AGING TRANSPORT SYSTEMS RULEMAKING ADVISORY COMMITTEE (ATSRAC)

Task 5
Final Report
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AIRCRAFT WIRING SYSTEMS TRAINING CURRICULUM AND LESSON PLANS

All comments to:
PLapwood@aol.com
paul.lapwood@fsbti.com
206-662-7934

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AGING TRANSPORT SYSTEMS RULEMAKING ADVISORY COMMITTEE (ATSRAC)

OVERVIEW, BACKGROUND, RECOMENDATIONS

CURRICULUM AND LESSON PLANS

I. Introduction

A. Overview

Through this document the author gives a description of the background of ATSRAC and the individual tasks that make up its mission. Each task represents responsibility to deliver information relating to aging aircraft wiring systems and their condition. Task 5, the training supplier, represents the Curriculum and Lesson Plans that address Task 1,3, & 4's training recommendations. The Curriculum and Lesson Plans are designed so additional content can be added to the framework if new information becomes available.

The Curriculum is also based on the "training gaps" based on knowledge identified and developed from Tasks 1,3 and 4, and input from industry and airline sources during development. These include; ATSRAC and Task 5 team members, national and international regulatory bodies, Airbus, Boeing, BF Goodrich, FSBTI, Pratt and Whitney Instructors Conference, and Aviation Technician Education Council members. The curriculum can be adjusted for any model of airplane, student skill level and can be taught by any competent instructor with the requisite practical experience.

In the Curriculum we give the outline of eight modules to be taught, including module titles, minimum times and section titles. It is the opinion of the author that the modules can be selectively taught, depending on the experience of the students. The modules can be integrated into airline/repair station training programs in a simple, user-friendly way to be used by instructors for all airplane technicians at any stage in their careers.

The Lesson Plan Modules come directly from the curriculum and are split into sections. All sections are objective driven, so the student have measurable skills. Each section is split into easily taught Sub-sections, so the instructors can author Teaching Notes to suit their students and the airplane model worked upon.

Strategies of teaching are discussed through the Lesson Plan to help the instructors deliver the most effective teaching. It is recommended that the Final Reports from the Aging Transport Systems Rulemaking Committee (ATSRAC) be used to inform instructors as to the latest findings of discrepancies in airplane aging wiring systems.

Because of the level of contamination of airplane wiring systems with dirt and debris, it is recommended that all airplane workers are taught Module D, Housekeeping.

Examinations are administered to the students. However the content and format are left to the Instructors' discretion, so they can be tailored to the student, specific airplane operation and circumstance.

NOTE: This document can be subject to an update according to the ATSRAC committee decision and Airworthiness Authorities acceptance.

Background

1. The FAA developed the Aging Non-Structural Systems Plan to address the recommendation of the White House Commission on Aviation Safety and Security (WHCSS) that states; "*In cooperation with airlines and manufactures, the FAA's Aging Aircraft program should be expanded to cover non-structural systems.* "

2. In order to fully address the WHCSS recommendation on aging systems, an Aging Non-Structural Systems Study team was formed. This team, led by the Transport Airplane Directorate, conducted an inspection of systems in several aging airplanes and met with the FAA Principal Maintenance Inspectors, tasked with oversight of major air carriers in order to make preliminary evaluation of the need for additional work relative to the Commission's concerns. The team concluded that additional work was warranted and that industry involvement in this work was essential.

3. The FAA chose to address these recommendations through an Aging Transport Systems Rulemaking Advisory Committee (ATSRAC), determining this was the most appropriate way to provide a forum for the parties involved in addressing the WHCSS recommendations. The elements of the aging systems plan were grouped into five major tasks, each incorporating one or more related elements of the plan. The individual task statements, deliverables and results are cited below.

   NOTE: Only Tasks 1, 3 & 5 has information that relate to Task 5, Training. Therefore Task 2 Specific Task, Deliverables, Conclusions and Recommendations are not included in this report

II. Task One

A. Specific Task: Conduct an in-depth survey of the condition of aging transport fleet electrical systems and propose model-specific safety recommendations related to airplane systems that eliminate or significantly reduce the hazards associated with the types of age-related degradation displayed by the fleet.

