SECTION 134900 - RADIATION PROTECTION

Note that this section has only been edited for NYSOGS standardization and has not been technically edited. The designer shall make all technical edits specific to the project for this section.

1. GENERAL
	* + 1. RELATED DOCUMENTS
				1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
			2. SUMMARY
				1. Section Includes:

Lead sheet, strip, and plate.

Lead bricks.

Borated polyethylene sheets.

High-density concrete blocks.

Lead-lined gypsum board.

Lead-lined softwood plywood.

Lead glass.

Lead glazing plastic.

Lead-lined hollow-metal doors.

Lead-lined hollow-metal frames.

Lead-lined flush wood doors.

Lead-lined split-core wood doors.

Lead-lined modular shielding partitions.

Informational signs.

* + - * 1. Related Requirements:

Retain subparagraphs below to cross-reference requirements Contractor might expect to find in this Section but are specified in other Sections.

Section 033000 "Cast-in-Place Concrete" for concrete floor topping over lead shielding in concrete slabs.

Section 055000 "Metal Fabrications" for steel framing members for bracing [**lead-brick**] [**and**] [**high-density concrete block**] wall shielding.

* + - 1. DEFINITIONS

Retain terms that remain after this Section has been edited for a project.

* + - * 1. Lead Equivalence: The thickness of lead that provides the same attenuation (reduction of radiation passing through) as the material in question under the specified conditions.

Lead equivalence specified for materials used in diagnostic x-ray rooms is as measured at 100 kV unless otherwise indicated.

* + - 1. PREINSTALLATION MEETINGS

Retain "Preinstallation Conference" Paragraph below if Work of this Section is extensive or complex enough to justify a conference.

* + - * 1. Preinstallation Conference: Conduct conference at [**Project site**] <**Insert location**>.

Retain first subparagraph below if additional requirements are necessary; include information about conference.

Review methods and procedures related to radiation protection, including, but not limited to, the following:

Sequence and schedule of radiation protection work in relation to other work.

Supplementary lead shielding at duct, pipe, and conduit penetrations of radiation protection.

Methods of attaching other construction and equipment to lead-lined finishes.

Notification procedures for work that requires modifying radiation protection.

Requirements for field quality control.

<**Insert agenda items**>.

<**Insert requirements**>.

* + - 1. SUBMITTALS
				1. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.
				2. Manufacturer’s installation instructions shall be provided along with product data.
				3. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).
				4. Product Data: For each type of product.

Doors and Frames: Include construction details, material descriptions, core descriptions, [**fire-resistance ratings,**] [**temperature-rise ratings,**] and finishes.

Retain "Shop Drawings" Paragraph below if manufacturer's product data are insufficient. Revise to suit Project.

* + - * 1. Shop Drawings: Show layout of radiation-protected areas, indicating lead thickness or lead equivalence of components. Show components and installation conditions not fully dimensioned or detailed in product data.

Show ducts, pipes, conduit, and other objects that penetrate radiation protection; include details of penetrations.

Show details of joints between radiation protection materials.

Show details of securing [**lead bricks**] [**and**] [**high-density concrete blocks**] to structure.

Include door details, including elevations, frame dimensions and profile, [**glazed light,**] [**louver cutouts,**]and clearances and undercuts.

* + - * 1. Samples: For units with factory-applied color finishes.
				2. Product Schedule: For [**observation windows and**]doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

Retain "Coordination Drawings" Paragraph below to facilitate the coordination and installation of radiation protection products with the work of other trades. Coordinate paragraph with other Sections specifying products listed below. Preparation of coordination drawings requires the participation of each trade involved in installations within the limited space.

* + - * 1. Coordination Drawings: For assemblies with radiation protection materials, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

Miscellaneous metal members that support [**lead bricks**] [**and**] [**high-density concrete blocks**].

Items penetrating radiation protection materials, including the following:

Electrical services.

Air outlets and inlets.

Sprinklers.

Access panels.

<**Insert item**>.

* + - * 1. Sample Warranty: For warranty.
			1. QUALITY ASSURANCE
				1. Installer Qualifications: Fabricator of products.
			2. DELIVERY, STORAGE, AND HANDLING

Retain "Lead-Lined (Gypsum Panels) (and) (Plywood)" Paragraph below if lead-lined gypsum board or plywood is required.

* + - * 1. Lead-Lined [**Gypsum Panels**] [**and**] [**Plywood**]: Store inside under cover, and keep dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

Retain "Lead-Lined, Hollow-Metal Doors and Frames" Paragraph below if lead-lined, hollow-metal doors and frames are required.

* + - * 1. Lead-Lined, Hollow-Metal Doors and Frames: Comply with requirements in Section 081113 "Hollow Metal Doors and Frames" for delivery, storage, and handling.

