



ACCEPTABLE MEANS OF COMPLIANCE

AMC 001

AEROPLANE ELECTRICAL WIRING SYSTEM TRAINING PROGRAM

**(Adopted from EASA AMC 20-22 – Annex III to ED Decision
2008/007/R of 29/08/2008)**

FOREWORD

- This is the initial issue of the standalone AMC 001, dated August 2015. This standalone AMC is adopted from EASA AMC 20-22 and is based on NPA 10-2015.
- The AMC enters into force on the day it is published on the GCAA website.
- Full compliance with the AMC will be required by end of December 2016. Where compliance with some AMC's is not practical, organisations may propose alternative means of compliance which can serve the objective of the AMC for GCAA acceptance.

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1 PURPOSE

This AMC introduces the requirements for aircraft operators, maintenance organization, holders of Type Certificate TC and/or Supplementary Type Certificate (STC) Holders and personnel involved in maintenance, repairs and modification of aeroplane wiring and system.

This AMC provides acceptable means of compliance for developing an enhanced Electrical Wiring Interconnection System (EWIS) training programme. The information in this AMC is derived from the best practices training developed through extensive research. This AMC serves to officially endorse these best practices and to dispense this information industry-wide so that the benefits of this information can be effectively realised and for enhancing the level of awareness of the affected organisations and personnel. Following this AMC will result in a training programme that will improve the awareness and skill level of the aviation personnel in EWIS production, modification, maintenance, inspection, alterations and repair. This AMC promotes a philosophy of training for all personnel who come into contact with aeroplane as part of their job and tailors the training for each workgroup to their particular needs.

2 OBJECTIVE

This AMC has been published to provide the approved organisations with acceptable means of compliance to comply with their training obligations as required in paragraphs 21.145 and 21.245 of CAR-21, 145.30 and 145.35 of CAR 145 and M.706 of CAR M with respect to EWIS.

To fully realise the objectives of this AMC, operators, holders of type certificates (TC), holders of supplemental type certificates (STC), maintenance organisations and persons performing modifications or repairs, will need to rethink their current approach to maintaining and modifying aeroplane wiring and systems. This may require more than simply updating maintenance manuals and work cards and enhancing training. Maintenance personnel need to be aware that aeroplane EWIS should be maintained with the same level of intensity as any other system in the aeroplane. They also need to recognise that visual inspection of wiring has inherent limitations. Small defects such as breached or cracked insulation, especially in small gage wire may not always be apparent. Therefore, effective wiring maintenance combines visual inspection techniques with improved wiring maintenance practices and training.

The objective of this EWIS training programme is to give operators, holders of TC, holders of STC, maintenance organisations and persons performing field approval modifications or repairs a model for the development of their own EWIS training programme. This will ensure that proper procedures, methods techniques, and practices are used when performing maintenance, preventive maintenance, inspection, alteration, and cleaning of EWIS.

The training syllabus and curriculum is mandatory for those personnel directly involved in the maintenance and inspection of EWIS, identified as Target Group 1 and 2, are in Appendix A and C to this AMC.

This AMC also provides guidance on the development of EWIS training programmes for personnel

who are not directly involved in the maintenance and inspection of EWIS. Although there is no direct regulatory requirement for EWIS training of these personnel, operators shall provide EWIS training for target Groups 3 and 4 and may choose to provide EWIS training for personnel identified as target Groups 5 through 8, as per Appendix B and C to this AMC.

It is believed that training personnel in these groups would greatly enhance awareness of the importance of EWIS safety in the overall safe operation of aeroplanes. Although these groups are not directly involved in the maintenance of EWIS, they have the potential to have an adverse impact on EWIS. This can occur through inadvertent contact with EWIS during aeroplane cleaning or when individuals perform unrelated maintenance that could impact the integrity of EWIS. Mechanics leaving drill shavings on wire bundles is one example of how this could occur. Some people prepare paperwork that guides mechanics, training this target group in EWIS should help to ensure that proper attention is paid to EWIS issues.

This programme was developed for eight different target groups and may be used for the minimum requirements for initial and recurrent training (see training matrix). Depending on the duties, some may fall into more than one target group and, therefore, must fulfil all objectives of the associated target groups. The target groups are:

- a) Qualified staff performing EWIS maintenance.

These staff members are personnel who perform wiring systems maintenance and their training is based on their job description and the work being done by them (e.g. avionics skilled workers or technicians cat B2).

- b) Qualified staff performing maintenance inspections on wiring systems.

These staff members are personnel who perform EWIS inspections (but not maintenance), and their training is based on their job description and the work being done by them (e.g. inspectors/technicians cat B2).

- c) Qualified staff performing electrical/avionic engineering on in-service aeroplane.

These staff members are personnel who are authorised to design EWIS installations, modifications and repairs (e.g. electric/avionic engineers).

- d) Qualified staff performing general maintenance/inspections not involving wire maintenance (LRU change is not considered wire maintenance).

These staff members are personnel who perform maintenance on aeroplane that may require removal/reconnection of electrical connective devices (e.g. inspectors/technicians cat A or B1).

- e) Qualified staff performing other engineering or planning work on in-service aeroplane.

These staff members are personnel who are authorised to design mechanical/structure systems installations, modifications and repairs, or personnel who are authorised to plan maintenance tasks.

- f) Other service staff with duties in proximity to EWIS.

These staff members are personnel whose duties would bring them into contact/view of aeroplane wiring systems. This would include, but not be limited to: Aeroplane cleaners, cargo loaders, fuelers, lavatory servicing personnel, de-icing personnel, push back personnel.

- g) Flight Deck Crew (E.g. Pilots, Flight Engineers).
- h) Cabin Crew.

3 APPLICABILITY

This AMC describes acceptable means, but not the only means, of compliance with the appropriate certification, maintenance and operations regulations.

The information in this AMC is based on lessons learned by foreign Aging Transport Systems Rulemaking Advisory Committee (ATSRAC) Harmonised Working Groups, regulatory authorities, manufacturers, airlines and repair stations. This AMC can be applied to any aeroplane training programme.

