1 General Information

When properly used, Magnetic Resonance Imaging technology provides a safe and powerful tool for understanding the human brain. However, the Siemens Magnetom Trio system could pose a serious risk if used incorrectly. Therefore, it is crucial that all users of the McCausland Center facilities learn the safety procedures described in this manual.

1.1 Reduction of Risks

To minimize risks to subjects and other members of the research team, only persons who have successfully completed the McCausland Center safety certification process are allowed unaccompanied access to the MR scanner room. Observers who have not been safety trained are not permitted to enter the MRI scanner room without special prior arrangements.

1.2 Reporting of Safety Incidents or Near-Incidents

All incidents or near-incidents must be reported to the Coordinating Manager and the Advisory Committee no more than 24 hours after the incident (McCauslandCenter@sc.edu). When appropriate, such events must also be reported to the University of South Carolina IRB (or Palmetto Richland IRB when applicable).

1.3 Contact Information

Contact information for the Center is listed below (all have the 803 area code). If you have any questions or need help while scanning please do not hesitate to call Scott Vendemia.

<table>
<thead>
<tr>
<th>Name</th>
<th>Office</th>
<th>Alternate</th>
<th>email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scott Vendemia</td>
<td>777-8902</td>
<td>467-9454</td>
<td><a href="mailto:ScottV@sc.edu">ScottV@sc.edu</a></td>
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<tr>
<td>Chris Rorden</td>
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<td>404-2573</td>
<td><a href="mailto:rorden@sc.edu">rorden@sc.edu</a></td>
</tr>
<tr>
<td>Jennifer Vendemia</td>
<td>777-6738</td>
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<td>777-5391</td>
<td></td>
<td><a href="mailto:jfridrik@sc.edu">jfridrik@sc.edu</a></td>
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<tr>
<td>McCausland Center</td>
<td></td>
<td></td>
<td><a href="mailto:McCauslandCenter@sc.edu">McCauslandCenter@sc.edu</a></td>
</tr>
<tr>
<td>Hospital MRI Group</td>
<td>(43) 4-7434</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1.4 Handling a Medical Emergency – “Code Blue”

If you believe that a participant or anyone in the McCausland Center has a medical emergency and needs immediate assistance, call 4-6222 in the case of medical emergency. Palmetto Richland Medical Center (PRMC) has trained individuals that respond to medical emergencies within the hospital. It is your responsibility to ensure that any of the respondents who enter the MRI room are free from metal and MRI safe.

1.5 Tours and Training Exercises

Tours or training exercises that would involve having non-safety trained personnel present in the scanner, the control room and/or the equipment room must be authorized in advance. If you would like to arrange for a safety test or a tour please contact the McCausland Center staff (McCauslandCenter@sc.edu).
2 Safety in the MR Environment

There are no areas in the MR suites that can be considered completely safe. Many objects in the scanner control room and equipment rooms are NOT MR COMPATIBLE and may become projectiles in the MR scanner room. You must never move any object from these rooms into the MR scanner room unless you are absolutely certain that the object is MR safe. Similarly, some objects in the MR scanner room may only be safe when kept at a distance from the MR scanner. Only personnel explicitly authorized to do so should move objects that are labeled “Not MR safe”, or that are of unknown construction. No metal objects are to be brought into the MRI room. The MRI safe wheelchair, MRI safe gurney and the MRI safe fire extinguisher are exceptions to this rule (You must be sure that it is an MRI safe item before you enter the MRI room).

Personnel who are unfamiliar with the equipment and its hazards pose a tremendous risk for the safety of all. Personnel working in the facility must be constantly vigilant of who is entering the console or scan room areas. Especially in emergency situations, you must ensure that no one without proper training enters the scanner room, and even then, that they have adequately checked themselves for possible hazards such as projectiles.

2.1 MR Hazards

The main hazards of the MR environment at the McCausland Center are:

• **Auditory Noise** Many of our sequences are very loud, and ear protection is required during scanning.

• **Projectiles** The “projectile effect” occurs when heavy, sharp, or dangerous objects are hurled into the instrument. Even seemingly innocuous objects, such as hand tools or toe-nail clippers can be lethal.