Retain "Lead-Lined Wood Doors" Paragraph below if lead-lined wood doors are required.

* + - * 1. Lead-Lined Wood Doors: Comply with requirements in Section 081416 "Flush Wood Doors" for delivery, storage, and handling.
			1. FIELD CONDITIONS
				1. Environmental Limitations: Do not deliver or install radiation protection until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
			2. WARRANTY

When warranties are required, verify with Owner's counsel that warranties stated in this article are not less than remedies available to Owner under prevailing local laws. See the Evaluations in Section 081416 "Flush Wood Doors" for information about wood door warranties.

* + - * 1. Warranty for Lead-Lined Wood Doors: Comply with requirements in Section 081416 "Flush Wood Doors."
1. PRODUCTS

Manufacturers and products listed in SpecAgent and Masterworks Paragraph Builder are neither recommended nor endorsed by the AIA or Deltek. Before inserting names, verify that manufacturers and products listed there comply with requirements retained or revised in descriptions and are both available and suitable for the intended applications.

* + - 1. SOURCE LIMITATIONS
				1. Obtain each type of radiation protection product from single source from single manufacturer[**unless otherwise indicated**].
			2. PERFORMANCE REQUIREMENTS
				1. Provide materials and workmanship, including joints and fasteners, that maintain continuity of radiation protection at all points and in all directions equivalent to materials specified in thicknesses and locations indicated.
				2. Materials, thicknesses, and configurations of radiation protection products indicated are based on radiation protection design prepared by State's radiation health physicist. This design is available to Contractor upon request.

Usually retain "Lead-Lined Assemblies" and "Lead Glazing" paragraphs below and indicate exceptions, if any, on Drawings. Indicate lead thicknesses or lead equivalences for exceptions on Drawings or in a schedule.

* + - * 1. Lead-Lined Assemblies: Unless otherwise indicated, provide lead thickness in lead-lined assemblies of not less than lead thickness indicated for assemblies in which they are installed.
				2. Lead Glazing: Unless otherwise indicated, provide lead equivalence of not less than that indicated for assembly in which glazing is installed.
				3. Fire-Rated[**and Smoke-Control**] Door and Frame Assemblies: Comply with [**Section 081113 "Hollow Metal Doors and Frames"**] [**and**] [**Section 081416 "Flush Wood Doors"**] <**Insert requirements**>.
			1. LEAD SHEET, STRIP, AND PLATE
				1. ASTM B749, Alloy UNS No. L51121 (chemical-copper lead).
			2. LEAD BRICKS

Revise paragraph below if square-edge lead bricks are required. Most manufacturers offer interlocking edges to avoid radiation paths between bricks.

* + - * 1. Cast- or extruded-lead bricks with interlocking tongue and grooves or wedge-shape edges, made from pig lead complying with ASTM B29 with 1/2 percent antimony added.
			1. BORATED POLYETHYLENE SHEETS

Most manufacturers offer 5 percent boron content; confirm availability of 30 percent boron material.

* + - * 1. High-density polyethylene containing not less than [**5**] [**30**] percent boron.

Color: [**As selected by the Director’s Representative from manufacturer's standard selection**] <**Insert color**>.

* + - 1. HIGH-DENSITY CONCRETE BLOCKS
				1. High-density cast concrete blocks with curved or wedge-shaped interlocking edges for dry-stack installation; [**145-lb/cu. ft.**] [**250-lb/cu. ft.**] [**300-lb/cu. ft.**] <**insert density**> density.
			2. LEAD-LINED GYPSUM BOARD

Revise paragraph below if Project requires abuse-resistant gypsum board, gypsum lath, gypsum veneer plaster base, or other gypsum panel products; or if 1/2-inch gypsum board is required. Manufacturers do not recommend using lead lining thicker than 1/8 inch on gypsum board, because the panel may not properly support the weight. Lead-lined plywood may be used under gypsum board in these locations. See the Evaluations.

* + - * 1. 5/8-inch- thick gypsum board complying with Section 092900 "Gypsum Board," of width and length required for support spacing and to prevent cracking during handling, and with a single sheet of lead laminated to the back of the board.

Retain one of first three options in "Lead Sheet Lining" Subparagraph below. Shielding may not be required above 84 inches in single-story buildings. Retain fourth option if lining extends beyond one vertical edge of the gypsum board to allow for overlapping of joints and eliminating the need for separate lead strips for backing joints.

Lead Sheet Lining: Full width [**and length of board**] [**of board and length necessary to extend from floor to 84 inches above floor**] [**of board and height as indicated on Drawings**].[**Extend lead sheet lining 1 inch beyond one vertical edge of board.**]

Furnish 2-inch- <**Insert dimension**> wide lead strips for backing joints.

