

## CASE STUDY iMRI SUITE- SOUTHEASTERN US



Leading hospitals are using advanced imaging modalities, such as intraoperative MRI (iMRI), in their hybrid operating rooms. As technology continues to advance, the desire to incorporate new imaging technologies into operating rooms will continue to increase. Intraoperative MRI is becoming the standard for advanced imaging in neurosurgery. It provides real-time image guidance that is used for pre-surgical planning, intraoperative scanning, and post-surgical follow-up. The availability of high-resolution intraoperative MR images helps neurosurgeons visualize anatomy, confirm device placement, and plan for further surgical intervention.

When a leading hospital in the southeastern United States wanted to expand their patient services to include an intraoperative MRI suite, they turned to the expertise of ETS-Lindgren and IMRIS, Deerfield Imaging.

IMRIS designed and managed the construction of the iMRI suite at the hospital. ETS-Lindgren provided the radio frequency (RF) shielding to enable high-quality MR imaging without interference. The high-powered magnet is sensitive

to ferrous metals, so it was essential that the entire suite be shielded from the outside presence of metals which cause ‘noise’ that impacts the clarity of MR images. Throughout the course of the project, ETS-Lindgren worked closely with IMRIS to ensure the RF shielding integrated seamlessly within the iMRI suite.

### Design Process

The design process was tailored to the footprint of the space allocated for the hybrid operating room (OR). As part of this process, IMRIS collaborated with key stakeholders to determine the most ideal floor plan. This

included locating and selecting appropriate RF doors to optimize patient and hospital personnel workflows. An automatic double RF door was placed between the OR and the diagnostic room for ease of transferring the patient to the magnet while taking up as little space as possible inside the OR.

For the MRI control room, a 1.5 m (5 ft) wide single sliding RF door was provided as this avoids collision concerns that a swinging door presents. A single .91 m (3 ft) wide swinging door was also provided for personnel access into the iMRI suite from the control room.

### Safety Systems

In a hybrid operating room, safety is always top of mind. This begins with choosing products that meet hospital safety standards. ETS-Lindgren has developed RF doors that are connected with a hospital’s fire alarm system. In the event of an emergency, RF door latches and seal mechanisms will release to allow for emergency egress. ETS-Lindgren’s TechGate® security device was installed with a single sliding door. This device provides a physical barrier to entry when the door is open while the MR technologist transfers the patient to the magnet for scanning.

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Limiting access to the room while scanning is critical to the safety of the patient and clinical staff, as well as to ensure expensive equipment is not accidentally damaged. TechGate automated technology has warning signs and lights which enable MR technologists to have a smooth workflow while providing a safe work environment.

### Specialty Magnetic Shielding Solution

Patients with pacemakers and other implanted medical devices, as well as computers and other electronic equipment, can be adversely affected by magnetic fields and cannot be subjected to 5 gauss or higher fields. Due to the low floor to ceiling space below the magnet, a magnetic shielding solution was implemented to contain the 5 gauss field from extending into this work area. The installation was a unique effort in applying M36 silicon steel to the underside of the slab of the floor below. Many existing communication lines and HVAC ducts had to be installed lower than usual to allow for sufficient distance from the 5 gauss field. This was a highly coordinated effort between ETS-Lindgren, Carolinas Medical Center, IMRIS, and the general contractor. All parties worked diligently to ensure the patients and hospital staff were minimally impacted by the construction.

### Key Details of the Project:

#### RF Shielding

- Construction included 59 sq m (630 sq ft) at 3.9 m (13 ft) of copper shielding material for the iMRI suite with nominal interior dimensions of 9.1 m

long x 7.6 m wide x 3.9 m high (30 ft x 25 ft x 13 ft).

- Monolithic RF floor system with cement floor topping over the shielding suitable for surgical clean room applications.
- Isolation from ground by 100Ω minimum, RF attenuation minimum 100 dB @ 128 MHz, acoustic enhancement of the RF wall and ceiling panels.

#### Under Slab Magnetic Shielding

- Shielding is 16 layers of M36 silicon steel, 10 mm (.4 in) thick, mounted to 1.9 cm (3/4 in) fire-treated plywood. Size is 230 cm (90 in) wide x 493 cm (194 in) long.
- Strut on the underside of the magnetic shielding for customer attachment of MEP and finishes.

#### RF Doors and Window

- Patient entry from operating room: 1.8 m x 2.1 m (6 ft x 7 ft) double swing, pneumatic RF shielded door assembly with pneumatic controls and auto opener/closer. Includes .6 m x .6 m (2 ft x 2 ft) RF windows.
- Single 1.5 m x 2.1 m (5 ft x 7 ft) sliding pneumatic RF shielded door assembly with pneumatic controls and acoustic upgrade package.
- Single out swing .9 m x 2.1 m (3 ft x 7 ft) pneumatic RF shielded door assembly.
- RF shielded window assembly at 1.8 m x 1.2 m (6 ft x 4 ft).

#### Accessories

- MRI compatible LED downlights were installed for optimal lighting in the imaging

suite to provide an image safe solution. The lighting is dimmable for patient comfort.

- RF filters were provided for all lines entering the shielded enclosure for signal, data, power, telephone, data, and ethernet applications.
- RF shielded penetrations and waveguides were provided for air, gas, cables, cryogen and ultrasound applications.

#### Performance Verification

Two RF shielding effectiveness tests verified performance of 100 dB at 128 MHz. An RF shield ground isolation test upon completion verified initial RF shield installation to 100Ω.

#### About ETS-Lindgren

ETS-Lindgren is an international manufacturer of components and systems that measure, shield, and control electromagnetic and acoustic energy. The company's products are used for electromagnetic compatibility (EMC), microwave and wireless testing, electromagnetic field (EMF) measurement, radio frequency (RF) personal safety monitoring, magnetic resonance imaging (MRI), and control of acoustic environments.

Headquartered in Cedar Park, Texas, ETS-Lindgren has manufacturing facilities in North America, Europe and Asia. Additional information about ETS-Lindgren is available at [www.ets-lindgren.com](http://www.ets-lindgren.com). Additional information about ETS-Lindgren's parent company ESCO and its subsidiaries is available at [www.escotechnologies.com](http://www.escotechnologies.com).



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