Preparing Activity: USACE Superseding
UFGS-13 49 10 (February 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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11/20

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USACE / NAVFAC / AFCEC / NASA **UFGS-13 49 10 (November 2020)**

Preparing Activity: USACE **Superseding**
UFGS-13 49 10 (February 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
****

SECTION 13 49 10

X-RAY SHIELDING
11/20

****
NOTE: This guide specification covers the requirements for x-ray shielding for medical and dental radiological facilities.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1	(2015) Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test

ASTM INTERNATIONAL (ASTM)

ASTM B749	(2020) Standard Specification for Lead and Lead Alloy Strip, Sheet and Plate Products
ASTM C129	(2022) Standard Specification for Nonloadbearing Concrete Masonry Units
ASTM C840	(2020) Standard Specification for Application and Finishing of Gypsum Board
ASTM C1396/C1396M	(2017) Standard Specification for Gypsum Board
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

HARDWOOD PLYWOOD AND VENEER ASSOCIATION (HPVA)

HPVA HP-1	(2020) American National Standard for Hardwood and Decorative Plywood

NATIONAL COUNCIL ON RADIATION PROTECTION AND MEASUREMENTS (NCRP)

NCRP 145	(2003) Radiation Protection in Dentistry
NCRP 147	(2004) Structural Shielding Design for Medical X-Ray Imaging Facilities
NCRP 148	(2004) Radiation Protection in Veterinary Medicines

STEEL DOOR INSTITUTE (SDI/DOOR)

SDI/DOOR A250.8	(2017) Specifications for Standard Steel Doors and Frames

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

16 CFR 1201	Safety Standard for Architectural Glazing

Materials

WINDOW AND DOOR MANUFACTURERS ASSOCIATION (WDMA)

ANSI/WDMA I.S.1A	(2013) Interior Architectural Wood Flush Doors

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Shielding Delegated Design; G[, [____]]

Installer Experience

SD-03 Product Data

Lead-Lined Concrete Masonry Units

Lead Lined Plywood

Lead-Lined Gypsum Wallboard

Interlocking Lead Bricks

Lead Glass

Lead-Lined Wood Doors

Lead-Lined Steel Doors

Door Frames

Window Frames

Louvers

SD-06 Test Reports

Testing and Certification

1.3 QUALITY CONTROL

1.3.1 Preinstallation Meeting

Hold a pre-installation meeting with the subcontractors and installers working in, on, or near the X-Ray Shielding. Review requirements and coordination to ensure the integrity of the shielding including sequence, schedule, penetrations, methods of attachment, service installations and unauthorized modifications.

[1.3.2 Shielding Delegated Design

****
NOTE: This section is used when the contractor designs the x-ray shielding protection. Typically delete this section.
****

Shielding design in accordance with [NCRP 145][NCRP 147][NCRP 148] by a qualified medical or health physicist. Calculate, design, detail and specify the x-ray shielding system requirements comprising of walls, [partitions, floor[s], ceiling,]doors, window[s], joints, patches, sleeves, and mazes as necessary to ensure shielding continuity at penetrations as well as embedded items including ducts, pipes, conduits, service boxes and hardware. Include the thickness of lead, concrete, lead glass and any other relevant materials.

Submit complete x-ray shielding system design comprising of calculations, detail drawings, specifications and product data sufficient to validate the design and for construction, to the Contracting Officer for approval prior to construction.

a. Medical or Health Physicist Qualifications: Regularly engaged in the design of radiation shielding, and certified by American Board of Radiology, American Board of Medical Physics, American Board of Health Physics, or Canadian College of Physicists in Medicine.

]1.3.3 Installer Experience

An experienced firm that has been regularly and successfully engaged in the installation of radiation protection systems, similar to the work required, for at least the previous 5 years.

a. Submit a project experience list on projects of similar scope completed during the previous 5 years for approval. Include project completion dates, name and telephone number of the user and/or owner.

1.3.4 Source Responsibility

Procure radiation protection materials, components and accessories as standard products. Obtain each type of product from a single manufacturer.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials and components in original packaging, labeled with the manufacturer/vendor, brand name and part number as appropriate.

Inspect materials and components upon receipt. Remove and replace damaged items. Minor damage may be repaired at the discretion of the Contracting Officer where repair matches new condition.

Comply with manufacturers/vendors instructions and recommendations for storage and handling of all materials and components.

Protect materials and components from deleterious environments including weather, direct sunlight, moisture, contamination, corrosion, and construction traffic.

