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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2009

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04/07

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SECTION 09 69 13

RIGID GRID ACCESS FLOORING 04/07

NOTE: This Guide Specification covers the requirements for rigid grid access flooring.

Edit this guide specification for each project specific requirements by adding, deleting, or revising text. Choose applicable bracketed items(s) or insert appropriate information.

Remove information and/or requirements not related to the respective project, whether or not brackets are present.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

PART 1 GENERAL

NOTE: This specification does not include the floor upon which the elevated floor is superimposed, except to define the nature and condition of the supporting floor.

Access flooring systems include floor panels, pedestals and items such as stringers, steps, ramps, closures and trim. Access flooring systems must be designed to accommodate static, rolling and impact loadings.

None of the mechanical and electrical services essential to the operation of equipment are included. Coordinate with mechanical and electrical

to provide ventilation and cable openings which will be required.

The designer is responsible for identifying and defining requirements for the floors. Drawings must indicate location and limits of the flooring systems, finish floor elevation, panel size, type, finish and anti-static provisions, colors, pedestal mounting and subfloor connection system details.

STRINGERLESS ACCESS FLOORING is covered in SECTION 09 69 19.

Stair and/or ramp information, such as tread width and riser height for stairs and width, slope and length of ramps, including railings, are included in this section.

Ancillary components such as floor diffusers and grills, fascias and floor opening trims are also included.

Seismic loadings and any other information required to indicate the extent of work must be considered in designing access flooring systems.

There are three fundamental conditions relative to the design of access flooring installations:

Condition I Floors are completely surrounded by building walls. These are the most resistant to seismic loadings.

Condition II Floors have part of the edge exposed and not restrained by other structural elements. Condition II floors are less resistive to seismic loadings along the axis of the unconstrained side. Seismic loadings can be resisted by securing the perimeter panels of all floors to the supporting structural framing and fitting the panels tightly together, or by cross bracing the structural frame to resist overturning. The designer must select fascia type and finish for exposed edges.

Condition III Floors are free standing without lateral contact with other structural elements. Type III floors are primarily strengthened with cross bracing to resist lateral loads.

Buildings not excluded by UFC 3-310-02A or TI 800-01 Design Criteria will be accessible in accordance with 36 CFR, Part 1191, Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities.

On the drawings, show:

1. Extent and shape of access flooring area. Include details of panel-to-panel and panel-to-wall

intersections, edge treatment at openings, expansion joints, elevation(s) above structural floor, and other special features of the elevated floor system.

2. Location and design of ramps, steps, and doors to access floor area; railing heights and design.

3. Location and sizes of registers, grilles, perforated panels, and cable openings through access floor panels.

4. Design and type of plenum fire extinguishing systems, if space under access floor is to be used as air plenum.

5. Layout of plenum dividers.

6. Pattern of access floor panels.

7. Location of building electrode. Coordinate structural grounding connections with appropriate building and electrical systems.

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 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 ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS (AATCC)

AATCC 134 (2006; E 2007) Standard Test Method for Electrostatic Propensity of Carpets

AATCC 16 (2004) Colorfastness to Light

APA - THE ENGINEERED WOOD ASSOCIATION (APA)

APA EWCG (2005) Engineered Wood Construction Guide:
Building Requirements and Related Panel
Systems

APA PS 1 (1995) Voluntary Product Standard for
Construction and Industrial Plywood

ASTM INTERNATIONAL (ASTM)

ASTM A 780 (2001; R 2006) Standard Practice for
Repair of Damaged and Uncoated Areas of
Hot-Dip Galvanized Coatings

ASTM B 85/B 85M (2008) Standard Specification for
Aluminum-Alloy Die Castings

ASTM E 648 (2008b) Standard Test Method for Critical
Radiant Flux of Floor-Covering Systems
Using a Radiant Heat Energy Source

ASTM E 84 (2009) Standard Test Method for Surface
Burning Characteristics of Building
Materials

ASTM F 1066 (2004) Standard Specification for Vinyl
Composition Floor Tile

CEILINGS & INTERIOR SYSTEMS CONSTRUCTION ASSOCIATION (CISCA)

CISCA Access Floors (2004) Test Procedures for Access Floors

COMPOSITE PANEL ASSOCIATION (CPA)

CPA A208.1 (2009) Medium Density Fiberboard (MDF) For
Interior Applications

CPA A208.2 (2009) Medium Density Fiberboard (MDF) for
Interior Applications

ICC EVALUATION SERVICE, INC. (ICC-ES)

ICC-ES AC300 (2005) Acceptance Criteria for Access
Floors

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC (2006; Errata 2006; Errata 2007;
Supplement 2007; Errata 2007)
International Building Code

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA LD 3 (2005) Standard for High-Pressure
Decorative Laminates

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 75 (2008) Protection of Information
Technology Equipment

NFPA 99 (2005; Errata 2005) Health Care Facilities

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS TT-C-490 (1990; Am 2) Cleaning Methods for Ferrous
Surfaces and Pretreatments for Organic
Coatings

UNDERWRITERS LABORATORIES (UL)

UL 779 (1995; Rev thru Nov 2005) Electrically
Conductive Floorings

1.2 SYSTEM DESCRIPTION

NOTE: Access flooring support systems are available
as either a stringer or stringerless system. Refer
to Section 09 69 19 STRINGERLESS ACCESS FLOORING for
stringerless applications.

A stringer is a horizontal framing member that
connects the pedestal head, supports the panel edges
and adds lateral stability to the floor system.
Stringers should be used on all systems with a
height that exceeds 300 mm (12 inches).

For Army facilities, specify the stringer system
when the total area is over 371 square meters (4000
square feet) unless the system provides bolted
connection between the panel and pedestal.

For Army facilities requiring stringer type systems,
aluminum, holder formed steel, metal-clad
cementitious fill, metal-clad wood core and concrete
panels may be used.

For Air Force facilities, use stringer Type floor
systems for data processing facilities.

For Air Force facilities requiring stringer type
floor systems, aluminum, hollow formed steel and
metal-clad wood core are permitted options.

