Indianapolis, Indiana, USA, of any Beckman Coulter rotor at the request of the user. (Shipping charges to Beckman Coulter are the responsibility of the user.) Rotors will be inspected in the user's laboratory if the centrifuge in which they are used is covered by an appropriate Beckman Coulter Service Agreement. Contact your local Beckman Coulter office for details of service coverage or cost.

Before shipping, contact the nearest Beckman Coulter Sales and Service office and request a Returned Goods Authorization (RGA) form and packaging instructions. Please include the complete rotor assembly, with buckets, lid, handle, tube cavity caps, etc. A SIGNED STATEMENT THAT THE ROTOR AND ACCESSORIES ARE NON-RADIOACTIVE, NON-PATHOGENIC, NON-TOXIC, AND OTHERWISE SAFE TO SHIP AND HANDLE IS REQUIRED.



# Related Documents

### Rotors and Tubes for Preparative Ultracentrifuges (LR-IM-24)

- Rotors
- Tubes, Bottles, and Accessories
- Using Tubes, Bottles, and Accessories
- Using Fixed-Angle Rotors
- Using Swinging-Bucket Rotors
- Using Vertical-Tube and Near-Vertical Tube Rotors
- Care and Maintenance
- Chemical Resistances for Beckman Coulter Centrifugation Products
- Use of the w2t Integrator
- The Use of Cesium Chloride Curves
- Gradient Materials
- References
- Glossary

Available in electronic pdf by request.

### Rotors and Tubes CD-ROM (369668)

- Rotors and Tubes for Tabletop Preparative Ultracentrifuges
- Rotors and Tubes for J2, J6, Avanti J Series Centrifuges
- Rotors and Tubes for Preparative Ultracentrifuges
- Rotor Safety Bulletin
- Chemical Resistances for Beckman Coulter Centrifugation Products

Included with shipment of instrument.

### Additional References

- Chemical Resistances for Beckman Coulter Centrifugation Products (IN-175)
- Beckman Coulter Ultracentrifuge Rotors, Tubes & Accessories catalog (BR-8101)
- Using OptiSeal Tubes (IN-189)
- Use and Care of Centrifuge Tubes and Bottles (IN-192)

Available in hard copy or electronic pdf by request.

### Data Sheets

- *g*-Max System: Short Pathlengths in High Force Fields (DS-709B)

Available at www.beckman.com

**www.beckman.com**

BECKMAN COULTER

# Instructions For Use

## Type 70 Ti Fixed-Angle Rotor

For Use in Beckman Coulter Class H, R, and S
Preparative Ultracentrifuges

PN L5-TB-030BD
August 2022

Beckman Coulter, Inc.
250 S. Kraemer Blvd.
Brea, CA 92821 U.S.A.

BECKMAN COULTER

**Type 70 Ti Fixed-Angle Rotor**
PN L5-TB-030BD (August 2022)



**Contact Us**
If you have any questions, contact our Customer Support Center.

- Worldwide, find us via our website at *www.beckman.com/support/technical*
- In the USA and Canada, call us at 1-800-369-0333.
- In Austria, call us at 0810 300484
- In Germany, call us at 02151 333999
- In Sweden, call us at +46 (0)8 564 859 14
- In Netherlands, call us at +31 348 799 815
- In France, call us at 0825838306 6
- In the UK, call us at +44 845 600 1345
- In Ireland, call us at +353 (01) 4073082
- In Italy, call us at +39  0295392 456
- In other locales, contact your local Beckman Coulter Representative.

Find us on the World Wide Web at: **www.beckman.com**

EC REP

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Tel: +41 (0) 22 365 36 11

Glossary of Symbols is available at beckman.com/techdocs (PN C24689).

Original Instructions

# Revision History

*This document applies to the latest and higher versions. When a subsequent version affects the information in this document, a new issue will be released to the Beckman Coulter website. For labeling updates, go to www.beckman.com/techdocs and download the latest version of the manual or system help for your instrument.*

**Issue BA, 02/2014**
Changes were made to:

- Available Tubes and Bottles for the Type 70 Ti Rotor
- Thinwall Tubes
- Thickwall Tubes

**Issue BB, 09/2016**
Changes were made to:

- Temperature Limits

**Issue BC, 10/2018**
Changes were made to:

- Table 1, Available Tubes and Bottles for the Type 70 Ti Rotor
- Certified Free Tubes
- Sterile Tubes
- Sterilization and Disinfection

**Issue BD, 08/2022**
Changes were made to:

- Table 1, Available Tubes and Bottles for the Type 70 Ti Rotor

***Note:*** *Changes that are part of the most recent revision are indicated in text by a bar in the margin of the amended page.*

# Safety Notice

Read all product manuals and consult with Beckman Coulter-trained personnel before attempting to use this equipment. Do not attempt to perform any procedure before carefully reading all instructions. Always follow product labeling and manufacturer's recommendations. If in doubt as to how to proceed in any situation, contact your Beckman Coulter Representative.

## Alerts for Warning, Caution, Important, and Note

**⚠ WARNING**

**WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.**

**⚠ CAUTION**

**CAUTION indicates a potentially hazardous situation, which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.**

**IMPORTANT** IMPORTANT is used for comments that add value to the step or procedure being performed. Following the advice in the Important adds benefit to the performance of a piece of equipment or to a process.

**NOTE** NOTE is used to call attention to notable information that should be followed during installation, use, or servicing of this equipment.

# Safety Information for the Type 70 Ti Rotor

This rotor was developed, manufactured, and tested for safety and reliability as part of a Beckman Coulter ultracentrifuge/rotor system. Its safety or reliability cannot be assured if used in a centrifuge not of Beckman Coulter's manufacture or in a Beckman Coulter ultracentrifuge that has been modified without Beckman Coulter's approval.

Handle body fluids with care because they can transmit disease. No known test offers complete assurance that such fluids are free of micro-organisms. Some of the most virulent—Hepatitis (B and C) viruses, HIV (I–V), atypical mycobacteria, and certain systemic fungi—further emphasize the need for aerosol protection. Handle other infectious samples according to good laboratory procedures and methods to prevent spread of disease. Because spills may generate aerosols, observe proper safety precautions for aerosol containment. Do not run toxic, pathogenic, or radioactive materials in this rotor without taking appropriate safety precautions. Biosafe containment should be used when Risk Group II materials (as identified in the World Health Organization *Laboratory Biosafety Manual*) are handled; materials of a higher group require more than one level of protection.

The rotor and accessories are not designed for use with materials capable of developing flammable or explosive vapors. Do not centrifuge such materials in nor handle or store them near the ultracentrifuge.

Although rotor components and accessories made by other manufacturers may fit in the Type 70 Ti rotor, their safety in this rotor cannot be ascertained by Beckman Coulter. Use of other manufacturers' components or accessories in the Type 70 Ti rotor may void the rotor warranty and should be prohibited by your laboratory safety officer. Only the components and accessories listed in this publication should be used in this rotor.

Make sure that filled containers are loaded symmetrically into the rotor and that opposing tubes are filled to the same level with liquid of the same density. Make sure that cavities in use have the proper spacers inserted (if applicable) before installing the rotor lid.

If disassembly reveals evidence of leakage, you should assume that some fluid escaped the rotor. Apply appropriate decontamination procedures to the centrifuge and accessories.

Never exceed the maximum rated speed of the rotor and labware in use. Refer to the section on *Run Speeds*, and derate the run speed as appropriate.

Do not use sharp tools on the rotor that could cause scratches in the rotor surface. Corrosion begins in scratches and may open fissures in the rotor with continued use.

# Contents

# Illustrations

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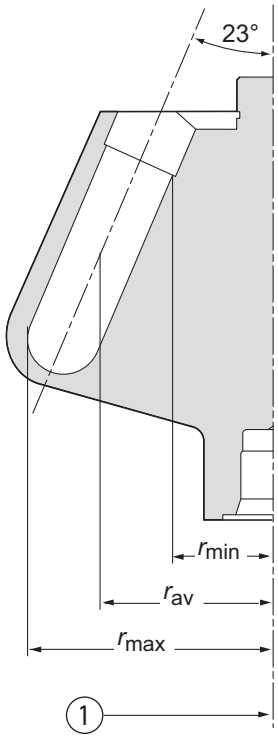
## Tables

# Type 70 Ti Fixed-Angle Rotor

## Specifications

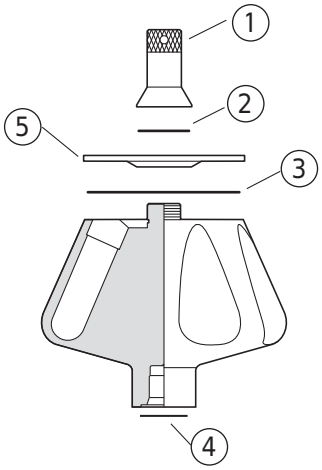



**1.** 1. Axis of Rotation

| | |
|---|---|
| Maximum speed | 70,000 RPM |
| Density rating at maximum speed | 1.2 g/mL |
| Relative Centrifugal Field[a] at maximum speed | |
| At $r_{max}$ (91.9 mm) | 504,000 × *g* |
| At $r_{av}$ (65.7 mm) | 361,000 × *g* |
| At $r_{min}$ (39.5 mm) | 217,000 × *g* |
| *k* factor at maximum speed | 44 |
| Conditions requiring speed reductions | see *Run Speeds* |
| Number of tube cavities | 8 |
| Available tubes | see Table 1 |
| Nominal tube dimensions (largest tube) | 25 × 89 mm |
| Nominal tube capacity (largest tube) | 39 mL |
| Nominal rotor capacity | 312 mL |
| Approximate acceleration time to maximum speed (fully loaded) | 8½ min |
| Approximate deceleration time from maximum speed (fully loaded | 7 min |
| Weight of fully loaded rotor | 9 kg (20 lb) |
| Rotor material | titanium |

a. 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 = $r\omega^2/g$ — where *r* is the radius in millimeters, $\omega$ is the angular velocity in radians per second (2 π RPM /60), and *g* is the standard acceleration of gravity (9807 mm/s$^2$). After substitution: RCF = 1.12r (RPM/1000)$^2$

# Description




1. Handle (337924)
2. Handle O-Ring (011757)
3. Lid O-Ring (870612)
4. Overspeed Disk (335585)
5. Lid (337923)

*Beckman Coulter Type 70 Ti rotors are manufactured in a facility that maintains certifications to both ISO 9001:2008 and ISO 13485:2003. They are for use with the specified Beckman Coulter ultracentrifuges. The rotors were developed, manufactured, and tested for safety and reliability as part of a Beckman Coulter ultracentrifuge/rotor system. Their safety or reliability cannot be assured if used in an ultracentrifuge not of Beckman Coulter's manufacture or in a Beckman Coulter ultracentrifuge that has been modified without Beckman Coulter's approval.*

The Type 70 Ti is a fixed-angle rotor designed to centrifuge up to eight tubes at a 23-degree angle to the axis of rotation. Used in Beckman Coulter class H, R, and S preparative ultracentrifuges, the rotor develops centrifugal forces sufficient for applications including pelleting of small particles, and purification of viruses and subcellular organelles using sucrose gradients. Up to 312 mL of sample and gradient can be centrifuged per run.

The rotor is made of titanium and is finished with black polyurethane paint. The aluminum lid and handle are anodized for corrosion resistance. The handle is interchangeable with the Type 70.1 Ti rotor handle but no others. O-rings made of Buna N rubber in the lid and handle maintain atmospheric pressure inside the rotor during centrifugation, if they are properly lubricated. The lid is a patented design that seats on the rotor body so that centrifugal force aids sealing. Four small holes in the lid provide a temporary vent, preventing pressure build-up and extrusion of the large lid O-ring in the event of leakage. Because of the weight of the rotor, drive pins are not required in the rotor drive hub cavity.

For overspeed protection, a photoelectrical detector in the ultracentrifuge monitors the overspeed disk on the rotor bottom and shuts down the run if speeds exceeding 70,000 RPM are detected.

See the Warranty at the back of this manual for warranty information.

# Preparation and Use

*Specific information about the Type 70 Ti rotor is given here. Information common to this and other rotors is contained in Rotors and Tubes for Preparative Ultracentrifuges* (publication LR-IM), *which should be used together with this manual for complete rotor and accessory operation.*

**NOTE** Although rotor components and accessories made by other manufacturers may fit in the Type 70 Ti rotor, their safety in this rotor cannot be ascertained by Beckman Coulter. Use of other manufacturers' components or accessories in the Type 70 Ti rotor may void the rotor warranty and should be prohibited by your laboratory safety officer. Only the components and accessories listed in this publication should be used in this rotor.

## Prerun Safety Checks

*Read the Safety Notice section at the front of this manual before using the rotor.*

1 Make sure that the rotor and lid are clean and show no signs of corrosion or cracking.

2 Make sure the 26-sector (70,000 RPM) overspeed disk is properly attached to the rotor bottom.

If the disk is missing or damaged, replace it according to the instructions in *Rotors and Tubes for Preparative Ultracentrifuges* (publication LR-IM).


3 Verify that only the tubes and bottles listed in Table 1 are being used.

4 Check the chemical compatibilities of all materials used (refer to *Chemical Resistances,* publication IN-175).

## Rotor Preparation

*For runs at other than room temperature refrigerate or warm the rotor beforehand for fast equilibration.*

1 Be sure that metal threads in the rotor are clean and lightly but evenly lubricated with Spinkote lubricant (306812).

Also ensure that O-rings are lightly but evenly coated with silicone vacuum grease.

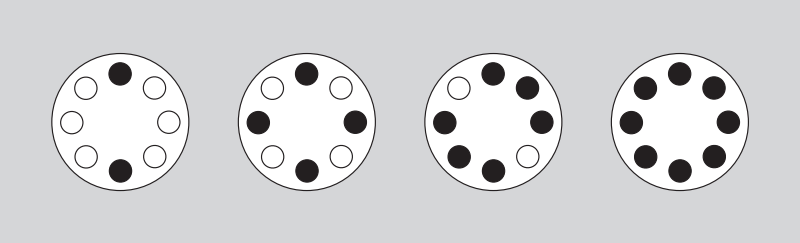
**2** Load the filled containers symmetrically into the rotor.

(Refer to *Tubes, Bottles, and Accessories* on page 12 for information about containers).

If fewer than eight tubes are being run, they must be arranged symmetrically in the rotor (see Figure 1).

Opposing tubes must be filled to the same level with liquid of the same density.

**Figure 1** Arranging Tubes in the Rotor



**NOTE** Two, four, six, or eight tubes can be centrifuged per run if they are arranged in the rotor as shown.

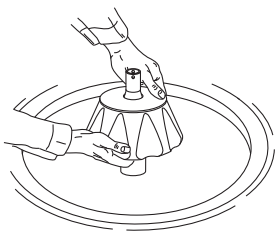
**3** Complete loading by placing the correct spacers (if required) over the tubes.

**NOTE** Place filled tubes in at least two opposing cavities. Make sure that cavities in use also have the proper spacers inserted (if applicable) before installing the rotor lid. See page 12 for special installation instructions for thinwall tubes (344367) with crimp-lock caps.

**4** Put the lid in place and tighten as firmly as possible.

## Operation

**1** Carefully lower the rotor straight down onto the drive hub.



**2** Refer to the applicable instrument instruction manual for ultracentrifuge operation.

3 For additional operating information, see the following:

- *Run Times*, page 16, for using *k* factors to adjust run durations.
- *Run Speeds*, page 17, for information about speed limitations.
- *Selecting CsCl Gradients*, page 18, for methods to avoid CsCl precipitation during centrifugation.

## Removal and Sample Recovery

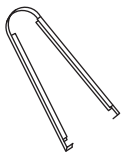
**⚠ CAUTION**

**If disassembly reveals evidence of leakage, you should assume that some fluid escaped the rotor. Apply appropriate decontamination procedures to the ultracentrifuge and accessories.**

1 Remove the rotor from the centrifuge by lifting it straight up and off the drive hub.

2 Remove the rotor lid.

3 Use the appropriate removal tool (listed in the *Supply List*) to remove the spacers and tubes.



Quick-Seal Tube Removal Tool (361668)

## Tubes, Bottles, and Accessories

The Type 70 Ti rotor uses the tubes, bottles, and accessories listed in Table 1. Be sure to use only those items listed, and to observe the maximum speed limits and fill volumes shown. (Maximum fill volume is the maximum amount that can be centrifuged in the container listed.) Refer to *Chemical Resistances* for information on the chemical compatabilities of tube, bottle, and accessory materials.

