

LABORATORY CENTRIFUGE SAFETY FACTSHEET

June 2003

Centrifuges come in three general classes; low speed (i.e., up to about 5000 rpm), high speed machines (i.e., up to about 25,000 rpm), and ultracentrifuges (i.e., up to 100,000 rpm or higher). Rotors on centrifuge and ultracentrifuge units are subjected to powerful mechanical stresses that may cause metal fatigue over time. This can lead to rotor failure where the rotor breaks apart with great force.

Centrifuges are designed to contain the rotor in the event of a failure. There have been instances, however, where the rotor was propelled through the centrifuge or the entire centrifuge moved with a force sufficient to penetrate cinder block walls and cause personal injury (see links to centrifuge accident descriptions at the end of this factsheet for details).

Check Your Operating Manual

The operating manual(s) for all centrifuges in use should be available to all users. They contain important information on how the centrifuge should be operated and maintained. The manual also indicates the maximum safe operating speeds for different rotors and for different loads. Each user should review the operating manual and become familiar with the precautions recommended by the manufacturer. Safety information for Beckman and Sorvall rotors is included at the end of this factsheet.

Do Not Use An Unapproved Rotor

Many incidents where the rotor has failed involved the use of an unapproved rotor. Only use rotors which have been approved for the centrifuge. Check the classification decal on the centrifuge and make sure it matches the classification decal on the rotor. If you are unsure of which rotor or tube to use, ask an experienced colleague or call the manufacturer.

Know When to Derate and When to Retire Your Rotors

Resources on when to derate (permanently lower the speed) and when to retire Beckman and Sorvall rotors are included at the end of this factsheet. The centrifuge operating manual will also include this information.

When spinning loads that are dense or that may result in precipitation, the speed of the centrifuge must be lowered, as required by the instrument's operating manual. The speed on an ultracentrifuge rotor must be derated when it has completed a certain number of runs or accumulated a certain number of hours. Rotors which have sustained damage usually have to be derated or even retired (no longer used). Derating is accomplished by the use of a speed derating disk that fits on the bottom of the rotor.

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Because of the high stress that centrifuge rotors are exposed to, they have a limited useful life span. All rotors must eventually be retired. For manufacturer's recommendations for retiring rotors, see the Beckman and Sorvall online resources at the end of this factsheet.

Have Centrifuge Rotors Inspected Periodically

Lab personnel should inspect the rotor before each use and should not use a rotor which has any corrosion or cracks, no matter how small. Periodically, an inspection by the manufacture or an approved vendor is also necessary because not all damage is easily visible. The inspection may use fiber-optics boroscopy to find signs of corrosion or other damage. Rotor inspection is **not** performed during centrifuge preventive maintenance unless specified.

UMDNJ has instituted a periodic rotor inspection program. The goal of the program is to assist researchers in determining which rotors need to be derated, repaired or no longer used. For SOM and RWJMS, the program is being coordinated by RWJMS Department of Shared Equipment Services (732) 235-4455. At NJMS, the program is coordinated by Facilities Management. Similar programs are in effect at other schools and units. Contact your local EOHSS office for details.

Maintain a Logbook

Maintain a logbook to monitor the number of runs and the number of hours that each rotor has been run. This information will help in determining when rotors must be derated and when they must be retired. The logbook should include date, user, rotor serial number and any problems encountered. A speed derating disk must be installed if and when the warranty conditions require it or when recommended during the annual rotor inspection.

Clean Your Rotor Without Damaging It

Centrifuge rotors are usually made of aluminum or titanium alloys. An aluminum rotor can be easily corroded by chlorine solutions (i.e., Clorox), salts or other chemicals which attack the rotor surface. It appears as rusting, pitting, and cracking usually in the bottom of the tube cavity or on the drive spindle adapter.

