



NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES®
sponsored by the National Society of Professional Engineers

Low Voltage Electronic Communications Systems

AUDIO SYSTEMS

PROGRAM DETAIL MANUAL

Please check NICET's web site (www.nicet.org) to make sure you have the most recent edition of this document.

Effective upon issuing a new edition of any program detail manual, all previous editions of that program detail manual become obsolete.

This manual may be freely copied in its entirety.

Field Code: 026
Subfield Code: 01

Interim Edition (Reprint)
May 2005

CAUTION

The Institute occasionally makes changes in its certification programs which will significantly affect the currency of individual program detail manuals. These changes could include any or all of the following:

- o deletion, modification, or addition of work elements
- o modification to the Examination Requirements Chart
- o modifications to crossover work element credit
- o changes to the work experience requirement
- o changes to the verification requirement

**Keep your
manuals
current**

Since these changes could affect the requirements for certification, it is highly recommended that you contact the Institute before applying for an examination if this manual is more than a year old. The date of publication of this manual is May 2005.

It is the responsibility of all applicants to make sure they are using a current manual.

FIELD OF LOW VOLTAGE ELECTRONIC COMMUNICATION SYSTEMS

SUBFIELD OF AUDIO SYSTEMS

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GENERAL INFORMATION

This Program Detail Manual contains the information needed to apply for the NICET certification examination in the Audio Systems subfield of Low Voltage Electronic Communications Systems.

This manual does not contain all of the policies and procedures for obtaining certification. For this, you must refer to the website (www.nicet.org).

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in Engineering Technologies (NICET)
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PROGRAM DESCRIPTION

This certification program is for technicians engaged in the layout, installation, and maintenance of audio systems for commercial, industrial, and large space applications. Areas covered on the exam include basic electronics, acoustics, and related math; basic understanding of other related low voltage systems; and application of codes and standards. Refer to the Technician Profile on page 17 of this manual for more details.

This program became operational in 1995. Development of the program was initiated in 1993 with technical guidance from the National Systems Contractors Association (Palos Hills, Illinois).

CERTIFICATION REQUIREMENTS

Certification candidates must meet the following criteria:

- ◆ complete the written examination requirement
- ◆ work element verification by the immediate supervisor
- ◆ appropriate employment history
- ◆ technician recommendation by an acceptable recommender (required at Level III)

Simply passing the examination does not guarantee certification. All other components **MUST** be accepted and approved in order to achieve certification.

Level I is designed for entry-level technicians with very limited relevant work experience in this technical subfield. The Institute recommends that persons with eighteen or more months of relevant work experience set their initial certification goal at Level II. Certification at Levels II and III does **NOT** require prior certification at Level I. The Examination Requirements Chart on page 4 lists the actual examination requirements for certification at Levels I, II, and III in the subfield of Audio Systems.

WORK ELEMENT DESCRIPTIONS

The typical job duties and associated responsibilities of engineering technicians involved in the layout, installation, and maintenance of audio systems have been broken down into discrete work elements which form the basis for an evaluation of the candidate's knowledge. Each work element is written in sufficient detail to permit candidates who have the appropriate work experience to make reasonable assumptions about the types of questions likely to be asked.

In addition, the supervisor verifying the experience of the candidate should be able to interpret the scope of the activities associated with each work element.

FIELD CODE AND WORK ELEMENT IDENTIFICATION NUMBERS

In order for us to prepare individualized examinations for each applicant, identification numbers have been assigned to each technical field and to each work element. Each technical field is represented by a 3-digit number. The technical field code number for Low Voltage Electronic Communications Systems is: **026**.

The identification number assigned to each work element is 5 digits long. The first digit identifies the technical subfield within the field of Low Voltage Electronic Communications Systems:

1 - Audio Systems

The second digit identifies the level (Levels I through III) and the type (General or Special) of work element:

GENERAL WORK ELEMENTS

- 1 - Level I General
- 3 - Level II General
- 5 - Level III General

SPECIAL WORK ELEMENTS

- 2 - Level I Special
- 4 - Level II Special
- 6 - Level III Special

The third, fourth and fifth digits identify the individual work element within each category.

A sample of this numbering system is illustrated below for work element 026/15001:

Technical Field Code:	026	Low Voltage Electronic Communications Systems
Subfield:	1	Audio Systems
Level/Type:	5	Level III General
Work Element Number:	001	INTERMEDIATE AUDIO CALCULATIONS

This eight-digit identification number is written on the application form to request a work element on an exam or to provide verification for a work element.

WORK ELEMENT SELECTION

1. Refer to Examination Requirements Chart on the following page
2. Select the appropriate box for the level of certification desired.
3. Note the number/type of work elements required for certification, by category, as shown in the selected box.
4. Turn to the Work Element Listing section and carefully select work elements from the required categories, paying attention at each level to whether they are classified as **General** or **Special** work elements. When possible, select a few extra in each category so that failing one or more work elements leaves enough passed work elements to satisfy the examination requirements.
5. The maximum number of work elements for any single examination sitting is 34, due to time restrictions.
6. The Institute recommends that the maximum number of work elements (34) be selected for each examination. This provides the greatest opportunity for successful completion of the examination requirements with the least number of subsequent examinations. Recognize, however, that all elements selected on an exam application **will be scored**, even if no attempt is made to answer the questions. That is, a score of "0" will be assigned to the work element even if the questions are not answered and the work element will have one failure marked against it.
7. If the requirement for the desired level is more than 34, it is advisable to test first all lower-level work elements needed to achieve certification. Save the upper-level work elements for a subsequent examination.
8. Examination candidates should keep copies of their applications for their records.
9. It is not necessary to retest failed work elements if there are other work elements, in the appropriate categories, which can be selected. If you need to retest a failed work element, you must wait 120 days from the last time you failed it before you will be permitted to test that element again. In addition, you will be blocked from signing up for a work element a fourth time **if it has been previously failed three times**. For further information, read Policy #20, "Retesting of Failed Work Elements," available on the Website.
10. If an adequate number of work elements has been selected to meet the desired certification requirement (with a few extra selected to provide a cushion), and there is room on the exam application to add more elements, it is appropriate to include work elements that will satisfy the examination requirement of the next level of certification or to include work elements from another field/subfield.

