Centre For Magnetic Resonance

Workplace Health and Safety Policy

Workplace Health and Safety Officer – Mr. David Butler

Occupational Health and Safety Committee –

Prof. Ian Brereton (Acting Director), Chair
Mr. David Butler (WHSO)
Dr. Katie McMahon (Wesley Representative)
Mr. Matt Meredith (Radiographer)
Mr. Alan Pringle (CMR Representative)
Prof. Andrew Whittaker (AIBN Representative)
Ms Kylie Varcoe, (Postgraduate Student representative)

First Aid Officer – Prof. Graham Hanson

Staff Responsibilities for Occupational Health and Safety

Overview

Staff at all levels within the University of Queensland (UQ) have specific responsibilities for ensuring occupational health and safety (OH&S). These responsibilities are based on the Queensland Workplace and Health and Safety Act 1995 and the related legislation. The University of Queensland OH&S policy further reinforces these responsibilities. The specific OH&S responsibilities of staff are dependent on their role within the University.

Description

Individual Staff

Individual staff members are to comply with requirements of Queensland OH&S legislation and related OH&S procedures developed by the University, School or CMR.

Performance criteria:

1. **Comply with safe working procedures**

    - Follow safe working procedures established by the University, School or CMR.

    - Follow the OH&S directions of the Director of CMR or supervisor.

2. **Use of appropriate personal protective equipment and safety systems**

    - Where personal protective equipment (PPE) is required to control exposure to hazards in the workplace, wear and maintain the PPE as directed or as required in OH&S procedures.

    - Use other safety and emergency equipment provided in the workplace as directed or as required in OH&S procedures.

3. **Assist with the preparation of risk assessments**
    - When requested, assist the supervisor and other workers in risk assessments of workplace hazards.
4. **Report OH&S problems**
    - Report workplace hazards to supervisor.
    - Report injury or illness arising from workplace activities.

Supervisors

Supervisors are to undertake effective occupational OH&S measures to ensure compliance with the Workplace Health and Safety Act and related legislative requirements.

Performance criteria:

1. **Provide OH&S information, training and supervision**
    - Disseminate OH&S information to staff, students and visitors relevant to the specific work hazards of the area.
    - Provide induction and refresher training to ensure ability of staff to discharge allocated OH&S responsibilities including: hazards within the workplaces, safe operating procedures, use and

maintenance of PPE and safety equipment and emergency response procedures.

- Supervise the occupational health and safety aspects of work undertaken by staff and students within the work area.
- Facilitate consultation between management and staff regarding OH&S issues.

2. Undertake risk assessments

- Undertake, or directly supervise the identification of hazards, evaluation of risks, and design and implementation of hazards control measures – application to research projects, teaching, field work, purchasing (plant, equipment or chemicals), service operations and minor or major works.
- Maintain appropriate documentation of procedures and interventions arising from risk assessments.
- Incorporate OH&S considerations into the design specification, purchase, hire, lease and supply of plant including equipment, materials, products and substances used in the workplace.
- Monitor the performance and effectiveness of the risk management program within the work area.

3. Ensure application of appropriate risk control measures

- Develop and periodically update OH&S procedures for management of risks specific to the work area.
- Ensure the provision of plant, safety systems and PPE required to control the risk of hazards in the work area.
- Ensure the maintenance of plant, safety systems and PPE required to control the risk of hazards in the work area.

4. Implement a scheme for hazard and accident follow-up

- Undertake investigations of accidents and illness arising from workplace activities. Recommend corrective actions to prevent or minimize the chance of recurrence.

- Facilitate the reporting of workplace hazards to the Centre's Workplace Health and Safety Officer (WHSO), the Centre Director, or the University's OH&S section.
- Oversee the implementation of corrective action arising from accident investigation and hazard reports.

Occupational Health and Safety policies.

Staff are expected to be familiar with OH&S policies specific to the work hazards of their area. The University of Queensland policies on OH&S can be found in 3 places.

1. The University handbook (www.uq.edu.au/hupp).
2. The OH&S department's web site (www.uq.edu.au/ohs). (Which has detailed OH&S information).
3. A printed copy of the information from the OH&S department's web site can be found at the Centre reception.

