
USACE / NAVFAC / AFCEA / NASA UFGS-27 51 16 (April 2006)

Preparing Activity: USACE Superseding
UFGS-27 51 16 (November 2003)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2012

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04/06

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SECTION 27 51 16

RADIO AND PUBLIC ADDRESS SYSTEMS 04/06

NOTE: This guide specification covers the requirements for radio and public address systems.

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

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

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

PART 1 GENERAL

NOTE: This guide specification is to be used in conjunction with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

If there is a requirement to integrate a Personnel Alerting System (to alert building occupants of eminent threat) to the PA system, assure that the necessary inputs and interfaces are included in this specification.

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.

ELECTRONIC COMPONENTS ASSOCIATION (ECA)

ECA EIA/ECA 310 (2005) Cabinets, Racks, Panels, and Associated Equipment

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41.1 (2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits

IEEE C62.41.2 (2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2011; Errata 2 2012) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1449 (2006; Reprint Feb 2011) Surge Protective Devices

1.2 SYSTEM DESCRIPTION

The radio and public address system shall consist of an audio distribution network to include amplifiers, mixers, microphones, speakers, cabling, and ancillary components required to meet the required system configuration and operation. Submit Data Package 3 in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA

1.2.1 Multi-Channel System with Paging

The system shall include microphones, microphone outlet receptacles, microphone inputs with preamplifiers, inputs for [film sound,] [compact

disc,] [magnetic tape,] [telephone,] [and] [_____] program sources, [single] [all] channel paging, control for each input, power amplifying equipment, and accessories required to output the public address and paging audio signals through selected portions of the audio distribution network as indicated. The paging signal shall replace by zones [channel [_____] [all channels] of the radio system output, when the paging function is activated.

1.2.2 Single-Channel System

The system shall control and amplify an audio program for distribution within the areas indicated. Components of the system shall include a [mixer-preamplifier,] [mixer-amplifier,] [mike input expander,] [power amplifier,] [microphone,] [speaker system,] [compact disc,] [cassette player,] [AM-FM tuner,] cabling and other associated hardware.

1.2.3 System Performance

The system shall provide even sound distribution throughout the designated area, plus or minus 3 dB for the 1/1 octave band centered at 4000 Hz. The system shall provide uniform frequency response throughout the designated area, plus or minus 3 dB as measured with 1/3-octave bands of pink noise at locations across the designated area selected by the Contracting Officer. The system shall be capable of delivering 75 dB average program level with additional 10 dB peaking margin sound pressure level (SPL) in the area at an acoustic distortion level below 5 percent total harmonic distortion (THD). Unless otherwise specified the sound pressure reference level is 20 micro Pascal (0.00002 Newtons per square meter).

1.2.4 Detail Drawings

Submit detail drawings consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions. Note that the contract drawings show layouts based on typical speakers. Check the layout based on the actual speakers to be installed and make necessary revisions in the detail drawings. Detail drawings shall also contain complete point to point wiring, schematic diagrams and other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

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.

The Guide Specification technical editors have designated those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of

the project.

For 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.] The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings[; G][; G, [_____]]

SD-03 Product Data

Spare Parts

SD-06 Test Reports

Approved Test Procedures[; G][; G, [_____]]
Acceptance Tests

SD-07 Certificates

Components

SD-10 Operation and Maintenance Data

Radio and Public Address System

1.4 DELIVERY, STORAGE, AND HANDLING

Equipment placed in storage until installation shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, and other contaminants.

1.5 EXTRA MATERIALS

Submit spare parts data for each different item of material and equipment specified, after approval of the detail drawings and not later than [2] [_____] months prior to the date of beneficial occupancy. The data shall

include a complete list of parts and supplies, with current unit prices and source of supply.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products, and that essentially duplicate material and equipment that have been in satisfactory use at least 2 years. All components used in the system shall be commercial designs that comply with the requirements specified. Submit copies of current approvals or listings issued by UL, or other nationally recognized testing laboratory for all components. Equipment shall be supported by a service organization that is within [_____] miles of the site.

2.1.1 Identical Items

Items of the same classification shall be identical. This requirement includes equipment, modules, assemblies, parts, and components.

2.1.2 Nameplates

Each major component of equipment shall have the manufacturer's name, address, model and catalog number, and serial number on a plate secured to the equipment.

