

# CMRR Magnet Safety FAQ

This document is intended to accompany the CMRR Volunteer Safety Screening form dated 17 June 2014. Numbered items in this document match numbered items on the safety screening form.

This document has brief descriptions of typical outcomes when researchers are required to make judgment calls about whether it is safe to scan a subject. This document is provided for educational purposes and should not be construed as permission to scan a subject with a particular safety concern.

An excellent resource for MR safety questions is <http://www.mrisafety.com>, although it is important to note that the risk assessments there are made with clinical (medically necessary) scans in mind, so the appropriate risk threshold for research scans – particularly with vulnerable participants – is often more conservative.

- 1. Hearing Aids:** Hearing aids must be removed, if it cannot be removed, it is considered an otologic implant – on the list in Section 3 of devices that require sign off by a CMRR MR-Professional.
- 2. Colored contacts:** The dye may conduct current and cause heating. Colored contacts must be removed. Subjects are welcome to use the MR-compatible eye-glasses stored in the cabinet at the 3T/A.
- 3. Jewelry:** Metallic jewelry can conduct electrical current during RF pulses and heat up, causing burns; many metals have the additional risk of attractive forces in the magnet's fringe field. All jewelry that can be removed must be removed. Research staff should visually check for forgotten necklaces, earrings, pins, rings and watches, and be careful to ask about jewelry (piercings, bedazzlings) worn beneath clothing.
- 4. Diaphragms:** The metal spring that forms the rim of Ortho diaphragms has a risk of conducting current and causing heating and/or being magnetic. MRIsafety.com lists Ortho diaphragms as Conditional 1 (weak deflection from ferromagnetism) in a 1.5T scanner. Diaphragms must be removed prior to scanning. Since premature removal of a diaphragm entails a risk of pregnancy, the scan should be scheduled for a time when subject can safely remove the diaphragm.
- 5. Transdermal drug delivery patches:** Adhesives or other materials used in the patch can conduct electricity and result in heating from RF energy. Scanning subjects who are wearing transdermal drug delivery patches (birth control, nicotine, etc.) is not advised. Subjects should consult with their physicians before removing patches to participate in scans.
- 6. Wigs:** Many wigs contain metal, so must be removed for scans.
- 7. Make-up, hair products, glittery nail polish, powdered hair dye:** Glittery makeup and nail polish may contain metallic particles which can heat up. Subjects wearing glittery or heavy make-up should remove make-up before participating in scan. Some hair products also appear to have metal in them – particularly products designed to tame curly hair. It shows up on the scan and distorts the field. Some of the dyes in powder-based hair dyes, e.g., Bigen, contain metal, which creates heating risks similar to those with tattoos.
- 8. Underwire bras:** Much has been made of underwire bras, but many subjects report no discomfort (and greater social or physical discomfort being required to remove a bra). Heating from RF-induced currents and physical forces (movement of parts of the bra) are both potential risks. Some groups ask subjects to remove underwire bras before participating in scans, but careful consideration must be made to the social consequences of this request and subjects must be provided with appropriate alternative apparel (or screened prior to the scanning session and told to wear a bra with minimal

metal). However, underwire in the bra is not the only concern. Adjustable bra straps (almost all are adjustable) include metal rings that are often very magnetic; rotation as the subject enters the fringe field can make the rings dig into the shoulder, particularly at 7T. On occasion, the 7T will also unlatch the clasps on a bra. However, when subjects are warned ahead of time of these potential discomforts, they may be minor compared to the awkwardness of being required to wear no bra.

