

SOP Number:	315.09
Title:	Gradient Insert Installation and Removal

Revision Chronology			
Version Number	Effective Date	Review Date	Reason for Change
315.01	20 Oct 2006	Oct 2007	Initial Version
315.02	02 Oct 2007	Oct 2008	Review/Updated Hardware
315.03	27 Jul 2009	Jul 2010	Review
315.04	23 Oct 2013	Oct 2014	Review/Updated
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315.07	13 Oct 2017	Oct 2018	Updated for DV26
315.08	17 Aug 2018	Aug 2019	Review
315.09	11 May 2020	May 2021	Review/Updated

Directors Signature: _____ Date: _____

Gradient Insert - Installation Procedure

RRI 3T MR750 20MX

Important:

Before using this document, you must be familiar with the equipment and terminology described in the document “MR750 and Gradient Insert – General Information”.

Section 1. Power Gradient Amplifiers down (Equipment Room)

- 1) Register in the **Gradient Insert Log Book** and in the **MR Patient Log Book** your name, time, and date you start your experiment.
- 2) Open the Plastic Cover that protects the Circuit Breakers at the middle of the PDU as shown in Figure 1.



Figure 1. Clear plastic cover closed (left) and open (right) that protects circuit breakers in PDU.

NOTE: It is very important to keep the order of the next two steps to avoid unexpected system behavior and/or possible circuit damage.

- 3) Turn OFF Gradients Power Switch (see Fig. 2, highlighted switch #1 at the right).
- 4) Turn OFF Gradients Control Switch (see Fig. 2, highlighted switch #2 at the left).

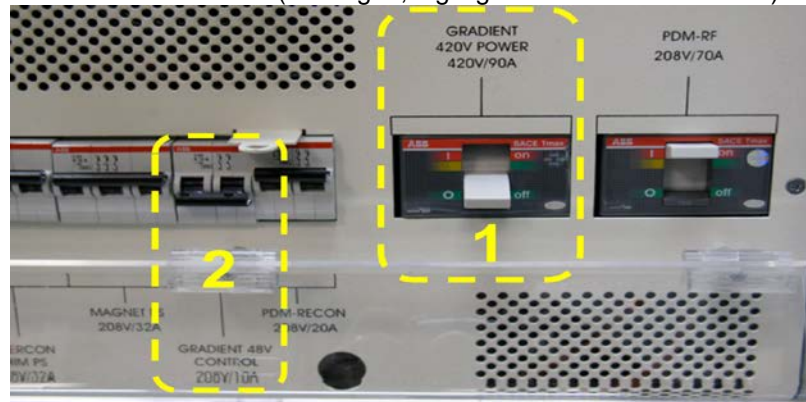


Figure 2. Turn the circuit breakers off in the following order:
 1st - “GRADIENT 420V POWER 420V/90A”
 2nd - “GRADIENT 48V CONTROL 208V/10A”

- 5) Close plastic cover, and use the lockout tag (Fig 3, stored on top of chiller) while gradient amplifiers are off and you are working with gradient cables and switches:



Figure 3. Use lockout tag when gradient amplifiers are off and while switching gradient cables

- 6) If the experiment requires the use of a proton RF coil that demands relatively small RF power to achieve a 90° pulse, such as small solenoid coils, then connect in series the RF attenuator as explained below:
 - a. In the RF power amplifier (lower right of PGR Cabinet – Fig. 4a), disconnect the coaxial cable connected to the BNC terminal J14 (Fig. 4b) and connect it to one end of the RF attenuator.
 - b. Using another coaxial cable, reconnect the J14 terminal to the other end of the RF attenuator.
 - c. Set the attenuation level by rotating the knob. The attenuation value corresponds to the number aligned to the pair of BNC connectors at the top of the attenuator (Fig. 4c)
 - Common attenuations: Mouse Body coil – 10dB
 - Mouse Head Coil – 20dB
 - d. Place the attenuator at the bottom of the cabinet to minimize strain to the cables (Fig. 4d).

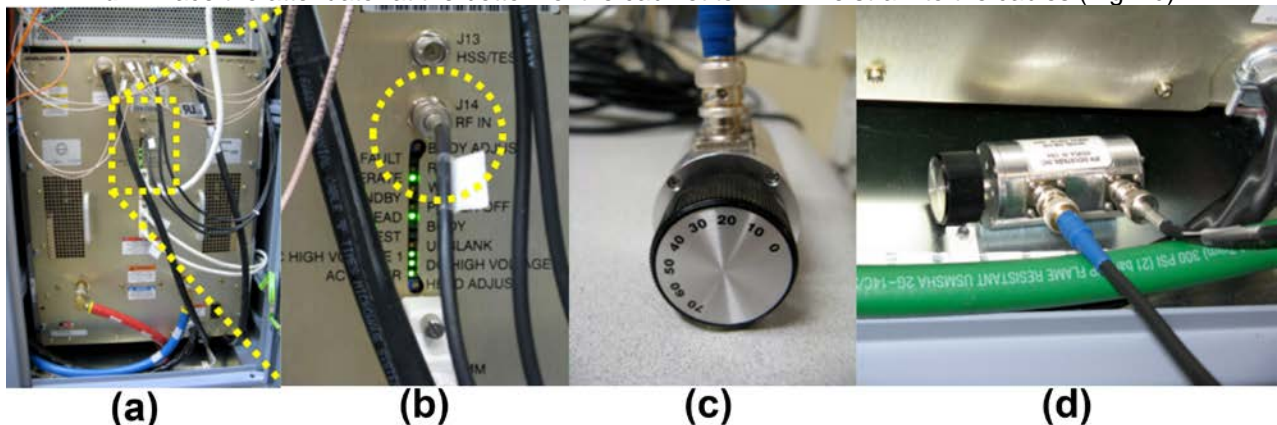


Figure 4. (a) RF Amplifier; (b) J14 BNC connector; (c) RF Attenuator (set to 20 dB for this picture); (d) Placement

- 7) Verify that the 2 yellow valves of the Chilled Water Sup. and the Chilled Water Ret. are **closed** (horizontal position) (Fig. 5). This is important for step No. 20), when you will be connecting the cooling system.



Figure 5. Chilled Water Supply and Chilled Water Return. Verify valve position (closed) in the Equipment Room

Section 2: Set Insert Coil (Magnet Room)

- 8) Dock the Patient Table and adjust its height to the maximum, such that the Low-Profile Carriage (Dog House) automatically engages the cradle.
- 9) Press the **[Table In]** button on the magnet panel to move the cradle toward the back of the magnet, until the position shown on the scanner monitor reaches 2200 mm or more (Max. 2540 mm), as presented in Figure 6. Note, the insert gradient will fit for values as low as 1600 mm, but 2200 is best for cable management.

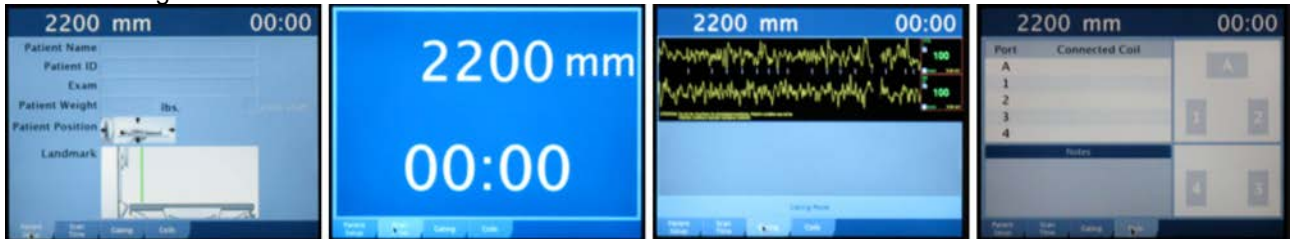


Figure 6. Position of cradle as seen on any of the four possible screens displayed on the scanner monitor (inside magnet room). From left to right: Patient Setup, Scan Time, Gating, and Coils.

- 10) Detach the cradle from the Dog House by twisting the release handle at the end of the cradle. (A in Fig 7)
- 11) Pull the cradle all the way back to the end of the patient table until it locks. Ensure the cradle is locked.
- 12) Undock the patient table by pressing down on the foot pedal (B in Fig. 7). If the table fails to undock see appendix 2 for troubleshooting tips.
- 13) Move the table out of the way using handle (C in Fig. 7) by pulling straight back from the magnet bore, next to cabinet with head coils.

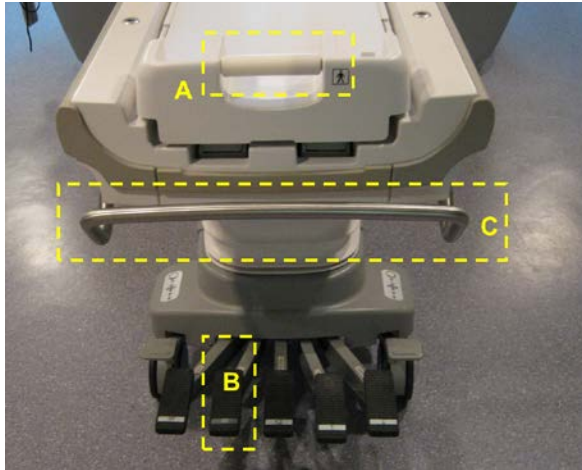


Figure 7. Position of cradle as seen on any of the

- 14) Align the insert coil cart with the magnet bore using the grey storage cart
- 15) Transfer the coil from the cart to the magnet bore using proper body mechanics (Fig.8).



Figure 8. Alignment of insert coil and bore of the magnet

- 16) Move the cart to the side. You can now use it to prepare samples, animals, RF coils, etc.
- 17) Uncoil the two hoses placed on top of the insert and put their endings (hose connectors) on the floor, as close as possible to the Water Switch Box. This will minimize spills inside the bore of the magnet.

