U.S. Department of
Homeland Security

United States
Coast Guard

ET2 UNIT 4 (Volume 1): ELECTRONIC EQUIPMENT & CABLING

EPQ 5.A.05	Modifying Electronic Equipment Through Field Changes
EPQ 5.A.06	How to Evaluate the Installation of Electronic Equipment/Systems
EPQ 5.D.05	How to Install Cabling Through Multi-Cable Transits
EPQ 5.D.01	How to Trace Point-to-Point Connections Through Multiple Compartments
EPQ 5.D.04 5.D.02 5.D.07	How to Evaluate Multiple-Conductor, Coaxial, and HELIAX® Cable
EPQ 5.D.06	How to Install HELIAX® Cable Connectors

Coast GUARD
Training Center Petaluma

U. S. Coast Guard
Pamphlet No. P22205
(January 2007)

ET2 UNIT 4 (VOLUME 1): ELECTRONIC EQUIPMENT & CABLING

Creation Date: January 2007
Revision Date:

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QUESTIONS ABOUT THIS TEXT SHOULD BE ADDRESSED TO THE SUBJECT MATTER SPECIALIST FOR THE ELECTRONICS TECHNICIAN RATING

TABLE OF CONTENTS

TITLE	PAGE
Acknowledgments and References	ii
Notice to Students	iii
Lessons	
#1 Modifying Electronic Equipment Through Field Changes	1-1
#2 How to Evaluate the Installation of Electronic Equipment/Systems	2-1
#3 How to Install Cable Through Multi-Cable Transits	3-1
#4 How to Trace Point-to-Point Connections Through Multiple Compartments	4-1
#5 How to Evaluate Multiple-Conductor, Coaxial, and HELIAX® Cable	5-1
#6 How to Install HELIAX® Cable Connectors	7-1
Appendices	
A Pamphlet Review Quiz	A-1
B Pamphlet Review Quiz Answers	B-1
C Glossary	C-1

Acknowledgments and References

Acknowledgments

Material is included in this pamphlet through courtesy of the designated source. The Coast Guard appreciates permission of the source to use this material, which contributes greatly to the effectiveness of this course. No copies or reproductions of the material are authorized without permission of the appropriate source.

The Coast Guard wishes to thank the following individuals for their expertise and support in the development of this document:

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List of References

This pamphlet contains original material developed at the U. S. Coast Guard Training Center, Petaluma, California, and excerpts from the following technical publications:

- *Electronics Manual*, COMDTINST M10550.25 (series)
- *CMplus 5.1 Job Aids*
- *Navy Installation and Maintenance Book*, NAVSEA SE000-00-EIM-110
- *Navy Installation and Maintenance Book*, NAVSEA SE000-00-EIM-160
- MLC Standard Operating Procedures
- *System Integrated Logistics Support (SILS) Command Policy Manual*, COMDTINST M4105.8 (series)
- *Major MEGGER® Insulation Testers User Guide* by Avo International Limited

Notice to Students

Purpose

This pamphlet serves to provide you with knowledge of how to address certain administration and documentation tasks required of an ET2.

Important Note

This text has been compiled for TRAINING ONLY. It should NOT be used in place of official directives or publications. The test information is current according to the references listed. You should, however, remember that it is YOUR responsibility to keep up with the latest professional information available for your rating. Current information is available from the *Enlisted Performance Qualifications Manual*, COMDTINST M1414.8 (series).

Course Content

This course content is based on the requirements stated in the *Enlisted Performance Qualifications Manual*, COMDTINST M1414.8 (series).

Pamphlet Content

This pamphlet contains six lessons:

Lesson 1	Modifying Electronic Equipment Through Field Changes
Lesson 2	How to Evaluate the Installation of Electronic Equipment/Systems
Lesson 3	How to Install Cable Through Multi-Cable Transits
Lesson 4	How to Trace Point-to-Point Connections Through Multiple Compartments
Lesson 5	How to Evaluate Multiple-Conductor, Coaxial, and HELIAX® Cable
Lesson 6	How to Install HELIAX® Cable Connectors

Performance Qualifications

This pamphlet covers the following enlisted performance qualifications (EPQ) for ET2 from the *Enlisted Performance Qualifications Manual*, COMDTINST M1414.8 (series):

5.A.05 INSTALL a Field Change/ORDALT to an electronics equipment and/or system per the Electronics Manual, COMDTINST M10550.25 (series); Ordnance Manual, COMDTINST 8000.2 (series); and Navy Electronics Installation and Maintenance Book, General Maintenance, NAVSEA SE000-00-EIM-160.

Continued on next page

Performance Qualifications (Continued)

5.A.06 EVALUATE the installation of an electronics equipment and/or system per the installation documentation (e.g. Engineering Change); the Electronics Manual, COMDTINST M10500.25 (series); and the Navy Electronics Installation and Maintenance Book, NAVSEA SE000-00-EIM-160.

5.D.05 INSTALL cabling through multi-cable transits (e.g. Roxtec/Nelson) per the Electronics Manual, COMDTINST M10550.25 (series); Navy Electronics Installation and Maintenance Book, Installation Standards, SE000-00-EIM-110; and manufacturer's guidelines.

5.D.01 TRACE a point-to-point connection through multiple compartments using cable tags, unit drawings or ship's COEDS per the Electronics Manual, COMDTINST M10550.25 (series); and Navy Electronics Installation and Maintenance Book, Installation Standards, SE000-00-EIM-110.

5.D.04 EVALUATE multiple conductor cable per the Electronics Manual, COMDTINST M10550.25 (series); and Navy Electronics Installation and Maintenance Book, Installation Standards, SE000-00-EIM-110.

5.D.02 EVALUATE coaxial cable per the Electronics Manual, COMDTINST M10550.25 (series); and Navy Electronics Installation and Maintenance Book, Installation Standards, SE000-00-EIM-110.

5.D.06 INSTALL HELIAX® cable connectors per the Electronics Manual, COMDTINST M10550.25 (series); Navy Electronics Installation and Maintenance Book, Installation Standards, SE000-00-EIM-110; and manufacturer's guidelines.

5.D.07 EVALUATE HELIAX® cables per the Electronics Manual, COMDTINST M10550.25 (series); Navy Electronics Installation and Maintenance Book, Installation Standards, SE000-00-EIM-110; and manufacturer's guidelines.

Learning Objectives

Read the learning objectives before you begin reading the text. The objectives will guide you through the text and help you answer the questions in the self-quiz at the end of each lesson.

Notice to Students (Continued)

Quizzes

Each lesson has a self-quiz and pamphlets may have a pamphlet review quiz. You will find answers to each quiz on the pages following the quiz. Included are reference pages for the answers.

These self-quizzes are meant to check your comprehension of the material you covered. If you have problems understanding a section, go through it again or ask someone for help. The pamphlet review quiz questions are samples of the type of questions you will find on the end-of-course-test.

SWE Study Suggestion

Servicewide exam questions for your rate and pay grade are based on the Professional and Military Requirements sections of the *Enlisted Performance Qualifications Manual*, COMDTINST M1414.8 (series).

If you use the references from this text and consult the *Enlisted Performance Qualifications Manual*, you should have good information for review when you prepare for your servicewide exam (SWE).

Glossary of Terms

A glossary of terms is included at the end of this pamphlet as Appendix C.

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LESSON 1

MODIFYING ELECTRONIC EQUIPMENT THROUGH FIELD CHANGES

Overview

Introduction

A field change is a modification to a specific type of electronic equipment. It is a universal change to all equipment of that specific type within the Coast Guard. Exceptions are specified by equipment serial number, location, or use, in the field change bulletin.

Field changes are issued to prescribe modifications to electronic equipment necessary to:

- Meet operational requirements
- Remove hazards
- Correct design deficiencies
- Improve reliability and maintainability
- Correct documentation.

Such modifications may involve the changing of components, physical alteration of cabinets or housing, change of operational tolerances or capabilitie, software upgrades, and changes to the technical manuals.

Equipment Relations

The term “field change” generally applies to electronic or mechanical systems. Ordnance Alterations (ORDALTs) are field changes that apply to ordnance-specific equipment only. Ship Alterations (SHIPALTs) are field changes specific to one ship and not necessarily to a class of ship. The process of handling and documenting these alterations is similar to the field change process.

Lesson Objectives

Given a description of a field change and its components **IDENTIFY** the key components of a field change.

References

The following references were used for this lesson:

- NAVSEA SE000-00-EIM-110, Navy Installation and Maintenance Book (NIMB)
- COMDTINST M10550.25 (series), Electronics Manual

Field Change Sources

Introduction

Various groups approve and fund field changes. Those groups include:

- Coast Guard
- Navy
- Commercial

Coast Guard Field Changes

Field changes are issued by CG-643 or SMEF. Information necessary to implement a field change must come from all levels of command. Coast Guard field changes are normally used to promulgate Army, Air Force, and commercial modifications.

These field changes include a field change bulletin, field change parts kit, and an errata sheet if necessary. The Coast Guard also uses field changes as generated by the Navy for Navy equipment that is used by the Coast Guard.

Navy Field Changes

It is required that the Coast Guard keep abreast of the Navy field changes to maintain compatibility of all Navy type equipment whether Navy-owned or Coast Guard-owned. Navy field changes are published in NAVSEA 0967-000-0000 (EIMB) series and updated in NAVSEA S0111-XX-EIB-XXXX (EIB) series.

Commercial Field Changes

When a manufacturer issues a change bulletin for commercial electronic equipment used by the Coast Guard, the bulletin is screened by CG-643 or SMEF. A field change bulletin is then issued by CG-643 or SMEF, which informs the units that a particular change is applicable to their equipment. Any unit receiving information concerning a change to commercial equipment, that was not previously published or authorized, shall forward the information to CG-643 through their respective MLC.

Field Change Types

Types of Field Changes

Type designations are used on Coast Guard and Navy field changes. These designators indicate the extent to which parts are furnished and may indicate technical manual corrections. The types are defined as follows:

Type of Field Change	Definition
Type 1	Furnishes documentation, parts, and special tools required to complete a change. Documentation, parts, and tools are assembled and supplied as a Field Change Parts Kit, which is assigned a stock number. This type of change involves alteration to equipment and requires changes to the technical documentation.
Type 2	Furnishes documentation only. The installing unit procures required parts or special tools with their own funds from an appropriate supply source. This type of change requires alteration to the equipment and also requires changes to the technical documentation.
Type 3	Furnishes documentation and some of the required parts or special tools. The remaining required parts or special tools are procured from a specified source by the installing unit. This type of field change requires alteration to the equipment, and requires corresponding changes to the technical documentation.
Type 4	Implements changes to technical documentation only and requires no alteration to the equipment.

Continued on next page

Field Change Types (Continued)

Depot Change

A Depot Change is a modification consisting of component changes to modules, sub-assemblies, or equipment, which have been designated as depot level repairable. A modified module may be electrically, physically, functionally, and pin-for-pin interchangeable with the unmodified module, in which case it is simply returned to the supply pipeline upon modification. However when a Depot Change module or equipment is not directly interchangeable and requires mainframe wiring or component changes it may be provided as part of a Type 1 or Type 3 field change.

Field Change Package

A complete Field Change Package consists of the Field Change Bulletin and a Field Change Parts Kit. Field Change Parts Kits are not required for Type 2 or Type 4 field changes

Continued on next page

Field Change Bulletin

Field Change Bulletins are distributed to all activities that have an interest in equipment modifications. For example, MLC/District Commanders receive bulletins but not the parts kits unless they have the equipment installed at the district office. The field change bulletin is the authority for the installation of the field change. The field change bulletin is organized into the following sections:

- Purpose
- Description
- Equipment Affected
- Identification of Accomplishment
- Materials Required
- Procedure
- Routine Instructions

The necessary documentation for implementing a field change is contained as part of the field change bulletin. This includes:

- Corrections to Technical Documentation
- Parts Lists
- Installation Procedures

All field change bulletins must contain information providing a stock number for the bulletin and also the Field Change Kit, if applicable. CG-643 is solely responsible for obtaining bulletin stock numbers from the ELC.

Continued on next page

Field Change Bulletin Example

This is an example of page 1 of a field change bulletin.