UQ Workplace Health and Safety Policies:

Below is a subset of UQ OHS policies relevant to the majority of work practices at CMR. Supervisors should check the complete policy list in one of the three sites mentioned above for anything falling outside the scope of these policies.

2.10 Management

2.10.1 Guidelines for Workplace Health and Safety Committees
2.10.2 Insurance Coverage of Staff Travelling on University Business
2.10.3 Occupational Health and Safety
2.10.4 Staff Responsibilities for Occupational Health and Safety
2.10.5 Student Injuries
2.10.6 Workplace Health and Safety Officers' Role
2.10.7 Workplace Injury, Illness, Incident and Hazard Reporting
2.10.8 Risk Assessment and Management Guidelines

2.15 Emergency and Critical Incident Procedures

2.15.1 Critical Incidents Affecting Staff or Students
2.15.2 Fire and Emergency Evacuation Procedures
2.15.3 Instruction of Staff in Fire Safety Procedures
2.15.4 Procedure for Dealing with Emergencies

2.20 Ergonomics

2.20.1 Hearing Conservation Policy

2.20.2 Screen Based Equipment

2.20.3 Vision Testing Policy

2.25 Workers' Compensation and Rehabilitation

2.25.1 Workplace Rehabilitation Policy and Procedures

2.25.2 Workers' Compensation – Reporting Injuries and Making Compensation Claims

2.30 Safe Working Environment

2.30.1 Asbestos Management Plan

2.30.2 Electrical Safety

2.30.3 Flammable and Combustible Liquids – Storage and Handling

2.30.4 Management of Work in Confined Spaces

2.30.5 Minimum Standards of Dress and Personal Protective Equipment

2.30.6 Occupation Exposure to Sunlight

2.30.7 Storage and Consumption of Food and Drink in Laboratories

2.30.8 Diving Safety

2.30.9 Fieldwork Safety Guidelines

2.30.10 First Aid Safety Guidelines

2.30.11 Safety in Workshops

2.30.12 Threats to Personal Safety at Work

2.30.13 Working with Carcinogens

2.30.14 Occupational Health and Safety in the Laboratory (Undergraduate Student)

2.30.15 Immunisation

2.30.16 Occupational Health and Safety in the Laboratory (Postgraduate Student)

2.30.17 Alcohol, Tobacco smoking and other Drugs Policy

2.30.18 Manual Handling of Furniture and Equipment

2.40 Radioactive Hazards

2.40.1 Management Unsealed Radioactive Wastes

2.40.2 Personal Radiation Monitoring

2.40.3 Safe Working Rules for Radioactive Laboratories

2.40.4 Transport of Radioactive Materials

2.45 Poisons

2.45.1 Labelling of Chemicals

2.45.2 Scheduled Poisons and Drugs Guidelines

2.50 Biosafety

2.50.1 Biological Safety and Blood – Borne Infection in the Laboratory

2.50.2 HIV Policy and Guidelines

CMR Specific OH&S Information.

1. Introduction

Magnetic fields are invisible, which makes them particularly dangerous. Operating within the Centre for Magnetic Resonance are several high field magnets. All staff members have an obligation under the Workplace Health and Safety Act to ensure the safety for all staff and visitors.

2. Purpose

Guidelines and rules for the safe entry by staff and visitors into CMR have been established to prevent injury and death to people who work at or visit the Centre For Magnetic Resonance (CMR). It is also to prevent damage to equipment caused by the strong magnetic fields within CMR. The superconducting magnets located within CMR produce strong magnetic fields within the immediate vicinity. The accepted human safety exclusion zone for these stray fields is at 5 Gauss. The relevant distance from each magnet will vary according to the designated field strength of the magnet and this distance is marked on the floor around each magnet.

3. Scope

This procedure is applicable to all people who work at or visit the Centre for Magnetic Resonance.

4. Definitions

Cardiac Pacemaker- Surgically implanted device to control the heart.

CMR - Centre for Magnetic Resonance

Electronic Devices- includes but not limited to any of the following:

- Mobile Phone
- Pager
- PDA
- Laptop computer

Metal Object - any of the following can regarded as a metal object:

- Credit cards
- Keys
- Watch
- Pen-Knife
- Coins
- Metal tools
- Jewellery
- Safety pins, Broaches, Badges
- Hairpins, hat pins, some hair bands

5. Entry Procedures

5.1 Visitor Entry

All visitors entering through the front doors of CMR need to be asked 2 questions. The first question is the most important of the 2.