EXAMINATION REQUIREMENTS CHART

Subfield: Audio Systems

You must pass the number of work elements shown in each box to complete the exam requirement for certification at that level.

You must pass this many work elements to complete the **Level I** exam requirement

Level I - General - <u>9</u>
TOTAL 9

You must pass this many work elements to complete the **Level II** exam requirement
Note (b)

Level I - General - 12a
Level II - General - 18a
Level II - Special - <u>7</u>
TOTAL 37

You must pass this many work elements to complete the **Level III** exam requirement
Note (b)

Level I - General - 12a
Level II - General - 18a
Level II - Special - 9
Level III - General - 14a
Level III - Special - <u>11</u>
TOTAL 64

NOTES:

- (a) All core work elements in this category must be passed to complete the exam requirement at this level.
- (b) Time restrictions dictate that no more than 34 work elements can be scheduled for any single examination sitting. Therefore, at least two examination sittings will be needed in order to complete this requirement.

GENERAL NOTES:

- (1) Work elements passed which are in excess of the requirement at a particular level and which can be used to meet the requirement at the next higher level are automatically applied to that higher level requirement.
- (2) Use the Personal Tally Worksheet on page 16 of this manual to keep track of the number of work elements you have successfully passed.

CROSSOVER WORK ELEMENTS

NICET "Crossover" work elements are identified as identical or nearly identical in topic coverage and test questions to work elements in other selected fields/subfields. Almost all NICET certification programs have "generic" crossover work elements covering communication skills, mathematics, physical science and other basic areas of knowledge. Once a crossover work element is passed on an examination, it does not normally have to be taken again on any other examinations. Crossover credit for the passed elements will be assigned to an examinee's record as follows:

- **First Time Testing in New Subfield:** When you test work elements in a new subfield (at least one element), any crossover credit from previously tested subfields will automatically be assigned to the new subfield. At the same time, any crossover credit from the new subfield will automatically be assigned to previously tested subfields. This assignment of crossover credit will occur every time a new subfield is tested.
- **Additional Testing in Previously Tested Subfield:** When you test new work elements or retest failed work elements from a previously-tested subfield, any crossover credit from the newly-passed work elements will automatically be assigned to all previously-tested subfields.
- No crossover credit will be assigned to a subfield until you **test at least one work element** from that subfield.
- Crossover credit will not be assigned to or from work elements if the certification is in Delinquent or Expired Status.
- The 120-day waiting period policy, which applies to, failed work elements also applies to all work elements that have crossover credit to that work element (see Policy #20).
- The following documents are available. Use the Decal and Personal Records Order Form on the Website.
 - **Personal Crossover Evaluation** lists your "potential" crossover credit to a designated **untested** subfield.
 - **Crossover Listing** lists all current crossovers between three specified subfields.
 - **Official Personal Transcript** lists all work elements presently credited to the examinee's testing record (including those passed on an exam and those achieved through crossover) for a designated subfield.

WARNING

Revisions to certification programs can occasionally eliminate previous crossovers relationships or create new ones. Thus, crossover credit shown on the "Personal Crossover Evaluation" and on any "Crossover Listing" cannot be assumed to be permanent.

The Personal Crossover Evaluation is a "potential" list. Only when a new subfield is tested and the crossover credit is posted to the test record does it become permanent. The Official Personal Transcript shows the crossover credit actually awarded.

VERIFICATION OF WORK ELEMENTS

Verification should be provided by the applicant's immediate supervisor. The verifier, by signing his or her initials, is signifying that the applicant has actually performed at least the operations indicated in the work element description and that the verifier is confident that the applicant has performed the specific job tasks **repeatedly and satisfactorily**. Exposure to a job task through demonstrations by others or through **partial involvement** by the applicant should not be a basis for a supervisor to verify that the task can be performed correctly by the candidate under a variety of conditions.

WARNING

NICET takes very seriously the role of the verifier. All certification candidates and their verifiers must understand that verification is an important component of the certification process.

The NICET document "Handling of Certification Process Irregularities" says, in part, that if NICET determines that any verification was obtained from a non-qualified verifier or was given for tasks not actually performed, the NICET action against the candidate can be to permanently deny the certification sought or revoke the certification(s) held. The NICET action against the verifier can be to terminate the privilege of serving as a verifier. If the verifier is NICET-certified, the certification(s) could be revoked.

Lack of verification on any (or all) work elements does not prevent an applicant from testing those work elements. Certification, however, will not be awarded until all work elements counted toward certification are verified.

TECHNICIAN PERSONAL RECOMMENDATION

A valid Technician Personal Recommendation form **MUST** be on file for the applicant before NICET can award certification at Level III. The recommendation is valid for one year from the date shown next to the recommender's signature.

The recommendation form is available on NICET's website. It must be completed by a person who is familiar with the applicant's technical capabilities and background.

WORK EXPERIENCE REQUIREMENT

A preponderance of the work experience must be acquired while residing in the United States and its territories, employing U.S. standards and practices.

