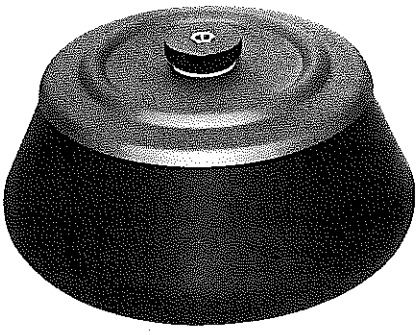
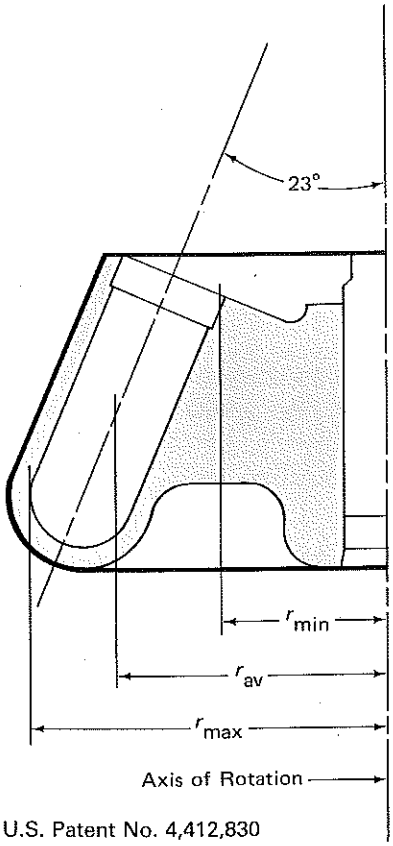
INSTRUCTIONS FOR USING THE JA-18 FIXED ANGLE ROTOR

In Beckman J2-21 and J-6 Series Centrifuges





U.S. Patent No. 4,412,830

SPECIFICATIONS (in a J2-21 Series Centrifuge)

Maximum speed	18 000 rpm*
Critical speed range†	600 to 800 rpm
Maximum solution density	1.2 g/mL
Maximum allowable imbalance of opposing loads	2 grams
Relative Centrifugal Field‡ at maximum speed	
At r_{max} (132 mm)	47 900 x g
At r_{av} (98 mm)	35 600 x g
At r_{min} (64 mm)	23 200 x g
k factor at maximum speed at r_{max}	566
Number of tube cavities	10
Available tubes	see Table 1
Nominal dimensions of largest tube	38 x 102 mm
Nominal tube capacity	100 mL
Nominal rotor capacity	1000 mL
Approximate acceleration time to maximum speed (rotor fully loaded)	6.5 min
Approximate deceleration time from maximum speed (max. brake, rotor fully loaded)	5 min
Weight of fully loaded rotor	26 lb (12 kg)
Rotor material	aluminum
Conditions requiring speed reductions	see Speed Limits
Rotor entry code	18

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* Or lower, depending upon the type of tube used (see Table 1).

† The Critical Speed Range is the range of speeds over which the rotor shifts so as to rotate about its center of mass. Passing through the Critical Speed Range is characterized by some vibration.

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

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

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

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

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DESCRIPTION

The JA-18 fixed angle rotor, rated for 18 000 rpm, is designed to hold up to ten 100-mL tubes at a 23-degree angle. Used in J-6 series centrifuges, the rotor develops centrifugal forces that efficiently pellet cells; in the J2-21 series centrifuges, smaller particles such as cellular organelles and membrane fragments can also be pelleted. Short column methods (i.e., partially filled tubes) may be used to shorten run times.

The rotor and lid are made of anodized aluminum (see Figure 1). Pins in the drive hole of the rotor seat into the centrifuge drive hub and prevent the rotor from slipping. The knob on the rotor lid acts as a tool for securing the rotor to the drive hub. An air pressure differential caused by the rotor as it spins keeps the lid in place. The rotor is warranted for seven years (see the Warranty).