9. **Previous surgeries:** This question presents an opportunity to help the subject think of the likelihood of metal in the body that s/he does not think about on a regular basis. Some surgeries that come up often:
  - a. Fusion of the vertebrae.
  - b. Hernia repairs. For hernia repairs, it is important to verify that the repair was done with a polymer mesh.
  - c. Tubes in ears. These are sometimes called grommets, and are tubes inserted through the tympanic membrane to aerate the middle ear when the Eustachian tube isn't doing its job. Very common in children (because the Eustachian tube is at a different angle). They are typically plastic, and typically are left to fall out on their own. However, stainless steel tubes do exist, so it is important to verify that tubes, if possibly present, are plastic.
10. **Health conditions:** The conditions listed on the safety screening form affect thermoregulation and caution should be exercised when using sequences that use maximum SAR limits. At systems above 8T these health conditions are contraindications.
11. **Claustrophobia:** Many subjects discover when they get in the scanner that they are claustrophobic. For this reason, constant communication with the subject and during the first few moments they are in the scanner is important. For subjects who express mild discomfort but want to continue, increasing air flow (while being mindful that strong airflow can dry contacts) can be very helpful, as is constant communication.
12. **Medications:** Certain medications can affect thermoregulation and caution should be exercised when using sequences that use maximum SAR limits. Certain medications can also have a negative impact on certain studies such as fMRI and investigators may want to cancel subjects that indicate their use. Medications that are classified as diuretics,  $\beta$ -blockers, calcium blockers, amphetamines, muscle relaxants, or sedatives are of particular concern and are contraindications above 8T.
13. **Braces / permanent retainers and other dental implants:** There is always a risk of heating and/or physical force from braces or permanent retainers. Specific brands are documented at MRIsafety.com. Subjects should be warned of risk and reminded to use the squeeze ball to alert the operator at the first *hint* of discomfort. One consideration is that image quality will be horrendous near the mouth and may also be negatively impacted in inferior frontal and anterior temporal lobes.
14. **Tattoos (including permanent make-up):** Some inks contain metals, which could result in heating from RF energy. A wide range of rubrics are often cited (tattoos before 1985, tattoos from prison, tattoos from Europe, red and green dyes) but none are deemed reliable, so all tattoos are considered risks. Best practice is to ask subject to verify with tattoo artist that none of the inks contain metal. When that is not possible, warn the subject of potential risk due to heating and impress upon them the importance of using the squeeze ball at the first *hint* of discomfort. If a body RF coil is being used (e.g., most 3T scans), tattoos anywhere on the body will see RF energy, although ankle tattoos are of lower concern. Larger and denser tattoos are of more concern because they contain more ink. If a head RF transmit coil is being used, tattoos from the waist down are of minimal concern. A large, dense tattoo on the neck of a subject being scanned with a 7T head coil would be reason for extreme caution or exclusion of the subject.

- 15. Body piercings:** All removable piercings should be removed. Non-removable metal piercings have been allowed at 3T on a case-by case basis, although always with careful instruction to the subject to be particularly mindful of any discomfort or motion of the jewelry, and to use the squeeze ball at the first *hint* of danger. No metal piercings should be allowed at 7T for healthy volunteers or control participants. For a critical patient study, non-removable piercings might be considered if they are non-magnetic (e.g., gold) and nowhere close to the RF coil (e.g., gold navel ring for a head study). However, careful consideration and consultation with an RF engineer would be required before proceeding. Piercings that have no metal in them are safe.
- 16. Hair extensions or weaves:** Extensions are often attached with metal (often ferromagnetic) wires and present a strong risk of heating and physical forces along with significant image distortion for head scans and careful consideration should be given to these risks before these individuals are scanned.
- 17. IUDs (Intra-uterine birth control devices):** Metal IUDs carry a significant risk of heating and, while some are rated safe at 1.5T, they are of concern at higher field strengths. Completely non-metal IUD's such as the Mirena are safe at all fields. IUD's require sign off by a CMRR MR-Professional.
- 18. Metal in the body, accidental:** No subject with known or suspected shrapnel or metal resulting from injury may be scanned without sign off by a CMRR MR-Professional.
- 19. Pregnancy:** Scanning of a pregnant or suspected pregnant volunteer is not allowed without specific IRB approval. Scanning of a pregnant or suspected pregnant PATIENT is allowed if deemed medically necessary.
- 20/21. Implanted Devices:** Scanning of subjects with implanted devices is not allowed without the signature of a CMRR MR-Professional.