NICET certification is only conferred upon persons performing engineering **technician** level work. We will not certify persons performing higher level work (such as engineering) or lower level work (such as craft). The Technician Profile on page 17 gives detailed information on the work experience, responsibilities and activities expected of an audio systems technician at each level of certification.

PREPARATION FOR TESTING

As the NICET written examinations are designed for the individual who has already performed the work elements associated with the program, it is anticipated that preparation for this examination should be minimal.

SUPPORT MATERIALS FOR TESTING

The exam is open-book; therefore, bringing standards, references, or textbooks to the exam is permitted. When appropriate, the work element description is specific in mentioning applicable standards or procedures. When work elements are keyed directly to specific industry-wide standards, they will be identified by a normally-used notation at the end of the work element description. NICET will use the most recent edition of the standards in the exams, provided that the edition was published at least one year prior to the date of testing.

When a specific publication is used as an authoritative source in writing the work element questions, the title will be listed at the end of the work element. Refer to the "Selected General References" in this manual for publisher information.

TRAINING COURSES

NICET does not endorse, certify, or accredit training programs and any claims to that effect should be viewed with caution. NICET does, however, provide information on the certification procedures and objectives so that training courses can be developed specifically to help persons planning to take a NICET certification exam.

EXPIRATION OF CERTIFICATE

The first certificate(s) awarded will have an expiration date of three years from the date of award. The certificate(s) will expire at the end of that three-year period unless renewed through recertification. A certificate that is not renewed at the end of three-year period will expire. A consequence of the certificate going into Expired Status will be deletion of all records, including test history.

Upgrading the certificate or adding a certificate in a different technical area does not change your 3-year expiration date.

PAYMENT OF REGISTRY FEE

During the first 3-year certification period, each certificant will be mailed 2 registry invoices -- at the end of year 1 and at the end of year 2. If both invoices are not paid within the prescribed time period, the certification(s) will become delinquent. Certifications in Delinquent Status cannot be upgraded to a higher level; they will not be published in the NICET Directory or listed in the NICET Registry; and crossover credit will not be posted to the test history. Individuals who are in Delinquent Status will not receive the NICET Newsletter until all fees are paid.

Payment of an exam fee does not substitute for payment of the registry fee. The registry fee is only due during the first 3 years of certification. After that period, only the recertification fee is due.

RECERTIFICATION POLICY

All certificants should read Policy #30, "Continuing Professional Development." At the end of each 3-year period, all certificants must demonstrate that they have accumulated sufficient Continuing Professional Development (CPD) points within the certification area(s) held to renew the certificate(s) for another 3 years. Once renewed, the certificate is valid for an additional three-year period. The recertification fee must be paid when submitting the recertification application form.

WORK ELEMENT LISTING

Audio Systems

LEVEL I - GENERAL WORK ELEMENTS

(Work at Level I is Performed Under Direct Supervision)

CORE WORK ELEMENTS (See Note 1)

ID No. Work Element Title and Description

- 11004 DC CIRCUITS
Identify series and parallel circuits and apply Ohm's Law to simple series DC circuits with linear non-reactive components. Calculate equivalent resistance of, and power consumed by, resistive devices.
- 11005 ELECTRONIC COMPONENTS
Identify the characteristics, values (stamped or color-coded) and circuit functions of resistors, capacitors, and inductors.
- 11010 FLUSH AND SURFACE MOUNTED LOUDSPEAKERS
Install loudspeakers with proper support, back boxes, connections, and grilles. Use manufacturers' literature.
- 11013 BASIC SWITCHES AND CONNECTORS
Connect, solder, or terminate simple devices, such as microphones, telephone jacks, relays, call-in switches, antenna jacks, timing devices, etc. (AES S14-1992 or ANSI S4.48-1991)

NON-CORE GENERAL WORK ELEMENTS

- 11001[^] BASIC COMMUNICATIONS SKILLS
Use proper punctuation, vocabulary, spelling, and sentence structure. Follow written instructions. (See dictionaries and basic grammar references.)
- 11002[^] BASIC MATHEMATICS
Solve mathematical problems requiring simple addition, subtraction, multiplication, division, and raising numbers to exponential powers. Round to the correct number of significant figures, calculate percentages, read graphs, and use simple geometric definitions and formulas. (See general mathematics textbooks.)
- 11003[^] BASIC PHYSICAL SCIENCE
Apply terms, definitions, and concepts from mechanics, electricity, heat, and chemistry. (Solutions may involve simple formulas found in basic physics textbooks, but will not involve algebraic manipulation or trigonometry.)
- 11006 BASIC PLANS AND SPECIFICATIONS
Recognize, or determine from a drawing's symbol list, symbols for basic sound system components, HVAC and electrical fixtures/devices, and symbols for basic structural components. Use a scale or ruler to measure architectural dimensions and determine equipment locations.

Note 1: General work elements can be categorized as either Core or Non-Core. All Level I General Core Work Elements must be passed in order to meet the exam requirement for Levels II and III.

General Note: See "Selected General References" in this manual for information on listed standards and publications.

([^]) Generic crossover credit exists in other fields for this work element. Information on crossover work elements is on page 5.

(*) Crossover credit exists in selected other fields for this work element. Information on crossover work elements is on page 5.