ELECTRONIC FIELD CHANGE BULLETIN

F. C. NO. 19 TYPE 1 TO AN/FPN-64A(V) LORAN-C TRANSMITTER SET

PURPOSE:

This field change reduces the off-air time when switching output/coupling networks in the AN/FPN-64(V) and AN/FPN-64A(V) LORAN-C Transmitter Sets.

DESCRIPTION:

This field change modifies the 2AlA2AIA7 RF Switch Control PCB to reduce the off-air time to 15 seconds when switching output/coupling networks. This field change also provides corrections to the technical manual to document the changes to the RF Switch Control PCB.

EQUIPMENT AFFECTED:

This field change is applicable to all AN/FPN-64(V), and AN/FPN-64A(V) LORAN-C Transmitter Sets.

IDENTIFICATION OF ACCOMPLISHMENT:

The presence of 510k ohm resistors for R20 and R35 on the 2AlA2AlA7 RF Switch Control PCB identifies accomplishment of this field change.

MATERIALS REQUIRED:

RF Switch Control PCB, NSN XB 5998-01-068-5615, modified by Depot Change 03 (orange stripe on the edge of the circuit card).

TOOLS REQUIRED:

None.

PROCEDURE:

1. Follow the step-by-step installation instructions in enclosure (1).

2. Perform the technical manual corrections in enclosure (2).

3. Complete and return the Field Change Installation Feedback Report provided as enclosure (3).

ROUTINE INSTRUCTIONS:

1. Record completion of this field change by making an entry on the Field Change Accomplishment Plate, NSN 01 0264-LP-456-6411, available from the Naval Publications and Forms Center, Philadelphia, PA.

2. Maintenance support facilities shall maintain a library copy of this and all other applicable field change bulletins. Additional and replacement copies can be obtained from Coast Guard Engineering Logistics Center, Baltimore, MD. Order directly at no cost using MILSTRIP procedures; NSN CG 761O-01-GE8-6673 applies.

3. Upon completion, a copy of this field change bulletin shall be inserted in front of all applicable technical manuals. Cognizant commands shall ensure that the field change has been accomplished and that applicable technical manual annotations and reports have been made.

C. A. SCHUE, III

Encl: (1) Installation instructions for FC 22/l 9 to the AN/FPN-64(V)/64A(V)
(2) Technical Manual Corrections for FC 22/19 to the AN/FPN- 64(V)/64A(V)
(3) Field Change Installation Feedback Report

Field Change Bulletin Example (cont'd)

This is an example of page 1 of the step-by-step installation instructions for the field change.

Installation Instructions for FC 22/19 to the AN/FPN-64(V)/64A(V)

SAFETY NOTE

COMPLY WITH U.S. COAST GUARD SAFETY PRECAUTIONS AND THE ELECTRONlCS MANUAL, COMDTINST M10550.25A

NOTE: Read all instructions before attempting to complete this field change.

1. Order three modified RF Switch Control PCBs, NSN XB 5998-01-068-5615 (one for the installed TOPCO, one for the spare TOPCO, and one for a MICA spare), and using normal APA requisitioning procedures. Once received, proceed to step 2.

2. Notify the control station that this field change is being installed and might cause a MOA when power is secured and reapplied to the TOPCO.

3. Place the MANUAL/AUTO switch on the PPU A11 Panel to **MANUAL**.

4. Secure power to the TOPCO by turning off CB1 (battery) and CB2 (AC) on the rear of the unit.

5. Open the TOPCO and locate the RF switch control PCB (green card extractor).

6. Remove the existing RF switch control PCB.

7. Insert the modified RF switch control PCB and close the TOPCO.

8. Return power to the TOPCO, by turning on CB2 (AC) and CB1 (battery) on the rear of the unit.

9. Place the MANUAL/AUTO switch on the PPU A11 Panel to **AUTO**.

10. Notify the control station that you will be switching output/coupling networks twice to test the new RF Switch Control PCB.

11. Switch output/coupling networks by pressing the COMMAND button on the TOPCO. Note how long the station is off air. It should be off air for approximately 15 seconds.

12. Switch output/coupling networks again by pressing the COMMAND button on the TOPCO. Note how long the station is off air. It should be off air for approximately 15 seconds.

13. Notify the control station that the installation is complete.

14. Return all unmodified RF Switch Control PCBs to ELC using normal procedures for returning defective XB items. On the “Serviceable/Unserviceable Material Tag” for trouble indication write “Requires most recent depot change”.

Field Change Bulletin Example (cont'd)

This is an example of Technical Manual Corrections for a field change.

Technical Manual Corrections for FC 22/19 to the AN/FPN-64(v)/64A(V)

1. Make the following pen and ink corrections to the AN/FPN-64(V)/64A(V) Technical Manuals. Write "FC 22/19 to the AN/FPN-64(V)/64A(V)" at the bottom of each corrected page.
   a. Page 2-19, Table 2-2, Item 38, line 6, in the Function column, change 20 seconds to 15 seconds.
   b. Page 3-125, Figure 3-45, change both 20-Sec One-Shot to 15-Sec One-Shot.
   c. Page 3-126, Paragraph 3-222, 5th and 9th lines, change 20-sec to 15-sec.
   d. Page 3-126, Paragraph 3-223, 1st and 5th lines, change 20-sec to 15-sec.
   e. Page 3-186, Paragraph 3-355, sub-paragraph 1, 2nd line, change 20-sec nominal to 15-sec nominal.
   f. Page 3-189, Paragraph 3-360, sub-paragraph 7, change 20-sec to 15-sec.
   g. Page 3-189, Paragraph 3-360, sub-paragraph 8, change 20-sec to 15-sec.

2. Make the following page change:

REMOVE	INSERT
Page 5-121 (Original)	Page 5-121 (FC 22/19)

Field Change Parts Kit

These kits are distributed by CG-643, SMEF, or requisitioned by the unit from a supply source as indicated in the field change bulletin. A field change parts kit is included in Type 1 and Type 3 field changes and consists of:

- Parts
- Special tools
- Related parts lists
- Installation procedures
- Copy of the field change bulletin

NOTE

Procurement information is included in the field change bulletin under the Material Required section.

Errata Sheet

If relatively minor mistakes have been made in the field change bulletin then an errata sheet will be issued to correct these errors. The errata sheet receives the same distribution as the related field change.

Continued on next page

Errata Sheet Example

Below is an example of a field change errata sheet.

ERRATA SHEET NO. 1
TO
F. C. NO. 19 TYPE l TO AN/FPN64A(V) LORAN-C TRANSMITTER SET

PURPOSE:

This errata is being released to ensure timely modifications to the RF Switch Control PCBs and increase the number of spares in the pipeline. This errata modifies the installation instructions and provides resistors to accomplish this field change. Normally field units would not work on XB modules; however, the LORSTAs and the ELC repair depot would benefit from this, enabling the LORSTAs to accomplish this field change quickly and ensuring that adequate spare PCBs remain in stock.

LORSTAs that have ordered, but have not received the RF Switch Control PCBs, should cancel their orders. If modified PCBs have been received, verify that they function properly and install them in accordance with the original installation instructions in Field Change 22/19 to the AN/FPN/64(V)/64A(V). If the modified boards do not function properly, return them to ELC for repair.

PROCEDURE:

A qualified Electronics Technician shall perform the following procedure on each RF Switch Control PCB, using the proper soldering tools and techniques:

1. Identify the resistors to be replaced; R20 and R35, on the MICA spare RF Switch Control PCB.

2. De-solder and remove R20 and R35. Be very careful not to damage the circuit runs or eyelets.

3. Insert the new 510k ohm resistors (provided by LSU) in the now vacant R20 and R35 locations.

4. Solder the new resistors in place, again being careful not to damage the circuit runs or eyelets.

5. Locate the black and brown stripes on the edge of the CCA. Using the paint pen provided, paint an orange stripe immediately following and the same length as the black and brown stripes.

6. Repeat steps 2 through 5 on the RF Switch Control PCB from the spare TOPCO

7. After installing the new 510k ohm resistors in both spare RF Switch Control PCBs (from the MICA and spare TOPCO), test them both by following steps 2 through 12 in the original installation instructions supplied in Field Change 22/19 to the AN/FPN-64(V)/64A(V).

8. Repeat steps 2 through 5 on the RF Switch Control PCB that was removed from the online TOPCO.

9. After installing the new 510k ohm resistors in the RF Switch Control PCB that was in the on-line TOPCO, test it by following steps 3 through 13 in the original installation instructions supplied in Field Change 22/l 9 to the AN/FPN-64(V)/64A(V).

10. After verifying that all the PCBs function properly, return one spare PCB into the spare TOPCO and the other one into the MICA for storage.

PARTS SUPPLIED WITH THIS ERRATA:

Item Name	NSN	Quantity
510k Ohm, 1/4 Watt Resistors	5905-00-246-8690	6
Orange paint pen	None	1

ROUTINE INSTRUCTIONS:

1. Record completion of this errata by making an entry on the Field Change

Accomplishment Plate, National Stock Number (NSN) Of 0264-LP-456-6411 (available from the Naval Publications and Forms Center, Philadelphia, PA).

2. Maintenance support facilities shall maintain a library copy of this and all other applicable field change bulletins. Additional and replacement copies can be obtained from Coast Guard Engineering Logistic Center, Baltimore, MD. Order directly using MILSTRIP procedures; no cost is involved. NSN CG 761O-O1-GE8-6674 applies.

3. Upon completion, a copy of this errata shall be inserted in front of all applicable technical manuals. Cognizant commands shall ensure that this errata has been accomplished and that applicable technical manual annotations and reports have been made.

G. K. WEEKS, JR.

Field Change Types (Continued)

Numbering Coast Guard Field Changes

CG-643 has the responsibility for assigning numbers for all Coast Guard electronic field changes. Drafters, such as SMEFs, shall submit a copy of the proposed bulletin to CG-643 to obtain a field change number and a field change bulletin stock number.

Numbering Field Changes for Navy Equipment

Navy field changes are numbered consecutively for a piece of equipment starting with number one. Coast Guard field changes for Navy equipment are numbered consecutively starting with the number 91 to distinguish between the two sources. Therefore, it is possible to have field changes 1, 2, 3, 4, and 5 (Navy) and field changes 91, 92, and 93 (Coast Guard) installed in Navy-type equipment without regard for ownership. The numbers remain sequential for a piece of equipment and will not start over at the beginning of the year. However, field change numbers will start over with a new piece of equipment or a new version of an older piece of equipment.

Supply Source

General service field change parts kits fabricated by the Coast Guard are stocked at Engineering Logistics Center (ELC), Baltimore. Procure field changes in accordance with MILSTRIP procedures, if not distributed by the CG-643 or SMEF. The field change bulletin provides the stock number for both the kit and the bulletin. Field change bulletins and kits procured from other sources are stocked at ELC and may be obtained using standard MILSTRIP procedures. Whenever possible, a trial installation is made for evaluation prior to service wide distribution of a field change.

Responsibility

It is the responsibility of the individual operating unit to assure that all applicable field changes have been installed in their equipment. For units not having technicians assigned, the supporting maintenance facility has the responsibility for insuring that field changes are installed.

Commercial Field Changes

Commercial field changes parts kits are procured as stipulated in the field change bulletin.

Class of Field Changes

Introduction

There are three Navy class designations (A, B, and C) for field changes, one of which is assigned to each field change kit. They provide an abbreviated method of indicating the funding and installation responsibility.

Class Designations

The Navy uses the following class designations.

Class of Field Change	Designation Description
A	Requires no installation funding. These field changes are approved for accomplishment (installation) by forces afloat or station personnel on ship- or shore-installed equipment without further reference to the cognizant management command, under conditions stated in the field change instructions.
B	Requires fleet installation funding (not applicable to shore-installed equipment except at training activities). Changes to shipboard equipment are approved for accomplishment by naval shipyards or repair facilities without further reference to NAVSEA, under conditions stated in the field change instructions, when authorized by Type Commanders. Changes to equipment at training activities are approved for accomplishment and funded by the appropriate Systems Command. The issuance of field changes, which require fleet funding for accomplishment, is discontinued. Except for class B field changes presently under procurement in the supply system, or in fleet installation planning stage, this type of field change will no longer be issued.
C	Normally requires industrial assistance for installation, and requires the appropriate Systems Command installation funding. This class of field change includes, but is not limited to, changes of an operational improvement nature, which are to be authorized and accomplished by SHIPALT in the modernization plan. Changes to equipment at training activities are approved for accomplishment and funded by the appropriate Systems Command.

