

**INSTALLATION, OPERATION AND SERVICE MANUAL**

**MODEL HN-SII**

**GENERAL PURPOSE CENTRIFUGE**

**Catalog No. 2355 (115 VAC, 60 Hz)**

**Catalog No. 2356 (230 VAC, 50 Hz)**

**IM-201**

**JANUARY, 1977**

 **DAMON/IEC DIVISION**  
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Telex 92-2499 INTLEQUIPNEDM Cable INTERCOBOSTON



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## 1.0 GENERAL DESCRIPTION

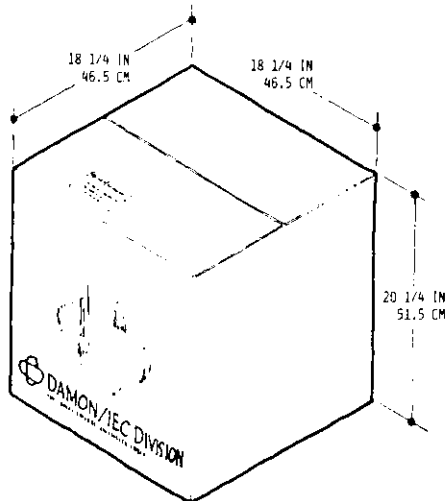
### 1.1 Purpose of Manual

This manual provides installation, operating and servicing instructions for the Model **HN-SII** Centrifuge manufactured by the IEC Division of Damon Corporation. The **HN-SII** is a general purpose bench top centrifuge designed for use in the medical, industrial, and scientific laboratory to perform separations by centrifugal force. It is listed as a device in accordance with HEW and FDA regulations governing distribution and use of such products.

The **HN-SII** is designed for 115 VAC, 60 Hz (Catalog No. 2355), or 230 VAC, 50 Hz operation (Catalog No. 2356).

### 1.2 Description of Centrifuge

The IEC **HN-SII** Centrifuge combines the economy and space-saving conveniences of bench type centrifuges with many of the performance advantages of larger cabinet models. This versatile unit accepts oil and Babcock testing accessories, a hematocrit rotor, multiple carriers, and more than 50 general purpose laboratory rotor and accessory combinations, with capacities of up to 100 ml bottles. The **HN-SII** provides a maximum speed of 4,900 rpm, maximum relative centrifugal force (RCF) of  $2,750 \times g$ , and maximum volume of 684 ml (see Speed/Force Table for accessories). The Hemato-kit™ Rotor (Cat. No. 930) provides  $6200 \times g$  at 7800 RPM. It is widely accepted for the most routine applications of clinical and industrial laboratories as well as the more varied, esoteric procedures of research centers.



A solid-state stepless speed control system includes a direct-readout electric tachometer for continuous indication of speed. The system provides automatic acceleration to selected speed, accurate and repeatable to within  $\pm 2\%$  at rated voltage.

The **HN-SII** employs a rugged, series-wound high torque motor. Two permanently sealed self-lubricating ball bearings assure smooth, quiet, and dependable operation.

A 60-minute electric timer automatically shuts the centrifuge off at any pre-determined time between 2 and 60 minutes. A continuous-operation mode is provided for longer runs. The **HN-SII** features an electric brake that can be used to reduce coast time by approximately 50%.

The instrument panel is located at the base of the machine to provide easy access to all controls. The solid, steel construction of the guard bowl and cover contributes to quiet operation, reliability, and operator safety. Three rubber feet mounted on the base absorb sound and vibration, and increase stability. Brushes are accessible for replacement.

### 1.3 Specifications

Table 1-1 provides a quick-reference listing of the major specifications.

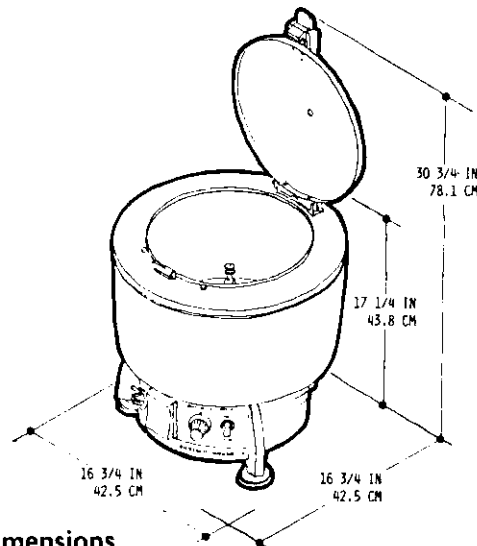


Figure 1-1 Outline Dimensions

**TABLE 1 - 1**  
**SPECIFICATIONS**

|                               |             |   |
|-------------------------------|-------------|---|
| SPEED, ATTAINABLE:            | ANGLE       | — 4900 RPM W/803 ROTOR, 356 SHIELDS   |
|                               | HORIZONTAL  | — 4150 RPM W/215 ROTOR, 366 TRUNNION RINGS,<br>369 MULTIPLE CARRIERS  |
|                               | HEMATO-KIT™ | — 7800 RPM W/930 ROTOR ALL AT 120 VAC, 60 Hz<br>(See Speed/Force Table for complete accessories and ranges.)        |
| RCF, ATTAINABLE:              | ANGLE       | — 2750 x g W/803 ROTOR, 356 SHIELDS   |
|                               | HORIZONTAL  | — 2250 x g W/215 ROTOR, 325 TRUNNION RINGS,<br>320 SHIELDS, MISCELLANEOUS ADAPTERS                                  |
|                               | HEMATO-KIT™ | — 6200 x g W/930 ROTOR, ALL AT 120 VAC, 60 Hz<br>(See Speed/Force, Table 3-3, for complete accessories and ranges.) |
| VOLUME, MAXIMUM:              | HORIZONTAL  | — 19ml x 36 = 684ml   |
|                               | ANGLE       | — 19ml x 24 = 456ml   |
| TUBE CAPACITY, MAXIMUM:       | HORIZONTAL  | — 48 TUBES (5ml ea.)  |
|                               | ANGLE       | — 24 TUBES (19ml ea.)   |
| TIMER:                        | RANGE       | — 2 to 60 MINUTES   |
|                               | TYPE        | — ELECTRIC  |
| TACHOMETER RANGE              |             | — 0-9000 RPM  |
| ACCURACY & REPEATABILITY      |             | — ± 2% of FULL SCALE  |
| TACHOMETER GRADUATIONS        |             | — 500 RPM INCREMENTS  |
| CENTRIFUGE MOTOR              |             | — 1/7 HP RATING AT 4000 RPM, 120 VAC, 60 Hz, 3.3<br>AMP. MAX.   |
| BRAKE RATE                    |             | — APPROX. 1/2 of COAST TIME   |
| HEIGHT WITH COVER OPEN        |             | — 78.1 cm (30¾")  |
| HEIGHT WITH COVER CLOSED      |             | — 43.8 cm (17¼")  |
| WIDTH                         |             | — 42.5 cm (16¾")  |
| DEPTH                         |             | — 42.5 cm (16¾")  |
| INSIDE DIAMETER OF GUARD BOWL |             | — 41.9 cm (16½")  |
| POWER, NOMINAL                |             | — 115±10% VAC, 60 Hz 3.3 AMPS (CAT. NO. 2355)<br>230±10% VAC, 50 Hz 1.7 AMPS (CAT. NO. 2356)                        |
| POWER CONSUMPTION             |             | — 150 WATTS OPERATING   |
| HEAT PRODUCED                 |             | — 520 BTU/HR. OPERATING   |
| NET WEIGHT                    |             | — 24.3 Kg (53.5 lbs.)   |
| SHIPPING WEIGHT               |             | — 27.3 Kg (60.1 lbs.)   |

## 1.4 Warranty

Damon/IEC Division warrants that it will repair or replace, free of charge to an Authorized Dealer of Damon/IEC Division any instrument which fails within one (1) year after delivery to the original customer because of defective material or workmanship, provided it does not fail under the exceptions and conditions specified in the warranty given with the instrument. Such exceptions and conditions include, but are not limited to, failure of parts due to natural wear, accident, neglect or operation in a manner not prescribed in the operating instructions supplied with the instrument. The foregoing expresses Damon/IEC Division's sole warranty with respect to the instrument. **THIS WARRANTY IS MADE IN LIEU OF ANY AND ALL OTHER WARRANTIES AND ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED AND EXCLUDED.** Damon/IEC Division and its Authorized Dealers will not be liable for consequential damages, loss or expense arising from the improper use of the instrument. Damon/IEC Division will not honor any other warranty given by the Authorized Dealer which is different from the warranty given by Damon/IEC Division. This warranty is not assignable and is operative only in favor of the original customer to whom this warranty is delivered.

### DEALER OBLIGATION UNDER WARRANTY

1. Any instrument having a retail value of over \$1000 will be installed by an Authorized Factory-Trained Dealer Serviceperson and the customer will be instructed in its use by a dealer representative.
2. Customers requesting service for an instrument during the period covered by warranty should receive a response, within a 48-hour period, from the Authorized Dealer who sold the instrument. If this obligation is not met and the customer so advises Damon/IEC Division, such Authorized Dealer will be notified of, and responsible for, the action taken, and expense incurred, by Damon/IEC Division in satisfying the customer.

### DISCLAIMERS AND EXCLUSIONS

The Installation, Operation and Service Manual supplied with this instrument includes a service troubleshooting chart. However, you are under no obligation to locate or remedy any service problem. You hereby release and forever discharge Damon/IEC Division, its successors, assigns, subsidiaries, affiliates, officers, agents, and employees from any and all claims, demands and liabilities in law or in equity, of any nature, based upon, arising out of, or resulting from locating, remedying or attempting to locate or remedy any service problem. Should

service be required, contact the dealer from whom you purchased this instrument to obtain service by factory-trained personnel.

The information included in this Installation, Operation and Service Manual is believed adequate for the operation and intended use of this instrument. If the instrument is to be used for any purpose exceeding or deviating from the capabilities specified herein, then written confirmation of acceptability for such purpose should be obtained from Damon/IEC Division. Failure to do so will affect the warranty, and Damon/IEC Division will not guarantee any results nor assume any obligation or liability arising from such unconfirmed action.

## 1.5 Ordering Information and Factory Returns

To obtain service and/or replacement parts under warranty, you should contact the authorized Damon/IEC Division dealer from whom you purchased your machine, or write directly to Damon/IEC Division, 300 Second Avenue, Needham Hgts., Massachusetts 02194, Attention: Service Manager. Your correspondence must include the model and serial number of your machine, the date of its delivery, and the name of the dealer from whom you purchased it. Damon/IEC Division can not accept goods returned without proper authorization. A "Returned Goods Authorization" must be obtained through a dealer and accompany the prepaid return shipment.

To obtain service and/or replacement parts not under warranty, or to order additional accessories, you may contact any authorized Damon/IEC dealer.

*NOTE: In the event you wish to return the machine or any part, you must comply with the following:*

1. If the machine or any part has been exposed or used to process potential pathogenic or radioactive material, you are required to decontaminate the machine or part being returned to insure there is no radioactivity or harmful bacteria present and to advise us accordingly.

2. Decontaminate the machine or any part that may have accumulated blood or any other chemical deposits by using standard laboratory procedures. Should this machine or any part be received in a condition we consider to be a potential biological hazard to our personnel, it will be returned to you unrepaired, at your expense, along with a report of our findings.

## 1.6 Registration of Instrument

For registration purposes please fill out the Warranty Registration/Installation Report form supplied with the instrument. Return the completed form to Damon/IEC Division.

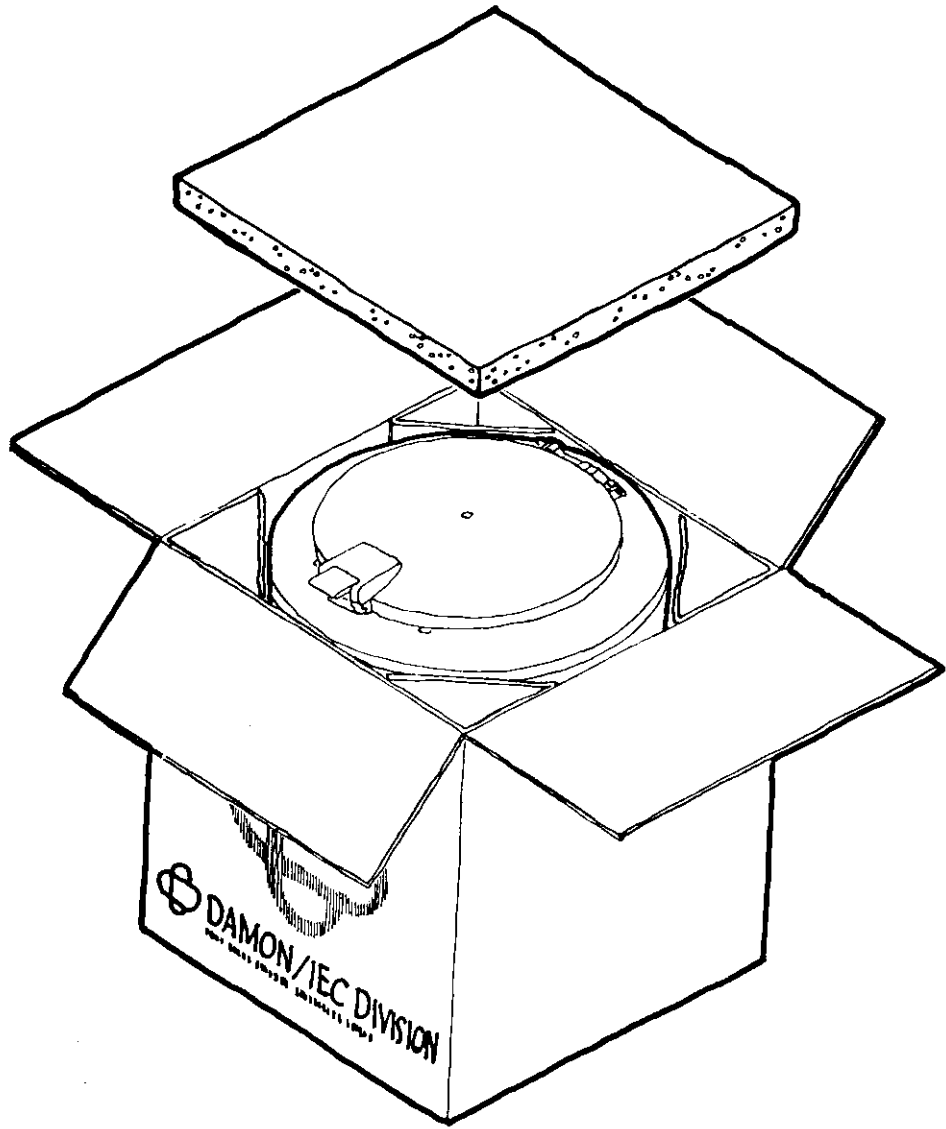


Figure 2-1 Unpacking



## 2.0 INSTALLATION

### 2.1 General

The **HN-SII** Centrifuge is shipped in a special carton designed to protect the machine from shipping hazards. Installation of the centrifuge includes an initial inspection of the carton before acceptance from the shipper, moving the carton to the operating location or incoming inspection area, unpacking, preliminary checkout, and installation for use.

