Safety Guide and Information for Users
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NMR Facility Internal Website: [https://www.lifesci.susx.ac.uk/nmr/](https://www.lifesci.susx.ac.uk/nmr/)
NMR Facility Safety Folder: Located on shelf at preparation end of Lab 2R116

A plan of the NMR Facility is given in Appendix II, is located on the website ([https://www.lifesci.susx.ac.uk/nmr/docs/LabPlan.pdf](https://www.lifesci.susx.ac.uk/nmr/docs/LabPlan.pdf)) and is to be found on the laboratory door.

**Introduction**

All persons working in the NMR facility must be inducted and receive training from the Facility Manager prior to starting work. This applies to all users, however, training will be tailored to suit previous experience. Records of training are kept by the Facility Manager.

**General Rules**

Risks are minimised by limiting access to the NMR laboratory to trained users. Other persons entering the laboratory must be escorted by the Facility Manager or experienced users.

Access to the NMR laboratory is restricted by coded door locks. The access code is available from the NMR Facility Manager.

Spectrometer modifications and maintenance, including the use of cryogens is limited to the NMR Facility Manager and experienced users as designated by the Facility Manager.

**Planned Preventative Maintenance**

Estates, Technical Services personnel and all other contractors must inform the NMR Facility Manager before entering the NMR laboratory. All works must be notified to the Facility Manager prior to commencing.

**Hazards of working in the NMR Facility**

All practical steps are taken to reduce hazards associated with working in the NMR laboratory. Compliance with the University of Sussex Science Schools Safety Handbook is required at all times.

**Strong Magnetic Fields**

High magnetic fields are present around the NMR spectrometer cryostats. These can be hazardous indirectly through the forces exerted on ferromagnetic materials or directly via the effect on electronic devices or potentially on the human body. Specific hazards are:

- Medical electronic implants such as cardiac pacemakers may be affected by magnetic fields. Medical implants, e.g. pins, blood vessel clips and prostheses, may contain ferromagnetic materials and could be subject to strong attractive forces near to the NMR magnet system.

- Large attractive forces are exerted on magnetic materials or equipment bought in close proximity to the NMR magnet systems, which are always at field. The force may become large enough to move tools or equipment uncontrollably towards the magnet; the closer to the magnet cryostat the larger the force. Risks come from release of ferromagnetic items/tools or equipment which are bought near the magnets. **For this reason fire extinguishers should not be used near NMR cryostats.** It is possible that even belt buckles, steel tipped shoes, coins, keys etc. may be strongly attracted to a magnet. This might result in damage to the spectrometer (possibly resulting in a quench, see below) or serious injury or death to personnel working near or under a magnet. Users periodically need to work under the magnet during its normal operation.

- Long-term cumulative exposure to large oscillating magnetic fields (60 Hz) may be associated with increased incidence of brain cancer in power industry workers*. The cumulative doses for an effect were large, and represent no hazard outside the 5 Gauss safety line normally used. Importantly, the magnetic field of an NMR spectrometer is static, however reasonable caution in avoiding lengthy exposure seems prudent.


Additionally, magnetic fields may permanently damage mobile phones, watches, calculators and certain types of magnetic or RFID devices such as swipe cards, credit cards, travel tickets/“Oyster” cards, USB drives, etc.

**Precautions**

A critical exclusion zone around each magnet is indicated by the taped area on the floor. Yellow and Black tape marks the area of the room which may be within the magnet 5 Gauss field, generally considered to be the critical field strength. A chained cordon is also in place around the 600 MHz spectrometer cryostat.

- All people with electronic medical implants such as pacemakers are excluded from the NMR laboratory (appropriate warning signs are displayed on the doors). People with other implants must not enter the area around the magnet.
cryostats where the field strength is >5 Gauss. It should be assumed that areas of the floor marked by the yellow and black tape may be within the 5 Gauss radius and must not be entered.