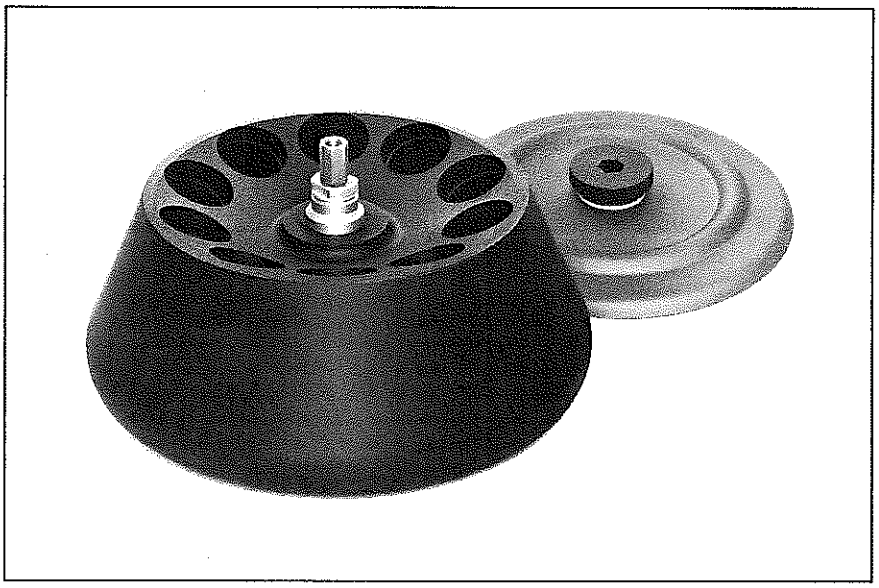

Figure 1. The JA-18 Fixed Angle Rotor

OPERATION

The tubes and bottles listed in Table 1 may be run in the JA-18. Be sure to observe the maximum speeds given as well as the other conditions specified (see also Speed Limits). Adapters are required for some containers. Certain adapters may also be used inside other adapters as listed, providing a greater range of tube selection for different applications. For runs at temperatures other than room temperature, refrigerate or warm the rotor beforehand. Containers may be centrifuged at most normal operating temperatures but you should test them first under simulated conditions if you will be operating below 4°C or above room temperature. (For the care, cleaning, sterilization, and chemical resistances of materials, see bulletin IN-175.)

CAUTION

Tubes with snap-on caps *must not* be run in this rotor. The forces generated cause the snap-on caps to come off, which could dislodge the rotor lid. Bottles and tubes with screw-on caps should be used in place of tubes with snap-on caps.

Table 1. Available Bottles and Tubes for the JA-18 Fixed Angle Rotor

Part Number	Description	Nominal Volume per Tube (mL)	Actual [a] Volume per Tube (mL)	Maximum Speed (rpm)	Tube Size (mm)	Cap [b] Required	Adapter Required
301099	SS	6.5		18 000	13x64	c	303449
326820	PA	6.5		18 000	13x64	346256	303449
355644	TPA	6.5	3.9	18 000 [d]	13x64	none	303449
355645	TPC	6.5	3.9	18 000	13x64	none	303449
344088	UC	6.5		18 000	13x64	346256	303449
326822	PA	10.5		18 000	13x89	346256	303459
355639	TPA	10.5	5.9	18 000 [d]	13x89	none	303459
355629	TPC	10.5	5.9	18 000	13x89	none	303459
344087	UC	10.5		18 000	13x89	346256	303459
301108	SS	13.5	10	18 000	16x76	c	303448
326814	PA	13.5		18 000	16x76	330860	303448
355640	TPA	13.5	7.5	18 000 [d]	16x76	338907	303448
355630	TPC	13.5	7.5	18 000	16x76	338907	303448
344085	UC	13.5		18 000	16x76	330860	303448
355672	PC Bottle	10		18 000	16x80	capped	870329 [e]
335432	P	15	11	4 000	16x100	none	870329 [e]
335430	C	15	14	9 000	17x100	none	870329 [e]
[f]	conical tube	15		15 000 [f]	17x120	sealed	356962 [f]
335431	C	30	25	9 000	25x105	none	870331
355660	PP Tube	50	32	18 000	29x103	g	347539
355661	PC Tube	50	32	18 000	29x103	g	347539
355670	PC Bottle	50	45	18 000	29x104	capped	347539
355671	PA Bottle	50	45	18 000	29x104	capped	347539
355600	PC Bottle Assy	50		18 000	29x104	sealed	347539
355602	PP Bottle Assy	50		18 000	29x104	sealed	347539
[h]	conical bottle	50		14 000 [h]	30x115	sealed	356963 [h]
345775	PA	94		18 000	38x102	330901	none
345777	UC	94		18 000	38x102	330901	none
303380	SS	94		18 000	38x102	c	none
355643	TPA	94	50	18 000 [d]	38x102	338905	none
355628	TPC	94	50	18 000	38x102	338905	none
355620	PC Bottle	70		18 000	38x102	sealed	none
355624	PP Bottle [j]	100		18 000	38x102	sealed	none