2.2 MIXER-PREAMPLIFIER

NOTE: Verify that the designated number of inputs are sufficient to meet the requirements of the design and increase the number of inputs if required.

Consideration should be given to the use of a mixer-amplifier instead of a mixer-preamplifier/power-amplifier combination. Mixer-amplifiers may not be available for power outputs of 200 watts or greater.

Mixer-preamplifier shall as a minimum conform to the following specifications:

Rated Output:	18 dB
Frequency Response:	Plus or Minus 1 dB, 20 - 20,000 Hz
Distortion:	Less than 0.5 percent, 20 - 20,000 Hz
Signal to noise:	Microphone - 60 dB Aux - 70 dB
Inputs:	5 independent balanced low- impedance transformer-isolated
Input Sensitivity:	Microphone - 0.003 volts Aux - 0.125 volts

Magnetic Cartridge - 0.0005 volts

Input Channel
Isolation: 80 dB minimum

Tone Controls: Plus or Minus 10 dB range at 50 and 15,000 Hz

Power Requirement: 110-125 Vac 60 Hz

2.3 POWER AMPLIFIERS

NOTE: The required wattage rating will be inserted in the blank. For radio system, this wattage may be computed as follows: Allow 1 watt for each loudspeaker. Use 1.4 multiplier for reserve power. Auditorium systems will have an output of not less than 20 watts or not less than 10 watts per 100 seats, whichever is greater. Special consideration will be given to acoustics, speaker placement, and the functions for which the system will be used, particularly for large auditoriums where music will be reproduced or amplified.

Power amplifiers as a minimum conform to the following specifications:

Rated power output: [60] [125] [250] [_____] watts RMS

Frequency Response: Plus or Minus 3 dB, 20-20,000 Hz

Distortion: Less than 2 percent at RPO, 600-13,000 Hz

Input Impedance: 50 k ohm unbalanced

Output Impedance: Balanced 4 and 8 ohms

Output voltage: 25 and 70.7 volts

Power Requirement: 110-125 Vac 60 Hz

2.4 MIXER AMPLIFIER

NOTE: Verify that the designated number of inputs are sufficient to meet the requirements of the design and increase the number of inputs if required.

Consideration should be given to the use of a mixer-amplifier instead of a mixer-preamplifier/power-amplifier combination. Mixer-amplifiers may not be available for power outputs of 200 watts or greater.

The required wattage rating will be inserted in the blank. For radio system, this wattage may be computed as follows: Allow 1 watt for each loudspeaker. Use 1.4 multiplier for reserve power. Auditorium systems will have an output of not less

than 20 watts or not less than 10 watts per 100 seats, whichever is greater. Special consideration will be given to acoustics, speaker placement, and the functions for which the system will be used, particularly for large auditoriums where music will be reproduced or amplified.

Mixer amplifier shall as a minimum conform to the following specifications:

Rated Power Output (RPO): [35] [60] [125] [_____] watts RMS

Frequency Response: Plus or Minus 3 dB, 20-20,000 Hz

Distortion: Less than 1% at RPO, 60 - 13,000 Hz

Inputs: 2 microphones (high impedance or low-impedance unbalanced)
2 Aux. (high-impedance)

Output Impedance: Balanced 4 and 8 ohms

Output Voltage: 25 and 70.7 volts

Power Requirement: 110-125 Vac 60 Hz

2.5 MICROPHONE INPUT MODULES

NOTE: Verify that the designated number of inputs are sufficient to meet the requirements of the design and increase the number of inputs if required.

Microphone input modules shall as a minimum conform to the following specifications:

Rated Outputs: 0.25 volts into 10,000 ohms
1.0 volts into 10,000 ohms

Frequency Response: Plus or Minus 2 dB, 20 - 20,000 Hz

Distortion: Less than 0.5 percent 20 - 20,000 Hz

Inputs: 4 transformer - coupled balanced 150 ohm

Input Sensitivity: 0.003 volts

Input Channel Isolation: 70 dB minimum

2.6 MICROPHONES

2.6.1 Desk Microphone

Microphones shall as a minimum conform to the following specifications:

Element: Dynamic

Pattern:	Cardioid
Frequency Response:	50 - 12,000 Hz
Impedance:	Low impedance mic (150-400 ohms)
Front-to-back Ratio:	20 dB
Selector switches:	Selector switches for zone shall be be [integral microphone] or [Separate console adjacent to microphone]

2.6.2 Gooseneck Microphone

Gooseneck microphone shall meet the minimum requirements of the desk microphone. Microphone shall have push to talk button. Gooseneck tube length shall be [305] [406] [_____] mm [12] [16] [_____] inch.

