SIGNA™ Victor

1.5T MR System

Operator Manual

CE 0197

The actual features, coils and applications will depend on the system configuration that you have opted to purchase.

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Applicable Regulations and Standards

Medical Device Regulation

This product conforms with the requirements of the Medical Device Regulation 2017/745 when they bear the following CE Mark of conformity:

CE 0197

SIGNA™ Victor year of CE marking is 2023.

Regulatory Markings-UDI Label

Every medical device has a unique marking for identification. The UDI marking appears on the device labeling.

The following figures are only examples of a UDI marking. The device may have a linear barcode as in Figure 3-1, or a DataMatrix code as in Figure 3-2, or only alphanumeric identifiers with no barcode. Also the identifiers vary per product.

Figure 3-1: Example of a UDI linear barcode

Figure 3-2: Example of a UDI DataMatrix code

Manufacturer

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TIANJIN, P.R.CHINA 300308

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Legal notices

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ASSET, VIBRANT, ReportCARD, INSITE and ILinq are trademarks of General Electric Company.

DICOM is the registered trademark of the National Electrical Manufacturers Association for its standards publications relating to digital communications of medical information.

All other trademarks are the property of their respective owners.

This equipment generates, uses, and can radiate radio frequency energy. The equipment may cause radio frequency interference with other medical and non-medical devices and radio communications. To provide reasonable protection against such interference, the:

GE MR Systems

comply with emissions limits for (Group 2, Class A) Medical Devices as stated in IEC 60601-1-2. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment is found to cause interference (which may be determined by turning the equipment on and off), the user (or qualified service personnel) should attempt to correct the problem by one or more of the following measures:

- reorient or relocated the affected devices;
- increase the separation between equipment and the affected device;
- power the equipment from a source different from that of the affected device; and/or
- consult the point of purchase or service representative for further suggestions.

The manufacturer is not responsible for any interference caused by using interconnect cables that are not recommended or by unauthorized changes or modifications to this equipment. Unauthorized changes or modifications could void the user's authority to operate the equipment.

Do not use devices that transmit RF Signals (cellular phones, transceivers, or radio controlled products) in the vicinity of this equipment as they may cause performance outside the published specifications. Keep the power to these types of devices turned off when near this equipment.

The medical staff in charge of this equipment is required to instruct technicians, patients, and other people who may be around this equipment to fully comply with the above requirement.

Immunity/Emissions Exceptions: Note the exceptions from the EMC test results. Check with the business EMC engineer for this information.

In accordance with the international safety standard IEC 60601-1, this system is:

- Class I device

WARNING

To avoid the risk of electric shock, this equipment must only be connected to a supply mains with protective earth.

- acceptable for Continuous Operation
- having ordinary protection against ingress of water (IPX0)
- type B and BF applied parts
- is not for use in the presence of flammable anesthetics.

Equipment disposal

A WEEE passport report is available from a GE representative upon request.

CAUTION

This symbol indicates that the waste of electrical and electronic equipment must not be disposed as unsorted municipal waste and must be collected separately. Contact an authorized representative of the manufacturer for information concerning the decommissioning of your equipment.

CAUTION

Federal law restricts the sale, distribution, and use of this device to or on the order of a physician.

Indications for use

The SIGNA™ Victor system is a whole body magnetic resonance scanner designed to support high resolution, high signal-to-noise ratio, and short scan times. It is indicated for use as a diagnostic imaging device to produce axial, sagittal, coronal, and oblique images, spectroscopic images, parametric maps, and/or spectra, dynamic images of the structures and/or functions of the entire body, including, but not limited to, head, neck, TMJ, spine, breast, heart, abdomen, pelvis, joints, prostate, blood vessels, and musculoskeletal regions of the body. Depending on the region of interest being imaged, contrast agents may be used.

The images produced by the SIGNA™ Victor system reflect the spatial distribution or molecular environment of nuclei exhibiting magnetic resonance. These images and/or spectra when interpreted by a trained physician yield information that may assist in diagnosis.

WARNING

Read the *full prescribing information* on the contrast media label before use of contrast media. Use contrast media only in accordance with Indications and Usage as described in full prescribing information.

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Chapter 2: Safety

This section presents the concepts necessary to successfully complete the working safely process. Specifically, you need to understand:

Introductions
Safety standards
Magnetic fields
Gradient fields
Electromagnetic fields
Clinical hazards
Equipment hazards
Clinical screening
Patient emergencies
Additional scan and display cautions and warnings
System maintenance
Safety procedures
Safety Review
MR Compatibility
Service Schedules
China RoHs

Introduction

The MR Safety Guide contains information applicable to several MR system configurations. A topic heading, a note, or other wording indicates information that is applicable to a specific system configuration.

This chapter focuses on the visible and invisible sources of hazard and concern in the magnetic resonance (MR) imaging environment and emphasizes the need to work safely. To ensure safe operation of your scanner, you must understand several components of your imaging system. This chapter provides brief guidelines for working in a magnetic field, key concepts regarding the patient alert system, as well as magnet, quench, radio frequency (RF), laser light, metal sliver, acoustic, peripheral nerve stimulation (PNS), and equipment hazards. It contains the step-by-step instructions to help you learn how to:

- Eliminate Magnet Hazards
- Respond to Emergencies
- Check the Cryogen Levels
- Handle Contact with Liquid Cryogens

 This chapter contains important safety information that you and the physician must understand thoroughly before using the system.

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INTRODUCTION

Safety Information

The Magnetic Resonance Imaging (MRI) system uses a magnet, which can have a field strength several thousand times greater than that of the earth's magnetic field. The magnetic field surrounding the magnet may present a hazard to personnel and equipment within the immediate area. Therefore, the magnetic field safety information described in this chapter is very important. You and your physician must understand it thoroughly before you begin to use the system. You can find additional safety information throughout your Operator Manual. If you need additional training, seek assistance from qualified General Electric (GE) personnel.

Make sure your training guides are readily available at all times. Review the procedures and safety precautions periodically. Through Magnetic Resonance (MR) safety education, careful planning, and diligent upkeep of your MR facility, a safe environment can be provided for both patients and personnel.

For any hazardous incident or system malfunction related to the use of the GE MR Scanner please use the following contact methods:

If Serviced by GE: Please contact your Field Service Engineer to report out on the incident.

If third party serviced: Please contact your third party Field Service Engineer and have them send a manufacturers notice to:

Complaint Handling Unit Manager

GE Medical Systems, LLC

3200 N Grandview Blvd WT-893

Waukesha, WI 53188

If the user is self servicing the GE MR Scanner please provide the following information:

- System type
- System ID
- Date of incident
- Description of incident
- Contact Information (facility, address, contact name, title, and telephone numbers)

Locate the contact number on your scanner or visit GE on the web http://www.gehealthcare.com/contact/contact_details.html and locate the appropriate telephone number for your location. In the US please us: 1-800-437-1171.

WARNING

Do not modify this equipment without the specific authorization of GE.

INTRODUCTION

Incident reporting

Any serious incident related to the use of this GE Healthcare device should be reported to both the manufacturer and the health authority/competent authority where the device is installed.

Complete a GE Healthcare report to one of the following:

- Contact your local service representative
- Report to: In-box.complaints@ge.com

Provide the following information in the report:

- The catalogue number or the model designation of the device as stated on its identification plate affixed on the device
- The SystemID/serial number/lot number of the device
- Date of incident
- Description of incident, including any patient or user impact/injury
- Your contact information (facility, address, contact name, title, and telephone number)

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INTRODUCTION

Intended use

SIGNA™ Victor system is a whole body magnetic resonance scanner used to produce images of the inside of the human body that help aid the diagnosis of disease. In a clinical setting, Magnetic Resonance imaging (MRI) may be used to distinguish diseased or compromised tissue from normal tissue.

MRI technology is routinely used to help the diagnosis in diseases such as oncology, stroke, heart and peripheral vascular disease, pediatric diseases, etc. MRI technology in general, however, is not limited to specific diseases, stage and condition of diseases, or clinical forms.

MRI technology is intended to be used by the healthcare professionals (clinicians and trained technologists) following good clinical practice. It can be used in broad patient population including adults, children and infants, following good clinical practice.

INTRODUCTION

Clinical benefit

The clinical benefit of an MR System is to help healthcare professionals provide accurate diagnostic information that enhances the diagnostic and treatment care pathways of patients for a variety of diseases and conditions.

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INTRODUCTION

Indications for use

To view indications for use statement, click **Indications for Use**.

CAUTION

These devices are limited by federal law to investigational use for indications not in the “Indications for Use” statement for a specific system type. Under federal law, these devices should only be used for the functions set forth in the “Indications for Use” statements.

WARNING

Read the *full prescribing information* on the contrast media label before use of contrast media. Use contrast media only in accordance with Indications and Usage as described in full prescribing information.

INTRODUCTION

Restrictions on use

CAUTION

Federal law restricts the sale, distribution, and use of this device to or on the order of a physician.

CAUTION

Do not load non-system software onto the system computer.

WARNING

The MR system is not designed to provide information for clinical stereotactic use. The spatial accuracy obtainable with your MR system may not be adequate for stereotactic procedures and can vary depending on the patient, the pulse sequence used, and the system itself. It is therefore recommend that MR images not be used for stereotactic applications.

WARNING

Electrically conductive stereotactic devices may lead to high localized SAR. Excessive transmit power may result from interactions between the structure and the transmit coil. In addition, improper padding between the patient and any conductor may lead to excessive localized heating.

Clinical stereotactic use refers to being used in localization for surgical procedures.

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INTRODUCTION

Instructions for use

IEC 60601-2-33 assumes that because no chronic effects from exposure to MR fields are known, worker safety limits are the same as for patients. However, it is prudent to minimize worker exposures.

Workers must prevent ferromagnetic materials from entering the magnet room. Ferrous projectile hazards are a major safety concern. Note that some materials that are initially non-magnetic may become magnetic when subjected to a static magnetic field over a period of time. Motion in static magnetic fields (especially near large spatial field gradients) may induce metallic tastes, vertigo, nausea, and possibly flashes of light (magneto-phosphenes). These motion effects are considered to be non-hazardous, provided they do not cause the worker to fall.

Time-varying gradient magnetic fields may induce peripheral nerve stimulation if the worker intercepts sufficient time-varying flux. Peripheral nerve stimulation is non-hazardous unless it causes the worker to injure himself when startled by the effect. MR workers shall be adequately trained to minimize health effects of high static magnetic field as described above. Field plots of the maximum time-varying gradient |B| workers could experience outside the magnet bore is shown in the figure below.

Figure 2-1: Maximum Magnitude Gradient Magnetic Field from three Simultaneous Axes at the Patient Bore Radius (worker exposure is limited to these levels as a function of z).

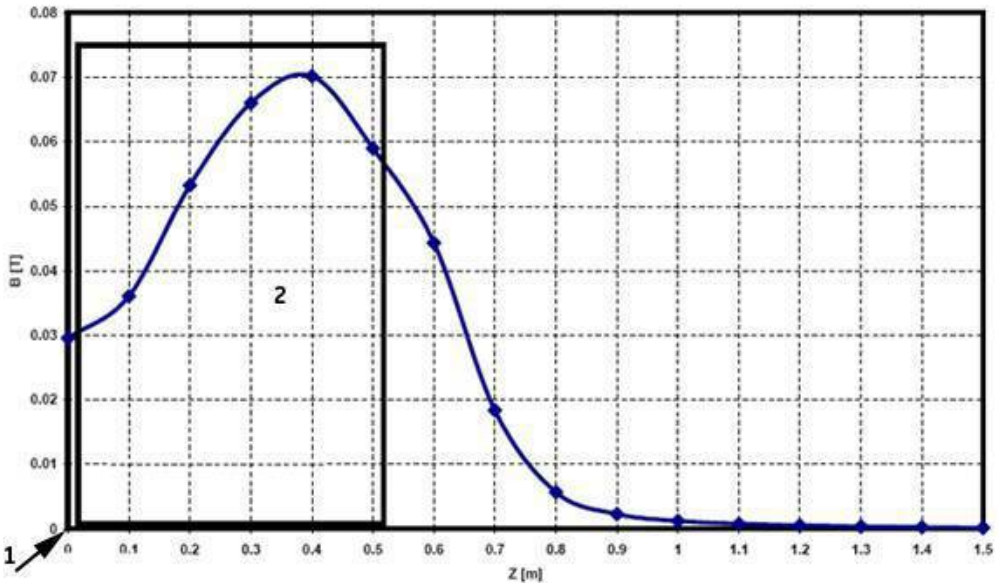

Table 2-1: Image legend

#	Description
1	Isocenter
2	Magnet from isocenter to front

Radio frequency fields at sufficiently high levels may cause heating. Outside the magnet bore the radio frequency fields rapidly decay. Let B1 be the magnetic field strength of the radio frequency magnetic field. A plot of the square B1 normalized to its value at isocenter is shown in figure below. At most B1 at isocenter may produce the whole-body Specific Absorption Rate (SAR) limit. If as much of the body were exposed outside the bore then the graph below shows the scale factor for each Z location. This is a very conservative estimate of SAR since the total flux into the body is likely to be much smaller.

Figure 2-2: Plot of the Square of B1 Normalized to Isocenter for the Body Birdcage Coil on Axis.

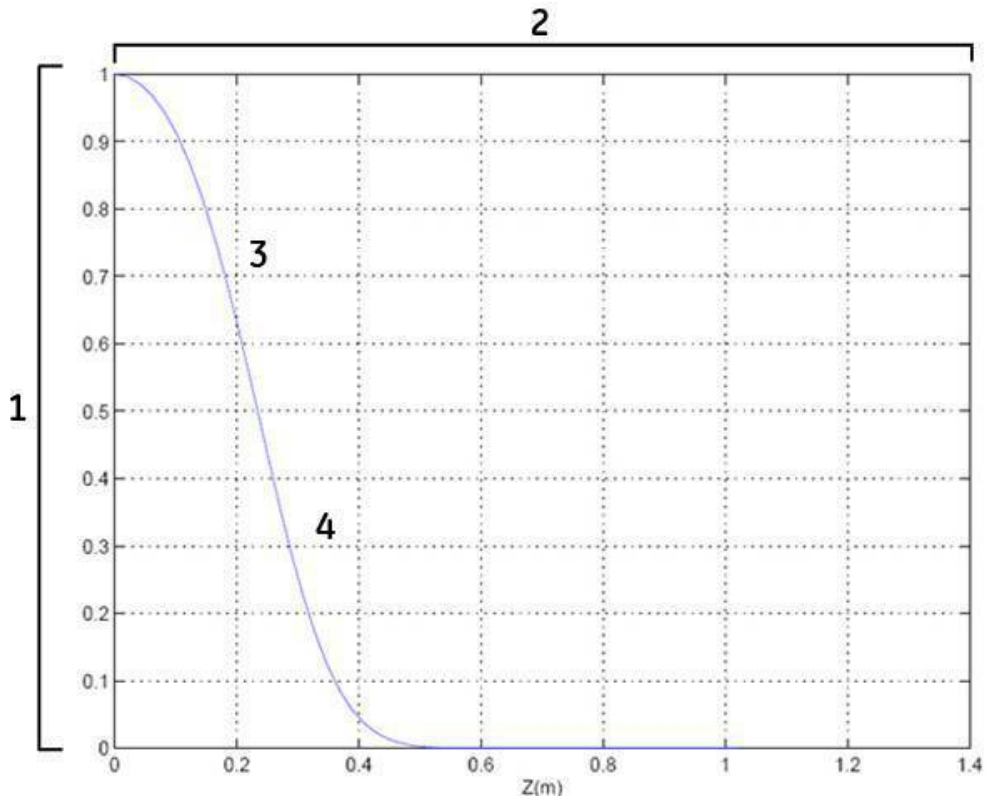

Table 2-2: Image legend

#	Description
1	Square of B1 normalized to isocenter.
2	Square of B1 normalized to isocenter for body birdcage coil on axis.
3	The point (0.707) at which RF transmission is reduced by 3 dB from maximum at isocenter.
4	The point (0.316) at which RF transmission is reduced by 10 dB from maximum at isocenter.

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Contraindications for use

Contraindications for use statement

In general, patients with conductive (e.g. metallic) implants are contraindicated for MR scans. Some implantable devices have been labeled as MR Conditional under certain operating conditions. MR Safe implants will have the MR Safe symbol in their implant documentation.

When evaluating whether to proceed with MR scanning on patients with such implants, consult the implantable device's labeling.

- **MR Safe**: For patients with implants that are labeled as MR Safe, consult the implantable device's labeling.
- **MR Conditional**: For patients with implants that are labeled as MR Conditional, consult the implantable device's labeling.
- **MR Unsafe**: Patients with implantable devices that are MR Unsafe are contraindicated.

If the level of MR compatibility is not known, then an implantable device should be considered MR Unsafe.

MR environment safety terminology

The MR Environment Safety Terminology is intended to help explain labeling matters for medical devices and other items that may be used in the MR environment to ensure the safe use of MR technology.

Terminology for defining the safety of items in the MR environment is provided in ASTM F2503 Standard Practice for Marking Medical Devices and Other Items for Safety in the Magnetic Resonance Environment. FDA recommended using the terminology MR Safe, MR Conditional, and MR Unsafe, defined in ASTM F2503 (FDA guidance document, "Establishing Safety and Compatibility of Passive Implants in the Magnetic Resonance (MR) Environment Document").

Definitions

MR safe:  or 

An item that poses no known hazards in all MR imaging environments.

With this terminology, MR safe items are non-conducting, non-metallic, and non-magnetic items, such as a plastic Petri dish. An item may be determined to be MR safe by providing a scientifically based rationale rather than test data.

MR Conditional: 

An item that has been demonstrated to pose no known hazards in specified MR environment with specified conditions of use. Field conditions that define the MR environment include static magnetic field strength, spatial gradient, time rate of change of the magnetic field (dB/dt), RF fields, and specific absorption rate (SAR).

Additional conditions, including specific configurations of the item (e.g., the routing of leads used for a neurostimulation system), may be required.

MR Unsafe: 

An item that is known to pose hazards in all MR environments.

MR unsafe items include magnetic items such as a pair of ferromagnetic scissors.

ASTM standard F2503 also describes how MR Safe, MR Conditional and MR Unsafe device Icons are to be used for MR labeling of implants and devices. For details see **MR safety labels.**

CAUTION

Safe scanning of patients with MR Conditional devices or implants may be complex. Health care professionals that scan patients with MR Conditional devices or implants should consult the implant or device manufacturer for instructions with respect to safety guidelines.

WARNING

Scanners are not designed to regulate SAR and dB/dt for levels other than the IEC NORMAL MODE (WB SAR <= 2 W/kg, head SAR <= 3.2 W/kg and dB/dt <= 80% of the mean nerve stimulation limit) and IEC FIRST MODE (WB SAR <= 4 W/kg, head SAR <= 3.2 W/kg and dB/dt <= 100% of the mean nerve stimulation limit). No other limits are enforced.

WARNING

The magnetic field of the MR system can cause a ferrous implant (e.g., surgical clip, cochlear implant, intracranial aneurysm clip etc.) or prosthesis to move or be displaced, resulting in serious injury. Patients and MR workers should be screened for implants and those individuals with implants should, in general, not enter the scan room. For patients and MR workers with implants that are labeled as “MR Safe” or “MR Conditional”, consult the implantable device’s labeling and the technical information about the MR system.

Prostheses should be removed before scanning to help prevent injury.

WARNING

The tests commonly employed to determine MR Conditional implant heating safety (standard, ASTM F2182, ASTM.org), require quadrature excitation. Heating results for non-quadrature excitation (such as parallel transmit, MultiDrive, or elliptical drive) are unknown.

For patients with MR Conditional implants or devices, applying Preset or Optimized RF Drive Modes may violate the MR Conditional specifications.

When scanning patients with MR Conditional implants, check with GEHC to ensure your system has quadrature transmit.

This system supports only quadrature (CP) transmit in scan parameters.

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Product identification labels

Product identification labels (ratings) can be found on the tops and sides of the cabinets, the rear of monitors, and other exterior surfaces on the equipment. Such product labels alert you to specific hazards and the level of hazard importance. The labels may also contain messages that communicate the specific hazard, the probable consequence of involvement with the hazard, and how the hazard can be avoided. In the event you are unable to identify these labels, contact your service personnel.

One or more of the product identification labels in the tables below may be on your system or peripheral equipment. Please familiarize yourself with the labels that apply to your particular system.

Table 2-3: Warning symbols

Label	Description (typical use)
	Warning: Crushing of hands
	Warning: Hot surface
	Warning: Magnetic field
	Warning: Electricity (barriers, points of entry)
	Warning: General warning sign
	Warning: Laser beam
	Warning: Non-Ionizing radiation

Table 2-4: Prohibited symbols

Label	Description (typical use)
	Prohibited: Do not obstruct
	Prohibited: No access for unauthorized persons
	Prohibited: Do not touch - hazardous voltage
	Prohibited: No metallic articles or watches
	Prohibited: No access for people with metallic implants*
	Prohibited: No access for people with active implanted cardiac devices*
	Prohibited: Do not loop cable

*In general, patients with conductive (e.g. metallic) implants are contraindicated for MR scans. Some implantable devices have been labeled as MR Conditional under certain operating conditions. Only use quadrature transmit for MR Conditional devices. MR Safe implants will have the MR Safe symbol in their implant documentation.

When evaluating whether to proceed with MR scanning on patients with such implants, consult the implantable device's labeling.

Table 2-5: Mandatory symbols

Label	Description (typical use)
	Mandatory: Maintenance instructions
	Mandatory: Refer to instruction manual/booklet
	Mandatory: Wear ear protection

Table 2-6: Manufacturer information symbols

Label	Description (typical use)
	Manufacturer
	Date of manufacture
	Country of manufacture-Assembled in US
REF	Model reference
SN	Serial number
CE 0197	CE - European Conformity Marking; 0197 – Notified Body designation
EC REP	Authorized Representative in the European Community
CH REP	Authorized Representative in Switzerland
MD	An indication that the device is a medical device
℞ ONLY	This symbol stands for that this device is intended for prescription use.

Table 2-7: Patient comfort symbols

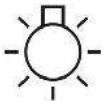
Label	Description (typical use)
	Patient comfort lighting
	Patient comfort ventilation (fan)

Table 2-8: Environmental symbols

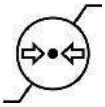
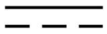
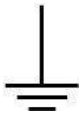
Label	Description (typical use)
	Atmospheric pressure limitation
	Temperature limitation
	Humidity limitation

Table 2-9: MR safety symbols

Label	Description (typical use)
 or 	MR Safe
	MR Conditional
	MR unsafe
 or 	Receive only coil
 or 	Transmit/Receive coil

Table 2-10: Product identification symbols

Label	Description (typical use)
	Alternating current (rating plate, terminals)
	Direct current (rating plate, terminals)
	Three-phase alternating current
	Earth (ground terminals)
	Protective earth (ground terminals)
	Equipotentiality (terminals)
	Dangerous voltage (components, points of entry)
	Main power on (main disconnect/power switch)
	Main power off (main disconnect/power switch)
	Power on (only for a part of equipment)
	Power off (only for a part of equipment)
	Emergency off (system power)
	Emergency stop
	Class II equipment (double insulated) (ratings)

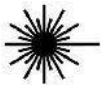
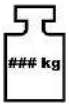
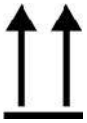
Label	Description (typical use)
	Type B Applied Part (ratings, AP connections)
	Type BF Applied Part
	Non-ionizing electromagnetic radiation (ratings)
	Caution
	CAUTION – Static Sensitive (Electrostatic discharge (ESD) susceptible parts)
	Laser Radiation (laser devices)
	Table mass in Kg. including table safe working load

Table 2-11: Environmental packaging symbols

Symbol	Description
	This way up.
	Keep away from rain.
	Fragile, handle with care.

INTRODUCTION

User Training

GE provides purchasable on-site training by an MR Applications Specialist. GE advises that anyone who operates the system should attend this session after reading the Operator Manual and related training materials.

GE strongly recommends that physicians who prescribe studies and review images on the MR system, attend at least two full days of professional meetings dealing with MR imaging each year. Such meetings include the Radiological Society of North America (RSNA), the Society for Magnetic Resonance in Medicine (SMRM) and the American Roentgen Ray Society (ARRS). In addition, MR system user groups present symposia and workshops throughout the year that provide additional learning opportunities.

The healthcare facility is responsible for training outside emergency personnel (e.g., fire department and other outside emergency personnel) not to bring any ferrous fire-fighting equipment, including axes, ferrous stretchers, or oxygen tanks into the magnet room. Be sure to show such outside emergency personnel where the Emergency Magnet Rundown switch is located.

MR workers shall be adequately trained to minimize health effects of high static magnetic field as described above. The training includes the following topics:

- **Emergency medical procedures**
- **Security zone** and **exclusion zone**
- **Emergency stop** and **emergency off**
- **Fire precautions**
- **Emergency actions in the event of a quench**

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MR safety standards

In most countries the MR safety standard IEC 60601-2-33 provides safety limits for MR exams, for ventilation, and for occupational exposure of MR workers. The International Electrotechnical Commission (IEC) developed a widely-used MR safety standard. The IEC MR safety standard is three-tiered. The NORMAL OPERATING MODE is for routine scanning of patients. The operator must take a deliberate action (usually an ACCEPT button) to enter the FIRST CONTROLLED OPERATING MODE. This mode provides higher scanner performance, but requires monitoring of the patient. Finally, there is a SECOND CONTROLLED OPERATING MODE used only for research purposes under limits controlled by an Investigational Review Board (IRB). The static magnetic field, gradient output and SAR levels for patient are based on current scientific literature research.

The scanner employs a whole body gradient system whose IEC 60601-2-33 compliance volume is:

- a cylinder with axis coinciding with the magnet axis and with a radius of 0.20 meters, for cylindrical magnets, or
- a volume bound by planes parallel to the magnet poles and separated by a distance of 0.40 meters, for vertical-field magnets.

Table 2-12: IEC safety limits

Operating mode	Whole body SAR (W/Kg)	Head SAR (W/Kg)	Partial body SAR (W/Kg)	Local head/trunk SAR (W/Kg)	Local extremity SAR (W/Kg)	Short term SAR (W/Kg)	dB/dt (% mean PNS)
IEC Normal Mode	2	3.2	$= \left(10 - \frac{8M_{exposed}}{M_{patient}}\right)$	10	20	2 x long term	80% PNS
IEC 1st Controlled Operating Mode	4	3.2	$= \left(10 - \frac{6M_{exposed}}{M_{patient}}\right)$	10	20	2 x long term	100% PNS
IEC 2nd Controlled Operating Mode	IRB Limit	IRB Limit	IRB Limit	IRB Limit	IRB Limit	IRB Limit	IRB Limit

Local SAR is averaged over the worst-case 10 g. Short term SAR is averaged over 10 s. SAR limits are reduced if temperature can exceeds 24 degrees C or if humidity exceeds 60%. Hearing protection (only earplugs have been validated) with NRR >/= 29 dB to reduce the A-weighted root-mean-squared sound pressure level below 99 dB(A) shall be used. IEC 60601-1 limits surface contact temperatures to 41 degrees C.

SAFETY STANDARDS

IEC EMC compliance

Per IEC 60601-1-2: 2014, YY9706.102-2021 (only for China), Medical Electrical Equipment needs special precautions regarding Electromagnetic Compatibility (EMC) and needs to be installed and put into service according to the EMC information provided in the following tables. The tables below provide details about the level of compliance and provide information about potential interactions between devices.

Portable and mobile RF communications equipment can affect Medical Electrical Equipment.

WARNING

The MR System may be interfered with by other equipment, even if that other equipment complies with CISPR EMISSION requirements.

WARNING

The MR System should not be used adjacent to or stacked with other equipment; if adjacent or stacked use is necessary, the MR System should be observed in order to verify normal operation in the configuration in which it will be used.

WARNING

The MR System should be used only in a shielded location named as the Magnet Room. Magnetic and RF Shielded Room requirements are defined in the Preinstallation Manual.

WARNING

The use of accessories, transducers and cables other than those specified, with the exception of transducers and cables sold by GE or replacement parts for internal components, may result in increased emissions or decreased immunity of the MR system.

Adhering to the recommendations provided herein for the interaction of the MR System with other electrical devices within the electromagnetic environment may not eliminate all the disturbances.

The MR system has no essential performance per IEC 60601 standards, however, the MR system will maintain its critical functions by continuing to acquire, display, and store scanning images safely.

The MR system complies with emissions limits (Group 2, Class A) Medical devices as stated in IEC 60601-1-2:2014、YY9706.102-2021 (only for China).

YY9706.102-2021Compatibility form:

Table 2-13: Guidance And Manufacturer's Declaration – Electromagnetic Emissions

The MR system is intended to be used in the electromagnetic environment specified below, and the purchaser or user should ensure that it is used in this electromagnetic environment		
Launch test	**Coincidence**	**Electromagnetic Environment———Guidance**
RF emission GB 4824	Group 2	An MR system must emit electromagnetic energy in order to perform its intended function.Nearby electronic equipment may be affected
RF emission GB 4824	Class A	The MR system is suitable for use in non-domestic and in all installations not directly connected to the public low-voltage supply network of domestic dwellings
Harmonic emission GB 17625.1	N/A	
Voltage fluctuations / FLASHING Emission GB 17625.2	N/A	
Note: The emissions characteristics of this equipment make it suitable for use in industrial areas and hospitals (GB 4824 class A).If it is used in a residential environment (for which GB 4824 class B is normally required) this equipment might not offer adequate protection to radio-frequency communication services.The user might need to take mitigation measures, such as relocating or re-orienting the equipment.		

Table 2-14: Guidance And Manufacturer's Declaration - Electromagnetic Immunity

The MR system is intended to be used in the electromagnetic environment specified below, and the purchaser or user should ensure that it is used in this electromagnetic environment			
Immunity Test	**IEC 60601 Test Level**	**Compliant**	**Electromagnetic Environment ——— Guidance**
Electrostatic discharge GB /T 17626.2	±6 kV contact discharge ±8 kV air discharge	±6 kV contact discharge ±8 kV air discharge	Floors should be wood, concrete or tile, if the floor is covered with synthetic material, the relative humidity should be at least 30%
Electrical fast transient/burst GB /T 17626.4	±2kV power cord ±1kV for input/output lines	±2kV power cord ±1kV for input/output lines	Mains power should be of typical quality used in a commercial or hospital environment
Surge GB /T 17626.5	±0.5 kV, ±1 kV Line to line	±0.5 kV, ±1 kV Line to line	Mains power should be of typical quality used in a commercial or hospital environment
	±0.5kV, ±1 kV, ±2 kV Line to ground	±0.5kV, ±1 kV, ±2 kV Line to ground	
Voltage dips on power input lines GB /T 17626.11	U_t < 5% for 0.5 cycle; U_t= 40% for 1 cycle; U_t = 70%, 25 cycle	N/A	Mains power should be of typical quality used in a commercial or hospital environment.If the user of the MR system requires continuous operation during

The MR system is intended to be used in the electromagnetic environment specified below, and the purchaser or user should ensure that it is used in this electromagnetic environment			
Immunity Test	**IEC 60601 Test Level**	**Compliant**	**Electromagnetic Environment ——— Guidance**
			power interruptions, it is recommended that the MR system be powered by an uninterruptible power supply or battery
Short-term interruptions and voltage changes on power input lines GB /T 17626.11	U_t< 5%, 5 Seconds	U_t< 5%, 5 Seconds	
Power frequency magnetic field (50 Hz/60 Hz) GB /T 17626.8	3 A/m 50 Hz	3 A/m 50 Hz	The power frequency magnetic field should have the power frequency magnetic field level characteristics of a typical location in a typical commercial or hospital environment
Radio frequency conduction GB /T 17626.6-2017	3V (rms) 150 kHz to 80 MHz	3V (rms) 150 kHz to 80 MHz	The MR system must be used in a shielded place with a certain specification, the place has the minimum RF shielding effectiveness, and each cable drawn from the place has the minimum RF filter attenuation, which must not be lower than 100dB.See the RF Shielding Requirements section of the RF Shielded Room MR Pre-Installation Manual.
Radio frequency radiation GB /T 17626.3	3V/m 80 kHz to 2.5GHz	3V/m 80 kHz to 2.5GHz	The field strength generated by the fixed radio frequency transmitter outside the shielded place should be less than 3V/ma as determined by the electromagnetic site survey. Interference may occur near equipment marked with the following symbols. 
Note 1: These guidelines may not be suitable for all situations. Electromagnetic propagation is affected by absorption and reflection from buildings, objects and people. Note 2: It is very necessary to verify and ensure that the actual shielding effectiveness and filter attenuation of the shielded location meet the specified minimum values.			

The MR system is intended to be used in the electromagnetic environment specified below, and the purchaser or user should ensure that it is used in this electromagnetic environment			
Immunity Test	**IEC 60601 Test Level**	**Compliant**	**Electromagnetic Environment ——— Guidance**

Note: U_t refers to the AC mains voltage before the test voltage is applied.

a. Stationary transmitters, such as base stations for wireless (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcasts, and television broadcasts, have field strengths that cannot be predicted theoretically with accuracy.To assess the electromagnetic environment of fixed RF transmitters, electromagnetic site surveys should be considered.If the measured field strength outside the shielding area used by the MR system exceeds 3V/m, the MR system should be observed to verify its normal operation.If abnormal performance is observed, supplementary measures may be necessary, such as reorienting the MR system or using a shielded location with high RF shielding effectiveness and filter attenuation.

Table 2-15: Recommended separation distances between portable and mobile RF communication equipment and MR systems

MR systems are intended for use in electromagnetic environments where radio frequency radiation disturbances are controlled.The purchaser or user can prevent electromagnetic interference by maintaining the minimum distance between portable and mobile RF communication equipment (transmitters) and the MR system as recommended below, according to the maximum rated output power of the communication equipment			
Rated maximum output power of transmitter/W	**Corresponding to the isolation distance of different frequencies of the transmitter/m**		
	150 kHz to 80 MHz	**80 MHz to 800 MHz**	**800 MHz to 2.5GHz**
	$d = 1.2 \sqrt{P}$	$d = 1.2 \sqrt{P}$	$d = 2.3 \sqrt{P}$
0.01	0.12	0.12	0.23
0.1	0.37	0.37	0.74
1	1.17	1.17	2.33
10	3.69	3.69	7.38
100	11.67	11.67	23.33

For the maximum rated output power of the transmitter not listed in the above table, the recommended isolation distance, in meters (m), can be determined by the formula in the corresponding transmitter frequency column.Here P is the maximum rated output power of the transmitter provided by the transmitter manufacturer, in watts (W).

Note 1: At the 80 MHz and 800 MHz frequency points, the formula for the higher frequency range is used.

Note 2: These guidelines may not be suitable for all situations. Electromagnetic propagation is affected by absorption and reflection from buildings, objects and people.

IEC 60601-1-2:2014 Compatibility Tables:

Table 2-16: Guidance And Manufacturer's Declaration – Electromagnetic Emissions

The MR System is intended for use in a typical health care electromagnetic environment specified below. The customer or the user of the MR System should assure that it is used in such an environment.		
Emissions Test	**Compliance Level**	**Electromagnetic Environment - Guidance**
RF emissions CISPR 11	Group 2	The MR system must emit electromagnetic energy in order to perform its intended function. Nearby electronic equipment may

The MR System is intended for use in a typical health care electromagnetic environment specified below. The customer or the user of the MR System should assure that it is used in such an environment.		
Emissions Test	**Compliance Level**	**Electromagnetic Environment - Guidance**
		be affected.
RF emissions CISPR 11	Class A	The MR system is suitable for use in all establishments other than domestic and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
Harmonic emissions IEC 61000-3-2	Not Applicable	
Voltage fluctuations/flicker emissions IEC 61000-3-3	Not Applicable	
NOTE: The emissions characteristics of this equipment make it suitable for use in industrial areas and hospitals (CISPR 11 class A). If it is used in a residential environment (for which CISPR 11 class B is normally required) this equipment might not offer adequate protection to radio-frequency communication services. The user might need to take mitigation measures, such as relocating or re-orienting the equipment.		

Table 2-17: Guidance And Manufacturer's Declaration – Electromagnetic Immunity

The MR System is intended for use in a typical health care electromagnetic environment specified below. The customer or the user of the MR System should assure that it is used in such an environment.			
Immunity Test	**IEC 60601-1-2 Test Level**	**Compliance Level**	**Electromagnetic Environment – Guidance**
Electrostatic discharge (ESD) IEC 61000-4-2	±8 kV contact ±15 kV air	±8 kV contact ±15 kV air	Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.
Electrical fast transient/burst IEC 61000-4-4	±2 kV for power supply lines ±1 kV for input/output lines	±2 kV for power supply lines ±1 kV for input/output lines	Mains power quality should be that of a typical commercial or hospital environment.
Surge IEC 61000-4-5	±0.5 kV, ±1 kV Line to line	±0.5 kV, ±1 kV Line to line	Mains power quality should be that of a typical commercial or hospital environment.
	±0.5, ±1 kV, ±2 kV Line to ground	±0.5, ±1 kV, ±2 kV Line to ground	
Voltage dips IEC 61000-4-11	U_t = 0%, 0.5 cycle (0, 45, 90, 135, 180, 225, 270, and 315 degrees) U_t = 0%, 1 cycle U_t = 70%, 25/30 cycles (0 degrees)	Not applicable	Mains power quality should be that of a typical commercial or hospital environment. If the user of the MR System requires continued operation during power mains interruptions, it is recommended that the MR System be powered from an uninterruptible power supply.
Short interruptions and voltage variations on power supply input lines IEC 61000-4-11	U_t = 0%, 250/300 cycles	U_t = 0%, 250/300 cycles	
Power frequency	30 A/m	30 A/m	Power frequency magnetic fields

The MR System is intended for use in a typical health care electromagnetic environment specified below. The customer or the user of the MR System should assure that it is used in such an environment.			
Immunity Test	**IEC 60601-1-2 Test Level**	**Compliance Level**	**Electromagnetic Environment – Guidance**
(50/60 Hz) magnetic field IEC 61000-4-8	50 Hz or 60 Hz	50 Hz or 60 Hz	should be at levels characteristic of a typical location in a typical commercial or hospital environment.
Conducted RF IEC 61000-4-6	3 Vrms 150 kHz to 80 MHz 6 Vrms 150 kHz to 80 MHz at ISM bands[a]	3 Vrms 150 kHz to 80 MHz 6 Vrms 150 kHz to 80 MHz at ISM bands	Portable and mobile RF communications equipment should not be used closer to any part of the equipment, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter. Recommended separation distance. d = 1.2 √P 150 kHz to 80 MHz d = 1.2 √P 80 MHz to 800 MHz. d = 2.3 √P 800 MHz to 2.7 GHz where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer, and d is the recommended separation distance in meters (m). Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey[c] should be less than the compliance level in each frequency range[d]. Interference may occur in the vicinity of equipment marked with the following symbol: 
Radiated RF IEC 61000-4-3	3 V/m[b] 80 MHz to 2.7GHz	3 V/m 80 MHz to 2.7GHz	

NOTE U_t is the AC mains voltage prior to application of the test level.

a The ISM (industrial, scientific and medical) bands between 0.15 MHz and 80 MHz are 6.765 MHz to 6.795MHz; 13.553 MHz to 13.567 MHz; 26.957 MHz to 27.283 MHz; and 40.66 MHz to 40.70 MHz.

b For more information, see section Proximity field immunity compliance.

c Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radio, AM and FM radio broadcast, and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site

The MR System is intended for use in a typical health care electromagnetic environment specified below. The customer or the user of the MR System should assure that it is used in such an environment.			
Immunity Test	**IEC 60601-1-2 Test Level**	**Compliance Level**	**Electromagnetic Environment – Guidance**
survey should be considered. If the measured field strength in the location in which the MR equipment is used exceeds the applicable RF compliance level above, the equipment should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as re-orienting or relocating the equipment.			
d Over the frequency range 150 KHz to 80 MHz, field strengths should be less than 3 V/m.			

Table 2-18: Recommended Separation Distances between portable and mobile RF communications equipment and the MR system

The MR System is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The customer or the user of the MR System can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the MR System as recommended below, according to the maximum output power of the communications equipment.			
Rated maximum output power of transmitter W	**Separation distance according to frequency of transmitter stated in meters**		
	150 kHz to 80 MHz	**80 MHz to 800 MHz**	**800 MHz to 2.7GHz**
	d = 1.2 √P	d = 1.2 √P	d = 2.3 √P
0.01	0.12	0.12	0.23
0.1	0.37	0.37	0.74
1	1.17	1.17	2.33
10	3.69	3.69	7.38
100	11.67	11.67	23.33
For transmitters rated at a maximum output power not listed above, the recommended separation distance d in meters (m) can be estimated using the equation applicable to the frequency of the transmitter, where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer.			
NOTE 1 At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies.			
NOTE 2 These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.			

Table 2-19: Proximity field immunity compliance

The MR System is intended for use in a typical health care electromagnetic environment specified below. The customer or the user of the MR System should assure that it is used in such an environment.							
Test Frequency [MHz]	**Band [MHz]**	**Service**	**Modulation**	**Maximum power [w]**	**Distance [m]**	**Immunity com-pliance level [V/m]**	**Immunity test level [V/m]**
385	380 ~ 390	TETRA 400	Pulse Modulation 18 Hz	1.8	0.3	27	27
450	430 ~ 470	GMRS 460,	FM ±5 kHz	2	0.3	28	28

The MR System is intended for use in a typical health care electromagnetic environment specified below. The customer or the user of the MR System should assure that it is used in such an environment.							
Test Frequency [MHz]	**Band [MHz]**	**Service**	**Modulation**	**Maximum power [w]**	**Distance [m]**	**Immunity compliance level [V/m]**	**Immunity test level [V/m]**
		FRS 460	deviation 1 kHz sine				
710	704 ~ 787	LTE Band 13, 17	Pulse Modulation 217 Hz	0.2	0.3	9	9
745							
780							
810	800 ~ 960	GSM 800/900, TETRA 800, iDEN 820, CDMA 850, LTE Band 5	Pulse Modulation 18 Hz	2	0.3	28	28
870							
930							
1720	1700 ~ 1990	GSM 1800; CDMA 1900; GSM 1900; DECT; LTE Band 1, 3, 4, 25; UMTS	Pulse Modulation 217 Hz	2	0.3	28	28
1845							
1970							
2450	2400 ~ 2570	Bluetooth, WLAN, 802.11 b/g/n, RFID 2450, LTE Band 7	Pulse Modulation 217 Hz	2	0.3	28	28
5240	5100 ~ 5800	WLAN 802.11 a/n	Pulse Modulation 217 Hz	0.2	0.3	9	9
5500							
5785							

Note: The distance values represent the recommended separation distance between interfering equipment and components of the MR system.

SAFETY STANDARDS

Temperature and humidity specifications

System Suite

Use the specifications listed in Table 2-20 for designing your HVAC (heating, ventilation, and air conditioning) system. Proper insulation and moisture barrier should be installed within the environmental controlled space (e.g. area above drop ceiling) for humidity, condensation, and temperature control.


To help prevent a patient from feeling uncomfortably warm during a scan, make sure the magnet room temperature does not exceed 69.8.F (21.C) maximum. If the scan room temperature exceeds 72.14°F (22.3°C), then the SAR is automatically derated, which means that the current scan parameters may trip the SAR monitor.

Table 2-20: Temperature and humidity specifications

Area	Temperature		Humidity	
	Range °F (°C)	Change °F/Hr (°C/Hr)	Range%	Change%/Hr
Equipment Room at Inlet to Equipment	59~82.4 (15~28)	5 (3)	30~75	5
Magnet Room	59~69.8 (15~21)	5 (3)	30~60	5
Operator's Control Room	59~89.6 (15~32)	5 (3)	30~75	5

Note :

the maximum temperature requirement is derated by 1° C per 300m above 800m.

The system shall be operational at altitudes ranging from -30 m to 2600 m.

The temperature and humidity change specification available when averaged over 1 hour.

SAFETY STANDARDS

Transportation and storage

Use the specifications listed in the table for transportation and storage of your MR system.

Table 2-21: SIGNA™ Victor transportation and storage

Temperature range: °F (°C)	Temperature change: °F/Hour (°C/Hour)	Relative humidity: % non-condensing	Humidity change: %/Hour	Atmospheric pressure
-22~131 (-30~55)	68 (20)	10-90	30	1060 to 525 hPa

Note:

The temperature and humidity change specification available when averaged over 1 hour.

MAGNETIC FIELDS

Magnetic field basics introduction

Though it is generally accepted that no published evidence exists supporting cumulative or long-term negative effects of EMF[1] exposure, it is advisable for pregnant MR workers to exercise extra precaution in limiting their exposure as much as possible. Health effects increase with increasing magnetic field strength. The existence of local regulations establishing upper limits for MR workers may not apply to pregnant MR workers, although no epidemiological evidence exists supporting negative effects of EMF exposure on the health of a pregnant worker or her fetus. The User is responsible for determining whether local or country legislation may exist establishing occupational limits for exposure to EMF. If such limits exist it is the User's responsibility to ensure they are being observed.

To ensure safe operation of your system, for both you and your patient, you must understand several components of your MR system. Your MR system includes the following magnetic fields:

- Static Magnetic Field (the magnet)
- Gradient Magnetic Fields (the gradients)
- Electromagnetic Fields (the RF)

The following definitions are used throughout Magnetic Field Basics section. Not all modes of operation apply to all GEHC MR scanners.

- **Normal Operating Mode (Clinical Mode):** mode of operation of the MR equipment in which none of the outputs have a value that may cause physiological stress to patients.
- **First Level Controlled Operating Mode:** mode of operation of the MR equipment in which one or more outputs reach a value that may cause physiological stress to patients, which needs to be controlled by medical supervision.
- **Second Level Controlled Operating Mode: mode of operation of the MR equipment in which one or more outputs reach a value that may produce significant risk for patients, for which explicit ethical approval is required (i.e., a human studies protocol approved to local requirements).**

[1]Electro Magnetic Field

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MAGNETIC FIELDS

Static magnetic fields

The main magnet is a stable and very intense magnetic field.

Note that the MR magnet is always on even when the system is not acquiring scan data. The only exception to this is if service has ramped down the magnet or it has been quenched.

The main safety issues regarding the static magnetic field include the potential for biological effects, the potential for attraction of ferromagnetic objects, and the potential for a quench of the cryogens.

The MR system static magnetic field may be classified under several modes:

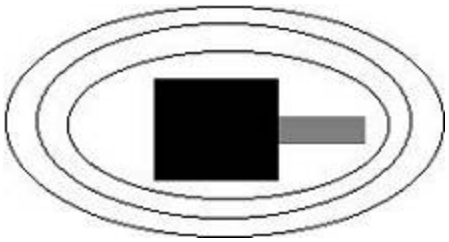
- Normal: the normal operating mode, admissible for all individuals.
- First Level: controlled operating mode, admissible for patients on whom a medical decision was made ensuring they can handle the increased physiological stress.
- Second Level: controlled operating mode, approval of an IRB or Human Ethical Committee required, with the static field limit explicitly stated.

Table 2-22: Static magnetic field

Mode	System
</= 3T for Normal Mode	1.5T

A magnet produces invisible lines of force that extend beyond the magnet that are called the fringe field. The size of the fringe field depends on the strength of the magnet and whether or not it is shielded. Active and inactive shielding are used to reduce or tighten the fringe field.

Figure 2-3: Fringe field



CAUTION

For some patients or MR workers, rapid movement of the head while in the magnetic field may cause dizziness, vertigo, or a metallic taste in their mouth. None of these motion effects are considered to be hazardous, provided they do not cause the worker to fall.

It is recommended that the patient and the MR worker endeavor to remain still while in the region of high static magnetic field. The MR worker should always vacate the area of the static magnetic field when duties do not require otherwise.

The tesla to gauss conversion is 1 tesla = 10,000 Gauss.

The magnetic field exerts force on susceptible materials and biomedical implants and can create hazards. There are two critical zones: the Security Zone and the Exclusion Zone. Each zone has specific restrictions regarding people and materials.

WARNING

It is your responsibility to ensure permanent creation of the Security Zone and the Exclusion Zone and to establish rules for access. Ensure occupational exposure to static magnetic field complies with local requirements.

MAGNETIC FIELDS

Security zone

The Security Zone is the magnet room and the walls of the magnet room.

Figure 2-4: Security Zone

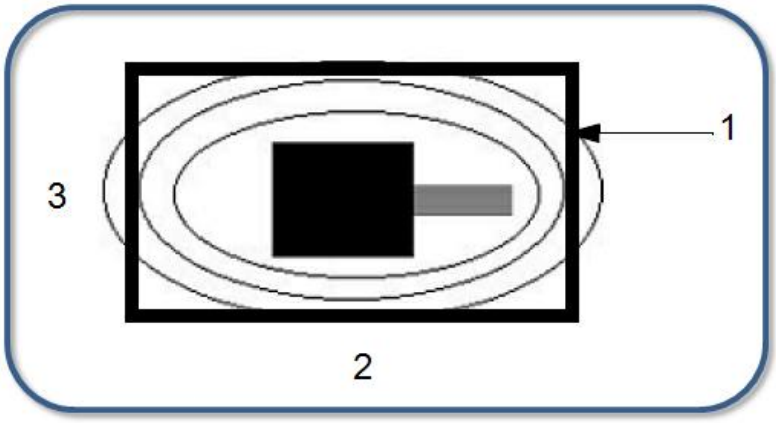


Table 2-23: Image legend

#	Description
1	Magnet room
2	Room length = 18 feet (5.5 m)
3	Room width = 11 feet (3.4 m)

Static magnetic field plots for siting (rule of thumb - assumes no ferromagnetic materials) may be found at:

https://www.gehealthcare.com/support/site-planning

NOTE: The figure above states the approximate minimum room size for your MR system. Consult your GE System Pre-Installation Manual for specific dimensions of your system and additional magnetic field plot information.

IMPORTANT!: You need to understand the meanings of ferromagnetic and ferrous substances or items:

- A substance that is ferromagnetic has a large positive magnetic susceptibility. (Example: Iron.)
- An item that is ferrous can posses intrinsic magnetic fields and react strongly in an applied magnetic field. (Examples: Iron, nickel, and cobalt.)

The attractive force of the magnetic field in the Security Zone can cause ferromagnetic items to become projectiles and contraindicated biomedical implants to fail. In short, ferromagnetic items and contraindicated biomedical implants are NOT allowed in the Security Zone.

The MR System operates with a highly sensitive RF receiving front end to be able to capture the signal of an object scanned. The Magnet Room part of the MR System installation provides the RF isolation to reduce the interference from electrical devices outside the shielded location.

It is possible that any device that functions with active electronic circuitry may potentially interfere the operation of the MR System if such device is introduced inside the Magnet Room even though the device does not have an intentional RF Transmitter. Extreme EMC measures must be taken into account in the design and manufacturing of an electrical device if such device is intended to operate inside the Magnet Room.

A device that may potentially interfere the MR System if introduced inside the Magnet Room are those containing active electronics. Some examples include: Switching Mode Power Supply (SMPS), microprocessor, Digital Signal Processors, analog to digital converters, LCD displays, keypad controllers, motors, battery operated devices.

WARNING

The Security Zone warning sign must be posted on the entrance to the magnet room to alert personnel to the high magnetic field and warn not to bring ferromagnetic objects into the magnet room.

WARNING

Ensure that the Security Zone complies with your local statutory requirements.

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Security Zone Warning sign

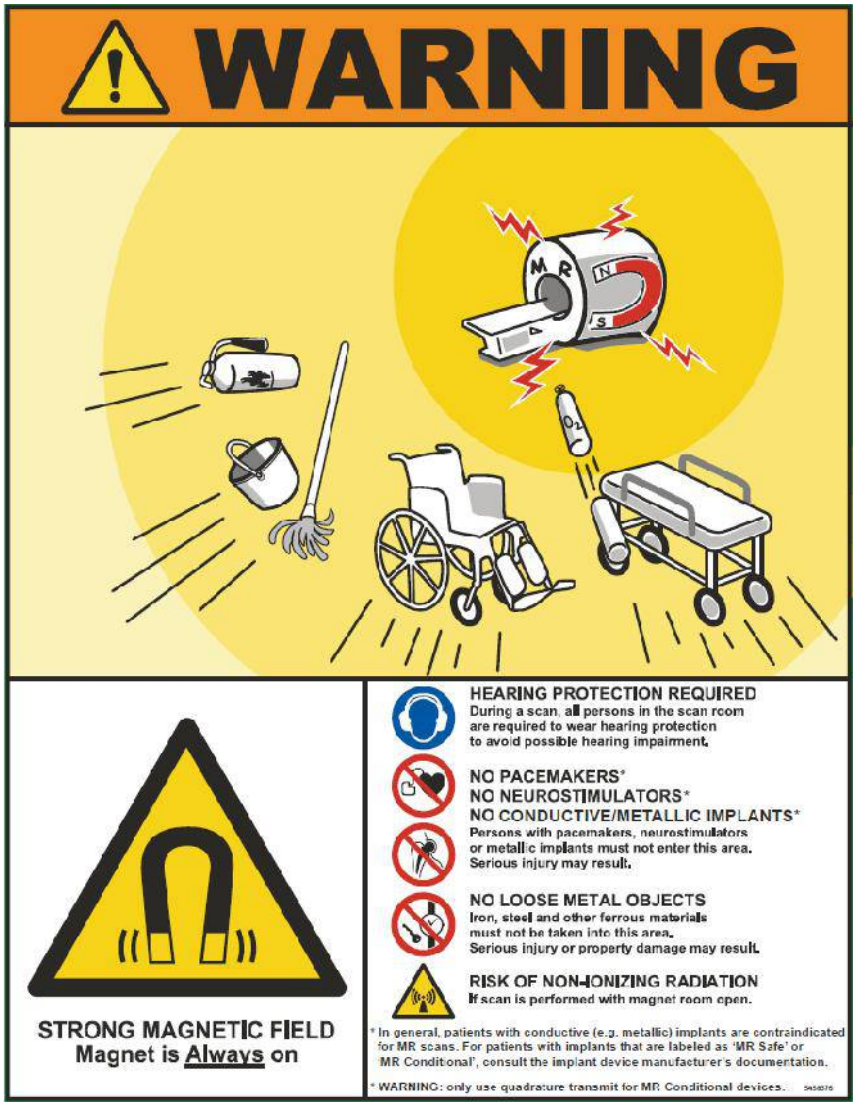
The Security Zone Warning Sign alerts personnel and patients of the following:

- Strong magnetic field
- Hearing protection: During a scan, all persons in the scan room are required to wear hearing protection to avoid possible hearing impairment.
- No pacemakers*
- No neurostimulators*
- No conductive/metallic implants*
  - Persons with pacemakers, neurostimulators or metallic implants must not enter this area. Serious injury may result.
- No loose metal objects: Iron, steel and other ferrous material must not be taken into this area. Serious injury or property damage may result.
- Risk of non-ionizing radiation: If a scan is performed with the magnet room open.

*In general, patients with conductive (e.g. metallic) implants are contraindicated for MR scans. Some implantable devices have been labeled as MR Conditional under certain operating conditions. Only use quadrature transmit for MR Conditional devices. MR Safe implants will have the MR Safe symbol in their implant documentation.

When evaluating whether to proceed with MR scanning on patients with such implants, consult the implantable device's labeling.

Figure 2-5: Security zone warning sign



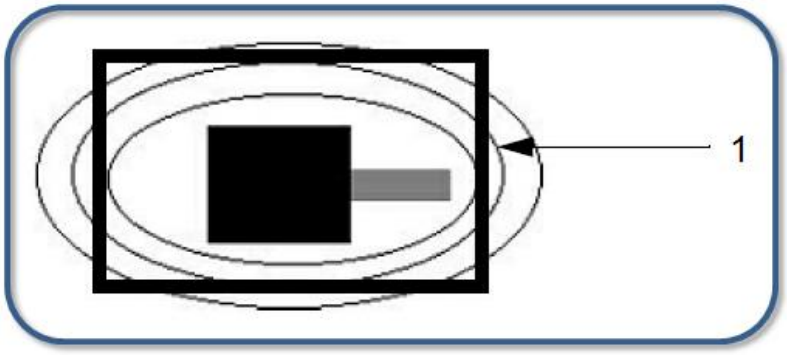
Your system may have a slight variation of this sign.

MAGNETIC FIELDS

Exclusion zone

The Exclusion Zone begins at the 5-gauss line. Magnetic shielding may, however, restrict the 5-gauss line to the magnet room, making the security and the exclusion zone the same.

Figure 2-6: Exclusion Zone, 1 = 5 gauss line



Static magnetic field plots for siting (rule of thumb - assumes no ferromagnetic materials) may be found at:

https://www.gehealthcare.com/support/site-planning

All personnel should be aware of the gauss line and actively screen the changing conditions of the environment. There are gauss lines and equipment that must remain outside certain limits. Consult your GE Service Engineer to know where these gauss lines are located in your facility.

WARNING

The Exclusion Zone warning sign must be posted at the 5 gauss boundary. Locate and read the Exclusion Zone signs at your facility.

Exclusion Zone Warning sign

The Exclusion Zone Warning Sign alerts personnel and patients of the following:

- Strong magnetic field
- No pacemakers*
- No neurostimulators*
- No conductive/metallic implants*
  - Persons with pacemakers, neurostimulators or metallic implants must not enter this area. Serious injury may result.

*In general, patients with conductive (e.g. metallic) implants are contraindicated for MR scans. Some implantable devices have been labeled as MR Conditional under certain operating conditions. Only use quadrature transmit for MR Conditional devices. MR Safe implants will have the MR Safe symbol in their implant documentation.

When evaluating whether to proceed with MR scanning on patients with such implants, consult the implantable device's labeling.

Figure 2-7: Exclusion zone warning sign

Your system may have a slight variation of this sign.

WARNING

Ensure that the Exclusion Zone complies with your local statutory requirements.

MAGNETIC FIELDS

Biological effects

The static magnetic field strengths used by your MR system are within the guidelines provided by the United States Food and Drug Administration (FDA) for clinical imaging. However, there are several cautions that need to be understood:

CAUTION

Minimize the time spent near the magnet. Spend only the time necessary to attend to the needs of the patient.

CAUTION

MR scanning has not been established as safe for imaging fetuses or infants. Carefully compare the benefits of MR versus alternative procedures before scanning to control risk to the patient. A physician should consider whether to limit scanning of pregnant or infant patients to the Normal dB/dt and Normal SAR operating mode. It is not advisable to scan pregnant patients in the first trimester or unknown pregnancy status as the fetus is especially sensitive to potential thermal events during the first trimester.

MAGNETIC FIELDS

Ferromagnetic objects

Ferromagnetic objects brought within close proximity of the static magnetic field can become projectiles, which could cause harm to someone standing between the object and the magnet. The force of attraction between a magnet and a ferromagnetic object is determined by the magnetic field strength (fringe field), the magnetic susceptibility of the object, its mass, its distance from the magnet, and its orientation to the field.

Use only non-ferrous oxygen tanks, wheelchairs, gurneys, intravenous (IV) poles, ventilators, etc. in the magnet room. Be sure anyone who has access to the MR suite is aware that only non-ferrous items are allowed in the magnet room. Make them aware that policies and procedures are in place for bringing medical devices and other equipment into the magnet room.

In addition to the projectile hazard, the static magnetic field can cause ferromagnetic objects within the patient (e.g., surgical clips, prostheses) to move, thus possibly causing harm. Electrically, magnetically, or mechanically activated implants can become dysfunctional due to the static magnetic field. If these devices are life-supporting, harm could result. For medical devices that are labeled as MR Safe or MR Conditional consult the device manufacturer's documentation.

WARNING

The attractive force of the magnetic field of the MR system can cause ferrous objects to become projectiles that can cause serious injury. Post the security zone warning sign on the entrance to the magnet room and keep all hazardous objects out of the magnet room. If a ferromagnetic object has become attached to the magnet, contact GE Service for assistance.

WARNING

To help prevent patient or operator injury, do not bring ferrous materials such as battery operated devices into the magnet room.

WARNING

To help prevent patient or operator injury, do not bring ferrous oxygen bottles into the magnet room.

CAUTION

Common hospital equipment, which often have ferrous battery packs, such as patient monitoring, and life supporting devices, may be adversely affected when in proximity to the magnetic field or image quality may be affected by the presence of this equipment.

CAUTION

The only GE supplied tools recommended for use inside the Security zone are the phantoms supplied with your system.

WARNING

Electrical discharges between conductive devices and the MR coils can startle or burn the patient and possibly cause the patient to injure himself/herself. To help avoid such reactions, do not place metal objects (e.g., limb braces, traction mechanisms, stereotactic devices, etc.) in the MR magnet.

WARNING

The fringe field can cause injury by interfering with the normal operation of biomedical devices.

MAGNETIC FIELDS

Spatial magnetic field data

MR environment safety terminology

The MR Environment Safety Terminology is intended to help explain labeling matters for medical devices and other items that may be used in the MR environment to ensure the safe use of MR technology.

Terminology for defining the safety of items in the MR environment is provided in ASTM F2503 Standard Practice for Marking Medical Devices and Other Items for Safety in the Magnetic Resonance Environment. FDA recommended using the terminology MR Safe, MR Conditional, and MR Unsafe, defined in ASTM F2503 (FDA guidance document, "Establishing Safety and Compatibility of Passive Implants in the Magnetic Resonance (MR) Environment Document").

Definitions

MR safe:  or 

An item that poses no known hazards in all MR imaging environments.

With this terminology, MR safe items are non-conducting, non-metallic, and non-magnetic items, such as a plastic Petri dish. An item may be determined to be MR safe by providing a scientifically based rationale rather than test data.

MR Conditional: 

An item that has been demonstrated to pose no known hazards in specified MR environment with specified conditions of use. Field conditions that define the MR environment include static magnetic field strength, spatial gradient, time rate of change of the magnetic field (dB/dt), RF fields, and specific absorption rate (SAR).

Additional conditions, including specific configurations of the item (e.g., the routing of leads used for a neurostimulation system), may be required.

MR Unsafe: 

An item that is known to pose hazards in all MR environments.

MR unsafe items include magnetic items such as a pair of ferromagnetic scissors.

ASTM standard F2503 also describes how MR Safe, MR Conditional and MR Unsafe device Icons are to be used for MR labeling of implants and devices. For details see **MR safety labels.**

 **CAUTION**

Safe scanning of patients with MR Conditional devices or implants may be complex. Health care professionals that scan patients with MR Conditional devices or implants should consult the implant or device manufacturer for instructions with respect to safety guidelines.

WARNING

Scanners are not designed to regulate SAR and dB/dt for levels other than the IEC NORMAL MODE (WB SAR <= 2 W/kg, head SAR <= 3.2 W/kg and dB/dt <= 80% of the mean nerve stimulation limit) and IEC FIRST MODE (WB SAR <= 4 W/kg, head SAR <= 3.2 W/kg and dB/dt <= 100% of the mean nerve stimulation limit). No other limits are enforced.

WARNING

The tests commonly employed to determine MR Conditional implant heating safety (standard, ASTM F2182, ASTM.org), require quadrature excitation. Heating results for non-quadrature excitation (such as parallel transmit, MultiDrive, or elliptical drive) are unknown.

For patients with MR Conditional implants or devices, applying Preset or Optimized RF Drive Modes may violate the MR Conditional specifications.

Magnet information

The peak main magnetic field (B_0), peak gradient of the main magnetic field (grad(B_0)), and the peak force product (main magnetic field times the peak gradient of the main magnet field [B_0 grad(B_0)]) and their spatial locations are provided in cylindrical coordinates with centers at magnet isocenter.

Note that peak accessible values typically occur (see figure below) at or near the magnet covers (shroud) in a patient accessible area. To find the magnet type used with your system, contact your GE field service engineer.

Definitions

- Peak main magnetic field (B_0), maximum magnetic field magnitude at patient accessible locations.

  For solenoid magnets these values typically lie on circles with radius R from the axis of the magnet on both the front and the back of the magnet at ±Z from isocenter.

- Peak gradient of the main magnetic field (grad(B_0)).

  The peak gradient of the static magnetic field, B_0, is the maximum rate of change of the main magnetic field magnitude along any direction at a patient accessible location. For solenoid magnets these values typically lie on circles with (see table and figure below) radius R from the axis of the magnet on both the front and the back covers of the magnet at ± Z from isocenter.

Note that the strength of time-varying gradients are small and not relevant to magnetic force considerations.

- Peak force product (B_0 grad(B_0)).

  The peak force product is the maximum product of B_0 and grad(B_0) at accessible locations. Note that maximum forces and torques will occur at this location. Only values in a patient accessible area with magnet covers in place are given in the table below. For solenoid magnets (see figure below) these values typically lie on circles with radius R from the axis of the magnet on both the front and the back of the magnet at ± Z from isocenter.

- Locations

  Defined in cylindrical coordinates, (Z, R) with (Z=0, R=0) being magnet isocenter apply to both the front and back of the magnet (see table and figure below). For solenoid magnets the same maximum values occur at R, ± Z for all angles, i.e., the same peak values form a circle with radius R at ±Z.

- Translational Force

  Force acting to move the center of mass of an object. Ferromagnetic objects in non-uniform magnetic fields experience translational forces.

- Torque

  A pair of opposite forces some distance apart acting to rotate an object without changing the position of the center of mass. Asymmetrically-shaped ferromagnetic objects (such as needle-shaped objects) experience torques in magnetic fields.

Figure 2-8: Magnet location of fringe-field maximum. Spatial locations of peak fields accessible to patients. The origin of the cylindrical coordinates is magnet isocenter. Cylindrical coordinates locate points a radius R from the magnet axis (centerline) and a distance z from isocenter on axis.

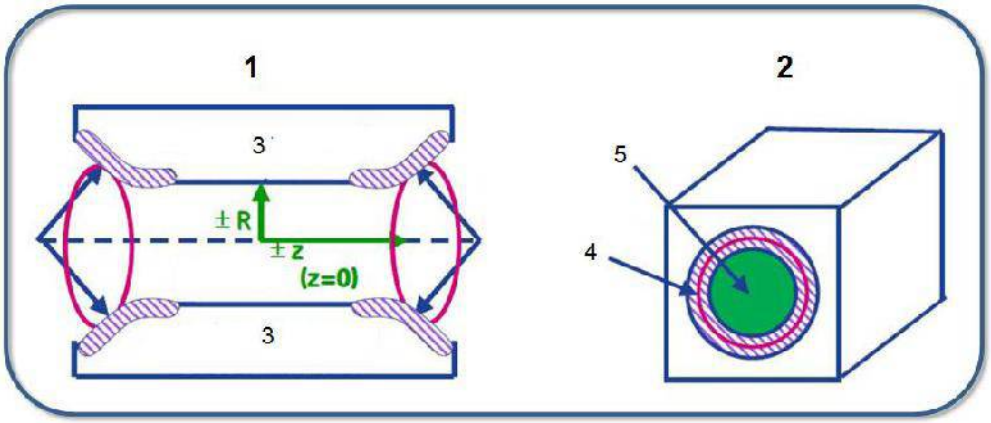


Table 2-24: Image legend

#	Description
1	Side cut-away view of magnet.
2	Front view of magnet.
3	Cylindrical magnet and cover (shroud).
4	Peak B Peak grad (B) Peak B* grad (B) Typically, peak B, peak grad (B), and peak B*grad(B) are close to the magnet covers in a patient accessible area and are symmetric for rotations about the long axis of the magnet (equal fields for (Z,R) along a circle centered on axis). The peak values are in the shaded regions. Specific locations (R.Z) are identified in table below.
5	Patient bore.

Spatial Magnetic Field

Maximum forces and torques on ferromagnetic objects depend on the force product.

Forces and Torques

Spheres of uniform ferromagnetic material experience translational forces near magnets, but no torque.

- Asymmetric ferromagnetic objects (for example long cylinders) may experience both translational forces and torques. For such objects the translational force can be orders of magnitude lower than those related to torque.

- Magnetic translational force depends on the force product (B0 grad(B0)) with the maximum force occurring for the maximum force product.
- Torques increase rapidly with $(B_0)^2$ and depend on angle from B_0 and shape of object.
- MR compatibility investigators have reported the maximum static magnetic fringe field gradient in the past as a safety criterion. For each maximum the maximum values, the spatial locations (cylindrical coordinates (Z,R)), and the values of the other (typically non-maximum) parameters are given below for GE magnets.

The table below contains coordinates for and values of maximum B_0, maximum grad(B_0), and maximum B_0(grad(B_0)). MR compatibility investigators have reported the maximum static magnetic fringe field gradient in the past as a criterion for MR compatibility though the force product actually determines translational force on ferromagnetic objects. The maximum field values (shown with red borders), the spatial locations (in cylindrical coordinates (z,R)), and the values of the other (typically non-maximum) parameters are given below for GE magnets

Useful unit conversions

- 1 T/m = 100 G/cm
- 1 G/cm = 0.01 T/m
- 1 $T^2/m = 10^6$ G^2/cm
- 1 $G^2/cm = 10^{-6}$ T^2/m

Peak static spatial gradients on patient accessible areas table

See figure above for explanation of R and Z. If you are not sure of your system configuration, consult your service engineer.