### 2.2 Receiving Inspection

Before signing the delivery receipt and accepting the shipment, inspect the shipping carton for any signs of mishandling, such as broken or dented sides. Damage to the carton must be noted and a written statement made on the delivery receipt before signing, describing the nature of the damage. A normal or undamaged carton does not necessarily ensure that the contents have not been damaged during shipping. If mishandling or damage is suspected, contact the office of the carrier so that a representative may witness the unpacking. The centrifuge and other contents of the carton should be carefully examined as the unpacking proceeds. Any damage discovered which can be attributed to mishandling or shipping damage should be documented and a signed inspection report should be furnished to the shipping company. Damon/IEC Division is not responsible for damage incurred in transit.

### 2.3 Unpacking the **HN-SII** Centrifuge

Unpack the centrifuge at the intended operating location or at a convenient area for inspection. Keep all shipping documents. Open the top of the carton and remove all accessible packing material and shipping supports. Remove centrifuge from carton by reaching inside carton, grasping lower curvature of guard bowl, and lifting out the centrifuge. Avoid grasping Tachometer meter (below lower curvature; located beneath cover latch). Save the carton and shipping material for possible re-location.

### 2.4 Line Voltage Check

The line voltage supply must be within six feet of the **HN-SII** centrifuge as a standard three wire grounded single phase circuit. It must be easily accessible to allow a rapid disconnect in case of an emergency, and as a protective precaution during machine maintenance. Check the line voltage and frequency requirements of the machine, shown on the data plate at the rear of the machine. Use an AC voltmeter to measure the voltage available at the power socket, and check with your power company as to line frequency.

Proceed as follows:

1. 115 VAC, 60 Hz machine (Catalog No. 2355): Line voltage must be between 103 VAC and 127 VAC. If outside these limits, an external voltage step-up or step-down transformer will be required.
2. 230 VAC, 50 Hz machine (Catalog No. 2356): Line voltage must be between 206 VAC and 254 VAC. If outside these limits, an external voltage step-up or step-down transformer will be required. Line frequency must not be below 48 Hz.

If the line voltage and frequency are suitable for your **HN-SII**, you are ready to proceed to the installation checkout. Note that fluctuations in line voltage or frequency will slightly alter the machine's performance with respect to the values listed in the Speed and Force Tables of this Manual.

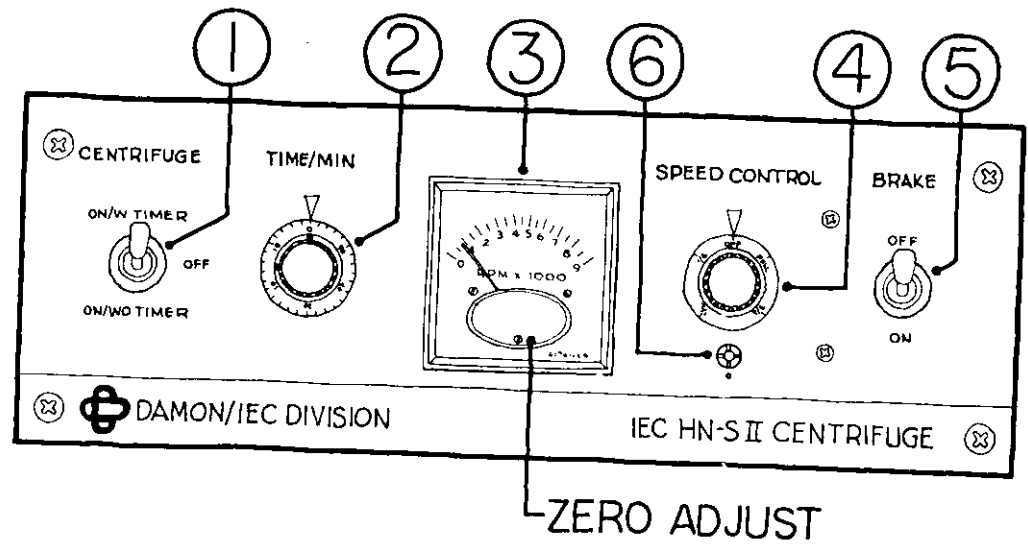
### 2.5 Installation Checkout

Perform the installation checkout procedures as listed below. Refer to Section 3.0, OPERATION, and Figure 3-1 as needed. In case of improper machine operation at any of these checkout steps, or in case of no operation, consult your authorized Damon/IEC dealer, or see the trouble shooting chart in this Manual. See also the warranty in paragraph 1.4.

1. Check that the centrifuge is on a firm, non-resonant surface.
2. Lift the cover, and remove all materials from inside the chamber.
3. Install a rotor on the shaft, and tighten the knurled nut finger-tight (see paragraph 3.5.1).
4. Close the cover and latch tightly.

*WARNING: Never open the cover while centrifuge is in operation.*

5. Set the Power Switch (S2) to OFF (center position).
6. Set the Speed Control knob to OFF.
7. Insert the power plug into the power socket.
8. Turn on power by setting the Power Switch (S2) to ON/WO TIMER.
9. Slowly advance the Speed Control (R1) for a rotor speed of 1,000 rpm as indicated on the Tachometer (M1).
10. Return the Power Switch (S2) to OFF (center position). The centrifuge will start to slow down.
11. While the rotor is still coasting, press the spring loaded Brake Switch (S1). Listen for a slowing effect and note the reduction in speed as shown on the Tachometer (M1). Hold the switch down until Tachometer (M1) indicates zero (0) RPM. Continued braking after the rotor has come to a stop gives reverse motor rotation, with possible damage to the motor brushes.
12. Advance the Timer (M2) to 10 minutes, then return to a 3-minute setting.
13. Turn on power by setting the Power Switch (S2) to ON/W TIMER.
14. The centrifuge will now operate for approximately three minutes, and turn off automatically at the end of that interval.
15. Return the Power Switch (S2) to OFF (center position).



- |   |  |
|---|--|
| <ol style="list-style-type: none"> <li>1. Power Switch (S2)</li> <li>2. Timer (M2)</li> <li>3. Tachometer (M1)</li> </ol> | <ol style="list-style-type: none"> <li>4. SPEED CONTROL (R1)</li> <li>5. BRAKE Switch (S1)</li> <li>6. Calibration Potentiometer (R5)</li> </ol> |
|---|--|

NOTE: Letters enclosed in parentheses refer to schematic and wiring diagram designations for these items. Refer to paragraph 5.0 for component part numbers. Refer to paragraph 4.11 for ZERO ADJUST.

Figure 3-1 Control Panel  
2 - 2

## 3.0 OPERATION

### 3.1 General

This section of the manual contains instructions for the operation of the centrifuge, and is intended primarily to acquaint the user of the instrument with the various controls, indicators, and operating characteristics.

### 3.2 Description of Operation

Centrifuge operation normally requires the following steps: installing a rotor, installing balanced accessories and a balanced load, selecting the speed and timing, closing and latching the cover, applying power, and starting the run cycle.

### 3.3 Control Panel

All of the controls and indicators necessary to operate and monitor the centrifuge are on the Control Panel, shown in figure 3-1.

1. Power Switch (S2) This three position toggle switch is used to control power to the instrument and to select the mode of operation.

Its three positions are:

- (1) ON/W TIMER for timed runs.
- (2) OFF for power off (except to brake circuit).
- (3) ON/WO TIMER for untimed runs.

Set this switch to OFF when the instrument is not in use.

2. Timer (M2) This electrical timer is used to select the run cycle time when the Power Switch (S2) is in the ON/W TIMER position. The total run cycle time can be selected from 2 to 60 minutes. For timed periods of less than ten minutes, set the control beyond the ten-minute position to close the internal timer switch, and then turn back to the desired time. For timed periods of ten minutes or more, simply advance the knob to the desired setting. When the timer control knob runs down to zero, the power is removed from the motor.

3. Tachometer (M1) This Tachometer is an electrical voltmeter, displaying in RPM, which operates from a tachometer generator connected to the drive motor.

Readout is from 0 to 9,000 RPM, in 500 RPM increments. Accuracy of the reading is  $\pm 2\%$  of full scale.

4. SPEED CONTROL (R1) This potentiometer controls the speed of the centrifuge through the speed control circuit board. Fractions marked on the knob *are for reference only*. For maximum accuracy and repeatability, set speed by reference to the Tachometer.

5. BRAKE Switch (S1) This switch is a spring-loaded toggle switch which returns to OFF when released. It is used to increase deceleration, and can reduce coast time by approximately 50%. Be sure to switch the Power Switch to OFF before using the BRAKE Switch at the end of a run cycle. Release the BRAKE Switch when the rotor comes to a stop, otherwise the rotor will begin to turn in the reverse direction, with possible damage to the motor brushes.

6. Calibration Potentiometer (R5) This potentiometer is used to calibrate the Tachometer, and is not used in everyday operation. Adjustments are to be made by factory-trained personnel only.

### 3.4 Operational Precautions

1. Do not operate rotors which do not have a full complement of accessories. See paragraph 3.5.2.

2. Load and balance all rotors properly. See paragraph 3.5.2.

3. CAUTION: Do not use mercury in cups or shields for balancing purposes. See paragraph 3.5.2.

4. Do not use other manufacturer's accessories on Damon/IEC centrifuges. Doing so will void the Damon/IEC Warranty.

5. Do not adjust any of the potentiometers on a printed circuit board or on the Control Panel unless recalibration is necessary, and then only by use of the established recalibration procedure, with the proper equipment, as outlined in this manual, and by factory-trained service personnel only.

6. Do not block the vent hole in the cover or on the louvered cover plate on the bottom of the machine. Doing so may result in excessive heat buildup and early failure of components and/or damage to samples.

7. Never open the cover while the rotor is spinning.

8. Replace the knurled nut securely by hand even when no rotor is installed, to prevent loss.

9. Turn the Power Switch to OFF when the instrument is not in use.

10. Do not use the centrifuge chamber for storage purposes.

11. Always pull out the power plug before cleaning the machine. Clean immediately after *any* spillage occurs, with mild soap and a cloth dampened with warm water. CAUTION: Do not use acetone type cleaners. See paragraph 3.13.

**12. WARNING: REMOVAL OF THE CONTROL PANEL OR BOTTOM PLATE WILL EXPOSE ELECTRICAL SHOCK AREAS WHERE POTENTIALLY LETHAL VOLTAGES ARE PRESENT.**

### 3.5 Operating Procedures

Operating procedures include installing the rotor, loading the rotor, setting the controls, performing the run cycle (with timer or without timer), determination of Relative Centrifugal Force (RCF) (see Table 3-1), and removing the rotor.

#### 3.5.1 Installing the Rotor

Set all controls to their OFF position, and then unlatch and open the cover. Remove the knurled nut from the top of the motor shaft by turning the nut counter-clockwise (CCW). Align the keyway in the rotor with the key on the shaft, and place empty rotor on shaft. Replace the knurled nut and tighten finger-tight. Always install the rotor without accessories, and then add shields, trunnions, glass, or plasticware as needed. Insert the larger rotors through the guard bowl opening with care. The normal direction of rotation is counter-clockwise (CCW), as viewed from above.

#### 3.5.2 Loading the Rotor

If constant vibration is noted during normal laboratory use, this is almost always caused by an unbalance in the rotor loading. The operator should be certain that the rotor is loaded symmetrically and with a full complement of accessories, and that the shields, trunnion rings, cups and/or carriers are all within 0.5 grams of each other. Also check that each shield has an equal number of the proper cushions. Tubes with samples must be of equal weight. It is essential that only Damon/IEC rotors and accessories be used on this centrifuge.

Accessory balance is an important factor in prolonging the life of the armature and bearings. Damon/IEC rotors, as well as all rotating parts of the centrifuge, are dynamically balanced at the factory. In addition, Damon/IEC trunnion rings, shields, cups and carriers are weighed and matched to one-half gram. The gram weight is stamped on each piece.

