

SECTION 13 49 00
RADIATION PROTECTION
HIGH DENSITY MODULAR RADIATION SHIELDING

PART 1 - GENERAL

1.01 SECTION INCLUDES:

- A. Applicable provisions of the General Conditions, Supplementary Conditions, Division 1, General Requirements and the related sections apply to the work under this section.
- B. Interlocking Radiation Shielding Modules and related support structure.

1.02 RELATED SECTIONS

- A. Section 05 12 00 - Structural Steel
- B. Section 05 12 10 - Structural Steel Erection
- C. Section 05 50 00 - Miscellaneous Metals

1.03 REFERENCES

- A. Federal Specifications
 - 1. QQL-171 Grade C.
 - 2. QQL-201 F Grade C.
- B. National Council on Radiation Protection (NCRP)
 - 1. NCRP Report No. 51, "Radiation Protection for Particle Accelerator Facilities".
 - 2. NCRP Report No. 79, "Neutron Contamination from Medical Electron Accelerators".
 - 3. NCRP Report No. 91, "Recommendations on Limits or Exposure to Ionizing Radiation.
 - 4. Structural Shielding Design and Evaluation for Megavoltage X and Gama Ray Radiotherapy Facilities.
- C. British Journal Supplement No. 11.
- D. ASTM International (ASTM):
 - 1. ASTM A 36 - Standard Specification for Carbon Structural Steel.
 - 2. ASTM A 366 - Standard Specification for Commercial Steel (CS) Sheet, Carbon (0.15 Maximum Percent) Cold-Rolled.
 - 3. ASTM A 500 - Standard Specification for Cold Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

1.04 DEFINITIONS

- A. Modular/Modules: Radiation shielding components shall be individual elements or modules that are combined together to form a composite structure to create the required radiation attenuating environment.
- B. Interlocking: Modules shall interlock together to form a solid and stable structure comprised primarily of dry stacked module system.
- D. Proper Attenuation: Shielding of all photon, neutron and electron radiation to the levels specified by the governing regulatory agencies as identified in the final physics report.
- E. Radiation Shielded Environment: The overall structure providing the radiation shielding along with associated components such as doors and duct shielding, thus forming the full shielded room.

1.05 SYSTEM DESCRIPTION

A. Furnish all labor, materials and equipment, and perform all work required to install high density modular radiation shielding work as shown on the drawings, including shielding modules, steel support structure, prefabricated metalwork, and all necessary incidental work in connection therewith. Shielding contractor shall be responsible for the radiation shielding design and related physics report, manufacturing, fabrication and installation of the shielding system inclusive of walls, ceiling, duct shielding, and other penetrations as may be required.

1. Detailed physics analysis and shielding design - Shielding system shall ensure proper attenuation of emitted radiation fields to limits prescribed by client physics parameters or governing regulatory agencies.
2. Structural Engineering Design - Furnish and install complete structural support system as necessary to contain and support all items of required radiation shielding.
3. Radiation Shielding - Provide and install all items of radiation shielding work as required for neutron, photon or electron radiation attenuation per contract documents.

1.06 SUBMITTALS

A. Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Guarantee: Written documentation guaranteeing that the design, shielding material and finished installation will meet or exceed the attenuation performance required by the Physicist of Record, or should testing indicate any deficiencies in shielding performance, these will be remedied by the shielding manufacturer at no additional cost.

C. Manufacturer's Physics Report documenting the full shielding design and certifying that the high density interlocking modules and all related items in this section fully comply with the requirements stated by the Physicist of Record.

D. Project manual containing:

- 00 73 16-1.1 Insurance Requirements - Certificate of Insurance
- 01 29 73-1.1 Schedule of Values
- 01 32 16-1.1 Construction Progress Schedule
- 01 32 19-1.1 Submittals Schedule
- 01 35 29-1.1 Health, Safety, and Emergency Response Procedures
- 01 78 23-1.1 Operation and Maintenance Data
- 01 78 36-1.1 Warranties
- 08 34 49-1.1 Radiation Shielding Doors and Frames Data
- 13 49 00-1.1 Product Data – Interlocking Shielding Modules and Grout
- 13 49 00-3.1 CD Submittals

E. Shop Drawings - complete shielded environment, including plan, section, elevation views and all details of construction. Submit shop drawings for any special components or installations not fully dimensioned or detailed in manufacturer's product data. Shop drawings detailing construction and assembly shall be submitted for approval prior to the start of any fabrication.