• **Electronic Devices** Electronic devices such as implanted pacemakers, cochlear implants, insulin pumps, or brain stimulation devices could malfunction in or near the scanner. Under no circumstances should persons with pacemakers enter the MRI scanner room.

• **Dangerous Voltages** As in many laboratories, the MRI lab contains wiring and circuitry that operate at dangerous voltages. Under no circumstances should users touch any exposed wiring, or any exposed terminals in the equipment cabinets.

• **Induced Electrical Currents** During scanning, the magnetic field will be rapidly changed. This switching can induce electrical currents within the body that cause nerve or muscle stimulation. The scanner will ensure that these effects are within FDA limits. On some scanning sequences however, the participant may feel muscle twitches or tingling. Prior to these scans, the system will typically note that due to the "dB/dt" (field changes over time) effects the participant may feel peripheral nerve stimulation.

• **RF Heating** Improper scanner operation could result in excessive heating of the subject due to radio-frequency (RF) energy being deposited in the tissue. Even normal scanning causes tissues to warm a little bit. The scanner console displays the current amount of warming, and will suggest modifications to your sequence if they exceed the FDA’s Specific Absorption Rate (SAR) guidelines. It is important that you always accurately report a participant's weight prior to scanning and observe all FDA limitations (e.g. for the head, you should not exceed 10watt/kg over any 10 minute period).

• **Suffocation** In extreme cases, the imaging magnet may release large volumes of helium gas that can rapidly force all air out of the scan room. Normally, the helium gas would be vented through the roof. However, there is a small but significant risk that the venting system could fail.

2.2 Metal Screening

Any participant preparing to enter an MR scanner room must complete a metal screening form, and this form must be reviewed thoroughly by the responsible investigator before access to the scanner room is granted. Forms are available for research subjects and for all other individuals (e.g., research personnel requiring one-time supervised access). Persons who are safety certified at the McCausland Center are not required to complete a metal screening form for themselves but are responsible for verifying that they are safe to enter the scanner room. A new form must be completed by participants for each day that they are to be scanned.
If there are any doubts regarding the metal screening responses, do not allow the individual to enter the scanner room. The fact that the individual has been scanned in an MR scanner previously (even at the McCausland Center) is never a sufficient basis upon which to conclude that the subject can enter the scanner room safely, since risks vary according to magnetic field strength. Dental fillings and orthodontic braces do not constitute significant risks (though the latter may produce unacceptable artifacts) and do not preclude scanning. Subjects with tattoos should be advised of the small risk of local redness or irritation, but may be scanned. Tattoos made outside of the USA propose a possible risk of metal contamination. Thus, potential participants whose tattoo was performed outside the USA may be precluded from study participation.

Some implanted metal devices have been established as safe for MR scanning. **It is the responsibility of the primary investigator to verify beyond any doubt that a given medical device is MRI safe.** Even if you are certain that the implanted metal does not constitute a risk, do not allow the individual into the scanner room unless you have obtained explicit authorization to do so. Qualified individuals (e.g., neuro-radiologists or neurosurgeons) may request blanket authorization to assume responsibility for such authorizations for their own research protocols. Silver, gold and platinum jewelry is not ferromagnetic. Nonetheless, subjects should remove jewelry before going in the scanner since these metals can still conduct electricity and therefore pose a risk for burns in the presence of time-varying magnetic fields. Jewelry that forms large loops is particularly hazardous.

### 2.3 Special Hazards

In addition to the general and metal-based hazards present in an MR environment, there are also several special hazards relating to the equipment and/or the scanning process (or type of scan) itself.

- **Laser Light Localizer** On the scanner, a laser is available for aligning the patient’s position in the scanner. If you use it, then subjects should be instructed to keep their eyes closed while the laser light is turned on to avoid eye injury.

- **MRI Phantom Leaks** The MR phantoms are used to calibrate the scanners. These are sealed and should not show any evidence of leakage. If a phantom develops a leak, protective clothing (gloves, lab coat, goggles) should be worn while cleaning the leak. The contents should be disposed of as hazardous materials (i.e., not simply poured down the drain).

