

SECTION 13095 – MRI RADIO FREQUENCY ENCLOSURE

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Structurally engineer, design, provide, and test radio frequency shielded enclosure, with shielding constructed of fully annealed pure copper, for the MRI Exam Room.
- B. Coordinate Work with MRI vendor's drawings, furnished with Drawing set

1.2 RELATED SECTIONS

- A. Section 01500 Temporary Facilities and Controls: Heating of installation area to minimum of 68 degrees for a period of 24 hours prior to, 8 and during enclosure installation.
- B. Division 3: Concrete slab substrate, level within ¼ inch in any 10 foot section, cured for minimum 7 days prior to start of enclosure installation.
- C. Division 7: Properly weatherproof entire area in which shielded enclosure will be installed. Protect MRI Room from moisture, standing water, running water prior to, during, and following enclosure installation to ensure enclosure integrity and specified earth ground isolation.
- D. Section 09912 -Painting: Field painting or other architectural finishes, either internal or external to enclosure.
- E. Division 9: Finish Work enveloping shielded enclosure, or preparing surfaces to receive shielded enclosure.
- F. Division 15: Connections of ductwork to or from the installed wave guide shielded air vents.
- G. Division 15: Pipe connections to or from the installed wave guide beyond-cutoff pipe penetrations.
- H. Division 15: Dielectric connection to exterior side of each mechanical pipe penetration of a suitable material to maintain minimum of 1000 ohms DC resistance to earth ground, constructed of material suitable to conditions of service on which it is installed.
- I. Divisions 15 and 16: Special filtering, other than that specified within this section, either mechanical or electrical, related specifically to the installation of the MRI imaging system.
- J. Division 16: Electrical connections to the installed RF power and/or signal filters, either internally or externally to the enclosure

1.3 SUBMITTALS

- A. Shop Drawings: Include typical floor plan of space, enclosure elevations, typical construction, sections, locations of RF shielded penetrations.
- B. Test Data: Door system life cycle test. Provide separate test report to the architect or owners agent for review.
- C. Test Reports (Upon Completion)
 - 1. Qualification Test
 - 2. Acceptance Test
 - 3. Ground Isolation monitoring Test.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications
 - 1. Shall have been engaged in manufacture and installation of radio frequency shielded enclosures of like size and complexity of that required for this Project for a period of not less than eight (8) years.
 - 2. Shall demonstrate if required, that all components of required enclosure are manufactured directly by manufacturer within manufacturer's own plants.
 - 3. Shall demonstrate that no parts, subassemblies, components or systems are remanufactured, reconditioned, or used.
 - 4. Shall have within his direct employment experienced and properly equipped installation and erection crews.
 - 5. Shall have within his direct employ experienced and properly equipped engineering, drafting, and project management departments
- B. Use of Dissimilar Metals
 - 1. Use of the following in manufacture and installation of shielded enclosure shall not be permitted.
 - a. Dissimilar metals that exhibit an anodic voltage differential greater than 0.25 volts.
 - b. Copper or aluminum in direct contact with bare concrete.
 - c. Zinc plated RF framing in direct contact with copper RF medium etc.
 - d. Copper plated steel or brass RF framing in direct contact with galvanized steel.
 - 2. Use of the following in manufacture and installation of shielded enclosure shall be permitted.
 - a. Bronze or brass flame spray treatment of steel or aluminum RF contact surfaces.
 - 3. RF shielding medium shall display an anodic voltage differential index of less than 0.40 volts and a cathodic group number of 1 (0.00 volts) to 9 (0.40 volts).
 - 4. Construct shielding system with proper materials so that ionic conduction across joints and RF seams shall be less than 0.10volts.

1.5 REFERENCES

- A. The standards of the issue listed below form a part of this specification. Standards are referred in the text by basic reference only.
- B. Federal Specifications (FS)
 - 1. FS QQ-S-571 E(2) -Solder, Tin Alloy; Tin-Lead Alloy; and Lead Alloy.
 - 2. FS QQ-B-626D -Brass, Leaded and Non-leaded: Rod, Shapes, Forgings, and Flat Products with Finished Edges (Bar and Strip).
 - 3. FS NN-P-530E -Plywood, Flat Panel.
 - 4. FS MM-L-751 H -Lumber, Softwood.
- C. Military Standards (MIL-STD)
 - 1. MIL-STD-285- (as modified for MRI testing) Methods of Attenuation Measurements for Electromagnetic Shielding Enclosures for Electrical Test Purposes.
 - 2. MIL-STD-220-A- Methods of Insertion Loss Measurements for Radio Frequency Power Line Filters.

1.6 WARRANTY

- A. Warrant the system to be free of defects in materials and workmanship as evidenced by retention of specified RF shielding characteristics for periods as follows:
 - 1. Basic Enclosure: Five (5) years.
 - 2. EMI Electrical Filters, RF Shielded Doors, RF Shielded Windows, Pipe Penetrations, and Air Vent RF Filters: One (1) year.
- B. Pass-through warranties provided by subcontractors to manufacturer shall not be allowed.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. The EST/Lindgren RF Enclosures, Inc., 400 High Grove Blvd., Glendale Heights, IL 60139, Ph. (630) 307-7200, FAX (630) 307-7571.

