

SECTION 27 51 19 – NETWORKED DIRECT-FIRED SOUND-MASKING EQUIPMENT
SECTION 27 15 13 – PAGING SYSTEMS

NOTE TO SPECIFIER

Lencore CrossNetOne™ - Networked Direct-Fired Sound Masking, Paging, and Music System

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to this section.

1.2 SUMMARY

- A. This section includes Digital Signal Processors, electronic noise generators, amplifiers, wiring, loudspeakers, controls and components to generate, amplify, distribute and reproduce digitally synthesized and stabilized background sound masking to improve speech privacy in zones of coverage. Components contained herein this paragraph may be collectively integrated in a printed circuit board, central control units, music paging interfaces or as part of a speaker unit.

1.3 DEFINITIONS AND REFERENCES

- A. Test and Calibration Conditions: Spaces completely furnished but unoccupied, lights and HVAC systems on, HVAC system testing and balancing completed, ceiling components in place. Additional testing to be provided after space is occupied to adjust for variations in use.
- B. Covered spaces: Spaces above which masking speakers are installed.
- C. Pink Noise: Random noise signal with equal energy in each octave.
- D. Sound Masking: Sound that reduces the intelligibility of intruding speech and the distraction from activity noise. Sound that when measured falls inside the “preferred curve”. The masking sound spectrum slopes downward with an increasing frequency. The rate of this slope of sound is 5 dB per octave, having a steeper roll-off above 2 KHz. The low frequency response is determined by the low frequency capabilities of the masking system loudspeakers.

1.3.1 AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI):

- A. ANSI S1.4 American National Standard Specification for Sound Level Meters

- B. ANSI S1.6 American National Standard Specification for Preferred Frequencies and Band Numbers for Acoustical Measurements
- C. ANSI S1.11 American National Standard Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters
- D. ANSI 709.1 Standard communication protocol

1.3.2 AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM):

- A. ASTM E 1130-02 Standard Test Method for Objective Measurement of Speech Privacy in Open Offices Using Articulation Index.
- B. ASTM E1573-02 Standard Test Method for Evaluating Masking Sound in Open Offices Using A-Weighted and One-Third Octave Band Sound Pressure Levels.
- C. ASTM E 1374-93 Standard Guide for Open Office Acoustics and Applicable ASTM Standards.
- D. ASTM E1041-85 – Standard Guide for Measurement of Masking Sound in Open Offices.

1.3.3 SYSTEM PERFORMANCE

- A. The Sound Masking System must use a unique integrated sound masking, music and paging system that uses the power of network technology, web appliances, internet access, infrared remote controls and digital signal processors (DSP's).
- B. The sound masking system must be capable of separately and independently configuring zones for sound masking, paging and music via the network empowered through its central control
- C. The sound masking system must produce 20Hz through 20,000Hz from its source.
- D. The masking must be random and provide a minimum pattern of no LESS than 25 hours.
- E. The sound masking devices must provide both a 1/3 octave band equalizer for a minimum of 30 bands and a parametric equalizer to adjust the sound masking.
- F. The paging devices must have a minimum of a 1/1 octave band equalizer to shape sound.
- G. The System must provide global muting function through dry contact closure for fire alarms.
- H. The System must provide automatic Adaptive Equalization to ensure a flat response for the entire building for paging.
- I. The System must provide zone overlap where each speaker channel has a minimum of 10 programmable zones for masking, paging and music separately.
- J. The System must meet ANSI 709.1 / ISO / IEC standards for open platform.
- K. The System must meet the US Army Corp.'s Unified Facilities Guide Specifications, UFGS 25 10 10, "Utilities Monitoring and Control System" and UFGS 23 09 23, "Direct Digital Control for HVAC and Other Local Building Controls".
- L. The masking volume shall be adjustable via digital means for ½ dB steps for a range of 30-78 dBA for 4 ½" speaker and 32- 80 dBA using 8" speaker, as measured 1m from the center of the speaker.

