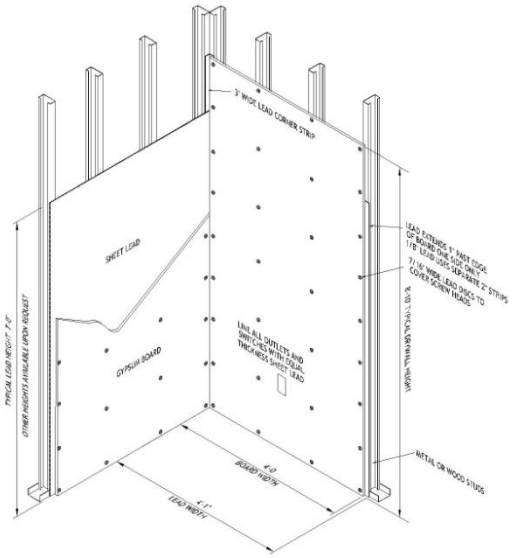
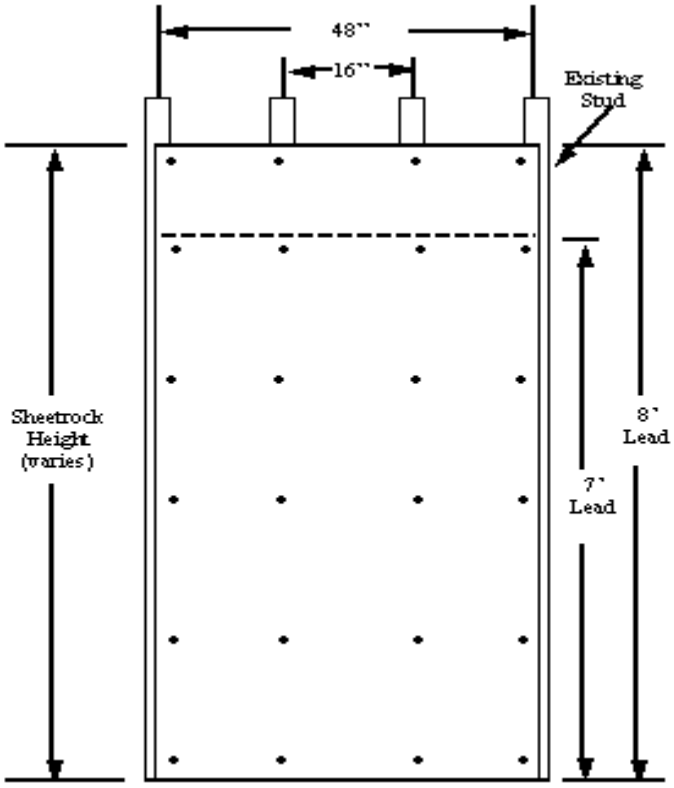
Direct Scientific www.drct.om
tel (310) 589-0601
email: sales@drct.com



Our **gypsum board for radiation shielding** is supplied on either 1/2-inch or 5/8-inch thicknesses, standard 48-inch width. 5/8-inch panels meet type "X" fire code gypsum board classification ASTM C1396. The gypsum wall board is backed with a continuous piece of pure lead sheet (99.5 percent or better) made to Federal Specification QQ-L-201f, Grade B or Grade C. The lead sheet is laminated in the factory to the back side of the wallboard panels.

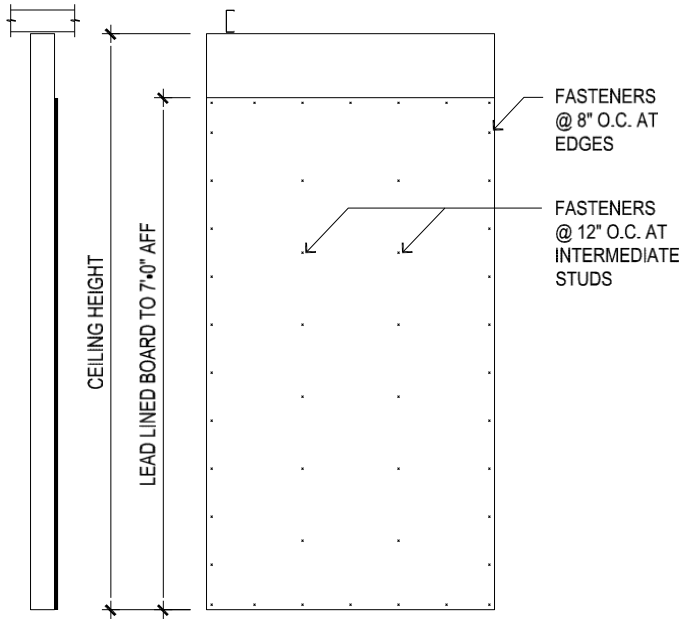
Installation: Lead-lined gypsum board should be fastened to support studs every 12 to 16 inches horizontally & vertically every 8 inches on edges & every 12 inches within the field of each board. 2-inch lead strips should be glued or screwed on to each of the support wall studs, to make sure there are overlaps at all joints. We also supplies lead corners, lead discs for screw penetrations, as well as sheet lead for the backing and shielding of cut-outs for electrical, plumbing, medical gas or other penetrations.

Board sizes:	*** Lead Sheet Thickness**	**Board Thicknesses**	**Accessories**
• 4 ft X 8 ft • 4 ft X 9 ft • 4 ft x 10 ft • 4 ft x 12 ft	• 1/32 in (2-lb. / 2#) • 1/24 in (2.5-lb. / 2.5#) • 3/64 in (3-lb. / 3#) • 1/16 in (4-lb. / 4#) • 3/32 in (6-lb. / 6#) • 1/8 in (8-lb. / 8#) 1/64" lead also available upon request	• 1/2 inch • 5/8 inch 	• lead discs for screw penetrations • Lead Strip • Lead Sheet • Lead Corners