2.6.3 Microphone Jack

Each outlet for microphones shall consist of a standard outlet box, flush-mounted, and fitted with a three-pole, polarized, locking-type, female microphone jack and a corrosion resistant-steel device plate.

2.7 LOUDSPEAKERS

NOTE: Indicate on drawings type of speaker and location. Horn Speaker shall be specified only in areas with high ambient noise or outdoors. High output speaker enclosures shall be restricted to large open spaces i.e. gymnasiums, auditoriums or commons

2.7.1 Cone Speaker

The cone speaker shall as a minimum conform to the following specifications:

Application:	[Wall baffle] [Ceiling]
Frequency range:	60 to 12,000 Hz
Power Rating:	Normal - [7] [_____] watts Peak - [10] [_____] watts
Voice Coil Impedance:	8 ohms
Line Matching Transformer Type:	25/ 70.7 volt line
Capacity:	4 watts
Magnet:	10 ounces or greater
Primary Taps:	0.5, 1, 2 and 4 watts
Primary Impedance:	25 volts - 1250, 625, and 312 ohms 70.7 volts - 10k, 5k, and 2.5k ohms

Frequency Response: 30 - 20,000 Hz

Insertion Loss: Less than 1 dB

2.7.2 Horn Speaker

The horn speaker shall as a minimum conform to the following specifications:

Application: [Indoor] [Outdoor] [Weatherproof]

Frequency Response: 400 - 14,000 Hz

Power Taps: 70 volt line - .9, 1.8, 3.8, 7.5,
and 15 watts

45 Impedance: 5000, 2500, 1300, 670, 330, 90, and
ohms

Power Rating: Normal - [7] [_____] watts
Peak - [15] [_____] watts

Dispersion: 110 degrees

2.7.3 Dual Horn Speaker

The dual horn speaker shall meet the minimum requirements of horn speaker except the dispersion shall be 100 degrees.

2.7.4 High Output Speaker Enclosures

High Output speaker enclosures shall be of the tuned-port design for precise balancing and tuning of the speaker. The enclosures shall be constructed throughout of 19.1 mm 3/4 inch high density board, with screwed and glued joints, durably braced, and padded with fiberglass where acoustically required. Speaker enclosures shall have a [25] [45] degree [_____] vertical dispersion and [90] [120] degrees [_____] horizontal dispersion. The effective length of throw shall be a minimum of [15] [40] [60] [_____]m[50] [130] [200] [_____] feet.

2.7.5 Wall Baffle Speaker Enclosures

The wall baffle speaker shall be of particle board construction covered with [walnut laminate] [_____] and complete with [black] [_____] cloth grille. Baffle shall feature 9.5 degree slope to provide directional sound dispersion offset in the direction of radiation. Wall baffle enclosure shall come equipped with a wall mounting bracket designed to assure a rigid mounting to any flat surfaces.

2.7.6 Ceiling Speaker Enclosures

Ceiling speaker enclosure shall be constructed of heavy gauge cold steel with interior undercoating and 38 mm 1-1/2 inch thick high density fiberglass 24 kg/cu. m 1-1/2 lbs/cu. ft. The unit shall be [round] [square] and designed for [recessed] [surface] installations which will be accomplished via [standard screw] [torsion spring] [flange mount] mounting. Recessed models shall have a rust-preventive, [textured black coating] [_____] and the surface mount unit finished in textured [white] [_____] . Enclosure shall include four triple compound conduit knockouts.

2.8 SPEAKER SWITCHING PANEL

NOTE: Delete if paging function is not required.
Show zone boundaries on the drawings.

2.8.1 Selector Switches

Zone control shall be provided for the paging function. The speaker switching panel shall contain at least [_____] double-pole, [[4-] [3-] position] [push button] selector switches and shall be [rack-mounted] [desk mounted] [selector switches built in microphone] to activate priority relays. Selector switches labeling shall be provided to identify the zones.