All horizontal rotors should be loaded with a full complement of accessories to prevent unequal stresses on the rotor during operation.

To obtain good dynamic balance the opposite loads must not only be equal in mass, but must have the same center of gravity. Take care to select centrifuge tubes and bottles in pairs which are alike in shape, thickness, and distribution of glass or plastic. The larger the container, the more critical the selection should be.

When measuring weight, use a laboratory balance having a sufficient capacity to handle the size container being used, and which has a sensitivity of one-tenth of a gram at full load.

The following balancing technique renders the best possible weight distribution, as well as providing maximum external support for the glassware or plasticware.

1. Place opposite cups containing filled glassware or plasticware on the balance.

2. To the lighter centrifuge cup, add water around the glassware, or plasticware, until the assembly is balanced.

**CAUTION**

*Mercury should never be placed in cups or shields for balancing. Mercury vapors are toxic, and will react with aluminum.*

**3.5.3 Control Settings Prior to Run Cycle**

Set panel controls as follows before starting the Run cycle:

1. Power Switch (S2) . . . . . OFF position
2. Timer (M2) . . . . . 0 minutes
3. Speed Control (R1) . . . . . OFF position

**3.5.4 Run Cycle with Timer**

1. Install rotor (see paragraph 3.5.1)
2. Load rotor (see paragraph 3.5.2)
3. Close and latch cover.
4. Turn Timer knob to the desired time setting.
5. Set the Power Switch to ON/W TIMER position.
6. Slowly turn the SPEED CONTROL knob to the desired setting.
7. Check the Tachometer to insure desired speed is achieved.
8. When the timer returns to zero (0 minutes), the motor power will shut off and the loaded rotor will coast to a stop. For increased deceleration, set the Power Switch to OFF and press the Brake Switch (S1). Release the BRAKE Switch when the rotor has come to a stop, as indicated on the Tachometer.

**3.5.5 Run Cycle Without Timer**

1. Install rotor (see paragraph 3.5.1).
2. Load rotor (see paragraph 3.5.2).
3. Close and latch cover.
4. Set the Power Switch to the ON/WO TIMER position.

5. Slowly turn the SPEED CONTROL knob to the desired setting.
6. Check the Tachometer to insure desired speed is achieved.
7. The centrifuge will continue operation until the run is terminated by the operator. The run is terminated by:
  - (1) Returning the SPEED CONTROL knob to OFF, and
  - (2) Setting the Power Switch to OFF.
8. After the run is terminated, the rotor will coast to a stop. For increased deceleration, set the Power Switch to OFF and press the BRAKE Switch (S1). Release the BRAKE Switch when the rotor has come to a stop as indicated on the Tachometer.

**3.5.6 Determination of RCF**

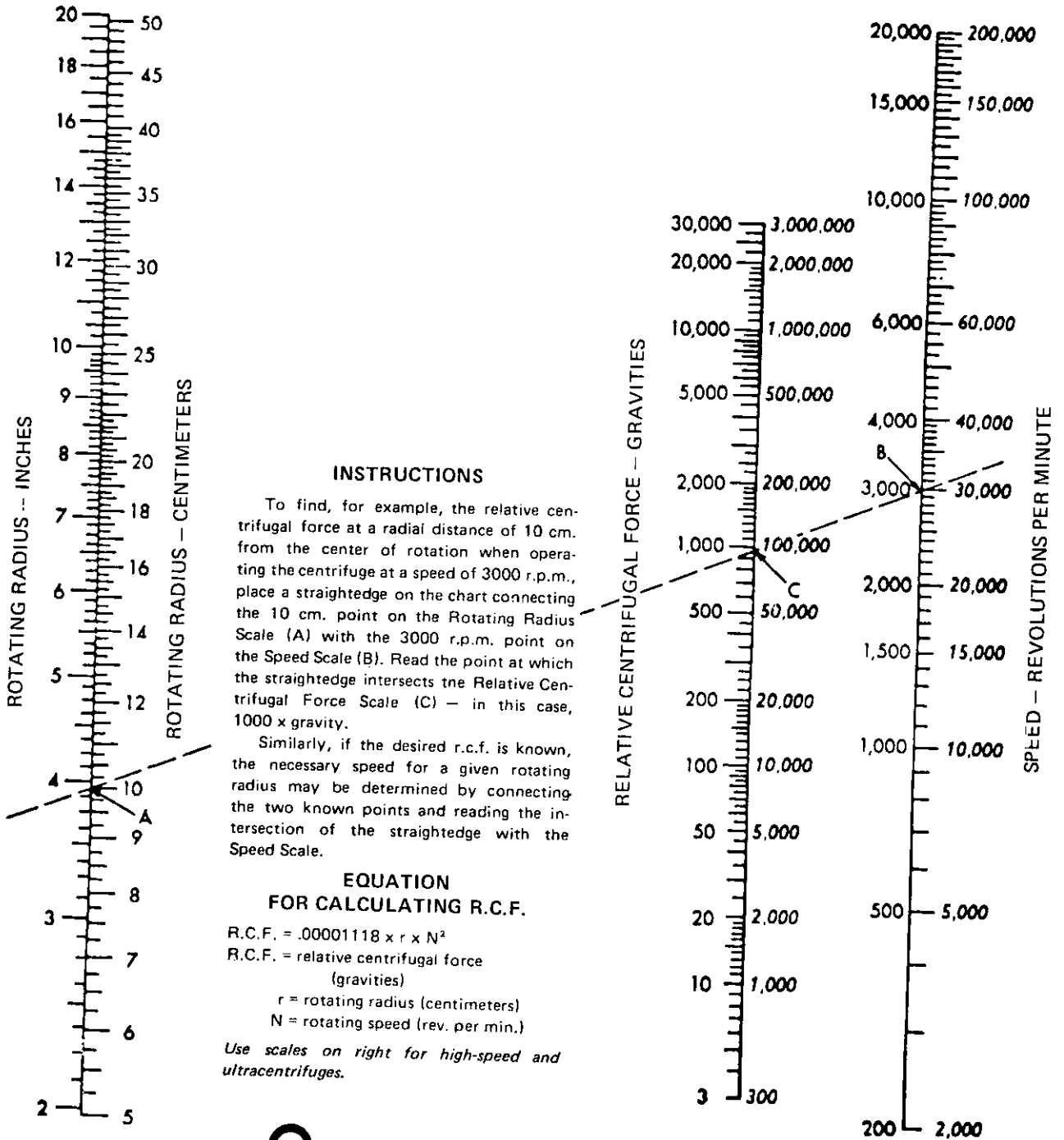
The Relative Centrifugal Force, in units of "g", may be determined by using the Damon/IEC nomograph which is shown in Table 3-1, or refer to the Speed/Force Table for maximum values, where "g" represents the force of gravity.

**3.5.7 Removing the Rotor**

Always unload the rotor before removing it from the centrifuge. The rotor can then be removed without damage to the centrifuged media or its containers.

When removing the rotor, it is helpful to first loosen the knurled nut, leaving it in place. Lift upward on the rotor with the fingers while pressing downward on the knurled nut with the thumbs. This procedure will normally provide all the leverage necessary to remove the rotor from the tapered shaft and keyway. If the rotor cannot be removed by using this procedure, check that the knurled nut is protecting the shaft threads, by screwing down several turns without contacting the rotor. Using a rubber-headed mallet, lightly tap the knurled nut flatly on its top surface while pulling upward on the rotor. When the rotor is loosened, remove the knurled nut and lift the rotor from the shaft and out of the guard bowl. Take care not to damage the screw threads while removing the rotor. After removal, screw the knurled nut back in place to prevent loss.

# THE IEC RELATIVE CENTRIFUGAL FORCE NOMOGRAPH



**DAMON/IEC DIVISION**

300 SECOND AVE., NEEDHAM HTS., MASS. 02194, TEL: (617) 449-0800

Table 3-1 Damon/IEC Nomograph

### 3.6 Operators Reference Data

The following paragraphs present valuable reference data for the operator, with emphasis on detail and with the goal of providing a maximum of complete information. The tabular information shown in this manual provides information on a wide range of tubes and centrifuge bottles. The following paragraphs refer to these tables.

#### 3.6.1 Tubes and Bottles

IEC plastic centrifuge tubes and centrifuge bottles referenced by catalog number in the tables at the rear of this section of the manual will withstand the maximum "(g)" forces listed *if in good condition*. Plasticware having such conditions as crazing or deformation should be discarded. All plasticware should be filled to at least 85% of nominal ml capacity when centrifuged at or near the maximum RPM.

Other manufacturer's centrifuge tubes and centrifuge bottles, as listed in these tables by their catalog or code numbers, may be used. However, Damon/IEC Division does not guarantee performance of other manufacturer's centrifuge tubes or centrifuge bottles including those listed in the tables. When selecting tubes for use in the centrifuge refer to the manufacturer's recommendations and claims regarding tube strength and suitability for centrifuge use.

#### 3.6.2 Tube Nominal Capacity in ml

See Table 3-2, "IEC Centritubes™", for a listing of nominal ml for IEC centrifuge tubes and centrifuge bottles. IEC plastic caps can be assembled to these tubes when filled to nominal capacity without displacing the liquid contents.

#### 3.6.3 Maximum Attainable RPM

The maximum attainable RPM listed in Table 3-3 is based on a line voltage supply of 120 VAC. Speeds listed will be maintained relatively constant for  $\pm 5\%$  change in line voltage. The maximum values of RPM listed require the following:

1. Centrifuging the full complement of the specific accessories listed at the RPM shown under "Maximum Attainable RPM".

2. Use of tubes of the same length and fill level, to assure symmetrical loading and good balance.

#### 3.6.4 Loading Requirements

Damon/IEC does not recommend that multiple combinations be used. Examples of such non-recommended loading would include loading such as four trunnion rings with shields and two multi-carriers on a six-place horizontal rotor.

Best operating results will be obtained with a balanced, fully-loaded rotor. If a complete complement of full tubes cannot be used, at least all accessory items (trunnions, shields, etc.) must be in place.

#### 3.6.5 Strength Considerations

The maximum allowable values of RPM followed by (+) and footnoted "Speed Limited" *must not be exceeded* because of strength limitations of sample containers.

#### 3.6.6 Rotating Radius (Refer to Figure 3-2)

The "rotating radius" is the distance measured from the rotor axis to the tip of the liquid inside the tubes at the greatest horizontal distance from the rotor axis.

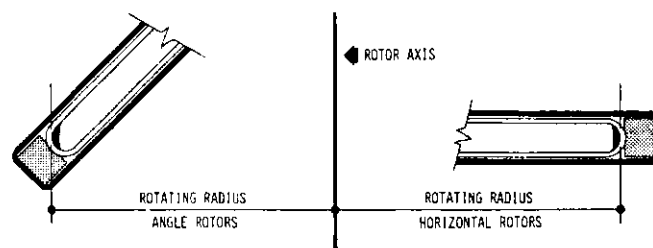


Figure 3-2 Rotating Radius

#### 3.6.7 Maximum Tube Lengths

The maximum tube lengths listed in the tables at the rear of this section include caps or stoppers assembled to the tubes. The column which lists the maximum tube sizes for the specified combination of accessories give dimensions which allow for clearance of the tube O. D. in the accessory and rotational clearance in horizontal rotors. Maximum lengths for angle rotors have been restricted to  $\frac{3}{4}$ " (19mm) above the tube support area in shields, carriers, and adapters.

### 3.6.8 Minimum Tube Diameter x Maximum Length in mm

For horizontal rotors, the recommended minimum tube diameters are, with few exceptions, approximately 0.080" (2mm) less than the maximum tube diameters. This is a guideline to prevent excessive clearance and resulting poor support between the tubes and bottles and their respective holders. The recommended maximum lengths generally allow for a maximum of 1½" (38mm) above the support area of the shield, adapter, carrier or cup.

For angle rotors, the recommended minimum tube diameters are approximately 0.080" (2mm) less than maximum tube diameters, or the same as with horizontal rotors. However, the recommended tube lengths generally allow for only ¾" (19mm) of tube length to be above the tube support area of the shield or adapter.

### 3.6.9 Table Notes and Legends

The notes and legends listed below apply to the tables which follow.

1. 1113\* Adapter — "Use plastic tubes only" — 1113 adapter does not have spherical bottom in the adapter cavity. Glassware should not be used.
2. "Omit Caps" — This instruction indicates that the use of a cap with the referenced accessory would increase the overall length of the accessory (e. g. 298 and 300 tubes) beyond the length which will physically fit in the given combination.
3. 305A where listed — The 305A is a 305 shield with a catalog 571 cushion, to accept tubes and adapters with round bottoms. Rotating radius is greater than when using the 320 shield.
4. 398A — The 398A is a 398 carrier with a catalog 668 cushion. This allows the 398 carrier to accept the 2858, 2837, and 1648 tubes in the 958 rotor. The rotating radius is greater than when using the standard 398 carrier with the 570 cushion. The greatest volume centrifuged in the instrument is obtained when using the 398A with 36 — catalog 2837 tubes. 36 x 19ML = 684ML
5. "1127, 1128, 1129 Not Recommended. Adapters too short." — Use of these adapters in the 303, 302, and 306 shields causes these adapters to be below the top of the shields. If used, tweezers, pliers,

etc., would be needed to remove tubes from adapters. This may be an *inconvenience* to some users. Damon/IEC does *not* forbid these adapters to be used in these shields provided tube diameters and tube lengths are within the recommended dimensions for each adapter.