- 18) Gently, slide the insert coil into the magnet bore until the marked black line (on left side of magnet bore). If the marked black line is not visible, see appendix 3.
- 19) Hook up the insert gradient cables at the **QuickCon Panel** (Fig. 9)
 - a. Slip the fork terminals into the correct slots, ensuring that all labels match. Cables with RED tape around them should be connected to the positive terminals.
 - b. Check that **all** metal forks are in complete contact with the metal connection (descended low enough)
 - c. Tighten the knobs
 - d. **Double check** that all labels match up correctly and that the metal forks are correctly positioned

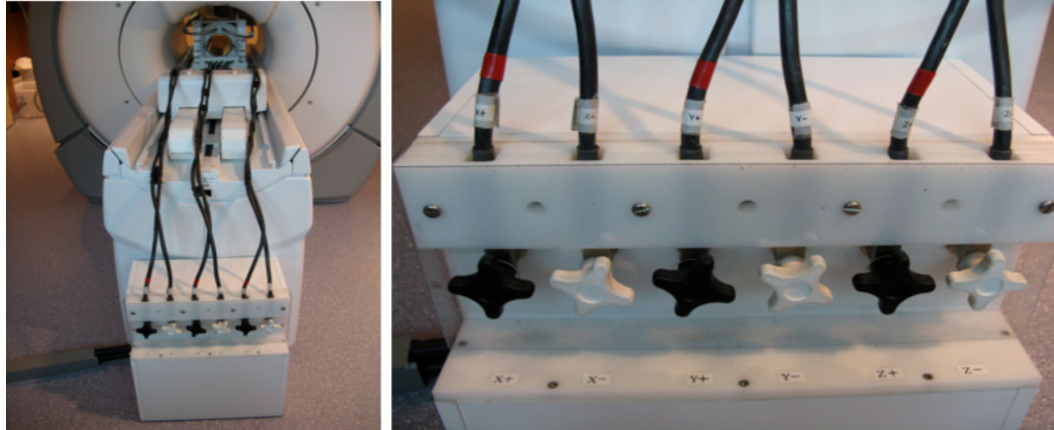


Figure 9. Connections of insert cables to “QuickCon” panel. The cables should be placed untangled and aligned, as much as possible, to the main magnetic field. Make sure that knob- and cable-labels match.

- 20) Connect Cooling Water

IMPORTANT: During Gradient Insert operation, water has to be constantly flowing or THE COIL WILL OVERHEAT AND MELT.

- a. Get the water hoses out of the **Water Switch Box** (Fig. 10).



Figure 10. Water Switch Box opened. Store box lid behind the box.

- b. Connect hoses to the insert coil (Fig. 11) as far as possible from the main magnet.
- c. Place towels from Water Switch Box under connection points to catch any small leaks that may happen during connection and/or disconnection.
- d. To minimize leaks, connection should be performed in one smooth motion.
- e. Connection can be tricky and must be connected properly for coolant flow.
- f. Connection may be easier if made while depressing grey release buttons.

- g. Wipe any spill using the wash cloth on the Water Switch Box.

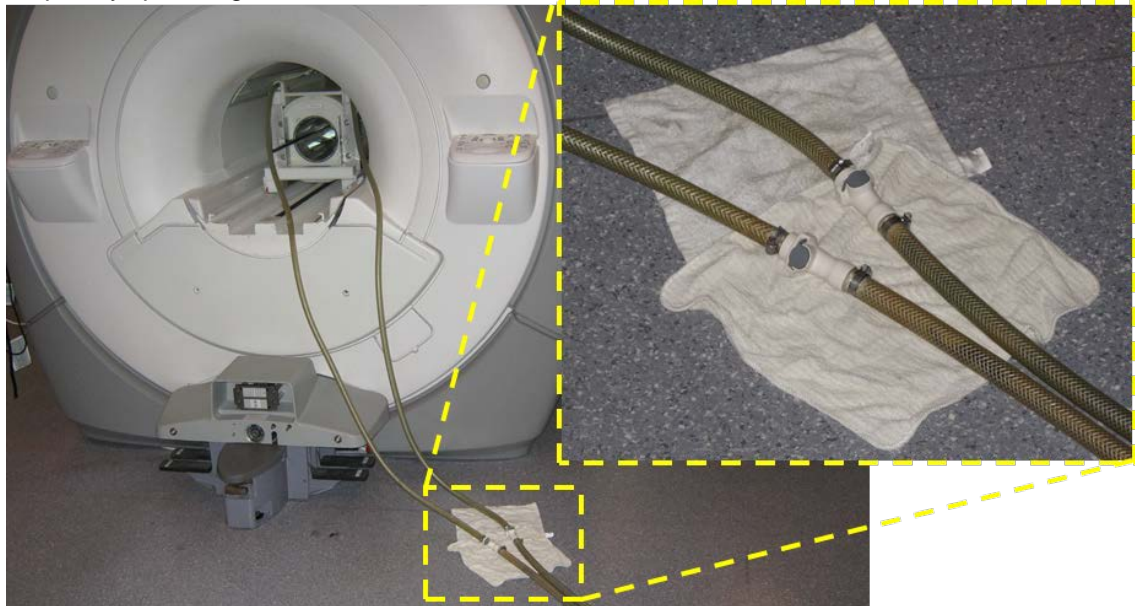


Figure 11. Connection of water-cooling lines for the insert.

- 21) Connect the 3T Linear T/R Gateway (RF coil adaptor) to the “dog house” (Fig. 12):
 - a. Gateway and cables are stored in the blue box on the left side of the scanner room
 - b. Connect the “male-to-male coaxial adaptor” (Fig.12A) to the 3T Linear T/R Gateway (Fig.12B). This adaptor will be used to attach your coil once set up is complete
 - c. Insert the 3T Linear T/R Gateway into the left port on the scanner “dog house” (Fig.12C)

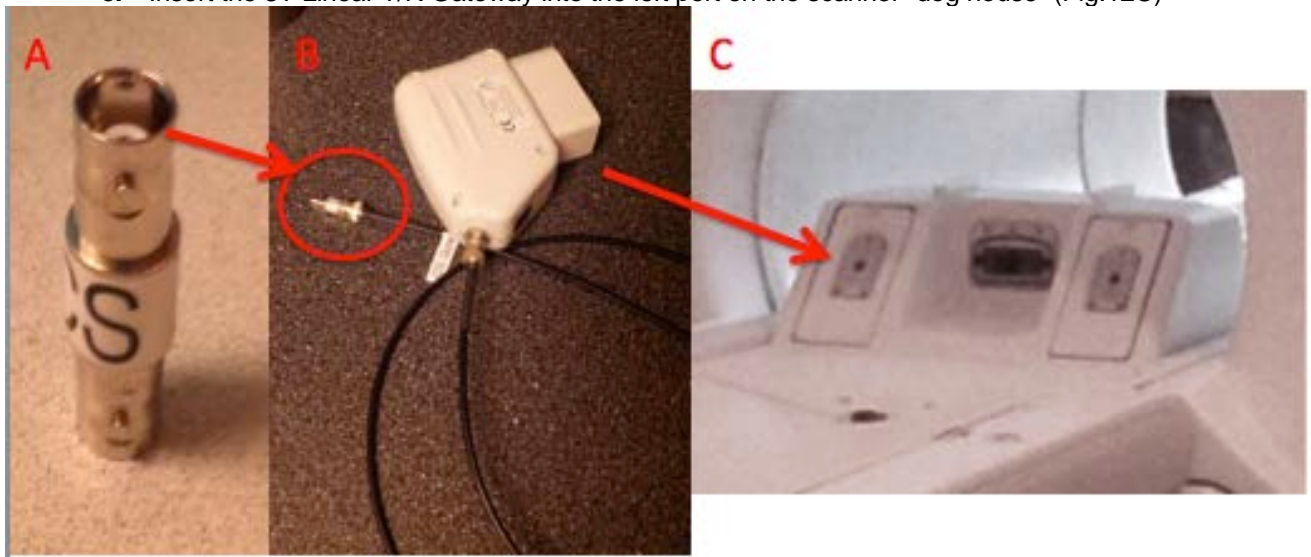


Figure 12. Connecting the 3T Linear Gateway

Section 3: Mechanical Switch and Power Up (Equipment Room)

- 22) In the Equipment Room open the yellow valves on the Chilled Water Sup. and the Chilled Water Ret. (vertical position) (Fig. 13).

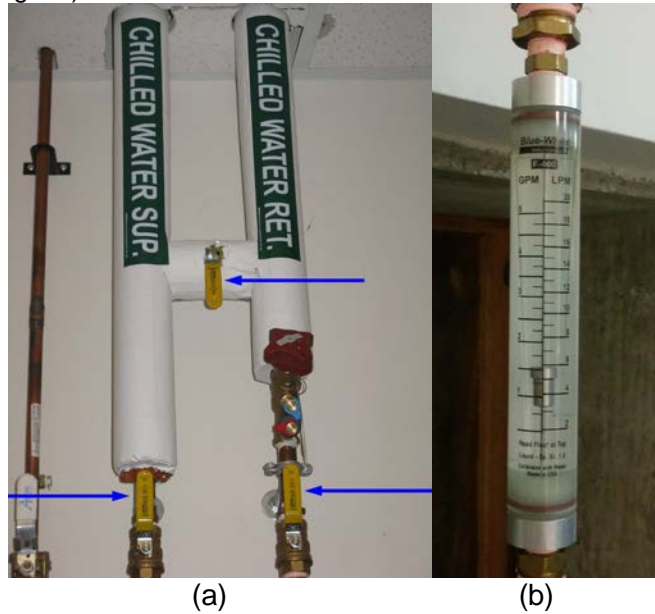


Figure 13. Chilled Water Sup. and Chilled Water Ret. (open), and Flow Meter reading 1.5 GPM

- 23) Turn on the Insert Water Chiller (Fig.14). The set point temperature for the chiller is already set up to 15°C.
 - a. Turn on main power if not already on.
 - b. Start chiller. Keep the button pressed for a few seconds, until the temperature display is stable. It may already be in if it is currently in use for the SpinMaster.
 - c. Verify “low coolant level” light is off and silent.
 - d. Register yourself as a user of the chiller by hanging the “Insert User” tag on the supplied hook.