- M. Sound masking system must be able to provide music muting capabilities to allow paging to smoothly override the masking.
- N. Spatial uniformity of sound must be no more than $\pm\frac{1}{2}$ dBA.
- O. Sound masking, paging and music must have individual identifiers located in an integrated LCD screen.
- P. Plenum mounted network locations must have a lighted LED for visual inspection.
- Q. System must be a multi-drop network system. Point to point systems are unacceptable.
- R. System must be capable of being tuned through a network and a hand-held remote.
- S. System must be capable of performing diagnostic functions.
- T. Control System must be an open platform system and confirm to ANSI 709.1. Proprietary software systems are UNACCEPTABLE.
- U. System must be capable of using off the shelf browser software for full manipulation.
- V. System must be capable of being used as a stand-alone system or a system tied into an intranet IT spine or manipulated through the internet.
- W. System MUST be a direct fired system.

1.4 DESCRIPTION OF SYSTEM

- A. All masking/paging units must be UL Listed for use in a ceiling plenum.
- B. The system must be manufactured in the USA.
- C. All equipment and associated hardware shall be fabricated and installed in accordance with the manufacturer's specified recommendations.
- D. All wiring for power shall be minimum 16 gauge.
- E. All Wiring for Data shall be CAT 5, 4 pair with RJ45 connectors.
- F. All Wiring for Audio shall be CAT 5, 3 pair with RJ12 connectors.
- G. Location of grounding points shall be determined carefully to insure minimizing of system hum and elimination of ground loops. In addition, all connections of shields and conductors to equipment shall be in accordance with manufacturer's instructions and best professional practices.
- H. In open areas and larger enclosed spaces, the overall sound level produced should have spatial uniformity of no more than $\pm\frac{1}{2}$ dB between any two sound generating units.
- I. The sound generating units must have an adjustable sound spectrum shaping control in order to meet the varying spectral requirements of drywall ceilings; various types of ceiling tile, air return grills and openings around lighting fixtures, etc.
 - I The spectrum shaping ability shall be variable within the accepted background sound masking range (acoustical preferred curve).
 - II Units will be able to be shaped with a 1/3 band octave equalizer.
 - III Units will be able to shaped with a parametric equalizer.

- IV Equalizers will cover the full Spectrum and be able to manipulate entire spectrum from 20Hz to 20KHz.
- V Systems that only cover PARTIAL ranges of spectrum (I.E. 1/3 of the 1/3 Octave Band) are UNACCEPTABLE.
- VI System must be capable at a minimum of delivering sound masking volume increments in ½ dB steps. All system that can not deliver attenuation controls of at least ½ dB steps are unacceptable.
- VII Units installed over drywall ceilings should be wired for spectrum control adjustment and remote sound level.
- VIII Sound-Power Level produced by system: Sound masking system must not exceed NC 40 contour between 400 and 2000Hz, and have smooth roll-off above and below those frequencies when measured 1 meter from speaker.
 - i. Final adjusted level: Determine final level for each space individually by measurement as specified.
 - ii. Measurements: Made under Calibration conditions.
- IX Maximum Average range of sound power level: 1 dB in the 250, 500, 1000, 2000, 4000 and 6000Hz range for 75 percent of the locations covered.
- X Spatial Uniformity (Directional Effect): People in masked space under normal operating conditions cannot determine source of masking sound.
- XI Temporal Uniformity: One minute time-averaged sound pressure level of any octave band of masking sound from 250 to 8000 Hz remains constant in any space to within a standard deviation of 2 dB when measured over a 30-minute period.
- XII Sound Quality: No audible hum or noise, other than masking noise, from this system in masked spaces should be detected.

