



MarShield™ is an experienced and widely proven partner for corporations, institutions, the military and government seeking a full-service provider of radiation protection solutions. Since 1977, MarShield™ lead radiation protection, storage and shielding products have brought value to various commercial markets including nuclear, medical, veterinary and dental, as well as institutions and government bodies engaged in scientific research through to military operations and national defence. MarShield™ services clients in the USA, Canada and targeted international markets worldwide.

MarShield™ has developed an impressive reputation among knowledgeable specifiers and purchasers for its capacity to deliver custom orders quickly, efficiently and cost effectively. MarShield™ provides a complete range of standard products including: lead aprons, lead-lined blankets and curtains; lead shields and barriers; lead-lined doors, windows and frames; cabinets; and many other types of radiation shielding - all of which can be conveniently ordered individually or in quantity.

When success must be absolutely assured, MarShield™ is trusted to provide guaranteed optimal lead radiation protection with every product.

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SECTION 13090/13 49 00

MARSHIELD™ RADIATION PROTECTION

Specifier Notes: The section must be carefully reviewed and edited to meet the requirements of the project and local building code. Coordinate this section with other specification sections and the drawings. Delete all "Specifier Notes" when editing this section.

PART 1 GENERAL

1.1 SECTION INCLUDES

*** NOTE TO SPECIFIER ** Delete items below not required for project.*

- A. Lead Sheet and Plate.
- B. Interlocking Lead Bricks.
- C. Straight Lead Bricks.
- D. Lead-Laminated Gypsum Board.
- E. Radiation-Shielded Doors.
- F. Lead-Lined Doors and Door Frames.
- G. Radiation Shielding Leaded Glass.
- H. Radiation Shielding X-Ray Safety Glass.
- I. Radiation Shielding Glass X-Ray Barriers.
- J. Lead-Lined View Windows and Window Frames.
- K. Borated Polyethylene.
- L. Related Accessories.

*** NOTE TO SPECIFIER ** Delete any sections below not relevant to this project; add others as required.*

1.2 RELATED SECTIONS

- A. Section 06100 - Rough Carpentry.
- B. Section 08110 - Hollow-Metal Doors and Frames.
- C. Section 08210 - Flush Wood Doors.
- D. Section 08710 - Door Hardware.
- E. Section 09260 - Gypsum Board Assemblies.

F. Section 09900 - Paints and Coatings.

1.3 REFERENCES

*** NOTE TO SPECIFIER ** Delete references from the list below that are not actually required by the text of the edited section.*

- A. American Wood Products Association (AWPA) C27 - Fire Retardant Treatment by Pressure Processes.
- B. ASTM A 366 - Standard Specification for Commercial Steel (CS) Sheet, Carbon (0.15 Maximum Percent) Cold-Rolled.
- C. ASTM A 526 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality.
- D. ASTM B 749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.
- E. ASTM B 29 - Standard Specification for Refined Lead.
- F. Federal Specification QQL-171 Grade C.
- G. Federal Specification QQL-201 F Grade C.
- H. Hollow Metal Manufacturers Association (HMMA) 861 - Commercial Hollow Metal Doors and Frames.
- I. Hollow Metal Manufacturers Association (HMMA) 840 - Installation and Storage of Hollow Metal Doors.
- J. National Electric Manufacturers Association (NEMA) LD 3 - High Pressure Decorative Laminates.
- K. NCRP reports #33, #35 and #49.
- L. Steel Door Institute (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.

**** NOTE TO SPECIFIER **** *Delete the next paragraph if Lead Glazing is not required.*

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.

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.

- E. Mock-Up: Provide a mock-up for evaluation of preparation techniques and application workmanship.
 - 1. Finish areas designated by Architect.
 - 2. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
 - 3. Rework mock-up area as required to produce acceptable work.

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 absolute limits.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable manufacturer: MarShield - Div. of Mars Metal Co., 4140 Morris Drive, Burlington, ON, L7L 5L6. ASD. Toll Free: (800) 381-5335. Tel: (905) 637-3862. Fax: (905) 637-8841. Email: sales@marsmetal.com. Web: www.marshield.com.

**** NOTE TO SPECIFIER **** Delete one of the following two paragraphs; coordinate with requirements of Division 1 section on product options and substitutions.

- B. Substitutions: Not permitted.
- C. Requests for substitutions will be considered in accordance with provisions of Section 01600.

**** NOTE TO SPECIFIER **** *Retain only those products required on this project from the following 3 included materials. Modify the retained text as instructed.*

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 B749-03 Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products, see NCRP reports #33, #35 and #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 Plate: 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 B749-03 Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products, see NCRP reports #33, #35 and #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, ASTM B29.