Enclosure

Figure 2-9: SIGNA™ Victor magnet cover

Table 2-25: Enclosure peak static spatial gradients on patient accessible areas

Field Name	Patient bore type	Parameter	Radial Location R(m)	Location along Z(m)	B(T)	Grad (B) (T/m)	max(B)* grad(B) (T^2/m)
1.5T Platform Magnet	60 BRM	Peak B	0.308	0.617	1.66	2.61	4.33
		Peak Gradi-ent	0.416	0.873	1.04	6.88	7.15
		Peak Product	0.367	0.823	1.26	6.28	7.91

Field Name	Patient bore type	Parameter	Radial Location R(m)	Location along Z(m)	B(T)	Grad (B) (T/m)	max(B)* grad(B) (T^2/m)
1.5T LCC / LCCw Magnet	60 BRM	Peak B	0.31	0.62	1.7	3.2	5.4
		Peak Gradi-ent	0.38	0.83	1.1	6.2	7.0
		Peak Product	0.33	0.77	1.4	5.6	7.7

Magnetic Field Plots

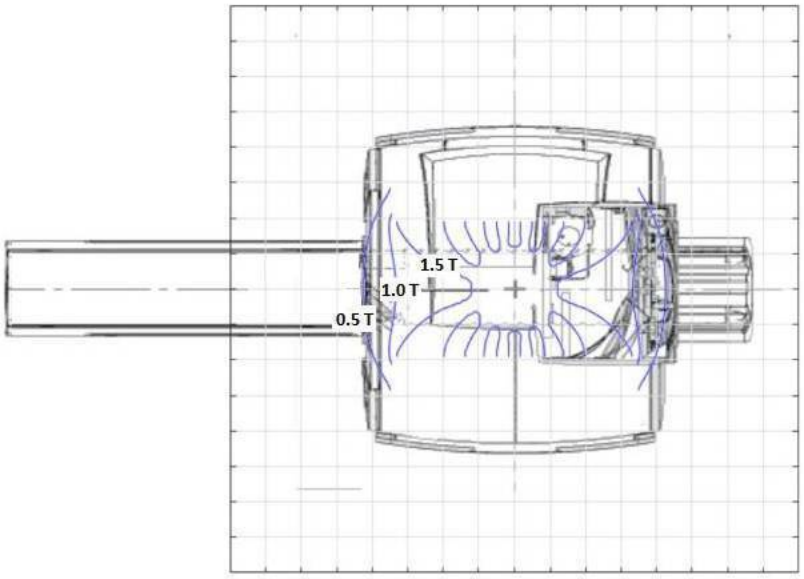
Static magnetic field plots for siting (rule of thumb - assumes no ferromagnetic materials) may be found at:

https://www.gehealthcare.com/support/site-planning

Coordinate system for field and gradient where Z is in the B0 direction, R is the radius, and the origin is isocenter.

The following figures represent the contour map for the static magnetic field (B0) from the MR system at positions accessible to the MR worker.

Figure 2-10: Contour map of the static magnetic field (B0) for an 1.5T magnet. View from above magnet with a 25 cm grid overlaid



MAGNETIC FIELDS

Understanding spatial gradients

This information is provided to assist in understanding spatial gradients. This information should be used together with the information in the safety manuals for your system.

MAGNETIC FIELDS

Cryogen and quench concerns

With superconductive MR systems, another concern related to the static magnetic field is a quench of the cryogens. A superconductive magnet uses cryogens to super-cool the electrical conductor that creates the magnetic field. Temperatures as low as -269°C (-452°F) are achieved to create the proper environment within the magnet. A quench, which is a sudden boil-off of the entire volume of cryogenic liquid, causes a rapid loss of the static magnetic field.

Liquid Cryogen Hazards

Cryogens come in large vacuum containers called dewars. Liquid helium is generally used for cooling purposes, although some service procedures also require liquid nitrogen. Nitrogen dewars weigh from 400 to 500 pounds when full. Helium dewars weigh from 700 to 800 pounds. In addition to large dewars, there may be smaller helium gas cylinders present. This helium gas is used to fill the magnet to proper cryogen levels. Special considerations should be observed when dealing with cryogens.

CAUTION

Leaking helium or nitrogen gas will displace oxygen. The ambient air oxygen concentration may then be insufficient for human respiration. The limit of the air oxygen concentration should meet national laws or regulations.

CAUTION

The following information defines the proper handling of cryogens.

- Dewars and cylinders should not be tipped or heated, nor should the valves be tampered with.
- The cryogens boil off as they cool the magnet wires and must be replenished periodically by qualified personnel. The rate of boil-off should be monitored by checking the cryogen level meter found on the system cabinet.
- Contact with the cryogenic liquids or gas could result in severe frostbite; care should be taken when in proximity to these substances. The wearing of protective clothing is essential during all work in conjunction with liquefied cryogens. Such clothing consists of
  - Safety gloves
  - Work gloves
  - Face shield
  - Laboratory coat or overalls (cotton or linen)
  - Non-magnetic safety shoes
- Dewars should be stored in a well-ventilated area. Cryogens could be accidentally released in gaseous form, resulting in an asphyxiation hazard.
- All dewars and gas cylinders must be non-magnetic.
- Gas cylinders should be stored upright and secured to the wall with a chain with the metal protective top in place. (If a cylinder falls over or the valve is knocked off, the container may act like a rocket; a full cylinder has enough power to penetrate walls.)
- Because the cylinder's metal cap may be magnetic, the cap should always be removed before bringing the cylinder into the magnet room.

- If possible, all personnel should stay out of the magnet room when a qualified service engineer is filling cryogens in the magnet. If personnel must be present, they must wear proper gloves, a face shield, and ear protectors.
- A qualified service engineer should be present any time cryogens are transported within the hospital or added to the magnet.
- It is crucial that ventilation and cryogenic systems be kept in good repair and checked regularly to ensure proper functionality.
- Flammable materials must not be brought near the cryogen containers.
- You are responsible for establishing and following a procedure, in accordance with your local and federal requirements (in the US: OSHA 29 CFR 1910.36), that includes possible evacuation of the MRI area, if flammable materials are identified near cryogenic gases. If grease, oil, or other combustible material is present in the vicinity of the containers, the escape of cryogenic gases can lead to the formation of a potentially combustible liquid due to liquefaction of air and concentration of oxygen.

Quench vent failure hazards

LHe will transform into a gaseous phase if a vacuum breach occurs. When this happens, the normal room temperature in the vacuum space will cause the liquid helium to quickly boil away and must be vented out of the building. Never install a magnet to an uncompleted vent and if a vent line has a failure, do not perform any service operations on the magnet and system.

LHe will also transform into a gaseous phase when the electrical energy stored in the magnet cryostat is released. A rapid release of wire current is defined as a magnet quench. A quench can occur when part of the superconducting coil enters the normal (resistive) state. When this happens, the electric current dissipates as heat and the liquid Helium quickly boils away and must be vented out of the building.

The very cold temperatures, dynamic forces, and internal pressures produced by this expanding gas must be accommodated by the customer supplied cryogen vent system.

Room safety is ensured when a quality and compliant cryogen vent system is connected to the GE magnet to the customer supplied cryogen vent. The cryogen vent will allow the Helium gas to flow out of the MR scan room to unoccupied spaces.

Cryogen management is a safety issue. All GE and Medical Device suppliers must follow IEC regulations.

Quenches are indicated by a loud noise, warning message, or the tilting of an image on the display screen. A quench is a hazard only if the vent fails, which would result in the release of white clouds of cryogen vapor into the magnet room. This would present a potential asphyxiation hazard to both the patient and personnel. It is critical to have a well-planned method to quickly evacuate the patient and personnel from the magnet room should a quench occur.

WARNING

In the unlikely event of a quench and vent failure, a procedure needs to be in place to evacuate the patient and all personnel from the magnet room. Failure to follow these precautions can result in serious injury (e.g., asphyxiation, frostbite, or injuries due to panic).

The table below lists the decay times in the case of a quench or the Emergency Magnet Rundown switch is activated.

Figure 2-32: Examples of system decay time to reach 20 mT for 1.5T systems

System	Decay time (seconds)
1.5T systems	60

GRADIENT MAGNETIC FIELDS

Gradient magnetic fields introduction

Gradient magnetic fields produce rapidly changing magnetic fields during scanning. Gradients turn on and off very rapidly to spatially encode the MR signal during a scan. High frequency gradient amplitudes switched very quickly (high dB/dt) may cause nerve stimulation at periphery of body due to induced currents in nerves. Because a current can be induced in any conductive material lying on or near the patient's body, a potential biological hazard exists. The greater the rate of change of the magnetic field (dB/dt, slew rate), the larger the induced current. The muscles, nerves, and blood vessels of the human body are all conductive materials.

WARNING

Ensure occupational exposure to time varying magnetic field caused by the gradients complies with local requirements.

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GRADIENT MAGNETIC FIELDS

Calculate maximum gradient output

Let d be the total duration of the gradient ramp (minimum to maximum) or the period of a sinusoidal waveform divided by π. Let f be a fraction (0.8 for Normal Mode or 1 for First Mode). Let c be the chronaxie time in microseconds. Let d|B|/dt_0 be the rheobase (rb, infinite ramp duration) value of the time varying gradient magnetic field. Gradient output may be expressed by the following equation;

Maximum gradient output on a cylinder of 0.2 m radius may be found from equation and table below. f is the fraction of the mean stimulation threshold, rb is the infinite ramp duration mean PNS threshold, c is the rheobase value (ramp duration where the mean threshold is 2*rb), and d is the gradient ramp duration.

$$\left(\frac{d|B|}{dt}\right)_{limit} = f\left(\frac{d|B|}{dt}\right)_0\left(1+\frac{c}{d}\right)$$

Table 2-44: Rheobase and chronaxie constants gradient coil

Type	rb (T/s)	C (µs)
BRM	23.7	370

Related topics

Contraindications for use

GRADIENT MAGNETIC FIELDS

Gradient output limits

Safety parameter levels approved for the Second Controlled Operating Mode are set by the Investigational Review Board (IRB) or other human studies boards. For Gradient Output these levels are measured as a percentage of the mean peripheral nerve stimulation threshold (PNS).

CAUTION

Continuous patient observation and contact are required in all modes of operation. Medical Supervision is required in the First or Second Level controlled operating modes.

The MR system gradients are capable of operating under several modes:

- Normal: the normal operating mode, admissible for all individuals.
- First Level: controlled operating mode, admissible for patients on whom a medical decision was made ensuring that they can handle the increased gradient output effects or increased SAR. Limits for increased gradient output and SAR are based on current scientific literature related to safety.
- Second Level: controlled operating mode, admissible for customers with Investigation (ethical studies) Review Board (IRB) clearance and with a proprietary license agreement with GE. IRB review must include explicit approval of the percentage PNS threshold.

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Product maximum gradient output

The table below gives d|B|/dt for the maximum magnitude values of the vector sum of the field components generated by each of the three GRADIENT UNITS simultaneously at the published peak gradient strength and peak slew rate. The values are in terms of d|B|/dt at various diameters (in meters) from the gradient coil axis. The diameters include 0.2 m, 0.4 m, and the bore diameter minus 0.1 m. The values include no peripheral nerve stimulation limits.

Table 2-45: Maximum d|B|/dt on cylinders of various diameters at the product slew rate

max d|B|/dt [T/s]	D= 0.2 (m)	D = 0.4 (m)	D = 0.5 (m)
BRM	65.2	87.3	111.1

CAUTION

Gradient output may be controlled by Local Approval.

Table 2-46: IEC gradient output limits

Operating mode	PNS Limit
Normal	80% mean nerve stimulation threshold.
First Level (controlled mode)	100% of the mean nerve stimulation threshold. Requires you to click the [Accept] button to proceed when the Normal mode dB/dt or SAR limits are exceeded, but Second Level mode has not yet been reached.
Second Level (controlled mode)	Requires research key and IRB or Human Ethical Committee approval of the research to be conducted.

GRADIENT MAGNETIC FIELDS

Peripheral nerve stimulation

The concern from time-varying gradient fields is to prevent cardiac stimulation and ventricular fibrillation. Cardiac stimulation in the most sensitive population percentile requires at least 39 times as much energy as is produced with peak gradient amplitude of 0.05 Tesla/meter and Slew Rate of 200 Tesla/meter/sec.

Regulatory bodies use avoidance of painful nerve stimulation to limit gradient output with an adequate safety margin. Painful nerve stimulation typically occurs at approximately double the mean stimulation perception threshold. Some discomfort is experienced about 1.5 times the mean PNS threshold, see figure below.

Peripheral nerve stimulation (PNS) problems are not of concern on systems compliant with IEC 60601-2-33 Normal or First Controlled Operating Modes. The IEC limits PNS to 80% of the mean threshold in Normal Mode (where stimulation should be rare) and 100% for the First Mode (where non-painful stimulation is expected in about half the patients).

If the patient can not tolerate PNS, change to Normal Mode to eliminate the problem. Otherwise change to a lower slew rate pulse sequence to continue scanning the patient. MR workers may experience similar sensations if they are in or very near gradient coils during active scanning, and so keep sufficient distance away from the gradient coils during scanning.

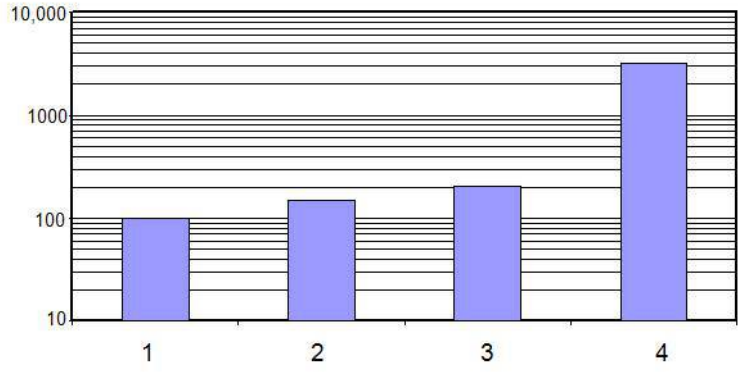
The Anterior/Posterior (A/P) (=Y) gradient axis typically has the lowest stimulation threshold. So it is prudent to keep the gradient waveform most likely to stimulate (the gradient waveform with the highest slew rate for the longest total ramp time) on a physical axis other than Y.

You should remain in constant contact with the patient, especially in the FIRST CONTROLLED MODE, to ensure that the patient does not feel painful stimulation (or high localized heating).

The figure below displays a graph of the relative mean threshold (vertical axis) and discomfort stimulation levels (horizontal axis) where relative means are for perception (100), discomfort (1000), and pain (10,000).

- 1 = threshold
- 2 = uncomfortable
- 3 = intolerable
- 4 = 1% cardiac

Figure 2-33: Relative mean threshold and discomfort stimulation levels



The distribution of those experiencing PNS is illustrated in the figure below; three curves where the horizontal axis is the normalized level and the vertical axis is the% probability of PNS. The curves represent the following:

- 1 = threshold
- 2 = uncomfortable
- 3 = intolerable

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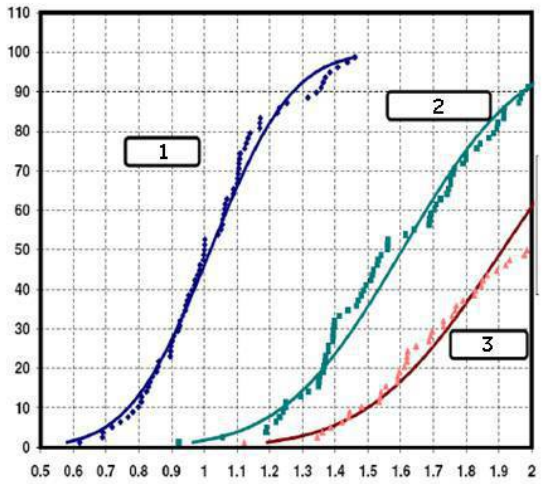
Figure 2-34: PNS probability. X axis = Fraction of the Mean Threshold (100% PNS). Y axis = Population percentile.



CAUTION

To reduce the possibility of PNS, make sure the patient's hands are not clasped or touching and that their feet are not crossed. Either or both of which could form a conductive loop.

CAUTION

Due to the rapid rate of change of the magnetic fields (dB/dt) used during some scans, a percentage of patients may experience a non-hazardous tingling or touch sensation. The **PNS probability graph** indicates the type of sensations caused at different percentages of the mean nerve stimulation threshold. Note that stimulation is relatively rare in NORMAL MODE (x-axis=0.8), but occurs about 50% of the time in the FIRST MODE (x axis=1). If this sensation is bothersome or uncomfortable to the patient, stop the scan. Change to NORMAL MODE to continue scanning the patient. The MR worker may experience similar sensations if remaining within the gradient field during active scanning.

CAUTION

There is a possibility that mild peripheral nerve stimulation (PNS) may be induced in the MR worker when that person is exposed to the gradients when the system is operating in the First Level Controlled Operation Mode. The MR worker should remain outside the magnet room during scanning in this Mode except when circumstances dictate otherwise.

CAUTION

Peripheral nerve stimulation is not harmful. The potential for inducing peripheral nerve stimulation is kept within limitations. The MR system is limited from operating above 80% of the PNS threshold in the NORMAL

Mode (100% of the mean PNS threshold in the First Mode) by the software (unless the system is in Second Controlled Mode). The point at which 50% of a population experiences PNS is the PNS threshold. PNS has been described as a light “touching” sensation felt on various areas of the skin surface. These areas vary depending upon which gradient axis is in use. Some common areas for the sensations are the bridge of the nose, arms, chest, and upper buttock/abdomen. Hands clasped together increase the potential for stimulation by approximately 65%. The potential for PNS is low, but it exists for all sequences in all gradient configurations.

 Please report all complaints of patient discomfort that may be associated with PNS during MR examinations (e.g., muscle twitches, tingling sensations, or headaches) to GE. See **Safety information** for contact information.

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GRADIENT MAGNETIC FIELDS

Acoustic noise

Another potential safety issue associated with gradient switching is the loud noise. The rapid alternations of currents within the gradient coils cause the coil assemblies to vibrate against their mountings, thus generating a loud resonant noise. The acoustic noise produced during scanning can exceed 99 dBA in the bore.

WARNING

The sound level at the operator's console should be limited to comply with local rules.

WARNING

Hearing protection is required for all people, including the MR worker, in the magnet room during a scan to prevent hearing impairment. Acoustic levels may exceed 99 dBA. Patient hearing protection with a noise reduction rating (NRR) of 29 dB or better is required to reduce acoustic level below 99dBA. The A-weighted RMS sound pressure level is measured according to NEMA MS 4: 2010.

CAUTION

All personnel should be trained on the proper use of hearing protection.

- Special attention should be utilized to protect the hearing of neonates, premature infants, and any other condition that does not allow for hearing protection to be applied.
- Patients with increased anxiety may have a lower acceptance to sound pressure (e.g., newborns, infants, young children, elderly, and pregnant women and the fetus).
- Anesthetized patients have less then normal protection against high sound pressure. Hearing protection should not be omitted.
- Typical operator console noise levels are below 60 dBA, so hearing protection is generally not required at the operator console. However, it is important to ensure the sound level complies with all local regulations.
- In some countries, legislation exists that limits employee exposure to noise levels. Ensure compliance with your local regulations by providing additional hearing protection to MR workers for use in the magnet room where required.
- If a music sound system is in use by the patient during scanning, the music sound system must provide > 29dB NRR of attenuation. All hearing protection devices must provide > 29dB NRR of attenuation.

Encourage the routine use of earplugs to prevent problems associated with acoustic noise during MR procedures. GE offers disposable ear protection of various noise reduction ratings. These can be ordered through the GE accessories catalog. The table below, describes the available types of disposable ear protection.

Table 2-47: Disposable ear protection

Description	dB
E8801BA EAR Disposable Foam Earplugs	29
E8801BB EAR Taperfit2 Foam Earplugs	32
E8801BC Max-Lite Foam Earplugs	30

ELECTROMAGNETIC FIELDS

Electromagnetic fields introduction

The Radio Frequency (RF) field is an oscillating electromagnetic field. Pulses of RF energy are used to generate the signal, which cause tissues to absorb RF power. Under certain conditions, this may cause tissue heating. The amount of heating depends on several factors, such as patient size and pulse sequence timing. RF heating of tissues is greatest at the periphery of the skin. The Specific Absorption Rate (SAR) is the estimated amount of heat dose received by the patient. This value is expressed as watts of power per kilogram of the patient's body weight.

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ELECTROMAGNETIC FIELDS

Tissue heating

Before the patient is scanned, the computer estimates the level of heating and compares it to the predetermined exposure limits. If the scan is expected to exceed these limits, the system then adjusts the scan parameters before starting the scan. The complete estimate is based in part on patient weight. Therefore, take care to enter the patient's weight correctly to prevent excessive RF exposure or scan abortion.

When patient temperature is not changing, typical skin temperatures are about 33 °C while core temperatures are about 37 °C. Patients dissipate metabolic heat at the same rate it is generated so there are no skin or core temperature changes. Humans subjected to significant radio frequency power deposition (i.e., significant SAR) will normally attempt to dissipate the additional heat load through vasodilatation of skin blood vessels permitting skin to approach core temperature. This action typically causes the skin to flush (turn red) and enables the body to dissipate heat more rapidly. This skin flushing is a normal response to significant radio frequency power deposition. Skin reddening or to a lesser degree the report of a warming sensation without reddening regardless of the method it was created (SAR, Contact, Metal, etc) is not hazardous if it clears in a few hours.

Patient comfort module

The temperature inside the magnet room should be set at less than 70°F and the bore fan should be turned on at all times to keep air flowing inside the bore of the magnet.

Thermal hazards

The increase in tissue temperature caused by RF exposure depends on a variety of factors associated with the thermoregulatory system of the individual and the surrounding environment. Thermoregulatory is the ability of the body to maintain regulated heat capacity levels. Observe the following warnings concerning tissue heating:

WARNING

RF power deposition can heat the patient's tissue if delivered faster than the patient's tissues can dissipate the generated heat. The amount of tissue heating depends on the patient's weight, type of pulse sequence, timing factors, number of slices, SAR, and the use of imaging options such as saturation. Power deposition will typically be lower when the NORMAL MODE is selected for SAR. FIRST MODE for SAR offers higher performance but also higher power deposition.

WARNING

A rise in body temperature can be a hazard to a patient with reduced thermoregulatory capacity and increased sensitivity to raised body temperature. These can be caused by pre-existing conditions, such as cardiac impairment that has reduced circulatory function, hypertension, diabetes, old age, obesity, fever, pregnancy, or an impaired ability to perspire. A patient with these complications must be carefully monitored at all times. Consider scanning with NORMAL MODE for SAR for patients that may not tolerate the higher levels.

CAUTION

The MR worker who remains in the scan room during a study could be subject to tissue heating caused by RF energy exposure. Care should be taken to limit the time the MR worker remains in the scan room during a study.

CAUTION

All patients should be monitored for increased temperature during the scan acquisition. If the patient reports discomfort due to warming, stop the scan. Patients should be provided with the hand-held Patient Alert bulb prior to scanning. The patient should be instructed to communicate any concerns through the intercom or by activating the Patient Alert bulb.

CAUTION

RF heating can be caused by:

- Damp clothing.
- Contact of body or extremities against the RF transmit coil surface, contact with metal, tattoos or metallic eyeliner, contact with other body parts.
- Scanning with an unconnected receive coil or other cables in the RF transmit coil during the examination.
- Formation of loops with RF receive coil cables and ECG leads.
- The use of MR Unsafe or MR Conditional (used outside of its conditions for use) ECG electrodes. Never use ECG electrodes past their expiration date.
- The use of MR Unsafe or MR Conditional (used outside of its conditions for use) ECG leads. MR ECG leads have a very high impedance that limits current to below the level of concern.

CAUTION

Extra attention should be utilized when scanning patients who are unconscious, sedated, or may have loss of feeling in any body part (temporary or permanent paralysis). They may not be able to alert you to RF heating.

CAUTION

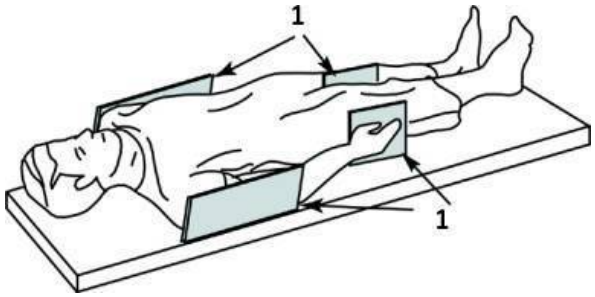
The coil selected should match the coil that is connected. When scanning with a transmit/receive only coil, DO NOT scan using the body coil (or use the Body coil configuration) at any time. Using the body coil can cause RF heating and could result in patient burns. In addition, scanning with the body coil can damage the transmit/receive only coil, making the coil unusable and requiring that the coil be returned to the factory for service.

ELECTROMAGNETIC FIELDS

Contact point heating

Patient positioning can affect the safety of the scan procedure. To help prevent a patient burn from closed loops formed by the following examples: clasped hands, by hands touching the body, from thighs contacting, the patient's breasts contacting the chest wall over a small area, etc., insert non-conducting pads at least 0.25 inches thick between touching parts and between the patient and the bore wall and the patient and any coils or conductors.

Figure 2-35: Patient positioned with non-conducting pads (1)



Observe the following warnings concerning contact point heating to protect patients from excessive heating or burns related to induced currents during MR procedures:

WARNING

RF can cause localized heating at contact points between the patient/bore and patient/RF coil resulting in discomfort or burns.

WARNING

RF can cause localized heating at contact points between adjacent body parts when a loop is formed. Such localized heating can result in discomfort, or burns. This could occur when a patient's hands are touching or when a female patient's breasts are compressed to her chest. Use pads between body parts to avoid creating a loop with adjacent body parts.

WARNING

Place appropriate non-conductive padding between the patient and the bore wherever a portion of the body may come into contact with the magnet opening.

WARNING

Always place appropriate non-conductive padding between the surface coil and the patient's skin to prevent burn injuries.

WARNING

For shoulder imaging, always place appropriate non-conductive padding between the patient's opposite shoulder or a portion of the patient's body and the bore wherever a portion of the body or opposite shoulder comes into contact with the bore.

CAUTION

RF can cause localized heating at patient contact points. Wet diapers or incontinence products have the same electrical properties as human tissue. All patients with diapers, including adults, should have dry diapers on prior to the start of the scan. If the patient reports discomfort due to warming, stop the scan.

ELECTROMAGNETIC FIELDS

Conductive material heating

Another potential hazard related to the RF field is the heating of implants, devices, and objects of conductive (e.g. metallic) compositions that may cause temperature changes during an MR examination. The induced currents in the conductive (e.g. metallic) objects may cause them to get so hot that they can actually cause burns in adjacent tissues. Therefore, it is very important to determine each patient's work history and thoroughly screen for any accessories containing conductive material.

Observe the following warnings concerning conductive material heating to protect patients from excessive heating or burns related to induced currents during MR procedures:

WARNING

Eye makeup that contains metal flakes can cause eye and skin irritation during MR scanning. Instruct patients to wash off removable makeup before the exam to avoid the risk of eye injury. Before scanning, warn patients with permanent eyeliner or other metallic ink tattoos about the risk of skin irritation and instruct them to get prompt medical attention if they experience severe discomfort following an MR exam.

WARNING

Metal fragments/slivers can deflect and/or heat in a magnetic field, damaging surrounding tissues. Patients thought to have metallic fragments in the eye should receive an eye exam to detect and remove any metal fragments that could deflect and damage the eye.

WARNING

Jewelry, even 14-karat gold, can heat and cause burns. RF can heat (even non-ferrous) metal and cause burns.

WARNING

Medicinal products in transdermal patches may cause burns to underlying skin.

WARNING

The use of MR Unsafe or MR Conditional (used outside of its conditions for use) stereotactic frames and RF blankets is not recommended.

ELECTROMAGNETIC FIELDS

Specific Absorption Rate (SAR) limits

It is necessary to measure the RF absorption in tissues since RF exposure cannot be measured by the system. Energy dissipation through absorption by the body can be described in terms of Specific Absorption Rate (SAR). SAR is a rate, meaning it is a measure of the amount of RF power absorbed per unit of mass of an object in watts per kilogram (W/kg). There are several types of SAR, listed in the table below, that must be understood.

Table 2-48: SAR definitions

SAR type	Definition
Whole body	SAR averaged over total patient body mass over any six-minute period for Body and Receive Only surface coils, which use body transmit.
Partial body	SAR averaged over the exposed mass in the coil averaged over any six-minute period.
Head	SAR averaged over the mass of the patient's head over any six-minute period.
Extremity	SAR averaged over the estimated mass of the patient's extremity over any six-minute period for small volume and Transmit/Receive coils.
Short term	The SAR averaged over any 10-second period.

The MR system SAR operating modes:

- **Normal:** the normal operating mode, admissible for all individuals assuming MR Conditional requirements are met.
- **First Level:** controlled operating mode, admissible for patients on whom a medical decision was made ensuring they can handle the increased SAR effects. Increased SAR levels are based on current scientific literature related to safety. There is a potential risk for increased tissue heating and nerve stimulation when operating above Normal mode.
- **Second Level:** controlled operating mode, admissible for customers with a propriety license agreement with GE and with Investigational Review Board clearance for the investigational protocol. IRB review must include explicit approval of the SAR limits. There is a potential risk for increased tissue heating and nerve stimulation when operating above Normal mode.

CAUTION

Continuous patient observation and contact is required in all modes of operation. Medical Supervision is required in the First or Second Level controlled operating modes.

CAUTION

SAR may be controlled by Local Approval.

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CAUTION

For sites which need to comply with IEC60601 3rd or local safety standard YY 9706.233-2021, this MR equipment shall not be used in the normal operating mode when the scan room temperature is greater than 24 °C or relative humidity about 60%.

WARNING

The magnet room temperature shall not be more than 21°C per the manufacturer's requirements and the relative humidity shall not be more than 60%. Temperatures above 21°C and humidity above 60% could result in lowering the system SAR limit.

The derating temperature is 25°C for relative humidity less than 60%. For each 10% increase of the relative humidity in excess of 60%, the temperature is reduced by 0.25°C, e.g., 24°C at 100% relative humidity.

For each degree of environmental temperature that exceeds the SAR-derating temperature, the whole-body SAR limit is reduced by 0.25 W/kg until the SAR is 2 W/kg or 0 W/kg for the First Level controlled operating mode or for the Normal mode, respectively.

WARNING

The RF power monitor and SAR limitations help prevent excessive RF exposure to the patient; SAR values are calculated based on the patient's weight. To help avoid injury, enter the patient's correct weight to set operating limits and prevent excessive RF exposure.

WARNING

The SAR algorithms for the MR systems calculate SAR values and set a limit on the number of slices/echoes per second in order to limit RF power deposition. The power monitor and SAR algorithm limit SAR, regardless of the patient weight or pulse sequence used. SAR limits are conservatively estimated from worse-case patient positioning as a function of weight.

The legacy power monitor module limits the RF amplifier output power thus limiting the patient SAR in case of a catastrophic failure. This module monitors peak power based on the patient's weight, duty cycle, and pulse sequence parameters. The peak power limits prevent you from using incorrect patient weights.

WARNING

The average power monitor and SAR algorithm limit SAR based on patient weight and RF transmit coil used. SAR limits are conservatively estimated from worse case patient positioning as a function of weight. The power monitor limits the RF power, which in turn limits the patient SAR to within controlled limits over time.

Pulse sequence SAR predictions (estimated SAR) are based on patient weight at the worst-case landmark. To minimize nuisance power monitor trips caused by patient-to-patient variability, pulse sequence predicted SAR is the mean plus

1.96 standard deviations (typically the normalized standard deviation is about 18% at the worst-case landmark). The expected worst-case nuisance trip rate is approximately 2.5%. If you experience a significant number of power trips above the 2.5% frequency, please consult your local field service representative. The power monitor measures actual power and limits SAR appropriately. The power measuring accuracy of the power monitor is about +/-12%.

Errors in patient weight do not result in excessive SAR. Low patient weight entries result in power monitor trips below the SAR limit. High patient weight entries result in fewer slices/images per unit time than would have been permissible.

SAR limits

The MR system's RF power monitor helps prevent excessive RF exposure due to equipment failure. Since the monitor protects the patient, it must be operational at all times, even when a scan is not in progress. If it detects an equipment failure, it immediately disables the RF system. This system must be repaired or adjusted by qualified service personnel.

Table 2-49: SAR operating limits

System	Normal mode (W/kg)	First level (W/kg)	Second level (W/kg)
1.5T	Head = 3.2 Body = 2.0	Head = 3.2 Body = 3.0	Head > 3.2 Body > 4.0

Patient acceptance of High SAR scanning can be increased by giving the patient breaks to cool down, providing light clothing, and limiting room temperature to 18 ± 3 °C, and by maximizing air flow.

The following table provides a bound for maximum B1rms (in micro-tesla) for body transmit coils and head transmit coils at 1.5 T. Values are shown for the limits at 1.5 T for the head transmit coil and for the body transmit coil with the patient's umbilicus at isocenter.

Table 2-50: B1rms limit (μT)

Coil	1.5T
Body Coil Umbilicus Landmark	3.6
Body Coil Chin Landmark	N/A
Head Coil	7.2

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CLINICAL HAZARDS

Clinical hazards introduction

Maintaining good patient contact and education can help reduce patient anxiety reactions and clinical scanning hazards in the MR environment and during procedures.

CAUTION

Continuous patient observation and contact are required in all modes of operation.

You need to be aware of the conditions and risks associated with the following:

- High-Risk Patients
- Scanning Hazards

CLINICAL HAZARDS

High risk patients

Several conditions are associated with high-risk patients, who may be at a greater risk of developing complications during an MR examination. Observe these warnings and be prepared to manage the needs of such patients during the examination.

WARNING

Patients with the following conditions are at the greatest risk of complications during MR scanning:

- Patients likely to develop seizure or have claustrophobic reactions.
- Greater than normal potential for cardiac arrest.
- Patients who are unconscious, heavily sedated, or confused and patients with whom no reliable communication can be maintained.

WARNING

Patient screening is required for patients who are going to be imaged on an MR scanner.

Some patients may experience feelings of fear or claustrophobia when undergoing an MR procedure. This could be related to the confining conditions of the magnet, the length of the examination, the acoustic noise, or the temperatures within the bore of the magnet. Discuss the procedure with the patient and be prepared to manage the needs of the patient during the examination.

CAUTION

The confining conditions of the MR system can precipitate claustrophobia in some patients. To prevent injuries due to panic, provide instructions and comfort the patient as needed to alleviate anxiety.

WARNING

Since direct observation from the operator's console can be partially obscured by the magnet enclosure, be sure to more closely monitor these types patients at all times to quickly identify and respond to medical emergencies. In some cases, emergency personnel should remain with the patient or be on standby alert to help prevent serious complications or death.

Related topics

Contraindications for use

Clinical screening

Screen patients and personnel

Patient emergencies

CLINICAL HAZARDS

Scanning hazards

During scan set-up, acquisition, and conclusion, be aware of the following scanning hazards:

WARNING

Do not use Projection Images for localization.

WARNING

Do not use 3D views only to perform voxel value, distance, angle, or area measurements. Always refer to 2D baseline views.

CAUTION

Measurements are more reliable when done on 2D views. Always check on the 2D reformatted views where exactly the points have been deposited.

CAUTION

Most multiple-channel receive only coils are designed to function best with adult patients. For smaller patients using the multiple-channel receive only coil the patient positioning is critical for optimal image quality. For small patients use appropriate non-conductive padding to place patient anatomy of interest in the center of the coil.

For example, the Head Neck Array coil is a multiple-channel receive only coil. Use appropriate non-conductive padding to place the patient's head in the center of the coil.

CAUTION

Make sure the patient connected IV lines, oxygen tubing, urinary catheters, and any other tubing and cables are long enough to allow full travel of the system and will not become entangled, pinched, or pulled.

CAUTION

Following the exam, your patient may need assistance when getting off the table. After lying in a prone position for a length of time, your patient may experience light-headedness upon sitting up.

CAUTION

If the magnet room door is open, the scan cannot be started. If the scan is already in process and the door is opened, the scan will pause. Close the door and press resume.

If the magnet room door is opened when attempting to start a scan, close the door and try again.

International regulations require the system to function in this manner.

CAUTION

Always base evaluations on all images in the data set and on the clinical history. Information from only a single image should not be used to evaluate a patient.

EQUIPMENT HAZARDS

Equipment hazards introduction

There are general equipment concerns in the MR environment. Make sure you are familiar with your MR equipment and the accessory equipment manufacturer's guidelines and precautions. Specifically, you need to be aware of the hazards associated with the following MR equipment:

- Laser Alignment Lights
- Cables and Equipment Connections

Also observe the following general equipment hazards:

WARNING

The MR staff must consult the GE Pre-installation Manual before installing any furniture or making any changes in the scan room. Failing to do so may hinder the servicing of the scanner and present a dangerous safety hazard to the service engineer.

CAUTION

Using equipment that is damaged or has been compromised, can put the patient and/or operator at risk of injury.

CAUTION

The MR system applications run on equipment that includes one or more hard disk drives, which may hold medical data related to patients. In some countries, such equipment may be subject to regulations concerning the processing of personal data and the free circulation of such data. It is strongly recommended that access to patient files be protected from all persons not in medical attendance.

CAUTION

Any application of physiological monitoring and sensing devices to the patient shall be made under the clinical staffs direction and is the clinical staff's responsibility. Use only MR Safe and MR Conditional (used within its conditions for use) devices. Devices with conductors or ferromagnetic parts may introduce safety concerns. For medical devices that are labeled as MR Safe or MR Conditional consult the device manufacturer's documentation.

EQUIPMENT HAZARDS

Laser alignment lights

The MR systems use semiconductor laser alignment lights for patient land marking. This type of alignment light casts a thin red light on the patient for the purpose of positioning and land marking. The laser lights can cause eye injury. The figures below display the safety labels for laser products and are located near the laser alignment light. Labels such as these provide safety information about laser radiation. The laser light is fixed over the patient in the anterior shell of the magnet and emits laser radiation in excess of Class 1 AEL.

Figure 2-36: Laser safety label

Figure 2-37: Chinese laser safety label for other MR systems

Your system may have a slight variation of these labels.

The eyes must be protected from laser radiation. The patient needs to be instructed to close their eyes when landmarking and the laser light is turned on. Exposing eyes to the laser alignment lights may result in eye injury.

CAUTION

Exposing eyes to laser alignment lights may result in eye injury.

- Do not stare directly into the laser beam.
- Instruct patients to close their eyes to avoid eye exposure to the alignment light.
- Closely monitor all patients and prevent them from accidentally staring into the beam. Do not leave the laser beam on after you position the patient.

EQUIPMENT HAZARDS

Cables and equipment connections

Various equipment and accessories are used in the MR environment for specific types of examinations that include cables and require connections to the MR system or the patient.

Application of MR conditional physiological monitoring and sensing devices to the patient should be made under your organization's direction and is the sole responsibility of your organization.

To avoid trip hazards, you should install yellow and black trip hazard indicator covers over any cables routed on the ground of the equipment room.

WARNING

The following general warnings should be followed when using cables and accessory connection equipment:

- For medical devices that are labeled as MR Safe or MR Conditional consult the device manufacturer's documentation.
- Use only GE or GE-authorized accessory coils, cables, monitoring and gating equipment that is labeled as MR Safe or MR Conditional (used within its conditions for use). Failure to restrict the use of such equipment not labeled for MR applications may result in patient burns or other injuries.
- Use only accessories, coils, and cables that are in good condition. If you suspect that an accessory is not in good condition, discontinue its use and contact your GE Service Engineer.
- Auxiliary devices indicated as MR Conditional may still cause patient injuries if the conditions for use are not explicitly followed. Never use equipment unless it is accompanied by the use instructions.
- Remove unplugged surface coils or unused accessory devices from the magnet bore; a patient burn can result.
- RF can heat non-compatible surface coils and MR Unsafe or MR Conditional (used outside of its conditions for use) gating cables, damaged surface coils/gating cables, surface coils that are not properly plugged in, and improperly routed cables can cause burns.
- The use of cable-connected surface coils, photopulse sensor for peripheral gating (PG), or electrocardiogram (ECG) gating accessories for patient scanning can result in localized heating, leading to a burn or fire if proper scan preparation is not followed. The cables often extend into the high intensity region of the RF field and it is possible that induced electrical currents in the cables may cause arcing.
- Always bring the cable directly out of the magnet bore with no slack. Place cables under the cushion whenever possible to separate the cable from the patient.
- Keep the length of cable in the bore to a minimum. Avoid bending the cable 180° and route the cables out of the bore in the most direct way.
- Route cables through the center of the magnet bore. Place cables under the cushion whenever possible to separate the cable from the patient. Routing near the sides of the bore increases the likelihood of cable heating (from induced currents).
- Do not cross or loop cables. Arcing and patient burns could result.

In addition to the warnings above, there are specific warnings related to Cardiac Gating Equipment and Accessory Coils you need to understand to maintain a safe MR environment.

Cardiac gating equipment

Electrocardiogram (ECG) gating (triggering) may be performed in an MR environment to synchronize the MR scan acquisition with the patient’s heart beat. Only MR Safe and MR Conditional (used within its conditions for use) electrodes and high-impedance leads should be used in the MR environment to ensure patient safety. For medical devices that are labeled as MR Safe or MR Conditional consult the device manufacturer's documentation.The ECG

triggering feature on the system should only to be used for cardiac gating and must not be used for patient monitoring. It is important to use only GE recommended disposable electrodes and GE High Impedance ECG Cables.

WARNING

Observe the following warnings when using ECG or peripheral gating:

- The MR cardiac gating feature is intended for use solely in acquiring MR images using cardiac gating/triggering, not for physiological monitoring. The patient's condition may not be reflected, resulting in improper emergency treatment.
- Do not use monitoring equipment when conductors are in the bore and touching the patient; burns can result.
- Do not use leads with broken shields or exposed conductors. Only use accessories in good condition. If you suspect that an accessory is not in good condition, discontinue its use and contact your GE Service Engineer.
- Check to see that the cardiac or peripheral gating cable does not pass under or near the surface coil or surface coil cable.
- Check to see that only the peripheral gating sensor touches the patient. Keep cables from coming in contact with the patient.
- Do not use equipment that has not been specifically tested and approved for use in the environment of a MR system.
- Physiological monitoring and sensing devices should be used solely under the operators direction and it is their responsibility to ensure patient safety.

WARNING

Do not use waveforms for physiological monitoring. Patient condition may not be reflected, resulting in improper treatment.

WARNING

Do not use expired or dried electrodes. They do not properly conduct the signal, which can lead to image degradation, create intermittent triggering, and can cause burns to the patient.

WARNING

GE High Impedance ECG Cables shall only be used under the conditions described below.

Non-clinical testing has demonstrated this device is MR Conditional and can be scanned safely only under the following conditions:

- Maximum static magnetic field: 3.0T
- Maximum spatial gradient: 1650 Gauss/cm
- Maximum whole body average SAR: 4W/kg for 60 minutes of scanning produced a temperature of less than 41°C
- The ECG lead signal may be visible in the images

Accessory coils

It is important you familiarize yourself with the operating instructions for each accessory coil used in your MR environment. Follow the recommended guidelines and precautions by the manufacturer.

WARNING

Observe the following warnings when using surface coils:

- Do not use surface coils with exposed coils or damaged insulation. Skin contact with metal conductors can cause burns.
- Do not allow the surface coil cable to touch the patient; patient burns can result. Use a thermal resistant material or pad to keep the cable from touching the patient.
- When using the 1.5T Breast Coil, make sure the patient's back and arms do not touch the magnet bore. Use thermal resistant material or padding between the patient and the magnet to prevent burns that could be caused by patient contact with the interior of the magnet bore.

CLINICAL SCREENING

Clinical screening introduction

To avoid potential health hazards in the MR environment, personnel and patient screening procedures should be established in your imaging facility. Every person working or entering the magnet room or adjacent rooms with a magnetic field needs to be instructed about the dangers. This should include all MR workers, maintenance, service, and cleaning personnel, as well as the local fire station team.

All MR workers need careful assessment prior to engaging in operation of the MR system. Additionally, all patients undergoing the MR examination need careful assessment prior to the procedure. Screening helps identify anything that might create a health risk or interfere with MR imaging. It also assists you in determining if the patient has any specific needs or limitations. Additionally, if another person accompanies the patient undergoing the MR examination, they should be screened and managed in the same manner as the patient. The aim of screening is to safely obtain high-quality images so an accurate diagnosis can be made. Maintaining a controlled and safe environment can be achieved by careful questioning patients, visitors/family members and all personnel.

 Screen each patient thoroughly for pertinent medical history and conditions that contraindicate scanning before initializing an examination. If proper scanning can not be performed, postpone MR examinations until the screening can be completed.

A documented screening procedure should be followed by a review of the completed form and a verbal conversation to verify the form information and provide the patient time to express his or her questions or concerns. The review and discussion should be conducted by MR safety-trained personnel to ensure there is no miscommunication about the MR safety issues.

A written screening form must be completed each time a patient is to have an MR examination. Even if the patient undergoing previous MR examinations and/or has completed the screening form previously, does not assure the patient another safe examination.

Related topics

Contraindications for use

High risk patient

Screen patients and personnel

Patient emergencies

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CLINICAL SCREENING

MR compatibility

Review the following information related to spatial magnetic field data:

- **Contraindications for use**
- **Spatial magnetic field data**

A device is labeled as MR Conditional if it has been demonstrated to pose no known hazards in a specified MR environment with specified conditions of use. Field conditions that define the MR environment include static magnetic field strength, static spatial gradient, time rate of change of the magnetic field (dB/dt), RF fields, specific absorption rate (SAR), and coil to be used. Additional conditions, including specific configurations of the item (e.g., the routing of leads used for a neurostimulation system), may be required.

WARNING

The attractive force of the magnetic field of the MR system can cause ferrous objects to become projectiles, which can cause serious injury. Post the Security Zone warning sign on the entrance to the magnet room and keep all hazardous objects out of the magnet room.

WARNING

GE shall not be responsible for assessing the proper function of any device. The user of the device must consult the device manufacturer to ensure the device is MR Safe or MR Conditional. Then the user must ensure the MR Conditions are met. Finally, the user must determine what is appropriate.

DANGER

Devices compatible at one field strength, such as 1.5T, may not be compatible at another field strength, such as 3.0T. Prior to patient scanning, confirm with the device manufacturer that the device is compatible at your field strength.

MR compatibility test guidelines

Introduction

This section document describes a set of specifications and standards that can be used to evaluate the Magnetic Resonance (MR) compatibility of hand-held, non-electronic equipment used in conjunction with the MR system.

MR compatibility standards

The American Society for Testing and Materials, International (ASTM) has developed the following MR compatibility standards (and are developing more):

- F1542 Specification for the Requirements and Disclosure of Self-Closing Aneurysm Clips
- F2052 Test Method for Measurement of Magnetically Induced Displacement Force on Medical Devices in the Magnetic Resonance Environment
- F2119 Test Method for Evaluation of MR Image Artifacts from Passive Implants
- F2182 Measurement of Radio Frequency Induced Heating Near Passive Implants During Magnetic Resonance Imaging
- F2213 Measurement of Magnetically Induced Torque on Medical Devices in the Magnetic Resonance Environment
- F2503 Practice for Marking Medical Devices and Other Items for Safety in the Magnetic Resonance Environment

These may be ordered online at http://www.astm.org.

CLINICAL SCREENING

Screening form

A comprehensive, printed screening form should be used to assess the patient and document the information. The form can be customized for your MR suite and might consists of three sections:

- Section 1: General Information
- Section 2: Hazardous Items Checklist
- Section 3: Magnet Room Pre-Entry Checklist

WARNING

Patient screening is required for patients who are going to be imaged on an MR scanner.

General information

Section 1 of a patient screening form contains general information concerning patient demographics and the patient's medical and work history. Relevant patient-related information is valuable for obtaining current medical conditions and information on prior diagnostic studies that may be helpful in evaluating the patient's state.

Determining the patient's work history is important for those who work in machine shops or similar environments. These individuals may have small metal slivers or fragments of steel embedded in their eyes. If metal fragments are suspected, the patient should receive an eye examination to detect and remove hazardous materials before scanning.

Section 1 of a screening form also contains questions needed to help identify high-risk patients, i.e., those with conditions posing higher risk of complications during the MR exam. Questions explore risks due only to the condition of the patient (e.g. elevated risk of seizure or cardiac arrest) and also those due to the elevated SAR possible when operating in First Level Controlled Mode (e.g. for patients with compromised thermoregulatory capacity.)

MR workers may be at risk if previous occupational, recreational or other life experiences have resulted in the accidental implantation of metallic substances, such as slivers or fragments. Page 2 of the patient screening form should be completed by each MR worker to ensure the magnetic field does not pose a hazard to their well-being.

This section also contains questions for female patients concerning matters that may affect the MR examination. Pregnant patients must be identified before they are permitted to undergo an MR procedure. A physician should carefully compare and discuss the risks and benefits of the MR examination versus alternative procedures before scanning to control risk to the patient.

Hazardous items checklist

The Hazardous Items Checklist, in section 2 of a patient screening form, is valuable in identifying various implants and devices that may be hazardous to the patient undergoing the MR examination. Items that may produce image artifacts, can also be detected through this section of the screening process.

Some patients, including those suffering from forms of dementia, may not be aware of having a pacemaker. On such patients, palpate the upper torso and abdomen to make sure no pacemaker is present. Pacemakers may be implanted in any of several locations in the chest and abdomen. Pacemaker lead wires are sometimes left in place after removal of the pacing mechanism. The wires can induce current, producing heat during the MR procedure. Therefore, checking for lead wires is also important.

The best way to ensure a metal-free environment is to have patients change into patient examination attire. The checklist also includes items the patient may externally possess. Do not limit your inspection to only ferrous objects alone. Even non-ferrous items, such as gold jewelry, can heat during a scan and burn a patient. Make sure the patient removes all of these objects. In addition, be sure to check small children for safety pins and snaps on diapers or undershirts.

Section 2 of a form also contains an anatomical figure of the human body for patients to mark the location of objects they have inside or on their body. This information can be useful in determining the approximate area of objects that may be hazardous or produce artifacts.

Magnet room pre-entry checklist

The last section of a screening form lists metal or magnetic-sensitive items with which the patient can not enter the magnet room. Ensure the patient removes the checked items prior to magnet room entry. Also obtain signatures to document the person who completed and reviewed the screening form.

Patient emergencies introduction

You must become very familiar with the location and proper use of certain emergency buttons and releases should an emergency occur in the MR environment. Advanced planning and being accustomed to your site's procedures and surroundings are necessary to ensure a safe environment.

Before you begin any scanning procedure, explain the use of the Patient Alert System to your patient. Make sure he or she understands its purpose and use. Remember that implants, pacemakers, and ferromagnetic life-support systems cannot be brought into the magnet room.*

Be sure to closely monitor patients with a increased potential for cardiac arrest or claustrophobia, or patients who are unconscious or extremely ill. Always maintain visual contact with the patient. Be familiar with your site's predetermined location outside the magnet room where you can transfer patients if it becomes necessary for emergency personnel to intervene.

The figure below displays a general layout of an MR magnet room. You should always be able to maintain visual contact with your patient from the operator's console.

*In general, patients with conductive (e.g. metallic) implants are contraindicated for MR scans. Some implantable devices have been labeled as MR Conditional under certain operating conditions. Only use quadrature transmit for MR Conditional devices. MR Safe implants will have the MR Safe symbol in their implant documentation.

When evaluating whether to proceed with MR scanning on patients with such implants, consult the implantable device's labeling.

Figure 2-38: Magnet room layout

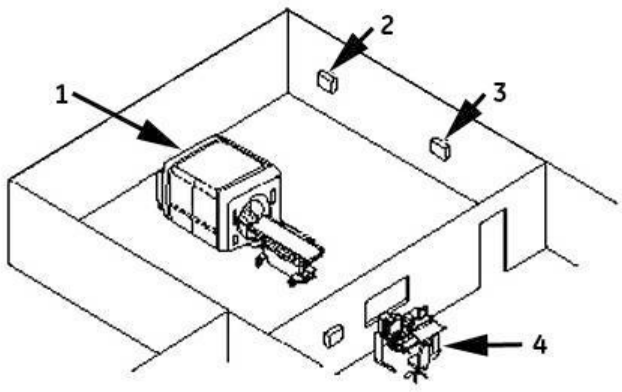

Table 2-51: Magnet room layout image legend

#	Description
1	Magnet and magnet enclosure
2	Oxygen monitor remote sensor (optional)
3	Emergency magnet rundown

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#	Description
4	Operator's console

Emergency medical procedures

Your site should define and implement specific procedures to follow in case of a medical emergency. These procedures should take account of the existence of the magnetic field. For example, they should instruct how to use the **Table Emergency Release** to remove a patient rapidly from the magnet's influence. Other product features useful in an emergency are described on the pages following.

PATIENT EMERGENCIES

Patient alert system

Your MR system has a Patient Alert system that enables the patient to alert you at the console by squeezing a bulb.

Figure 2-39: Patient alert system

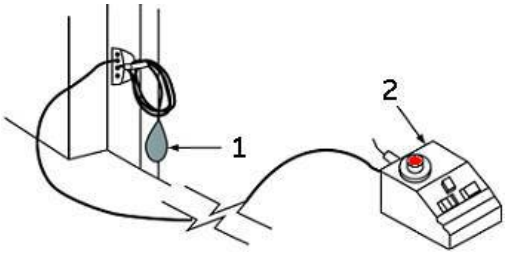

Table 2-52: Patient alert system image legend

#	Description
1	Patient alert bulb
2	Control box

Squeezing the Patient Alert bulb causes the control box to light up and emit an audible signal. A switch on the control box allows you to set the signal for intermittent or constant light and sound.

Your MR system also has an intercom system that enables you to maintain verbal contact with the patient throughout the examination.

CAUTION

Provide all patients with the Patient Alert bulb. This can be especially important for procedures that require the concerted attention of the technologist/operator at the MR or Advantage Workstation (AW) operator console, e.g., fMRI sequences.

PATIENT EMERGENCIES

Emergency stop

The **Emergency Stop** button is located on the keyboard and on both the right and left sides of the magnet enclosure. This function cuts off electrical power from equipment located in the magnet room that may present a hazard to the patient in an emergency situation.

You can press the **Emergency Stop** button to stop a scan in a patient emergency situation. To quickly recover from an Emergency Stop situation, you can press the **Reset EMO** button from the ISC cabinet. You should not be afraid to press the **Emergency Stop** button because it may shut the system down for an extended length of time. This is not required to shut down the magnet coldhead.

Figure 2-40: Emergency Stop buttons.

The **Emergency Stop** button disables the following systems:

- RF
- Gradient power supply
- Magnet room unit
- Table and patient support subsystem

WARNING

The Emergency Stop button does not remove the magnetic field, turn off the computer cabinets, operator's console, or camera.

PATIENT EMERGENCIES

Emergency off

The **Emergency Off** button is located on the wall next to all computer equipment and next to the MR magnet room doors and on the MR system Main Disconnect Panel (if provided). It removes ALL electrical power from ALL components of the system, including any power sources from uninterrupted power supply (UPS) devices.

The **Emergency Off** button not only stops a scan in a patient emergency, but also in the event of a serious equipment fault or hazards such as fire/water in the vicinity of the MR equipment. The entire MR system is to be turned OFF except for the static magnetic field and the magnet rundown unit used to shut down the magnetic field.

Figure 2-41: Emergency Off button

Use this button only in a major emergency in the computer or MR magnet room. For example, use this button when you notice fire, sparks, or loud noises not associated with normal operation of the system.

To restore power after emergency off, the main circuit breaker must be reset before rebooting the system. Always contact a service engineer before restoring power.

WARNING

The Emergency Off button does not turn off the magnetic field. To avoid personal injury or equipment damage, do not bring any ferromagnetic equipment into the magnet room. Assume that equipment is magnetic unless it is clearly labeled otherwise.

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PATIENT EMERGENCIES

PDU main breaker

The PDU Main Breaker turns off power to system components other than the Magnet Rundown Unit, cryogen compressor, scan room lights, chillers and magnet cryogen monitor. Typically, service uses this power off switch and the MR customer does not use it.

Figure 2-42: SIGNA™ Victor ISC cabinet

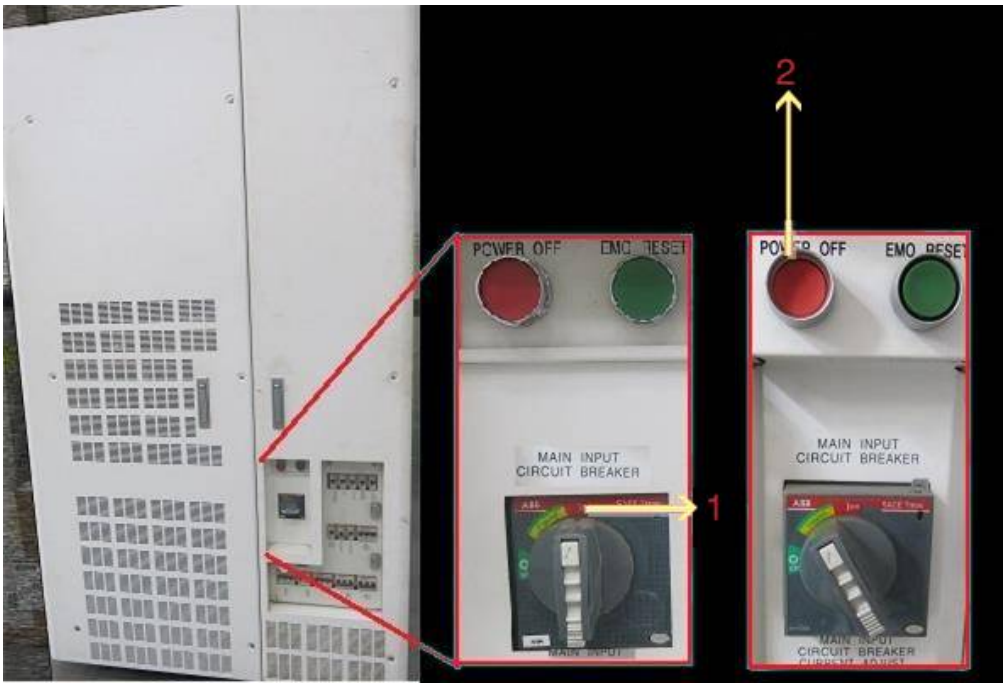


Table 2-53: Image legend

#	Description
1	Breaker
2	EMO Reset (green button) and Power OFF (red button)

PATIENT EMERGENCIES

Table emergency release

In an emergency, the patient cradle can be manually pulled out of the magnet.

You can release the cradle with the following three steps:

1. Hold the handle.
2. Rotate the handle
3. Pull the cradle out

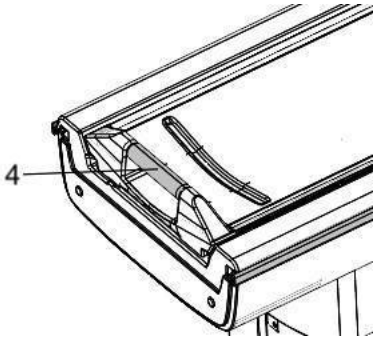
The P port connector housing will disengage from the LPCA and be pulled out with the coil connector during a table emergency release.

The label attached on the cradle illustrates the steps.

Figure 2-43: Cradle label

The figure below displays the cradle release handle on the patient table.

Figure 2-44: #4 points to the cradle release handle



Coil connector on the table after table emergency release.

The table can be lowered and raised with foot pedals in normal conditions. However, when the manual cradle release lever is used, the foot pedals no longer work to raise and lower the table because the cradle driving mechanism is retained in the magnet.

Figure 2-45: #1 points to the foot pedals

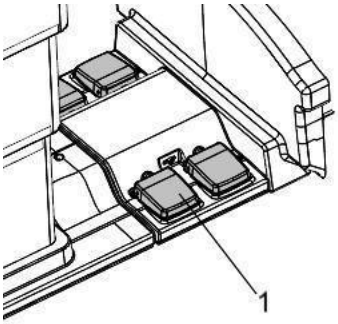


Figure 2-46: Table pedal labels

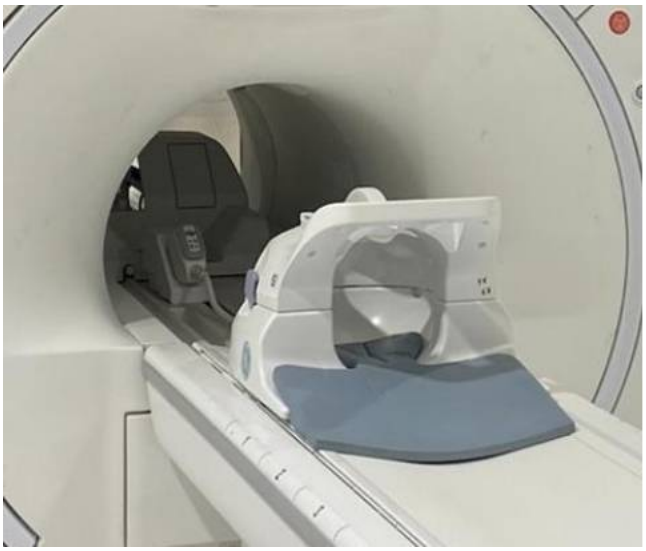
icon	Description
	Up pedal
	Down pedal

IMPORTANT! The patient table is permanently fixed to the magnet system. Always have a non-ferrous gurney placed outside the magnet room for emergency patient transportation.

IMPORTANT! Do not use the Magnet control buttons after the table emergency release procedure is completed. Wait until the table is re-engaged to the system before you use the Magnet control buttons.

It is recommended that all MR workers manually practice this procedure so you become familiar with the noise and the force needed to pull the cradle out of the magnet. Therefore, in the event of an emergency, you will know what to expect.

Figure 2-47: P-Port RF coil connector of the table.



Re-engage cradle after table emergency release

Use these steps to re-engage the cradle. It is required for the normal operation after the cradle is released.

1. Disconnect the coil from the P-Port. Push the port horizontally into the rectangular hole on the LPCA.

Figure 2-48: Pushing the port into the original position on LPCA horizontally

2. Grasp the handle and squeeze the lever to unlock the cradle from the home position.
3. Slowly push the cradle toward the magnet until the cradle attaches to the cradle drive.

- Push the cradle a little harder until it the cradle engages with the cradle drive.

4. Use the Magnet control buttons to make sure the cradle moves in and out.

After connecting a surface coil to the restored port, the In Room Display and Operator Console UI should tell that the coil is connected. If not, try to connect other coils. If none of the coils can be shown connected through UI, the problem may come from the port. Call GE service for further help.

ADDITIONAL WARNINGS AND CAUTIONS

Scan and Display introduction

This section includes additional warnings and cautions for the following areas:

Scan and equipment

- Auto Protocol Optimization
- AutoPaste
- CD/DVD handling
- Filters
- IDEAL Imaging Option
- IV pole
- MR Conditional
- Multi-echo FGRE/FSPGR
- Navigator
- Patient orientation
- Patient transfer
- Patient weight
- Post-contrast scans
- Prescan
- Radiation Oncology table tops
- Coils

Display or post processing

- AutoPaste
- Add/Subtract images
- Applications
  - VIBRANT Flex and LAVA Flex
- Imaging Option
  - IDEAL
- READY View
- Volume Viewer
  - Annotation
  - Filter Floaters
  - Measurements
  - Reformat
  - Threshold

ADDITIONAL WARNINGS AND CAUTIONS

Scan

This section contains additional scan warnings and cautions.

Auto Protocol Optimization

WARNING

When Enable is selected in ARC/ASSET Automatic Acceleration Allowed, a higher acceleration factor is used by applying the lowest resolution if the scan time or breath hold time is not short enough. This condition may cause aliasing artifact.

AutoPaste

WARNING

Do not use Pasting post process application with images that demonstrate metal implants.

CD/DVD handling

CAUTION

To avoid image loss, never touch the recording surface of a recordable CD (CD-R). Handle the disk only by the outer edge or central hole. Do not place it face down on a hard surface. Fingerprints or scratches will make the disk unusable.

Filters

CAUTION

Intensity Filter x and X+ may contain blur on tissue junction, and the results may be affected by tissue contrast. When intensity Filter is none, no intensity filter will be setting.

CAUTION

Images filtered for uniformity with SCENIC may contain hyper- or hypo-intense signal areas that are not apparent on unfiltered images. SCENIC filtering is derived from the image itself, and the results can therefore be affected by tissue shape and contrast.

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Flex Imaging Option

CAUTION

Verify that the FOV includes all anatomy. If not, phase wrap will cause water/fat signal to swap.

CAUTION

Images labeled as water may include signal from fatty tissue, and images labeled as fat may include signal from water. This error may occur in regions of high magnetic field variation, in spatially isolated tissue, due to patient or tissue motion, due to phase wrap artifacts, due to similar water and fat intensity in T2-weighted Flex scans, due to TE values beyond recommended limits, and/or in images with low signal-to-noise ratios. The presence of fat tissue in images labeled as water, or vice versa, may occur within single images or throughout an in entire stack of slices. By default, both sets of images (labeled fat and labeled water) will be reconstructed and inserted into the database for review. Proper calibration and center frequency selection will reduce the occurrence of this error. Complete elimination of this error may not be possible and thus interpretation of MR images must be completed by trained personnel.

IDEAL Imaging Option

WARNING

Computed R2* values are affected by the presence of contrast agents in tissue, and results may be incorrect. Do not utilize post-contrast images for generating R2* maps. Affected applications include multi-echo FGRE/FSPGR acquisitions such as IDEAL IQ, and any post process applications that create R2 star maps such as StarMap and READY View R2 Star.

CAUTION

Make sure that the FOV includes all anatomy. Phase wrap will cause water/fat signal swap.

MR Conditional

WARNING

Susceptibility artifacts, such as those related to MR Conditional metal implants, will result in incorrect 3D Geometry Correction. Please carefully verify images.

WARNING

If the calibration scan covers a region containing MR Conditional metal implants, the calibration images are expected to have distortion and signal void artifacts. Therefore, PURE and ASSET images that have MR Conditional metal present should not be used for post processing.

WARNING

READY View fusion does not function reliably if MR Conditional metal implants are present and a reference image other than the original image is used. READY View Fusion should not be applied on series if the image area includes MR Conditional metal implants. Strong B0 and B1 distortion caused by MR Conditional metal implants will cause image distortion and signal void in images. Reference images may have different level of distortion (e.g., MAVRIC SL versus non-MAVRIC SL) with functional series, and mis-registration will occur.

WARNING

Due to the strong magnetic field disturbance in a region containing metal, do not use the RF Drive Mode parameter: Optimized.

WARNING

Do not use the PURE[1] image filter when acquiring scans in the vicinity of metallic implants or devices. Signal distortion effects are not predictable and will result in incorrect images.

WARNING

The tests commonly employed to determine MR Conditional implant heating safety (standard, ASTM F2182, ASTM.org), require quadrature excitation. Heating results for non-quadrature excitation (such as parallel transmit, MultiDrive, or elliptical drive) are unknown.

For patients with MR Conditional implants or devices, applying Preset or Optimized RF Drive Modes may violate the MR Conditional specifications.

CAUTION

Safe scanning of patients with MR Conditional devices or implants may be complex. Health care professionals that scan patients with MR Conditional devices or implants should consult the implant or device manufacturer for instructions with respect to safety guidelines.

Multi-echo FGRE/FSPGR

CAUTION

Measurement of relaxation time by Multi-Echo FGRE/FSPGR is very sensitive to the result of gradient shim (Auto-Shim) in the slice direction. Auto-Shim with shim-volume setting is recommended.

[1]Phased array Uniformity Enhancement

CAUTION

It is possible that READY View results of the calculated T2* and R2* values have an error with acquisitions that have a large slice number value.

Navigator

CAUTION

Motion compensation accuracy may be affected by the presence of contrast agents, resulting in decreased image quality.

Patient orientation

WARNING

Ensure that the Patient Position selection matches the actual patient orientation. Making a selection that does not match the patient's actual position results in incorrectly annotated and/or rotated images, possibly resulting in improper medical treatment.

Patient transfer

CAUTION

The arm boards are not to be used as a seat or shelf. The arm board is not designed as a weight bearing device and there is a possibility for failure and the patient or load falling.

CAUTION

Following the exam, your patient may need assistance when getting off the table. After lying in a prone position for a length of time, your patient may experience lightheadedness upon sitting up.

Patient weight

CAUTION

The patient's weight determines the SAR. Entering a weight more than the actual patient weight could potentially harm the patient. Patient weight is not pulled with the other patient information from the ConnectPro worklist. You must manually enter the weight.

Post-contrast scans

WARNING

With post-contrast imaging using inversion-prepared pulse sequences, there is a potential that lesion conspicuity may be reduced and some lesions may not be apparent in comparison to T1-weighted spin-echo imaging.

Prescan

CAUTION

Auto prescan is used to calibrate the flip angle and to accurately estimate SAR levels. Do not manually adjust the transmit gain for GRE, SPGR, FGRE, FSPGR and FIESTA scans since excessive SAR may result if the TG is set too high. Using Auto prescan rather than manual prescan insures that accurate SAR limits are used.

Synthetic DWI is commercially known as MAGiC DWI.