1.5 PERFORMANCE

- A. The system shall be capable of producing masking frequencies (20Hz – 20KHz) in the preferred spectrum range.
 - 1. Each unit shall allow smooth and seamless adjustability of the sound spectrum within the preferred curve, to allow for a variety of ceiling conditions.
- B. Speaker housings/enclosures must be damped to avoid undesirable resonance.
- C. System shall be designed so that individual speaker or component failure will have no impact on the balance of the system.
- D. Security: Central control must only be able to be accessed via an authorized computer access point with the use of a password.
- E. Design of system must be powered by low voltage.
 - 1. Use adequately rated power supply's.
 - i. a. Primary: 85-264 Volt AC 47-63 Hz
 - ii. b. Secondary: 48 Volt DC

2. Power usage:

- i. Power typical consumption: 100 Watts per 36,000 square feet for masking only.
- ii. Power typical consumption: 300 Watts per 36,000 square feet for masking and paging.

1.6 CODES AND PERMITS

- A. Install all work in full accordance with the requirements of all local and governmental departments having jurisdiction over these matters, as well as with any requirements of the NFPA, MEA, BSA, UL, and other applicable Codes.
- B. Secure and pay for necessary approvals, permits, inspections, carting, legal dumping, etc., and deliver the official records of the granting of permits to the Owner without additional cost.
- C. Provide signs as required by the municipal authorities.

1.7 QUALIFICATIONS

- A. Source Limitations: Obtain sound masking equipment components from a single source that assumes responsibility for compatibility of items used.
- B. Components, speakers and power transformers must be UL listed for their appropriate use or listed as an equal to UL through another competent agency.
- C. Green: Sound masking equipment must be comprised of at least 50% recycled content.
- D. Privacy: Perform a speech and privacy evaluation to provide an articulation index (AI) as per ASTM E1130-02. A report of the AI must be provided with each exclusive project.
- E. Manufacture Qualifications: Manufacturer must manufacture sound masking equipment and have a minimum of 10 years of sound masking experience. Sound masking product provided must be in existence for a minimum of six years with proven performance criteria for providing speech privacy.
- F. Warranty: A 10 year full warranty from the manufacturer must be provided for all sound masking equipment.
- G. System is capable of using both in-plenum and direct fired speakers by same manufacturer.

1.8 SUBMITTALS

- A. Product Data: For each component including nationally recognized testing laboratory listing data.
- B. Submit manufacturer's data or shop drawings of the following apparatus, giving full information as to dimensions, materials, and all information pertinent to adequacy of submitted equipment:
 - i. Masking Sound Speakers
 - ii. Additional necessary masking equipment needed
 - iii. Wire
 - iv. Power supply
 - v. Paging/Music Equipment
 - vi. Paging Only Speakers
 - vii. Programmable Timers
- C. Shop Drawings: Prepare and submit detailed dimensioned shop drawings for conduit runs (if required) and other

distribution services including elevations showing minimum clearances and installed features and devices for system components. Show types and locations of masking speakers and their wiring connections. Channel assignments, and axis orientations. Show ducts, beams. And other significant sound reflecting and absorbing elements in ceiling space and show locations of partitions below ceiling. Include a diagram showing interconnection of major system components for each zone and channel and indicating grounding connections.

- D. Each shop drawing shall contain job title and reference(s) to the applicable drawing(s) and/or specification article(s).
- E. Product Certificates: Signed by manufacturers of sound masking equipment and components certifying that products furnished comply with requirements.
- F. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
- G. Record of Final Field Tests and Measurements: Include final adjustment of system.
- H. Maintenance Data: For sound masking equipment and components (if needed) to include in maintenance manuals specified in Division 1. Include data for each type of product, including all features and operating sequences. Both automatic and manual.

1.9 COORDINATION

- A. Coordinate quantity and arrangement of speaker assemblies with ceiling space configuration and with components occupying ceiling space, including structural members, Pipes air distribution components, raceways, cable trays, recessed lighting fixtures and other items.