- **Medical Gases** Medical oxygen is not available in the scan room. Please note that the medical crash cart brought by the emergency team will include oxygen but their oxygen tank is NOT MR COMPATIBLE!

### 2.4 Ear Plugs and Headphones

Anyone in the scanner room while the scanner is in operation must be provided with and must use hearing protection in the form of earplugs and/or headphones to avoid hearing injury from the acoustic noise generated by the scanner. Unless the design precludes it, subjects should wear both ear-plugs and the MR compatible headphones for added protection.

### 2.5 MR Compatible Gurney

An MR compatible gurney is available in the holding room. The gurney is a vital piece of safety equipment and should not be removed from the MR suite under any circumstances other than for evacuation of a non-ambulatory person from the building in the event of an emergency. The MR compatible gurney should not be used to pick up or deliver a patient. Such patients should be brought to the McCausland Center using standard transport equipment and transferred to the MR compatible gurney. An extra large MR compatible wheelchair is also available in the holding area and no other gurney or wheelchair should ever be brought into either of the scanner rooms. If you are unsure which wheelchair or gurney is MRI safe, please contact Scott Vendemia or the Hospital MRI staff (47434).

The MR compatible gurney has a weight limit of 400 pounds. Typically two people are required to transfer a person on or off the gurney. For any non-ambulatory subject or any ambulatory subject at significant risk for a medical emergency, staff sufficient to transfer the patient onto the gurney must be present in the MR suite at all times when the subject is in the scanner room.
Figure 1 Only an MR compatible gurney should be used when moving a patient from or to the MR scanner room.

Procedure for transferring subjects between scanner and gurney

1. Make sure that the gurney is free of magnetic objects (oxygen bottles, IV poles, etc.) before bringing it into the scan room.
2. If possible, make sure that the subject is lying on a sheet.
3. Move the scanner bed out of the gantry and adjust its height to match the gurney's.
4. Lower one gurney side rail and position this side of the gurney next to the scanner bed.
5. Lock all four wheels of the gurney (The wheels don't lock completely. So, make sure that you have secured the gurney against the patient's or scanner bed during transfer).
6. With at least one person on each side of the subject, slip the edge of the white slide board under the side of the patient that corresponds to the direction in which the subject will be moved. If necessary, lower the other gurney side rail in preparation for transfer.
7. Slide the subject across the slide board (located behind the scanner room door). The person standing next to the gurney should use his or her weight to hold the gurney firmly against the scanner bed during the transfer.
8. Once the subject is well situated on the bed or gurney, remove the slide board from beneath the subject from whichever side is most convenient.
9. Put up the gurney side rails if appropriate and unlock the gurney wheels.
10. Visually inspect to verify that nothing is physically caught before moving the gurney away from the scan bed.

2.6 ECG, Pulse and Respiratory Monitoring

The scanner is equipped with leads and devices that can be used for ECG, pulse and/or respiratory monitoring. These are primarily intended for acquisition of gated scan images, but can also be used for monitoring purposes. Only specially designed electrodes can be safely used for monitoring and must be used in strict accordance with the manufacturer's guidelines. These devices must be properly placed and shielded to prevent risk of burns to the subject. Also, please return any devices (especially those for recording heart rate and pulse) to their charging stations after use to ensure they are ready for the next experimenter to use.

3 Safety Policies

3.1 Door Security

The McCausland Center is a secure, swipe-access-only facility located on the second floor of the Palmetto Health Richland Memorial Hospital. If you do not already have hospital credentials, you must first obtain an identification badge with a "McCausland Center" designation to gain unaccompanied access to the 3T MRI suite. Access doors to the McCausland Center or the scan room should never be left open.

Figure 2 The McCausland Center is a secure, swipe-access-only facility located on the second floor of the Palmetto Health Richland Memorial Hospital.