6. "1125 Adapter. Not Recommended. Adapter too Long" — (For 356 shield in 803, 809, and 815 rotors.) Use of this adapter in the above rotors using the 356 shield allows the adapter to protrude beyond the ¾" recommended limit above the support area of the shield. The 303 and 302 shield will properly accept this adapter.

### 3.7 Preventive Maintenance

Preventive maintenance includes those procedures designed to ensure continued operation of the centrifuge with a minimum of "down-time" which may be caused by failure of a part or by unsatisfactory operation. The most important feature of preventive maintenance lies in the care and cleaning of the centrifuge, with special attention to the rotors, cups, and carriers, for the prevention of corrosion.

### 3.8 Corrosion

The operator or person responsible for preventive maintenance must be careful to prevent corrosion of the rotors and structural accessories (shields, cups and carriers). These parts are manufactured by Damon/IEC, and are properly finished and checked by quality control facilities before leaving the factory. Consideration has been taken in their design and manufacture to provide a maximum resistance to corrosion. However, long-term satisfactory operation requires a high standard of preventive maintenance to maintain this high level of corrosion resistance. If corrosion is allowed to continue, small cavities will form within the part which will grow deeper with continued operation, resulting in eventual failure. Deep-seated corrosion may also occur, and be more serious than appears on the surface.

### 3.9 Inspection

Before and after each run, accessories should be routinely examined for corrosion and cracks. Give special attention to the inside and bottom of rotor cavities, shields, and cups, and to the inside surfaces of multiple carriers. If corrosion is found, and cannot be removed (see paragraph 3.12), discard the accessory immediately and order a replacement from your authorized Damon/IEC Distributor.



### 3.10 Corrosion Prevention

The hazard of corrosion can be almost completely eliminated by conscientious operator technique. After each run, the part should be rinsed in warm tap water and finally in distilled water. If material is spilled onto the part, it should be washed out with a MILD DETERGENT solution, and the cavities scrubbed with a stiff test-tube brush having end bristles. The part should be rinsed in warm tap water after scrubbing, and given a final rinse in distilled water. When particularly caustic materials are run, this procedure should be carried out immediately upon completion of the run.

### 3.11 Drying

After the part has been thoroughly cleaned, it is important to dry it properly, preferably by wiping with a clean, absorbent towel. A drying oven may be used, but the temperature should not exceed 80°C. Angle rotors should be stored open to the atmosphere. Horizontal rotors should be turned upside down to expose the greatest amount of surface area. Shields, cups, and carriers should have their cavities open to the atmosphere. Parts should be stored on a soft surface to prevent damage to anodized or other finished surfaces. Parts may be stored under refrigeration, after the proper cleaning and drying procedures have been followed, when the part is in routine use. For general storage, however, it is advisable to store the part clean and dry at room temperature. Parts should not be stored wrapped in a plastic bag, as moisture may be trapped or develop in the bag, with resulting corrosion.

### 3.12 Corrosion Removal

If corrosion occurs, it is of the utmost importance to remove it as soon as possible. The following procedure is recommended.

1. The part should be soaked to remove deposits from the metal surface. Use a mild detergent solution. Do not use soaps or detergents which contain strong alkalis.
2. Scrub the part thoroughly with a stiff test-tube brush having end bristles. Pay particular attention to the bottom of the tube carriers, and to multiple carriers.
3. Allow the part to soak again in clear warm water for a minimum of one hour.

4. Rinse the part well in warm water, and finally rinse thoroughly in distilled water.
5. Dry the part thoroughly with a clean, absorbent cloth.
6. If corrosion cannot be removed with a tube brush, discard the item and order a replacement from your authorized Damon/IEC dealer.

### 3.13 Cleaning the Centrifuge

The centrifuge should be maintained in a clean, uncluttered condition, to insure satisfactory operation and a long service life. The following procedure is recommended:

1. Always unplug the power cord for safety during cleaning.
2. Unlatch and open the cover of the centrifuge, and remove the rotor.
3. Check the guard bowl for spillage or broken glass. Remove with a vacuum cleaner if possible. Clean with a damp sponge. Remove rubber cushions and replace in case of glass breakage. Grey dust is the result of finely ground glass. This must be removed to insure satisfactory motor life, to prevent sample contamination, and to prevent abrasion of the inside painted surfaces.
4. Clean the inside of the guard bowl, and then the outside, using a moist (not wet) sponge, with warm water and a mild detergent. Repeat using clear warm water.
5. Observe the following precautions at all times:
  - a. Never use an abrasive cleaner or steel wool pads. If there are stubborn stains, remove them with a plastic scrub pad.
  - b. Never pour water into the guard bowl chamber.

#### WARNING

*When the cleanup involves hazardous, contaminated, or radioactive material, wear rubber gloves and take any other precautions appropriate to the hazards involved. Contact laboratory safety personnel, if available.*

Table 3-2 IEC Centritube™ Table

**IEC Centritubes**

Centritubes™ are manufactured specifically for centrifugation by Damon/IEC Division, the world's leading manufacturer of centrifuges. Each IEC tube, bottle and cap is designed and molded for perfect fit, maximum strength and wide versatility.

**"Oak Ridge" Type Screw Cap Tubes**

"Oak Ridge" type screw-cap Centritubes eliminate the need for costly, time-consuming 5-piece metal sealing systems. With a simple twist of the wrist, a one-piece IEC knurled metal cap seals tightly, assuring a positive vacuum tight seal. The caps are available in anodized aluminum and teflon coated aluminum.

"Oak Ridge" type screw cap tubes are ideal for working with virological or other infectious material, and are available in polypropylene and Autoclear polycarbonate.

Plastic screw caps are supplied with the tubes and may be safely used in low speed centrifuges.

| Autoclear Polycarbonate Tubes |                       |                          | Metal Screw Caps               |                   |                        |
|-------------------------------|-----------------------|--------------------------|--------------------------------|-------------------|------------------------|
| Tubes Catalog No.             | Nominal Capacity (ml) | Outside* Dimensions (mm) | Replacement Plastic Screw Caps | Anodized Aluminum | Teflon Coated Aluminum |
|                               |                       |                          | Catalog No.                    | Catalog No.       | Catalog No.            |
| 2067                          | 10                    | 16.1x81.4                | 2887                           | 2066              | 2064                   |
| 2055                          | 30                    | 25.3x93                  | 2886                           | 2056              | 2057                   |
| 2053                          | 50                    | 28.6x106.1               | 2888                           | 2063              | 2054                   |
| 2059                          | 73                    | 38.1x110.2               | 2889                           | 2060              | 2058                   |

\*Includes Plastic Cap

| Polypropylene Tubes |                       |                          | Metal Screw Caps               |                   |                        |
|---------------------|-----------------------|--------------------------|--------------------------------|-------------------|------------------------|
| Tubes Catalog No.   | Nominal Capacity (ml) | Outside* Dimensions (mm) | Replacement Plastic Screw Caps | Anodized Aluminum | Teflon Coated Aluminum |
|                     |                       |                          | Catalog No.                    | Catalog No.       | Catalog No.            |
| 2046                | 10                    | 16.1x81.4                | 2887                           | 2066              | 2064                   |
| 2047                | 30                    | 25.3x93                  | 2886                           | 2056              | 2057                   |
| 2048                | 50                    | 28.6x106.1               | 2888                           | 2063              | 2054                   |

\*Includes Plastic Cap

**Round Bottom Polypropylene Tubes**

IEC general purpose polypropylene Centritubes are molded from a special high strength resin which is the clearest of the translucent polypropylene plastics. All are autoclavable.

| Tubes Catalog No. | Nominal Capacity (ml) | Outside Dimensions (mm) | Plastic Caps Catalog No. | Aluminum Sealing Caps Catalog No. |
|-------------------|-----------------------|-------------------------|--------------------------|-----------------------------------|
| 1629              | 13                    | 16x98.3                 | 1514                     | 1578                              |
| 1630              | 46                    | 28.6x103.8              | 1518                     | 1580                              |

**Autoclear Conical Graduated Tubes**

Autoclear polycarbonate graduated tubes are ideal for clinical work requiring precise graduations and are molded under extremely close tolerances.

| Tubes Catalog No. | Nominal Capacity (ml) | Outside Dimensions (mm) | Plastic Caps Catalog No. |
|-------------------|-----------------------|-------------------------|--------------------------|
| 2809              | 50                    | 28.6x133.4              | 1518                     |
| 2810              | 15                    | 16.8x119.1              | 2884                     |

**Autoclear® Round Bottom Tubes**

Autoclear round bottom tubes combine many of the advantages of glass with the strength and economy of plastic. Ideal for high or low speed applications, these crystal clear polycarbonate tubes are shatterproof, autoclavable and resistant to most chemicals.

| Tubes Catalog No. | Nominal Capacity (ml) | Outside Dimensions (mm) | Plastic Caps Catalog No. | Aluminum Sealing Caps Catalog No. |
|-------------------|-----------------------|-------------------------|--------------------------|-----------------------------------|
| 2852              | 3                     | 10.9x54.7               |                          |                                   |
| 2804              | 4                     | 10.9x77.2               | 2880                     |                                   |
| 1696              | 8                     | 16x60.3                 | 2876                     |                                   |
| 1698              | 8.5                   | 13x106.3                | 1699                     |                                   |
| 2816              | 10                    | 14.5x96                 | 1676                     | 1586                              |
| 2801              | 10                    | 16.1x76.2               | 2877                     | 1183                              |
| 1649              | 12                    | 16.0x98.7               | 1514                     | 1578                              |
| 2808              | 12                    | 20.4x60.4               | 1677                     |                                   |
| 1648              | 15                    | 16x114.3                | 1514                     | 1578                              |
| 2806              | 22                    | 18.7x111.1              | 2881                     |                                   |
| 2802              | 30                    | 25.3x88.9               | 2878                     | 1177                              |
| 2997              | 47                    | 28.6x103.8              | 1580                     | 1580                              |
| 2806              | 96                    | 31.9x161.8              | 2882                     |                                   |

**Transparent Polyallomer Tubes**

Special IEC transparent thin-walled polyallomer tubes combine the flexibility and capacity of cellulose nitrate with the autoclavability and chemical stability of polypropylene. Ideal for gradient or routine analysis, these tubes may be easily pierced with a hypodermic syringe.

| Tubes Catalog No. | Nominal Capacity (ml) | Dimensions (mm) | Plastic Caps Catalog No. | Aluminum Sealing Caps Catalog No. |
|-------------------|-----------------------|-----------------|--------------------------|-----------------------------------|
| 2841              | 3.5                   | 10.9x54.7       | 1524                     |                                   |
| 2840              | 6                     | 10.9x77.2       | 1524                     |                                   |
| 2860              | 9                     | 16.1x57.9       | 2897                     |                                   |
| 2836              | 10                    | 12.7x98.4       |                          |                                   |
| 2864              | 10                    | 12.7x108        |                          |                                   |
| 2842              | 12                    | 14.5x96         | 1514                     |                                   |
| 2860              | 12                    | 16.1x76.2       | 2897                     | 1181                              |
| 2859              | 16                    | 16.1x101.6      | 2897                     |                                   |
| 2858              | 17                    | 16.1x108        | 2897                     |                                   |
| 2837              | 19                    | 16.1x114.3      | 2897                     |                                   |
| 2839              | 28                    | 26.2x66.8       | 2899                     |                                   |
| 2847              | 37                    | 25.4x88.9       |                          | 1175                              |
| 2828              | 52                    | 28.6x103.7      |                          |                                   |

Table 3-3, Speed and Force Tables, Horizontal Rotors (sheet 1 of 6)