1.10 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. Furnish a minimum of four complete sets of operating instructions and service maintenance manuals for the equipment employed in the systems. This shall include wiring diagrams. The information in the manuals and on the drawings shall be sufficiently detailed to allow a technician of normal competence to understand, install, operate, maintain, calibrate and repair the equipment.
- B. The Owner's designated operating personnel shall be provided instruction. This shall include instruction in the operation, care and maintenance of the installation. Instruction shall be scheduled at the mutual convenience of the Owner and Subcontractor, after demonstrations and acceptance testing.

1.11 Diagnostics

- A. System must be capable of performing a complete diagnostics of its entire functions including diagnostics of the network, hubs, nodes, routers, dsp's, memory, circuitry, amplifiers and power.

1.12 Reporting Features

- A. System must be capable of reporting entire settings for each zone for masking, paging and music indicating a minimum the volume, contour, 1/3rd band octave equalization, parametric equalization, diagnostics, and groupings.

1.13 GUARANTEES AND CERTIFICATION

- A. System shall be warranted to be free from defects in materials, workmanship, and performance for a 10-year from date of installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements. Provide products by the following:

Lencore Acoustics Corp.

1 Crossways Park Drive W
Woodbury, NY 11797
PH: 516-682-9292
FX: 516-682-4785
Website: www.lencore.com
Email: drawings@lencore.com

2.2 EQUIPMENT

- A. The enclosure for the sound masking speakers shall consist of aluminum or electroplated steel, cylindrical housing.
- B. Speakers: Direct fired, available in two sizes 4 ½ " and 8 ". Can be easily installed in ceilings with special dog ear clamps.
- C. The system must be capable of being independently zoned on both a global and local level for sound masking, paging and music. All zoning must be controlled from a network appliance.

D. LOUDSPEAKER

1. Size: 4 ½" diameter
2. Power Rating: 3 - 5 Watts Root Mean Squared (RMS)
3. Frequency Response: 250-20,000 Hz
4. Impedance: 32 Ohms

- E. Noise generator: Octave bands from 20Hz to 20KHz

1. Contour Adjustments
2. Spectrum adjustment shall meet acoustical preferred curve

F. OUTPUT ADJUSTMENTS

- i. 1/3 band EQ for entire spectrum (25Hz – 20KHz). Meets ANSI specification for bands
- ii. Parametric EQ for entire spectrum (20Hz – 20KHz)
- iii. Central volume control, contour control and EQ control for zones for sound masking.
- iv. Central volume control, and EQ control for zones and units for paging and music.

G. Wire:

- i. The power wiring shall be minimum 16 gauge, stranded, non-shielded, UL Listed, Plenum Rated
- ii. The data wiring shall be CAT 5, 4 pair with an RJ45 jack.
- iii. The audio wiring shall be CAT 5, 3 pair with an RJ12 jack.

H. Power Supply:

1. Output:

- i. DC VOLTAGE: 48v
- ii. RATED CURRENT: 3.2A
- iii. CURRENT RANGE: 0~3.2A
- iv. RATED POWER: 153.6 W
- v. OUTPUT VOLTAGE ADJ. RANGE: 45.6~52.8V

- vi. LINE REGULATION: $\pm 0.5\%$
- vii. LOAD REGULATION: $\pm 0.5\%$
- viii. SETUP, RISE TIME: 600ms, 30ms at full load
- ix. HOLD UP TIME (Typ.): 20ms at full load

2. Input:

- i. Voltage Range: 85~264VAC 120~370VDC (Derating may be needed under low input voltages. Please check derating curve)
- ii. FREQUENCY RANGE: 47~63Hz
- iii. POWER FACTOR (Typ.): PF>0.93/230VAC PF>0.98/115VAC at full load
- iv. AC CURRENT (Typ.): 2.5A/115VAC 1.2A/230VAC
- v. INRUSH CURRENT (Typ.): Cold Start 40A/230VAC