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Practice Exercise

Exercise Instructions

Use this exercise to check your comprehension of the lesson material. Read each question and write the answers in the spaces provided. Check your answers in the Feedback section following the exercise.

Exercise Questions

Match the definition with the term. (**Note**: Some terms may appear in the Glossary in Appendix C.)

	Term	**Definition**
1. _____	Emergency Alteration	A. Published field changes to Navy and commercial equipment.
2. _____	Navy Field Change Numbers	B. Involves alteration to equipment and requires changes to the technical documentation.
3. _____	Field Change Parts Kit	C. No equipment alteration required; only changes technical documentation.
4. _____	Field Change Bulletins	D. Issued when minor mistakeshave been made in a field change bulletin.
5. _____	Depot Change	E. The change to the equipment shall be reported immediately.
6. _____	Errata Sheet	F. A modification consisting of component changes to modules, sub-assemblies, or equipment and may be provided as a part of a Type 1 or Type 3 field change.
7. _____	Type 1	G. Distributed to all activities that have interest in equipment modifications and is the authority for the installation of the field change.
8. _____	Equipment Systems Information Bulletin	H. Distributed by CG-643 and includes parts, special tools, related parts lists, installation procedures, and a copy of the field change bulletin.
9. _____	Type 4	I. Numbered consecutively starting with one.

Feedback

Exercise Question Answers

Compare your answers to the ones below.

Question	Answer	Reference page
1.	E	C-1
2.	I	1-10
3.	H	1-8
4.	G	1-5
5.	F	1-4
6.	D	1-8
7.	B	1-3
8.	A	C-1
9.	C	1-3

LESSON 2

HOW TO EVALUATE THE INSTALLATION OF ELECTRONIC EQUIPMENT/SYSTEMS

Overview

Introduction

Section 5.2.5 of the Electronics Manual states that "Certifications of electronics installations verify that equipment arrangement and installation details conform to the class/platform drawings and good installation practices."

Conducted after an installation required by an approved Field Change or Engineering Change, formal certifications are the responsibility of Headquarters and/or the MLC (depending on the type of equipment or system installed).

However, the CO of a unit undergoing an installation certification will "furnish one electronic specialist to the certification team. A Chief Warrant Officer is preferred but the senior electronic technician onboard may be assigned if a Warrant Officer is not available. Where circumstances warrant, the commanding officer shall provide additional members, such as EM, ET, FT, TT ratings."

In light of the above, at some point you will likely find yourself designated as a member of a certification team and therefore have a role in evaluating an electronics/system installation.

Lesson Objectives

Given a completed electronic equipment and/or system installation, **EVALUATE** the installation for compliance with installation documentation and reference standards.

References

The following references were used for this lesson:

- Electronics Manual, COMDTINST M10550.25 (series)
- Navy Installation and Maintenance Book, NAVSEA SE000-00-EIM-110

Certification Process

Certification Responsibilities

A certification team leader is designated to oversee functions and duties of the certification team. The senior Commandant or MLC member acts as team leader, whose responsibilities are outlined in Section 5.2.5.2.4 of the Electronics Manual.

As a member of the installation certification team, you will follow the direction and instructions of the team leader, specifically with regard to checking the status of the following:

Item(s)	**Factors**
Equipment foundations	• Are they adequate?
Cable runs, connections and labels	• Are the cables properly terminated, secured, bonded, tagged, etc.? • Are cables sized properly for their intended functions?
Grounding/Bonding	• Is the ship/facility adequately grounded/bonded? • Is equipment grounded/bonded?
Power panels and connecting boxes	• Is equipment connected to correct breakers? • Are breakers of proper size and adequately labeled?
Equipment positioning	• Is equipment positioned for easy maintenance; will the equipment open fully, extend fully etc.?
Wave guide/Antenna Feeds	• Is wave guide/antenna feed run properly, free of bends and dents? • Are appropriate accessories (bends, twists, adapters, flanges, etc.) used?
Penetrations	• Are penetrations of watertight boundaries properly made and sealed?
Housekeeping	• Have the equipment and the areas surrounding the equipment been cleared, debris removed, nicks and scratches touched up, etc.?
Adjacent equipment and spaces	• Have other nearby equipment or spaces been damaged by the installing activity and not corrected?

Continued on next page

Certification Process (Continued)

Installation Standards

In addition to the guidelines for installation of specific electronic equipment and systems outlined in NAVSEA SE000-00-EIM-110 (Installation Standards), the document also contains in Section 6 broader parameters for the installation of equipment in general. These cover such topics as:

- Location
- Foundations
- Fasteners
- Habitability
- Accessibility
- Grounding and bonding
- Safety

You are encouraged as always to review the material noted above during this lesson: it will come in handy when you are tasked with certification team-member responsibilities.

Certification Checklist

In addition to the Navy standards discussed above, Section 5.2.3.10.8 of the Electronics Manual states that an "Engineering Certification Checklist" is used to certify an installation as and after it occurs. The checklist is ordinarily included as part of the relevant Field Change package or Engineering Change plan, and should provide for:

- Checks of all of the new/modified system functionality;
- Checking of functionality of any ancillary equipment;
- Checks concerning the quality of the installation (e.g., cables properly dressed, drawings properly "red-lined," training provided, etc.)

Signature blocks are included on the checklist for the installing activity and receiving unit. A copy is left at the station and the original returned to the Project Manager's command. The CO may use the Engineering Certification as part of, or in total, for the Operational Certification.

Such a checklist is an invaluable tool for the certification team in its efforts to ensure proper installation has been made.

Reporting of Discrepancies

Discrepancies you find during your evaluation should be reported to the Certification Team Leader in the prescribed manner, for consolidation into the final certification report.

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Practice Exercise

Exercise Instructions

Use this exercise to check your comprehension of the lesson material. Read each question and write the answers in the spaces provided. Check your answers in the Feedback section following the exercise.

Exercise Questions

1. The Senior Commandant or MLC member acts as _____, whose responsibilities are outlined in section 5.2.5.2.4 of the Electronics Manual.

2. Section 5.2.3.10.8 of the Electronics Manual states that an "_____" is used to certify an installation as and after it occurs.

Feedback

Exercise Question Answers

Compare your answers to the ones below.

Question	Answer	Reference page
1.	team leader	2-2
2.	Engineering Certification Checklist	2-3

LESSON 3

HOW TO INSTALL CABLING THROUGH MULTI-CABLE TRANSITS

Overview

Introduction

The Electronics Manufacturers Directory website describes multi-cable transits, or "MCTs," as…

> "...sealing systems which seal and protect cable and pipe transits against fire, smoke, gas, water, etc. A cable transit is used for protecting against the ingress of liquids and electromagnetic disturbances or interference at a wall transit location within a wall. Cable transits are generally modular systems including outer frames (at least one module-based cable seal and a final seal which fills out the frame together with the cable seal) such as two semi-cylindrical bodies that are made of a compressible material and that together fit into the internal cavity of the sleeve."

ET EPQ 5.D.05 calls for you to be able to install cabling through MCTs using supplies from such companies as Roxtec and Nelson Firestop Products, from which the Navy and Coast Guard often obtain necessary equipment for cable-transiting purposes. This lesson is meant to quickly introduce you to MCTs and to point you to information, available online, that will help you to meet EPQ 5.D.05.

Lesson Objectives

Given multi-cable transit materials (e.g., from Roxtec Corp. or Nelson Firestop Products), a previously installed multi-cable transit frame, and appropriate tools, **INSTALL** cabling through the multi-cable transit per standard Navy/Coast Guard references and manufacturer's guidelines.

References

The following references were used for this lesson:

- *Electronics Manual*, COMDTINST M10550.25 (series)
- *Navy Installation and Maintenance Book (NIMB), Installation Standards*, NAVSEA SE000-00-EIM-110 (0967-LP-000-0110)
- *DOD-STD-2003 (Navy)*
- Electronics Manufacturers Directory website informational material (http://www.electronics-manufacturers.com/Cables_and_connectors/Cable_transits/)
- Nelson Firestop Products MCT™/MPS™ Engineering Manual (http://www.nelsonfirestop.com/MCT%20Engineering%20Manual.pdf)
- Roxtec International AB website informational material (http://www.roxtec.com/frameIns.htm)

Cable Transits

Naval References

According to Section 5-2.5.5 of the *Navy Installation and Maintenance Book (NIMB), Installation Standards*,

> "The multi-cable transit [MCT] device is a modular system that utilizes standard units and dimensions to allow maximum flexibility and compatibility with various numbers and sizes of cables. Final sealed units will provide watertight, airtight and fireproof bulkhead or deck penetrations."

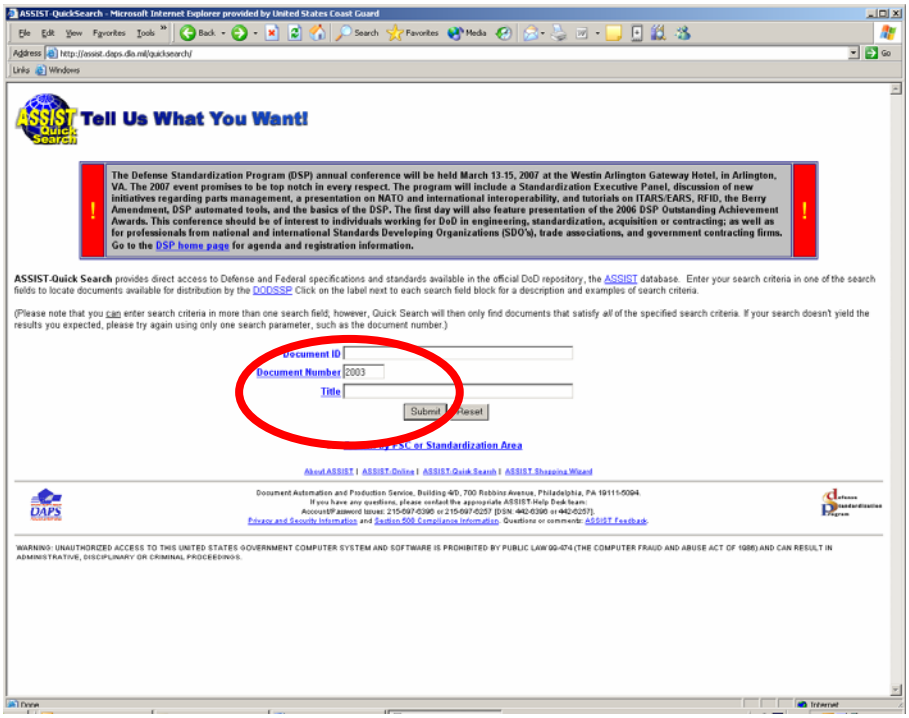
Section 5-2.5.5 also mentions that "complete installation and assembly instructions for multi-cable transit devices are covered in DoD-STD-2003."

DOD-STD-2003

You are encouraged to obtain a copy of DOD-STD-2003 (Navy) by Quick Search through the Acquisition Streamlining and Standardization Information System (ASSIST) database at:

http://assist.daps.dla.mil/quicksearch/

At the site, type 2003 in the "Document Number" box and click on "Submit."