2.2 MATERIALS

- A. Shielding Material: Annealed pure copper with a conductivity rating of 1 or greater, and conforming to the galvanic requirements of Quality Assurance paragraph.
- B. Design RF seam and joint construction methods to provide the maximum in shield conductivity, low impedance, RF attenuation, and reduction of eddy current generation at RF seams and joints.

- C. RF Shielded Floor System: Provide RF shielded flooring within entire area of MRI room (inclusive of any depicted cable trenching designed flush with finished floor).
1. Monolithic copper membrane, with a conductivity rating of 1 or greater, FS UU-P-127B Type V182-C1, A. B. C.
 2. Render RF copper floor membrane monolithic. Fully seam solder copper membrane seams in conformance with FS QQ-B-571 E, Type RA50 SN and FS OO-S-571 E Type RA 60 SN.
 3. Provide electrical isolation of enclosure and RF floor system by use of a two-part, thermosetting resin applied directly to concrete floor substrate. Use of masonite or other pressed wood materials as electrical isolation material is forbidden.
 4. Moisture Barrier: Thermosetting resin acceptable to enclosure manufacturer. Install at concrete floor substrate according to resin manufacturer's instructions. Use of plastic sheet or other sheet goods as moisture barrier is forbidden.
 5. Membrane Adhesive: Adhere monolithic copper membrane to moisture barrier with an adhesive compatible with both copper and moisture barrier.
 6. Epoxy Grout Coating: Over-coat copper membrane with a chemically cured epoxy grout. Install grout overcoat to minimum 1/2 inch thickness over entire exam room surface. Grout coating shall withstand the direct loading of the magnet cryostat and patient table.
- D. Primary Enclosure: Vertical walls and ceiling, made integral with RF floor system.
1. Fire retardant treated wood frame construction wrapped on three sides of each individual frame with minimum 3 ounce pure copper RF medium. The face of shielding material shall comprise exterior surface of enclosure. Construct each individual RF frame with wood plates and high strength adhesive to prevent possibility of "antenna action" that would be caused by metal fasteners. Metal mechanical fasteners such as screws, nails, staples, or other penetrating devices are forbidden. Provide cross bracing, spaced nominally on 32" centers, glued solid on one end and free floating on other end. Provide rigid backing at shielding material to prevent reverberation caused by pressure differentials within enclosure.
 2. Bolt RF panels together to provide continuous, constant and uniform RF seams providing attenuation of electromagnetic energy to the level required by installed MRI system.
 3. Method employed to clamp individual RF panels to enclosure and constituting the RF seams or joints shall conform to requirements of Quality Assurance paragraph.
 4. RF panels shall be capable of being assembled and disassembled numerous times without adversely affecting specified shield attenuation performance.
 5. Wood frames for support of the enclosure shall be 1-3/4 inch thick D-select or better kiln dried pine, FS MM-L-571 D.
 6. Fire-retardant treated glue-laminated beams at ceiling for support of RF ceiling as well as gypsum board furring, acoustical lay-in ceiling, and other finishes indicated on Drawings.
 7. Support Frame Fire Treatment
 - a. Treat RF support frames with a topically applied, Class A UL rated fire retardant solution.
 - b. Pressure treat wood furring strips with fire retardant chemicals which meet UL requirements for FR-S rating.

8. Fasteners: Non-oxidizing, spaced on minimum 8 inch centers or of a distance equal to or less than the quarter wave length of the highest frequency specified for installed MRI system.
- E. RF Shielded Patient Entry Door: Door system shall be visually similar to standard hospital grade interior doors and shall utilize conventional hospital quality hardware.
1. RF Performance: Provide a proven RF seal design that is easily maintained and serviced. The RF door leaf, frame and seal assembly shall maintain a shielding effectiveness equal to that of shielded enclosure.
 2. The RF door system shall have a demonstrated life cycle test rating of at least 10,000 operational cycles without loss of specified RF attenuation. Door system shall demonstrate a life cycle test rating of 50,000 cycles with planned maintenance without loss of specified RF attenuation.
 3. Latch Handles and Trim: Forged brass, finish US26D.
 4. Door Latch: Adjustable integral roller cam latching mechanism, incapable of being mechanically disabled in closed position. Door latching mechanisms containing ferromagnetic parts, or items on either inside or outside of door are forbidden.
 5. Door Lock: Model B250PD, Series 4000, 626 Finish Schlage Night Latch, Conforms to ANSI A156.5.
 6. Door Leaf Hinges: Minimum 4-1/2 inch brass or stainless steel, fully mortised, with minimum of two ball-bearing swing joints per hinge. Provide minimum of three hinges per leaf.
 7. RF Door Finish: Wood veneer, as specified in Section 08211, "Flush Wood Doors".
 8. Provide a RF door interlock switch.
- F. RF Shielded Patient View Window: Construct RF shielded view window assembly utilizing an aluminum extrusion of an engineered shape to affix RF attenuating screens and provide a means of securing double-sided glazing. Treat contact surface of extrusion with brass flame spray.
1. RF Performance: Provide a proven RF seal design that is easily maintained and serviced. RF window frame and seal assembly shall maintain a shielding effectiveness equal to that of the shielded enclosure.
 2. Construct RF screen of a double layer of 304 stainless steel and place layers in a horizontal orientation to each other so that resultant distortion of viewed image through RF shielded window approaches zero.
 3. Stain the visible area of RF screens pure black in color for optimum image visibility.
- G. Heating Ventilation and Air Conditioning
1. Vent Type: Wave guide below cutoff type, 3116 inch brass hex cell, 1 inch in thickness.
 2. Design RF shielded air vents to provide proper air flow as designed, and to maintain a shielding effectiveness equal to that of shielded enclosure.
- H. Intentionally left blank.
- I. Cryogenic Gas Exhaust Wave Guide Vent: Wave guide below cutoff type, size as required by MRI system manufacturer. Construct cryogenic wave guide vent of suitable material to maintain a shielding effectiveness equal to that of shielded enclosure, and to resist, structural failure during a magnet quench event.