1. Drawings shall be prepared, signed and sealed by a qualified Professional Engineer. A letter of certification shall state that all structural shop drawings were prepared under their direction, and their seal will appear on all shop drawings.

F. Closeout and Maintenance Documents:

1. Closeout Conference: Including all parties as may be appropriate.
2. Onsite inspection reports and final punch list.
3. Operator manuals, maintenance schedules and contact information as necessary.
4. Shielding Guarantee Certificate

1.07 QUALITY ASSURANCE

- A. Qualifications: Shielding supplier with minimum of 5 years successful experience manufacturing radiation protection products similar to those specified for this project.
- B. Single Source Responsibility: Obtain radiation protection materials and accessories produced as standard products from single manufacturer regularly engaged in production of high energy shielding materials, equipment, and accessories.
- C. Radiation Protection Survey: Employ registered Health Physicist, certified by American Board of Radiology, for testing specified radiation protective work and to conduct radiation protection survey of facility.
- D. Radiation Protection Work: Shall comply with National Council of Radiation Protection (NCRP) Report No. 049 - Structural Shielding Design and Evaluation for Medical Use of Gamma Rays of Energies up to 18 MV.
1. Comply with requirements of local regulatory agencies where local standards and criteria exceed requirements for NCRP Report No. 049.
 2. Shall be installed per the recommended practices of National Council on Radiation Protection as outlined in handbooks #151, #51 (#144) and #49.
- E. Guarantee: Completed installation must be 100% guaranteed to meet agreed upon shielding requirements applicable at the time of contract, and that any shielding deficiencies will be rectified by the shielding manufacturer at no additional charge.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's instructions for receiving, handling, storing, and protecting materials.
1. Provide reasonable access to the building site and protect existing floors, carpets, tile, plumbing/electric stub up fixtures, walls, etc. as necessary.
 2. Provide hard surfaced storage area capable of supporting 2 ton pallets.
 3. Ensure that all routes into the building site to be accessible and capable of supporting the loads noted herein.
- B. Exercise care to prevent damage to individual modules.

1.09 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

1.10 SCHEDULING WITH OTHER WORK:

- A. Coordinate with other trades to ensure they have ample opportunity to build in their work as the shielding work progresses.

1.10 PRE-INSTALLATION MEETINGS

- A. There shall be a pre-installation conference at the job site at the beginning of the project, or at least two months prior to shielding installation to review all requirements of construction including shielding placement, protection and inspection.
- B. Conduct the conference to comply with the requirements in Division 01 Section "Project Management and Coordination". Review methods and procedures related to radiation protection.
1. The shielding subcontractor shall prepare a comprehensive "Shielding Construction Plan (SCP)" addressing all procedures associated with supply and placement of the shielding and associated

assemblies. Submit plan to Architect and Owner's Testing and Inspection Agency a minimum of seven (7) days prior to Pre-installation Conference. SCP to include:

- a. Shielding design and door system requirements.
- b. Consistency of materials.
- c. Staging, scheduling and access.
- d. Sufficient plant and field manpower.
- e. Procedures for placement with sufficient backup equipment.
- f. Coordination with other trades.
- g. Inspections and acceptances.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. To ensure that all shielding design criteria are met, the specifications and construction drawings are based on the use of High Density Shielding Modules as manufactured by:

Veritas Medical Solutions, LLC,
160 Cassell Road, Harleysville, PA 19438
Phone: 484.991.8928
www.veritas-medicalsolutions.com