2.8.2 System Power supply

Power supply shall be provided for priority relays and controls, rack-mounted and sized for a capacity equal to 200 percent of the as-built control system, and shall operate at 24 Vdc. Input and output shall be protected to permit Class 2 wiring in accordance with NFPA 70.

2.9 AM/FM EQUIPMENT

2.9.1 AM/FM Tuner

AM/FM tuner shall be rack-mounted and shall as a minimum conform to the following characteristics:

Tuning Range:	AM - 540 to 1605 kHz FM - 88 to 108 MHz
Selectivity:	60 dB on FM 40 dB on AM
Sensitivity:	FM - 1.5 microvolts AM - 2.0 microvolts
Capture Ratio:	1.0 dB
Readout/selection:	Digital
Other features:	Phased Lock Loop (PLL)
Power Requirement:	110-125 Vac, 60Hz

2.9.2 AM/FM Antenna

NOTE: In remote reception areas, an RF preamplifier may be required to receive sufficient FM radio stations.

The AM/FM antenna shall be roof-mounted, either combined and suitable for both AM and FM reception or separate AM and FM antennas and shall cover all frequency bands specified for radio tuners. [The antenna system shall be coordinated with the TV system and other systems with antenna

communication.] The system shall be furnished complete with a transformer, insulators, crossover insulator, cable of proper length, lightning arresters, coupling transformer and divider network at the radio tuners.

2.10 COMPACT DISC PLAYER

NOTE: Multi-disc players utilize a carousel or magazine which will hold and load 5 inch disc for extended unsupervised play.

Player shall have three beam laser pickup, dual Digital-to-Analog converters, random access and random mode programmable playback. [Player shall have capability to play a minimum of [5] [6] [_____] discs automatically.] Player shall as a minimum conform to the following:

Frequency:	10 - 20,000 Hz Plus or Minus 1 dB
Signal-to-Noise:	Minimum of 100 dB
Dynamic Range:	Minimum of 96 dB
Total Harmonic Distortion:	Maximum of 0.005% at 1 KHZ
Channel Separation:	Minimum 100 dB at 1 KHZ
Quantization:	Minimum of 18 Bits Linear per channel
Conversion Rate:	Minimum 8 x Oversampling
Disc Size:	5 inch
Power Requirement:	110-125 Vac, 60Hz

2.11 CASSETTE TAPE EQUIPMENT

The [dual] cassette tape play deck shall as a minimum conform to the following specifications:

Frequency Response:	Plus or minus 3 dB, 20 - 20,000 Hz
Wow and Flutter:	Less than 0.09 percent WRMS
Signal-to-Noise:	74 dB
Noise Reduction system:	Dolby [B] [C] [S] [HX PRO]
Play Head:	Hard Parmalloy
Operation:	Automatic Reverse
Power Requirement:	110-125 Vac, 60 Hz

2.12 PRIORITY RELAYS AND CONTROLS

Provide priority relays and controls required to accomplish operations specified. Relays shall be completely enclosed with a plastic dust cover

for maximum protection against foreign matter, and shall be plug-in type. Relays shall be provided with a diode wired across the relay coil for transient suppression and shall be installed utilizing factory-prewired, rack-mounted receptacle strips. Coil shall be maximum 24 volts dc.

2.13 SWITCHES AND CONTROLS

2.13.1 Radio System Control Switch

**NOTE: The multi-channel radio system described is
only applicable for hospital and medical facilities
and should be specified only where required.**

Provide the loudspeaker in each room, or group of speakers in a room, with a flush program channel selector rotating-switch knob. The switch shall be mounted at location and height above the floor [as shown] [_____] and in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Install a volume control with a switch at each station of the auto transformer type and set so that the maximum volume is sufficient for the area while not disturbing adjacent areas. If music is turned down or off, the paging signal shall override controls except speakers designated for music only. [Each device plate shall be satin-finished, corrosion-resisting steel permanently marked to indicate the channel selected.] [In neuropsychiatric nursing units, control switches for individual speakers will not be required, but one switch and volume control shall be installed at the Nurses Control Station.]