- ***Do you have a cardiac pacemaker?***
- ***Do you have any metal implants?***

If the answer is yes to ***Do you have a cardiac pacemaker?*** Then it is not safe for them to enter CMR. Do not let the visitor enter CMR under any circumstances. Please inform the visitor that they cannot enter CMR for their own safety.

If the answer is yes to *Do you have any metal implants?* it is safe for them to enter. But inform the visitor that they cannot enter a magnet room unless they talk to one of the medical staff first.

All Visitors must now sign a visitor's book when they enter and leave the Gehrmann Labs. There are 2 visitors book. 1 is held in reception area. The other is held on the desk in the entrance hallway.

5.2 Magnet room entry

If a staff member or visitor is going enter a magnet room for the first time the procedure outlined below must be followed:

- The information sheet titled "Information about Magnetic Resonance" (Attachment 1) must be read by visitors or subjects entering the 2T wholebody MRI laboratory or MRI scanner rooms at The Wesley Hospital or Royal Brisbane Hospital. Regular users and visitors of all other MR laboratories, including the AV700 microimaging, Bio190, AV750, AV500, solids 300 and SWB300 laboratories in the Gerhmann Building and the 900MHz laboratory in the QBP must read and sign the information document provided in Attachment 4. Occasional visitors to these laboratories under staff supervision should be provided with Attachment 3.
- Within every magnet room there is a black/yellow stripped line on the floor, or a zone marked by a change in floor tile colour (700, 900), representing the 5 Gauss exclusion zone. It is not safe to pass over this line without first removing any metal / magnetic objects on your person.

5.3 MRI Volunteers Entry

Not all staff are involved with the Whole body MRI scanners. But it is important that every member of staff knows the procedures:

- When a volunteer arrives the project coordinator is informed who will then escort the volunteer to the whole body scanner.
- Before anyone has a MRI scan at the CMR they need to talk with a medical officer or radiographer to determine whether it is safe to proceed with the scan. They may need to undergo a brief medical assessment.
- The volunteer is then asked to remove any metal objects and electronic devices.
- The volunteer is required to complete a metals check questionnaire (Attachment 2), to make sure all metal objects have been removed, and sign the checklist.
- Women need to be informed that if they have an Intrauterine Device or Diaphragm *in situ* it may move and be displaced by the magnetic field and therefore may not be reliable as a form of contraception.
- All women should be warned that it is not advisable for someone in the early stages of pregnancy to enter a strong magnetic field. A pregnancy test can be performed if requested.
- A metal detector may then be passed over the volunteer's body to check for any missed metal objects.
- The volunteer may be changed into medical scrubs to reduce the risk of taking metal objects into the magnet, as per current clinical practice.
- Staff who scan with human volunteers must maintain current CPR certification, and undergo regular training in the evacuation of patients in case of an emergency.
- In order to maintain a safe scanning environment, it is vital that two people trained in emergency evacuations are available for any scan.

6 Procedures in the event of a magnet quench

Under normal operating conditions, superconducting magnets such as within CMR are stable and safe, given attention is paid to the presence of stray magnetic fields. However, it is possible that for some reason, the superconducting wire within a magnet suddenly becomes non-superconducting. This results in rapid energy loss from the coil and heat transfer to the liquid helium in which the coil is immersed. Very rapid boil-off the helium ensues, resulting in a noisy expulsion of gas from the magnet and formation of a vapour cloud. This phenomenon is known as a magnet "quench". A similar effect may occur if the vacuum in the magnet cryostat is lost, also resulting in rapid helium boil-off and eventually a quench. The whole event is usually over in the matter of minutes and results in high concentrations of helium gas in the nearby atmosphere. Clearly this is a dangerous situation as workers may be exposed to oxygen deprivation, potentially leading to asphyxiation.

The following procedures are in place to avoid injury resulting from a quench or slow gas buildup:

1. In those labs where helium discharge during a quench is into the room space and not via ducting to the outside, oxymeters have been installed to monitor the oxygen levels. Audio and visual alarms will be activated if the oxygen level drops below a safe threshold.

