

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. This section includes: The requirements for furnishing and installing Neutron Shielding and X-Ray Protection Materials for Linear Accelerators including Borated Polyethylene, Neutron Putty, Neutron Shielded Doors and frame, Lead Sheet, Lead Plate, Interlocking Lead bricks, lead backed gypsum wallboard, lead lined doors, lead lining of door frames and related shielding materials and products.

**1.02 RELATED DOCUMENTS**

- A. The requirements of the General Conditions, Supplementary Conditions, and Division 1, General Requirements apply to the work of this Section.
- B. Section 09 2960-Lead Backed Drywall, Section 13090 X-Ray Protection and Section 083449 Lead Lined Hollow Metal Doors, as applicable.

**1.03 QUALITY ASSURANCE**

- A. **Standards:** Comply with all applicable requirements of National Council on Radiation Protection and Measurement (NCRP) Report No. 147 titled "Structural Shielding and Design Evaluation for Medical Use of X-rays and Gamma Rays of Energies up to 10MeV" and NCRP Report No. 51 "Radiation Protection Design Guidelines for 0.1-100 MeV Particle Accelerator Facilities"
  - 1. Comply with any applicable requirements of local, state or federal regulatory agencies where building or safety standards or criteria exceed NCRP Report Numbers 49,51 and 147.
- B. **Acceptable Manufacturer:** Ray-Bar Engineering Corporation, Toll Free (800) 444-XRAY (9729) Phone:(626) 969-1818 · Fax (800) 333-XRAY(9729) · www.raybar.com · e-mail:sales@raybar.com / (or approved equal with similar experience). A recognized manufacturer regularly engaged in the successful production of the products as specified herein for over 70 years.
- C. **Fabricator-Installer Qualifications:** Fabricator-Installer shall be experienced in and equipped for work of fabrication and installation equal to standards specified. The contractor shall furnish evidence of Fabricator-Installer having not less than twenty (20) years experience in successful fabrication-installation of radiation protection similar to work specified herein utilizing properly trained personnel with good hygiene practices and proper lead handling training and procedures meeting all applicable OSHA requirements.
  - 1. Fabricator-Installer shall furnish proof of insurance certifying Fabricator-Installer is specifically insured in the fabrication and installation of X-ray Protection Materials for Shielding.

**1.04 SUBMITTALS**

- A. **Product Data:** Submit manufacturers printed data and specifications for each item of radiation shielding and accessories proposed for use and indicate compliance with all applicable building and safety codes.
- B. **Shop Drawings:** Submit shop drawings indicating thickness of lead, in compliance with Radiation Shielding Report, details of construction products and all other details to clearly define method of installation to assure that the required lead shielding protection will be obtained.
- C. **Certification:** Submit at completion of work, certificate of compliance from manufacturer and Fabricator-Installer stating that all material has been produced and installed in accordance with this specification.

## 1.05 DELIVERY, STORAGE AND HANDLING

- A. **Leadlined Door Frames:** Comply with requirements of Section 08 1420-Steel Doors and Frames.
- B. **Lead-lined Hollow Metal Doors:** Comply with requirements of Section 08 1400, as applicable.  
Specifically 08 3440 – Radiation Protection Doors or  
**Product Handling:** Keep flat until ready to use. NEVER store outdoors, Never store in sun or near moisture.
- C. **Lead Backed Gypsum Wallboard:** Comply with requirements of Section 09 2900- Gypsum Board.  
Specifically 09 2960 – Lead Backed Drywall. Follow all manufacturer and lead MSDS requirements.  
**Product Handling:** Keep flat until ready to use. NEVER store outdoors, Never store in sun or near moisture.
- D. Borated Polyethylene:  
**Product Handling:** Follow Manufacturer/Fabricator specific MSDS handling instructions and storage requirements to prevent damage. Keep flat to avoid cracking or breakage. Never store outdoors.
- F. **Lead Plate, Lead Sheet. Interlocking Lead Brick:** Follow Manufacturer/Fabricator specific MSDS handling instructions and storage requirements to prevent damage. Wear personal protection and never store outdoors. Comply with all applicable OSHA safety rules and always recycle lead trimmings.

## PART 2 – PRODUCTS

### 2.01 APPROVED MANUFACTURERS

- A. Ray-Bar Engineering Corporation, Ray-Bar Engineering Corporation, Toll Free (800)444-XRAY (9729) Phone:(626) 969-1818 · Fax (800)333-XRAY(9729) · www.raybar.com · e-mail:sales@ray-bar.com / (no known equal). A recognized domestic manufacturer regularly engaged in the production of X-Ray Protection Materials for over 70 years (no known equal).