4 DEFINITIONS

Arc tracking: A phenomenon in which a conductive carbon path is formed across an insulating surface. This carbon path provides a short circuit path through which current can flow. Normally, a result of electrical arcing. Also referred to as "Carbon Arc Tracking", "Wet Arc Tracking", or "Dry Arc Tracking".

Combustible: For the purposes of this AMC, the term combustible refers to the ability of any solid, liquid or gaseous material to cause a fire to be sustained after removal of the ignition source. The term is used in place of inflammable/flammable. It should not be interpreted as identifying material that will burn when subjected to a continuous source of heat as occurs when a fire develops.

Contamination: For the purposes of this AMC, wiring contamination refers to either of the following:

- The presence of a foreign material that is likely to cause degradation of wiring.
- The presence of a foreign material that is capable of sustaining combustion after removal of ignition source.

Detailed Inspection (DET): An intensive examination of a specific item, installation, or assembly to detect damage, failure or irregularity. Available lighting is normally supplemented with a direct source of good lighting at an intensity deemed appropriate. Inspection aids such as mirrors, magnifying lenses or other means may be necessary. Surface cleaning and elaborate access procedures may be required.

Electrical Wiring Interconnection System (EWIS): See CS 25.1701.

Functional Failure: Failure of an item to perform its intended function within specified limits.

General Visual Inspection (GVI): A visual examination of an interior or exterior area, installation, or assembly to detect obvious damage, failure or irregularity. This level of inspection is made from within touching distance unless otherwise specified. A mirror may be necessary to enhance visual access to all exposed surfaces in the inspection area. This level of inspection is made under normally available lighting conditions such as daylight, hangar lighting, flashlight or droplight and may require removal or opening of access panels or doors. Stands, ladders or platforms may be required to gain proximity to the area being checked.

Lightning/High Intensity Radiated Field (L/HIRF) protection: The protection of aeroplane electrical systems and structure from induced voltages or currents by means of shielded wires, raceways, bonding jumpers, connectors, composite fairings with conductive mesh, static dischargers, and the inherent conductivity of the structure; may include aeroplane specific devices, e.g., RF Gaskets.

Maintenance: "maintenance means inspection, overhaul, repair, preservation, and the replacement of parts, and includes preventive maintenance.

Maintenance Significant Item (MSI): Items identified by the manufacturer whose failure:

- (1) Could affect safety (on ground or in flight).
- (2) Is undetectable during operations.
- (3) Could have significant operational impact.
- (4) Could have significant economic impact.

Needling: The puncturing of a wire's insulation to make contact with the core to test the continuity and presence of voltage in the wire segment.

Stand-alone General Visual Inspection (GVI): A GVI which is not performed as part of a zonal inspection. Even in cases where the interval coincides with the zonal inspection, the stand-alone GVI shall remain an independent step within the work card.

Structural Significant Item (SSI): Any detail, element or assembly that contributes significantly to carrying flight, ground, pressure, or control loads and whose failure could affect the structural integrity necessary for the safety of the aeroplane.

Swarf: A term used to describe the metal particles, generated from drilling and machining operations. Such particles may accumulate on and between wires within a wire bundle.

Zonal Inspection: A collective term comprising selected GVI and visual checks that are applied to each zone, defined by access and area, to check system and powerplant installations and structure for security and general condition.

5 BACKGROUND

Over the years there have been a number of in-flight smoke and fire events where contamination sustained and caused the fire to spread. Regulators and Accident Investigators have conducted aircraft inspections and found wiring contaminated with items such as dust, dirt, metal shavings, lavatory waste water, coffee, soft drinks, and napkins. In some cases, dust has been found completely covering wire bundles and the surrounding area.

Research has also demonstrated that wiring can be harmed by collateral damage when maintenance is being performed on other aircraft systems. For example, a person performing an inspection of an electrical power centre or avionics compartment may inadvertently cause damage to wiring in an adjacent area.

Aviation Accident Investigators have specifically cited the need for improved training of personnel to ensure adequate recognition and repair of potentially unsafe wiring conditions.

This AMC addresses only the training programme. It does not attempt to deal with the condition of the fleet's wiring, or develop performance tests for wiring.

This AMC captures, the aeroplane EWIS training programme developed by ATSRAC. This includes a training syllabus, curriculum, training target groups and a matrix outlining training for each training group.

6 ESSENTIAL ELEMENTS FOR A TRAINING PROGRAMME

a) Initial Training.

Initial training should be conducted for each designated work group. The initial training for each designated work group is outlined in EWIS Minimum Initial Training Programme - Appendix A and B. Curriculum and Lesson Plans for each dedicated module are included in Appendix C.

The most important criteria are to meet the objectives of the Lesson Plans – Appendix C (using classroom discussion, computer-based training or hands-on practical training).

Assessment or achieving the objectives should be at the discretion of the training organisation (such as written test, oral test or demonstration of skills).

Supporting documentation such as AMC is an integral part of training and should be used to support development of the Curriculum and Lesson Plans.

b) Refresher Training.

Refresher training should be conducted in a period not exceeding two years. It could consist of a review of previously covered material plus any new material or revisions to publications. Refresher training will follow the EWIS Minimum Initial Training Programme - Appendix A or B for that particular target group.

Appendix A – EWIS Minimum Initial Training Programme for Group 1 and 2

Target Group 1: Qualified staff performing EWIS maintenance (mandatory).