User CVs

Fat SAT Efficency

CAUTION

When a wide scan volume is acquired by using more slabs, Fat enhancement option may cause a heavy background signal saturation at superior slab position.

Coils

CAUTION

Never use an incompatible legacy coil with the table. The curved bottom of the coil placed on the flat surface of the table can lead to patient injury.

CAUTION

The AA coil may not fit in the bore when used on patients with large torsos. To avoid injuring the patient or damaging the coil, watch carefully as the table moves into the bore. Stop advancing the table if the AA coil comes into contact with the top of the bore.

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CAUTION

Do not carry any of the coil components by the cable. Damage to the coil component may occur. The coil may not work if damaged.

CAUTION

The coil contains sensitive electronic components that may become damaged. Do not spray or pour cleaning solution directly onto the coil. Do not submerge the coil in any solution. Under no circumstances should the coil be placed into any type of sterilizer.

CAUTION

Do not place a coil directly on the table surface over the PA area. Be certain that the pads are on the table before using a coil. For example, only place the wrist coil on the table surface with the pads in place. Placing a coil directly on the PA area of the patient table results in coil-to-coil contact, which can result in poor image quality.

CAUTION

RF can cause localized anterior coil warming when it is positioned close to the top of the bore. Place non-conductive padding between the coil and the bore in order to keep the coil positioned away from the bore wall.

CAUTION

Ensure that no hair or fabric is caught between the components. Failure to comply may cause artifacts and decreased image quality.

CAUTION

Do not pick up or carry the Head Component by the mirror attachment. To avoid damaging the coil, pick up and carry the Head Component using two hands on the bottom of the coil.

CAUTION

Users should place a service call any time the coil is dropped or mishandled. A GE Service Representative should inspect the coil after it has been dropped or mishandled to ensure it is safe to use.

Coil CAUTION

Looped cables may cause RF coupling and degrade the scan performance of the coil. Do not cross or loop cables.

Pinch Point CAUTION

To avoid injuring the patient or damaging the coil, watch carefully for pinch points as the table moves into the bore. Stop advancing the table if the patient or any part of the coil comes into contact with the bore.

WARNING

Do not use accessories (e.g. pads or straps) that have not been specifically tested and approved for use in the MR environment (i.e., MR Safe or MR Conditional). Use of MR Unsafe or MR Conditional (used outside of its conditions for use) accessories may result in patient burns or injuries or image degradation. Even auxiliary devices labeled as MR Conditional are capable of causing injury if the manufacturer's conditions are not followed.

WARNING

Electric shock may occur if the coil is attached to the system during cleaning or when it is still wet. Detach coil connector from the scanner before attempting to clean the coil. Do not touch connectors with bare fingers. Never press sharp objects against connector surface. Do not reattach connector after cleaning until the coil has dried completely.

WARNING

Electric shock hazard. No user serviceable parts. Refer service to qualified service personnel.

WARNING

All coil components must be plugged in when they are in the scanner. This includes coil components that should be plugged into the system and coil components that should be plugged into another coil component. Leaving components unplugged can damage the coil, or cause harm to the patient.

WARNING

Do not allow the coil cables to touch the patient. Use a thermal resistant material or pad to keep the cable from touching the patient. Failure to comply may cause patient burns.

WARNING

Prior to patient placement in the coil, assure that any breached or compromised patient skin surfaces that come in contact with the coil have been adequately bandaged or covered.

ADDITIONAL WARNINGS AND CAUTIONS

Display

This section contains additional warnings and cautions related to image display and post processing.

AutoPaste

WARNING

Do not use Pasting post process application with images that demonstrate metal implants.

Add/Subtract images

CAUTION

Since "COMB" series contain images resulting from a combination of images from different locations in the patient's body, the absolute anatomical coordinates accompanying these series (shown both in the Browser and on the displayed images) are not accurate. Only relative geometric measurements (i.e. distance, angle, or area) are accurate.

Applications

VIBRANT, VIBRANT-Flex and LAVA-Flex

CAUTION

Images labeled as water may include signal from fatty tissue, and images labeled as fat may include signal from water. This error may occur in regions of high magnetic field variation, in spatially isolated tissue, due to patient or tissue motion, due to phase wrap artifacts, due to similar water and fat intensity in T2-weighted Flex scans, due to TE values beyond recommended limits, and/or in images with low signal-to-noise ratios. The presence of fat tissue in images labeled as water, or vice versa, may occur within single images or throughout an in entire stack of slices. By default, both sets of images (labeled fat and labeled water) will be reconstructed and inserted into the database for review. Proper calibration and center frequency selection will reduce the occurrence of this error. Complete elimination of this error may not be possible and thus interpretation of MR images must be completed by trained personnel.

WARNING

It is possible that a spatial distortion can be seen on 3D data sets, especially in the lateral-most VIBRANT images. The distortion can be demonstrated in sagittal versus axial data sets. There is a potential risk for lesion localization misregistration during biopsy procedures, which could result in a re-biopsy of the patient.

Imaging Option

IDEAL

CAUTION

Images labeled as water may include signal from fatty tissue, and images labeled as fat may include signal from water. This error may occur in regions of high magnetic field variation, in spatially isolated tissue, due to patient or tissue motion, due to phase wrap artifacts, and/or in images with low signal-to-noise ratios. The presence of fat tissue in images labeled as water, or vice versa, may occur within single images or throughout an in entire stack of slices. By default, both sets of images (labeled fat and labeled water) will be reconstructed and inserted into the database for review. Proper calibration and center frequency selection will reduce the occurrence of this error. Complete elimination of this error may not be possible and thus interpretation of MR images must be completed by trained personnel.

READY View

Care should be taken when using quantitative measures of cerebral blood flow from 3DASL in clinical populations. Differences in CBF values may be seen when the same subject is scanned on different systems and coils. Diagnostic and treatment decisions should not be based solely on these absolute values.

WARNING

Do not use 3D views only to perform voxel value, distance, angle, or area measurements. Always refer to 2D baseline views.

Diffusion Tensor images attempt to characterize behavior of water molecules in imaged tissue. Therefore, fiber tracking representation actually displays algorithmically predicted water molecule direction. These displays may be only representative of the actual white matter anatomy. A trained neuro radiologist is required to make the association between the rendered tract display and the actual patient's anatomy.

CAUTION

Failure to place the ROI as described will negatively impact the output measurement.

CAUTION

Always click ***Compute*** again to re-compute the functional maps after making changes to the input parameters. The changes are not taken into account automatically.

CAUTION

It is possible that READY View results of the calculated T2* and R2* values have an error with acquisitions that have a large slice number value.

WARNING

Under no circumstances should the pixel value from saved functional maps be used by any software applications that rely on Hounsfield values. This applies, in particular, to dose computation software applications.

Volume Viewer

Annotation

CAUTION

When saving images for diagnostic purposes, always make sure the patient name is displayed on all views.

Filter floaters

WARNING

Floater filtering removes all 3D objects from the displayed 3D volume that have a size equal to or smaller than the selected filter size. Before applying a filter, make sure that the selected filter size will not result in removing pathologies or other essential anatomical structures.

Measurements

CAUTION

Measurements are more reliable when done on 2D views. Always check on the 2D reformatted views where exactly the points have been deposited.

CAUTION

Post processing results may be affected by the presence of MR Conditional implants. Consider the following related to post-processing MAVRIC SL images on your MR[1], PACS[2] or AW[3] systems:

If an image includes susceptibility artifact, such as from MR Conditional metal implants, measurements made on the image may be incorrect due to distortion of actual physical locations.

[1]Magnetic Resonance. The absorption or emission of electromagnetic energy by nuclei in a static magnetic field after excitation by a suitable RF pulse.
[2]Picture Archiving Communications System
[3]Advantage Workstation

CAUTION

Distance, angle, and area measurements are valid only if all trace segments are longer than the inter-slice distance.

Reformat

WARNING

A curved VOI can introduce distortion in the shape of objects. To prevent misinterpretation of the shape of an object, always verify the cursor position by correlation with the baseline and reformatted views.

Threshold

WARNING

The use of thresholding for the building of the 3D model excludes all voxel values outside the selected range from the 3D model. Before applying the threshold(s), make sure that the selected threshold settings will not result in removing pathologies or other essential anatomical structures from the 3D model.

Summary table

WARNING

While ROI statistics are calculated on displayed volumes in volume viewer (segmented or not), the summary table only displays statistics calculated from original volumes (non-segmented).

Before a report is distributed, always preview the report to ensure content accuracy.

SYSTEM MAINTENANCE

System maintenance introduction

Maintaining a controlled environment also involves routine preventative maintenance checks by the service engineer and site personnel. Careful planning and diligent upkeep of an MR facility can provide a safe environment for both patients and employees. Your system requires maintenance at specific service intervals in which many of the maintenance checks should be performed by a qualified service engineer. There are several checks you can perform. Be aware of required maintenance and the personnel responsible for meeting each requirement.

After-sale service of MR systems under GE warranty or service-contract shall be done by GE engineers or GE-assigned qualified people.

GE makes available, on request, such information as circuit diagrams and component lists to assist your technical personnel in the repair of equipment classified by GE as repairable. Where there are no user serviceable parts, adhere to this warning and refer service to qualified service personnel.

WARNING

Electric shock hazard. No user serviceable parts. Refer service to qualified service personnel.

WARNING

When installing and maintaining the products, follow lockout and tagout procedures, and adhere to MR safety requirements, high voltage and radio frequency prevention requirements. If these instructions are ignored, damage to the equipment and patient/personnel injury can result.

SYSTEM, COIL AND ACCESSORY MAINTENANCE

General cleaning and disinfection

Cleaning and disinfection of patient contact surfaces is recommended following each use.

Non-patient contact surface cleaning and disinfection should be conducted following internal housekeeping procedures unless otherwise indicated in the following instructions.

Inspect pads for peeling or cracking. To prevent a biohazard, replace cracked or peeling pads before using.

Cleaning and disinfection recommendations for the MR system, Coils and most Accessories

- **Clean** with commercially available wipes that contain 0.55% minimum sodium hypochlorite as the only active ingredient. If commercially available wipes are not available, then follow one of these instructions.
  - Clean with a lint free cloth saturated with a 1:10 dilution of commonly available bleach containing a recommended minimum sodium hypochlorite of 5.50%. Dilute the bleach with tap water.
  - Use a lint free cloth that has been saturated with a 70% isopropyl alcohol solution made from 100% isopropyl alcohol and 30% tap water.
  - Use a lint free cloth with a commercially prepared solution of 70% concentration isopropyl alcohol.
  - Carefully clean all surfaces including cracks and crevices. Consider placing a wipe around a rigid implement (GE Part Number 5878912 or equivalent) and use this to get into cracks.

    Figure 2-49: Example of cleaning tool

    

  - Regardless of the method used, inspect to ensure visual cleanliness prior to disinfection. Repeat the cleaning process until all visible soil has been removed.
- **Disinfect** with commercially available wipes that contain 0.55% minimum sodium hypochlorite as the only active ingredient following the manufacturer's instructions. If commercially available wipes are not available, then follow these instructions.
  - Disinfect with a lint free cloth, a 1:10 dilution of commonly available bleach containing a recommended minimum sodium hypochlorite of 5.0%. Dilute the bleach with tap water.
  - For general disinfection or disinfection following cleaning of blood and/or body fluids, 5 minutes contact time is recommended.
  - Refer to internal procedures or refer to publications such as "CDC Guideline for Disinfection and Sterilization in Healthcare Facilities," 2008 or latest revision, for guidance. Disinfectant may need to be reapplied to ensure surfaces remain wet for the duration of the selected contact time.

- After you have cleaned and disinfected with bleach (sodium hypochlorite), wipe surfaces with a disposable lint free wipe that has been dampened with purified water to remove any remaining bleach residue.

CAUTION

To avoid possible damage to equipment, do not use solutions containing amines, strong alkalis, quaternary ammonium chloride compounds, esters, iodine, aromatic or chlorinated hydrocarbons, or ketones. Do not use autoclaves or the industrial washers and dryers found in most hospitals or professional laundry services.

WARNING

Electric shock may occur if the coil is attached to the system during cleaning or when it is still wet. Detach coil connector from the scanner before attempting to clean the coil. Do not touch connectors with bare fingers. Never press sharp objects against connector surface. Do not reattach connector after cleaning until the coil has dried completely.

CAUTION

The coil contains sensitive electronic components that may become damaged. Do not spray or pour cleaning solution directly onto the coil. Do not submerge the coil in any solution. Under no circumstances should the coil be placed into any type of sterilizer.

SYSTEM MAINTENANCE

Exhaust fan

The magnet (RF-shielded) room exhaust fan, vent, and duct system are intended to evacuate the magnet room of cryogenic gas at the MR product specified rate. Over time, the exhaust fan system may become blocked with lint, hair, and other air-borne particles. It is important for personnel safety reasons that the exhaust fan system (vent, exhaust fan, ducts, etc.) be kept clean to make sure the exhaust fan system operates properly and exhausts cryogenic gas to an outside area.

In the unlikely event of a magnet quench or a cryogen gas leak, it is important that this exhaust fan system performs at or above the specified airflow to remove the cryogen gas from the magnet room. The magnet room exhaust fan and air inlet must be sized for a minimum of 1200 CFM (34 m3/minute) and minimum of room 12 air exchanges per hour. The minimum air flow and air exchange rate for mobile, transportable, and relocatable systems are different from those for fixed sites and varies depending on the type of site. Any blockage or obstruction could prevent the exhaust fan system from providing the required airflow. If the exhaust fan system fails to operate at or above specification, accumulation of dangerous levels of helium or nitrogen within the RF screen room could occur.

It is important that this exhaust system vent be cleaned regularly as part of the normal room cleaning. Regular customer inspection, cleaning, and testing of the exhaust fan system (vent, exhaust fan, ducts, etc.) are needed to make sure all equipment and parts of the system are always in good working order and able to perform to specification. It is recommended the exhaust fan system be cleaned and inspected annually to make sure the specified air flow rate can be met and thus ensures proper performance.

SYSTEM MAINTENANCE

Maintenance services

The planned maintenance (PM[1]) services prescribed in the PM schedules represent the current manufacturer's recommendations. Specific customer requirements and/or your site environment may necessitate more or less frequent intervals for PM service. An agreement to perform PMs less frequently than these recommendations can be made with the understanding that a reduction of system performance may result.

The PM service schedules in the **Maintenance Service** Schedules, list all the PM procedures and the frequency they should be completed by qualified service personnel. There are different schedules for each system type.

You should perform the maintenance services shown in the table below.

Table 2-54: Operator services

Item	Required maintenance	Service interval
General	Clean Check the table emergency release.	4 months 4 months
Patient cradle and pads	Check for cleanliness of pads and clean the inside of the cradle.	Daily
Patient table	Check the table alignment and proper operation.	6 months
Coils, pads, and straps	Clean with non-abrasive cleanser. Clean coil anti-skid pads with water and mild detergent only.	Daily
Coils and coil cables	Check for defects or damage, worn cable or exposed wires.	Daily
Image quality	Perform quality assurance and functional checks.	As recommended

[1]Planned Maintenance

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PROCEDURES

Procedures introduction

This section provides the step-by-step instructions for working safely in a magnetic field environment. Specifically, it describes how to:

- Eliminate Magnet Hazards
  - **Protect the security and exclusion zones**
  - **Screen patients and personnel**
- **Prepare the patient**
- **Protect the patient from RF burns**
- **Protect the patient's eyes and ears**
- Respond to Emergencies
  - **Patient emergencies**
  - **Equipment or environmental emergencies**
  - **Quench with vent failure**
- Magnet rundown procedures
  - **Primary magnet rundown procedure**
  - **Secondary ramp down procedure**
- **Check the Cryogen Levels**
  - Systems with a helium level meter
  - Systems with a magnet monitor unit
- **Handle contact with liquid cryogens**

IMPORTANT!: You should understand the following definitions before continuing:

- A substance that is ferromagnetic has a large positive magnetic susceptibility, meaning it is very easily magnetized (example: Iron).
- An item that is ferrous can posses intrinsic magnetic fields and become a projectile in an applied magnetic field (examples: Iron, nickel, and cobalt).

Safety checklist

It is recommended that your site develop a safety check list based on your local, regional and country regulations.

This can be used before system acceptance (site readiness) after installation and should be considered for periodic review. A check list includes reviewing the following suggested topics:

- Safety Areas
  - **Exclusion zone**
  - **Security zone**
- **Patient screening**
- **Patient emergencies**
- **Clothing screening of anyone who enters the magnet room**
- **Equipment screening that enters the magnet room**
- **Cleaning supplies for the MR room, equipment, and accessories**

- **Cryogens**
- **Magnets**
- **Gradients**
- **RF**

A suggested list of reviewers of the safety check list includes the following:

- MR staff
- Physicians
- Nursing staff
- Administrative staff
- Service staff
- Support staff
- Cleaning staff
- Fire department
- Police department

Protect the security and exclusion zones procedure

It is vital to have supervised and controlled access within the MR environment to keep it safe from ferromagnetic items and to guard against accidents, injuries, or damage to MR systems. Keep in mind that even a paperclip inside the bore of the magnet can cause image artifacts or a patient burn. All personnel should be aware of the following important steps.

1. Keep the door to the MR environment and the magnet door closed.
   - The doors should not be held open for other people or propped open.
   - Only essential personnel should be allowed to enter the magnet room.
2. Limit and monitor access to the MR environment and magnet room.
   - Personnel trained in MR safety should be present at all times during the operation of your MR facility to ensure that no unaccompanied or unauthorized individuals are allowed to enter the MR environment or magnet room.
   - Personnel trained in MR safety are also responsible for performing thorough screening of patients and other individuals before allowing them to enter the magnet room.
3. Supervise non-MR personnel when working in the magnet room.
   - Everyone who needs to enter the MR environment on a regular or periodic basis should be educated regarding the potential hazards related to the magnetic field.
4. Prominently display the Security and Exclusion Zone warning signs to make all individuals and patients aware of the risks associated with the MR system.
   - The Security Zone sign must be posted on the entrance to the magnet room.*
     - These signs warn patients about the strong magnetic field and stresses the presence that no pacemakers, metallic implants, neurostimulators, or loose objects are allowed.
   - The Exclusion Zone sign must be posted at the 5 gauss boundary.*
     - This sign warns against the strong magnetic field and stresses the presence of no pacemakers, metallic implants, or neurostimulators.

*In general, patients with conductive (e.g. metallic) implants are contraindicated for MR scans. Some implantable devices have been labeled as MR Conditional under certain operating conditions. Only use quadrature transmit for MR Conditional devices. MR Safe implants will have the MR Safe symbol in their implant documentation.

When evaluating whether to proceed with MR scanning on patients with such implants, consult the implantable device's labeling.

5. Test all items for ferromagnetic properties before taking them into the magnet room.
   - Use a hand magnet to test items.
6. Remove ferrous items from the immediate vicinity of the magnet room.
   - This can reduce the chance that someone might carry a ferrous item into the magnet room.
   - Replace ferrous items that must remain in the vicinity of the magnet room with non-ferrous versions whenever possible.
7. Tag ferrous items that remain at the facility so that all personnel know the item cannot be taken into the magnet room.
   - Tag all ferrous items with the same label to be consistent in identifying items that are not to be in the magnet room.
8. Do a pocket check before entering the magnet room.
   - Check for loose metal objects, such as keys, and remove.
9. Keep the magnet door in sight at all times.
   - When working in the magnet room, do not stand between the door and the magnet or turn your back to the door.
10. Do not turn your back on the patient or anyone else in the magnet room.

PROCEDURES

Screen patients and personnel

For your safety and the safety of the patient, an MR safety-trained health care worker at your facility should carefully screen for hazards before patients and personnel enter the Exclusion Zone. All personnel must be aware of and comply with your facility's screening procedure.

WARNING

Patient screening is required for patients who are going to be imaged on an MR scanner.

1. Use a Patient Screening form routinely before bringing patients or other personnel into the Exclusion Zone.
   - Thoroughly review all safety information and considerations before starting a scan with patients that have an MR Conditional implant. In general, patients with conductive (e.g. metallic) implants are contraindicated for MR scans. For patients with implants that are labeled as MR Safe or MR Conditional consult the implant device manufacturer's documentation.
   - Every patient, individual, and employee must be carefully screened prior to admission to the magnetic field. Refer to the **Screening form** topic.
2. Review the completed screening form and evaluate the individual prior to entry.
   - Identify circumstances that contraindicate admission to the Exclusion Zone or items that need to be removed before entering the Security Zone.
   - In addition to safety issues, metal objects or materials containing metal may distort the magnetic field and detract from the image quality.
3. Discuss the items on the screening form with the patient or other individual.
   - Verbally interview the patient to verify the information on the form and ensure the patient understands each question he/she is answering.
   - Allow discussion of any question or concern that the patient may have.
4. Examine all patients with diapers or incontinence products, including adults, should have dry diapers on prior to the start of the scan.
5. Examine or X-Ray patients who are at risk for metal eye slivers.
   - Serious injury may occur as a result of movement or heating of the metallic foreign body as it is attracted by the magnetic field of the MR system.
   - Follow your departmental clinical screening policy.
6. Require that patients change clothes.
   - Provide clothes without metallic fasteners and pockets.
   - Patients should not wear shoes into the magnet room as they may have collected metal on the soles.
7. Instruct the patient to wash off non-permanent make-up.
   - Follow the precautions for patients with permanent make-up such as permanent eyeliner, which can cause tissue heating.
8. Keep metal out of the bore.*

- A metal-free bore prevents burns and image artifacts.

*In general, patients with conductive (e.g. metallic) implants are contraindicated for MR scans. Some implantable devices have been labeled as MR Conditional under certain operating conditions. Only use quadrature transmit for MR Conditional devices. MR Safe implants will have the MR Safe symbol in their implant documentation.

When evaluating whether to proceed with MR scanning on patients with such implants, consult the implantable device's labeling.

Related topics

Contraindications for use

High risk patient

Clinical screening

Patient emergencies

PROCEDURES

Prepare the patient procedure

Some patients undergoing an MR procedure may experience feelings of fear, anxiety, or claustrophobia. The following techniques may help reduce or eliminate these sentiments. Use the following techniques for all patients, even if your patient does not exhibit signs of fear or claustrophobia. Larger patients can feel anxious due to a confined feeling in the magnet. Degradation of image quality can also occur. Verify that the patient's weight does not exceed the table weight limit as defined in your MR system's documentation. Consult your system operator manual for details.

1. For safety reasons, patients must be thoroughly screened prior to scan preparation.
   - Screen for pertinent medical history and conditions that contraindicate scanning.
   - If proper screening cannot be performed, postpone the MR examination until screening can be done.
   - Review **Contraindications for use** before scanning the patient.
2. Determine scan protocol and enter the patient's information in advance.
   - This saves time during the preparation for the procedure so the patient is not left waiting for the examination to begin.
3. Provide the patient an information booklet to read.
   - Educating the patient concerning specific aspects of the MR examination is an effective way to prepare for the situation and explain what is about to happen.
4. Have the patient use the restroom prior to the examination.
   - Fewer interruptions during the scanning procedure can help you stay on schedule and keep the patient focused on holding still during the examination.
5. Examine all patients with diapers or incontinence products, including adults, to make sure the patient has dry diapers and dry clothing on prior to the start of the scan.
6. Discuss the procedure with the patient.
   - The length of the examination
   - What can be seen during the examination
   - What can be heard during the examination
   - What can be felt during the examination
7. Transfer the patient to the MR table.
   - Refer to your specific MR system operator manual for patient transfer details.

CAUTION

Position the patient's limbs, hair, and clothes completely on the table to avoid risk of injury when the table is moving.

8. Let the patient see the MR system while you explain the features of the bore.
   - Soft lighting
   - Good ventilation
   - A microphone and speaker to enable the patient to hear and be heard at all times
9. Demonstrate the use and function of the Patient Alert System.

- This system is patient-activated and allow the patient to signal for assistance during a scan.

10. Explain the use of straps. See your system operator manual for details.
11. Ensure the patient is comfortable.
    - Use sponges and wedges to relieve pressure points and support the body in the correct position.
    - Ask if a blanket is needed while being aware that once the scan begins, a blanket may increase patient warming.
12. Explain the need for **hearing protection**.
    - Use recommended earplugs (>/= 29dB NRR) to minimize the noise from the gradient magnetic field.
    - Alternatively, use recommended MR-compatible headphones (>/= 29dB NRR) to provide relaxing music to the patient and minimize the noise.
13. Stress the need for cooperation to attain a diagnostic study.
    - It is extremely important the patient not move during the examination.
14. Stay in constant verbal and visual communication with the patient throughout the examination.
    - Some patients may require the physical presence of an family member or nurse in the magnet room.
15. See the following procedures for details regarding:
    - **Protect the patient from RF burns**
    - **Protect patient's eyes and ears**
    - **Patient emergencies**

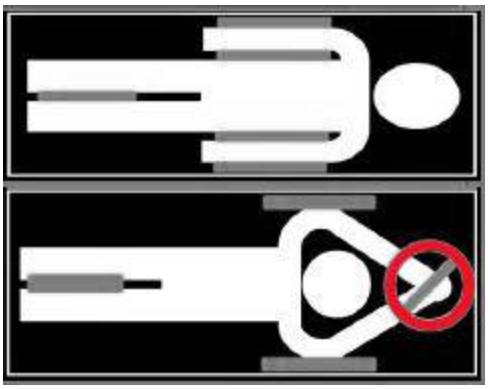
PROCEDURES

Protect the patient from RF burns procedure

All personnel should be aware of several factors to protect a patient from burns and peripheral nerve stimulation. The following steps should be observed by all personnel that position patients for scanning.

1. Remove any accessory devices from the bore of the magnet that are not required for the procedure.
   - This includes any unplugged electrically conductive materials such as surface coils, cables, etc.
2. Examine all patients with diapers or incontinence products, including adults, to make sure the patient has dry diapers on prior to the start of the scan.
3. Position the patient to prevent direct contact between the patient's skin and the bore of the magnet or an RF surface coil.
   - Before connecting halves of a split coil, take care that the patient's body (for example, ear, jowl, neck, finger, hand, etc.) is not trapped or pinched by coil parts.
   - Padding is required. To help prevent patient burns, make sure that closed loops are not created by the body of the patient (e.g., clasped hands, hands touching the body, thighs in contact, and breast tissue contacting the chest wall).

Figure 2-50: Patient positioned with non-conducting pads

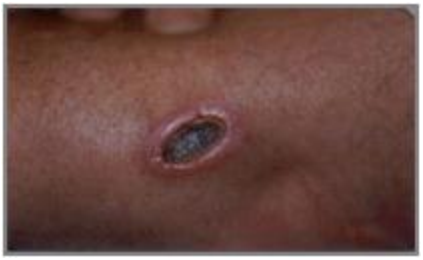


   - Use additional pads to immobilize the patient and make them comfortable.
   - Preventing patient warming is one of the most important safety measures you must take into consideration as you prepare a patient for an MR exam. Appropriate RF padding and proper patient positioning are the most effective means of preventing injury related to RF heating. The following are a few golden rules to remember as you position and pad your patients:
     - Only use GE-approved RF padding.
     - Use non-conductive padding that is at least 0.25 inches (0.635 cm) thick between the patient's skin and the magnet bore.
     - Appropriate padding must be used EVERY time without exception
     - Sheets and gowns are not a substitute for approved RF padding.
     - Never allow your patient’s skin to come in direct contact with the scanner bore or any surface coil or cable.
     - Never allow skin-to-skin contact.
     - If a patient does not fit in the MR scanner bore with the required padding, another modality should be used to scan the patient.

- While some of these rules may seem a little tough to follow at times, remember that RF injury, which can in extreme cases include burns such as the one you see below, can happen very quickly and your patient may not have time to warn you in time to prevent an injury.

Patient padding

Figure 2-51: Elbow RF burn



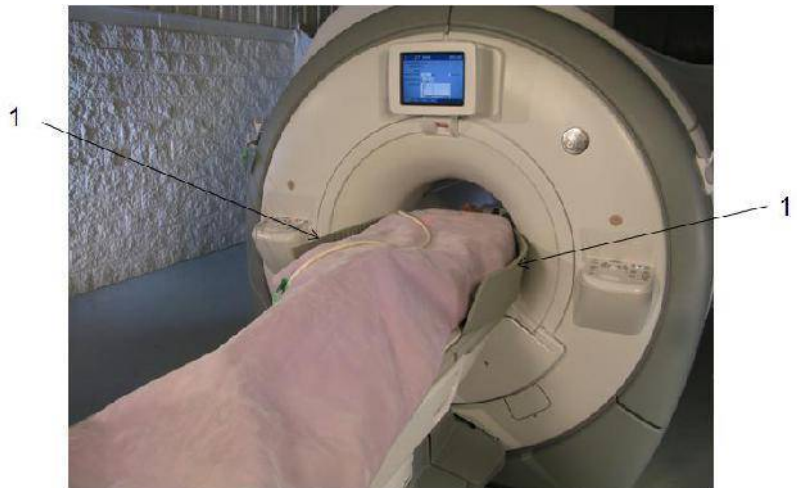
- The following are a tips that will assist you in properly positioning and applying RF padding to your patients. Should you need more information on prevention of patient warming than what is provided here, refer to your surface coil and refer to Tissue Heating in this manual. If you need help beyond the documentation please do not hesitate to reach out to your local Applications Specialists.

Whole body padding

Although the photos are from a Discovery system, the safety padding guidelines apply to all MR systems.

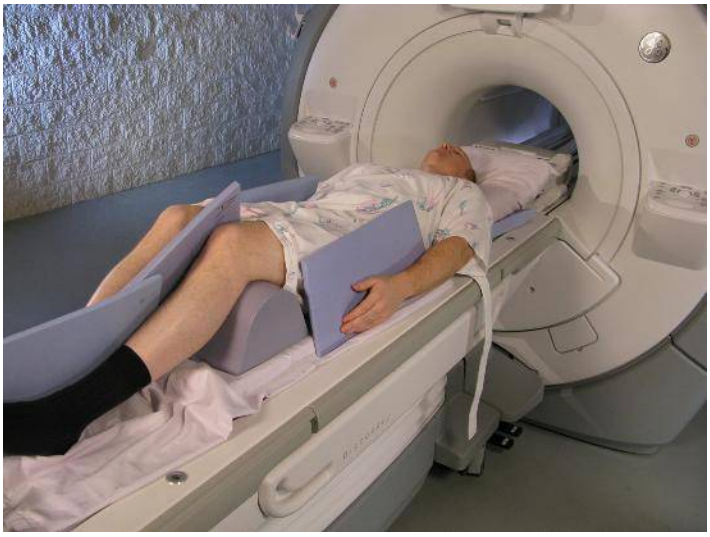
- An important consideration when padding your patients is that you will need to double check the position of the pads once the patient is in the bore. Table movement may dislodge padding and expose skin to the scanner bore.

Figure 2-52: Padding between patient and bore. 1 = bore pads



- Notice that padding is positioned not only at the patient's sides to prevent their arms from touching the bore, but that padding is also placed between the hands and thighs and between knees and ankles to prevent forming conductive loops.

Figure 2-53: Patient padding



Surface coil padding

Although the photos are from a Discovery system, the safety padding guidelines apply to all MR systems.

- Padding with a surface coil presents different challenges from a patient RF padding perspective.
  - First rule of thumb is to remember to use all manufacturer provided padding to prevent motion and the patient's skin from coming in contact with the coil, and to also use additional padding if appropriate to secure an opposing extremity to prevent contact with the coil which could also lead to burns or motion artifacts.
  - Just as with the whole body RF padding demonstration, you'll need to make certain that the patient's skin does not come into contact with the scanner bore and that padding is placed between the hands and thighs to prevent conductive loops.

Figure 2-54: Extremity padding

- A final safety consideration for surface coils is to ensure that the patient does not come into contact with the coil cable, therefore you may need to use additional RF padding to protect the patient.
  - Care should also be taken to ensure the cable is not looped in the bore and that it is routed down the center of the scanner bore.

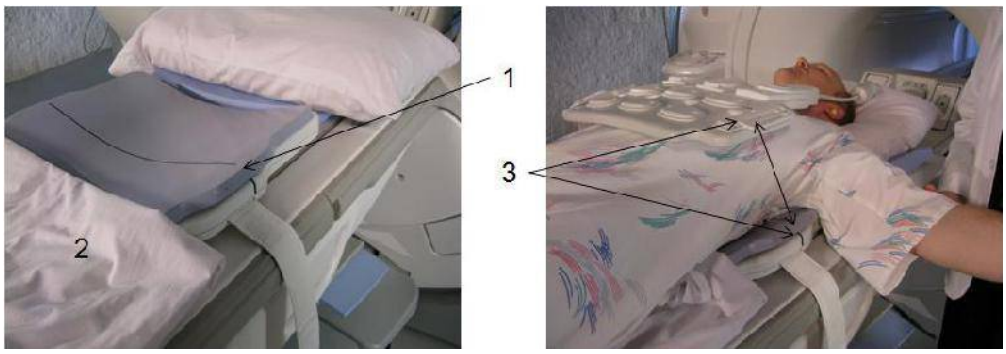
Figure 2-55: Coil cable with no loop

Cardiac coil padding

Although the photos are from a Discovery system, the safety padding guidelines apply to all MR systems.

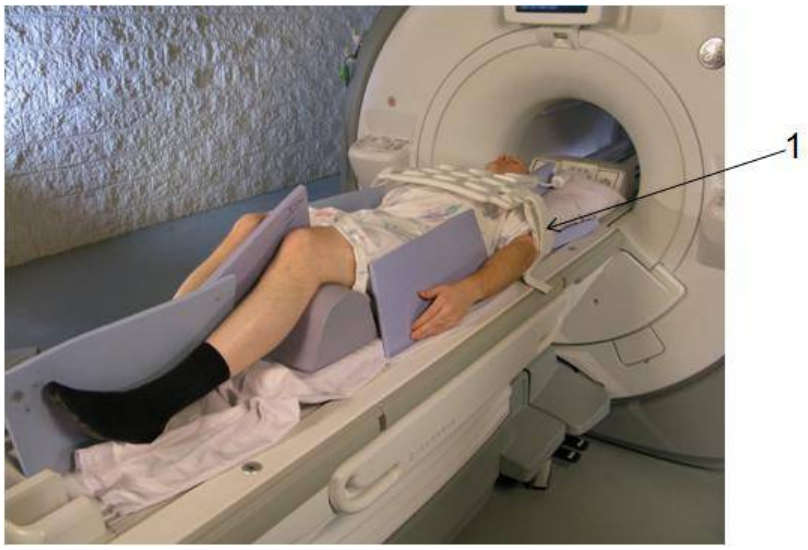
- Follow your basic padding recommendations to prevent contact with the scanner bore and prevent conductive anatomical loops, but there are a couple of additional steps you'll need to take to ensure patient safety
  - The cardiac coil does not require additional RF padding to be placed between the patient and the anterior coil component, but you should use the manufacturers pad on the posterior component of the coil for patient RF protection. You should also cover the patient with their gown before placing the anterior component of the coil and make certain both the anterior and posterior elements are in alignment.

Figure 2-56: 1 = coil pad aligned with coil, 2 = sheet to cover pad, 3 = anterior and posterior coil elements aligned



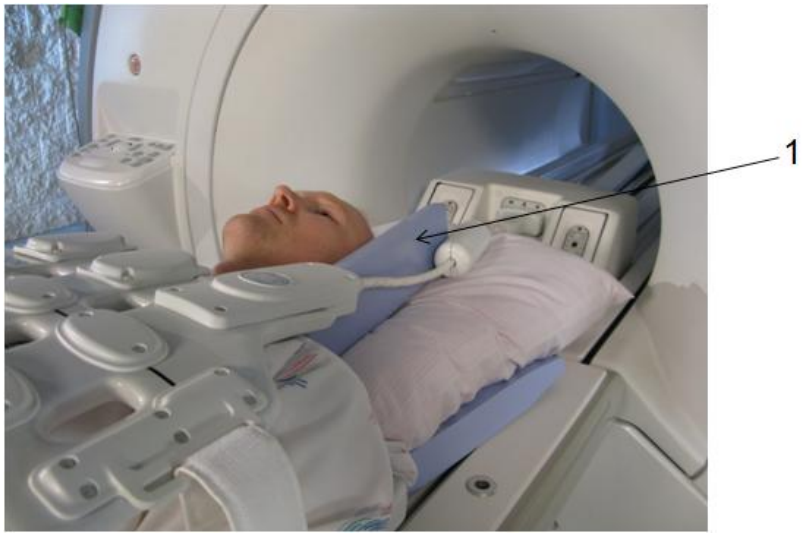
  - Secure the coil snugly, but comfortably with the straps.

Figure 2-57: Coil secured with straps



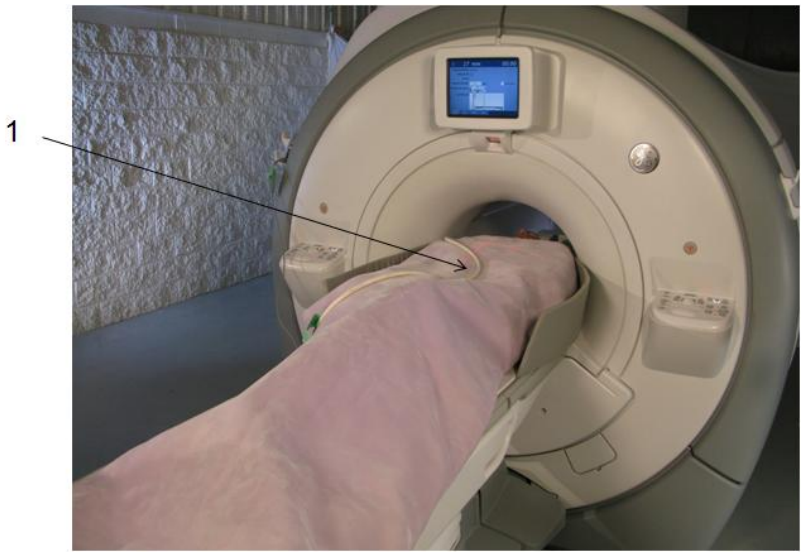
- As is the case of all surface coils ensure that the cables do not come in contact with the patient and that they are not looped and routed down the center of the bore. As you can see there is significantly more cable that we need to isolate from the patient, so be sure to use as much padding as needed.

Figure 2-58: 1 = Pad placed between cable and patient skin



- If you are using the cardiac coil, it's likely you are also using the ECG leads and cable. The rules for the ECG cable are the same as the coil cable. Route the ECG cable down the center of the bore, do not loop the ECG cable and do not allow it to come in contact with the coil cable.

Figure 2-59: 1 = ECG cable with no loops



4. Only use approved RF coils that are not damaged.
   - Labels such as the one in the figure below, provide warnings about working with RF coils.

Figure 2-60: Warning label

   - Before using the coil, check the integrity of the electrical insulation of the components or accessories of the device.
5. Keep electrically conductive material that must remain in the magnet bore from directly contacting the patient by placing insulation between the conductive material and the patient.
   - Place a clean cotton sheet over the coil and comfort pad so the patient's skin does not come in contact with the coil or the comfort pad.
6. Position RF cables down the center and directly out of the bore, without looping or crossing the cables.
   - Route the cables so there are no loops in any cables in the magnet. Use the appropriate gating cable for surface coil imaging
   - Use only MR system recommended monitoring equipment, ECG leads, wires, electrodes, and other components and accessories.

- For medical devices that are labeled as MR Safe or MR Conditional consult the device manufacturer's documentation.
- Follow all instructions for the proper operation of physiologic monitoring or other equipment provided by the manufacturer of the device.

7. Test the patient intercom.
   - Make sure that the patient can hear you and you can hear the patient.
8. Enter the correct patient weight.
   - Correct weight entries maximize performance and help prevent excessive RF exposure.
9. Turn on the bore light and fan.
   - Lights turned on inside the bore can help alleviate feelings of claustrophobia.
   - A fan inside the magnet bore provides adequate air movement for the patient. Keep the fan on at all times.
10. Show the patient how to use the Patient Alert System.
    - Patients experiencing uneasiness or concern can squeeze the Patient Alert bulb.
    - When the Patient Alert bulb is squeezed, an alarm emits a signal to you.

PROCEDURES

Protect the patient's eyes and ears procedure

Hearing protection is required. During a scan, all persons in the scan room are required to wear proper hearing protection to avoid possible hearing impairment. Acoustic levels may exceed 99dBA. Properly worn hearing protection is required for all people in the magnet room during a scan, including any MR workers.

Patients must close his or her eyes when the alignment light is on during positioning. Follow these guidelines to ensure proper eye and ear protection for your patient.

1. Provide the patient with hearing protection.
   - Earplugs or a headphone system with stereo music. For details, see **Acoustic Noise**.
     - Earplugs reduce the intensity of the sound, while allowing your patient to hear normal conversations.
     - Headphone systems soften acoustic noise, but may impede verbal communication with patients while the system is operating.

Table 2-55: Disposable ear protection

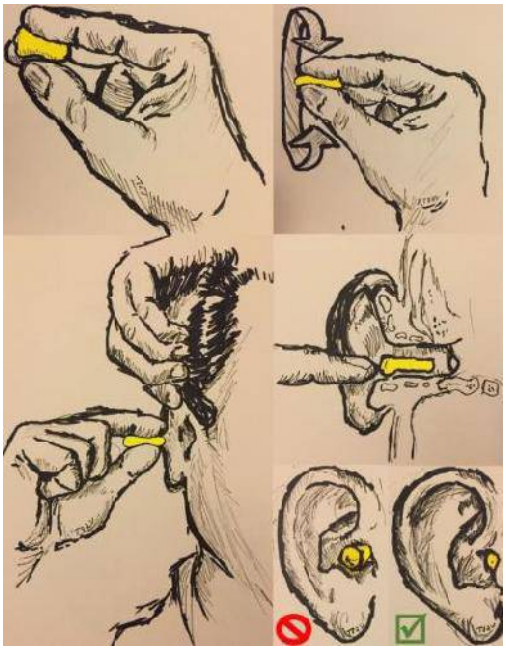
Description	dB
E8801BA EAR Disposable Foam Earplugs	29
E8801BB EAR Taperfit2 Foam Earplugs	32
E8801BC Max-Lite Foam Earplugs	30

WARNING

Hearing protection is required for all people in the magnet room during a scan to prevent hearing impairment. Acoustic levels may exceed 99 dB(A)

2. Make sure that the hearing protection device is worn properly.
   - Earplugs should be comfortable for the patient and inserted fully. Pliable earplugs compress when they are rolled between the fingers and conform to the ear after they are inserted.

Figure 2-61: Hearing protection



- The headphone system should be audible and comfortable for the patient.

3. Instruct the patient to close his or her eyes when the alignment light is on.
   - The Laser Alignment Lights for patient positioning can cause eye injury.

CAUTION

Turn off the laser light after positioning the patient.

PROCEDURES

Patient emergencies procedure

Dealing with patient emergencies requires special planning in the MR environment because of the magnetic field. Certain equipment used for resuscitation does not function in a magnetic field, and ferrous items can become projectiles. If a patient needs emergency medical attention during the scanning session, follow these guidelines:

1. Press ***Emergency Stop*** on the operator's console or magnet enclosure.
   - The scan aborts.
   - The power disables the patient-handling and scan-related equipment.
2. Notify emergency personnel, if necessary.
   - Since ferromagnetic life support and related equipment cannot be brought into the magnet room, it must await the patient outside the magnet room.
3. Quickly bring the patient out of the magnet bore. For details on cradle emergency release, see **Table emergency release**.
4. Transfer the patient onto a non-ferrous gurney or transport and remove the patient from the magnet room as quickly as possible.
   - It is important to have an assigned emergency area outside of the magnet room where you can take a patient so that the emergency team can use the necessary equipment.
5. Follow your facility's emergency protocol.

WARNING

The Emergency Stop button does not remove the magnetic field, turn off the computer cabinets, operator's console, or camera.

PROCEDURES

Equipment or environmental emergencies procedure

If you experience a serious equipment fault (system overheating, smoke, or odor associated with the system) or hazards such as fire/water in the vicinity of the MR equipment, you may need to perform a system shutdown with the Emergency Off button. The entire MR system is turns OFF with this button, except for the static magnetic field and the Magnet Rundown Unit used to shutdown the magnetic field.

Use this procedure to perform an emergency shutdown on your system during an equipment or environmental emergency.

1. Press the ***Emergency Off*** button located on the wall next to the computer equipment or next to the magnet room door.
   - This stops power to the magnet room, removing all electrical power from all components of the system.
   - This button also removes any power sources from UPS devices.
2. Evacuate the patient.
   - Follow the guidelines in the **Patient Emergencies procedure**.
3. Evacuate the MR suite.
   - Follow your facility's emergency protocol.
4. Call the fire department, if appropriate.
   - When the fire department arrives, evaluate the need for an emergency MRI magnet quench.
   - If the firefighters need to take ferromagnetic equipment into the MRI magnet room, quench the magnet.
5. Contact a service engineer before restoring power.
   - To restore power after an Emergency Off, the main circuit breaker must be reset before rebooting the system.
6. After service has examined the system, document the correct cause of the emergency.
   - Keeping the events documented allows you to reference this information in the future and may help prevent similar incidents.

WARNING

The Emergency Off button does not turn off the magnetic field. To avoid personal injury or equipment damage, do not bring any ferromagnetic equipment into the magnet room. Assume that equipment is magnetic unless it is clearly labeled otherwise.

PROCEDURES

Quench with vent failure procedure

A magnet quench can result in the release of cryogen vapor into the magnet room if the vent fails; white clouds of vapor appear in the magnet room. Cryogens released during a quench can cause asphyxiation, frostbite, or injuries due to panic. Magnet quenches are indicated by a loud noise, warning message, or the tilting of an image on the image screen. It is critical to have a well-planned method to quickly remove the patient and all personnel from the magnet room if a quench should occur.

These magnets contain approximately 1950 liters of liquid helium:

- 1.5T

If 100% of the 1950 LHe fills the minimum sized scan room, a properly functioning emergency exhaust fan with 1200 CFM and 12 scan room air exchange / per hour would evacuate that minimum sized scan room in about 2 hours. After that time it would be assumed safe for a qualified GE Field Service Engineer to enter the scan room and measure the O2 levels. It remains the customer responsibility to approximate the time to evacuate 1850 LHe for use in the site specific emergency procedures.

Use your site specific magnet room evacuation procedure. The following steps are guidelines for a site procedure in case of a sudden cryogen release into the magnet room.

1. Do not panic.
   - Staying calm helps you remain focused so you are able to safely remember and follow your site planned method of action.
2. Using the intercom, tell the patient to stay calm and remain on the table.
   - Tell the patient that someone will be in shortly to offer assistance.
3. Turn on the magnet room exhaust fan.
   - The exhaust fan is designed for 1200 cubic feet per minute, which exchanges the total volume of air in the room 12 times per hour. The time for the helium to be near a safe level is based on the amount of helium within a magnet,
4. Prop open the door between the operator room and hallway or if in a mobile unit, open the door to the outside.
   - This promotes air circulation.
5. Prop open the door to the magnet room.
   - If the magnet room door does not open, follow your site specific emergency procedure to open the door.
6. Enter the magnet room and assist anyone present to exit from the room.
   - If a gurney or wheelchair is needed to remove the patient, make sure it is a non-ferrous type.
   - When exiting, stay near the floor where the oxygen will be and immediately exit the magnet room.
7. Close the MR scan room door when all have been evacuated.
   - If the magnet room door is left open, there is a potential that helium gas will spread to other areas, including heating and cooling vents.
8. Evacuate all personnel from the area until the air is restored to normal.

PROCEDURES

Check cryogen levels procedure

Systems with a Helium Level Meter

It is very important to check and record the helium level. Sufficient helium is necessary to avoid accidental quench. If the helium levels fall below 60%, or the level your service engineer says is acceptable, contact a service engineer immediately.

Use this procedure to check cryogen levels.

1. Turn on the Helium Meter power switch.
   - This switch is located at the system cabinet.
2. Press Update on the system cabinet.
   - An updated reading of the helium level posts.
3. Record the percent of helium reading.
   - Keep a logbook to record readings daily.
   - It is crucial that cryogenic systems be checked regularly to be sure they are properly functioning.
4. Turn off the Helium Meter power switch when complete.

Systems with a Magnet Monitor Unit

It is very important to check and record the helium level. Sufficient helium is necessary to avoid accidental quench. If the helium falls below 600L, contact a service engineer immediately.

Use this procedure to daily check cryogen levels of a system with a Magnet Monitor Unit.

1. Locate the magnet monitor, which is typically in the equipment room. Push the sample button on the Magnet Monitor Unit and hold it for approximately 10 seconds.
   - An updated reading of the helium level posts.
2. Record the He Level value when it displays on the monitor.
   - The reading also toggles to the magnet pressure. Monitor any change in pressure. Normal pressure is between 3.9psi and 4.1psi.
   - Keep a logbook to record readings daily.
   - It is crucial that cryogenic systems be checked regularly to be sure they are properly functioning.
3. If the alarm LED is illuminated, contact your service engineer.

PROCEDURES

Handle contact with liquid cryogens procedure

Since the cryogen gasses are odorless, tasteless, and colorless, it is particularly important to have specific procedures in place to avoid frostbite if there is ever an accident in which the liquid or gaseous cryogen contacts human skin. Such procedures should be established and made readily available to all personnel.

Use this procedure immediately in the unlikely event that someone comes in contact with a liquid cryogen.

1. Promptly flush the area with large volumes of tepid water.
   - Tepid water is 105° to 111°F or 41° to 46°C.
   - For cold burns, immerse affected area in tepid water for at least 15 minutes.
2. Calm the victim.
3. Avoid aggravating the injury.
   - Do not rub or massage the affected parts of the body.
4. Cover the area with a sterile dressing.
   - You may also use a clean sheet if the exposed area is large.
   - This protects the area from further trauma.
5. Consult a physician immediately.
   - Maintain the affected area at normal body temperatures until a physician arrives.

PROCEDURES

Safety review

Table 2-56: Safety review table

Situation	Procedure
Fire, sparks, a loud noise or other emergency condition in the magnet room not associated with normal operation of the system.	Press an **Emergency Off** button, either in the computer equipment room or at the magnet room door. Remove the patient from the magnet room.
Magnet quench, indicated by a loud noise, warning message, dense white vapor with vent failure, helium meter dropping considerably or the tilting of an image on the image screen. Oxygen monitor is activated indicated by a loud sound.	Evacuate the patient and personnel from the magnet room and close the magnet room door. Follow your site's overnight procedure. All helium vapor should automatically be vented outside of the magnet room.
Magnetic-field emergency, e.g., a person pinned between the magnet and a ferromagnetic object.	Press the Magnet Rundown button in the magnet room. Remove the patient from the scan room.
Fire, sparks or a loud noise, indicating a severe system malfunction in the computer equipment room.	Press an Emergency Off button, either in the computer equipment room or at the magnet room door. Remove the patient from the magnet room.
Fire or severe condition relating to the power distribution unit (PDU) or service outlets.	Press an Emergency Off button, either in the computer equipment room or at the magnet room door. Remove the patient from the magnet room.
Overtemp indicator lights up at the remote power panel (RPP) or at the PDU, and an error message appears on the scan console's System Status Display area.	Remove the patient from the magnet room. Check the PDU vent for obstructions. If the vent is obstructed, or if the overtemp light or message remains on, perform a system shutdown and then press an Emergency Off button, either in the computer equipment room or at the magnet room door.
Patient needs medical attention.	Press the Emergency Stop button on the console or magnet and remove the patient from the magnet room.
Hydraulic failure of the table.	Keep all personnel (including patients) away from any spill. If the patient is on the table, keep the patient there until safe transfer is possible. Check for oil leaks and if any exist, clear then up to prevent anyone from slipping on the oil. Do not use the table for clinical use until it is repaired.
Imaging functions are lost without warning.	Follow your facility's emergency procedures during this type of occurrence.


In all cases, notify a GE Service Engineer as soon as possible.

The ACR Guidance Document for Safe MR Practices may be found at ACR.org. GE does not necessarily endorse the document, but provides the reference for information.

PROCEDURES

Primary magnet rundown procedure

The content in this topic applies to all magnets.

In addition to patient and equipment emergencies, magnetic field emergencies can also occur. Examples of magnetic field emergencies include instances where the presence of the magnetic field may cause injury or harm, if someone is pinned between the magnet and ferromagnetic object or there is a fire in the magnet scan room. All personnel should be familiar with how to respond to magnet emergencies.

WARNING

Personal Injury or Equipment Damage

This emergency magnet rundown procedure may create dangerous situations or damage equipment.

Perform this emergency magnet rundown procedure only in emergency situations (such as when a person is trapped between a magnetic object and the magnet).

In situations where there is no immediate threat, contact your GE Service Representative for non-emergency rundown procedures.

Use this procedure to perform an emergency magnet rundown on your system during a magnetic field emergency.

1. Ensure all ventilation systems are on and the scan magnet room door(s) is open.
2. Follow you facility's emergency protocol and evacuate the patient and all other personnel from the scan magnet room unless they are actively providing first aid to the entrapped person.
3. Press the Magnet Rundown button located in the scan magnet room or located remotely (if provided), whichever is easiest to access.
   - Only activate the Magnet Rundown switch in an emergency situation.
   - This results in a rapid reduction of the magnetic field in about two minutes.
   - There is a boil-off of cryogens, accompanied by crackling and hissing sounds.

Notify your Qualified Service Representative that a quench occurred.

Related topics

Magnet rundown consideration

Magnet Rundown Unit test procedure

Secondary ramp down procedure

Quench with vent failure procedure

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PROCEDURES

Secondary magnet rundown procedure

This secondary quench method should be attempted only after other approved methods of rundown have been attempted and in the event of a life threatening condition. Performing this procedure will take the magnet out of service for at least one month.

WARNING

Personal Injury or Equipment Damage

This emergency magnet rundown procedure may create dangerous situations or damage equipment.

Perform this emergency magnet rundown procedure only in emergency situations (such as when a person is trapped between a magnetic object and the magnet).

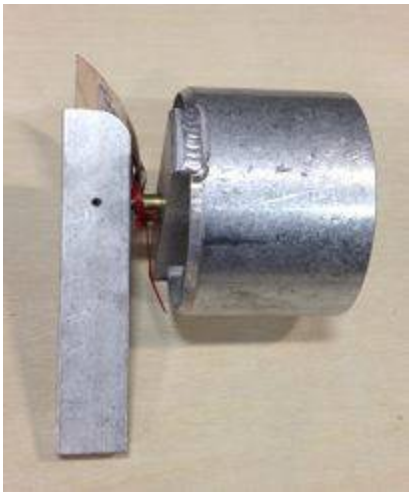
In situations where there is no immediate threat, contact your GE Service Representative for non-emergency rundown procedures.

Use these steps with the Vacuum Break Tool to break the magnet vacuum for a magnet rundown.

1. If possible, call your Qualified Service Representative.
2. Locate the Vacuum Break Tool (46-260852G3).

This tool is for emergency only and should be stored in a safe and easily accessible location. Ensure that all operators are informed of this tool's location.

Figure 2-63: Vacuum Break Tool



3. Ensure all room ventilation systems are on and the scan magnet room door is propped open.
4. Locate the vacuum port access cover on your magnet cover.

Figure 2-64: Vacuum port access panel on the lower right hand side of the magnet cover

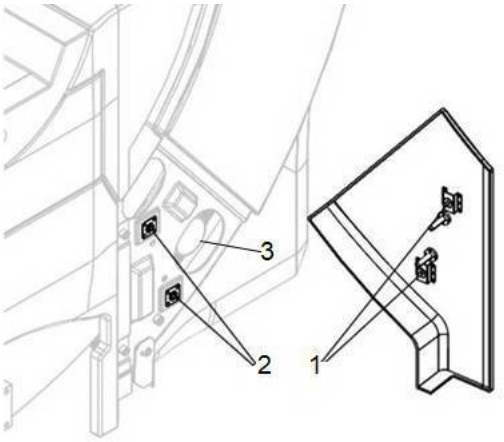


Table 2-59: Image legend

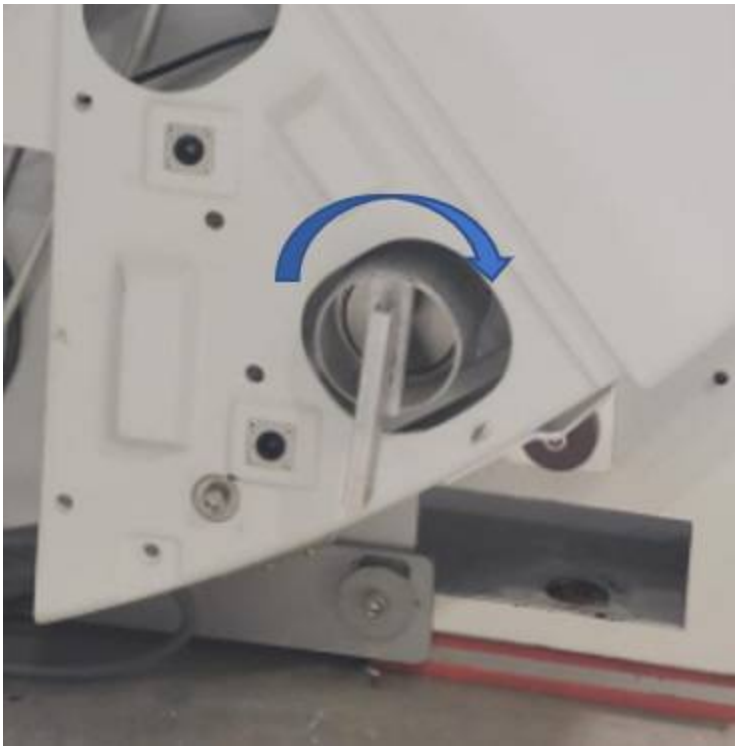
#	Description
1	Pins that insert into receivers.
2	Receivers that hold pins.
3	Exposed vacuum port.

5. Remove the vacuum port access cover from the magnet cover to expose the vacuum port.
   - You should be able to remove the access cover with your finger or non-magnetic tool.
6. Remove the protective dust cover from the vacuum port.

Figure 2-65: Dust cover removed

7. Screw the handle of the Vacuum Break Tool into the plug of the vacuum port by turning it clockwise.
   - At least three full turns are required to ensure thread engagement.
   - If you are unable to turn the handle, either call a GE Service Representative for further assistance or remove system enclosure cover.

Figure 2-66: Vacuum Break Tool screwed into vacuum port plug



8. Lift the Vacuum Break Tool handle until it is parallel to the floor. Leave the handle in this position.

Figure 2-67: Vacuum Break Tool parallel with floor

- There will be an inrush of air into the magnet and the magnet will quench in about 30 seconds.

Related topics

Primary magnet rundown procedure

Magnet Rundown Unit test procedure

Magnet rundown introduction

Quench with vent failure procedure

China RoHS label directive

The following product pollution control information is provided according to SJ/T11364: Marking for the Restriction of the use of Hazardous Substances in Electrical and Electronic Products.

This symbol indicates the product contains hazardous materials in excess of the limits established by the Chinese standard GB/T 26572: Requirements of concentration limits for certain restricted substances in electrical and electronic products. The number in the symbol is the Environment-friendly Use Period (EFUP), which indicates the period during which the toxic or hazardous substances or elements contained in electronic information products will not leak or mutate under normal operating conditions so that the use of such electronic information products will not result in any severe environmental pollution, any bodily injury or damage to any assets. The unit of the period is "Year".

In order to maintain the declared EFUP, the product shall be operated normally according to the instructions and environmental conditions as defined in the product manual, and periodic maintenance schedules specified in Product Maintenance Procedures shall be followed strictly.

Consumables or certain parts may have their own label with an EFUP value less than the product. Periodic replacement of those consumables or parts to maintain the declared EFUP shall be done in accordance with the Product Maintenance Procedures.

This product must not be disposed of as unsorted municipal waste, and must be collected separately and handled properly after decommissioning.

Table 2-60: Table of hazardous substances' name and concentration (SJ/T 11364).

Component name	Hazardous substances' name					
	(Pb)	(Hg)	(Cd)	(Cr(VI))	(PVBB)	(PBDE)
Magnet	X	O	O	X	O	O
Patient Table	X	O	O	X	O	O
Systems Cabinet	X	O	X	X	O	O
Coils	X	O	O	X	O	O
Global Operating Console (GOC)	X	O	X	X	O	O
Chiller	O	O	O	O	O	O
Accessories (Uninterruptable Power Supply)	X	O	X	X	X	X
LCD Monitor	O	X	O	O	O	O

O: Indicates that hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement in GB/T 26572.

X: Indicates that this hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement in GB/T 26572.

Data listed in the table represents best information available at the time of publication.

Applications of hazardous substances in this medical device are required to achieve its intended clinical uses, and/or to provide better protection to human beings and/or to environment, due to lack of reasonably (economically or technically) available substitutes.

Chapter 3: Equipment

This chapter includes information related to the MR system hardware.

STARTUP/SHUTDOWN

System startup and shutdown introduction

This section contains information on how to turn on and off and log into and out of your MRI system. It also includes quality control information to make sure your system is operating before scanning a patient and how to reset a subsystem of your scanner to safely recover from errors and various conditions.

A system restart brings the software down and then back up in an orderly fashion. It does not terminate power to the electronics or turn off power to the magnet. A corollary is restarting a PC. Safety rules should be followed to prevent personnel injury or magnet damage.

A system shutdown terminates power to the system's electronics in an orderly fashion so image files are saved. A corollary to this is turning off a PC. It does not turn off power to the MRI magnet. Safety rules should be followed during system shutdown to prevent personnel injury or magnet damage.

An emergency shutdown can be performed to remove the power from the magnet room. System overheating, smoke, or odor associated with the system are good reasons for an emergency power down.

Procedures

STARTUP/SHUTDOWN

System startup procedure

Considerations

For optimum system performance, restart your MR system, at a minimum every three days. It is advisable to restart your system daily.

There are times during a system startup or reboot, that the MR system executes a thorough file integrity check (correcting corrupted files, bad blocks, capturing file system information for better analysis of issues, etc.). The startup or reboot can take as long as 40 minutes. The following criteria determines the check:

- If the system is not shut down in an orderly fashion, for example a power outage shuts down the computer.

Procedure

Use these steps to turn on your MR system.

1. Press the on/off button to turn the power on to the computer.
   - When power is on, the power indicator light is illuminated.
   - For details, see **Computer concept**.
2. Click ***Start*** on the GE screen.
   - If Auto Start is enabled from the Service Browser, the scanner applications automatically begin before a user logs on. A message displays with a 30 second count-down to logon.
   - If Auto Start is not enabled, the system is in manual logon mode. The GE screen displays without the timer. The system waits to start the applications until you click ***Start***. Then, the "Do Not Interact with the System" message displays followed by the Logon screen.

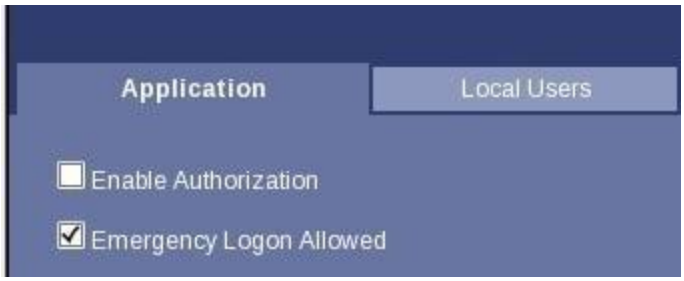
   Figure 3-1: GE screen

3. Wait until all messages are removed from the screen to enter your logon name and password.
   a. In the Logon Name field, type your user name.
      - Check with your system administrator for your specific logon credentials, If you don't know your logon name.
   b. In the Password field, type your password.
      - Check with your system administrator for your specific logon credentials, If you don't know your password.
      - To change the password, click ***Change Password***. Type the old and new passwords as prompted. The password complexity needed is set by the system administrator.

- Emergency logon button is only visible if the administrator has enabled the Emergency Logon Allowed feature from the Application tab.
- The Emergency Logon button disabled is the default and the recommended option.

Figure 3-2: Emergency Logon from Application tab



- If configured, you are automatically logged off after a period of inactivity. When you or another user logs back in, the system returns to its last known state.

c. Click ***logon***.

Figure 3-3: Example of Logon screen

If the **Penetration Cabinet** has been powered off, once power has been restored, wait 20 minutes before you begin scanning. Allowing 20 minutes for the electronics to warm up results in optimum system performance and image quality.

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Related topics

System startup from an extended shutdown procedure

SIGNA™ Victor emergency stop recovery procedure

System startup and shutdown introduction

STARTUP/SHUTDOWN

System restart procedure

Considerations

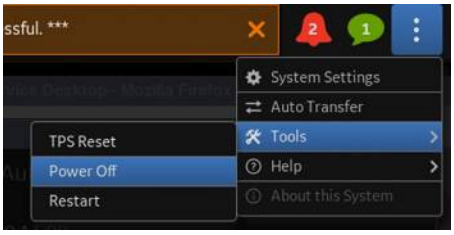
There are times during a system startup or reboot, that the MR system executes a thorough file integrity check (correcting corrupted files, bad blocks, capturing file system information for better analysis of issues, etc.). The startup or reboot can take as long as 40 minutes. The following criteria determines the check:

- If the system is not shut down in an orderly fashion, for example a power outage shuts down the computer.

Use these steps to restart your MR system.

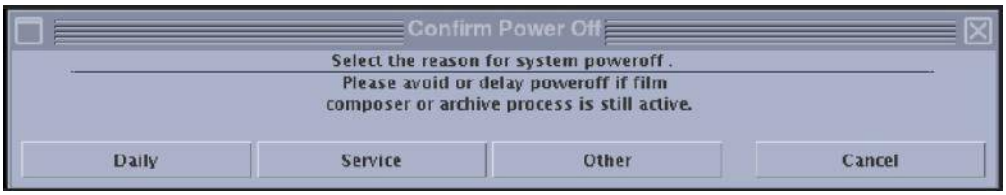
1. Make sure all of the images have reconstructed and are available for display from the Patient List.
2. Click ***End Exam***, if necessary.
3. Wait for all Archive and Network functions to complete.
4. Remove any archive media, if necessary.
5. To restart the system from the Overflow menu, follow these steps:
   a. From the Main Menu, click the Overflow icon to open the Overflow menu.
   b. From the Over flow menu, click ***Tools***.
   c. From the Tools menu, click ***Restart.***

Figure 3-4: Overflow menu



6. An alternative method to restart the system from the Tools menu follow these steps:
   a. From the Main Menu, click ***Tools***.
   b. From the System Management work area, click the ***Service Desktop Manager***.
   c. From the Service Desktop Manager, click ***System Restart***.
   d. It may take up to 30 seconds for the system to respond.
7. When prompted, click the reason for the system restart: ***Daily***, ***Service***, ***Other***, or ***Cancel*** to exit the restart of your system.

Figure 3-5: Confirm Restart screen



- The system displays a blue screen with the icon/status area at the beginning of shutting down.
- Wait for the Welcome to... logon window to appear. This indicates restart completion.

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Related topics

System startup and shutdown introduction

STARTUP/SHUTDOWN

System startup from an extended shutdown procedure

Use these steps if you have performed an **extended shutdown** procedure.

The equipment room is typically used by service engineers to service the equipment. Use caution when inside the equipment room.

Do NOT open any GE MRI System Cabinets or protective covers. There are dangerous high voltages within the cabinets.

There are several Cabinets and components within the equipment room used by the GE MRI System.

- The Main Disconnect Panel (MDP) is the in-coming Power for the MRI System and Heat Exchange Cabinet (HEC). Do **NOT** turn off power to this component.
- The system cabinet contains the PDU[1] for the MRI System.

Figure 3-6: SIGNA™ Victor ISC cabinet

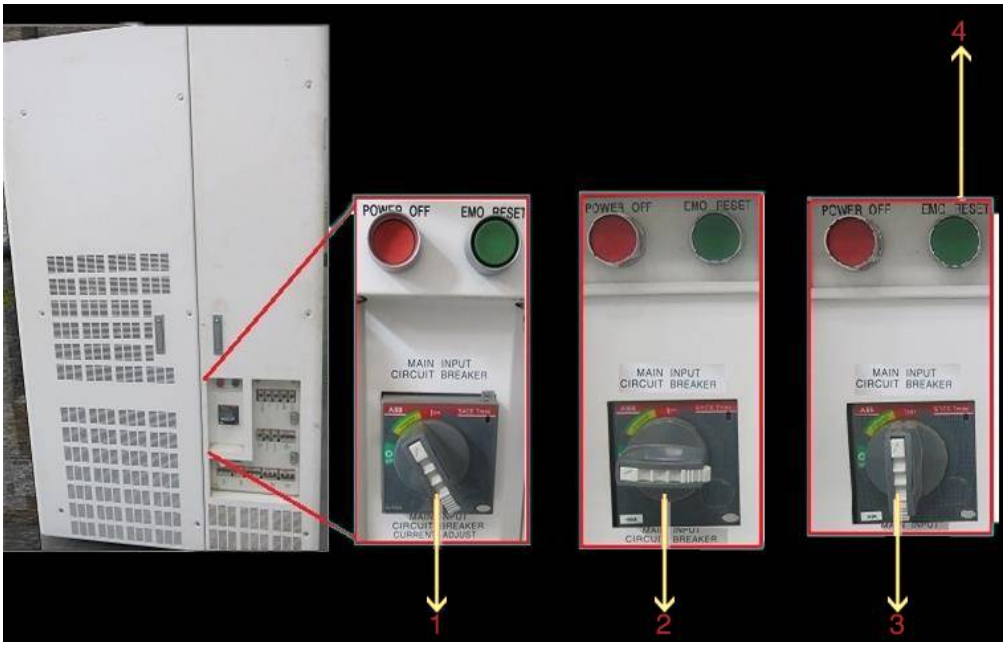

Table 3-1: Image legend

#	Description
1	Breaker in intermediate position from when the breaker was turned off.
2	Breaker in reset position, fully horizontal.
3	Breaker in on position, fully vertical.
4	EMO[2] Reset button.