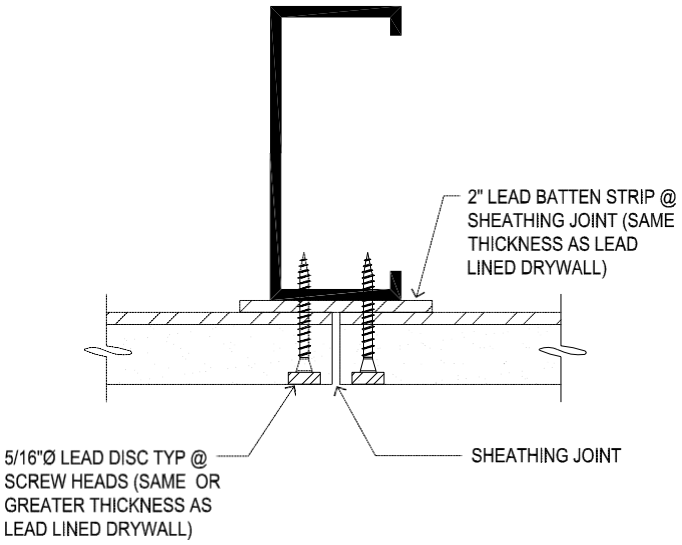

48"
16"
Existing
Stud
Sheetrock
Height
(varies)
8'
Lead
7'
Lead

RADIATION SHIELDING

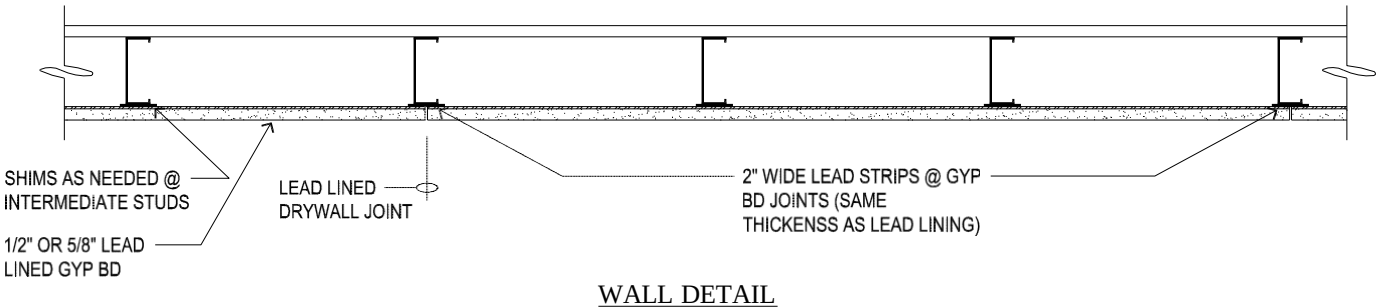
LEAD LINED DRYWALL



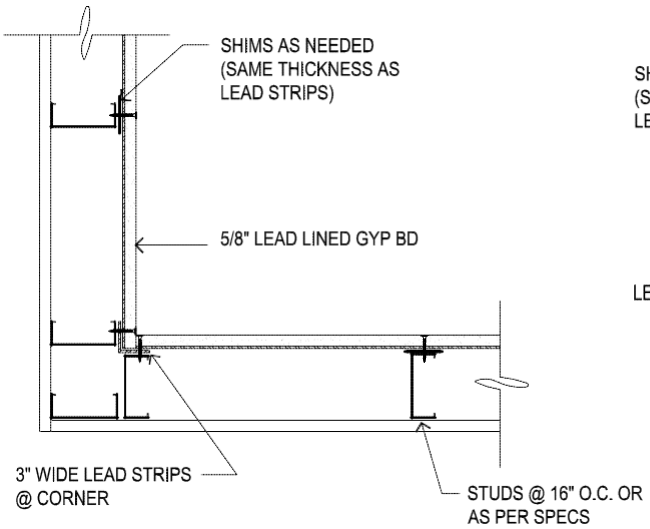
LEAD LINED GYPSUM BOARD
TO HEIGHT INDICATED