Target Group 2: Qualified staff performing maintenance inspections on EWIS (mandatory).

| TARGET GROUP | | 1 | 2 |
|--------------|--|---|---|
| A | <u>GENERAL ELECTRICAL WIRING INTERCONNECTION SYSTEM PRACTICES</u> | | |
| | Know or demonstrate safe handling of aeroplane electrical systems, line replaceable units (LRU), tooling, troubleshooting procedures, and electrical measurement. | | |
| 1 | Safety practices | X | X |
| 2 | Electrostatic discharge sensitive (ESDS) device handling and protection | X | X |
| 3 | Tools, special tools, and equipment | X | |
| 4 | Verifying calibration/certification of instruments, tools, and equipment | X | |
| 5 | Required wiring checks using the troubleshooting procedures and charts | X | |
| 6 | Measurement and troubleshooting using meters | X | |
| 7 | LRU replacement general practices | X | X |
| B | <u>WIRING PRACTICES DOCUMENTATION</u> | | |
| | Know or demonstrate the construction and navigation of the applicable aeroplane wiring system overhaul or practices manual. | | |
| 8 | Standard wiring practices manual structure/overview | X | X |
| 9 | Chapter cross-reference index | X | X |
| 10 | Important data and tables | X | X |
| 11 | Wiring diagram manuals | X | X |
| 12 | Other documentation as applicable | X | X |
| C | <u>INSPECTION</u> | | |
| | Know the different types of inspections, human factors in inspections, zonal areas and typical damages. | | |
| 13 | General visual inspection (GVI), detailed inspection (DET), special detailed inspection (SDI), and zonal inspection, and their criteria and standards | X | X |
| 14 | Human factors in inspection | | X |
| 15 | Zonal areas of inspection | | X |
| 16 | Wiring system damage | X | X |
| D | <u>HOUSEKEEPING</u> | | |
| | Know the contamination sources, materials, cleaning and protection procedures. | | |
| 17 | Aeroplane external contamination sources | X | X |
| 18 | Aeroplane internal contamination sources | X | X |
| 19 | Other contamination sources | X | X |

| | | | |
|----------|--|---|---|
| 20 | Contamination protection planning | X | |
| 21 | Protection during aeroplane maintenance and repair | X | |
| 22 | Cleaning processes | X | |
| E | | | |
| | <u>WIRE</u> | | |
| | Know or demonstrate the correct identification of different wire types, their inspection criteria and damage tolerance, repair and preventative maintenance procedures. | | |
| 23 | Wire identification, type and construction | X | X |
| 24 | Insulation qualities and damage limits | X | X |
| 25 | Inspection criteria and standards for wire and wire bundles | | X |
| 26 | Wire bundle installation practices | X | X |
| 27 | Typical damage and areas found (aeroplane specific) | X | X |
| 28 | Maintenance and repair procedures | X | X |
| 29 | Sleeving | X | X |
| 30 | Unused wires - termination and storage | X | X |
| 31 | Electrical bonding and grounds | X | X |
| F | | | |
| | <u>CONNECTIVE DEVICES</u> | - | - |
| | Know or demonstrate the procedures to identify, inspect, and find the correct repair for typical types of connective devices found on the applicable aeroplane. | | |
| 32 | General connector types and identification | X | X |
| 33 | Cautions and protections | X | X |
| 34 | Visual inspection procedures | X | X |
| 35 | Typical damage found | X | X |
| 36 | Repair procedures | X | X |
| G | | | |
| | <u>CONNECTIVE DEVICE REPAIR</u> | | |
| | Demonstrate the procedures for replacement of all parts of typical types of connectors found on the applicable aeroplane. | | |
| 37 | Circular connectors | X | |
| 38 | Rectangular connectors | X | |
| 39 | Terminal blocks - modular | X | |
| 40 | Terminal blocks - non-modular | X | |
| 41 | Grounding modules | X | |
| 42 | Pressure seals | X | |

APPENDIX B – EWIS MINIMUM INITIAL TRAINING PROGRAMME FOR GROUP 3 THROUGH 8

Target Group 3: Qualified staff performing electrical/avionic engineering on in-service aeroplane (mandatory).

Target Group 4: Qualified staff performing general maintenance/inspections not involving wire maintenance (LRU change is not considered wire maintenance) (mandatory).

Target Group 5: Qualified staff performing other engineering or planning work on in-service aeroplane

Target Group 6: Other service staff with duties in proximity to electrical wiring interconnection systems

Target Group 7: Flight Deck Crew

Target Group 8: Cabin Crew

| TARGET GROUPS | | 3 | 4 | 5 | 6 | 7 | 8 |
|---------------|--|---|---|---|-----------|-----------|-----------|
| A | <u>GENERAL ELECTRICAL WIRING INTERCONNECTION SYSTEM PRACTICES</u> | | | | | | |
| | Know or demonstrate the safe handling of aeroplane electrical systems, line replaceable units (LRU), tooling, troubleshooting procedures, and electrical measurement. | | | | | | |
| 1 | Safety practices | | X | | X | X | X |
| 2 | Electrostatic discharge sensitive (ESDS) device handling and protection | | X | | | | |
| 7 | LRU replacement general practices | | X | | | | |
| B | <u>WIRING PRACTICES DOCUMENTATION</u> | | | | | | |
| | Know or demonstrate the construction and navigation of the applicable aeroplane wiring system overhaul or practices manual. | | | | | | |
| 8 | Standard wiring practices manual structure/overview | X | | | | | |
| 9 | Chapter cross-reference index | X | | | | | |
| 10 | Important data and tables | X | | | | | |
| 11 | Wiring diagram manuals | X | | | | | |
| 12 | Other documentation as applicable | X | | | | | |
| C | <u>INSPECTION</u> | | | | | | |
| | Know the different types of inspections, human factors in inspections, zonal areas and typical damages. | | | | | | |
| 13 | General visual inspection (GVI), detailed inspection (DET), special detailed inspection (SDI), and zonal inspection, and their criteria and standards | | X | X | | | |
| 14 | Human factors in inspection | | | X | | | |
| 15 | Zonal areas of inspection | | | X | | | |
| 16 | Wiring system damage | | X | X | Low Level | Low Level | Low Level |
| D | <u>HOUSEKEEPING</u> | | | | | | |