B. Deliverables: Identify significant wiring related concerns; determine whether there exists previous corrective actions; and recommend to the committee the steps necessary to address these items of safety. Deliverable is a report to ATSRAC, recommending mandated incorporation of existing corrective actions and the development of preventative measures.

C. Non-Intrusive Inspection Conclusions: The majority of observed wiring installation discrepancies were found to be in areas of frequent maintenance activity, or related to housekeeping.

1. Contamination: Fluid contamination, dust and dirt accumulations were seen on most airplanes. Overall, wiring installations on all aircraft were found in good condition showing little or no evidence of deterioration, particularly those installations undisturbed since manufacture. The working groups did not note any direct correlation between the condition of the wire and actual time in service.

2. Hardware: Review of the over three thousand individual discrepancies found during the survey led each working group independently to conclude that none appeared to be wire-type dependent. Existing and original wire types were found with degradation such as insulation breakdown and cracking. It is the consensus of the working groups that most or all of the deteriorated wire conditions were in environments not protected from environmental and/or accidental damage. Time in service and the systems that they service seemed to have no appreciable bearing on the condition of the wiring. Areas and zones that are subject to a high level of maintenance activity display more disturbances to the wiring installation than those areas not regularly frequented by maintenance personnel. Items such as improper clamp sizing, inadequate clearance to structure and accumulation of dust or debris were common.

3. Maintenance: Existing maintenance programs may benefit from providing additional wiring inspection detail. Existing inspection training programs and current GVI criteria should be enhanced to improve detection of wiring installation degradation especially in unprotected areas. These programs should also be enhanced in the area of wiring maintenance practices, for example, protection of wiring from debris or fluid/chemical contamination. There appears to be some lack of understanding and appreciation for the impact of wiring installation techniques on the durability of that installation and on the reliability of related systems.

4. Visual inspection is an effective tool in the management of wires subject to heat damage, burning, and chafing. In high-risk situations (where less than 100% detection is inadequate), visual inspection must be combined with other means of preventing or mitigating failure. Visual inspection could probably not be relied upon to detect degraded repair, cracking, arcing, or delamination. Where these conditions may occur, and where the consequence of wire failure is unacceptable, other means for prevention and mitigation must be used.

D. Non-Intrusive Inspection Recommendations Pertaining to Task Five

It is the recommendation of the Aging Systems Task Force (ASTF) that the following actions be accomplished as a result of the non-intrusive airplane inspections conducted in response to ATSRAC Tasks 1.1 through 1.4:

1. Consider the content of ATA Specification 117, Wiring Maintenance Practices/Guidelines to enhance the awareness of wiring issues (i.e., inspection, installation, cleanliness, maintenance and repair.

2. Identify appropriate logic to develop specific inspection tasks to permit enhancement of maintenance program documents or upgrade to MSG-3 GVI criteria. Also review appropriate intervals.

3. Enhance standard practices by identifying recommendations that may be implemented in an individual airline foreign object damage (FOD) program to preclude debris contamination inside the aircraft during maintenance or modifications. Implement a 'clean as you go' philosophy.

4. Incorporate into aircraft maintenance documentation additional cautions and procedures aimed at preventing accidental damage and/or contamination of wiring installations.