2. Signs are posted in labs instructing operators and other workers to immediately evacuate the lab in the event of a quench or oxygen alarm, and to inform senior CMR staff or Security of the event.

7 After Hours Policy

Concern about after hours work on potentially high risk projects has been raised with the OHS committee. The following procedures have been developed in conjunction with UQ OH&S and University Security:

1. **People working at CMR after hours should notify security when they arrive, and let them know when they intend to leave.**

This is a courtesy to security who have already registered an entry.

UQ Security Ext: 53333
Wesley Security: 7214

2. **Principle investigators of all new projects should submit a summary of the work and a completed risk assessment to the OHS committee.**

In this way, the OHS committee can make sure that your workplace health and safety needs are met, and ensure that you are familiar with the risks and procedures involved. Particular attention will be paid to work carried out after hours.

3. **If the project contains a potential risk of harm to the investigator, a buddy system must be implemented.**

Most of our labs are out of sight. Even during the workday there is no guarantee that someone will be aware that you are in trouble. You should make sure that your supervisor or fellow investigators are aware of the work you are undertaking and can check on you if required.

4. **If the project contains a potential risk of harm to the investigator, and is to be conducted after hours:**
    - **Organize for a buddy system with other staff working after hours**

The OH&S committee may deem that particular operations are too dangerous to be undertaken without a buddy system in place. This means that there must be at least one other person working in the vicinity who can provide aid and raise the alarm in the event of an emergency. If working after hours under these conditions, you must arrange for another person to act as your "buddy". If there is no one else in the Centre at the time, this work must not be undertaken.

8. Project Risk Assessments

A risk assessment must be conducted for each research project conducted by UQ staff (see UQ OHS website for details: http://www.uq.edu.au/ohs/). Risk assessments are to be submitted to the CMR OHS committee for approval. The approval process ensures that OHS standards are met within laboratory and other work areas

and, if not, steps may be taken to do so, e.g. provision of protective equipment, workplace hazards training, adaptation of emergency procedures. If a CMR OHS audit reveals non-compliance with OHS standards, the relevant research activity will be suspended until the situation is corrected.

All supervisors should attend a risk database management training course offered by TEDI.

8.1 ChemWatch

Staff should also consult the ChemWatch web site when conducting risk assessments if needed. ChemWatch can found at http://hazsafety.pf.uq.edu.au/chemwatch.

9 Roles and Responsibilities

9.1 All employees

The Workplace Health and Safety Acts states that it is the responsibility of all staff to ensure a workplace free from death and injury. So all staff must ensure that these guidelines are carried out within CMR.

10 Staff Induction

10.1 All new staff starting at CMR must read and understand these guidelines. This manual is to be included in the University's new staff induction package handed to new staff upon starting duties within the Centre and can be accessed at the CMR intranet found on the CMR website: http://www.cmr.uq.edu.au/CMR_OccSafety.htm

10.2 Postgraduate Students

All postgraduate students whose research programs are based at CMR must read the University OH&S document entitled "Occupational Health and Safety in the Laboratory, Postgraduate Student Edition" (Attachment 5) before commencing any work within the Centre. The

declaration form appended to the document should be completed, signed and handed to the Centre's Assistant Director (Admin).

Supervisors of postgraduate students should also read the document and be familiar with the responsibilities and roles outlined in the policy.

10.3 External users, staff and student swipe card access

i) To ensure that all new staff, students and regular external users of CMR facilities are familiarized with CMR-specific OH&S issues, including magnet safety, a copy of the information material (Attachment 1) metals checklist (Attachment 2) and Risk Assessment (Attachment 4) will be required reading prior to the issue of access swipe cards. In the case of postgraduate students, (Attachment 5) will also be required to be completed as described above (10.2).

ii) External operators of whole-body MRI scanners at The Wesley Hospital, Royal Brisbane Hospital and CMR are required to read this manual in its entirety and agree to adhere to the policies described, with particular attention to section 5.3 relating to procedures for working with human volunteers.

11 Training & Improvement

11.1 Training

All staff of CMR must read and understand these guidelines and attend a refresher training course every 12 months. An internal intranet system is to be implemented which will provide access to OH&S documentation and information updates. The master copy of this manual will be held on the CMR website. (http://www.cmr.uq.edu.au/CMR_OccSafety.htm)

Staff will be directed to the website annually as part of the refresher training. Training in risk database management should be undertaken as soon as possible after commencing duties at the Centre. A training register is to be kept to include records of staff attendance at training courses in OH&S awareness, Risk Management, Environmental Management System, CPR, First Aid and other courses as appropriate.