| | | | | | | | |
|----------|--|---|--------|---|-----------|-----------|-----------|
| | Know the contamination sources, materials, cleaning and protection procedures. | | | | | | |
| 17 | Aeroplane external contamination sources | | X | | X | X | X |
| 18 | Aeroplane internal contamination sources | | X | | X | X | X |
| 19 | Other contamination sources | | X | | X | X | X |
| 20 | Contamination protection planning | X | X | X | | | |
| 21 | Protection during aeroplane maintenance and repair | X | X | X | | | |
| 22 | Cleaning processes | X | X | X | X | | |
| E | <u>WIRE</u> | | | | | | |
| | Know or demonstrate the correct identification of different wire types, their inspection criteria and damage tolerance, repair and preventative maintenance procedures. | | | | | | |
| 23 | Wire identification, type and construction | X | | | | | |
| 24 | Insulation qualities and damage limits | X | | | | | |
| 25 | Inspection criteria and standards of wire and wire bundles | X | | | | | |
| 26 | Wire bundle installation practices | X | | | | | |
| 27 | Typical damage and areas found (aeroplane specific) | X | X | X | Low Level | Low Level | Low Level |
| 28 | Maintenance and repair procedures | X | | | | | |
| 29 | Sleeving | X | | | | | |
| 30 | Unused wires - termination and storage | X | | | | | |
| 31 | Electrical bonding and grounds | X | X Bond | X | | | |
| F | <u>CONNECTIVE DEVICES</u> | | | | | | |
| | Know or demonstrate the procedures to identify, inspect, and find the correct repair for typical types of connective devices found on the applicable aeroplane. | | | | | | |
| 32 | General connector types and identification | X | | | | | |
| 33 | Cautions and protections | X | | | | | |
| 34 | Visual inspection procedures | X | | | | | |
| 35 | Typical damage found | X | | | | | |
| 36 | Repair procedures | X | | | | | |

Appendix C – Curriculum and Lessons Plan

Electrical Wiring Interconnection System Curriculum

1 OVERVIEW

This training is targeted at each person who performs aeroplane maintenance, inspections, alterations or repairs on EWIS and/or structure. After training, the person is able to properly evaluate the EWIS and effectively use the manufacturers Chapter 20 Wiring System overhaul manual for that aeroplane. The training programme must include: wiring system condition, applicable repair schemes, wiring modifications and ancillary repairs to wiring systems and components. All of the training components are integrated to maintain wiring system quality and airworthiness of the aeroplane.

2 OBJECTIVES

Depending on the modules taught, the person shows competency in the following skills:

- a) Know or demonstrate the safe handling of aeroplane electrical systems, Line Replaceable Units (LRU), tooling, troubleshooting procedures, and electrical measurement.
- b) Know or demonstrate the construction and navigation of the applicable aeroplane wiring system overhaul or wiring practices manual.
- c) Know the different types of inspections, human factors in inspections, zonal areas and typical damages.
- d) Know the contamination sources, materials, cleaning and protection procedures.
- e) Know or demonstrate the correct identification of different wire types, their inspection criteria, and damage tolerance, repair and preventative maintenance procedures.
- f) Know or demonstrate the procedures to identify, inspect and find the correct repair for typical types of connective devices found on the applicable aeroplane.
- g) Demonstrate the procedures for replacement of all parts of typical types of connective devices found on the applicable aeroplane.

3 SCOPE

The course is to be used by training providers for all maintenance persons at any stage in their careers. The person can be trained to the appropriate level using the applicable modules, depending on the person's experience, work assignment and operator's policy.

MODULE A – GENERAL ELECTRICAL WIRING INTERCONNECTION SYSTEM PRACTICES:

- (1) Safety practices
- (2) ESDS device handling and protection
- (3) Tools, special tools and equipment
- (4) Verify calibration/certification of instruments, tools, and equipment
- (5) Required wiring checks using the Troubleshooting Procedures and charts
- (6) Measurement and troubleshooting using meters
- (7) LRU replacement general practices

MODULE B – WIRING PRACTICES DOCUMENTATION:

- (1) Chapter 20 structure/overview
- (2) Chapter 20 cross-reference index
- (3) Chapter 20 important data and tables
- (4) Wiring Diagram Manual
- (5) Other documentation (as applicable)

MODULE C – INSPECTION:

- (1) Special inspections
- (2) Criteria and standards
- (3) Human factors in inspection
- (4) Zonal areas of inspection
- (5) Wiring system damage

MODULE D – HOUSEKEEPING:

- (1) Aeroplane external contamination sources
- (2) Aeroplane internal contamination sources
- (3) Other contamination sources
- (4) Contamination protection planning
- (5) Protection during aeroplane maintenance and repair
- (6) Cleaning processes

MODULE E – WIRE:

- (1) Identification, type and construction
- (2) Insulation qualities
- (3) Inspection criteria and standards of wire and wire bundles
- (4) Wire bundle installation practices
- (5) Typical damage and areas found (aeroplane specific)
- (6) Maintenance and repair procedures
- (7) Sleeving
- (8) Unused wires - termination and storage
- (9) Electrical bonding and grounds

MODULE F – CONNECTIVE DEVICES:

- (1) General types and identification
- (2) Cautions and protections
- (3) Visual inspection procedures
- (4) Typical damage found
- (5) Repair procedures

MODULE G – CONNECTIVE DEVICE REPAIR:

- (1) Circular connectors
- (2) Rectangular connectors
- (3) Terminal blocks - modular
- (4) Terminal blocks - non-modular
- (5) Grounding modules
- (6) Pressure seals

MODULE A: GENERAL ELECTRICAL WIRING INTERCONNECTION SYSTEM PRACTICE

1 OVERVIEW

Through Module A, the instructor lays the groundwork of safe, effective maintenance and repair of the aeroplane EWIS and LRU removal and replacement, including BITE test, without damage to the aeroplane or injury to the student.

The instructor may vary the depth and scope of the topics to be covered, depending on the type of aeroplane to be maintained and skills of the persons.

2 OBJECTIVES

After this module is complete, the student is able to demonstrate the following skills:

- a) Know the safety procedures of normal and non-normal maintenance procedures so that the person can protect himself/herself and the aeroplane.
- b) Recognise ESDS equipment and demonstrate standard anti-static procedures so that no damage occurs to that equipment.
- c) Demonstrate the correct use of hand tools including specialised and automated tools and equipment.
- d) Verify the calibration of electrical measuring instruments, tools and equipment so that correct maintenance procedures may be carried out.
- e) Demonstrate the process and procedures to successfully use the troubleshooting procedures and charts of current aeroplane faults and know re-occurring problems causing “No Fault Found” on removed LRU.
- f) Demonstrate the correct use of electrical meters for measuring voltage, current, resistance, continuity, insulation and short to ground.
- g) Know the removal and replacement techniques so that no damage will occur to the LRU or aeroplane connector.