NCRP Report No. 147 does not require shielding, such as lead caps, for nails or screws; however, authorities having jurisdiction may. Insert text if required. See the Evaluations.

Furnish finishing materials, accessories, and trim for lead-lined gypsum board complying with Section 092900 "Gypsum Board."

* + - 1. LEAD-LINED SOFTWOOD PLYWOOD

Lead-lined plywood can be furnished in custom-sized dimension by many manufacturers to reduce weight and make handling easier. Other types of plywood may be available. Consult manufacturers.

* + - * 1. Lead-Lined Softwood Plywood: DOC PS 1, Exposure 1; [**fire-retardant-treated**] with touch-sanded C-plugged veneer on face to receive lead lining. [**5/8-inch-**] [**3/4-inch-**] <**Insert thickness**> thick plywood of width and length required for support spacing, with a single sheet of lead laminated to the back of the panel.

Retain one of first three options in "Lead Sheet Lining" Subparagraph below. Shielding may not be required to extend more than 84 inches when plywood is used on walls in single-story buildings. Retain fourth option if lining extends beyond one vertical edge of the plywood panel to allow for overlapping of joints and eliminating the need for separate lead strips for backing joints.

Lead Sheet Lining: Full width [**and length of panel**] [**of panel and length necessary to extend from floor to 84 inches above floor**] [**of panel and height as indicated on Drawings**].[**Extend lead sheet lining 1 inch beyond one vertical edge of panel.**]

Furnish 2-inch- <**Insert dimension**> wide lead strips for backing joints.

* + - 1. LEAD GLASS

Some manufacturers offer lead glass with up to 70 percent lead oxide by weight. Consult manufacturers.

* + - * 1. Lead-barium, polished glass containing not less than 60 percent heavy metal oxides, including not less than 48 percent lead oxide by weight.

Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

Tempered Safety Glass: ASTM C1048, Kind FT (fully tempered), lead glass with thickness [**as needed to provide lead equivalence indicated**] [**as indicated**] <**Insert thickness**>.

Some manufacturers recommend that lead glass be laminated between layers of float glass to help prevent damage due to cleaning and use; lead glass is more susceptible to staining or discoloration from cleaning materials than float glass.

Laminated Safety Glass: ASTM C1172 lead glass with thickness [**as needed to provide lead equivalence indicated**] [**as indicated**] <**Insert thickness**> laminated with polyvinyl butyral interlayer to clear float glass on [**one side**] [**both sides**]of lead glass.

* + - 1. LEAD GLAZING PLASTIC
				1. Transparent acrylic sheet impregnated with an organolead compound and containing 30 percent lead by weight.

Thickness: [**As needed to provide lead equivalence indicated**] [**As indicated**] <**Insert thickness**>.

* + - 1. LEAD-LINED HOLLOW-METAL DOORS
				1. Steel doors complying with NAAMM-HMMA 861, except as indicated.

Provide single continuous sheet of lead of thickness [**not less than that required for partition in which door is installed**] [**as indicated on Drawings**] <**Insert thickness**> extending from top to bottom and edge to edge, supported by hat-channel stiffeners. Do not weld stiffeners through lead lining.

Line-inverted channels at top and bottom of doors with lead sheet of same thickness used in door and close with filler channels to provide flush top and bottom edges.

Shield cutouts for locksets with lead sheet of same thickness used in door. Overlap lining of cutouts with lining of door by 1 inch.

Retain first subparagraph below for glazed lights or louvers in steel doors.

Prepare doors to receive [**glazed lights**] [**and**] [**louvers**]; Factory cut and trim openings through doors. Furnish removable stops for glazed openings.

Furnish lead-lined astragals for pairs of doors.

Factory fit doors to suit frame-opening sizes indicated with [**1/16-inch**] <**Insert dimension**> clearance at heads and jambs and minimum clearance at bottom.

Factory-applied finishes are not covered by NAAMM-HMMA 861. Revise to suit product and Project.

Finish: Apply manufacturer's [**standard primer immediately after cleaning and pretreating**] [**factory-applied paint**].

Retain "Color and Gloss" Subparagraph below if retaining second option in "Finish" Subparagraph above.

Color and Gloss: [**As indicated by manufacturer's designations**] [**Match Director’s Representative's sample**] [**As selected by Director’s Representative from manufacturer's full range**] <**Insert color and gloss**>.

