



## SECTION 13090

### RADIATION PROTECTION

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#### PART 1 GENERAL

##### 1.1 SECTION INCLUDES

- A. Radiation protection products including the following:
  - 1. Lead sheets.
  - 2. Lead plates.
  - 3. Interlocking lead bricks.
  - 4. Lead castings/fabrications and lead pigs.
  - 5. Lead-laminated gypsum board.
  - 6. Lead-lined plywood.
  - 7. Lead-lined wood doors.
  - 8. Lead-lined hollow metal doors.
  - 9. Lead-lined hollow metal door frames.
  - 10. Neutron shielding doors and frames.
  - 11. Radiation shielding leaded glass.
  - 12. Radiation shielding X-ray safety glass.
  - 13. Radiation shielding glass X-ray barriers.
  - 14. Lead-lined hollow metal view window frames.
  - 15. Lead-lined aluminum splayed telescopic frames.
  - 16. Lead-lined cassette transfer cabinets.

##### 1.2 RELATED SECTIONS:

- A. Section 06100 - Rough Carpentry.
- B. Section 08113 - Hollow-Metal Doors and Frames.
- C. Section 08140 - Flush Wood Doors.
- D. Section 09260 - Gypsum Board Assemblies.
- E. Section 09900 - Painting and Coating.

##### 1.3 REFERENCES

- A. American Wood Products Association (AWPA): AWPA C27 - Fire Retardant Treatment by Pressure Processes.
- B. 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.
  - 4. ASTM A 526 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality.
  - 5. ASTM B 749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.
  - 6. ASTM C 1396 - Standard Specification for Gypsum Board.
- C. Federal Specifications:
  - 1. QQL-171 Grade C.
  - 2. QQL-201 F Grade C.
- D. Hollow Metal Manufacturers Association (HMMA):
  - 1. HMMA 840 - Installation and Storage of Hollow Metal Doors.
  - 2. HMMA 861 - Commercial Hollow Metal Doors and Frames.
- E. National Electric Manufacturers Association (NEMA): LD 3 - High Pressure Decorative Laminates.
- F. National Council on Radiation Protection (NCRP): Reports No. 33, No. 35 and No. 49.
- G. Steel Door Institute (SDI): SDI-100 - Recommended Specifications for Standard Steel Doors and Frames.

#### 1.4 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.

#### 1.5 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 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 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.
  - 3. Lead Glazing: Provide lead equivalence not less than that indicated for assembly in which glazing is installed unless indicated otherwise.

#### 1.6 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
  - 1. Preparation instructions and recommendations.
  - 2. Storage and handling requirements and recommendations.
  - 3. Installation methods.
- C. Shop Drawings:
  - 1. Indicate dimensions, description of materials and finishes and general construction.
  - 2. Indicate layout of radiation-protected areas.
  - 3. Indicate lead thickness or lead equivalencies of components.
- D. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.
- E. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) square, representing actual product, color, and patterns.

## 1.7 QUALITY ASSURANCE

- A. Qualifications: Firm with minimum of 5 years successful experience manufacturing radiation protection products similar to those specified for this Project.
- B. Radiation Protection Survey: Employ 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.
- 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 No. 049.
- D. Single Source Responsibility: Obtain radiation protection materials and accessories produced as standard products from single manufacturer regularly engaged in production of X-Ray shielding materials, equipment, and accessories.

## 1.8 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.

## 1.9 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 WARRANTY

- A. Provide manufacturer's standard limited warranty.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURERS

- A. Acceptable manufacturer: Radiation Protection Products, Inc., 1000 Superior Boulevard, Suite 310, Wayzata, MN 55391. ASD. Tel: (888) 746-4777. Fax: (866) 554-8445. Email: [customerservice@rppinc.com](mailto:customerservice@rppinc.com). Web: <http://www.radiationproducts.com>.
- B. Substitutions: Not permitted.
- C. Requests for substitutions will be considered in accordance with provisions of Section 01600.