### 2.02 MATERIALS AND FABRICATION

- A. **Lead Sheet, Lead Plate and Interlocking Lead Brick:** In compliance with Federal Specification QQ-L-201f, Grade C, 99.9% pure, and ASTM B 749, Type L51121. Thickness as indicated on Lead Protection Schedule in single or multiple layers to meet total lead requirements at locations as noted on plans and radiation physicist shielding report.
- B. **Lead Backed Gypsum Board:** As manufactured by Ray-Bar Engineering Corporation; ASTM C 36, and as follows:
  - 1. **Sheet Size:** Width and length as required for support spacing to prevent cracking during handling. Not to exceed 4'0" X 10'0", Type X Standard (RB-LBG), also available in Abuse Resistant (AR), Mold Resistant (MR), Water Resistant (WR) and High Impact (HI) gypsum panels where required.
  - 2. **Thickness:** Not less than 5/8" inch - unless otherwise indicated
  - 3. A single thickness of unpierced lead sheet must be laminated to the back of gypsum board units with lead thickness value clearly identified on each sheet. Lead thickness as indicated on Lead Protection Schedule.  
Provide minimum 1-1/2" wide lead batten strips for lapping at all vertical joints and inside and outside vertical corners, same height and lead thickness as on lead backed gypsum board.
- C. **Fire rated lead backed 5/8" gypsum board** (type RB-LBG) to be utilized at any fire rated lead lined partitions (such as partition design U430) and identified with proper yellow U.L Label laminated on actual lead side indicating shielding material manufacturer and current fire resistance listing and U.L. classification per the current U.L. certification directory and as tested in accordance with the standard fire test of building construction and materials per ANSI / UL263 (ASTM E119, NFPA 251). There are absolutely no substitutions allowed by UL.

1. **Accessories and Fasteners:** Manufacturer's standards, maintaining the equivalent protection as the system. Lead shielding of fasteners: size, type and design as recommended by the manufacturer of protection system such as lead discs or tabs, or simply 1-1/4" long steel screws when appropriate per NCRP Report No. 147 and approved in advance prior to installation by physicist of record for 1/16" / 4# lead areas or less.

**D. Lead Lined Hollow Metal Doors:** Comply with applicable requirements of Section 083449 as applicable.

1. Fabricate doors of hollow metal construction with one or more continuous unpierced lead sheets to make up total lead thickness as indicated. Apply lead sheet continuously from top to bottom and edge to edge. Lead lining may be constructed in core at manufacturer's option. Lead must be the same thickness as the partition in which door opening occurs in. Top of door to be clearly marked with manufacturers name and lead thickness.
2. Shield cutouts for lock sets with sheet lead lapping, lead lining of lock sets or door lining, of equal thickness lead as used in door of same opening.

**E. Leadlined Hollow Metal Door Frames:** Comply with requirements of Section 08 1420-Steel Doors and Frames.

1. Provide additional reinforcements and internal supports to adequately carry weight of lead lined doors. Perform all such work before installation of any lead lining into frames.
2. Either concrete cast in place or line inside of frames with unpierced strips of sheet lead of not less than same thickness as lead in doors and walls in which installed. Form lead sheet to match contour of frame on radiation exposure side of frame, continuous in each jamb and across head and over lap into formed stop. Form lead shields around areas prepared to receive hardware. Fabricate lead lining wide enough to maintain an effective 1/2" minimum overlap lap with lead of same thickness value as adjoining shielding.

**F. Lead Sheet, Lead Plate and Interlocking Lead Brick:** 99.9% pure lead meeting Federal Specification QQ-L-201F Grade C and ASTM B749-85 Type L51121.

1. Install in single or multiple layers to meet total shielding thickness required, stagger and overlap all vertical and horizontal joints by a minimum of 1/2" or more. Interlocking bricks provide proper overlaps by design.

**G. Borated Polyethylene:** minimum of 5% boron content of homogeneous consistency and density throughout polyethylene panel, also available as High Density when fire resistance is required.

1. Sizes: Up to 48" x 96" maximum panel size, or cut to size by manufacturer or by installer.
2. Thickness: 1" thick, or in multiple layers to meet shielding requirements.

**Neutron Shielded Door and Frame:** Steel Fabrication painted with rust resistant primer finish, and borated polyethylene and lead core as required per the radiation physicist shielding report. Door and frame as manufactured by Ray-Bar Engineering Corp Toll Free (800) 444-XRAY Phone (626) 969-1818 • Fax (800) 333-XRAY(9729) email: sales@raybar.com • www.raybar.com (or approved equal of similar documented experience)

1. **Door Faces:** 1/4" thick steel of prime quality cold rolled, pickled carbon steel conforming to ASTM #A366
2. **Door Edges:** 1/2" thick steel of prime quality cold rolled, pickled carbon steel conforming to ASTM #A366
3. **Door Core:** \_\_\_" of 5% Borated Polyethylene (BPE) and \_\_\_" pure lead plate per FS QQ-L-201F Grade C. Reference radiation physicist shielding report for required thickness of borated polyethylene and lead.
4. **Hinges:** Heavy Duty Full Surface Mounted Hinges of sufficient capacity for total door weight, with adjustable height feature, and bolt on installation with high strength bolts.
5. **Frame:** 1/4" formed steel to required wall throat thickness single rabbit frame profile, with additional steel reinforcement at hinge locations, welded at mitered corners with internal welded anchors for high density concrete cast in place installation. Frame to be painted with rust resistant primer.