- 11007^ **FIRST AID PROCEDURES**
Understand the basic rules and procedures of first aid. (See general handbooks on first aid.)
- 11008^ **BASIC INDIVIDUAL SAFETY**
Follow standard safety practices in performing job tasks. Recognize and call attention to improper safety practices at the work site. (OSHA 2201 & 2202)
- 11009 **PERSONAL PROTECTIVE EQUIPMENT**
Properly use safety equipment such as eye protection, gloves, hard hats, hearing protection, safety shoes, etc.
- 11011 **BASIC MICROPHONES**
Identify common microphone types, impedances, and applications. Install microphones using proper mounting techniques.
- 11012 **BASIC WIRING**
Pull and install specified wire. Recognize pull tensions, different wire types, and simple connections. (NEC Table 725-61 and Figure 725-61)
- 11014 **SHOP ASSEMBLY**
Follow simple drawings and instructions for shop assembly of equipment racks, loudspeaker assemblies, wall plates, cable assemblies, etc. Understand rack units (RU).

LEVEL II - GENERAL WORK ELEMENTS

(Work at Level II is Performed Under General Supervision)

CORE WORK ELEMENTS (See Note 2)

- 13002^ **BASIC METRIC UNITS AND CONVERSIONS**
Perform conversions to and from basic metric (SI) units. (ASTM E-380)
- 13004 **BASIC AUDIO CALCULATIONS**
Perform basic calculations involving decibels, the inverse-square law, and information derived from charts.
- 13005 **BASIC ACOUSTICAL TERMINOLOGY**
Define and identify basic acoustical factors and terminology such as reflection, diffraction, interference, atmospheric absorption, etc.
- 13007 **AC CIRCUITS**
Identify series and parallel circuits and apply Ohms Law to simple single-loop AC circuits with linear components. Calculate equivalent capacitance and inductance. Measure and/or calculate audio impedance and power.
- 13015 **CONSTANT VOLTAGE LOUDSPEAKER SYSTEMS**
Select appropriate transformer taps. Calculate total loudspeaker load. Match loudspeaker load with amplifier output.
- 13017 **BASIC GROUNDING**
Recognize and understand proper grounding procedures for commonly used connectors and components. (AES 14-1992/ANSI S4.48-1992; NEC Article 200)
- 13019 **INTERMEDIATE SWITCHES AND CONNECTORS**
Connect multiple contact devices such as switches, relays, simple diode matrices, lamps, LEDs, connectors, etc.

Note 2: General work elements can be categorized as either Core or Non-Core. All Level II General Core Work Elements must be passed in order to meet the exam requirement for Levels II and III.

NON-CORE GENERAL WORK ELEMENTS

- 13001[^] BUSINESS COMMUNICATIONS
Use the rules of syntax and style to write clear sentences and paragraphs in preparing routine correspondence and reports. Follow standard business communications procedures. (See basic grammar and writing handbooks.)
- 13003 TRIGONOMETRY AND GEOMETRY
Use trigonometric functions, laws, and identities to solve problems involving right and oblique triangles, and vector addition. Recognize the properties of lines and planes, circles and spheres, ellipses, parabolas, and hyperbolas. Calculate distances, slopes, and intersections involving straight lines. (See textbooks on trigonometry and elementary analytical geometry.)
- 13006 BASIC ACOUSTICAL MEASUREMENTS
Measure sound pressure levels using a sound level meter. Perform wavelength/frequency/velocity calculations and determine travel times for given wave paths. Interpret A, B, and C weighting, and noise criteria curves. Recognize typical power and loudness values for common acoustical sources.
- 13008 INTERMEDIATE PLANS AND SPECIFICATIONS
Read and interpret conduit riser diagrams and wiring plans. Determine or verify equipment/installation information from specifications and drawings. Assist in maintaining as-built drawings and document all work performed. (NEC)
- 13009 INTERMEDIATE SAFETY
Follow safe work practices in regard to hazardous materials. Understand materials safety data sheets (MSDS) and the Right to Know Law. Recognize potential sources of fire ignition, and the four classes of fires and portable fire extinguishers. Use proper extinguishing materials and techniques. Recognize the symptoms of substance abuse. Follow safe practices in regard to the erection and use of scaffolds. (OSHA)
- 13010 GENERAL CODES AND STANDARDS
Identify electrical and building codes (such as those produced by BOCA, ICBO, and SBCCI), and equipment standards which apply to particular situations. (NEC/NFPA 70, UL)
- 13011 NEC 517
Understand the contents of NEC Article 517.
- 13012 NEC 725
Understand the contents of NEC Article 725.
- 13013 NEC 800
Understand the contents of NEC Article 800.
- 13014 SMALL LOUDSPEAKER ARRAYS
Install box loudspeakers and small arrays (those with two loudspeakers), including the use of passive and active crossovers and appropriate suspension components. Follow manufacturer's installation instructions.
- 13016 INTERMEDIATE MICROPHONES
Install the major types of microphone systems (wired and wireless, phantom power, etc.) and muting switches, considering system components, polar patterns, and applications. Understand how loudspeakers are used as a sound pickup device.
- 13018 INTERMEDIATE WIRING - METALLIC CABLE
Set up for installation of system wiring. Verify adequate conduit size and proper grouping of wires. Determine and use proper installation and termination techniques. Conduct tests, using VOMs or specialty testers, for cable integrity, including opens, shorts, grounds, polarity, and resistance. (NEC)

- 13020 INTERMEDIATE ASSEMBLY
Interconnect and terminate equipment, including patch bays, in racks and cabinets, following industry standards, manufacturer's installation manuals, and using point-to-point wiring diagrams. Label wiring and provide basic job site documentation. Assist with the on-site installation of completed assemblies.
- 13021 BASIC MIXERS
Install and maintain simple rack mounted mixers and automatic mixers, including gain control adjustments, input and output connections, metering, and built-in limiters. Use manufacturers' instruction manuals.