[1] Power Distribution Unit

[2] EMergency stOp

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1. From the system cabinet lower left corner, complete the following:
   a. Reset the breaker. Move the breaker from the intermediate to reset position (fully horizontal). See 1 and 2 in Figure 3-6.
   b. Move the breaker to the on position. See 3 in Figure 3-6
   c. Press the **EMO Reset** button. See 4 in Figure 3-6
      - The EMO Reset button turns on power to the high voltage components and results in a blower and relay noise.
      - The system computer should automatically turn on.
2. If the computer does not automatically turn on, then complete the steps below in the Standard startup procedure.

Related topics

System startup procedure

System startup and shutdown introduction

STARTUP/SHUTDOWN

SIGNA™ Victor: emergency stop recovery procedure

Use these steps to recover normal system operation after an emergency-stop has occurred. For emergency stop details, see **Emergency shutdown procedure**.

1. Go into the equipment room and locate the ISC cabinet.
   - The equipment room is typically only used by service engineers to service the equipment. Use caution when inside the equipment room.
   - Do NOT open any GE MRI System Cabinets or protective covers. There are dangerous high voltages within the cabinets.
2. From the ISC cabinet that contains the PDU[1] for the MRI System, press the green **EMO Reset** button.

   Figure 3-7: Controls in the lower area of the ISC cabinet

   

3. Return to the operator console and complete a TPS Reset. for details, see **TPS reset procedure**.
4. After the TPS Reset is finished, the emergency-stop condition should be recovered. If the emergency-stop condition remains after the TPS Reset is finished, call your service engineer.

Related topics

System startup and shutdown introduction

[1]Power Distribution Unit

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STARTUP/SHUTDOWN

System logon procedure

The logon feature requires you to log on to access your system. It can be turned on or off by your administrator.

How your site uses this feature depends on if your site has a central user repository to which the system is connected. Sites with networks are referred to as enterprise systems, those without are referred to as stand-alone systems. This feature can be used with either configuration, although some features are more applicable to enterprise systems.

After a period of inactivity set by your administrator, or after a user locks the screen, the system splash screen displays. Use these steps to log back in.

1. Type your Logon Name.
2. Type your password.
3. Click ***Logon***.
   - Logging off does not prohibit other users from logging in. Logout is designed to protect patient privacy, not stop approved users from logging in.
   - When you or another user logs back in, the system returns to its last known state.
   - Note the GE logo area content changes based on your MR system
   - If you have administrator privileges, when you log on you are asked if you wish to perform administrative tasks or scan. Do not click the button next to the Enter admin screen if you only want to scan.

Figure 3-8: Example of a Startup screen

Logon Name:

The Logon Name for your system. The default Logon Name is SDC or sdc. Your administrator can set-up a unique Logon ID for you through your hospital Enterprise system.

Password

A password assigned to you by the system administrator.

Related topics

System logout procedure

System emergency logon procedure

System startup and shutdown introduction

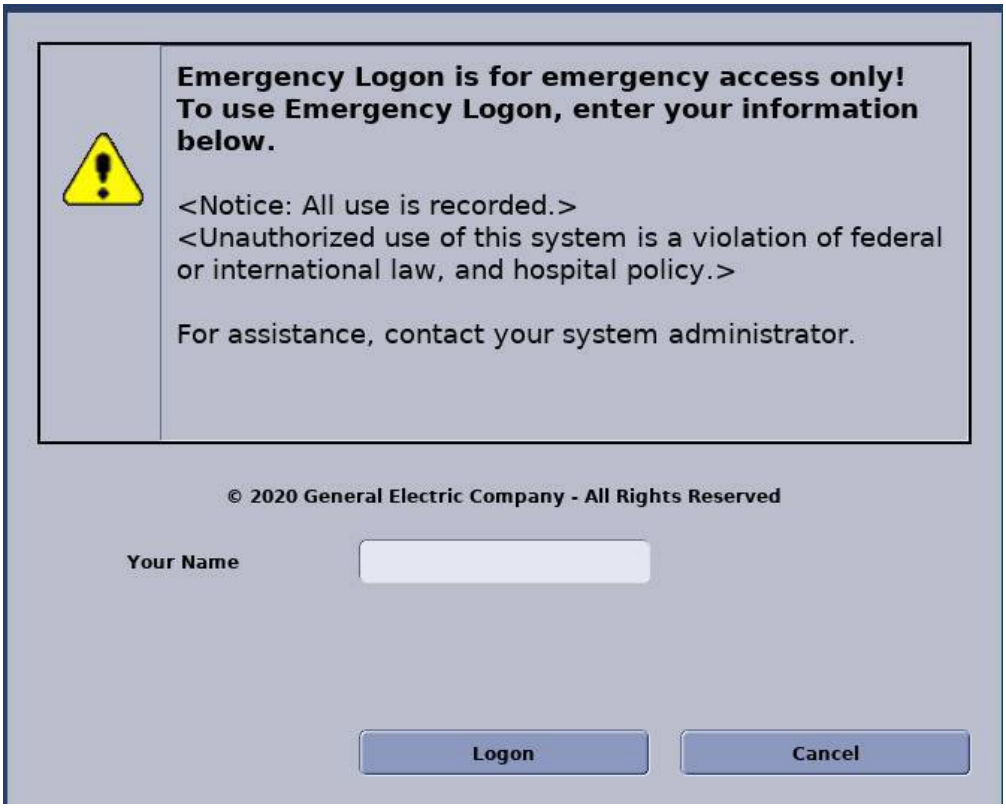
STARTUP/SHUTDOWN

System emergency logon procedure

The splash screen may or may not display the Emergency Logon button. Turning this option on or off is set by your system administrator. When using Emergency Logon, you are prompted to enter your name, but there is no password. Use Emergency Logon only if you do not have a valid account set up.

1. From the Emergency Logon screen, type any name in the ***Your Name*** text field.
2. Click ***Logon***. One of two actions occurs:
   - The screen unlocks and displays the desktop that was last visible right before the screen was locked.
   - The system starts-up or re-boots.

Figure 3-9: Emergency logon



Related topics

System logout procedure

System startup and shutdown introduction

STARTUP/SHUTDOWN

System logout procedure

The procedure for logging out of the system has changed. Use these steps to lock the screen and switch the user of the system. When you or another user logs back in, the system returns to its last known state.

1. From the Main Menu, click ***Tools***.
2. From the **System Management work area**, click the ***Service Desktop Manager***.
3. From the Service Desktop Manager, click ***Lock Screen Switch User***.
   - The Logon screen displays for you to log on to the system.
   - Only users with valid accounts set up by the system administrator can log on to the system, unless the Emergency Logon Allowed feature is enabled.

Related topics

System logon procedures

System startup and shutdown introduction

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STARTUP/SHUTDOWN

System shutdown procedure

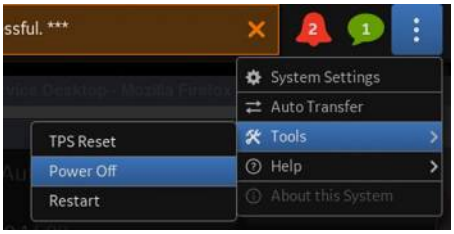
Use these steps to save energy when the system is not expected to be in use for extended periods of time, such as evenings, weekends and holidays. The shutdown procedure terminates power to the system electronics in an orderly fashion so image files are saved. This procedure does not turn off power to the MRI magnet.

For optimum system performance, restart your MR system, at a minimum every three days. It is advisable to restart your system daily.

Power off or Overnight mode

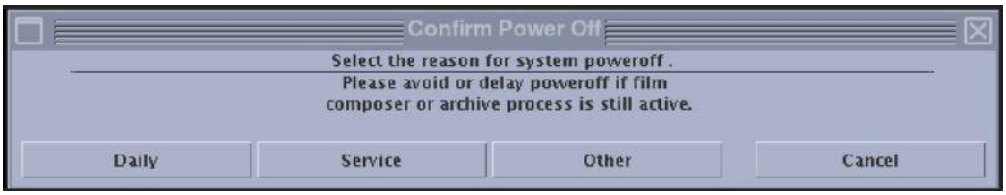
1. Make sure all images have reconstructed and are available for display from the Patient List.
2. End an exam, if necessary.
3. Wait for all post processing, archive, network, filming, CD/DVD, etc. functions to complete.
4. Remove any archive media, if necessary.
5. From the Main Menu, click the Overflow icon to open the **Overflow** menu.

Figure 3-1: Shutdown menu



6. From the Overflow menu, click **Tools**.
7. From the Tools menu click **Power Off**.
8. When prompted, click on the reason for the system shutdown: ***Daily***, ***Service***, ***Other*** or ***Cancel*** to exit the shutdown of your system.

Figure 3-2: Confirm Power Off screen



- The application begins to shut down, which can take less than 15 minutes.
- When the shut down is completed, the screen goes blank and the computer turns off.

Related topics

System extended shutdown procedure

System Startup procedure

System restart procedure

System startup and shutdown introduction

STARTUP/SHUTDOWN

Emergency shutdown procedure

System overheating, smoke, or odor associated with the system are good reasons for an emergency power down.

1. Press any **Emergency Stop** button (**magnet cover,** or **keyboard**) to remove power from the magnet room.
2. Evacuate the patient and all other personnel from the MRI suite.
3. Call service.
4. After service has examined the system, the cause of the emergency should be written down for future reference.
5. After service has approved a system restart, follow these steps:
   a. From the PDU, press the **EMO Reset** button.
   b. Execute the **TPS reset procedure**.

- **SIGNA™ Victor: emergency stop recovery procedure**

The MR Safety chapter contains more instructions on responding to patient emergencies.

Related topics

System logon/logout procedures

System startup and shutdown orientation

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STARTUP/SHUTDOWN

System extended shutdown procedure

Use these steps to execute an extended power shut down once the computer has successfully shutdown and the computer power is off.

The equipment room is typically used by service engineers to service the equipment. Use caution when inside the equipment room.

Do NOT open any GE MRI System Cabinets or protective covers. There are dangerous high voltages within the cabinets.

The Main Disconnect Panel (MDP) is the in-coming Power for the MRI System and cooling system cabinet. Do **NOT** turn off power to this component. The cooling cabinet must remain on to keep the helium at the proper temperature to maintain correct magnet pressure.

1. Confirm that the computer is turned off.
2. From the system cabinet lower left corner, press the red **POWER OFF** button.
   - Only the system cabinet is turned off. The system cabinet contains the Power Distribution Unit (PDU) for the MRI System. It results in noise as the relays and switches open.
   - The HEC cabinet, Sumitomo compressor and coldhead remain on.

Figure 3-10: SIGNA™ Victor ISC cabinet

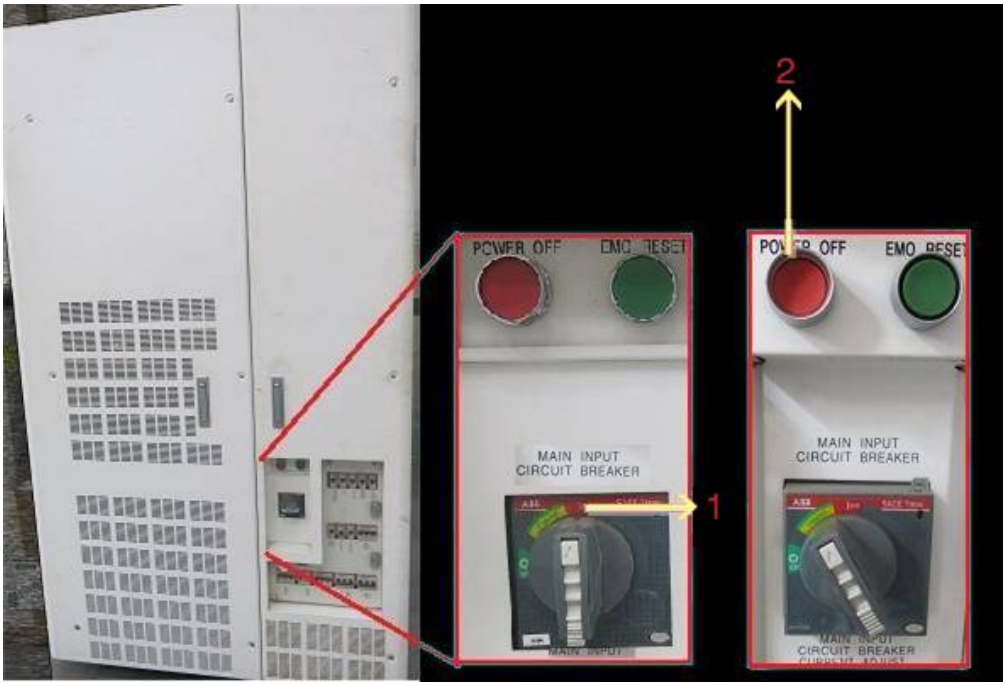


Table 3-2: Image legend

#	Description
1	Breaker in on position, fully vertical.
2	Breaker in intermediate position after the breaker is turned off by pressing the red **POWER OFF** button.

Related topics

System shutdown procedure

Emergency shutdown procedure

System startup and shutdown introduction

STARTUP/SHUTDOWN

Emergency stop and abort scan buttons introduction

Emergency stop

The **Emergency Stop** button disables power to the patient handling and scan related equipment when pressed. It does not shut down the magnetic field.

Figure 3-11: Emergency Stop button

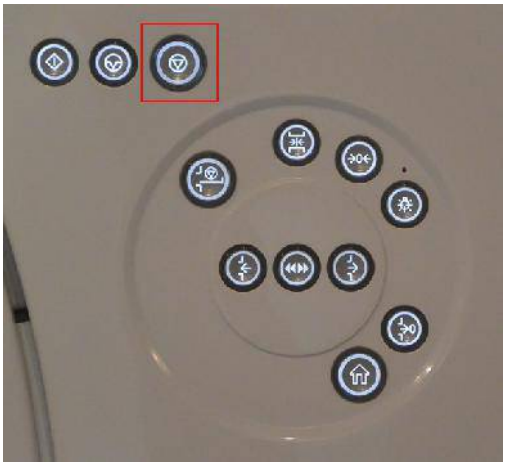
The Emergency Stop buttons are located on either side of the magnet cover right above the control panels.

Figure 3-12: Location of Emergency stop buttons

Abort scan

The **Abort Scan** buttons are located on either side of the magnet cover on the magnet control panels. They stop an active scan.

Figure 3-13: Abort scan on magnet controls



Related topics

Equipment components introduction

In-Room Display

6339006-1EN (2022-12) Rev.2

STARTUP/SHUTDOWN

TPS reset introduction

The *TPS*[1] subsystem oversees raw data processing. The TPS is housed in your system cabinet, located in your computer room. It is sometimes reset to safely recover from many error conditions. Perform the reset procedure when instructed by either a system message or an InSite technician.

When the TPS reset procedure is finished, continue the patient's exam while keeping the following in mind:

- The series scanned following the TPS reset is assigned the next available series number.
- The landmark remains unchanged as long as the table is not moved during the TPS reset.
- The IEC operating mode (Normal, First, and Second Control Mode) are preserved.
- Graphic Rx remains open when the TPS reset is started; therefore, when it is completed, you can continue to prescribe scan locations.
- Bookmarks created in Realtime or Fluoro Trigger are retained after the TPS reset is completed.
- Calibration files are still valid if the patient or landmark has not moved after the TPS reset is finished.
- Although the Gating Control window closes during a TPS reset, all selections are retained. A Gating Reset is automatically performed when the TPS reset is finished.

Procedures

TPS reset procedure

Related topics

System startup and shutdown introduction

[1]Transceiver Processing and Storage

STARTUP/SHUTDOWN

TPS reset procedure

Use these steps to reset the TPS when instructed by either a system message or an InSite technician.

1. From the Main Menu, click ***Tools***.
2. From the **System Management work area**, click the ***Service Desktop Manager***.
3. From the Service Desktop Manager, click ***TPS Reset.***
   - TPS reset aborts realtime or normal scanning.
   - During TPS Reset, the Scan desktop and Graphic Viewport are locked. This means that you cannot view/edit, save, cut, copy, paste, or download any series in the Workflow Manager.
   - The Rx state may change after a TPS reset.
   - The following warning message is displayed after TPS Reset has been selected if all images have not been reconstructed, "Image reconstruction is in progress. Pending images may be lost. Are you sure you want to start TPS Reset?".
   - For a multi-station group, if some (not all) series in that group have been scanned and then TPS Reset is started, all the series in that group will be locked and they cannot be downloaded or scanned again.
4. Click ***OK***.
   - The TPS reset aborts reconstruction of pending images, Manual Prescan, Auto Prescan, Reference Scan and Normal Scan.
   - The bore fans and lights turn off during the TPS reset. When the reset completes, bore fans and lights return to their previous state.
5. Wait for the "TPS successfully reset" message in the system status display message box.
   - If the TPS reset fails, the following messages display:
     - "TPS Reset Failed. Please see the message log for more details".
     - "TPS/APG communication failed (s) A re-download of TPS may be necessary."
     - Click ***OK*** to acknowledge your response to the message.
   - If the TPS reset fails two consecutive times, the exam is automatically ended.
6. Continue scanning where the system left off.

Related topics

TPS introduction

System restart procedure

System startup and shutdown introduction

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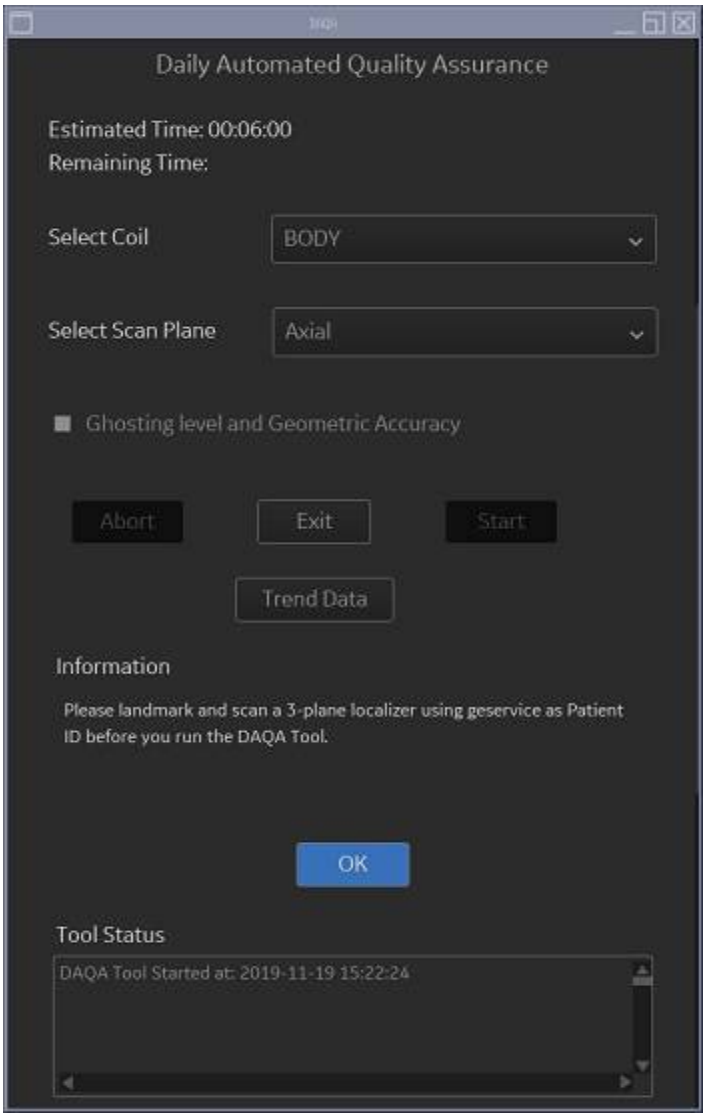
DAQA

Daily Automated Quality Assurance introduction

Quality control is an important part of the daily start up procedure. Performing a *DAQA*[1] test allows you to make sure that your system is operating before you begin patient scanning.

A DAQA test requires the use of a phantom to simulate the weight of a particular body part. The spherical *TLT*[2] phantom can be used to perform DAQA scans with the Body and Head coils. The TLT phantom provides useful information about the quality of your DAQA scans.

Figure 3-14: Daily Automated Quality Assurance screen



[1] Daily Automated Quality Assurance

[2] Top Level Test

Table 3-3: DAQA screen details

Screen area	Description
Select Coil	The currently connected *RF*[1] coil is displayed in the Selected Coil field. If there is more than one coil configuration for the connected coil, select the desired coil configuration from the menu. ● If a coil is not plugged in, the tool lists the Body coil. ● This field is not active if Ghosting Level and Geometric Accuracy is selected.
Select Scan Plane	The options are Axial, Sagittal and Coronal. Only Axial is available when Ghosting and Geometric Accuracy is selected.
Ghosting Level and Geometric Accuracy	Selecting this option puts the tool into the system test mode. In this mode, *SNR*[2], ghosting, and geometry tests are performed and summarized. This test is run using the head *TLT*[3] sphere and one of the following coils: ● GE T/R split-top head ● Express HNA (Head Neck Array)
Start ●	Initiates the test and is disabled when the test is running.
Abort	Stops data acquisition/post-processing before completion. When selected, the system may take up to 30 seconds to complete the abort process.
Exit	Closes the screen.

Background

Geometric accuracy calculation

For geometric accuracy, it is assumed that the 17 cm round sphere is used in DQA measurements. Measurements are performed on axial, coronal, and sagittal images to calculate the relative diameter of the phantom along the phase and frequency directions. The ratio is given by

$$D^{i}_{x,y,z} = \frac{d^{m,i}_{x,y,z}}{d_{x,y,z}}$$

where i is the frequency or phase direction, dx, y, z = 17 cm (the known diameter along x, y, or z direction of the head TLT sphere phantom), is the measured diameter along the measured encoding direction.

The application reports the following three parameters for this test:

$$D_{x=}D_{x}^{phase} - D_{x}^{frequency},$$

$$D_{y=}D_{y}^{phase} - D_{y}^{frequency},$$

$$D_{z=}D_{z}^{phase} - D_{z}^{frequency}.$$

[1]Radio Frequency

[2]Signal-to-Noise Ratio

[3]Top Level Test

Ghosting level

The images used for characterizing the ghosting level in DQA measurements are the same as those used in the geometric accuracy measurement.

- The ghost (G) is the average value of the signal reported in a square 25 pixel *ROI*[1] (5×5 pixels) in the region beyond the phantom area in the phase-encoding direction.
- The signal (S) is the average value of the signal reported within the phantom in a square 25 pixel ROI (5×5 pixels).
- The noise (N) is the average value of the signal reported in a square 25 pixel ROI (5×5 pixels) in frequency encoding direction outside the phantom.

If the *SNR*[2] (S/N) is greater than or equal to 100, the reported value is G/S. However, if S/N is less than 100, the reported value is (G-N)/S.

Procedures

About phantom scan

Scan phantom procedure

SNR test procedure

System test procedure

DAQA trend setting procedure

DAQA messages

Related topics

System startup and shutdown introduction

[1]Region Of Interest

[2]Signal-to-Noise Ratio

DAQA

About phantom scan

When prescribing a phantom scan, from the New Patient screen, type **111** lbs (or **50** kg) as the patient weight.

Figure 3-15: New patient screen

A higher weight than 50 kg for the phantom scan could cause system damage.

Related topics

Scan phantom procedure

6339006-1EN (2022-12) Rev.2

DAQA

Phantom breakage of spillage considerations

Information regarding MR phantom content solutions and spill procedure (NiCl2 (nickel chloride), MSDS 8363917) is shipped with your phantom. In the event of a chemical spill, notify the building security. They will alert the spill team.

In the event of the DAQA phantom breaking and resulting in a nickel chloride spill, keep the following in mind. The information below is an extract from MSDS 8363917:

Health hazard information

Routes of Entry: Inhalation, ingestion, skin or eye contact.

Target Organs: Skin, paranasal sinus, lungs, gastrointestinal system, kidneys and liver.

Symptoms and Effects of Exposure: Metallic taste in the mouth. Exposure can result in irritation of the mucous membranes and the respiratory system. Contact with the skin can result in itchy sensations, redness, erythema, contact dermatitis, eczema, sensitization, or loss of fats and lipids. Contact with the eyes can result in conjunctivitis. Other symptoms include dizziness, giddiness, delirium, confusion, lassitude, loss of strength, asthma, nausea, vomiting, headache, fever or hypothermia, anorexia, loss of sense of smell, diarrhea, anuria, liver damage, jaundice and convulsions.

Animal experiments have resulted in observable birth defects.

Cancers of the lung and nasal sinuses in Nickel workers have been known for more than 50 years to be associated with nickel refining, nickel plating, and nickel polishing.

First Aid:

- If this chemical gets in the eyes, immediately flush the eyes with large amounts of water, occasionally lifting the lower and upper lids. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.
- If this chemical gets on the skin, immediately wash contaminated skin with soap or mild detergent and water. If this chemical soaks clothing, immediately remove clothing and wash contaminated skin with soap or mild detergent and water. Get medical attention promptly.
- When this chemical has been swallowed and person is conscious, immediately give the person large quantities of water or milk. Remove by gastric lavage unless patient is vomiting. Do not make an unconscious person vomit. Get medical attention immediately.

Spill, leak and disposal procedures

Observe all federal, state and/or local regulations when storing or disposing of this substance. Contact local and/or state environmental authorities to insure proper compliance.

This substance does not meet the definition of a hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA) (40CFR260).

DAQA

Scan phantom procedure

The *DAQA*[1] procedure provides a means for you to track overall system or *RF*[2] coil functionality. The application supports all GE coils that have the coil ID feature.

Considerations

To obtain meaningful, reproducible data for a given RF coil, consistency and repeatability is key. Always use the same phantom, the same positioning of the phantom in the coil and the same landmark at the same location on the phantom/coil.

Table 3-4: Phantoms used in DAQA tests

Phantom name
Head TLT
Body TLT phantom sphere
Body TLT Loader

1. Set up the desired coils and the phantom on the table. The coil and phantom you choose will depend on whether you are going to perform the **SNR** or **System** test.

   a. Place the coil on top of the cradle and place the phantom holder and phantom inside the coil.

   Figure 3-16: Example of the Express HNA (Head Neck Array)

   b. If you are using the body coil, use the Body TLT phantom and Loader. Follow the pictorial guidelines below to transport the phantom.

[1] Daily Automated Quality Assurance

[2] Radio Frequency

Figure 3-17: Correct phantom transportation

Figure 3-18: Incorrect phantom transportation

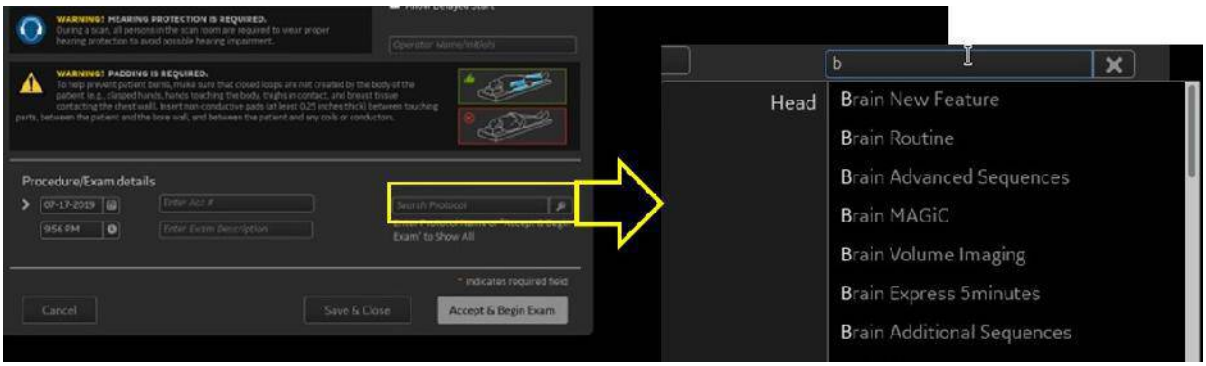
2. Landmark the coil and phantom.
3. Press **Advance to Scan**.
4. From the Dashboard, to begin a scan, click the *New Patient icon* 
5. From the New Patient screen, type **geservice** as the patient ID and **111** lbs (or 50 kg) as the patient weight.

Figure 3-19: New patient screen

- A higher weight than 50 kg for the phantom scan could cause system damage.

6. Select a 3-plane localizer protocol from the Protocol list.

Figure 3-20: 3-Plane protocol



7. Click ***Accept and Begin Exam***.
8. Scan the 3-plane localizer.
9. When complete, click ***End Exam*** from the bottom of the Task List.
10. Perform either the **SNR** or **System** test.

Related topics

Daily Automated Quality Assurance introduction

6339006-1EN (2022-12) Rev.2

DAQA

SNR test procedure

The phantom remains in the magnet for this test. This test can be run with a variety of coil/phantoms/holders, but it will fail if you do not have the right combination.

1. From the Main Menu, click ***Tools***.
2. From the **System Management work area**, click the ***Service Desktop Manager***.
3. From the Service Desktop Manager, click ***Service Browser***.
4. From the MR Service Desktop, click the ***Image Quality*** tab.
5. From the Image Quality tab, click ***Daily Automated Quality Assurance***.
6. Click ***Click here to start this tool*** to open the tool and click ***OK*** to the prompt(s).
7. From the **DAQA screen**, verify that the ***Ghosting Level and Geometric Accuracy*** option is not selected.
8. Verify the currently connected *RF*[1] coil is displayed in the Selected Coil field.
   - If there is more than one coil configuration for the connected coil, select the desired coil configuration from menu.
   - If a coil is not plugged in, the tool will list the Body coil.
9. From Select Scan Plane menu, choose the desired SNR testing plane.
10. Click ***Start*** to initiate the test.
    - The Abort button stops data acquisition/post-processing before completion. When selected, the system may take up to 30 seconds to complete the abort process.
    - If the connected RF coil is changed after the DAQA tool has started, selecting the Start button displays a "Coil not Valid" message. Click ***OK*** and the tool refreshes the main user interface with the information of the new connected coil. Confirm the UI settings and click ***Start*** again to begin data acquisition.
11. Click ***Yes*** in the "Confirm!" window to acknowledge phantom placement and landmark.
    - A progress bar indicates the status.
    - The system collects one signal image and one noise image and displays the values for signal, noise, SNR, Transmit Gain (TG) in 0.1dB units and the center frequency (CF) in units of Hz in the Test Complete window.
12. Record the results and click ***OK*** to the prompt.
13. Click ***Exit***.

Related topics

Daily Automated Quality Assurance introduction

[1]Radio Frequency

DAQA

System test procedure

The *DAQA*[1] System test is run using the head *TLT*[2] sphere and one of the following coils:

- GE T/R split-top head
- Express HNA (Head Neck Array)

If you do not use the head TLT sphere placed in the appropriate positioner (pad or holder) and centered properly, then the test will fail.

1. From the Main Menu, click ***Tools***.
2. From the **System Management work area**, click the ***Service Desktop Manager***.
3. From the Service Desktop Manager, click ***Service Browser***.
4. From the MR Service Desktop, click the ***Image Quality*** tab.
5. From the Image Quality tab, click ***Daily Automated Quality Assurance***.
6. Click ***Click here to start this tool*** to open the tool and click ***OK*** to the prompt(s).
7. From the **DAQA screen**, select the ***Ghosting Level and Geometric Accuracy*** option.
   - The Selected Coil and Selected Scan Plane fields are unavailable.
8. Click ***Start*** to initiate the test.
   - The Abort button stops data acquisition/post-processing before completion. When selected, the system may take up to 30 seconds to complete the abort process.
   - If the connected RF coil is changed after the DQA tool has started, selecting the Start button displays a "Coil not Valid" message. Click ***OK*** and the tool refreshes the main user interface with the information of the new connected coil. Confirm the UI settings and click ***Start*** again to begin data acquisition.
9. Click ***Yes*** to the "Confirm!" message to acknowledge the correct coil and phantom use.
10. Click ***Yes*** in the next "Confirm!" message to acknowledge the phantom placement and landmark.
    - A progress bar indicates the status.
    - The system acquires three signal images from all three planes and one axial noise image. The axial signal image is used to calculate center frequency, transmit gain, SNR, ghosting, and geometric accuracy. The noise image is used to calculate SNR. The sagittal and coronal images are used to calculated geometric accuracy. The results display in the Test Complete window.
11. Record the results and click ***OK*** to the prompt.
12. Click ***Exit***.

Related topics

Daily Automated Quality Assurance introduction

[1] Daily Automated Quality Assurance
[2] Top Level Test

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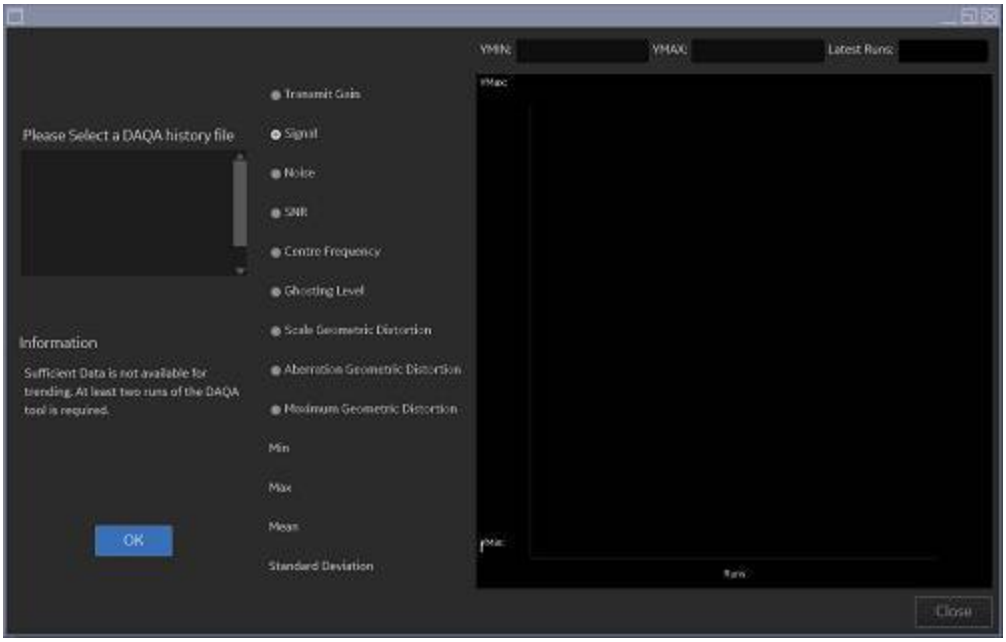
DAQA

DAQA trend setting procedure

Use these steps to view the trends of your DAQA tests.

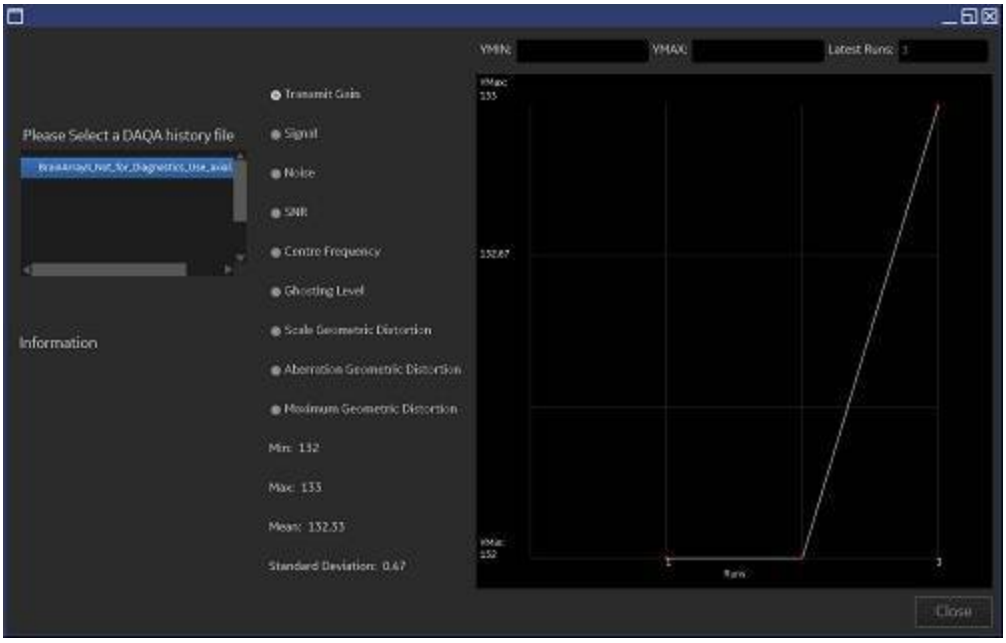
1. From the Main Menu, click ***Tools***.
2. From the **System Management work area**, click the ***Service Desktop Manager***.
3. From the Service Desktop Manager, click ***Service Browser***.
4. From the MR Service Desktop, click the ***Image Quality*** tab.
5. From the Image Quality tab, click ***Daily Automated Quality Assurance***.
6. Click ***Click here to start this tool*** to open the tool and click ***OK*** to the prompt(s).
7. From the **DAQA screen**, Click ***Trend Data*** to view the Trend Viewer screen.

Figure 3-21: Trend Viewer screen



8. Click one of the coils and one of the items in the Result File list to view the trend graph.

Figure 3-22: Trend graph



9. Click any of the available option buttons to view a unique graph, which is representative of the option label.
10. Click ***Close*** to close the Trend Viewer screen.

Related topics

Daily Automated Quality Assurance introduction

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DAQA

DAQA messages

The following table displays the content of DAQA messages.

#	Message
1.	A different coil is connected! Please re-select the coil and plane before hitting [Start].Coil not valid.
2.	A different coil is connected! This coil is also not supported by Daily QA Tool. Please plug in a valid supported coil before hitting [Start].Coil not valid.
3.	Aberration Geometric Distortion
4.	Abort
5.	ATP execution has hung, please check atp process or the scanner hardware
6.	but was called with incorrect input arguments., ...
7.	Center not within the object. This algorithm works best for convex objects. Very likely that your results are in error
8.	Center Frequency
9.	Close
10.	Coil configuration notice
11.	Daily Automated Quality Assurance
12.	Daily QA Tool aborted on date_time
13.	Do you really want to abort the current scan?','Abort?
14.	ERROR
15.	Error building SVAT file for manual prescan.
16.	Error building SVAT file to load the protocol.
17.	Error editing the protocol for COIL
18.	Error editing the protocol for FOV
19.	Error editing the protocol for GRADMODE
20.	Error editing the protocol for PLANE
21.	Error editing the protocol for SWAPPF
22.	Error executing the SVAT script to load the protocol.
23.	Error executing the SVAT script to run Auto-Prescan.
24.	Error executing the SVAT script to run first image scan.
25.	Error executing the SVAT script to run Manual-Prescan.
26.	Error executing the SVAT script to run second image scan.
27.	Error from get_coilid function.
28.	Error from read_coil_id_list function.
29.	Error with abort_svat function
30.	ERROR with APS_EVENT svat command
31.	ERROR with DOWNLOAD svat command

#	Message
32.	ERROR with DOWNLOAD svat command, scanner busy
33.	ERROR with IPG_ADVANCE_TOSC svat command
34.	ERROR with LOADPROTOCOL svat command
35.	ERROR with MODIFY_CV svat command
36.	ERROR with MPS_SCAN_TR svat command
37.	ERROR with NEW_EXAM svat command
38.	ERROR with PROTOCOL_DIR svat command
39.	ERROR with PROTOCOL_MODE svat command
40.	ERROR with PSC_UPDATE_VAL svat command
41.	ERROR with RECON_STOPPED svat command
42.	ERROR with RESET_SCAN svat command
43.	Error with reset_svat function
44.	ERROR with SCAN_EVENT svat command
45.	ERROR with START_LOOP_EVENT svat command
46.	ERROR with STOP_LOOP_EVENT svat command
47.	Error with table_wait_time function
48.	ERROR with VIEW_EDIT svat command
49.	Error! Cannot find the phantom!
50.	Error! Two test images do not have the same size!
51.	Exit
52.	Ghosting Level
53.	Ghosting Level & Geometric Accuracy
54.	Images: too Few Inputs
55.	Images: too Many Inputs
56.	Incomplete Rx, please check coil and landmark
57.	Max
58.	Maximum Geometric Distortion
59.	Mean
60.	Min
61.	No
62.	No P files found!!!
63.	No valid landmark
64.	Noise
65.	Note: Phantom placement and coil landmarking are critical for repeatable results. Verify coil and phantom are properly placed and landmarked at correct location. Also verify there are no large air bubbles in the phantom. Do you wish to continue?
66.	OK

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#	Message
67.	Only system configuration is allowed for ghosting level option. Make sure you landmark on this configuration or unselect ghosting level option. SNR is measured on Axial plane
68.	Please Select a DAQA history file
69.	Please select the coil ! Select Coil
70.	Please select the coil and scan plane!.Select Coil & Plane
71.	Please wait at least 15 minutes before scanning to prevent swirling artifacts. Do you wish to continue?
72.	Please wait while the DAQA initializes..
73.	Protocol download failed
74.	Result Files
75.	Scale Geometric Distortion
76.	Select coil
77.	Select Scan Plane
78.	Signal
79.	SNR
80.	Standard Deviation
81.	Start
82.	Success: Center within the object!!!
83.	Sufficient Data is not available for trending. Atleast two runs of the DAQA tool is required.
84.	Table check has hung, please check table_feedback process or the scanner hardware
85.	Test Completed
86.	Test Completed
87.	Test Completed! Results are recorded in output file
88.	Test proceeds without at least 15-minute waiting time. Test result might not be stale','Test proceeds without enough waiting time
89.	The current coil is not supported by Daily QA Tool. Please plug in a valid supported coil before hitting [Satrt].Coil not valid.
90.	There is not that many files listed !!!
91.	There might be artifacts on the test images or you are not using homogeneous phantoms!
92.	Transmit Gain
93.	Trend Data
94.	Trend Viewer
95.	Wait for a minute after moving the table
96.	Yes
97.	You chose to include ghosting level and geometry accuracy in addition to SNR in the test. The test will use connected coil configuration and 17 cm sphere phantom with loader if Head Coil is used, otherwise 17 cm sphere phantom without loader. Do you want to continue?
98.	You chose to include ghosting level and geometry accuracy in addition to SNR in the test. The

#	Message
	test will use connected coil configuration and 27 cm sphere phantom with a loader. Do you want to continue?
99.	You chose to use connected coil configuration and Axial plane. Please make sure that you use a 17 cm sphere phantom with loader if Head Coil is used, otherwise 17 cm sphere phantom without loader. Do you want to continue?

Related topics

Daily Automated Quality Assurance introduction

EQUIPMENT COMPONENTS

Equipment components introduction

SIGNA™ Victor consists of 1.5T superconducting magnet(IPM), gradient system(Gradient Coils BRM, gradient amplifier XFD), radio frequency system (RFA9.5kW), coil, computer system and console(GOC), physiological signal gating system (include Cardiac gating, Respiratory Gating and Peripheral gating (PAC)) and Low-height fixed table (LHFT).

This section helps you to become familiar with your MR system.

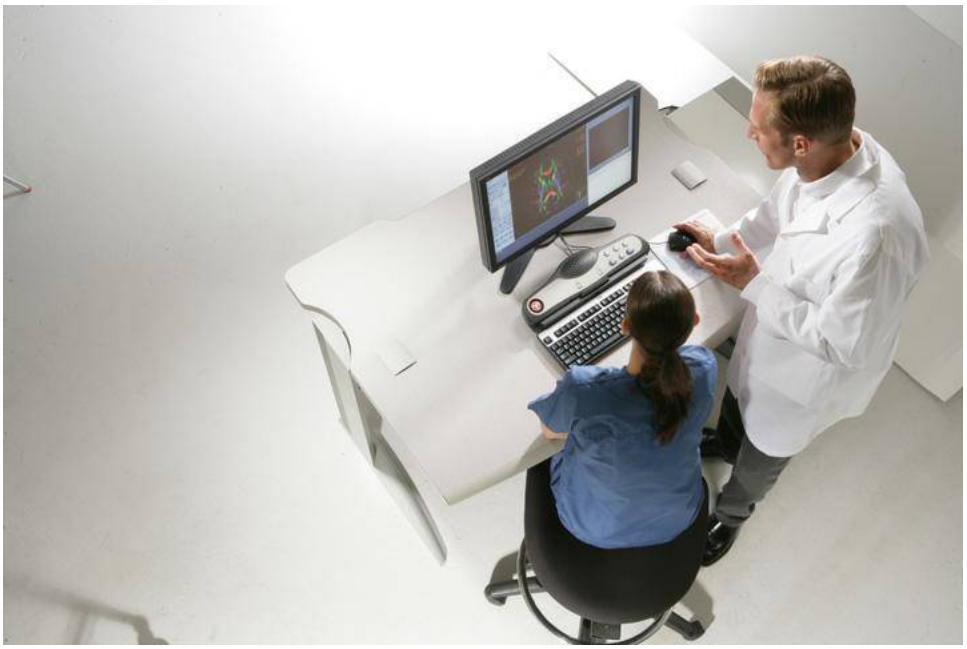
WORKSTATION

Workstation introduction

The workstation monitor displays images and scan, display, archive, network, service, and ***iLink*** programs. It also displays protocol notes and physiological waveforms when they are activated. AutoView is always displayed in the upper right area of the monitor. All routine operations are carried out from this workstation monitor.

The monitor can be raised and lowered, tilted forward or backward, or rotated left to right. Adjust the monitor's height and tilt for a comfortable viewing position.

Figure 3-23: MR Workstation



Related topics

Computer concept

Keyboard concept

Mouse controls concept

Equipment components introduction

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WORKSTATION

Computer concept

The computer is located in the cabinet stored below the desk.

Figure 3-24: System computer

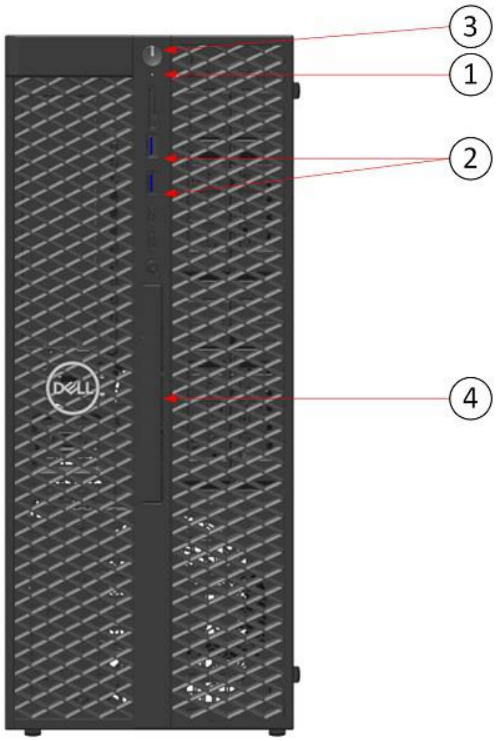


Table 3-5: Image legend

#	Description
1	Insert a pin or ballpoint pen to press the button in the hole to reset the computer when the on/off button doesn't work.
2	USB ports that can be used when exporting images or importing jpgs to add to a **Task Note**.
3	Power on button.
4	The CD/DVD drive that is used by service to install software and the operator manual. The Read/Write CD/DVD drive is used to burn CDs or DVDs when using the CD/DVD for the following image storage: • **Data Export**

Procedure

System startup procedure

System Power Off/On procedure

Related topics

Equipment components introduction

WORKSTATION

Keyboard concept

The **keyboard** contains all the keys you would find on any computer keyboard along with a few specialized buttons along the top. Standard keyboard keys and their functions include:

- **Delete** or **Backspace** erases characters
- **Enter** confirms what is typed or selected
- **Tab** moves across the areas on the current screen
- **Up** or **Down** arrow keys move between text boxes or adjust window width or window level

Figure 3-25: Keyboard auxiliary keys

Table 3-6: Keyboard

#	Selection	Description
1	**Emergency Stop**	Disables all electrical power sources near the patient. It shuts down the *RF*[1], gradient amplifier, table movement, shim power supply, and main MRI magnet power supply cabinets. It will not quench the magnet or turn off the computer.
2	**eIFU**	The eIFU symbol located by the Emergency Stop button indicates that there are electronic instructions for use on your MR system. For details, see **online help**. **Figure 3-26:** eIFU symbol

[1]Radio Frequency

#	Selection	Description
		
3	**Volume Control**	Regulates the patient in bore volume for the patient communication system.
4	**Volume Control**	Regulates the MR operator console volume for the patient communication system.
5	**Talk**	Activates the intercom system so you can speak to the patient inside the bore. Press to talk, release to listen.
6	**Start Scan**	Resumes scanning after pause or breath hold techniques.
7	**Pause Scan**	Stops the scan temporarily.
8	**Stop Scan**	Aborts a scan or prescan. Scan data is not saved or reconstructed.
9	**Move to Scan**	Moves the cradle to scan position when pressed.
10	**Stop Move**	Stops the cradle movement when pressed.
11	**PC Icons**	Inactive.
12	**Function Keys**	Activates shortcuts in certain features.

Related topics

Computer concept

Equipment components introduction

WORKSTATION

Mouse controls concept

The mouse is a hand-operated device that you maneuver across the surface of a pad. As you move it, the on-screen cursor mimics the movement of the mouse, allowing you to move among windows and menus. For instance, moving the mouse to the right causes the on-screen cursor to move to the right. The mouse is used to make selections by clicking the left, right, and middle buttons.

Figure 3-27: Mouse

Table 3-7: Mouse image legend

#	Description
1	Left button
2	Middle wheel button
3	Right button

For mouse button actions see **About this manual.**

Related topics

Computer concept

Keyboard concept

Equipment components introduction

SEQUIPMENT COMPONENTS

Equipment cabinet room concept

The *PDU*[1], gradient amplifiers locate in integrated system cabinet.

The integrated system cabinet, chiller / Integrated cooling cabinet, shield cooler compressor and other equipments are located in equipment cabinet room.

This room is usually kept at very cool temperature in order to keep the equipment operating normal. If you have any questions about the temperature settings, or the equipment kept in this room, please consult your service engineer.

Figure 3-28: SIGNA™ Victor cabinet

Related topics

Equipment components introduction

Gradient coils concept

[1]Power Distribution Unit

EQUIPMENT COMPONENTS

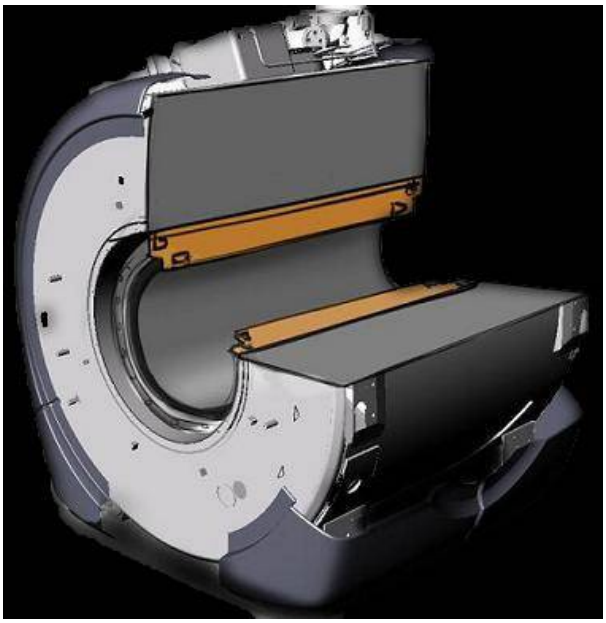
Gradient coils concept

The **gradient coils** are three sets of wire coils wrapped around a fiberglass cylinder located within the magnet housing. Electric current flows through the coils and is turned on and off very rapidly, thereby producing expansion and contraction of the gradient coils. This expansion and contraction creates the tapping sound when scanning.

Each coil affects a different plane (the XY, YZ, or XZ plane), as it is turned on and off at different points in a pulse sequence. The scan plane and pulse sequence selected determine which gradient functions as the slice selective, phase encoding, and frequency encoding gradient. The system calculates this automatically.

The gradients are resistive magnets and are water cooled by the chiller/ICC located in the **Equipment cabinet room.**

Figure 3-29: Cut away of gradient coil inside the body coil



Related topics

Equipment components introduction

RF coils concept

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RF COILS

RF coils introduction

Imaging coils are tuned to match the precessional frequency of nuclei under evaluation. Generally, the length of coil is equal to the *FOV*[1] the coil covers. The depth of penetration is governed by the coil elements. When selecting a coil, keep in mind the FOV, how deep you need to image, and the size of the patient. Phased array and surface coils need to be placed close to the area of interest. The broad category of imaging coils can be classified into 4 coil categories:

- Head
- Body
- Surface
- Phased array

Each coil, other than the body coil, has an operator manual. Refer to the coil operator manual when setting up the patient for an exam.

Head coil

Figure 3-30: SIGNA™ Victor head coil

The head coils are transmit/receive coils. It provides higher *SNR*[2] in comparison to the Body coil due to the smaller size. It is used primarily to image the head, although they can be used for imaging any body part that fits into the coil. It is an example of a volume (uniform depth of signal) coil.

It is a Type BF applied part.

Body coil

The body coil is a transmit/receive volume coil used for large FOV imaging and for uniform depth penetration. The body coil is located within the magnet enclosure and is invisible to you and the patient. The body coil can also act as a transmit only coil when used with receive only coils.

[1]Field Of View

[2]Signal-to-Noise Ratio

Phased Array coils

Figure 3-31: Express Head-Neck Array coil

Phased array coils are a number of coils combined together to increase SNR, and depending on the coil design, may increase available FOV (either length or depth) without decreasing SNR.

Eight-channel surface coils can help you improve productivity, a crucial consideration in today's competitive scanning environments. These devices can be optimized for parallel imaging techniques, improved SNR, and can provide better image resolution. Parallel imaging techniques, like ASSET, reduce scan times, which can decrease patient exam times. Reduced coil diameter together with the 8-channel phased array elements over a given volume increase SNR and thereby resolution. It is a Type BF applied part.

Surface coil

Figure 3-32: Example of a surface coil: 8ch Flex coil

Surface and phased array coils are used to increase SNR when imaging a limited area of the body. Flat surface and phased array coils do not have uniform depth penetration.

It is a Type BF applied part.

Procedures

Connect coils procedure

Patient position procedure

Related topics

Equipment components introduction

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RF COILS

Connect coils procedure

Coils can be plugged into either the coil carriage located at the magnet end of the MR system. All coils have a coil ID. There are two purposes for Coil ID: matching the coil plugged in with the selected coil in the prescription, and checking if the coil is properly seated in the port.

Coil Positioning Tips

- Choose the coil most appropriate for the corresponding anatomy of interest and required FOV[1].
- Landmark on the coil marker, not on the patient's anatomy. The landmark line(s) on the coil indicate the center of the coil for each coil configuration. Imaging coils will function most accurately when placed at the magnet's isocenter.
- If the coil has multiple configurations, select the appropriate number of elements according to the area that needs to be covered.
- If the coil has multiple configurations, center the coil elements corresponding to the coil configuration chosen over the region of interest.

Procedure

1. For coils that have a locking mechanism, place the coil's lock face in the unlock position.
2. Insert the coil plug into the coil port.
   - All coils on the system are plugged into this port.

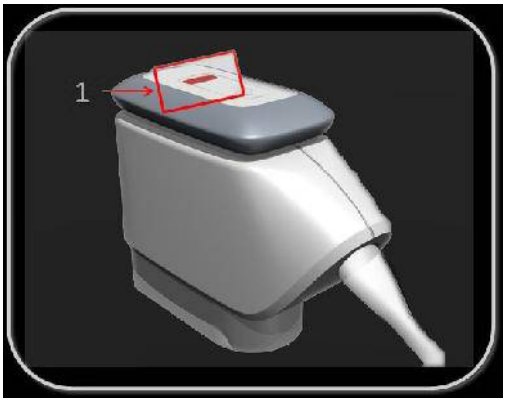
   Figure 3-33: Coil carriage with RF coil port

3. Move the lock mechanism to the lock position.
   - Red=unlocked on the coil plug, Green=locked

[1] Field Of View

Figure 3-34: 1 = Coil Unlocked/Locked status indicator



4. Verify that the Coil Locked is ready for scanning.

- There are two purposes for Coil ID:
  - Matching the coil plugged in with the selected coil in the prescription.
  - Checking if the coil is properly seated in the port.
- As soon as a coil is connected to a coil carriage port, the information of the connected coil is displayed on the IRD screen.

Related topics

RF coils introduction

Equipment components introduction

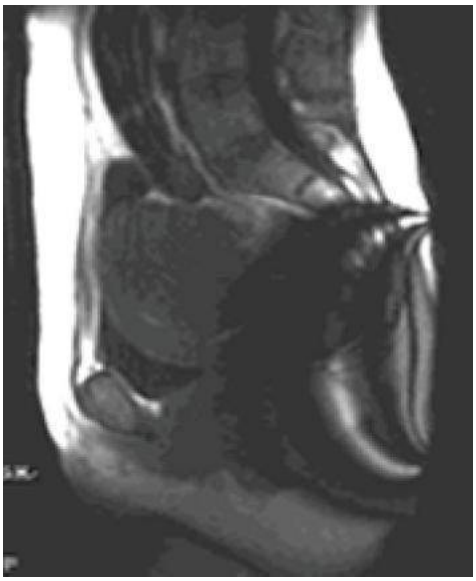
RF COILS

Coil malfunction consideration

Coil decoupling mechanisms are circuits activated by diodes to prevent *RF*[1] currents from flowing in the receive-only coil during transmission from the **Body coil**. This results in local distortion of the transmit field and signal intensity variations within the image.

If you suspect a coil malfunction, consult your service engineer and discontinue use of the coil.

Figure 3-35: Coil malfunction



Related topics

Equipment components introduction

Coil signal non-uniformity considerations

[1]Radio Frequency

RF COILS

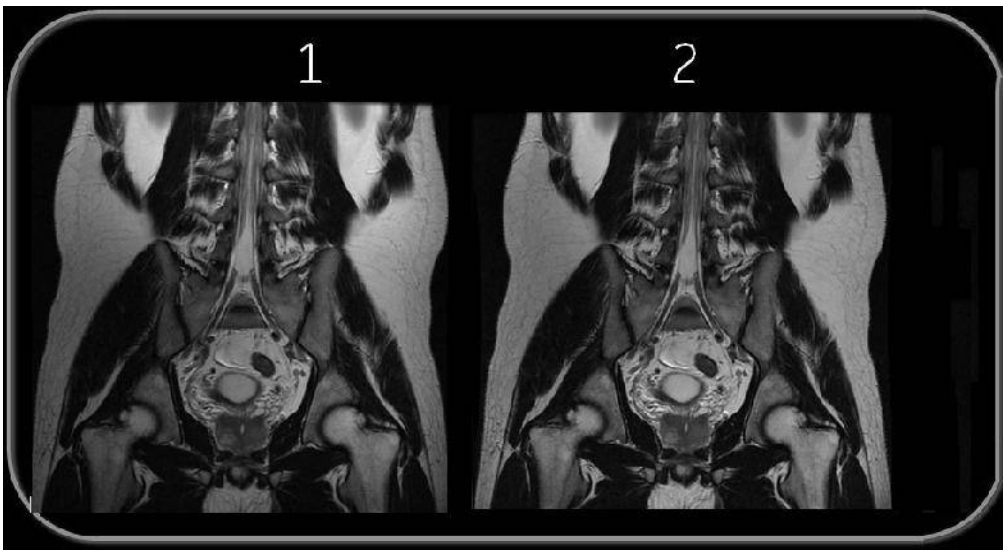
Coil signal non-uniformity considerations

The *RF*[1] receiver detects signals closest to it most efficiently. This characteristic may cause a non-uniformity of signal in the image. The effect is more pronounced with surface coils than with volume coils, appearing as localized bright areas close to the coil. Signal variability may also result in incomplete fat suppression when chemical fat suppression techniques are used.

To minimize the chance of non-uniformity of signal in a coil:

- try a different coil or use a ***STIR*** sequence rather than trying additional fat saturation techniques
- apply a coil intensity correction technique, such as PURE[2] .
  - PURE can be used with compatible surface coils
  - PURE can also be used with the 8-channel transmit/receive high resolution **MRI Devices Knee coil**

Figure 3-36: 1 = NONE, 2 = PURE



Related topics

Equipment components introduction

Coil malfunction consideration

[1]Radio Frequency

[2]Phased array Uniformity Enhancement

IN-ROOM DISPLAY

In-Room Display

The IRD [1] is a shielded touch panel color monitor. The monitor and scan room interface provides immediate feedback on patient information and gating information.

Figure 3-37: SIGNA™ Victor In-room monitor

Figure 3-38: SIGNA™ Victor In-room display

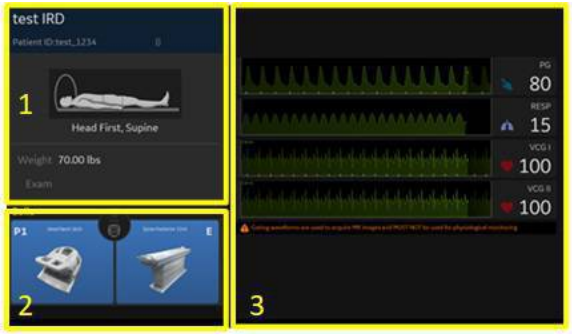


Table 3-8: In-room display monitor description

#	Description
1	Setup In-Room Display procedure

[1] In-Room Display

#	Description
2	In-Room Display coil screen
3	In-room Display gating screen

Related topics

Equipment components introduction

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MAGNET CONTROLS

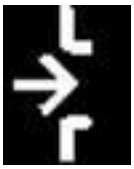
SIGNA™ Victor: magnet controls concept

Magnet controls provide the method for setting up patient comfort and scanning. The magnet controls are on two panels located on both sides of the magnet cover. The control panels have the same buttons, they are just located in a mirror image of each other. The control panel has a subset of backlit buttons that light up to show what typically is the next step in the workflow. The lights are only typical next steps. You can choose to select another button at any time.

Figure 3-39: Magnet Controls located on both sides of magnet cover

Figure 3-40: Magnet controls panel

Table 3-9: Magnet control buttons

Button label	Description
	**Abort or Stop Scan** stops a scan during either prescan, an active scan, or after Pause Scan is pressed.
	**Pause Scan** temporarily halts scanning.
	**Start Scan** restarts a study if Pause Scan is pressed, or cradle motion exceeds 2 mm.
	**Alignment** turns alignment lights on or off. When the alignment lights are on, this button is lit and the “landmark on” message is posted on the status panel.
	**Landmark** enters the defined landmark.
	**Advance to Scan** advances the defined landmark to magnet isocenter.
 	**In** advances the cradle into the bore. To advance the cradle quickly, press **In/Out Fast** button and simultaneously press the **In** button.
 	**Out** retracts the cradle from the bore. To retract the cradle quickly, press **In/Out Fast** button and simultaneously press the **Out** button
	Stop Table halts in-and-out cradle movement. This button overrides all other cradle motion commands.
	**Back to Landmark** returns the table back to last landmarked position.
	**Home** returns the cradle to the home position, fully retracted on the patient transport.

Related topics

Equipment components introduction

EQUIPMENT COMPONENTS

SIGNA™ Victor: PAC control

The PAC Physiological Acquisition Control connects the ECG leads, peripheral gating device, the respiratory bellows, and the patient alert bulb to the system. It is located on the side of the magnet.

The connection ports are used to collect triggering information for cardiac and respiratory data acquisition.

Figure 3-41: PAC Panels

#	Description
1.	 Single port for the respiratory compensation bellows. (Type B applied part)
2.	 Single port connection for patient call (patient alert) system. (Type B applied part)
3.	 Six pin connection for either the thin film or high impedance ECG leads. (Type BF applied part)
4.	 Two port fiber optic connection for the peripheral gating lead. (Type B applied part)
5	Light control button.

Related topics

Equipment components introduction

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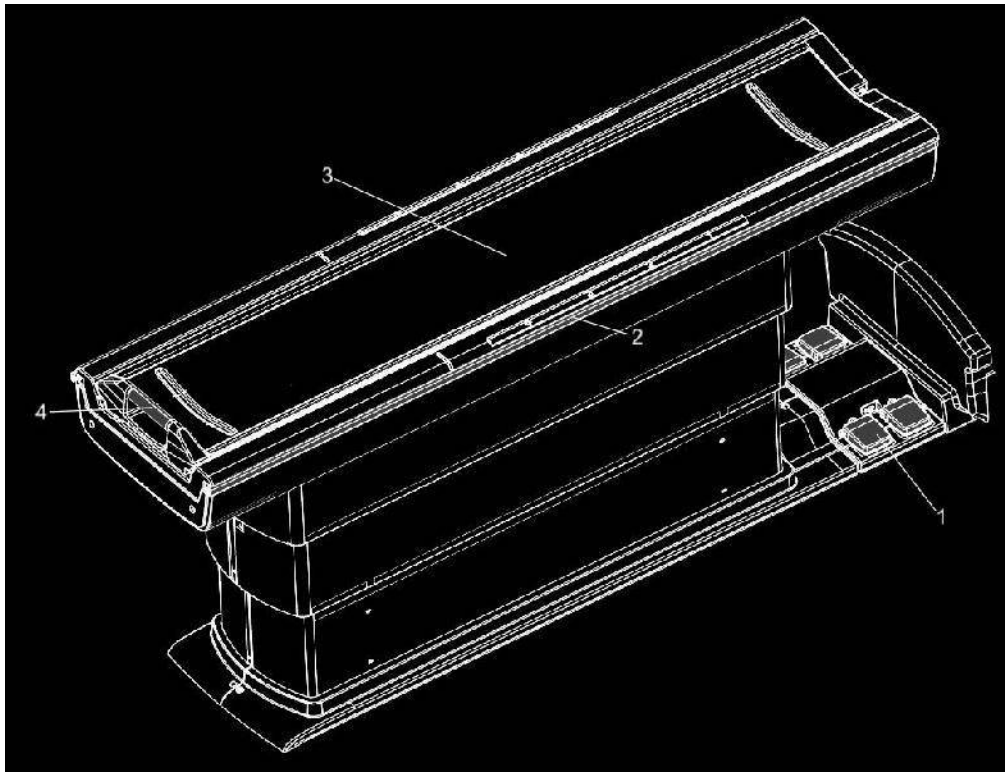
EQUIPMENT COMPONENTS

SIGNA™ Victor: table concept

The fixed table is rigidly attached to magnet, which cannot be removed from the scan room to transfer the patient.

Figure 3-42: Low-Height Fixed Table



No.	Selection
1	Up/Down Pedals  indicates the Up pedal.  indicates the Down pedal.  CAUTION Unplug the coil cable from the coil port before pressing Down pedal.
2	Bumper
3	Cradle*
4	Cradle Release Handle • Patient removal using the cradle release handle can be much quicker than the Out Fast buttons on the

	magnet enclosure. Grasp the handle and roll the cradle release handle toward you and pull quickly to release the handle. • Use the cradle release handle in the event of power outage to the magnet room or after pressing the Emergency Stop button.

*Although the terms cradle and table are often used synonymously, the cradle is a part of the table that moves the patient into and out of the magnet. Patient table cradle is a Type BF applied part.

You can release the cradle with the following three steps:

1. Hold the handle.
2. Rotate the handle
3. Pull the cradle out

The label attached on the cradle illustrates the steps.

Related Topics

Magnet Controls

Patient transfer

Patient position

Equipment components introduction

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EQUIPMENT COMPONENTS

SIGNA™ Victor: system specifications

This section provides system specifications.

- For details regarding spatial magnetic field compatibility, see **Spatial magnetic field data**.
- Static magnetic field plots for siting (rule of thumb - assumes no ferromagnetic materials) may be found at: **https://www.gehealthcare.com/support/site-planning**

1.5T technical specifications

Magnet information

Component	Specification
Magnet Type	Super-Conducting
Static Field Strength	1.5T
Size with Enclosures	194 cm x 245 cm x 240 cm (L x W x H)
Cryogen Type	Liquid Helium
Boil Off Rate	Zero boil off under normal operating conditions

Gradient Information

Component	Specification
Gradient type	Non resonant, actively shielded, rapidly switching
Max Amplitude	35 mT/m
Min Rise time to Max Amplitude	250 µs
Max Slew Rate	140 T/m/s

RF Information

Component	Specification
Transmit RF	
Types of RF transmit coils	Body Coil, Head Coil, and Extremity Coils
Amplifier peak RMS power	10 kw for body and 2 kw for head
Maximum RF Field	24 µT
Amplifier Preferred Resonance Frequency	63.86 MHz
Maximum transmit bandwidth	+/- 650 kHz
Receive RF	
Minimum/Maximum reception frequency	63.61 MHz / 64.11 MHz
Nominal RF reception center frequency	63.86 MHz
Receive Bandwidth	+/- 250 kHz

Patient Comfort Information

Component	Specification
Patient space size	71.6 cm x 60 cm x 60 cm (L x W x H)
Ventilation	In bore patient ventilation system
Communication	In bore 2 way intercom system
Lighting	In bore fiber track lighting

Patient Support Information

Component	Specification
Height	49 cm to 96.5 cm continuous
Cradle Length	225.5 cm
Positioning repeatability	± 1.0 mm
Maximum load when attached to scanner or when it is used as a transport	200 kg (440 lbs)

For more information on technical specification, please refer to *Service Methods*.