**Table 1** Available Tubes and Bottles for the Type 70 Ti Rotor[a]

| Tube | | | | Required Accessory | | Max Speed/ RCF/*k* factor |
|---|---|---|---|---|---|---|
| **Dimensions** | **Description** | **Part Number** | **Max Fill Volume** | **Description** | **Part Number** | |
| 25 × 89 mm | Certified Free & Sterile Ultra-Clear Quick-Seal | C14299 Carton of 48 (6 packs of 8) | 39 mL | red aluminum spacer | 342699 | 70,000 RPM 504,000 × *g* 44 |
| | Certified Free Ultra-Clear Quick-Seal | C14283 (pkg/50) | | | | |
| | Standard Ultra-Clear Quick-Seal | 344326 (pkg/50) | | | | |
| 25 × 89 mm | Certified Free & Sterile Polypropylene Quick-Seal | C14304 Carton of 48 (8 packs of 6) | 39 mL | red aluminum spacer | 342699 | 70,000 RPM 504,000 × *g* 44 |
| | Certified Free Polypropylene Quick-Seal | C14288 (pkg/50) | | | | |
| | Standard Polypropylene Quick-Seal | 342414 (pkg/50) | | | | |
| 25 × 89 mm | Certified Free & Sterile Ultra-Clear Open-Top | C14292 Carton of 48 (8 packs of 6) | 38.5 mL[b] | red aluminum cap | 331151 | 60,000 RPM 371,000 × *g* 59 |
| | Certified Free Ultra-Clear Open-Top | C13926 (pkg/50) | | | | |
| | Standard Ultra-Clear Open Top | 344058 (pkg/50) | | | | |
| 25 × 89 mm | Certified Free & Sterile Polypropylene Open-Top | C14301 Carton of 48 (8 packs of 6) | 38.5 mL[b] | red aluminum cap | 331151 | 60,000 RPM 371,000 × *g* 59 |
| | Certified free Polypropylene Open-Top | C14285 (pkg/50) | | | | |
| | Standard Polypropylene Open Top | 326823 (pkg/50) | | | | |

**Table 1** Available Tubes and Bottles for the Type 70 Ti Rotor[a] *(Continued)*

| Tube | | | | Required Accessory | | |
|---|---|---|---|---|---|---|
| **Dimensions** | **Description** | **Part Number** | **Max Fill Volume** | **Description** | **Part Number** | **Max Speed/ RCF/*k* factor** |
| 25 × 89 mm | Stainless steel | 301112 | 38.5 mL | aluminum cap | 302133 | 40,000 RPM[c]<br>165,000 × *g*<br>135 |
| 25 × 83 mm | Thinwall polypropylene | 344367 (pkg/50) | 38.5 mL | titanium/aluminum cap | 337927[d] | 70,000 RPM<br>504,000 × *g*<br>43 |
| 25 × 83 mm | Quick-Seal polypropylene bell-top | 344623 (pkg/50) | 33 mL | plastic spacer | 344635 | 70,000 RPM<br>504,000 × *g*<br>38 |
| 26 × 77 mm | OptiSeal bell-top[e] | 361625 (pkg/56) | 29.9 mL | amber polyetherimide (PEI) spacer | 361669 (pkg/2) | 70,000 RPM<br>504,000 × *g*<br>44 |
| 25 × 89 mm | Thickwall polypropylene | 355642 (pkg/25) | 30 mL | blue aluminum cap | 338906 | 60,000 RPM<br>371,000 × *g*<br>59 |
| | | | 16.5 mL | none | — | 20,000 RPM<br>41,200 × *g*<br>535 |
| 25 × 89 mm | Thickwall polycarbonate | 355631 (pkg/25) | 30 mL | blue aluminum cap | 338906 | 60,000 RPM<br>371,000 × *g*<br>60 |
| | | | 16.5 mL | none | — | 45,000 RPM[f]<br>208,000 × *g*<br>106 |
| 25 × 64 mm | Quick-Seal Ultra-Clear bell-top | 344323 (pkg/50) | 27 mL | polyphenylene oxide (PPO) floating spacer | 343448 | 70,000 RPM<br>504,000 × *g*<br>31 |
| 25 × 64 mm | Quick-Seal polypropylene bell-top | 343665 (pkg/50) | 27 mL | polyphenylene oxide (PPO) floating spacer | 343448 | 70,000 RPM<br>504,000 × *g*<br>31 |
| 25 × 89 mm | Polycarbonate bottle and cap assembly | 355618 (assembly)<br>355654 (bottle only) | 26.3 mL[g] | aluminum cap | 355619 | 60,000 RPM[h]<br>371,000 × *g*<br>59 |
| 25 × 38 mm | Quick-Seal Ultra-Clear bell-top | 344324 (pkg/50) | 15 mL | polyphenylene oxide (PPO)floating spacer | 343448 | 70,000 RPM<br>504,000 × *g*<br>24 |

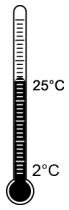
**Table 1** Available Tubes and Bottles for the Type 70 Ti Rotor[a] *(Continued)*

| Tube | | | | Required Accessory | | |
|---|---|---|---|---|---|---|
| **Dimensions** | **Description** | **Part Number** | **Max Fill Volume** | **Description** | **Part Number** | **Max Speed/ RCF/*k* factor** |
| 25 × 38 mm | Quick-Seal polypropylene bell-top | 343664 (pkg/50) | 15 mL | polyphenylene oxide (PPO) floating spacer | 343448 | 70,000 RPM 504,000 × *g* 24 |
| 16 × 76 mm | Ultra-clear | 344085 (pkg/50) | 13.5 mL | acetal (POM) adapter | 303307 | 40,000 RPM 151,000 × *g* 104 |
| | | | | aluminum cap | 330860 | |
| 16 × 76 mm | Thinwall polypropylene | 326814 (pkg/50) | 13.5 mL | acetal (POM) adapter | 303307 | 40,000 RPM 151,000 × *g* 104 |
| | | | | aluminum cap | 330860 | |
| 16 × 76 mm | Thickwall polypropylene | 355640 (pkg/25) | 10 mL | acetal (POM) adapter | 303307 | 40,000 RPM 151,000 × *g* 104 |
| | | | | aluminum cap[i] | 338907 | |
| 16 × 76 mm | Thickwall polycarbonate | 355630 (pkg/25) | 10 mL | acetal (POM) adapter | 303307 | 40,000 RPM 151,000 × *g* 104 |
| | | | | aluminum capi | 338907 | |
| 13 × 64 mm | Certified Free & Sterile Ultra-Clear Open-Top | C14296 Carton of 48 (8 packs of 6) | 6.5 mL | acetal (POM) adapter | 303392 | 45,000 RPM 102,000 × *g* 69 |
| | Certified Free Ultra-Clear Open-Top | C14280 (pkg/50) | | cap assembly | C20178[j] | |
| | Standard Ultra-Clear Open Top | 344088 (pkg/50) | | | | |
| 13 × 64 mm | Thinwall polypropylene | 326820 (pkg/50) | 6.5 mL | acetal (POM) adapter | 303392 | 45,000 RPM 102,000 × *g* 69 |
| | | | | cap assembly | C20178[j] | |
| 13 × 64 mm | Thickwall polypropylene | 355644 (pkg/25) | 4 mL | adapter | 303392 | 45,000 RPM 102,000 × *g* 69 |

**Table 1** Available Tubes and Bottles for the Type 70 Ti Rotor[a] *(Continued)*

| Tube | | | | Required Accessory | | Max Speed/ RCF/*k* factor |
|---|---|---|---|---|---|---|
| Dimensions | Description | Part Number | Max Fill Volume | Description | Part Number | |
| 13 × 64 mm | Thickwall polycarbonate | 355645 (pkg/25) | 4 mL | adapter | 303392 | 45,000 RPM 102,000 × *g* 69 |
| 13 × 64 mm | Stainless steel | 301099 | 6.5 mL | adapter | 303392 | 30,000 RPM[c] 78,900 × *g* 155 |
| | | | | cap | 303113 | |

a. Use only the items listed here.
b. Nominal volume—in operation, fill as completely as possible.
c. For solution densities of 2.0 g/mL and below; above 2.0, further speed reductions are required. Refer to publication L5-TB-072 when centrifuging stainless steel tubes
d. Specially designed cap; do not use any other cap with this tube.
e. Includes disposable plastic plugs.
f. 50,000 RPM for 4 hours or less.
g. Minimum fill level is 16.0 mL.
h. 50,000 RPM if filled below maximum volume.
i. Tube cap is optional.
j. Cap assembly includes neoprene gasket (344672) and stem (346246).




## Temperature Limits

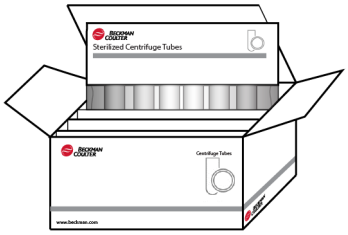
- Plastic tubes and bottles have been centrifuge tested for use at temperatures between 2 and 25°C. For centrifugation at other temperatures, pretest tubes under anticipated run conditions.
- If plastic containers are frozen before use, make sure that they are thawed to at least 2°C prior to centrifugation.

## Certified Free Tubes


Based on Sample Results Below Detectable Limit

Certified free tubes are lot traceable to testing that confimrms the absence of endotoxin, DNase, RNase, and human & mouse DNA below a detectable limit.

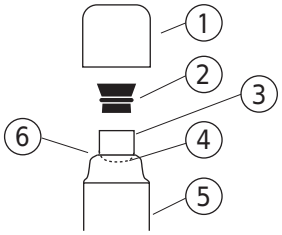
## Sterile Tubes




Sterile Tubes are sterilized via ethylene oxide in compliance with ISO 11135:2014. Cartons include several peel packages, each containing a typical run quantity of tubes per the tube details table in Table 1. Packaging meets requirements of IS 11607:2006.

## OptiSeal Tubes

OptiSeal tubes come with plastic plugs and can be quickly and easily prepared for use. With the tube spacer in place, the *g* force during centrifugation ensures a tight, reliable seal that protects your samples.



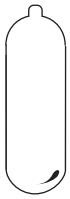

1. Spacer
2. Plug
3. Stem
4. Meniscus
5. Tube
6. Base of Stem

**1** Place the tubes in the rack and fill each tube to the base of the stem, leaving no fluid in the stem.

**NOTE** Overfilling the tube can cause spillage when the plug is inserted or can compromise seal integrity. However, too much air can cause excessive tube deformation, disrupting gradients and sample bands.

**2** Refer to *Using OptiSeal Tubes* (publication IN-189), included in each box of tubes, for detailed information on the use and care of OptiSeal tubes.

## Quick-Seal Tubes



Quick-Seal tubes must be sealed prior to centrifugation. These tubes are heat sealed and do not need caps; however, spacers are required on top of the tubes when they are loaded into the rotor.

**1** Fill Quick-Seal tubes leaving a *small* bubble of air at the base of the neck.

Do not leave a large air space—too much air can cause excessive tube deformation.

**2** Refer to *Rotors and Tubes for Preparative Ultracentrifuges* (publication LR-IM) for detailed information on the use and care of Quick-Seal tubes.

Quick-Seal tubes are disposable and should be discarded after a single use.

### Thinwall Tubes

Thinwall polypropylene and Ultra-Clear tubes require caps for tube support. Fill the tubes as full as possible to prevent tube collapse during centrifugation. If necessary, float mineral oil (or some other low-density, immiscible liquid) on top of the tube contents to fill the tube to its maximum volume. (Do not use an oil overlay in Ultra-Clear tubes.)

### Thickwall Tubes

Thickwall polypropylene and polycarbonate tubes can be run partially filled (at least half filled) with or without caps, but all opposing tubes for a run must be filled to the same level with liquid of the same density. Do not overfill capless tubes; be sure to note the reductions in fill volume and run speed shown in Table 1.

**NOTE** Special instructions for using thinwall tubes (344367) are provided on page 12.

### Tube Caps

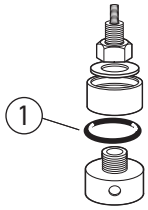
Thinwall tubes require caps for tube support during centrifugation; thickwall tubes and bottles can be run with or without caps (speed reduction may be required). Use only the caps listed in Table 1. Refer to *Rotors and Tubes for Preparative Ultracentrifuges* (publication LR-IM) for the use, assembly, and maintenance of caps.

**1** Inspect tube caps before use as described in *Rotors and Tubes for Preparative Ultracentrifuges* (publication LR-IM).

Replace any damaged components.

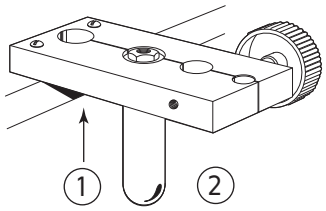
**2** Inspect the O-rings or gaskets in the caps for cracks, nicks, or flattened areas.

Be sure that they are dry and free of lubricant during assembly.




**1.** O-ring or Gasket

**3** Tighten aluminum caps with a hex driver while the tube is held in the tube-cap vise (305075).




1. Insert tube from bottom
2. Tube Cap Vise (305075)

**4** Tighten bottle caps by hand.

### Thinwall Tubes with Red-anodized Caps

These tubes must be capped. Refer to Instructions for Using Aluminum Tube Caps (publication L5-TB-060) for the use, assembly, and maintenance of these caps. Tighten the caps with a torque wrench to 13.6 N•m (120 in.-lb) for the first four runs and to 11 N•m (100 in.-lb) for subsequent runs.

### Polycarbonate Bottles

The capped polycarbonate bottles may be centrifuged completely filled, or partially filled (not less than half full). Again, all opposing containers for a run must be filled to the same level. Be sure to note the reductions in run speed shown in Table 1 if bottles are partially filled.

## Thinwall Tubes with Crimp-Lock Caps

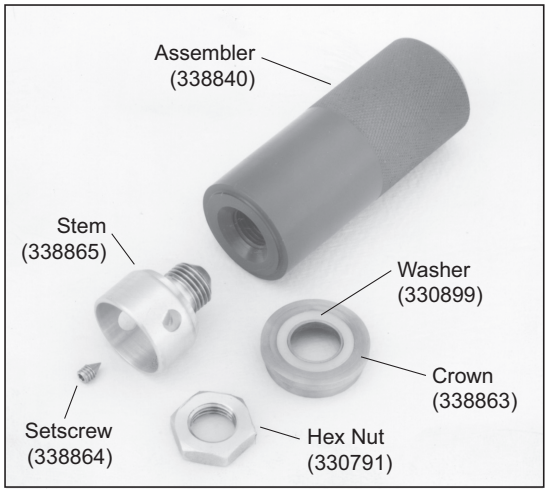
Thinwall tubes, part number 344367, must be used with the crimp-lock cap assembly. The special titanium-aluminum cap provides the added support needed for the tube to withstand centrifugation at 70,000 RPM. The 83-mm tube has a **BECKMAN** logo at its top for identification—DO NOT use any other caps wit this tube. These tubes should be used only once, and MUST NOT be autoclaved before use. Assemble and use this tube and cap assembly as follows.

### Assembly

Refer to Figure 2 as you perform the steps below.

**NOTE** The tube can be destroyed during assembly if any steps are performed carelessly.

**Figure 2** Crimp-Lock Titanium-aluminum Cap Parts and Assembling Tool




**1** Screw the aluminum stem into the gray vinyl assembler.

**2** Push the tube onto the stem until it fits flush against the assembler.

**3** Insert the tube in the tube vise hole; seat firmly, with the tube below and the assembler on top.

**4** Turn the vise knob to clamp the tube securely.

**5** Unscrew the assembler and remove it.

**6** Put the titanium crown on top of the stem, with the rim uppermost.

Make sure the crown is level and the white acetal (POM) washer is centered on the crown.

**7** Add the aluminum hex nut; screw it down finger tight.

**8** Tighten the hex nut with a torque wrench to 11 N•m (100 in.-lb) to collapse the tube rim.

**⚠ CAUTION**

**Do not over-torque, or the assembly will not fit in the rotor.**

**9** Make sure that the mating surfaces of the tube and crown are smooth and even, with the entire rim of the tube folded inside the crown.

Make sure no part of the rim has been left out.

## Filling and Sealing

1 Use a syringe to completely fill the tube through the hole in the cap.

2 With tube removal tool (301875), tighten the pointed setscrew firmly on the nylon insert in the filling hole, sealing the tube.