Consideration should be given to loads which will be
imposed during operation. Some equipment, such as
high speed printers require large quantities of
paper to be delivered by carts. When in motion,
these heavy loads may exceed capacity of floor
system. Check with user activity and floor system
manufacturer when heavy rolling loads are expected.

Install access flooring at the location and elevation and in the

arrangement shown on the drawings. The floor system shall be of the rigid grid stringer type, complete with all supplemental items, and be the standard product of a manufacturer specializing in the manufacture of access flooring systems.

a. Provide for self-alignment of floor panels, adjustable pedestals and readily removable floor panels covered as specified.

b. Lateral stability of floor support system shall be independent of panels. Provide a finished assembly that is rigid and free of vibration, noises, and rocking panels.[Provide bolted stringer system with equipotential plane grounding.]

c. Submit Certificates for the complete Access Flooring System including, but not limited to the following:

1) Compliance with ICC-ES AC300.

2) Load-bearing capabilities of pedestals, floor panels, and pedestal adhesive resisting force.

3) Supporting independent laboratory test reports. For panel loads, test results include concentrated loads at center of panel, panel edge midpoint, and uniform loads.

4) Floor electrical characteristics.

5) Material requirements

6) An elevated floor system free of defects in materials, fabrication, finish, and installation, that will remain so for a period of not less than [_____] years after completion.

d. Warrant that, upon notification by the Government, defective work will be immediately replaced with new work at no additional cost to the Government.

1.2.1 Allowable Tolerances

a. Floor Panel Flatness: Plus or minus 0.5 mm 0.02 inches on diagonal on top of panel or underneath edge.

b. Floor Panel Length: Plus or minus 0.4 mm 0.015 inch.

c. Floor Panel Squareness: Plus or minus 0.5 mm 0.02 inch in panel length.

d. Finish Floor: Level within plus or minus 1.6 mm in 2 meters 0.062 inch in 10 feet, and plus or minus 2.5 mm 0.10 inch for entire floor.

1.2.2 Floor Panels

NOTE: Insert heavier load as required by facility use conditions. The deflection and permanent deformation limits are for panels 610 by 610 mm (24 by 24 inches), and smaller.

Check manufacturer's literature for maximum loadings

available. Generally, computer rooms are based on live load of 12 kPa (250 psf) and point load of 450 kg (1000 lbs). Coordinate design loads for access floor with design of structural slab.

For Navy projects design loads will be in accordance with the International Building Code and NAVFAC P-355.

Conduct floor panel testing in accordance with CISCA Access Floors. When tested as specified, make all deflection and deformation measurements at the point of load application on the top surface of the panel. Floor panels shall be capable of supporting the following loads:

- a. Concentrated load of [4450] [5563] [6675] [_____] N [1000] [1250] [1500] [_____] pounds on 645 square mm one square inch, at any point on panel, without deflecting more than 2 mm 0.08 inch, with a safety factor of 2 based on static design load, without permanent deformation in excess of 0.25 mm 0.01 inch in any of the specified tests.
- b. Uniform live load of [11.97] [14.36] [16.76] [_____] kPa/square meter [250] [300] [350] [_____] psf, without deflecting more than 1 mm 0.04 inch.
- c. A rolling load of [_____] kg pounds applied through hard rubber surfaced wheel 150 mm 6 inch diameter by 50 mm 1 1/2 inch wide for 10,000 cycles over the same path. Permanent set at conclusion of test shall not exceed 0.25 mm 0.010 inch.
- d. A rolling load of [2670] [4450] [_____] N [600] [1000] [_____] pounds applied through a 75 mm 3 inch diameter by 30 mm 1-13/16 inch wide caster for 10 cycles over the same path, without deflecting more than 1 mm 0.04 inch and without permanent deformation in excess of 0.5 mm 0.02 inch. In accordance with CISCA Access Floors, the permanent deformation limit under rolling load shall be satisfied in all of the specified tests. In the specified tests, the permanent deformation shall be measured after 10 passes with Wheel 1 and after 10,000 passes with Wheel 2.
- e. An impact load of [_____] kg on 645 square mm pounds on one square inch from a height of 300 mm 12 inches with permanent set not to exceed 1.5 mm 0.060 inch.

1.2.3 Stringers

Provide stringers capable of supporting a [1110 N 250 pound] [90 kg 200 pounds] concentrated load at midspan without permanent deformation in excess of 0.25 mm 0.010 inch.

1.2.4 Pedestals

NOTE: Pedestals consist of a base plate, post and an adjustable head, and are available in heights from 150 mm (6 inches) to 2400 mm (96 inches). Pedestals 610 mm (24 inches) high or higher must be securely anchored to the structural floor in addition to being held in place by adhesive.

Pedestals are normally held in place with an adhesive and must be in full contact with the subfloor surface. Pedestal 610 mm (24 inches) high or higher will be securely anchored to the structural floor in addition to the adhesive.

For Air Force projects, the minimum pedestal height is 300 mm (12 inches).

Pedestals shall be capable of supporting a 22.24 kN 5000 pound axial load without permanent deformation.

1.2.5 Bonding Strength of Pedestal Adhesive

NOTE: Use 113 Nm (1,000 lbf-in) for raised floors with a maximum height of 610 mm (24 inches) and 226 Nm (2,000 lbf-in) for raised floor heights greater than 610 mm (24 inches) up to 1219 mm (48 inches) maximum. Raised floor heights greater than 1219 mm (48 inches) require specific structurally designed bracing.

Adhesive for anchoring pedestal bases shall have a bonding strength capable of resisting an overturning moment of [113 Nm 1,000 lbf-in] [_____] when a force is applied to the top of the pedestal in any direction.

1.2.6 Bond Strength of Factory Installed Covering

Bond strength of floor covering shall be sufficient to permit handling of the panels by use of the panel lifting device, and to withstand moving caster loads up to 4.45 kN 1000 pounds, without separation of the covering from the panel.