- Risks of moving metal causing injury/damage are minimised by exclusion of all metallic objects from the marked areas in the NMR facility. It is necessary to use steel tools for maintenance and repair of the consoles, but such work may only be done by the NMR Facility Manager, his nominated deputy or engineers from the equipment manufacturer (Agilent Technologies). Users are not allowed near the magnet during such work. Where possible non-magnetic tools are used on the magnets themselves.

- NMR staff and researchers should spend no longer than reasonably necessary within the immediate proximity of the magnets, i.e. only for sample changing and routine adjustments.

- Mobile phones, watches, calculators and types of magnetic or RFID devices such as swipe cards, credit cards, travel tickets/“Oyster” cards, USB drives, etc. must not be taken into the marked 5 Gauss area.

**Cryogens**

The cryogens used are liquid nitrogen and liquid helium. These are present within the magnet cryostats and during normal operation users are not exposed directly. The magnet cryostats continuously expel a small quantity of gaseous He and N₂ into the air due to liquid boil-off. The use of liquid nitrogen during variable temperature (VT) operation is restricted to trained users who should follow standard procedures for its handling. The main risks are thus:

- Cold burns when handling cryogens.

- Asphyxiation due to boil-off during filling or if a magnet quenches. Magnet quenches can be spontaneous and cause the rapid release of the cryogens within the magnet cryostat into the room, reducing air (and thus oxygen) content.


**Precautions**

The NMR laboratory has air handling preventing build up of asphyxiants under normal boil-off conditions. Asphyxiation risk is additionally minimised by oxygen monitoring within the NMR laboratory, which triggers an evacuation alarm within the room.
• Only trained staff may fill the magnets with liquid nitrogen. Filling the magnet with liquid helium must only be performed under the direction of the Facility Manager. Users of the facility must not attempt re-fills or interfere with the vessels used for cryogens. Always contact the Facility Manager if there is a problem with the equipment (contact details in appendix I).

• Access to the NMR spectrometers is not permitted during refills.

• Cryogen fill must be carried out according to the Standard Operating Procedure (SOP) described in the Magnet System Manuals, available in the NMR facility, on the bookshelves near the preparation area. A specific risk assessment has also been completed for the use of cryogens and asphyxiating gases within the facility, a copy of which resides in the NMR laboratory safety folder.

**Trip Hazards**

The NMR laboratory contains electrical cabling and pipe work which are likely to be unfamiliar to non-experienced users. These are close to the magnet cryostats so present a possible hazard to users making routine adjustments near or under the spectrometer cryostats.

*Precautions*

The facility has been designed to route cables and pipe work around the walls or under covered trunking wherever possible so danger of tripping during normal movement around the room is no greater than normal.

• Reasonable caution and good laboratory practice should be exercised to prevent risk of personal injury and expensive damage to the NMR equipment.

• NMR users should take extra care close to and under the NMR magnets.

**Electrical / RF (radio frequency)**

NMR spectrometers and their accessories contain a number of devices operating at mains or higher voltages and currents. No exposed live electrics are present under normal circumstances, so with standard operation of an NMR spectrometer, risks are similar to those encountered in the use of other laboratory or computer equipment.

*Precautions*

• Modification/maintenance of the equipment is restricted to the NMR Facility Manager, and designated experienced users only in consultation with the spectrometer manufacturer (Agilent Technologies, formerly Varian Inc.).
Only carbon dioxide fire extinguishers should be used around electrical equipment (including computers). NB: Fire extinguishers are not to be used near the magnet cryostats (within the yellow and black taped floor areas) as they may be attracted by the magnetic field.

Handling NMR samples

Samples for NMR are relatively small (normally dissolved in < 1 ml of solvent for liquid state NMR) and are contained within NMR sample tubes sealed with a lid or J-Youngs valve. Liquid-state NMR samples are normally dissolved in DMSO-d$_6$ or chloroform-d, or other common laboratory solvent, e.g. acetone-d$_6$, acetonitril-d$_3$, benzene-d$_6$, D$_2$O, Dichloromethane-d$_2$ or toluene-d$_8$. The main hazards are therefore most likely to be a result of tube breakage causing:

- Sharps injury
- Exposure to a hazardous sample compound or additive. For example, biochemical samples often contain small quantities of sodium azide as an additive.