**NOTE** Use only pointed setscrews (338864) in these cap assemblies.

## Installation

1 Place the capped tube in the rotor cavity.

2 When the crown is resting on the counterbore, push it down firmly with your thumb.

3 Measure the distance from the top of the cap to the outer top surface (O-ring surface) of the rotor.

This should be at least 8 mm (0.33 in.), as shown in Figure 3.

**Figure 3** Measuring Distance from Cap to Rotor Tray

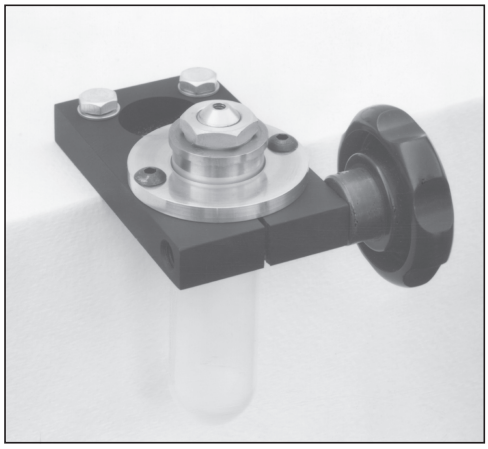
## Removing Crimp-Lock Caps from Thinwall Tubes

**1** To avoid spills during this process, first remove 3 or 4 mL of the supernatant through the setscrew hole, when possible.

**2** Insert the tube into the tube vise.

Position it so the bottom of the crown is nearly flush with the top of the vise (see Figure 4).

**Figure 4** Bottom of Crown is Nearly Flush with Vise Top



**3** Use the torque wrench to remove the nut and crown.

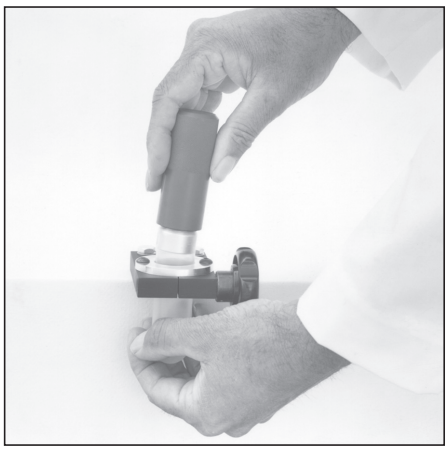
**4** Screw the gray assembler back on the stem.

**5** Loosen the vise slightly so the stem can be removed.

Support the tube from below, or carefully adjust the pressure so the tube is still held firmly in the vise.

**6** Using a rotary motion, pull the stem out of the tube as shown in Figure 5.

**Figure 5** Pulling the Stem from the Tube



## Run Times

The *k* factor of the rotor is a measure of the rotor's pelleting efficiency. (Beckman Coulter has calculated the *k* factors for all of its preparative rotors at maximum rated speed and using full tubes.) The *k* factor is calculated from the formula

$$k = \frac{\ln(r_{max}/r_{min})}{\omega^2} \times \frac{10^{13}}{3600} \quad \text{EQ 1}$$

where ω is the angular velocity of the rotor in radians per second (ω = 0.105 × RPM), $r_{max}$ is the maximum radius, and $r_{min}$ is the minimum radius.

After substitution:

$$k = \frac{(2.533 \times 10^{11})\ln(r_{max}/r_{min})}{RPM^2} \quad \text{EQ 2}$$

Use the *k* factor in the following equation to estimate the run time *t* (in hours) required to pellet particles of known sedimentation coefficient *s* (in Svedberg units, *S*).

$$t = \frac{k}{s} \quad \text{EQ 3}$$

Run times can be estimated for centrifugation at less than maximum speed by adjusting the *k* factor as follows:

$$k_{adj} = k\left(\frac{70,000}{\text{actual run speed}}\right)^2 \quad \text{EQ 4}$$

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

$$\frac{t_a}{t_b} = \frac{k_a}{k_b} \qquad \textbf{EQ 5}$$

## Run Speeds

The centrifugal force at a given radius in a rotor is a function of speed. Comparisons of forces between different rotors are made by comparing the rotors' relative centrifugal fields (RCF). When rotational speed is adjusted so that identical samples are subjected to the same RCF in two different rotors, the samples are subjected to the same force. The RCF at a number of rotor speeds is provided in Table 2.

Do not select rotational speeds that exceed the limits in Table 1. In addition, speeds must be reduced under the following circumstances:

1. If nonprecipitating solutions more dense than 1.2 g/mL are centrifuged, the maximum allowable run speed must be reduced according to the following equation:

$$\text{reduced maximum speed} = 70{,}000\ \text{RPM}) \sqrt{\frac{1.2\ \text{g/mL}}{\rho}} \qquad \textbf{EQ 6}$$

   where ρ is the density of the tube contents. This speed reduction will protect the rotor from excessive stresses due to the added tube load. *Note, however, that the use of this formula may still produce maximum speed figures that are higher than the limitations imposed by the use of certain tubes or adapters* (see Table 1). In such cases, use the lower of the two speeds.

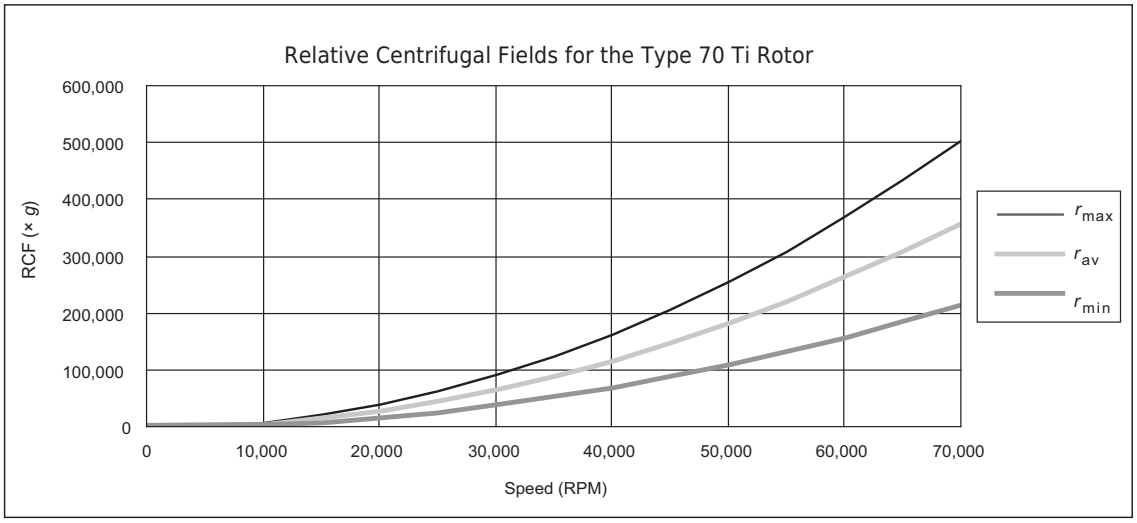
2. *Further speed limits must be imposed* when CsCl or other self-forming-gradient salts are centrifuged, as equation (6) does not predict concentration limits/speeds that are required to avoid precipitation of salt crystals. Solid CsCl has a density of 4 g/mL, and if precipitated during centrifugation may cause catastrophic rotor failure and instrument damage. Figure 6 and Figure 7, together with the description and examples below, show how to reduce run speeds when using CsCl gradients.

**Table 2** Relative Centrifugal Fields for the Type 70 Ti Rotor[a]

| Rotor Speed (RPM) | Relative Centrifugal Field (×*g*) | | | *k* Factor[b] |
|---|---|---|---|---|
| | At $r_{max}$ (91.9 mm) | At $r_{av}$ (65.7 mm) | At $r_{min}$ (39.5 mm) | |
| 70,000 | 505,000 | 361,000 | 217,000 | 44 |
| 65,000 | 435,000 | 311,000 | 187,000 | 51 |
| 60,000 | 371,000 | 265,000 | 159,000 | 60 |
| 55,000 | 311,000 | 223,000 | 134,000 | 71 |
| 50,000 | 257,000 | 184,000 | 111,000 | 86 |
| 45,000 | 208,000 | 149,000 | 89,600 | 106 |
| 40,000 | 165,000 | 118,000 | 70,800 | 134 |
| 35,000 | 126,000 | 90,100 | 54,200 | 175 |
| 30,000 | 92,600 | 66,200 | 39,800 | 238 |
| 25,000 | 64,300 | 46,000 | 27,700 | 342 |
| 20,000 | 41,200 | 29,400 | 17,700 | 535 |
| 15,000 | 23,200 | 16,600 | 9,950 | 951 |

a. Entries in this table are calculated from the formula RCF = 1.12*r* (RPM/1000)$^2$ and then rounded to three significant digits.

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




## Selecting CsCl Gradients

Precipitation during centrifugation would alter density distribution, and this would change the position of the sample bands. Curves in Figure 6 and Figure 7 are provided up to the maximum rated

speed of the rotor, but note also that *tubes or bottles must never be centrifuged faster than the limits in Table 1*.

**NOTE** The curves in Figure 6 and Figure 7 are for solutions of CsCl salt dissolved in distilled water only. If other salts are present in significant concentrations, the overall CsCl concentration may need to be reduced.

Rotor speed is used to control the slope of a CsCl density gradient, and must be limited so that CsCl precipitation is avoided. Speed and density combinations that intersect on or below the curves in Figure 6 ensure that CsCl will not precipitate during centrifugation in the Type 70 Ti rotor. Curves are provided at two temperatures: 20°C (black curves) and 4°C (gray curves)

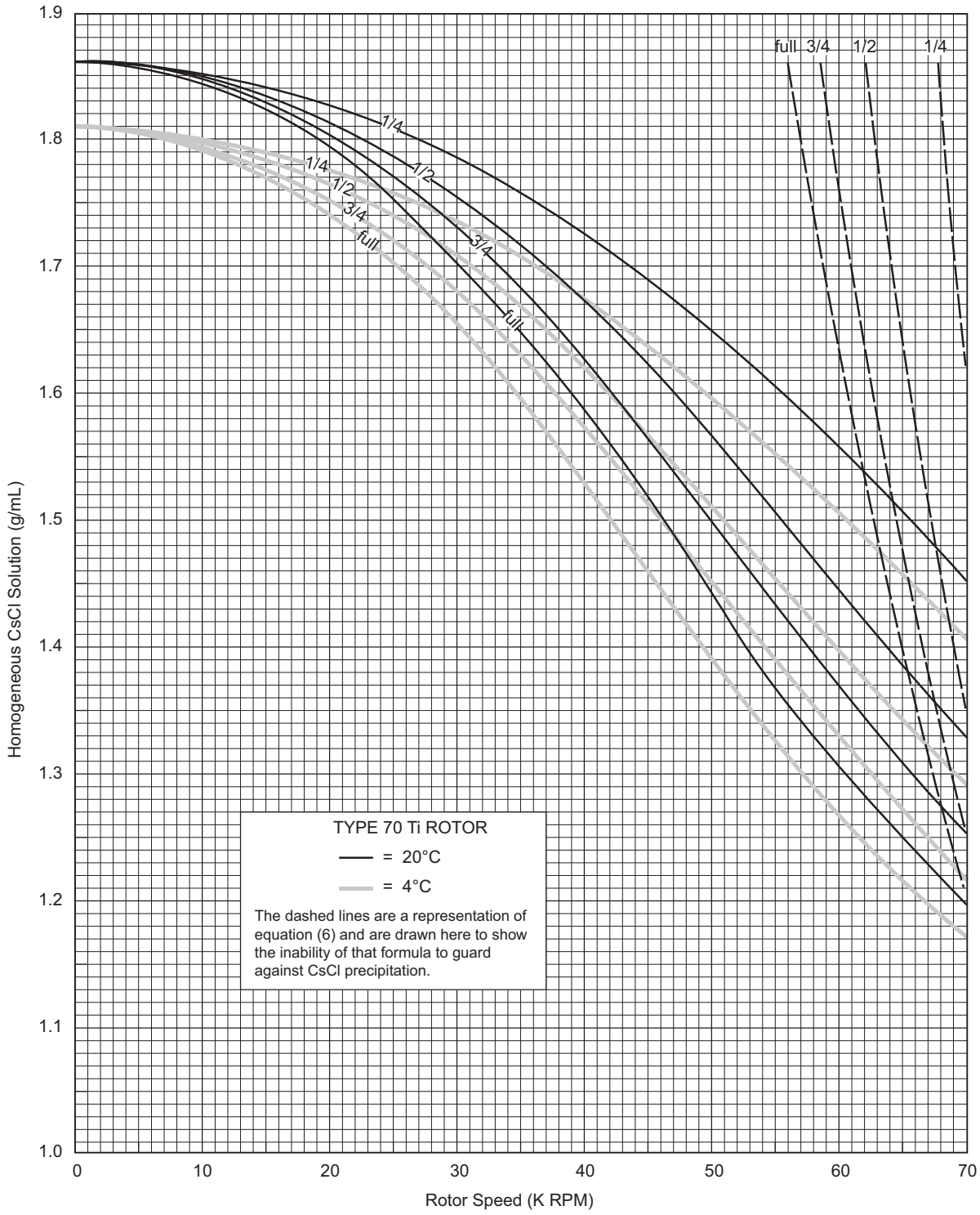
The reference curves in Figure 7 show gradient distribution at equilibrium. Each curve in Figure 7 is within the density limits allowed for the Type 70 Ti rotor: each curve was generated for a single run speed using the maximum allowable homogeneous CsCl densities (one for each fill level) that avoid precipitation at that speed. (The gradients in Figure 7 can be generated from step or linear gradients, or from homogeneous solutions. But the total amount of CsCl in solution must be equivalent to a homogeneous solution corresponding to the concentrations specified in Figure 6.) Figure 7 can also be used to approximate the banding positions of sample particles.

## Adjusting Fill Volumes

Figure 6 and Figure 7 show that several fill volumes are possible in a tube. If a tube is partially filled with gradient solution, float mineral oil (or some other low-density, immiscible liquid) on top of the tube contents to fill the tube to its maximum volume. (Do not use an oil overlay in Ultra-Clear tubes.) Note that for a given CsCl density, as the fill level decreases the maximum allowable speed increases. Partial filling may be desirable when there is little sample or when you wish to shorten the run time.

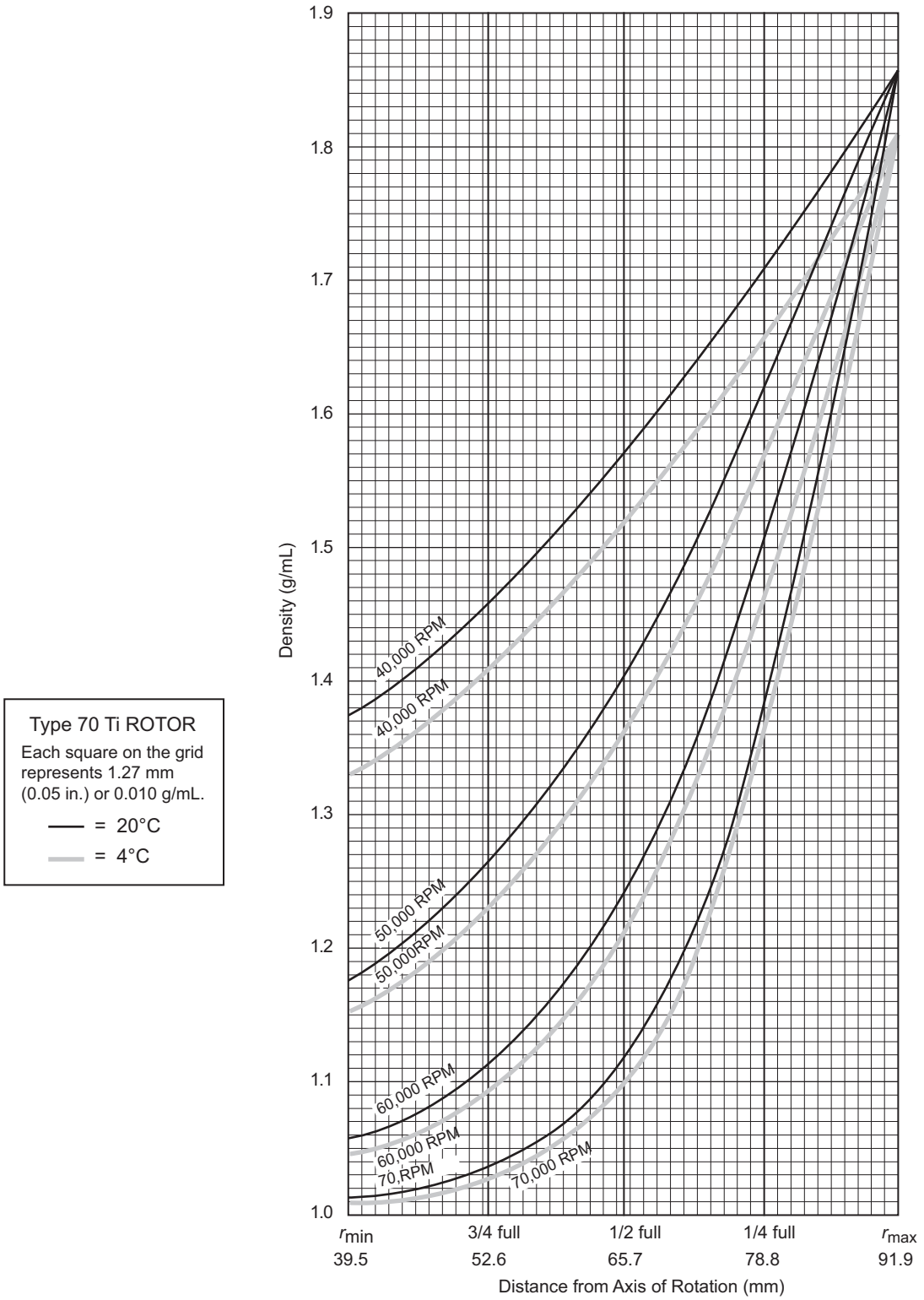
For example, a half-filled tube of 1.44-g/mL homogeneous CsCl solution at 20°C may be centrifuged at 60,000 RPM (see Figure 6). The segment of the 60,000-RPM curve (Figure 7) from the half-filled line to 1.86 g/mL at the tube bottom represents this gradient. The same solution in a quarter-filled tube may be centrifuged no faster than 54,000 RPM. (Gradient curves not shown in Figure 7 can be interpolated.) A tube full of the 1.44-g/mL CsCl solution may be centrifuged no faster than 50,000 RPM.