1.2.7 Seismic Calculations

[1.2.7.1 Navy Requirements

NOTE: For Navy projects, provide lateral bracing calculations on all installations. Level 1 Contracting Officer's approval was granted for calculations by a registered professional engineer. Occupancy importance factor (I) and seismic zone factor (z) should be deleted in accordance with NAVFAC P-355.

Submit seismic calculations for lateral bracing, sealed by a Professional Engineer. Document that access flooring system complies with seismic requirements of ICC IBC and ICC-ES AC308 for Occupancy Importance Factor (I) of [1.5] [1.25] [1.0], Seismic Zone Coefficient (Z) of [0.075] [0.15] [0.20] [0.30] [0.40] and Horizontal Force Factor (Cp) of 0.75.

]1.2.7.2 Army Requirements

NOTE: Provide seismic requirements, if a Government designer (Corps office or A/E) is the Engineer of Record, and show on the drawings. Delete the second bracketed phrase if seismic details are not provided. Pertinent portions of UFC 3-310-04 and Section 13 48 00 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT must be included in the contract documents.

Submit calculations for special bracing to resist the effects of seismic or other forces [in accordance with UFC 3-310-04, ICC IBC and ICC-ES AC300] [as shown on the approved detailed installation drawings].

]1.2.8 Air Leakage

NOTE: Delete the requirements for air leakage when the space under the finished floor is not used as an air plenum. Concrete floors to be used as air plenums must be sealed and coated.

When the space below the finished floor is to be an air plenum, air leakage through the joints between panels and around the perimeter of the floor system shall not exceed 0.15 L/s of air per linear meter 0.1 cubic foot of air per minute per linear foot of joint subjected to 2.5 mm 0.1 inch, water gauge, positive pressure in the plenum.

1.2.9 Grounding

NOTE: Access flooring system must be grounded for safety hazard and static control. The three most common static control requirements are:

1. Computer rooms, electronic offices, data centers and control rooms. The access floor system should provide resistance from floor wearing surface to building grounding electrode within range of 0.5 to 20,000 megohms.
2. Clean rooms, laboratories, and other environments which are more sensitive to static discharge. The access floor system should provide resistance within range of 0.2 to 2.0 megohms.
3. Hospitals and other facilities described by NFPA 99 and referenced to UL 779. The access floor system should provide resistance within range of 0.025 to 1.0 megohms.

These limits may be changed if other values are required by the Using Agency. Design the grounded floor system to provide positive contact between all metal components. Grounding details must be shown

on the project drawings; the option of using manufacturer's alternate methods of grounding may be included in the project specification.

Ground the access flooring system for safety hazard and static suppression. Provide positive contact between components for safe, continuous electrical grounding of entire floor system. Total system resistance from wearing surface of floor to building grounding electrode shall be within range of [0.5 to 20,000 megohms] [0.2 to 2.0 megohms] [0.025 to 1.0 megohms].

1.2.9.1 Metal Grilles

Exposed metal is not allowed at wearing surface of access floor system, except at metal grilles and registers. When grilles and metal registers are provided, insulate as required to provide same grounding resistance as wearing surface.

1.2.9.2 Joint Resistance

NOTE: Coordinate with electrical drawings and specifications to assure that connection to building grounding electrode is shown. Do not use sound deadening materials which prevent grounding of system. Select a total system resistance to comply with user requirements.

Electrical joint resistance between individual stringer and pedestal junctions shall be less than 0.1 milliohms. Electrical resistance between stringers and floor panels, as mounted in normal use, shall be less than 3 ohms.

1.3 SUBMITTALS

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation 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.

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

SD-02 Shop Drawings

Detailed Installation Drawings[; G][; G, [_____]]

Drawings showing location, details at floor perimeter, method of anchorage to structural subfloor, grounding, description of [shop] [factory] coating, installation height above structural floor, stairs, ramps, accessories and other details as specified.

SD-03 Product Data

Access Flooring System

Manufacturer's descriptive data, catalog cuts, and installation instructions. Include in the data information about any design and production techniques, total system including all accessories and finish coatings of under-floor components, procedures and policies used to conserve energy, reduce material, improve waste management or incorporate green building/recycled products into the manufacturer of their components or products. Include cleaning and maintenance instructions.

NOTE: Zinc whiskers can occur on the underside of raised floor systems which are treated with a zinc electroplated anti-corrosion coating. Zinc whiskers are small enough (2 microns in diameter up to several millimeters in length) to render normal dust filters on computer equipment ineffective. The result is possible electrical shorts and damage to circuitry and equipment.

Systems which contain zinc electroplated anti-corrosion coatings are prohibited.

SD-04 Samples

[Three][_____] complete Floor Panels
[Three][_____] separate samples of the specified Finish Flooring

Panel Support System Accessories

[One sample of each panel type and suspension system proposed for use.]

SD-05 Design Data

Compliance with ICC-ES AC308

Design data substantiating compliance with International Building Code Acceptance Criteria for Access Floors.

Seismic Calculations

Design calculations which demonstrate that the proposed floor system meets requirements for seismic loading. Certified copies of test reports may be submitted in lieu of calculations.

SD-06 Test Reports

Factory Tests Electrical Resistance Field Tests

Certified copies of test reports from an approved testing laboratory, attesting that the proposed floor system components meet the performance requirements specified.

SD-07 Certificates

Access Flooring System

Certificate of compliance attesting that the installed access floor system meets specification requirements, including all special equipment loads and specific electrical and or cable requirements.

1.4 QUALITY ASSURANCE

Take measurements from finished areas at site and submit [Detailed Installation Drawings](#) indicating:

- a. Location of panels
- b. Layout of supports, panels, and cutout locations
- c. Stair, handrail, and ramp framing
- d. Sizes and details of components
- e. Lateral bracing
- f. Typical cutout details
- g. Gasketing, return air grilles, supply air registers, and perforated panels. Include air transfer capacity of grilles, registers and panels
- h. Floor finishes

i. Location of connection to building grounding electrode

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

Deliver materials to site in undamaged condition, in original containers or packages, complete with accessories and instructions. Label packages with manufacturer's name and brand designations. Package materials covered by specific references bearing specification number, type and class as applicable.