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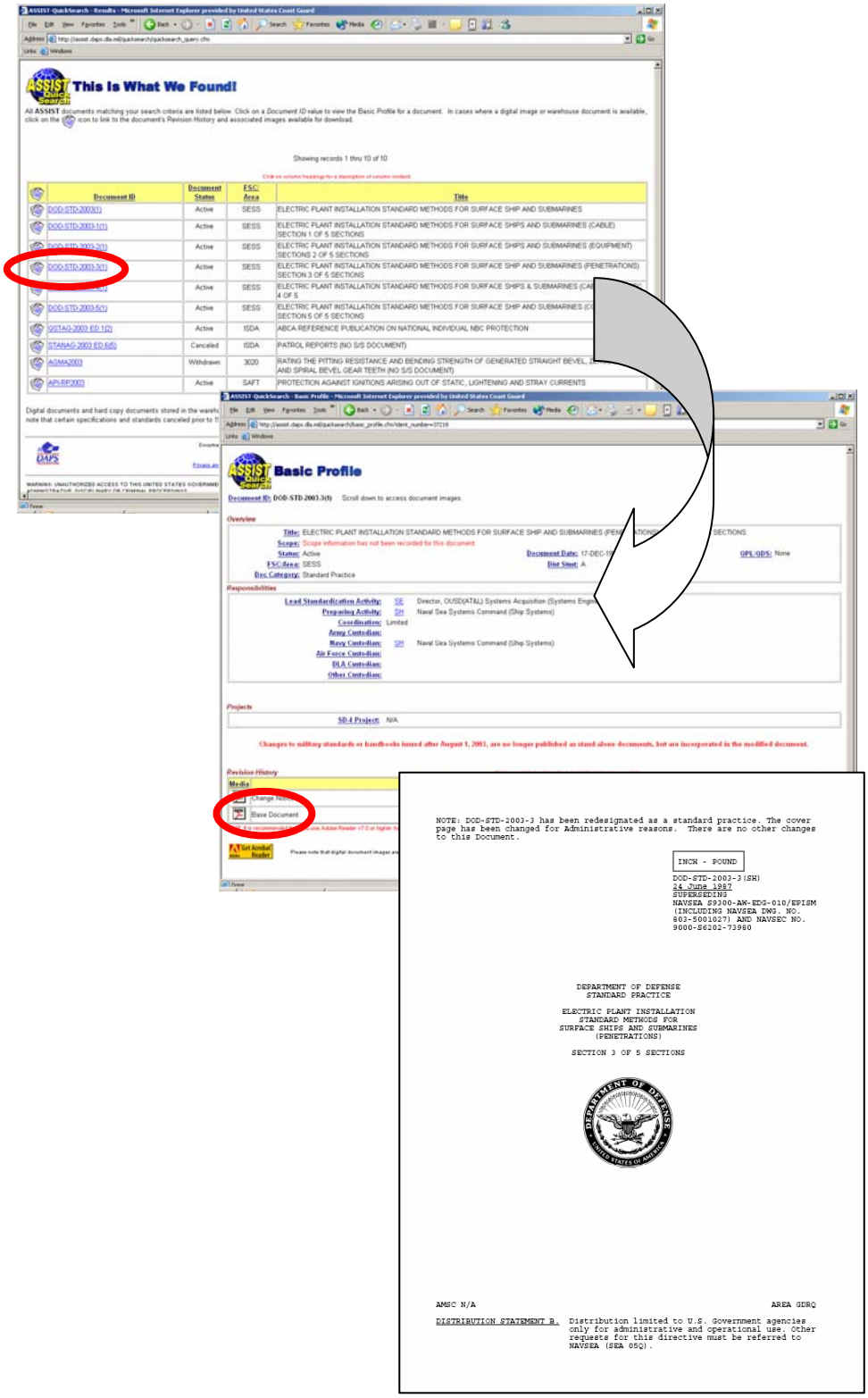
DOD-STD-2003 (cont'd)

From the next screen, click on the link to Section 3 (Penetrations); from the screen that appears, you can download a .pdf file of the relevant instruction:



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DOD-STD-2003 (cont'd)

As you go through the DOD-STD-2003 (Navy) directive, you'll note that the document deals extensively with devices known as "multiple cable penetrators," or "MCPs." An MCP is defined in Section 3.4 as "a system of passing multiple cables through water and non-watertight bulkheads and decks in order to provide watertight, airtight and firetight penetration of electrical cable." In other words, for our purposes, MCPs are synonymous with MCTs.

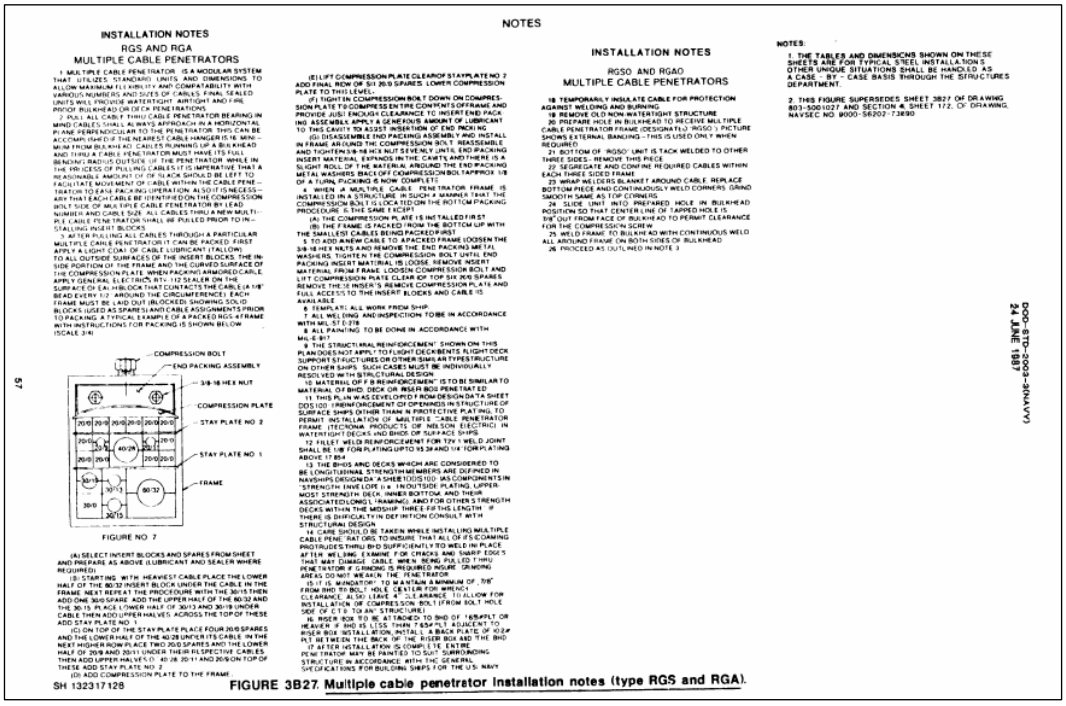

FIGURE 3B27. Multiple cable penetrator installation notes (type RGS and RGA).

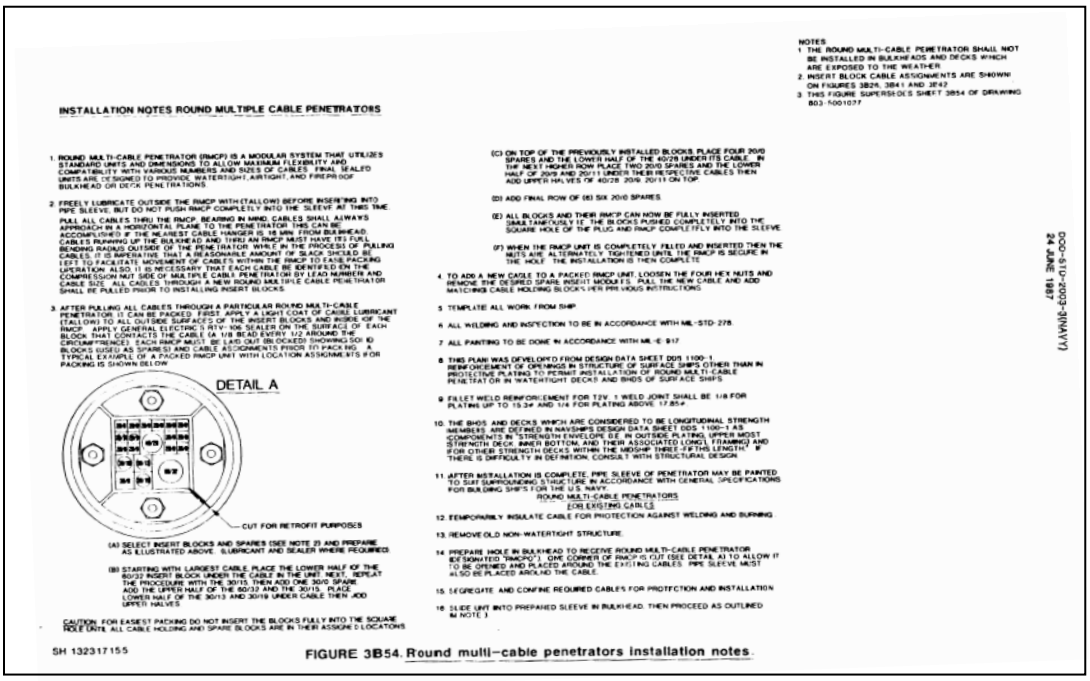

FIGURE 3B54. Round multi-cable penetrators installation notes.

Continued on next page

Nelson Firestop Products

While DOD-SATD-2003 contains general guidelines on MCT/MCP installation, instructions from the equipment manufacturers are usually more specific, relevant, and current. Here, for example, is an MCT diagram, glossary, and installation instructions from Nelson Firestop Products at

http://www.nelsonfirestop.com/MCT%20Engineering%20Manual.pdf

MULTI-CABLE TRANSIT MCT™

Multi-Cable Transit is based on a simple but effective design. It consists of a rectangular metal frame suitable for floor or wall installation, which is available in single or multiple units. Each frame contains an arrangement of Tecron™ elastomer modules grooved to fit snugly around cables, pipes, or conduits passing through the frame. The intumescent Tecron™ modules expand when exposed to heat, providing a continuous seal even if cable jackets disintegrate. The entire assembly within each frame is locked in position to prevent dislodgement and the spread of fire and the products of combustion.

Nelson Glossary

Transit Frame	The transit frame is the housing into which the other components are fitted.
MCT Lubricant (Tallow)	Used when packing. Allows the insert modules to slide easily over each other.
RTV-106 Sealer	For armored cable. Sealer should be applied in the grooves to seal the space between the armor and the cable sheath in navy cables, and the groove in the interlock of industrial cables.
Compression Bolt	When tightened, the bolt applies pressure to the compression plate sealing the grooved insert modules around the cables.
End Packing Standard	End packing assembly is bolted into place to provide a fire and watertight seal above the compression plate. The standard end packing assembly is used when both sides of the transit frame are accessible.
End Packing Special	The special end packing assembly serves the same purpose as the standard and is used when the transit frame is accessible from only one side.
Compression Plate	The compression plate acts as a pressure plate above the internal assembly.
Stay Plates	Stay plates are inserted between every completed row to help distribute compression forces within the frame and to keep modules from dislodging under high pressure conditions.
Grooved Insert Modules	Grooved insert modules are available in seven module sizes to accommodate a range of cable/pipe from 5/32" to 3-3/4" O.D. They fit snugly around the cable or pipe to form an airtight, watertight seal when compression applied in final assembly step.
Spare Insert Modules	Solid modules are used to fill voids or allow for future addition of cables. They are available in 3 module sizes.
Fill-in Insert Strips	Used to fill space gaps. Available in 5 and 10mm thickness. Strips are 120 mm long and are split to allow cutting at any desired length.

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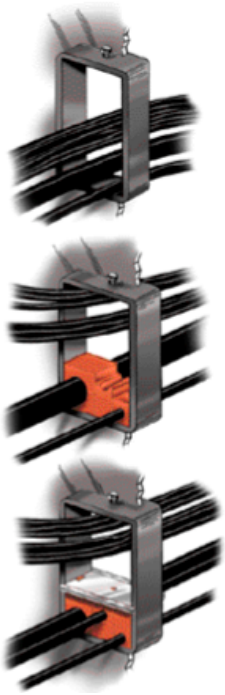
Nelson Firestop Products (cont'd)

INSTALLATION OF MULTI-CABLE TRANSIT IS QUICK, EASY AND ECONOMICAL. THE BASIC STEPS ARE DESCRIBED BELOW:



1. Empty frames are cast into or surface mounted to walls or floors by conventional construction methods. Cables, conduit, or pipe are run according to standard design criteria.

2. Preformed Tecron™ elastomer modules are inserted around each cable, conduit, or pipe.

3. Stay plates are placed between rows of Tecron™ modules.

4. The compression plate is inserted and pressed against top of frame before packing the last row of Tecron™ modules.

5. When the last row of modules has been packed the compression bolt is tightened until there is space enough to install the end packing.

