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USACE / NAVFAC / AFCESA **UFGS-13094N (December 2001)**

Preparing Activity: NAVFAC **Superseding UFGS-13094N (August 2001)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 22 December 2004

Latest change indicated by CHG tags
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DIVISION 13 - SPECIAL CONSTRUCTION

SECTION 13094N

RADIO FREQUENCY SHIELDED ENCLOSURES, WELDED TYPE

12/01

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SECTION 13094N

RADIO FREQUENCY SHIELDED ENCLOSURES, WELDED TYPE
12/01

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NOTE: This guide specification covers the requirements for radio frequency shielded enclosures, welded type in sizes under 50 square meters 500 square feet.

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).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.
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NOTE: For larger enclosures and for High Altitude Electromagnetic Pulse (HEMP) protected enclosures, contact NAVFAC Engineering Innovation and Criteria Office (Code EICO) before beginning design. The electrical designer should refer to MIL-HDBK-419 Volumes I and II for special grounding and bonding requirements for EMC enclosures and to NACSIM 5203 for TEMPEST enclosures. All metallic electrical conduits which penetrate a TEMPEST shield must be isolated within 50 mm 2 inches of the exterior of the shield by a nonmetallic conduit section at least 150 mm six inches long to prevent conduction of information from the shielded enclosure. Although not addressed in this specification, it is recognized that fiber optic cable has gained acceptance as an effective method of transmitting data across the boundary of shielded enclosures

without filtering. If fiber optic cable is used, describe the penetration of the shield in detail. For a discussion of the advantages and disadvantages of fiber optic systems see NAVFAC DM-12.02. Designer should consult these documents and other appropriate sources before applying this guide specification to large scale EMI enclosures to HEMP and to TEMPEST Projects. The potential requirement for thermal expansion joints inherent to large scale enclosures is not addressed in this guide specification. The extent and location of the work to be accomplished and wiring, equipment, and accessories necessary for a complete installation should be indicated on the project drawings.

NOTE: The following information shall be shown on the project drawings:

1. Assembly details;

2. Penetration details;

3. Location and method of mounting shielded enclosure within building;

4. Location of mechanical and electrical equipment within shielded enclosure;

5. Interior wall finish;

6. Suspended ceiling; and

7. Raised computer floor.

PART 1 GENERAL

1.1 REFERENCES

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest guide specification. Use of SpecsIntact automated reference checking is recommended for projects based on older guide specifications.

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.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL(AMCA)

AMCA 210	(1999) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 316	(1989) ASD Manual of Steel Construction

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2004) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A 366/A 366M	(1997e1) Commercial Steel, Sheet, Carbon,(0.15 Maximum Percent Cold-Rolled**
ASTM A 568/A 568M	(2004) Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for
ASTM B 194	(2001e1) Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar
ASTM E 90	(2004) Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
ASTM F 1066	(2004) Vinyl Composition Floor Tile

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 299	(1997) Standard Method for Measuring the Effectiveness of Electromagnetic Shielding Enclosures

INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS (ICBO)

ICBO UBC	(2000) Uniform Building Code (3 Vol.)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2005) National Electrical Code

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-F-15733	(Rev H; Supp 1) Filters and Capacitors, Radio Frequency Interference
MIL-STD-220	(Rev B) Method of Insertion-Loss Measurement
MIL-STD-461	(Rev E) Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS A-A-50032	(Rev B) Fans, Ventilating, Propeller

1.2 GENERAL REQUIREMENTS

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NOTE: Insert additional details describing the specific project for which this specification is being used. Projects involving military communications equipment must be designed to incorporate the applicable requirements of MIL-STD-188-124, "Grounding, Bonding, and Shielding for Common Long Haul/Tactical Communication Systems." An 2400 by 2400 by 2400 mm 8 by 8 by 8 feet test module has proven beneficial on complex, extra large, or extra critical construction projects. The module simulates the Contractor's welding techniques, penetration techniques, and testing techniques prior to trying them out in the actual building shield. The test module fabrication and testing plan should also detail the SELDS and NSA 65-6/IEEE Std 299 test to be performed including test dates so that an expert government witness may be present for the tests. The results of all module testing must be included in a final test module reports. Be aware that standard manufactured shielded doors are not designed for exposure to weather.