Do not scratch or otherwise damage the aluminum oxide layer that protects the underlying metal. Rotor cavities and buckets must never be cleaned with a bottle-brush or other brushes with sharp wire ends. Use special plastic coated brushes. Use a 1% non-alkaline soap rather than alkaline detergents or cleaning solutions that may damage the coating. Finish by rinsing with de-ionized water. To prevent corrosion, let rotors air-dry upside down so liquid will not ac-

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Use The Following Safety Practices for Nitrocellulose Tubes

Nitrocellulose tubes should only be used when they are clear, without discoloration, and flexible. It is advisable to purchase small lots several times a year rather than one large lot. Storage at 40°C will extend their shelf life. They must never be heated because they may explode.

User Error: The Biggest Cause of Rotor Incidents

Approximately 90% of rotor incidents are due to user error. According to Howard Hughes Medical Institute, the most common user errors are:

- failure to put the lid on the rotor
- failure to secure the lid
- failure to properly secure the rotor to the drive

A rotor that has become detached from the drive shaft can cause serious damage to the centrifuge. There is also a risk that the rotor can be ejected from the unit. There have been incidents with high-speed or large heavy heads where the whole centrifuge was thrown across the floor. Be aware that the head of the rotor may be damaged if the special tool provided to remove it is not used.

Other user errors that can lead to rotor failure include:

- overloading beyond the rotor's maximum mass without reducing the rated rotor speed
- running swinging bucket rotors with missing buckets
- buckets hooked incorrectly or not able to move freely on a horizontal rotor

Online Resources for Centrifuge Safety

- Beckman/Coulter Rotor Safety Guide: <http://www.beckmancoulter.com/resourcecenter/labresources/centrifuges/pdf/rotor.pdf>
- Sorvall Rotor Care Guide: <http://www.chem.purdue.edu/safety/SOPs/RotorCareGuide.pdf>
- The Howard Hughes Medical Institute has a 9 minute video on Centrifugation Hazards which may be ordered online at no charge. (<http://www.hhmi.org/research/labsafe/training/order.html>)
- Laboratory Accidents Involving Centrifuges, posted by the AIHA Laboratory Health and Safety Committee (<http://www2.umdj.edu/eohssweb/aiha/accidents/explosion.htm#explosion>)
- Additional Centrifuge Safety Links, posted by the AIHA Laboratory Health and Safety Committee: (<http://www2.umdj.edu/eohssweb/aiha/technical/labequipment.htm#Centrifuges>)

Centrifuge Rotor Maintenance and Safe Work Practices

1. Check the rotor for evidence of damage before you use it. If you find any of these conditions, do not use the rotor.
2. Before placing a rotor in the centrifuge drive, make sure the bowl is dry and that the drive spindle is clean.
3. Check “o” rings on containers and rotor for cracks, nicks, chemical degradation, pitting or corrosion.
4. Avoid overfilling tubes or bottles, Remember that centrifugal forces drive the fluid up the outside tube wall for tubes used in fixed angle rotors.
5. If you have derated the rotor, ensure that you are using the correct over-speed disk.
6. Check that the rotor is seated on the drive hub correctly.
7. Use only the correct tubes for the rotor. You should not have to modify them to make them fit.
8. Ensure that the load is balanced. Remember that a .5 gram difference at 500,000 Gs is equivalent to a 250 kg difference.
9. Stay at the centrifuge until it is running smoothly. Shut the machine down immediately if there is any unusual noise or vibration.
10. Record details about the run in the rotor log.
11. Do not open the door until the rotor stops spinning.
12. Always check for spills. If you find one, clean the centrifuge and rotor thoroughly. Clean the equipment after it is used with salts or corrosives.

Precautions when centrifuging infectious materials:

1. Always use aerosol containment tubes and safety cups or a sealed rotor.
2. Load and unload tubes and rotors in a biological safety cabinet.
3. Wait ten minutes before opening the centrifuge door in order to avoid hazardous aerosols.
4. If there is evidence of leakage or damage of any kind, close the lid immediately and carefully plan the cleanup. Request assistance from EOHSS as necessary.



Environmental and Occupational Health and Safety Services

Newark (2-4812) ✉ Piscataway (5-4058) ✉ New Brunswick (5-8497)
Scotch Plains (908-889-2486) ✉ Stratford/Camden (6-6189)