Related topics

Equipment components introduction

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SYSTEM MANAGEMENT

System Management introduction

The System Management work area allows you to access the Service Desktop Manager, Error Log, Gating, fan and light controla, iLINQ, System Preferences, e-Report, etc. You can perform planned maintenance and software performance tests, save raw data, or connect to TiP Virtual Assist from these areas.

Figure 3-43: System Management work area

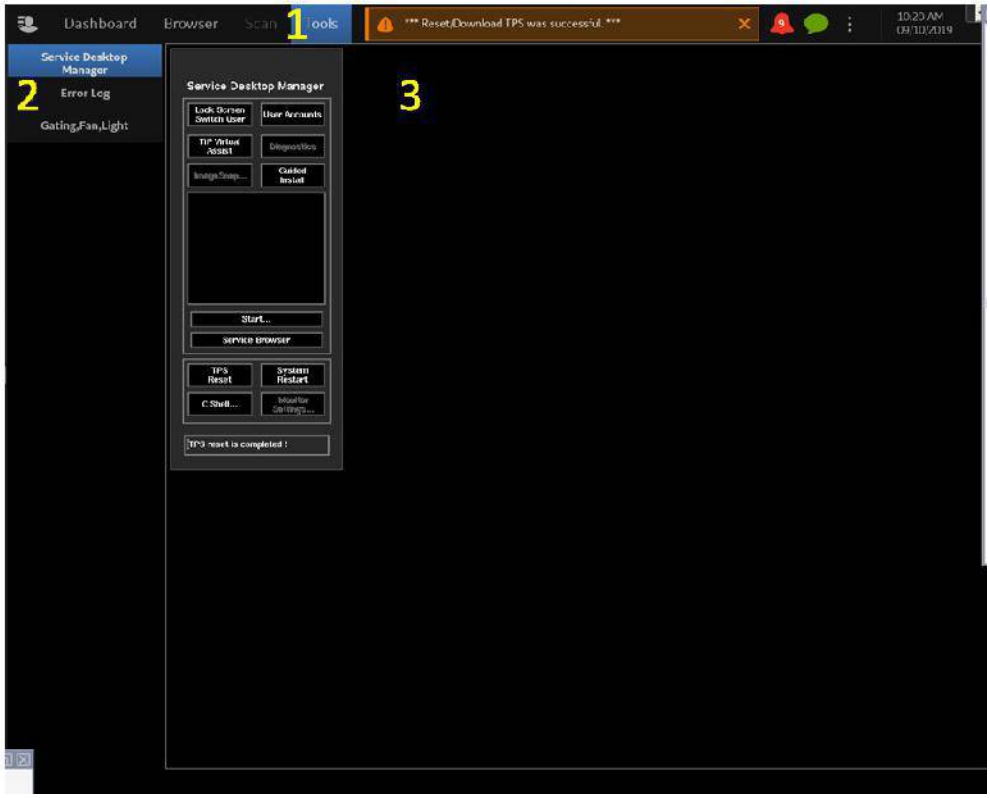


Table 3-10: Systems Management work area image legend

#	Description
1	Tools button
2	Applications area
3	Applications work space

Introductions and procedures

- Planned Maintenance procedure

Raw data introduction

- Raw data save procedure

Secure Service Access introduction

- Secure Service Access procedure

TiP Virtual Assist introduction

- TiP Virtual Assist activation procedure

Remote software download procedure

Remote service configuration procedure

Create a software download user role procedure

Related topics

Equipment chapter

SYSTEM MANAGEMENT

Open System Management work area procedure

From the Main Menu, click ***Tools*** to open the System Management work area.

Figure 3-44: System Management work area

Related topics

System Management introduction

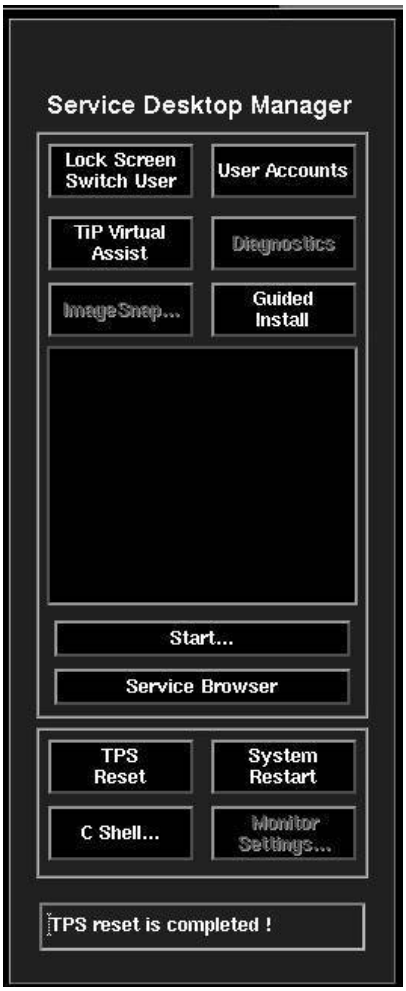
SYSTEM MANAGEMENT

Open the Service Desktop Manager procedure

Use these steps to open a Service Desktop Manager session to access the System Management and Utilities programs.

1. From the Main Menu, click ***Tools***.
2. From the **System Management work area**, click the ***Service Desktop Manager***.

Figure 3-45: Example of Service Desktop Manager screen



3. To open the MR Service Desktop, click ***Service Browser***.

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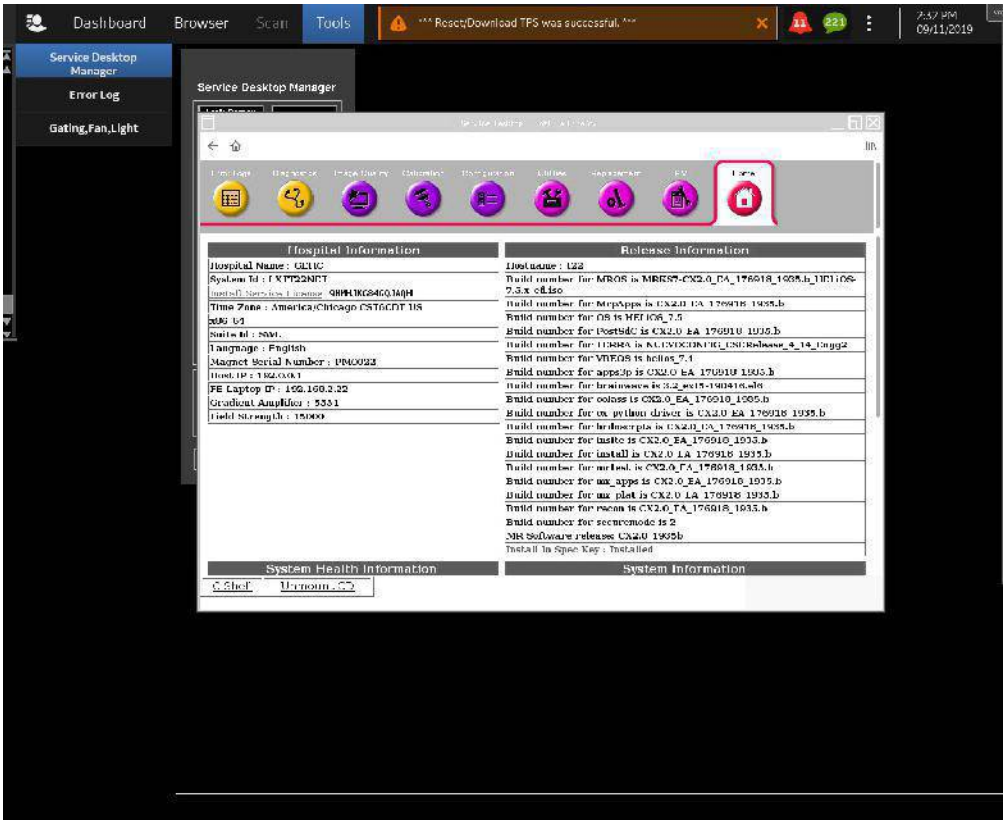
Figure 3-46: Example of an MR Service Desktop screen



Related topics

System Management introduction

Open Guided Install procedure

Guided Install introduction

SYSTEM MANAGEMENT

Error Log introduction

Throughout the scanning and review sessions, you may see a number of information or error messages. The messages are stored in the Error Log and can be viewed by anyone.

In the error log, you can also add a note for your service engineer, keeping all your questions in one easy to access area.

When you view the Error Log, you will most likely see many more messages than have been displayed during a scan or review session. This is because not every message that is written to the Error Log is one you will see. Your service engineer may look here to see the types of messages and the time messages were posted.

Figure 3-47: Error Log screen

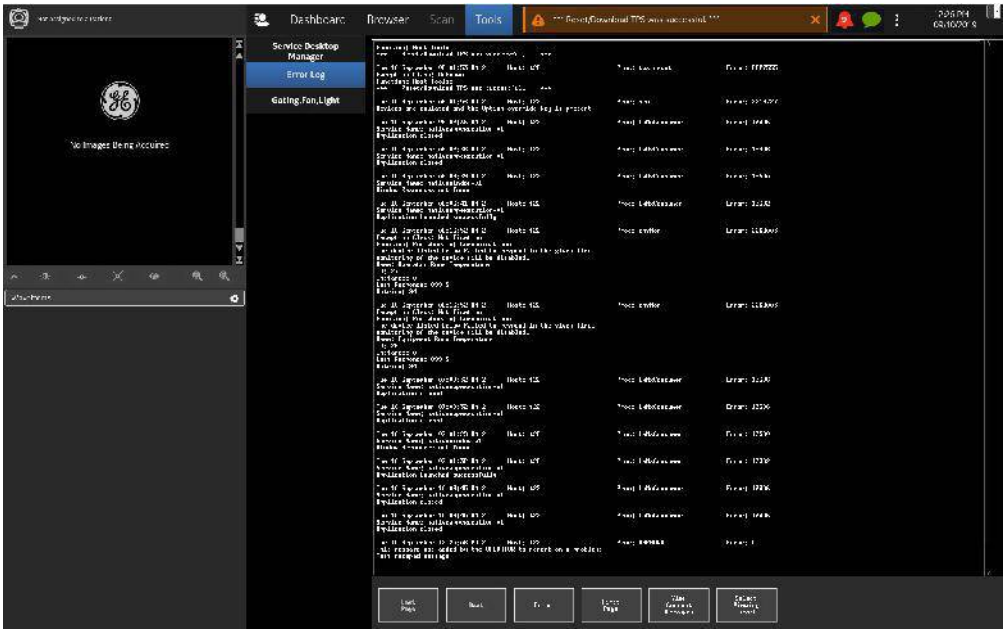
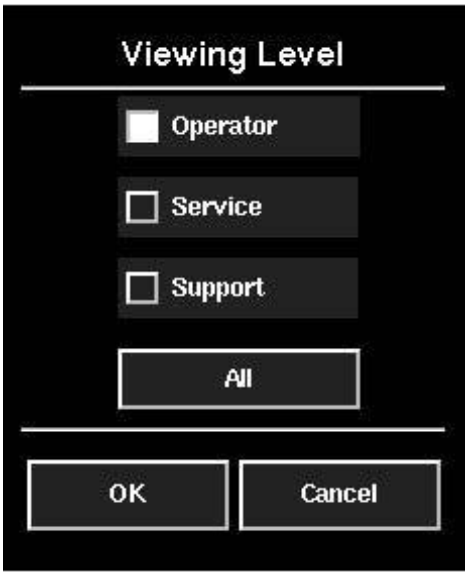


Table 3-11: Error Log screen details

Screen area	Description
Clear	Click to clear the error log. The next error message appears at the top of the log. Subsequent messages are posted beneath the first error message. The most recent error message appears at the bottom of the log.
View Log	Click to view the error log history. The most recent error message appears at the bottom of the log. You cannot erase any messages from the log.
Update	Click to view new messages as they are posted to the Scan Error log.
Notepad	Click to display a Service Notepad window.
Last Page	Advances the error log to the last page.
Next	Advances the error log to the next page.
Prior	Advances the error log to the previous page.
First Page	Advances the error log to the first page.
View Current Mes-	Displays the most recent messages at the top of the error log.

Screen area	Description
sages	
Viewing level	Select Viewing Level to choose any combination of Operator, Service and Support, or all three levels. **Figure 3-48:** Viewing level area 

Procedures

Error log view messages procedure

Service Notepad write a message procedure

Related topics

System management introduction

SYSTEM MANAGEMENT

Error log view messages procedure

Use these steps to view error log messages or to view the time an error message occurred.

View system messages

1. From the Main Menu, click ***Tools***.
2. From the **System Management work area**, click the ***Error Log***.
3. On the **Error log screen**, click ***View Log***.
4. Click ***Select Viewing level*** and choose a viewing level.
5. Click ***OK***.
6. Use the buttons at the bottom of the screen to navigate through the error log.

Considerations

- Additional messages are displayed at the following locations:
- View the Message area in the Main Menu.

Related topics

Service Notepad write a message procedure

System management introduction

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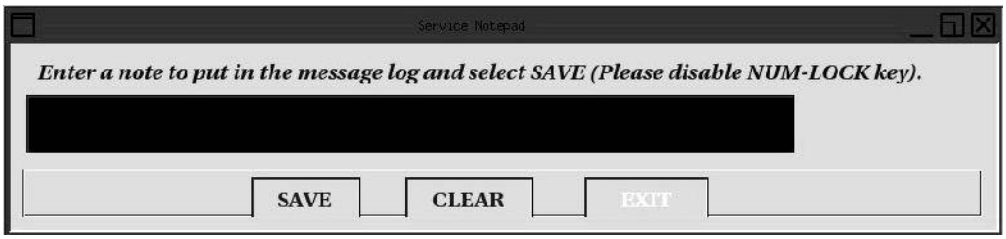
SYSTEM MANAGEMENT

Error log write a message procedure

Use these steps to write a message that will be posted on the Error Log.

1. From the Main Menu, click ***Tools***.
2. From the System Management work area, click ***Error Log***.
3. From the Error Log, click ***View Current Messages***.
4. From the Error Log screen, click ***Notepad***.
5. Verify that the Number Lock keypad is ***off***.
6. In the Service Notepad text box, type a message.

Figure 3-49: Notepad text box



7. Click ***SAVE*** to save the message to the error log and close the window.
   - ***CLEAR*** erases the message and allows you to write a new message.
   - ***EXIT*** closes the Service Notepad screen without posting your message on the Scan Error Log.
     - Respond to prompts on the Exit message screen: ***YES*** to saves the message, ***NO*** to not save the message or ***CANCEL***.

Figure 3-50: Exit message prompt

Related topics

Error log view messages procedure

System management introduction

SYSTEM MANAGEMENT

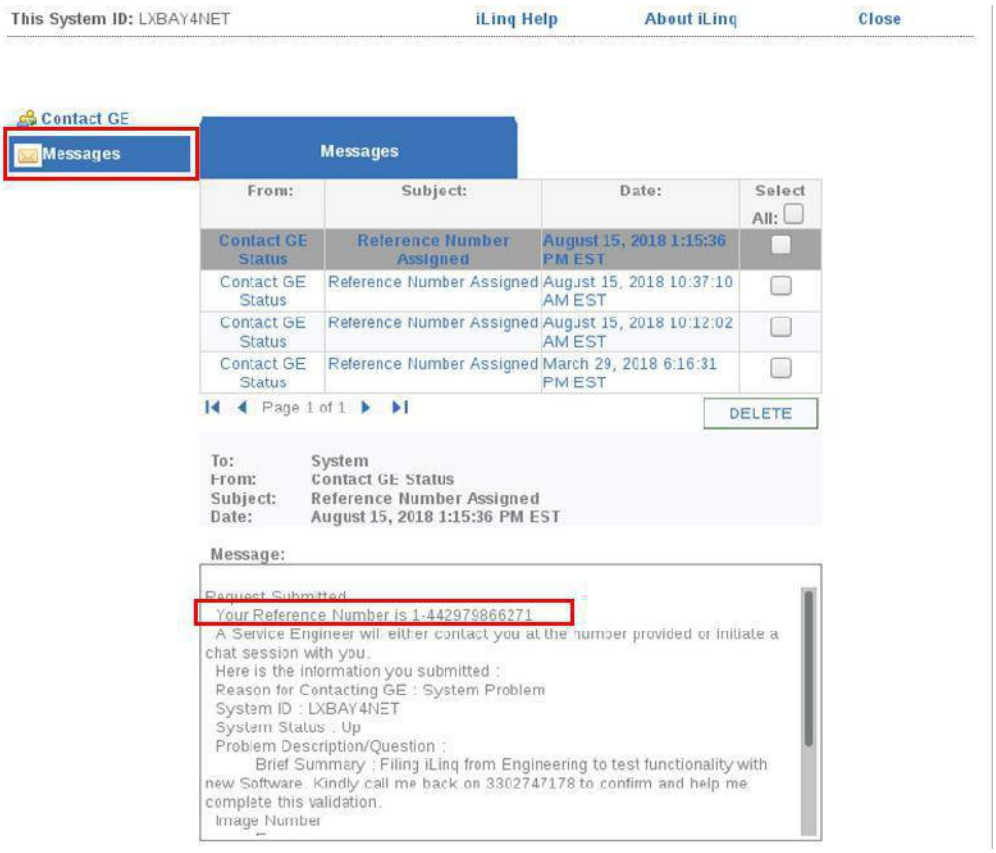
iLinq procedure

Use this procedure to contact GE regarding system problems or application questions. For iLinq to be active you must have:

- a GE service/application contract
- InSite checkout must be completed

1. Follow these steps to send a message to GE.
   a. From the Main Menu, click **Dashboard**.
   b. From the Dashboard, click **Helpful Resources**.
   c. From the Helpful Resources, click on **iLinq**.

Figure 3-51: Example of message area



2. Follow these steps to view a message from GE.
   a. From the footer area of the screen, click the *iLinq icon* 

, which indicates a message is received from GE.
   b. Click ***Messages*** to open the message window and view the response.
   c. Click the desired message check box to view the message content.

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d. To delete a message, when desired, click the Message check box next to the message you want to delete and then click ***Delete*** to erase the message from iLinq.

3. To view details about the iLinq application, from the menu bar, click ***About***.
4. To view the iLinq Help screen, from the menu bar, click ***Help***.
   - Scroll to the bottom of the Help screen to view the various iLinq icons that appear in the footer of the screen.

SYSTEM MANAGEMENT

Legacy Image Converter introduction

The content of the DICOM images produced on an EXCITE II system (Lx11.0 and future releases) is different from what was produced on previous scanner releases. This content change was necessary to support new features introduced with the 11.0 software release. However, this change has made these new images incompatible with post-processing applications on some older systems.

The *LIC*[1] is a Tools-launched post processing application to create images compatible with the older systems. The LIC application creates a duplicate exam whose images will have the same DICOM content as those created by Lx scanners running software versions prior to 11.0. Depending on the application, there will be some loss of information translating to the old content or in some cases translation will not be allowed. For these reasons both the original and the converted images will be available.

The exam containing the legacy format images can then be networked to older Lx and AW systems for post processing. Additionally, once networked to AW (version 3.1 and 4.0) or Lx (pre 11.0) the images can be networked (using AdvantageNet) to a Genesis (5.x) system. The LIC application will only process images that can be properly represented in the legacy format.

The Legacy Image Converter provides controls to start or cancel image conversion as well as displays the processing status during image conversion.

Figure 3-52: LIC screen

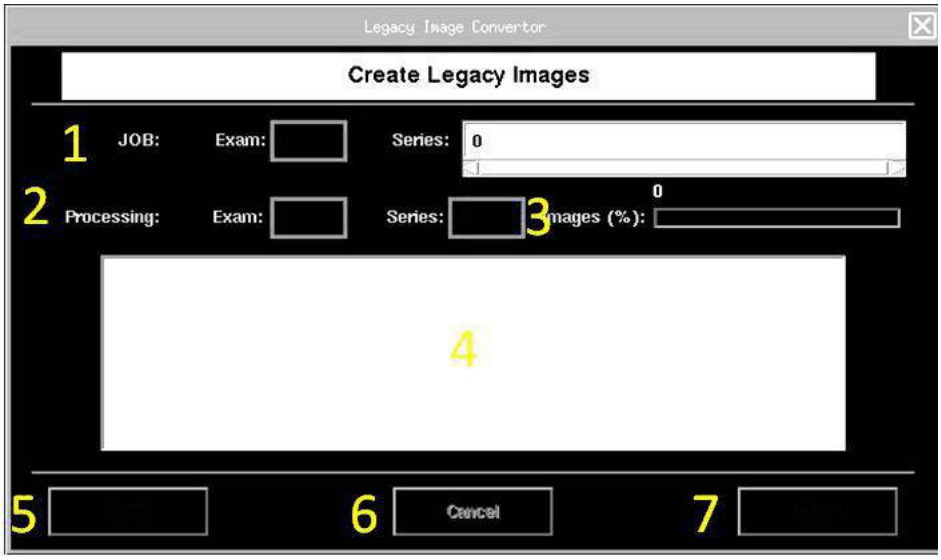


Table 3-12: LIC image legend

#	Screen area	Description
1	**JOB: Exam**	Displays the selected exam number for processing.
1	**JOB: Series**	Displays the list of series selected for conversion to legacy format.
2	**Processing: Exam**	Displays the Exam number being processed.
2	**Processing: Series**	Displays the series number currently being processed.
3	**Images (%)**	Displays the percentage of images converted in the processing series.

[1]Legacy Image Converter

#	Screen area	Description
4	**Text Area:**	Displays the status of each series being converted.
5	**Start**	Begins processing the selected exam/series in the browser window. This button is disabled when the Cancel button is available.
6	**Cancel**	Stops processing the current exam. Images already converted will remain available. This button is unavailable if the Start or Close buttons are available.
7	**Close**	Closes the LIC application. This button is disabled when the Cancel button is available.

Procedure

Legacy Image Converter procedure

Related topics

System management introduction

SYSTEM MANAGEMENT

Legacy Image Converter procedure

Use these steps to convert images on your MR system so that they can be displayed on a pre-11.0 MR system.

1. From the Main Menu, click ***Tools***.
2. From the **System Management work area**, click the ***Service Desktop Manager***.
3. From the Service Desktop Manager, click ***C Shell...***.
4. From the xterm screen, type **LIC** and press **Enter**.
5. From the Legacy Image Converter screen, select the exam and series for processing. The following image types are not supported and cannot be converted:

- TRICKS, FIESTA-C, VIBRANT, PROPELLER
- Raw data images (embedded Pfiles)
- Legacy format images (these images are already in the correct format)
- Foreign images (non-GE images)
- GSPS objects
- SR objects

6. Click ***Start*** to begin image processing.

- While images are being processed, you can click ***Cancel*** to stop the active conversion.
- Once processing starts, a new exam with the same exam number is added to the Browser. As images are converted they will appear in the image browser under the newly created exam. (See Identifying Converted Images below for discriminating between the original and the legacy format exams.)

7. Only one exam may be selected at a time and within this exam it will only process the selected series (more than one series can be entered). Therefore, to process more exams, return to step 4.
8. When processing has completed the ***Cancel*** button will be disabled and the ***Start*** and ***Close*** button will become available.
9. Review the message area for errors, then click the ***Close*** button on the LIC user interface. The LIC user interface screen will disappear.

- The new exam is created using the same exam, series, and image numbering as the original. Legacy images can be identified by the annotation "Signa 3.0T SYS" rather than your system (for example: "SIGNA™ Victor") when displayed in the viewer.
- After networking the images to a pre-11.0 Lx scanner (e.g. 9.x, 10.x), the legacy format images can be identified by type "Advt" rather than "DICO" in the image browser.

10. The converted images can be used with legacy system applications such as CV flow analysis on AW3.1. Once networked to either a Lx scanner (pre-11.0 versions) or an AW 3.1 or 4.0 workstation, the converted images can be further sent to Genesis (5.x) systems. (The unconverted 11.x-format images cannot be sent to a Genesis systems.)

Messages and error conditions

Successful Conversion

The following message is logged in the message box when conversion has completed successfully for each series being processed:

"Series #: Passed: Processed xxx Images"

Unsuccessful Conversion

If processing is attempted on a series containing unsupported image types, one of the following messages is displayed and no images are converted for that series.

"Series #: Failed: Fiesta-c, Tricks, Vibrant etc series not Supported."

"Series #: Failed: fMRI Series Cannot be converted."

"Series #: Failed: Post Processed Images Cannot be converted."

"Series #: Failed: Raw data Images Cannot be converted."

"Series #: Failed: Monarch Images Cannot be converted."

"Series #: Failed: Filtered (non-SCIC) Images Cannot be converted."

"Series #: Failed: Legacy Images Cannot be converted."

Other Error Conditions

If multiple exams are selected from the Patient List and you click ***Start***, the following error is displayed:

"Multiple Exams Not Supported"

Select a single exam, then select the series within the selected exam for processing. If multiple exams need to be converted, you must convert one exam at a time.

If you click ***Start*** a second time without changing the selection in the Patient List, the following message is displayed (no image processing will occur):

"Exam #: Failed: Already Converted/Rejected"

This prevents accidental generation of multiple copies of the same image set. It is possible to close the LIC application and restart it to create a duplicate set of converted images.

Related topics

Legacy Image Converter introduction

System management introduction

SYSTEM MANAGEMENT

Planned Maintenance introduction

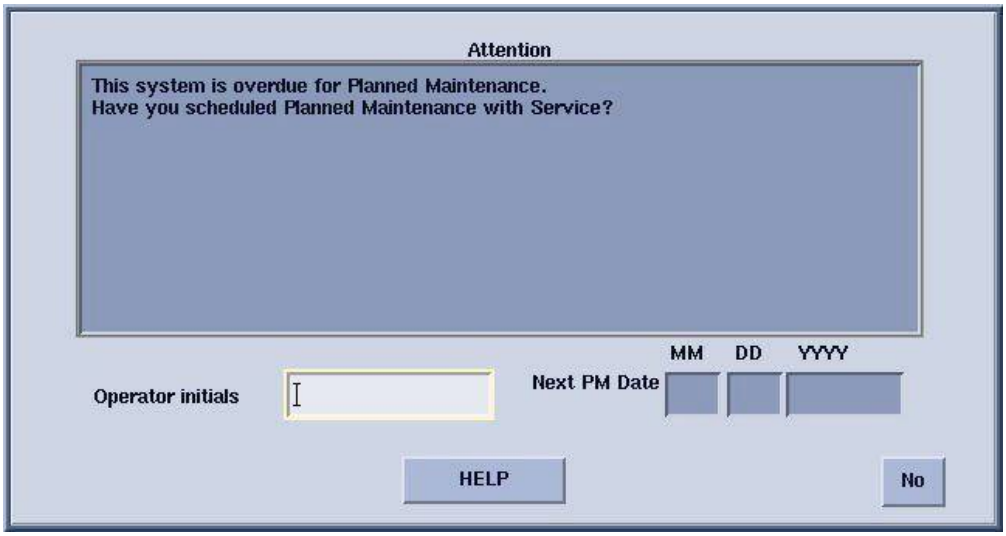
The goal of ***PM Assist*** is to ensure that *PM*[1] is done in a timely manner, is complete, and that identified problems are quickly resolved. You are prompted when planned maintenance is due, when it is overdue, and when failures have not been resolved within 21 days of the last PM. The prompts that appear are varied and dependent on the situation. Your system operation is unaffected regardless of your answer to the PM messages.

Planned Maintenance notification occurs under three different scenarios.

Planned Maintenance overdue

This message displays if the Planned Maintenance interval has been too long.

Figure 3-53: Planned maintenance overdue Attention screen

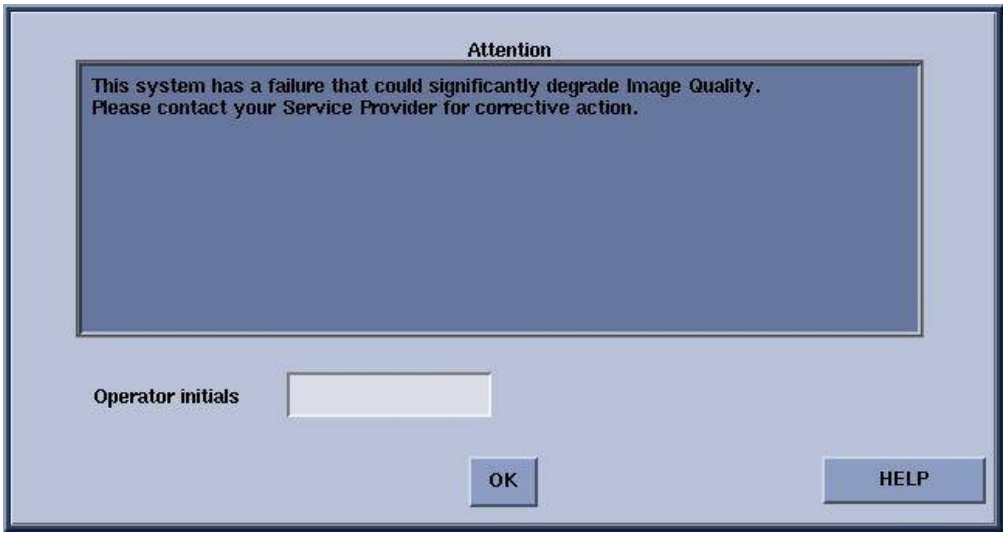


Planned Maintenance failure

This message displays when there are certain failures that have not been resolved within 21 days of the last PM. The message appears during system startup and in the Operator Attention area at the start of each new patient prescription. The message appears once and is overwritten by any other message being posted in the area.

[1]Planned Maintenance

Figure 3-54: Planned Maintenance failure Attention screen



Procedure

Planned Maintenance procedure

Related topics

System management introduction

SYSTEM MANAGEMENT

Planned Maintenance procedure

Use this information to help you respond to PM Assist messages that display periodically on your system.

PM Date message

The PM Date message, "This system should have Planned Maintenance performed before <date>", where <date> is the last day of the current month, displays when the response has been a Yes to the PM Due message. The prompt is posted to the Operator Attention area at the start of each new patient prescription. The message appears once and is overwritten by any other message being posted in the area. No acknowledgment is required.

Follow these steps for the PM Overdue and PM failure message displays.

1. For the PM Overdue, the message displays if the Planned Maintenance interval has been too long.
   a. Type your initials in the text box.
   b. Type the date in the text boxes.

   -  Once a response is made, the system startup is completed with no further waiting.

2. For the PM Failure message displays when there are certain failures that have not been resolved within 21 days of the last PM. The message appears during system startup and in the Operator Attention area at the start of each new patient prescription. The message appears once and is overwritten by any other message being posted in the area.
   a. Type your initials in the text box.
   b. Click ***OK***.

System management introduction

SYSTEM MANAGEMENT

Raw data introduction

Raw data is unreconstructed data used to create the MR image or MR spectroscopy results. The service engineer may ask you to save raw data if an image reconstructs with an artifact or distortion. This information can help determine the cause of the artifact or problem. For certain applications such as spectroscopy, raw data is saved automatically to Pfiles, which are stored in the /usr/g/mrraw directory. In cases where the raw data is not automatically saved, it is possible to create a Pfile from the raw data acquired during the most recent scan. This is done via the Raw File Manager tool. It is also possible to set the research CV, autolock =1, to generate Pfiles for each scan. This functionality is supported by most applications.

Figure 3-55: TPS Raw Data screen

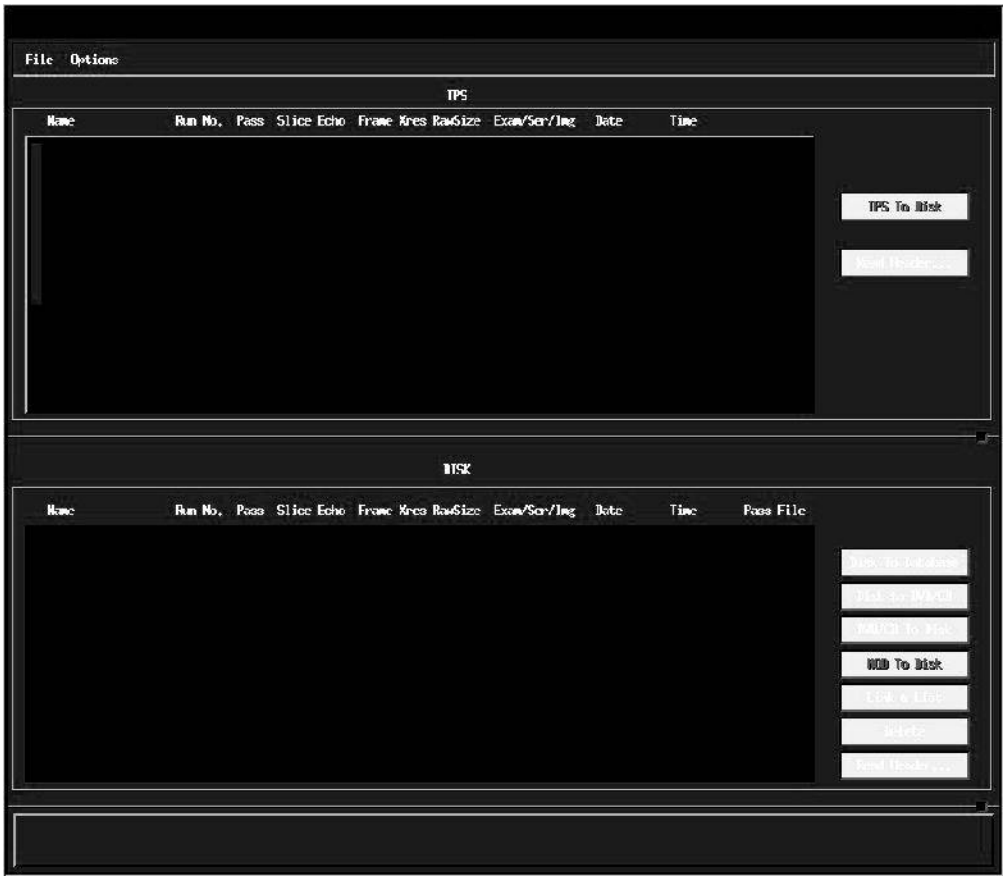
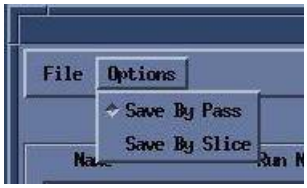


Table 3-13: Raw Data screen details

Screen area	Description
Options menu	Select ***Save by Pass*** to save the entire series or ***Save by Slice*** to save selected slices. **Figure 3-56:** Options menu 

Screen area	Description
File menu	Click ***File > Quit*** to close the screen.
TPS area	The TPS area displays the raw data files that can be saved. It is used to store the raw data on the system hard disk until it is manually removed.
Disk area	The Disk area displays the raw data that has successfully been saved when ***TPS to Disk*** is clicked.

Procedure

Raw data save procedure

Related topics

System management introduction

SYSTEM MANAGEMENT

Raw data save procedure

Use these steps to save Raw data immediately after a scan has completed. Because the raw data resides in the temporary memory of the system, you must save the raw data before starting the next series. Please be patient during the raw data transfer.

1. From the Main Menu, click ***Tools***.
2. From the System Management work area, click ***Service Desktop Manager***.
3. From the Service Desktop Manager, click ***Service Browser.***
4. From the MR Service Desktop, click the ***Utilities*** tab.
5. From the Utilities tab, click ***Raw File Manager***.
6. From the Raw File Manager area of the Service Desktop screen, click ***Click here to start this tool***.
7. From the Raw File Manager screen, select the data from the TPS area.
8. Click ***TPS to Disk***.

- The raw data is saved on the system hard disk until it is removed.
- Raw data uses disk space, and, as the disk becomes full, system performance can be degraded.

9. Click ***File > Exit***.

Related topics

Raw data introduction

System management introduction

SYSTEM MANAGEMENT

Security tools introduction

The security tools accessed from the Service Desktop Manager Utilities tab, allow you to:

- to start an antivirus scan on a GE MR system connected to a MCAfee ePo server. For all McAfee content, see the Privacy and Security operator manual.

Enterprise procedures

Enterprise Audit Trail introduction

McAfee manual scan procedure

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SYSTEM MANAGEMENT

Enterprise Audit Trail introduction

EAT[1] is a component to generate and transport standard audit messages about protected health information. The audit message format is compliant with DICOM[2] supplement 95 and IHE extensions.

The concept of protecting Patient Health Information is becoming more important within the medical industry today. This is caused by HIPAA[3] regulations and a heightened awareness of electronic security. Although it is ultimately the clinical site's responsibility to protect PHI, GE Healthcare should provide tools to help secure electronic systems.

Audit Trails provides key information when PHI[4] is accessed, transferred, exported or imported. The major benefit in Enterprise Audit Trails is enterprise integrated audit information: audit event logs can be stored either in 3rd party Audit Repositories or within the scope of GE Healthcare products (in protected local files).

The EAT component provides industry standard audit trailing feature and comes standalone or with the EA3 authentication and authorization component.

For more Enterprise Audit details, see your MR Privacy and Security operator manual.

[1] Enterprise Audit Trail

[2] Digital Imaging and COmmunications in Medicine

[3] Health Insurance Portability and Accountability Act

[4] Protected Health Information

SYSTEM MANAGEMENT

McAfee manual scan procedure

Use these steps to start an antivirus scan on a GE MR system connected to a MCAfee ePo server.

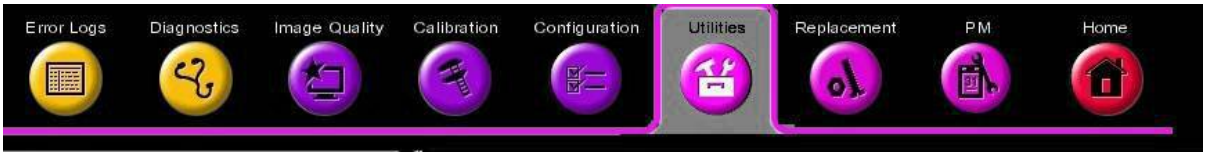
Prerequisites

- Existing and functional ePo server, along with the server details and access to the machine it is set up on.
- A GE MR system that is to be scanned for threats.
- The antivirus scan might take over an hour. Therefore, do not start an antivirus scan until you are finished with clinical scanning for the day.

Procedure

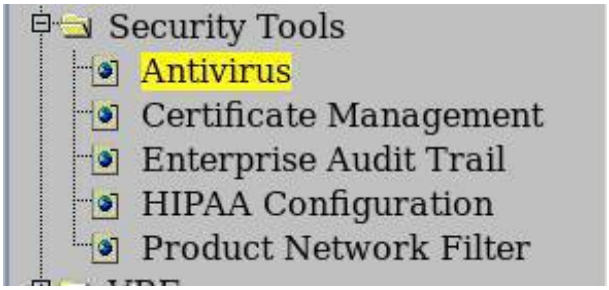
1. From the **System Management work area**, click the ***Service Desktop Manager***.
2. On the **Service Desktop Manager**, click ***Service Browser.***
3. From the MR Service Desktop screen, click the ***Utilities*** tab.

   Figure 3-57: MR Service Desktop tabs area

5. From the Security Tools folder, click > ***Antivirus***.

   Figure 3-58: Toolbox list

6. Click ***Antivirus Scan*** tab.
7. Click ***Start Scan***

   - When the antivirus scan starts, the Status Information box notifies you that the it is running.
   - When the antivirus scan is complete, the Status Information box displays that the scan is completed, and the Scan Results details can be seen in the lower half of the screen.

Related topics

Security tools introduction

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SYSTEM MANAGEMENT

Secure Service Access introduction

Secure Service Access is a soft service license key that enables various levels of service software tools packages. If you have a SSA[1] license, you are required to renew the soft service license yearly.

Considerations

- Depending on your Soft service license contract, your key may expire in 1 year from first date used. Please refer to service license page for expiration dates.
- For additional information on your SSA license, contact your local sales/service representative.
- To find how to order a new license and more details regarding the new Secure Service Access customer website link, please refer to your "Service Licensing" section in the Service Documentation.

Figure 3-59: Example of a Service License screen. Your screen will vary based on the licenses on your system.

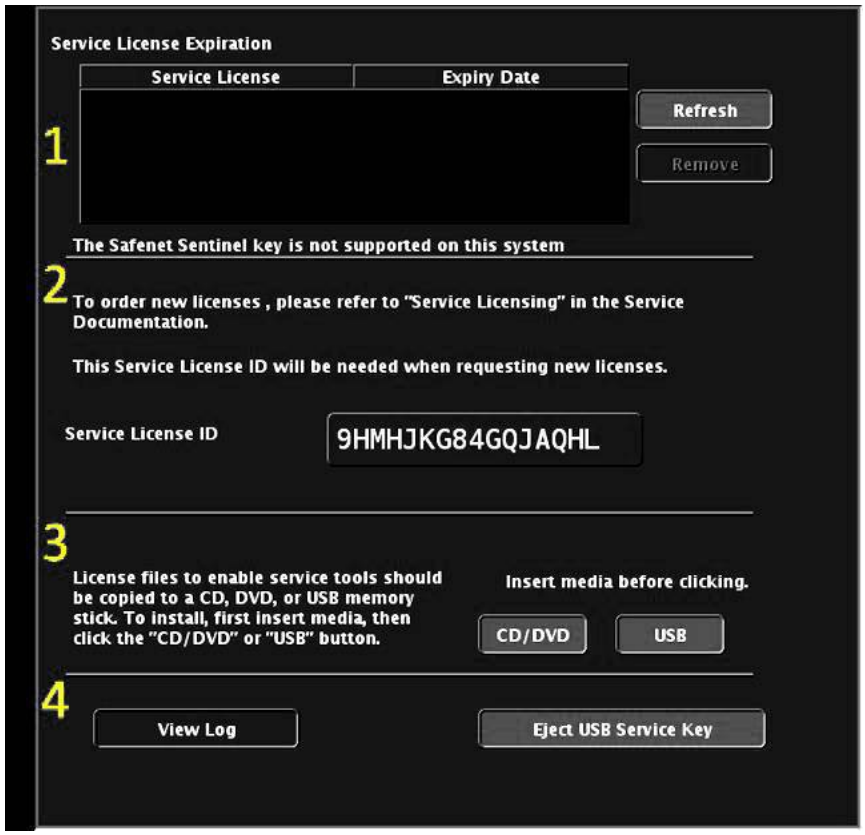


Table 3-14: Image legend

#	Description
1	**Service License Expiration** area displays the Service License name and its expiration date. • Click ***Refresh*** to update the list. • Click a license from the list and click ***Remove*** to remove a service license.
2	Your service license ID that is required to order new licenses.

[1]Secure Service Access

#	Description
3	Use a CD, DVD or USB device to install a new Service License file (used by service representative).
4	Click ***View Log*** to view the date, License name and its status. Click ***Eject USB Key*** (used by service representative) to remove the USB service key.

Procedure

Secure Service Access procedure

Related topics

System Management introduction

SYSTEM MANAGEMENT

Secure Service Access procedure

Use these steps to access the SSA screen.

1. From the Main Menu, click ***Tools***.
2. From the **System Management work area**, click the ***Service Desktop Manager***.
3. From the Service Desktop Manager, click ***Service Browser***.
4. From the MR Service Desktop, click the ***Home*** tab.
5. From the Home tab, click ***Install Service Licenses***.
6. The Service License screen displays.
   - The service representative completes the fields to install a service license.
7. Click the ***X*** in the upper right corner to close the screen.

 For more information about your licenses, contact your GE sales/service representative.

Related topics

System Management introduction

SYSTEM MANAGEMENT

Remote service configuration procedure

Remote Service Enables system connectivity to GE Healthcare's back office. A valid GE System ID and an internet connection to the system is needed in order to establish this connectivity.

Use these steps to configure InSite Remote service on your system,

1. From the Main Menu, click ***Tools***.
2. From the **System Management work area**, click the ***Service Desktop Manager***.
3. From the Service Desktop Manager, click ***Service Browser***.
4. From the MR Service Desktop, click the ***Configuration*** tab.
5. From the left pane, select ***Configure Insite***.
6. Click ***Click here to start this tool***.

   - The Agent Configuration screen displays.

Figure 3-60: Agent Configuration screen

   a. Read the caution displayed under Agent Configuration.

CAUTION

Disabling connectivity disconnects the system from the GE Healthcare Back Office. This will make the system unreachable for remote service or AutoSC sweeps.

If connectivity is disabled, it can be enabled again by clicking the Enable Connectivity Button.

b. Ensure that the CRM number displayed is exactly the same as the System ID that belongs to your system. If this is not configured correctly, then update the correct system ID in the Service ID & System ID fields under the System Configure tab in Guided Install.
   - Guided Install modifications in relation to System ID and Networking information updates are only allowed in the root login environment

7. If internet connectivity to the system is established via proxy, then enable Proxy setting and provide Proxy credentials.
8. If internet connectivity to the system is established via DNS, then configure the DNS Option in Guided Install under the Networking tab.
   - Guided Install modifications in relation to System ID and Networking information updates are only allowed in the root login environment
9. Click ***Submit*** once all the information has been entered. It could take up to 5 minutes for connectivity to be established. The refresh button can be used to check the correct status.
10. Observe the following, which indicates connectivity is successfully established:
    - Agent Running is **Yes**.
    - Registered is **Yes**.
    - CRM Verified is **Yes**.
11. If entitled, GE Remote Service involves analysis of system performance data and downloading software updates. This data can be sent back and forth from the system through one of the following methods. Note that data collected through these methods are used only to enhance product/service quality.
    - Proactive Diagnostics (ProDiags): Automatic push of system hardware parametric data at regular intervals
    - Sweeps: Automated scripts that login from the GE back office to pull only system configuration and performance data
    - Software Download: Used to download software updates in the form of service packs to the system
12. Click an item in the Feature List window to enable or disable the remote features.
13. Contact GE service if you have a problem configuring InSite.
14. Click ***Disable Connectivity*** if you want to stop remote service connection.
15. Click ***X*** to exit the Configure InSite screen.

Related topics

System management introduction

TiP Virtual Assist Procedure

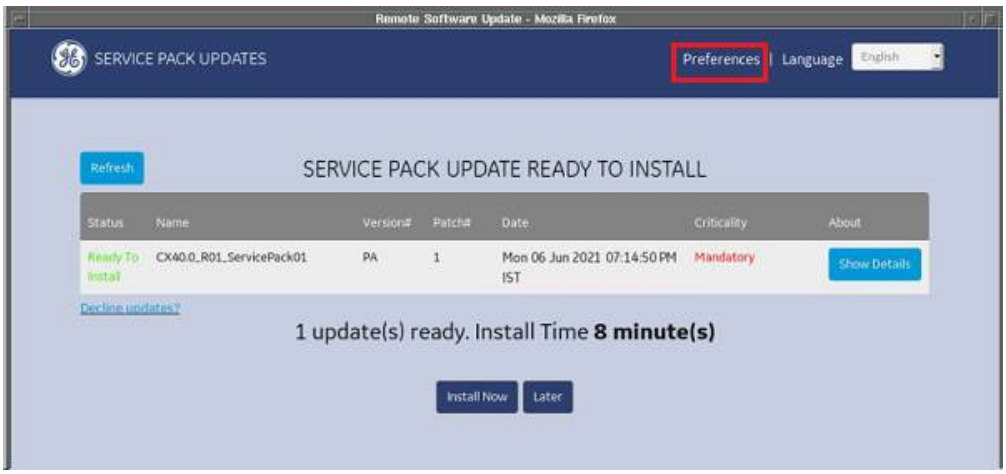
SYSTEM MANAGEMENT

Create a software download user role procedure

Use these steps to create an authorized EA3 user role for GE Software Installer Group.

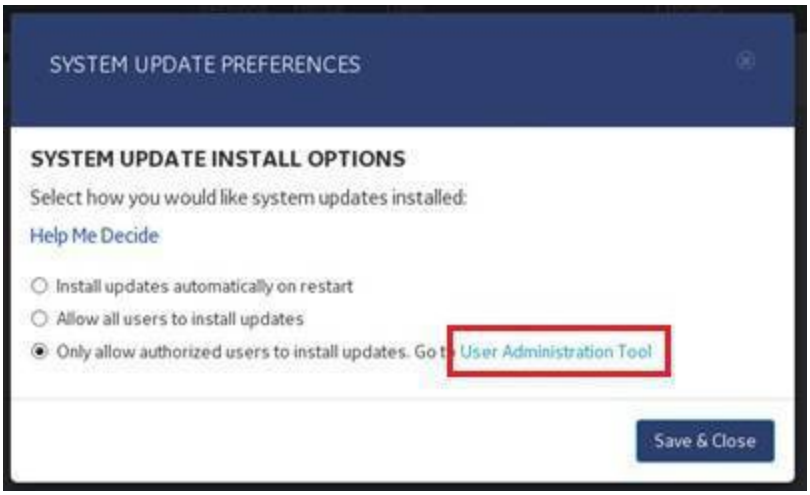
1. From the Remote Software Update screen, click ***Preferences***.

Figure 3-61: Remote Software Update screen



2. From the Preferences screen, click ***User Administration Tool***.

Figure 3-62: Preferences screen

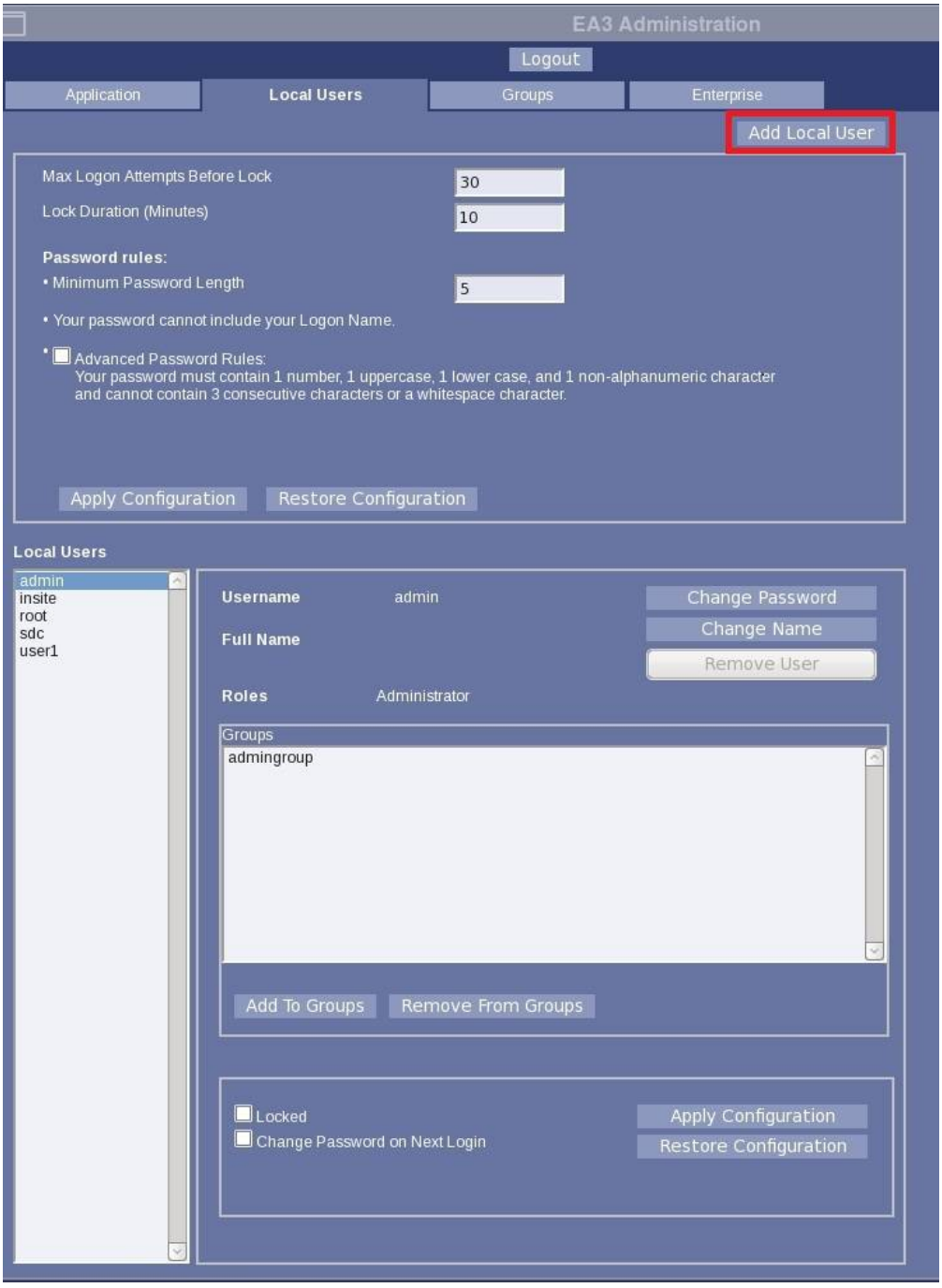


3. Enter User name ***root*** and your password and click ***Login***.

Figure 3-63: Password screen

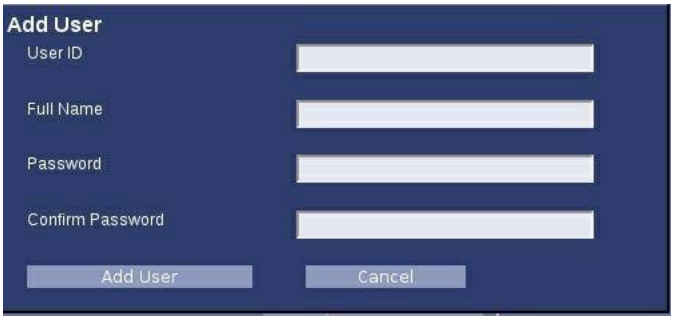
4. From the Local User tab, click ***Add Local User***.

Figure 3-64: Local User tab



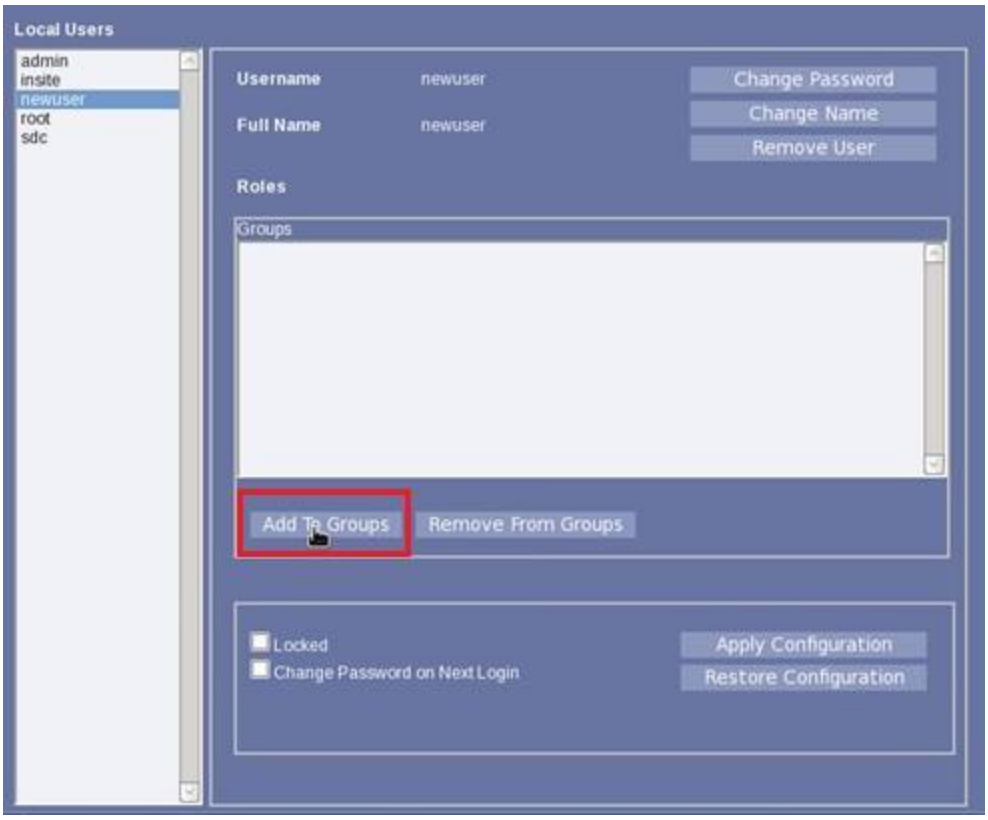
5. From the Add User screen, type information for each of the following and then click ***Add User***:
   - A unique User ID
   - Full Name
   - Password
   - Confirm Password

Figure 3-65: Add User screen



6. Click ***Add To Groups***.

Figure 3-66: Groups area of Local User tab



7. From the Add Membership for User screen, select ***GESoftwareInstallerGroup*** and click ***Add Memebership***.

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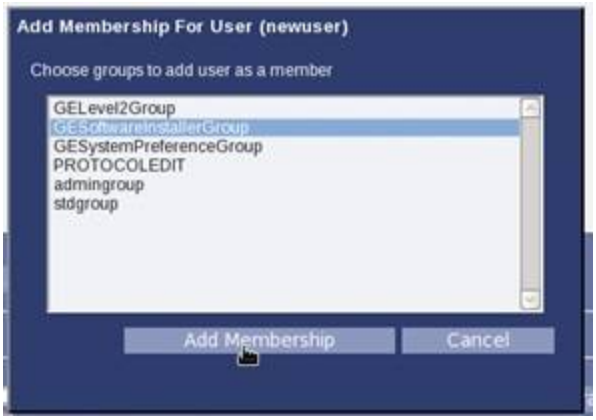
Figure 3-67: Add Membership for User screen



8. From the bottom area of the screen, click ***Apply Configuration*** and close the screen.

Figure 3-68: Bottom area of screen

9. Logout or reboot the system.
   - System logout procedure
   - System restart procedure

Related topics

System management introduction

Remote software download procedure

SYSTEM MANAGEMENT

Remote software patch download procedure

There are three modes in which the remote software can be installed. These modes are configured by an authorized user in root login.

- EA3 by an authorized user
- Auto
- Any User

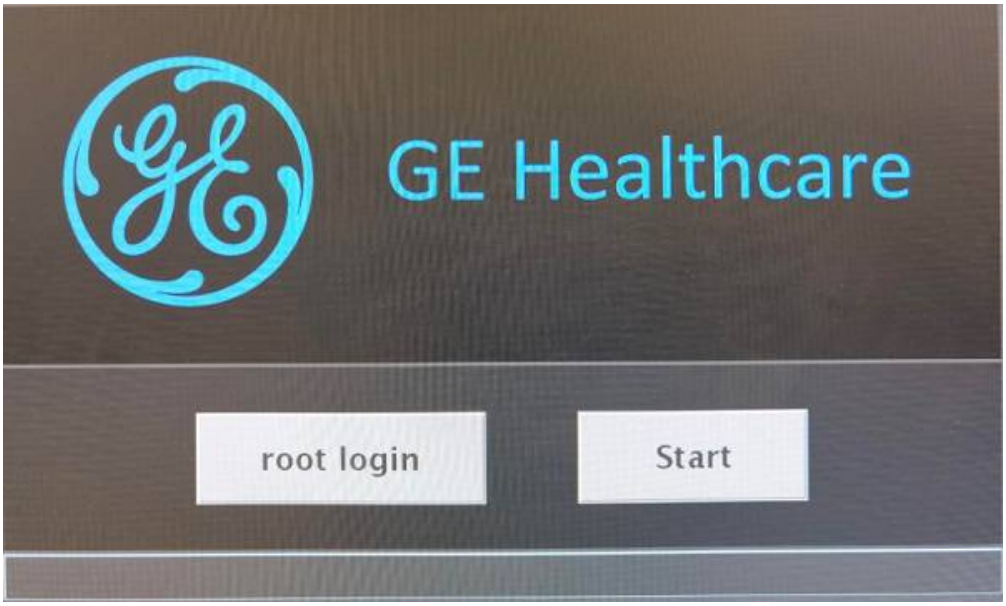
Procedure

Use these steps to accept and install software service packs.

1. To perform a remote software download follow these steps.

a. From the logon screen, click ***root login*** to logon as a Unix Root User.

Figure 3-69: Logon screen



b. Enter your username and click **Next**.

Figure 3-70: Username screen

c. Enter your password and click ***Sign In***.
   - The remote software update automatically launches after sign in.

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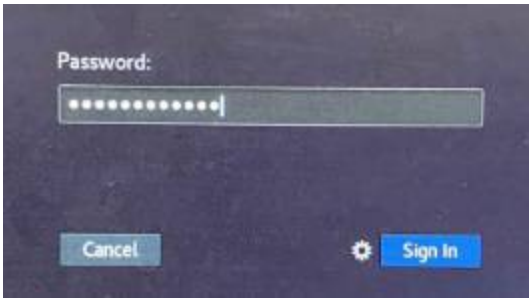
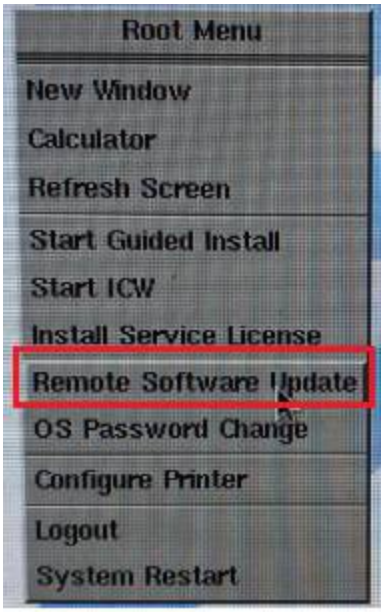
Figure 3-71: Password screen



c. If the remote software does not automatically launch, place the cursor in the screen background and right-click to view the Root menu.

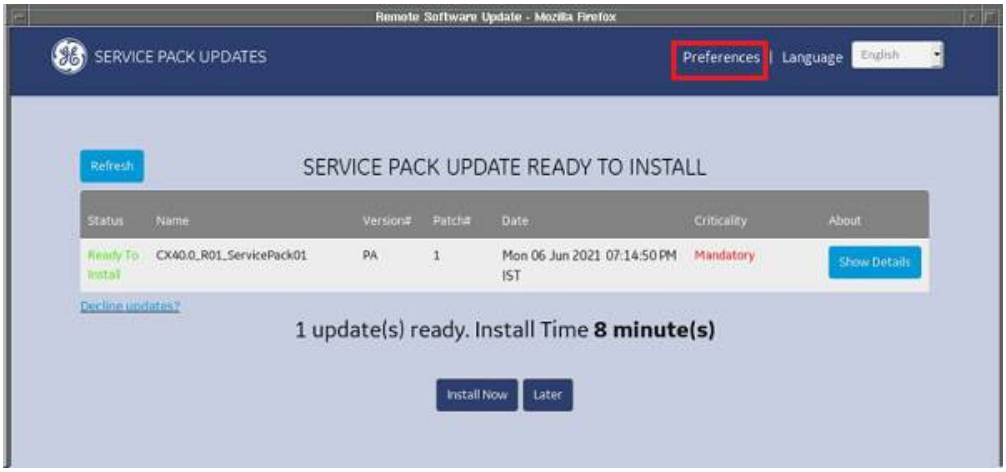
Figure 3-72: Root menu



d. From the Root menu, click ***Remote Software Update*** to display the Remote Software Update screen.

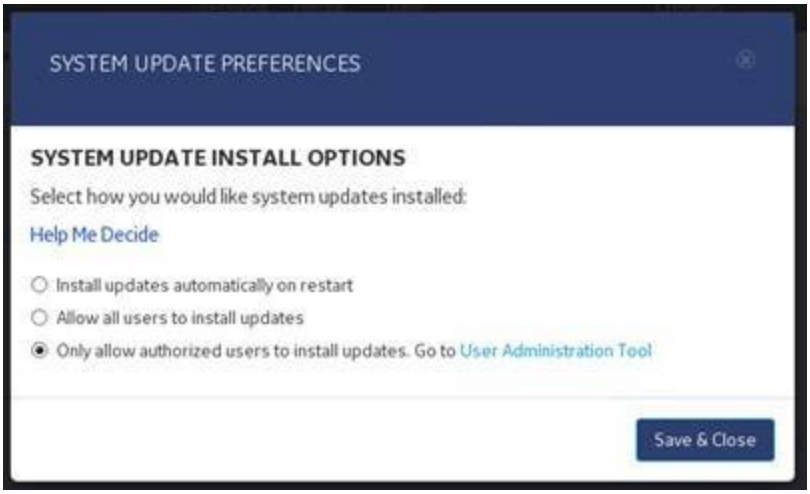
e. From the Remote Software Update screen, click ***Preferences***.

Figure 3-73: Remote Software Update screen



f. Select an option from the Preferences menu and click ***Save & Close***.
   - Install updates automatically on restart.
   - Allow all users to install updates
   - Only allow authorized users to install updates (controlled through EA3 access).

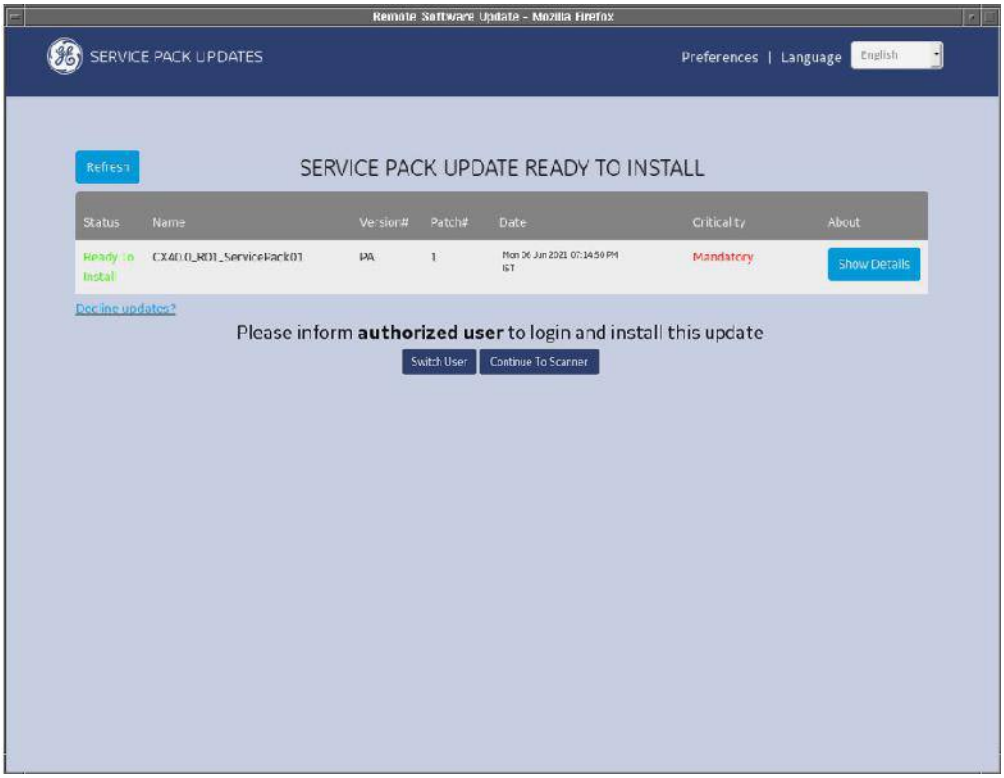
Figure 3-74: Preferences screen



2. If you are a EA3 user, follow these steps.
   - A software download can only be installed or declined by an authorized user.
   - To become an authorized EA3 user, see **Create a software download user role procedure**.

   a. If you are an unauthorized user, the following screen appears at logon to inform you that a download is available.