* + - * 1. Metal Frames for Glazed Lights: Lead-lined frame formed of 0.048-inch- thick, cold-rolled steel sheet; [**factory primed for paint**] [**with baked-enamel- or powder-coated**] finish[**; and approved for use in doors of fire-protection rating indicated**].
				2. Lead Door Louvers: Louvers with [**20**] [**30**] <**Insert number**> percent free area made from formed-lead sheet or lead extrusions of not less than lead thickness required for door in which louver is installed. Fabricate louvers to be lightproof with fixed maze-type blades that maintain required lead equivalence at all points and in all directions. Fit and assemble louvers in doors at factory.
			1. LEAD-LINED HOLLOW-METAL FRAMES

Retain this article if hollow-metal door frames or borrowed lite (observation window) frames fabricated from steel are required.

* + - * 1. Hollow-Metal Frames: Steel frames complying with NAAMM-HMMA 861, except as indicated.

Retain first subparagraph below if knocked down frames are acceptable or required; NAAMM-HMMA 861 requires welded frames.

Provide knocked down frames [**where indicated**] [**and**] [**where installed in existing partitions**].

Retain first subparagraph below if observation windows are required.

Provide borrowed lite observation window frames of split or telescoping design with welded corners, allowing frame to be installed after construction of partition.

Construct so lead lining overlaps glazing material perimeter by at least 3/8 inch and furnish removable stops.

First subparagraph below allows oral communication between spaces. Retain if required to suit product and Project.

Form sill with an opening for sound transmission. Offset sound passage to make opening lightproof and to maintain required lead equivalence at all points and in all directions.

Retain first subparagraph below if extra-heavy-duty frames, often used with heavy, lead-lined doors, are required; NAAMM-HMMA 861 required steel thickness is 0.053 inch.

Provide [**door**] [**and**] [**observation window**] frames from steel sheet with minimum thickness of 0.0667 inch.

Furnish with additional reinforcements and internal supports to adequately carry the weight of lead-lined doors. Install reinforcements and supports before installing lead lining.

Line frame with lead sheet of thickness not less than that required for doors and walls where frames are used. Form lead sheet to match frame contour, continuous in each jamb and across the head, lapping the stops. Form lead shields around areas prepared to receive hardware. Fabricate lead lining wide enough to maintain an effective lap with lead of adjacent shielding.

Factory-applied finishes are not covered by NAAMM-HMMA 861. Revise to suit product and Project.

Finish: Apply manufacturer's [**standard primer immediately after cleaning and pretreating**] [**factory-applied paint**].

Retain "Color and Gloss" Subparagraph below if retaining second option in "Finish" Subparagraph above.

Color and Gloss: [**As indicated by manufacturer's designations**] [**Match Director’s Representative's sample**] [**As selected by Director’s Representative from manufacturer's full range**] <**Insert color and gloss**>.

* + - 1. LEAD-LINED FLUSH WOOD DOORS

Lead-lined flush wood doors in first paragraph below are constructed with lead sheet laminated to both sides of the core, with crossbands and faces laminated to the lead. Each lead sheet is one-half the total lead thickness required. Doors constructed in this manner are typically limited to about 1/8-inch equivalent lead thickness, depending on manufacturer.

* + - * 1. Solid-core wood doors with lead sheet laminated to each side of core, with faces applied over lead lining.

Construction: Hot pressed, bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before applying lead lining and faces.

Coordinate core type with fire-rating requirements.

Core: [**Mineral**] [**Particleboard**] [**Structural composite lumber**].

Lead-lined wood doors are 1-3/4 inch thick, with lead thicknesses of up to 1/8 inch. Door thickness increases when lead thickness is above 1/8 inch thick.

Lead Lining: Continuous sheets of lead extending from top to bottom and edge to edge; with total lead thickness [**not less than that required for partition in which door is installed**] [**as indicated on Drawings**] <**Insert thickness**>.

Retain "Wood Veneer Faces" or "Plastic-Laminate Faces" Paragraph below.

Wood Veneer Faces: Wood veneer applied to crossbands over core.

Comply with Section 081416 "Flush Wood Doors" for veneer species, grade, and matching; finishing; and other requirements unless otherwise indicated.

Plastic-Laminate Faces: High-pressure decorative laminate complying with NEMA LD 3, Grade HGS; applied to crossbands over core.

Generally, retain subparagraph below; lead-lined doors are much heavier than doors of similar construction but without lead lining.

ANSI/WDMA I.S.1-A Performance Grade: Extra Heavy Duty.

* + - * 1. Lead Door Louvers: Louvers with [**20**] [**30**] <**Insert number**> percent free area, made from formed-lead sheet or lead extrusions of not less than lead thickness required for door in which louver is installed. Fabricate louvers to be lightproof with fixed maze-type blades that maintain required lead equivalence at all points and in all directions. Factory fit and assemble louvers in doors.