You should not scan if the door to the scanner room does not properly seal since your data will potentially be contaminated. It is possible in the event of a door malfunction that you might be unable to open the door, and if you are inside the scanner room, you might think yourself trapped (Remember that there is an emergency hatch that opens into the equipment room).
3.2 Accurate Entry of Subject Weight, Age and Sex

The scanners require that the subject’s weight, age and sex be entered before scanning. Accurate information must be provided to ensure that FDA limits for energy deposition are not exceeded. Weights should be correct to within five pounds. Incorrect information should never be entered in an effort to get the scanner to conduct a study that it otherwise would not perform because FDA limits would be exceeded. i.e., for the head, you should not exceed 10 Watts/kg over any 10 minute period. For scanning populations with quickly changing weights, such as children, we recommend that you bring a scale to determine their correct weight.

3.3 Temperature Control

In regulating energy deposition in the subject’s body in accordance with FDA guidelines, the scanners assume that the ambient temperature in the room does not exceed 75° and that the relative humidity does not exceed 60%. Consequently, the thermostat should never be set for a room temperature higher than 75°. Blankets and sheets are available for patient comfort if needed; these are located in the upper cabinet on the left side of the scanner.

3.4 Pregnancy

Although there is no evidence that participation in an MR study by a pregnant woman would be harmful to her fetus, federal guidelines for the use of MRI in clinical settings recommend that MRI studies be delayed until after the pregnancy when possible. Consequently, it is McCausland Center policy that:

1. Pregnant women may not undergo MR studies unless the study itself is specifically designed to investigate pregnancy with IRB approval.
2. Except for members of the research team, women who are pregnant (including a pregnant parent or spouse of a research subject) are not allowed into the scanner room at any time.
3. Pregnant members of the research team are allowed in the scanner room (e.g., for positioning a subject), but are not to remain in the scanner room while the scanner is in operation.

It is not McCausland Center policy to require pregnancy testing for research subjects.

3.5 Obese Subjects

Subjects weighing more than 400 pounds should not be scanned. This is the weight limit for the MR compatible gurney that might be needed to transfer the patient off the table during an emergency. The Siemens Trio scanner bed is designed to support weights up to 440 pounds. Even subjects weighing substantially less than 400 pounds should never be allowed to sit at the distal end of the scanner bed, since it is not designed to support the full weight of a large subject applied at full mechanical advantage.

3.6 Children

Children may only enter the scan rooms as participants in an IRB approved research study of children. Children not involved in the research study (e.g., the child or sibling or a research subject) may not enter the scan room and may only be present in the control room if under direct adult supervision. Equipment room doors must be kept closed whenever children are present. All safety precautions applicable to adult subjects are applicable and if anything, more important for children. Careful metal screening, accurate entry of age, sex and weight, and use of “Standard Mode” scanning options whenever possible are important steps in minimizing risks to this population.

3.7 Patient Populations

Although located in Palmetto Richland Medical Center (PRMC), the McCausland Center for Brain Imaging is operated by the Department of Psychology during non-clinical hours. Nevertheless, in the case of medical emergency the crash team of PRMC should be notified by calling 4-6222.

To reduce the likelihood of adverse outcome in the event of a medical emergency, the following policies apply to all patient studies:

1. All hospital inpatients undergoing studies in the McCausland Center must be accompanied by a physician or nurse familiar with the patient’s medical condition. The only exception to this policy pertains to patients who are admitted to the geriatric or stroke clinic as a result of participation in a research study and who would otherwise not be hospitalized.
2. All patients (inpatients or outpatients) at significant risk of a life threatening medical event (e.g., cardiac arrest, respiratory arrest, generalized or complex partial seizure) must be accompanied
by a physician familiar with the patient’s medical condition and qualified to treat the life threatening condition.

3. Staffing adequate to assure the patient’s safety in the event of an emergency must be present at all times. For example, if the patient is obese and not ambulatory, sufficient personnel to transfer the patient onto a gurney in the event of a fire or medical emergency must remain with the patient throughout the study. If the patient is confused, staffing sufficient to assure that the patient does not get up and fall from the exam table during the examination must be present.