#### 2.2 MATERIALS

- A. Lead Sheets: 99.9 percent 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-201 F Grade C and ASTM B 749 Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products, see NCRP reports No. 33, No. 35 and No. 49.
  - 2. Thickness: As determined by Radiation Protection Survey, or not less than 1/16 inch (1.5 mm) if not indicated.
  - 3. Variation in sheet thickness: Not to exceed 3 percent.
- B. Lead Plates: 99.9 percent pure virgin lead, free from dross, oxide inclusions, scale, laminations, blisters, and cracks.
  - 1. Lead plate shall meet or exceed the Federal Specification QQL-201 F Grade C and ASTM B 749 Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products, see NCRP reports No. 33, No. 35 and No. 49.
  - 2. Thickness: As indicated on drawings.
  - 3. Variation in plate thickness: Not to exceed 3 percent.
- C. Interlocking Lead Bricks: 99.9 percent pure virgin lead, free from dross, oxide inclusions, scale, laminations, blisters, and cracks. Fabricate bricks with tongue and groove sides:
  - 1. Lead bricks shall meet or exceed the federal specification QQL-171 Grade C.
  - 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: 2-1/2 inches (63.5 mm) by 4 inches (102 mm) by 12 inches (305 mm).
  - 5. Size: 2 inches (51 mm) by 4 inches (102 mm) by 8 inches (204 mm).
- D. Lead Castings/Fabrications and Lead Pigs: 99.9 percent pure virgin lead, free from dross, oxide inclusions, scale, laminations, blisters, and cracks. Fabricate as indicated on drawings.

#### 2.3 MANUFACTURED UNITS

- A. Lead-Laminated Gypsum Board: Single unpierced layer of sheet lead laminated to back of gypsum board, ASTM C 1396/1396M; gypsum core wall panel with additives

to enhance fire resistance of core and surfaced with paper on front, back, and long edges; Type X, UL rated.

1. Size: 48 inch (1219 mm) wide gypsum board sheets by height indicated.
2. Thickness: 1/2 inch (13 mm).
3. Thickness: 5/8 inch (16 mm).

B. Lead-Lined Plywood: APA plywood touch-sanded C-D plugged, Group 2.

1. Exposure: Exposure 1.
2. Thickness: 5/8 inch (16 mm).
3. Thickness: 3/4 inch (19 mm).
4. Fire-Retardant-Treated Plywood: Where indicated on Drawings, provide fire-retardant-treated plywood complying with performance requirements in AWWA C27.
  - a. Use Interior Type A, unless otherwise indicated.

C. Lead-Lined Wood Doors:

1. Construction: Flush veneered construction using single layer of sheet lead in center of door. Laminate wood cores under hydraulic pressure on each side of lead.
  - a. Extend sheet lead lining to door edges providing X-Ray absorption equal to partition in which door occurs.
2. Cores: Further bond cores with 6 poured lead dowels at the following locations:
  - a. Two 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.
3. 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.
4. Face Veneer for Opaque Finish: Rotary cut, mill choice close-grain hardwood. Use only one species for wood face veneer.
5. Glazing Stops: Secure glass with hardwood stops of same species as face veneer. Secure frame to door with wood screws.

D. Lead-Lined Hollow Metal Doors:

1. Material: A60 galvanized steel, ASTM A 526 (Galvanized).
2. Material: Cold rolled steel, ASTM A 366 (Cold Rolled Steel).
3. Face Sheet: 14 gauge.
4. Face Sheet: 16 gauge.
5. Construction: The edges of doors shall be continuously seam welded, ground and filled to provide a smooth finish. The top and bottom of the doors shall be reinforced with continuous steel channels, spot welded to both sides of the door. Doors shall have 11 gauge steel angles, 12 inches (305 mm) long for hinge reinforcement.
  - a. Core: Mineral core board.
  - b. Core: Vertically steel stiffened.
6. Compliance: Doors shall comply with HMMA 861-00 For Commercial Hollow Metal Doors and Frames, and SDI-100, Grade II, Heavy Duty Model 3, Seamless Hollow Metal Construction.
7. Schedule: Refer to Door schedule and door types for UL labels and vision glass requirements.

E. Lead-Lined Hollow Metal Door Frames: 16 gage (1.5 mm) welded steel frames with 4-7/8 inches (124 mm) throat and 2 inches (51 mm) face. Provide angle iron spot

welded at 6 inches (152 mm) on center, and anchor bolts to secure frame if lead thickness is 1/8 inch (3 mm) or greater. Design lead-lined door frames to accommodate lead lining up to 1/2 inch (13 mm) thick.