**Figure 6** Precipitation Curves for the Type 70 Ti Rotor*




* Using combinations of rotor speeds and homogeneous CsCl solution densities that intersect on or below these curves ensures that CsCl will not precipitate during centrifugation.

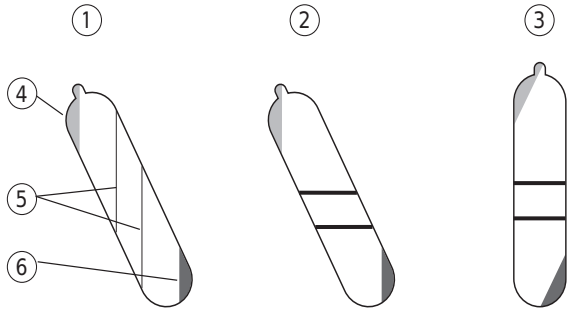
**Figure 7** CsCl Gradients at Equilibrium for the Type 70 Ti Rotor*




* Centrifugation of homogeneous CsCl solutions at the maximum allowable speeds (from Figure 6) results in gradients presented here.

## Typical Examples for Determining CsCl Run Parameters

**Example A:**
Knowing homogeneous CsCl solution density (1.57 g/mL) and approximate particle buoyant densities (1.6 and 1.7 g/mL), at 20°C, where will particles band?




1. At Speed
2. At Rest in Rotor
3. Upright
4. Floating Components
5. Bands
6. Pelleted Material

**1** In Figure 6 find the curve that corresponds to the desired run temperature (20°C) and fill volume (half full).

The maximum allowable rotor speed is determined from the point where this curve intersects the homogeneous CsCl density (50,000 RPM).

**2** In Figure 7, sketch in a horizontal line corresponding to each particle's buoyant density.

**3** Mark the point in the figure where each particle density intersects the curve corresponding to the selected run speed and temperature.

Particles will band at these locations across the tube diameter at equilibrium during centrifugation.

In this example, particles will band about 81 and 85 mm from the axis of rotation, about 4 mm of centerband-to-centerband separation at the rotor's 23-degree tube angle. When the tube is removed from the rotor and held upright (vertical and stationary), there will be about 4.35 mm of centerband-to-centerband separation. This interband distance, $d_{up}$, can be calculated from the formula:

$$d_{up} = \frac{d_\theta}{\cos\theta} \qquad \text{EQ 7}$$

where $d\theta$ is the interband distance when the tube is held at an angle, $\theta$, in the rotor.

**Example B:**
Knowing particle buoyant densities (1.70 and 1.65 g/mL), how do you achieve good separation?

1 In Figure 7, sketch in a horizontal line corresponding to each particle's buoyant density.

2 Select the curve at the desired temperature (20°C) and tube volume (full) that gives the best particle separation.

3 Note the run speed along the selected curve (40,000 RPM).

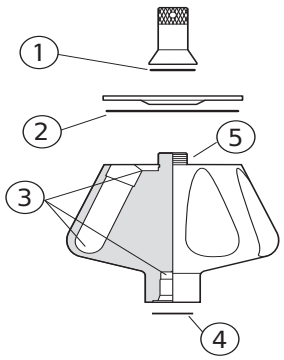
4 From Figure 6, select the maximum homogeneous CsCl density (in this case, 1.585 g/mL) that corresponds to the temperature and run speed established above.

These parameters will provide the particle-banding pattern selected in Step 2.

In this example, particles will band at about 73 and 78 mm from the axis of rotation (about 5 mm apart). When the tube is held upright there will be about 5.42 mm of center-of-band to center-of-band separation.

# Care and Maintenance

## Maintenance




1. Handle O-ring (011757)
2. Lid O-ring (870612)
3. Check for Corrosion
4. Overspeed Disk (335585)
5. Threads

**NOTE** Do not use sharp tools on the rotor that could cause scratches in the rotor surface. Corrosion begins in scratches and may open fissures in the rotor with continued use.

1 Periodically (at least monthly) inspect the rotor, especially inside cavities, for rough spots or pitting, white powder deposits (frequently aluminum oxide), or heavy discoloration.

If any of these signs are evident, do not run the rotor.

2 Regularly lubricate the metal threads in the rotor with a thin, even coat of Spinkote lubricant.

Failure to keep these threads lubricated can result in damaged threads.

**3** Regularly apply silicone vacuum grease (335148) to the O-rings.

Replace O-rings about twice a year or whenever worn or damaged.

**4** Regularly inspect the overspeed disk (335585).

If it is scratched, damaged, or missing, replace it according to the instructions in *Rotors and Tubes*.

**5** Refer to *Chemical Resistances* for the chemical compatabilities of rotor and accessory materials.

Your Beckman Coulter representative provides contact with the Field Rotor Inspection Program and the rotor repair center.

## Cleaning

*Wash the rotor and rotor components immediately if salts or other corrosive materials are used or if spillage has occurred. Do not allow corrosive materials to dry on the rotor.*

Under normal use, wash the rotor frequently (at least weekly) to prevent buildup of residues.

**1** Remove the O-rings before washing.

**2** Wash the rotor and lid in a mild detergent, such as Solution 555 (339555), that won't damage the rotor.

Dilute the detergent with water (10 parts water to 1 part detergent).

**NOTE** Do not wash rotor components in a dishwasher. Do not soak in detergent solution for long periods, such as overnight.

The Rotor Cleaning Kit (339558) contains two plastic-coated brushes and two quarts of Solution 555 for use with rotors and accessories.

**3** Thoroughly rinse the cleaned rotor and components with distilled water.

**4** Air-dry the rotor and lid upside down.

*Do not use acetone to dry the rotor*.

**5** Apply a thin, even coat of silicone vacuum grease to the lid O-ring before replacing it in the groove in the outer rim of the lid.

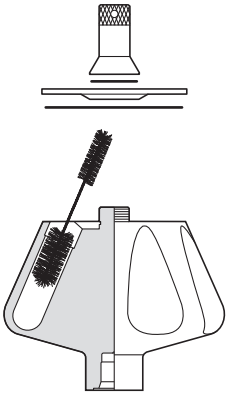
Also apply silicone vacuum grease to the handle O-ring before reassembly.

**6** Clean metal threads every 6 months, or as necessary.

**a.** Use a brush and concentrated Solution 555.

**b.** Dilute the detergent with water (10 parts water to 1 part detergent).

**c.** Rinse and dry thoroughly, then lubricate lightly but evenly with Spinkote to coat all threads.



**7** Periodically remove the O-rings and wipe clean as necessary.

**a.** Clean the O-ring grooves with a cotton-tipped swab.

**b.** Reapply a light film of silicone vacuum grease.

## Decontamination

If the rotor (and/or accessories) becomes contaminated with radioactive material, it should be decontaminated using a solution that will not damage the anodized surfaces. Beckman Coulter has tested a number of solutions and found two that do not harm anodized aluminum: RadCon Surface Spray or IsoClean Solution (for soaking),* and Radiacwash.†

**NOTE** IsoClean can cause fading of colored anodized surfaces. Use it only when necessary and remove it promptly from surfaces.

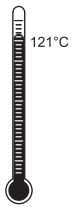
* In U.S., contact Nuclear Associates (New York); in Eastern Europe and Commonweath States, contact Victoreen GmbH (Munich); in South Pacific, contact Gammasonics Pty. Ltd. (Australia); in Japan, contact Toyo Medic Co. Ltd. (Tokyo).

† In U.S., contact Biodex Medical Systems (Shirley, New York); internationally, contact the U.S. office to find the dealer closest to you.

While Beckman Coulter has tested these methods and found that they do not damage components, no guarantee of decontamination is expressed or implied. Consult your laboratory safety officer regarding the proper decontamination methods to use.

If the rotor or other components are contaminated with toxic or pathogenic materials, follow appropriate decontamination procedures as outlined by your laboratory safety officer.

### Sterilization and Disinfection




- The rotor and all rotor components, except those made of polyphenylene oxide (PPO), can be autoclaved at 121°C for up to an hour. Remove the lid from the rotor and place the rotor, lid, and spacers in the autoclave upside down.
- Ethanol (70%) or hydrogen peroxide (6%) may be used on all rotor components, including those made of plastic. Bleach (sodium hypochlorite) may be used, but may cause discoloration of anodized surfaces. Use the minimum immersion time for each solution, per laboratory standards.

**⚠ CAUTION**

**Ethanol is a flammability hazard. Do not use it in or near operating ultracentrifuges.**

While Beckman Coulter has tested these methods and found that they do not damage the rotor or components, no guarantee of sterility or disinfection is expressed or implied. When sterilization or disinfection is a concern, consult your laboratory safety officer regarding proper methods to use.

Where sterilization is critical in your application, consider using Beckman Coulter Certified Free & Sterilized Tubes. For tubes not available in the sterilized option, refer to *Use and Care of Centrifuge Tubes and Bottles* (publication IN-192) included in each box of tubes or bottles for sterilization and disinfection procedures.*Quick-Seal and thinwall open-top tubes are disposable and should be discarded after a single use.*

### Storage

When the rotor is not in use, store it in a dry environment (not in the instrument) with the lid removed to allow air circulation so moisture will not collect in the tube cavities.

## Returning a Rotor

Before returning a rotor or accessory for any reason, prior permission must be obtained from Beckman Coulter, Inc. A return authorization form is necessary and may be obtained from your local Beckman Coulter sales office. The return form should contain the following information:

- rotor type and serial number,
- history of use (approximate frequency of use),
- reason for the return,

- original purchase order number, billing number, and shipping number, if possible,
- name and email address of the person to be notified upon receipt of the rotor or accessory at the factory,
- name and email address of the person to be notified about repair costs, etc.

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

Use the address label printed on the return form when mailing the rotor and/or accessories.

Customers located outside the United States should contact their local Beckman Coulter office.

## Supply List

See the Beckman Coulter *Ultracentrifuge Rotors, Tubes & Accessories* catalog (BR-8101, available at www.beckman.com), call Beckman Coulter Customer Service at 1-800-742-2345 (U.S.A. or Canada), or contact your local Beckman Coulter office for detailed information on ordering parts and supplies. For your convenience, a partial list is given below.

### Replacement Rotor Parts

| Description | Part Number |
|---|---|
| Type 70 Ti rotor assembly | 337922 |
| Rotor lid | 337923 |
| Rotor handle | 337924 |
| Handle O-ring | 011757 |
| Lid O-ring | 870612 |
| Overspeed disk (70,000 RPM) | 335585 |

### Other

**NOTE** For MSDS information, go to the Beckman Coulter website at www.beckman.com.

| Description | Part Number |
|---|---|
| Tubes, bottles, and accessories | see Table 1 |
| OptiSeal tube rack assembly | 361646 |

| Description | Part Number |
|---|---|
| Quick-Seal Cordless Tube Topper kit, 60 Hz | 358312 |
| Quick-Seal Cordless Tube Topper kit, 50 Hz (Europe) | 358313 |
| Quick-Seal Cordless Tube Topper kit, 50 Hz (Great Britain) | 358314 |
| Quick-Seal Cordless Tube Topper kit, 50 Hz (Australia) | 358315 |
| Quick-Seal Cordless Tube Topper kit, 50 Hz (Canada) | 367803 |
| Tube Topper rack (16-mm dia. tubes) | 348124 |
| Special tool kit for the Type 70 Ti rotor<br>includes:<br>Torque wrench<br>Socket adapter for 20-mm (3/4-in. hex nuts<br>Socket for 20-mm (3/4-in.) hex nuts<br>Socket for 11-mm (7/16-in.) hex nuts<br>Tube/cap vise<br>Tube cap assembler<br>Removal tool (capped tubes) | 338841<br><br>858121<br>858122<br>858123<br>870432<br>338835<br>338840<br>301875 |
| Tube Cap vise | 305075 |
| Removal tool (floating spacer) | 338765 |
| Removal tool (polycarbonate bottles) | 878133 |
| Removal tool (Quick-Seal tubes) | 361668 |
| Handle tool | 356959 |
| Spinkote lubricant (2 oz) | 306812 |
| Silicone vacuum grease (1 oz) | 335148 |
| Rotor Cleaning Kit | 339558 |
| Solution 555 (1 qt) | 339555 |
| Rotor cleaning brush | 339379 |
| Centering tool (for replacing overspeed disk) | 331325 |

# Beckman Coulter, Inc.
# Ultracentrifuge Rotor Warranty

All Beckman Coulter ultracentrifuge Fixed Angle, Vertical Tube, Near Vertical Tube, Swinging Bucket, and Airfuge rotors are warranted against defects in materials or workmanship for the time periods indicated below, subject to the Warranty Conditions stated below.

| | |
|---|---|
| Preparative Ultracentrifuge Rotors | 5 years — No Proration |
| Analytical Ultracentrifuge Rotors | 5 years — No Proration |
| ML and TL Series Ultracentrifuge Rotors | 5 years — No Proration |
| Airfuge Ultracentrifuge Rotors | 1 year — No Proration |

For Zonal, Continuous Flow, Component Test, and Rock Core Ultracentrifuge Rotors, see separate warranty.

1. This warranty is valid for the time periods indicated above from the date of shipment to the original Buyer by Beckman Coulter or an authorized Beckman Coulter representative.
2. This warranty extends only to the original Buyer and may not be assigned or extended to a third person without written consent of Beckman Coulter.
3. This warranty covers the Beckman Coulter Centrifuge Systems only (including but not limited to the centrifuge, rotor, and accessories) and Beckman Coulter shall not be liable for damage to or loss of the user's sample, non-Beckman Coulter tubes, adapters, or other rotor contents.
4. This warranty is void if the Beckman Coulter Centrifuge System is determined by Beckman Coulter to have been operated or maintained in a manner contrary to the instructions in the operator's manual(s) for the Beckman Coulter Centrifuge System components in use. This includes but is not limited to operator misuse, abuse, or negligence regarding indicated maintenance procedures, centrifuge and rotor classification requirements, proper speed reduction for the high density of certain fluids, tubes, and tube caps, speed reduction for precipitating gradient materials, and speed reduction for high-temperature operation.
5. 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.
6. This warranty does not cover the failure of a Beckman Coulter rotor in a centrifuge not of Beckman Coulter manufacture, or if the rotor is used in a Beckman Coulter centrifuge that has been modified without the written permission of Beckman Coulter, or is used with carriers, buckets, belts, or other devices not of Beckman Coulter manufacture.
7. Rotor parts subject to wear, including but not limited to rotor O-rings, VTi, NVT, TLV, MLN, and TLN rotor tube cavity plugs and gaskets, tubing, tools, optical overspeed disks, bearings, seals, and lubrication are excluded from this warranty and should be frequently inspected and replaced if they become worn or damaged.
8. Keeping a rotor log is not mandatory, but may be desirable for maintenance of good laboratory practices.