Retain first paragraph below for glazed lights or louvers in wood doors. Coordinate with lead lining and fire rating if retaining fourth option.

* + - * 1. Prepare doors to receive [**glazed lights**] [**and**] [**louvers**]; factory cut and trim openings through doors.[**Provide removable wood stops for glazed lights.**]
				2. Metal Frames for Glazed Lights: Lead-lined frame formed of 0.048-inch- thick, cold-rolled steel sheet; [**factory primed for paint**] [**with baked-enamel- or powder-coated**] finish[**; and approved for use in doors of fire-protection rating indicated**].
				3. Shield cutouts for locksets with lead sheet of same thickness used in door. Lap lining of cutouts with door lining.
				4. Furnish lead-lined astragals for pairs of doors.

Generally, retain paragraph below. Always retain for factory-finished and plastic-laminate doors.

* + - * 1. Factory fit doors to suit frame openings indicated with [**1/16-inch**] <**Insert dimension**> clearance at heads and jambs and minimum clearance at bottom. Factory machine doors for hardware not surface applied.
			1. LEAD-LINED SPLIT-CORE WOOD DOORS

Lead-lined split-core wood doors in this article are constructed with one sheet of lead in the center of the core. The core halves and the lead are then typically through-bolted on 8-inch centers; some manufacturers laminate the cores without bolts for thinner lead cores. Doors constructed in this manner can use lead sheet of any thickness.

* + - * 1. Solid-core wood doors with lead lining in center of core; with lead thickness [**not less than that required for partition in which door is installed**] [**as indicated on Drawings**] <**Insert thickness**>.

Some manufacturers are able to laminate core and lead-lining without fastening, depending on the thickness of lead sheet required. Consult manufacturers for additional information.

Construction: Split core with lead lining in center of core; bonded (vertical and horizontal edging is bonded to core). Assemble lead lining and core with poured-lead fasteners or steel bolts. Space fasteners not more than 1-1/2 inches from door edge and about 8 inches o.c. Countersink bolt heads and cover with lead.

Coordinate "Core" Subparagraph below with fire-rating requirements.

Core: [**Mineral**] [**Particleboard**] [**Structural composite lumber**].

Lead-lined wood doors are 1-3/4 inch thick, with lead thicknesses of up to 1/8 inch. Door thickness increases when lead thickness is more than 1/8 inch thick.

Lead Lining: Provide continuous sheet of lead extending from top to bottom and edge to edge; with total lead thickness [**not less than that required for partition in which door is installed**] [**as indicated on Drawings**] <**Insert thickness**>.

Retain "Wood Veneer Faces" or "Plastic-Laminate Faces" Paragraph below.

Wood Veneer Faces: Wood veneer applied to crossbands over core.

Comply with Section 081416 "Flush Wood Doors" for veneer species, grade, and matching; finishing; and other requirements unless otherwise indicated.

Plastic-Laminate Faces: High-pressure decorative laminate complying with NEMA LD 3, Grade HGS; applied to crossbands over core.

* + - * 1. Lead Door Louvers: Louvers with [**20**] [**30**] <**Insert number**> percent free area, made from formed-lead sheet or lead extrusions of not less than lead thickness required for door in which louver is installed. Fabricate louvers to be lightproof with fixed maze-type blades that maintain required lead equivalence at all points and in all directions. Factory fit and assemble louvers in doors.

Retain first paragraph below for glazed lights or louvers in wood doors. Coordinate with lead lining and fire rating if retaining fourth option.

* + - * 1. Prepare doors to receive [**glazed lights**] [**and**] [**louvers**]; factory cut and trim openings through doors.[**Provide removable wood stops for glazed lights.**]
				2. Metal Frames for Glazed Lights: Lead-lined frame formed of 0.048-inch- thick, cold-rolled steel sheet; [**factory primed for paint**] [**with baked-enamel- or powder-coated**] finish[**; and approved for use in doors of fire-protection rating indicated**].
				3. Shield cutouts for locksets with lead sheet of same thickness used in door. Lap lining of cutouts with door lining.
				4. Furnish lead-lined astragals for pairs of doors.

Generally, retain paragraph below. Always retain for factory-finished and plastic-laminate doors.

* + - * 1. Factory fit doors to suit frame openings indicated with [**1/16-inch**] <**Insert dimension**> clearance at heads and jambs and minimum clearance at bottom. Factory machine doors for hardware not surface applied.
			1. LEAD-LINED MODULAR SHIELDING PARTITIONS
				1. Partial-height modular partitions assembled from factory-finished standard components consisting of lead-lined, steel or aluminum framing members; lead-lined opaque panels; lead glass or glazing plastic vision panels; and hardware necessary for assembly and for securing to other construction. Fabricate opaque panels from honeycomb-core metal panels with polyurethane paint finish.