3 STRATEGIES

Normal classroom lecture can be used for the majority of the training. The following strategies can be used to expedite learning and are recommended to the instructor:

| | |
|--|--------------------------|
| ESDS handling and protection | Multimedia/training aids |
| Calibration/certification of instruments, tools, and equipment | Company policy |
| Wiring checks using the Troubleshooting Procedures and | Aeroplane manuals charts |
| Measurement and troubleshooting using meters | Meters and circuits |
| LRU removal and replacement | Aeroplane manuals |

MODULE A – GENERAL ELECTRICAL WIRING INTERCONNECTION SYSTEM PRACTICES:

- 1 Safety Practices
 - a) Current is lethal - First aid
 - b) Applying power to the aeroplane
 - c) Isolating the circuit
 - d) Aeroplane warnings
 - e) Human factors
- 2 ESDS Device Handling and Protection
 - a) Sources of electrostatic discharge
 - b) Soft and hard failures
 - c) ESDS safety procedures
 - d) ESDS handling/packing procedures
- 3 Tools, Special Tools and Equipment
 - a) General hand tools
 - b) Specialised tools
 - c) Automated tools and equipment
- 4 Verify Calibration/Certification of Instruments, Tools and Equipment
 - a) Tools requiring certification
 - b) Determining certification requirements
 - c) Typical problems
- 5 Required Wiring Checks Using the Troubleshooting Procedures and charts
 - a) Troubleshooting procedures manual (all chapters)
 - b) Aeroplane Maintenance Manual/Illustrated Parts Catalogue
 - c) Wiring schematics/troubleshooting graphics
 - d) Wiring diagrams
 - e) The process of troubleshooting f. Testing of LRU connectors

- f) Troubleshooting exercises
 - g) Company “No Fault Found” policy and data
- 6 Measurement and Troubleshooting Using Meters
- a) Voltage, current and resistance
 - b) Continuity
 - c) Insulation
 - d) Short to ground
 - e) Loop impedance
- 7 LRU Replacement - General Practices
- a) Different retention devices
 - b) Certification considerations (e.g. CAT 2/CAT3 Landing)
 - c) LRU re-racking procedures
 - d) “No Fault Found” data (aeroplane specific)
 - e) Built-in test equipment (BITE)

MODULE B: WIRING PRACTICES DOCUMENTATION

1 OVERVIEW

Through Module B, the instructor lays the groundwork for safe, effective maintenance and repair of aeroplane EWIS. The intent of this module is to teach the person how to locate desired information in the Chapter 20 Wiring System overhaul manual, Wiring Diagram Manual and other applicable documentation. The instructor may vary the depth and scope of the topics to be covered, depending on the type of aeroplane to be maintained and skills of the persons.

2 OBJECTIVES

After this module is complete, the person is able to demonstrate the following skills:

- a) Know the applicable Sub-Chapters and Section to follow during normal and non-normal electrical maintenance procedures.
- b) Demonstrate the use of the Cross-Reference Index, Chapter Table of Contents, and Subject Tables of Contents so as to find specific material within each Sub-Chapter and Section.
- c) Demonstrate the use of the associated tables for replacement of wire, connective devices and contacts, and associated components, including approved replacements.
- d) Demonstrate the use of the Wiring Diagram Manual.
- e) Demonstrate the use of other documentation (as applicable).

3 STRATEGIES

Normal classroom lecture can be used for the majority of the training. The Chapter 20 Wiring Practices Manual, Wiring Diagram Manual, and other applicable documentation should be made available to the class so that hands-on exploration of the material can be achieved.

MODULE B - WIRING PRACTICES DOCUMENTATION:

- 1 Chapter 20 Structure/Overview
 - a) Table of contents
 - b) Sub-chapter titles
 - c) Section structure
 - d. General procedures

- 2 Chapter 20 Cross-Reference Index
 - a) Cross-reference index – Alphanumeric
 - b) Cross-reference index – Standard Part number
 - c) Cross-reference index – Suppliers
 - d) Equivalence tables – Std Part Numbers EN-ASN-NSA

- 3 Chapter 20 Important Data and Tables
 - a) Contact crimp tools, insertion/extraction tools
 - b) Wire Insulation removal tools
 - c) Electrical cable binding
 - d) Wire type codes and part numbers identification
 - e) Connective devices types and contacts
 - f) Terminal blocks and terminations
 - g) Terminal blocks modules, grounding modules and contacts
 - h) Cleaning procedures
 - i) Repair procedures

- 4 Wiring Diagram Manual (WDM)
 - a) Front matter
 - b) Diagrams
 - c) Charts
 - d) Lists

- 5 Other documentation (as applicable)

MODULE C: INSPECTION

1 OVERVIEW

Through Module C, the instructor lays the groundwork for safe, effective maintenance and repair of aeroplane wiring systems, by teaching the skills of inspection so as to identify wiring system damage. The instructor may vary the depth and scope of the topics to be covered, depending on the type of aeroplane to be maintained and skills of the persons.

2 OBJECTIVES

After this module is complete, the person is able to demonstrate the following skills:

- a) Know the different types of inspections: General Visual Inspection (GVI), Detailed Inspection (DET), Zonal Inspection and Enhanced Zonal Analysis Procedure (EZAP).
- b) Know the criteria and standards of inspection so that the person knows which tools are used to ensure inspection procedures and standards are achieved, which leads to all defects being found.
- c) Know the effects of fatigue and complacency during inspection and how to combat these effects (Human Factors).
- d) Know the specific zonal inspection requirements related to system affiliation and environmental conditions.
- e) Recognise typical wiring system damage, such as hot gas, fluid contamination, external mechanically induced damage, chafing, corrosion, signs of overheating of wire, wire bundles, connective and control device assemblies.

3 STRATEGIES

Normal classroom lecture can be used for the majority of the training. ATA 117 video and colour photos of actual wiring system damage could be used to show typical problems found on the aeroplane. Examples of discrepancies should be made available to the student. AMC 20-21, Programme to Enhance Aeroplane EWIS Maintenance is recommended as a source of typical aeroplane wiring installations and areas of concern.