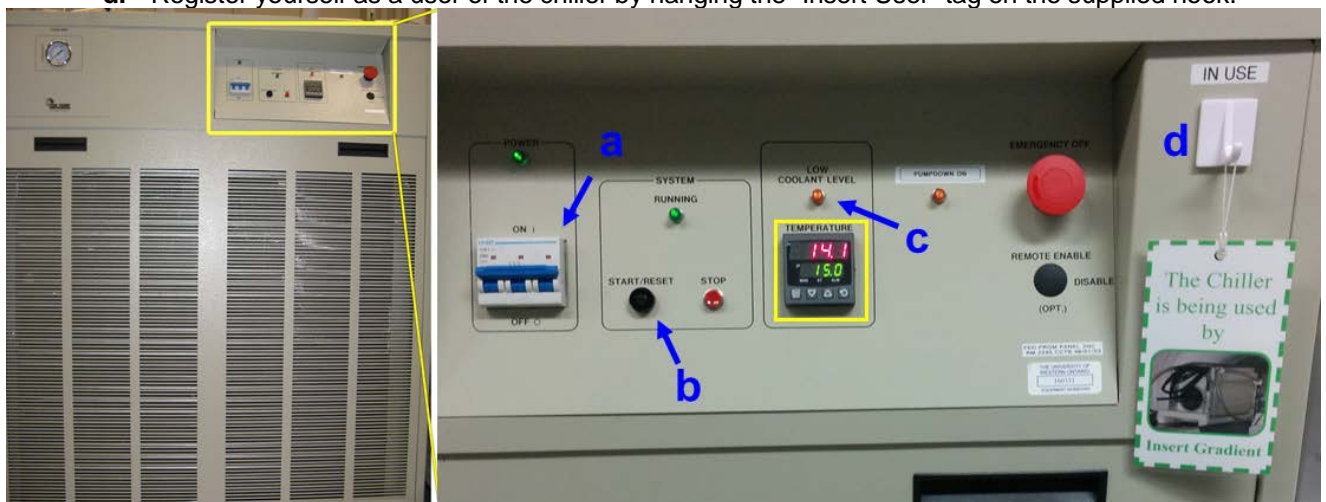


Figure 14. Chiller.

NOTE: If the “low coolant level” light and alarm are on, do not continue your experiment and consult support personnel (Scholl Lab). You can resume your experiment once the coolant is replenished. If no support available, see Appendix 3

- 24) Perform a visual check of the flow meter (Fig 13b) to verify that flow is going through the coil. A few bubbles in the first few seconds is not unusual, but if no flow is being registered or the flow is low or unstable this is a sign of either a blockage or a leak that should be investigated immediately. Normal flow for the S-coil is >1.5 GPM measured at the top of the float.
- 25) In the Equipment Room, switch the gradient hardware to RESEARCH Mode.
 - a. Double check that the power is off.
 - b. Remove the clear plastic cover from the front of the gradient switch (Fig. 15)

IMPORTANT: Never touch any metallic part of the gradient switch with any part of your body or any metallic tool or material in direct contact with your skin.

IMPORTANT: Never take the provided tool inside the magnet room. It contains ferromagnetic parts and may cause damage to the equipment or inflict personal injury.

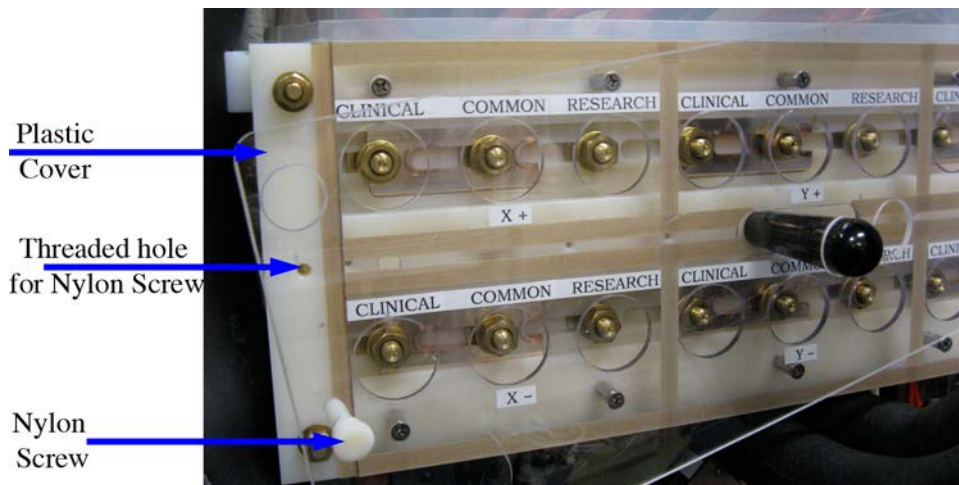


Figure 15. Unscrew the two Nylon screws located at the right and left end of the gradient switch and remove the plastic cover. Pay attention to the hole for the black handle and minimize the motion of the cooling hoses.

- c. Using the tool shown in Fig. 16, loosen the twelve brass nuts that keep the switch connected in “Clinical Mode” (left side): CLINICAL (X+, X-, Y+, Y-, Z+, Z-) and COMMON (X+, X-, Y+, Y-, Z+, Z-). One quarter to half a turn is enough to loosen the twelve nuts.



Figure 16. Use the tool shown at the left to loosen the brass nuts.

- d. Using the black handle at the middle of the Gradient Switch, firmly slide the switch to “RESEARCH” Mode (right side). See Fig. 17 to differentiate correct and incorrect connections.
- e. Tighten the twelve nuts that keep the Gradient Switch in “Research Mode”: COMMON (X+, X-, Y+, Y-, Z+, Z-) and RESEARCH (X+, X-, Y+, Y-, Z+, Z-).

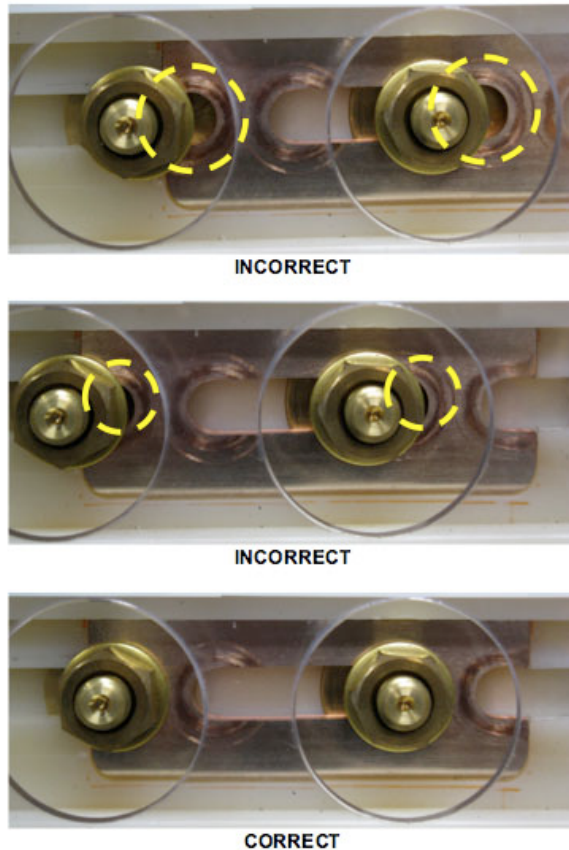


Figure 17. Gradient switch incorrect (top and middle) and correct (bottom) connections. It is important to maximize the surface contact area between the sliding knife and the washers.

- f. Put the clear plastic cover that protects the gradient switch back, trying to minimize the motion to the cooling hoses in front of it. The black handle should pass through the right hole of the plastic cover. If you experience any difficulties when placing the safety cover on the switch, double-check the status of the switch (Fig. 17). The clear plastic safety cover fits properly only when the switch stays in clinical or in research mode.

- 26) In the equipment room, return to the PGR cabinet, remove and set aside the lockout tag placed earlier and open the plastic cover of the circuit breakers.

NOTE: It is very important to keep the order of the next two steps to avoid unexpected system behavior and/or possible circuits damage.

- 27) **Turn ON** Gradients Control Switch (Fig. 18 – highlighted switch #1) and wait for about 10 seconds to ensure the gradient control system is functional. As a visual cue, you can wait until the LEDs “heartbeat” of the three gradient amplifiers XGA (X, Y, Z) are continuously flashing ON and OFF (Fig. 18 – highlighted LED #2a).
- 28) **Turn ON** Gradients Power Switch (Fig. 18 – highlighted switch #2b).

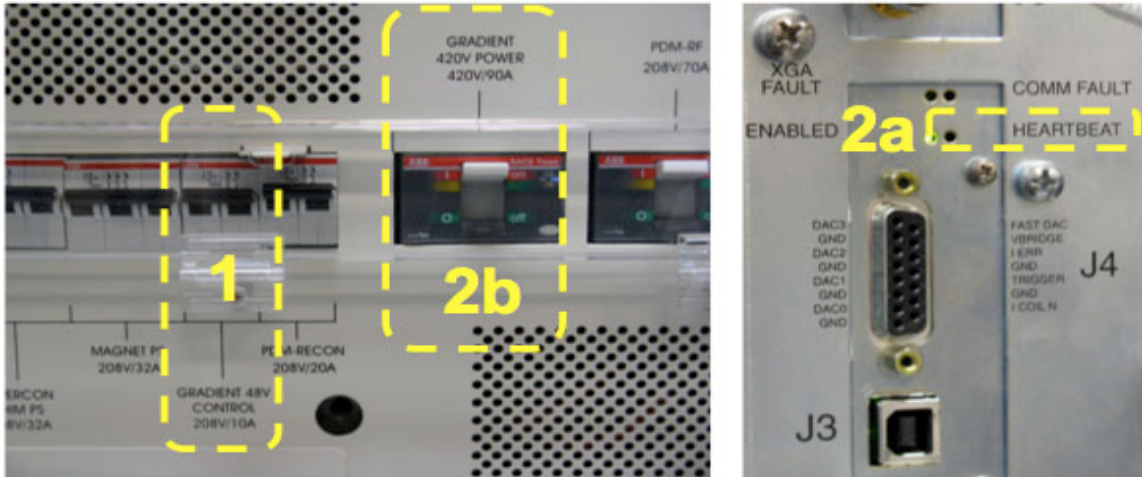


Figure 18. Turn circuit breakers on in the following order:
 1st - “GRADIENT 48V CONTROL 208V/10A”
 2nd – “GRADIENT 420V POWER 420V/90A” after “HEARTBEAT” signals of XGAs are ready.