E. Intrusive Inspection Recommendations Pertaining to Task Five

It is the recommendation of the ASTF that the following actions be accomplished as a result of the intrusive airplane inspections as a result of ATSRAC. The Task Five Group should:

1. Update training guidelines on a regular basis to correspond to ESPM updates. Emphasize the need to inspect splices closely for obvious deterioration as well as proper materials and workmanship. (**Chapter 7-5-1)**

2. Review visual indications of overheating in order to more precisely characterize symptoms of heat-degraded wire. (**7-5-2)**

3. Insure that training adequately addresses wire bundle segregation, clamp and tie best practices specifically with regard to high vibration areas. (**7-5-2)**

4. Develop enhanced training to ensure proper mechanical use of OEM/FAA approved tie downs, clamps, and wire separation/segregation are used in areas were wires or cables cross or come in contact. Ensure maintenance personnel recognize potential areas of chafing. (**7-5-3)**

5. Develop guidelines that ensure that all maintenance personnel, not just electrical maintenance technicians, are made aware of those actions that could result in breached wire. Small breaches (such as those resulting from the needling of wire) should not be dismissed as inconsequential. (**7-5-6)**

III. Task Three

A. Specific Task: Participate on industry teams as required. Determine if the existing maintenance and inspection criteria adequately address aging systems' issues. Make recommendations, if required, for enhancing maintenance inspection criteria.

B. Deliverables: Support industry development of enhanced maintenance inspection criteria and development of an analytical approach to determining maintenance inspection tasking. Deliverable is a document maintenance/inspection analysis process (such as MSG-3) that can be applied uniformly to all aging transport category airplanes to determine inspection tasks (if any).

C. Recommendations and Conclusions Pertaining to Task Five:

1. Enhancement of Inspection Criteria:

   Training material utilized by regulators, OEMs, operators and 3rd party maintenance organizations to be updated to reflect the revised GVI/DET definitions **(Chapter 12.1.2)**

2. Maintenance Program Enhancement:

   Operators shall ensure that they have a dedicated Zonal Inspection section within their approved maintenance program that addresses both systems and structures. This may not have been developed for the original MRB Report and thus OEM's will be required to assist operators to develop appropriate zonal inspections. **(12.2.1)**

   STC holders shall update the instructions for continued airworthiness that they provided in support of their design changes. This shall be done through application of the enhanced zonal analysis procedure. Once developed, these shall be introduced in operators maintenance programs. **(12.2.3)**

3. Expectations of a Zonal GVI:

   OEM/operator training material (for both aircraft inspection and MSG-3 analysis) and maintenance documentation (as appropriate) should include information on the typical deterioration that is expected to be seen and addressed during accomplishment of a zonal inspection. Chapter 7 identifies some items that should be included in addition to the main system components and structural items. **(12.3.1)**

4. Minimization of Contamination:

   OEMs should be tasked with providing specific guidance for pressure washing to minimize adverse effects on wiring and electrical components (i.e., maximum pressures, minimum nozzle-to-surface distance, maximum cleaning solution pH, maximum temperatures of water, maximum air temperature, and rinse requirements). The results should be in the form of internationally accepted practices. **(12.4.4)**

   With respect to Carriage of Livestock and Carriage of Hazardous Materials, OEMs/operators should examine existing documentation to ensure that appropriate and complete instructions are given with respect to cleaning of any spillage that might occur despite the precautions taken. This documentation should emphasize the potential severity of deterioration caused to systems and structure by animal waste products, salt water, caustic chemicals, etc. Guidance should be given on the extent of the cleaning procedures since it is often insufficient to remove only the visible evidence of contamination. **(12.4.5)**

5. Need for a cultural revolution:

   The importance of changing maintenance mentality towards electrical wiring installations will require more than simply updating manuals and enhancing training. The need for change must be promoted from above and thus actions must be taken to convince senior management that extended inspection time and improved working procedures are fundamental in achieving an improvement in continuous airworthiness. **(12.5.2)**

6. Protection or Cautions

   Structural repairs or modifications often require displacement (or removal) of wiring to provide access to the work area. Even minor displacement of wiring , especially while clamped, can damage wire insulation which can result in degraded performance, arcing or circuit failure. If wiring must be displaced (or removed) for work area access, it must be adequately released from It's clamping (or other restraining provisions) to allow movement without damage.