Standard glass NMR tubes are generally robust if cautiously handled, in the same manner as other laboratory glassware, such as Pasteur pipettes. The main risk of breakage is either through dropping the tube or during transfer of the sample into the tube, especially if the NMR tube is old and/or chipped. Damaged tubes should be either repaired by the glass blower if practical, or discarded.

The handling of all NMR samples should compile with SPG-23-09: Implementing the COSHH Regulations:

Precautions

Risk of exposure to a hazardous sample through dropping the NMR tube is minimised by carrying it within a secondary container (e.g. plastic “Tupperware” box) with lid during transport. This also reduces risk of sharps injury. Hence, all NMR samples must be transported to the facility in this manner.

- Risk of breakage during tube loading and handling is minimised by using only NMR tubes which have no chips, cracks or other flaws by visual inspection.
- Samples should be transferred into the tube using appropriate apparatus, such as extended Pasteur pipettes which allow the solution to be deposited straight into the bottom of the NMR tube.
- All used glassware or other sharps must be either placed in an appropriate container after use or disposed of in a sharps safe bin.
Risk of exposure during loading of the sample is no different from that during sample preparation and the researcher and/or PI is responsible for ensuring appropriate risk assessments have been carried out for their work.

Users should inform the Facility Manager prior to the use of highly toxic, or extremely hazardous samples.

**Carousel Sample Changer attached to the 400 MHz Spectrometer**

The carousel sample changer on the 400 MHz spectrometer is only capable of moving at slow speed and as such presents no significant risk of injury. NMR tubes which are over 24 cm in length will also be damaged by sensor arm over the carousel. Their use is therefore not permitted.

**Precautions**

- Risks are minimised by user training.
- Samples should not be placed in the carousel whilst it is performing a sample change procedure.

**SMS-50 Robot attached to the 500 MHz Spectrometer**

The SMS-50 robot on the 500 MHz spectrometer is capable of moving at high speed and as such presents a risk of impact injury. NMR tubes which are over 24 cm in length will also be damaged by the robot. Their use is therefore not permitted.

**Precautions**

- Risks are minimised by user training and observation of warning signs on robot table.
- Samples should not be placed in the SMS tray while the robot is performing a sample change procedure.
- An emergency “kill” switch is located on the table leg. This will cut power to the robot. If it is activated inform the NMR Facility Manager or his nominated deputy.

**7600AS Robot attached to the 600 MHz Spectrometer**

The 7600AS robot on the 600 MHz spectrometer is capable of moving at high speed and as such presents a risk of impact injury. The robot is contained within a Perspex screened area with interlocked doors. Access is only possible via the “Request Access” button on the robot tower. This moved the robot to a safe position and it will
not resume operation until the doors are closed. NMR tubes which are over 24 cm in length will also be damaged by the robot. Their use is therefore not permitted.

Precautions

- Risks are minimised by Perspex screening and interlocked access doors to robot enclosure and user training.
- An emergency “kill” switch is located on the tower. This will cut power to the robot. If it is activated inform the NMR Facility Manager or his nominated deputy.

**Working Outside Normal Hours**

Normal working hours for the NMR facility are considered to be 08:00-18:00, Monday-Friday, when the building is unlocked.

Operation of the NMR instruments is permitted by trained users outside normal working hours. Any operation which would normally require the NMR Facility Manager or his nominated deputy to be present is specifically excluded.

There is no working in the NMR facility during the Christmas Vacation closure period without the express permission of the Facility Manager. All instruments are typically shut down during this time.


**Emergency Procedures**

In the event of any of the following scenarios please ensure the Facility Manager has been informed as soon as it is safe to do so. This is especially important out-of-hours. The Facility Manager should also be informed of any accidents, near misses or requirement of First Aid to help guide safe practice in the facility.