3. Safety: & EMC

- i. SAFETY STANDARDS: UL60950-1, TUV EN60950-1 and S-Mark J60950 Approved
- ii. HARMONIC CURRENT: Compliance to EN61000-3-2,-3
- iii. EMS IMMUNITY: Compliance to EN61000-4-2,3,4,5,6,8,11; ENV50204, EN55024, light industry level, criteria A

4. Environment:

- i. WORKING HUMIDITY: 20 ~ 90% RH non-condensing
- ii. WORKING TEMP: -10 ~ +60 (Refer to output load derating curve)
- iii. STORAGE TEMP., HUMIDITY: -20 ~ +85 , 10 ~ 95% RH
- iv. TEMP. COEFFICIENT: 0.05%/ (0 ~ 50°C)
- v. VIBRATION: 10 ~ 500Hz, 2G 10min./1cycle, 60min. each along X, Y, Z axes

5. Others:

- i. MTBF: 191.2K hrs min. MIL-HDBK-217F (25°C)
- ii. DIMENSION: 7 27/32" x 3 29/32" x 1 15/16"

6. Protection:

- i. OVERLOAD: 105 ~ 150% rated output power
- ii. Protection type : Constant current limiting, recovers automatically after fault condition is removed
- iii. OVER VOLTAGE: 52.8 ~ 64.8V
- iv. OVER TEMPERATURE: 95°C \pm 5°C (TSW1: Detect on Heat sink of Power Transistor)
- v. Protection type : Shut down o/p voltage, recovers automatically after temperature goes down

7. FUNCTION:

- i. REMOTE CONTROL(OPTION): CN1:4 ~ 10VDC POWER ON, <0 ~ 0.8VDC
- ii. POWER OFF

I. Remote Central Volume and Contour Control:

1. Generation and integration of sound masking sources and by using E-sound™ technology equates to the best sound and effective sound masking. Each channel outputs with three levels of global and independent control.

- i. Contour control – At the source using infra-red technology for each independent channel, quad-pod and global control or via a centralized control.
- ii. Parametric equalization control for one to thousands of speakers.
- iii. 1/3rd Band Octave controls – (Same as Parametric controls for groups)
- iv. Volume control for entire spaces to channels to individual speakers.

2. Integration of separate paging and music channels

- i. Each channel can be digitally controlled for zone management and changed on the fly without any change in wiring. No need to go back into the ceiling to change settings.

J. Programmable Audio-Level Control Unit:

1. Standard applications include scheduling, data logging, alarm detection & dispatch, meter reading, analog functions, and type translation. The scheduling application permits events and exceptions to be initiated based on time and date schedules configured by the user. An astronomical position calculator permits scheduling to be done based on the calculated position of the sun. The data logging application collects network activity for use by trending, reporting, and analysis applications. New DIME support enables data log

upload to a Web services application to occur through a firewall. The alarming application provides a means to identify, annunciate, and log alarm conditions. The meter reading application supervises impulse meters and provides suitable conversion values for energy, gas, and water metering. Automatic Sound Power Level Changes: Two system channel changes, four times per day, and capable of different time settings for each day of the week:

- i. Programmable attenuation range: -24 to +24 dB (48 dB)
- ii. Slide control attenuation range: -24 to +24 dB
- iii. Minutes per dB change: User programmable
- iv. Acclimation attenuation range: -24 to +24 dB
- v. Acclimate days per dB change: 1 to 5 days
- vi. Programmable events: 24 events per day for each zone

2. Program Memory: Nonvolatile for one year, minimum, without power. When re-energized after a power outage, control starts at zero level and automatically advances system sound level at same rate used for programmed level changes.