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Section 16050N BASIC ELECTRICAL MATERIALS AND METHODS applies to this section, with the additions and modifications specified herein. [The enclosure[s] shall be designed and fabricated in accordance with ICBO UBC for free-standing structures.] [The enclosure[s] shall be [mounted on rollers] [fitted with forklift channels in the base] [fitted with lifting eyes on the roof].] Provide enclosure complete with [power line filters,] [telephone/signal line filters,] [RF air vents,] [penetrations for compressed air lines, water lines, and [_____],] [[_____],] [coaxial-cables] [lighting fixtures,] [workbenches with convenience outlets,] and door assembly. Provide each item with fittings and hardware necessary for a complete and operable RF shielded enclosure. Where two or more units of the same type, class, and size of equipment are required, units shall be products of a single manufacturer. Completely isolate the enclosure electrically from the building in which the enclosure is to be installed.

1.2.1 Mechanical Work

****

NOTE: Modify or delete these paragraphs as required for each project. Additional items such as raised computer floors may be specified in the same manner.

****

****

NOTE: Insert appropriate Section number and title in blank below using format per UFC 1-300-02.

****

Provide complete shielded enclosure[s] including work specified in [_____][and [_____]].

1.2.2 Electrical Work

****

NOTE: Modify or delete these paragraphs as required for each project. Additional items such as raised computer floors may be specified in the same manner.

****

****

NOTE: Insert appropriate Section number and title in blank below using format per UFC 1-300-02.

****

Conform to the requirements of the NFPA 70, National Electrical Code. Provide complete shielded enclosure[s] including work specified in [_____][and [_____]].

1.2.3 Acoustical Ceiling System

****

NOTE: Modify or delete these paragraphs as required for each project. Additional items such as raised computer floors may be specified in the same manner.

****

Provide as specified in Section 09510 ACOUSTICAL CEILINGS.

1.3 SUBMITTALS

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NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

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 projects.

Submittal items not designated with a "G" are considered as being for information only for Army projects and for Contractor Quality Control approval for Navy projects.

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Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Radio frequency shielded enclosure

Include penetration details. The shop drawings for the shielded enclosures shall be prepared by a shielding manufacturer/ fabricator experienced in the installation of metal welded [Electromagnetic Pulse (EMP) and] EMI shielded enclosures and who has supervised the installation of two such enclosures which have operated satisfactorily. Prior to commencing work, and as a condition of continuing work, forward to the Contacting Officer information demonstrating such experience. [Drawings shall be approved by and bear the seal of a registered, professional structural engineer.]

SD-03 Product Data

Telephone and signal line filters

Shielded air vents

Lighting fixtures

Exhaust fans

Door assemblies

SD-06 Test Reports

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NOTE: When specifying nonlatching doors, delete door static load and sag tests and cycle test for door latches. Retain cycle test for door hinges.

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Door static load test

Door sag test

Swinging door closure test

EMI factory tests for line filters

Attenuation testing

SELDS seam tests

For SELDS seam testing, include location of the permanent test leads.

SD-07 Certificates

Performance test plan

Qualifications of shielding enclosure testing agency

Qualifications of installation supervision personnel

Components of shielded enclosure individually and as a system, meet specified attenuation requirements.

SD-08 Manufacturer's Instructions

Radio frequency shielded enclosure

SD-10 Operation and Maintenance Data

Radio frequency shielded enclosure, Data Package 2; G

Submit in accordance with Section 01781 OPERATION AND MAINTENANCE DATA. Indicate allowable loads on top of room and on shelves mounted on walls, including permissible weights of equipment that can be mounted on walls. Include prescribed method of welding panels, cleaning of seams and contact fingers, bonding jumpers, installing metallic items penetrating the shielding material without decreasing the attenuation characteristics.