   Extreme care must be exercised to protect wiring from mechanical damage by tools used in structural repairs or modification. Wiring located adjacent to drilling or riveting operations should be carefully displaced or covered to reduce the possibility of mechanical damage

   Structural debris such as drill shavings, liberated fastener pieces, broken drill bits, etc., must not be allowed to contaminate wiring or electrical components. This type of contamination can cause severe damage to insulation and potential arcing by providing a conductive path to ground or between two (2) or more wires of different loads. Once contaminated, removal of this type of debris from wire bundles is extremely difficult. Before initiating structural repairs or modification activity, the work area must be carefully surveyed to identify all wiring and electrical components that may be subject to contamination. All wiring and electrical components in the debris field must be covered to prevent contamination. Consideration to be given to using drills equipped with vacuum aspiration to further minimize risk of metallic debris contaminating wire bundles. Clean electrical components and wiring after completion of work per applicable AMM. **(8 Item 2)**

IV. Task Four

A. Specific Task: Review the Wiring Manuals and related documentation to identify areas of improvement which may result in significant improved detection to prevent wire degradation from advanced aging, during regular or scheduled maintenance.

B. Deliverables: Recommend to the committee the changes to the Wiring Manuals and related documents and steps necessary to address them.

C. Recommendations and Conclusions Pertaining to Task Five:

1. Define a process for training development based on the airlines customized Chapter 20. This training process should be in a format that is easily assimilated into the training for repair stations, air carrier and non-air carrier operations. This should be integrated with the work of Task Group 5.

2. Establish the requirement for recurrent qualification training of maintenance technicians to include WDM Chapter 20 content, with particular attention to aging concerns including:
    a. Safety
    b. Degradation of wire installations
    c. Corrosion of components
    d. Contamination due to chemically active material
    e. Accumulation of dust, lint, debris
    f. Damage prevention and cleaning

3. Encourage all applicable training programs to highlight prevention as number one and “clean-as-you-go” approaches to reduce potential for compromising nearby wiring installations.

4. WDM Chapter 20 standard and supporting documentation including ATA Spec 117 and applicable FAA circulars should be included as source data to create a training program.

5. Highlight the “human factors” element during training for all disciplines to assure that standard practices are followed.

V. Task Five

A. Specific Task: Review air carrier and repair station training programs for non-structural systems inspection and repair to ensure that they adequately address aging wiring systems components (wire, connectors, brackets, shielding, clamps, ground) and other non-structural systems. Incorporate the work of Tasks 1-4 as it applies to training.

B. Deliverables: Deliverable is a document containing a series of recommended, detailed lesson plans covering recommended additional training for aging systems based on results of tasks 1,3 & 4. The lesson plans must be of sufficient detail to allow specific training material to be developed by airline/repair station of OEM training personnel, and integrated into their training programs.

C. Recommendations: Pages 11 through 31 detail the recommended Training Curriculum and Lesson Plans for aging wiring systems and components based on results of tasks 1,3 & 4.

D. Joint Airworthiness Requirement Response: "Having received your proposals and view its contents, modules A to H are recommended as the way to proceed and to provide sufficient instruction period. Of note, the CAA/JAA do carry out training and examinations of prospective engineers (technicians) in subject that you have highlighted and are recorded in the following JAR-66 syllabus."

Module A (1)	covered in JAR-66 syllabus module 7.1
Module A (2)	covered in JAR-66 syllabus module 5.12
Module B (1-3)	covered in JAR-66 syllabus module 7.18
Module C (1-4)	covered in JAR-66 syllabus module 7.3 & 7.5
Module D (1-3)	covered in JAR-66 syllabus module 7.2 &7.7
Module E (1-4)	covered in JAR-66 syllabus module 7.7 & 7.18
Module F (1-5)	covered in JAR-66 syllabus module 7.7
Module G (1-2)	covered in JAR-66 syllabus module 7.7
Module H (1-3)	covered in JAR-66 syllabus module 5.2, 7.3 & 7.18

WIRING SYSTEMS
CURRICULUM

Overview

This training is targeted to the airplane technician who performs inspections or repairs on structure and/or wiring systems. After training the technician is able to properly evaluate the wiring system and effectively use the manufacturers Chapter 20 Wiring System overhaul manual for that airplane. This 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 in the airplane.