1. Door Frame Supports: 2-1/4 inches (57 mm) steel angle iron.

F. Neutron Shielding Doors and Frames: Provide neutron shielded doors complying with the following requirements:

1. Operation: Swinging.
  - a. Frame: Fabricate from 1/4 inch (6 mm) thick steel. Provide lead lining and bottom lead lined sill, and welded wall and sill anchors. Provide five gussets.
2. Operation: Sliding.
  - a. Structural Steel Supports: Engineer structural support system based upon the length, width, thickness, and weight of the door.
  - b. Structural Steel Compliance:
    - 1) Beams: ASTM A 36.
    - 2) Rectangular Tubing: ASTM A 500.
3. Perimeter of Door:
  - a. Stiles and Rail Thickness: As indicated on Drawings.
  - b. Stiles and Rail Thickness: 1/2 inch (13 mm).
  - c. Stiles and Rail Thickness: 3/4 inch (19 mm).
  - d. Reinforcing Bar Thickness: As indicated on Drawings.
  - e. Reinforcing Bar Thickness: 1/2 inch (13 mm), full length of door at hinge face.
  - f. Reinforcing Bar Thickness: 3/4 inch (19 mm), full length of door at hinge face.
4. Face Plates: Door manufacturer's lead shielding and polyethylene at hinge face plates of door. Provide 1/2 inch (13 mm) by 5 inches (127 mm) welded diagonally to interior of face plate.
  - a. Back Face: 1/4 inch (6 mm) thick steel welded to frame at 6 inches (152 mm) on center.
  - b. Front Face: 1/4 inch (6 mm) thick steel screwed to frame at 12 inches (304 mm) on center.
5. Core: Shielding contents and thickness of doors determined by manufacturer's licensed physicist.
  - a. Materials: As indicated on Drawings.
  - b. Materials: Lead, in interlocking bricks.
  - c. Materials: Lead, in interlocking plates.
  - d. Materials: HD polyethylene.
  - e. Materials: HD polyethylene and Borated polyethylene 5 percent in sheet form and thickness necessary for shielding requirements.
6. Hardware and Accessories:
  - a. Pivot/hinges.
  - b. Pulls.
  - c. Electric programmable door operator (As manufactured by:  
Crown Industrial  
213 Michelle Court  
So. San Francisco, CA 94080  
Voice: (650)952-5150  
Main Fax No: (650)873-1495
  - d. Safety edge.
  - e. Presence detection.
  - f. Interlock Switch.
  - g. Battery backup.

G. 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. Equivalencies based on 150 kV unless indicated otherwise.

1. Equivalency: 1.6 mm.
  2. Equivalency: 2.1 mm.
  3. Equivalency: 2.5 mm.
  4. Equivalency: 3.3 mm.
- H. Radiation Shielding X-Ray Safety Glass: Lead glass laminated to clear float glass to comply with applicable building codes for safety glass.
1. Total Thickness: 17/32 inch (13.5 mm).
  2. Outer Lite: 5/16 inch thick leaded X-Ray glass (2.1mm lead equivalency).
  3. Interlayer: 1/16 inch (1.5 mm) thick PVB.
  4. Inner Lite: 5/32 inch (4 mm) thick clear float glass.
- I. Radiation Shielding Glass X-Ray Barriers: Mobile full body radiation shielding barriers complying with the following requirements:
1. Frames: 16 gage (1.5 mm) steel.
  2. Casters: Heavy duty type.
  3. Veneer Face: Birch for opaque finish.
  4. Veneer Face: Birch for stained finish.
  5. Veneer Face: Birch for transparent finish.
  6. Veneer Face: Oak for opaque finish.
  7. Veneer Face: Oak for stained finish.
  8. Veneer Face: Oak for transparent finish.
  9. High-Pressure Decorative Laminate: NEMA LD 3.
    - a. Color: Selected by Architect from manufacturer's full standard color range.
    - b. Acceptable Manufacturer: WilsonArt International or approved substitution.
  10. Window Frames: Fabricated from hardwood to match finish.
  11. Leaded Glass: Radiation shielding leaded glass.
  12. Leaded Glass: Radiation shielding leaded safety glass.
  13. Leaded Glass Size for 3 feet by 7 feet (914 mm by 2134 mm) Screens: 12 inches (305 mm) wide by 12 inches (305 mm) high by thickness required for protection level.
  14. Leaded Glass Size for 3 feet by 7 feet (914 mm by 2134 mm) Screens: 24 inches (610 mm) wide by 36 inches (914 mm) high by thickness required for protection level.
  15. Leaded Glass Size for 4 feet by 7 feet (1219 mm by 2134 mm) Screens: 12 inches (305 mm) wide by 12 inches (305 mm) high by thickness required for protection level.
  16. Leaded Glass Size for 4 feet by 7 feet (1219 mm by 2134 mm) Screens: 36 inches (914 mm) wide by 36 inches (914 mm) high by thickness required for protection level.
  17. Leaded Glass Size for Screens: \_ inches (\_ mm) wide by \_ inches (\_ mm) high by \_ inches (\_ mm) thick.
- J. Lead-Lined Hollow Metal View Window Frames: 16 gage (1.5 mm) welded steel frames adjustable from 4-1/4 inches (108 mm) to 6 inches (152 mm) wall thickness. Design window frames to accept any thickness of radiation shielding leaded glass, radiation shielding X-Ray safety glass, or radiation shielding leaded acrylic.
1. Protection: Provide radiation protection equivalent to that provided by sheet lead in partition in which view window is installed.
  2. Stops: Provide 1/2 inch (13 mm) removable stops.
  3. Voice Transmission Slots: Provide frames with voice transmission slots.