6. Insertion and tightening of the end packing completes the job.

Roxtec

Here's some information from another manufacturer, Roxtec, at:

http://www.roxtec.com/frameMultidiameter.htm

Multidiameter technology

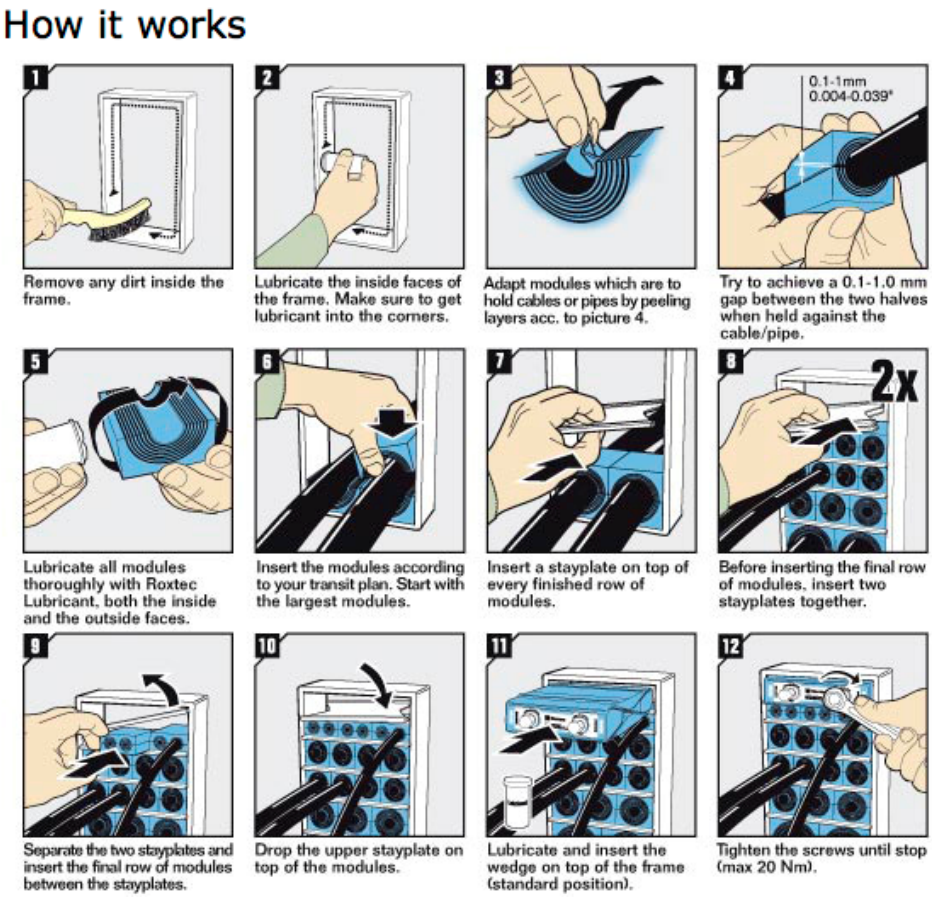
The Multidiameter technology enables a Roxtec sealing unit to be adapted to fit a wide range of diameters of cables or pipes.

The method is simple. Just peel the inner opening in the sealing unit, layer by layer, until the cable or pipe fits.

This unique and smart technique was invented by Roxtec to simplify installation work, purchasing and logistics for the industry.

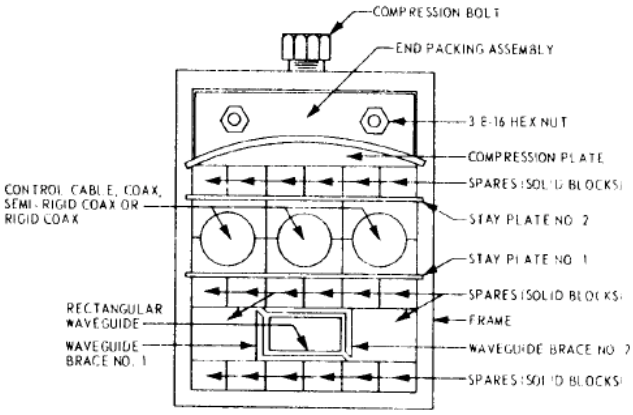
Continued on next page

Roxtec (cont'd)



MCT for Waveguide or Rigid Coax Lines

According to Section 5-2.5.5 of the *Navy Installation and Maintenance Book (NIMB), Installation Standards*, "multi-cable transit device can be used for passing waveguide and/or rigid coaxial lines through watertight decks or bulkheads with minor modifications . . . ." The following figure "identifies components of an assembled multi-cable transit device modified to accept rectangular waveguide and rigid coaxial transmission lines":



Note: *Multi-Cable Transit device use on weather decks is not authorized per DOD-STD-2003*.

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Practice Exercise

Exercise Instructions

Use this exercise to check your comprehension of the lesson material. Read each question and write the answers in the spaces provided. Check your answers in the Feedback section following the exercise.

Exercise Questions

1. As you go through the DOD-STD-2003 (NAVY) directive, you'll note that the document deals extensively with devices known as "_____."

2. Multi-Cable Transit device use on weather decks is not authorized per _____.

Feedback

Exercise Question Answers

Compare your answers to the ones below.

Question	Answer	Reference page
1.	multiple cable penetrators	3-4
2.	DOD-STD-2003	3-7

LESSON 4

HOW TO TRACE POINT-TO-POINT CONNECTIONS THROUGH MULTIPLE COMPARTMENTS

Overview

Introduction

There are many times when being able to troubleshoot and repair the electronic equipment is not enough to fix the electronic system. As an Electronics Technician, you must be able to also trace wires and cables through multiple compartments. This requirement involves the ability to read wiring diagrams, blueprints, and physically tracing wiring and cable connections.

All electronic and electrical wiring and cabling is installed with cable, and connector destination tags. This lesson will provide training on interpreting and translating these tags to enable you to trace point-to-point connections.

Lesson Objectives

DEMONSTRATE how to trace point-to-point cable/wire connections through multiple compartments.

- **IDENTIFY** the proper cable tag specifications.
- **IDENTIFY** the proper connector destination tags.

References

The following references were used for this lesson:

- *Electronics Manual*, COMDTINST M10550.25 (series)
- NAVSEA SE000-00-EIM-110 (0967-LP-000-0110)
- NAVSEA 0967-LPP-000-0140

Cable Tag Specifications

Introduction

All cables must be properly labeled with cable tags during installation. Cable tags consist of soft aluminum material and are secured to the cable with aluminum strips. Properly installed cable tags allow technicians to:

- Quickly identify an individual cable and its equipment association within a wiring bundle.
- Trace point-to point connections for troubleshooting and cable replacement.

Placement

Cable identification tags shall be installed:

- On all permanently installed cables
- As close as practicable to each point of termination
- On both sides of decks and bulkheads
- No more than 50 feet apart

The cable tags shall always be positioned so that they can easily be read without disturbing equipment circuitry.

Exceptions

The following are exceptions to the placement rules above:

- Only one tag is required when cables within a space are direct and are traceable, e.g., vertical run between decks.
- Only one tag is required within a space where the trace can easily be viewed.
- Additional tags are required when cables run through congested areas.

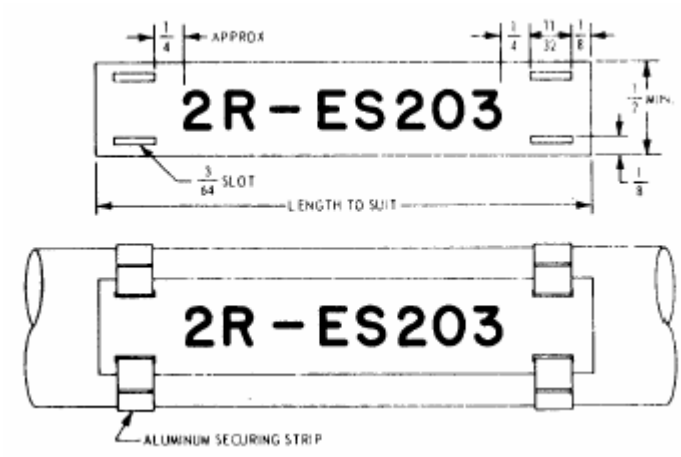
Continued on next page

Cable Tag Specifications (Continued)

Identification and Marking

Cable tags consist of a series of letters and numbers separated by a dash. Reading from left to right, the letters and numbers are grouped as follows:

- The first number represents the identical system number
- The second letter is the cable segregation marking
- The center markings indicate the system designation marking
- The third group of numbers indicate the system cable number



Identical System Number

2R-ES203

This number is used in cases where there are two or more identical electronic systems. In the example above, the number “2” represents the second system. When there is only one system, this identical system number is not required.

Continued on next page

Cable Tag Specifications (Continued)

Cable Segregation Marking

2R-ES203

The letter “R” is used to identify all cables used for electronics equipment interconnection service. The second letter (if any) identifies the class of the cable. The example above is a passive cable (having no second letter). The chart below provides the classifications:

Classification	Marking
Active cables	“A”
Susceptible cables	“S”
Passive cables	No marking

System Designation Marking

2R-ES203

This set of letters indicates what type of system the cable is used for. The example above represents a surface search radar and because of the identical system number “2,” this cable tag is for the second search radar. The chart below provides a few of the most typical system designations. For a complete list, refer to Cable Function Markings in NAVSEA 0967-LPP-000-0140.

System	Marking
Radar remote indicators	ER
Surface search radar	ES
Radio receiver circuits	RR
Radio synchronization	RS
Radio transmitter control	RT
Radio teletype	RY
Radio navigation	RN

System Cable Number

2R-ES203

This number indicates the number of a cable in a particular system. In the example above, this tag number would be for cable 203.

Connector Destination Tags

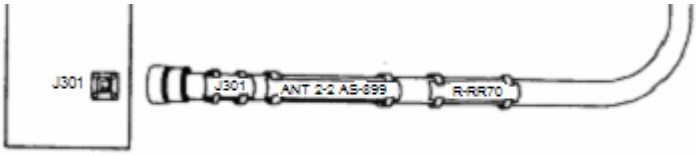
Introduction

Electronic equipment/system cables that terminate in a connector shall have a tag placed on the cable next to the connector. The tag shall designate the jack number to which the connector is attached.

In the example above, the first tag indicates that this cable is connected to J602. The second tag (R-RR69) is the normal cable tag.

Antenna Connections

When a cable is connected to an antenna, the antenna number and type shall be indicated on a tag located at the equipment end of the cable.



In the example above, the center tag is showing “ANT” and the number “2-2 AS-899.” This tag is located at the equipment end of the cable. The first tag is the connector tag (J301) and the third tag is the normal cable tag (R-RR70).

Continued on next page

Connector Destination Tags (Continued)

Conductor Tags

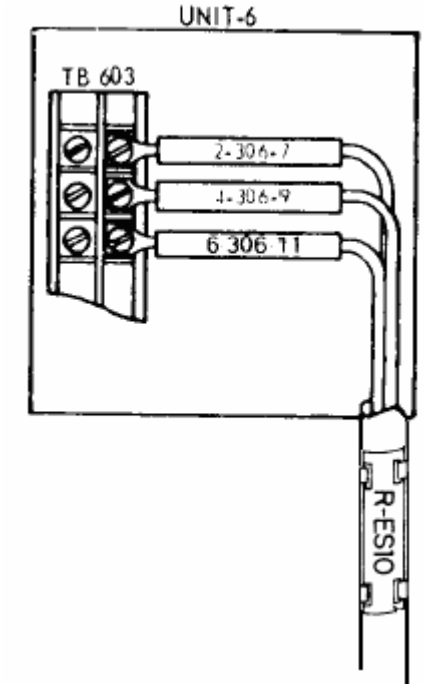
When conductors are connected to a terminal board they should be properly labeled with a conductor tag. Conductor tags can also be referred to as wire markings. These tags are made from flexible vinyl sleeving, either clear or white opaque, and of a selected size to properly fit the wire being marked. Conductor tags shall be marked with the following information:

- The terminal to which the conductor will be connected
- The unit and terminal board to which the conductor is connected on the opposite end
- The terminal to which the connector is connected to on the opposite end

NOTE

A spare conductor shall have "Spare" written on the conductor tag.