MODULE C – INSPECTION

1. Special Inspections
 - a) General Visual Inspection (GVI)
 - b) Detailed Inspection (DET)
 - c) Zonal Inspection
 - d) Enhanced Zonal Analysis Procedure (EZAP)

2. Criteria and Standards
 - a) Tools
 - b) Criteria/standards
 - c) Procedures of inspection

3. Human Factors in Inspection
 - a) Fatigue
 - b) Complacency

4. Zonal Areas of Inspection
 - a) Zonal areas of inspection
 - b) Zonal inspection procedures and standards

5. Wiring System Damage
 - a) Swarf/FOD/metal shavings
 - b) External mechanically induced damage
 - c) Hot gas
 - d) Fluid contamination
 - e) Vibration/chafing
 - f) Corrosion
 - g) Signs of overheating

MODULE D: HOUSEKEEPING

1 OVERVIEW

Through Module D, the instructor lays the groundwork for safe, effective maintenance and repair of aeroplane EWIS, by teaching housekeeping strategies, so as to keep the EWIS free of contamination. The Instructor may vary the depth and scope of the topics to be covered, depending on the type of aeroplane to be maintained and skills of the persons.

2 OBJECTIVES

After this module is complete, the person is able to demonstrate the following skills:

- a) Recognise external contamination and other damage due to external environmental conditions.
- b) Know the aeroplane internal contamination sources so that inspection processes can be effectively carried out and contamination damage easily recognised.
- c) Recognise other possible contamination sources.
- d) Know the planning procedures to be followed, on EWIS areas in different parts of the aeroplane.
- e) Know the protection procedures and processes to protect the EWIS during maintenance and repair.
- f) Know the process of cleaning wiring systems during maintenance and repair.

3 STRATEGIES

Normal classroom lecture can be used for the majority of the training. ATA 117 video and colour photos of actual EWIS contamination could be used to show typical problems found on the aeroplane. Relevant Aeroplane Maintenance Manual and/or Chapter 20 Wiring Practices procedures should be used. The ATSRAC Task Group 1, Non-Intrusive Inspection Final Report could be used to identify typical housekeeping issues. AMC 20-21, Programme to Enhance Aeroplane EWIS Maintenance is recommended as a source of typical aeroplane wiring installations and areas of concern.

MODULE D – HOUSEKEEPING

- 1 Aeroplane External Contamination Sources
 - a) De-ice fluids
 - b) Water and rain
 - c) Snow and ice
 - d) Miscellaneous (e.g. cargo/beverage spillage)
 - e) Air erosion

- 2 Aeroplane Internal Contamination Sources
 - a) Hydraulic oils
 - b) Engine and APU oils
 - c) Fuel
 - d) Greases
 - e) Galleys and toilets
 - f) Lint/Dust
 - g) Bleed air and hot areas
 - h) Hazardous materials

- 3 Other Contamination Sources
 - a) Paint
 - b) Corrosion inhibitor
 - c) Drill shavings/Swarf
 - d) Foreign objects (screws, washers, rivets, tools, etc.)
 - e) Animal waste

- 4 Contamination Protection Planning
 - a) Have a plan/types of plan/area mapping
 - b) Protection and Caution Recommendations
 - c) Procedures
 - d) Keep cleaning

- 5 Protection during Aeroplane Maintenance and Repair
 - a) Recommended general maintenance protection procedures
 - b) Recommended airframe repair protection procedures
 - c) Recommended powerplant repair protection procedures

- 6 Cleaning Processes
 - a) Fluid contamination
 - (1) Snow and ice
 - (2) De-ice fluid
 - (3) Cargo spillage
 - (4) Water and rain
 - (5) Galleys
 - (6) Toilets water waste
 - (7) Oils and greases

- (8) Pressure washing
- b) Solid contamination
 - (1) Drill shavings/Swarf
 - (2) Foreign objects (screws, washers, rivets, tools, etc.)
- c) Environmental contamination
 - (1) Lint and dust
 - (2) Paint
 - (3) Corrosion inhibitor
 - (4) Animal waste

MODULE E: WIRE

1 OVERVIEW

Through Module E, the instructor lays the groundwork for safe, effective maintenance, alteration and repair of aeroplane EWIS by teaching wire selection and inspection strategies. The Instructor may vary the depth and scope of the topics to be covered, depending on the type of aeroplane to be maintained and skills of the persons.

2 OBJECTIVES

After this module is complete, the person is able to demonstrate the following skills:

- a) Demonstrate the procedure used to identify specific wire types using the aeroplane manuals.
- b) Know from approved data different insulation types and their relative qualities.
- c) Know the inspection criteria for wire and wire bundles.
- d) Know the standard installation practices for wire and wire bundles (aeroplane specific).
- e) Know typical damage that can be found (aeroplane specific).
- f) Demonstrate the repair procedures for typical damage found on the student's type of aeroplane.
- g) Demonstrate the procedures to fitting differing types of sleeving (aeroplane specific).
- h) Know the procedures for termination and storage of unused wires.
- i) Know the correct installation practices for electrical bonds and grounds (aeroplane specific).

3 STRATEGIES

Normal classroom lecture can be used for the majority of the training with hands-on practice for Section 6. Chapter 20 Wiring Practices, Wiring Diagram Manual and WDM Lists should be made available to the class to ensure hands-on use of the manual so that wire identification, inspection, installation and repair procedures can be fully explored. Examples of wire discrepancies should be made available to the student. The ATSRAC Task Group 1, Intrusive Inspection Final Report could be used to identify typical wire issues. AMC 20-21, Programme to Enhance Aeroplane EWIS Maintenance is recommended as a source of typical aeroplane wiring installations and areas of concern.