K. Paging/Music Equipment - Music Page Interface (MPI):

1. The MPI shall perform to the following requirements:

- i. The MPI replaces all the bulky head end equipment. (Green Statement) No need for additional cable home-runs, amplifiers, separate equalizers, special switching equipment or matching vendors for compatible product interfaces.
- ii. MPI must be able to make zone additions, modifications, deletions and other changes to the paging and music/EBS system without rewiring.
- iii. MPI must be able to provide a minimum ability to program up to 100 zones for paging using DTMF tones through standard POTS telephone line. MPI must be able to be programmed for all call and emergency broadcast paging.
- iv. Each zone and group must have a dedicated one band octave equalizer that is able to adjust either individual zones or groups.
- v. The MPI must be able to from one point manage up to 1.5 million square feet of space through a single interface.
- vi. Volume and equalizer settings for paging and music must be administered in no more than ½ dB steps
- vii. Music and Page interface must automatically compensate and readjust for frequency line loss broadcast and correct throughout the entire system at each node.
- viii. Must provide crystal clear page.

2. The paging interface shall perform to the following requirements:

- i. TYPE 99-channel Paging, Music Interface
- ii. Once Octave EQ per channel capable with Sound Manager
- iii. INPUT VOLTAGE 7.5 Volts DC
- iv. INPUT CURRENT 333 Milliamps DC
- v. ON/OFF SLIDE SWITCH
- vi. FREQUENCY RESPONSE 50 – 20,000 Hz (+ / - 3 dB)

3. INPUTS

- i. Telephone page input: POTS line telephone input. RJ12 Connector
- ii. Data Input: Screw Terminals
- iii. Music input:
 - i. Left channel, 10k ohm input impedance, single ended RCA jack (phono connector)
 - ii. Right channel, 10k ohm input impedance, single ended RCA jack (phono connector)
 - iii. Left and Right channels are combined to form one music input.
- iv. Aux input...
 - i. All Call Page, 10k ohm input impedance, single ended RCA jack (special order)

4. OUTPUT

- i. Cat5e data cable, RJ45 Connector. Connects to node
- ii. Three ground (Common) screw terminal block. Connects to (-) of first node

5. INDICATORS

- i. 1 Power LED
- ii. 1 Telephone Answer/Hookup LED

6. TOTAL HARMONIC DISTORTION of Node (OP)

- i. OP Output - 0.5% or less at 1kHz, rated output
- ii. OP Output - 0.1% or less at 1kHz, 5 W output

7. OTHER FEATURES Momentary push button sequencer to sequentially initialize attached nodes

8. DIMENSIONS 6" x 8 3/8" x 1 7/8"

9. ATTACHMENT POINTS 2 Screw tabs located on left and right of MPI

10. USAGE

- i. Lift Telephone Receiver.
- ii. Dial Access Code.
- iii. Wait for short dial tone.
- iv. Dial two digit paging zone number and the # key. (00# for All Call).
- v. Wait for short beep.
- vi. Issue Page.
- vii. Hang Up.

11. Node Paging/Music/EBS specification

- i. OUTPUT REGULATION Less than 2.0 dB, no load to full load
- ii. SIGNAL TO NOISE RATIO Mic: 60 dB
- iii. (Band pass 20 – 20,000 Hz) Telephone Page: 75 dB
- iv. (Tone controls: set at center) Program: 75 dB, Aux: 75dB
- v. One Octave EQ per Channel. ± 5 dB in $\frac{1}{2}$ dB steps
- vi. CONTROLS
- vii. Volume (34 – 80dB) in 1/2dB steps via Central Control and/or IR Remote

12. PAGING VOLUME ADJUSTMENTS:

- i. Four channels/OP
- ii. Maximum output: 5.3 Volt RMS at speaker terminal
- iii. Attenuation range: 48 dB, in 1 dB steps, plus a mute setting.

13. PAGING ZONES

- i. Individual channel, groups or global paging zones.