P = Pyrex; C = Corex (do not run these tubes below 4°C); PC = Polycarbonate; TPC = Thickwall Polycarbonate; PA = Thinwall Polyallomer; TPA = Thickwall Polyallomer; PP = Polypropylene; SS = Stainless Steel; UC = Ultra-Clear. Sealed containers are bottles with 3-piece, liquid-tight cap assemblies. Capped containers are bottles with single-piece caps which are not liquid-tight (if filled to maximum capacity, some leakage may occur). Pyrex and Corex are registered trademarks of Corning Glass Works.

[a] You may fill containers less than or equal to these volumes; above 20°C, fill polypropylene tubes at least half full. Where actual volumes are listed, figures represent the amount of sample which can be run in an open container. Blank spaces indicate that volumes remain unchanged from listed nominal figures (i.e., sealed containers).

[b] Tube caps are required when Ultra-Clear and thinwall polyallomer tubes are run in fixed angle rotors. Tube caps are optional for thickwall polyallomer, thickwall polycarbonate, and stainless steel tubes. Caps are not available for some tubes which are intended solely for capless use.

Footnotes continued—

ROTOR PREPARATION AND INSTALLATION

Before installing the JA-18 rotor, lightly coat the centrifuge drive hub where it will contact the rotor drive hole using Spinkote ™ lubricant. A lifting handle is provided for installing and removing the rotor. Place the lid on the rotor and, while holding the lid knob with one hand, screw the lifting handle into the threads in the top of the rotor tie-down bolt until it is tight (see Figure 2). Carefully lower the rotor *straight down* onto the centrifuge drive hub. While again holding the lid knob, unscrew the lifting handle from the rotor.

CAUTION

The centrifuge drive hub can be bent if the rotor is forced sideways or dropped onto it. Install the rotor by centering it over the hub and carefully lowering it straight down.