| CAT. ROTOR AND NO OF PLACES | CAT. TRUN RING AND NO OF PLACES | CAT. SHIELD        | CAT. MULTI-CARRIER AND NO. OF PLACES | CAT. ADAPTER AND NO. OF PLACES | WILL ACCEPT IEC TUBE CATALOG NO.            | TUBE NOMINAL ML | TOTAL PLACES X NOMINAL ML | MIN-MAX CAPACITY RANGE IN ML | MAX. RPM | RCF MAX. G'S | ROTATING RADIUS |        | WILL ACCEPT TUBE MAX. OD X MAX. LENGTH IN MM | RECOMMENDED MIN. TUBE OD X RECOMMENDED MAX. LENGTH IN MM |
|-----------------------------|---------------------------------|--------------------|--------------------------------------|--------------------------------|---|-----------------|---------------------------|------------------------------|----------|--------------|-----------------|--------|--|--|
|                             |                                 |                    |                                      |                                |   |                 |                           |                              |          |              | CM              | INCHES |  |  |
| 204(4)                      |                                 | 338                |                                      |                                | 100ML OIL BOTTLE KIMAX45244 (PEAR SHAPED)   | 100             | 4 x 100                   | 400                          | 2500     | 1350         | 19.2            | 7.550  |  |  |
| 215(4)                      | 310(1)                          | 356                |                                      |                                | 2046 2067 2801                              | 10-13           | 4 x (10-13)               | 40-52                        | 3900     | 2225         | 13.1            | 5.179  | 17.2 x 113                                   | 15.3 x 104   |
|                             |                                 | 356                |                                      |                                | 1629 1649 2850                              | 10-13           | 4 x (10-13)               | 40-52                        | 3900     | 2225         | 13.1            | 5.179  | 17.2 x 113                                   | 15.3 x 104   |
|                             |                                 | 356                | 1125(1)                              |                                | 1698 2836 2864                              | 8-10            | 4 x (8-10)                | 32-40                        | 3900     | 2225         | 13.1            | 5.179  | 13.6 x 114                                   | 11.7 x 114   |
|                             |                                 | 356                | 1126(1)                              |                                | 2804 2840                                   | 4-5             | 4 x (4-5)                 | 16-20                        | 3900     | 2225         | 13.1            | 5.179  | 11.1 x 114                                   | 9.3 x 105  |
|                             |                                 | 356                | 1127(1)                              |                                | 2804 2840                                   | 4-5             | 4 x (4-5)                 | 16-20                        | 3900     | 2225         | 13.1            | 5.179  | 11.1 x 114                                   | 9.3 x 95   |
|                             |                                 | 356                | 1128(1)                              |                                | PYREX 8060 1ML                              | 1               | 4 x 1                     | 4                            | 3900     | 2225         | 13.1            | 5.179  | 8.6 x 114                                    | 6.7 x 92   |
|                             |                                 | 356                | 1129(1)                              |                                | PYREX 8060 0.5ML                            | 0.5             | 4 x 0.5                   | 2                            | 3900     | 2225         | 13.1            | 5.179  | 6.4 x 114                                    | 4.5 x 89   |
| 215(4)                      | 310(1)                          | 303                |                                      |                                | 1629 1649 1648 2810                         | 13-19           | 4 x (13-19)               | 52-76                        | 3500     | 2025         | 14.7            | 5.803  | 17.2 x 128                                   | 15.3 x 123   |
|                             |                                 | 303                |                                      |                                | 2858 2859 2837                              | 13-19           | 4 x (13-19)               | 52-76                        | 3500     | 2025         | 14.7            | 5.803  | 17.2 x 128                                   | 15.3 x 123   |
|                             |                                 | 303                | 1125(1)                              |                                | 1698 2836 2864                              | 8-10            | 4 x (8-10)                | 32-40                        | 3500     | 2025         | 14.7            | 5.803  | 13.6 x 130                                   | 11.7 x 127   |
|                             |                                 | 303                | 1126(1)                              |                                | 2804 2840                                   | 4-5             | 4 x (4-5)                 | 16-20                        | 3500     | 2025         | 14.7            | 5.803  | 11.1 x 130                                   | 9.3 x 105  |
|                             |                                 | 303                | 1127,1128,1129                       |                                | NOT RECOMMENDED. TOO SHORT.                 |                 |                           |                              |          |              |                 |        |  |  |
| 215(4)                      | 310(1)                          | 302                |                                      |                                | 2858 2859 1648                              | 15-19           | 4 x (15-19)               | 60-76                        | 3050     | 1725         | 16.6            | 6.556  | 17.2 x 146                                   | 15.3 x 135   |
|                             |                                 | 302                |                                      |                                | 2837 2810                                   | 15-19           | 4 x (15-19)               | 60-76                        | 3050     | 1725         | 16.6            | 6.556  | 17.2 x 146                                   | 15.3 x 135   |
|                             |                                 | 302                | 1125(1)                              |                                | 1698 2864                                   | 8-10            | 4 x (8-10)                | 32-40                        | 3050     | 1725         | 16.6            | 6.556  | 13.6 x 148                                   | 11.7 x 130   |
|                             |                                 | 302                | 1126(1)                              |                                | 2804 2840                                   | 4-5             | 4 x (4-5)                 | 16-20                        | 3050     | 1725         | 16.6            | 6.556  | 11.1 x 148                                   | 9.3 x 105  |
|                             |                                 | 302                | 1127,1128,1129                       |                                | NOT RECOMMENDED. TOO SHORT                  |                 |                           |                              |          |              |                 |        |  |  |
| 215(4)                      | 310(1)                          | 306                |                                      |                                | DO NOT USE. SHIELD HITS GUARDBOWL           |                 |                           |                              |          |              |                 |        |  |  |
| 215(4)                      | 325(1)                          | 320                |                                      |                                | 1630 2997 2048 2053                         | 48-52           | 4 x (48-52)               | 192-208                      | 3700     | 2125         | 13.9            | 5.453  | 30.0 x 116                                   | 28.2 x 107   |
|                             |                                 | 320                |                                      |                                | 2828 613SS                                  | 48-52           | 4 x (48-52)               | 192-208                      | 3700     | 2125         | 13.9            | 5.453  | 30.0 x 116                                   | 28.2 x 107   |
|                             |                                 | 320                | 651(1)                               |                                | 2805  | 22              | 4 x 22                    | 88                           | 3800     | 2250         | 13.9            | 5.453  | 18.8 x 117                                   | 16.9 x 117   |
|                             |                                 | 320                | 1105(1)                              |                                | 1698 2864                                   | 8-10            | 4 x (8-10)                | 32-40                        | 3800     | 2250         | 13.9            | 5.453  | 14.0 x 120                                   | 12.2 x 120   |
|                             |                                 | 320                | 1106(1)                              |                                | 1648 2858 2837 2810                         | 15-19           | 4 x (15-19)               | 60-76                        | 3800     | 2250         | 13.9            | 5.453  | 17.4 x 122                                   | 15.5 x 122   |
|                             |                                 | 320                | 1108(1)                              |                                | 2805 514PYREX 12ML                          | 12-22           | 4 x (12-22)               | 48-88                        | 3800     | 2150         | 13.4            | 5.258  | 19.3 x 116                                   | 17.4 x 116   |
|                             |                                 | 320                | *1113(3)                             |                                | 2804 2840                                   | 4-5             | 12 x (4-5)                | 48-60                        | 3800     | 1800         | 11.1            | 4.363  | 11.3 x 90                                    | 9.4 x 90   |
|                             |                                 | 320                | 2917(1)                              |                                | 2816 2842(Omit Caps)                        | 10-12           | 4 x (10-12)               | 40-48                        | 3800     | 2200         | 13.6            | 5.359  | 14.4 x 117                                   | 12.5 x 117   |
|                             |                                 | 320                | 3151(1)                              |                                | 2805  | 22              | 4 x 22                    | 88                           | 3800     | 2250         | 13.9            | 5.453  | 18.8 x 118                                   | 16.9 x 118   |
| 215(4)                      | 325(1)                          | 320                | 3152(1)                              |                                | 1698 2864                                   | 8-10            | 4 x (8-10)                | 32-40                        | 3800     | 2200         | 13.7            | 5.381  | 14.2 x 120                                   | 12.3 x 120   |
|                             |                                 | 320                | 3153(1)                              |                                | 1648 2837 2858                              | 15-19           | 4 x (15-19)               | 60-76                        | 3800     | 2200         | 13.7            | 5.381  | 16.1 x 120                                   | 14.1 x 120   |
|                             |                                 | 320                | REMOVE 571 CUSHION                   |                                | 368(5) 8 x 95MM WINTROBE. FISHER #5-668-2   |                 |                           |                              | 3800     | 2275         | 14.1            | 5.543  | 8.3 x 117                                    | 7.1 x 117  |
| 215(4)                      | 325(1)                          | 320A               | 312(1)                               |                                | 2810CONICAL(Omit Cap)                       | 15              | 4 x 15                    | 60                           | 3700     | 2125         | 13.9            | 5.481  | 18.0 x 119                                   | 16.0 x 119   |
| 215(4)                      | 325                             | 320A               |                                      |                                | USE CONICAL TUBES ONLY                      |                 |                           |                              | 3700     | 2125         | 13.9            | 5.481  | 30.0 x 113                                   | 28.2 x 113   |
| 215(4)                      | 325(1)                          | 305                | 312(1)                               |                                | 2810 CONICAL                                | 15              | 4 x 15                    | 60                           | 3200     | 1825         | 15.9            | 6.276  | 18.0 x 139                                   | 16.0 x 139   |
|                             |                                 | 305                |                                      |                                | 2809 CONICAL(Omit Cap)                      | 50              | 4 x 50                    | 200                          | 3100     | 1700         | 15.9            | 6.276  | 30.0 x 133                                   | 28.2 x 133   |
| 215(4)                      | 325(1)                          | 305A †             |                                      |                                | 1630 2997 2048                              | 48-52           | 4 x (48-52)               | 192-208                      | 3150     | 1775         | 15.9            | 6.248  | 30.0 x 135                                   | 28.2 x 107   |
|                             |                                 | 305A               |                                      |                                | 2053 2828 613SS                             | 48-52           | 4 x (48-52)               | 192-208                      | 3150     | 1775         | 15.9            | 6.248  | 30.0 x 135                                   | 28.2 x 107   |
|                             |                                 | 305A               | 651(1)                               |                                | 2805  | 22              | 4 x 22                    | 88                           | 3150     | 1775         | 15.9            | 6.248  | 18.8 x 138                                   | 16.9 x 130   |
|                             |                                 | 305A               | 1105(1)                              |                                | 1698 2864                                   | 8-10            | 4 x (8-10)                | 32-40                        | 3150     | 1775         | 15.9            | 6.248  | 14.0 x 140                                   | 12.2 x 130   |
|                             |                                 | 305A               | 1106(1)                              |                                | 1648 2837 2858 2810                         | 15-19           | 4 x (15-19)               | 60-76                        | 3150     | 1775         | 15.9            | 6.248  | 17.4 x 140                                   | 15.5 x 130   |
|                             |                                 | 305A               | 1108(1)                              |                                | 2805 514PYREX 12ML                          | 12-22           | 4 x (12-22)               | 48-88                        | 3150     | 1700         | 15.3            | 6.053  | 19.3 x 130                                   | 17.4 x 120   |
|                             |                                 | 305A               | *1113(3)                             |                                | 2804 2840                                   | 4-5             | 12 x (4-5)                | 48-60                        | 3150     | 1450         | 13.1            | 5.158  | 11.3 x 108                                   | 9.4 x 100  |
|                             |                                 | 305A               | 2917(1)                              |                                | 2816 2842(Omit Caps)                        | 10-12           | 4 x (10-12)               | 40-48                        | 3150     | 1725         | 15.6            | 6.154  | 14.4 x 138                                   | 12.5 x 130   |
|                             |                                 | 305A               | 3151(1)                              |                                | 2805  | 22              | 4 x 22                    | 88                           | 3150     | 1775         | 15.9            | 6.248  | 18.8 x 138                                   | 16.8 x 130   |
|                             |                                 | 305A               | 3152(1)                              |                                | 1698 2864                                   | 8-10            | 4 x (8-10)                | 32-40                        | 3150     | 1750         | 15.7            | 6.176  | 14.2 x 138                                   | 12.3 x 130   |
|                             |                                 | 305A               | 3153(1)                              |                                | 1648 2837 2858                              | 15-19           | 4 x (15-19)               | 60-76                        | 3150     | 1750         | 15.7            | 6.176  | 16.1 x 138                                   | 14.1 x 130   |
|                             |                                 | 305A               | REMOVE 571 CUSHION                   |                                | 368(5) 8 x 95MM WINTROBE. FISHER #5-668-2   |                 |                           |                              | 3150     | 1800         | 16.1            | 6.338  | 8.3 x 117                                    | 7.1 x 117  |
| 215(4)                      | 326(2)                          | 320, 305, 305A     |                                      |                                | DO NOT USE. INNER SHIELD HITS MOTOR HOUSING |                 |                           |                              |          |              |                 |        |  |  |
| 215(4)                      | 350(1)                          | 341                |                                      |                                | 2806(Omit Cap)                              | 96              | 4 x 96                    | 384                          | 2550     | 1375         | 18.8            | 7.388  | 33.2 x 162                                   | 31.3 x 162   |
| 215(4)                      | 366(1)                          |                    | 369(5)                               |                                | 2841 2852 2804 2840                         | 3-5             | 20 x (3-5)                | 60-100                       | 4150     | 2125         | 11.1            | 4.384  | 12.6 x 83                                    | 10.7 x 81  |
|                             | 366                             |                    | 1018(4)                              |                                | 2836  | 1016            | 6 x 10                    | 160                          | 3650     | 1900         | 12.8            | 5.030  | 14.2 x 103                                   | 12.3 x 103   |
|                             | 366                             | 365                |                                      |                                |   |                 |                           |                              | 3350     | 1850         | 14.8            | 5.838  | 38.0 x 118                                   | 36.0 x 118   |
|                             | 366                             | 367A               |                                      |                                | KIMAX #15066 BOTTLE                         |                 |                           |                              | 2500     | 1325         | 19.0            | 7.468  | 38.0 x 165                                   | 36.0 x 165   |
| 215(4)                      |                                 | 362C <sup>sp</sup> |                                      |                                |   |                 |                           |                              | 3650     | 1875         | 12.6            | 4.958  | 36.7 x 100                                   | 34.8 x 100   |