LEVEL II - SPECIAL WORK ELEMENTS

- 14001 NEC 770
Understand the contents of NEC Article 770.
- 14002 AERIAL WORK PLATFORMS
Conduct pre-operation checks. Follow correct and safe operational procedures. Maintain adequate distance from electrical wires and equipment. (OSHA 1910.333 (c)3, 1910.67 (b)4)
- 14003 BENCH TEST EQUIPMENT
Operate such bench test equipment as oscilloscopes, VOMs, function generators, logic probes, etc.
- 14004 BASIC ELEMENTS OF LOUDSPEAKER SYSTEM SUSPENSION
Identify the characteristics and appropriate application of hardware used to suspend loudspeakers. Understand the principles of load distribution.
- 14005 BASIC DATA CABLE
Set up for installation of system wiring. Verify correct wire type, maximum length, and adequate conduit size. Determine and use proper installation and termination techniques. Conduct VOM tests, using VOMs or specialty testers, for cable integrity, including opens, shorts, grounds, polarity, and resistance. Recognize certification categories. (EIA/TIA TSB-36, TSB-40A, TSB-53, 568A; NEMA WC 63-19xx)
- 14006 INTERMEDIATE WIRING - OPTICAL FIBER CABLE
Set up for installation of system wiring. Verify adequate conduit size and/or inner duct. Determine and use proper installation and termination techniques. Check for cable integrity, including loss and/or OTDR testing. (NEC)
- 14007 BASIC PRIORITY SWITCHING SYSTEMS
Install devices, including VOX, relays, and switches, to provide override, zoning, and/or mute functions.
- 14008 BASIC MAINTENANCE
Perform system checkout, scheduled/preventive maintenance, and basic service calls using appropriate test equipment.
- 14009 ANALOG INTERCOM SYSTEMS
Identify the types of call origination methods, audio circuits, and applicable system components. Install and maintain the major types of wired intercom systems (master to slave, master to master, combination systems), considering system components, applications, and ambient noise. Recognize proper termination at the head end and station. Modify basic system layouts to meet field conditions. Assist in maintaining as-built drawings. (NEC)
- 14010 MICROPROCESSOR BASED INTERCOM SYSTEMS
Identify the applicable system components. Install microprocessor based intercom systems, considering system components, applications, ambient noise, AC power requirements and lightning protection. Follow proper circuit board handling techniques. Recognize proper termination at the head end and station. Assist in maintaining as-built drawings. (NEC)
- 14011 ANALOG NURSE CALL SYSTEMS
Install and maintain analog nurse call systems. Identify the types of signals, audio circuits, and applicable system components. Recognize proper termination at the head end and at the room junction box. (NEC Article 517, UL 1069 Installation Standards)

- 14012 **CLOCK SYSTEMS**
Install and maintain clock systems. Identify the types of systems, circuits, and applicable system components. Recognize proper termination at the control unit and at the room clock. Assist in maintaining as-built drawings. Recognize applicable codes and use manufacturers' installation manuals. (NEC)
- 14013 **MASTER ANTENNA PLANT INSTALLATION**
Install mast and/or tower and guys as required. Assemble, connect, and orient antennas. Connect taps, splitters, and outlets. Use appropriate wire types. Conduct performance test at each outlet.
- 14014 **CLOSED CIRCUIT TELEVISION INSTALLATION**
Install and connect cameras, monitors, recorders, switchers, remote controls, and pan-tilt units. Assemble and/or install camera housings and mounts, scanners, and lenses. Use appropriate wire types. Conduct an operational test of the system. Assist in maintaining as-built drawings.

LEVEL III - GENERAL WORK ELEMENTS

CORE WORK ELEMENTS (See Note 3)

- 15001 **INTERMEDIATE AUDIO CALCULATIONS**
Perform electrical and acoustical calculations involving power, amplitude, the speed of sound, and sound pressure level.
- 15003 **CIRCUIT ANALYSIS**
Apply Kirchhoff's Laws to circuits with linear components. Calculate impedance and current in a circuit with resistive and reactive components.
- 15010 **AUDIO TRANSFORMERS AND AUTO-TRANSFORMERS**
Identify the characteristics and applications of common loudspeaker transformers and autotransformers. Select appropriate taps.
- 15011 **SYSTEM GROUNDING**
Identify possible ground loops. Use proper procedures for grounding connections between components within a system (balanced to balanced, balanced to unbalanced). Perform resistance to ground measurements. Recognize the different kinds of ground reference. (NEC Articles 200, 210, 250)

NON-CORE GENERAL WORK ELEMENTS

- 15002[^] **INTERMEDIATE PHYSICAL SCIENCE**
Solve problems in mechanics, electricity, heat, and inorganic chemistry. (Solutions may involve algebra and trigonometry.)
- 15004 **ELEMENTS OF TRANSISTOR CIRCUITS**
Define the basic terminology associated with transistor circuits. Identify basic transistor types, pinouts, and configurations from markings or schematics.
- 15005 **ANALYSIS OF TRANSISTOR CIRCUITS**
Determine signal phase and amplitude at various points in a transistor circuit. Interpret logic gates, tables, and diagrams.
- 15006 **AS BUILT DOCUMENTATION**
Maintain accurate drawings and notes which record changes to the original plans, equipment, wiring, and physical layout of your project. Report changes as appropriate.

Note 3: General work elements can be categorized as either Core or Non-Core. All Level III General Core Work Elements must be passed in order to meet the exam requirement for Level III.