2.13.2 Remote Loudspeaker ON/OFF Switches

**NOTE: If more than one switch is required, indicate
in a schedule on the drawing.**

Remote switches shall be [key-operated] [toggle switch] 2-pole, wall-mounted, single gang type with engraved switch plates finished to match the approved finish of electrical wall switches. Low-voltage priority override relays shall be provided as part of the switches with all wiring to the racks to allow override of the ON/OFF switches for priority announcements.

2.13.3 Remote Loudspeaker Volume Controls

**NOTE: If more than one control is required,
indicate in a schedule on the drawing.**

Remote volume controls shall be an auto transformer type with detented 3 dB steps and an OFF position. The controls shall be wall-mounted in single-gang outlet boxes and furnished with engraved switching plates finished to match approved finish of electrical wall switches. Insertion loss of the controls shall not exceed 0.6 dB and the power-handling capacities of the control shall be [10] [35] [75] [_____] watts. Low-voltage priority override relays shall be furnished as part of these controls with all wiring to the racks to allow override of the volume controls for priority announcements.

2.14 EQUIPMENT RACKS

NOTE: For low powered systems i.e. only paging systems, specify perforations or louvers for cooling through convection currents. Systems that are continously powered i.e. music or radio broadcast and total amplifier capacity exceeding 400 watts use top rack mounted fan option.

Equipment shall be mounted on 482.6 mm 19 inch racks in accordance with ECA EIA/ECA 310 and located as shown on drawings. Ventilated rear panels, solid side panels, and solid top panels shall be provided. Equipment racks shall be provided with lockable front panels that limit access to equipment. The lockable front shall not cover items that require operator access such as am/fm tuner, CD player, or tape player. Rack cooling shall be through [perforations or louvers in front panels to ensure adequate ventilation of equipment] [top rack mounted fan]. The racks and panels shall be factory finished with a uniform baked enamel over rust inhibiting primer.

2.15 CABLES

2.15.1 Speaker Cable

Cables shall be of the gauge required depending upon the cable run length. In no case shall cable be used which is smaller than 18 AWG. Insulation on the conductors shall be polyvinyl chloride (PVC) or an equivalent synthetic thermoplastic not less than 0.2 mm 0.009 inch. Cables shall be jacketed with a [PVC] [Fluoropolymer] compound. The jacket thickness shall be 0.5 mm 0.02 inch minimum.

2.15.2 Microphone Cable

Cable conductor shall be stranded copper 20 AWG. Insulation on the conductors shall be polyvinyl chloride (PVC) or an equivalent synthetic thermoplastic not less than 0.2 mm 0.009 inch. Cable shall be shielded 100% of aluminum polyester foil with a bare 22 gauge stranded soft copper drain conductor. Cables shall be jacketed with a [PVC] [Fluoropolymer] compound. The jacket thickness shall be 0.5 mm 0.02 inch minimum.

2.15.3 Antenna Cable

Antenna coaxial cable shall have 75 ohm plus or minus 2 ohm. Attenuation of the coaxial cable span between the antenna and amplifier shall not exceed 2.5 dB at 108 MHz.

2.16 TERMINALS

Terminals shall be [solderless, tool-crimped pressure] [or] [_____] type.

2.17 SURGE PROTECTION

2.17.1 Power Line Surge Protection

Major components of the system such as power amplifiers, mixer-preamplifiers, and tuners, shall have a device, whether internal or

external, which provides protection against voltage spikes and current surges originating from commercial power sources in accordance with IEEE C62.41.1/IEEE C62.41.2 B3 combination waveform and NFPA 70. Fuses shall not be used for surge protection. The surge protector shall be rated for a maximum let thru voltage of 350 Volts ac (line-to-neutral) and 350 Volt ac (neutral-to-ground). Surge protection device shall be UL listed and labeled as having been tested in accordance with UL 1449.

2.17.2 SIGNAL SURGE PROTECTION

Major components of the system shall have internal protection circuits which protects the component from mismatched loads, direct current, and shorted output lines. Communication cables/conductors shall have surge protection installed at each point where it exits or enters a building.

2.18 TELEPHONE INTERFACE MODULE

NOTE: Telephone Interface module may be used to access PA system from telephone in conjunction or lieu of microphone. If there is a requirement to integrate Telephone Interface module to the PA system, assure that the necessary inputs and interfaces are included in this specification.