MODULE E – WIRE

- 1 Identification, Type and Construction
 - a) Wire type codes – alphanumeric
 - b) Wire type codes – specification and standard part number
 - c) Wire type codes – specified wire and alternate
 - d) Manufacturer identification

- 2 Insulation Qualities
 - a) Types of insulation
 - b) Typical insulation damage and limitations
 - c) Carbon arcing

- 3 Inspection Criteria and Standards of Wire and Wire Bundles
 - a) Inspection of individual wiring
 - b) Inspection of wire bundles

- 4 Wire Bundle Installation Practices
 - a. Routing
 - b. Segregation rules
 - c. Clearance
 - d. Clamp inspection
 - e. Clamp removal and fitting
 - f. Conduit types and fitting
 - g. Raceways
 - h. Heat shields and drip shields

- 5 Typical Damage and Areas Found (aeroplane specific)
 - a. Vibration
 - b. Heat
 - c) Corrosion
 - d) Contamination
 - e) Personnel traffic passage

- 6 Maintenance and Repair Procedures
 - a) Wire damage assessment and classification
 - b) Approved repairs - improper repairs
 - c) Shielded wire repair
 - d) Repair techniques
 - e) Terminals and splices
 - f) Preventative maintenance procedures

- 7 Sleeving
 - a) Identification sleeves
 - b) Shrink sleeves
 - c) Screen braid grounding crimp sleeves

- d) Screen braid grounding solder sleeves
- 8 Unused Wires - Termination and Storage
- a) Termination – end caps
 - b) Storage and attachment
- 9 Electrical Bonding and Grounds
- a) Inspection standards
 - b) Primary Bonding (HIRF protection)
 - c) Secondary Bonding (System grounding)
 - d) Lightning strikes

MODULE F: CONNECTIVE DEVICES

1 OVERVIEW

Through Module F, the instructor lays the groundwork for safe, effective maintenance, alteration and repair of aeroplane EWIS by teaching the identification, inspection and repair of connective devices found on the aeroplane. The instructor may vary the depth and scope of the topics to be covered, depending on the type of aeroplane to be maintained and skills of the persons.

2 OBJECTIVES

After this module is complete, the person is able to demonstrate the following skills:

- a) Know the general types and positive identification of connective devices (aeroplane specific).
- b) Know the various safety procedures, cautions and warnings prior to inspection.
- c) Know the relevant visual inspection procedures for each type of connector so that any internal or external damage can be found.
- d) Recognise typical external and internal damage to the connector.
- e) Demonstrate where to find the relevant repair schemes from Chapter 20 for connector repair.

3 STRATEGIES

Normal classroom lecture can be used for the majority of the training. The Chapter 20 Wiring Practices manual should be made available to the class so that hands-on use of the manual can be ensured. Connector identification, inspection and repair procedures should be fully explored. Colour photographs of typical external damage and internal damage could be used to show problems on the aeroplane. The ATSRAC Task Group 1, Non-Intrusive Inspection and Intrusive Inspection Final Report, Chapter 7, could be used to identify typical connector issues. AMC 20-21, Programme to Enhance Aeroplane EWIS Maintenance is recommended as a source of typical aeroplane wiring installations and areas of concern.

MODULE F – CONNECTIVE DEVICES

- 1 General Types and Identification
 - a) Part number identification
 - b) Reference tables
 - c) Specific connective devices chapters

- 2 Cautions and Protections
 - a) Safety precautions
 - b) Maintenance precautions

- 3 Visual Inspection Procedures
 - a) Installed inspection criteria
 - b) Removed inspection criteria

- 4 Typical Damage Found
 - a) Exterior damage
 - b) Internal damage

- 5 Repair Procedures
 - a) Finding the correct section
 - b) Finding the correct part
 - c) Finding the correct tooling
 - d) Confirming the correct repair

MODULE G: CONNECTIVE DEVICES REPAIR

1 OVERVIEW

Through Module G, the instructor lays the groundwork for safe, effective maintenance, alteration and repair of aeroplane EWIS. This module is primarily a hands-on class, emphasising the repair and replacement of connective devices found on the aeroplane. This list can be used to cover typical connectors for aeroplanes and can be adjusted to suit training requirements. The instructor may vary the depth and scope of the topics to be covered, depending on the type of aeroplane to be maintained and skills of the persons.

2 OBJECTIVE

After this module is complete, the person will have the following skills:

- a) Demonstrate the replacement of components for circular connectors.
- b) Demonstrate the replacement of components for rectangular connectors.
- c) Demonstrate the replacement of components for terminal blocks - modular.
- d) Demonstrate the replacement of components for terminal blocks - non-modular.
- e) Demonstrate the replacement of components for grounding modules.
- f) Demonstrate the replacement of pressure seals.

3 STRATEGIES

This class is primarily a hands-on class to give the student motor skills in the repair of connective devices from their aeroplane. The Chapter 20 Wiring Practices Manual and the appropriate connective devices should be made available to the class so that repair procedures can be fully explored. Photographs of typical internal conditions and external damage could be made available. It is recommended that MODULE F: CONNECTORS should precede this module. AMC 20-21, Programme to Enhance Aeroplane EWIS Maintenance is recommended as a source of typical aeroplane wiring installations and areas of concern.

MODULE G – CONNECTIVE DEVICES REPAIR

- 1 Circular Connectors
 - a) Disassembly
 - b) Back-shell maintenance
 - c) Contact extraction and insertion
 - d) Contact crimping
 - e) Assembly and strain relief

- 2 Rectangular Connectors
 - a) Disassembly
 - b) Back-shell maintenance
 - c) Contact extraction and insertion
 - d) Contact Crimping
 - e) Assembly and strain relief

- 3 Terminal Blocks - Modular
 - a) Disassembly
 - b) Contact extraction and insertion
 - c) Contact Crimping
 - d) Assembly and strain relief

- 4 Terminal Block – Non-modular
 - a) Disassembly
 - b) Terminal Lug Crimping
 - c) Terminal Lug Stacking
 - d) Assembly, torque and strain relief

- 5 Grounding Modules
 - a) Disassembly
 - b) Contact extraction and insertion
 - c) Contact Crimping
 - d) Assembly and strain relief

- 6 Pressure Seals
 - a) Disassembly
 - b) Maintenance
 - c) Assembly and strain relief

RELATED DOCUMENTS

Regulation (EC) No 216/2008 ¹
Regulation (EC) No 1702/2003 ²
Regulation (EC) No 2042/2003 ³
EASA Certification Specification CS-25 Large Aeroplanes ⁴
EU-OPS Commercial Air Transportation (Aeroplanes) ⁵