SD-11 Closeout Submittals

Radio frequency shielded enclosure record drawings

Submit a complete set of assembly drawings.

1.4 RELIABILITY

Reliability to maintain high shielding effectiveness for long term usage with minimum maintenance shall be stressed throughout the design, construction, and erection of the specified shielded enclosure. Particular attention shall be paid to the total project so that corrosion and the installation of electrical service, power line filters, ventilation and connector panels do not derate the required shielding effectiveness. The enclosures will be subject to varying moveable live floor loads and continuous use of the ventilation system and ac power line filters.

1.5 DELIVERY AND STORAGE

Deliver materials to the job site in undamaged condition. Store material to ensure proper alignment, and protect material against dampness and accumulated moisture before and after delivery. Store materials under cover in a well-ventilated enclosure, and do not allow materials to be exposed to extreme changes in temperature and humidity. Do not store materials in the building until concrete and masonry are dry.

1.6 QUALITY ASSURANCE

1.6.1 Certifications

1.6.1.1 Performance Test Plan

Submit a performance test plan for SELDS and IEEE Std 299 testing of the facility. The test plan shall include tester qualifications, equipment listings (including calibration dates and antenna factors), and proposed test report format. The plan shall also address specific dates and durations that testing will be conducted during the overall construction period so that the expert Government witness may be scheduled to observe the testing and so that repairs may be made to the shield and retests conducted before the building finish materials are installed. Finally the test plan shall indicate the proposed dates and duration of the lowest and highest frequency tests following installation of the building finish materials [so that an expert Government witness may be available for these final acceptance tests]. The results of EMI testing shall be submitted to the Contracting Officer on a daily basis and test results incorporated into an EMI Shielding Test Final Report.

1.6.1.2 Qualifications of the Shielding Enclosure Testing Agency

Submit the experience and qualifications of an independent testing agency for review and approval. The testing agency shall have recent experience in Shielded Enclosure Leak Detection System (SELDS) and IEEE Std 299 shielded enclosure testing and shall list where and when the experience was obtained. Certify that laboratory is equipped and staffed to perform field tests of RF shielded enclosures and performs the tests as a normal service. Certify that test equipment has been calibrated within the last 12 months.

1.6.1.3 Door Static Load Test

The door shall be mounted and latched to its frame, then set down in a horizontal position such that the door will open downward and only the frame is rigidly and continuously supported from the bottom. A load of 2 kPa 40 psf shall be applied uniformly over the entire surface of the door for at least 10 minutes. The door will not be considered acceptable if this load causes breakage, failure, or permanent deformation which varies the clearance between door leaf and stops to vary more than 2 mm 1/16 inch from the original dimension.

1.6.1.4 Door Sag Test

The door and its frame shall be installed normally and opened 90 degrees. Two 23 kg 50 pound weights, one on each side of the door, shall be suspended from the door within 125 mm 5 inches of the outer edge for at least 10 minutes. The door will not be considered acceptable if this test causes breakage, failure, or permanent deformation which varies the clearance between the door leaf and floor frame more than 2 mm 1/16 inch from its original dimension.

1.6.1.5 Swinging Door Closure Test

Door shall be operated 5000 complete open-close cycles. The door will not be acceptable if closure test causes any breakage, failure, or permanent deformation that causes the clearance between door and door frame to vary more than 2 mm 1/16 inch from the original dimension.

PART 2 PRODUCTS

2.1 SHIELDED ENCLOSURE CHARACTERISTICS

2.1.1 Radio Frequency Interference Attenuation

The attenuation and shielding effectiveness requirements apply to the finished shielded enclosure[s] and enclosure's components when all power line filters are installed and carrying current, ventilation systems are operating, [the coaxial connector panels capped,] and shielded door[s] are in normal operating position. The specified shielding effectiveness shall be achieved without using conductive tapes, gaskets, or cement materials. Provide enclosure[s] having the following minimum magnetic, electric, and plane wave attenuation:

Magnetic - [60] [_____] dB at 14 KHz increasing linearly to [100] [_____] dB at 200 KHz

Electric - [100] [_____] dB from one KHz to 50 MHz

Plane Wave - [100] [_____] dB between 50 MHz and 10 GHz

2.1.2 Sound Transmission Class (STC)

****
NOTE: STC 30 provides only minimum sound transmission loss. For greater sound control, more detailed acoustical design requirements must be incorporated into the specification.
****

Provide enclosure[s] having an STC of [30] [_____] dB minimum when tested according to ASTM E 90 [not including sound transmission loss of surrounding building construction].