29) Close plastic cover of circuit breaker.

Section 4: Flow Switch (Main Console).

30) At the main console desk, turn the Flow Monitoring device on. At this point the green light should be on, indicating that there is adequate cooling water circulating through the insert. (Fig.19)



Figure 19. Flow monitoring device. Power switch is located on the back.

- The green light indicates that the flow rate is adequate and you may proceed with your experiment.
- **The red light indicates inadequate flow rate of coolant; ABORT THE SCAN!**
- **Troubleshooting: In case of a red light alarm, see Appendix 4.**
- Flow should be >1.5GPM (Fig. 13b). Flow meter is located in equipment room below the Chilled Water valves.

Section 4: Software Switch to Insert Mode (Main Console).

The procedure for switching to insert mode has been changed as of DV26 to simplify the management of the various gradient operating modes. A more detailed description is in the appendices but the S-coil steps are summarized here:

- 1) From the Toolbox/Service Desktop Manager, open a C Shell terminal window (Fig. 20).
- 2) Follow the procedure shown in the following table. The first column indicates things that you need to type in and then press <ENTER>, indicated with “**Bold Courier font**”, or things that you need to select moving the cursor with the mouse and then click the left mouse button, indicated with “*<Italic Courier Font>*”. See Figs. 20 - 24 for a complete overview of the “software switch” as seen in the main console.

Type in / <Select>	System Response	Comment
cd /usr/g/research/gradients	-	Change directory
setGrad S50	The clinical restore directory appears good Are you sure you want like to proceed? (y/n):	Script checks the existing clinical backup and prompt's to continue
y	This will set the system for <S-Coil 500mT/m 3333 T/m/s> mode Default settings include: * Grafidy Eddy Current Compensation System files have been switched Config File Manager starting... 1) Select <GradientConfig> tab 2) Are settings correct for desired mode? 3) Select <QUIT> 4) Select <No> Please reset TPS to accept the changes.	“y” tells the script that you want to continue with the switch. The files will be switched, and the prompt tells you how to continue to finalize the changes.
<i><GradientConfig></i>	Switch to Gradient Configuration Screen	Verify that parameters match with S50 mode (Fig. 21)
<i><Quit></i>	“Do you really want to save changes and quit? <Yes> <No> <Cancel>”	Pop up window (Fig. 22)
<i><No></i>	Close Config File Manager	Return to C-Shell window
<i>gradStat</i>	***** Gradient is currently in S-Coil Insert (50 Gauss/cm) Mode *****	Check software status
<i><TPS Reset></i>	“WARNING: TPS Reset? <OK> <Cancel>”	Pop up window (Fig. 23)
<i><OK></i>	“TPS is resetting...”	See TPS status message in “Service Desktop Manager” window (Fig. 24)

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xterm
{sd@MR3T}[102] gradStat
gradient mode set to: clinical
-> clinical MR750 XRGB <50 mT/m 200 T/m/s> mode
{sd@MR3T}[103] setGrad S50

state saved in /usr/g/research/gradients/clinical matches current state
scanner is in clinical mode
exiting /usr/g/research/gradients/checkClinical with status 0 (=Success)

The clinical restore directory appears good
Are you sure you want like to proceed? (y/n): y

This will set the system for <S-Coil 500 mT/m 3333 T/m/s> mode
default settings include:
* Grafidy Eddy Current Compensation
* emulating table
* using clinical EPI/EPT delay

System files have been switched
Config File Manager starting...
1) Select <GradientConfig> tab
2) Ensure settings are correct for desired mode
3) Select <QUIT>
4) Select <No>

Please reset TPS to accept the changes.

{sd@MR3T}[104]

{sd@MR3T}[104] gradStat
gradient mode set to: S50
-> animal gradient S50 <500 mT/m 3333 T/m/s> mode
-> this default has:
* none
{sd@MR3T}[105] 

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Figure 20. Complete Software Switch as seen on terminal window (C Shell)

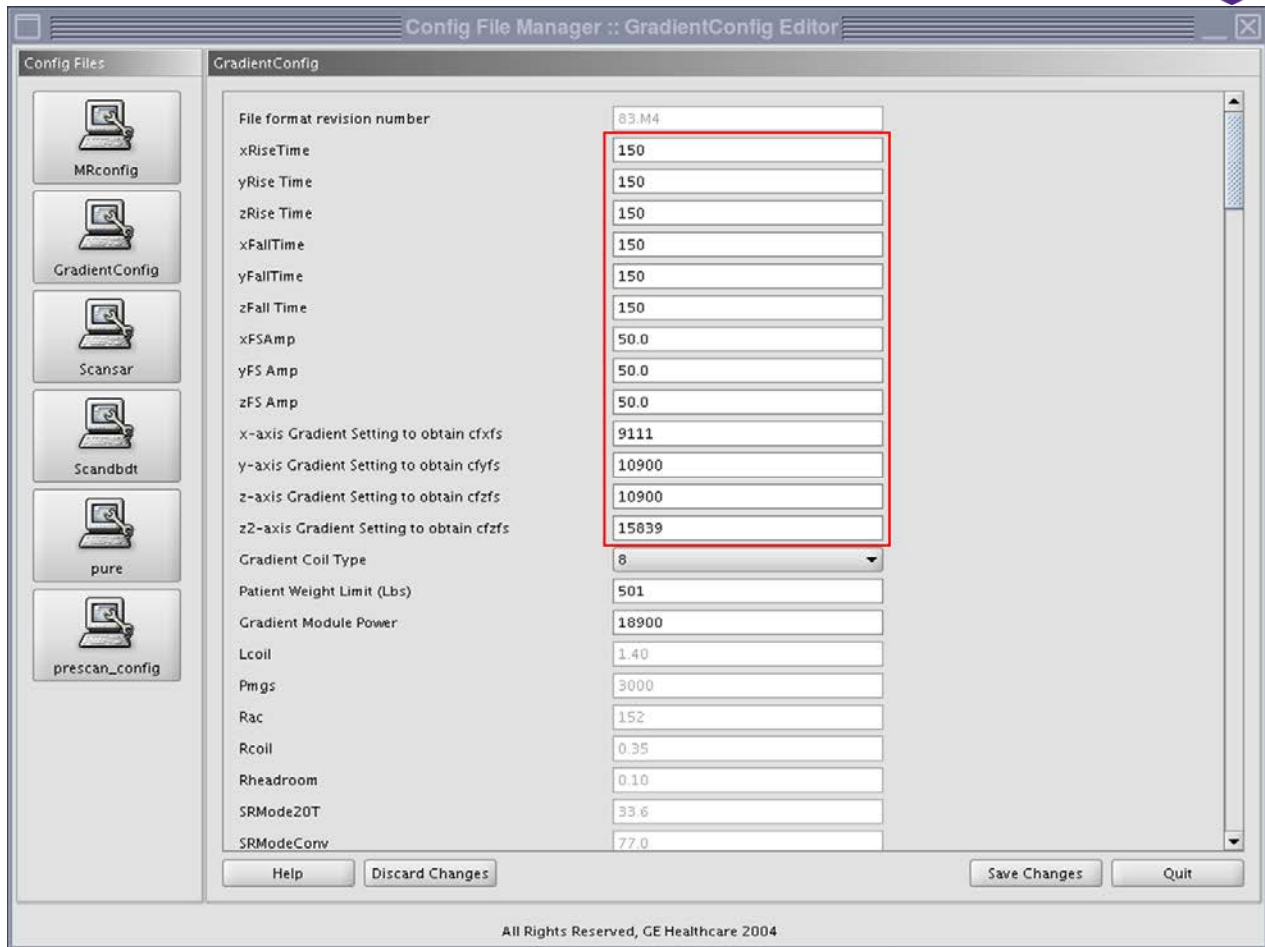


Figure 21. Gradient Config window. Observe the most important fields that define the S50 Gradient Insert. After verifying the values of the highlighted entries, click on the “Quit” button (lower right corner), which will pop up the window presented in Fig. 22.

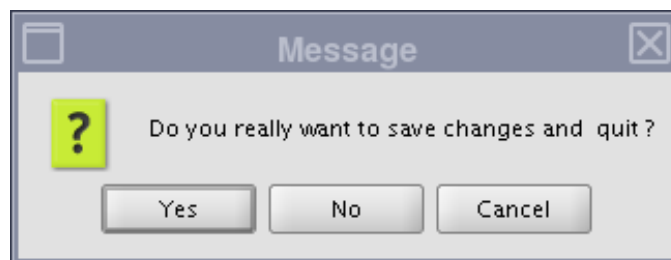


Figure 22. Click on <No> to close and quit the “Config File Manager”.

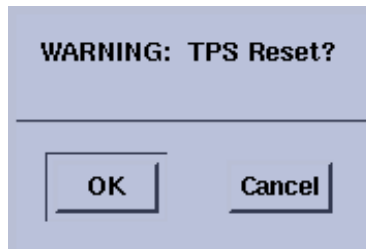


Figure 23. This pop up window will appear after clicking the “TPS Reset” button of the “Service Desktop Manager” window. Select <OK> to start the TPS reset.