11.2 Improvement

If any employee believes this procedure could be improved, they should discuss the matter with their supervisor. A recommendation may be made to the Workplace Health and Safety Officer or any member of the Workplace Health and Safety Committee.

12 References

Workplace Health and Safety Act
www.uq.edu.au/hupp

13 Attachments

1. Information sheet titled "Information about Magnetic Resonance"
2. Metals Check and Interim Medical exam questionnaire for MRI subjects
3. Safety information sheet for occasional visitors to MR labs not undergoing MRI examination and under staff supervision
4. Risk assessment for high-field NMR laboratories
5. Occupational Health and Safety in the Laboratory, Postgraduate Student Edition

Attachment 1

Information About Magnetic Resonance

INFORMATION ABOUT MAGNETIC RESONANCE

Magnetic resonance imaging (MRI) is an alternative radiological technique to x-ray (CT scanning) for producing images of the internal structure of the body. MRI examinations arc routinely carried out in many hospitals in Brisbane. In some cases, MR images can provide more diagnostic information than can be obtained with x-rays. Magnetic resonance spectroscopy (MRS) is useful in deriving information about the chemical composition of tissues and organs. MRS is still at the developmental stage and its eventual role in clinical diagnosis is currently being evaluated.

No evidence to date indicates that the magnetic field strength used here (2 Tesla) produces any adverse health effects on people undergoing a scan or visitors to the magnet room. M R imaging and spectroscopy procedures strictly adhere to National Health and Medical Research Council guidelines.

Some objects/substances must not be taken into the magnetic field, including most metals, and this is the reason why we ask all visitors/volunteers to check for metal on or within the body. People with a Pacemaker should never enter the area. All other surgical implants or devices must be nominated and discussed with the Scientist or Medical Officer before entering the area. (If you have had surgery please talk to the Medical staff about possible retained metals.) Dentures, medicated skin patches and Intrauterine Device and Diaphragms may cause problems.

Those undergoing a scan will be required to list all their medications, whether taken orally, inhaled, implanted or worn on the skin (including over-the-counter preparations). Your participation in this examination will have no adverse effect on your current course of treatment.

Some things may be damaged by the magnetic field (see check list) and will need to be left outside. You can ask for a locked box for secure storage during your visit.

The procedure is similar to having an x-ray examination but it takes a little longer (15-50 minutes) and does not use radiation. It is entirely painless. At present the information obtained from MRS studies may not prove to be of benefit to the individual concerned, but we expect that it will be of value to patients in the future. You have the freedom to withdraw at any stage during the examination. The examination will be performed free of charge.

A check list is attached to screen for prohibited objects or potential problems and it is important for all visitors and volunteers to complete this. If you have any questions or concerns about something not on the list please discuss this with the Scientist or Medical Officer.

Attachment 2

Metals Checklist

MRI INVESTIGATION
METALS CHECK/INTERIM MEDICAL

FACILITY: _____

Subject/Visitor Name:_____DOB:_____

Date: _____Time: _____Checked By: _____

Contact Phone Number_____

DO YOU HAVE	YES	NO
Pacemaker A Heart valve		
Syringe Driver		
Metal mesh Implants/Clips/wire sutures		
Medicated Skin Patches		
Hearing Aid/Implant		
Dental Bridge or Dentures with wires		
Glass Eye		
Joint Replacement		
Bullet/Shrapnel Wound		
Metal Fragments in Eye, Head, Skin		
Artificial Limb or		
Do you work with metals?		
Do you suffer claustrophobia?		
Could you be pregnant? Do you have an IUD?		
Fractures bones treated with Metal?		
Have you had any major surgery?		
A Shunt, spinal or Ventricular?		
Brain clip, aortic clip or neurostimulators		
Do you have any tattoos?		