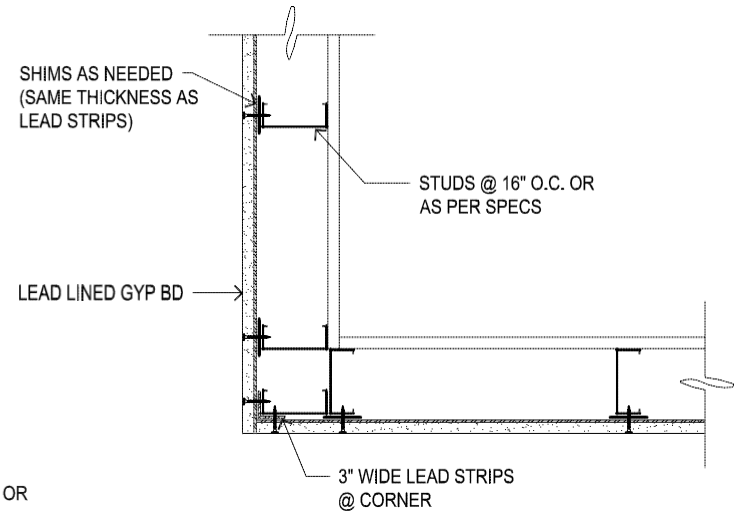
TYPICAL JOINT
DETAIL



WALL DETAIL



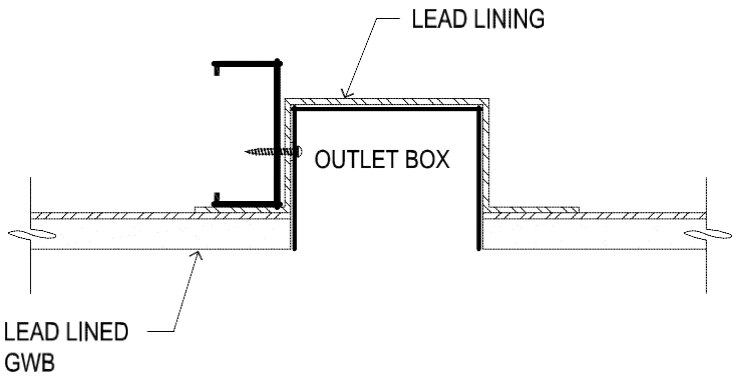
INSIDE CORNER STUDS



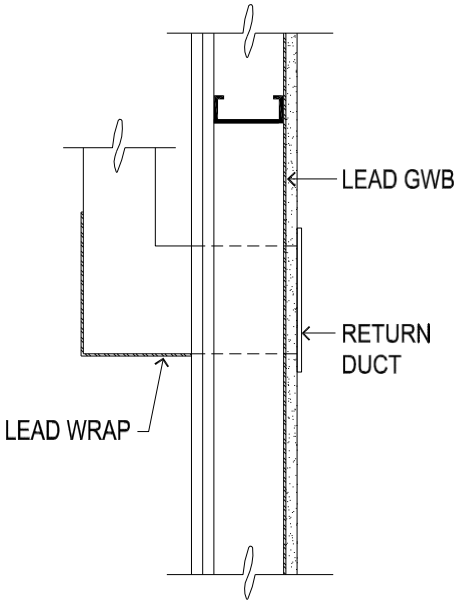
OUTSIDE CORNER STUDS

RADIATION SHIELDING

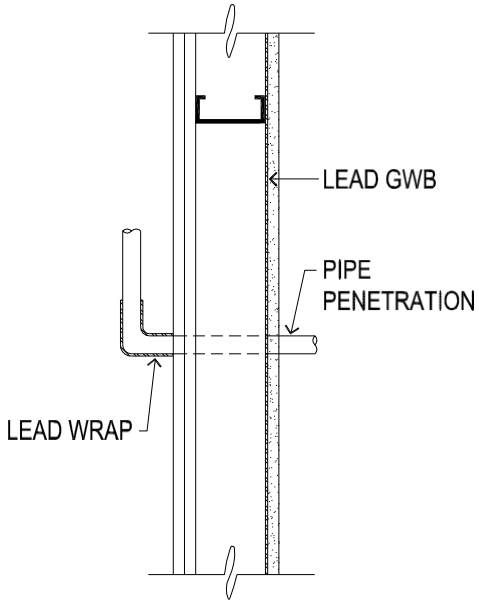
DRYWALL CUT OUTS AND PENETRATIONS



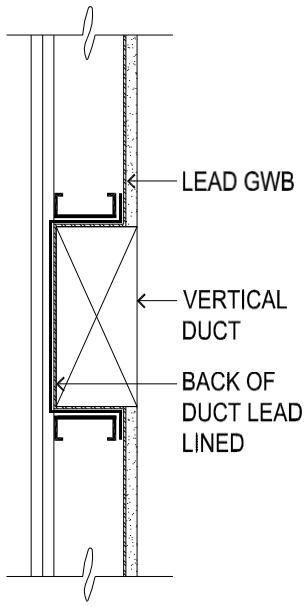
LEAD FOR OUTLET BOXES AND
SWITCH BOXES



THRU DUCT WRAP



TYP PIPE WRAP



WALL DUCT

RADIATION SHIELDING

LEAD LINED DRYWALL INSTALLATION INFORMATION

Lead-Laminated Gypsum Board: Single unpierced layer of sheet lead laminated to back of gypsum board.

Lead Lined Drywall (also referred to as Lead Lined Sheetrock or Lead Lined Gypsum) supplied with lead lining bonded to 1/2" or 5/8" drywall.

2" lead batten strips of the same lead thickness and height of lead lined drywall are required to provide the necessary 1" overlap with adjoining Lead Lined Drywall sheets.

5/16" diameter lead discs, same thickness as sheet lead, may be required at screw heads. Lead angle of same thickness lead may be used in place of discs.

3" minimum lead corner batten strips, same lead thickness and height of lead lined drywall, are required for inside and outside corners of wall intersections. This lead is bent on angle to create a 1-1/2" center on both sides of lead.

Screw Fasteners: Type S Bugle Head, length as required.

The Lead Lined Drywall should be fastened at a minimum of 8" on center at the edges of each sheet, and at minimum of 12" on center at the intermediate studs with normal drywall screws.

Comply with manufacturer's recommendations for wrapping electrical outlet boxes, view window frames, and other penetrations through lead barrier material with sheet lead to provide radiation protection to levels indicated or levels required to match adjacent wall protection.

Wherever lead protection is penetrated, cut, or punctured, assure continuity of shielding by use of sheet lead (same thickness as sheet lead), lead plugs or other approved method.

Install sheet lead lining within steel door frames to provide radiation protection to levels indicated or levels required to match adjacent wall protection.

SECTION 13 49 00

RADIATION PROTECTION

Display hidden notes to Specifier. (Don't know how? **Click Here**)

Specifier Note: This guide specification is written according to the Construction Specifications Institute (CSI) 2010 MasterFormat and 2008 Section Format outline. This section must be carefully reviewed and edited by the Architect or Engineer to meet the requirements of the project. Coordinate this section with other related specification sections and the Drawings. Note: **["Red text" within brackets]** indicates a choice to be made by the Specifier.

Specifier Note: The current NCRP (National Council of Radiation Protection) Report #151 (2005) 1.10 General Concepts, states:

"The term qualified expert used in this Report is defined as a medical physicist or a health physicist who is competent to design radiation shielding in radiotherapy facilities, and who is certified by the American Board of Radiology, American Board of Medical Physics, American Board of Health Physics, or the Canadian College of Physicists in Medicine."

"Radiation shielding shall be designed by a qualified expert to ensure the required degree of protection is achieved."

"The qualified expert should be consulted during the early planning stages since the shielding requirements may affect the choice of location of radiation facilities and type of building construction. The qualified expert should be provided with all pertinent information regarding the proposed radiation equipment and its use, type of building construction, and occupancy of nearby areas. It may be necessary to submit the final shielding drawings and specifications to pertinent regulatory agencies for review prior to construction."

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: X-Ray radiation protection products:

Specifier Note: Edit the list of radiation products as required for the project. Add other products that directly relate to this section.

1. Lead sheet.
2. Lead plate.
3. Interlocking lead bricks.
4. Lead-laminated gypsum board.
5. Lead-laminated plywood.
6. Structural laminated steel sheet.
7. Radiation shielding leaded glass.

8. Radiation shielding leaded acrylic.
9. Lead-lined telescopic view window frames.
10. Lead-lined two-piece slip window frames.
11. Lead-lined radiation-shielded solid core wood doors.
12. Lead-lined hollow metal door frames.
13. Related accessories.

B. Related Sections:

Specifier Note: Edit the list of Related Sections as required for the project. List other sections that directly relate to this section.

1. Section 06 10 00 - Rough Carpentry.
2. Section 08 11 13 - Hollow-Metal Doors and Frames.
3. Section 08 14 16 - Flush Wood Doors.
4. Section 09 22 16 - Non-Structural Metal Framing: Interior metal framing to receive radiation protection products.
5. Section 09 29 00 - Gypsum Board: Joint taping and finishing of lead-laminated gypsum board.
6. Section 09 91 00 - Painting: Field-applied primers and finish painting.

1.2 DEFINITIONS

A. Lead Equivalence: Thickness of lead that provides same attenuation (reduction of radiation passing through) as material in question under specified conditions. Lead equivalence specified for materials used in diagnostic X-Ray rooms is measured at 150 kV unless indicated otherwise.

1.3 REFERENCES

A. American National Standards Institute – ANSI:
1. Fire Resistance Ratings – ANSI / UL 263.

B. American Society of Testing and Materials:
1. ASTM B749 – Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.
2. ASTM C 954: Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness.
3. ASTM C 1002: Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
4. ASTM C 1396 – Standard Specification for Gypsum Board.
5. ASTM C 1629 – Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels.
6. ASTM - D 3273 – Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
7. ASTM E 119 – Fire Tests of Building Construction and Materials.

