

# SECTION 13096 – COPPER MODULAR PANEL RADIO FREQUENCY AND ELECTRO-MAGNETIC SHIELDING (STEEL OPTION)

## PART 1 – GENERAL

### 1.1 SUMMARY

- A. Section Includes: Radio frequency shielding system for the MRI Scan Room and Electro-magnetic shielding. Systems shall consist of the following:
1. Copper sheet for shielding with related supports and fasteners;
  2. Shielded door, frame, and hardware;
  3. Wave guide type air supply and return vents;
  4. RF filters for electrical and communication service;
  5. Wave guide type shielded fittings for all piping penetrating through shield;

### 1.2 REFERENCES

- A. The Editions of standards and specifications published by the following organizations, and referenced herein, apply to the work only to the extent specified by the reference.
1. American Society for Testing and Materials (ASTM)
  2. American Welding Society (AWS)
  3. National Fire Protection Association (NFPA)
  4. National Security Agency (NSA)
  5. U.S. Department of Defense Military Standards (MS)
  6. Underwriters Laboratories, Inc.

### RELATED SECTIONS

- A. Section 08710 - Door Hardware.
- B. Section 08800 - Glazing.
- C. Section 09260 - Gypsum Board Systems.
- D. Section 09650 - Resilient Flooring.
- E. Section 09900 - Painting.
- F. Section 15200 – Medical Gases

- G. Section 15410 - Plumbing Piping.
- H. Section 15890 - Air Conditioning Ductwork.
- I. Section 15900 – Fire Suppression
- J. Section 15990 – HVAC Controls
- K. Section 16123 - Building Wire and Cable.

### 1.3 PERFORMANCE REQUIREMENTS

- A. The function of the RF shielding is to permit an interference free environment with a single ground point and/or to retain RF signals inside the shielded environment. The installed enclosure shall, as a minimum, provide functional RFI attenuation to decibel ratings as follows when tested according to equipment vendor specifications.

### 1.4 SUBMITTALS

- A. Submittal procedures and quantities for the following are specified in Section
  - 1. Product Data: Manufacturer's specifications and other data needed to prove compliance with the specified requirements and manufacturer's recommended installation procedures for both Radio frequency shielding and Electro-magnetic shielding, if required.
  - 2. Shop Drawings in sufficient detail to allow fabrication, installation, anchorage, and interface of the work of this Section with the work of adjacent trades, and including large-scale details and layout showing plan, elevations, details, and other conditions, which affect the shielded enclosure or contiguous work of other trades.
  - 3. Elevation of penetration panel and interior routing of utilities inside the RF shielding after passing through the penetration panel.
  - 4. Coordination drawings with all other subcontractors.
  - 5. Manufacturer's literature and test reports for all components, including UL or other recognized independent testing agency ratings for applicable items.

- B. Closeout Submittals: Submittal procedures and quantities for the following are specified in Section
  - 1. Maintenance Data: Submit three copies of an operation and maintenance manual, including maintenance procedures, trouble shooting procedures, parts list, and service agreement.

## 1.5 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Manufacturer shall have been engaged continuous business for at least 15 years in manufacture and installation of shielded facilities.
- B. Installer Qualifications: trained employee of manufacturer.
- C. Testing Laboratory Qualifications: Certify that test equipment has been calibrated within the last 12 months.
- D. 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.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the job site in undamaged condition. Store material to ensure proper alignment, and protect material against dampness and accumulated moisture before and after delivery. Store materials under cover in a well-ventilated enclosure, and do not allow materials to be exposed to extreme changes in temperature and humidity. Do not store materials in the building until dried and conditions exist.

## SITE READINESS GUIDELINES

The following general conditions are necessary to have the status of "Ready Site":

- 1. The MRI Exam Room and Staging Area shall be weatherproofed, dry (non-condensing, and temperature controlled between 60°F & 90°F. The MRI Exam Room must be free of clutter and debris with the floor broom swept. The

general contractor shall verify these conditions before NELCO delivers the RF Shielding components to the project site.