Figure 3-75: Unauthorized EA3 user install screen



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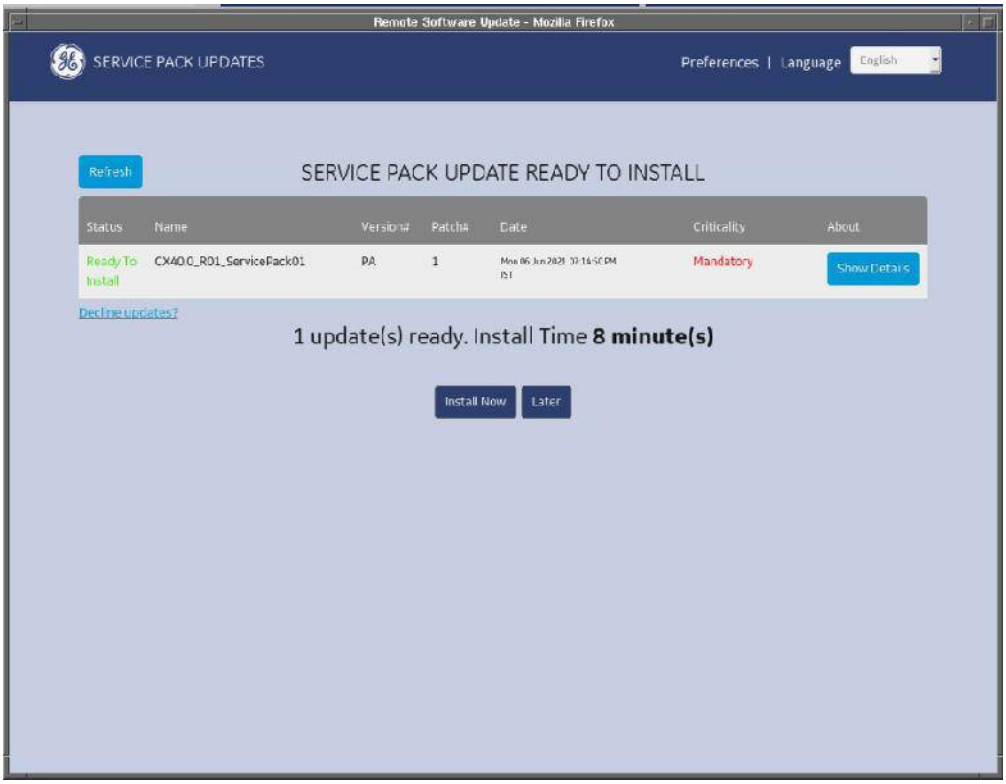
- You can click ***Switch User*** and the HIPAA screen appears.
- You can click ***Continue to Scanner*** and the Logon screen appears.

b. If you are an authorized user, the following screen appears.

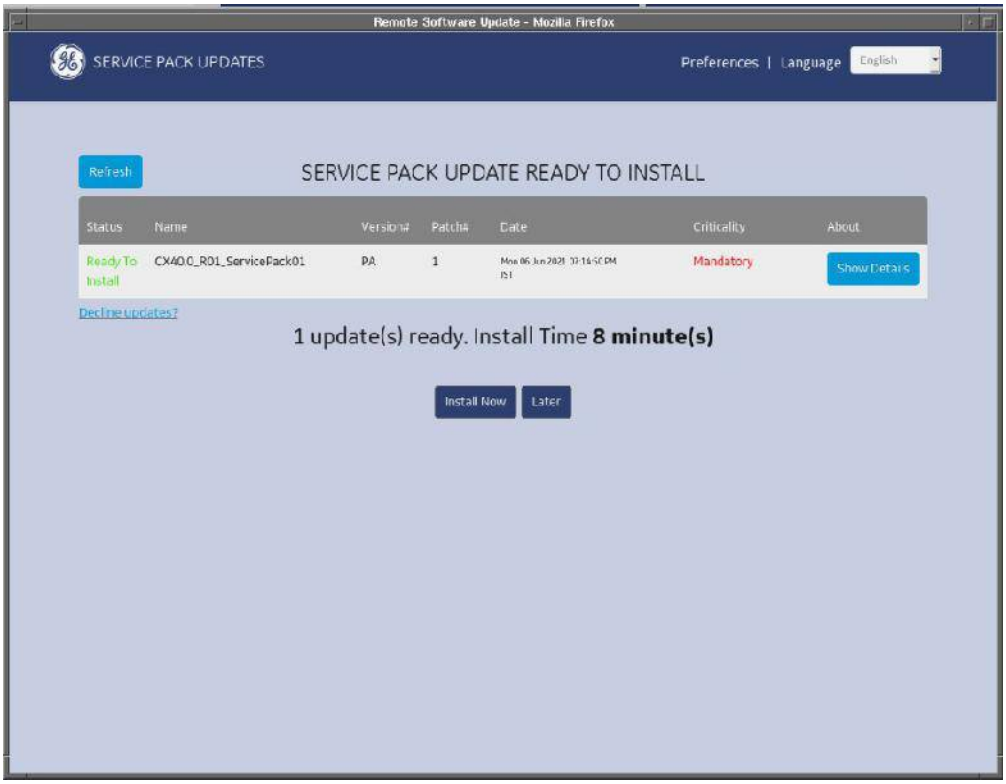
Figure 3-76: Authorized EA3 user install screen



- You can click ***Install Now*** to start the software download.
- You can click ***Later*** to install the software at a later date and then proceed to logon.

3. If your site has Auto Install, the following screen appears.

Figure 3-77: Auto Install screen



- The counter will count down to 30 seconds and then automatically install the service pack.
- The system does not check for any authorization.

a. If you do not want the installation to occur, click ***Later***.

4. If your system is configured for all users to authorized a software download, the following screen appears.

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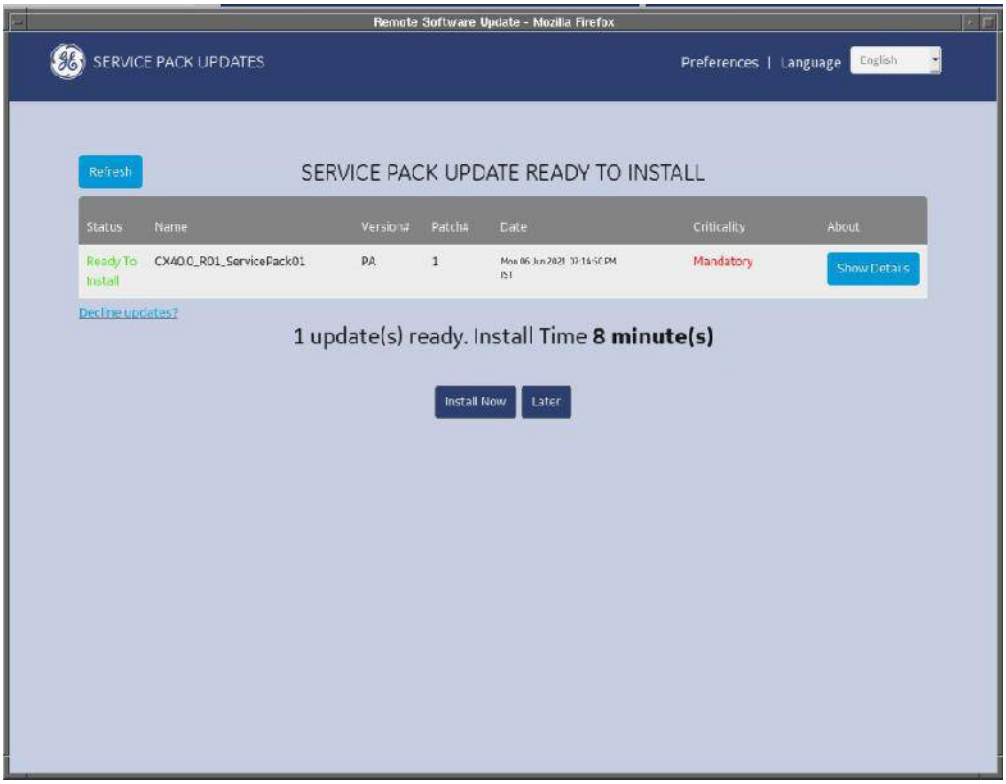
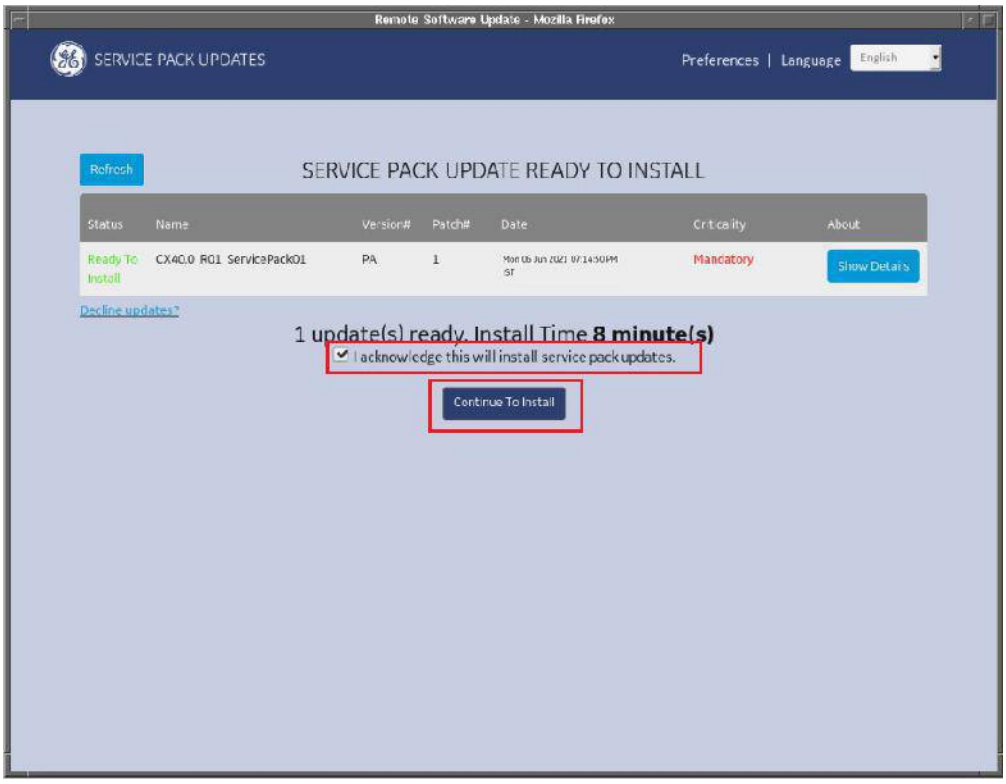
Figure 3-78: All users install screen



- The system does not check for any authorization.

5. Once you have accepted an Install Now, the following screen appears.

Figure 3-79: Continue to install screen

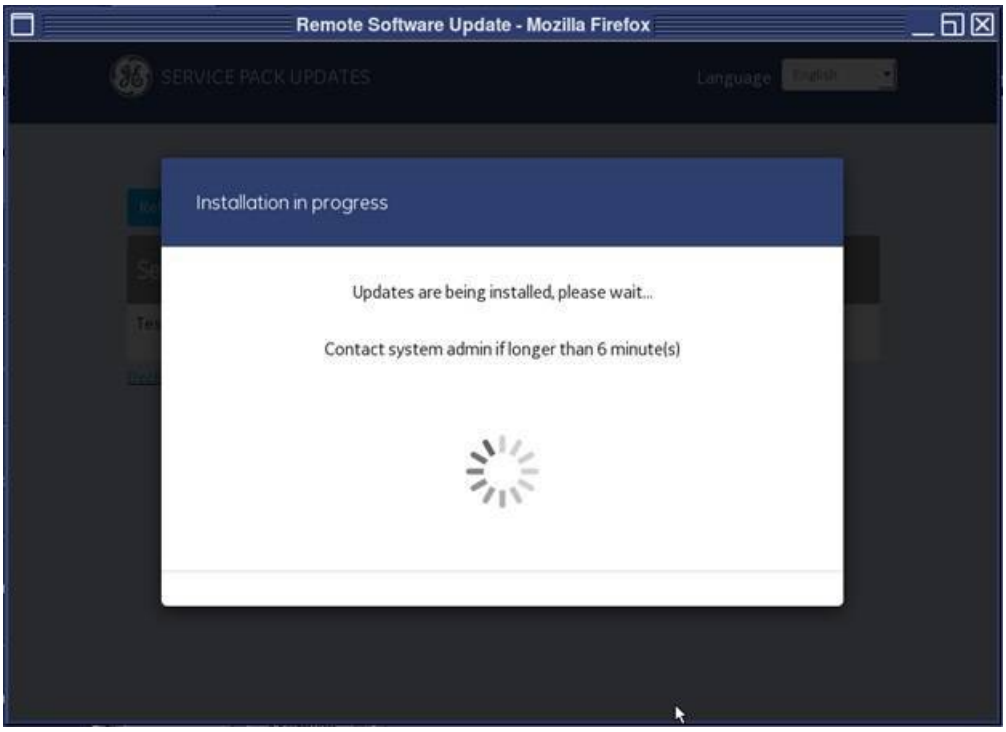


a. Click the ***Acknowledge*** box.

b. Click ***Continue to Install***.

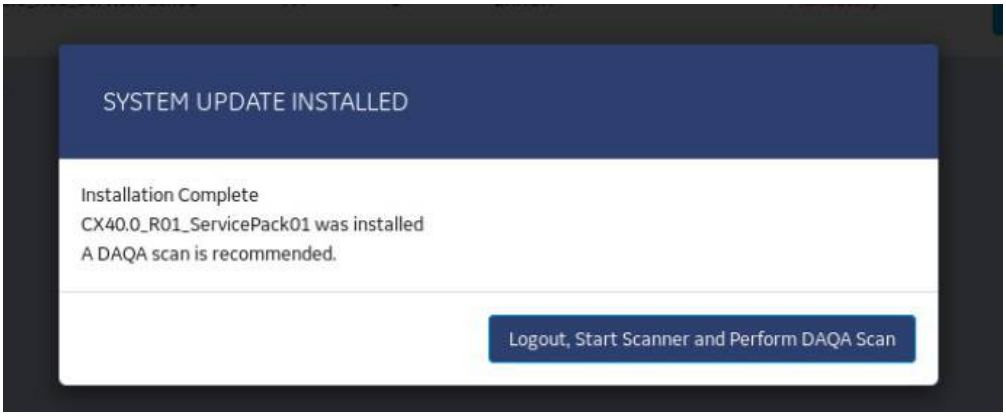
- The following screen appears while the installation occurs.

Figure 3-80: Installation screen



6. When the installation is completed, the following screen appears. Make one of the following selections.

Figure 3-81: Installation complete screen



a. Perform ***Log Out*** to log out the currently logged in data privacy user and continue to boot the system.

b. Perform ***Start Scanner and Perform DAQA Scan*** to proceed to scan once a DAQA scan is completed.

Considerations

Later

In all modes, if you click ***Later***, a prompt for install during next startup of MR scanner, appears. Click ***Continue to Scanner*** to proceed to logon.

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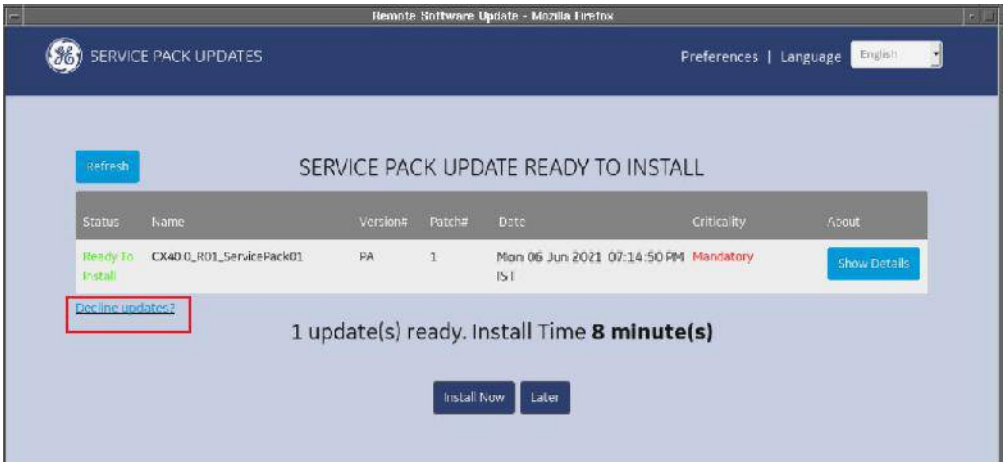
Figure 3-82: Later screen prompt

Decline Updates

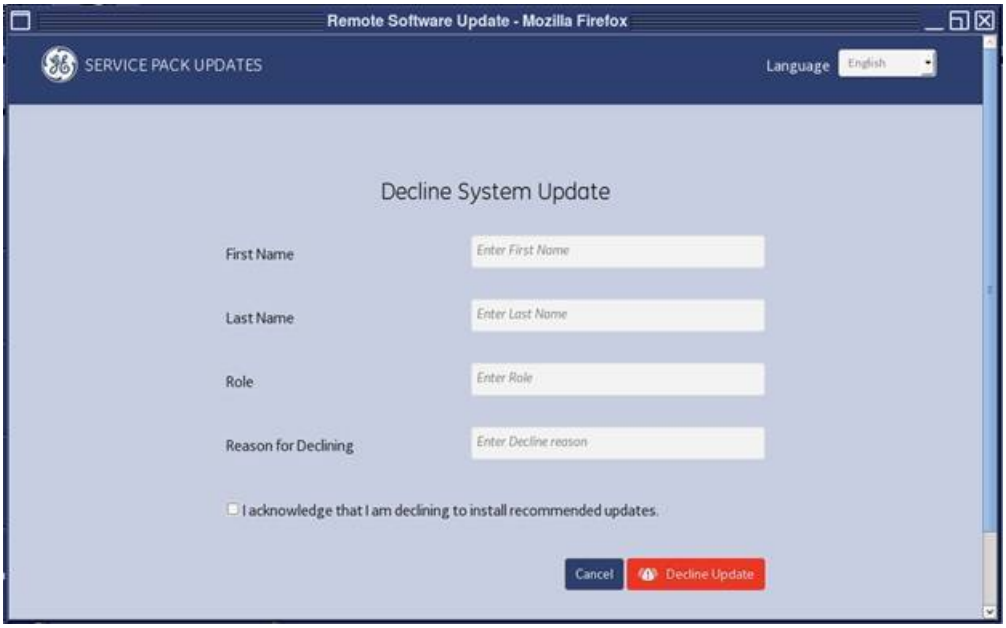
Figure 3-83: Decline Updates selection



In all modes, if you select ***Decline updates***, the following screen appears, from which you must enter text in all fields and click the Acknowledgment box:

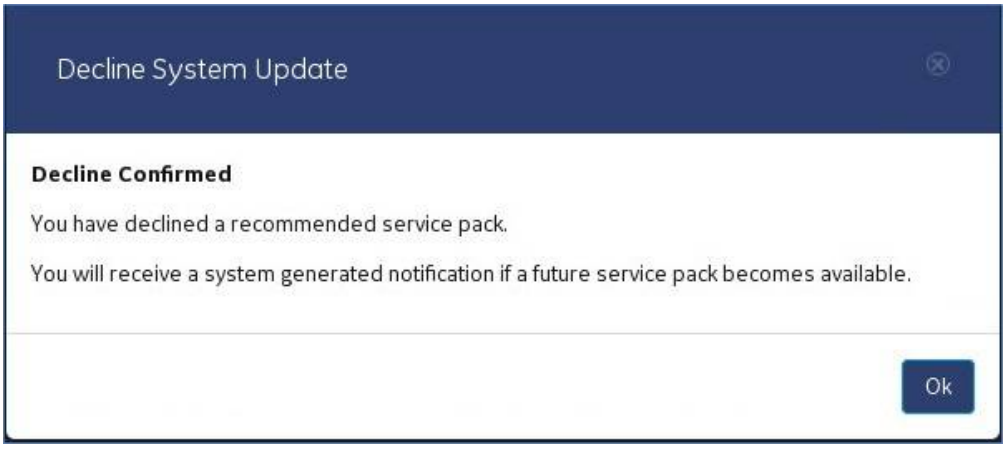
- First Name
- Last Name
- Role
- Reason for declining
- Acknowledgment box

Figure 3-84: Decline updates screen



Once the text fields are completed, click ***Decline Update*** and the following prompt appears.

Figure 3-85: Decline updates confirmation prompt screen



Click ***Ok*** to proceed to logon.

Service Pack icons

Once the MR system is up and operational, if a software download is available, an icon appears in the footer area of the screen.

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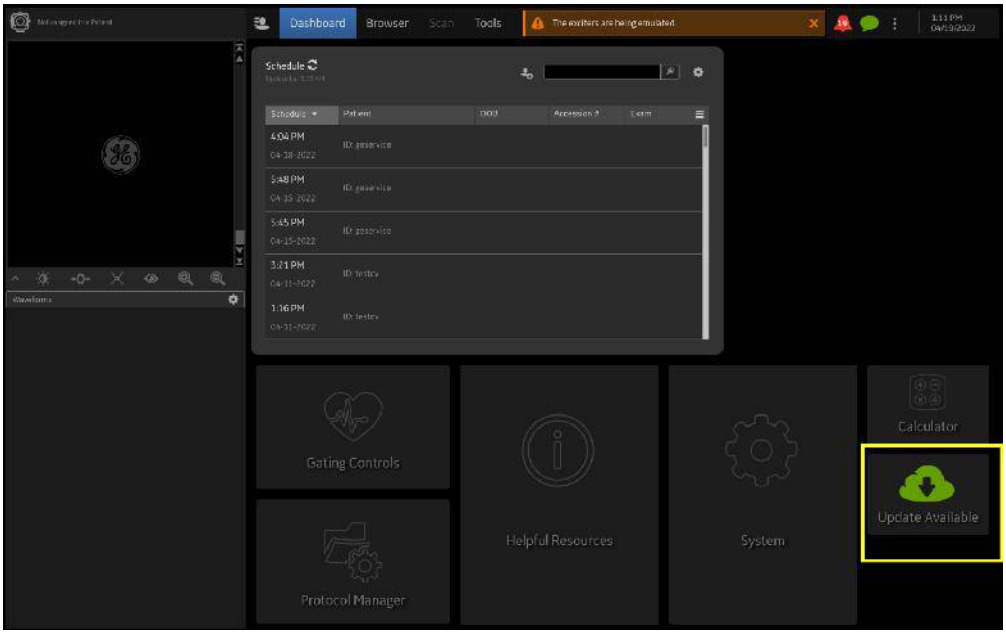
Figure 3-86: Software download available icon



The icon changes based on conditions described in the table below.

Table 3-15: Service Pack icons

Icon	Description
	This icon displays when a new service pack is available and the MR system is up and operational. Click the icon to see an information screen about the service pack. Click ***Close*** to close the information screen.

Related topics

System management introduction

SYSTEM MANAGEMENT

Remote full software download procedure

Pre-requisite

- Only users that have the **GESoftwareInstaller Group** status can install the full software.
- Reference the Privacy and Security for MR systems for Role-based membership considerations. The url link to the Privacy and Security for MR systems operator manual is:

  https://www.gehealthcare.com/security

Several tasks need to be completed before performing a full software update and these full software updates can occur several times a year.

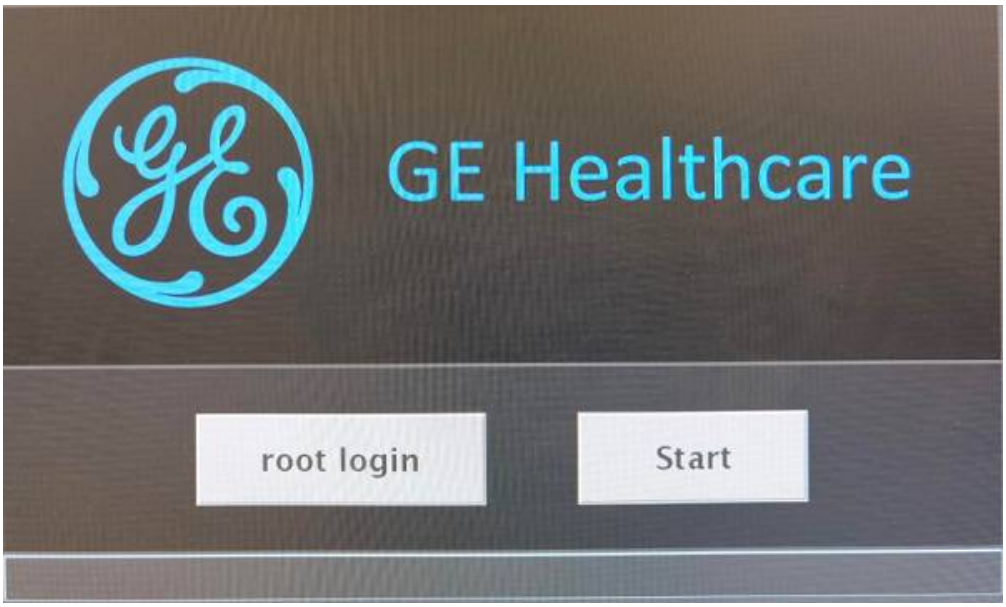
- Locate your MR GE Software upgrade USB media, it is sent with your software collector. Typically, the administration, IT person or the Radiology department manager has the MR GE Software upgrade USB media.
  - Do not use any other USB media to save the software downloads.
- Back up all images! A full software update will erase ALL images, be sure to film and archive all images before starting this update.
- Schedule your full software downloads to occur at the end of your clinical imaging day. The system must be idle and powered on.
- It is very important to remove any save info (DVD) from the drive. If you don't remove the DVD the install will be corrupted.
- Post a note on scanner to not touch or reboot scanner while its installing the software.

Procedure

Use these steps to download and install a full software through **Remote SW download**.

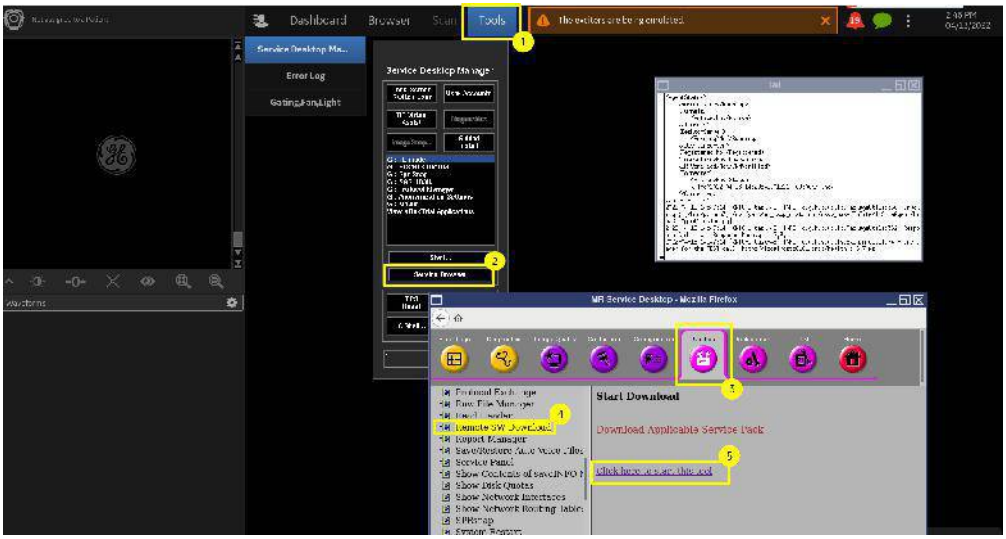
1. From the logon screen, click **Start**, and then enter your username and password to sign in.

   Figure 3-87: Logon screen



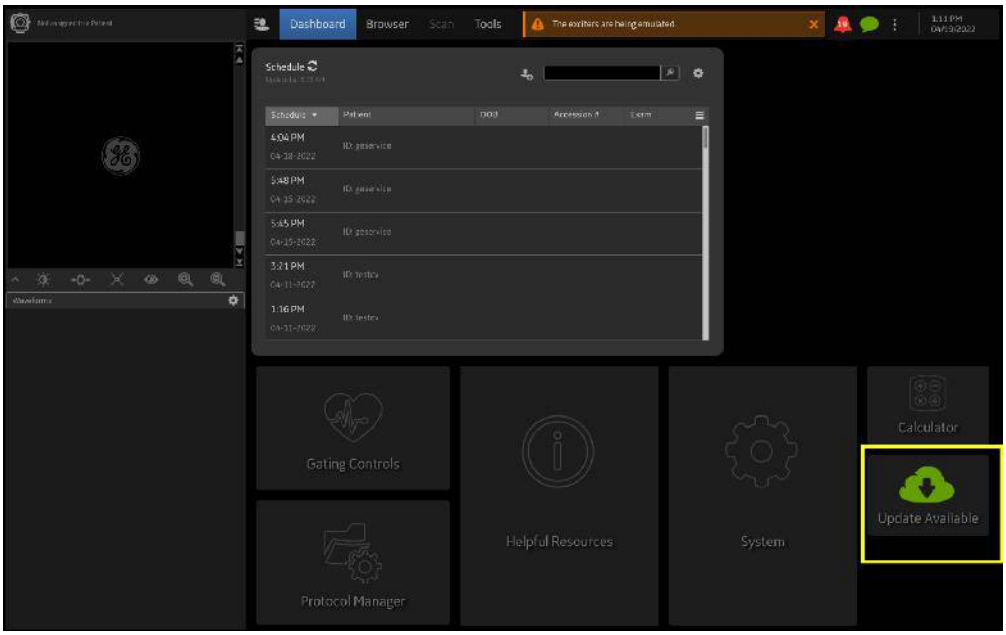
2. On the screen that is opened, click **Tools** > **Service Browser** > **Utilities** > **Remote SW Download** > **Click here to start this tool** to start downloading the latest full software through RSD.

Figure 3-88: Tools screen



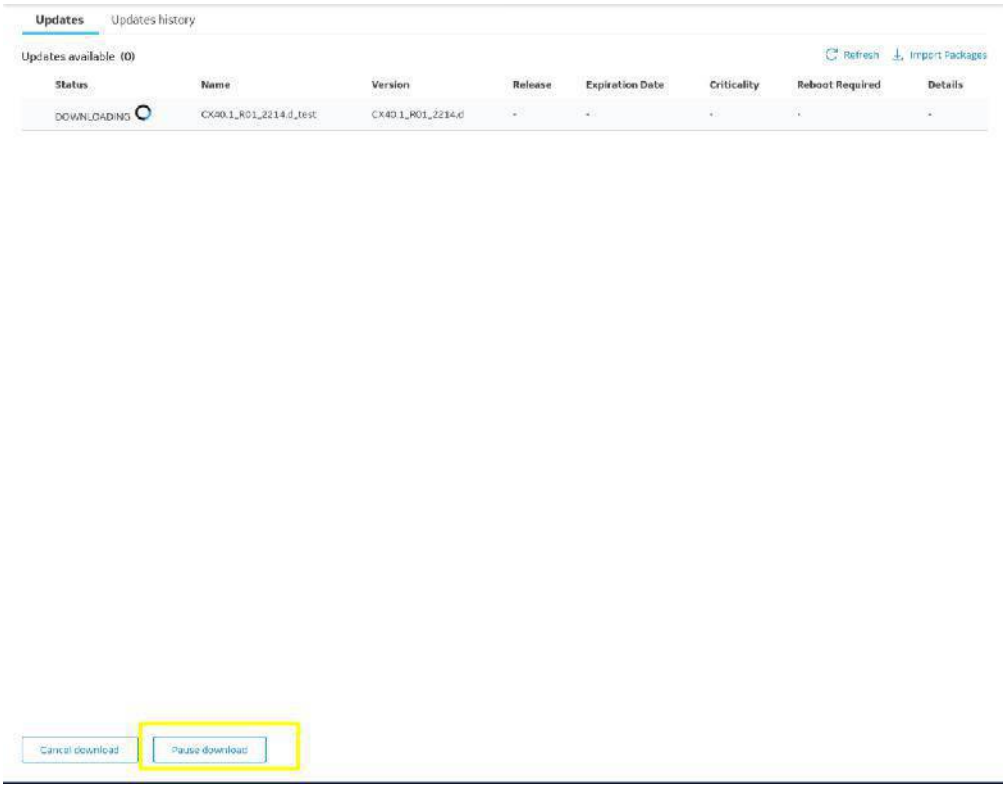
3. Go back to the **Dashboard** screen, the remote software icon appears in the lower right corner of the screen during the downloading process.

Figure 3-89: Green cloud icon in Dashboard screen



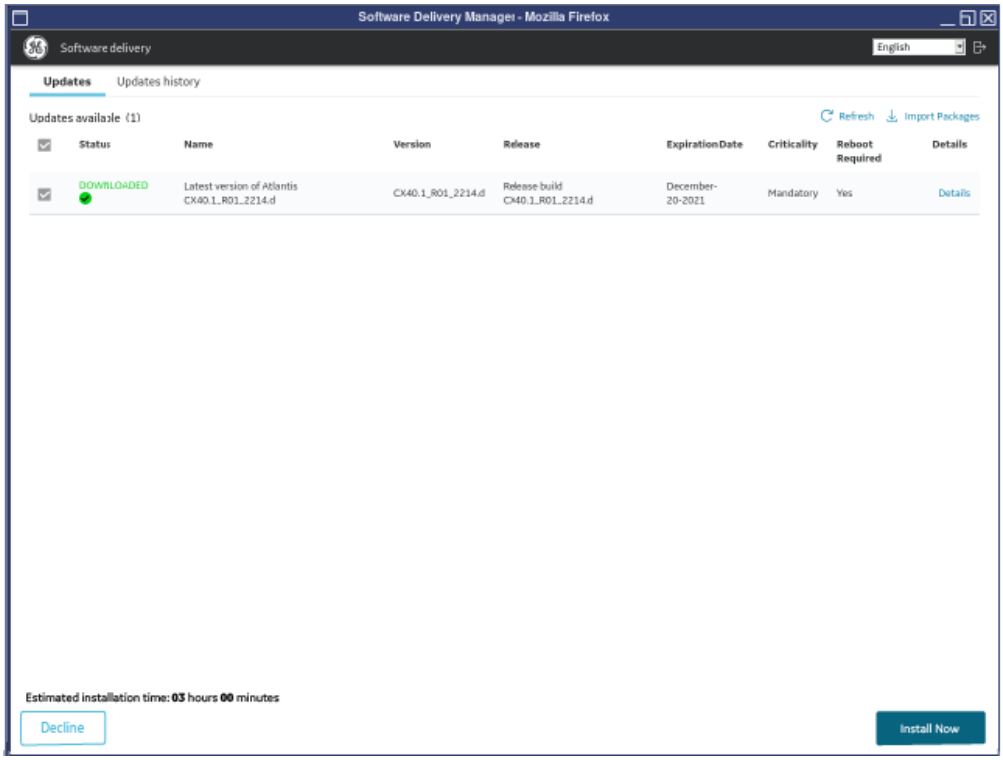
4. Click the remote software icon to check the Downloading details in the **Software Delivery Manager** screen. Click **Pause Download** to suspend the download progress which can be resumed from the break point later as needed.

Figure 3-90: Software Delivery Manager screen with Downloading Details



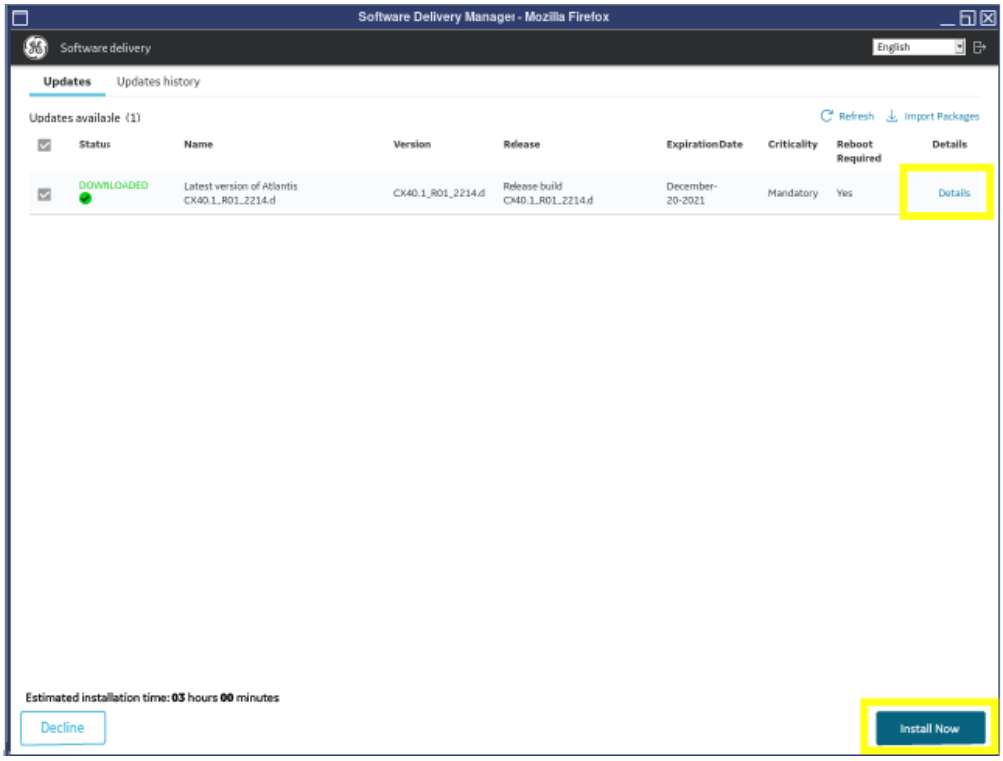
5. After the status becomes DOWNLOADED on the **Software Delivery Manager** screen, insert MR USB Software Installer to a USB 3.0 port on the MR Host PC.

Figure 3-91: Software Delivery Manager screen after full software downloaded



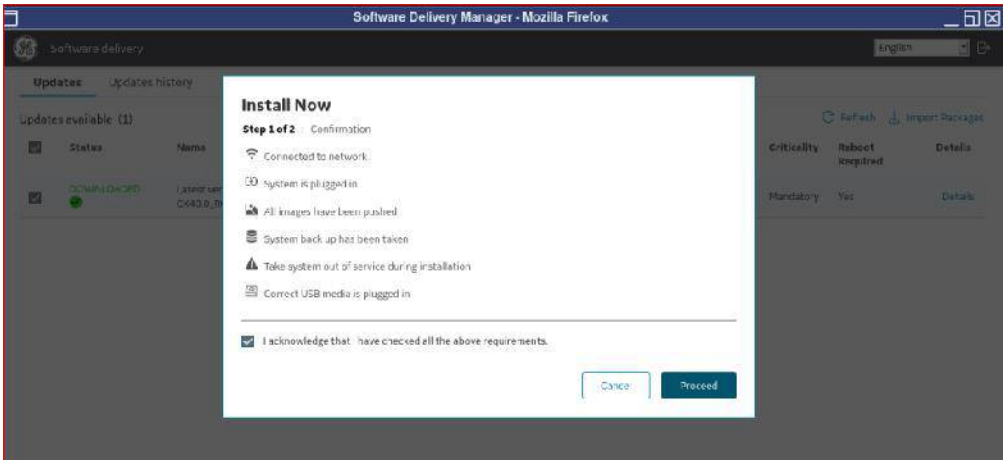
6. From the **Software Delivery Manager** screen, select the check box next to the item you want to install.
   - To view software installation details related to the selected download, click **Details**.
   - To start the installation progress, click **Install Now**.

Figure 3-92: Software Delivery Manager screen with DOWNLOADED item



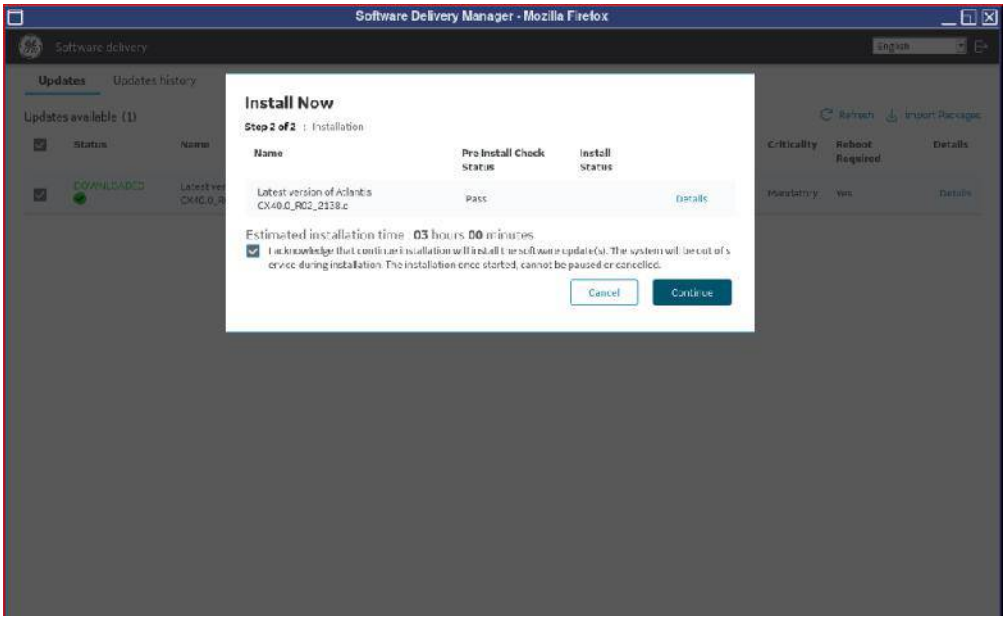
7. In the pop-up window, click the **Acknowledge** box, and then click **Proceed**.

Figure 3-93: Install Now Step 1 of 2



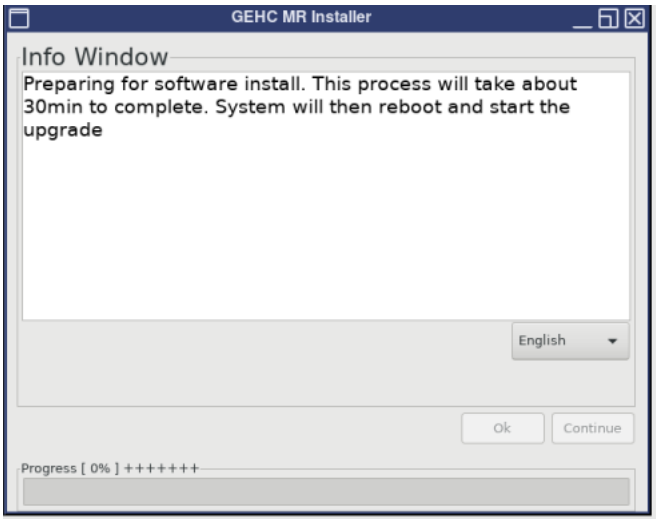
8. In the second pop-up window, click the **Acknowledge** box, and then click **Continue**.

Figure 3-94: Install Now Step 2 of 2



9. A pop up appears which will reboot the system at the end.

Figure 3-95: GEHC MR Installer



10. After the system is restarted, the **GEHC MR Installer** screen is displayed again with the message "*Installation is starting, please wait while the system begins the installation.*"

11. After the installation is completed, the **Guided Install** screen is displayed. Click **Set Time/Date** tab and then do the following:

    - Check if the information in **Date/Time/Zone** is correct.
    - If you correct the information in the **Date/Time/Zone**, click **Configure** after the changes are made.
    - To exist the current screen, click **File** > **Quit**. A prompt appears instructing you to make sure the time/date is correct. Click **Yes** to the prompt and the prompt screen closes.

Figure 3-96: Guided Install

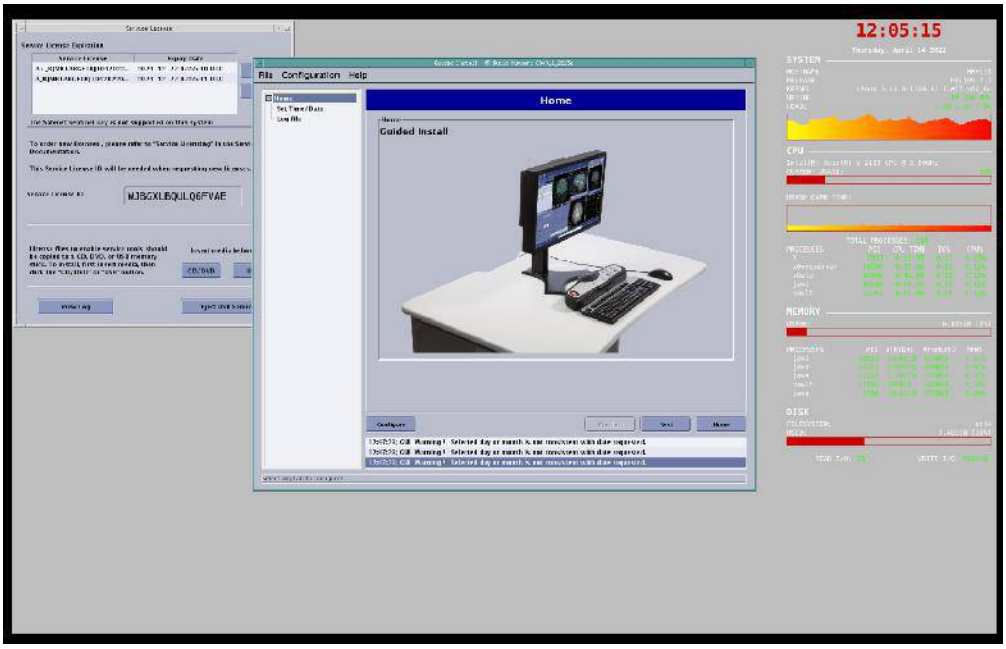
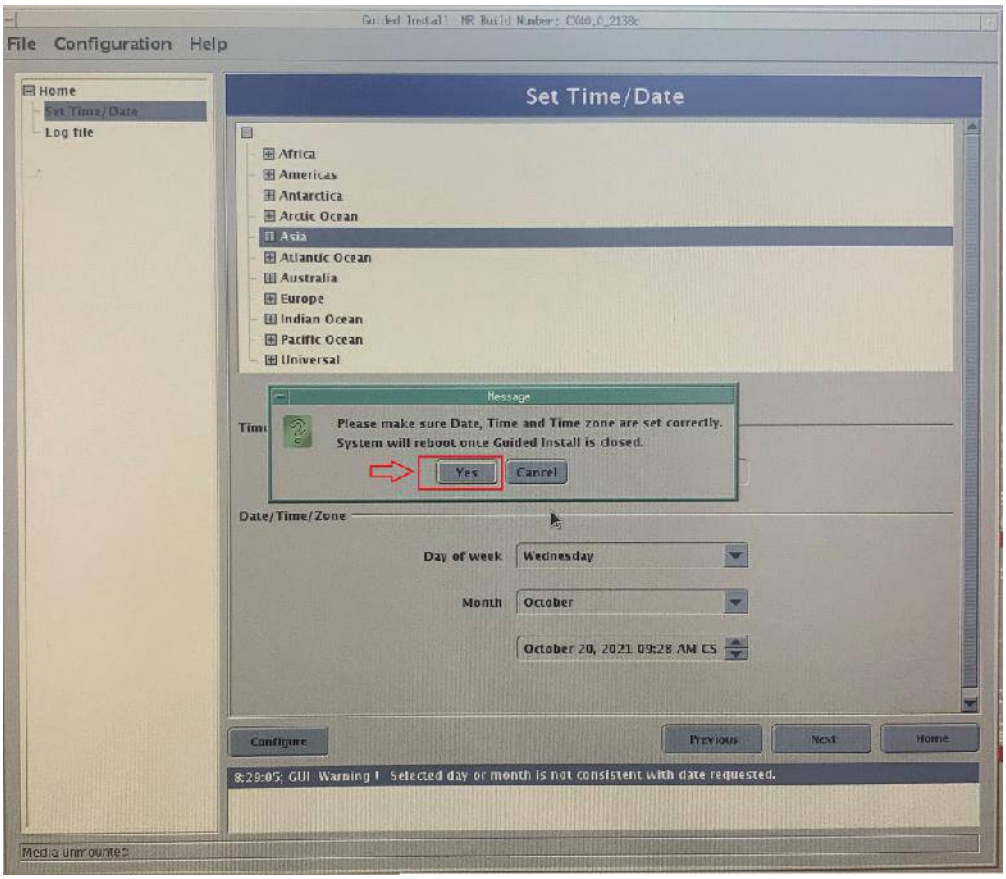


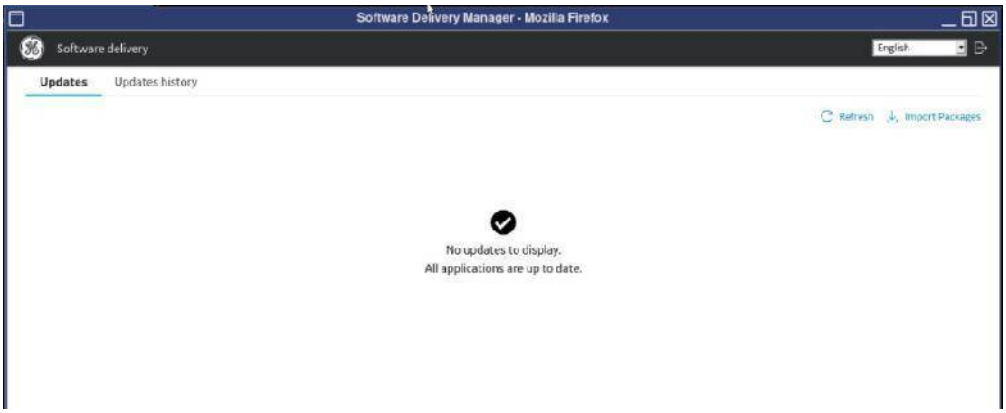
Figure 3-97: Set Time/Date



12. The system is restarted automatically again.

13. After logged in the system again, the **Software Delivery Manager** screen is displayed with the message "*No updates to display. All applications are up to date.*"

Figure 3-98: No updates in Software Delivery Manager



Related topics

System management introduction

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SYSTEM MANAGEMENT

TiP Virtual Assist introduction

TVA (TiP Virtual Assist) combines the hands-on benefits of on-site training with the convenience and cost savings of distance learning. TVA provides a one-on-one training powered by a high-speed broadband link, which allows GE personnel to connect directly to your imaging console. You and the trainer see the same screen at the same time and can even share control of console. TVA is designed in compliance with Data Privacy guidelines.

TIP Virtual Assist provides:

- live-on-demand support to troubleshoot system performance
- the ability to share control of the console to demonstrate and instruct complex procedures
- real-time critique of image quality
- protection against GE personnel from performing a scan, moving the table or editing patient data
- customer-initiated connections; GE cannot access your console without your permission
- full site control at any time

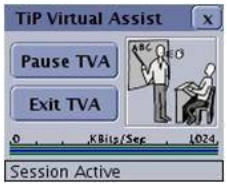
TVA requires user-initiated activation to allow a GE trainer access to your console for training or troubleshooting.

A default password is provided to each console for GE personnel to use when accessing the console. As an added layer of security, you may change the password, but you must provide the new password to any GE personnel using your console for remote training or troubleshooting.

If you or the GE trainer do not use the console for 10 minutes, TVA automatically disconnects.

The Remote Training screen displays when your console is connected to TiP Virtual Assist. The buttons displayed depend on the current status of the training session.

Figure 3-99: TVA: Remote training screen



Procedure

TiP Virtual Assist activation procedure

Related topics

System management introduction

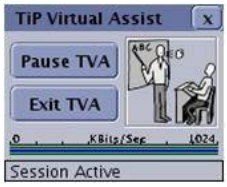
SYSTEM MANAGEMENT

TiP Virtual Assist activation procedure

Use these steps to activate **TVA** for receiving live-on-demand support to troubleshoot system performance.

1. From the Main Menu, click **Tools** to open the System Management work area.
2. From the Service Desktop Manager, click **TiP Virtual Assist**
3. From the Remote Control screen, click **Accept** to view the Remote training screen and connect the console to TVA.

Figure 3-100: TVA: Remote training screen



- The buttons displayed depend on the current status of the training session.
- Click ***Exit TVA*** to close the screen without connecting to TVA.

Related topics

TiP Virtual Assist introduction

System management introduction

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Chapter 4: Patient handling

Patient preparation depends on a range of factors including the type of study, the RF coil being used, and the patient's condition. Regardless of the type of examination, patient comfort and safety are of primary importance.

Procedures

PATIENT HANDLING

Patient transfer procedure

The table is designed to accommodate the transfer of ambulatory, wheelchair, and gurney patients. For table weight specification details, see:

- SIGNA™ Victor: system specifications

Note that the MR magnet is always on even when the system is not acquiring scan data. The only exception to this is if service has ramped down the magnet or it has been quenched.

1. Make sure the patient has completed the screening sheet and has removed all metal items.
2. Bring the patient to the table either in a non-ferrous wheelchair or non-ferrous gurney, or escort the ambulatory patient into the scan room.

WARNING

Do not bring conventional life-support equipment into the magnet room, because it may contain metal parts and may malfunction or cause patient injury or equipment damage.

3. If the patient is using a non-ferrous wheelchair or gurney, lock the wheels.
4. If using a coil, place it on the table and connect it.
5. Press the **Up** and **Down** foot pedals at the magnet end of the table to adjust the table height.
6. Transfer the patient onto the table.
7. Help the patient with any medical accessories he or she may have.
8. Raise the table to scanning height.
9. Remove any wheelchairs or gurneys from the scan room.
10. To remove the patient from the table, follow these steps:
    a. Adjust the table height while paying careful attention to all health lines, to safely transport the patient back to a non-ferrous gurney, wheel chair, or to exit the table and walk out of the scan room or prep area.
    b. Bring either a non-ferrous wheelchair or gurney into the room, next to the table, and lock the wheelchair or gurney wheels.
    c. Transfer the patient off the MR table and move the transportation device out of the scan room.

Related topics

Patient handling

Patient position procedure

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PATIENT HANDLING

Patient position procedure

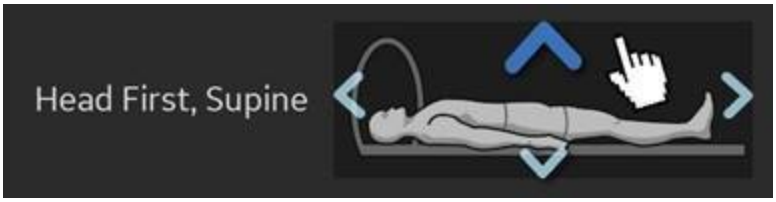
Thoroughly review all **patient preparation** and **screening** information in the **MR Safety chapter**, prior to scanning a patient or allowing anyone into the MR scan room.

1. Position the patient on the table, either head or feet first.
   - Typically, use head or feet first for body scans and head first for head and neck.
   - For table weight specification details, see:
     - **SIGNA™ Victor system specifications**
   - All MR healthcare providers that work with the patient must be trained to reduce the risk of patient muskuloskeletal injury such as fracture, dislocation or subluxation during the transfer of the patient on/off the table, positioning the patient on the table, positioning coils on the patient, etc.
2. Position the patient either supine, prone, left decubitus, or right decubitus.
   - From the **Patient Exam Information screen**, match the patient's position and orientation with the selection made on the ***Patient Orientation*** button. Click the arrows to change the patient orientation icon.
   - Ensure that the patient forms no closed body loops. For details, see step 4.

WARNING

Ensure that the Patient Position selection matches the actual patient orientation. Making a selection that does not match the patient's actual position results in incorrectly annotated and/or rotated images, possibly resulting in improper medical treatment.

Figure 4-1: Patient Orientation



3. Position the imaging coil, if needed.
   - Each coil, other than the body coil, has an operator manual. Refer to the coil operator manual when setting up the patient for an exam.
   - Use the supplied coil pads with the coil at all times. The coil should never come into contact with the patient.
   - Never let the coil's *RF*[1] cables come into contact with the patient. Position cables under a cushion whenever possible.
   - Use only approved, undamaged RF coils.
   - Inspect coils for damage and wear. Do not use a coil that is not functioning properly, e.g., tuning problems or intermittent poor quality images.
   - When using the Head coil, it is recommended to first place the base of the coil on the table then position the coil on the patient. Storing the coil on the table or the bore entry is not advised.

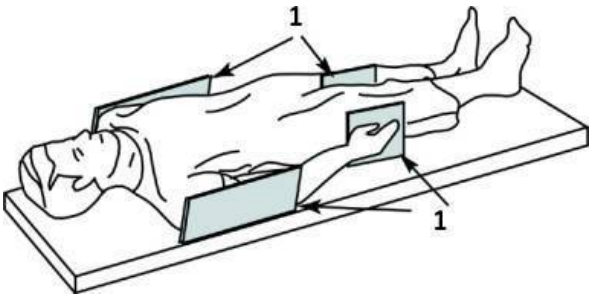
[1]Radio Frequency

WARNING

All coil components must be plugged in when they are in the scanner. This includes coil components that should be plugged into the system and coil components that should be plugged into another coil component. Leaving components unplugged can damage the coil, or cause harm to the patient.

4. Position the patient with padding.
   - Review the **Contact Point Heating** section of the MR Safety chapter for patient positioning information.
   - For more patient padding details, see **Padding introduction**.
   - Position the patient so that there is no direct contact between the patient's skin and the bore of the magnet or an RF coil.
   - Hand-to-hand, calf-to-calf, and elbow to side contact should be avoided. To help prevent a patient burn from closed loops formed by clasped hands, hands touching the body, from thighs touching, or from the patient's breasts contacting the chest wall over a small area, insert nonconducting pads at least 0.25 inches thick between touching parts.

Figure 4-2: Patient positioned with non-conducting pads



WARNING

RF can cause localized heating at contact points between adjacent body parts when a loop is formed. Such localized heating can result in discomfort, or burns. This could occur when a patient's hands are touching or when a female patient's breasts are compressed to her chest. Use pads between body parts to avoid creating a loop with adjacent body parts.

5. Position the patient with straps. Insert the straps into the mounting track on the table and wrap the straps around the patient. Straps are to stabilize, not restrain the patient.

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Figure 4-3: Strap inserted in table mounting track

- If you find it difficult to insert the strap into the track or move it in the track, then slightly bend the strap base on a hard surface.

Figure 4-4: Bend the strap base

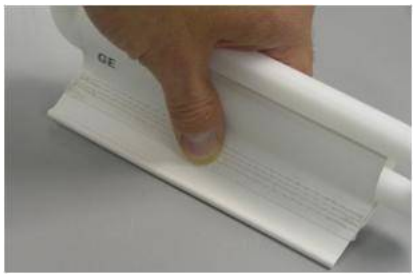

Figure 4-5: Bent strap that more easily slides in the mounting track

6. Provide blankets, pillows, etc. and adjust the magnet bore fan/light for **patient comfort**.
7. If necessary, attach cardiac leads and the respiratory device.

WARNING

Do not use waveforms for physiological monitoring. Patient condition may not be reflected, resulting in improper treatment.

8. Remove any accessory devices from the bore of the magnet that are not required for the procedure.
9. Keep electrically conductive material that must remain in the magnet bore from directly contacting the patient by placing insulation between the conductive material and the patient.
10. Place a clean cotton sheet over the coil and comfort pad so the patient's skin does not come in contact with the coil or the comfort pad.
11. Position RF cables down the center and directly out of the bore (i.e., not along side of the MR system or close to the body coil or other transmit RF coil), without looping or crossing the cables.
    - Route the cables so there are no loops (conductive loops can be circular, u-shaped, or s-shaped) in any cables in the magnet.
    - Use the appropriate gating cable for surface coil imaging.
    - Use only MR system recommended monitoring equipment, ECG leads, wires, electrodes, and other components and accessories.
    - Follow all instructions for the proper operation of physiologic monitoring or other equipment provided by the manufacturer of the device.
12. Provide the patient with the **patient alert bulb** so that the patient may signal you if needed.
    - If your patient tells you he or she is experiencing a burning sensation, stop the scan.
13. Explain breathing instructions, table movement, length of exam, gradient noise, adjustment of mirror on head coil, etc.
    - Instruct the patient not to clasp his or her hands or cross his or her feet in the magnet bore.
14. Provide the patient with hearing protection.
    - Review the **Acoustic Noise section** of the MR Safety Guide.

 Closely monitor the patient (especially those who are unconscious) during the procedure. If the patient reports sensations of heating or other unusual sensation, discontinue the procedure immediately and perform a thorough assessment of the situation.

Related topics

Patient transfer procedure

Patient landmark with alignment light procedure

Patient return to landmark procedure

Patient handling

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PATIENT HANDLING

Patient landmark with alignment light procedure

Axial and sagittal alignment lights help position the area of interest at isocenter.

1. Press the Alignment light button on the Magnet control panel.

CAUTION

Exposing eyes to laser alignment lights may result in eye injury.

- Do not stare directly into the laser beam.
- Instruct patients to close their eyes to avoid eye exposure to the alignment light.
- Closely monitor all patients and prevent them from accidentally staring into the beam. Do not leave the laser beam on after you position the patient.

2. Press the **table movement** buttons to advance the cradle until the axial alignment light rests at the desired landmark. Confirm centering with the sagittal alignment light.
3. Press **Landmark** button from the Magnet control panel. The cradle position reads zero.
4. Make sure all health lines are long enough to accommodate movement and then press **Advance to Scan** to move the cradle to magnet isocenter.
   - The alignment lights automatically turn off.
5. Adjust the in-bore light and fan.
   - For details see the **Patient comfort procedure**.
6. Leave the scan room and enter the console room to begin scan prescription.
   - Close the scan room door during the acquisition to prevent RF leaks.
   - An open door prevents scanning.

Related topics

Patient handling chapter

SIGNA™ Victor table concept

PATIENT HANDLING

Patient return to landmark procedure

Once you have started scanning, you can remove the patient from the magnet bore and then return the patient to the scan position without losing the landmark. This may be done to prep the patient for another phase of the exam, give the anxious or claustrophobic patient a break between acquisitions, etc.

1. When the system is in between scans, press the ***Out icon***  and if desired, press the ***Fast icon***  to bring the patient out of the magnet bore.
   - For table movement details, see **SIGNA™ Victor: magnet controls concept**.
2. When the patient is ready to be placed back into the magnet, press the ***Back to Landmark icon***  .

Related topics

Patient landmark with alignment light procedure

Patient handling

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PATIENT HANDLING

Patient alert procedure

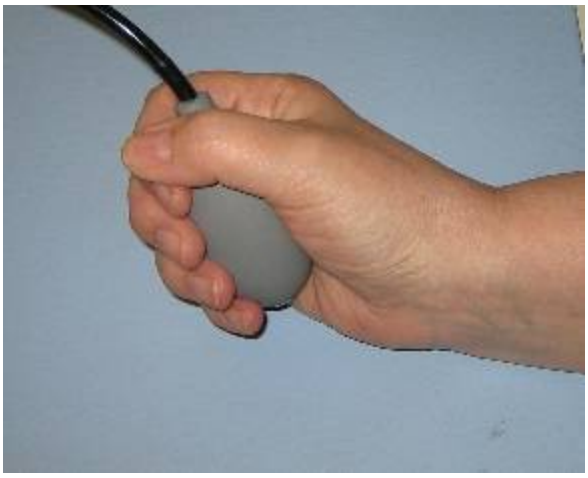
The patient alert system is comprised of a squeeze ball and a control box. The control box is typically located at the operator console. The squeeze bulb is connected to the **PAC unit**.

Use the following steps to set the patient up with the alert bulb.

The patient alert port is a Type BF applied part.

1. Give the patient the alert bulb. The bulb is a rubber product and not latex.
2. Instruct the patient to loosely hold the alert bulb and to only squeeze the bulb to bring you into the scan room to consult with the patient and attend to his needs.

Figure 4-6: Patient holding alert bulb



3. If the patient squeezes the rubber ball end of the alert system, a loud sound is heard in the control room. Press **RESET** to stop the alarm and reactivate it. Go into the scan room and attend to the patient's needs.

Figure 4-7: Patient Alert control box: Steady/Pulse button on left and Reset button on right

Adjust the patient alert sound pattern

Press the **STEADY/PULSE** toggle button on the control box to select the sound pattern. The Patient Alert control box is typically located on the operator's console or mounted on a wall close to the desk.

Related topics

Equipment components introduction

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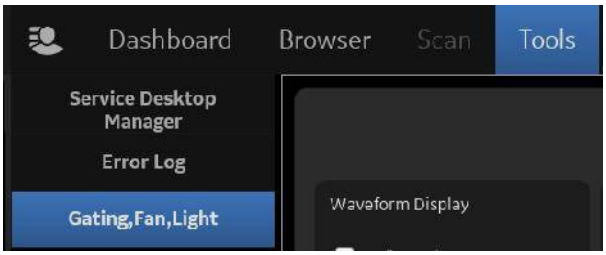
PATIENT HANDLING

Patient comfort procedure

Use these steps to adjust the magnet bore fan and light.

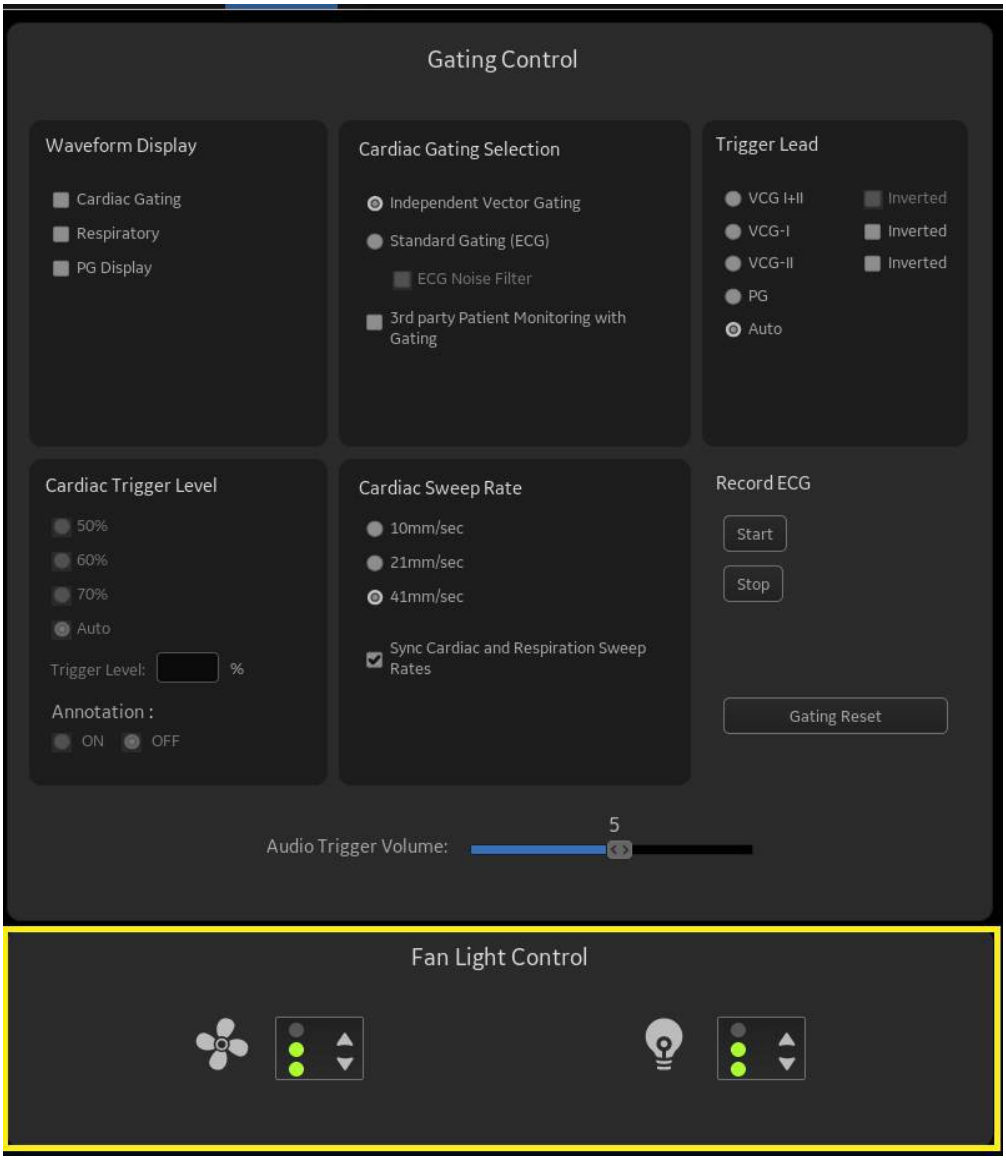
1. From the Main Menu, click ***Tools***.
2. From the Tools screen, click the ***Gating, Fan, Light*** tab.

   Figure 4-8: Tools screen



3. From the Fan Light Control area of the Gating Control screen, click the up/down arrows to adjust the speed of the fan or intensity of the light inside the magnet bore.

Figure 4-9: Fan Light controls



4. To turn the fan/light off, select the down arrow key until the level indicator next to fan/light is not illuminated.

Related topics

Patient alert procedure

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PATIENT PADDING

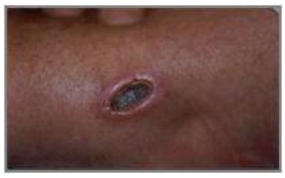
Padding introduction

Preventing patient warming is one of the most important safety measures you must take into consideration as you prepare a patient for an MR exam. Appropriate RF padding and proper patient positioning are the most effective means of preventing injury related to RF heating. The following are a few “golden rules” to remember as you position and pad your patients:

- Only use GE approved RF padding.
- Approved padding must be a minimum of 0.25 inches (0.635 cm) thick.
- Appropriate padding must be used EVERY time without exception.
- Sheets and gowns are not a substitute for approved RF padding.
- Never allow your patient’s skin to come in direct contact with the scanner bore or any surface coil or cable.
- If a patient does not fit in the MR scanner bore with the required padding, another modality should be used to image the patient.

While some of these rules may seen a little tough to follow at times, remember that RF injury, which can in extreme cases include burns such as the one you see below, can happen very quickly and your patient may not have time to warn you in time to prevent an injury.

Figure 4-10: Elbow RF Burn



The following are a series of short vignettes that will assist you in properly positioning and applying RF padding to your patients. Should you need more information on prevention of patient warming than what is provided here, refer to your surface coil and MR Safety Manuals. If you need help beyond the documentation please do not hesitate to reach out to your local Applications Specialists.