**In the event of magnet quench/loud alarm sounding within the NMR laboratory**

In the event of a quench, the cryomagnets rapidly vent helium and nitrogen gases into the laboratory. This is apparent from an extremely loud noise emanating from the magnets (and/or the noise of escaping gas and vapour clouds above the magnet) and an alarm from the oxygen deficiency meter within the NMR laboratory and/or the noise of escaping gas and vapour clouds above the magnet. In this event:

- Evacuate the NMR laboratory, ensuring those around you also do so.
• Inform the Facility Manager, contact details on laboratory door.

• Areas outside of the NMR laboratory can be considered safe.

• The room may be entered only when the oxygen meter indicates that it is safe to do so.

**In the event of fire**

In the event of fire, or if you hear the fire alarm (apparent as an alarm sounding outside of the NMR laboratory, but audible inside):

• Proceed to the nearest fire exit, ensuring others around you are aware.

• Sound the fire alarm button situated in the Chichester II corridor if not already activated.

• The fire assembly point is on the grass outside Pevensey Building

• Fire extinguishers are located in the corridor outside the laboratory and should only be used if you are trained in their use and you feel able to tackle the blaze safely.

• Only carbon dioxide fire extinguishers should be used around electrical equipment (including computers)

• Fire extinguishers should **not** be used within the yellow and black taped areas.

**Damage to the facility equipment or equipment indicating fault**

Let the Facility Manager know as soon as possible of any damage to any of the NMR facility equipment or if any equipment indicates fault. Especially important are audible alarms in the NMR laboratory from the uninterruptible power supply (UPS) units.

**Metal objects become attached to a magnet**

If a metal object accelerates and strikes an NMR magnet cryostat:

• Evacuate the room immediately, ensuring those around you are aware.

• Under no circumstances should an attempt be made to pull a stuck metal object away from an NMR cryostat as this may trigger a quench.
• Inform the NMR Facility Manager or nominated deputy who will be required to deflate the magnet support legs before attempting removal.

Spillage of samples


Please clear up spillages as soon as possible using the spill kits provided, locations as in SPG-32-09:

• Inform those around you and ensure that other people cannot walk through the spillage area.

• Wear appropriate personal protective equipment to clear up the spill (lab coat, safety specs, cut-resistant gloves and disposable gloves).

• Collect any broken glass/solids using the dustpan and brush from the spill kit. Dispose of glass into a sharps bin.

Sample breakage inside a spectrometer

If you suspect a tube has broken inside the NMR spectrometer (e.g. no lock solvent signal):

• Do not eject the sample using the lift air

• Inform those around you to ensure no-one else attempts to eject the sample.

• Inform the Facility Manager or his nominated deputy as soon as possible

Do not attempt any remedial works without the permission of the Facility Manager, his deputy or the instrument vendor (Agilent Technologies).


Medical emergency
If there is a medical problem dial the University emergency number 3333, using the telephone located on the wall near the 400 MHz spectrometer host computer and await assistance.

Reactive emergency maintenance

In the event of a flood or other problem within the NMR laboratory no-one is to enter until the Facility Manager or the nominated deputy have been contacted and given their authorisation to enter the laboratory.

Security incident

Any unauthorised access to the facility must be reported to the Facility Manager. Signs on the doors leading to the restricted area give emergency contact numbers. Do not approach intruders - always call security and report to the Facility Manager.

Acknowledgements

This guide is based on that for the Cross Faculty NMR Facility at Imperial College (http://www.imperial.ac.uk/nmrcentre).
## Appendix I: NMR Facility And Related Staff

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Appendix II: NMR Laboratory Plan

Chichester 2R116 - School of Life Sciences / Chemistry NMR Laboratory

Equipment Working Overnight:
NMR spectrometers (magnet and console)
High-Performance Liquid Chromatograph
PCs (x6)
Fridge
Air conditioning unit

In Case of Emergency:
NMR magnets cannot be switched off!
NMR consoles switch off at wall supply.
PCs, Fridge and Misc. Lab. Equipment switch off at wall.

Heed warning signs regarding strong magnetic fields.
5 Gauss lines shown in red

Emergency contacts:
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