4. Solo scanning is not acceptable. At least two people (not including the participants or the participants’ friends and family) must be present, free from metal, and MRI Safe for any research study.

5. Careful attention must be given to metal screening of patients with impaired cognitive abilities.

4 Safety Procedures

4.1 Performing an Emergency Magnet Quench

Normally, the scanners magnetic field is continuously on, regardless of whether you are scanning or not. In emergency situations, it is possible to turn off this magnetic field (a process referred to as “quenching”). Users of the McCausland Center facility should only quench the magnet in the event that the magnetic field itself poses an immediate risk to life or major property. Two such circumstances are:

1. A metal object is lodged in the scanner in a way that poses an immediate serious threat to a person (e.g., a person is pinned to the magnet by a metal object that is causing internal injuries).

2. Fire personnel determine that there is no other alternative to entering the room with axes or other heavy gear when fighting a fire.

In the absence of a major emergency, facility users should never quench the magnet by themselves, even if they are convinced that a magnet quench will ultimately be necessary. In the control room, a quench button is located on the top portion of the wall between the two scanner room windows to the right of the scanner console. Another quench button is located next to the door inside the scanner room. Each quench button is covered by a Plexiglas cover and the button itself has the word “STOP” printed three times around its perimeter.

![Figure 3 The magnet quench buttons will cause a complete shutdown of the magnet and all associated software and hardware systems.](image)

Magnet Quench Procedure

1. When the magnet is quenched, the helium in the scanner boils off. To minimize the chance of asphyxiation in the event that the helium is improperly vented you should remove yourself and the subject from the scanner room before quenching the magnet. Caution: Helium vent ducts become dangerously cold during a quench. Do not touch them!

2. Make sure the door to the scanner room is wide open before quenching the magnet.

3. Locate and press the QUENCH BUTTON in the control room or scanner room. Lift the Plexiglas cover and press the button. The magnetic field will fall to a safe level within 20 seconds.

4. If emergency medical assistance is needed, call 4-6222 and request medical assistance as detailed on page 12 of this manual.

5. Notify McCausland Center staff that you have quenched the magnet.

4.2 Performing an Emergency Electrical Shutdown

The following events should prompt an emergency electrical shutdown:

1. You see smoke or fire coming from the scanner, equipment room or console.

2. Flooding has carried or is threatening to carry water into electrical equipment
Please note that an electrical shutdowns does not turn off the magnetic field—the magnet is always on unless the magnet has been quenched!

The electrical shutdown buttons have a metal shroud around them, and there is no writing on the button itself. Buttons are located as follows: On the wall to the left of the scanner console in the control room; on the wall immediately right of the scanner room door (to the left of the MRI operator when at the MRI console computer).

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**Figure 4** The emergency electrical shutdown buttons does not shutdown the magnet. (Button shown without shroud.)

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**Emergency Electrical Shutdown Procedure**

1. Locate and press one of the large red electrical shutdown buttons in the scanner room or control room. Make sure that it is the electrical shutdown button, not the quench button.
2. Electrical shutdown immediately stops all power to the scanner, the scanner equipment and the console computers. It does not turn off the lights. Also, power to the stimulation equipment will not be interrupted, so be aware that electrical or fire hazards may still be present.
3. In the case of fire or medical emergency, call 4-6222.
4. Remove your subject from the scanner room. The electric brakes on the scanner bed will have been released automatically, so simply pull the bed out of the gantry manually using the handle at the foot of the bed.
5. Notify McCausland Center staff that you have performed an Emergency Electrical shutdown

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**4.3 Performing a Routine Electrical Shutdown**

A routine electrical shutdown requires 3-5 minutes to complete. You should initiate a routine electrical shutdown if you believe that a situation is developing that might predispose the equipment to damage. Situations that would warrant a routine electrical shutdown may include:

1. Receiving notice that an electrical outage in the building is likely.
2. Development of a minor water leak that is not expected to flood electrical equipment before a routine shutdown can be completed.
3. Alarms indicating that the magnet has quenched or that helium is low.
4. Error messages indicating that correction of a problem requires a reboot of the system.
5. Failure of the scanner bed to respond to its controls

Per the manufacturer’s updated recommendations, the routine electrical shutdown should NOT be routinely performed at the end of the day. The scanner should be left in operational status.