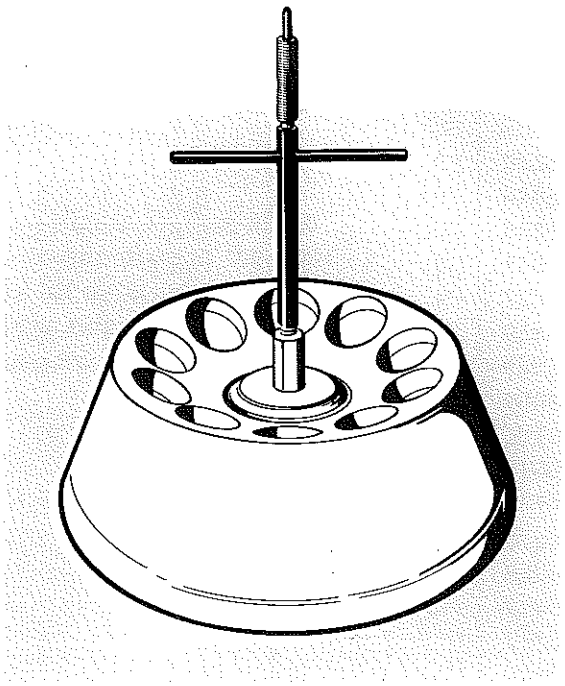

Figure 2. Using the Lifting Handle

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[c] Stainless steel tubes may be run without caps. When caps are desired, four different kinds are available: for $^1/_2$-inch-diameter tubes, there are an all-aluminum cap (303113), an aluminum cap with filling hole (346256), and an aluminum cap with stainless steel stem (305022); for $^5/_8$-inch, 1-inch, and 1-$^1/_2$-inch tubes there are all-aluminum caps (303319, 302133, and 326905).

[d] The maximum speed for polyallomer tubes run without caps is 15 000 rpm.

[e] Adapter 870329 fits inside adapter part number 342327; both are then used inside adapter part number 347539.

[f] Conical tubes from a number of other manufacturers may be used with this conical tube adapter. Beckman has tested several and recommends that tubes not be run higher than 15 000 rpm at temperatures of 20°C or below; at higher temperatures, reduce speed to 13 000 rpm. Because Beckman cannot test all manufacturer's tubes with respect to their ability to withstand the *g*-forces generated by this rotor, it is highly recommended that you pretest any other manufacturer's tubes in this adapter using water samples. Special note: the length of tubes used in this adapter prevents the lid from seating properly on the rotor. *Do not use the lid* when running tubes in these adapters.

[g] This part number is for the bottle only since these bottles *must not* be run with caps. Caps are available, however, for storing samples in these bottles.

[h] Conical tissue culture tubes from a number of other manufacturers may be used with this conical adapter. Beckman has tested several and recommends that tubes not be run higher than 14 000 rpm at temperatures of 20°C or below; at higher temperatures, reduce speed to 11 000 rpm. Because Beckman cannot test all manufacturer's tubes with respect to their ability to withstand the *g*-forces generated by this rotor, it is highly recommended that you pretest any other manufacturer's tubes in this adapter using water samples. Special note: the length of tubes used in this adapter prevents the lid from seating properly on the rotor. *Do not use the lid* when running tubes in these adapters.

[j] This bottle assembly was specially designed for use in this rotor. It includes a one-piece screw-top cap with an O-ring seal. Since the bottle is made of thinwall polyallomer, some deformation is to be expected; this deformation will not affect performance. *The bottle must be filled to the neck or above to minimize deformation.* If desired, the bottle may be submerged in hot water or autoclaved to recover its original shape. The cap may also be autoclaved. *The bottle cap (and sealing surface of the O-ring) must be thoroughly dry before use.* The O-ring does not normally need to be removed; if you remove it for cleaning or replacement, take care not to damage the groove in the cap.

If you wish to order separate components of the assembly, part numbers are as follows: bottle only: 355626, cap: 355625, O-ring for cap: 889633.

Turn the rotor slowly by hand until the rotor pins seat correctly in the grooves in the drive hub (see Figure 3). The lid handle fits over the hex hub and acts as a wrench; turning the handle clockwise attaches the rotor to the hub. The lid remains free and may simply be slipped on or off while the rotor remains secured in the centrifuge.

NOTE: This rotor was designed to run with the lid in place, but the rotor can be run without the lid. Once the rotor is fastened, the lid can be lifted off while the rotor remains secured in the centrifuge. If the rotor is run without the lid, air friction and turbulence may prevent the rotor from reaching its top speed. In addition, temperature control may be impaired. If you run the rotor routinely without the lid, you should make a practice of tightening the rotor tie-down bolt before every run.

CAUTION

The pins located in the rotor drive hole must be seated in the bottom of the grooves in the drive hub before attempting to run the centrifuge. Running a rotor that is seated incorrectly can result in rotor failure.

LOADING THE ROTOR

You may load the rotor either in or out of the centrifuge. Slip the lid off the hex hub and fill the rotor. Tubes must be placed symmetrically around the center of the rotor and opposing loads should balance to within 2 grams. Do not use rubber adapters in which glass tubes have previously broken. Pieces of glass will be embedded in the rubber, and will damage or break subsequently used tubes.