14. E.B./MUSIC VOLUME ADJUSTMENTS

- i. Four channels/Node (OP)
- ii. Maximum output: 5.3 Volt RMS at speaker terminal
- iii. Attenuation range: 48 dB, in 1/2 dB steps, plus a mute setting

15. EMERGENCY BROADCAST/MUSIC ZONES

- i. Individual channel, groups or global zones

16. PAGING/E.B./MUSIC OCTAVE EQUALIZER

- i. One page/music equalizer for all channels
- ii. 10 bands, 31.5 Hz to 16 kHz, each user adjustable by ± 5 dB in 1 dB steps

17. POWER SUPPLY

- i. Input from building power: 100-240 VAC, 50-60 Hz, 1.0A
- ii. Output to MPI device: 7.5 VDC, 4.0A, 30W max
- iii. Power Consumption: 2.5W

PART 3 - EXECUTION

3.1 MOUNTING OF MASKING SOUND LOUDSPEAKERS

- A. Mountings and Loudspeakers shall be installed into the acoustical ceiling. The loudspeakers shall be suspended by integrated dog ear clamps into the center of an acoustical tile. It is most important that all units hang at a uniform height throughout to insure a uniformity of sound when the system is turned on. Each speaker shall be suspended in an inverted orientation with the speaker facing downward (Direct-Fired).
- B. Wiring Method: Install wiring in accordance with all local electrical codes. Conceal cable in accessible ceilings, walls and floors where possible.
- C. Pulling Cable: Do not exceed manufacturers' recommended pulling tensions. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between normal termination points. Remove and discard cable where damaged during installation and replace it with new cable.
- D. Exposed Cable: Install parallel to building lines, follow surface contours, and support as recommended by manufacturer.
- E. Grounding: As recommended by manufacturers, unless more stringent requirements are indicated. Ground equipment and conductors to eliminate shock hazard and to minimize ground loops. Common mode returns, noise pickup, cross talk and other impairments. Install 5-Ohm ground at main equipment location. Measure, record and report ground resistance.
- F. Impedance Matching: For systems components including connecting cable, provide end-to-end level and impedance matched signal paths. Use matching networks and balancing devices at connections where necessary to avoid mismatches.
- G. Splices, taps and terminations: Make splices, taps and terminations on numbered terminal strips in junction, pull and outlet boxes; and equipment closures.
- H. The speaker locations shown on the drawings are schematic only and may require field modification to avoid major ductwork, structures and other plenum barriers. Additional speakers may be required to provide uniform sound distribution because of these plenum obstructions.
- I. All local hanging codes must be reviewed and observed by the installer/contractor.
- J. Identification:
 - a. Identify system components, wiring, cabling, and terminals according to Division 16 Section "Electrical Identification" Use color coded conductors and apply wire and cable marking tape to designate wires and cables so media are identified in coordination with system wiring diagrams.
 - b. Identify system components, wiring, cabling, and terminals according to Division 16 Section "Basic Electrical Materials and Methods". Use color coded conductors and apply wire and cable marking tape to designate wires and cables so media are identified in coordination with system wiring diagrams.
- K. All equipment and associated hardware shall be fabricated and installed in accordance with the manufacturer's specified recommendations.

3.2 PRELIMINARY TESTS AND ADJUSTMENTS

- A. At the completion of installation of speakers, the Subcontractor shall perform initial tests and adjustment. It is suggested that, with the speakers installed in accordance with specified spacing and orientation, tests be conducted in an open area of 35 ft. x 35 ft. minimum size. Tests shall indicate that all acoustical performance requirements described herein are satisfied.
- B. All testing and adjusting of the system shall be accomplished in the absence of the eventual occupants whenever possible. These precautions are essential to insure that the attention of the occupants will not be unnecessarily drawn to the noise or to its source.
- C. Tests and adjustments shall be performed as described below.
 - a. Hum and Noise Level
 - b. Loudspeaker Operation
 - c. Freedom from Buzzes, Rattles and Objectional Distortion
 - d. Gain Control Settings
 - e. A written report representing the results of the above tests, including numerical values where applicable, shall be submitted for review