Lead Equivalence for Opaque Panels: [**1/16 inch**] <**Insert thickness**>.

Lead Equivalence for Framing Members: [**1/16 inch**] <**Insert thickness**>.

Lead Equivalence for Vision Panels: [**1/16 inch**] <**Insert thickness**>.

Color of Panels and Framing: [**As indicated by manufacturer's designations**] [**Match Director’s Representative's sample**] [**As selected by Director’s Representative from manufacturer's full range**] <**Insert color and gloss**>.

* + - 1. INFORMATIONAL SIGNS

Retain "Panel Signs" or "High-Pressure-Laminate Signs" Paragraph below. Revise sign material if required.

* + - * 1. Panel Signs: Comply with Section 101423 "Panel Signage."

Color: As selected by Director’s Representative from manufacturer's full range of colors.

Provide copy indicated or as directed.

Indicate lead equivalence in millimeters and heights of radiation protection in inches.

* + - * 1. High-Pressure-Laminate Signs: High-pressure laminate engraving stock with contrasting face and core, machine engraved from master templates for accurately formed letters, numbers, and symbols.

Color: As selected by Director’s Representative from manufacturer's full range of colors.

Provide copy indicated or as directed.

Indicate lead equivalence in millimeters and heights of radiation protection in inches.

Retain one or more of first four paragraphs below to suit Project. Revise each paragraph as required by radiation health physicist or authorities having jurisdiction. Delete paragraphs if information is in a schedule or on drawings.

* + - * 1. Rooms Where the Level of Protection Is Uniform Throughout: Provide one sign for each room indicating lead equivalence of partitions, ceilings, floors, doors, and other portions of radiation protection enclosure. Indicate height of radiation protection above floor, or indicate that partitions are radiation protected to full height.
				2. Rooms Where the Level of Protection Is Not Uniform Throughout: Provide one sign for each room with different lead equivalences in different locations. Indicate, in tabular form, lead equivalence of each wall, partition, ceiling, floor, door, and window. Indicate height of radiation protection above floor, or indicate that partitions are radiation protected to full height. Indicate where lead equivalence changes or is not continuous.
				3. Rooms Where Some Partitions Are without Radiation Protection: Provide one sign for each partition that contains radiation protection, and indicate its lead equivalence. Indicate height of radiation protection above floor, or indicate that partitions are radiation protected to full height.
				4. Rooms Where Only the Door Has Radiation Protection: Provide one sign for each door indicating its lead equivalence.
				5. Mounting: Provide manufacturer's standard [**two-faced tape**] [**or**] [**adhesive**].
			1. DOOR AND DOOR FRAME FABRICATION
				1. Hardware Preparation: Factory prepare doors and frames to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping in accordance with door hardware schedule and templates furnished, as specified in [**Section 087100 "Door Hardware."**]
			2. MISCELLANEOUS MATERIALS
				1. Glazing Compounds, Gaskets, and Accessories: Comply with requirements in Section 088000 "Glazing."
				2. Accessories and Fasteners: Manufacturer's standard fasteners and accessories as required for installation, maintaining same lead equivalence as rest of system.
				3. Asphalt Coating: Cold-applied asphalt emulsion complying with ASTM D1187.
				4. Asphalt Felt: ASTM D226.
1. EXECUTION
	* + 1. EXAMINATION
				1. Examine substrates with Installer present for compliance with requirements, installation tolerances, and other conditions affecting performance of radiation protection.
				2. Proceed with installation only after unsatisfactory conditions have been corrected.
			2. INSTALLATION OF LEAD SHEETS IN CONCRETE FLOOR SLABS
				1. Proceed with installation only after concrete surfaces are clean, dry, and free of depressions and sharp projections that could damage or penetrate lead sheet.
				2. Coat concrete surfaces with asphalt emulsion before installing lead sheet.
				3. Lead Sheet, 1/8 Inch Thick or Less: Install in a single layer with a 2-inch minimum lap at joints.

Retain "Lead Sheet More Than 1/8 Inch Thick" Paragraph below for lead sheet more than 1/8 inch thick.

* + - * 1. Lead Sheet More Than 1/8 Inch Thick: Install in two or more layers with a 2-inch minimum lap at joints, or in a single layer with joints butted and covered with a 4-inch- wide lead strip of same thickness.

Retain one or both of first two paragraphs below if applicable.

* + - * 1. Extend lead sheet at least 12 inches beyond radiation shielding in walls of treatment room.
				2. In floor slabs above shielded rooms, where lead sheet is indicated, extend lead sheet at least 12 inches beyond radiation shielding in walls of room below.