### Repair and Replacement Policies

1. If a Beckman Coulter rotor is determined by Beckman Coulter to be defective, Beckman Coulter will repair or replace it, subject to the Warranty Conditions. A replacement rotor will be warranted for the time remaining on the original rotor's warranty.
2. If a Beckman Coulter centrifuge is damaged due to a failure of a rotor covered by this warranty, Beckman Coulter will supply free of charge (i) all centrifuge parts required for repair (except the drive unit, which will be replaced at the then current price less a credit determined by the total number of revolutions or years completed, provided that such a unit was manufactured or rebuilt by Beckman Coulter), and (ii) if the centrifuge is currently covered by a Beckman Coulter warranty or Full Service Agreement, all labor necessary for repair of the centrifuge.
3. If a Beckman Coulter rotor covered by this warranty is damaged due to a malfunction of a Beckman Coulter ultracentrifuge covered by an Ultracentrifuge System Service Agreement, Beckman Coulter will repair or replace the rotor free of charge.
4. If a Beckman Coulter rotor covered by this warranty is damaged due to a failure of a Beckman Coulter tube, bottle, tube cap, spacer, or adapter, covered under the Conditions of this Warranty, Beckman Coulter will repair or replace the rotor and repair the instrument as per the conditions in policy point (2) above, and the replacement policy.
5. Damage to a Beckman Coulter rotor or instrument due to the failure or malfunction of a non-Beckman Coulter tube, bottle, tube cap, spacer, or adapter is not covered under this warranty, although Beckman Coulter will assist in seeking compensation under the manufacturer's warranty.

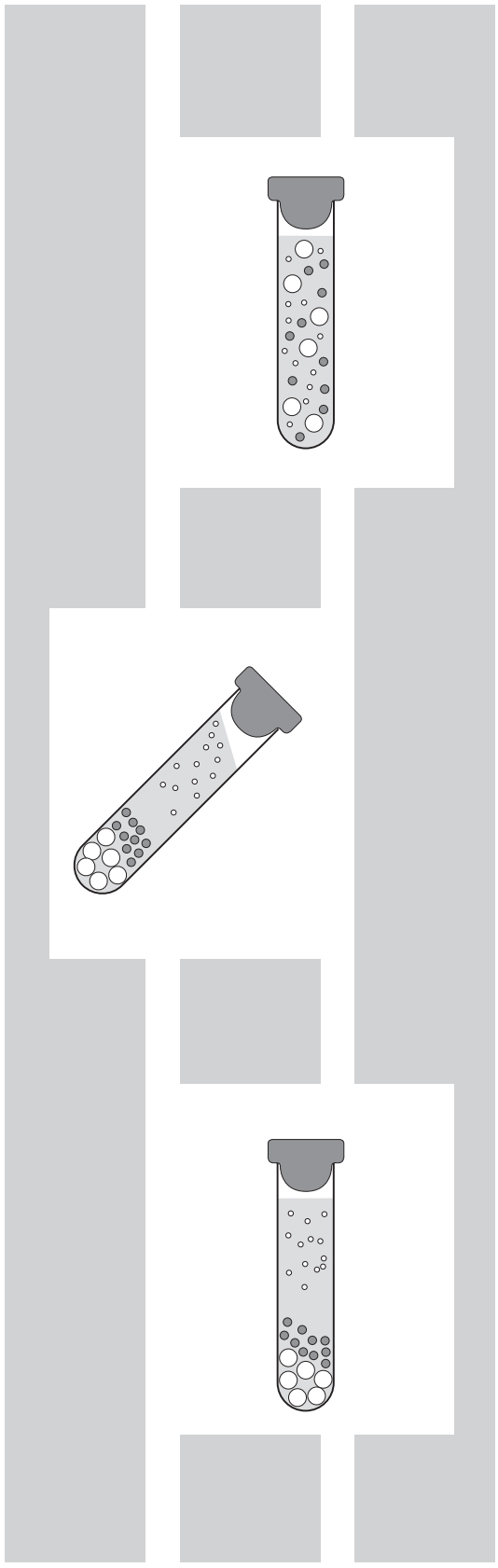
### Disclaimer

IT IS EXPRESSLY AGREED THAT THE ABOVE WARRANTY SHALL BE IN LIEU OF ALL WARRANTIES OF FITNESS AND OF THE WARRANTY OF MERCHANTABILITY AND BECKMAN COULTER, INC. 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.

### Factory Rotor Inspection Service

Beckman Coulter, Inc., will provide free mechanical and metallurgical inspection in Indianapolis, Indiana, USA, of any Beckman Coulter rotor at the request of the user. (Shipping charges to Beckman Coulter are the responsibility of the user.) Rotors will be inspected in the user's laboratory if the centrifuge in which they are used is covered by an appropriate Beckman Coulter Service Agreement. Contact your local Beckman Coulter office for details of service coverage or cost.

Before shipping, contact the nearest Beckman Coulter Sales and Service office and request a Returned Goods Authorization (RGA) form and packaging instructions. Please include the complete rotor assembly, with buckets, lid, handle, tube cavity caps, etc. A SIGNED STATEMENT THAT THE ROTOR AND ACCESSORIES ARE NON-RADIOACTIVE, NON-PATHOGENIC, NON-TOXIC, AND OTHERWISE SAFE TO SHIP AND HANDLE IS REQUIRED.



# Related Documents

**Rotors and Tubes for Preparative Ultracentrifuges (LR-IM)**

- Rotors
- Tubes, Bottles, and Accessories
- Using Tubes, Bottles, and Accessories
- Using Fixed-Angle Rotors
- Using Swinging-Bucket Rotors
- Using Vertical-Tube and Near-Vertical Tube Rotors
- Care and Maintenance
- Chemical Resistances for Beckman Coulter Centrifugation Products
- Use of the w2t Integrator
- The Use of Cesium Chloride Curves
- Gradient Materials
- References
- Glossary

Available in hard copy or electronic pdf by request.

**Rotors and Tubes CD (369668)**

- Rotors and Tubes for Tabletop Preparative Ultracentrifuges
- Rotors and Tubes for J2, J6, Avanti J Series Centrifuges
- Rotors and Tubes for Preparative Ultracentrifuges
- Rotor Safety Bulletin
- Chemical Resistances for Beckman Coulter Centrifugation Products

Included with shipment of instrument.

**Additional References**

- Chemical Resistances for Beckman Coulter Centrifugation Products (IN-175)
- Beckman Coulter Ultracentrifuge Rotors, Tubes & Accessories catalog (BR-8101)
- Using OptiSeal Tubes (IN-189)
- Use and Care of Centrifuge Tubes and Bottles (IN-192)

Available in hard copy or electronic pdf by request.

**Data Sheets**

- *g*-Max System: Short Pathlengths in High Force Fields (DS-709B)

Available at www.beckman.com

**www.beckman.com**

BECKMAN COULTER

# Instruction For Use

## Type 70.1 Ti Rotor

Used In Beckman Coulter Class H, R, and S
Preparative Ultracentrifuges

L5-TB-061AU
October 2019

Beckman Coulter, Inc.
250 S. Kraemer Blvd.
Brea, CA 92821 U.S.A.

BECKMAN COULTER

**Type 70.1 Ti Rotor**
**Used in Beckman Coulter Class H, R, and S Preparative Centrifuges**
PN L5-TB-061AU (October 2019)



**Contact Us**
If you have any questions, contact our Customer Support Center.

- Worldwide, find us via our website at www.beckman.com/support/technical
- In the USA and Canada, call us at 1-800-369-0333.
- Outside of the USA and Canada, contact your local Beckman Coulter Representative.

Find us on the World Wide Web at:
**www.beckman.com**

EC REP

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Glossary of Symbols is available at beckman.com/techdocs (PN C24689).

*May be covered by one or more pat. - see www.beckman.com/patents*

Original Instructions

# Revision History

*This document applies to the latest and higher versions. When a subsequent version changes the information in this document, a new issue will be released to the Beckman Coulter website. For updates, go to www.beckman.com/techdocs and download the latest version of the manual or system help for your instrument.*

**Issue AT, 09/2018**
Changes or additions were made to: *Table 1, Available Tubes and Bottles for the Type 70.1 Ti Rotor; Certified Free Tubes; Sterile Tubes; Sterilization and Disinfection; Supply List.*

**Issue AU, 10/2019**
Changes or additions were made to: Table 1, Available Tubes and Bottles for the Type 70.1 Ti Rotor.

***Note:*** *Changes that are part of the most recent revision are indicated in text by a bar in the margin of the amended page.*

# Safety Notice

Read all product manuals and consult with Beckman Coulter-trained personnel before attempting to operate instrument. Do not attempt to perform any procedure before carefully reading all instructions. Always follow product labeling and manufacturer's recommendations. If in doubt as to how to proceed in any situation, contact your Beckman Coulter Representative.

## Alerts for Danger, Warning, Caution, Important, and Note

**⚠ WARNING**

**WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.**

**⚠ CAUTION**

**CAUTION indicates a potentially hazardous situation, which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.**

**IMPORTANT** IMPORTANT is used for comments that add value to the step or procedure being performed. Following the advice in the Important adds benefit to the performance of a piece of equipment or to a process.

**NOTE** NOTE is used to call attention to notable information that should be followed during installation, use, or servicing of this equipment.

## Safety Notice

This safety notice summarizes information basic to the safe use of the rotor described in this manual. The international symbol displayed above is a reminder to the user that all safety instructions should be read and understood before operation or maintenance of this equipment is attempted. When you see the symbol on other pages throughout this publication, pay special attention to the specific safety information presented. Observance of safety precautions will also help to avoid actions that could damage or adversely affect the performance of the rotor. This rotor was developed, manufactured, and tested for safety and reliability as part of a Beckman Coulter ultracentrifuge/rotor system. Its safety or reliability cannot be assured if used in a centrifuge not

of Beckman Coulter's manufacture or in a Beckman Coulter ultracentrifuge that has been modified without Beckman Coulter's approval.

- Handle body fluids with care because they can transmit disease. No known test offers complete assurance that such fluids are free of micro-organisms. Some of the most virulent — Hepatitis (B and C) viruses, HIV (I –V), atypical mycobacteria, and certain systemic fungi — further emphasize the need for aerosol protection. Handle other infectious samples according to good laboratory procedures and methods to prevent spread of disease. Because spills may generate aerosols, observe proper safety precautions for aerosol containment. Do not run toxic, pathogenic, or radioactive materials in this centrifuge without taking appropriate safety precautions. Biosafe containment should be used when Risk Group II materials (as identified in the World Health Organization *Laboratory Biosafety Manual*) are handled; materials of a higher group require more than one level of protection.
- The rotor and accessories are not designed for use with materials capable of developing flammable or explosive vapors. Do not centrifuge such materials in nor handle or store them near the ultracentrifuge.
- Although rotor components and accessories made by other manufacturers may fit in the Type 70.1 Ti rotor, their safety in this rotor cannot be ascertained by Beckman Coulter. Use of other manufacturers' components or accessories in the Type 70.1 Ti rotor may void the rotor warranty and should be prohibited by your laboratory safety officer. Only the components and accessories listed in this publication should be used in this rotor.
- Make sure that filled containers are loaded symmetrically into the rotor and that opposing tubes are filled to the same level with liquid of the same density. Make sure that cavities in use have the proper spacers inserted (if applicable) before installing the rotor lid.
- If disassembly reveals evidence of leakage, you should assume that some fluid escaped the rotor. Apply appropriate decontamination procedures to the centrifuge and accessories.
- Never exceed the maximum rated speed of the rotor and labware in use. Refer to the section on *Run Speeds*, and derate the run speed as appropriate.
- Do not use sharp tools on the rotor that could cause scratches in the rotor surface. Corrosion begins in scratches and may open fissures in the rotor with continued use.

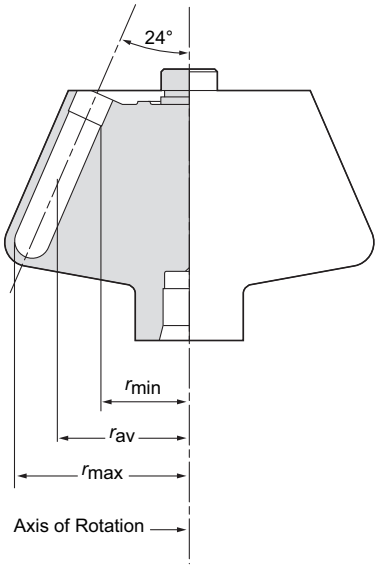
# Contents

# Illustrations

# Tables

# Type 70.1 Ti Rotor

## Specifications




| | |
|---|---|
| Maximum speed | 70 000 rpm |
| Density rating at maximum speed | 1.2 g/mL |
| Relative Centrifugal Field* at maximum speed | |
| At $r_{max}$ (82.0 mm) | 450 000 × *g* |
| At $r_{av}$ (61.2 mm) | 336 000 × *g* |
| At $r_{min}$ (40.5 mm) | 222 000 × *g* |
| *k* factor at maximum speed | 36 |
| Conditions requiring speed reductions | see *Run Speeds* |
| Number of tube cavities | 12 |
| Available tubes | see Table 1 |
| Nominal tube dimensions (largest tube) | 16 × 76 mm |
| Nominal tube capacity (largest tube) | 13.5 mL |
| Nominal rotor capacity | 162 mL |
| Approximate acceleration time to maximum speed (fully loaded) | 6 min |
| Approximate deceleration time from maximum speed (fully loaded) | 4 min |
| Weight of fully loaded rotor | 5.9 kg (13.0 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:

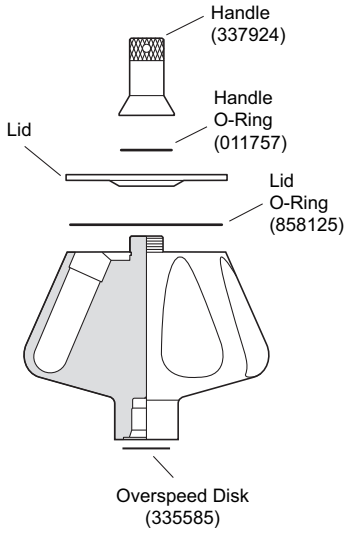
$$\mathrm{RCF} = \frac{r\omega^2}{g}$$

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

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

# Description

*This rotor has been manufactured in a registered ISO 9001 or 13485 facility for use with the appropriately classified Beckman Coulter ultracentrifuge.*




The Type 70.1 Ti, rated for 70 000 rpm, is a fixed angle rotor designed to centrifuge up to twelve tubes at a 24-degree angle to the axis of rotation. Used in Beckman Coulter class H, R, and S preparative ultracentrifuges, the rotor develops centrifugal forces sufficient for applications including pelleting of small particles, and purification of viruses and subcellular organelles using sucrose gradients. Up to 162 mL of sample and gradient can be centrifuged per run.

The rotor is made of titanium and is finished with black polyurethane paint. The aluminum lid and handle are anodized for corrosion resistance. The handle is interchangeable with the Type 70 Ti rotor handle *but no others*. O-rings made of Buna N rubber in the lid and handle maintain atmospheric pressure inside the rotor during centrifugation, if they are properly lubricated. Four small holes in the lid provide a temporary vent, preventing pressure build-up and extrusion of the large lid O-ring in the event of tube leakage. Because of the weight of the rotor, drive pins are not required in the rotor drive hub cavity.

For overspeed protection, a photoelectrical detector in the ultracentrifuge monitors the overspeed disk on the rotor bottom and shuts down the run if speeds exceeding 70 000 rpm are detected.

See the Warranty at the back of this manual for warranty information.

# Preparation and Use

*Specific information about the Type 70.1 Ti rotor is given here. Information common to this and other rotors is contained in Rotors and Tubes for Preparative Ultracentrifuges* (publication LR-IM-24), *which should be used together with this manual for complete rotor and accessory operation.*

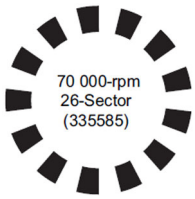
**NOTE** Although rotor components and accessories made by other manufacturers may fit in the Type 70.1 Ti rotor, their safety in this rotor cannot be ascertained by Beckman Coulter. Use of other manufacturers' components or accessories in the Type 70.1 Ti rotor may void the rotor warranty and should be prohibited by your laboratory safety officer. Only the components and accessories listed in this publication should be used in this rotor.