2.2 STEEL AND WELDING MATERIALS

AISC 316.

2.2.1 Shielding Steel

****
NOTE: Be aware that shielding steel thickness should not be based solely on the minimum thickness required for RFI/EMI attenuation. Thicker steel may be necessary because of structural factors and heat deformation or burn-through from seam welding.
****

ASTM A 366/A 366M or ASTM A 568/A 568M, minimum [_____] [_____] gage.

2.2.2 Welding Electrodes

AWS D1.1/D1.1M for Metal Electrode, Inert Gas (MIG) welding method.

2.2.3 Floor

****
NOTE: Indicate or specify whether other flooring is

to be provided or higher floor loads are required. This is most critical when raised floors are specified. Allowances must be made for elevated door thresholds. Specify special requirements for laboratory loads or seismic loading in this paragraph. If concrete floors are specified, they should be thick enough to hold anchor bolts for equipment, supports, and interior partitions. Vinyl tile composition 1 is asbestos-free and should be specified for all projects.

****

Provide welded steel floor that is flat and free from warping and buckling to support the intended floor finish without damage under design traffic and loads. The floor shall be capable of [1950 kg/sq m] [400 psf][_____] minimum loading [and shall not buckle or distort when lifted by a forklift].

2.2.3.1 Floor Finish

Vinyl composition tile, ASTM F 1066, Type IV composition 1, 300 by 300 mm, 3 mm 12 by 12 inches, 1/8 inch thick.

[2.2.3.2 Subfloor

19 mm3/4 inch exterior grade Douglas Fir plywood.

][2.2.3.3 Heavy Duty Floor

Heavy Duty Floor shall be a minimum of [100 mm] [4 inches] [_____] of steel reinforced concrete rated at 20 MPa 3000 psi, compressive strength applied directly on top of the steel floor of the enclosure.

]2.3 DOOR ASSEMBLIES

****

NOTE: Do not accept doors that deviate from this specification without consulting NAVFAC 15C. Probable deviations include: magnetic and electromagnetic doors, other non-finger stock type doors, adhesive mounted finger stock, and requests to approve doors tested to less than 10,000 open close cycles, among others.

****

The enclosure door[s] shall be nonsagging and nonwarping and shall afford shielded effectiveness equal to the rest of the enclosure when the door is closed. Provide [multiple rows] [at least one row] of RF finger stock around the shielded door or door frame. The fingers that form a contact between the door and door frame shall be protected from damage due to physical contact and shall be concealed within the door and frame assemblies. The door shall have a clear opening of [900 mm] [36 inches] [_____] wide and [2100 mm] [84 inches] [_____] high. Door assemblies shall be factory made. Doors shall be reinforced steel or laminated type. Laminated type shall have the steel faces electrically and mechanically joined by channels or overlapping seams, both of which shall be continuously seam welded along joined surfaces.

[2.3.1 Finger Stock

ASTM B 194, Condition HT. The finger stock shall be secured to the door or frame without using special tools or soldering or adhesives and shall have a minimum overlap of 50 mm 2 inches.

]2.3.2 Latching Type

Provide lever controller door with roller cam action requiring not more than 90 N 20 pounds of operating force on the handle for both opening and closing. The door shall be equipped with a three-point latching mechanism that provides proper compressive force for the RF seal. The mechanism shall be operable from both sides of the door and shall have permanently-lubricated ball bearings at points of pivot and rotation. The door latches and hinges shall be rated for a minimum of 10,000 cycles without loss of attenuation and without adjustments.