ARE YOU WEARING	YES	NO
Hairpins, slides, wig, hairbands		
Ear rings		
Necklace/Chains		
Safety pins/Broaches/Badges		
Watch		
Bracelets		
Rings		
Body piercing		
Braces with metal clips		
Mobile phone/Pager		
Coins		
Credit Cards		
Wallet		
Penknife		
Keys		

Do you consent to undergo the MRI?
I have read the MRI Information Sheet

Signed:

Volunteer: _____

Authorised MRI
Supervisor: _____

Blood Pressure: _____Pulse_____
Height_____Weight_____

_____

Attachment 3

Information Sheet for Visitors to CMR laboratories

HIGH FIELD NMR LABORATORY

Visitor Safety Information

Magnetic fields can generate large attractive forces on ferromagnetic (metal) objects. Such objects include most tools, gas cylinders, pocketknives, key rings, and most electronics. Any such object that gets too close to the magnet will be accelerated towards the magnet with great force. Metal belt buckles, steel tipped shoes, medical implants and any other metal on the person may be strongly attracted when close to the magnet. In the event of such an accident the best case scenario is simply lost time and expense of removing the object from the magnet. Larger objects (floor polisher for example) are dangerous and can seriously damage the magnet, potentially requiring replacement of a multi-million dollar instrument Worst case is injury of the user or bystanders that could occur in two ways. First, an object pulled with great force towards the magnet could strike someone causing severe injury, possibly fatal. Second, the object striking the magnet could cause the magnet to quench (i.e., become resistive). This vaporizes the magnets cryogenic cooling gases (helium, nitrogen), which will rapidly displace air in the laboratory. In this instance everyone must immediately leave the laboratory to avoid the potential for asphyxiation. Once energized the field of the superconducting magnet of the spectrometer is always present. These magnetic fields propagate horizontally and vertically and extend outside the magnet; therefore, no movable metal objects should be allowed within the danger area of the instrument.

It is unsafe for people wearing pacemakers or having a history of metal fragments in the eyes to enter the magnet room.

A coloured line (usually either blue or black and yellow) indicates the limits of the magnetic field in the magnet room and must NOT be crossed until the following Metals Checklist has been completed.

Use of cameras, digital equipment: Like all electronic equipment, cameras must not be taken inside the magnet field exclusion zone defined by the 5G field line marked on the floor. Outside this zone, cameras, mobile phones and other devices should work properly and are safe. They will not operate correctly when exposed to higher fields and may be irreparably damaged. If taken too close to the magnet they may become a projectile, dangerous to both the magnet and the holder.

Small personal items such as credit cards and mobile phones, which will be wiped by the magnetic field in the magnet room, and other items such as keys, jewellery, wallets, watches, etc. (see the Checklist below) must be removed from your person before entering the magnet exclusion zone.

EVERYBODY entering the laboratory must complete the following METALS CHECKLIST

DO YOU HAVE	YES	NO	ARE YOU WEARING	YES	NO
Pacemaker A Heart valve			Hairpins, slides, wig, hairbands		
Hearing Aid/Implant			Ear rings		
Joint replacement			Necklace/Chains		
Bullet/Shrapnel Wound			Safety pins/Broaches/Badges		
Artificial limb			Watch		
Could you be pregnant? Discuss with the facility administrator			Bracelets		
Fractured bones treated with metal?			Rings		
Eye injury (embedded metal fragments)					
Body piercing					
Braces with metal clips					
Mobile phone/Pager					
Camera					
Laptop computer					
Electronic device					
Coins					
Credit Cards					
Wallet					
Penknife					
Keys					
Signed: Visitor: _____ Authorised Laboratory Officer:____					

Attachment 4

General Risk Assessment for work in CMR laboratories

CMR Safety Information

Risk assessment

This information relates to high field NMR laboratories within CMR (Gehrmann) and QBP (900 laboratory) and is specifically concerned with access to the vertical magnet labs

The main risks come from the high magnetic fields, the handling of cryogens and high electrical voltages/RF sources. In general, the risks are minimised by limiting access to the NMR rooms to only CMR staff and users of the instruments wherever possible and by limiting any hardware modifications/maintenance to the NMR staff who have the requisite technical understanding and training. Access to the NMR labs is controlled by swipe card. All new staff and users are required to read the Magnet Safety Information sheet and this Risk Assessment prior to receiving swipe cards.