- 15007 NEC 640
Understand the contents of NEC Article 640.
- 15008 NEC 720
Work element deleted and not available for testing.
- 15009 OSHA
Assure compliance with OSHA and state safety requirements. Correct and/or report violations. (OSHA 2207)
- 15012 TROUBLESHOOTING AUDIO SYSTEMS WIRING
Identify, trace, and repair cable faults.
- 15013 COMPLEX SWITCHING SYSTEMS
Install and troubleshoot complex diode matrix switches, microprocessor switching devices, sequential switchers, PLC devices, etc. Perform repairs as needed.
- 15014 ADVANCED ASSEMBLY
Inspect and test completed rack systems for proper assembly and operation. Make internal modifications to the equipment as necessary. Prepare as-built documentation. Supervise and assist with on-site installation of completed assemblies.
- 15015 EQUIPMENT TESTING
Conduct tests of mixers, equalizers, and compressor/limiters for frequency response, output, total harmonic distortion, and signal to noise ratio. Test electronic crossovers for crossover point(s) and crossover slope.
- 15016 SYSTEM TROUBLESHOOTING
Verify problem. Analyze system configuration. Use the logical steps of troubleshooting to identify and locate faults and/or deficiencies. Report findings. Make recommendations regarding equipment and/or cost estimates.
- 15017 HEARING ASSISTANCE SYSTEMS
Install hearing assistance systems in accordance with plans and specifications and the Americans with Disabilities Act. Interconnect to sound system as needed. Verify proper operation and coverage. Perform maintenance as needed.

LEVEL III - SPECIAL WORK ELEMENTS

- 16001 INTERPERSONAL COMMUNICATIONS
Use negotiation and conflict avoidance/resolution skills, cultural sensitivity, and understanding of the organization of trades to communicate effectively with members of other trades working on your project.
- 16002 COMPUTER ASSISTED DESIGN PROGRAMS
Use computer programs to provide for specified coverage and speech intelligibility. Understand the differences between programs.
- 16003 ARCHITECTURAL MAPPING
Using the principles of three-dimensional geometry, convert an architectural plan into a wire frame model. Assign absorption characteristics to room surfaces.
- 16004 ACOUSTICS
Solve problems involving sound in various spaces. Define and use octaves and sabin's. Consider such factors as boundaries, material absorption, diffraction, reverberation, critical distance, etc.
- 16005 NEC 820
Understand the contents of NEC Article 820.

- 16006 **LARGE LOUDSPEAKER ARRAYS**
Assemble and install large loudspeaker arrays (those with three or more loudspeakers), including specified suspension, using appropriate safety precautions. Perform repairs as needed. (OSHA)
- 16007 **CONNECTION AND AIMING OF LARGE LOUDSPEAKER ARRAYS**
Make a proper connection between the loudspeaker and the amplifier. Correctly implement mounting angles. Correctly position loudspeakers to achieve required signal alignment and coverage.
- 16008 **TESTING OF LOUDSPEAKER ARRAYS**
Conduct and perform initial evaluation of frequency response, loudness levels, and polarity tests of loudspeaker arrays. Make adjustments necessary to meet specifications. Provide accurate field as-built documentation.
- 16009 **ADVANCED MICROPHONES**
Install and troubleshoot microphone systems. Perform repairs as needed. Layout basic microphone systems considering such factors as loudspeaker location, NOM, ambient noise, working distances, etc. Use manufacturers' literature.
- 16010 **ADVANCED DATA CABLE**
Supervise cable installation. Certify that the installation meets specified wire and link standards using appropriate test equipment. (EIA/TIA TSB-36, TSB-40A, TSB-53, 568A: NEMA WC-19xx)
- 16011 **SMALL SYSTEMS LAYOUT**
Verify customer needs. Determine appropriate equipment and wire routing. Interface with others as required to assure proper system installation and operation. Prepare appropriate sketches and drawings. Submit to supervisor for review and approval.
- 16012 **SUPERVISED AUDIO SYSTEMS**
Install and calibrate detection equipment for supervision of audio system integrity. Provide transfer switching. Perform repairs as needed.
- 16013 **SIGNAL PROCESSING ADJUSTMENT**
Calibrate and adjust signal processing equipment such as compressor/limiters, signal delays, multi effect processors, etc.
- 16014 **POWER AMPLIFIERS**
Conduct performance testing of power amplifiers for power output, frequency response, signal-to-noise ratio, and gain. (Understand correct operation of) Interpret common power output indicators. Provide for proper load matching, and AC power requirements.
- 16015 **MIXING CONSOLES**
Install and set up mixing consoles, considering gain structure, type of use, and connected devices. Identify the functions (e.g. - output grouping, queue/solo, muting, mono/stereo, matrix mixing monitoring, etc.), applications, major components, and operational considerations of sound reinforcement, recording, and stage monitor mixing consoles.
- 16016 **BASIC EQUALIZATION**
Define broadband and narrowband terminology and recognize typical applications of each. Identify the functions served by a spectrum analyzer, and differentiate between graphic and parametric equalizers. Follow proper procedures for the use of multiple equalizers. Recognize the significance of, and perform equalization adjustments at, crossover points.
- 16017 **SYSTEM SIGNAL ALIGNMENT**
Conduct and/or supervise the system signal alignment process including measurement and adjustment of signal delays and phase alignment of loudspeakers. Consult with supervisor as needed. Document all control settings.