Diagram 1

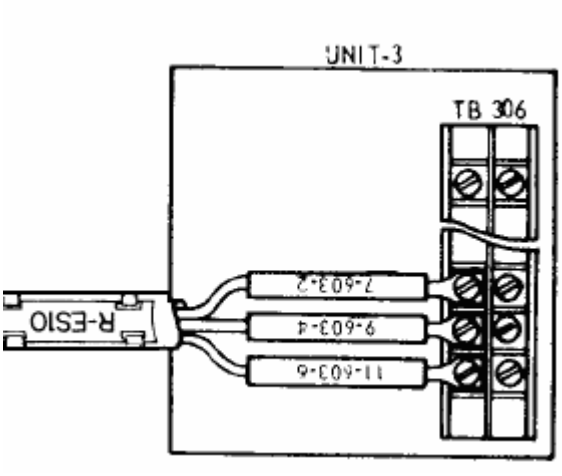


In the diagram above, the conductor tag labeled 2-306-7 is connected to terminal number 2 of TB 603, unit 6. The second and third numbers (306-7) identify that the wire is going to and connected to unit 3, TB 306, terminal number 7. See Diagram 2.

Continued on next page

Connector Destination Tags (Continued)

Diagram 2



In the diagram above, the top wire's conductor tag labeled 7-603-2 is connected to terminal number 7 of TB 306, unit 3. The second and third numbers (603-2) identify that the wire is going to and connected to unit 6, TB 603, terminal number 2.

Summary

Interpreting cable and connector tags and knowing the specifications on where they are installed will enable you to trace cables and wires from point-to-point through shipboard and station compartments.

Trace Point-to-Point Connections

Procedure

Perform the procedure below to trace point-to point connections through multiple compartments.

Step	Action
1.	Check with your supervisor to determine: • The type of electrical or electronic system • The type of wiring/cable within the system that requires tracing • The location of the wire/cable run (get a general idea of the start and end points of the wire/cable run)
2.	Gather any available blueprints or diagrams (these will assist you in determining feed-thru and bulkhead connections).
3.	Determine your starting point.
4.	Read the wire/cable and connector tags.
5.	Follow the wire/cable run by continuing to read and interpret the tags from one point to another.

Practice Exercise

Exercise Instructions

This exercise is meant to check your comprehension of the material covered in this lesson. Read each question and write the answers in the spaces provided. Check your answers in the Feedback section following the exercise. If you are having difficulty understanding a section, go through it again or ask someone for help.

Exercise Questions

1. What are cable tags made of?_____

2. How do you determine which cable to trace when going through a bulkhead?_____

3. What is the identical system number used for?_____

   _____

4. For the tag number R-RT12, what does the RT stand for?

   _____

5. What three pieces of information can be obtained from a conductor tag?

   a. _____

   b. _____

   c. _____

Continued on next page

Feedback

Exercise Question Answers

Compare your answers to the following:

Question	Answer	Reference page
1	Soft aluminum	4-2
2	Identification tags must be on both sides of the bulkhead	4-2
3	To identify two or more identical electronic systems	4-3
4	Radio transmitter control	4-4
5	Terminal the conductor is connected to, unit and terminal board connected to on opposite end, terminal connected to on opposite end	4-6

LESSON 5

HOW TO EVALUATE MULTICONDUCTOR, COAXIAL, AND HELIAX® CABLE

Overview

Introduction

You are familiar with coaxial and multiple-conductor cables through previous lessons and job tasks. HELIAX® is the brand name given to a type of coaxial cable manufactured by the Andrew® Corporation. All such coaxial cables are evaluated in similar fashion and therefore EPQs 5.D.02, 5.D.04, and 5.D.07 are addressed by this single lesson.

Lesson Objectives

Given standard, multiconductor, or HELIAX® coaxial cable, EVALUATE the cable in accordance with the Electronics Manual, COMDTINST M10550.25 (series); Navy Electronics Installation and Maintenance Book, Installation Standards, SE000-00-EIM-110; and manufacturer's guidelines.

References

The following references were used for this lesson:

- Electronics Manual, COMDTINST M10550.25 (series)
- Navy Electronics Installation and Maintenance Book, Installation Standards, SE000-00-EIM-110

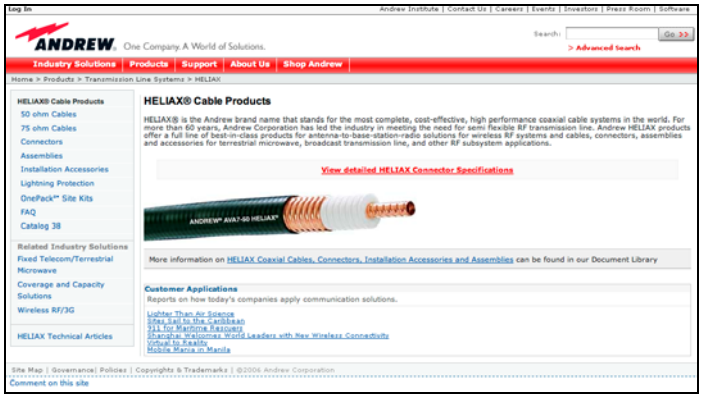
  Note: *It would be helpful for you to download this pub for review and reference during the lesson and while you are completing the quals performance. You can use this link through ESD Portsmouth:*

  http://cgweb.lant.uscg.mil/ESDPORTSMOUTH/NIMB.PDF

- Andrew® Corporation online web pages

  Note: *You are encouraged to visit the Andrew® website and familiarize yourself with the information and materials available to you regarding their particular brand of coax cable:*

  http://www.andrew.com/products/trans_line/heliax/default.aspx

- 

Evaluating Coaxial Cabling

General Inspection Requirements

Refer to *Navy Electronics Installation and Maintenance Book, Installation Standards*, SE000-00-EIM-110, which states in Section 2.8 that

> "Cables installed in shipboard electronic systems shall receive visual inspections, continuity checks and insulation resistance tests prior to energizing of equipment. Coaxial cables shall, in addition to the above, be tested for attenuation and voltage standing wave ratio (VSWR). This requirement may be relaxed for certain types of coaxial cables when used for such purposes as video and audio circuits."

Visual Inspection (EIM-110 2-8.1)

Cables shall be visually inspected for signs of physical damage and dampness prior to and after installation is completed. Cable showing signs of physical damage shall not be installed.

- Any indication that the cable has been subjected to excessive heat, damaged by heavy or sharp objects, or permanently twisted or kinked shall be justification for replacement of cable.
- Coaxial cable that has had the dielectric deformed or changed by any condition shall be replaced.
- Coaxial cables showing any signs of deformity, such as kinks, flatness, twists, split jackets or indentations shall be rejected. in those cases where possible damage of any type is apparent or suspected.
- The Installing Activity shall, at the time of visual inspection, determine what caused the cable damage and take the necessary corrective action prior to replacement.

Repair or Replace Damaged Cable?

Flexible and semi-rigid coaxial cables that have had their jackets damaged during or after installation shall be replaced where practicable.

- The cable jacket may be repaired if cable replacement is cost prohibitive or replacement time would delay ship departure.
- Coaxial cables that have a damaged shield as well as a damaged jacket shall be replaced and not repaired.
- Authorized approval shall be obtained prior to repairing of coaxial cable jackets.

Note: *You should refer to Section 2-18.2.1 of EIM-110 to find correct procedures for repair of coaxial cables.*

Continued on next page

Continuity Checks

(EIM-110 2-8.2)

Continuity checks shall be made on all conductors in all cables after installation is completed, including the attachment of connectors and/or terminal lugs.

- This is to certify that there are no open or shorted conductors inside the cable sheath and that the connectors are correctly terminated and identified.

Insulation Resistance Tests for Coaxial Cables

(EIM-110 2-8.3.3)

Insulation resistance tests shall be made on coaxial cables prior to installation and upon completion of installation.

- The tests conducted after completion of installation shall include the installed connectors *but with the cables disconnected from the equipment*.
- The 500-volt megohmeter used for these tests shall have a resistance range capable of accurately indicating the values required by this test.

The following table shows the acceptable insulation resistance value for various types of coax cable. *Cables not meeting the minimum insulation resistance values shall be replaced*.

Coax cable with…	**Length (feet)**	**Insulation resistance in megohms (To equal or exceed)**
Polyethylene or polytetrafluorethylene (Teflon) dielectric	100 (or less)	40,000
	200	20,000
	500	8,000
	1,000	4,000
Synthetic rubber dielectric	Up to 1,000	1,000
Magnesium oxide dielectric	Up to 1,000	10,000
Dielectric material arranged in layers of conducting and nonconducting rubber	Up to 1,000	500

Continued on next page

Insulation Resistance Tests for Multiconductor Cables

(EIM-110 2-8.3.2)

Insulation resistance measurements for multiconductor cables with conductors of less than 1700 circular mil area in size:

- Shall be made between each conductor and all other conductors of the same cable, and between each conductor and ground.
- Include twisted pair, triads, shielded and unshielded, normally used in interior communications and instrumentation systems.
- Shall have a minimum resistance value of 50,000 ohms.

The following instructions for insulation testing are taken from the *Major MEGGER® Insulation Testers User Guide* by Avo International Limited:

Insulation Testing
After connecting the test leads to the instrument and carrying out the Preliminary Checks:

1) Set the selector switch to the required test voltage. Connect the test leads to the isolated circuit to be tested, as follows:-
   (a) For insulation tests to earth (ground):- Connect the '+'test lead to earth (ground) or the frame of the equipment,and the '-' lead to that part of the circuit to be tested.

   b) For insulation tests between wires:- Connect a lead to the core of each of the wires.

2) Press the 'Test' button and whilst keeping it pressed turn the generator handle (hand cranked models) at >180 rev/min.

3) The meter needle will indicate the value of insulation resistance on the 'MΩ' scale.

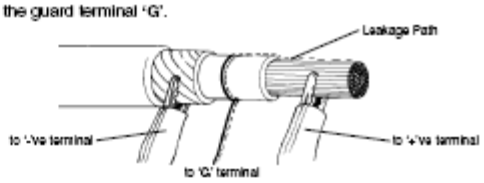
If a capacitive circuit is tested the needle will initially deflect towards zero and then gradually rise to its final steady value as the capacitance is charged up to the output voltage of the tester.

If several successive readings of '∞' are obtained, connect the two farthest ends of the test leads together and carry out a check on the leads. A zero reading should result which double checks that the leads are not disconnected or broken and therefore, the insulation resistance readings are correct.

Note:—With non-hand cranked models, the readings are taken after pressing the 'Test' button, there is no other control to operate.

Capacitive circuits automatically discharge through the tester when the 'Test' button is released. The approximate discharge voltage will be indicated on the voltage scale. Wait a few moments for the voltage to decay to zero before disconnecting the test leads.

Using the Guard terminal (G)
For basic insulation tests and where there is little possibility of surface leakage affecting the measurement, it is unnecessary to use the guard terminal. i.e. if the insulator is clean and there are unlikely to be any adverse current paths. However in cable testing, there may be surface leakage paths across the insulation between the bare cable and the external sheathing due to the presence of moisture or dirt. Where it is required to remove the effect of this leakage, particularly at high testing voltages, a bare wire may be bound tightly around the insulation and connected via the third test lead to the guard terminal 'G'.



The guard terminal is at the same potential as the negative terminal. Since the leakage resistance is effectively in parallel with the resistance to be measured, the use of the guard causes the current flowing through surface leakage to be diverted from the measuring circuit. The instrument therefore reads the leakage of the insulator, ignoring leakage across its surface.

Attenuation and Voltage Standing-Wave Ratio (VSWR) Measurements

(EIM-110 2-8.4)

Coaxial cables are classified as flexible and semirigid as to their construction and grouped according to their use and function in the radio frequency range. Attenuation and Voltage Standing-Wave Ratio (VSWR) tests shall be conducted on all flexible and semi-rigid coaxial cables.

- Test readings shall not exceed those specified in MIL-C-17 or by the cable manufacturer for a specified cable.
- NAVSEA SE000-00-EIM-130 may be used for test methods and guidance for testing of coaxial cables.

Pressurization and Dehydrators

(EIM-110 2-18.1 and 5.2.6.6.4.16)

Semi-rigid coaxial cables may be classed in two categories in reference to dielectric types:

1. Solid or foam dielectric cables that do not require pressurization.
2. Semi-air dielectric type that requires dry air pressurization.