1.5.2 Storage

Store all materials in original protective packaging in a safe, dry, and clean location. Store panels at temperatures between 4 and 32 degrees C 40 and 90 degrees F, and between 20 and 70 percent humidity. Replace defective or damaged materials.

1.5.3 Handling

Materials shall be handled and protected in a manner to prevent damage during the entire construction period.

1.6 EXTRA MATERIALS

NOTE: To assure matching floor panel, which may become damaged and require replacement, supply of extra stock is recommended. Set amount based on conditions of specific project. Do not specify extra stock unless user activity concurs; warehousing may not be available.

Select the appropriate paragraph for the agency indicated, and delete the remaining two.

[a. ARMY: Furnish spare floor panels, complete pedestal assemblies, and stringers at the rate of one for each 100 or fraction thereof required.]

[b. NAVY: Provide [four] [_____] floor panels complete with specified floor covering for future use.]

[c. [AIR FORCE] [NASA]: Provide four spare panels with identical finish flooring pedestals and stringers for each 100 square meters 1,000 square feet of access flooring and total of 3 linear meters 10 linear feet of cut-out trim. Store extra stock in same manner and location as project materials.]

PART 2 PRODUCTS

NOTE: The designer should consider incorporating, when possible, any design provisions which encourage use of innovative construction materials or techniques which are environmentally sensitive, take advantage of recycled materials, and conserve our

natural resources.

2.1 FLOOR PANELS

2.1.1 Floor System Drawings And Planer Quality

- a. Submit Fabrication Drawings for elevated floor systems consisting of fabrication and assembly details to be performed in the factory.
- b. Indicate on Location Drawings exact location of pedestals, ventilation openings, cable cutouts, and the panel installation pattern.
- c. Provide Detail Drawings showing details of the pedestals, pedestal-floor interlocks, floor panels, panel edging, floor openings, floor opening edging, floor registers, floor grilles, cable cutout treatment, perimeter base, expansion joints, and peripheral support facilities.
- d. Design and workmanship of the floor, as installed, shall be completely planar within plus or minus 1.5 mm in 3050 mm 0.060 inch in 10 feet, 2.5 mm 0.100 inch for the entire floor, and 0.7 mm 0.030 inch across panel joints.
- e. Floor-panel joint-width tolerances shall be 0.20 mm 0.008 inch as measured with a feeler gage at any point in any joint when the panels are in the pressure contact required in final installation.

2.1.2 Panel Construction

NOTE: There are five basic floor panel types: aluminum, hollow formed steel, metal-clad cementitious fill, metal-clad wood core, and concrete. Nonferrous materials should be used in areas where there is potential for damage by rust oxides or paint flakes. In accordance with CISCA Test Method, hollow panels should have a safety factor of 2 and filled panels a safety factor of 3 in terms of ultimate load.

The standard panel size of 600 by 600 mm or 1200 by 1200 mm for metric projects and 24 by 24 inch or 48 by 48 inch for imperial unit projects will normally be used. Check with user activity and verify product availability before specifying nonstandard panels of 450, 750 and 900 mm (18, 30, and 36 inch) where required to match existing floor systems or to satisfy special requirements.

Use 150 mm (6 inches) as minimum practical height for access floor installation and 300 mm (12 inches) minimum when there is a plenum. Include the five panel types as options except that wood core panels should not be specified for Air Force projects, NASA projects, SPAWARS projects, or other projects where data processing involves highly strategic data having direct bearing on National Defense effort. Check with user activity before specifying wood core

panels.

- a. Base access floor system on a 600 by 600 mm 24 by 24 inch square module providing minimum of [150] [300] [_____] mm [6] [12] [_____] inch clearance between structural floor and bottom of finished floor. Fabricate so accurate job cutting and fitting may be done using standard sizes for perimeters and around columns.
- b. Do not expose metal on finished top surface of panels. Provide cutouts and cutout closures to accommodate utility systems and equipment intercabling. Reinforce cutouts to meet design load requirements. Provide extra support pedestals at each corner of cutout for cutout panels that do not meet specified design load requirements.
- c. Panel design shall provide for convenient panel removal for underfloor servicing and for openings for new equipment. Use panels of uniform dimensions within specified tolerances. Permanently mark panels to indicate load rating and model number..
- d. Machine square floor panels to within plus or minus 0.13 mm 0.005 inch with edge straightness plus or minus 0.064 mm 0.0025 inch. Tolerances apply to the panel before the plastic edging is applied.

[2.1.2.1 Aluminum

NOTE: Die-cast aluminum panels are lightweight, have very little variation in dimension from panel to panel, and are acceptable in environments where nonferrous materials are required (e.g., Magnetic Resonance Imagery rooms), but they tend to be more expensive than other types of panels.

Die-cast aluminum panels are normally used as a stringerless system. Stringers, when required, are fastened to the top of the pedestal shaft.

Provide aluminum panels of die-cast or extruded construction conforming to ASTM B 85/B 85M.

]2.1.2.2 Hollow Formed Steel

NOTE: Die-formed hollow steel panels perform best under static loads and should not be used under dynamic (rolling) loads. These panels are more economical than other types of panels and can be provided by most flooring system manufacturers.

Steel panels shall be of die-formed construction, consisting of a flat steel top sheet welded to one or more formed steel stiffener sheets or components. Panels shall be chemically cleaned, bonderized, and painted with the manufacturer's standard finish.

][2.1.2.3 Metal-Clad Cementitious Fill (Composite Panels)

NOTE: Cementitious core filled panels are enclosed in steel sheeting and are designed to provide improved resistance to rolling and impact loads. Specific strength and load requirements should be specified wherever it is a critical concern. These panels are quiet due to their mass, but usually cost slightly more than the standard formed steel panels.

There is some concern that the fill material may deteriorate when subjected to repeated loading cycles, and the cut edges could introduce dust into the underfloor space. Where the underfloor space will be a plenum, or where dust-sensitive computer equipment is to be installed, verify that the composite panel is acceptable to the Using Agency.