7 RELATED READING MATERIAL

a) EASA AMC-20

- AMC 20-21 Programme to Enhance Aeroplane Electrical Wiring Interconnection System Maintenance
- AMC 20-23 Development of Electrical Standard Wiring Practices Documentation

b) FAA 14 CFR Parts

- Part 21, Certification Procedures for Products and Parts
- Part 25, Airworthiness Standards, Transport Category Aeroplanes
- Part 43, Maintenance, Preventive Maintenance, Rebuilding, and Alteration
- Part 91, General Operating and Flight Rules
- Part 119, Certification: Air Carriers and Commercial Operators
- Part 121, Operating Requirements: Domestic, Flag, and Supplemental Operations
- Part 125, Certification and Operations: Aeroplanes Having a Seating Capacity of 20 or More Passengers or a Maximum Payload Capacity of 6,000 pounds or More
- Part 129, Operations: Foreign Air Carriers and Foreign Operators of U.S.-Registered Aircraft Engaged in Common Carriage
- Part 135, Operating Requirements: Commuter and On-demand Operations
- Part 145, Repair Stations

c) FAA Advisory Circulars (AC)

- AC 20-13, Protection of Aircraft Electrical/Electronic Systems against the Indirect Effects of Lightning

(1) Regulation (EC) No 216/2008 of the European Parliament and of the Council of 20 February 2008 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency, and repealing Council Directive 91/670/EEC, Regulation (EC) No 1592/2002 and Directive 2004/36/EC (OJ L 79, 19.3.2008, p. 1).

(2) Commission Regulation (EC) No 1702/2003 of 24 September 2003 laying down implementing rules for the airworthiness and environmental certification of aircraft and related products, parts and appliances, as well as for the certification of design and production organisations (OJ L 243, 27.9.2003, p. 6). Regulation as last amended by Regulation (EC) No 287/2008 (OJ L 87, 29.3.2008, p. 3).

- (3) Commission Regulation (EC) No 2042/2003 of 20 November 2003 on the continuing airworthiness of aircraft and aeronautical products, parts and appliances, and on the approval of organisations and personnel involved in these tasks (OJ L 315, 28.11.2003, p. 1). Regulation as last amended by Regulation (EC) No 376/2007 of (OJ L 94, 4.4.2007, p. 18).
- (4) Executive Director Decision No 2003/2/RM of 14 October 2003 on certification specifications, including airworthiness codes and acceptable means of compliance, for large aeroplanes («CS-25»). Decision as last amended by Executive Director Decision No 2008/006/R of 29 August 2008 (CS-25 Amendment 5).
- (5) Council Regulation (EEC) No 3922/91 of 16 December 1991 on the harmonisation of technical requirements and administrative procedures in the field of civil aviation (OJ L 373, 31.12.1991, p. 4). Regulation as last amended by Regulation (EC) No 8/2008 of 11 December 2007 (OJ L 10, 12.1.2008, p. 1).
- AC 20-53A, Protection of Aeroplane Fuel Systems against Fuel Vapour Ignition due to Lightning AC 25-16, Electrical Fault and Fire Protection and Prevention
 - AC 25.981-1B, Fuel Tank Ignition Source Prevention Guidelines
 - AC 25.17YY Development of Standard Wiring Practices Documentation
 - AC 43-3, Non-destructive Testing in Aircraft
 - AC 43-4A, Corrosion Control for Aircraft
 - AC 43-7, Ultrasonic Testing for Aircraft
 - AC 43-12A, Preventive Maintenance
 - AC 43.13-1A, Acceptable Methods, Techniques and Practices - Aircraft Inspection and Repair
 - AC 43.13-1B, Acceptable Methods, Techniques and Practices for Repairs and Alterations to Aircraft
 - AC 43-204, Visual Inspection for Aircraft
 - AC 43-206, Avionics Cleaning and Corrosion Prevention/Control
 - AC 65-15A, Airframe and Powerplant Mechanics Airframe Handbook, Chapter 11. Aircraft Electrical Systems
 - AC 120-XX, Programme to enhance aircraft Electrical Wiring Interconnection System maintenance

- AC 120-YY Aircraft Electrical Wiring Interconnection System training programme d. Reports
- Transport Aircraft Intrusive Inspection Project, (An Analysis of the Wire Installations of Six Decommissioned Aircraft), Final Report, the Intrusive Inspection Working Group, December 29, 2000. http://www.mitrecaasd.org/atstrac/intrusive_inspection.html
- FAA Aging Transport Non-Structural Systems Plan, July 1998.
- National Transportation Safety Board, Safety Recommendation, September 19, 2000, A-00-105 through -108. http://www.nts.gov/recs/letters/2000/A00_105_108.pdf
- Wire System Safety Interagency Working Group, National Science and Technology Council, Review of Federal Programmes for Wire System Safety 46 (2000).
- Aging Transport Systems Rulemaking Advisory Committee, Task 1 and 2, Aging Systems, Final Report. http://www.mitrecaasd.org/atstrac/final_reports/Task_1&2_Final%20August_2000.pdf
- Aging Transport Systems Rulemaking Advisory Committee, Task 3, Final Report. http://www.mitrecaasd.org/atstrac/final_reports/Task_3_Final.pdf
- Aging Transport Systems Rulemaking Advisory Committee, Task 4, Final Report, Standard Wiring Practices. http://www.mitrecaasd.org/atstrac/final_reports/Task_4_Final_Report_Sept_2000.pdf
- Aging Transport Systems Rulemaking Advisory Committee, Task 5, Final Report, Aircraft Wiring Systems Training Curriculum and Lesson Plans. http://www.mitrecaasd.org/atstrac/final_reports/Task_5_Final_March_2001%20.pdf
- ATA Specification 117 (Wiring Maintenance Practices/Guidelines).
- Aging Transport Systems Rulemaking Advisory Committee, Task 6, Task 7 and Task 9 Working Group Final Reports. http://www.mitrecaasd.org/atstrac/final_reports.html

f. Other Documents

- ATA Operator/Manufacturer Scheduled Maintenance Development as revised, ATA Maintenance Steering Group (MSG-3), may be obtained from the Air Transport Association of America; Suite 1100: 1301 Pennsylvania Ave, NW, Washington, DC 20004-1707.
- FAA Handbook Bulletin 91-15 "Origin and propagation of inaccessible aircraft fire under in-flight airflow conditions".