1. The mechanical contractor shall provide a dielectric connection to the exterior side of the cryogenic vent of a suitable material to maintain a minimum of 1000 ohms DC resistance to earth ground and resist structural failure during a magnet quench event.
- J. EMI Rated Power Line and Signal Electrical Filters: RF shielded electrical filters shall provide an insertion loss as specified within MIL-STD 220-A, and maintain the shielding effectiveness equal to that of the shielded enclosure. Provide an EMI filter for each electrical conductor that penetrates the enclosure, including neutral conductors. UL ratings will be required for all power line conductors. Design filters to attenuate RF energy on incoming conductor at 100 db from 150 KHz to 10 GHz. Power line and DC lighting EMI filters shall exhibit no greater than 3 milli-amps of leakage current at rated amperage.
1. Non-invasive monitoring filters.
 2. MRI stereo filters.
 3. Telephone and intercom filters.
 4. Feed-thru apertures as required.
- K. Mechanical Pipe Penetrations: Wave guide below cutoff type. Construct pipe penetrations of a material suitable to conditions of service on which it is installed, and to maintain shielding effectiveness equal to that of the shielded enclosure.
- L. Grounding Conductor Terminal: Provide a single point ground conductor terminal using a brass stud and copper bus bar, common to both interior and exterior of enclosure. Locate terminal as close as possible to MRI penetration panel and to EMI power line filters.

2.3 PERFORMANCE

- A. The function of the shielded enclosure is to provide a highly conductive medium (material conductivity of 1 or greater) that will attenuate externally generated electromagnetic energy to a level acceptable for proper operation of the installed MRI Imaging System. The installed enclosure shall, as a minimum, provide functional EMI attenuation to decibel ratings as follows:
1. Magnetic Field
 - a. Frequency range: 1 OMhz -100MHz
 - b. Decibel rating: 90db
 2. Electric Field
 - a. Frequency range: 1 OMHz -100MHz
 - b. Decibel rating: 100db
 3. Plane Wave
 - a. Frequency range: 30MHz -100MHz
 - b. Decibel rating: 100db
- B. Construct installed enclosure so that, without connections to earthing terminal, ohmic value of enclosure relative to earth ground shall be equal to or greater than 1000 ohms.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verify site conditions effecting Work of this Section. Report discrepancies g between building Drawings, shop drawings, and actual field conditions prior to commencing Work. Commence Work after discrepancies have been corrected

3.2 INSTALLATION

- A. Assemble enclosure RF panels into straight walls with true, level and plumb surfaces. Align and secure RF joints.
- B. Perform installation by system manufacturer, or under manufacturer's direct supervision

3.3 TESTING

- A. Test enclosure in accordance with MIL-STD-285, as modified for MRI system installation. Demonstrate the required attenuation as detailed under Performance paragraph.
- B. Qualification Testing: Perform immediately after completion of the enclosure and prior to installation of architectural surfaces within or outside the enclosure. Make no trade connections to enclosure until successful completion of test process.
 - 1. Testing will be witnessed by at a representative of Owner, or by the MRI supplier.
 - 2. Furnish a written test report to Owner and Architect.
- C. Acceptance Testing: Perform immediately after installation of the selected MRI cryostat and closure of the RF entrance panel.
 - 1. Testing will be witnessed by a representative of Owner, or by the MRI supplier.
 - 2. Furnish a written test report to Owner and Architect.
- D. Ground Isolation Monitoring: Monitor ground isolation during entire phase of construction for a minimum of 1000 ohms above earth potential. Immediately correct deficiencies found that are the result of a fault condition caused by the enclosure supplier. Immediately report deficiencies found to be caused by other trades.
 - 1. Testing of actual ground isolation will be witnessed by a representative of Owner, or the MRI supplier.
 - 2. Furnish a written test report to Owner and Architect.

END OF SECTION 13095