## Prerun Safety Checks

*Read the Safety Notice page at the front of this manual before using the rotor.*

1 Make sure that the rotor and lid are clean and show no signs of corrosion or cracking.

2 Make sure the 26-sector (70 000 rpm) overspeed disk is properly attached to the rotor bottom. If it is missing or damaged, replace it according to the instructions in *Rotors and Tubes for Preparative Ultracentrifuges* (publication LR-IM-24).




3 Check the chemical compatibilities of all materials used (refer to Appendix A in *Rotors and Tubes for Preparative Ultracentrifuges* (publication LR-IM-24).

4 Verify that the tubes and bottles being used are listed in Table 1.

## Rotor Preparation

*For runs at other than room temperature, refrigerate or warm the rotor beforehand for fast equilibration.*

1 Be sure that metal threads in the rotor are clean and lightly but evenly lubricated with Spinkote lubricant (306812). Also ensure that O-rings are lightly but evenly coated with silicone vacuum grease (335148).

**2** Load the filled containers symmetrically into the rotor. (Refer to *Tubes and Bottles* on page -6 for information about containers.) If fewer than twelve tubes are being run, they must be arranged symmetrically in the rotor (see Figure 1). Opposing tubes must be filled to the same level with liquid of the same density.

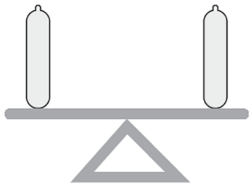
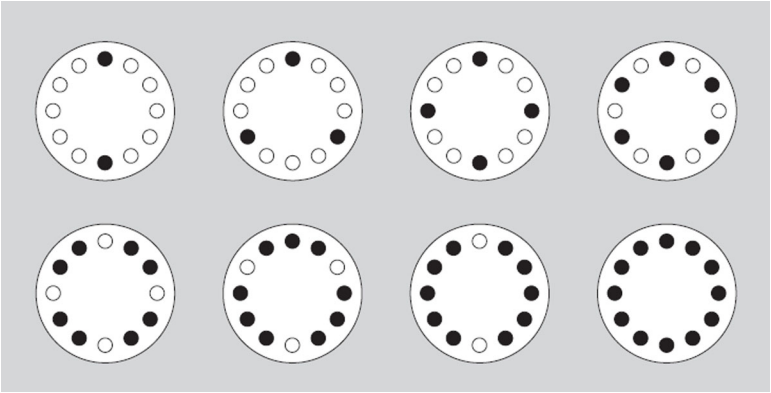


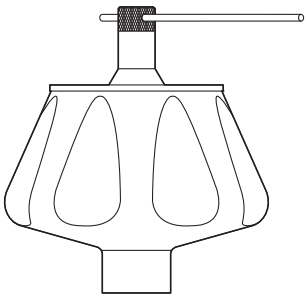
**Figure 1** Typical Examples of Symmetric Loading of Twelve or Fewer Tubes



**3** Complete loading by placing the correct spacers (if required) over the tubes.

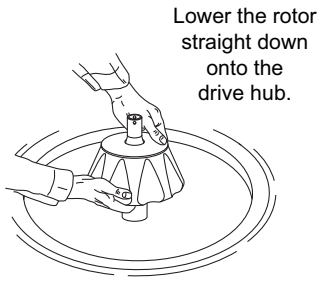
**NOTE** Place filled tubes in at least two opposing cavities. Make sure that cavities in use have the proper spacers inserted (if applicable) before installing the rotor lid.

**4** Put the lid in place and tighten by hand as firmly as possible.



## Operation

1 Carefully place the rotor on the drive hub.




2 Refer to the applicable instrument instruction manual for ultracentrifuge operation.

3 For additional operating information, see the following:

- *Run Times*, page -11, for using k factors to adjust run durations
- *Run Speeds*, page -12, for information about speed limitations
- *Selecting CsCl Gradients*, page -14, for methods to avoid CsCl precipitation during centrifugation.

## Removal and Sample Recovery

**⚠ CAUTION**

**Risk of contamination. If disassembly reveals evidence of leakage, you should assume that some fluid escaped the rotor. Apply appropriate decontamination procedures to the centrifuge and accessories.**

1 Remove the rotor from the centrifuge by lifting it straight up and off the drive hub.

2 Remove the rotor lid.

**3** Use the appropriate removal tool (listed in the *Supply List*) to remove the spacers and tubes.

Quick-Seal Tube
Removal Tool
(361668)

## Tubes and Bottles

The Type 70.1 Ti rotor uses the tubes and bottles listed in Table 1. Be sure to use only those items listed, and to observe the maximum speed limits and fill volumes shown. (Maximum fill volume is the maximum amount that can be centrifuged in the container listed.) Refer to Appendix A in *Rotors and Tubes* for chemical compatibilities of tube, bottle, and accessory materials.

**Table 1** Available Tubes and Bottles for the Type 70.1 Ti Rotor

| Tube | | | | Required Accessory | | Max Speed/ RCF/ *k* Factor |
|---|---|---|---|---|---|---|
| **Dimensions** | **Description** | **Part Number** | **Max Fill Vol** | **Description** | **Part Number** | |
| 16 × 76 mm | Quick-Seal Ultra-Clear | 344322 (pkg/50) | 13.5 mL | red aluminum spacer | 342695 | 70 000 rpm 450 000 × *g* 36 |
| 16 × 76 mm | Certified Free & Sterile Polypropylene Quick-Seal | C14306 Carton of 48 (8 packs of 6) | 13.5 mL | red aluminum spacer | 342695 | 70 000 rpm 450 000 × *g* 36 |
| | Certified Free Polypropylene Quick-Seal | C14290 (pkg/50) | | | | |
| | Standard Polypropylene Quick-Seal | 342413 (pkg/50) | | | | |
| 16 × 76 mm | Ultra-Clear | 344085 (pkg/50) | 13.5 mL | titanium cap (use the red silicone O-ring) | 341968 | 70 000 rpm 450 000 × *g* 36 |
| 16 × 76 mm | thinwall polypropylene | 326814 (pkg/50) | 13.5 mL | titanium cap (use the black Buna N O-ring) | 341968 | 70 000 rpm 450 000 × *g* 36 |
| 16 × 76 mm | thickwall polypropylene | 355640 (pkg/25) | 9.3 mL (capped) 8 mL (w/o cap) | aluminum cap | 338907[a] | 30 000 rpm 82 700 × *g* 199 |

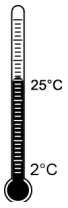
**Table 1** Available Tubes and Bottles for the Type 70.1 Ti Rotor *(Continued)*

| Tube | | | | Required Accessory | | Max Speed/ RCF/ *k* Factor |
|---|---|---|---|---|---|---|
| **Dimensions** | **Description** | **Part Number** | **Max Fill Vol** | **Description** | **Part Number** | |
| 16 × 76 mm | thickwall polycarbonate | 355630 (pkg/25) | 9.3 mL (capped) 8 mL (w/o cap) | aluminum cap | 338907[a] | 50 000 rpm[b] 230 000 × *g* 71 |
| 16 × 76 mm | polycarbonate bottle and cap assembly | 355603 (pkg/6) | 10.4 mL | — | — | 65 000 rpm[c] 388 000 × *g* 42 |
| | bottle only | 355651 | | Noryl[d] cap | 335257 | |
| 16 × 67 mm | Quick-Seal polypropylene bell-top | 344622 (pkg/50) | 10 mL | Noryl spacer | 344676 | 70 000 rpm 450 000 × *g* 34 |
| 16 × 60 mm | OptiSeal bell-top[e] | 361623 (pkg/56) | 8.9 mL | amber Ultem[f] spacer | 361670 (pkg/2) | 70 000 rpm 450 000 × *g* 32 |
| 13 × 64 mm | Certified Free & Sterile Ultra-Clear Open-Top | C14296 Carton of 48 (8 packs of 6) | 6.5 mL | Acetal adapter | 303313 | 50 000 rpm 212 000 × *g* 60 |
| | Certified Free Ultra-Clear Open-Top | C14280 (pkg/50) | | | | |
| | Standard Ultra-Clear Open-Top | 344088 (pkg/50) | | aluminum cap | 346256[g] | |
| 13 × 64 mm | thinwall polypropylene | 326820 pkg/50) | 6.5 mL | Acetal adapter | 303313 | 50 000 rpm 212 000 × *g* 60 |
| | | | | aluminum cap | 346256[g] | |
| 13 × 64 mm | stainless steel | 301099 | 6.5 mL | Acetal adapter | 303313 | 40 000 rpm[h] 147 000 × *g* 112 |
| | | | | aluminum cap | 305022 | |
| 16 × 45 mm | Quick-Seal polypropylene bell-top | 345830 (pkg/50) | 6.3 mL | Noryl floating spacer | 303448 | 70 000 rpm 450 000 × *g* 24 |
| 16 × 38 mm | Quick-Seal polypropylene bell-top | 356562 (pkg/50) | 4.2 mL | Noryl floating spacer | 345828 | 70 000 rpm 450 000 × *g* 17 |
| 13 × 64 mm | thickwall polypropylene | 355644 (pkg/25) | 4 mL | Acetal adapter | 303313 | 50 000 rpm 212 000 × *g* 60 |
| 13 × 64 mm | thickwall polycarbonate | 355645 (pkg/25) | 4 mL | Acetal adapter | 303313 | 50 000 rpm[b] 212 000 × *g* 60 |

**Table 1** Available Tubes and Bottles for the Type 70.1 Ti Rotor *(Continued)*

| Tube | | | | Required Accessory | | Max Speed/ RCF/ *k* Factor |
|---|---|---|---|---|---|---|
| Dimensions | Description | Part Number | Max Fill Vol | Description | Part Number | |
| 13 × 41 mm | Ultra-Clear | 344093 (pkg/50) | 4 mL | Acetal adapter | 303402 | 45 000 rpm 152 000 × *g* 58 |
| | | | | aluminum cap | 346256[g] | |
| 8 × 49 mm | Ultra-Clear | 344091 (pkg/50) | 2 mL | Acetal adapter | 303376 | 45 000 rpm 138 000 × *g* 63 |
| | | | | aluminum cap | 303624 | |

a. Cap is optional.
b. Max speeds given are those which the tubes could withstand when tested at 25°C for 24 hours. Further tests have shown that the polycarbonate tubes can run at 70 000 rpm for 6 hours or at 65 000 rpm for 8 hours.
c. For lower fill volumes (not less than 5 mL) centrifuge no faster than 60 000 rpm.
d. Noryl is a registered trademark of GE Plastics.
e. Includes disposable plastic plugs.
f. Ultem is a registered trademark of GE Plastics.
g. Cap assembly includes neoprene gasket (344672) and stem (346246).
h. For solution densities of 2.0 g/mL and below; above 2.0, further speed reductions are required. Refer to publication L5-TB-072 before centrifuging stainless steel tubes.




## Temperature Limits

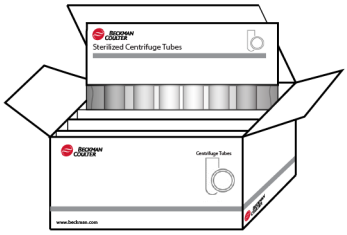
- Plastic tubes and bottles have been centrifuge tested for use at temperatures between 2 and 25°C. For centrifugation at other temperatures, pretest tubes under anticipated run conditions.
- If plastic containers are frozen before use, make sure that they are thawed to at least 2°C prior to centrifugation.

## Certified Free Tubes


Based on Sample Results Below Detectable Limit

Certified free tubes are lot traceable to testing that confirms the absence of endotoxin, DNase, RNase, and human & mouse DNA below a detectable limit.

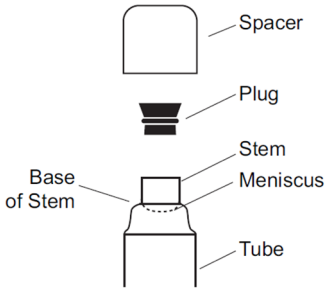
## Sterile Tubes




Sterile tubes are sterilized via ethylene oxide in compliance with ISO 11135:2014. Cartons include several peel packages, each containing a typical run quantity of tubes per the tube details in Table 1. Packaging meets requirements of ISO11607:2006.

## Optiseal Tubes

OptiSeal tubes come with plastic plugs and can be quickly and easily prepared for use. With the tube spacer in place, the g force during centrifugation ensures a tight, reliable seal that protects your samples.




- Place the tubes in the rack and fill each tube to the base of the stem, leaving no fluid in the stem. Overfilling the tube can cause spillage when the plug is inserted or can compromise seal integrity. However, too much air can cause excessive tube deformation, disrupting gradients and sample bands.
- Refer to *Using OptiSeal Tubes* (publication IN-189), included in each box of tubes, for detailed information on the use and care of OptiSeal tubes.

## Quick-Seal Tubes

Quick-Seal tubes must be sealed prior to centrifugation. These tubes are heat sealed and do not need caps; however, spacers are required on top of the tubes when they are loaded into the rotor.

- Fill Quick-Seal tubes leaving a *small* bubble of air at the base of the neck. Do not leave a large air space — too much air can cause excessive tube deformation.
- Refer to *Rotors and Tubes for Preparative Ultracentrifuges* (publication LR-IM-24) for detailed information on the use and care of Quick-Seal tubes.

### Thinwall Tubes

Thinwall polypropylene and Ultra-Clear tubes require caps for tube support. Fill the tubes as full as possible to prevent tube collapse during centrifugation. If necessary, float mineral oil (or some other low-density, immiscible liquid) on top of the tube contents to fill the tube to its maximum volume (Do not use an oil overlay in Ultra-Clear tubes).

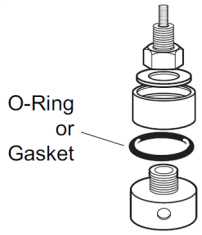
### Thickwall Tubes

Thickwall polypropylene and polycarbonate tubes can be run partially filled (at least half filled) with or without caps, but all opposing tubes for a run must be filled to the same level with liquid of the same density. Do not overfill capless tubes; be sure to note the reductions in fill volume and run speed shown in Table 1.

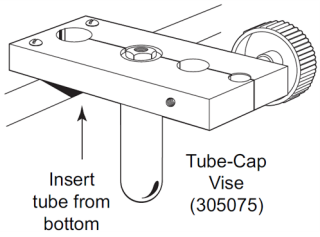
### Tube Caps

Thinwall tubes require caps for tube support during centrifugation; thickwall tubes and bottles can be run with or without caps (speed reduction may be required). Use only the caps listed in Table 1. Refer to *Rotors and Tubes for Preparative Ultracentrifuges* (publication LR-IM-24) for the use, assembly, and maintenance of caps.

- Inspect tube caps before use as described in *Rotors and Tubes for Preparative Ultracentrifuges* (publication LR-IM-24). Replace any damaged components.
- Inspect the O-rings or gaskets in the caps for cracks, nicks, or flattened areas. Be sure that they are dry and free of lubricant during assembly.




- Tighten aluminum caps with a hex driver while the tube is held in the tube-cap vise (305075).




- Tighten bottle caps by hand.

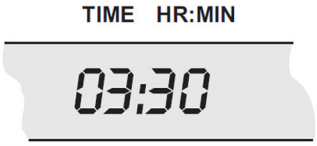
### Thinwall Tubes with Red-Anodized Caps

These tubes must be capped. Refer to *Instructions for Using Aluminum Tube Caps* (publication L5-TB-060) for the use, assembly, and maintenance of these caps. Tighten the caps with a torque wrench to 11 N•m (100 in.-lb).

### Polycarbonate Bottles

The polycarbonate bottles may be centrifuged completely filled, or partially filled (not less than half full). Again, all opposing containers for a run must be filled to the same level. Be sure to note the reductions in run speed shown in Table 1 if bottles are partially filled.

## Run Times




The *k* factor of the rotor is a measure of the rotor's pelleting efficiency. (Beckman Coulter has calculated the *k* factors for all of its preparative rotors at maximum rated speed and using full tubes.) The *k* factor is calculated from the formula:

$$k = \frac{1\mathrm{n}(r_{max}/r_{min})}{\omega^2} \times \frac{10^{13}}{3600} \quad \text{EQ 1}$$

where $\omega$ is the angular velocity of the rotor in radians per second ($\omega = 0.105 \times \mathrm{rpm}$), $r_{max}$ is the maximum radius, and $r_{min}$ is the minimum radius.