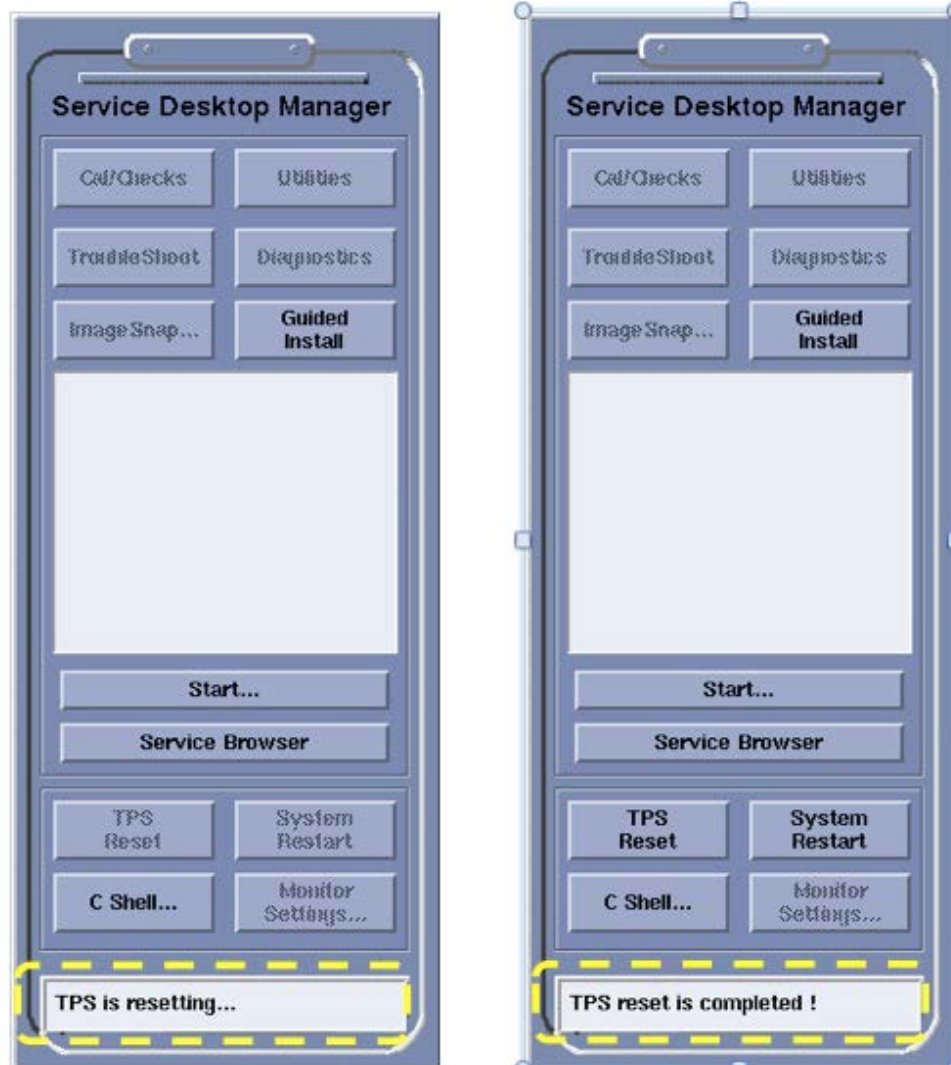


Figure 24. Observe the status of the TPS reset at the bottom of the “Service Desktop Manager” window

- 3) While the TPS is resetting, you can set up all other required equipment for your experiment inside or outside the magnet room. TPS reset currently lasts about five minutes. You should also take this moment to perform a check on the cooling water and the QuickCon Panel.

NOTE: If you intend to image a live animal, wait until TPS reset is completed to prepare your animal and place it inside the RF coil and the gradient insert.

- 4) Once again ensure that the gradient insert coil is correctly positioned.
- 5) Once TPS reset is completed, you can start your imaging session.
- 6) Register in the Insert Log Book the time your imaging session started. Not only register if your set up was OK but also register any problem you observed during the insert installation such as: damaged cables, coolant leaks, damaged hoses, TPS reset failed, RF coil not recognized, bad tuning of RF coil, equipment out of place or missing, system restart required, etc.

Important: Insert Coil users are required to remain in the MRI suite or **at most** be away from the MRI for 5 minutes while the Insert Coil is at work (water is on; cables are connected). This is a precaution for possible contingencies that require immediate actions by the user. Periodically, check the normal operation of the system and the temperature displayed on the chiller. Remember that it should be around 15 °C. Register in the Insert Log book the time you performed these periodical checks and write down your observation either if everything is normal or not.

(Insert Gradient Coil Setup complete)

Gradient Insert – Removal Procedure

RRI 3T MR750 20MX

NOTE: This procedure should be followed after you END your exam. If you imaged a live animal, take care of it to insure its survival and well-being. That also gives more time for the cooling system to dissipate heat from the insert coil after a long or demanding imaging session.

Section 1. Power Gradient Amplifiers down (Equipment room).

- 1) Register in the Insert Log Book the time you finished your experiment.
- 2) Open the Plastic Cover that protects the Circuit Breakers at the middle of the PDU.

NOTE: It is very important to keep the order of the next two steps to avoid unexpected system behavior and/or possible circuit damage.

- 3) Turn OFF Gradients Power Switch (see Fig. 25 – highlighted switch # 1 at the right)
- 4) Turn OFF Gradients Control Switch (see Fig. 25 – highlighted switch # 2 at the left)



**Figure 25. Turn the circuit breakers off in the following order:
 1st - “GRADIENT 420V POWER 420V/90A”
 2nd - “GRADIENT 48V CONTROL 208V/10A”**

- 5) Close plastic cover, and use the lockout tag while gradient amplifiers are off and you are working with gradient cables and switches.
- 6) If the experiment used an RF attenuator, this is the proper time to remove it using the following steps:
 - a. Disconnect the coaxial cable from the BNC terminal J14 of the RF Driver. You can leave this cable connected to one end of the RF attenuator.
 - b. Disconnect the other coaxial cable from the RF attenuator and reconnect it to the terminal J14 of the RF Driver.
 - c. Close the right door of the PGR cabinet.
 - d. Store the RF attenuator in an appropriate place.

7) Switch gradient hardware to CLINICAL Mode.

IMPORTANT: Never touch any metallic part of the gradient switch with any part of your body or any metallic tool or material in direct contact with your skin.

IMPORTANT: Never take the provided tool inside the magnet room. It contains ferromagnetic parts and would become a dangerous projectile inside the magnet room.

- a. Remove the clear plastic cover from the front of the gradient switch.
 - b. Using the proper tool, loosen the twelve brass nuts that keep the switch connected in "Research Mode" (right side): RESEARCH (X+, X-, Y+, Y-, Z+, Z-) and COMMON (X+, X-, Y+, Y-, Z+, Z-). One quarter to half a turn is enough to loosen the twelve nuts.
 - c. Using the black handle at the middle of the Gradient Switch, firmly slide the switch to "CLINICAL" Mode (left side). Make sure you made correct connections between the washers and the sliding metallic knives.
 - d. Tighten the twelve nuts that keep the Gradient Switch in "CLINICAL" Mode: COMMON (X+, X-, Y+, Y-, Z+, Z-) and CLINICAL (X+, X-, Y+, Y-, Z+, Z-).
 - e. Put back the clear plastic cover that protects the gradient switch. The black handle should pass through the left hole of the plastic cover. If you experience any difficulties when placing the safety cover on the switch, double-check the status of the switch. Try to minimize the motion to the cooling hoses in front of the gradient switch.
- 8) Check if the Spinmaster is being used and if the users need the chiller to remain on. This is very important since you can ruin others' experiments by turning it off when still in use. If the Spinmaster still requires the chiller simply remove the "Insert User" tag and place it on top of the chiller to communicate that you are done with it. If not still in use for the Spinmaster, proceed to turn off the Water Chiller (Fig. 26).

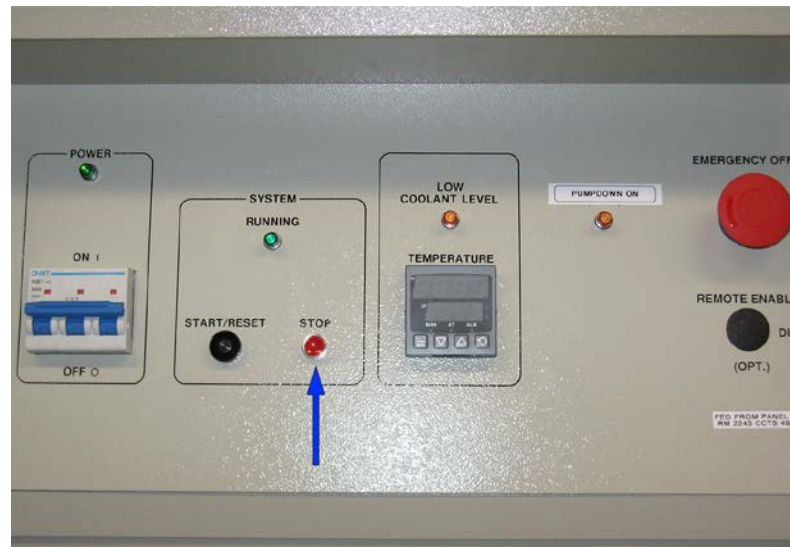


Figure 26. Turn off chiller if Spinmaster not in use.

- 9) Close the chiller valves (Fig. 27)



Figure 27. Chilled Water Sup. and Chilled Water Ret. Verify valve position (closed) in the Equipment Room.

- 10) At the main console desk, verify that only the red light of the Water Flow Indicator/Alarm is ON (no water flowing through the insert) and then turn off the Flow Alarm.

Section 2: Remove Insert Coil (Magnet Room).

- 11) Disconnect the RF equipment.
- 12) Disconnect insert gradient power cables from the QuickCon panel.
- 13) Put the power cables on top of the gradient insert coil making sure they won't get trapped between the main magnet walls and the insert body when the latter is removed from the magnet. Not doing so may cause damage to the cables.
- 14) If you use the black carbon fiber rail system to hold your imaged object and RF coil, this is an adequate moment to loosen the knobs at the back of the insert to release the tray. You may need to slightly push forward the RF shield to freely move the knobs. This is also the right moment to put the RF-Coil cables inside the insert so you do not have problems with a trapped cable when removing the RF-Coil or the whole tray.
- 15) If you imaged a sample or a phantom (not live animal), remove it from the insert and store it in an appropriate place.
- 16) Remove the RF Coil and store it in an appropriate place.