For the latter type of hollow, pressure-type coaxial cables (employed in shipboard and shore station equipment), there is usually a dehydrator installed to maintain a constant pressure of dry air on the line, thus keeping out moisture.

- These dehydrators consist of an air compressor and a drying system whereby dry air is furnished under pressure to the line.
- An indicator is provided to warn of the presence of moisture.
- Constant vigilance must be kept to insure that the line is tight; furthermore, the proper functioning of the dehydrator must be checked regularly.

If there are any leaks or if the air is not being properly dried, moisture will form in the line and a great deal of trouble will be encountered in drying it again.

- If a line of this type will not hold pressure, all joints should be checked with a soap solution.
- The presence of bubbles will indicate a leak at this point, which should be repaired immediately.

Continued on next page

Moisture Absorption and Damp Cable Repair

(EIM-110 2-8.3.4)

Cables that have been subjected to dampness shall, prior to installation, receive an insulation resistance test as noted previously. Cables that cannot be brought to the minimum acceptable insulation resistance values shall be rejected.

For cables that have an unsatisfactory insulation resistance value due to moisture absorption, the Installing Activity may either replace the cable or take corrective action similar to the following methods.

a. If it is determined that the moisture penetration is confined to the cable ends, a length not greater than four feet may be cut from each end and a new measurement of insulation resistance shall be made.
    - If this method does not raise the insulation resistance to the acceptable value, but does show a definite improvement, proceed to the following method.

b. Moisture intrusion localized at the cable ends can usually be driven out by passing a current not greater than that for which the cable is rated, through the cable for a few hours.
    - Check for temperature rise in the cable sheath, and after approximately four hours of treatment, run another insulation test.
    - If the cable shows a marked improvement continue the current treatment until the cable meets the required insulation resistance value.
    - If no improvement is shown after four hours of treatment, the cable shall be replaced.

Weather-Proofing

(EIM-110 2-20.3)

Deterioration of coaxial connectors due to the corrosive action resulting from moisture, salt, and stack gasses is a serious problem aboard ships.

Weatherproofed connections shall be checked at least monthly for signs of deterioration.

At the first signs of deterioration, the old weatherproofing shall be removed, the connectors checked for damage and replaced if necessary.

The sealing area should be thoroughly cleaned and new weatherproofing applied by one of the methods of EIM-110 2-20.3.

Rigid Coaxial Transmission Line Inspection

(EIM-110 5-4.10 and 5-2.10)

The guidelines listed in EIM-110 5-2.10 for Quality Control inspections of waveguides shall apply to rigid coaxial transmission lines.

Practice Exercise

Exercise Instructions

Use this exercise to check your comprehension of the lesson material. Read each question and write the answers in the spaces provided. Check your answers in the Feedback section following the exercise.

Exercise Questions

1. You should refer to Section 2-18.2.1 of _____ to find correct procedures for repair of coaxial cables.

2. Coaxial cables that have a damaged shield as well as a damaged jacket shall be _____ and not _____.

3. Insulation resistance tests shall be made on coaxial cables _____ and upon completion of installation.

4. Attenuation and _____ tests shall be conducted on all flexible and semi-rigid coaxial cables.

5. NAVSEA SE000-00-_____ may be used for test methods and guidance for testing of coaxial cables.

6. The guidelines listed in _____ Section 5-2.10 for Quality Control inspections of waveguides shall apply to rigid coaxial transmission lines.

Feedback

Exercise Question Answers

Compare your answers to the ones below.

Question	Answer	Reference page
1.	EIM-110	5-2
2.	replaced, repaired	5-2
3.	prior to installation	5-3
4.	Voltage Standing-Wave Ratio (VSWR)	5-4
5.	EIM-130	5-4
6.	EIM-110	5-6

LESSON 6

HOW TO INSTALL HELIAX® CABLE CONNECTORS

Overview

Introduction

HELIAX® is the brand name given to a type of high-performance coaxial cable manufactured by the Andrew® Corporation, which also supplies various versions of HELIAX®-compatible cable connectors.

Virtually all of the information and guidance you need to have to install HELIAX® cable connectors is supplied by the printed instructions included with the cable connectors themselves or though the Andrew® Corporation website.

http://www.andrew.com/products/trans_line/heliax/default.aspx

You are strongly encouraged to visit the Andrew website and familiarize yourself with the information and materials available to you.

Lesson Objectives

Given HELIAX® cable, appropriate HELIAX®-compatible cable connectors, and manufacturer's instructions for cable preparation and installation, **INSTALL** the connectors in accordance with the manufacturer's guidelines..

References

The following references were used for this lesson:

- Andrew® Corporation online web pages through http://www.andrew.com/
- *HELIAX® Connector Installation Tips and Techniques*, Andrew® Corporation publication SP50423, 12 August 2004

Installing HELIAX® Cable Connectors

Printed Instructions

Andrew® Corporation includes specific installation instructions with each HELIAX® cable connector package.

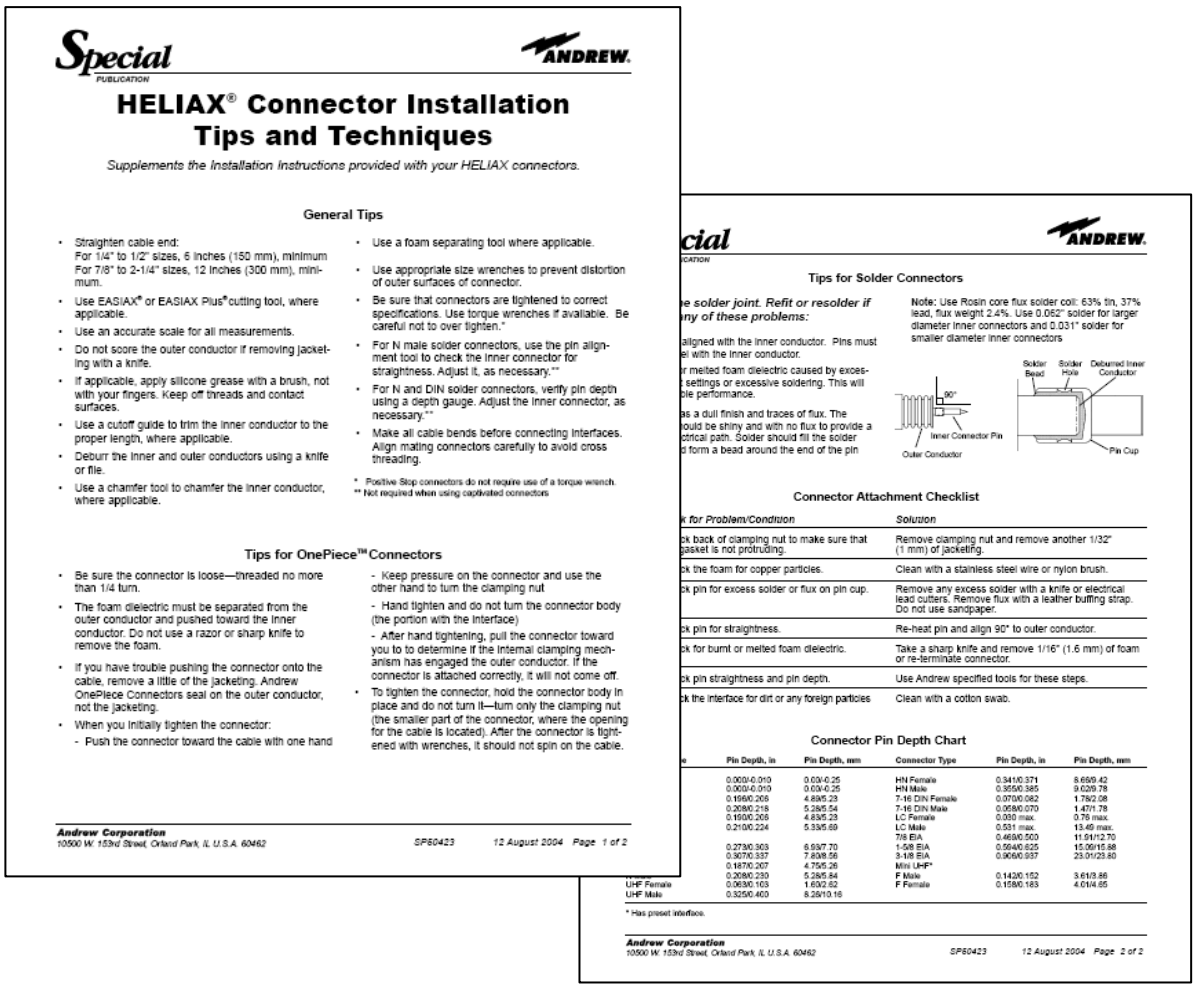
Supplemental Instructions

The following pub supplements the installation instructions provided with you connectors:

HELIAX® Connector Installation Tips and Techniques, Andrew® Corporation publication SP50423, 12 August 2004

This .pdf document may be downloaded through the following link:

www.andrew.com/search/BN_50423.aspx



Special PUBLICATION — ANDREW.

HELIAX® Connector Installation Tips and Techniques

Supplements the Installation Instructions provided with your HELIAX connectors.

General Tips

- Straighten cable end:
  For 1/4" to 1/2" sizes, 6 inches (150 mm), minimum
  For 7/8" to 2-1/4" sizes, 12 inches (300 mm), minimum.
- Use EASIAX® or EASIAX Plus® cutting tool, where applicable.
- Use an accurate scale for all measurements.
- Do not score the outer conductor if removing jacketing with a knife.
- If applicable, apply silicone grease with a brush, not with your fingers. Keep off threads and contact surfaces.
- Use a cutoff guide to trim the inner conductor to the proper length, where applicable.
- Deburr the inner and outer conductors using a knife or file.
- Use a chamfer tool to chamfer the inner conductor, where applicable.
- Use a foam separating tool where applicable.
- Use appropriate size wrenches to prevent distortion of outer surfaces of connector.
- Be sure that connectors are tightened to correct specifications. Use torque wrenches if available. Be careful not to over tighten.*
- For N male solder connectors, use the pin alignment tool to check the inner connector for straightness. Adjust it, as necessary.**
- For N and DIN solder connectors, verify pin depth using a depth gauge. Adjust the inner connector, as necessary.**
- Make all cable bends before connecting interfaces. Align mating connectors carefully to avoid cross threading.

* Positive Stop connectors do not require use of a torque wrench.
** Not required when using captivated connectors

Tips for OnePiece™ Connectors

- Be sure the connector is loose—threaded no more than 1/4 turn.
- The foam dielectric must be separated from the outer conductor and pushed toward the inner conductor. Do not use a razor or sharp knife to remove the foam.
- If you have trouble pushing the connector onto the cable, remove a little of the jacketing. Andrew OnePiece Connectors seal on the outer conductor, not the jacketing.
- When you initially tighten the connector:
  - Push the connector toward the cable with one hand
  - Keep pressure on the connector and use the other hand to turn the clamping nut
  - Hand tighten and do not turn the connector body (the portion with the interface)
  - After hand tightening, pull the connector toward you to to determine if the internal clamping mechanism has engaged the outer conductor. If the connector is attached correctly, it will not come off.
- To tighten the connector, hold the connector body in place and do not turn it—turn only the clamping nut (the smaller part of the connector, where the opening for the cable is located). After the connector is tightened with wrenches, it should not spin on the cable.

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Tips for Solder Connectors

e solder joint. Refit or resolder if ny of these problems:

ailigned with the inner conductor. Pins must el with the inner conductor.

r melted foam dielectric caused by exces- settings or excessive soldering. This will ble performance.

s a dull finish and traces of flux. The ould be shiny and with no flux to provide a ctrical path. Solder should fill the solder d form a bead around the end of the pin

Note: Use Rosin core flux solder coil: 63% tin, 37% lead, flux weight 2.4%. Use 0.062" solder for larger diameter inner connectors and 0.031" solder for smaller diameter inner connectors

Connector Attachment Checklist

k for Problem/Condition	Solution
ck back of clamping nut to make sure that asket is not protruding.	Remove clamping nut and remove another 1/32" (1 mm) of jacketing.
ck the foam for copper particles.	Clean with a stainless steel wire or nylon brush.
ck pin for excess solder or flux on pin cup.	Remove any excess solder with a knife or electrical lead cutters. Remove flux with a leather buffing strap. Do not use sandpaper.
ck pin for straightness.	Re-heat pin and align 90° to outer conductor.
ck for burnt or melted foam dielectric.	Take a sharp knife and remove 1/16" (1.6 mm) of foam or re-terminate connector.
ck pin straightness and pin depth.	Use Andrew specified tools for these steps.
ck the interface for dirt or any foreign particles	Clean with a cotton swab.