PART 2 PRODUCTS

2.1 X-RAY SHIELDING SYSTEM

A continuous x-ray shielding system in accordance with [NCRP 145][NCRP 147][NCRP 148], comprising of walls, [partitions, floor[s], ceiling,]doors, window[s], joints, patches, sleeves, and mazes as necessary to ensure shielding continuity at penetrations as well as embedded items including ducts, pipes, conduits, service boxes and hardware.

Minimum sheet lead thickness as indicated.

Nominal sheet lead overlap as indicated to achieve a minimum overlap of not less than 0.4 inch in the field including sheet to sheet joints, sheet to shielded element/component joints, and sheet to patches, sleeves, and mazes, unless specified otherwise.

2.2 LEAD SHEET

Sheet Lead: conform to ASTM B749, Grade C, thickness as indicated.

2.3 LEAD-LINED CONCRETE MASONRY UNITS

Single thickness of unpierced sheet lead bonded or permanently anchored to concrete masonry units conforming to ASTM C129, Type 1. Nominal sheet lead overlap between blocks [1 inch][1-1/2 inch]. Provide preformed half block lengths to ensure bond and shielding without cutting in the field. 300 by 300 by [100] [150] mm 150 by 300 by [100] [150] mm 100 mm

2.4 LEAD LINED PLYWOOD

Single thickness of unpierced sheet lead laminated to plywood, PS 1 Structural grade, Grade C-C or better, sanded; APA span rated to suit application, [5/8 inch] [3/4 inch] thick conforming to HPVA HP-1.

a. Fire-Retardant Treated Plywood: Where indicated, fire-retardant treated plywood complying with performance requirements in ASTM E84, Interior Type A.

2.5 LEAD-LINED GYPSUM WALLBOARD

Single thickness of unpierced sheet lead laminated to [13][16] mm [1/2][5/8] inch thick gypsum board conforming to ASTM C1396/C1396M, Type III, Grade R, Class 1, Form a, [Style 1][Style 3].

[2.6 CONCRETE SHIELDING MATERIAL

2355 kg/cubic meterRefer to Section 03 30 00 CAST-IN-PLACE CONCRETE.

][2.7 INTERLOCKING LEAD BRICKS

99.9 percent pure lead, free from inclusions, scale, laminations, blisters, cracks, and projections that could affect interlock. Nominal lead overlap between bricks [1 inch].

]2.8 LEAD GLASS

Clear x-ray protective quality glass in single or multiple thicknesses. Shielding equivalent not less than the adjacent construction. Permanently labeled as "X-Ray Lead Glass" and with the equivalent lead shielding thickness identified.

a. Lead Safety Glass: Laminated clear float glass, permanently labeled as impact resistant in compliance with ANSI Z97.1 and 16 CFR 1201, CAT II.

2.9 LEAD-LINED WOOD DOORS

[Hardwood veneer, solid core, lead-lined wood doors to ANSI/WDMA I.S.1A, with manufacturer's standard lead core thickness to achieve shielding equivalent to not less than the adjacent construction.][Add door description.][Refer to Section 08 14 00 WOOD DOORS.]

2.9.1 Door Hardware

Provide sheet lead and lead plugs to maintain shielding at hardware locations not less than the shielding equivalent in the adjacent construction.

[2.9.2 Thresholds

****
NOTE: Threshold construction may not be required for installations operating below critical power levels where the primary beam does not strike the door area.
****

Line thresholds with a single thickness of sheet lead to provide not less than the shielding equivalent in the adjacent construction.

]2.10 LEAD-LINED STEEL DOORS

[SDI/DOOR A250.8, Level 2 Heavy Duty, Model 1, minimum 0.042 inch faces with vertical steel stiffeners throughout and manufacturer's standard lead core thickness to achieve shielding equivalent to not less than the adjacent construction.][Add door description.][Refer to Section 08 11 13 STEEL DOORS AND FRAMES.]

2.10.1 Door Hardware

Provide sheet lead and lead plugs to maintain shielding at hardware locations not less than the shielding equivalent in the adjacent construction.

[2.10.2 Thresholds

****
NOTE: Threshold construction may not be required for installations operating below critical power levels where the primary beam does not strike the door area.
****

Line thresholds with a single thickness of sheet lead to provide not less than the shielding equivalent in the adjacent construction.