NOTE: Depending on the imaged sample and the type of RF Coil, removing them from the insert may be done at once. In addition, storing the sample or phantom and the RF coil can be done during the TPS reset but **remember to store them in adequate places** and not just put them on the countertops, in the back of the magnet room, inside the cabinets, or on the insert cart.

- 17) Roll the insert cart back to the magnet. Be careful not to damage the hoses still connected. If required, move them so that they are not trapped between the cart and the magnet.
- 18) Slide the insert coil to the cart.

- 19) Disconnect Cooling Water.
 - a) Disconnect hoses to the Insert coil trying to minimize the spills.
 - b) Using a cloth or paper towel wipe all hose connections and, if needed, also the floor. This will avoid possible slips and injury to personnel or patients and stains to the floor, insert, main magnet, patient table, or insert cart.
 - c) Individually, coil all the hoses up and put them inside the Water Switch Box and on top of the insert coil, as required.
 - d) Close Water Switch Box.
- 20) If the experiment did not use the RF Shield, then this is the moment to replace it following the next steps:
 - a. Tightly wrap the RF shield with the Teflon sheets.
 - b. Carefully slide the RF shield inside the gradient insert coil. Use the Teflon sheets as a guide and do not to force the shield into place because that may damage the metallic mesh.
 - c. Adjust the position of the RF shield inside the gradient insert such as it protrudes about the same amount at both ends of the cylinder.
- 21) If the experiment did not use the black rods, then put them back into the insert coil:
 - a. Slide the rods into the gradient insert.

NOTE: It is very important to keep the position and orientation of the rods. Follow the labels on the insert and the rods to put them always in the correct side (left or right) and in the correct orientation (front or back).

- b. Moving both ends of each rod at the same time, introduce the screws attached at both ends of the rods into the holes located in the aluminum frame. Do not bend the screws or damage their thread.
 - c. Finally, tighten the white knobs into the screws of each rod (back and front).
- 22) Store the insert coil in a safe location inside the equipment room.
- 23) Carefully roll the patient table to the magnet.
- 24) Perform both a mechanical and an electrical dock.

Section 3: Power up (Equipment Room).

- 25) Back to the PGR cabinet, remove the Insert User tag (store it on top of the Chiller) and open the plastic cover of the circuit breakers.

NOTE: It is very important to keep the order of the next two steps to avoid unexpected system behavior and/or possible circuits damage.

- 26) **Turn ON** Gradients Control Switch (Fig. 28 – switch #1 at the left) and wait for about 10 seconds to ensure the gradient control system is functional. As a visual cue, you can wait until the LEDs “heartbeat” of the three gradient amplifiers XGA (X, Y, Z) are continuously flashing ON and OFF (Fig. 28 – LED 2a).

27) Turn ON Gradients Power Switch (Fig. 28 – switch #2b).

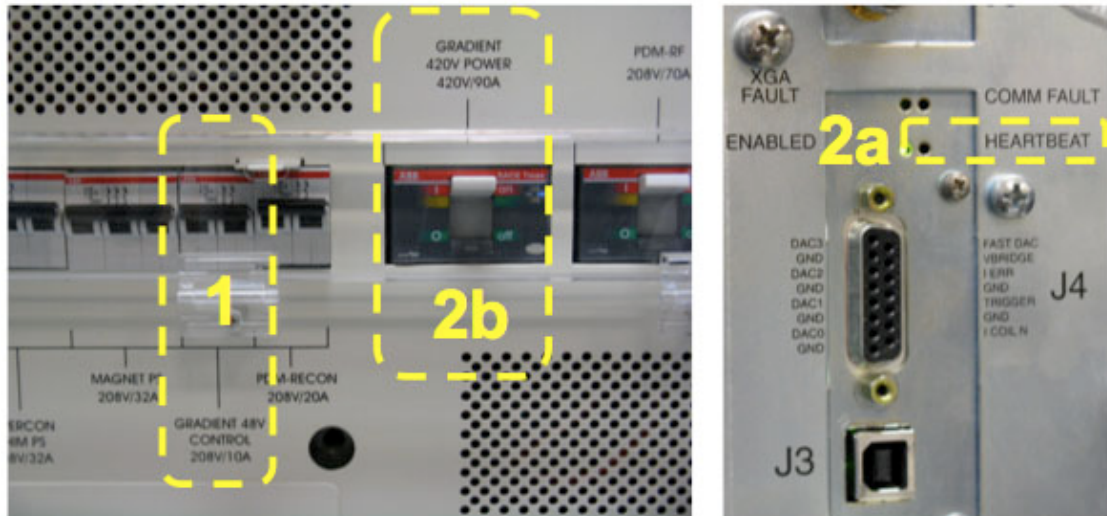


Figure 28. Turn circuit breakers in the following order:
1st - “GRADIENT 48V CONTROL 208V/10A”
2nd – “GRADIENT 420V POWER 420V/90A” after “HEARTBEAT” signals of XGAs are ready.

28) Close plastic cover of circuit breakers.

29) Close PGR Cabinet.

Section 4: Software Switch to Clinical Mode (Main Console).

- 1) From the Toolbox/Service Desktop Manager, open a C Shell terminal window (Fig. 29).
- 2) Follow the procedure shown in the following table. The first column indicates things that you need to type in and then press <ENTER>, indicated with “**Bold Courier font**”, or things that you need to select moving the cursor with the mouse and then click the left mouse button, indicated with “<Italic Courier Font>”. See Figs. 29 - 33 for a complete overview of the “software switch” as seen in the main console.

Type in / <Select>	System Response	Comment
cd /usr/g/research/gradients	-	Change directory
setGrad clinical	The clinical restore directory appears good Are you sure you want like to proceed? (y/n):	Script checks the existing clinical backup and prompt's to continue
y	This will set the system for <clinical 50 mT/m 200T/m/s> mode State saved in clinical matches current state Scanner is in clinical mode Exiting checkClinical with status 0 (=Success) System files have been switched Config File Manager starting... 1) Select <GradientConfig> tab 2) Are settings correct for desired mode? 3) Select <QUIT> 4) Select <No> Please reset TPS to accept the changes.	“y” tells the script that you want to continue with the switch. It will then prompt you how to continue.
<GradientConfig>	Switch to Gradient Configuration Screen	Verify that parameters match clinical mode (Fig. 30)
<Quit>	“Do you really want to save changes and quit? <Yes> <No> <Cancel>”	Pop up window (Fig. 31)
<No>	Close Config File Manager	Return to C-Shell window
<i>gradStat</i>	***** Gradient is currently in S-Coil Insert (50 Gauss/cm) Mode *****	Check software status
<TPS Reset>	“WARNING: TPS Reset? <OK> <Cancel>”	Pop up window (Fig. 32)
<OK>	“TPS is resetting...”	See TPS status message in “Service Desktop Manager” window (Fig.33)

```
xterm
{sd@MR3T}[101] cd /usr/g/research/gradients
{sd@MR3T}[102] gradStat

gradient mode set to: S50
-> animal gradient S50 <500 mT/m 3333 T/m/s> mode
-> this default has:
    * none
{sd@MR3T}[103] setGrad clinical

The clinical restore directory appears good

Are you sure you want like to proceed? (y/n): y

This will set the system for <clinical 50 mT/m 200 T/m/s> mode

state saved in /usr/g/research/gradients/clinical matches current state
scanner is in clinical mode
exiting /usr/g/research/gradients/checkClinical with status 0 (=Success)

System files have been switched

Config File Manager starting...
1) Select <GradientConfig> tab
2) Ensure settings are correct for desired mode
3) Select <QUIT>
4) Select <No>

Please reset TPS to accept the changes.

{sd@MR3T}[104]

{sd@MR3T}[104] gradStat

gradient mode set to: clinical
-> clinical MR750 XRGB <50 mT/m 200 T/m/s> mode
{sd@MR3T}[105] █
```

Figure 29. Complete Software Switch to Clinical Mode as seen on terminal window (C Shell)