**Routine Electrical Shutdown Procedure**

1. At the console, select “End” from the “System” menu at the far right
2. In the dialog box that appears, make sure the “Shutdown All” option is selected and then press the “OK” button
3. In the confirmation dialog box that appears, click “Yes”
4. Wait until the console displays a dialog box indicating that it is safe to turn off the computer (other dialog boxes will typically appear before this final dialog box).
5. On the Siemens control box next to the window in the control room, press the blue “power off” button to turn off electrical power.

When it is appropriate to restore power, press the blue “power on” button located on the Siemens control box next to the control room window. The system will need about twenty minutes to reinitialize (There is a countdown timer on the power amplifier in the equipment room). To avoid subsequent problems, make sure that the bed is completely out of the gantry before restoring power.
5 Handling Medical Emergencies and Subject Problems

5.1 Medical Emergencies – “Code Blue”

If you believe that a participant or anyone in the McCausland Center has a medical emergency and needs immediate assistance, call 4-6222. Palmetto Richland Medical Center (PRMC) has trained individuals that respond to medical emergencies within the hospital.

The following procedures are designed on the assumption that a physician or nurse is not immediately available in the MR laboratory at the time of the emergency. If a physician or nurse is present, the medical recommendations may be adjusted as deemed medically appropriate for the subject’s condition. However, all non-medical aspects of these guidelines, particularly those relating to removing a person from the magnet or the scanner room, must be followed to avoid unnecessary injury to the subject or personnel.

1. If (and only if) the medical emergency involves the subject being pinned to the magnet by a metal object held in place by the magnetic field, quench the magnet following the magnet quench procedure described on page 9 of this manual.
2. Call 4-6222. Describe the event. Give the location as: McCausland 3T MRI Center; Medical Park 5, 2nd Floor; Phone Ext: 8219 (Scanner Console)
3. Open either of the doors to the McCausland Center facility so that emergency personnel will be able to enter when they arrive.
4. If the emergency involves a subject in the magnet then follow the Code Blue Procedure described in the next section.
5. Provide medical assistance in accordance with your training and experience while awaiting arrival of the paramedics. Consider the following options:
   a. Initiate CPR if the person has no pulse or not breathing
   b. Provide Advanced Cardiac Life Support measures if you have the appropriate training.
   c. Provide oxygen when needed.

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Figure 5 The Siemens Magnetom Trio may be stopped by (left image) pressing the red stop button (labeled “(1)”) on the intercom in the console room or (right image) by pressing the stop button located on the scanner.

Code Blue Procedure: Under no circumstances should a code team or emergency personnel untrained in MR safety enter the scan room. If the emergency involves a subject in the magnet then the following steps should be taken:

1. Always remove the subject from the instrument first (See Figure 5)
   a. If you are at the scanner console then press the “STOP” button on the top of the intercom to abort the scan.
   b. If you are in the scanner room, then press the “STOP” button on the scanner control panel.
2. This will require that the scanner bed to be moved manually and you should pull the bed completely out of the scanner bore. (The scanner bed cannot be detached from the scanner.)
3. Remove the subject from the scanner room:
   a. Get the MR compatible gurney and slide board stored behind the door in the scanner room.
   b. Lock the gurney wheels and stabilize the gurney against the scanner bed using your own body.
c. Transfer the subject onto the gurney using the slide board to reduce friction (at least two people - one on each side - are required to safely transfer a 200 pound subject.)

d. Set the slide board down, put up the side rails on the gurney, and unlock the wheels.

e. Wheel the gurney from the scanner room into the hallway.

If for any reason you are unable to remove subject from the scanner room, it is your responsibility to ensure that any of the “Code Blue” respondents who enter the MRI room are free from metal and MRI safe.