Connector Pin Depth Chart

e	Pin Depth, in	Pin Depth, mm	Connector Type	Pin Depth, in	Pin Depth, mm
	0.000/-0.010	0.03/-0.25	HN Female	0.341/0.371	8.66/9.42
	0.000/-0.010	0.03/-0.25	HN Male	0.365/0.385	9.02/9.78
	0.196/0.206	4.89/5.23	7-16 DIN Female	0.070/0.082	1.78/2.08
	0.208/0.218	5.28/5.54	7-16 DIN Male	0.058/0.070	1.47/1.78
	0.190/0.206	4.83/5.23	LC Female	0.000 max.	0.76 max.
	0.210/0.224	5.33/5.69	LC Male	0.531 max.	13.49 max.
			7/8 EIA	0.469/0.500	11.91/12.70
	0.273/0.303	6.93/7.70	1-5/8 EIA	0.594/0.625	15.09/15.88
	0.307/0.337	7.80/8.56	3-1/8 EIA	0.906/0.937	23.01/23.80
	0.187/0.207	4.75/5.26	Mini UHF*		
	0.208/0.230	5.28/5.84	F Male	0.142/0.152	3.61/3.86
UHF Female	0.063/0.103	1.60/2.62	F Female	0.158/0.183	4.01/4.65
UHF Male	0.325/0.400	8.26/10.16			

* Has preset interface.

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Continued on next page

Video Instructions

Andrew® Corporation also provides instructional videos on installation of connectors belonging to their OnePiece™ and Positive Stop™ connector families. To view these videos, access the Andrew® Corporation "Connectors" webpage at

http://www.andrew.com/products/trans_line/heliax/connectors.aspx

and select the appropriate video to watch:

Continued on next page

Installation Tools

Andrew® Corporation offers specialized tools to facilitate HELIAX® connector installations. Check with your supervisor regarding procurement ***if*** your unit does not already have them and ***if*** it would be advantageous to have them on hand.

- www.andrew.com/search/BN_PA-100414.2-EN.aspx
- www.andrew.com/search/BN_237704.aspx

ANDREW

Andrew Installation Tools

The first step in quality installation

PRODUCT SPECIFICATION

Installation Tools from Andrew deliver speedy, precise, and consistent results each and every time.

To optimize the quality of HELIAX® transmission line used in wireless systems, installation specialists rely on tools that provide speed, accuracy, and consistency.

Cable installers and system designers use Andrew Installation Tools to reduce cable preparation time and expense while improving overall system performance. The first step in a quality installation is precise cable preparation. Every cut by every technician is the same, ensuring consistent electrical performance for your system.

Andrew Installation Tools include:

- EASIAX Plus® Automated Preparation Tools
- EASIAX® Cable PreparationTools
- CPTV2 Series Manual Preparation Tools
- Foam Separation Tools
- Torque Wrenches
- Ground Kit Preparation Tools
- SnapStak Hanger Tools

EASIAX Plus® Automated Preparation Tools, fit to any standard power drill, remove the cable jacket, outer conductor and foam, then cut back and chamfer the inner conductor to the correct dimensions for connector attachment—in less than 15 seconds.

EASIAX® Cable Preparation Tools, made exclusively for HELIAX Coaxial Cable, make a clean and precise cut at the optimized spot on the corrugation at the exact distance required for easy connector attachment. The clean cut makes flaring easier than ever and the precise blade depth makes it impossible to cut the inner conductor.

CPTV2 Series Manual Preparation Tools remove the jacketing, cut through the outer conductor and foam, then cut through the inner conductor—all in a matter of seconds.

One Company. A World of Solutions.

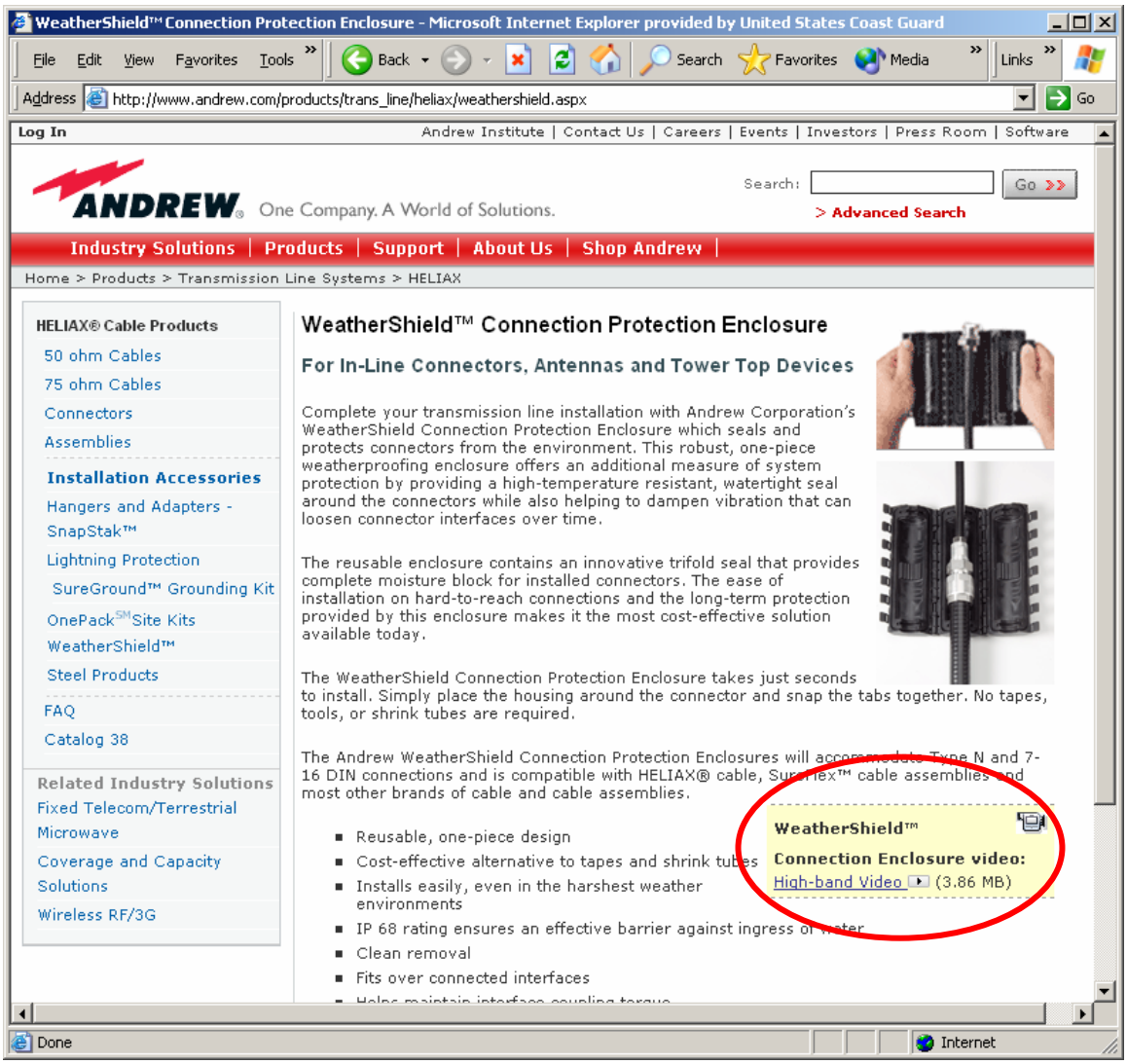
Continued on next page

Weather-proofing

If it's necessary to weatherproof the HELIAX® cable connection, Andrew® Corporation offers their WeatherShield™ Connection Protection Enclosure. Refer to:

http://www.andrew.com/products/trans_line/heliax/weathershield.aspx

Note that there is a video explaining the installation process.



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APPENDIX A

PAMPHLET REVIEW QUIZ

1. Various groups approve and fund field changes. Those groups include:

   _____, _____, and _____.

2. Coast Guard field changes are issued by _____ or _____.

3. A complete Field Change package consists of the Field Change Bulletin and a _____.

4. Surface search radar system cables have a marking of _____.

5. Radio navigation system cables have a marking of_____.

6. A spare conductor shall have "_____" written on the conductor tag.

7. When should cables installed in shipboard electronic systems receive visual inspections, continuity checks, and insulation resistance tests?

8. Cables not meeting the minimum insulation resistance values shall be _____.

9. Coax cable with polyethylene or polytetrafluorethylene (Teflon) dielectric and a length of 100 feet (or less) shall have an insulation resistance greater than or equal to _____ megohms.

10. Semi-rigid coaxial cables may be classed in two categories in reference to dielectric types: Solid or foam dielectric cables that do not require pressurization or _____.

11. Deterioration of coaxial connectors due to the corrosive action resulting from moisture, salt, and stack gasses is a serious problem where? _____

12. **True or False**: Andrew® Corporation includes specific installation instructions with each HELIAX® cable connector package.

APPENDIX B

PAMPHLET REVIEW QUIZ – ANSWER KEY

Question	Answer	Reference Page
1.	Coast Guard, Navy, commercial	1-2
2.	CG-643, SMEF	1-2
3.	Field Change Parts Kit	1-4
4.	ES	4-4
5.	RN	4-4
6.	Spare	4-6
7.	Prior to energizing of equipment	5-2
8.	replaced	5-3
9.	40,000	5-3
10.	Semi-air dielectric type that requires dry air pressurization	5-5
11.	Aboard ships	5-6
12.	True	6-2

APPENDIX C

GLOSSARY

Alteration	All authorized equipment alterations are documented by field changes. In urgent situations, such as safety hazards, an Alteration Distribution (ALDIST) or SMEF advisory for SMEF equipment may authorize the equipment alteration. It will then be confirmed with a field change.
CG-643	Systems Support
EIB	Electronics Installation Bulletin
EIMB	Electronics Installation and Maintenance Books
Electronics Installation and Maintenance Books	Published by NAVSEA to provide installation and maintenance information for naval electronic equipment.
Electronics Installation Bulletin	List of other electronics bulletins that have been published throughout the year.
Emergency Alteration	Operational requirements may necessitate emergency alterations to the equipment. Under such conditions the change to the equipment shall be reported immediately.
Equipment Systems Information Bulletin	A list of field changes to Navy equipment or commercial equipment will be published periodically in the ESIB. The list appearing in the ESIB is a management aid. Units having the equipment appearing in the ESIB need authorization from the CG-643 through the chain of command before installing any field change. The ESIB is an informal publication and is not an authority for official action.
ESIB	Equipment Systems Information Bulletin
Frequency Determining Circuits	No modification shall be accomplished which will affect the frequency determining circuits of any equipment without first receiving specific authority from the Commandant.
Maintenance Hint	A revised method for disassembly and re-assembly of a complicated piece of equipment and simplifies the procedure or decreases the time involved.

APPENDIX C

GLOSSARY (CONTINUED)

SMEF	Systems Management & Engineering Facility
Systems Management & Engineering Facility	Engineering facilities designated to provide support for specific systems.
Systems Support	The Systems Support Division (CG-643) provides policy, guidance and resources for life-cycle support of Coast Guard electronic systems and sensor equipment. They also provide limited technical oversight for design, procurement, integration and installation. Systems include, but are not limited to, direction finders, receivers, depth sounders, Navy Type Navy Owned (NTNO) equipment, LORAN-C-Differential GPS Short Range Aids to Navigation (SRAN) sensors, control, communications computer (C4) systems.

Request for Feedback – ET2 UNIT 4 (VOLUME 1): ELECTRONIC EQUIPMENT & CABLING

Suggestions and Corrections

Please note your suggestions, corrections, and comments below:

Page	Location on Page	What Correction is Needed

Your Comments

If you were writing this pamphlet, what improvements would you make? What was good about it? What did you not like about it? Please be specific in your comments/suggestions.

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