Retain first paragraph below if required. This provision can be used at doors, even if floor is not lined, to decrease radiation scattered under door. Recess slab to receive lining.

* + - * 1. At door openings, extend lead sheet at least 12 inches beyond radiation protection in walls and at least 12 inches beyond door opening on both sides[**, except where lead-lined thresholds are provided**].
				2. After installation, apply [**one coat**] [**two coats**] of asphalt emulsion on top surface of lead sheet and protect from damage until concrete topping is placed.
			1. INSTALLATION OF LEAD BRICKS
				1. Remove projections from concrete surfaces to receive lead bricks, and apply one layer of asphalt felt to prevent contact between lead bricks and concrete.

Retain subparagraph below if lead bricks are installed in concrete floor slabs.

At recesses in concrete floors to receive lead bricks, turn up asphalt felt at perimeter of recess.

* + - * 1. Install lead bricks to dimensions indicated, tightly fitted together, with joints offset in succeeding courses. Cut bricks neatly at joints with adjacent materials for a snug fit, with edges straight and true and at right angles.

Retain paragraph below if applicable.

* + - * 1. Secure lead bricks to structure, as indicated on approved Shop Drawings.
			1. INSTALLATION OF HIGH-DENSITY CONCRETE BLOCKS
				1. Dry-stack blocks in running bond, using methods recommended in writing by high-density concrete block manufacturer.
				2. Install concrete blocks to dimensions indicated, tightly fitted together, with joints offset in succeeding courses. Cut neatly at joints with adjacent materials for a snug fit, with edges straight and true and at right angles.
				3. Secure concrete blocks to structure, as indicated on approved Shop Drawings.
			2. INSTALLATION OF LEAD-LINED GYPSUM BOARD
				1. Install and finish lead-lined gypsum board in accordance with Section 092900 "Gypsum Board."

Construction adhesive in first paragraph below may reduce the number of fasteners required if partitions are not fire rated.

* + - * 1. Install lead-lined gypsum board panels with long edge parallel to supports and lead lining facing supports. Provide blocking at end joints.[**Install using construction adhesive and supplementary fasteners.**]

NCRP Report No. 147 does not require additional shielding for nails or screws. Revise first paragraph below if additional shielding is required by Project or by authorities having jurisdiction.

* + - * 1. Install lead-lined gypsum board panels in sequence, so lead lining that extends beyond edge of gypsum board is covered by next panel installed.
				2. At joints where lead lining does not extend beyond edge of gypsum board panels, install lead strips 2 inches wide and same thickness as lead lining to face of framing and blocking. Secure lead strips with construction adhesive.
				3. Provide shims at face of supports and blocking, where lead lining does not overlap, to provide a uniform plane across panel surfaces.
				4. Fasten lead-lined gypsum board to framing, with steel drill screws spaced as recommended in writing by lead-lined gypsum board manufacturer.

Retain "Two-Layer System" Paragraph below if required.

* + - * 1. Two-Layer System: Apply a facing sheet of gypsum board vertically over base sheet, using laminating adhesive recommended in writing by gypsum board manufacturer. Offset joints in finish layer from joints in base layer, and fasten at top and bottom of sheet to support finish panel until adhesive has set.
				2. Openings: Extend lead-lined gypsum board into frames of openings, lapping lead lining with lead frames or frame linings at least 1 inch. Arrange board around openings, so neither horizontal nor vertical joints occur at corners of openings.

Retain paragraph below if control or expansion joints occur in lead-lined construction. Detail joints if any are required.

* + - * 1. Install control and expansion joints where indicated, with appropriate trim accessories. Install lead strip on face of framing, extending across joint, and lap with lead lining of gypsum board.
			1. INSTALLATION OF LEAD-LINED PLYWOOD

Retain first paragraph below if additional shielding is required at framing members.

* + - * 1. Install fastener shields to framing before installing lead strips at joints.
				2. Install lead strips 2 inches wide and same thickness as lead lining to face of framing and blocking. Secure lead strips with construction adhesive.
				3. Provide shims at face of supports and blocking, where lead lining does not overlap, to provide a uniform, plane across panel surfaces.
				4. Install lead-lined plywood panels with long edge parallel to supports and lead lining facing supports. Provide blocking at end joints. Fasten lead-lined plywood panels to framing, with adhesive and steel drill screws spaced as recommended in writing by panel manufacturer.
			1. INSTALLATION OF LEAD-LINED DOORS AND DOOR FRAMES
				1. Install lead-lined steel [**doors**] [**and**] [**door frames**] in accordance with Section 081113 "Hollow Metal Doors and Frames."

Retain subparagraph below if no lead-lined steel door frames are installed in masonry or concrete walls.