5.2 Subject Squeeze Bulb

The scanner is equipped with a squeeze bulb that allows the subject to set off an audible alarm to attract the operator’s attention. The squeeze bulb should be made available to subjects unless some alternative method of constant monitoring (e.g., another person in the scanner room) is in effect. Use of the squeeze bulb or some comparable form of continuous subject monitoring is mandatory if you are operating the scanner in “Level 1” mode, which has an increased risk of magneto stimulation or subject heating due to RF energy deposition.

The squeeze bulb plugs into a connector at the foot of the bed. You can verify that the squeeze bulb is connected by noting that the squeeze bulb LED lights up when you press the talk button on the intercom. If the subject squeezes the squeeze bulb, a continuous audible alarm is emitted via the intercom and the intercom squeeze bulb LED lights up. This is especially important if you are scanning in “Level 1” mode rather than standard mode since the subject may have triggered the squeeze bulb in response to magneto stimulation or excessive heating. You will get a “warning window” before the initiation of your scan if it is classified as a “Level 1” scan (e.g., DTI, EPI, or TOF).

**Figure 6** When the squeeze bulb alarm sounds the LED labeled “(11)” is illuminated. The “STOP” button is labeled “(9)” and the talk button - labeled “(12)” – allows one to talk to the subject.

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Squeeze Bulb Alarm Procedure

1. If a scan is ongoing, press the “STOP” button on the intercom once to stop the scan immediately. Alternatively, you may press the “Stop” button on the console using the mouse (This is only available in the “Exam” application).

2. Press the intercom talk button (labeled “(12)” as above) to stop the audible alarm.

While holding down on the intercom talk button, speak to the subject to determine why the squeeze bulb was pressed. Make sure that the volume is turned up so that you can hear the subject’s response. (If there is obvious distress; you may skip this step and go to step 4)

3. If necessary, enter the room to further investigate and/or correct the problem.

5.3 Removing Persons from the Scanner

As discussed above, there are several situations where it is important to remove the participant from the scanner (e.g. magnet quench, code blue, etc). For this reason it is also important for users of the McCausland Center facilities to know how to slide out the scanning bed from the MRI scanner. This can be done at the scanner by pressing the “home” button or on the console by selecting the “table positioning” icon (bottom right column of icons) and then pressing the home icon.

In case of an emergency the manual release for the table may also be used. This is a lever located beneath the end of the scanner bed. To manually slide out the scanning bed from the scanner you simply
pull out the handle and then you can slide the table out freely. To reset the bed, you push the lever back, slide the table until it locks with the motor, and then press the 'in' and 'out' buttons located on the scanner.

### 5.4 Subject Tingling or Muscle Twitch

Tingling or muscle twitches are potential physiologic effects of time varying magnetic fields. Such effects are particularly likely to occur with echo-planar imaging in fMRI studies. To minimize the likelihood of such magneto stimulation, operate the scanner in “Standard Mode”. In this mode, only 1% of subjects should experience such effects. However, the scanner may refuse to scan certain subjects with certain pulse sequences in “Standard Mode”. If you operate in “Level 1” operating mode, up to 50% of subjects may experience magneto stimulation with certain pulse sequences.

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Figure 7: Illustrated are some subject positioning loops that may predispose them to magneto stimulation or burns.

Complaints of tingling or muscle twitches should prompt re-screening for any metal objects that might have been previously overlooked and verification that subject positioning does not form potential loops. For echo planar imaging, selecting a phase encoding direction that is anterior-posterior (when this is an option) should reduce the likelihood of magneto stimulation. Note that the sensory input associated with magneto stimulation will pose an unwanted confound in fMRI studies.

### 5.5 Perspiration and Increased Pulse

Perspiration and an increased pulse rate may result from energy deposition in the body during scanning. Energy deposition in the body is carefully regulated by the scanner in accordance with FDA guidelines. If your subject develops these symptoms, you should verify that the subject’s age, height and weight were entered correctly when registering the patient, since these parameters may influence the calculated energy deposition. You should also verify that the room temperature does not exceed 75° and the humidity does not exceed 60% since the calculated energy deposition limits assume that they do not. For subjects who have medical conditions such as fever, diabetes, pregnancy, or cardiovascular disease that can impair thermal regulation, you should operate the scanner in “Standard Mode” if possible, since energy deposition is not a concern in this mode. Children or elderly subjects are also at increased risk of overheating.