Consult the appropriate instrument instruction manual for centrifuge operation. See also Temperature, below.

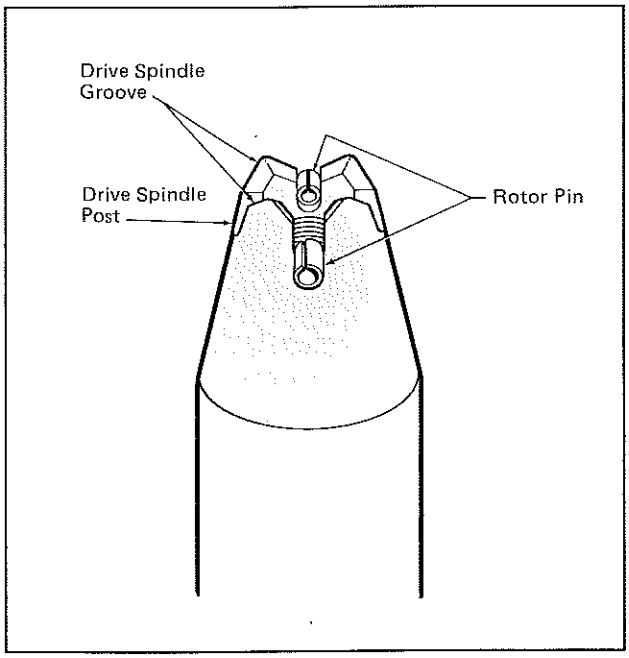

Figure 3. Make Sure the Rotor is Properly Seated. The pins in the rotor drive hole must be located in the grooves of the drive spindle as shown.

ROTOR REMOVAL

> **NOTE:** Always remove filled tubes or bottles from the rotor before removing the rotor from the centrifuge.

With the lid in position on the rotor, turn the lid handle counterclockwise to unscrew the rotor tie-down bolt from the hub. You may use the lifting handle to remove the rotor from the centrifuge, if desired, attaching it as previously explained. Lift the rotor straight up off the drive hub to prevent damaging or bending the hub.

Should the rotor stick to the drive hub of the centrifuge, use the other end of the rotor lifting handle (the rotor removal tool) to release it (see Figure 4). Remove the lid and use an adjustable wrench to unscrew the tie-down bolt assembly from the rotor. Set the bolt assembly aside. Screw the rotor removal tool into the threaded opening. As the removal tool tightens down, it will push against the drive hub, forcing the rotor up and off of it. Unscrew the removal tool. Then reassemble the tie-down bolt in the rotor and tighten it securely with the adjustable wrench. You should now be able to remove the rotor from the centrifuge. Lubricating the centrifuge drive hub with a light coat of Spinkote should prevent the rotor from sticking.