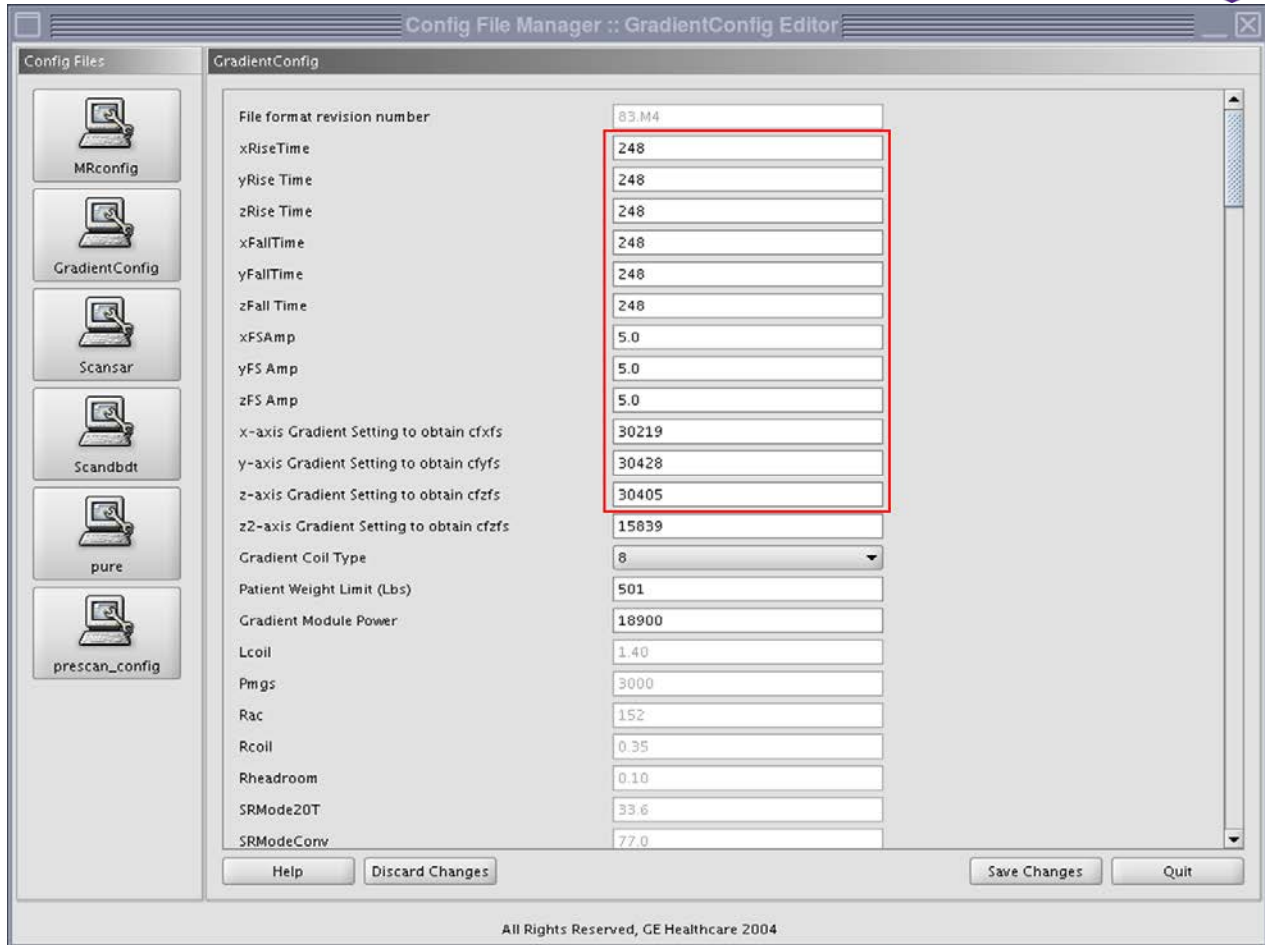


Figure 30. Gradient Config window. Observe the most important fields that define the Clinical Mode. After verifying the values of the highlighted entries, click on the “Quit” button (lower right corner), which will pop up the window presented in Fig. 31.

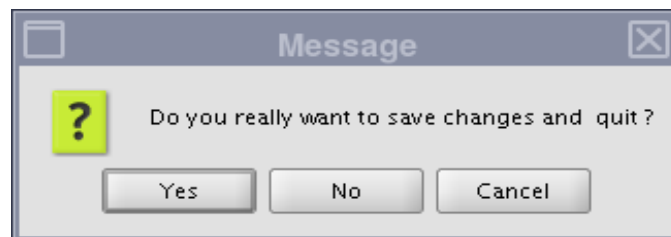


Figure 31. Click on <No> to close and quit the “Config File Manager”.

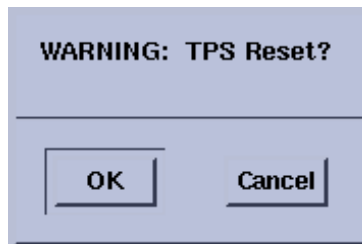


Figure 32. This pop up window will appear after clicking the “TPS Reset” button of the “Service Desktop Manager” window. Select <OK> to start the TPS reset.

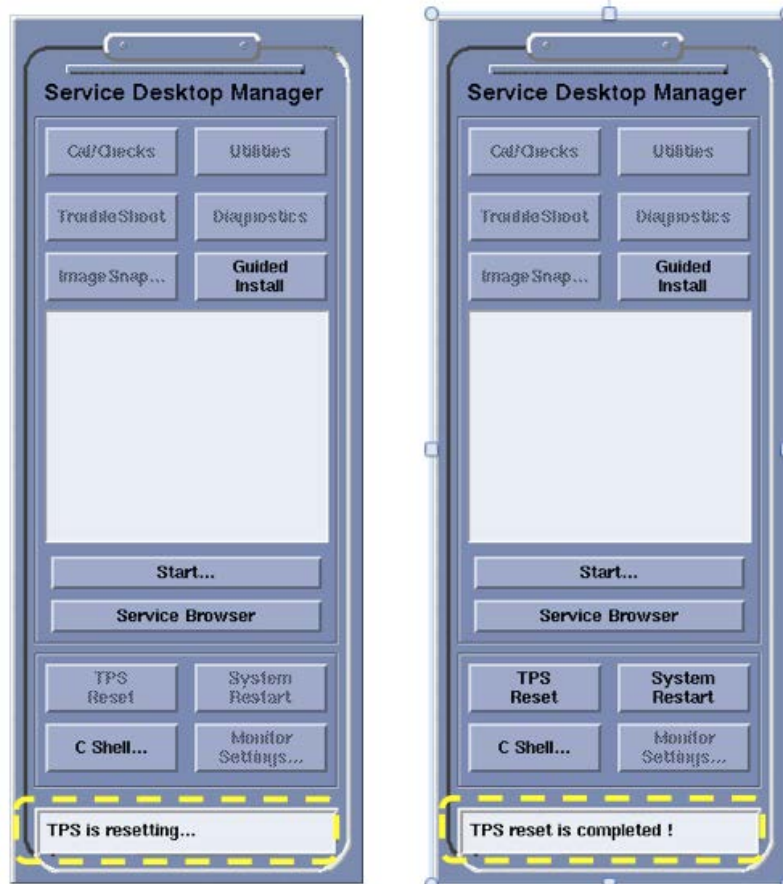


Figure 33. Observe the status of the TPS reset at the bottom of the “Service Desktop Manager” window.

- 3) Once TPS reset is completed, you must perform a Goodbye Scan to ensure the system works properly in Clinical Mode.
 - a. Using the pink head phantom, load the goodbye scan protocol from Pediatric → Other → Goodbye
- 4) Register in the Insert Log Book the time your whole experiment ended. Register if your TPS reset and Goodbye Scan were OK and also register any problem or irregularities you observed such as: poor SNR, problems Docking/Undocking the table, image artifacts, low coolant level, etc.

(Insert Gradient Coil Removal complete)

Appendix 1: Modifying the Insert

- 1) If the experiment does not require the black carbon fiber rail system, remove it as explained below:
 - a. Completely unscrew the white knobs that keep the black carbon fiber rods in place.
 - b. Try to move the front and the back of each rod at the same time and the same distance to release the screws attached to the rods (front and back) from the holes on the aluminum frame of the insert. Carefully remove the rods without bending the screws or damaging the thread of the screws.
 - c. Store the white knobs and the black rods on the insert cart.

- 2) If the experiment does not require the RF Shield, remove it as explained below:
 - a. Pull the plastic cylinder and the white Teflon sheets, which protect and give form and structure to the RF shield, out from the gradient insert. Do not unwrap the Teflon sheets from the plastic cylinder because they protect the fine metallic mesh of the RF shield.
 - b. Carefully, store the RF shield on the insert cart or inside the magnet room.

Appendix 2: Patient Table Fails to UnDock

- 1) If the patient table fails to undock when the “undock” foot pedal is depressed, notify support personnel as this is a sign that the table needs adjustment., You should be able to proceed, however, by attempting the following procedures.

- 2) Try redocking by pressing the mechanical and electric dock pedals and then attempt to undock again using the foot pedal while pressing down near the end of the patient cradle



Figure 34. Provide downward pressure while attempting to undock table.

- 3) If the patient table still fails to undock it may be necessary to release by pulling (significant force may be required) on the red emergency table release handle located near the front pedestal (See Fig. 35). Once the table is out of the way, push the handle back into position so that the table will re-dock at the end of the experiment.



Figure 35. Emergency table release handle.

Appendix 3: Positioning the Insert

- 1) Position the insert coil at the center of the magnet. The front end of the Insert coil should be aligned with the mark on the magnet bore. If the mark on the magnet bore is not present, the distance from the edge of the bore to the front end of the Insert Coil (Fig. 12) should be as shown in the following table:

Coil	Distance (mm / in)
S1	543 / 21.375

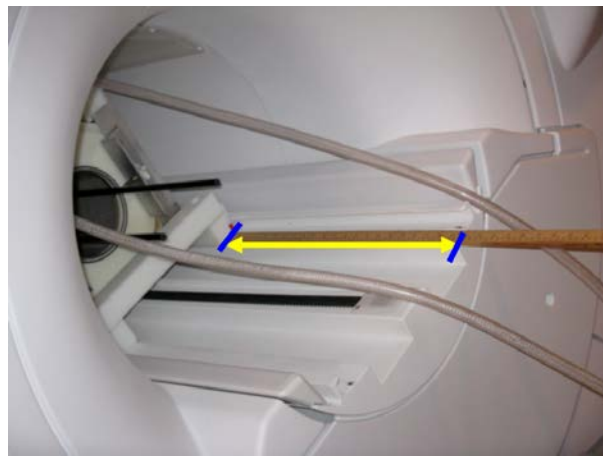


Figure 36. Distance from edge of insert base to edge of bore base

Appendix 4: Flow problems

- 1) check the following:
 - a. The status of the chiller. It should be on, no alarms present, the pump and the fan should work normally.
 - b. Flow should be >1.5GPM (Fig. 13 b)
 - c. Check the hoses for cuts, kinks, etc.
 - d. Check that the Spinmaster is not in use. If it is, speak with the users; Flow can be adjusted so that coolant flow to the insert is increased.
 - e. Check the power to the flow switch. The flow switch should stay plugged in to the wall receptacle, next to the main power outlet to the chiller.
 - f. If the red light still stays ON, consult support personnel.

Appendix 5: Additional Options

setGrad S50

- Sets the gradient to conventional S50 mode. In this mode, we have typically only been emulating the table.
- For volumes prescribed off isocenter in z, the scanner assumes that the requested volume will be moved to isocenter using the moving table, and thus the scan volume is still acquired symmetrically about gradient isocenter in z.
- Thus to ensure the prescribed volume matches the desired volume it is necessary to ensure all prescriptions are symmetric about z.

setGrad S50 fixedTable

- The scanner will use phase and/or frequency shifts to move the scan volume off isocenter in the Z direction, so the prescribed volume should be accurate without having to ensure that it is symmetric in Z.
- The Config File Manager and TPS reset procedure is not sufficient to update the scanner into / out of this mode. Doing so require logging out and then back into the scanner.
- The script should prompt you to proceed directly with, "**endsession -f**".
NOTE: this will abort any currently ongoing data transfers.