If you do scan subjects with conditions associated with impaired thermal regulation in “Level 1” mode, you should be attentive to signs or symptoms of overheating and stop the scan if overheating is suspected. “Level 1” mode should be avoided if possible in subjects who are unable to communicate reliably (e.g., children, sedated subjects, stroke patients). Adjusting the fan in the scanner may be helpful in reducing the likelihood of overheating in subjects.

### 5.6 Incidental Findings – Abnormal Looking Scans

Handling of incidental findings from your MRI scanning are to be done in accordance with your specific research IRB. If you have any further questions about any incidental findings, please contact the McCausland Center Coordinating Manager and/or your IRB committee.

### 6 Handling Facility Emergencies

#### 6.1 Fire Emergencies

In case of a fire emergency at the McCausland Center

- Call 4-6222 and give the location as: McCausland 3T MRI Center; 2nd Floor, Palmetto Richland Medical Center Medical Park 5, Harden St.
- If smoke or fire is coming from the scanner, equipment room or console, perform an emergency electrical shutdown as described elsewhere in this manual.
• If you are scanning and smoke or fire is NOT coming from the scanner, equipment room or console, stop the scan and release the bed by tapping the red “STOP” button on top of the intercom twice. If time permits, initiate a routine electrical shutdown by selecting “End” from the “System” menu at the far right at the console. (See left panel of Figure 5: The “STOP” button is labeled “1”).

• If you determine that it is necessary or appropriate to attempt to extinguish a fire in the scanner room yourself (e.g., if your subject is on fire), use either the Crome or the blue and white MR compatible fire extinguishers in the MR suite.

• Never bring a standard fire extinguisher from elsewhere in the building into the scanner room.

• Remove the subject from the scanner and escort the subject out of the building.

• Do not return to the building until advised by fire personnel that it is safe to do so.

• Contact the McCausland Center personnel to advise them that there was a fire in the building.

6.2 Non-Fire Facility Emergencies

In the event of a non-fire emergency at the McCausland Center, such as an unscheduled power shutdown, a water leak, or an earthquake or other natural disaster, the following general guidelines should be followed:

1. Remove the subject from the scanner
2. Perform a routine electrical shutdown, or if circumstances such as a rapid flooding threaten to reach the equipment before a routine shutdown could be completed, perform an emergency electrical shutdown. Both shutdown procedures are described elsewhere in this manual.
3. If appropriate, evacuate the building and do not return until advised to do so.
4. Notify a McCausland Center staff member of the emergency.

6.3 Audible Alarms

You should never scan while an audible scanner-related alarm is sounding. If you cannot identify and correct the underlying problem, your study should be discontinued. If an audible alarm is sounding, investigate the following possibilities:

1. The alarm might be the building fire alarm. This extremely loud alarm is audible throughout the building, is associated with flashing lights in the hallways. Even if you suspect that the fire alarm has been triggered accidentally, you MUST do the following:
   a. If you are scanning, press the “STOP” button on top of the intercom twice.
   b. Go into the scanner room and pull the bed out of the gantry using the handle at the foot of the bed.
   c. Assist the subject off the bed (if appropriate, use the MR compatible wheelchair or gurney.
   d. Accompany the subject out of the building via the nearest accessible exit.
   e. Do not reenter the building until told that it is safe to do so by fire personnel

2. The alarm might have been triggered by someone squeezing the squeeze bulb. Look to see if the squeeze bulb LED on the intercom is lit. If it is, see the separate section regarding the squeeze bulb. You will be able to continue your study if this is the source of the alarm.

3. The helium level might be low or the magnet might have quenched. Check the Siemens control box located in the control room immediately to the right of the window. If the magnet stop LED is lit, the magnet has quenched. If the helium level LED is lit, the helium level is low. You can press the alarm silencer to stop the audible alarm, but do not scan. Notify McCausland Center staff of the problem and send your subject home.