2.3.3 Nonlatching Type

****

NOTE: Nonlatching doors may be used for enclosures having many daily open-close operations; however, nonlatching doors may not retain as high as attenuation over the long term compared to doors having three-point latching mechanisms.

****

Provide door equipped with three heavy-duty ball bearing hinges and a door pull. Door shall open and close with a force not to exceed 20 N 5 pounds.

2.3.4 Special Door Assemblies

2.3.4.1 Hydraulic or Pneumatic Sealing Mechanism

Shall accomplish the electromagnetic sealing of the opening by use of pressure to force the door panels against the frame surfaces. The contact areas of door and frame shall be a peripheral strip not less than 75 mm 3 inches wide, completely around the door, of tinned or highly conductive noncorrosive surface. After the door is in sealing position, the sealing mechanism shall accomplish the exertion of pressure in not more than 10 seconds. Actuation shall be possible from both inside and outside of enclosure. Release mechanism shall actuate in not more than 5 seconds and shall be provided with a manual override. The mating and sealing of the door to frame shall be further enhanced by two peripheral rows of beryllium copper 6 by 25 mm 1/4 by one inch mesh gasket or beryllium copper finger stock. Removal and replacement of finger stock or gasketing shall be possible in less than 8 hours without the use of soldering or special tools. When the door is sealed, the attenuation around the edges shall meet the requirements of this specification. Provide a threshold of zinc-plated steel, not less than 10 mm 3/8 inch thick, at each swinging door. The steel shall be the same alloy as the shielding steel.

2.3.4.2 Sliding Doors

Shall be manually operated from either inside or outside of the shielded enclosure with a maximum break-away pull of [160 N] [35 pounds][_____] in the unsealed condition. The door shall center inside of the steel RF sealing frame designed for the forces involved. The door shall form an RF seal by the operation of an air valve so that the door shielding, on both

sides, expands to a minimum mating surface 90 mm 3.5 inches wide around the periphery of the door. Mating surfaces of the door's expandable shields and the door frame shall be a conductive material. Provide the door with an air system that maintains a nominal sealing pressure of [240 kPa] [35 psi] [_____]. In the RF sealed position, the shielded door shall provide the same minimum attenuation as the class of shielding specified without derating.

a. Design: The door shall be designed for long life and reliability without the use of RF gaskets, RF finger stock, or other sealing devices other than the direct metal-to-metal contact as specified above. The RF sealing device shall be fail-safe upon loss of air pressure and shall readily allow manual opening of the door. For either normal operation or fail-safe operation, the maximum time to reach the open condition shall be no more than 7 seconds. The enclosure design shall include provision for removing the door for routine maintenance without disturbing the door alignment and RF sealing properties.

b. Control Panel: The inside and outside of the shielded enclosure shall contain a control panel to include the necessary opening and closing air valves. The outside control panel shall also have a pressure regulator and filter. Provide for quick opening of door air supply from inside the enclosure to allow escape when opening-air valves fail or malfunction.

2.4 LINE FILTERS

2.4.1 Power Line Filters

Shall conform to the requirements of Section 16280N RADIO FREQUENCY INTERFERENCE POWER LINE FILTERS and shall have current and voltage ratings as [indicated] [specified].

2.4.2 Telephone and Signal Line Filters

MIL-F-15733. Filters shall have an insertion loss of 100 dB in the frequency range of 14 KHz to 10 GHz measured according to MIL-STD-220, full load condition. Filters shall have a pass band of [_____] KHz to [_____] KHz with a characteristic impedance of [_____] ohms.

2.5 WAVEGUIDE-TYPE AIR VENTS

Provide honeycomb type with cores fabricated of brass or steel. Each waveguide shall be electrically and mechanically bonded to adjacent waveguides. Air vents shall be a permanent part of the shielded enclosure and shall have a shielding effectiveness equal to that of the total enclosure. Static pressure drop through the vents shall not exceed 5 Pa 0.02 inch water gage at an air velocity of 3 m/s 600 feet per minute.