]2.11 DOOR FRAMES

[SDI/DOOR A250.8, Level 2 welded frame, minimum 0.053 inch frame thickness and manufacturer's standard lead core thickness to achieve shielding equivalent to not less than the adjacent construction.][Add door frame description.][Refer to Section 08 11 13 STEEL DOORS AND FRAMES.]

Continuously lined with a single thickness of factory installed sheet lead to provide the shielding equivalent not less than the adjacent construction. Include sheet lead and lead plugs to maintain shielding at hardware locations and adjoining lead shielding.

2.12 WINDOW FRAMES

[Add window frame description.][Refer to Section 08 51 13 ALUMINUM WINDOWS.][Refer to Section 08 51 23 STEEL WINDOWS.]

Continuously lined with manufacturer's standard lead core thickness to provide the shielding equivalent not less than the adjacent construction. Overlap frames a minimum of 9 mm 3/8 inch at the perimeter of the lead glass or twice the thickness of the sheet lead shielding, whichever is

greater. Lead frames and glazing panel to provide shielding equivalent not less than the adjacent construction. Include sheet lead and lead plugs to maintain shielding to adjoining lead shielding.

2.13 LOUVERS

[Add louver description]

One-unit with a maze-type blade to allow [30 percent] free area and continuously lined with a single thickness of factory installed sheet lead to provide the shielding equivalent not less than the adjacent construction.

2.14 DESIGNATING PLAQUES

Aluminum, plastic, or other durable material recording the shielding thicknesses for the enclosure types listed below.

2.14.1 Continuous X-Ray Shielding System

Provide one sign, [_____] mm inches tall by [_____] mm inches wide, for each shielded room as follows:

"SURFACES OF THIS ROOM HAVE BEEN INSULATED WITH SHEET LEAD OF THE FOLLOWING THICKNESSES:

	LEAD THICKNESS	TOTAL LEAD EQUIVALENT SHIELDING
DOORS	[_____]inches	[_____]inches
WALLS TO [7] FEET ABOVE FLOOR SLAB	[_____]inches	[_____]inches
FLOOR	[_____]inches	[_____]inches

DO NOT REMOVE"

2.14.2 Shielded Partitions

Provide one sign, [_____] mm inches tall by [_____] mm inches wide, for each shielded partition as follows:

"THIS PARTITION HAS X-RAY SHIELDING

[FULL HEIGHT][FROM FLOOR SLAB TO A HEIGHT OF[_____] FEET]
LEAD SHIELDING THICKNESS: [_____] mm INCH
TOTAL LEAD EQUIVALENT SHIELDING: [_____] INCHES

DO NOT REMOVE"

PART 3 EXECUTION

3.1 INSTALLATION

Perform installation in accordance with drawings, manufacturer's instructions and recommendations, and [NCRP 145][NCRP 147][NCRP 148].

3.1.1 Workmanship

Install sheet lead free of waves, lumps, and wrinkles and with a minimum number of joints. Finish joints smooth and neat.

3.1.2 Protection

Provide patches, plugs, sleeves, and mazes to ensure shielding continuity at penetrations and embedded items including ducts, pipes, conduits, service boxes, and hardware. Coordinate service installations.

Nominal sheet lead overlap as indicated to achieve a minimum overlap of not less than 0.4 inch in the field, including sheet to sheet joints, sheet to shielded element/component joints, and sheet to patches, sleeves, and mazes. Use sheet lead not less than the thickness of the sheet lead being jointed. Ensure all joints are robust and close fitting.

3.2 LEAD-LINED CONCRETE FLOORS

3.2.1 Preparation

Ensure concrete surface is clean, dry, and free of projections that could deform, damage or penetrate the sheet lead. When necessary, apply self leveling underlayment over rough or uneven concrete surfaces. Apply a coat of [asphalt][latex] paint to the concrete surface prior to installation of the sheet lead.

3.2.2 Shielding

Apply sheet lead 1/8 inch thick or less in a single layer with a 1-1/2 inch nominal lap at joints. Apply sheet lead more than 1/8 inch thick in two or more layers 1/8 inch or less in thickness with 1-1/2 inch nominal lap at joints, or in a single layer with joints butted and covered with lead strips 2 inches wide, placed centrally over the joint. Strip thickness not less than the thickness specified for the floor.

3.2.3 Protection from Damage

Apply a coat of [asphalt][latex] paint to the top surface of the sheet lead prior to application of [concrete]surfacing. Do not permit traffic or work in the area until protection is applied over the sheet lead.