- 16018 **PAGING AND TELEPHONE SYSTEMS INTERFACE**
Install telephone paging interface units using various types of telephone paging circuits, common and multiple zones, page delay devices, message repeaters, etc. Use appropriate wire, wiring techniques, and manufacturers' installation manuals.
- 16019 **MICROPROCESSOR BASED NURSE CALL SYSTEMS**
Install microprocessor based nurse call systems and applicable system components. Terminate wiring at the head end and/or at junction/device boxes. Perform system programming. Interface with associated systems. Conform to applicable codes. Perform repairs as needed. (NEC, NFPA 99, UL 1069)
- 16020 **SOUND MASKING SYSTEMS**
Install sound masking systems in accordance with plans and specifications. Understand the basic characteristics of sound masking systems and office acoustics. Conform to applicable codes. Perform repairs as needed. (NFPA 90A, UL 2043, NEC)
- 16021 **MEDIA RETRIEVAL SYSTEMS**
Install media retrieval systems in accordance with plans and specifications. Understand the basic types, characteristics, and components of media retrieval systems. Conform to applicable codes. Perform repairs as needed. (NEC)
- 16022 **MASTER ANTENNA HEAD END INSTALLATION**
Install master antenna head end components in accordance with plans and specifications. Complete system connections to antenna(s) and distribution wiring. Adjust signal strength to proper levels and supervise system performance test. (NEC)
- 16023 **PROJECT ANALYSIS**
Review plans, specifications, and equipment lists. Recognize deficiencies and mistakes, and determine appropriate corrective actions. Determine applicability of equipment to specific jobs. Prepare recommendations for presentation to the appropriate person in charge.
- 16024 **CUSTOMER TRAINING**
Conduct or provide hands-on training in the operation of installed systems. Familiarize the owner with the functions, maintenance requirements, and warranty provisions of each element of the system.
- 16025 **INSTALLATION SUPERVISION**
Assign daily tasks and provide appropriate instruction to individuals. Monitor, evaluate, and verify completion of assigned tasks. Coordinate installation with other trades and maintain contact with project manager(s). Provide for required job material, specialized installation tools, and miscellaneous equipment.

PERSONAL TALLY WORKSHEET

Passed Work Elements in Audio Systems

- o Put a checkmark next to the appropriate work element number when you receive a passing score on your Examination Score Report.
- o Put a "C" next to the appropriate work element number if you have crossover credit from another field. Read page 5 in this manual concerning crossover credit.

Level I General	Level II General	Level II Special	Level III General	Level III Special
_11001	_13001	_14001	_15001 (Core)	_16001
_11002	_13002 (Core)	_14002	_15002	_16002
_11003	_13003	_14003	_15003 (Core)	_16003
_11004 (Core)	_13004 (Core)	_14004	_15004	_16004
_11005 (Core)	_13005 (Core)	_14005	_15005	_16005
_11006	_13006	_14006	_15006	_16006
_11007	_13007 (Core)	_14007	_15007	_16007
_11008	_13008	_14008	_15008*	_16008
_11009	_13009	_14009	_15009	_16009
_11010 (Core)	_13010	_14010	_15010 (Core)	_16010
_11011	_13011	_14011	_15011 (Core)	_16011
_11012	_13012	_14012	_15012	_16012
_11013 (Core)	_13013	_14013	_15013	_16013
_11014	_13014	_14014	_15014	_16014
	_13015 (Core)		_15015	_16015
	_13016		_15016	_16016
	_13017 (Core)		_15017	_16017
	_13018			_16018
	_13019 (Core)			_16019
	_13020			_16020
	_13021			_16021
				_16022
				_16023
				_16024
				_16025

IMPORTANT NOTES:

- a. All Level I General Core Work Elements must be passed in order to meet the exam requirement for Levels II and III.
- b. All Level II General Core Work Elements must be passed in order to meet the exam requirement for Levels II and III.
- c. All Level III General Core Work Elements must be passed in order to meet the exam requirement for Level III.

*work element 15008 deleted.

TECHNICIAN PROFILE FOR CERTIFICATION IN AUDIO SYSTEMS

	Level I	Level II	Level III	Level IV (Level IV is not available for testing.)
Education:	None	Formal education not required but level of education expected is that for an associate degree. (Note 1)		
Minimum Work Experience:	None to very limited work experience in audio systems or related activities.	A minimum two years of installation, main-tenance and/or design-related work, one year of which shall be specifically involved with audio systems, and the balance may be employment in technical specialties within the normal scope of communications systems contracting.	Level II certification experience plus a minimum of three years of communication systems work during which at least two of the three years shall be installation, maintenance and/or layout of audio systems. (Note 2)	Level III certification experience plus five years of full time communication systems layout, installation, maintenance and/or supervision to include at least one major audio project involving a system of substantial complexity. At least three years of this five year period must be in connection with audio systems. (Note 2)
Level of Responsibilities:	Assignments requiring direct supervision.	Routine installation, maintenance, and system layout work under general supervision.	Audio systems installation, service, maintenance or small system layout with little or no job supervision. May provide daily supervision for one or more Level I or II technicians.	Project management and supervision, personnel assignment, and/or company design responsibility for complex audio systems.
Typical Activities Include:	Perform simple, repetitive, specific installation tasks, measurements, and assigned duties.	Perform a wide range of various segments of standard system installation; participate in job planning; conduct supervised maintenance or service projects; assist in maintaining as-built drawings; configure simple systems.	Install, service, or participate in the design of complete and operating audio systems to include job planning, documentation, limited change orders, final testing, and commissioning. Develop specific layouts of a variety of standard systems.	Provide technical advice, complete system layout and documentation, and oversee specialized completion or acceptance testing. Interact with owners, architects, engineers, construction project managers, and other contractors to correct problems and complete projects.
Typical Job Titles Include:	Helper Trainee	Technician Assistant Designer	Senior Technician Lead Technician Designer	Chief Technician Project Manager Senior Designer
Note 1:	Program content at Level II assumes educational experiences (college, or self-study, or correspondence courses, or workshops, etc.) that develop knowledge equivalent to courses in an electronics engineering technology or closely related associate degree program.			
Note 2:	At least one year of the work experience in audio systems must have been acquired within the three year period just prior to the date that certification is awarded at this level.			