Appendix 6: Swap Script Troubleshooting

setGrad S50 fails

- This indicates that the current state of the config files on the scanner does not match the clinical restore directory. This may be due to the clinical system being recalibrated, or the config files getting corrupted in one of the previous changeovers. Seek assistance if possible, and look in log/gradSwap.log for clues. If no help is immediately available, notify them by phone / email and, proceed as follows:
 - 1) **saveGradState**
Saves a snapshot of the config and calibration directories as they currently exist on the scanner. This will help with sorting out the cause of the problem, and providing a fix. If this appears to complete successfully, proceed to the next step.
 - 2) **touch .clinicalRestoreDirIsGood**
Even though the existing clinical restore directory does not appear to match the current state, this should force the setGrad S50 command to skip the checkClinical step, and continue into insert gradient mode.
 - 3) **setGrad S50**
Proceed as usual to swapping config and calibration files into gradient mode
- When done with insert gradient operation, restore to clinical using **setGrad clinical** as usual.
- Providing the above procedure is followed, support personnel should be able to use the log/gradSwap.log and the saveGradState snapshot to sort out what happened and correct any issues that arose.

endsession -f hangs on blue screen

- endsession -f forces a logout, and sometimes the system will appear frozen with no apparent progress for several minutes. If it appears stalled for more than 5 minutes try re-running endsession -f by opening a new terminal window.
- A new terminal window can be opened by holding down the right mouse button in blank space and selecting "terminal" or "shell" in the drop down menu that appears.

Appendix 7: Description of gradient control files and scripts

checkClinical

- Compares the state saved in /usr/g/research/gradients/clinical with the current state of configuration and calibration files on the scanner.
- Creates the .INCLINICAL file and returns a value of 0 on success, or 1 on failure.

setGrad VERSION [OPTS]

- Main command for swapping in/out file configuration parameters. When swapping out of clinical mode, it will run checkClinical automatically to ensure the existing backup matches the current clinical state.
- It needs to be run with at least one parameter: "setGrad VERSION" or "setGrad VERSION OPTS". Valid values for VERSION include S50, H4, clinical, etc, which will point it to use the directories matching VERSION to search for the files to swap using the instruction files VERSION/fileList.VERSION and VERSION/fileList.OPT. OPTS can be a list of valid options that will trigger the additional use of VERSION/fileList.OPT file controls in the order that they are specified.
 - Examples:
 - setGrad S50
will set the system to S50
 - setGrad S50 fixedTable
will set the system to operate assuming the system has a fixed table. I.e. it will shift scan volumes in Z using phase and frequency offsets just like it does for x and y
 - setGrad clinical
restore scanner to clinical operation

gradStat

- The current state of the gradient system files is stored in the file status.log.
- gradStat reports this status to the terminal window.

checkCfgChanges

- Used to check which config files have been changed and set the reset level based on which have been changed.
 - 0 = no reset required
 - 1 = open and close grafidy tool
 - 2 = webCfgEditor and TPS reset
 - 3 = endsession -f

log/gradSwap.log

- a log of all the recent gradient swaps and errors. Should help with troubleshooting problems

gradAliases

- A place to define the aliases and directories used by the various scripts

VERSION/fileList.VERSION

VERSION/file.List.OPT

- These files contain lists of the files to swap in and out to attain the desired gradient mode.

.clinicalRestoreDirIsGood

- This file is created when using setGrad to switch out of clinical mode. It is used as a flag to indicate that the clinical/ directory can safely be used to return to clinical mode.

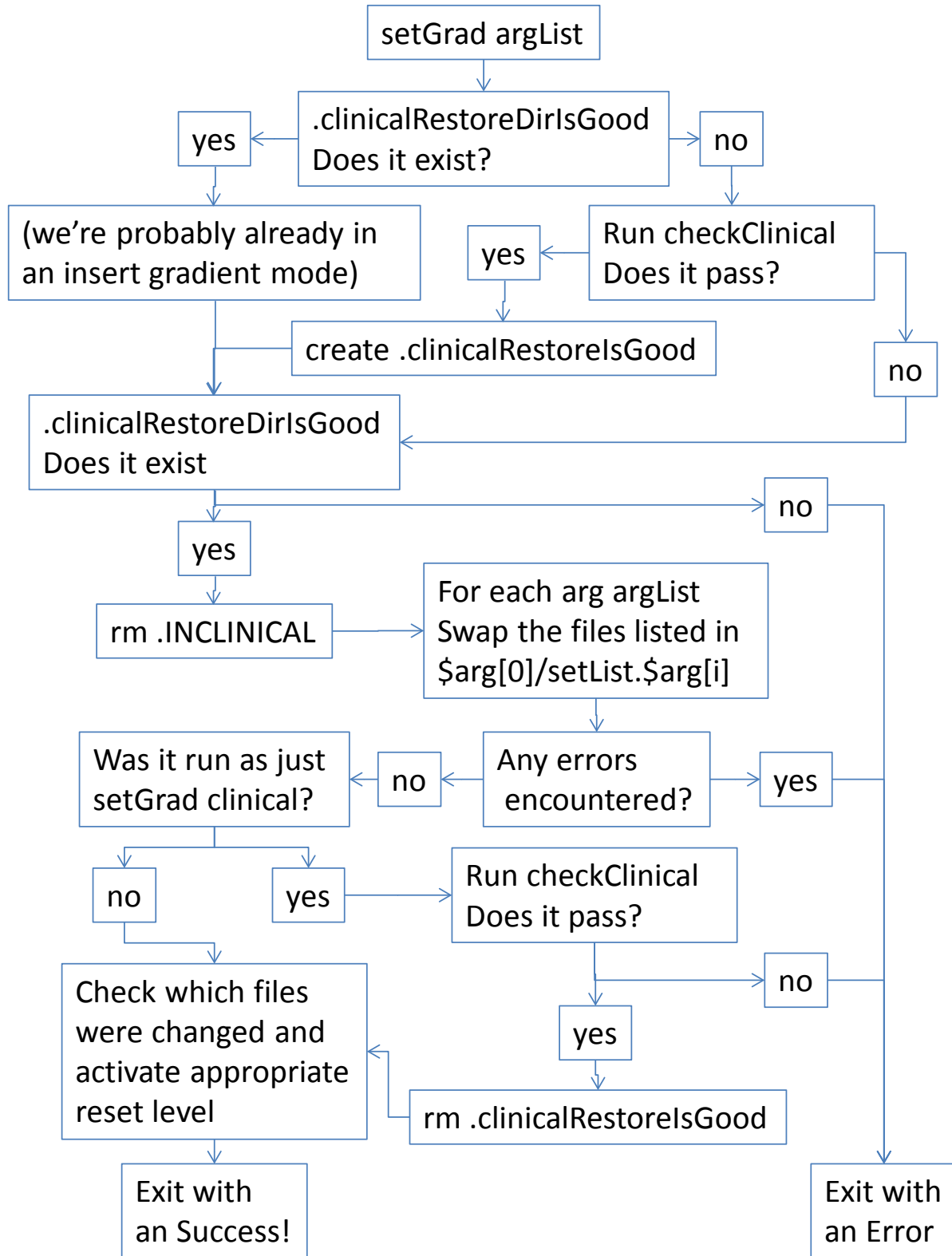
.INCLINICAL

- This file is created when checkClinical verifies that the clinical restore directory is still good.

saveGradState

- Saves a snapshot of the current scanner configuration directories to a time stamped folder in snapShots/.
- The directories saved include:
 - /w/config
 - /usr/g/w/caldir
 - /usr/local/bin/install/.CRCbackup

Appendix 8: setGrad Logic Diagram



Appendix 9: Switch to INSERT check-list

Equipment Room

1. Turn Off (down): High Voltage (420V/90A) Breaker
2. Turn Off (down): Low Voltage (Gradient 48V Control) Breaker
3. Install Lockout Tag
4. (optional) Install Attenuator

Magnet Room

5. Send LPCA to > 1700mm
6. Remove Patient Table
7. Slide Gradient Insert into Position
8. Connect Gradient Leads
9. Connect Flow
10. Connect RF gateway

Equipment Room

11. Open Chilled Water Valves
12. (if not already on for SpinMaster) Turn On Chiller, and Place "In Use" tag
13. Visual Check of Flow
14. Mechanical Power Switch to RESEARCH
15. Remove Lockout Tag
16. Turn On (up): Low Voltage (Gradient 48V Control) Breaker
17. Wait for HEARTBEAT
18. Turn On (up): High Voltage (420V/90A) Breaker

Console Room

19. Turn On Flow Switch
20. setGrad S50

verify Gradient Config

TPS reset

OR

endsession -f

Appendix 10: Switch to CLINICAL check-list

Equipment Room

1. Turn Off (down): High Voltage (420V/90A) Breaker
2. Turn Off (down): Low Voltage (Gradient 48V Control) Breaker
3. Install Lockout Tag
4. (optional) Remove Attenuator
5. Mechanical Power Switch to CLINICAL
6. (if not in use by SpinMaster) Turn Off Chiller, and Remove "In Use" tag
7. Close Chilled Water Valves

Magnet Room

8. Disconnect RF
9. Disconnect Gradient Leads
10. Disconnect Flow
11. Slide Gradient back onto transport cart
12. Install Patient Table:
 - a. Mechanical Dock
 - b. Electrical Dock

Equipment Room

13. Remove Lockout Tag
14. Turn On (up): Low Voltage (Gradient 48V Control) Breaker
15. Wait for HEARTBEAT
16. Turn On (up): High Voltage (420V/90A) Breaker

Console Room

17. Turn Of Flow Switch
18. setGrad clinical
19. verify Gradient Config
TPS reset
OR
endsession -f
perform goodbye scan

I, _____(name), have read the Insert Gradient operating procedures and been made aware of the safety precautions. I hereby declare that I understand the requirement for safely installing, operating, and removing the Insert Gradient.

Signature: _____

Time: _____