C. American Wood Products Association (AWPA) C27 – Fire Retardant Treatment by Pressure Processes.

D. Federal Specification QQL-201f, Grade B or Grade C.

E. Hollow Metal Manufacturers Association (HMMA) 840 – Installation and Storage of Hollow Metal Doors.

F. National Council on Radiation Protection and Measurements (NCRP):
1. NCRP Report No. 145 – Radiation Protection in Dentistry.
2. NCRP Report No. 147 – Structural Shielding for Medical X-Ray Imaging Facilities.
3. NCRP Report No. 151 – Structural Shielding Design and Evaluation for Megavoltage X- and Gamma Ray Radiotherapy Facilities.

G. Steel Door Institute (SDI)-100 – Recommended Specifications for Standard Steel Doors and Frames.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Pre-Installation Meetings: Conduct pre-installation meeting to coordinate radiation protection survey and verify project requirements and substrate conditions.

1.5 ACTION SUBMITTALS

A. Submit under provisions of “Section 01 33 00 - Submittal Procedures.”

B. Product Data: Manufacturer's data sheets on each product to be used.

C. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

Specifier Note: Product Certificates for Credit MR 5" Subparagraph below applies to LEED-NC, LEED-CS, and LEED for Schools.

2. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials, certificates indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating distance to Project, cost for each regional material, and fraction by weight that is considered regional.

Specifier Note: Product Certificates for Credit MR 5" Subparagraph below applies to LEED-CI. Retain option for Credit MR 5, Option 2.

3. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regionally manufactured [and regionally extracted and manufactured] materials. Include statement indicating cost for each regionally manufactured material.

Specifier Note: First subparagraph below applies to LEED-CI Credit MR 5, Option 1 and Option 2

a. Include statement indicating location of manufacturer and distance to Project for each regionally manufactured material.

Specifier Note: First subparagraph below applies to LEED-CI Credit MR 5, Option 2

b. Include statement indicating location of manufacturer and point of extraction, harvest, or recovery for each raw material used in regionally extracted and manufactured materials. Indicate distance to Project and fraction by weight of each regionally manufactured material that is regionally extracted.

Specifier Note: Product Data for Credit IEQ 4.1" Subparagraph below applies to LEED-NC, LEED-CI, and LEED-CS; coordinate with requirements for adhesives.

4. Product Data for Credit IEQ 4.1: For adhesives used to laminate gypsum board panels to substrates, documentation including printed statement of VOC content.

Specifier Note: Laboratory Test Reports for Credit IEQ 4" Subparagraph below applies to LEED for Schools.

5. Laboratory Test Reports for Credit IEQ 4: For adhesives used to laminate gypsum board panels to substrates, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Shop Drawings:

1. Indicate layout of radiation-protected areas.
2. Indicate details, dimensions, finishes, and interface with adjoining work.
3. Indicate lead thickness or lead equivalencies of components.

E. Initial Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.

F. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (152 mm) square, representing actual product, color, and patterns.

1.6 INFORMATIONAL SUBMITTALS

A. Manufacturer's Certificates:
   1. Certificate that leaded glazing capabilities meet or exceed specified requirements.
   2. Certificate of compliance with applicable provisions of the National Council of Radiation Protection (NCRP).

B. Manufacturer's Instructions:
   1. Preparation and installation instructions and recommendations.
   2. Storage and handling requirements and recommendations.

C. Qualification Statements:
   1. Manufacturer.
   2. Installer.
   3. X-ray physicist.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: Cleaning instructions for leaded and acrylic glass.

B. Record Documentation: Record Drawings, with dimensions, showing locations of radiation protection.

C. Radiation Protection Survey: Record copy of physicist's Radiation Protection Survey indicating measurements and evaluation of measurements of installed radiation shielding materials.

D. Manufacturer's Certification: Upon completion of radiation protection work, Manufacturer and Installer shall furnish a certificate of compliance that all materials are in accordance with the specifications and physicist's radiation protection survey.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company with minimum of five (5) years successful experience specializing in manufacturing radiation protection products similar to those specified in the section.

B. Installer Qualifications: Company specializing in performing the work of this section with minimum five (5) years documented experience.

C. Radiation Protection Work: Comply with National Council of Radiation Protection (NCRP) Report No. 049 - Structural Shielding Design and Evaluation for Medical Use of X-Rays and Gamma Rays of Energies up to 10 MeV.
   1. Comply with requirements of local regulatory agencies where local standards and criteria exceed requirements of NCRP Report Nos. #145, #147 and #151.

D. Single Source Responsibility: Obtain radiation protection materials and accessories produced or distributed as standard products from single manufacturer regularly engaged in production of X-Ray shielding materials, equipment, and accessories.

Specifier Note: Include a Mock-Up if the project size and/or quality warrant taking such a precaution. The following is one example of how a mock-up on a large project might be specified. When deciding on the extent of the mock-up, consider all the major different types of work on the project.

E. Mock-Up: Provide a mock-up of type and size as directed by Architect for testing purposes to verify the protection integrity of the work of this section and to establish application workmanship.
   1. Locate mock-up where directed by Architect.
   2. Rework mock-up area as required to produce acceptable work.
   3. Do not proceed with remaining work until protection integrity and workmanship are approved by Architect.
   4. Approved mock-up may remain as part of the Work.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's instruction for receiving, handling, storing, and protecting materials.

B. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

C. Store materials in original packaging, protected from exposure to harmful environmental conditions, including static electricity, and at temperature and humidity conditions recommended by manufacturer.

D. Exercise care to prevent edge damaged materials.

1.10 FIELD CONDITIONS

A. Ambient Conditions: Maintain temperature, humidity, and ventilation condition within limits recommended by manufacturer for optimum results. Do not install products under ambient conditions outside manufacturer's absolute limits.

B. Lead-Laminated Gypsum Board:
   1. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.
   2. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
   3. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.
      a. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
      b. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

1.11 COORDINATION

A. Coordinate the work of this Section with the respective trades responsible for installing interfacing work.

PART 2 - PRODUCTS

2.2 RADIATION PROTECTION SYSTEM DESCRIPTION

A. Design Requirements:
   1. Provide materials and workmanship, including joints and fasteners, that maintain continuity of radiation protection at all points and all directions equivalent to materials specified in thicknesses and locations indicated.
      a. Employ a physicist knowledgeable in radiation protection for medical facilities to determine thicknesses and configurations of lead-lined materials.
   2. Lead-Lined Assemblies: Provide lead thickness in gypsum board, plywood, doors, door frames, window frames, and other items located in lead-lined assemblies, not less than that indicated for assemblies in which they are installed unless indicated otherwise.

