No unauthorized individuals are allowed in the NMR Facility.

Guests must be escorted at all times.

All NMR users should read and be familiar with the following safety information. There are multiple potential hazards in the NMR laboratory.

Magnetic Field Hazards

The NMR instruments use large superconducting magnets that are housed in a cryostat containing liquid helium and liquid nitrogen. Magnets will exert large attractive forces on equipment or other magnetic objects when brought close. The force may become large enough to move the equipment uncontrollably towards the NMR magnet. Small pieces of metallic subjects (wrenches, screwdrivers...) may become projectiles. Large equipment (gas cylinders) can cause bodies or limbs to become trapped between the equipment and the magnet. Keep in mind the following:

The closer to the magnet, the larger the force.
The larger the mass, the larger the force.
Remember: Superconducting magnets are ALWAYS on

Videos of what happens when you get a heavy iron object too close to a magnet are posted online with the NMR information.

Rules:

- **Do bring any metallic object within 10 feet of any magnet.** Assume all metallic objects are ferromagnetic and will be attracted to the magnets, unless verified by NMR staff.
- **Do NOT bring compressed gas cylinders into the NMR laboratories without NMR personnel supervision.**
- **NEVER put any object into the magnet, except the NMR tube and holder.**
- **If the oxygen sensor sounds alarm or the magnet quenches - leave the room immediately.**
- **Always ensure that a cryogen dewar has a means to vent.**
- For low-temperature NMR experiments, use a non-magnetic nitrogen dewar.
- **Some of the equipment in the NMR room is magnetic; trained personnel should know what equipment cannot be brought within the 5G line.**
- Only authorized users can change the probe.

Medical Implants

The operation of electronic,electrical or mechanical medical implants, such as cardiac pacemakers, biostimulators, and neurostimulators may be affected or even stopped in the presence of either static or changing magnetic fields. Medical implants such as aneurysm clips, surgical clips or protheses may contain ferromagnetic materials and therefore would be subjected to strong attractive forces near the magnet. This could result in injury or death. Additionally, in the vicinity of rapidly changing fields (pulsed gradient fields), eddy currents may be induced in the implant resulting in heat generation.

Rules:

- Persons with these types of implants MUST remain outside the NMR laboratories until more extensive safety training is provided by NMR staff.

Cryogen Hazards

Cryogens such as liquid nitrogen (LN2) and liquid helium that are present in the magnet cryostat and portable dewars may pose several dangers, including asphyxiation, frostbite and chemical explosions. A) When a magnet quenches, or suddenly becomes non-superconducting, large amounts of liquid cryogens are quickly vaporized. Videos of magnets quenching are posted online. Due to their large expansion ratios (nitrogen 695:1, helium 760:1), these gases can quickly displace all the oxygen in the NMR room and cause asphyxiation. Effects from oxygen deficiency become noticeable at levels below ~18% and sudden death may occur at ~6% oxygen content by volume. B) Direct contact with cryogenic substances in liquid or vapor form can produce "cold burns" on the skin similar to conventional burns. The temperature of liquid helium is -269 °C and of liquid nitrogen is -196 °C. C) Cryogenic fluids with a boiling point below that of liquid oxygen are able to condense oxygen from the atmosphere. Repeated replenishment of the system can thereby cause oxygen to accumulate. Violent reactions, e.g. rapid combustion or explosion, may occur if the materials, which make contact with the oxygen, are combustible.

Rules:

- If you observe a sudden exhaust of gas from a magnet (and NMR staff are not performing a cryogen fill) or if the oxygen sensor alarm sounds, EXIT the NMR laboratory IMMEDIATELY.
- NMR staff periodically must replenish the magnet's cryogens. During a fill, keep away from the gaseous exhaust from the magnet as frostbite burns may result.
- When handling cryogens, wear gloves, googles, and closed toe shoes.
- When doing low-temperature NMR work and using the LN_2 dewar, beware of liquid splashing

and rapid flash off of LN_2 when immersing the variable-temperature NMR apparatus into the dewar. This operation must be carried out very slowly.

- Always replace the loose-fitting cap onto the LN_2 dewar to avoid the condensation of oxygen in the dewar.

NMR Tube Safety

NMR tubes have thin walls and are easily broken. Once broken, they are extremely sharp. When inserting NMR tube into spinner, grap the tube close to the spinner. This will avoid applying a torque that can easily break a tube and, often, drive it into a finger.

Chemical Safety- Hazardous and dangerous materials

All users who conduct experiments with hazardous materials, including toxic and radioactive materials, including pressurized, explosive, or otherwise unusually hazardous materials must closely follow Columbia Environmental Health and Safety guidlines. Failure to do so may jeopardize the environment and safety of all users and may lead to suspension of facility access privilege and payment of any cleanup cost.

Rules:

- When using NMR tubes filled with highly toxic and dangerous materials, such as mercury, thalium, etc, transport NMR tubes in appropriate safety containers, not simply in a flask or other open container, or carried by hand.
- NMR tubes are often broken in and around the NMRs. Please clean up non-hazardous spills and broken glass. For toxic or hazardous materials, do not attempt to clean up yourself. Instead, inform NMR staff and contact Envirnmental Health and Safety

In Case of Emergency:

Dial .

It is your responsibility to report any accident to the NMR technical personnel immediately.

Cryogen Fill Safety

Protective equipment: gloves and safety goggles are required during cryogen fills.

Cryogen Fills, especially Helium, can induce a magnet quench:

- If you keep your head out of the cloud as you dash for the door, you should be ok. If you are up on a ladder and suddenly can't see anything, you are in a bit more trouble. Of course, this volume of gas does not appear instantaneously, allowing time to escape. But if you are wrestling with a transfer line and are reluctant to just let it go and flee, you increase your risk substantially.
- It would be extremely unwise to attempt a fill by yourself without the presence of someone who knows what might happen in the event of a quench and what to do provide assistance, particularly in a small room.
- It should be noted that the OSHA limit (see 29CFR1915.12) is 19.5% oxygen, and anything less is defined as an oxygen deficient atmosphere. According to the Compressed Gas Association (http://cganet.com), the following physiological effects of low oxygen availability (percentages are by volume) are observed:
  - 15-19% Decreased ability to perform tasks. May impair coordination and induce early symptoms in persons with head, lung or circulatory problems.
  - 12-15% Breathing increases, especially in exertion. Pulse rate up. Impaired coordination, perception, and judgement.
  - 10-12% Breathing further increases in rate and depth, poor coordination and judgement, lips slightly blue.
  - 8-10% Mental failure, fainting, unconsciousness, ashen face, blueness of lips, nausea and vomiting.
  - 6-8% 8 minute exposure may be fatal in 50-100% of cases; 6 minute exposure may be fatal in 25 to 50% of cases; 4-5 minutes, recovery with treatment.
  - 4-6% Coma in 40 seconds, followed by convulsions, breathing failure and death.
- Exposure to atmospheres containing 8-10% or less oxygen will bring about unconsciousness without warning and so quickly that the individuals cannot help or protect themselves.

If you have ANY reason to believe a substantial amount of cryogen has escaped into the room as gas, leave the room!

Cryogen containers should always be allowed to vent.