3.3 FINAL TESTS AND ADJUSTMENTS

- A. The manufacturers' agent with the support and cooperation of any Subcontractor installer shall perform the acceptance testing of the completed installation. These tests shall be performed to demonstrate that the equipment is fully furnished and installed in compliance with the terms of the Specifications in all Contract Documents. Except as otherwise specified, the Manufacturer or Subcontractor shall provide all instruments, equipment, labor and materials necessary to complete these tests.
- B. Manufacturers Field Service: Engage a factory authorized service representative to inspect field assembled components and equipment installation and connections. Report results in writing. Include the following.
 - i. Operational Test: Start system to confirm proper operation. Remove malfunctioning units, replace with new units and retest. Make initial sound spectrum and level adjustments for each zone.
 - ii. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - iii. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
 - iv. Sound Masking Power Level Adjustments: Adjust independently for each space to minimum level of 47dBA to ensure speech privacy between adjacent workstations while complying with other system requirements.
- C. The Subcontractor shall project the completion date of tests and adjustments so that he can give a minimum of one week's notice to the active Project Manager.
- D. Measurements of system performance shall be made using a calibrated ANSI precision sound level meter set for "slow" meter damping and 'A' scale filtering. The measurements shall be made at not less than twenty test positions at 4' height above the floor level, with gain adjusted to provide the system design level. All interior finishes and furnishings shall be in place. Tests shall be for each floor at times not occupied by personnel.
- E. Final Acceptance Testing:
 - i. Instrumentation: Use a professional quality sound level meter in accordance with ANSI S1.4
 - ii. Record test observations, readings and corrective actions.
 - iii. System Tests: Include the following for each zone:
 - iv. Relative Sound Power Level**

Band	Open Plan Areas	Enclosed Offices
200	+2.5	-2
250	+3	-2

315	+2	-2.5
400	+1	-3
500	0	-4
630	-1	-5
800	-2	-6
1000	-3	-7
1250	-4	-8.5
1600	-5	-10
2000	-6	-12

Adjust level of masking sound for each space so one third octave band centered at 500 Hz has final selected sound power level for that space. Measure deviation from listed values in one-third octave bands from 400 to 2000Hz. Measured values must not deviate from those listed by more than 4 dB for open plan areas and 8dB for enclosed offices. The total of individual band deviations in eight bands must not exceed 16 dB for open plan areas and 30 dB for enclosed offices

- v. Walk Through Test: People in masked spaces cannot discern speaker locations.
 - vi. Temporal Stability Test: Check for uniformity of time by measuring sound level in each of 11 octave bands at one-minute intervals over a 30-minute test period. Deviations must not exceed limits specified in "System Description" Article in Part 2
- F. Retest: Correct deficiencies identified by tests and observations and retest until meeting specified requirements.
- G. Recording Control Settings and System Adjustments: Record final control settings and programming and final tap setting of speaker matching transformers. Record final sound level measurements and observations.

3.4 Adjustment

- A. Occupancy Adjustments: When requested within 12 months of date of substantial completion manufacturer is to provide on site assistance in adjusting system to suit actual occupied conditions. Provide one visit to site outside normal occupancy hours for this purpose without additional cost to the owner.

3.5 Demonstration

- A. Engage a factory authorized service representative to train Owner's maintenance personnel to adjust, operate and maintain services as specified below:
 - i. Train owner's maintenance personnel on procedures and schedules for starting up and shutting down, troubleshooting, servicing, and maintaining equipment and schedules.
 - ii. Review data in maintenance manual. Refer to Division 1 Section "Contract Closeout"
 - iii. Review data in maintenance manual. Refer to Division 1 Section "Operation and Maintenance Data"
 - iv. Schedule training with owner through Architect with at least seven days advance notice.

End of Section 27 51 19 and Section 27 15 13