Objectives

Depending on the modules taught, the technician demonstrates competency in the following skills:

A. Demonstrate the safe handling of airplane electrical systems, Line Replaceable Units (LRU's), tooling, troubleshooting procedures, and electrical measurement.
B. Know the construction and navigation of the applicable airplane wiring system overhaul or wiring practices manual
C. Understand the General Visual Inspection Detailed inspection and Special Detailed Inspection procedures, human factors in inspection, zonal areas, and typical damage that can occur.
D. Know the contamination sources, materials, cleaning and protection procedures.
E. Demonstrate the correct identification of different wire types, their inspection criteria, and damage tolerance, repair and preventative maintenance procedures.
F. Know the procedures to identify, inspect and find the correct repair for typical types of connective devices found on the technician's airplane.
G. Demonstrate the procedures for replacement of all parts of typical types of connective devices found on the technician's airplane (i.e. G1: Boeing, G2: Airbus, G3: Lockheed, and G4: McDonnell Douglas).
H. Know the removal, testing and repair of LRU's and their connective devices.

Scope

The course is to be used by training providers for all airplane technicians at any stage in their careers. The technician can be trained to the appropriate level using the applicable modules, depending the technicians experience, work assignment and operators policy. The time stated for each module is a minimum.

MODULE A – INTRODUCTION: 3 hours

1. Safety practices
2. Electrostatic Discharge Sensitive (ESDS) Device handling and protection
3. Tools, special tools and equipment
4. Calibration/certification of instruments, tools, and equipment
5. Required wiring checks using the Troubleshooting Procedures and Charts
6. Measurement and troubleshooting using meters.

MODULE B – CHAPTER 20 STRUCTURE: 3 hours

1. Chapter 20 structure/overview
2. Chapter cross-reference Index
3. Important Data and Tables

MODULE C – INSPECTION: 3 hours

1. General Visual Inspection (GVI), Detailed Inspection (DI) and Special Detailed Inspection (SDI), criteria and standards
2. Human factors in inspection
3. Zonal areas of inspection
4. Wiring system damage

MODULE D – HOUSEKEEPING: 3 hours

1. Airplane external contamination sources
2. Airplane internal contamination sources
3. Other contamination sources
4. Contamination protection planning
5. Protection during airplane maintenance and repair
6. Cleaning processes

MODULE E – WIRE: 6 hours

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 (airplane specific)
6. Maintenance and repair procedures
7. Sleeving
8. Unused wires-termination and storage
9. Electrical bonding and grounds

MODULE F – CONNECTIVE DEVICES: 3 hours

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

MODULE G1 – CONNECTIVE DEVICE REPAIR (BOEING): 6 hours

1. Cannon plug type round body connectors (e.g. 2020-61-11, 12 & 13)
2. ITT Cannon (type DPX, DPD, and DPA) connectors
3. Burndy Block (type F, G, and H) junction connectors
4. Burndy Block (type X, Y, and Z) junction connectors
5. ARINC 600 type connectors
6. Burndy Block (type S280W555-()) junction connectors
7. Wire Wrap (type S280UOO0 and S284U1147) connectors
8. MTCPQ Quick Disconnect connectors (flat pin contacts)
9. Radial EPX Style (BACC65AA & BACC65AB) (Spec. BAC 5162-72)

MODULE G2 – CONNECTIVE DEVICE REPAIR (AIRBUS): 6 hours

1. Circular Connectors Types NAS 1599, MIL-C-83723, EN2997
2. Circular Connectors Types MIL-C-26482 & MIL-C-26500
3. Circular Connectors Types MIL-C-5015 & EN6047
4. Rectangular Connectors-ARINC 404 & ARINC 600
5. Rectangular Connectors-Types EN3545 & Sub-D Type MIL-C-24308
6. Terminal Blocks-Modular Type NSA937901 ASNE0467
7. Terminal Blocks- Non-modular Type NSA937905, ASNE0467
8. Grounding Modules Type ASNE0425
9. Pressure Seals-DTP Types
10. Pressure Seals-Compound filled shell types