\*USE PLASTIC TUBES ONLY

† 305A IS A 305 USING A 571 CUSHION FOR ROUND BOTTOM TUBES

Table 3-3, Speed and Force Tables, Horizontal Rotors (sheet 2 of 6)

| CAT. ROTOR AND NO. OF PLACES | CAT. TRUN. RING AND NO. OF PLACES | CAT. SHIELD | CAT. MULTI-CARRIER AND NO. OF PLACES | CAT. ADAPTER AND NO. OF PLACES | WILL ACCEPT IEC TUBE CATALOG NO.             | TUBE NOMINAL ML | TOTAL PLACES X NOMINAL ML | MIN-MAX CAPACITY RANGE IN ML | MAX. RPM | RCF MAX. G'S        | ROTATING RADIUS |        | WILL ACCEPT TUBE MAX. OD X MAX. LENGTH IN MM | RECOMMENDED MIN. TUBE X RECOMM. MAX. LENGTH IN MM |
|------------------------------|-----------------------------------|-------------|--------------------------------------|--------------------------------|--|-----------------|---------------------------|------------------------------|----------|---------------------|-----------------|--------|--|---|
|                              |                                   |             |                                      |                                |  |                 |                           |                              |          |                     | CM              | INCHES |  |   |
| 221(6)                       | 356                               |             |                                      |                                | 1629 1649 2801                               | 10-13           | 6 x (10-13)               | 60-78                        | 3750     | 2050                | 13.0            | 5.118  | 17.2 x 102                                   | 15.3 x 102  |
|                              |                                   |             |                                      |                                | 2850 2046 2067                               | 10-13           | 6 x (10-13)               | 60-78                        | 3750     | 2050                | 13.0            | 5.118  | 17.2 x 102                                   | 15.3 x 102  |
|                              |                                   |             |                                      |                                | 1125(1) 2836                                 | 10              | 6 x 10                    | 60                           | 3750     | 2050                | 13.0            | 5.118  | 13.6 x 104                                   | 11.7 x 104  |
|                              |                                   |             |                                      |                                | 1126(1) 2804 2840                            | 4-5             | 6 x (4-5)                 | 24-30                        | 3750     | 2050                | 13.0            | 5.118  | 11.1 x 104                                   | 9.3 x 104   |
|                              |                                   |             |                                      |                                | 1127(1) 2804 2840                            | 4-5             | 6 x (4-5)                 | 24-30                        | 3750     | 2050                | 13.0            | 5.118  | 11.1 x 104                                   | 9.3 x 95  |
|                              |                                   |             |                                      |                                | 1128(1) PYREX 8060 1ML                       | 1               | 6 x 1                     | 6                            | 3750     | 2050                | 13.0            | 5.118  | 8.6 x 104                                    | 6.7 x 92  |
|                              |                                   |             |                                      |                                | 1129(1) PYREX 8060 0.5ML                     | 0.5             | 6 x 0.5                   | 3                            | 3750     | 2050                | 13.0            | 5.118  | 6.4 x 104                                    | 4.5 x 89  |
| 221(6)                       | 303                               |             |                                      |                                | 1629 1649 1648 2858                          | 13-19           | 6 x (13-19)               | 78-114                       | 3400     | 1875                | 14.6            | 5.743  | 17.2 x 119                                   | 15.3 x 119  |
|                              |                                   |             |                                      |                                | 2859 2837 2810 (Cap)                         | 13-19           | 6 x (13-19)               | 78-114                       | 3400     | 1875                | 14.6            | 5.743  | 17.2 x 119                                   | 15.3 x 119  |
|                              |                                   |             |                                      |                                | 1125(1) 1698 2836 2864                       | 8-10            | 6 x (8-10)                | 48-60                        | 3400     | 1875                | 14.6            | 5.743  | 13.6 x 120                                   | 11.7 x 120  |
|                              |                                   |             |                                      |                                | 1126(1) 2804 2840                            | 4-5             | 6 x (4-5)                 | 24-30                        | 3400     | 1875                | 14.6            | 5.743  | 11.1 x 120                                   | 9.3 x 105   |
|                              |                                   |             |                                      |                                | 1127, 1128, 1129, NOT RECOMMENDED. TOO SHORT |                 |                           |                              |          |                     |                 |        |  |   |
| 221(6)                       | 302                               |             |                                      |                                | 1648 2858 2859                               | 15-19           | 6 x (15-19)               | 90-114                       | 2950     | 1600                | 16.5            | 6.495  | 17.2 x 133                                   | 15.3 x 130  |
|                              |                                   |             |                                      |                                | 2837 2810                                    | 15-19           | 6 x (15-19)               | 90-114                       | 2950     | 1600                | 16.5            | 6.495  | 17.2 x 133                                   | 15.3 x 130  |
|                              |                                   |             |                                      |                                | 1125(1) 2864 1698                            | 8-10            | 6 x (8-10)                | 48-60                        | 2950     | 1600                | 16.5            | 6.495  | 13.6 x 134                                   | 11.7 x 130  |
|                              |                                   |             |                                      |                                | 1126(1) 2804 2840                            | 4-5             | 6 x (4-5)                 | 24-30                        | 2950     | 1600                | 16.5            | 6.495  | 11.1 x 134                                   | 9.3 x 105   |
|                              |                                   |             |                                      |                                | 1127, 1128, 1129, NOT RECOMMENDED. TOO SHORT |                 |                           |                              |          |                     |                 |        |  |   |
| 221(6)                       | 306                               |             |                                      |                                | DO NOT USE. SHIELD HITS GUARDBOWL            |                 |                           |                              |          |                     |                 |        |  |   |
| 930(24 PLACE)                |                                   |             |                                      |                                | HEMATOKIT 1.75x75MM CAPILLARY TUBES          |                 |                           | 7800                         | 6200     | 9.1                 | 3.594           |        |  |   |
| 957(4)                       | 1120                              |             |                                      |                                | 100ML ASTM OIL BOTTLE KIMAX 45243            | 100             | 4 x 100                   | 400                          | 2450     | 1350                | 20.1            | 7.898  |  |   |
| 958(6)310(1)                 | 356                               |             |                                      |                                | 1629 1649 2046                               | 10-13           | 6 x (10-13)               | 60-78                        | 2950     | 1575                | 16.1            | 6.322  | 17.2 x 119                                   | 15.3 x 104  |
|                              |                                   |             |                                      |                                | 2067 2801 2850                               | 10-13           | 6 x (10-13)               | 60-78                        | 2950     | 1575                | 16.1            | 6.322  | 17.2 x 119                                   | 15.3 x 104  |
|                              |                                   |             |                                      |                                | 1125(1) 1698 2836 2864                       | 8-10            | 6 x (8-10)                | 48-60                        | 2950     | 1575                | 16.1            | 6.322  | 13.6 x 120                                   | 11.7 x 110  |
|                              |                                   |             |                                      |                                | 1126(1) 2804 2840                            | 4-5             | 6 x (4-5)                 | 24-30                        | 2950     | 1575                | 16.1            | 6.322  | 11.1 x 120                                   | 9.3 x 105   |
|                              |                                   |             |                                      |                                | 1127(1) 2804 2840                            | 4-5             | 6 x (4-5)                 | 24-30                        | 2950     | 1575                | 16.1            | 6.322  | 11.1 x 120                                   | 9.3 x 95  |
|                              |                                   |             |                                      |                                | 1128(1) PYREX 8060 1ML                       | 1               | 6 x 1                     | 6                            | 2950     | 1575                | 16.1            | 6.322  | 8.6 x 120                                    | 6.7 x 92  |
|                              |                                   |             |                                      |                                | 1129(1) PYREX 8060 0.5ML                     | 0.5             | 6 x 0.5                   | 3                            | 2950     | 1575                | 16.1            | 6.322  | 6.4 x 120                                    | 4.5 x 89  |
| 958(6)310(1)                 | 303                               |             |                                      |                                | 1629 1649 1648 2810                          | 13-19           | 6 x (13-19)               | 78-114                       | 2700     | 1425                | 17.6            | 6.946  | 17.2 x 134                                   | 15.3 x 122  |
|                              |                                   |             |                                      |                                | 2859 2858 2837                               | 13-19           | 6 x (13-19)               | 78-114                       | 2700     | 1425                | 17.6            | 6.946  | 17.2 x 134                                   | 15.3 x 122  |
|                              |                                   |             |                                      |                                | 1125(1) 1698 2836 2864                       | 8-10            | 6 x (8-10)                | 48-60                        | 2700     | 1425                | 17.6            | 6.946  | 13.6 x 135                                   | 11.7 x 122  |
|                              |                                   |             |                                      |                                | 1126(1) 2804 2840                            | 4-5             | 6 x (4-5)                 | 24-30                        | 2700     | 1425                | 17.6            | 6.946  | 11.1 x 135                                   | 9.3 x 105   |
|                              |                                   |             |                                      |                                | 1127, 1128, 1129 NOT RECOMMENDED. TOO SHORT. |                 |                           |                              |          |                     |                 |        |  |   |
| 958(6)310(1)                 | 302                               |             |                                      |                                | DO NOT USE. SHIELD HITS GUARDBOWL            |                 |                           |                              |          |                     |                 |        |  |   |
| 958(6)310(1)                 | 306                               |             |                                      |                                | DO NOT USE. SHIELD HITS GUARDBOWL            |                 |                           |                              |          |                     |                 |        |  |   |
| 958(6)325(1)                 | 320                               |             |                                      |                                | 1630 2997 2048                               | 48-52           | 6 x (48-52)               | 288-312                      | 2800     | 1475                | 16.7            | 6.580  | 30.0 x 124                                   | 28.2 x 107  |
|                              |                                   |             |                                      |                                | 2053 2858 613SS                              | 48-52           | 6 x (48-52)               | 288-312                      | 2800     | 1475                | 16.7            | 6.580  | 30.0 x 124                                   | 28.2 x 107  |
|                              |                                   |             |                                      |                                | 651(1) 2805                                  | 22              | 6 x 22                    | 132                          | 2800     | 1475                | 16.7            | 6.580  | 18.8 x 127                                   | 16.9 x 125  |
|                              |                                   |             |                                      |                                | 1105(1) 1698 2864                            | 8-10            | 6 x (8-10)                | 48-60                        | 2800     | 1475                | 16.7            | 6.580  | 14.0 x 128                                   | 12.2 x 125  |
|                              |                                   |             |                                      |                                | 1106(1) 1648 2858 2837 2810                  | 15-19           | 6 x (15-19)               | 90-114                       | 2800     | 1475                | 16.7            | 6.580  | 17.4 x 127                                   | 15.5 x 125  |
|                              |                                   |             |                                      |                                | 1108(1) 2805 514 PYREX 12ML                  | 12-22           | 6 x (12-22)               | 72-132                       | 2800     | 1425                | 16.2            | 6.385  | 19.3 x 124                                   | 17.4 x 122  |
|                              |                                   |             |                                      |                                | * 1113(3) 2804 2840                          | 4-5             | 18 x (4-5)                | 72-90                        | 2800     | 1225                | 13.9            | 5.490  | 11.3 x 95                                    | 9.4 x 95  |
|                              |                                   |             |                                      |                                | 2917(1) 2816 2842 (omit Caps)                | 10-12           | 6 x (10-12)               | 60-72                        | 2800     | 1450                | 16.5            | 6.486  | 14.4 x 122                                   | 12.5 x 120  |
|                              |                                   |             |                                      |                                | 3151(1) 2805                                 | 22              | 6 x 22                    | 132                          | 2800     | 1475                | 16.7            | 6.580  | 18.8 x 127                                   | 16.8 x 125  |
|                              |                                   |             |                                      |                                | 3152(1) 1698 2864                            | 8-10            | 6 x (8-10)                | 48-60                        | 2800     | 1450                | 16.5            | 6.508  | 14.2 x 127                                   | 12.3 x 125  |
|                              |                                   |             |                                      |                                | 3153(1) 1648 2837 2858                       | 15-19           | 6 x (15-19)               | 90-114                       | 2800     | 1450                | 16.5            | 6.508  | 16.1 x 127                                   | 14.1 x 125  |
|                              |                                   |             |                                      |                                | 368(3) x 95MM WINTROBE, FISHER               | #5-668-2        |                           |                              | 2800     | 1500                | 16.9            | 6.670  | 8.3 x 120                                    | 7.1 x 117   |
|                              |                                   |             |                                      |                                | 958(6)325(1)                                 | 320A            |                           |                              |          | 312(1) 2810 CONICAL | 15              | 6 x 15 | 90   | 2800  |
| 958(6)325(1)                 | 320A                              |             |                                      |                                | USE CONICAL TUBES ONLY                       |                 |                           |                              | 2800     | 1475                | 16.8            | 6.608  | 30.0 x 116                                   | 28.2 x 116  |