Related topics

Whole body padding considerations

Surface coil padding considerations

Protect the patient from RF burns procedure

PATIENT PADDING

Whole body padding considerations

In this first example, some general guidelines are reviewed for positioning the RF padding.

- Notice that padding is positioned not only at the patient's sides to prevent their arms from touching the bore, but that padding is also placed between the hands and thighs and between knees and ankles to prevent forming conductive loops.
- An important consideration when padding your patients is that you will need to double check the position of the pads once the patient is in the bore. Table movement may dislodge padding and expose skin to the scanner bore.

Related topics

Padding introduction

Surface coil padding considerations

Protect the patient from RF burns procedure

PATIENT PADDING

Surface coil padding considerations

Surface coils present different challenges from a patient RF padding perspective.

- First rule of thumb is to remember to use all manufacturer provided padding to prevent motion and the patient's skin from coming in contact with the coil, and to also use additional padding if appropriate to secure an opposing extremity to prevent contact with the coil which could also lead to burns or motion artifacts.
- Just as with the whole body RF padding demonstration, you'll need to make certain that the patient's skin does not come into contact with the scanner bore and that padding is placed between the hands and thighs to prevent conductive loops.
- A final safety consideration for surface coils is to ensure that the patient does not come into contact with the coil cable, therefore you may need to use additional RF padding to protect the patient.
- Care should also be taken to ensure the cable is not looped in the bore and that it is routed down the center of the scanner bore.

Related topics

Padding introduction

Whole body padding considerations

Protect the patient from RF burns procedure

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Chapter 5: Scan workflow

This chapter includes information related to the acquisition of MR images.

Start and exam procedure

Exam status procedure

Scan Session considerations

Scan Messages consideration

Schedule introduction

Patient information introduction

SAR and dB/dt introduction

Auto Coil Select procedure

Auto coil select considerations

Auto Voice introduction

AutoView introduction

Scan control introduction

Task List introduction

Sharing Overview introduction

Prescan introduction

Protocols introduction

ProtoCopy introduction

Stop Watch introduction

Stop scan/end exam procedure

Related topics

Scan parameters chapter

SCAN WORKFLOW

Auto Coil Select procedure

Auto coil select means that your MR system automatically selects the coils that are currently connected to your system that will best cover the slices graphically prescribed from a 3-plane localizer. In brief, below is an overview of the scan workflow with auto coil select.

1. Position the patient on the MR table.
   - For details, see **Patient position procedure**.
2. Connect the coils to the appropriate coil ports.For details, see **Connect coils procedure**.
3. Establish a patient landmark.

- For details, see **Patient landmark procedure**.

4. Select the patient from the schedule or enter the patient from the Worklist Manager and select a protocol.

- For details, see **New patient workflow**.

5. Acquire the 3-plane localizer.
6. Select the first diagnostic series from the Workflow Manager and complete the following.

a. Prescribe the FOV.
b. Define the graphic Rx scan locations.
c. Check the coil extent lines to confirm coil coverage of slice locations. The blue lines should encompass the graphic slice lines.
   - For details, see **Show Coil Extents procedure**.

Figure 5-1: Show Coil Extent Option screen

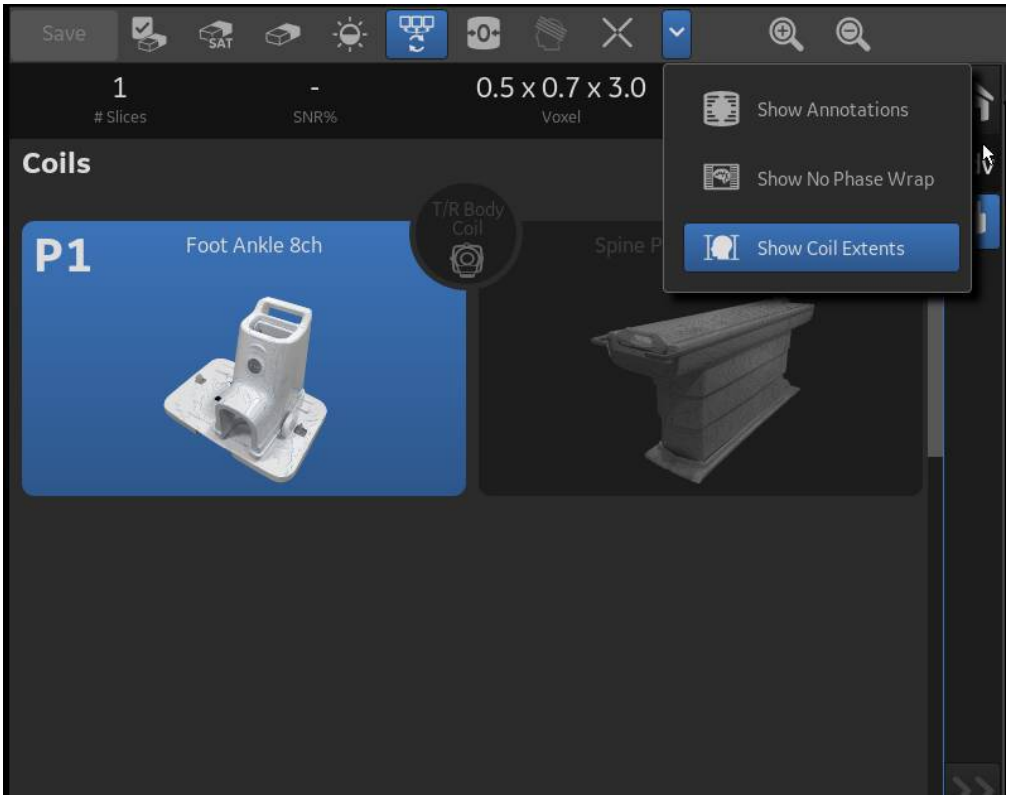

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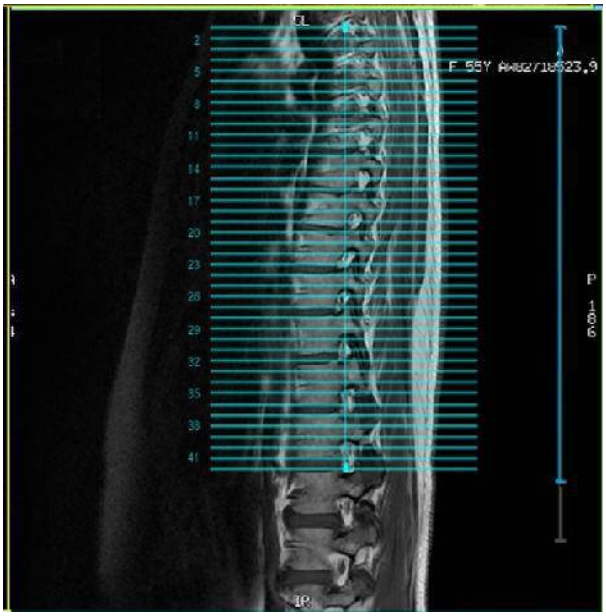
Figure 5-2: Blue coil extent lines cover the graphic slice lines



- If the FOV or coil position needs adjustment, see **Auto coil select considerations**.

7. Select subsequent series from the Workflow Manager and scan.
   - If the scan location and FOV are the same as the previous scan, then the auto coil calibration is not acquired in auto prescan.
   - If a different scan location and FOV are different from the previous scan, a new auto coil calibration is acquired in auto prescan.

SCAN WORKFLOW

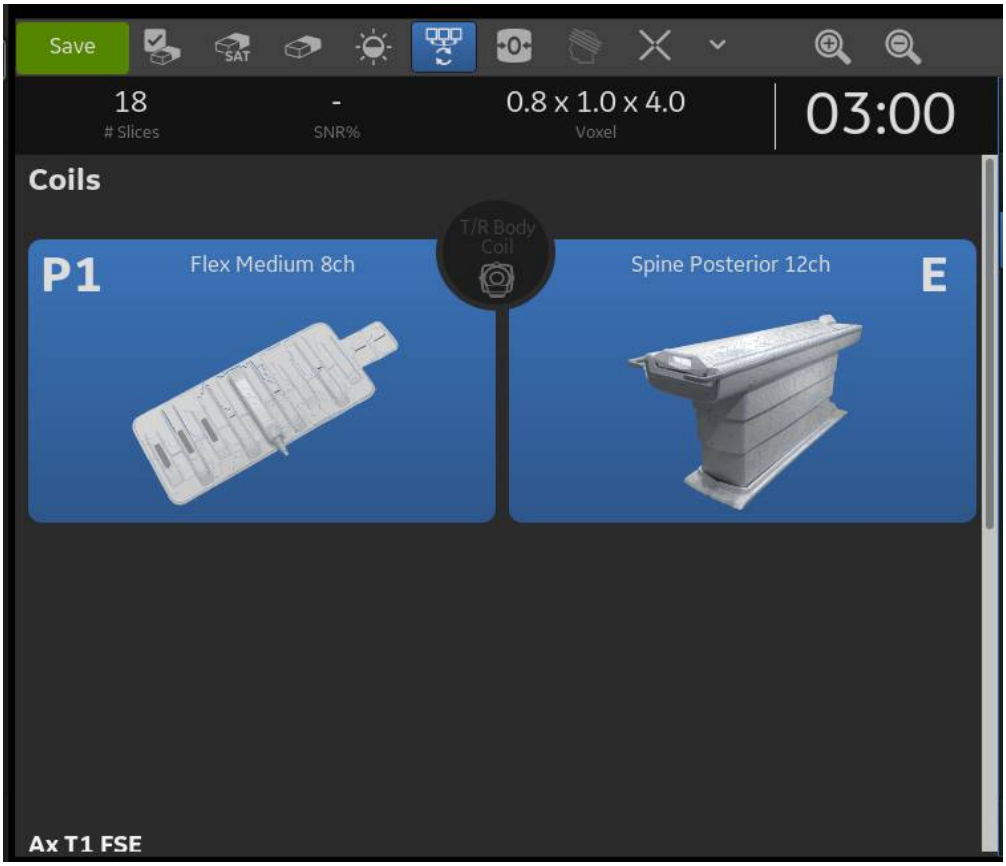
Auto coil select considerations

The information in this topic is related to the Auto coil select feature.

Coil tab

To update the coils selected, click on the Coil tab and deselect the desired coil. For example, for a shoulder exam you wish to use the Medium array but not the Posterior Phased Array, click on the Posterior Phased Array to turn it off.

Figure 5-3: Coil tab with P1-Medium Array and E- Posterior Phased Array connected



- Note the coil tab displays both the port and coil name.

Related topics

Auto Coil Select procedure

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SCAN WORKFLOW

Start an exam procedure

Before you start a scan, thoroughly review all safety information and considerations before starting a scan with patients that have an MR Conditional implant. Specifically, review the following topics in the Safety chapter and your operator manual before the patient is brought into the scan room.

- **Contraindications for use**
- **MR compatibility test guidelines**
- **Magnetic field basics introduction**
- **Spatial magnetic field data**
- **Static spatial gradients on concentric cylinders for IPM magnet**
- **Electromagnetic fields introduction**
- **Specific Absorption Rate (SAR) limits**
- **SAR or dB/dt level procedure**

WARNING

The tests commonly employed to determine MR Conditional implant heating safety (standard, ASTM F2182, ASTM.org), require quadrature excitation. Heating results for non-quadrature excitation (such as parallel transmit, MultiDrive, or elliptical drive) are unknown.

For patients with MR Conditional implants or devices, applying Preset or Optimized RF Drive Modes may violate the MR Conditional specifications.

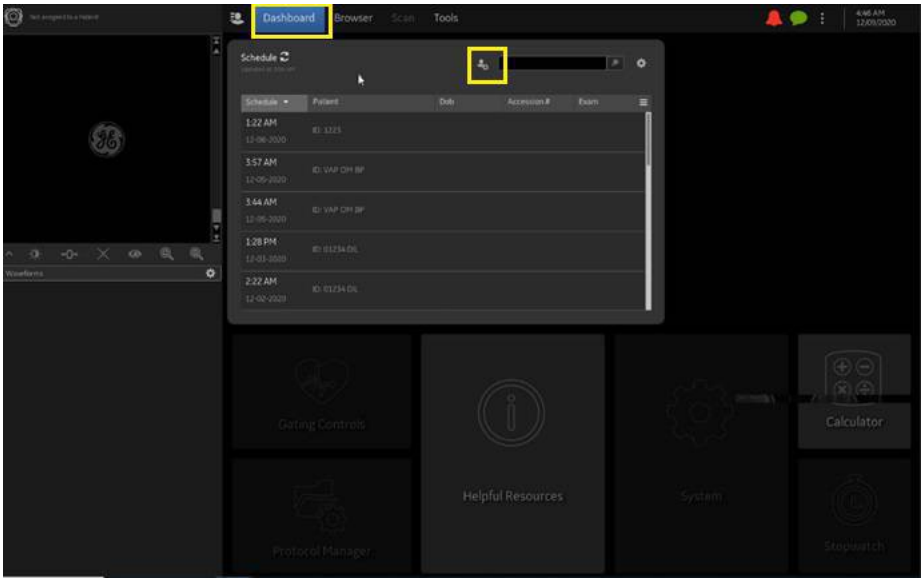
CAUTION

For patients with MR Conditional metal implants or devices, applying Preset or Optimized RF Drive Modes may violate the MR Conditional specifications.

Use these steps to start a new patient exam.

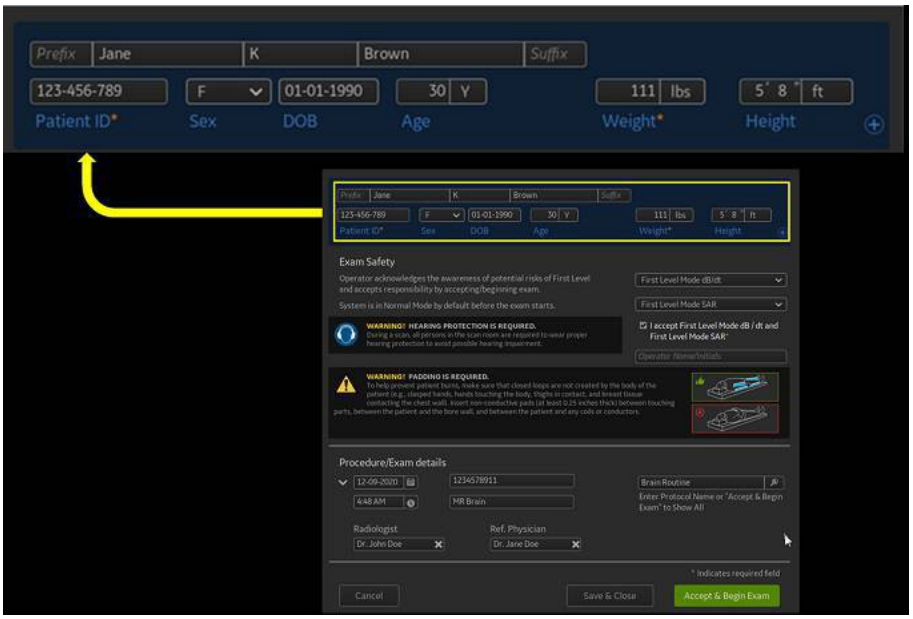
1. From the Dashboard, select a patient using one of the following:
   - Select a patient from the Schedule.
   - Select the ***New Patient icon***  .

Figure 5-4: New patient icon screen



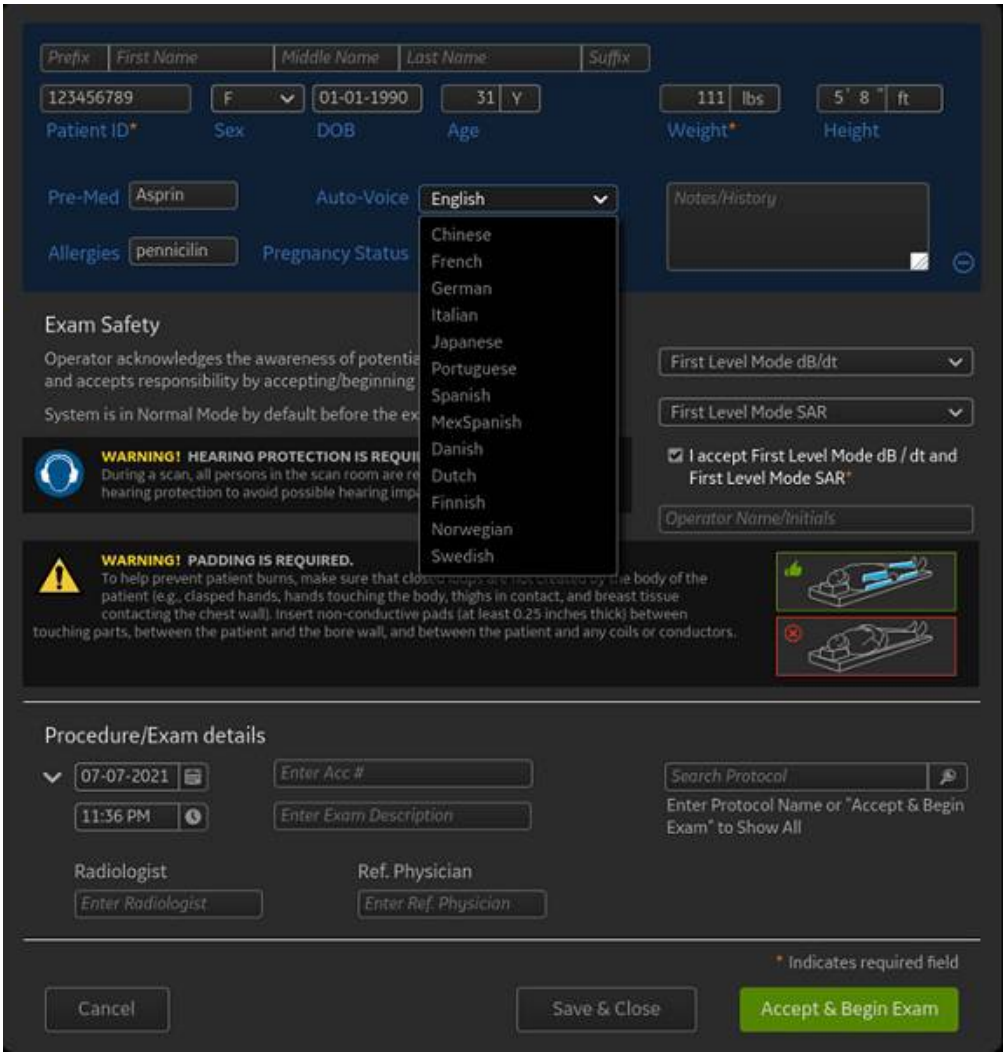
2. From the New Patient screen, complete the demographic information fields.

Figure 5-5: New patient information screen



3. From the New Patient screen, next to demographic information fields click on the plus sign. Click on the Pred-Med and Allergies to fill in pertinent information. From the Auto Voice pulldown select a language.

Figure 5-6: New patient language selection screen



4. From the New Patient screen, complete the SAR and dB/dt selections.
   - For details on how to select protocols, see **New or edit protocol workflow**

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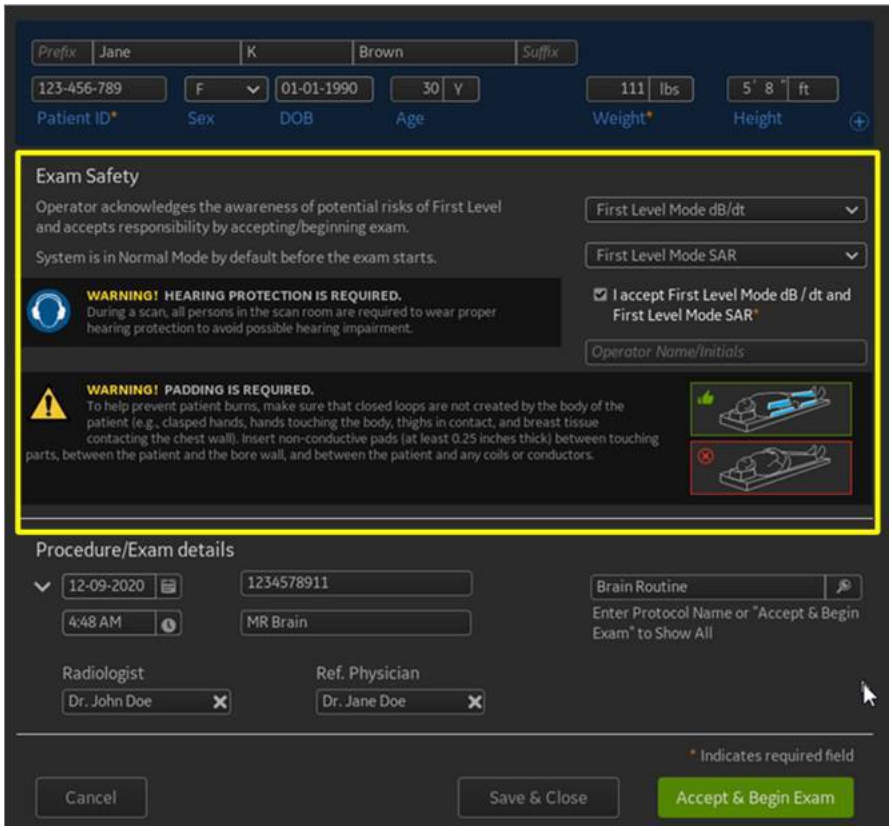
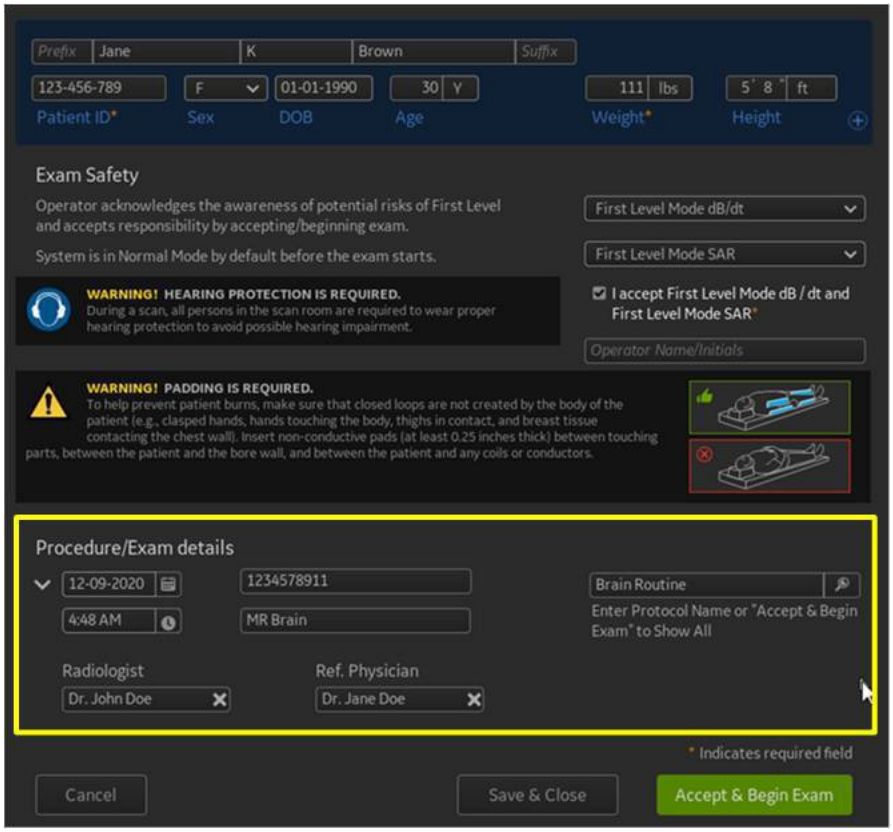
Figure 5-7: New patient SAR and dB/dt screen



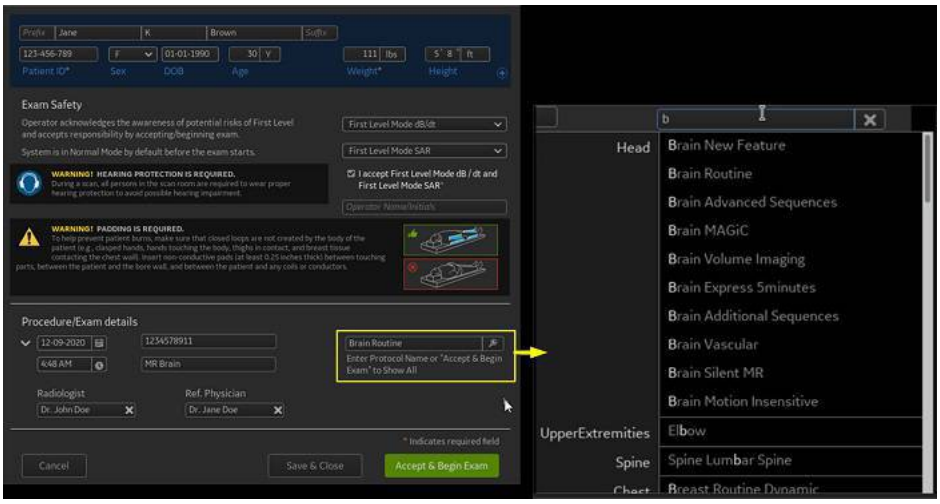
5. From the Procedure/Exam details area, complete the fields.

Figure 5-8: New patient procedure/Exam details screen



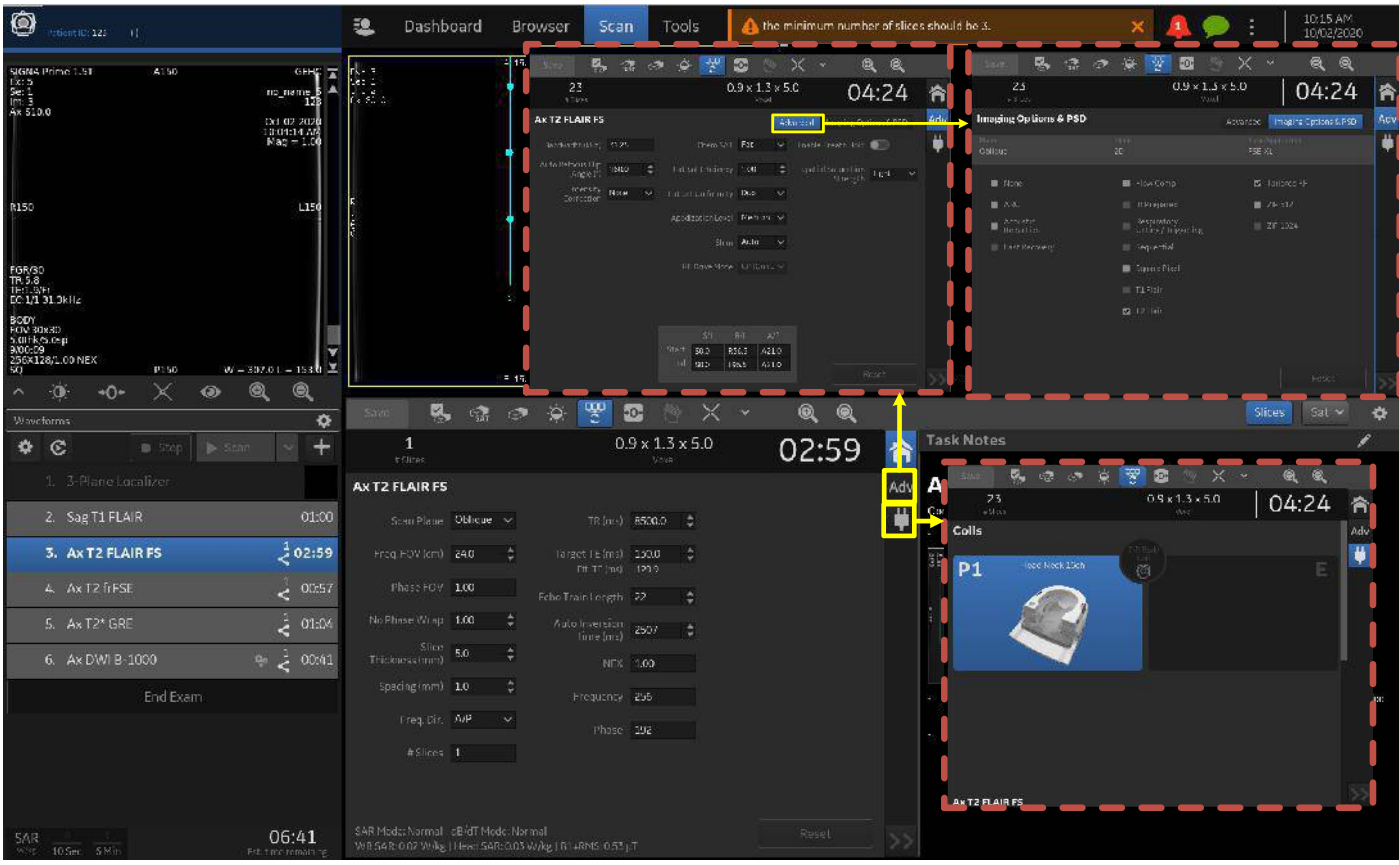
6. From the New Patient screen, select a protocol.
   - In this example, the search field is used to find a protocol.

Figure 5-9: Select protocol screen



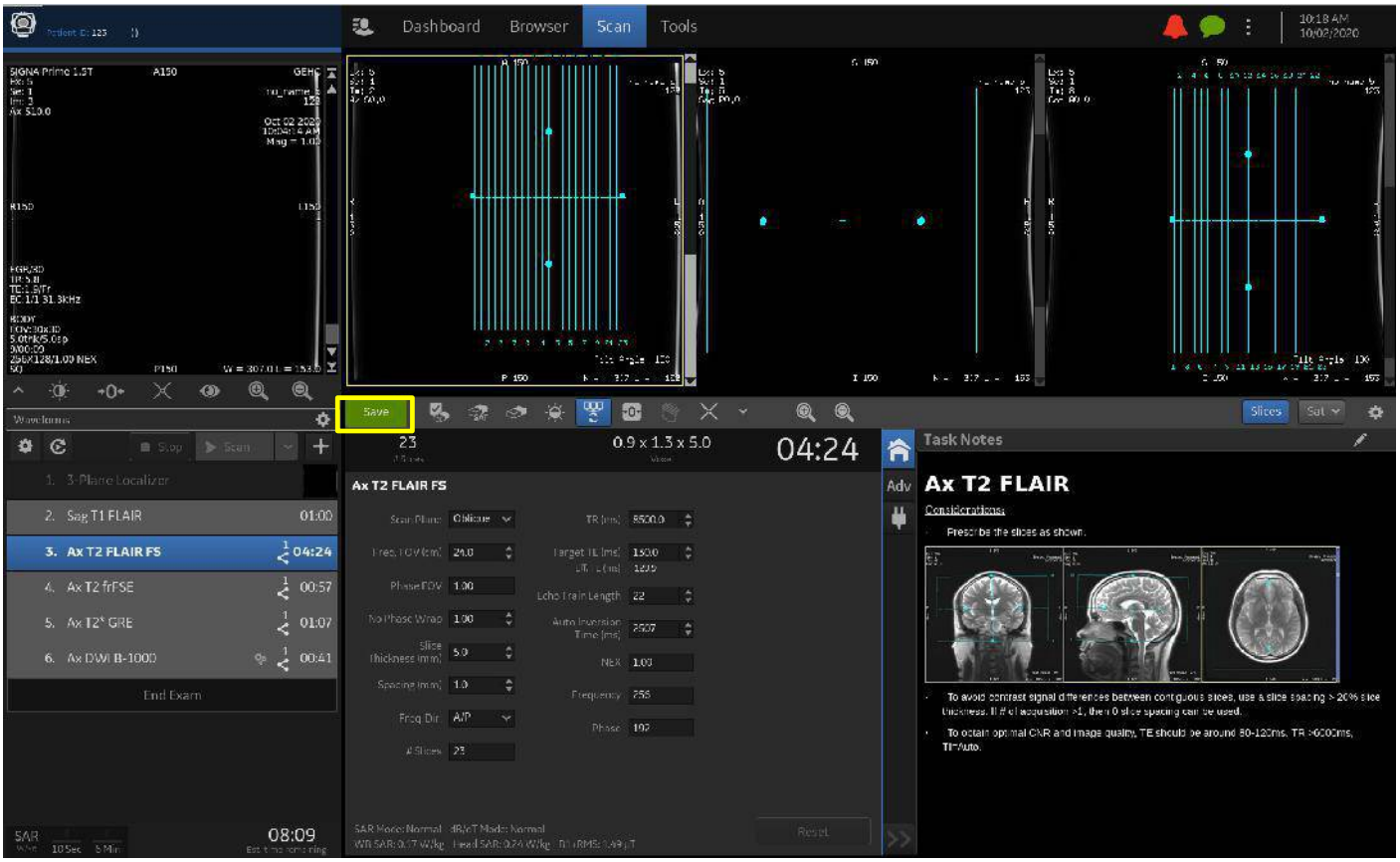
7. From the New Patient screen, click ***Accept & Begin***.
8. Review the scan parameters.
   - Click an icon in the vertical menu to display additional parameters over the scan parameter screen.
   - Click the ***Home icon***  to return to the primary scan parameter screen.

Figure 5-10: Scan parameters screen



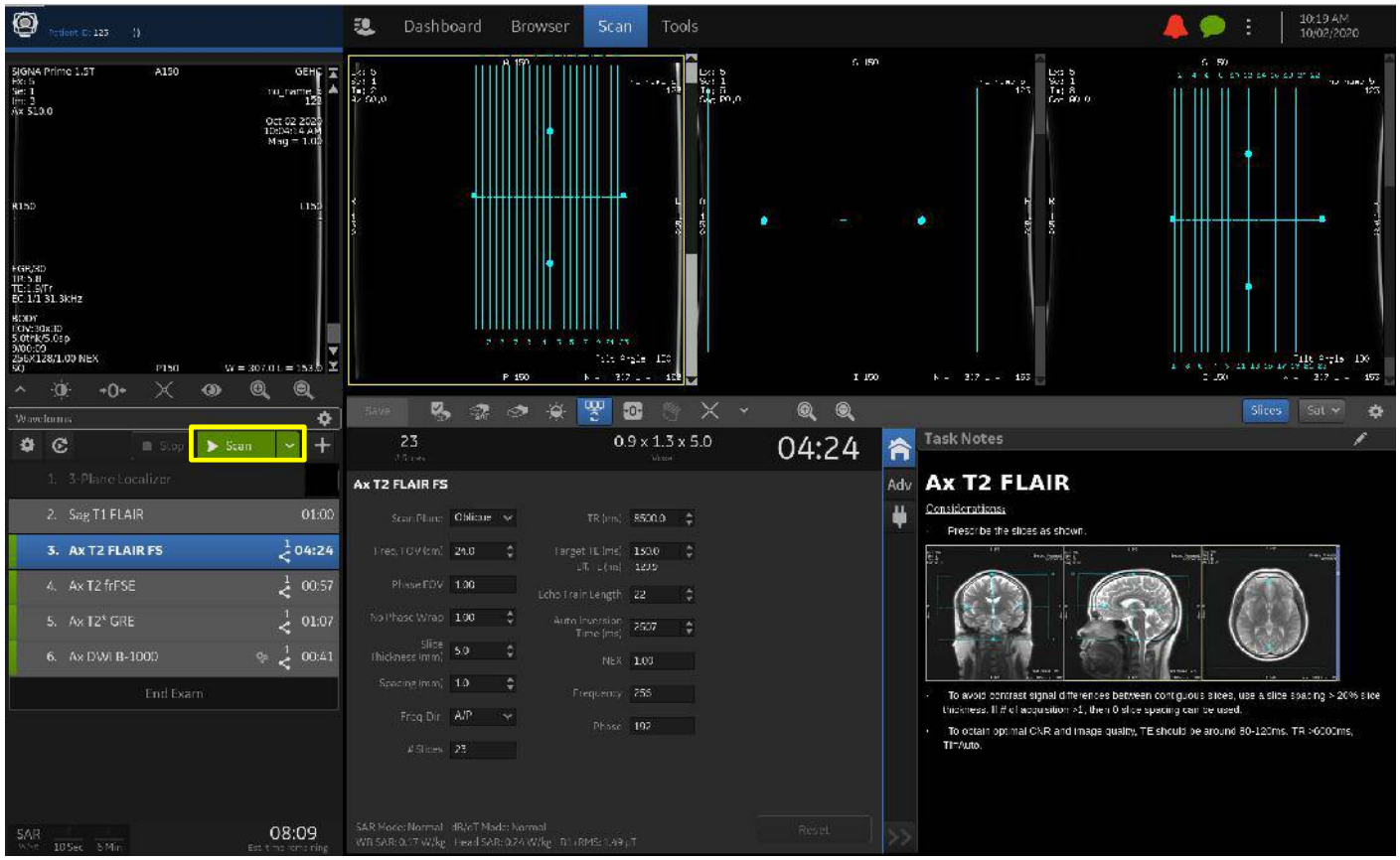
9. When you are satisfied with the scan parameter values, click ***Save***.

Figure 5-11: Save icon screen



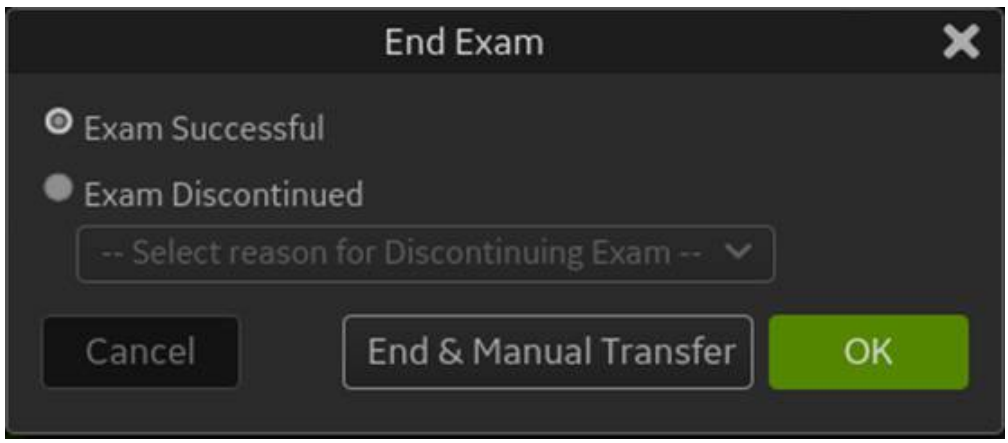
10. To start the acquisition for the saved series, click ***Scan***.

Figure 5-12: Scan icon screen



11. To end the exam, click ***End Exam*** from the bottom of the Task List screen.

Figure 5-13: End exam icon screen



SCAN WORKFLOW

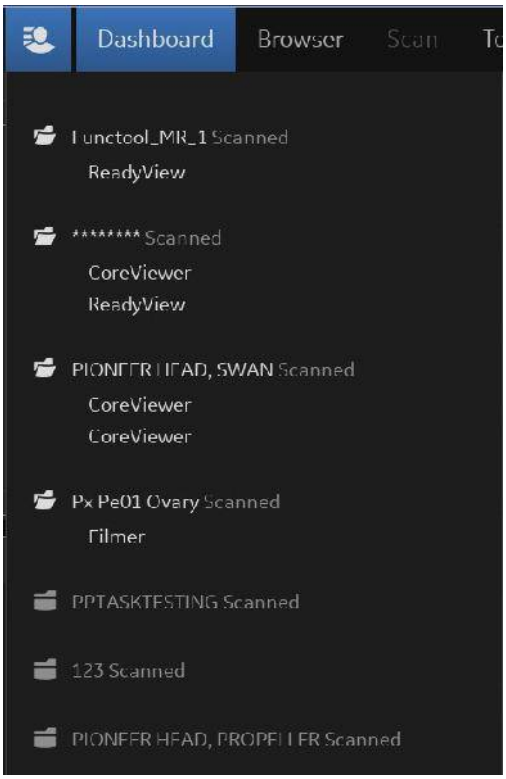
Exam status procedure

Use these steps to view the status of the current and recently scanned exams and to quickly access open applications associated with the exam. The following is the maximum number of applications that can be displayed:

- 5 Viewers
- 5 MR General Viewers
- 5 Filmers
- 1 of each of the Browser applications: Filmer, ClariView, Pasting, etc.

1. From the Main Menu, click the ***Active Application icon***  to open the exam status screen.

Figure 5-14: Exam status screen



- The patient name appears, is followed by the scan status (Scan or Scanned), and scan date.
- Below the patient name is a list of applications that were opened from the Browser, for example: Viewer, ClariView, Filmer, etc.

2. From an ***open folder icon***  , which indicates the exam is active, complete these steps.
   a. Click the patient name and the system displays the exam in the Browser.
   b. Click the application to display the exam opened in the application.

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3. From a ***closed folder icon***  , which indicates the exam is closed, click the patient name and the system displays the exam in the Browser.

SCAN WORKFLOW

Scan Session considerations

Once you have selected a patient from the Schedule and entered the patient's information, when you select ***Accept and Begin Exam***, a scan session is started for the patient. The protocol is loaded into the Task List with the tasks associated with the protocol and the patient is added to the schedule.

A scan workflow session can be further defined based on its state in the process of scanning or active scanning.

- **Active scanning session:** Start Exam has been selected for a patient from the Modality Worklist, which allocates the scanning resources. Only scans with patient information entered can be in this state. There can only be one active scan session.

Procedures

Start an exam procedure

Related topics

Scan workflow

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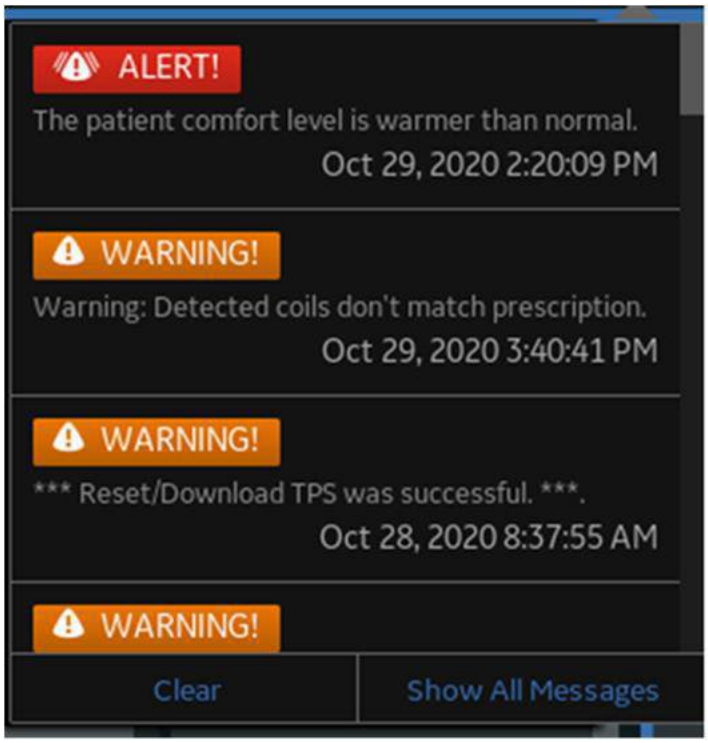
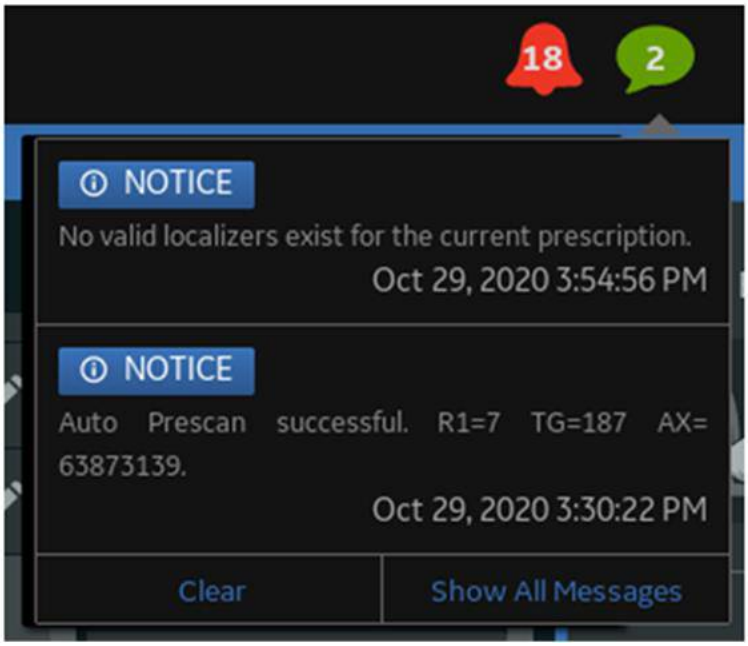
SCAN RX PARAMETER

Scan Messages Introduction

Scan messages display in the box Main Menu toolbar. Typically, the messages direct you to complete the scan parameters so that you can proceed to save the prescription and scan the series.

Figure 5-15: Scan Parameters: Scan Messages

	The red bell is for alert and warnings, where different levels of message are considered as more important than alerts. **Figure 5-16:** Red bell messages 
	The green message represents error messages that are more of a notification. For example, No valid localizer exists for the current prescription. **Figure 5-17:** Green balloon messages



When there is a new alert generated, the scan message banner behaves as below:

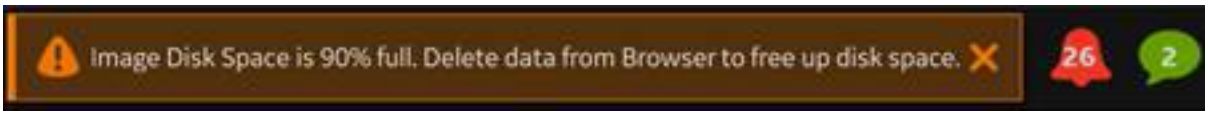
- If the new alert has a greater priority than the alert that is currently displayed on the banner, the banner displays the new alert with the banner background highlighted for a second, and the bell icon background flashes for a second with the number incremented.
- If the new alert has a less priority than the alert that is currently displayed on the banner, the new alert will not replace the current one that is displayed on the banner, but the bell icon background still flashes for a second with the number incremented.

Image Database Disk Status Message

The notification or error message will be shown when the image database disk space reaches 90% perfect full.

- Image database disk space is 90% full. Delete image data from Browser to free up the disk space.
- Failed prescan due to the image disk space is full. Delete data from Browser to free up disk space.
- Failed to allocate image database space because of internal errors.

Figure 5-18: Image Database Disk Status Message



Related topics

Scan Messages procedure

Error log view messages procedure

Scan Rx parameters introduction

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SCAN WORKFLOW

Stop scan/end exam procedure

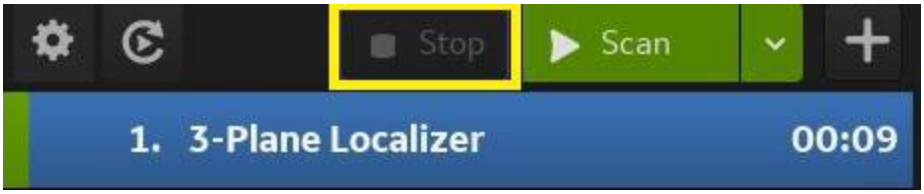
Use these steps to stop or end an exam.

Stop scan

You can stop a scan from the operator console or at the magnet.

- From the **keyboard** auxiliary keys, press **Pause** to stop the scan temporarily. Press **Start Scan** to resume scanning after a pause.
- From the keyboard auxiliary keys, press **Stop Scan** to abort the scan or prescan. Scan data is not saved or reconstructed.
- From the magnet controls, press ***Stop Scan***  .
- From the Scan Control screen area, click ***pause*** and then click ***Stop***. A **Pause** is required prevent accidentally clicking of the stop button.

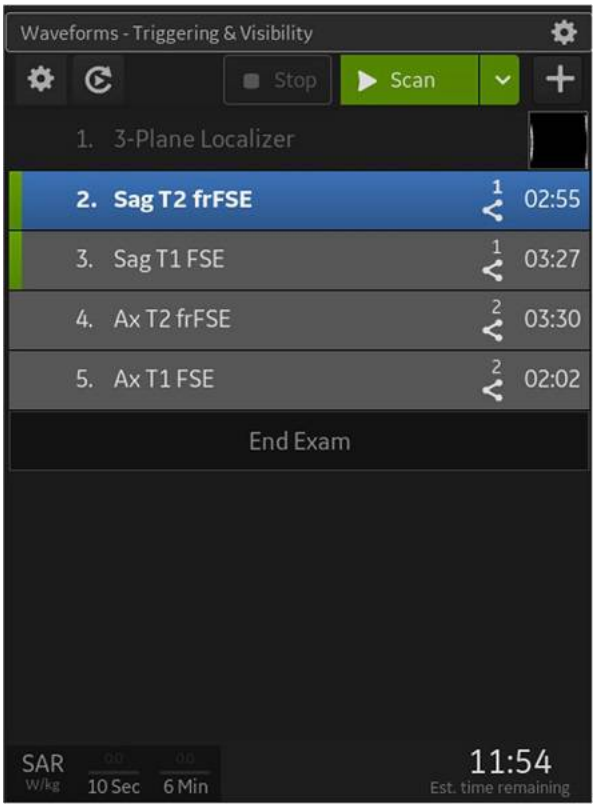
Figure 5-19: Scan Control Stop button



End scan or end exam

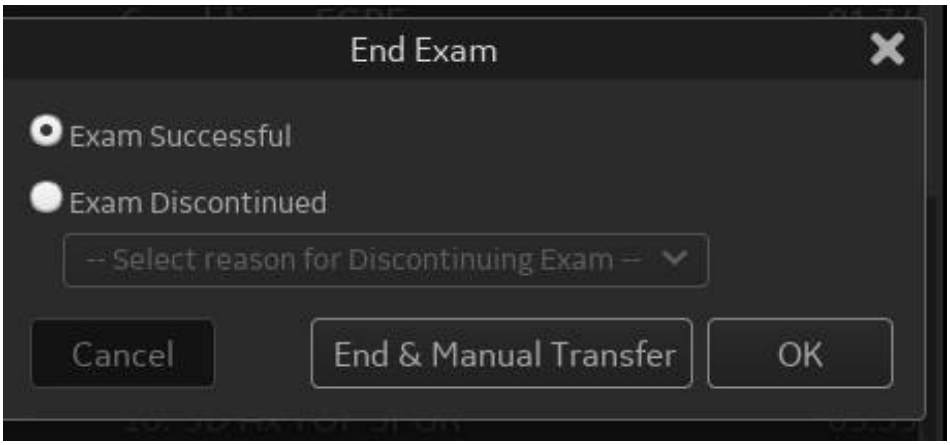
1. Click ***End Exam*** from the bottom of the Task List screen.

Figure 5-20: Task list screen



2. Complete the following from the End Exam screen.

Figure 5-21: End Exam screen



   a. Click ***Exam Successful*** option button.
   a. Click ***End & Manual Transfer*** if you want to end the exam and manually transfer the data.
   b. Click ***OK*** if you want to end the exam and start an automatic data transfer.

3. If you want to discontinue the exam, complete the following.
   a. Click ***Exam Discontinued*** option button.
   b. Make a selection from the Exam Discontinued menu.

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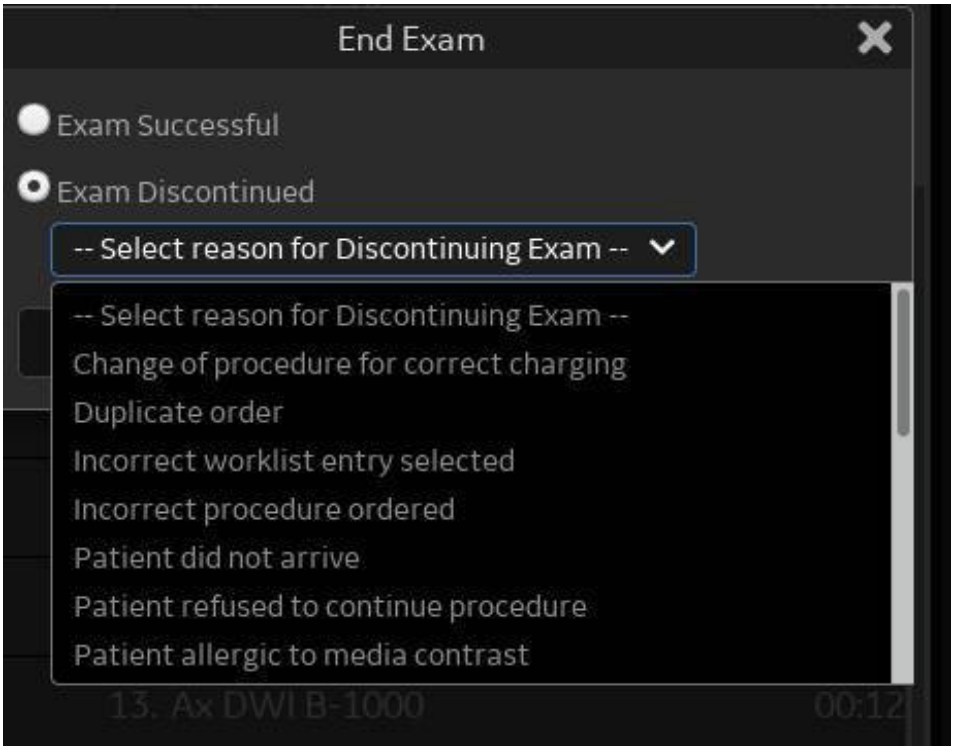
Figure 5-22: Exam Discontinued menu



Considerations

- Performed Procedure Step (PPS) provides a mechanism to pass information about the MR exam back to the RIS[1] and/or PACS[2]. The billing information is embedded in the end exam action and sent to the site PPS server for the Billing information. Note that the PPS billing option requires a working PPS server from the MR facility side. Multiple error messages are created if the PPS option key is installed without a properly configured facility PPS server. If not using a facility PPS server, it is recommended to uninstall the PPS option key.
- If your system has the PPS (Performed Procedure Step) option and End Exam is selected, the PPS End Exam screen displays. Make a selection from the End Exam menu and click ***Accept*** to accept your selection and to close the PPS End Exam screen.
  - ***Complete***: The exam is finished and charge the patient,
  - ***Deferred***: Radiologist may still want to do some additional post processing and the procedure has not been completed
  - ***Discontinue***: The exam is incomplete and abort with no charge

Related topics

Scan workflow chapter

[1]Radiology Information System

[2]Picture Archiving Communications System

SCHEDULE

Schedule introduction

From the Main Menu, click ***Dashboard*** to view the Schedule list. It is populated with patients/exams that are to be scanned.

The number and order of the columns can be adjusted. Therefore, your system may appear with the column headers in a different order.

Figure 5-23: Schedule work area

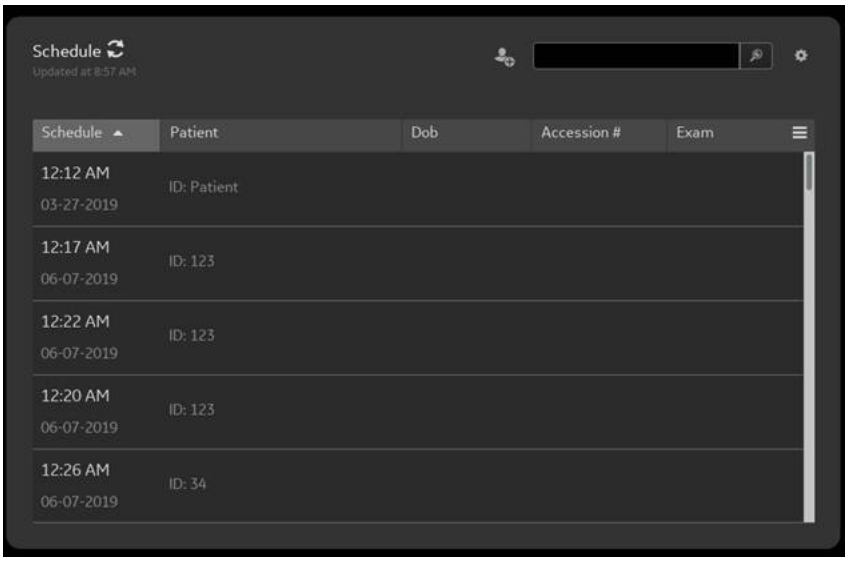
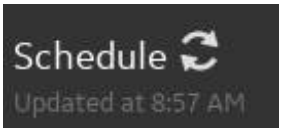
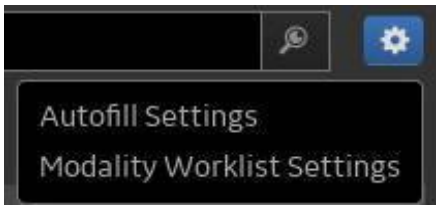
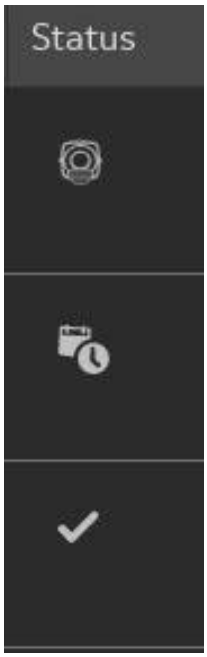


Table 5-1: Schedule parameters

Parameter	Description
Refresh 	The Refresh icon updates the Schedule List. The date of the last refresh action is listed below the icon.
New Patient icon 	The New Patient icon opens the Patient Information screen. It allows you to enter a new patient into the Schedule. The patient is added to the Patient List once you click ***Save and Close*** from the Patient Information screen. For details, see
Search field 	The Search text box allows you to enter information to search the data base. For details, see
Cog icon	The Schedule Cog icon opens a menu with the following selections: • Autofill Settings that allows population of several fields on the Patient Demographic

Parameter	Description
	• Information screen. For details, see **Auto fill patient information procedure**. • Modality Worklist settings that allows modification of the Schedule Lists columns and refresh properties. For details, see **Modify number of columns procedure**.
More columns icon 	• Displays additional columns that can be added to the Schedule List. • For details, see **Modify number of columns procedure**.
Schedule column	Displays the date the exam was scheduled. This information is automatically populated from the HIS/RIS system or from the time the patient was scheduled on the MR system.
Patient Name column	Displays the last name, first name.
Dob column	Displays the patient's date of birth.
Exam column	The anatomical type of exam, which is determined from the Patient Information screen.
Accession # column	Accession Number is related to a number assigned by the hospital, clinic, or site, and is tied to the patient's records. You can enter the number manually or by using the optional barcode reader (if applicable) or it is automatically populated from the HIS/RIS system. This text box is limited to 16 characters.
Modality column	Identifies the modality, for example, MR or CT.
Caution	For details when a Caution symbol appears, see the New Patient screen.
Status column	•  Completed, which means that ***End Exam*** has been selected from the End menu from the Task List screen. •  Scheduled exam, not yet scanned. •  In Progress, which means that the exam has had scanning ended or placed in suspension but it has not been placed in an End Exam state.

Parameter	Description
	

Procedures

Modify number of columns procedure

Reorganize columns procedure

Sort procedure

Edit a patient procedure

Search procedure

Related topics

Scan workflow chapter

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SCHEDULE

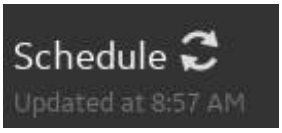
Modify number of columns procedure

Use these steps to add or delete the number of columns in the Schedule header.

1. From the Main Menu, click ***Dashboard*** to open the **Schedule List screen**.
   - There are two methods to add or delete columns from the Schedule List header.
2. To modify the Schedule List header using the More Columns icon, complete these steps.
   a. From the Schedule List, click the ***More Columns icon***  to open the columns menu.

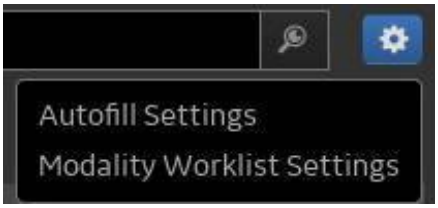
   Figure 5-24: More columns menu

   b. Click each item you want to add to the Schedule header.
      - A check mark indicates an item added to the Schedule header.
      - An x mark indicates an item is not on the Schedule header.
      - The last item toggles between Show Completed Exams/Show All Exams.
   c. Click ***Schedule Refresh*** 

 to update the Schedule list.
3. To modify the Schedule List header from the Modality Worklist Settings screen, complete these steps.
   a. Click the ***Cog icon***  to open the menu.

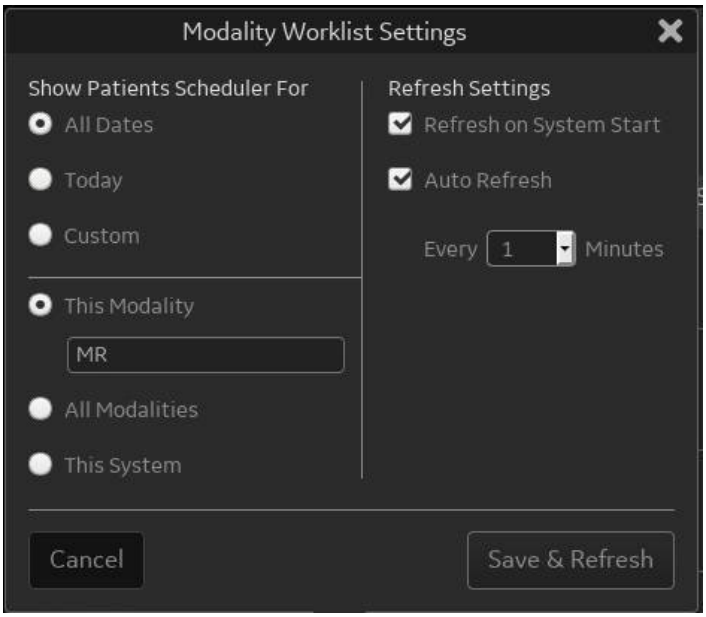
   Figure 5-25: Schedule List cog icon menu

b. From the Cog menu, click ***Modality Worklist Setting***.

c. From the Modality Worklist Settings screen > Show Patients Schedule For column, click each option button you want to add to the Schedule header.

Figure 5-26: Modality Worklist Settings screen



d. From the Refresh Settings column, click the desired option buttons.

e. Click ***Save & Refresh***.

Related topics

Schedule introduction

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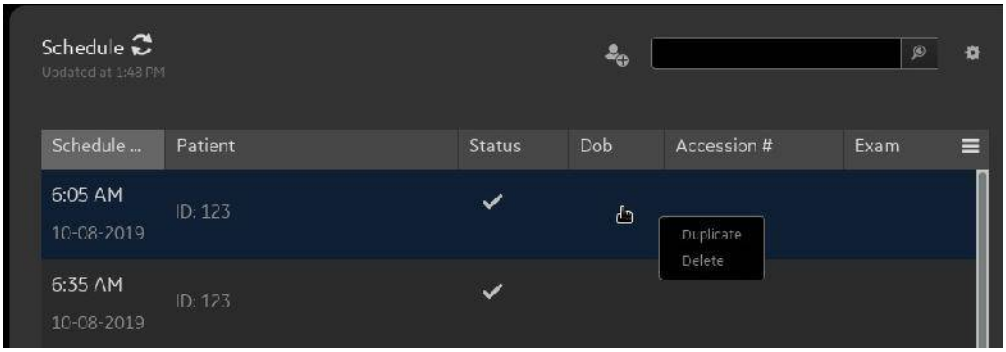
SCHEDULE

Edit an entry procedure

Use these steps to change a patient's information that is in the Schedule List.

Figure 5-27: Schedule right-click menu



1. From the Main Menu, click ***Dashboard*** to open the **Schedule List screen**.
2. To edit patient information, complete these steps.
   - To edit a patient it must be a currently scheduled patient in the Schedule List.
   - To view all exams in the Schedule List, click the *More Columns icon*  to open the columns menu. Click ***Show All Exams***.
   a. Place the cursor over the patient you want to edit and single-click.
   b. From the **Patient Demographic Information screen**, edit the information as needed.
   c. Click ***Save & Close***.
3. To delete a patient from the Schedule list, complete these steps.
   a. Place the cursor over the patient you want to delete and right-click.
   b. From the right-click menu, click **Delete**.
4. To generate a new scan session on a patient that is already in the Schedule List, follow these steps.
   a. Place the cursor over the patient you want to duplicate and right-click.
   b. From the right-click menu, click **Duplicate**.
      - If you scan a patient twice by duplicating the patient from the Schedule List, this results in two separate exam numbers and subsequent series and images. For example, exam 1000 with series 1, 2, and 3 and exam 1001 with series 1, 2, and 3. When these images are networked to an *AW*[1] or *PACS*[2], the two exams are combined and therefore the single exam will have two series one, two series two, etc. To avoid this problem, when you need to rescan a patient due to some failure, do one of the following:
      - Enter a new patient to the Schedule List so you do not need to reuse the one where the error (including system failure) occurred.
      - Use Edit Patient Data on the first exam to regenerate a new study UID which will break the hard connection between the two studies. For details, see **Edit Patient procedure**.

[1]Advantage Workstation

[2]Picture Archiving Communications System

Related topics

Schedule introduction

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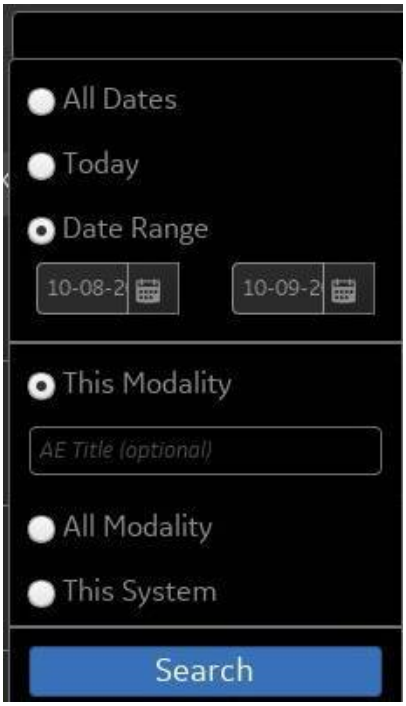
SCHEDULE

Search procedure

Use these steps to modify the contents of the patient list to more easily find a particular patient.

1. From the Main Menu, click ***Dashboard*** to open the **Schedule List screen**.
2. From the Schedule List, place the cursor in the Search text field.
3. Type any of the following:
   - Patient's last name
   - Patient's ID
   - Accession number
   - Exam #
   - Date of Birth
   - Modality
   - Enter your systems AE Title or AET (an abbreviation for Application Entity Title.) An AE Title is used by an Application Entity (AE) to identify itself. AE Titles need to be locally unique and are typically managed by a system administrator.
4. For an advanced search, complete the following:
   a. Hover the cursor over the search text field to display Advanced search.
   b. Click ***Advanced search***.
   c. Click the desired option buttons from the Advanced search menu:
      - All Dates
      - Today's date
      - Date Range, click the calendar icons to select the dates
      - This Modality only selects MR exams
      - All Modality selects exams from all Modalities
      - This System only selects exams from your MR system

Figure 5-28: Advanced search menu



d. Click ***Search***.
   - Only the patients that meet the search criteria are displayed in the patient list.

Related topics

Schedule introduction

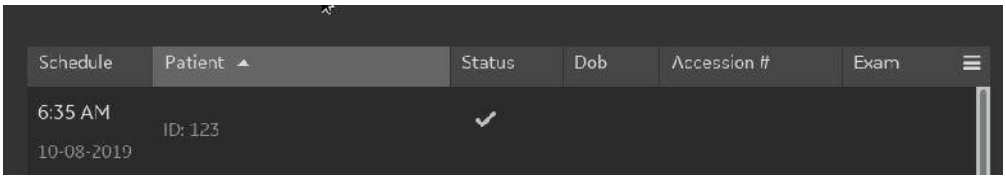
SCHEDULE

Sort procedure

Use these steps to sort the Schedule List from an ascending to descending order or vice versa.

1. From the Main Menu, click ***Dashboard*** to open the **Schedule List screen**.
2. From the Schedule List, click a menu bar title. The patient list is sorted by the menu item. For example, if you click Patient Name, the list is sorted alphabetically by patient name.
   - The sort arrow indicates the sort order: ascending or descending.

Figure 5-29: Sort arrow



Related topics

Schedule introduction

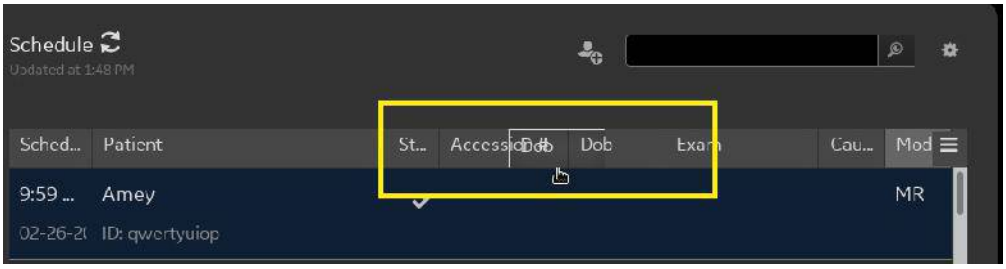
SCHEDULE

Reorganize columns procedure

Use these steps to reorganize the columns in the Schedule header.