After substitution:

$$k = \frac{(2.533 \times 10^{11}) \ln(r_{max}/r_{min})}{\mathrm{rpm}^2} \quad \text{EQ 2}$$

Use the *k* factor in the following equation to estimate the run time *t* (in hours) required to pellet particles of known sedimentation coefficient *s* (in Svedberg units, *S*).

$$t = \frac{k}{s} \quad \text{EQ 3}$$

Run times can be estimated for centrifugation at less than maximum speed by adjusting the *k* factor as follows:

$$k_{adj} = k\left(\frac{70000}{\text{actual run speed}}\right)^2 \quad \text{EQ 4}$$

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

$$\frac{t_a}{t_b} = \frac{k_a}{k_b} \qquad \text{EQ 5}$$

For more information on *k* factors see *Use of k Factor for Estimating Run Times from Previously Established Run Conditions* (publication DS-719).

## Run Speeds


The centrifugal force at a given radius in a rotor is a function of speed. Comparisons of forces between different rotors are made by comparing the rotors' relative centrifugal fields (RCF). When rotational speed is adjusted so that identical samples are subjected to the same RCF in two different rotors, the samples are subjected to the same force. The RCF at a number of rotor speeds is provided in Table 2.

Do not select rotational speeds that exceed the limits in Table 1. In addition, speeds must be reduced under the following circumstances:

1. If nonprecipitating solutions more dense than 1.2 g/mL are centrifuged, the maximum allowable run speed must be reduced according to the following equation:

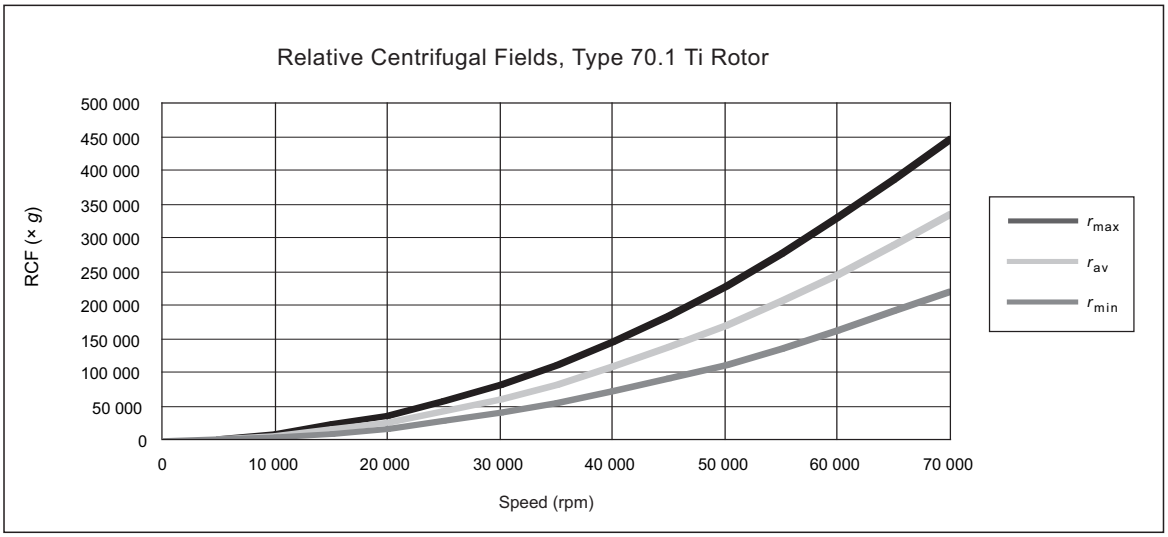
$$\text{reduced maximum speed} = (70\,000\ \text{rpm})\sqrt{\frac{1.2\ \text{g/mL}}{\rho}} \qquad \text{EQ 6}$$

   where ρ is the density of tube contents. This speed reduction will protect the rotor from excessive stresses due to the added tube load. *Note, however, that the use of this formula may still produce maximum speeds that are higher than the limitations imposed by the use of certain tubes or adapters (see Table 1).* In such cases, use the lower of the two speeds.

**Table 2** Relative Centrifugal Fields for the Type 70.1 Ti Rotor. 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 (× *g*) Inner Row | | | *k* Factor[a] |
|---|---|---|---|---|
| | At $r_{max}$ (96.4 mm) | At $r_{av}$ (81.1 mm) | At $r_{min}$ (65.7 mm) | |
| 70 000 | 450 000 | 336 000 | 222 000 | 36 |
| 65 000 | 388 000 | 290 000 | 192 000 | 42 |
| 60 000 | 331 000 | 247 000 | 163 000 | 50 |
| 55 000 | 278 000 | 207 000 | 137 000 | 59 |
| 50 000 | 230 000 | 171 000 | 113 000 | 71 |
| 45 000 | 186 000 | 139 000 | 91 900 | 88 |
| 40 000 | 147 000 | 110 000 | 72 600 | 112 |
| 35 000 | 113 000 | 84 000 | 55 600 | 146 |
| 30 000 | 82 700 | 61 700 | 40 800 | 199 |
| 25 000 | 57 400 | 42 800 | 28 400 | 286 |
| 20 000 | 36 700 | 27 400 | 18 100 | 447 |

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




**2.** *Further speed limits must be imposed* when CsCl or other self-forming-gradient salts are centrifuged, as EQ 6 does not predict concentration limits/speeds that are required to avoid precipitation of salt crystals. Solid CsCl has a density of 4 g/mL, and if precipitated during centrifugation may cause catastrophic rotor failure and instrument damage. Figure 2 and Figure 3, together with the description and examples below, show how to reduce run speeds when using CsCl gradients.

# Selecting CsCl Gradients

Precipitation during centrifugation would alter density distribution, and this would change the position of the sample bands. Curves in Figure 2 and Figure 3 are provided up to the maximum rated speed of the rotor, but note also that *tubes or bottles must never be centrifuged faster than the limits in Table 1*.

**NOTE** The curves in Figure 2 and Figure 3 are for solutions of CsCl salt dissolved in distilled water only. If other salts are present in significant concentrations, the overall CsCl concentration may need to be reduced.

Rotor speed is used to control the slope of a CsCl density gradient, and must be limited so that CsCl precipitation is avoided. Speed and density combinations that intersect on or below the curves in Figure 2 ensure that CsCl will not precipitate during centrifugation in the Type 70.1 Ti rotor. Curves are provided at two temperatures: 20°C (gray curves) and 4°C (black curves).

The reference curves in Figure 3 show gradient distribution at equilibrium. Each curve in Figure 3 is within the density limits allowed for the Type 70.1 Ti rotor: each curve was generated for a single run speed using the maximum allowable homogeneous CsCl densities (one for each fill level) that avoid precipitation at that speed. (The gradients in Figure 3 can be generated from step or linear gradients, or from homogeneous solutions. But the total amount of CsCl in solution must be equivalent to a homogeneous solution corresponding to the concentrations specified inFigure 2.) Figure 3 can also be used to approximate the banding positions of sample particles.

**Figure 2** Precipitation Curves for the Type 70.1 Ti Rotor. Using combinations of rotor speeds and homogeneous CsCl solution densities that intersect on or below these curves ensures that CsCl will not precipitate during centrifugation.

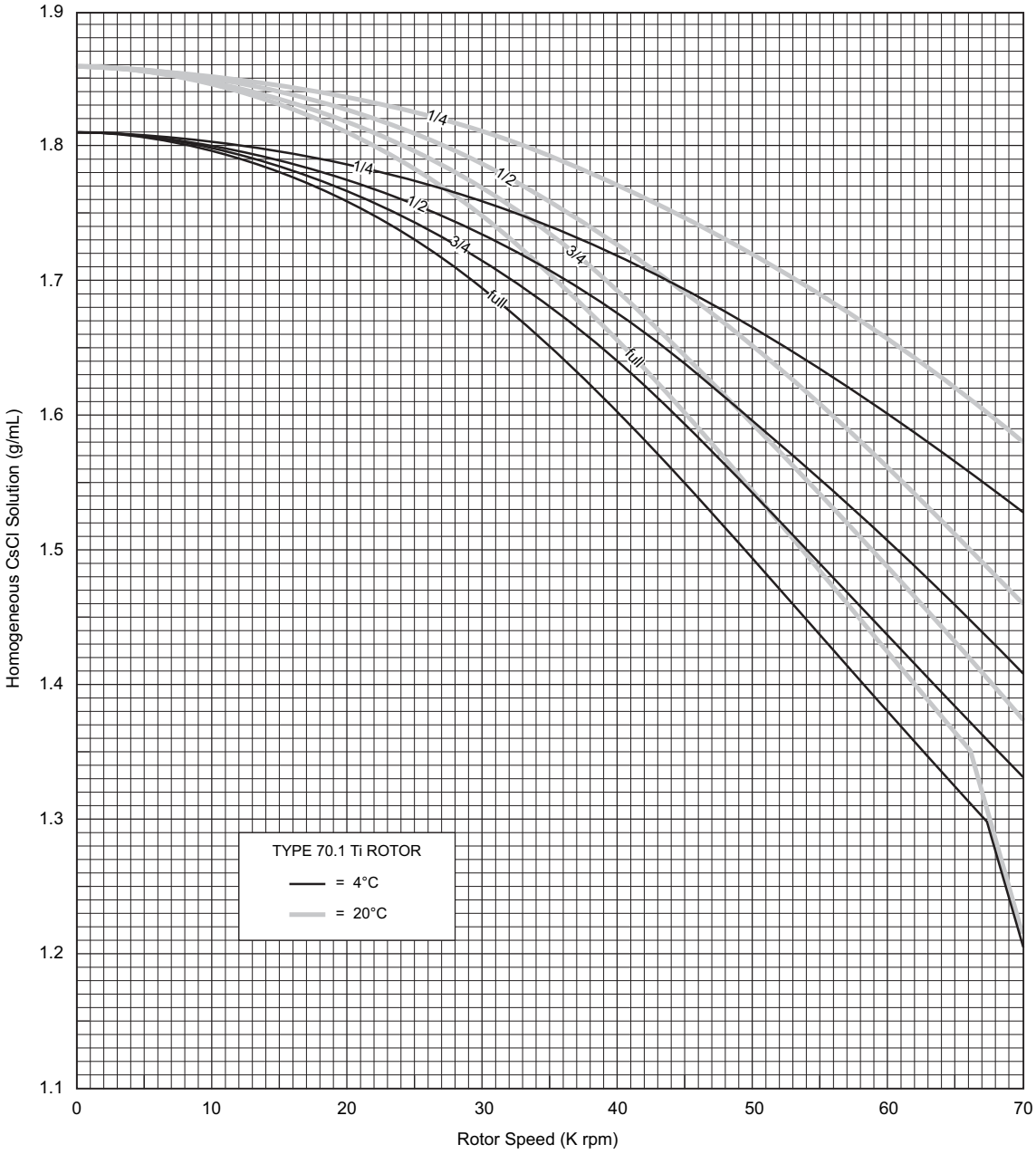
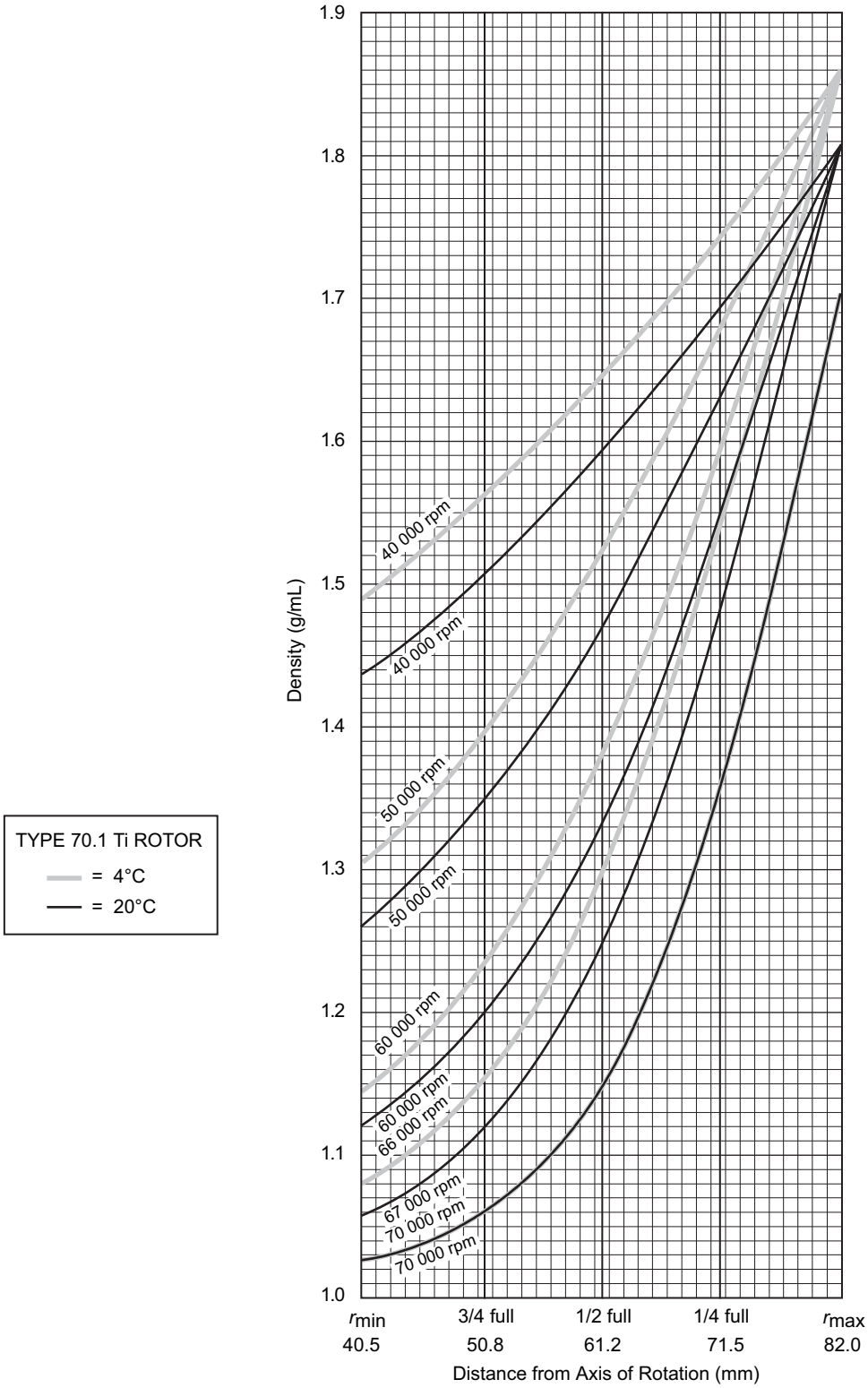


**Figure 3** CsCl Gradients at Equilibrium for the Type 70.1 Ti Rotor. Centrifugation of homogeneous CsCl solutions at the maximum allowable speeds (from Figure 2) results in gradients presented here.



## Adjusting Fill Volumes

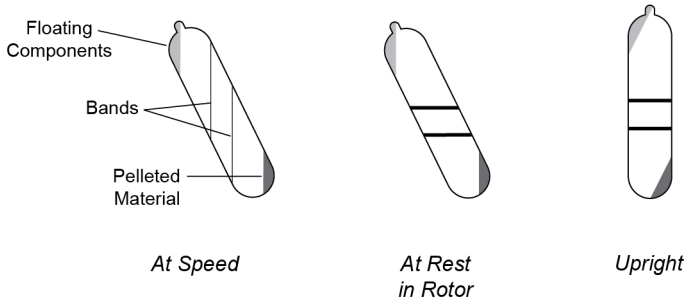
Figure 2 and Figure 3 show that several fill volumes are possible in a tube. If a tube is partially filled with gradient solution, float mineral oil (or some other low-density, immiscible liquid) on top of the tube contents to fill the tube to its maximum volume. (Do not use an oil overlay in Ultra-Clear tubes.) Note that for a given CsCl density, as the fill level decreases the maximum allowable speed increases. Partial filling may be desirable when there is little sample or when you wish to shorten the run time.

For example, a *half-filled* tube of 1.60-g/mL homogeneous CsCl solution at 4°C may be centrifuged at 50 000 rpm (see Figure 2). The segment of the 50 000-rpm curve (Figure 3) from the half-filled line to 1.81 g/mL at the tube bottom represents this gradient. The same solution in a *quarter-filled* tube may be centrifuged no faster than 60 000 rpm. (Gradient curves not shown in Figure 3 can be interpolated.) A tube *full* of the 1.60-g/mL CsCl solution may be centrifuged no faster than 40 000 rpm.