\*USE PLASTIC TUBES ONLY

Table 3-3. Speed and Force Tables, Horizontal Rotors (sheet 3 of 6)

| CAT<br>ROTOR<br>AND<br>NO OF<br>PLACES | CAT<br>TRUN<br>RING<br>AND<br>NO OF<br>PLACES | CAT<br>SHIELD | CAT<br>MULTI-<br>CARRIER<br>AND<br>NO. OF<br>PLACES | CAT<br>ADAPTER<br>AND<br>NO. OF<br>PLACES | WILL ACCEPT<br>IEC TUBE<br>CATALOG NO. | TUBE<br>NOMINAL<br>ML | TOTAL PLACES<br>X<br>NOMINAL<br>ML | MIN-MAX<br>CAPACITY<br>RANGE<br>IN ML | MAX.<br>RPM | RCF<br>MAX.<br>G'S | ROTATING<br>RADIUS |        | WILL ACCEPT<br>TUBE MAX OD<br>X<br>MAX LENGTH<br>IN MM | RECOMMENDED<br>MIN. TUBE OD<br>X<br>RECOMMENDED<br>MAX LENGTH<br>IN MM |
|--|---|---------------|---|---|--|-----------------------|------------------------------------|---------------------------------------|-------------|--------------------|--------------------|--------|--|--|
|  |   |               |   |   |  |                       |                                    |                                       |             |                    | CM                 | INCHES |  |  |
| 958(6)                                 | 325(1)  | 305           |   | 312(1)                                    | 2810 CONICAL                           | 15                    | 6 x 15                             | 90                                    | 2400        | 1200               | 18.8               | 7.416  | 18.0 x 143   | 16.0 x 140   |
|  | 325(1)  | 305           |   |   | 2809 CONICAL                           | 50                    | 6 x 50                             | 300                                   | 2400        | 1200               | 18.8               | 7.416  | 30.0 x 137   | 28.2 x 137   |
| 958(6)                                 | 325(1)  | 305A †        |   |   | 1630 2997 2048                         | 48-52                 | 6 x (48-52)                        | 288-312                               | 2400        | 1200               | 18.8               | 7.388  | 30.0 x 142   | 28.2 x 107   |
|  |   | 305A          |   |   | 2053 2828 613SS                        | 48-52                 | 6 x (48-52)                        | 288-312                               | 2400        | 1200               | 18.8               | 7.388  | 30.0 x 142   | 28.2 x 107   |
|  |   | 305A          |   | 651(1)                                    | 2805                                   | 22                    | 6 x 22                             | 132                                   | 2400        | 1200               | 18.8               | 7.388  | 18.8 x 144   | 16.9 x 130   |
|  |   | 305A          |   | 1105(1)                                   | 1698 2864                              | 8-10                  |                                    | 48-60                                 | 2400        | 1200               | 18.8               | 7.388  | 14.0 x 146   | 12.2 x 130   |
|  |   | 305A          |   | 1106(1)                                   | 1648 2858 2837 2810                    | 15-19                 | 6 x (15-19)                        | 90-114                                | 2400        | 1200               | 18.8               | 7.388  | 17.4 x 147   | 15.5 x 130   |
|  |   | 305A          |   | 1108(1)                                   | 2805 514 PYREX 12ML                    | 12-22                 | 6 x (12-22)                        | 72-132                                | 2400        | 1175               | 18.3               | 7.193  | 19.3 x 142   | 17.4 x 130   |
|  |   | 305A          |   | *1113(3)                                  | 2804 2840                              | 4-5                   | 18 x (4-5)                         | 72-90                                 | 2400        | 1025               | 16.0               | 6.298  | 11.3 x 115   | 9.4 x 110  |
|  |   | 305A          |   | 2917(1)                                   | 2816 2842 (Omit Caps)                  | 10-12                 | 6 x (10-12)                        | 60-72                                 | 2400        | 1200               | 18.5               | 7.294  | 14.4 x 146   | 12.5 x 130   |
|  |   | 305A          |   | 3151(1)                                   | 2805                                   | 22                    | 6 x 22                             | 132                                   | 2400        | 1200               | 18.8               | 7.388  | 18.8 x 144   | 16.8 x 130   |
|  |   | 305A          |   | 3152(1)                                   | 1698 2864                              | 8-10                  | 6 x (8-10)                         | 48-60                                 | 2400        | 1200               | 18.6               | 7.316  | 14.2 x 146   | 12.3 x 130   |
|  |   | 305A          |   | 3153(1)                                   | 1648 2858 2837                         | 15-19                 | 6 x (15-19)                        | 90-114                                | 2400        | 1200               | 18.6               | 7.316  | 16.1 x 141   | 14.1 x 141   |
|  |   | 305A          | REMOVE<br>571<br>CUSHION                            |   | 368(5)                                 | 18 x 95MM WINTROBE.   | FISHER #5-66A-2                    |                                       | 2400        | 1225               | 19.0               | 7.472  | 8.3 x 140  | 7.1 x 120  |
| 958(6)                                 | 355(3)  | 356           |   |   | 1629 1649 2801                         | 10-13                 | 18 x (10-13)                       | 180-234                               | 2450        | 1075               | 16.1               | 6.322  | 17.2 x 112   | 15.3 x 107   |
|  |   | 356           |   |   | 2850 2046 2067                         | 10-13                 | 18 x (10-13)                       | 180-234                               | 2450        | 1075               | 16.1               | 6.322  | 17.2 x 112   | 15.3 x 107   |
|  |   | 356           |   | 1125(1)                                   | 1698 2836 2864                         | 8-10                  | 18 x (8-10)                        | 144-180                               | 2450        | 1075               | 16.1               | 6.322  | 13.6 x 113   | 11.7 x 111   |
|  |   | 356           |   | 1126(1)                                   | 2804 2840                              | 4-5                   | 18 x (4-5)                         | 72-90                                 | 2450        | 1075               | 16.1               | 6.322  | 11.1 x 113   | 9.3 x 105  |
|  |   | 356           |   | 1127(1)                                   | 2804 2840                              | 4-5                   | 18 x (4-5)                         | 72-90                                 | 2450        | 1075               | 16.1               | 6.322  | 11.1 x 113   | 9.3 x 95   |
|  |   | 356           |   | 1128(1)                                   | PYREX 8060 1ML                         |                       | 18 x 1                             | 18                                    | 2450        | 1075               | 16.1               | 6.322  | 8.6 x 113  | 6.7 x 92   |
|  |   | 356           |   | 1129(1)                                   | PYREX 8060 0.5ML                       | 0.5                   | 18 x 0.5                           | 9                                     | 2450        | 1075               | 16.1               | 6.322  | 6.4 x 113  | 4.5 x 89   |
| 958(6)                                 | 355(3)  | 303           |   |   | 1629 1649 1648 2858                    | 13-19                 | 18 x (13-19)                       | 234-342                               | 2250        | 1000               | 17.6               | 6.946  | 17.2 x 129   | 15.3 x 123   |
|  |   | 303           |   |   | 2859 2837 2810                         | 13-19                 | 18 x (13-19)                       | 234-342                               | 2250        | 1000               | 17.6               | 6.946  | 17.2 x 129   | 15.3 x 123   |
|  |   | 303           |   | 1125(1)                                   | 1698 2836 2864                         | 8-10                  | 18 x (8-10)                        | 144-180                               | 2250        | 1000               | 17.6               | 6.946  | 13.6 x 130   | 11.7 x 125   |
|  |   | 303           |   | 1126(1)                                   | 2804 2840                              | 4-5                   | 18 x (4-5)                         | 72-90                                 | 2250        | 1000               | 17.6               | 6.946  | 11.1 x 131   | 9.3 x 105  |
|  |   | 303           |   | 1127, 1128, 1129,                         | NOT RECOMMENDED. TOO SHORT             |                       |                                    |                                       |             |                    |                    |        |  |  |
| 958(6)                                 | 355(3)  | 302,          | 306,  | SHIELDS                                   | DO NOT USE. SHIELDS                    |                       | HIT GUARDBOWL                      |                                       |             |                    |                    |        |  |  |
| 958(6)                                 | 354(4)  | 356           |   |   | 1629 1649 2801                         | 10-13                 | 24 x (10-13)                       | 240-312                               | 2400        | 1025               | 16.1               | 6.322  | 17.2 x 103   | 15.3 x 102   |
|  |   | 356           |   |   | 2850 2046 2067                         | 10-13                 | 24 x (10-13)                       | 240-312                               | 2400        | 1025               | 16.1               | 6.322  | 17.2 x 103   | 15.3 x 102   |
|  |   | 356           |   | 1125(1)                                   | 2836                                   |                       | 1024 x 10                          | 240                                   | 2400        | 1025               | 16.1               | 6.322  | 13.6 x 105   | 11.7 x 102   |
|  |   | 356           |   | 1126(1)                                   | 2804 2840                              | 4-5                   | 24 x (4-5)                         | 96-120                                | 2400        | 1025               | 16.1               | 6.322  | 11.1 x 105   | 9.3 x 102  |
|  |   | 356           |   | 1127(1)                                   | 2804 2840                              | 4-5                   | 24 x (4-5)                         | 96-120                                | 2400        | 1025               | 16.1               | 6.322  | 11.1 x 105   | 9.3 x 95   |
|  |   | 356           |   | 1128(1)                                   | PYREX 8060 1ML                         |                       | 24 x 1                             | 24                                    | 2400        | 1025               | 16.1               | 6.322  | 8.6 x 105  | 6.7 x 92   |
|  |   | 356           |   | 1129(1)                                   | PYREX 8060 0.5ML                       |                       | 24 x 0.5                           | 12                                    | 2400        | 1025               | 16.1               | 6.322  | 6.4 x 105  | 4.5 x 89   |
| 958(6)                                 | 354(4)  | 303           |   |   | 1629 1649 1648 2858                    | 13-19                 | 24 x (13-19)                       | 312-456                               | 2200        | 950                | 17.6               | 6.946  | 17.2 x 119   | 15.3 x 119   |
|  |   | 303           |   |   | 2859 2837 (2810 Omit Cap)              | 13-19                 | 24 x (13-19)                       | 312-456                               | 2200        | 950                | 17.6               | 6.946  | 17.2 x 119   | 15.3 x 119   |
|  |   | 303           |   | 1125(1)                                   | 1698 2836 2864                         | 8-10                  | 24 x (8-10)                        | 192-240                               | 2200        | 950                | 17.6               | 6.946  | 13.6 x 120   | 11.7 x 115   |
|  |   | 303           |   | 1126(1)                                   | 2804 2840                              | 4-5                   | 24 x (4-5)                         | 96-120                                | 2200        | 950                | 17.6               | 6.946  | 11.1 x 120   | 9.3 x 105  |
|  |   | 303           |   | 1127, 1128, 1129,                         | NOT RECOMMENDED. TOO SHORT             |                       |                                    |                                       |             |                    |                    |        |  |  |
| 958(6)                                 | 354(4)  | 302,          | 306,  | SHIELDS                                   | DO NOT USE. SHIELDS                    |                       | HIT GUARDBOWL                      |                                       |             |                    |                    |        |  |  |
| 958(6)                                 |   | 379(6)        |   |   | 1696 2860                              | 8-9                   | 36 x (8-9)                         | 288-324                               | 2900        | 1300               | 13.7               | 5.398  | 17.7 x 77  | 15.7 x 75  |
|  |   | 380(6)        |   |   | 1696 2860 2850                         | 8-12                  | 36 x (8-12)                        | 288-432                               | 2600        | 1125               | 15.0               | 5.898  | 17.7 x 88  | 15.7 x 86  |
|  |   | 380(6)        |   |   | 2801 2046 2067                         | 8-12                  | 36 x (8-12)                        | 288-432                               | 2600        | 1125               | 15.0               | 5.898  | 17.7 x 88  | 15.7 x 86  |
|  |   | 381(8)        |   |   |  |                       | 48 x                               |                                       | 2600        | 1125               | 15.0               | 5.898  | 13.6 x 92  | 11.7 x 91  |
|  |   | 398(6)        |   |   | 1629 1649 2801 2850                    | 10-16                 | 36 x (10-16)                       | 360-576                               | 2150        | 875                | 16.8               | 6.598  | 17.7 x 109   | 15.7 x 107   |
|  |   | 398(6)        |   |   | 2046 2067 2859                         | 10-16                 | 36 x (10-16)                       | 360-576                               | 2150        | 875                | 16.8               | 6.598  | 17.7 x 109   | 15.7 x 107   |
|  |   | 1080(6)       |   |   | 2801 2850 2046 2067                    | 10-13                 | 36 x (10-13)                       | 360-468                               | 2350        | 975                | 15.6               | 6.148  | 16.4 x 112   | 14.5 x 110   |
|  |   | 1080(6)       |   |   | 1629 1649                              | 10-13                 | 36 x (10-13)                       | 360-468                               | 2350        | 975                | 15.6               | 6.148  | 16.4 x 112   | 14.5 x 110   |
|  |   | 2760(8)       |   |   | 2804 2840                              | 4-5                   | 48 x (4-5)                         | 192-240                               | 2600        | 1125               | 14.9               | 5.873  | 11.0 x 92  | 9.1 x 90   |
| 958(6)                                 | 366(1)  |               | 369(5)  |   | 2841 2852 2804 2840                    | 3-5                   | 30 x (3-5)                         | 90-150                                | 3200        | 1600               | 14.0               | 5.523  | 12.6 x 98  | 10.7 x 95  |
|  | 366(1)  |               | 1018(4)   |   | 2836                                   |                       | 1024 x 10                          | 240                                   | 2800        | 1375               | 15.7               | 6.173  | 14.2 x 106   | 12.3 x 104   |
| 958(6)                                 |   | 362 Cap       |   |   |  |                       |                                    |                                       | 2800        | 1350               | 15.5               | 6.098  | 36.7 x 101   | 34.8 x 100   |
| 958(6)                                 | 366(1)  | 365           |   |   |  |                       |                                    |                                       | 2600        | 1350               | 17.8               | 6.998  | 38.0 x 123   | 36.0 x 120   |
|  | 366(1)  | 367A          |   |   | DO NOT USE. SHIELD HITS GUARDBOWL      |                       |                                    |                                       |             |                    |                    |        |  |  |