2. All metallic surfaces such as conduit, duct work & piping that may contact the installed RF enclosure must be (electrically) isolated or removed.
3. The owner or general contractor must provide a clean, dry storage & staging area for lay out & storage of the RF Shield Enclosure components. This area must be adjacent to the installation area (or as close as possible).
4. The RF Enclosure Ceiling Panels are typically supported by the parent room overhead construction, such as bar joist, concrete slab, truss's or beams with the use of adjustable, electrically isolated dielectric hanger rod assemblies that are clamped to the parent room overhead construction and through bolted to the RF Ceiling Panels. Hangers are typically supplied on a four foot grid pattern or field installed where possible.
5. The RF Ceiling System weight or load is approximately 6 pounds per square foot. This weight does not include interior finishes such as magnetic shielding, lighting, duct work, suspended or acoustic ceilings or other finishes or construction. It is the responsibility of the owner to insure that the parent room overhead construction will adequately support the RF Enclosure Ceiling System and any other additional weight.
6. To insure against grounding of the RF Shielded Enclosure, a clearance to the building structure is required. The clearance required between the RF Shielded Enclosure walls and the Parent Room walls varies per installation and site conditions. The minimum clearance between the Parent Room wall and the RF Shielded walls is 2". The minimum clearance between the Parent Room Ceiling & the RF Shielded Ceiling is 8". All RF Shielded surfaces will have no physical electrical or mechanical contact with existing building construction.
7. Installation of the RF Shielded Enclosure will require two (2) 120 VAC, 20 AMP service connections at the installation location. These services must be grounded and comply with any and all applicable local and N.E.C. codes.
8. Location of the magnet isocenter shall be established and marked by others prior to NELCO starting installation of the RF Shielded Enclosure.
9. Final fabrication of the RF Shield Panels cannot be completed until NELCO drawings are approved in writing.

10. The general contractor must provide a secure area for the NELCO installation tools and equipment.
11. The general contractor must provide a secure area for the NELCO installation tools and equipment. The general contractor must provide proper lighting in the area where the RF Shielded Enclosures will be installed.
12. The general contractor or owner must provide refuse containers for the disposal of expendable materials from the RF Enclosure installation site. The general contractor or owner shall be responsible for the removal of the refuse containers.
13. At the completion of the basic RF Enclosure, the NELCO installation supervisor will perform an isolation test to demonstrate that the RF Enclosure is isolated from ground by a minimum of 1,000 OHMS. NELCO will provide a ground alarm; the alarm must remain on throughout the project. During the installation of the various systems into the RF Enclosure, an individual should be designated by the general contractor to check the isolation of the RF Enclosure during the day. NELCO recommends the alarm be checked at least four (4) times daily. If a ground is detected, it can be found by the contractor reviewing the additional systems that were installed into the RF Enclosure after the last successful test.

## 1.7 WARRANTY

- A. General Warranty: The warranties specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Special Enclosure Warranty: Submit a written warranty signed by manufacturer stating that the enclosure installations are guaranteed to be free from defects of materials and workmanship for a period of 5 years after date of "Notice of Completion". Defects include, but are not necessarily limited to, failure to retain the specified RF shielding characteristics based on Owner's proper maintenance, cleaning and service.
- C. The warranty shall be submitted in accordance with specifications requirements.

## PART 2 – PRODUCTS

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Phone: 800-635-2613 / [www.nelco-usa.com](http://www.nelco-usa.com)

NELCO Offices: 800 W. Cummings Park, Ste. 3950  
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Phone: 780-933-1940 / Fax: 781-933-4763

1840 Williams Street  
San Leandro, CA 94577  
Phone: 510-343-8006 / Fax: 510-357-7909

4600 Homestead Road  
Houston, TX 77028  
Phone: 713-577-1003 / Fax: 713-675-4778

125 Chenoweth Lane, Ste. 206  
Louisville, KY 40207  
Phone: 502-899-3726 / Fax: 502-899-3293

## 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 exam room (inclusive of any depicted cable trenching designed flush with finished floor).
  - 1. A sheet copper membrane.
  - 2. Provide electrical isolation of enclosure and RF floor system.
  - 3. Moisture Barrier: Install at concrete floor substrate according to manufacturer's instructions.
  - 4. Membrane Adhesive (if required) Adhere copper membrane to moisture barrier with an adhesive compatible with both copper and moisture barrier.
  - 5. Epoxy Grout Coating: Over-coat copper membrane with a chemically cured epoxy grout. Install grout overcoat to minimum 3/8inch thickness over entire MRI room floor surface. Grout coating shall withstand the direct loading of the magnet cryostat and patient table.
  - 6. Infill Method and Materials for Covers of the Cable Trenches.