Current Air Force criteria does not permit the composite panel.

a. Provide composite panels of die-formed steel construction totally enclosing the panel, including the top surface. The void spaces between the top sheet and the formed steel bottom sheet shall be completely filled with an incombustible cementitious or concrete material. Seal cut edges in accordance with manufacturer's recommendations. Gravity held panels with bolted stringer understructure: Fasten end of each stringer and mid-point of each 1212 mm 4 foot stringer positively to pedestal heads, using manufacturer's standard screws. Provide screws that are removable from top.

b. Grid supported panels shall be further tested by supporting them at two opposite edges and applying a 2225 newton 500-pound load at the center of a panel selected; the panel shall be similarly tested while supported at the other two edges. Weld failure at any point under this loading is not acceptable. This additional test shall be applied to one panel per 46.45 square meter 500 square feet of floor in the system, but in no case less than two panels. When any weld fails, the number of panels designated by the Contracting Officer shall be similarly tested; replace those panels that have a weld failure at no cost to the Government.

][2.1.2.4 Metal-Clad Wood Core

NOTE: Wood core panels consist of a core of particleboard with an overlapping skin of galvanized steel. The wood core is a good sound deadener and insulator and increases resistance to rolling loads. Wood core panels are the most economical to procure.

Although the core material is combustible, the composite panel with bonded steel for face sheets when tested in accordance with the NFPA 225, revealed the composite panel to be noncombustible with a flame spread index of 0, a smoke developed

index of 10, and to have a Class A fire rating.

Wood core panels can be easily cut and trimmed; however, doing so causes loss of fire retardancy and UL rating. The edges of wood core panels must be protected from moisture in order to prevent warping.

Provide wood core panels with cores of wood particleboard conforming to **CPA A208.1**, Grade 1-M-3, or of plywood conforming to **CPA A208.2**, **APA EWCG**, and **APA PS 1**, EXT-DFPA-C-C. The core shall be not less than **25 mm 1 inch** thick, and be faced on both sides with structurally bonded zinc-coated steel sheets not lighter than **0.70 mm 24 gauge**. All edges and corners shall be sealed with zinc-coated steel or extruded aluminum. The completed panels shall have a flame spread rating of 25 or less when tested in accordance with **ASTM E 84**. Provide zinc-coated steel, extruded aluminum, fire resistant vinyl, or other fire resistant edging to protect shop and field edge cuts and cutouts through the face of panels in a manner to meet specified flame spread requirements.

]2.1.2.5 LightweightConcrete Panels

NOTE: Lightweight concrete panels are either solid or metal clad. They perform well under dynamic loadings with little deformation and their weight is approximately 195 kg/m² (40 psf). They are primarily used in office flooring and are similar in cost to cementitious fill panels.

Provide lightweight concrete of lightweight structural concrete with either structural reinforcing or a die-formed, electro-galvanized steel bottom pan. All concrete surfaces, including those resulting from field cuts, shall be sealed with the manufacturer's standard sealer before covering the surfaces with other materials.

]2.1.3 Floor Covering

Surface floor panels with materials firmly bonded in place with waterproof adhesive. The electrical resistance shall remain stable over the life expectancy of the floor covering. Any anti-static agent used in the manufacturing process shall be an integral part of the material, not surface applied. Bolt heads or similar attachments shall not rise above the traffic surface.

2.1.3.1 High Pressure Laminate

NOTE: High pressure laminate is the standard surfacing material and is preferred where cost is not an overriding factor.

Grade HW-120, approximately 3 mm (1/8 inch) thick, is recommended on metal floor panels to reduce the possibility of cracking due to impact. On wood core, filled steel and concrete panels, Grade HW-62, 1.5 mm (1/16 inch) thick is sufficient due to absorptive quality of panel material. This option

is recommended when there is frequent movement of equipment.

Provide high pressure laminate surfacing conforming to NEMA LD 3, Grade [HW 62] [120]. Total system electrical resistance from the wearing surface of the floor to the ground connection shall be between 150,000 ohms and 20,000,000,000 ohms.

2.1.3.2 Conductive Surfacing

NOTE: Conductive floor surfacing material is used where minimal electrical resistance is desired, mainly in clean rooms, hospital operating rooms, etc. The surface does not perform well under the application of heavy concentrated loads.

When conductive floor surfacing is specified, require submittal of maintenance instructions as per paragraph OPERATION AND MAINTENANCE MANUALS to identify special cleaning and maintenance requirements to maintain "conductive" properties of the panel finishes.

Provide conductive surfacing conforming to NEMA LD 3, Grade HW 62. The total system electrical resistance from the wearing surface of the floor to the ground connection shall be between 25,000 ohms and 1,000,000 ohms.

2.1.3.3 Conductive High Pressure Laminate

NOTE: Conductive high pressure laminate floor surfaces combine the electrical resistance qualities of the conductive surfacing with the wear characteristics of high pressure laminate.

Conductive high pressure laminate floor surfacing shall conform to ASTM F 1066, Type III, Vinyl Tile and UL 779. The total system electrical resistance from the wearing surface of the floor to the ground connection shall be between 25,000 ohms and 1,000,000 ohms.

2.1.3.4 Vinyl Composition Tile

NOTE: Vinyl composition tile is the lowest cost surfacing tile, however the availability of tile meeting the electrical resistance requirements is limited. Wax build-up on vinyl tile is a prime cause of static problems.

Normally either Composition 1 or 2 will be specified; however Composition 1 should be specified when the Using Agency desires an asbestos-free material. ASTM F 1066, Type II - Rubber or Type III - Vinyl tile may be specified when requested; however the electrical resistance characteristics

should be verified before use. At installations where operating personnel will be required to wear conductive footwear to prevent static electricity buildup, conductive vinyl tile flooring may be necessary to satisfy the conductivity requirements.

Vinyl composition tile surfacing shall be 3 mm 1/8 inch thick conforming to ASTM F 1066, Type IV, Composition [1] [1 or 2]. Tiles may be approximately 300 mm 12 inches square or may be the full size of the panel.