B. Requests for substitutions will be considered in accordance with provisions of Section 01600.

2.02 HIGH DENSITY SHIELDING MODULES

A. Provide High Density VeriShield® interlocking modules in full and half module increments.

1. Cementitious modular shielding with a sine wave shape.
2. 100% interlocking edge with no straight line seams.
3. Interlocking blocks shall be supplied in two thicknesses so as to allow for the offsetting of the various layers of modules. No wall ties shall be required. Block shall stack to provide a stable, structural construction.
 - a. Full modules - 10" (254mm) by 5" (127mm) by 5" (127mm).
 - b. Half modules - 10" (254mm) by 2 1/2" (64mm) by 5" (127mm).
4. Minimum 2,800 lbs./sq. in. compressive strength
5. Provide appropriate density modules to fully meet Physics Requirements.
 - a. 150 lbs./cu. ft.
 - b. 220 lbs./cu.ft.
 - c. 250 lbs./cu.ft.
 - d. 300 lbs./cu.ft.
6. Individual units shall not exceed 45 lb. maximum safe handling limit. No special lifting devices or safety machinery shall be required.

2.03 MORTAR AND GROUT

A. Grout used for infilling structural or penetration voids shall be provided by the manufacturer in a density corresponding to the density of the shielding modules.

B. Mortar used for levelling shall be freshly mixed and shall be proportioned with 1 part cement, 1 part lime and 6 cu.ft. sand (Type N mix). Mortar shall comply with ASTM C270 for Type N mortar (750 psi compressive strength).

2.04 RADIATION ATTENUATION

- A. Modules shall be placed at a proper thickness and density to attenuate all photon and neutron radiation produced to acceptable levels as prescribed by the physicist of record and other Governing Regulator Agencies.
- B. Built-In Items: Where items penetrate shielding, manufacturer shall provide grout as required to maintain the continuity of shielding. Install in accordance with manufacturer's instructions.
- C. Where outlet boxes, junction boxes, ducts, conduit and similar items penetrate shield walls or ceilings the shielding subcontractor shall provide shielded baffles and/or overlaps to maintain the integrity of design shielding and eliminate any paths for radiation "streaming" or "channeling" effects.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Examine areas and conditions under which work is to be performed and identify and correct conditions detrimental to proper or timely completion.
- 8. Prior to installation of interlocking modules, carefully inspect all prior work of other trades that may impact on the installation of the shielding to insure that conditions are acceptable.
- C. Do not proceed until any unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF MODULAR SHIELDING

- A. Determine boundaries for all walls, doors and equipment.
- 8. Layout of Work: Before starting module installation, lay out all walls, space individual block coursing accurately based upon manufacturer drawings, and lay out course lengths to minimize cutting of interlocking block.
- C. Installation: Lay first course of interlocking modules in full bed of mortar, plumb, true to line and level. Before placing additional layers, be sure to remove any debris, flashing, etc. that may be attached to the block.
- D. Place all interlocking block in a modified running bond pattern. See manufacturer drawings for specific details. Do not use mortar between each course.
- E. Every fifth course, offset the layer by using half modules to fully interlock with previous block layer. Lay this course in a leveling bed of 3/8" maximum thickness of mortar.
- F. Pack all voids, intersection areas, etc. with high density grout to insure shielding integrity.
- G. Build in all frames, cable raceways, electrical, plumbing and HVAC penetrations as required. Pack around all penetrations with high density grout.

3.03 INSTALLATION OF PENETRATING ITEMS

- A. At penetrations, provide shielding to maintain continuity of protection. Refer to manufacturers drawings. Provide sleeves, shields, and other protection in thickness not less than that required in assembly being penetrated.
- B. Duct Penetrations will be located either on the wall or on the roof. Refer to manufacturers drawings.

3.06 FIELD QUALITY CONTROL

- A. Field Inspection: Owner will engage qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Shielding manufacturer will correct deficiencies in, or remove and replace, all radiation protection that inspection reports indicate does not comply with specified requirements.

3.07 CLEANING

- A. Cleaning work will be conducted per Section 01 73 00 – Execution.

- B. Remove excess materials from site daily. Vacuum surfaces in compliance with OSHA Standard 1926.62.
- C. Leave exposed surfaces ready for site finishing

3.08 PROTECTION

- A. Take reasonable care to protect installed materials from damage. Repair any existing materials that may be damaged by shielding work to match original.