2.6 GROUNDING STUD

Enclosure shall have a permanently installed, solid brass or bronze grounding stud complete with hardware and jamb nuts located in the entrance plate [unless otherwise specified or indicated]. The stud shall be 12 mm 1/2 inch diameter double-threaded bolt which allows a full 50 mm 2 inch running thread inside and outside of the shielded enclosure.

2.7 SERVICE ENTRANCE PLATES (SET-UP PANELS)

Shall be minimum 3 mm 1/8 inch thick steel, sized [300 by 300 mm] [12 by 12 inches] [_____] and shall have a 6 mm 1/4 inchextruded brass frame for mounting to shielded enclosure wall panel.

2.8 NAMEPLATES

Major components of equipment shall have manufacturer's name, address, catalog number, model, style, and type on a plate securely and conspicuously attached to each item of equipment. Nameplates for electrical apparatus shall conform to NEMA standards.

2.9 LIGHTING

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NOTE: In shielded enclosures where electronic equipment is very sensitive to EMI, specify a dual lighting system so that fluorescent lighting can be turned off and incandescent lighting turned on during sensitive tests or operations.
****

Provide lighting fixtures as indicated [and as specified in Section 16510 INTERIOR LIGHTING.] Fluorescent lighting fixtures shall meet the requirements of MIL-STD-461, Class C3, Group I for both conducted and radiated interference.

2.10 EXHAUST FANS

****
NOTE: This paragraph cites only minimum requirements. Design calculations are necessary to size HVAC to suit room size and equipment/personnel contained within. Exhaust fan motors located inside shielded enclosure must meet MIL-STD-461, Class C3, Group 1.
****

FS A-A-50032, Type I, Class 1 for direct drive, Class 2 for belt drive, Style A for wall or window mounting, Style B for roof or ceiling mounting, except that fans shall be centrifugal type with aluminum housing and wheel. Additionally, exhaust fans shall meet the electromagnetic compatibility requirements of FS A-A-50032. Motors shall be completely shielded from the airstream. Provide exhaust opening and gravity closing type automatic louvers. Provide exhaust which can supply 15 room air changes per hour. Capacity of fans shall be certified in accordance with AMCA 210, and shall be not greater than 110 percent of the indicated capacity at indicated pressure drop.

2.11 COAXIAL CABLE PENETRATIONS

For each coaxial cable entering the shielded enclosures, provide RF waveguide threaded insert with cap and chain on shielded room side of enclosure.

PART 3 EXECUTION

3.1 SHIELDING STEEL INSTALLATION

Install in strict accordance with the shielding manufacturer's/fabricator's recommendations. Exercise care while handling and installing shielding steel to ensure against damage. Clean exposed surfaces of dirt, finger marks, and foreign matter resulting from manufacturing processes, handling, or installation. Inside the enclosure, mount items including boxes, conduits, fixtures, and switches directly to the structural steel members. Do not allow mounting bolts and screws to penetrate shielding steel. Locate electrical conduits as close to RF shielding as possible. If materials and equipment penetrate the shielded enclosure, seam weld or solder materials and equipment to both surfaces or shielding steel. Where the steel sheet is much thinner than the penetrating member, provide a welded collar of intermediate thickness for transition to accomplish the welding.

3.1.1 Surface Preparation

Clean and buff surfaces to ensure firm contact with shielding steel. Remove paint or other coverings on mating surfaces of special boxes such as for fire alarm systems, buzzers, and signal lights, including areas between box and cover, box and wall, and box and conduit. Remove insulating material to maintain a low-resistance ground system and to ensure firm mating of metal surfaces.

3.1.2 Installation Supervision

Furnish the services of a qualified installation engineer or technician regularly employed by the shielding manufacturer/fabricator for a minimum of three 8 hour working days to instruct Contractor personnel in the installation of the RFI shield. A qualified installation technician is acceptable in lieu of a qualified installation engineer. After the shielded enclosure has been completely installed including RF filters, vents, and exhaust fans, furnish the services of the engineer or technician described herein to inspect the installation for compliance with the specifications. The inspection shall be made before any finishes or the concrete topping coat are installed.