1. From the Main Menu, click ***Dashboard*** to open the **Schedule List screen**.
2. From the Schedule List, place the cursor over a column header.
3. Click and drag the header to a new location in the Schedule List.
4. Place the cursor over the edge of a column and click and drag to expand or contract the column.

Figure 5-30: Adjust column location



Related topics

Schedule introduction

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PATIENT INFORMATION

Patient information introduction

From the Schedule screen, click the ***New Patient icon***  to display the new patient screen. The fields with an * are required fields that must be completed to start an exam.

Patient Information work area

Figure 5-31: Patient Information work area

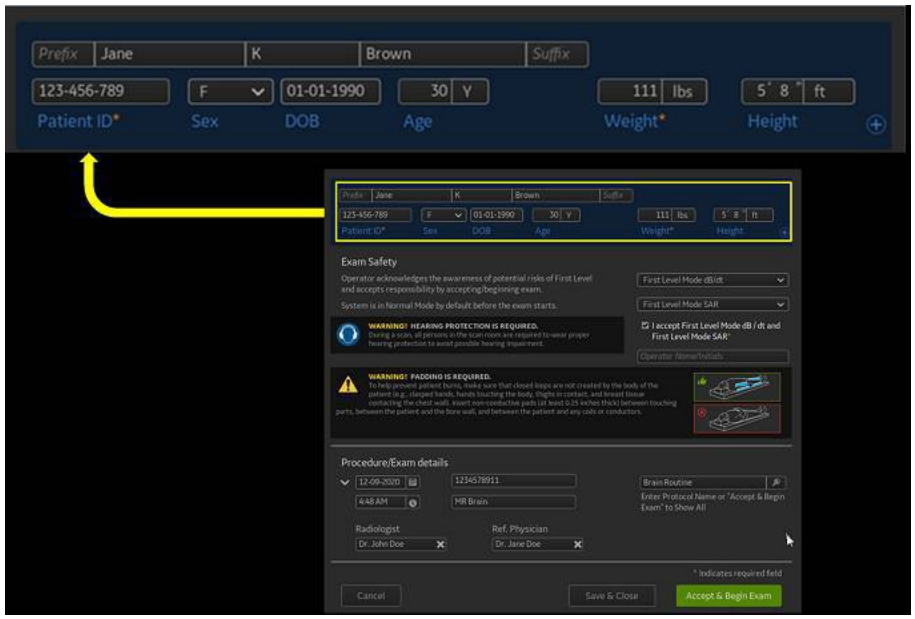


Table 5-2: Patient Information parameters

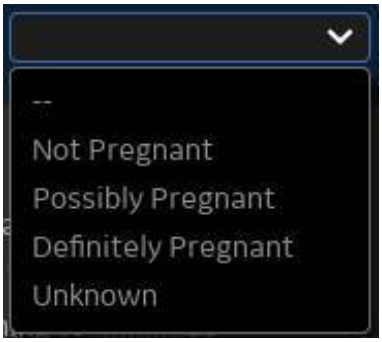
Parameter	Description
Patient name	Prefix, for example: MR, Mrs, Ms, Dr, etc. First, Middle and Last name. Suffix, for example: PhD, RN, MD, etc.
Patient ID	The Patient ID is a required field.
Sex field 	Enter one of the following: • -- for indeterminant • **M** for Male • **F** for female • **Other**

Parameter	Description
DOB	Enter a Date of Birth.
Age 	Enter the patient's age in one of the following increments: • **Y** for years • **M** or Months • **W** for weeks • **D** for days
Weight	Weight is a required field. Enter either in kilograms or pounds.
Height	Enter the patient's height in feet, meters or inches.

Figure 5-32: Additional patient history information

From the Patient Information work area, click the plus symbol **+** to open the additional patient history information.

Table 5-3: Additional patient history information

Parameter	Description
Pre-med	Enter pre-medication information.
Allergies	Enter allergy information.
Pregnancy status 	Make a selection from the Pregnancy menu if either **--** (for indeterminant) or F (for Female) is selected from the Sex field. • Not Pregnant • Possibly Pregnant • Definitely Pregnant • Unknown
Notes/history	Enter Notes/patient medical history as needed.

Carefully enter the Patient ID and name checking for accuracy.

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Exam Safety work area

- Operator name or initials text box.
- For more details regarding Exam Safety section, see **SAR introduction**.

Procedure/Exam details work area

Figure 5-33: Procedure/Exam details screen

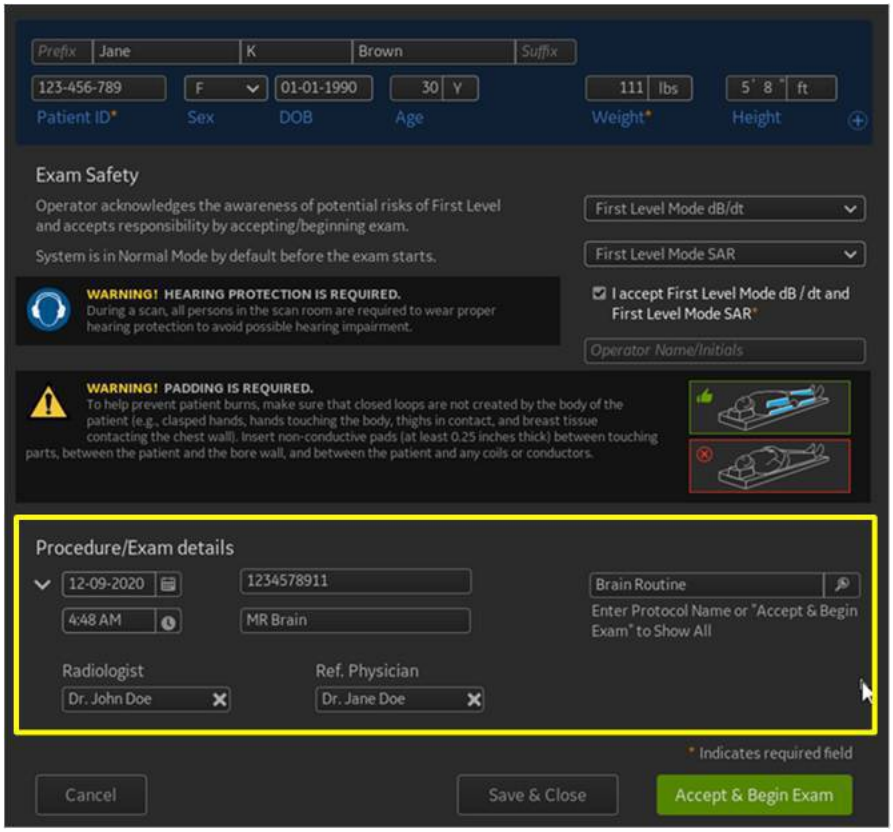
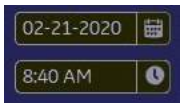


Table 5-4: Procedure/Exam details parameters

Parameter	Description
Date/Time 	Complete the date and time if the exam is scheduled for the future.
Acc #	Enter the Accession number in the text field.
Exam description	Enter an exam description in the text field.
Radiologist	Enter the radiologist's name in the text field.
Referring Physician	Enter the referring physician's name in the text field.
Protocol	Select a protocol. For details, see **Protocol introduction**.

Procedures

Patient information procedure

Related topics

Scan workflow chapter

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PATIENT INFORMATION

Demographic information procedure

Use these steps to complete the demographic information on the Patient Information screen.

1. From the Main Menu, click ***Dashboard*** to view the Schedule list.
2. From the Schedule List, click the ***New Patient icon***  ***to display the Patient Information screen.***
3. From the Patient demographic information area complete the following.

Figure 5-34: Patient demographic information screen

a. Enter information into each name text field: Prefix, First, Middle and Last name, Suffix.

Figure 5-35: Patient name fields

- The patient's name can be entered with any combination of letters and numbers. There is a 64 character limitation for patient name, although only 24 characters can be displayed on an image. If more than 24 characters are entered from the patient name field during scan prescription, then the displayed image shows the first 24 characters followed by a *. The * indicates that more text was entered at scan prescription.

b. Enter a Patient ID, which is a required field.
   - The patient's identification (ID) can be any combination of numbers, letters, and dashes. It cannot contain a backslash (\). If the system finds a matching ID in its memory, it displays all the pertinent data so long as the entry is identical, including the use of upper-case and lower-case letters. Enter MR and the system displays the last (most recent) patient's data. This text box is limited to 64 characters.
c. Enter the patient's gender.
   - The patient's gender can be entered as **M** for male or **F** for female and **O** for other (for example hermaphrodite).
d. Enter the patient's date of birth (DOB).
   - The birth date can be entered using numbers 1 to 12 for the month, 1 to 31 for the day, and 19xx or 20xx for the year as mm/dd/yyyy or mm-dd-yyyy. The year entry must contain four digits. This entry is optional when pre-registering patients. The system can be configured for dd/mm/yyyy by the service engineer.
e. Enter the patient's age.
   - The age is automatically calculated if the birth date is entered. Only whole numbers (i.e., no decimals) can be entered. The calculation of the patient age ranges from 1 to 123 years, days (1 to 90), weeks (1 to 52), or months (1 to 23). For example, 28d, 4w or 1m.

f. Enter the patient's weight and height.
   - The patient's weight can be entered in pounds or kilograms. The system automatically calculates and displays the other weight measure. Weight range is from 1 kilogram to 500 lb. (227 kg). Accurate weight information is essential for safe scanning.

CAUTION

The patient's weight determines the SAR. Entering a weight more than the actual patient weight could potentially harm the patient. Patient weight is not pulled with the other patient information from the ConnectPro worklist. You must manually enter the weight.

g. Enter pre-medication in this text field.
   - A ***Caution symbol***  appears on the Schedule List and next to the Pre-Med field when any text is entered.

h. Enter the patient's allergies.
   - If an allergy was entered in the *HIS*[1]/*RIS*[2] system and you pulled the patient from the HIS/RIS list, then this field is automatically completed with the patient's allergy information
   - A ***Caution symbol***  appears on the Schedule List and next to the Pre-Med field when any text is entered.

i. Enter the patient's pregnancy status.
   - This field appears if ***F*** (Female) or ***O*** (Other) were entered as the gender. Select an item from the menu.
   - A ***Caution symbol***  appears on the Schedule List and next to the Pregnancy field if ***Possibly Pregnant*** or ***Definitely Pregnant*** is selected from the menu.

j. Enter history or notes if desired.
   - Enter relevant background information regarding the patient's symptoms or other relevant information. The first 35 characters of the history appear on the Exam text page and can be filmed as part of the patient's record.

k. Select an item from the Auto Voice menu.

4. In the Exam Safety area of the screen, complete the following steps.

[1]Hospital Information System
[2]Radiology Information System

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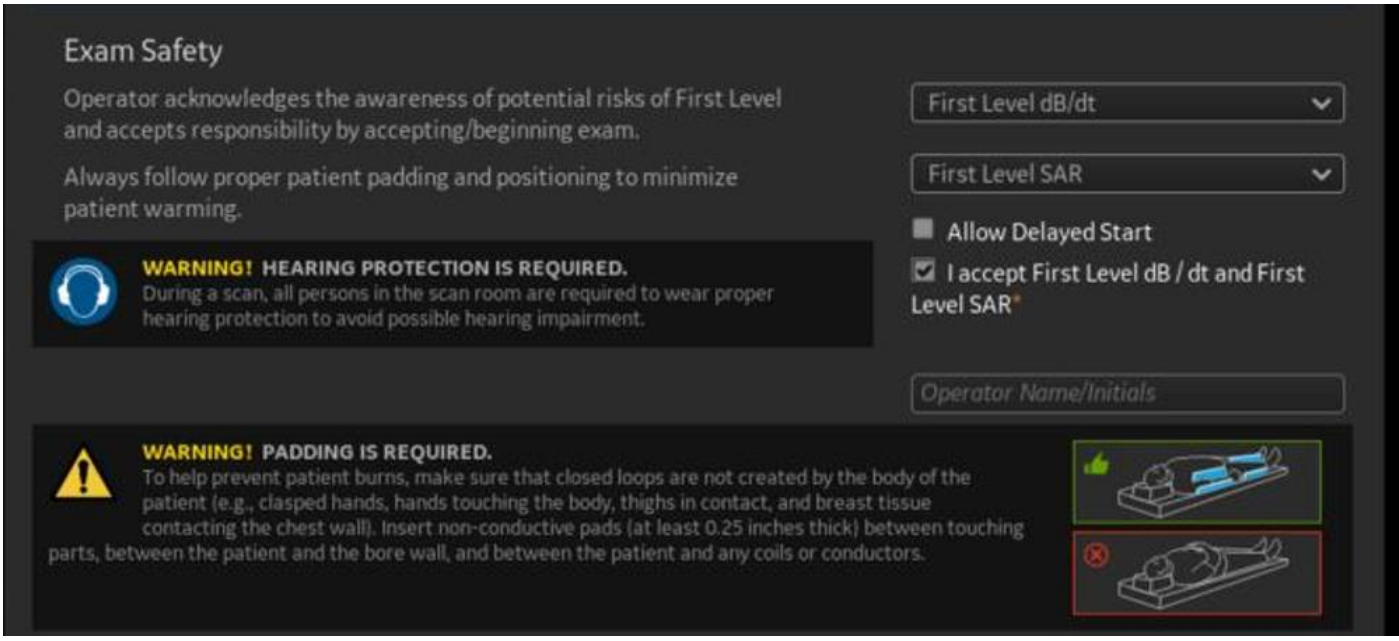
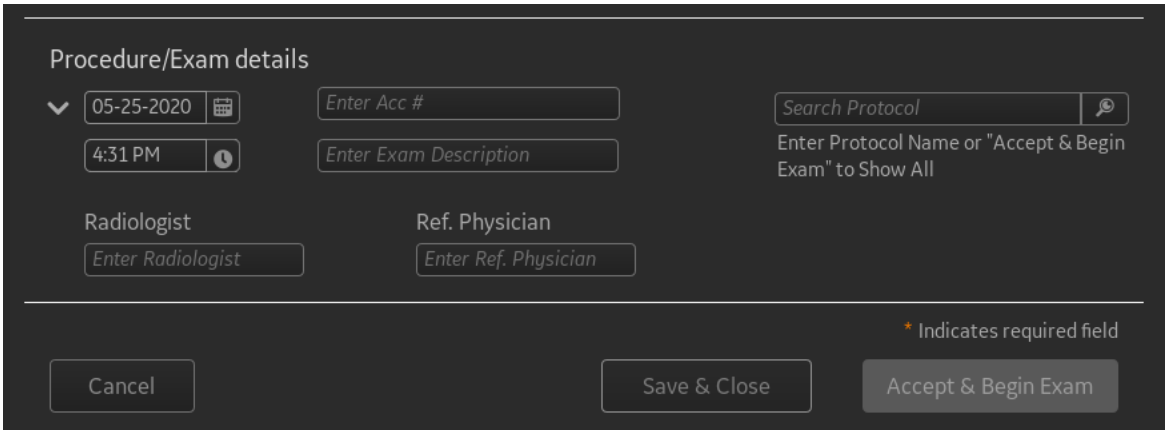
Figure 5-36: Exam Safety screen



a. Enter the name of the acting MR technologist in the text field.
   - For more details regarding Exam Safety section, see **SAR introduction**.

5. In the Procedure/Exam details area of the screen, complete the following steps.

Figure 5-37: Procedure/exam details screen



a. Enter the date/time if the exam is scheduled for the future.
b. Enter the Accession number in the text field.
c. Enter an exam description in the text field.
d. Enter the name of the acting radiologist in the text field.
e. Enter the referring physician's name in the text field.
f. Select a protocol, for details, see **Protocol introduction**.

6. From the bottom of the **Patient Information screen**, click ***Save & Close*** to add it to the Schedule or ***Accept & Begin Exam***.

Related topics

Patient Information introduction

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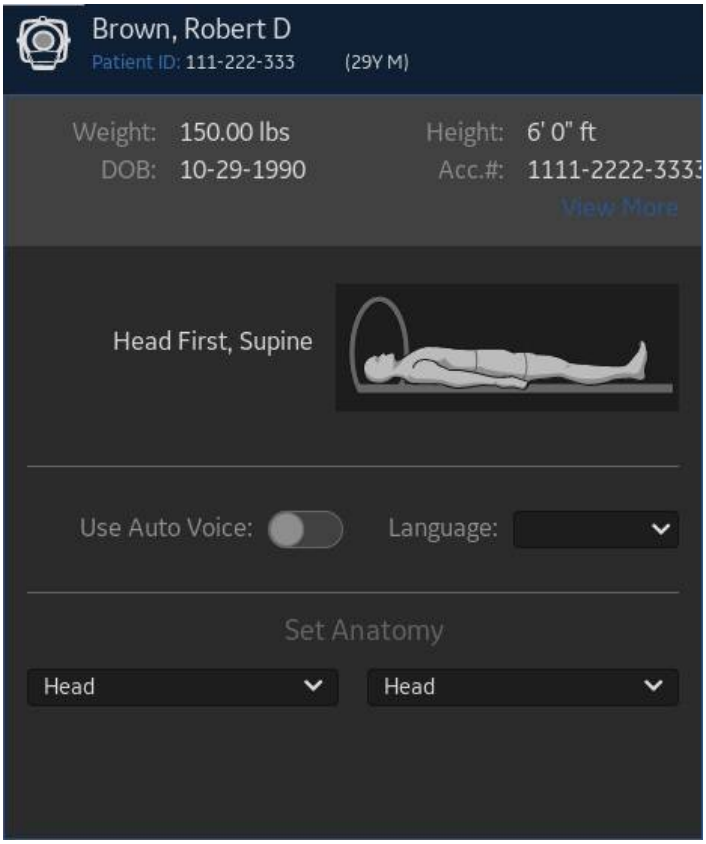
PATIENT INFORMATION

Exam information procedure

Use these steps to set the patient orientation and anatomical region.

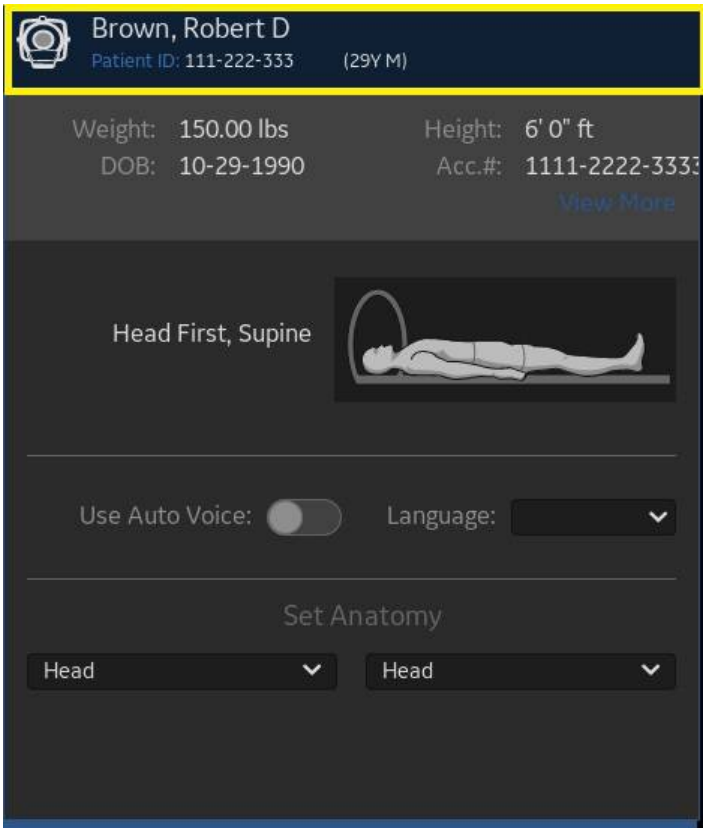
1. The Patient Exam Information screen appears once you click ***Accept & Begin Exam*** from the **New Patient screen**.

Figure 5-38: Patient Exam Information screen



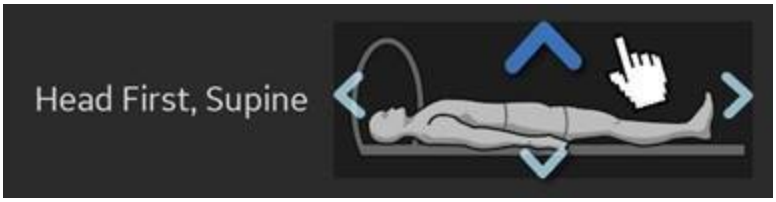
2. Once you start a scan, the Patient Exam Information screen switches to the Auto View screen. To switch from Auto View to the Patient Exam Information screen, simply place the cursor over the Patient Banner are (see Figure 5-39). To display Auto View again, move the cursor away from the Patient Exam Information screen.

Figure 5-39: Cursor placement area to toggle between Patient Exam Information and Auto View



3. The patient orientation is part of the protocol. To change the patient orientation, complete the following:
   a. Place the cursor over the Patient Orientation icon and click to view the arrows.
   b. Click an arrow to change the orientation.
      - The text to the left of the icon updates.

Figure 5-40: Patient orientation icon with arrows



4. To define the anatomy for the one or multiple tasks, complete the following.
   a. Make a selection from the two Anatomical menus in the Set Anatomy area of the Patient Exam Information screen. The menu on the right has sub-categories of the menu on the left.
   b. Select one of the following, which only appear if you change the anantomy selections from the loaded protocol:
      - Click **Apply** to only apply the Anatomical Region for the currently viewed/edit series.
      - Click **Apply All** to apply the Anatomical Region to all New and InRx tasks in the Tasks List.
      - Click ***Cancel*** to close the Set Anatomy screen without applying the Anatomical Region.

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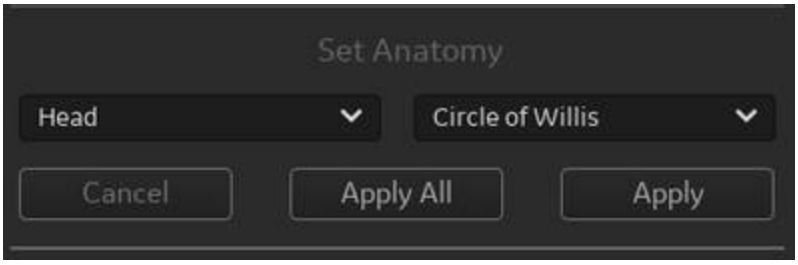
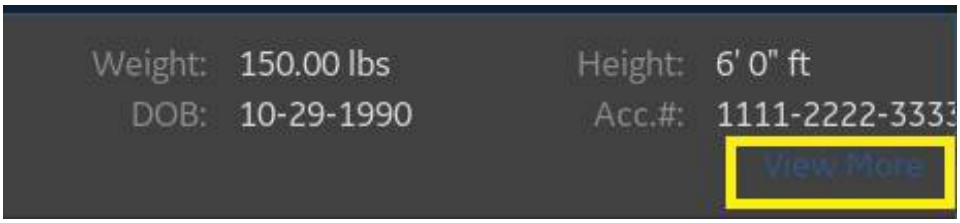
Figure 5-41: Set Anatomy area



- The anatomical region appears on the series text page.
- The anatomical region appears on the DICOM Header screen.

5. To view the **Patient Demographic Information screen**, click ***View More*** located in the lower right corner of the Patient Exam Information screen.
   - The information in this screen area cannot be edited. It is populated from the Patient Demographic Information screen and therefore can only be edited from the Patient Demographic Information screen. The only fields that can be edited from View More are Patient Weight and SAR mode settings.

Figure 5-42: View More button



6. If you update the Patient Weight and SAR mode settings, from the bottom of the **Patient Information screen**, click ***Save & Close*** to update these changes.

Related topics

Patient Information introduction

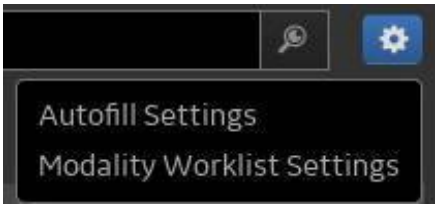
PATIENT INFORMATION

Auto fill patient information procedure

Use these steps to add items to certain fields in the Patient Demographic Information screen. The items you add to these fields appear in a menu each time you start a new exam.

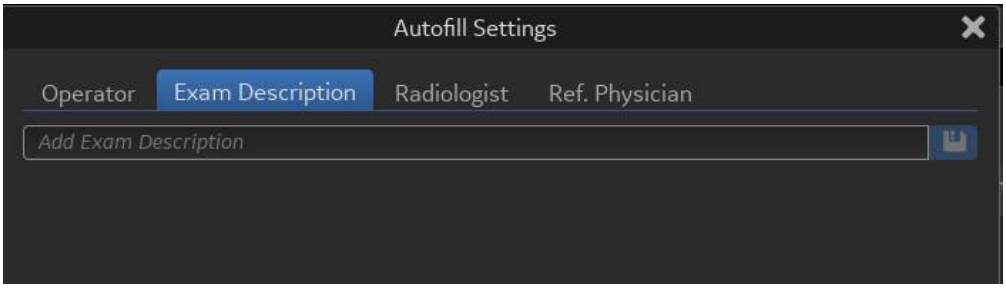
1. From the Main Menu, click ***Dashboard*** to view the Schedule list.
2. From the Schedule List, click the ***Cog icon***  to open the menu.

Figure 5-43: Schedule List cog icon menu



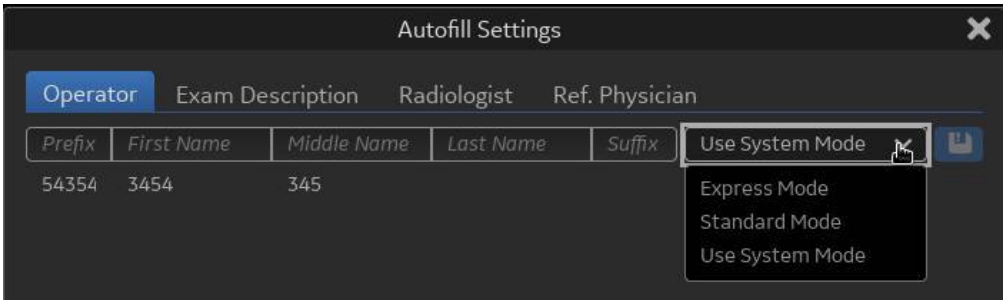
3. From the Cog menu, click ***Autofill Settings***.
4. From the Autofill Settings screen, select one of the options:
   - Operator
   - Exam Description
   - Radiologist
   - Referring Pysician

Figure 5-44: Autofill Settings screen



5. Click Operator and complete the following:

Figure 5-45: Operator options



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a. Fill each text name field. Use one of these methods move between text fields:
   - Click the keyboard **Tab** key.
   - Type text and press **Enter**.
   - Place the cursor in the desired text field and click to begin typing.

b. From the System Mode menu, select one of the following:
   - ***Express Mode***
   - ***Standard Mode***
   - ***User System Mode*** which is typically set by the system administrator or lead technologist.

c. Click the ***Save icon***  to save your updates.

6. Click Exam Description and complete the following.
   a. Add an Exam Description
   b. Click the ***Save icon***  to add the exam description
7. For Radiologist and Ref. Physician, compete these fields:
   a. Enter information into each name text field: Prefix, First, Middle and Last name, Suffix.
   b. Click the ***Save icon***  to add the physicians into the Autofill settings.

Related topics

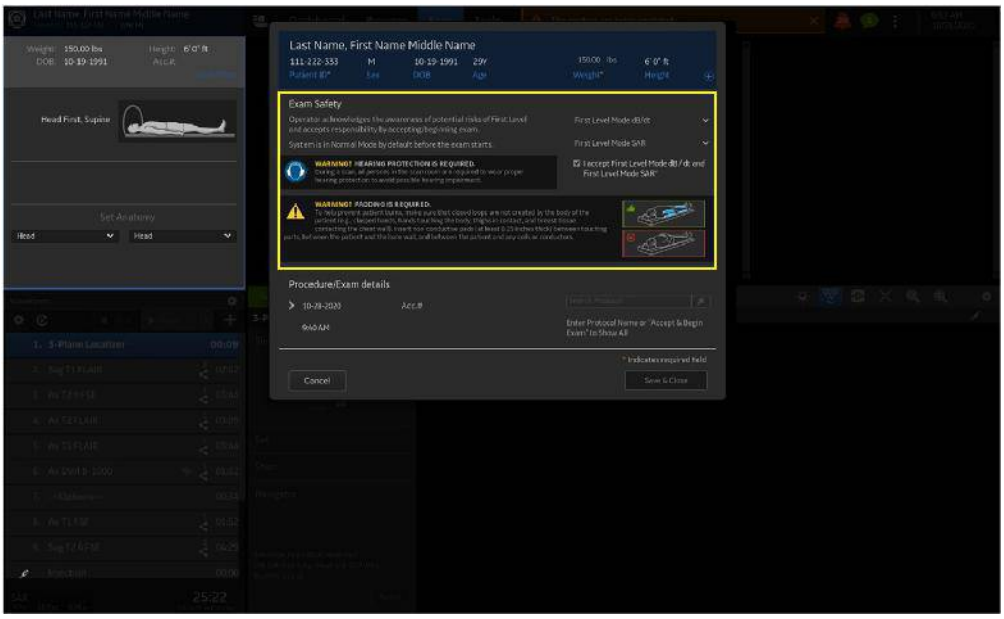
Patient Information introduction

SCAN SAR

SAR and dB/dt introduction

The SAR and dB/dt screen is an area of the New Patient screen. It appears when you start a new exam.

Figure 5-46: SAR/dB/dt screen area



SAR menu

SAR[1] refers to the RF power absorbed per unit of mass of an object (Watts/kg), which in turn can lead to heating. Therefore SAR affects the Specific Absorption Rate or heat deposition. SAR levels for the patient are based on current scientific literature related to safety. The level of exposure shall be a medical judgment as to the patient's potential risk versus benefit.

The levels displayed in the dB/dt and SAR menus, are the levels for the prescribed scan. If a head transmit coil is in use, the estimated average head SAR (Head-SAR) is displayed along with the estimated whole-body SAR (WB-SAR) value. If an extremity transmit coil is in use, the estimated average partial-body SAR (PB-SAR) is displayed along with the estimated whole-body SAR (WB-SAR) value.

dB/dt menu

DB/dt controls gradient slew rate, which refers to the rate of change in magnetic field to time. It affects peripheral nerve stimulation. The dB/dt is expressed in T/s (Tesla/seconds).

dB/dt and SAR levels

The system is capable of operating under several modes: Low SAR, normal, first level controlled operating mode, and second level controlled operating mode.

- ***Normal level*** limits the system to a level that all persons, regardless of health status, should be able to tolerate.
  - In normal mode, the system is limited to 2 W/kg average whole body SAR.

[1]Specific Absorption Rate

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- ***First Level*** is the default selection. In most cases, First Level allows for the shortest TE and TR values resulting in optimum image quality and number of slices per acquisition. Do not use First Level for patients with impaired thermo-regulatory and cardiovascular systems.
  - In first control mode, it is limited to 3.0 W/kg.
  - Additionally, a First Controlled Operating Mode message appears. When the exam ends, the system resets to the normal clinical mode. When creating protocols, the system treats SAR levels the same as real-time prescriptions. If you want to always stay under 2 W/kg, create your protocol by clicking Normal Mode when the warning message appears. If you click Accept, the system calculates the scan parameters based on the first controlled operating mode limits.
- ***Low SAR*** mode ensures that the Head SAR can be strictly met for implant imaging.

Allow Delayed Start

Allow Delayed Start option enables/disables the Scan Sequence Time Optimization feature. When enabled, it can decrease overall exam time by allowing a delay before some scans. This allows the system to take full advantage of the 6 minute average for SAR.

Considerations

SAR dB/dt considerations

Procedures

SAR or dB/dt level procedure

Low SAR mode procedure

Monitor SAR during an exam procedure

SAR or dB/dt level change within a scan procedure

Retain SAR dB/dt levels procedure

SAR

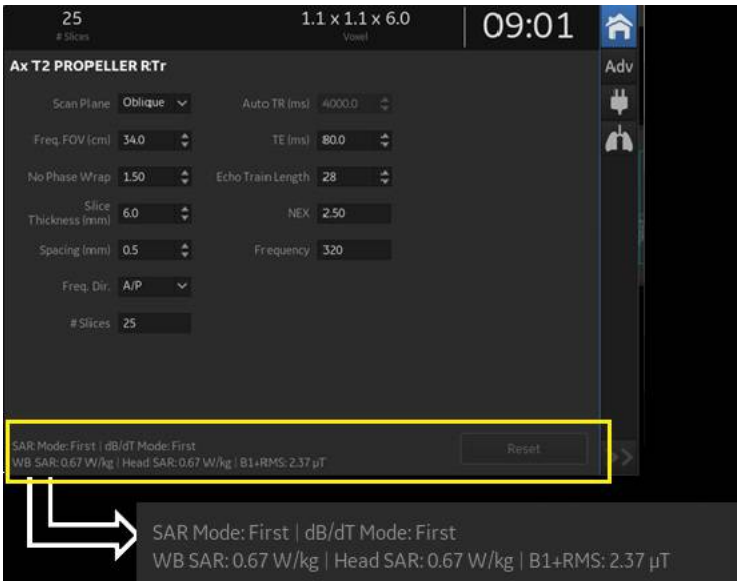
SAR and dB/dt considerations

The selections made from the **SAR and dB/dt screen** are applied to all series with the scan session.

SAR and dB/dt levels for a scan

- For more details about SAR term definition, see **MR Terminology: SAR**.
- The values of the currently prescribed scan include the following:

Figure 5-47: Footer area of Scan Parameter screen



- **WB-SAR:** Whole Body SAR (always shown)
- **Head-SAR:** Head SAR (shown with head or neck coil modes)
- **PB-SAR:** Partial Body SAR (shown with extremity transmit/receive coils)
- **B_1+ RMS:** the estimated peak B1 RMS for currently prescribed scan.
- B_{1+}RMS is the root mean square of the RF[1] magnetic field (B1) of a pulse sequence averaged over a pulse repetition period (TR) . You can choose to view the B1rms of a pulse sequence on the control panel as a supplemental metric to SAR. For example, B1rms might be included in the labeling for MR Conditional implants.
- B_{1+}RMS is estimated from the tip angle at the RF transmit coil center for the B1 component that precesses with the nucleus of interest (for example, protons). The estimate assumes the proper tip angle is set and that the RF magnetic field is in circular polarization.
- **Mode:** The mode of operation for SAR control: Normal or First (always shown).
- **dB/dt:** the dB/dt and SAR levels for the series currently prescribed scan.

Good clinical practices

As is the case for all MR imaging, follow these good clinical practices:

[1]Radio Frequency

- Continuous patient observation and contact are required. All patients should be monitored for increased temperature during the scan acquisition. If the patient reports discomfort due to excessive warming, stop the scan.
- Extra attention should be employed when scanning patients who are unconscious, sedated, or may have loss of feeling in any body part (temporary or permanent paralysis). They may not be able to alert you to RF heating.
- Give patient breaks to cool down, provide light clothing, limit room temperature to 18 ± 3 °C, and maximize air flow.
- During a exam scanning session, consider interleaving scans/sequences that are prone to high SAR (e.g. Spin Echo) and low SAR sequences (e.g. Gradient Echo) to minimize the effects of SAR related issues.

Hearing protection

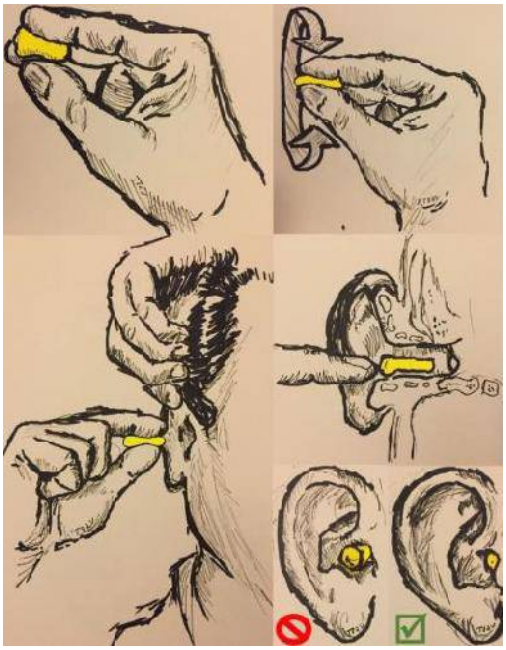
Hearing protection is required. During a scan, all persons in the scan room are required to wear proper hearing protection to avoid possible hearing impairment.

Acoustic levels may exceed 99dBA. Properly worn hearing protection is required for all people in the magnet room during a scan, including any MR workers.

See these operator manual topics for further recommendations about hearing protection.

- **Acoustic noise**
- **Protect the patient's eyes and ears procedure**

Figure 5-48: Hearing protection



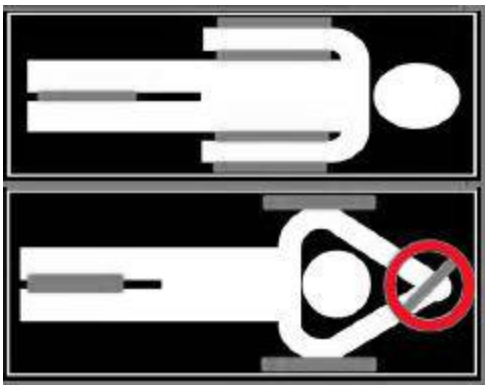
Patient padding

Padding is required. To help prevent patient burns, make sure that closed loops are not created by the body of the patient (e.g., clasped hands, hands touching the body, thighs in contact, and breast tissue contacting the chest wall). Insert nonconductive pads (at least 0.25 inches/0.64 cm thick) between touching parts, between the patient and the bore wall, and between the patient and any coils or conductors.

See these operator manual topics for more information regarding patient padding:

- **Contact point heating**
- **Protect the patient from RF burns procedure**

Figure 5-49: Patient pads



SAR and the First Operating Mode considerations

Consider the following with SAR and the First Operating Mode:

- For more information about your MR system, see **About MR scanner**.
- An override of 14.4 kj/kg is allowed in low SAR and normal operating modes; however in first control mode and second control mode no override is allowed.
- To reduce the possibility of a power monitor trip due to high SAR values, interleave high SAR series such as FSE, FLAIR, and SSFSE with lower SAR series such as GRE and EPI. This is particularly helpful when the ***Allow Delayed Start*** option is selected. Interleaving high and low SAR sequences will minimize the overall exam time.
- During the scan acquisition (not prescan), monitor the 10 sec SAR display, that is located at the bottom of the task list.

  Figure 5-50: 10 sec SAR display

- Hover over the SAR display to view a full SAR display.

  Figure 5-51: Full SAR Display screen

- If the 10 sec SAR is exceeding the 6 minute SAR limit and Allowed Delayed Start option is not enabled from the SAR and dB/dt Limits screen, stop the scan and if possible, re-prescribe the protocol with fewer slices or increase the TR. When the Allow Delayed Start option is enabled, it is normal for the 10 second head SAR meter to occasionally exceed the 6 minute SAR limit. For more details, see **Monitor SAR during an exam**.

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- If the specific energy limit appears likely to trip before the end of the scan, consider revising the scan protocol to reduce the SAR to a level that may go to completion without tripping an accumulative power monitor.
- If you do not want to change the TR or the number of slices, then the following work-flow is recommended:
  - Do NOT use auto-scan.
  - Manually start each series when the 6-min average on the SAR display reads < 0.5 W.

Related topics

SAR and dB/dt introduction

SAR

SAR or dB/dt level procedure

Use these steps to select the SAR or dB/dt levels when the exam is first launched.

Review all **SAR dB/dt considerations**.

1. Start a new exam. For details, see **New patient workflow**.
2. From the **SAR dB/dt screen area**, change the dB/DT and SAR modes to the desired level.

Figure 5-52: Exam dB/dt menu

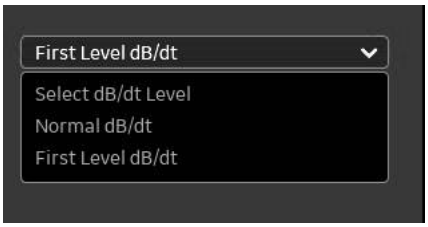

Figure 5-53: SAR level menu

- For details about dB/dt and SAR definitions, see **dB/dt and SAR levels**.
- If the regulatory limit for SAR is reached, the scan pauses and you must wait until the 6-minute SAR average is within regulatory limits to complete the scan. The current series is lost or paused (depending on the sequence), but all completed series are saved. In addition, you must wait until the SAR is within the regulatory limit before you are allowed to restart the series.
- If the user clicks on First level SAR or First level dB/dT or both, click on the : I accept First Level dB/dt and First Level SAR pop-up dialogue box in the patient demographic screen.

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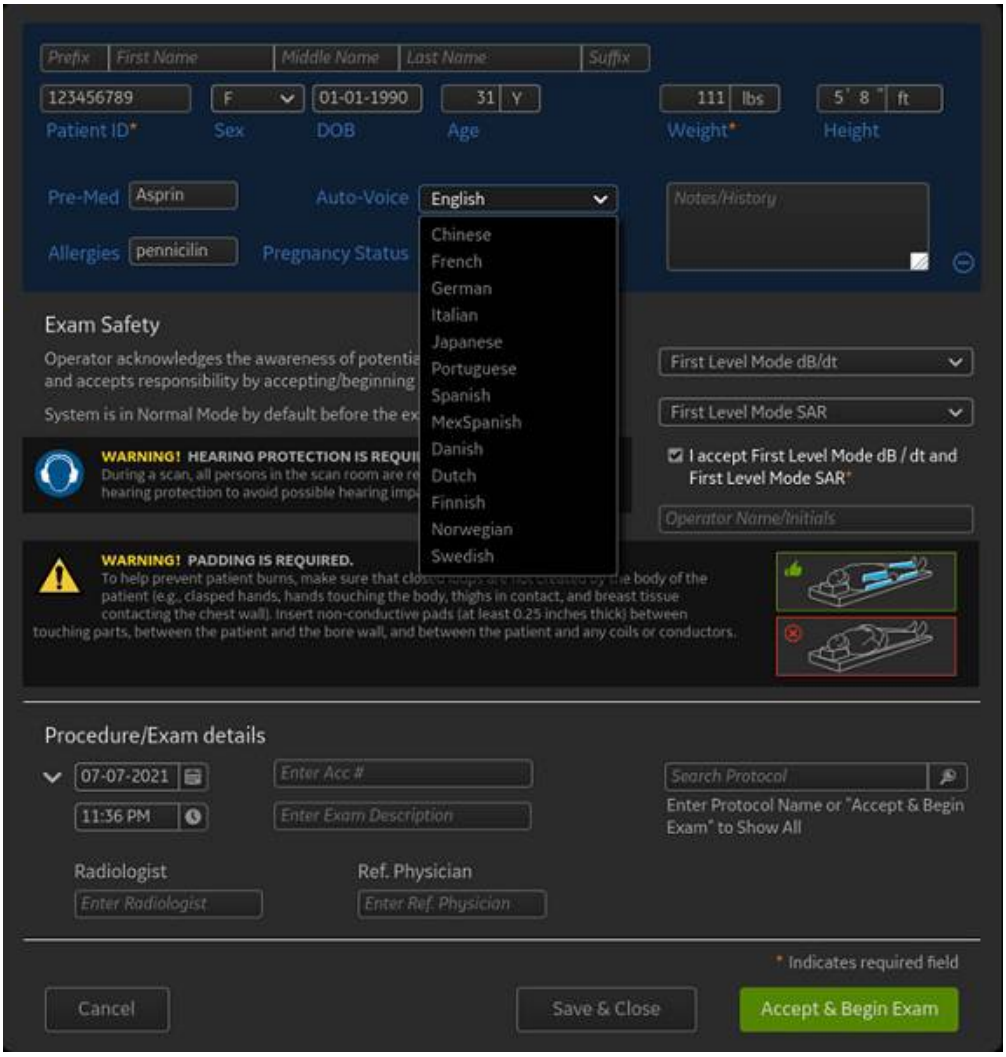
Figure 5-54: I accept First Level dB/dt and First Level SAR



3. Once all fields are completed on the New Exam screen, ***Accept & Begin Exam*** to apply the dB/dt and SAR levels and begin the scan.

To retain SAR and dB/dt level across series, see **Retain SAR dB/dt levels procedure**

Related topics

SAR and dB/dt introduction

SCAN SAR

Low SAR mode procedure

Modern MR scanners deliver high-performance gradients and RF systems. Strong time-varying electromagnetic fields (EMF) from an MR scanner can potentially invoke physiological responses including, but not limited to, peripheral nerve stimulation and tissue heating. In most countries the MR safety standard IEC 60601-2-33 provides safety limits for MR exams. The International Electrotechnical Commission (IEC) developed a widely-used MR safety standard via OPERATING MODE concept as described previously in the Operator Manual.

There is a critical need for safely performing MR exams on subjects with an MR Conditional Implant. MR Conditional Implant Imaging often requires a more flexible RF system control limit of physical parameters such as B_1+ PEAK, B_1+ RMS, Whole Body Specific Absorption Rate (WB-SAR), and Head Specific Absorption Rate (Head-SAR) to minimize potential tissue heating.

Low SAR mode is a mode designed to address such a need. Low SAR mode provides a means to limit the RF field based on values entered by the user.

WARNING

When considering or conducting MR Conditional implants imaging, please ensure the following:

Strictly follow the implant's labeling and instructions.

DO NOT use Low SAR mode for scanning subjects with implants that are MR Unsafe or have not been evaluated for safety and compatibility in the MR environment. Scanning subject who has these implant may result in patient injury or death.

DO NOT use Low SAR mode for implants with FIXED PARAMETER OPTION (FPO) or FPO:B labeling. Low SAR mode does not provide a means to limit gradient output |dB/dt| and does not operate within NORMAL OPERATING MODE or FIRST LEVEL CONTROLLED OPERATING MODE as specified by IEC 60601-2-33 Edition 3.2 for FPO labeling.

DO NOT use GEM Flex coil for scanning patients with MR Conditional head/neck implants.

Low SAR mode does the following:

- Provides a scan mode for physicians to use for special situations where the risk may be higher (for example, sedated or unconscious patients where they are unable to report discomfort due to warming).
- Provides a flexible RF system control limit for scanning implants.

Low SAR mode allows you to set the Head SAR limit between 0.5 – 3.2 W/kg and the WB-SAR limit between 0.5 – 2.0 W/kg. In Low SAR mode, all PSDs operate with SAR as low as 0.5W/kg except the following, if applicable to your scanner:

- SSFSE: the WB-SAR and Head-SAR must be greater than or equal to 1.5 W/kg.
- Time Course FGRE is not supported for Low SAR mode if the SAR limit is less than 1.0 W/kg.

Figure 5-55: Time Course FGRE message: GRE Time Course is incompatible with limit less than 1.0 W/kg

- Silenz MRA and 3D ASL are not supported when any of the following conditions are present: WB-SAR or HEAD-SAR is less than 1.5 W/kg, the B1+Peak is less than 20µT, the B1+RMS less than 2.0µT, and patient weight is greater than 150 kg.

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The Low SAR option cannot be changed once an exam begins. The other SAR modes retain normal behavior in that they can be moved up; for example, you can move from Normal mode to First level mode within an exam.

GE recommends using Low SAR mode for scanning patients with MR Conditional implants. For all patients with MR Conditional implants, limit the length of scan protocols based on the manufacturers labeling. In general, you can reduce SAR by modifying PSD parameters such as:

- selecting the SAR Optimization User CV from the Advanced tab, if it is available
- decreasing the number of slices
- increasing the repetition time (TR)
- decreasing Echo Train Length (ETL) in Fast Spin Echo (FSE)
- replacement of Spin Echo (SE) or FSE PSDs with Gradient Echo (GRE) PSDs
- decreasing the flip angle in GRE
- decreasing the flip angle or refocus flip angle in SE or FSE (if available)
- replacement of FIESTA/COSMIC PSDs with GRE based PSDs
- selecting a parallel Imaging Option. For details, see **ASSET procedure** or **ARC considerations**
- if the **Spatial Saturation Strength considerations** is available from the Advanced tab, replace Strong (option 2) with Medium (option 1) or Light (option 0)

The Low SAR mode sets the same limits to both the long-term (6 minutes) and short-term (10 seconds) SAR, which means that a UPM trip is more likely in comparison to Normal mode.

In Low SAR mode, power monitor trips become more likely if the temperature in the scan room exceeds 24 degrees Celsius (75.2 degrees Fahrenheit), due to changes in the power monitor limitation as the temperature increases. If the power monitor trips and the six minute average is equal to User specified SAR limit or less, adjust the scan room temperature to be 24 degrees Celsius or less (for patient comfort the temperature should be 18 +/- 3 Celsius degrees).

Current IEC 60601-2-33 standard allows a short term SAR limit to be as high as 2 times as a long term 6 minutes average. There is some concern that RF-induced heating in the vicinity of implants can be very rapid. For simplicity, Low SAR mode strictly obeys the SAR limit, i.e. same limit for short and long term exposure.

The Auto TI scan parameter on the Details tab is available for T1FLAIR and T1FLAIR PROPELLER as long as Head-SAR and WB-SAR are larger or equal to 1.5W/kg, and B_1+RMS are larger or equal to 1.5μT.

Use these steps when scanning patients with MR Conditional implants.

IMPORTANT: If you are unable to fill in the editable fields with the manufacturer's conditional implant information, please consult the attending radiologist, referring physician, or the MR physicist for instructions on exam completion.

Procedure

1. Identify the MR Conditional implant and consult the implantable device's labeling.
2. From the Dashboard, select the*New Patient icon*  .
3. From the Exam dB/dt and SAR Limits screen, click the ***Low SAR*** option button.

Figure 5-56: Exam dB/dt and SAR Limits screen comparison-First Level SAR mode selected.

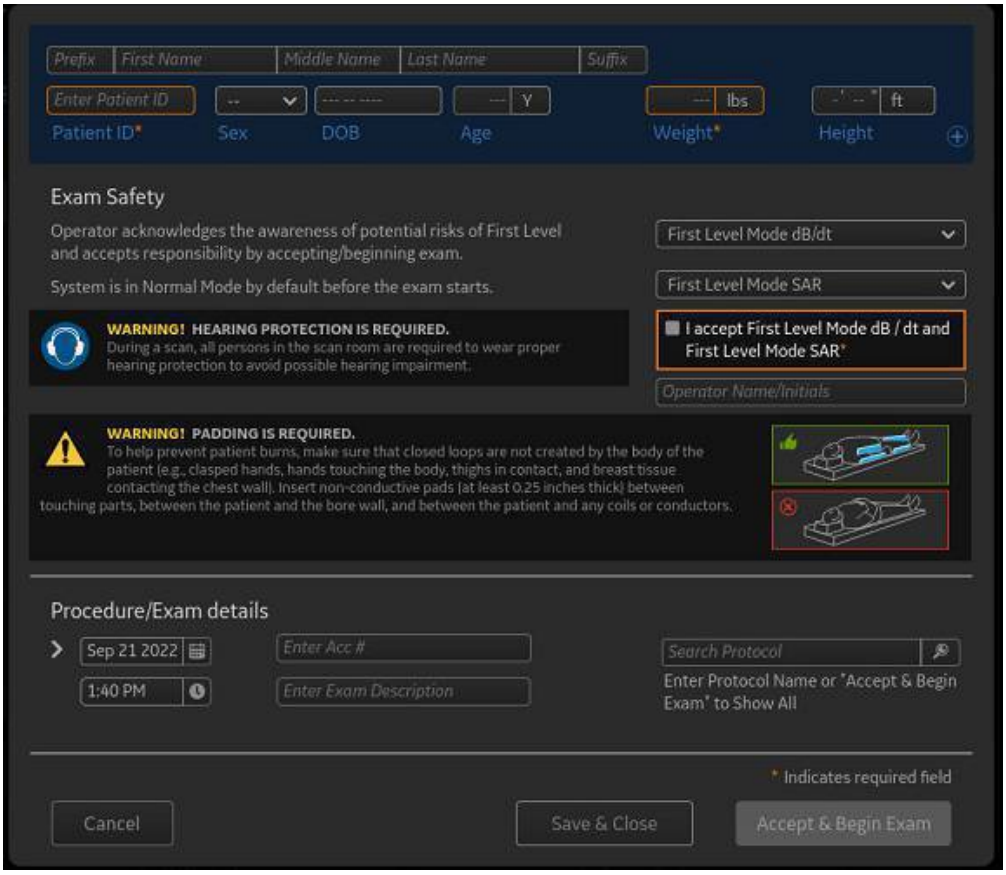
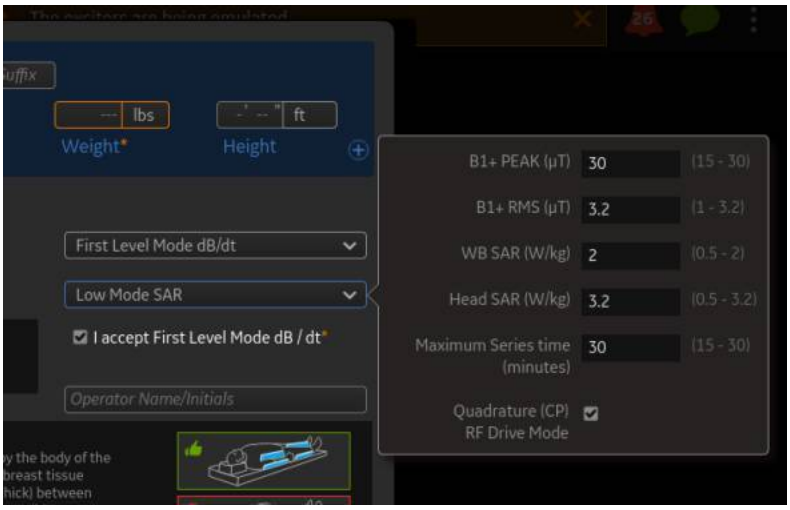


Figure 5-57: Exam dB/dt and SAR Limits screen comparison-Low SAR mode selected



4. A display with text boxes appears with default values that reflect the NORMAL OPERATING MODE. Change these default values and enter a value for each text box based on the information from the implantable device's labeling. The value you enter is the maximum allowed value for every series within the exam.

   - B_1+ Peak (μT): The highest amplitude of the radio frequency magnetic field.
   - B_1+ RMS (μT): B_1+RMS is the root mean square of the RF magnetic field (B1) of a pulse sequence averaged over a pulse repetition period (TR).

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- WB - SAR (W/kg): The MR Conditional label's limit for Whole Body SAR.
- Head - SAR (W/kg): The MR Conditional label's limit for Head SAR.
- Maximum Series time (minutes): The maximum time that any series (that is, any pulse sequence) can run. If the scan time of any series exceeds the value entered in the text box, then an error message is posted.

5. Once all text fields are completed, click Accept to close the Exam dB/dt and SAR Limits screen.
   - Once you have selected Accept, you cannot switch to any other SAR mode.
   - The Low SAR option cannot be changed once an exam begins. The other SAR modes retain normal behavior in that they can be moved up; for example, you can move from Normal mode to First level mode within an exam.
6. Proceed to scan the exam
   - If the PSD for a series selected exceeds the Maximum Series time limit entered on the Exam dB/dt and SAR Limits screen, a message appears on the screen. Respond to the prompt: "Series scan time XX minutes, exceeds maximum allowed YY minutes. Please reduce NEX, number of slices, phase encodes or another method to reduce scan time."
   - The SAR and dB/dt information is displayed below the message area on the scan user interface.

Figure 5-58: SAR and dB/dt area

SAR

Monitor SAR during an exam procedure

Use these steps to monitor the SAR during an exam and to prevent the MR exam from exceeding the maximum SAR per exam (14.4 kJ/kg = 240 W min/kg). This workflow is for a scan session on a patient that has not been scanned within 2 hours.

- For more details about SAR term definition, see **MR Terminology: SAR**.
- Review **General Considerations** for more details about Monitoring SAR during an exam.

1. Open a scan session.
2. From the footer area of the Task list screen, hover over the SAR display to view a full SAR display.

Figure 5-59: Full SAR screen prior to scan acquisition

- The **Specific Energy** bar graph indicates the cumulative SAR by the patient across scans and examinations that have occurred within two hours. Therefore, it does not represent only a single scan or exam. There are three color codes to the bar:
  - Green is for energy less than equal to 50% (7.2 kJ/kg) of the limit (14.4 kJ/kg).
  - Yellow is for energy above 7.2 kJ/kg until the estimated time to limit is less than 10 minutes.
  - Red is the energy once the estimated time to limit is 10 minutes.
- The **kJ/kg** value in the Actual row shows the actual accumulated energy for the patient. The value reads 0.0 when the patient has not been scanned during the last 2 hours. Usually, a rest time of 2 hours is required to dissipate the absorbed energy from any previous MR scan.
- The **Estimated Time to Limit** display shows the estimated time to reach the maximum limit, which at the start of a new exam (patient not having been scanned within 2 hours) is 1 hr, 0 min. Note that the Estimated Time to Limit is not the clock time but is the time calculated assuming a maximum energy absorption rate of 4W/kg. The actual scan time to limit will be greater than or equal to the displayed Estimated Time to Limit.

3. Start the scan and acquire series data.
   - During the course of the exam the following occurs:
     - The **kJ/kg** value in the Actual row displays the cumulative absorbed energy by the patient.
     - The progress bar updates with the accumulated energy rise.
     - As the progress bar rises, the time to reach the limit decreases.
4. If the Estimated Time to Limit reads less than or equal to 10 minutes, the following occurs:

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Figure 5-60: SAR screen when Estimated Time to Limit reads less than or equal to 10 minutes

- The Specific Energy graph changes from yellow to red.
- The following warning appears: Scanning will stop when the limit is reached.
- If the limit is reached, a pop-up screen displays and an Extended Time option appears for Normal SAR.

Figure 5-61: Overriding SAR Limit screen

  - Do not select the ***Extended Time*** option unless your site guidelines allow for it under specified conditions that would apply when the risk to the patient of not having the scan is more than exceeding the regulatory limit. Selecting the Extended Time option continues the scan even after the limit is reached. This might increase the body temperature above the defined permissible limit.
  - If the ***Extended*** option is selected the scan does not stop once the limit of 14.4 is reached. Respond to the confirmation prompt to continue scanning. The scan continues until completion or when a limit of 16.8 kJ/kg is reached.
  - If the ***Extended*** option is not selected, the scan stops upon reaching the limit.

Considerations

- If a new exam is started with the same patient after a reasonable rest time that is usually 2 hours, the patient's energy data is reset.
- If there is a failure to retrieve the patient's energy data, a message is posted on the scan user interface.

Related topics

SAR introduction

SAR

SAR or dB/dt level change within a scan procedure

Use these steps to change the SAR or dB/dt levels and weight that was set when the exam was first launched.

Review all **SAR dB/dt considerations**.

1. Click the Patient Banner, upper left corner, to open the Patient Information screen.
2. From the Patient Information screen, click ***View More*** to display the New Patient screen.

Figure 5-62: Patient Information screen

- If the regulatory limit for SAR is reached, the scan pauses and you must wait until the 6-minute SAR average is within regulatory limits to complete the scan. The current series is lost or paused (depending on the sequence), but all completed series are saved. In addition, you must wait until the SAR is within the regulatory limit before you are allowed to restart the series.

3. From the New Patient screen, click the dB/dt and SAR menu arrows and make a new selection.

- You can change the SAR or dB/dt levels from Normal to First Level and update the when the exam is first launched.

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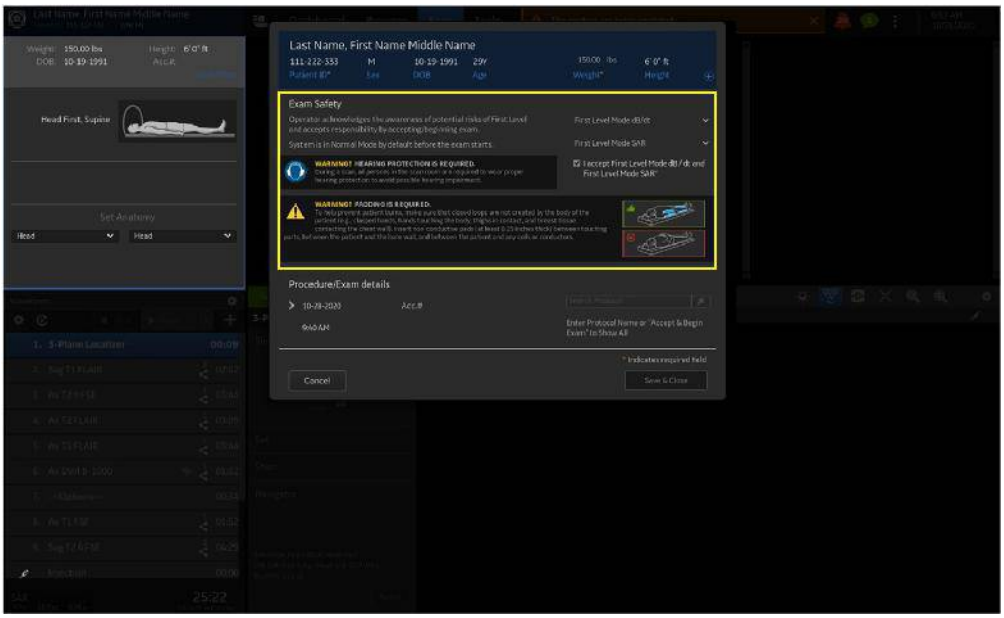
Figure 5-63: Exam dB/dt and SAR Limits screen area



- The First level mode cannot be changed once an exam begin but you can move from Normal mode to First level mode within an exam.

4. Click ***Save & Close*** to apply the changes to the remaining series in the Workflow Manager and click ***Cancel*** to exit the Patient Information screen.

Related topics

SAR introduction

SCAN SAR

Retain SAR dB/dt levels procedure

If you use the prescribe ahead feature and have some series prescribed with Normal level (e.g., series 1 to 4) and some series prescribed with First Level (e.g., series 5 to 8), you can scan the series out of the order prescribed and retain the SAR and dB/dt levels as they were during prescription. This only occurs as long as you do not click ***Setup*** after you have saved each series. If you click ***Setup*** on one of the Normal Level series, it will automatically change to First Level.

Below is an example that may clarify this scenario.

1. On the SAR and dB/dt level screen, select ***Normal Level***.
2. Acquire a localizer.
3. Define the scan locations, modify desired scan parameters, and click ***Save Rx*** following each series prescription for series 2 to 4.
4. From the Scan Session tab menu, click ***Exam Preferences***.
5. From the Exam Preferences screen, click ***SAR, dB/dt...***
6. From the SAR dB/dt screen, change the levels to ***First Level***.
7. Click ***Accept***.
8. Define the scan locations, modify desired scan parameters, and click ***Save Rx*** following each series prescription for series 5 to 8.
9. Select ***series 5*** in the Workflow Manager and click ***Scan***.
   - This series will be acquired using First Level.
10. Select ***series 2*** in the Workflow Manager and click ***Scan***.
    - This series will be acquired using Normal Level.
11. Continue to click the desired series in the Workflow Manager and then click ***Scan*** and the prescribed levels will be used in the acquisition. If, for any of the series in the Workflow Manager, you click ***Setup***, the SAR and dB/dt levels will automatically be set to First Level, regardless of where it was set during prescription.

Related topics

SAR or dB/dt level procedure

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SCAN CONTROL

Scan Control introduction

The Scan Control panel is used to control scan processes.

Figure 5-117: Scan Control panel

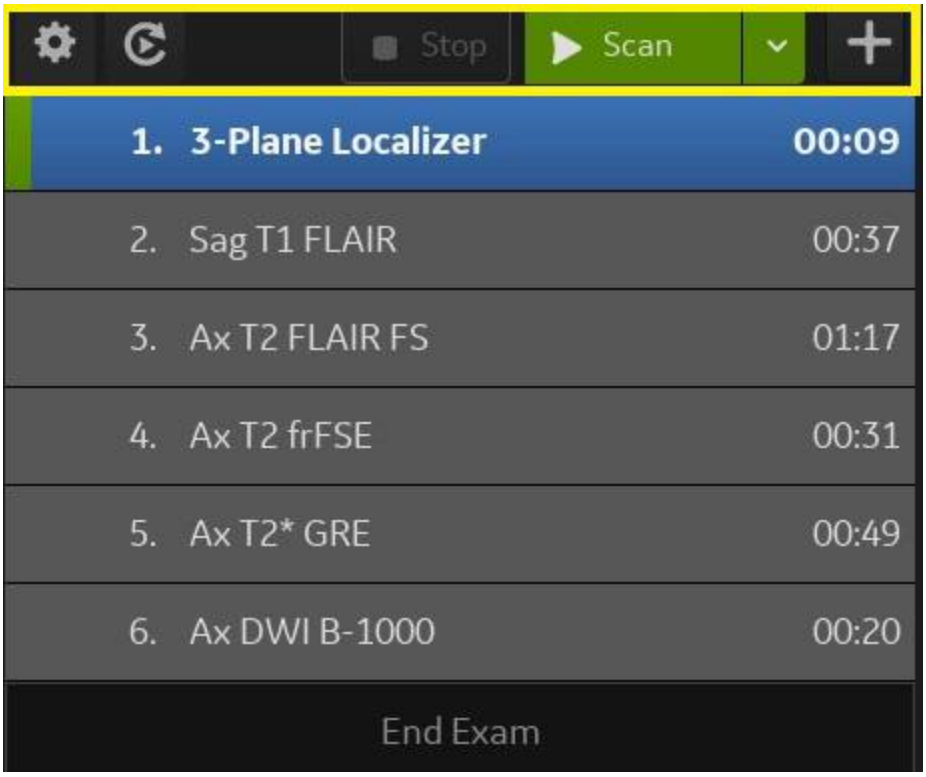
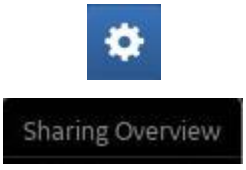
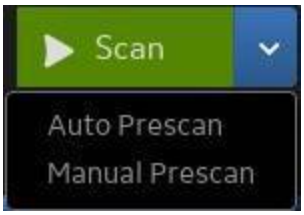


Table 5-13: Scan Control parameters

Parameter	Description
	The Sharing Overview
	The AutoScan icon automatically downloads, prescans, and scans all tasks in the Task List. For details, see **AutoScan considerations**.
	The Stop scan buttons stops the scan.
	The Scan/Pause/Resume button starts, pauses or resumes a paused scan. The green color indicates it is a call to action, in other words the next button in the scan workflow.

Parameter	Description
	The scan menu has two choices. For details, see: • Auto Prescan considerations • Manual Prescan introduction
	The Protocol icon opens the Protocol user interface. For details, see Protocol introduction.

Considerations

Scan/Pause/Resume/Prep Scan considerations

AutoScan considerations

Related topics

Scan workflow chapter

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SCAN CONTROL

AutoScan considerations

AutoScan automatically downloads, prescans, and scans all *RXD*[1] series in the **Task List**.

AutoScan extends the multi-tasking capabilities by allowing you to prescribe multiple scans in advance. The next RXD series in the list begins automatically when AutoScan is selected. All RXD series in the Workflow Manager list are scanned sequentially.

AutoScan stops if the following conditions exist:

- A table move is required (Move to Scan).
- Move to Scan is not activated after two audio alarms and scan times out.
- A contrast series is in the queue following a non-contrast series. When the first series containing contrast On is ready to scan, the contrast injection message appears. You must click OK to proceed. The message does not appear again. AutoScan must be reselected to start AutoScanning mode.
- A new landmark is selected.
- New Patient or a patient from Patient Register list is selected.

Related topics

Scan Control introduction

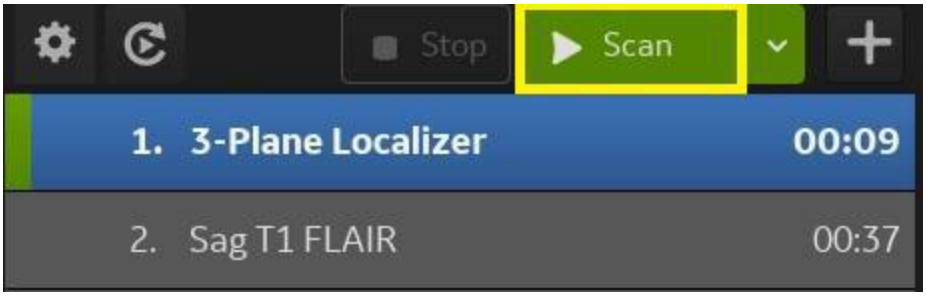
[1]Prescribed

SCAN CONTROL

Scan/Pause/Resume considerations

The Scan button on the Scan Control panel changes function based on the scan process.

Figure 5-118: Scan/Pause/Resume/Prep Scan button



Scan

Scan initiates the scan with a Smart Prescan that uses prescan values from previous series within the exam. Alternatively, click ***Auto Prescan*** to run a full auto prescan that automatically adjusts Center Frequency, Transmit Gain, and Receive Gain without reusing previous prescan values. It also performs a calibration scan, when needed, based on the task's Imaging Options or filters (ASSET, SCENIC, etc.).

Pause Scan

Pauses a scan.

Resume Scan

Resumes a paused scan.

Related topics

Scan Control introduction

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