2.1.3.5 Carpet

NOTE: Carpet should be specified only when requested by the Using Agency. Carpet may be bonded to the panels, or may be installed as loose-laid carpet squares. Where loose-laid carpet squares are used, delete the test for floor covering bond strength specified in paragraph BOND STRENGTH OF FLOOR COVERING. Carpet squares may be placed with carpet joints in alignment with panel joints, or may be placed with carpet joints at the panel midpoint. Color and pattern of carpet will be in accordance with current Air Force or Army carpet policy.

Carpet surfacing shall be [factory] [field] installed using one full carpet square per panel. Carpet shall be nylon filament, loop pile, minimum 0.8 kg/square m 24 ounce/square yard, minimum density 4000, and without cushion. Conform color fastness to AATCC 16. Carpet shall conform to ASTM E 648 with a minimum average critical radiant flux of 0.25 watts per square centimeter. Static control shall be less than 2.0 kV at 20 percent relative humidity at 21 degrees C 70 degrees F, when tested in accordance with AATCC 134. Provide vinyl edge trim to prevent unraveling.

2.1.4 Edge Strip

Edge panels with extruded vinyl edge strips secured in place with mechanical interlock or adhesive bond, or use replaceable type. Top of strip shall be approximately 3 mm 1/8 inch wide, and flush with the floor surfacing. Metal edge strips exposed at finish floor surface will be rejected.

2.1.5 Accessories

NOTE: Perforated panels are preferred for use in areas with hard surfaces such as high pressure laminates, and grilles or registers are preferred in areas with carpet

Provide the manufacturer's standard registers, grilles, perforated panels, and plenum dividers type where indicated. Provide registers, grilles, and perforated panels designed to support the same static loads as floor panels without structural failure, and capable of delivering the air volumes indicated. Registers and perforated panels shall be 25 percent open area and equipped with adjustable dampers.

2.1.6 Resilient Base

Base shall be [rubber] [or] [vinyl] [straight style (installed with carpet)] [coved style (installed with resilient flooring)], [100] [150] mm [4] [6] inches high and a minimum 3 mm 1/8 inch thick. Furnish [Preformed offsite] [Job Formed] corners.

2.1.7 Lifting Device

Provide each individual room with one floor panel lifting device standard with the floor manufacturer. Furnish a minimum of two devices.[For AIR FORCE projects provide a total of two suction-type floor panel lifting devices for each floor area.]

2.2 PANEL SUPPORT SYSTEM

Design support system to allow for 360 degree clearance in laying out cable and cutouts for service to machines and so that panel and stringer together take up maximum of 50 mm 2 inches.

2.2.1 Pedestals

Provide pedestals made of steel or aluminum or a combination thereof. Ferrous materials shall have a factory-applied corrosion-resistant finish. Provide pedestal base plates with a minimum of 10,300 square mm 16 square inches of bearing surface and a minimum of 3 mm 1/8 inch thickness. Pedestal shafts shall be threaded to permit height adjustment within a range of approximately 50 mm 2 inches, to permit overall floor adjustment within plus or minus 2.5 mm 0.10 inch of the required elevation, and to permit leveling of the finished floor surface within 1.56 mm 0.062 inch in 3000 mm 10 feet in all directions. Provide locking devices to positively lock the final pedestal vertical adjustments in place. Pedestal caps shall interlock with [panels] [stringers] to preclude tilting or rocking of the panels.

2.2.2 Stringers

NOTE: Specify bolted stringer and bolted panel systems. Specify bolted stringer type system and plastic laminate finish for computer room access flooring in Air Force and Naval Warfare Systems Command (SPAWARS) facilities, except where die-cast interlocking panel to pedestal aluminum system is designated.

Consideration must be given to equipment planned for installation including type and amount of grounding required. If such equipment has extendable drawers or chassis which require equipment to be firmly anchored to prevent overturning, a rigid grid stringer system of suitable strength and rigidity may be used as anchoring point in lieu of fabricating special subfloor foundations for such equipment, which would restrict 360 degree freedom. The specification may require modification to provide sufficiently rigid grid system to accommodate this condition.

Provide stringers of rolled steel or extruded aluminum, to interlock with the pedestal heads to prevent lateral movement. Provide stringers that can be added or removed after floor is in place.

2.3 FASCIA

Provide aluminum or steel fascia plates at open ends of floor, at sides of ramps and steps, and elsewhere as required to enclose the free area under the raised floor. Steel plates shall have a factory applied baked enamel finish. Finish on aluminum plates shall be standard with the floor system manufacturer. Fascia plates shall be reinforced on the back, and supported using the manufacturer's standard lateral bracing at maximum 1200 mm 4 feet on center. Provide trim, angles, and fasteners as required.

2.4 STEPS AND RAMPS

Securely fasten steps and ramps to the access flooring system and to the structural floor. Include in the construction standard floor system components and custom components as required, and all supports, fasteners, and trim necessary for a finished installation. Step nosings, threshold strips, and floor bevel strips shall be cast or extruded aluminum with non-slip traffic surfaces.

2.4.1 Steps

Height of risers shall not exceed 180 mm 7 inches. Design steps to support a uniform load of 7.18 kPa 150 psf. Surface treads with the manufacturer's standard non-slip floor finish.

2.4.2 Ramps

Slope of ramps shall not exceed 25 mm 1 inch rise to 300 mm 12 inches of run. Design ramps to support the same loads as specified for floor panels. Surface ramps with the manufacturer's standard non-slip floor finish.

2.5 RAILINGS

NOTE: Where open sides of floors are 1200 mm (4 feet) or more above adjacent ground or floor level, install "standard railing" in accordance with CFR 1910.23(e). Run post through raised floor and bolt to concrete floor for stability.

Provide railings of the double rail and post type, fabricated of at least [25 mm 1 inch] [_____] [round] [square] seamless [aluminum tubing] [_____] with a [satin natural anodized] [_____] finish. At steps and ramps, make the top rail a minimum of 900 mm 36 inches high and parallel to the incline. Make the top rail 1050 mm 42 inches high at open ends of the floor. Guardrails shall have intermediate rails or an ornamental pattern such that a sphere 100 mm 4 inches in diameter cannot pass through. Space posts maximum of [1200] [1500] [1800] mm [4] [5] [6] feet oc. Provide railings complete with anchorages, floor plates, and end caps. [Electronically ground hand rails to raised floor system to prevent static build-up.]