3.1.3 Floor Panel Setting

Place a polyethylene dielectric film of 0.15 mm 6 mil thickness over the structural floor of the parent enclosure before any other work is set thereon. Provide a 3 mm 1/8 inch thick layer of hardboard over the film, with joints loosely butted. Over hardboard layer, provide an additional layer of similar filler material of equal thickness as the projection of the structural member from the bottom surface of the floor panel, leaving no more than 6 mm 1/4 inch space between the hardboard and the structural member. Along panel seams and at support channels, provide a refractory glass cloth strip to protect subfloor and dielectric film from welding heat.

3.1.4 Welding

Provide the electromagnetic shielding work in accordance with performance criteria specified. Structurally weld the shielding steel to the steel frame in accordance with AWS D1.1/D1.1M, and seal electrical seams RF tight by the MIG method, using electrodes structurally and electrically compatible with the adjacent steel sheets. Plug weld or tack weld steel sheet to framework at 300 mm 12 inches on center to support steel sheets,

then use continuous seam welding to seal RF seams in the enclosure. Do not allow slag inclusions, gas pockets, voids, or incomplete fusion anywhere along continuous welded seams. Be aware that welds which seem highly satisfactory upon visual inspection may fail the electromagnetic test. Correct weld failures by grinding out such welds and replacing with new welds. Perform welding, both structural and RF sealing, by employing a welder certified competent for MIG welding in all positions in accordance with the Standard Qualification Procedure of AWS D1.1/D1.1M.

3.2 DOOR ASSEMBLIES

Mount so that the clearance between the door edges and frame shall not vary more than 2 mm 1/16 inch and the innerface of the door periphery does not vary more than 2 mm 1/16 inch from the plane of the door stop's face. Through-bolt hinges to the door and the frame.

3.3 LINE FILTERS

Provide filters for incoming electrical power lines [, including neutrals,] and for incoming telephone and signal lines. Support filters independently of the shielding.

3.4 WAVEGUIDE-TYPE AIR VENTS

[Provide each inlet and return air duct with the number and size of waveguide-type air vents at each location where the ducts enter the shielded enclosure.] [As a minimum, provide each enclosure with one 300 mm 12 inch square inlet and one 300 mm 12 inch square return waveguide-type air vent.]

3.5 EXHAUST FAN

Mount on [wall] [or] [ceiling] over the exhaust vent on the exterior surface of shielded enclosure. Provide power from electrical source exterior to the shielded enclosure.

3.6 CONDUCTOR INSTALLATION

Provide filtered conductors in conduit, except for coaxial cable, from filter to shielding and penetrate the enclosure through threaded rigid steel conduits. [Twist conductors leading from the filters and conductors inside the shielded enclosure approximately 30 turns per meter 10 turns per foot in the conduit.]

3.7 GROUNDING

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NOTE: If not specified in Division 16, "Electrical," the following sentence shall be added: "Wires inside the enclosure and for a distance of at least 15 meters 50 feet outside of the enclosure shall be enclosed in a grounded, threaded rigid steel conduit system."

****

Extend the grounding stud through and [bolt] [weld] stud to the electrical power panel with a minimum No. 4 AWG insulated stranded copper conductor to effectively serve as a single grounding point for the completely assembled shielded enclosure, both internally and externally.

3.8 SERVICE ENTRANCE PLATE

Install RF connectors from coaxial cable and other RF shielded cable on entrance plate. Soft solder connectors to the plate. If location of plate is not indicated, mount plate in wall panel adjacent to power line filters.

3.9 FIELD TESTS

3.9.1 Weld Testing

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NOTE: If the installation is critical, further welding tests may be specified such as ultrasonic, radiographic, or magnetic particle tests.
****

Visually inspect welding during the welding operation and after the welding is completed. Inspect completed welds after the welds have been thoroughly cleaned by hand or power wire-brush. Inspect welds with magnifiers under bright light for surface cracking, porosity, slag inclusion, excessive roughness, unfilled craters, gas pockets, undercuts, overlaps, size, and insufficient throat and concavity. Grind out defective welds and replace with sound welds.