- K. Lead-Lined Aluminum Splayed Telescopic Frames: Lined with 1/16 inch (1.5 mm) lead; adjustable from 4-1/4 inches (108 mm) to 6 inches (152 mm) wall thickness.
  - 1. Stops: Provide 1/2 inch (13 mm) removable stops.
- L. Lead-Lined Cassette Transfer Cabinets: Complete with rough-in frame, support brackets, opposing wall trim, and manual interlock. Provide radiation protection equivalent to that provided by sheet lead in partition in which view window is installed.

## 2.4 ACCESSORIES

- A. Screw Fasteners: Type S Bugle Head, length as required.
- 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. Lead Discs: 3/8 inch (9.5 mm) diameter lead discs for use with screw heads.
- E. Adhesive: Acceptable to radiation protection product manufacturer and capable of adhering lead sheets where required.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verification of Conditions: Examine areas and conditions under which Work is to be performed and identify conditions detrimental to proper or timely completion.
- B. Verify that steel framing is not less than 20 gage (0.9 mm) with studs spaced not more than 16 inches (406 mm) on center, unless noted otherwise.
- C. Do not proceed until unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION OF 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.
- D. 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 shielding.

### 3.3 INSTALLATION OF LEAD-LAMINATED GYPSUM BOARD

- A. Comply with manufacturer's recommendations.
- B. Adhere lead strips on face of studs at joints in lead-laminated gypsum board, including inside and outside corners. Use 2 inches (50 mm) wide strips by same thickness as sheet lead laminated on gypsum board.
- C. Shim studs and other framing members as necessary to provide flat, flush finished surfaces.
- 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 09260.
- H. Where second layer of gypsum board occurs over lead-laminated gypsum board, comply with Section 09260 for application of second layer.

#### 3.4 INSTALLATION OF DOORS AND FRAMES

- A. Install lead-lined steel door frames per 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 to structure above.
    - b. Bolt supports to wood joists.
    - c. Weld supports to steel joists.
    - d. Spot-weld supports at 6 inches (152 mm) along jambs and at corners of jambs and head frame.
    - e. Anchor frame to substrate with fasteners appropriate for substrate.
    - f. 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. Install lead-lined wood doors per Flush Wood Doors Section unless otherwise indicated. Install doors in frames level and plumb, aligned with frames and with uniform clearance at edges.
- C. Line covers, escutcheons, and plates to provide effective shielding at cutouts and penetrations of frames and doors. Refer to the Door Hardware Section for other

installations requirements.

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

### 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 CASSETTE TRANSFER CABINETS

- A. Install double rough-in frames plumb and square in wall opening.
- B. Secure rough-in frames with equal spaced screws through each jamb.
- C. Set transfer cabinet inside rough-in frame and X-Ray side of wall and anchor to rough-in frame at face of wall.
- D. Install opposing wall flange in position and screw to rough-in frame.

### 3.7 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. Install outlet boxes and conduit 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.

### 3.8 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.

### 3.9 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.

### 3.10 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. Correct deficiencies in, or remove and replace, radiation protection that inspection reports indicate does not comply with specified requirements.
- C. Testing: After radiology equipment has been installed and placed in operating condition, Owner will engage radiation health physicist to test radiation protection.
- D. Correct deficiencies in, or remove and replace, radiation protection that testing indicates does not comply with specified requirements, including finishes and other Work covering defective Work.

### 3.11 ADJUSTING

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

### 3.12 CLEANING

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

- B. Leave exposed surfaces ready for site finishing.

### 3.13 PROTECTION

- A. Lock radiation-protected rooms once doors 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".

END OF SECTION