2.6 FACTORY TESTS

Factory test access flooring, using an independent laboratory, at the same position and maximum design elevation and in the same arrangement as shown on the drawings for installation so as to duplicate service conditions as much as possible.

2.6.1 Load Tests

Conduct floor panel, stringer, and pedestal testing in accordance with CISCA Access Floors.

2.6.2 Bond Strength of Covering

Support The test panel on pedestals and stringers as specified for the installed floor. Brace the supports as necessary to prevent sideways movement during the test. Impose a test load of 4.45 kN 1000 pounds on the test assembly through a hard plastic caster 75 mm 3 inches in diameter and 25 mm 1 inchwide. Roll the caster completely across the center of the panel. The panel shall withstand 20 passes of the caster with no delamination or separation of the covering.

2.7 COLOR

NOTE: Editing of color reference sentence(s) must be coordinated with the Government. Generally UFGS 09 06 90 COLOR SCHEDULE or drawing is used when the project is designed by an Architect or Interior designer. Color should be selected from manufacturer's standard colors or identified as a manufacturer's color in this specification only when the project is very simple and has minimal finishes.

When the Government directs that color be located in the drawings, a note must be added that states: "Where color is shown as being specific to one manufacturer, an equivalent color by another manufacturer may be submitted for approval. Manufacturers and materials specified are not intended to limit the selection of equal colors from other manufacturers. The word "color" as used herein includes surface color and pattern."

Prior to specifying a custom color finish, research to determine if additional cost and lead time is feasible. Note that there is often a minimum order requirement; this requirement will also affect future orders.

When a manufacturer's name, stock number, pattern, and color is used, be certain that the product conforms to this specification, as edited.

Color shall be [in accordance with Section 09 06 90 COLOR SCHEDULE.] [as indicated on the drawings.] [selected from manufacturers standard colors.] [_____]. Color listed is not intended to limit the selection of equal

colors from other manufacturers.

[2.8 REGISTERS AND GRILLES

NOTE: Delete paragraph heading and paragraph if they are not applicable. Size of registers should be stated if applicable.

Registers and grilles shall be [_____] mm inches by [_____] mm inches long with a minimum free area of [_____] square mm inches, made from extruded [aluminum] [_____] in [mill] [_____] finish, to sustain point loads of 1100 newton 250 pounds per vane without failure or permanent deformation. No part of a grille may project more than 3 mm 1/8 inch above the floor. Registers and grills are not permitted in a laminate floor tile system.

] [2.9 PERFORATED AIR SUPPLY PANELS

NOTE: Delete the paragraph heading and following paragraph if not applicable.

Provide air supply floor panels that meet the design criteria specified for standard panels, are fabricated of 2 mm 14-gage perforated steel sheet welded to minimum 1.6 mm 16-gage side channels, are covered with plastic laminate to match standard panels, and have a uniform perforated pattern to allow even air distribution

] [2.10 CUT OUTS

NOTE: Delete the paragraph heading and paragraph if cutouts are not applicable.

Provide cable cutouts finished with rigid polyvinylchloride or molded polypropylene edging to conform to the appearance level of the floor surface and to cover raw edges of the cutout panel. Extrusion shall be of a configuration to permit its effective and convenient use when new cable openings are required. Provide at least 7300 mm 24 feet of additional extrusion for future use.

- a. Provide non-metallic adapter for openings less than 100 mm 4 inches wide. Secure adapter adhesively in cutout to preclude removal from panel. Provide at least two adapters per 10 square meter 1000 square feet for future use.
- b. Openings larger than 100 mm 4 inches wide shall use rigid polyvinylchloride or molded polypropylene edging. Perform cutting of panels, including cutouts, outside of the building.
- c. When size of cutout reduces the performance requirement of panel, provide intermediate stringers adjacent to cutouts.

] [2.11 EDGE CLOSURE

NOTE: Delete the paragraph heading and paragraph if cutouts are not applicable.

Provide 1.5 mm 1/16 inch aluminum closure plate and extruded aluminum nosing at exposed edge of floor. Back up the closure plates with aluminum or steel framing braced diagonally, or anchor at bottom to continuous angle.

]PART 3 EXECUTION

3.1 INSTALLATION

Install the floor system in accordance with the manufacturer's instructions and with the approved detail drawings. Open ends of the floor, where the floor system does not abut wall or other construction, shall have positive anchorage and rigid support. Maintain areas to receive access flooring between [16] [4] and 32 degrees C [60] [40] and 90 degrees F, and between 20 and 70 percent humidity for 24 hours prior to and during installation.

3.1.1 Preparation for Installation

NOTE: Sections 03 31 00.00 10 CAST-IN-PLACE STRUCTURAL CONCRETE and 03 30 00 CAST-IN-PLACE CONCRETE should require that concrete floors used as air plenum surfaces beneath raised floors be sealed with approved liquid sealer compound. Sealer should be compatible with pedestal adhesive, if pedestals are anchored with adhesive. If a non-compatible sealer is applied before pedestals are anchored, specify removal of sealer at pedestal locations before adhesive is applied. If an existing subfloor has been painted or otherwise sealed with non-compatible sealer or paint, specify removal of coating before applying adhesive.

Clear of all debris the area in which the floor system is to be installed. Thoroughly clean structural floor surfaces and remove all dust. Install floor coatings, required for dust or vapor control, prior to installation of pedestals, only if the pedestal adhesive will not damage the coating. If the coating and adhesive are not compatible, apply the coating after the pedestals have been installed and the adhesive has cured.

3.1.2 Pedestals

NOTE: Seismic calculations must be made by the designer to determine if adhesives or anchors are to be used; pedestal adhesives must be capable of securing pedestals in place with sufficient bonding strength to resist an overturning force of 113 N-m (1000 inch-pounds). If the calculations indicate the overturning force is greater than 113 N-m (1000 inch-pounds) steel expansion anchors will be used.