\*USE PLASTIC TUBES ONLY

† 305A IS A 305 USING A 571 CUSHION FOR ROUND BOTTOM TUBES

Table 3-3, Speed and Force Tables, Horizontal Rotors (sheet 4 of 6)

| CAT. ROTOR AND NO. OF PLACES | CAT. TRUN RING AND NO. OF PLACES | CAT. CHIEF | CAT. MULTI-CARRIER AND NO. OF PLACES | CAT. ADAPTER AND NO. OF PLACES | WILL ACCEPT IEC TUBE CATALOG NO.         | TUBE NOMINAL ML | TOTAL PLACES X NOMINAL ML | MIN-MAX CAPACITY RANGE IN ML | MAX. RPM | RCF MAX G'S | ROTATING RADIUS CM INCHES | WILL ACCEPT TUBE MAX. OD X MAX. LENGTH IN MM | RECOMM. MIN. TUB X RECOMME. MAX. LE. MM |
|------------------------------|----------------------------------|------------|--------------------------------------|--------------------------------|--|-----------------|---------------------------|------------------------------|----------|-------------|---------------------------|--|---|
| CARRIERS WITH ADAPTERS       |                                  |            |                                      |                                |  |                 |                           |                              |          |             |                           |  |   |
| 958(6)                       |                                  |            | 380 (6)                              | 1125(1)                        | DO NOT USE. ADAPTER TOO LONG.            |                 |                           |                              |          |             |                           |  |   |
| 958(6)                       |                                  |            | 380 (6)                              | 1126(1)                        | 2804 2840                                | 4-5             | 36 x (4-5)                | 144-180                      | 2600     | 1125        | 15.0                      | 5.898  | 11.1 x 88 9.3 x                         |
|                              |                                  |            | 380 (6)                              | 1127(1)                        | 2804 2840                                | 4-5             | 36 x (4-5)                | 144-180                      | 2600     | 1125        | 15.0                      | 5.898  | 11.1 x 88 9.3 x                         |
|                              |                                  |            | 380 (6)                              | 1128(1)                        | PYREX 8060 1ML                           | 1               | 36 x 1                    | 36                           | 2600     | 1125        | 15.0                      | 5.898  | 11.1 x 88 9.3 x                         |
|                              |                                  |            | 380 (6)                              | 1129(1)                        | PYREX 8060 0.5ML                         | 0.5             | 36 x 0.5                  | 18                           | 2600     | 1125        | 15.0                      | 5.898  | 8.6 x 88 6.7 x                          |
| 958(6)                       |                                  |            | 398 (6)                              | 1125(1)                        | 2836 2864 1698                           | 8-10            | 36 x (8-10)               | 288-360                      | 2150     | 875         | 16.8                      | 6.598  | 13.6 x 109 11.7 x                       |
|                              |                                  |            | 398 (6)                              | 1126(1)                        | 2804 2840                                | 4-5             | 36 x (4-5)                | 144-180                      | 2150     | 875         | 16.8                      | 6.598  | 13.6 x 109 11.7 x                       |
|                              |                                  |            | 398 (6)                              | 1127, 1128, 1129               | NOT RECOMMENDED.                         |                 | TOO SHORT.                |                              |          |             |                           |  | 11.1 x 109 9.3 x                        |
| 958(6)                       |                                  |            | 398A(6)                              |                                | 1629 1649 2859                           | 13-19           | 36 x (13-19)              | 468-684                      | 2150     | 900         | 17.5                      | 6.898  | 17.7 x 117 15.3 x                       |
|                              |                                  |            | 398A(6)                              |                                | 2858 2837 1648                           | 13-19           | 36 x (13-19)              | 468-684                      | 2150     | 900         | 17.5                      | 6.898  | 17.7 x 117 15.3 x                       |
|                              |                                  |            | 398A(6)                              | 1125(1)                        | 2836 2864 1698                           | 8-10            | 36 x (8-10)               | 288-360                      | 2150     | 900         | 17.5                      | 6.898  | 17.7 x 117 15.3 x                       |
|                              |                                  |            | 398A(6)                              | 1126(1)                        | 2804 2840                                | 4-5             | 36 x (4-5)                | 144-180                      | 2150     | 900         | 17.5                      | 6.898  | 13.6 x 120 11.7 x                       |
|                              |                                  |            | 398A(6)                              | 1127, 1128, 1129               | NOT RECOMMENDED.                         |                 | TOO SHORT                 |                              |          |             |                           |  | 11.1 x 120 9.3 x                        |
| 958(6)                       | 326(2)                           | 320        |                                      |                                | 1630 2997 2048                           | 48-52           | 12 x (48-52)              | 576-624                      | 2400     | 1100        | 16.9                      | 6.650  | 30.0 x 120 28.2 x 1                     |
|                              |                                  | 320        |                                      |                                | 2053 2828 613SS                          | 48-52           | 12 x (48-52)              | 576-624                      | 2400     | 1100        | 16.9                      | 6.650  | 30.0 x 120 28.2 x 1                     |
|                              |                                  | 320        |                                      | 651(1)                         | 2805                                     | 22              | 12 x 22                   | 164                          | 2400     | 1100        | 16.9                      | 6.650  | 30.0 x 120 28.2 x 1                     |
|                              |                                  | 320        |                                      | 1105(1)                        | 1698 2864                                | 8-10            | 12 x (8-10)               | 96-120                       | 2400     | 1100        | 16.9                      | 6.650  | 18.6 x 126 16.9 x 1                     |
|                              |                                  | 320        |                                      | 1106(1)                        | 1648 2858 2837 2810                      | 15-19           | 12 x (15-19)              | 180-228                      | 2400     | 1100        | 16.9                      | 6.650  | 14.0 x 127 12.2 x 1                     |
|                              |                                  | 320        |                                      | 1108(1)                        | 2805 514 PYREX 12ML                      | 12-22           | 12 x (12-22)              | 144-164                      | 2400     | 1100        | 16.9                      | 6.650  | 17.4 x 126 15.5 x 1                     |
|                              |                                  | 320        | *                                    | 1113(3)                        | 2804 2840                                | 4-5             | 36 x (4-5)                | 144-180                      | 2400     | 1050        | 16.4                      | 6.455  | 19.3 x 121 17.4 x 1                     |
|                              |                                  | 320        |                                      | 2917(1)                        | 2816 2842 (Omit Caps)                    | 10-12           | 12 x (10-12)              | 120-144                      | 2400     | 900         | 14.1                      | 5.560  | 11.3 x 98 9.4 x                         |
|                              |                                  | 320        |                                      | 3151(1)                        | 2805                                     | 22              | 12 x 22                   | 164                          | 2400     | 1075        | 16.7                      | 6.556  | 14.4 x 122 12.5 x 11                    |
|                              |                                  | 320        |                                      | 3152(1)                        | 1698 2864                                | 8-10            | 12 x (8-10)               | 96-120                       | 2400     | 1075        | 16.7                      | 6.578  | 18.8 x 126 16.8 x 12                    |
|                              |                                  | 320        |                                      | 3153(1)                        | 1648 2858 2837                           | 15-19           | 12 x (15-19)              | 180-228                      | 2400     | 1075        | 16.7                      | 6.578  | 14.2 x 126 12.3 x 12                    |
|                              |                                  | 320        | REMOVE 571                           |                                | 368 (5) x 95MM WINTROBE FISHER #5-668-2  |                 |                           | 2400                         | 1100     | 17.1        | 6.740                     | 16.1 x 125 14.1 x 12                         |   |
|                              |                                  |            | CUSHION                              |                                |  |                 |                           |                              |          |             |                           |  | 8.3 x 120 7.1 x 11                      |
| 958(6)                       | 326(2)                           | 320A       |                                      | 312(1)                         | DO NOT USE. ADAPTER INTERFERENCE AT O.D. |                 |                           |                              |          |             |                           |  |   |
| 958(6)                       | 326(2)                           | 320A       |                                      |                                | USE CONICAL TUBES ONLY                   |                 |                           |                              | 2400     | 1100        | 16.9                      | 6.650  | 30.0 x 116 28.2 x 11                    |
| 958(6)                       | 326(2)                           | 305        |                                      | 312(1)                         | DO NOT USE. ADAPTER INTERFERENCE AT O.D. |                 |                           |                              |          |             |                           |  |   |
| 958(6)                       | 326(2)                           | 305        |                                      |                                | 2809 CONICAL                             | 50              | 12 x 50                   | 600                          | 2150     | 975         | 19.0                      | 7.486  | 30.0 x 137 28.2 x 13                    |
| 958(6)                       | 326(2)                           | 305A †     |                                      |                                | 1630 2997 2048                           | 48-52           | 12 x (48-52)              | 576-624                      | 2150     | 975         | 18.9                      | 7.458  | 30.0 x 140 28.2 x 10                    |
|                              |                                  | 305A       |                                      |                                | 2053 2828 613SS                          | 48-52           | 12 x (48-52)              | 576-624                      | 2150     | 975         | 18.9                      | 7.458  | 30.0 x 140 28.2 x 10                    |
|                              |                                  | 305A       |                                      | 651(1)                         | 2805                                     | 22              | 12 x 22                   | 164                          | 2100     | 925         | 18.9                      | 7.458  | 30.0 x 140 28.2 x 10                    |
|                              |                                  | 305A       |                                      | 1105(1)                        | 1698 2864                                | 8-10            | 12 x (8-10)               | 96-120                       | 2100     | 925         | 18.9                      | 7.458  | 18.8 x 147 16.9 x 130                   |
|                              |                                  | 305A       |                                      | 1106(1)                        | 1648 2858 2837 2810                      | 15-19           | 12 x (15-19)              | 180-228                      | 2100     | 925         | 18.9                      | 7.458  | 14.0 x 148 12.2 x 130                   |
|                              |                                  | 305A       |                                      | 1108(1)                        | 2805 514 PYREX 12ML                      | 12-22           | 12 x (12-22)              | 144-164                      | 2100     | 925         | 18.9                      | 7.458  | 17.4 x 147 15.5 x 130                   |
|                              |                                  | 305A       | *                                    | 1113(3)                        | 2804 2840                                | 4-5             | 36 x (4-5)                | 144-180                      | 2100     | 900         | 18.5                      | 7.263  | 19.3 x 143 17.4 x 130                   |
|                              |                                  | 305A       |                                      | 2917(1)                        | 2816 2842 (Omit Caps)                    | 10-12           | 12 x (10-12)              | 120-144                      | 2100     | 800         | 16.1                      | 6.368  | 11.3 x 110 9.4 x 100                    |
|                              |                                  | 305A       |                                      | 3151(1)                        | 2805                                     | 22              | 12 x 22                   | 164                          | 2100     | 925         | 18.7                      | 7.364  | 14.4 x 146 12.5 x 130                   |
|                              |                                  | 305A       |                                      | 3152(1)                        | 1698 2864                                | 8-10            | 12 x (8-10)               | 96-120                       | 2100     | 925         | 18.9                      | 7.458  | 18.8 x 147 16.8 x 130                   |
|                              |                                  | 305A       |                                      | 3153(1)                        | 1648 2858 2837                           | 15-19           | 12 x (15-19)              | 180-228                      | 2100     | 925         | 18.8                      | 7.386  | 14.2 x 146 12.3 x 130                   |
|                              |                                  | 305A       |                                      |                                | 368 (5) x 95MM WINTROBE, FISHER #5-668-2 |                 |                           | 2100                         | 950      | 19.2        | 7.548                     | 16.1 x 145 14.1 x 130                        |   |
| ANGLE ROTORS                 |                                  |            |                                      |                                |  |                 |                           |                              |          |             |                           |  |   |
| 801(6)                       |                                  | 320        |                                      |                                | 1630 2997 2048                           | 48-52           | 6 x (48-52)               | 288-312                      | 4600     | 2550        | 10.8                      | 4.250  | 30.0 x 115 28.2 x 107                   |
|                              |                                  | 320        |                                      |                                | 2053 2828 613SS                          | 48-52           | 6 x (48-52)               | 288-312                      | 4600     | 2550        | 10.8                      | 4.250  | 30.0 x 115 28.2 x 107                   |
|                              |                                  | 320        |                                      | 651(1)                         | 2805                                     | 22              | 6 x 22                    | 132                          | 4600     | 2525        | 10.7                      | 4.200  | 30.0 x 115 28.2 x 107                   |
|                              |                                  | 320        |                                      | 1105(1)                        | 1698 2864                                | 8-10            | 6 x (8-10)                | 48-60                        | 4600     | 2500        | 10.6                      | 4.170  | 14.0 x 122 12.2 x 116                   |
|                              |                                  | 320        |                                      | 1106(1)                        | 1648 2858 2837 2810                      | 15-19           | 6 x (15-19)               | 90-114                       | 4600     | 2500        | 10.6                      | 4.190  | 17.4 x 122 15.5 x 122                   |
|                              |                                  | 320        |                                      | 1108(1)                        | 2805 514 PYREX 12ML                      | 12-22           | 6 x (12-22)               | 72-132                       | 4600     | 2500        | 10.5                      | 4.125  | 19.3 x 116 17.4 x 116                   |
|                              |                                  | 320        | *                                    | 1113(3)                        | 2804 2840                                | 4-5             | 18 x (4-5)                | 72-90                        | 4600     | 2250        | 9.5                       | 3.750  | 11.3 x 91 9.4 x 85                      |
|                              |                                  | 320        |                                      | 2917(1)                        | 2816 2842 (Omit Caps)                    | 12-22           | 6 x (10-12)               | 60-72                        | 4600     | 2500        | 10.5                      | 4.115  | 14.4 x 117 12.5 x 110                   |
|                              |                                  | 320        |                                      | 3151(1)                        | 2805                                     | 22              | 6 x 22                    | 132                          | 4600     | 2525        | 10.7                      | 4.200  | 18.8 x 125 16.8 x 17                    |
|                              |                                  | 320        |                                      | 3152(1)                        | 1698 2864                                | 8-10            | 6 x (8-10)                | 48-60                        | 4600     | 2500        | 10.5                      | 4.125  | 14.2 x 122 12.3 x 1                     |
|                              |                                  | 320        |                                      | 3153(1)                        | 1648 2837 2858                           | 15-19           | 6 x (15-19)               | 90-114                       | 4600     | 2500        | 10.5                      | 4.150  | 16.1 x 122 14.1 x 122                   |
|                              |                                  | 320        |                                      |                                | 368 (5) x 95MM WINTROBE FISHER #5-668-2  |                 |                           |                              |          |             |                           |  | DO NOT USE. TUBES TOO LONG.             |

\*398A IS 398 USING A 668 CUSHION  
 † USE PLASTIC TUBES ONLY

† 305A IS A 305 USING A 571 CUSHION FOR ROUND BOTTOM TUBES