- 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 5-ounce pure copper RF medium. The face of shielding material shall comprise exterior surface of enclosure. Construct each individual RF frame with wood plates. Provide cross bracing for support.
  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 with stainless steel fasteners.
  3. Method employed to clamp individual RF panels into enclosure and constituting the RF seams or joins 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 (by NELCO).
  5. Support Frame Fire Treatment
    - a. Pressure treat wood furring strips with fire retardant chemicals, which meet UL requirements for FR-S rating.
    - b. Fasteners structural steel minimum 8-inch centers or of a distance equal to or less than the quarter wavelength 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. All lock cylinders to be furnished and installed by shielding vendor, if required.
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 the shielded enclosure.
  2. Door operation shall be fail-safe.
  3. The door shall have optional remote activation/deactivation capabilities.
  4. Latch Handles and Trim: Forged brass, finish US26D.

5. 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.
6. Door Leaf Hinges: Minimum 4-1/2 inch brass or stainless steel, with minimum of two ball-bearing swing joints per hinge (provide 2 hinges).
7. RF Door Finish: Plastic laminate or wood veneer, as specified by the Owner.

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.

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.
4. Glazing:
  - a. For exam room control wall system – provide 1/4/ inch laminated glass both sides.
  - b. For exam room exterior wall(s) system – provide ¼ inch plate glass on interior side only, on both sides if required.

G. Heating Ventilation and Air Conditioning

1. Vent Type: Wave guide below cutoff type, 3/16-inch brass hex cell, and 1 inch in thickness.
2. Design RF shielded air vents to provide proper airflow as designed, and to maintain shielding effectiveness equal to that of shielded enclosures.

- H. Integral Extruded Aluminum Interior RF Curtain Window Wall system (if required).
  - 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.
  
- 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 vent.
  - 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 ampacity.
  
- 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. Medical Gas Piping Systems.
  
- M. Earthing Conductor Terminal: Provide a single point ground conductor terminal using a brass stud and brass 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 per magnetic vendors specifications.
- 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.

## 2.4 MAGNETIC SHIELDING (If Required)

- A. All magnetic shielding is to be provided and installed per the MRI manufacturer's specifications.
- B. Silicon steel manufacturing requirements:
  - 1. Silicon steel panels shall be pre-engineered.
  - 2. All leveling is to be accomplished at the mill. No uncoiling of silicon steel will be permitted at the job site.

## PART 3 – EXECUTION

### 3.1 PREPARATION

- A. Verify site conditions affecting Work of this section. Report discrepancies 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 manufacturers direct supervision.

### 3.3 TESTING

- A. Test enclosure in accordance with Mil-STD-285, as modified for MR 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. Furnish a written test report to the Owner.
- C. Acceptance Testing: Perform immediately after installation of the selected MRI cryostat and enclosure of the RF entrance panel.
  - 1. Testing can be witnessed by the Owner, and by the MRI supplier at the option of the County Project Director.
  - 2. Furnish a written test report to the Owner.
- D. Ground Isolation Monitoring: The RF shield supplier shall monitor ground isolation during entire phase of the initial RF shield construction for a minimum of 1000 ohms above earth potential. The shield supplier shall immediately correct deficiencies found that are the result of a fault condition caused by the enclosure supplier. The general contractor or other owner's agent shall be required to monitor the shield for ground isolation after the initial RF shield construction and first RF test are completed. Immediately report deficiencies found to be caused by other trades during this period to the RF shielding supplier.
  - 1. Furnish a written test report by Owner.

### 3.4 PROTECTION AND CLEANING

- A. Provide final protection and maintain conditions, which ensure that RF shielding will be without damage or deterioration at time installation is completed.
- B. Remove debris caused by work of this Section, adjust door hardware, and touch up damaged finishes to be invisible to the unaided eye from a distance of five feet.