STANDARDS ISSUING ORGANIZATIONS

AES	Audio Engineering Society New York, NY 212-661-8528 212-682-0477 (fax)
ANSI	American National Standards Institute New York, NY 212-642-4900 212-398-0023 (fax)
ASME	American Society of Mechanical Engineers New York, NY 212-705-7722
ASTM	American Society for Testing and Materials Philadelphia, PA 215-299-5585 215-977-9679 (fax)
EIA	Electronics Industries Association Arlington, VA 703-907-7500 703-907-7501 (fax)
UL	Underwriters Laboratories, Inc. Northbrook, IL 708-272-8800 708-509-6249 (fax)

SELECTED GENERAL REFERENCES

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- Baylin, F and S. Berkhoff. Wireless Cable and SMATV. Baylin Publications. Boulder, CO.
- Beranek, L.L. Acoustics. McGraw Hill Book Company. New York, NY.
- Bose, Keith W. Video Security Systems. Butterworth-Heinemann. Boston, MA.
- Clough, Richard H. Construction Contracting. John Wiley & Sons, Inc. New York, NY.
- Cooke, N.M. and H R. Adams. Basic Mathematics for Electronics. McGraw Hill Book Company. New York, NY.
- Davis, D and C. Davis. Sound System Engineering, 2nd edition. Howard W. Sams & Company. Indianapolis, IN.
- Davis, Gary and Ralph Jones, editors. Yamaha Sound Reinforcement Handbook. Hal Leonard. Milwaukee, WI.
- Dunham, Clarence W. and Robert D. Young. Contracts, Specifications, and Law for Engineers. McGraw Hill Book Company. New York, NY.
- Eagan, M. David. Architectural Acoustics. McGraw Hill Book Company. New York, NY.
- Eargle, John. Handbook of Sound System Design. Elar. Plainview, NY.
- Eiche, Jon F., editor. Guide to Sound Systems for Worship. Hal Leonard. Milwaukee, WI.
- Glerum, J.O. Stage Rigging Handbook. Southern Illinois University Press. Carbondale, IL.
- Heden, Robert A. Compendium of Materials for Noise Control, DEHW (NIOSH) Publication No. 80-116. US Government Printing Office. Washington, D.C.
- Huber, David M. Microphone Manual: Design and Application. Howard W. Sams & Company. Indianapolis, IN.
- Kaufman, M and A. H. Seidman. Handbook of Electronics Calculations. McGraw Hill Book Company. New York, NY.
- Kinsler, L.E. and A.R. Frey. Fundamentals of Acoustics. John Wiley and Sons, Inc. New York, NY.
- Klepper, David L., editor. AES Anthology: Sound Reinforcement. Audio Engineering Society. New York, NY.
- Kreugel, H. CCTV Surveillance (Video Practices and Technology). Butterworth-Heinemann. Woburn, MA.
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- Olson, H.F. Music, Physics, and Engineering. Dover. New York, NY.
- Pease, Robert A. Troubleshooting Analog Circuits. Butterworth-Heinemann. Woburn, MA.
- Rossnagel, W.E., L.R. Higgins, and J.A. MacDonald. Handbook of Rigging for Construction and Industrial Operations. McGraw Hill Book Company. New York, NY.
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Sterling, Donald J., Jr. Technicians Guide to Fibre Optics. Delmar Publishers, Inc. Albany, NY.

Tremaine, H.M. Audio Cyclopedia, 2nd edition. Howard W. Sams & Company. Indianapolis, IN.

Troyka, Lynn Q. Handbook for Writers. Simon & Schuster, Prentice-Hall, Inc. Englewood Cliffs, NJ.

Acoustic Measurement. John Wiley & Sons, Inc. New York, NY.

Basic Principles for Suspending Loudspeaker Systems (Technical Notes Vol 1, No. 14). JBL Professional. Northridge, CA.

Catalog of Tables, Data and Helpful Information. MacWhyte Wire Rope Company. Kenosha, WI.

General Conditions of the Contract for Construction. American Institute of Architects. Washington, D.C.

Handbook of Industrial Loss Prevention. Factory Mutual Engineering Corporation. McGraw Hill. New York, NY.

Handbook for Riggers, Revised Edition. Newberry Investments. Calgary, Canada.

IEEE Standard Dictionary of Electrical and Electronics Terms, 2nd edition. The Institute of Electrical and Electronics Engineers. New York, NY.

The Microphone Handbook. Elar. Plainview, NY.

Official OSHA Safety Handbook. J.J. Keller and Associates, Inc. Neenah, WI.

Proceedings of the AES 6th International Conference: Sound Reinforcement. Audio Engineering Society. New York, NY.

Riggermeister, Production Rigging Guide. Abridged Edition. ATM Group, Carson, CA.

Rigging Information for Flying Systems of Community Loudspeakers. Community Professional Loudspeakers. Chester, PA.

Standard First Aid and Personal Safety. American Red Cross. Washington, D.C.

Wire Rope Users Manual. Wire Rope Technical Board. Kansas City, MO. (Call 816-842-3351 to order from shipping company.)

Wire Rope Sling Users Manual. Wire Rope Technical Board. Kansas City, MO. (Call 816-842-3351 to order from shipping company.)

*This listing is not intended to be complete or representative. In all cases where a date is not listed, we suggest that the most current edition of the publication be used.