Electrical/RF

Risks are similar to those encountered in the use/maintenance of other laboratory equipment and are minimised by restricting any modification/maintenance of the equipment to CMR engineering staff and in consultation with the manufacturer.
Only carbon dioxide fire extinguishers should be used to avoid equipment damage and exceptional care is needed to ensure that fire extinguishers are not used near the magnet cryostat. In case of serious flooding, or in other situations where there is risk of electrocution, the equipment circuit breakers should be turned off.

Cryogens

The cryogens used are liquid N2 and liquid He:
Temperature: N2: -196 and He: -269 deg. C
Colour: none
Toxicity: very low
Fire hazard: non combustible
Volume Expansion (from normal boiling point to room temp.): ca. 700x
The main risks are of burns when handling cryogens and of asphyxiation if a magnet quenches. These are minimized by only allowing experienced technicians to fill the magnets with liquid nitrogen and helium.

The magnet cryostats are only filled using stainless steel transfer lines to reduce risk of rupture. At least two staff must be present during liquid He refilling and appropriate safety clothing must be worn (gloves and eye protection). Refills must be continuously attended. Magnet quenches (the rapid release of gaseous cryogens from the cryostat into the room) may trigger the fire alarm and in those labs where exhaust fans are fitted, these should be automatically activated.

In the event of a quench personnel **should immediately evacuate the area** (a quench warranting evacuation would be obvious by the noise of the escaping gas and clouds of vapour).

The magnet cryostats continuously expel a small quantity of gaseous He and N2 into the air. This does not present a hazard since during everyday use the air is constantly changed in the NMR rooms by the air-conditioning system. Should the oxygen content of the air fall to a dangerous level this will be detected by oxygen monitoring systems installed in most labs. Other labs have direct venting systems to the outside.

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High Magnetic Fields

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 system and the closer to the magnet system the larger the force.

This is probably the main risk because it is one with which most people are not familiar. Risks come from release of any steel items/tools or equipment which are bought near the magnets. Even belt buckles, steel tipped shoes etc. may be strongly attracted to a magnet. This might result in damage to the magnets/probes (possibly resulting in a quench) or serious injury or death to personnel working near or under a magnet. The latter is probably the most serious risk, as staff and users often need to work under the magnet during its normal operation.

These risks are minimised by preventing access to the NMR rooms by anyone other than CMR staff and trained users. Anyone else needing to enter the NMR rooms can only do so in the presence of one of the CMR staff. The normally accepted exclusion zone for all ferromagnetic objects is the 5Gauss line. This zone is marked on the floor, usually by black/yellow tape or by a change in floor tile colour.

It is necessary to use steel tools for maintenance and repair of the consoles, but such work should only be done by the CMR engineering staff (or engineers from the manufacturers) and users are not allowed near the magnet during such work. Where possible non-magnetic tools are used.

Medical electronic implants such as cardiac pacemakers may be affected by static or changing magnetic fields (not all pacemakers respond the same way). Medical implants e.g. clips, prostheses which may contain ferromagnetic materials would be subject to strong attractive forces near to the NMR magnet system. All people with such implants are excluded from the NMR laboratories and appropriate warning signs are displayed.

Recent publications suggest that long term cumulative large exposures to 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. Reasonable caution in avoiding lengthy exposure to higher fields seems prudent, none the less. Our current advice is that CMR staff and researchers should spend no longer than reasonably necessary within the 5 gauss line for sample changing and adjustments. No other equipment unrelated to the NMR system is placed within the 5 gauss line, which should be contained in the NMR rooms themselves. The NMR magnets will cause disturbance to VDUs etc. in nearby rooms (eg. where the stray field is 1-2 gauss).

see: David A. Savitz and Dana P. Loomis (1995). "Magnetic field exposure in relation to leukemia and brain cancer mortality among electric utility workers." Am. J. Epidemiology 141(1), 123-134.

Magnetic fields may permanently damage watches, calculators, mobile phones and certain types of credit cards. These items need to be kept outside the 5G line.

Video Display Terminals (VDTs)

Extensive radiation measurements and health data do not indicate that these units present a health risk. Most of the symptoms related to the use of computer terminals are related to strain and discomfort that can be corrected by ergonomic measures. The potential for eye strain can be reduced by the use of non-glare screens, fitting a filter to the VDU, or by improving the lighting conditions. Users are strongly advised to consult the University’s Code of Practice for the safe use of VDUs.