**6. Power Operation:** Supplied and installed by others, of sufficient capacity rating to properly control total door weight during entire opening and closing functions. Must have all required safety features, disconnects, interlocks and sensors to meet ANSI and all applicable safety codes. Manufacturer/supplier must have 10 years documented experience in successfully providing power operation on similar weight doors in medical facilities.

## **PART 3 - EXECUTION**

### **3.01 INSTALLATION**

#### **A. Lead Backed Gypsum Wallboard**

1. Apply gypsum board vertically with long edges parallel to supports and lead lining facing supports and lead lining facing supports. Provide blocking at end joints. Install lead strips minimum 1-1/2 inches wide and same height and thickness as gypsum board lead lining to inside of face of supports and blocking where all vertical joints, inside and outside corners occur. Secure lead batten strips to studs, lead shielding to 7'0" high, minimum national standard on walls (unless otherwise noted). No untrained persons or trades to occupy room or work area during any lead material installation per OSHA requirements.
2. Secure gypsum board to supports with fasteners spaced as recommended by board manufacturer. Drive fasteners slightly below exposed surface and shield with either lead discs, tabs or internally with 1-1/2" wide batten strips, or simply 1-1/4" long steel screws when appropriate if 1/16" lead or less per NCRP Report No. 147 and specifically approved in advance by project radiation physicist of record prior to installation.
3. Refer to Section 09250 for joint treatment and preparation for taping and finishing.

#### **B. Lead Sheet, Lead Plate and Interlocking Lead bricks**

1. Install lead sheet and plate shielding products in single or multiple layers to meet total lead shielding requirements per radiation shielding report at each location. Stagger and overlap all vertical and horizontal joints by 1/2" minimum and keep all joints tight.
2. Interlocking Lead bricks of proper thickness required are tightly stacked with built in a keyway interlock design. Any gaps can be gently tapped together with a hand mallet or filled with lead wool.

#### **C. Neutron Shielded Door and Frame**

1. Neutron Shielded Door and Frame and factory pre-hung as a modular unit to be carefully formed and set in place true, plumb, square, and level by experienced professional concrete tradesmen. Frame and door are to be cast in place with high density concrete of a density as specified by radiation physicist or a minimum 147 lbs per cubic foot dry weight per NCRP or whichever is greater, and free of any voids, butt joints or cold joints. All formed or cast concrete joints must be "keyway" overlapped or interlock type joints.

### **3.02 BUILT-IN ITEMS**

A. Leadlined Doors and Frames: Refer to Section 08100, "Steel Doors and Frames" for installation requirements of leadlined metal door frames, and refer to Section 08211 or 083449 Lead Lined Hollow Metal, for installation requirements.

1. Finish hardware is specified in Door Hardware Section. Locksets are to be leadlined.

B. Built-In Items: Where other built-in items penetrate shielding materials, provide borated polyethylene, neutron putty, and /or lead shielding of same thickness as in surrounding wall partition as required to maintain continuity of shielding system. Install in strict accordance with manufacturer's instructions and recommendations.

C. Surface mount any utilities when possible. No through penetrations are permitted. All penetrations should be baffled or staggered. Shielding material manufacturer can provide details on proper shielding solutions for various project penetration conditions meeting applicable NCRP requirements. Where recessed outlet boxes, junction boxes, ducts, conduit and similar items prevent the use of shields, provide borated polyethylene, neutron putty or lead sleeves or lead lining or backing as required per radiation physicist report to compensate for displaced concrete or other shielding materials with proper overlaps.

1. Provide borated shielding materials, lead lining, sleeves, shields and other products of equivalent shielding protection as used in the wall partition shielding system that each penetration occurs in.

2. Thoroughly HEPA vacuum , clean up and properly recycle all lead trimmings and debris carefully following MSDS instructions. Never dispose of any lead materials in general trash or refuse.

### **3.03 CERTIFICATION**

- A. Upon completion of Radiation Shielding, the Manufacturer and Fabricator-Installer shall furnish a certificate of compliance stating that all materials provided are in accordance with this specification and the radiation physicist shielding report.

### **3.04 TESTING**

- A. After the intended radiation equipment has been installed and placed in operating condition, and prior to any occupancy and use, the radiation shielding will be tested by the original calculating project health radiation physicist of record at Owners expense.

**END OF SECTION 13 49 00.13 NEUTRON SHIELDING**