3.3 LEAD-LINED BLOCKS

Lay lead-lined blocks in running bond courses with staggered vertical joints. Erect blocks with minimum 0.40 inch wide tight sheet lead lap. Use preformed half block lengths to ensure bond and shielding without cutting in the field.

3.3.1 Joints

Fill mortar joints solid with 3/8 inch thick Type N mortar. Do not place

mortar between lead laps.

3.3.2 Pipe and Conduit Chases

Remove concrete from one side of the block only as needed to permit installation. Fill voids with mortar and finish flush. Reinstall continuous sheet lead and overlap the adjoining sheet a minimum of 0.40 inch. Do not install pipe and conduit chases directly opposite each other within the same wall.

3.4 LEAD-LINED PLYWOOD

Provide studs at vertical joint locations[and blocking at horizontal joint locations]. Secure 2 inch wide sheet lead strips, not less than the shielding thickness, centrally at the location of each panel vertical[and horizontal] joint. Butt joint lead lined plywood centrally over lead strips, with shielding on inside face and long edges parallel to vertical supports. Use bent 4 inch wide sheet lead strips at corners. Fasten edges at 8 inch on center and 16 inch on center in the field. Finish fasteners flush to the surface without distortion.

3.5 LEAD-LINED GYPSUM WALLBOARD

Provide studs at vertical joint locations[and blocking at horizontal joint locations]. Secure 2 inch wide sheet lead strips, not less than the shielding thickness, centrally at the location of each panel vertical[and horizontal] joint. Butt joint lead lined gypsum wallboard centrally over lead strips, with shielding on inside face and long edges parallel to vertical supports. Use bent 4 inch wide sheet lead strips at corners. Fasten edges at 8 inch on center and 12 inch on center in the field. Install and finish lead-lined gypsum wallboard in accordance with ASTM C840.

[3.6 INTERLOCKING LEAD BRICKS

Apply a coat of [asphalt][latex] paint to the concrete floor surface prior to installation of lead bricks. Erect bricks with minimum 0.40 inch wide tight lead lap. Use preformed half block lengths to ensure bond and shielding without cutting in the field.

][3.7 SUSPENDED LEAD-LINED CEILINGS

Provide suspended lead-lined ceilings consisting of ceiling bars, and hangers. Space continuous bars approximately [315] [415] mm [12-1/2][16-1/2] inch on center and supported by steel hangers from overhead structure. Use bent 4 inch wide sheet lead strips at ceiling to wall junctions.

]3.8 LEAD DOOR THRESHOLDS

Install thresholds in accordance with approved detail drawings. Apply a coat of [asphalt][latex] paint to the concrete surface prior to installation of the sheet lead.

3.9 LEAD-LINED DOORS

Install doors with a clearance of 1/16 inch at sides and top and minimum clearance at bottom. Provide 1/8 inch beveled lock edge and adjust hardware as required. Do not exceed a warp or twist of 1/4 inch in any face dimension of door including full diagonal, after doors have been hung

and finished. [Seal cuts required for installation with a clear varnish or sealer.]

3.9.1 Door Hardware

Patch cutouts for lock sets and latch cases with sheet lead not less than the thickness of the door shielding. Lap sheet lead lining of the lock set and sheet lead lining of the door to achieve a minimum overlap of not less than 0.4 inch.

3.9.2 View Windows

Provide stops and moldings around glazed view windows where indicated. Install view windows in doors with hardwood stops to match face veneer. Glue stops to door on corridor side and fasten with countersunk[oval head screws][finishing nails].

[a. Install view windows in doors with hardwood stops to match face veneer. Glue stops to corridor side of door(s) and fasten with countersunk[oval head screws][finishing nails].]

[b. Install view windows in doors with fixed frame moldings on corridor side of door(s). Provide loose stops and moldings on inside of hollow-metal doors and fasten with countersunk [flat-] [or] [oval-]head machine screws spaced uniformly not more than [9] inches o.c. and not more than [2] inches o.c. from each corner.]

3.9.3 Lead Louvers

Install lead louvers in doors with [cadmium-] [or] [chromium-]plated screws.

3.10 TESTING AND CERTIFICATION

Perform shielding verification, by a qualified medical or health physicist, to determine that the barrier requirements specified in the shielding design were correctly installed. Perform the verification during construction by physically observing and documenting the installation of the barrier materials or after construction by taking transmission measurements. Prior to building occupancy, submit this shielding verification to the Contracting Officer for approval. Correct or replace any part of x-ray shielding work found to be defective.

-- End of Section --