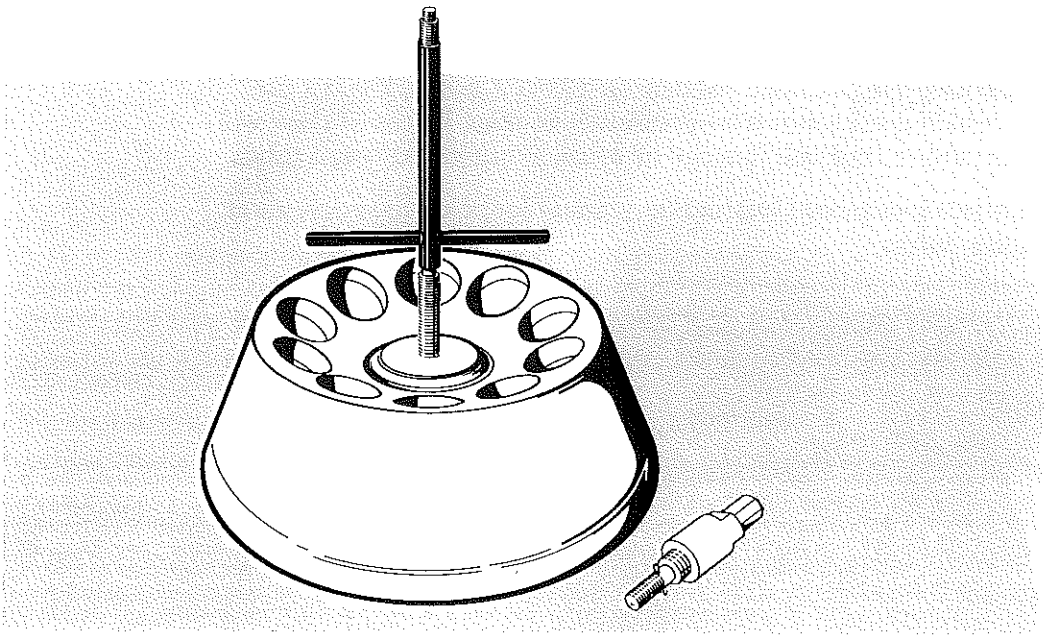

Figure 4. Using the Rotor Removal Tool

RUN CONDITIONS

Time

Run times for pelleting in the JA-18 rotor can be readily estimated if the sedimentation coefficients (s) of the particles are known. Use the following equations. The rated k factor of the rotor at maximum speed is 566 for full tubes, s is in Svedberg units, and the run time t is in hours.

$$t = \frac{k}{s}$$

For example, at 18 000 rpm in this rotor, calculations indicate that E. Coli (s = 3600) will pellet in about nine minutes.

Since listed k factors are calculated for the rotor's maximum speed, the value of k must be adjusted if the rotor is to be run at less than 18 000 rpm as follows:

$$k = k_{\text{rated}} \left(\frac{18\ 000}{\text{actual speed}} \right)^2$$

Temperature

> **NOTE:** Should extremely accurate temperature control be required, sample temperature should be determined after a timed run (which should be long enough to ensure that the rotor has reached temperature equilibrium) and the setting may be adjusted accordingly.

Centrifuge temperature control settings for the JA-18 rotor depend on which centrifuge is used. Table 2 provides information required for proper temperature control in the J2-21 Model Centrifuge. Temperature control values must be empirically determined for J-6, J-21, J-21C, and J-21B Model Centrifuges. Rotor temperature settings in the J-6B centrifuge directly reflect chamber temperatures.

Temperature compensation is not automatically set when the rotor code is entered in microprocessor-controlled centrifuges. The information in Tables 3 and 4 must be entered for J-6M, J-6M/E, J2-21M, and J2-21M/E centrifuges.

Find the compensation value which corresponds with the desired run temperature and rotor speed. To enter this value, you need only do the following:

1. Press [COMP ADJ]. The word "COMP" flashes below the TEMPERATURE display and the display flashes.
2. Press the appropriate keyboard digits to enter the compensation value. Press the [±] key for a minus sign; pressing it again will remove the minus sign.
3. Check the temperature display. If the entry is incorrect, press [CE] and reenter the digits.
4. When the entry is correct, press [ENTER/RECALL].

> **NOTE:** To clear a COMP ADJ entry, press [COMP ADJ], [0], and [ENTER/RECALL].

Speed Limits

The centrifugal force at a given radius in a rotor is a function of run speed. Comparisons of forces between different rotors are made by comparing the rotors' relative centrifugal fields (RCF). When rotational speed is selected so that identical samples are subjected to the same RCF in two different rotors, one may then describe the samples as being subjected to the same force (see Table 5). Rotational speeds may not be selected in excess of the limits provided in Table 1.