**** NOTE TO SPECIFIER **** *Retain only size(s) required for project from the next 7 options.*

- 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: 1-1/4 inches (32mm) by 4 inches (102 mm) by 12 inches (305 mm).
 - 5. Size: 1-3/4 inches (44.5mm) by 4 inches (102mm) by 12 inches (305mm).
 - 6. Size: 2-1/2 inches (63.5 mm) by 4 inches (102 mm) by 12 inches (305 mm).
 - 7. Size: 2 inches (51 mm) by 4 inches (102 mm) by 8 inches (204 mm).
 - 8. Size: 2 inches (51mm) by 4 inches (102 mm) by 12 inches (305 mm).
- D. Straight Lead Bricks: 99.9 percent pure virgin lead, free from dross, oxide inclusions, scale, laminations, blisters, and cracks.
 - 1. Lead bricks shall meet or exceed the federal specification QQL-171 Grade C, ASTM B29.

**** NOTE TO SPECIFIER **** *Retain only size(s) required for project from the next 8 options.*

- 2. Size: 1-1/2 inches (38 mm) by 2 inches (51 mm) by 8 inches (204 mm).
- 3. Size: 1 inch (25 mm) by 4 inches (102 mm) by 8 inches (204 mm).
- 4. Size: 1 inch (25 mm) by 4 inches (102 mm) by 12 inches (305 mm).
- 5. Size: 2 inches (50 mm) by 4 inches (102mm) by 6 inches (152 mm).
- 6. Size: 2 inches (50 mm) by 4 inches (102 mm) by 8 inches (204 mm).
- 7. Size: 2 inches (51 mm) by 4 inches (102 mm) by 12 inches (305 mm).
- 8. Size: 1 inch (25 mm) by 8 inches (204 mm) by 12 inches (305 mm).
- 9. Size: 3/4 inch (19 mm) by 11-1/2 inches (292 mm) by 24 inches (607 mm).

E. Lead Castings/Fabrications and Lead Pigs: As indicated on drawings.

**** NOTE TO SPECIFIER **** *Retain only those products required on this project from the included 9 products. Modify the retained text as instructed.*

2.3 MANUFACTURED UNITS

A. Lead-Laminated Drywall: Single unpierced layer of sheet lead meeting or exceeding the requirements of ASTM B 749 laminated to back of gypsum drywall meeting or exceeding the requirements of ASTM C36 with additives to enhance fire resistance of core. Drywall is surfaced with paper on front, back, and long edges.

1. Size: 48 inch (1219 mm) wide gypsum board sheets by height indicated.

**** NOTE TO SPECIFIER **** *Retain only thickness required from the following 4 options*

2. Gypsum Type: 1/2 inch (13 mm).
3. Gypsum Type: 5/8 inch (16 mm).
4. Gypsum Type: 1/2 inch (13 mm) Type X.
5. Gypsum Type: 5/8 inch (16 mm) Type X.

**** NOTE TO SPECIFIER **** *Retain only thickness required from the following 5 options.*

6. Lead Thickness: 1/32 inch (0.75 mm).
7. Lead Thickness: 1/16 inch (1.5 mm).
8. Lead Thickness: 1/8 inch (3 mm).

B. Lead-Lined Plywood: Single unpierced layer of sheet lead meeting or exceeding the requirements of ASTM B 749, laminated to the back of AWPA C27 Type A Fire retardant plywood.

1. Maximum Sheet Dimensions: 48 inches by 96 inches (1219 mm x 2438mm)

**** NOTE TO SPECIFIER **** *Retain only thickness required from the following 2 options.*

2. Plywood Thickness: 5/8 inch (16 mm).
3. Plywood Thickness: 3/4 inch (19 mm).

**** NOTE TO SPECIFIER **** *Retain only thickness required from the following 5 options.*

4. Lead Thickness: 1/16 inch (1.5 mm).
5. Lead Thickness: 1/8 inch (3 mm).
6. Lead Thickness: 3/16 inch (4.5 mm).
7. Lead Thickness: 1/4 inch (6 mm).
8. Lead Thickness: 1/2 inch (13 mm).

C. Radiation-Shielded Wood Doors:

1. 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. 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.
3. Face Veneer for Opaque Finish: Rotary cut, mill choice close-grain hardwood. Use only one species for wood face veneer.

**** NOTE TO SPECIFIER **** *Delete the next paragraph if doors do not contain glazing.*

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

D. Lead-Lined Hollow Metal Doors:

**** NOTE TO SPECIFIER **** *Select Material. Delete 1 of the next 2 paragraphs.*

- 1. Material: A60 galvanized steel, ASTM A526 (Galvanized).
- 2. Material: Cold rolled steel, ASTM A366 (Cold Rolled Steel).

**** NOTE TO SPECIFIER **** *Select Face Sheet. Delete 1 of the next 2 paragraphs.*

- 3. Face Sheet: 14 gauge.
- 4. Face Sheet: 16 gauge.

**** NOTE TO SPECIFIER **** *Select Construction. Delete 1 of the next 2 paragraphs.*

- 5. Construction: Mineral core board.
- 6. Construction: Vertically steel stiffened.
- 7. The edges of our 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.
- 8. Door 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.
- 9. 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. Radiation Shielding Leaded Glass: Clear leaded glass containing a minimum 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.