Pedestals shall be accurately spaced, and set plumb and in true alignment. Set base plates in full and firm contact with the structural floor, and

secured to the structural floor with [adhesive] [steel expansion anchors].

3.1.3 Stringers

Interlock stringers with the pedestal caps to preclude lateral movement, spaced uniformly in parallel lines at the indicated elevation.

3.1.4 Auxiliary Framing

Provide auxiliary framing or pedestals around columns and other permanent construction, at sides of ramps, at open ends of the floor, and beneath panels that are substantially cut to accommodate utility systems. Use special framing for additional lateral support as shown on the approved detail drawings. Provide additional pedestals and stringers designed to specific heights and lengths to meet structural irregularities and design loads. Connect auxiliary framing to main framing.

3.1.5 Panels

Interlock panels with supports in a manner that will preclude lateral movement. Fasten perimeter panels, cutout panels, and panels adjoining columns, stairs, and ramps to the supporting components to form a rigid boundary for the interior panels. Floors shall be level within the specified tolerances. Cut edges of [steel and wood-core panels shall be [painted] [finished] [_____] as recommended by the panel manufacturer.] [composite panels shall be coated with a silicone rubber sealant or with an adhesive recommended by the panel manufacturer.] Secure extruded vinyl edging in place at all cut edges of all panel cut-outs to prevent abrasion of cables.[Where the space below the floor is a plenum, close cutouts for conduit and similar penetrations using self-extinguishing sponge rubber.]

3.1.6 Resilient Base

Provide base at vertical wall intersections. Cracks and voids in walls and other vertical surfaces to receive base shall be filled with an approved filler. Apply the base after the floor system has been completely installed with adhesive, in accordance with the base manufacturer's recommendations.

3.1.7 Fascia Plates

Cover exposed floor ends and exposed openings of ramps and stairs with [aluminum] [steel closures] [finish material as indicated on the detailed drawings.].

3.1.8 Repair of Zinc Coating

Repair zinc coating that has been damaged, and cut edges of zinc-coated components and accessories, by the application of a galvanizing repair paint conforming to [ASTM A 780](#). Areas to be repaired shall be thoroughly cleaned prior to application of the paint.

3.2 FIELD TESTS

3.2.1 Acceptance Tests

Conduct acceptance tests after installation of floor system. Make at least one test for each [40] [100] [_____] square meters [400] [1000] [_____] square feet of floor area. Conduct tests in presence of Contracting

Officer and representatives of manufacturer and installer.

3.2.2 Electrical Resistance

Conduct testing of electrical resistance, in the completed installation, in the presence of the Contracting Officer in accordance with NFPA 99, modified by placing one electrode on the center of the panel surface and connecting the other electrode to the metal flooring support. Take measurements at five or more locations. Each measurement shall be the average of five readings of 15 seconds duration at each location. During the tests, relative humidity shall be 45 to 55 percent and temperature set at 21 to 24 degrees C 69 to 75 degrees F. Select panels used in the testing at random and include two panels most distant from the ground connection. Measure electrical resistance with instruments that are accurate within 2 percent and that have been calibrated within 60 days prior to the performance of the resistance tests. The metal-to-metal resistance from panel to supporting pedestal shall not exceed 10 ohms. The resistance between the wearing surface of the floor covering and the ground connection, as measured on the completed installation, shall be in accordance with paragraph FLOOR COVERING.

3.3 CLEANING AND PROTECTION

3.3.1 Cleaning

Free of all debris the space below the completed floor. Before any traffic or other work on the completed raised floor is started, clean the completed floor in accordance with the floor covering manufacturer's instructions.[Do not permit seepage of cleaner between individual panels.] [Cleaning of ferrous surfaces shall conform to FS TT-C-490.]

3.3.2 Protection

Protect traffic areas of raised floor systems with a covering of building paper, fiberboard, or other suitable material to prevent damage to the surface. Cover cutouts with material of sufficient strength to support the loads to be encountered. Place plywood or similar material on the floor to serve as runways for installation of heavy equipment not in excess of design load capacity. Maintain protection until the raised floor system is accepted.

3.3.3 Surplus Material Removal

Clean surfaces of the work, and adjacent surfaces soiled as a result of the work. Remove all installation equipment, surplus materials, and rubbish from the work site.

[3.4 FIRE SAFETY

Install an automatic detection system below the raised floor meeting the requirements of NFPA 75 paragraph 5-2.1 to sound an audible and visual alarm. Air space below the raised floor shall be subdivided into areas not exceeding 929 square meters 10,000 square feet by tight, noncombustible bulkheads. Seal all penetrations for piping and cables to maintain bulkhead properties.

]3.5 SEISMIC SPECIAL INSPECTION AND TESTING

NOTE: Include this paragraph only when special inspection and testing for seismic-resisting systems is required by Chapter 2 of FEMA 450, NEHRP RECOMMENDED PROVISIONS FOR SEISMIC REGULATIONS FOR NEW BUILDINGS AND OTHER STRUCTURES.

This paragraph will be applicable to both new buildings designed according to UFC 3-310-04 SEISMIC DESIGN FOR BUILDINGS, and to existing building seismic rehabilitation designs.

The designer must indicate on the drawings all locations and all features for which special inspection and testing is required in accordance with UFC 3-310-04 and Chapter 2 of FEMA 450. This includes indicating the locations of all structural components and connections requiring inspection.

Add any additional requirements as necessary.

Perform special inspections and testing for seismic-resisting systems and components in accordance with UFC 3-310-04 and Section 01 45 35 SPECIAL INSPECTION FOR SEISMIC-RESISTING SYSTEMS.

]3.6 OPERATION AND MAINTENANCE MANUALS

Submit maintenance instructions for proper care of the floor panel surface. When conductive flooring is specified, also submit maintenance instructions to identify special cleaning and maintenance requirements to maintain "conductivity" properties of the panel finish.

-- End of Section --