Table 2. J2-21 Centrifuge Temperature Settings. Turn the SET *knob to the desired sample temperature and set the* COMPENSATE *dial on the appropriate setting given in the table. Interpolate if intermediate values are required.*

Rotor Speed (rpm)	Desired Sample Temperatuare (°C, green bar)						
	-20°	-10°	2°	5°	10°	20°	40°
18 000	*N*	*N*	*N*	*N*	*N*	–10	–7
17 000	*N*	*N*	*N*	–10	–9	–8	–6
16 000	*N*	*N*	–10	–10	–9	–7	–5
12 000	*N*	–6	–6	–6	–5	–4	–3
8 000	–5	–4	–4	–3	–2	–1	0
5 000	–4	–3	–2	–2	–1	0	0

An *"N"* indicates that the rotor cannot achieve the desired temperature at this speed.

Table 3. J-6M Centrifuge Temperature Settings. Enter the desired temperature compensation listed in this table using the instructions given under "Temperature" in this bulletin.

Rotor Speed (rpm)	Desired Sample Temperature (°C)			
	2°	10°	20°	40°
6000	–3	–2	0	*N*
4000	–2	0	0	*N*
2000	–1	0	0	*N*

An *"N"* indicates that the rotor cannot achieve the desired temperature at this speed.

Table 4. J2-21M Centrifuge Temperature Settings. Enter the desired temperature compensation listed in this table using the instructions given under "Temperature" in this bulletin.

Rotor Speed (rpm)	Desired Sample Temperature (°C)						
	-20°	-10°	2°	5°	10°	20°	40°
18 000	*N*	*N*	*N*	*N*	*N*	–9	–7
17 000	*N*	*N*	*N*	–9	–9	–8	–6
16 000	*N*	*N*	–9	–9	–9	–8	–5
12 000	*N*	–9	–8	–6	–4	–4	–3
8 000	–5	–4	–3	–3	–2	–1	0
5 000	–4	–3	–2	–2	–1	0	0

An *"N"* indicates that the rotor cannot achieve the desired temperature at this speed.

When solutions more dense than 1.2 g/mL are centrifuged in this rotor, use the following equation to calculate the maximum allowable rotor speed.

$$\text{reduced maximum speed} = (18\ 000\ \text{rpm})\sqrt{\frac{1.2\ \text{g/mL}}{\text{density of tube contents}}}$$

Table 5. Relative Centrifugal Fields. Entries in this table are calculated from the formula RCF = 1.12 r (RPM/1000)² and then rounded to three significant digits.

Rotor Speed (rpm)	Relative Centrifugal Field (x g)		
	At r_{max} (132 mm)	At r_{av} (98 mm)	At r_{min} (64 mm)
18 000	47 900	35 600	23 200
17 500	45 300	33 600	22 000
17 000	42 700	31 700	20 700
16 500	40 200	29 900	19 500
16 000	37 800	28 100	18 400
15 500	35 500	26 400	17 200
15 000	33 300	24 700	16 100
14 500	31 100	23 100	15 100
14 000	29 000	21 500	14 000
13 500	26 900	20 000	13 100
13 000	25 000	18 500	12 100
12 500	23 100	17 200	11 200
12 000	21 300	15 800	10 300
11 500	19 600	14 500	9 480
11 000	17 900	13 300	8 670
10 500	16 300	12 100	7 900
10 000	14 800	11 000	7 170
9 500	13 300	9 910	6 470
9 000	12 000	8 890	5 810
8 500	10 700	7 930	5 180
8 000	9 460	7 020	4 590
7 500	8 320	6 170	4 030
7 000	7 240	5 380	3 510
6 500	6 250	4 640	3 030
6 000	5 320	3 950	2 580
5 500	4 470	3 320	2 170
5 000	3 700	2 740	1 790
4 500	2 990	2 220	1 450
4 000	2 370	1 760	1 150
3 500	1 810	1 340	878
3 000	1 330	987	645
2 500	924	686	448
2 000	591	439	286
1 500	332	246	161
1 000	147	109	71

MAINTENANCE

Routinely apply a light coat of Spinkote to the drive hub of the centrifuge to prevent the rotor from sticking. Do not use sharp metal tools on the rotor, since corrosion begins in scratches and may open fissures in the metal with increased use. If the rotor has been scratched by broken glass tubes or metal tools, ask your local Beckman office about having the rotor reanodized. To prevent corrosion, store the rotor upside down with the lid off. Do not store the rotor in the centrifuge. See publication IN-175, *Chemical Resistance Table*, to evaluate your rotor's ability to withstand a given chemical solution.