Specifier Note: Delete Lead Glazing if not required

   3. Lead Glazing: Provide lead equivalence not less than that indicated for assembly in which glazing is installed unless indicated otherwise.

Specifier Note: Delete Lead Sheet if not required

2.3 LEAD SHEET

A. Lead Sheet: 99.5 percent or better pure unpierced virgin lead, free from dross, oxide inclusions, scale, laminations, blisters, and cracks.
   1. Sheet Lead shall meet or exceed the Federal Specification QQL-201f, Grade B or Grade C, and ASTM B749-03 Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products, see NCRP reports #145, #147 and #151.

   2. Thickness: As determined by Radiation Protection Survey, but not less than 1/16 inch (1.5 mm) if not indicated.
   3. Variation in Sheet Thickness: Not to exceed five (5) percent.

Specifier Note: Delete Lead Plate if not required.

2.4 LEAD PLATE

A. Lead Sheet: 99.5 percent or better pure virgin lead, free from dross, oxide inclusions, scale, laminations, blisters, and cracks.
   1. Sheet Lead shall meet or exceed the Federal Specification QQL-201f, Grade B or Grade C and ASTM B749-03 Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products, see NCRP reports #145, #147 and #151.

   2. Thickness: As indicated on Drawings.
   3. Variation in Sheet Thickness: Not to exceed five (5) percent.

Specifier Note: Delete Lead Bricks if not required.

2.5 LEAD BRICKS

A. Interlocking Lead Bricks: 99 percent pure virgin lead, free from dross, oxide inclusions, scale, laminations, blisters, and cracks. Fabricate bricks with tongue and groove sides:

Specifier Note: Delete the following sizes not required.

   1. Size: 3/4 inch (19 mm) by 4 inches (102 mm) by 12 inches (305 mm).
   2. Size: 1 inch (25 mm) by 4 inches (102 mm) by 12 inches (305 mm).
   3. Size: 1-1/2 inches (38 mm) by 4 inches (102 mm) by 12 inches (305 mm).
   4. Size: 2 inches (51 mm) by 4 inches (102 mm) by 8 inches (204 mm).
   5. Size: 2 inches (51 mm) by 4 inches (102 mm) by 12 inches (305 mm).
   6. Size: 2-1/2 inches (63.5 mm) by 4 inches (102 mm) by 12 inches (305 mm).

Specifier Note: Delete Lead-Laminated Gypsum Board if not required.

2.6 LEAD-LAMINATED GYPSUM BOARD, GENERAL

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by UL (Underwriter's Laboratories Inc.) or other independent testing agency.

Specifier Note: Retain "Recycled Content of Gypsum Panel Products" Paragraph below to specify recycled content if applying for LEED Credit MR 4. An alternative method of dealing with these credit requirements is to retain requirement in Section 018113.13 "Sustainable Design Requirements - LEED for New Construction and Major Renovations," Section 018113.16 "Sustainable Design Requirements - LEED for Commercial Interiors," Section 018113.19 "Sustainable Design Requirements - LEED for Core and Shell Development," Section 018113.23 "Sustainable Design Requirements - LEED for Schools" that gives Contractor the option and responsibility to determine how these credit requirements will be met.

B. Recycled Content of Gypsum Panel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <Insert number> percent.

Specifier Note: Retain first "Regional Materials" Paragraph below for LEED-NC, LEED-CS, and LEED for Schools Credit MR 5 or LEED-CI Credit MR 5, Option 2; before retaining, verify availability of materials that comply.

C. Regional Materials: Gypsum panel products shall be manufactured within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.

Specifier Note: Retain "Regional Materials" Paragraph below for LEED-CI Credit MR 5, Option 1; before retaining, verify availability of materials that comply

D. Regional Materials: Gypsum panel products shall be manufactured within 500 miles (800 km) of Project site.

E. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.7 LEAD-LAMINATED GYPSUM BOARD

A. Lead-Laminated Gypsum Board: Single unpierced layer of sheet lead laminated to back of gypsum board.

Specifier Note: Delete the following sizes not required.

1. Fire-Resistance Rated Gypsum Board: Type X, ASTM C 1396.
   a. Core: Fire-resistant rated gypsum core
   b. Surface paper: 100% recycled content paper on front, back and long edges
   c. Long Edges: [Square] [Tapered] [Beveled]
   d. Thickness: [5/8 inch] [1/2 inch]

2. Fire-Resistance Rated Gypsum Board With Enhanced Mold And Mildew: Type X, ASTM C 1396.
   a. Core: Mold and moisture resistant, fire-resistance rated gypsum core
   b. Surface paper: 100% recycled content moisture/mold/mildew resistant paper on front, back and long edges.
   c. Long Edges: [Square] [Tapered] [Beveled]
   d. Thickness: [5/8 inch] [1/2 inch]
   e. Mold/Mildew Resistance: 10 when tested in accordance with ASTM D 3273 Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber

3. Abuse-Resistance Gypsum Board: Type X, ASTM C 1396.
   a. Classification: Level 2 - Moderate Duty in accordance with ASTM C 1629 Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels.

b. Core: Fire resistance rated gypsum core, with additives to enhance, surface indentation resistance and impact resistance
c. Surface Paper: Abrasion-resistant, 100% recycled content moisture/mold/mildew resistant paper on front, back and long edges.
d. Long Edges: [Tapered] [Square]
e. Thickness: [5/8 inch] [1/2 inch]
f. Panel complies with Type X requirements ASTM C 1396 Standard Specification for Gypsum Board.
g. Surface Abrasion Resistance: [0.059 inch, maximum] [0.009 inch] when tested in accordance with ASTM D 4977 Standard Test Method for Granule Adhesion to Mineral Surfaced Roofing by Abrasion.
h. Indentation Resistance: [0.100 inch, maximum] [0.132 inch] when tested in accordance with ASTM D 5420 Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Striker Impacted by a Falling Weight (Gardner Impact)
i. Soft Body Impact: [195 ft-lbf, minimum] [210 ft-lbf] when tested in accordance with ASTM E 695 Standard Method for Measuring Relative Resistance of Wall, Floor, and Roof Construction to Impact Loading.
j. Mold/Mildew Resistance: score of 10 when tested in accordance with ASTM D 3273 Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber

4. High Impact Gypsum Board With Enhanced Mold And Mildew: Type X, ASTM C 1396.
a. Classification: Level 3 - Heavy Duty in accordance with ASTM C 1629 Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels.
b. Core: Fire resistance rated gypsum core, with additives to enhance mold/mildew resistance, surface indentation resistance and impact resistance, moisture and mold resistant.
c. Surface paper: Abrasion resistant, 100% recycled content moisture/mold/mildew resistant paper on front, back and long edges
d. Embedded fiberglass mesh
e. Long Edges: Tapered
f. Thickness: [5/8 inch] [1/2 inch]
g. Panel complies with requirements of both ASTM C 1396 Standard Specification for Gypsum Board, Type X.
h. Surface Abrasion Resistance: [0.010 inch, maximum] [0.009 inch] when tested in accordance with ASTM D 4977 Standard Test Method for Granule Adhesion to Mineral Surfaced Roofing by Abrasion.
i. Indentation Resistance: [0.050 inch, maximum] [0.114 inch] when tested in accordance with ASTM D 5420 Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Striker Impacted by a Falling Weight (Gardner Impact).
j. Soft Body Impact: [300 ft-lbf, minimum] [540 ft-lbf] when tested in accordance with ASTM E 695 Standard Method for Measuring Relative Resistance of Wall, Floor, and Roof Construction to Impact Loading.
k. Hard Body Impact: [150 ft-lbf, minimum] [160 ft-lbf] in accordance with ASTM C 1629 Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels.
l. Mold/Mildew Resistance: 10 when tested in accordance with ASTM D 3273 Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.

Specifier Note: Delete Lead-Lined Plywood if not required

2.8 LEAD-LAMINATED PLYWOOD

A. Lead-Lined Plywood: PS 1 Structural grade, Grade C-C or better, sanded; APA span rated to suit application.
1. Thickness: [5/8 inch] [3/4 inch] [*specify thickness*]

Specifier Note: Delete fire-retardant-treated plywood if not required

2. Fire-Retardant-Treated Plywood: Where indicated on Drawings, provide fire-retardant-treated plywood complying with performance requirements in AWPA C27.
   a. Type: Interior Type A, unless otherwise indicated.

Specifier Note: Structural Laminated Steel Plate is used in specific applications where heavy lead shielding is required and steel is required for integrity. Delete if not required.

2.9 STRUCTURAL LAMINATED STEEL PLATE

A. Steel/Lead/Steel Laminated Panels:
   1. Outer Steel Case Thickness: Thickness as indicated or as recommended by manufacturer.
   2. Adhesive: High-strength epoxy adhesive.
   3. Core: Pure lead core up to 3" thick.
   4. Edges: Standard steel shapes as required.
   5. Sizes: [Up to 80" x 120"]

Specifier Note: Delete Leaded Glass if not required

2.10 RADIATION SHIELDING LEADED GLASS

A. Radiation Shielding Leaded Glass: Clear leaded glass containing 48 percent lead oxide (by weight) and 15 percent barium. Thickness as required to provide radiation protection equivalent to that provided by sheet lead in partition in which lead glass is installed.

Specifier Note: Standard lead equivalency is 2.0 mm (1/16") with a thickness of 9.0 mm (23/64"). Higher equivalencies are available.

1. Thickness: 9.0 mm (23/64") yielding an equivalency of 2.0 mm (1/16").
2. Thickness: [list other equivalencies and thicknesses]

Specifier Note: Delete Leaded Acrylic if not required

2.11 RADIATION SHIELDING LEADED ACRYLIC

A. Radiation Shielding Leaded Acrylic: Clear Pb lead-plastic.

Specifier Note: Clear Pb lead-plastic is available in seven lead equivalencies ranging from 0.3 mm to 3.0 mm and thicknesses ranging from 7mm to 46mm. Panels are available in more than 100 stock sizes up to 6 feet by 8 feet.

1. Thickness: [7.0 mm yielding an equivalency of 0.3 mm.]
2. Thickness: [____ mm yielding an equivalency of _____]

Specifier Note: Delete Lead-lined telescopic view frames if not required. Frames are designed to fit walls from 4" to 6 ¼" thick. Telescoping frames will allow for either one or two panes of 5/16" leaded glass, or one pane of 9/16" leaded glass.

2.12 LEAD-LINED TELESCOPIC VIEW WINDOW FRAMES

A. Lead-Lined Telescopic View Window Frames: Construct of 16 gage welded steel frames adjustable from 4 inches to 6¼ inches wall thickness. Frames shall be capable of accepting any thickness of radiation shielding leaded glass, radiation shielding X-Ray safety glass, or radiation shielding leaded acrylic. Frame corners shall be fully welded and ground smooth.
   1. Provide radiation protection equivalent to that provided by sheet lead in partition in which view window is installed.

   2. Provide ½" (13 mm) removable, reversible stops. Predrill and countersink to allow for:

Specifier Note: Delete the following sizes not required Insert custom sizes as required

a. One pane of 23/64" leaded shielding glass.
b. Two panes of 23/64" leaded shielding glass.
c. One pane of 9/16" lead shielding glass.
d. [*select thickness*]

Specifier Note: Delete if voice transmission slots are not required.

3. Provide frames with voice transmission slots.

Specifier Note: Delete Lead-lined telescopic view frames if not required. This custom steel two-piece slip frame is suitable when large throat dimensions are required, or mullions are necessary. Any existing rough opening can be wrapped with a welded 4-sided frame. Double rabbet is standard, with optional single-rabbet or cased open profiles.

2.13 LEAD-LINED TWO-PIECE SLIP FRAMES

A. Lead-Lined Telescopic View Window Frames: Two-piece slip lead lined frames manufactured to a specific throat dimension to suit wall thickness. Frames shall be capable of accepting any thickness of radiation shielding leaded glass, radiation shielding X-Ray safety glass, or radiation shielding leaded acrylic. Frame corners shall be fully welded and ground smooth.
1. Throat Dimension: As required to suit wall thickness.
2. Metal Thickness: [16] [14] gauge.
3. Provide radiation protection equivalent to that provided by sheet lead in partition in which view window is installed.
4. Provide ½" (13 mm) removable, reversible stops. Predrill and countersink to allow for:

Specifier Note: Delete the following sizes not required Insert custom sizes as required

a. One pane of 23/64" leaded shielding glass.
b. Two panes of 23/64" leaded shielding glass.
c. One pane of 9/16" lead shielding glass.
d. [*custom size*]

Specifier Note: Delete if voice transmission slots are not required.

5. Provide frames with voice transmission slots.

Specifier Note: Delete lead-lined solid core wood doors if not required.