## Typical Examples for Determining CsCl Run Parameters

**Example A:**
**A separation that is done frequently is the banding of plasmid DNA in cesium chloride with ethidium bromide. The starting density of the CsCl solution is 1.55 g/mL. In this separation the covalently closed, circular plasmid bands at a density of 1.57 g/mL, while the nicked and linear species bands at 1.53 g/mL. At 20°C, where will particles band?**

1. In Figure 2, find the curve that corresponds to the required run temperature (20°C) and fill volume (full). 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's buoyant density.
3. Mark the point in the figure where each particle density intersects the curve corresponding to the selected run speed and temperature.
4. Particles will band at these locations across the tube diameter at equilibrium during centrifugation.



In this example, particles will band about 62 and 64 mm from the axis of rotation, about 2 mm of centerband-to-centerband separation at the rotor's 24-degree tube angle. When the tube is removed from the rotor and held upright (vertical and stationary), there will be about 2.19 mm of centerband-to-centerband separations.This interband distance, $d_{up}$, can be calculated from the formula:

$$d_{up} = \frac{d_\theta}{\cos\theta} \qquad \text{EQ 7}$$

where $d_\theta$ is the interband distance when the tube is held at an angle, $\theta$, in the rotor.

### Example B:
**Knowing particle buoyant densities (1.729 and 1.669 g/mL), how do you achieve good separation?**

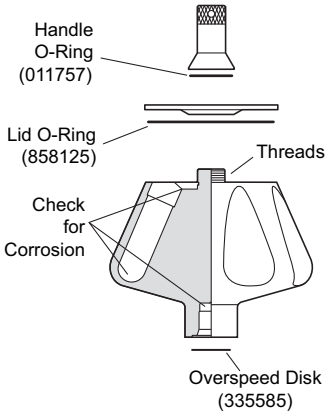
1. In Figure 3, sketch in a horizontal line corresponding to each particle's buoyant density.
2. Select the curve at the required temperature (20°C) and tube volume (half full) that gives the best particle separation.
3. Note the run speed along the selected curve (40 000 rpm).
4. From Figure 2, select the maximum homogeneous CsCl density (in this case, 1.72 g/mL) that corresponds to the temperature and run speed established above. These parameters will provide the particle-banding pattern selected in Step 2.

In this example, particles will band at about 66 and 69 mm from the axis of rotation (about 3 mm apart). When the tube is held upright there will be about 3.28 mm of center-of-band to center-of-band separation.

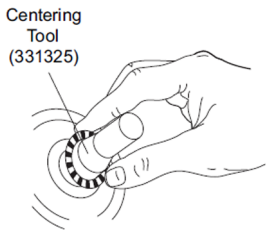
# Care and Maintenance

## Maintenance

**NOTE** Do not use sharp tools on the rotor that could cause scratches in the rotor surface. Corrosion begins in scratches and may open fissures in the rotor with continued use.




- Periodically (at least monthly) inspect the rotor, especially inside cavities, for rough spots or pitting, white powder deposits (frequently aluminum oxide), or heavy discoloration. If any of these signs are evident, do not run the rotor. Contact your Beckman Coulter representative for information about the Field Rotor Inspection Program and the rotor repair center.
- Regularly lubricate the metal threads in the rotor with a thin, even coat of Spinkote lubricant (306812). Failure to keep these threads lubricated can result in damaged threads.
- Regularly apply silicone vacuum grease (335148) to the O-rings. Replace O-rings about twice a year or whenever worn or damaged.
- Regularly inspect the overspeed disk (335585). If it is scratched, damaged, or missing, replace it according to the instructions in *Rotors and Tubes.*




Refer to the chemical resistances table in Appendix A of *Rotors and Tubes for Preparative Ultracentrifuges* (publication LR-IM-24) for chemical compatibilities of rotor and accessory materials. Your Beckman Coulter representative provides contact with the Field Rotor Inspection Program and the rotor repair center.

## Cleaning

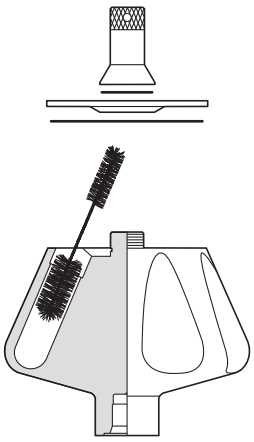
*Wash the rotor and rotor components immediately if salts or other corrosive materials are used or if spillage has occurred. Do not allow corrosive materials to dry on the rotor.*

Under normal use, wash the rotor frequently (at least weekly) to prevent buildup of residues.

**1** Remove the O-rings before washing.

**2** Wash the rotor and lid in a mild detergent, such as Beckman Solution 555 (339555), that won't damage the rotor. The Rotor Cleaning Kit (339558) contains two special plastic-coated brushes and two quarts of Solution 555 for use with rotors and accessories. Dilute the detergent 10 to 1 with water.


**NOTE** Do not wash rotor components in a dishwasher. Do not soak in detergent solution for long periods, such as overnight.



**3** Thoroughly rinse the cleaned rotor and components with distilled water.

**4** Air-dry the rotor and lid upside down. *Do not use acetone to dry the rotor.*

5 Apply a thin, even coat of silicone vacuum grease to the lid O-ring before replacing it in the groove in the outer rim of the lid. Also apply silicone vacuum grease to the handle O-ring before reassembly.

Clean metal threads every 6 months, or as necessary. Use a brush and concentrated Solution 555. Rinse and dry thoroughly, then lubricate lightly but evenly with Spinkote to coat all threads.

Periodically remove the O-rings and wipe clean as necessary. Clean the O-ring grooves with a cotton-tipped swab. Reapply a light film of silicone vacuum grease.

## Decontamination

If the rotor (and/or accessories) becomes contaminated with radioactive material, it should be decontaminated using a solution that will not damage the anodized surfaces. Beckman Coulter has tested a number of solutions and found two that do not harm anodized aluminum: RadCon Surface Spray or IsoClean Solution (for soaking)*, and Radiacwash†.

**NOTE** IsoClean can cause fading of colored anodized surfaces. Use it only when necessary and remove it promptly from surfaces.

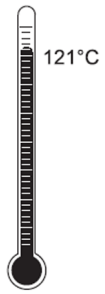
While Beckman Coulter has tested these methods and found that they do not damage components, no guarantee of decontamination is expressed or implied. Consult your laboratory safety officer regarding the proper decontamination methods to use.

If the rotor or other components are contaminated with toxic or pathogenic materials, follow appropriate decontamination procedures as outlined by your laboratory safety officer.

* In U.S., contact Nuclear Associates (New York); in Eastern Europe and Commonwealth States, contact Victoreen GmbH (Munich); in South Pacific, contact Gammasonics Pty. Ltd. (Australia); in Japan, contact Toyo Medic Co. Ltd. (Tokyo).

† In U.S., contact Biodex Medical Systems (Shirley, New York); internationally, contact the U.S. office to find the dealer closest to you.

### Sterilization and Disinfection




- The rotor and all rotor components can be autoclaved at 121°C for up to an hour. Remove the lid from the rotor and place the rotor, lid, and spacers in the autoclave upside down.

**⚠ CAUTION**

**Risk of injury or equipment damage. Ethanol is a flammability hazard. Do not use in or near operating centrifuges.**

- Ethanol (70%) or hydrogen peroxide (6%) may be used on all rotor components, including those made of plastic. Bleach (sodium hypochlorite) may be used, but may cause discoloration of anodized surfaces. Use the minimum immersion time for each solution, per laboratory standards.

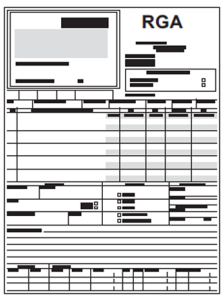
While Beckman Coulter has tested these methods and found that they do not damage the rotor or components, no guarantee of sterility or disinfection is expressed or implied. When sterilization or disinfection is a concern, consult your laboratory safety officer regarding proper methods to use.

Where sterilization is critical in your application, consider using Beckman Coulter Certified Free & Sterilized Tubes. For tubes not available in the sterilized option, refer to *Use and Care of Centrifuge Tubes and Bottles* (publication IN-192) included in each box of tubes or bottles for sterilization and disinfection procedures. *Quick-Seal and thinwall open-top tubes are disposable and should be discarded after a single use.*

### Storage

When the rotor is not in use, store it in a dry environment (not in the instrument) with the lid removed to allow air circulation so moisture will not collect in the tube cavities.

## Returning a Rotor




Before returning a rotor or accessory for any reason, prior permission (a Returned Goods Authorization form) must be obtained from Beckman Coulter, Inc. This RGA form may be obtained from your local Beckman Coulter sales office, and should contain the following information:

- serial number
- history of use (approximate frequency of use)

- reason for the return
- original purchase order number, billing number, and shipping number, if possible
- name and phone number of the person to be notified upon receipt of the rotor or accessory at the factory, and
- 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 all parts are free from pathogens and/or radioactivity. Sterilization and 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.***

Use the address label printed on the RGA form when mailing the rotor and/or accessories.

Customers located outside the United States should contact their local Beckman Coulter office.

# Supply List

**NOTE** Publications referenced in this manual can be obtained by calling Beckman Coulter at 1-800-742-2345 in the United States, or by contacting your local Beckman Coulter office.

See the *Beckman Coulter Ultracentrifuge Rotors, Tubes, & Accessories Catalog* (BR-8101, available at www.beckman.com) for detailed information on ordering parts and supplies or contact us. For your convenience, a partial list is given below.

## Replacement Rotor Parts

Type 70.1 Ti rotor assembly . . . . . 342184
Rotor handle . . . . . 337924
Handle O-ring . . . . . 011757
Lid O-ring . . . . . 858125
Overspeed disk (70 000 rpm) . . . . . 335585

## Other

Tubes, bottles, and accessories . . . . . see Table 1
OptiSeal tube rack assembly . . . . . 361642
Quick-Seal Cordless Tube Topper kit, 60 Hz . . . . . 358312
Quick-Seal Cordless Tube Topper kit, 50 Hz (Europe) . . . . . 358313
Quick-Seal Cordless Tube Topper kit, 50 Hz (Great Britain) . . . . . 358314
Quick-Seal Cordless Tube Topper kit, 50 Hz (Australia) . . . . . 358315
Quick-Seal Cordless Tube Topper kit, 50 Hz (Canada) . . . . . 367803
Tube Topper rack (16-mm dia. tubes) . . . . . 348123
Tool kit . . . . . 338841
  includes:
  Torque wrench . . . . . 858121
  Socket adapter for 20-mm (3/4-in.) hex nuts . . . . . 858122
  Socket for 20-mm (3/4-in.) hex nuts . . . . . 858123
  Socket for 11-mm (7/16-in.) hex nuts . . . . . 870432
  Tube removal tool . . . . . 301875
Floating spacer removal tool . . . . . 338765
Tube-cap vise . . . . . 305075
Removal tool (polycarbonate bottles) . . . . . 878133
Tube removal tool (Quick-Seal and OptiSeal tubes) . . . . . 361668
Spinkote lubricant (2 oz) . . . . . 306812
Silicone vacuum grease (1 oz) . . . . . 335148
Rotor Cleaning Kit . . . . . 339558
Beckman Solution 555 (1 qt) . . . . . 339555
Rotor cleaning brush . . . . . 339379
Centering tool (for replacing overspeed disk) . . . . . 331325

# Ultracentrifuge Rotor Warranty

All Beckman Coulter ultracentrifuge Fixed Angle, Vertical Tube, Near Vertical Tube, Swinging Bucket, and Airfuge rotors are warranted against defects in materials or workmanship for the time periods indicated below, subject to the Warranty Conditions stated below.

Preparative Ultracentrifuge Rotors. . . . . 5 years — No Proration

Analytical Ultracentrifuge Rotors . . . . . 5 years — No Proration

ML and TL Series Ultracentrifuge Rotors. . . . . 5 years — No Proration

Airfuge Ultracentrifuge Rotors . . . . . 1 year — No Proration

For Zonal, Continuous Flow, Component Test, and Rock Core ultracentrifuge rotors, see separate warranty.

### Warranty Conditions (as applicable)

1. This warranty is valid for the time periods indicated above from the date of shipment to the original Buyer by Beckman Coulter or an authorized Beckman Coulter representative.
2. This warranty extends only to the original Buyer and may not be assigned or extended to a third person without written consent of Beckman Coulter.
3. This warranty covers the Beckman Coulter Centrifuge Systems only (including but not limited to the centrifuge, rotor, and accessories) and Beckman Coulter shall not be liable for damage to or loss of the user's sample, non-Beckman Coulter tubes, adapters, or other rotor contents.
4. This warranty is void if the Beckman Coulter Centrifuge System is determined by Beckman Coulter to have been operated or maintained in a manner contrary to the instructions in the operator's manual(s) for the Beckman Coulter Centrifuge System components in use. This includes but is not limited to operator misuse, abuse, or negligence regarding indicated maintenance procedures, centrifuge and rotor classification requirements, proper speed reduction for the high density of certain fluids, tubes, and tube caps, speed reduction for precipitating gradient materials, and speed reduction for high-temperature operation.
5. 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.
6. This warranty does not cover the failure of a Beckman Coulter rotor in a centrifuge not of Beckman Coulter manufacture, or if the rotor is used in a Beckman Coulter centrifuge that has been modified without the written permission of Beckman Coulter, or is used with carriers, buckets, belts, or other devices not of Beckman Coulter manufacture.
7. Rotor parts subject to wear, including but not limited to rotor O-rings, VTi, NVT, TLV, MLN, and TLN rotor tube cavity plugs and gaskets, tubing, tools, optical overspeed disks, bearings, seals, and lubrication are excluded from this warranty and should be frequently inspected and replaced if they become worn or damaged.
8. Keeping a rotor log is not mandatory, but may be desirable for maintenance of good laboratory practices.

### Repair and Replacement Policies

1. If a Beckman Coulter rotor is determined by Beckman Coulter to be defective, Beckman Coulter will repair or replace it, subject to the Warranty Conditions. A replacement rotor will be warranted for the time remaining on the original rotor's warranty.
2. If a Beckman Coulter centrifuge is damaged due to a failure of a rotor covered by this warranty, Beckman Coulter will supply free of charge (i) all centrifuge parts required for repair (except the drive unit, which will be replaced at the then current price less a credit determined by the total number of revolutions or years completed, provided that such a unit was manufactured or rebuilt by Beckman Coulter), and (ii) if

the centrifuge is currently covered by a Beckman Coulter warranty or Full Service Agreement, all labor necessary for repair of the centrifuge.

3. If a Beckman Coulter rotor covered by this warranty is damaged due to a malfunction of a Beckman Coulter ultracentrifuge covered by an Ultracentrifuge System Service Agreement, Beckman Coulter will repair or replace the rotor free of charge.
4. If a Beckman Coulter rotor covered by this warranty is damaged due to a failure of a Beckman Coulter tube, bottle, tube cap, spacer, or adapter, covered under the Conditions of this Warranty, Beckman Coulter will repair or replace the rotor and repair the instrument as per the conditions in policy point (2) above, and the replacement policy.
5. Damage to a Beckman Coulter rotor or instrument due to the failure or malfunction of a non-Beckman Coulter tube, bottle, tube cap, spacer, or adapter is not covered under this warranty, although Beckman Coulter will assist in seeking compensation under the manufacturer's warranty.

### 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 BECKMAN COULTER, INC. 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.

### Factory Rotor Inspection Service

Beckman Coulter, Inc., will provide free mechanical and metallurgical inspection in Indianapolis, Indiana, USA, of any Beckman Coulter rotor at the request of the user. (Shipping charges to Beckman Coulter are the responsibility of the user.) Rotors will be inspected in the user's laboratory if the centrifuge in which they are used is covered by an appropriate Beckman Coulter Service Agreement. Contact your local Beckman Coulter office for details of service coverage or cost.

Before shipping, contact the nearest Beckman Coulter Sales and Service office and request a Returned Goods Authorization (RGA) form and packaging instructions. Please include the complete rotor assembly, with buckets, lid, handle, tube cavity caps, etc. A SIGNED STATEMENT THAT THE ROTOR AND ACCESSORIES ARE NON-RADIOACTIVE, NON-PATHOGENIC, NONTOXIC, AND OTHERWISE SAFE TO SHIP AND HANDLE IS REQUIRED.

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