INSPECTION

Periodically inspect the rotor (especially inside the cavities) for rough spots, pitting, white powder deposits (frequently aluminum oxide), or heavy discoloration. If any of these signs are evident, *do not run the rotor.* Show it to your Beckman Field Service Representative. Your Beckman Representative provides contact with both the Field Rotor Inspection Program and the rotor repair program.

CLEANING

Under normal use, you should wash the rotor at least once a week. Wash the rotor immediately after use if you have run salt solutions or other corrosive materials, or if spillage has occurred. Do not allow corrosive solutions to dry on or in the rotor. Most laboratory detergents are too harsh for use on anodized aluminum rotors. Beckman has prepared a detergent (Solution 555 ™) for use with all rotors and rotor accessories (the Rotor Cleaning Kit contains two quarts of Solution 555 and brushes that will not scratch the rotor). Solution 555 should be diluted 5 or 10 to 1 with water. Rinse a cleaned rotor with distilled water and air dry upside down. Do NOT use acetone to dry the rotor.

DECONTAMINATION

An anodized rotor contaminated with radioactive material should be decontaminated using a solution which will not damage its anodized surface. Beckman has tested a number of solutions and can recommend two which do not harm anodized aluminum: RAD-CON (Nuclear Associates, Carle Place, New York 11514) and RADIACWASH (Atomic Products Corp., Center Moriches, New York 11934). Beckman does not, however, attest to the decontaminating capability of these solutions.

If the rotor should be contaminated with pathogenic material, follow guidelines for decontamination established by your laboratory safety officer. See publication IN-175, *Chemical Resistance Table*, to evaluate your rotor's ability to withstand a given chemical solution.

CAUTION

Strongly alkaline solutions will damage the rotor.

SUPPLY LIST

JA-18 Rotor 346944
Spinkote lubricant 335148
Solution 555 339555
Tubes and adapters ..... see Table 1
Rotor cleaning kit 339558
Rotor removal/lifting tool 346965

SPECIAL J2-21 SERIES ROTOR WARRANTY

Subject to the conditions specified below and the warranty clause of the Beckman terms and conditions of sale in effect at the time of sale, Beckman agrees to correct either by repair, or, at its election, by replacement any defects of material or workmanship which develop within seven (7) years after delivery of a J2-21 series rotor to the original buyer by Beckman or by an authorized representative, provided that investigation and factory inspection by Beckman discloses that such defect developed under normal and proper use. Should a Beckman centrifuge be damaged due to a failure of a rotor covered by this warranty, Beckman will supply free of charge all centrifuge parts required for repair.

REPLACEMENT

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

A defective rotor will be replaced by Beckman at its then current list price less a credit based upon the age of the rotor (years since date of purchase). The Buyer shall not receive credit until the claimed defective rotor is returned to Beckman's Spinco Division at Palo Alto, California, or delivered to a Beckman Field Service Representative.

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

Replacement price =

$$\text{Current rotor list price} \times \frac{\text{years}}{7}$$

CONDITIONS

1. Except as otherwise specifically provided herein, this warranty covers the rotor only and Beckman shall not be liable for damage to accessories or ancillary supplies including but not limited to (i) tubes, (ii) tube caps, (iii) tube adapters or (iv) tube contents.

2. This warranty is void if the rotor has been subjected to customer misuse such as operation or maintenance contrary to the instructions in the Beckman rotor or centrifuge manual.

3. This warranty is void if the rotor is operated with a rotor drive unit or in a centrifuge unmatched to the rotor characteristics, or is operated in a Beckman centrifuge that has been improperly disassembled, repaired or modified.

4. Rotor bucket sets purchased concurrently with or subsequent to the purchase of a swinging bucket rotor are warranted only for term coextensive with that of the rotor for which the bucket sets were purchased.

DISCLAIMER

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