2.14 LEAD-LINED SOLID CORE WOOD DOORS

A. Flush veneered construction using single layer of sheet lead in center of door. Laminate wood cores under hydraulic pressure on each side of lead.
1. Extend sheet lead lining to door edges providing X-Ray absorption equal to partition in which door occurs.
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.
3. Further bond cores with 6 poured lead dowels at the following locations:
   a. 2 at 8 inches (203 mm) from top and 4 inches (102 mm) sides, 2 at center 4 inches from sides, and 2 at 8 inches (203 mm) from bottom and 4 inches (102 mm) sides.
4. Edge Strips: Minimum thickness of 2 inches (51 mm) each edges of door.
   a. Species: Same as wood face veneer.
   b. Glue strips to cores before face veneer is applied.
   c. Extend vertical edge strips full height of door and bevel 1/8 inch (3 mm) for each 2 inches (51 mm) of door thickness.

Specifier Note: Select a face veneer from the following options. Other veneers are available upon request.

5. Face Veneer for Transparent Finish: [Plain-Sliced Red Oak], [Rotary-Cut Red Oak], [Rotary-Cut Birch], [Rift-Cut White Oak] [*"custom" veneer*]
6. Opaque Finish: [Medium-density overlay] [Any closed-grain hardwood of mill option].

7. Secure glass with hardwood stops of same species as face veneer. Secure frame to door with wood screws.

2.15 LEAD-LINED HOLLOW METAL DOOR FRAMES

A. Lead-Lined Hollow Metal Door Frames:
   1. Construction: Line inside of frames with single unpierced strip of sheet lead of not less than same thickness as lead in doors and walls in which installed.
      a. 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.
      b. Form lead shields around areas prepared to receive hardware.
      c. Fabricate lead lining wide enough to maintain an effective 1/2" (13 mm) minimum overlap lap with lead of adjoining shielding.
      d. Design lead-lined door frames to accommodate lead lining up to 1/2 inch (13 mm) thick.
   2. Door Frame Supports: 2-1/4 inches (57 mm) steel angle iron.
   3. Jamb Depth: 4 ½” thru 14”, in 1/8” increments.
   4. Jamb Profile: 2”
   5. Head Profile: [2”] [4”]
   6. Frame Thickness: [18] [16] [14] gauge.

2.16 FINISHES

A. Field Painted Surfaces: As specified in “Section 09 91 00 - Painting”
   1. Colors: As selected.

B. Prefinished Surfaces: Colors as selected.

2.17 ACCESSORIES

A. Lead Discs: 5/16 inch (8 mm) diameter lead discs for use with screw heads.

B. Lead Strips: 2 inches (51 mm) wide, unless indicated otherwise, by same thickness as sheet lead laminated on gypsum board.

C. Lead Angles: Leak-proof, lead angle system providing complete coverage of gamma rays used in lieu of lead strips and lead discs where sheet lead thickness is greater than 1/8 inch (3 mm) thick.

D. Gypsum Board Fasteners:
   1. Screw Fasteners for Metal Framing: Type S, bugle head drill screws complying with ASTM C 954, length as required, for applying lead-laminated gypsum board to light gage metal framing having thickness of 0.033 to 0.112 inch [0.84 to 2.84 mm] thick.
   2. Screw Fasteners for Metal Framing - Self Tapping: Type S, bugle head self-piercing tapping screws complying with ASTM C 1002, length as required, for applying lead-laminated gypsum board to light gage metal framing having thickness of 0.033 to 0.112 inch [0.84 to 2.84 mm] thick.
   3. Screw Fasteners for Wood Framing: Type W, bugle head screws complying with ASTM C 1002, length as required, for applying lead-laminated gypsum board to wood framing and furring.

E. Adhesive: Acceptable to radiation protection product manufacturer and capable of adhering lead sheets where required.

F. Tie Wire: Leaded steel, annealed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that existing framing, surfaces and substrates are ready to receive work and opening dimensions are as indicated on Shop Drawings or as instructed by the manufacturer.

B. Do not proceed until unsatisfactory conditions have been corrected.

Specifier Note: Delete Lead-Laminated Gypsum Board if not required.

3.2 INSTALLATION OF LEAD-LAMINATED GYPSUM BOARD

A. Comply with manufacturer's recommendations.

Specifier Note: Lead strips are not required on 49" or greater lead sheet widths. Delete this paragraph only if 49" or greater lead sheet widths are specified.

B. Lead Strips: Adhere lead strips on face of studs at joints in lead-laminated gypsum board, including inside and outside corners. Use 2 inches (51 mm) wide strips by same thickness as sheet lead laminated on gypsum board.
   1. Lead strips are not required on 49" or greater lead sheet widths.

C. Shim studs and other framing members as necessary to provide flat, flush finished surfaces.

Specifier Note: Retain the following lead angles where thicknesses of lead in gypsum board exceeds 1/8 inch (3 mm).

D. Install lead angles per manufacturer's recommendations.

E. Install lead-laminated gypsum board on framing with screws spaced not more than 8 inches (203 mm) on center along edges of board and 12 inches (305 mm) on center in field of board.

F. Adhere lead discs to fastener heads. In each case, use method that provides continuous radiation shielding.

G. Where lead-laminated gypsum board is final substrate, apply joint treatment on fasteners and joints per "Section 09 29 00 - Gypsum Board."

H. Where second layer of gypsum board occurs over lead-laminated gypsum board, comply with "Section 09 29 00 - Gypsum Board" for application of second layer.

Specifier Note: Delete Lead-Lined Plywood if not required.

3.3 LEAD-LAMINATED PLYWOOD

A. Comply with manufacturer's recommendations.

B. Adhere lead strips on face of studs at joints in lead-laminated plywood, including inside and outside corners. Use 2 inches (50 mm) wide strips by same thickness as sheet lead laminated on plywood.

C. Shim studs and other framing members as necessary to provide flat, flush finished surfaces.

Specifier Note: Retain the following lead angles where thicknesses of lead in gypsum board exceeds 1/8 inch (3 mm)

D. Lead Angles: Install lead angles per manufacturer's recommendations.

E. Install lead-laminated plywood on framing with screws spaced not more than 8 inches (203 mm) on center along edges of board and 12 inches (305 mm) on center in field of board.

F. Adhere lead discs to fastener heads. In each case, use method that provides continuous radiation protection.

Specifier Note: Delete Doors and Frames if not required.