Apply a coat of asphalt mastic or paint to lead lining in door frames where lead comes in contact with masonry or concrete.

* + - * 1. Install lead-lined wood doors in accordance with Section 081416 "Flush Wood Doors."
				2. Lead-Lined Hollow-Metal Door Frames: Comply with ANSI/NAAMM-HMMA 840 unless otherwise indicated. Except for frames located in existing walls or partitions, place frames before constructing walls. Set frames accurately in position, plumb, and brace securely until permanent anchors are set.

Provide three anchors per jamb, located adjacent to hinge on hinge jamb and at corresponding heights on strike jamb.

In masonry construction, use wire or T-strap anchors, and apply a coat of asphalt mastic or paint to lead lining where lead comes in contact with masonry or grout.

In metal stud construction, use wall anchors attached to studs with screws.

In wood stud construction, use strap anchors attached to studs with screws.

* + - * 1. Lead-Lined Split-Frame Observation Windows: Install lead-lined hollow-metal frames with split or telescoping design, with leaded side of frame on radiation side of wall.

Retain one of first two paragraphs below. Retain first paragraph if frames in this Section have been specified as factory lined. Retain second paragraph if frames without lining are specified in another Section.

* + - * 1. Lap lead lining of frames over lining in walls at least 1 inch.
				2. Lead Lining of Frames: Line inside of frames with lead of thickness of not less than that required in doors and walls where frames are used. Form lead to match frame contour, continuous in each jamb and across the head, lapping the stops. Form lead shields around areas prepared to receive hardware. Lap lining over lining in walls at least 1 inch.
				3. Install leaded side of frame on radiation side of wall. Lap lead lining of frames over lining in walls at least 1 inch.
				4. Lead Glazing: Comply with installation requirements in Section 088000 "Glazing" and with manufacturer's written instructions.

Retain first paragraph below if astragals are not furnished with lead lining.

* + - * 1. Line astragals with lead sheet.

Retain "Hardware" Paragraph below if required to maintain lead equivalent thickness of door and frame. In some cases, the hardware may provide sufficient shielding.

* + - * 1. Hardware: Line covers, escutcheons, and plates to provide effective shielding at cutouts and penetrations of frames and doors. See Section 087100 "Door Hardware" for other installation requirements.
			1. INSTALLATION OF LEAD-LINED MODULAR SHIELDING PARTITIONS

Retain this article if lead-lined modular shielding partitions are required.

* + - * 1. Install partitions after finishes are complete in spaces where partitions are located. Install in accordance with manufacturer's written instructions and approved Shop Drawings.
				2. Cut and remove wall base where modular shielding partitions meet other walls, so partition fits tightly to wall.
				3. Secure partition framing to floor with 1/4-inch expansion anchors 16 inches o.c., and fasten to walls and ceilings as indicated. Brace partitions with tie rods fastened to walls or ceilings as indicated.
			1. INSTALLATION OF PENETRATING ITEMS
				1. At penetrations of lead linings, provide lead shields to maintain continuity of protection.
				2. Provide lead linings, sleeves, shields, and other protection in thickness of not less than that required in assembly being penetrated.
				3. Secure shields at penetrations using adhesive or wire ties but not penetrating fasteners unless indicated on Drawings.
				4. Outlet Boxes and Conduit: Cover or line with lead sheet lapped over adjacent lead lining at least 1 inch. Wrap conduit with lead sheet for a distance of not less than 10 inches from box.

Retain "Duct Openings" Paragraph below for shielded duct openings. For openings in secondary barriers, National Council on Radiation Protection and Measurements recommends a distance of 3 times the duct opening dimension. Verify with radiation health physicist.

* + - * 1. Duct Openings: Unless otherwise indicated, line or wrap ducts with lead sheet for distance from partition/ceiling equal to 3 times the largest opening dimension. Lap lead sheet with adjacent lead lining at least 1 inch.

"Piping" Paragraph below is adequate for pipes NPS 2 and smaller. If pipes NPS 3 and larger penetrate radiation protection, indicate details on Drawings.

* + - * 1. Piping: Unless otherwise indicated, wrap piping with lead sheet for a distance of not less than 10 inches from point of penetration.
			1. FIELD QUALITY CONTROL

Retain "Testing Agency" Paragraph below to identify who shall perform tests and inspections.

* + - * 1. Testing Agency: Director’s Representative will engage a qualified testing agency to perform tests and inspections after radiology equipment has been installed and placed in operating condition.
				2. Correct deficiencies in or remove and replace radiation protection that inspection reports indicate does not comply with specified requirements.
			1. PROTECTION
				1. Lock radiation-protected rooms once doors and locks are installed, and limit access to only those persons performing work in the rooms.

END OF SECTION 134900