**** NOTE TO SPECIFIER **** *Retain only equivalencies required for project and delete all others.*

- 1. Equivalency: 1.68 mm.
- 2. Equivalency: 2.0 mm.
- 3. Equivalency: 2.33 mm.

4. Equivalency: 2.7 mm.
5. Equivalency: 2.94 mm.
6. Equivalency: 3.2 mm.

G. 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.

H. Radiation Shielding Glass/Acrylic 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.

**** NOTE TO SPECIFIER **** *Select Face Finish. Delete 1 of the next 2 paragraphs.*

3. Face: Stainless Steel
4. Face: High-Pressure Decorative Laminate:
 - a. Color: Selected by Architect from manufacturer's full standard color range.
5. Window Frames: Fabricated from steel to match finish.

**** NOTE TO SPECIFIER **** *Select Glass/Acrylic Type. Delete 2 of the next 3 paragraphs.*

6. Leaded Glass: Radiation shielding leaded glass.
 - a. Glass Size: __ inches (__mm) wide by _ inches (__mm) high by _ inches (__mm) thick by __ mm Lead Equivalency.
 7. Leaded Glass: Radiation shielding leaded safety glass.
 - a. Glass Size: _ inches (_ mm) wide by _ inches (_ mm) high by _ inches (_ mm) thick by __ mm Lead Equivalency.
 8. Leaded Acrylic: Radiation shielding leaded acrylic.
 - a. Acrylic Size: _ inches (_ mm) wide by _ inches (_ mm) high by _ inches (_ mm) thick by __ mm Lead Equivalency.
- I. Lead-Lined 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. Provide radiation protection equivalent to that provided by sheet lead in partition in which view window is installed.
 2. Provide 1/2 inch (13 mm) removable stops.

**** NOTE TO SPECIFIER **** *Delete the next paragraph if voice transmission slots are not required.*

3. Provide frames with voice transmission slots.

- J. Aluminium Lead Lined/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. Provide 1/2 inch (13 mm) removable stops.

**** NOTE TO SPECIFIER **** Retain only required products from the following included options.

2.4 BORATED POLYETHYLENE

- A. MarShield Borotron Borated PE: Borated polyethylene for use in Neutron shielding in medical, nuclear and industrial applications.
1. Weight: 5 Lbs per square foot.
 2. Thickness: 1 inch (25mm).
 3. Sheet Size: 48 inches by 96 inches (1219mm x 2438mm).

**** NOTE TO SPECIFIER **** Select grade. Delete two of the next three paragraphs.

4. Grade: Grade I - 5 percent boron by weight (purple).
5. Grade: Grade II - 2 percent boron by weight (yellow).
6. Grade: Grade III - 1 percent boron by weight (red).

**** NOTE TO SPECIFIER **** Retain only accessories required from the following included options.

2.5 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 Discs: 3/8 inch (9.5 mm) diameter lead discs for use with screw heads.
- D. Adhesive: Acceptable to 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.

**** NOTE TO SPECIFIER **** *Delete if Lead Lined Gypsum Board is not specified.*

3.2 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-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.
- E. Adhere lead discs to fastener heads. In each case, use method that provides continuous radiation shielding.
- F. Where lead-laminated gypsum board is final substrate, apply joint treatment on fasteners and joints per Section 09260.
- G. Where second layer of gypsum board occurs over lead-laminated gypsum board, comply with Section 09260 for application of second layer.

**** NOTE TO SPECIFIER **** *Delete if Doors and Door Frames are not specified.*

3.3 INSTALLATION OF DOORS AND DOOR FRAMES

**** NOTE TO SPECIFIER **** *Delete this article if no lead-lined doors and frames on project.*

- A. Lead-Lined Frames: Install lead-lined steel door frames per Section 08110. 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.

**** NOTE TO SPECIFIER **** *Delete the following subparagraph is no wood joists on project.*

- b. Bolt supports to wood joists.

**** NOTE TO SPECIFIER **** *Delete the following subparagraph is no steel joists on project.*

- 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. Lead-Lined Doors:
1. Install lead-lined wood doors in accordance with Section 08210.
 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. Coordinate with requirements of Section 08710 for other installations requirements.
- D. Touch up damaged finishes with compatible coating after sanding smooth.

**** NOTE TO SPECIFIER ** Delete if Window Frames are not specified.**

3.4 INSTALLATION OF WINDOW FRAMES

**** NOTE TO SPECIFIER ** Delete the next paragraph if no lead-lined window frames exist on the project.**

- 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.

3.5 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.

3.6 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.

3.7 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.

3.8 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.

*** NOTE TO SPECIFIER ** Delete the next article if no lead-lined doors and frames exist on the project.*

3.9 ADJUSTING

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

3.10 CLEANING

- A. Remove excess materials from site and leave Work areas broom clean.
- B. Leave exposed surfaces ready for site finishing.

3.11 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