3.4 INSTALLATION OF DOORS AND FRAMES

A. Lead-Lined Frames: Install lead-lined steel door frames in accordance with “Section 08 11 13 - Hollow-Metal Doors and Frames.” Comply with NAAMM HMMA 840 unless otherwise indicated. Set frames accurately in position, plumb, and braced securely until permanent anchors are set.
   1. Secure door frames with steel stud anchors if lead lining is below 1/8 inch (3 mm) thick.
   2. Door Frame Supports (utilize if lead thickness is 1/8 inch (3 mm) or greater):
      a. Run steel angle supports full height on each door frame jamb and fasten to structure above.
      b. Spot-weld supports at 6 inches (152 mm) along jambs and at corners of jambs and head frame.
      c. Anchor frame to substrate with fasteners appropriate for substrate.
      d. Apply coat of asphalt mastic or paint to lead lining in door frames where lead will come in contact with masonry or grout.
   3. Provide 3 anchors per jamb, located adjacent to hinge on hinge jamb, and at corresponding heights on strike jamb.
   4. In metal stud construction, use wall anchors attached to studs with screws.
   5. Lap lead lining of frames over lining in walls at least 1 inch (25 mm).
   6. Lead Lining of Frames: Line inside of frames with lead of thickness not less than that required in doors and walls in which frames are used. Form lead to match frame contour, continuous in each jamb and across head, lapping stops. Form lead shields around areas prepared to receive hardware. Lap lining over lining in walls at least 1 inch (25 mm).

B. Lead-Lined Wood Doors:
   1. Install lead-lined wood doors in accordance with “Section 08 14 16 - Flush Wood Doors” unless otherwise indicated
   2. Install doors in frames level and plumb, aligned with frames and with uniform clearance at edges.

C. Hardware: Line covers, escutcheons, and plates to provide effective shielding at cutouts and penetrations of frames and doors. Refer to “Section 08 71 00 - Door Hardware” for other installations requirements.

D. Touch up damaged finishes with compatible coating after sanding smooth.

Specifier Note: Delete Window Frames if not required.

3.5 INSTALLATION OF WINDOW FRAMES

A. Set unleaded side of frame plumb and square in wall opening on control room side of wall with shims.

B. Set leaded side of frame plumb and square in wall opening on X-Ray side of wall.

C. Compress sides together against faces of wall.

D. Install setting blocks, shims, and glazing tape in glazing channel to prevent galls from touching steel frame.

E. Install radiation resistant glazing in telescopic frame.

F. Place steel stops in position and mark location of stop and frame retaining holes on steel frame.

G. Remove glazing and drill holes in steel frame.

H. Place glazing and stops and hand drive setting screws.

3.6 INSTALLATION OF PENETRATING ITEMS

A. At penetrations of lead linings; provide lead shields to maintain continuity of protection.

B. Provide lead linings, sleeves, shields, and other protection in thickness not less than that required in assembly being penetrated.

C. Cut wall penetration covers from lead sheet of equal or greater thickness than backing on adjacent wall panels. Cut wall penetration covers to size required to cover wall penetrations with laps 1 inch (25 mm) minimum wide as indicated on penetration detail drawings.

D. Adhesive-apply lead sheet penetration covers on penetrating boxes and raceways and return penetration covers to backside of lead-backed wall panels with 1 inch (25 mm) minimum laps.
   1. Do not use penetrating fasteners unless indicated otherwise.

E. Outlet Boxes and Conduit: Install between studs using steel telescoping mounting brackets. Cover or line with lead sheet lapped over adjacent lead lining at least 1 inch (25 mm). Wrap conduit with lead sheet for 10 inches (250 mm) in from box.

3.7 INSTALLATION OF WALL PENETRATION COVERS

A. Duct Penetrations With 8 PSF or Less Lead Sheet:
   1. Wrap ducts with wall penetration covers, lapping lead joints 1 inch (25 mm) minimum.
   2. Secure lead sheet in place with 1 inch (25 mm) minimum width steel bands spaced not more than 12 inches (305 mm) on center.
   3. Do not cut into lead sheet with tightening steel bands.

B. Duct Penetrations with Greater than 8 psf Lead Sheet and Where Duct Shielding Exceeds 24 Inches (610 mm) in Width:
   1. Laminate wall penetration covers to plywood or other similar structural panels conforming to shape of duct, lapping lead joints 1 inch (25 mm) minimum.
   2. Secure lead laminated panels to ducts with mechanical fasteners located at duct seams and corners.
   3. Where necessary to prevent lead laminated panels from overloading duct supports, independently suspend panels from hangers secured to overhead building structure.
   4. Cover fastener heads with lead sheet matching thickness of adjacent lead.

C. Piping: Unless indicated otherwise, wrap piping with lead sheet for 10 inches (250 mm) from point of penetration.

3.8 ACCESSORY INSTALLATION

A. Comply with manufacturer's recommendations.

B. Wherever lead protection is penetrated, cut, or punctured, assure continuity of shielding by use of sheet lead, lead plugs or other approved method.

C. Install sheet lead lining within steel door frames to provide radiation protection to levels indicated or levels required to match adjacent wall protection.

D. Wrap electrical outlet boxes, view window frames, and other penetrations through lead barrier material with sheet lead to provide radiation protection to levels indicated or levels required to match adjacent wall protection.

3.9 FIELD QUALITY CONTROL

A. Radiation Protection Survey: Employ a registered X-Ray physicist, certified by American Board of Radiology, for testing specified radiation protective Work and to conduct radiation protection survey of facility after radiation shielding materials are installed.
   1. Take radiation measurements and indicate evaluation of measurements in report. Submit report to Architect and Owner upon completion of report.
   2. Take radiation measurements in locations indicated by Architect.

B. Correct deficiencies in, or remove and replace, radiation protection Work that testing indicates does not comply with specified requirements.

Specifier Note: Delete this article if no lead-lined doors and frames on project.

3.10 ADJUSTING

A. Check and readjust operating hardware items, leaving doors and frames undamaged and in proper operating condition.

3.11 CLEANING

A. Remove excess materials from site and leave Work areas broom clean.

B. Leave exposed surfaces ready for site finishing.

3.12 PROTECTION

A. Lock radiation-protected rooms once door hardware is installed. Limit access to only those persons performing Work in radiation-protected rooms or as directed by Owner.

B. Tape temporary paper signs on radiation-resistant walls with the following text:
   1. “Do not mount equipment on this wall without covering penetrating fasteners with lead sheet of thickness required by Contract Documents."

Specifier Note: Schedules may be placed in the specifications rather than on the Drawings. Delete this article and examples below if not required.

3.13 SCHEDULES

A. Room No. _____; [North; South; East; West; and _____] wall, [1/16 inch; _____ inch] lead from floor to [96 inches; _____ inches] above [floor; or suspended ceiling]

B. Room No. _____; [North; South; East; West; and _____] wall, [1/16 inch; _____ inch] lead from floor to [96 inches; _____ inches] above [floor; or suspended ceiling]

C. Room No. _____; [North; South; East; West; and _____] wall, [1/16 inch; _____ inch] lead from floor to [96 inches; _____ inches] above [floor; or suspended ceiling]

END OF SECTION