3.9.2 Seam Leak Detection Testing

****
NOTE: SELDS testing the welds in the floor shielding is usually very difficult because you cannot "sniff" on both sides (assuming the shield is on the ground level). To circumvent this problem SELDS loops may be positioned beneath the floor shield for SELDS testing. Dye penetrant has also been used to test the welds and if the dye is used properly this test can be as critical of a test as SELDS.
****

Continuously test welds during fabrication using the SELDS, commonly known as a "sniffer." Upon completion of the basic shielded enclosure, before applying any metal primer or installing any accessories, test the entire shielded enclosure with the SELDS. Install terminal points on the shielding exterior and permanently attach test leads on two sets of diagonally opposing corners during construction for use with SELDS. Continuously probe seams with the test receiver set to detect abrupt changes of shielding level greater than 10 dB on the "shielding unit" scale. Clearly mark points having change greater than 10 dB and repair the weld to meet the specified requirement. Retest each repaired point until there are no points on seams which fail test.

3.9.3 Attenuation Testing

[Furnish the services of an independent testing laboratory, approved by the Contracting Officer, to test the shielded enclosure.] [Final acceptance testing will be by the Government.] Conduct the final shielding acceptance test after penetrations have been completed, specifically including electrical and other utility penetrations. In addition, the Contractor may schedule a complete or abbreviated test to verify that the shielding

assembly is adequate prior to conducting final shielding acceptance test.

3.9.3.1 Test Procedure, Frequencies, and Equipment

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NOTE: Expert Government witness should be present for all final acceptance testing. Note that IEEE Std 299 requires one magnetic field test (150 KHz), three electric field tests (200 KHz, one MHz, 18 MHz), and one plane wave test (400 MHz). Also, note that IEEE Std 299 and NSA 65-6 differ on positioning of source and receiver. IEEE Std 299 requires source outside and receiver inside the shield while NSA 65-6 requires source inside and receiver outside (to simulate TEMPEST conditions). For TEMPEST shielding effectiveness testing, continuous sweeping of seams at one or more plane wave frequencies should also be specified, in addition to testing around all door panels, filters, air duct penetrations and all other penetrations of the shielding at all test frequencies. When finish materials are in place (floor topping slabs, gypsumboard wall finishes, roof insulation and coverings, etc.) it is recommended that limited testing be repeated. One plane wave frequency sweep, baked up by magnetic field probing of any new leakage areas discovered, with repair and retest as necessary to bring the enclosure back into proper SE performance, is recommended. If enclosure is designed specifically for attenuating microwave frequencies, specify additional test frequencies above 1 GHz. Such testing is expensive and should only be used when a firm requirement exists (e.g., NSA-65-6).
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The test procedure, frequencies, and equipment shall be as specified in IEEE Std 299 [plus the additional frequencies specified in the contract]. Perform the test as soon as possible after completion of the shielded enclosure, including installation of services, power/telephone/signal lines, RF filters, and waveguide vents. Conduct test with doors closed and the filters under normal load conditions.

3.9.3.2 Additional Test Points

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NOTE: Use this paragraph if design includes strict tolerances, high attenuation requirements, and many penetrations. If all of the welded seams are to be tested using IEEE Std 299 procedure and frequencies, the specification must clearly state this to avoid change orders.
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Measure additional test points beyond those specified in IEEE Std 299. Test points include the periphery of doors and covers, handles, latches, power filter penetrations, air vent filters, telephone and control line filter penetrations, and points of penetration by pipes, tubes, and bolts.

3.9.3.3 Final In Service Testing

Upon completion of acceptance checks, settings, and tests, show by demonstration in service that equipment and devices are in operating condition and performing the intended function. Give the Contracting Officer five working days advance notice of the dates and times for checks and tests.

-- End of Section --