Telephone Interface module shall provide one way all call paging access from telephone to PA system. Paging shall be accomplished by the building telephone system instruments interconnected to the PA system via an interface module to allow telephone dial up access to the paging amplifier. Interface module shall produce an alert tone in the associated speakers on activation. Telephone interface module shall as a minimum conform to the following specifications:

Impedance:	600 ohms
Frequency response:	100Hz to 10Khz
70V Input Impedance:	200K ohms
Output level:	400mV rms
Input Power Requirement:	12-24Vdc (from power supply)
Access requirement:	Electronic (analog) or IA2 line key (line card required) PABX loop or ground-start trunk port, or dedicated single-line phone.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with the details of the work and working conditions, verify dimensions in the field, and advise the Contracting Officer of any discrepancies before performing the work.

3.2 INSTALLATION

Equipment shall be installed as indicated and specified, and in accordance with the manufacturer's recommendations except where otherwise indicated. Equipment mounted out-of-doors or subject to inclement conditions shall be weatherproofed. The antenna shall be supported at least 1.5 m 60 inch clear above the roof by means of self-supported or guyed mast.

3.2.1 Equipment Racks

NOTE: Racks be located adjacent to walls. If a mechanical rack/floor attachment is required, controls shall not be lower than 762.0 mm (30 inches) nor higher than 1.7 m (66 inches) above floor; CD, Cassette player and Tuner shall not be lower than 1220 mm (48 inches) nor higher than 1524 mm (60 inches) above floor.

Racks shall be mounted side-by-side and bolted together. Items of the same function shall be grouped together, either vertically or side-by-side. Controls shall be symmetrically arranged at a height as shown. [CD, Cassette & Tuner shall be at a height above the floor as shown.] Audio input and interconnections shall be made with approved shielded cable and plug connectors; output connections may be screw terminal type. All connections to power supplies shall utilize standard male plug and female receptacle connectors with the female receptacle being the source side of the connection. Inputs, outputs, interconnections, test points, and relays shall be accessible at the rear of the equipment rack for maintenance and testing. Each item shall be removable from the rack without disturbing other items or connections. Empty space in equipment racks shall be covered by blank panels so that the entire front of the rack is occupied by panels.

3.2.2 Wiring

Install wiring in rigid steel conduit, intermediate metal conduit, cable trays, or electric metallic tubing as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Wiring for microphone, grounding, line level, speaker and power cables shall be isolated from each other by physical isolation and metallic shielding. Shielding shall be terminated at only one end.

3.3 GROUNDING

All grounding practices shall comply with NFPA 70. The antenna mast shall be separately grounded. Equipment shall be grounded to the serving panelboard ground bus through a green grounding conductor. Metallic conduits serving the equipment shall be isolated on the equipment end with an insulating bushing to prevent noise from being transferred to the circuit. Equipment racks shall be grounded to the panelboard ground bus utilizing a #8 conductor. Grounding conductor shall be terminated to the rack using connector suitable for that purpose.

3.4 TRAINING

Conduct a training course for [_____] members of the operating and maintenance staff as designated by the Contracting Officer. The training course will be given at the installation during normal working hours for a total of [_____] hours and shall start after the system is functionally complete but prior to final acceptance tests. The field instructions shall cover all of the items contained in the approved operating and maintenance manuals, as well as demonstrations of routine maintenance operations. Notify the Contracting Officer at least 14 days prior to the start of the training course.

3.5 ACCEPTANCE TESTS

Submit test reports in booklet form showing all field tests performed to adjust each component and to prove compliance with the specified performance criteria, upon completion and testing of the installed system. The reports shall include the manufacturer, model number, and serial number of test equipment used in each test. Each report shall indicate the final position of controls and operating mode of the system. After installation has been completed, conduct acceptance tests, utilizing the [approved test procedures](#), to demonstrate that equipment operates in accordance with specification requirements. Submit test plan and test procedures for the acceptance tests. The test plan and test procedures shall explain in detail, step-by-step actions and expected results to demonstrate compliance with the requirements specified. The procedure shall also explain methods for simulating the necessary conditions of operation to demonstrate system performance. Notify the Contracting Officer [14] [_____] days prior to the performance of tests. In no case shall notice be given until after the Contractor has received written Contracting Officer approval of the test plans as specified. The acceptance tests shall include originating and receiving messages at specified stations, at proper volume levels, without cross talk or noise from other links or nondesignated units.

-- End of Section --