MODULE G3 – CONNECTIVE DEVICE REPAIR (LOCKHEED): 6 hours

1. Cannon Plug Type Round Body Connectors (e.g. series CV & FRF)
2. Deutsch (type AFD & DL) Connectors
3. Burndy Block (type MB24p & 24r) Junction Connectors
4. Burndy Block (type YHLZ) Junction Connectors
5. Pyle-National (type ES, FPL, FPK & ZZL) Connectors
6. AN 3116 and MS 274 (67, 72, 73, 74, 84, 87) and MS 27656 circular connectors.
7. Matrix fluid resistant and Minimate connectors
8. Canon general purpose and environmental rectangular connectors
9. Coaxial connectors (Cannon, Hughes, Kings, TED, & Amp)

MODULE G4 – CONNECTIVE DEVICE REPAIR (MC DONNELL DOUGLAS): 6 hours

TBD

MODULE H – LINE REPLACEABLE UNITS (LRU): 3 hours

1. Removal and replacement techniques
2. Testing of LRU connectors
3. “No Fault Found”
4. Troubleshooting procedures.

WIRING SYSTEMS LESSON PLAN
MODULE A: INTRODUCTION

Overview

Through Module A, the instructor lays the groundwork of safe effective maintenance and repair of the airplane wiring systems, without damage to the airplane or injury to the student. The Instructor may vary the depth and scope of the topics to be covered, depending on the type of airplane to be maintained and skills of the technicians.

Objectives

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

1. Know the safety procedures of normal and non-normal maintenance procedures so the technician can protect him/herself and the airplane.
2. Recognize ESDS equipment and demonstrate standard anti-static procedures so that no damage occurs to that equipment.
3. Demonstrate the correct use of hand tools including specialized and automated tools and equipment.
4. Demonstrate the successful calibration of electrical measuring instruments, tools and equipment so that correct maintenance procedures may be carried out.
5. Demonstrate the process and procedures to successfully use the Troubleshooting Procedures and Charts of current airplane faults.
6. Demonstrate the correct use of electrical meters for measuring voltage, current, resistance, continuity, insulation and short to ground.

Strategies

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

Electrostatic Discharge Sensitive (ESDS) Device handling and protection……Video/Training Aids
Calibration/certification of instruments, tools, and equipment……..Company Policy
Wiring checks using the Troubleshooting Procedures and Charts……..Airplane manuals
Measurement and troubleshooting using meters……..Meters and circuits

MODULE A - INTRODUCTION:

1. Safety practices
    a. Current is lethal - First aid
    b. Applying power to the airplane
    c. Isolating the circuit
    d. Airplane warnings
    e. Human Factors

2. Electrostatic Discharge Sensitive (ESDS) Device handling and protection
    a. Sources of electrostatic discharge
    b. Soft and hard failures
    c. ESDS safety procedures
    d. ESDS packing procedures

3. Tools, special tools and equipment

    a. General hand tools
    b. Specialized tools
    c. Automated tools and equipment

4. 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. Aircraft Maintenance Manual/ Illustrated Parts Catalog
    c. Wiring schematics / Troubleshooting graphics
    d. Wiring diagrams
    e. The process of troubleshooting
    f. Troubleshooting exercises

6. Measurement and troubleshooting using meters

    a. Voltage, current and resistance
    b. Continuity
    c. Insulation
    d. Short to ground.

WIRING SYSTEMS LESSON PLAN
MODULE B: CHAPTER 20 STRUCTURE

Overview

Through Module B, the instructor lays the groundwork for safe effective maintenance and repair of airplane wiring systems. The intent of this module is to teach the technician how to locate desired information in the Chapter 20 Wiring Systems overhaul manual. The Instructor may vary the depth and scope of the topics to be covered, depending on the type of airplane to be maintained and skills of the technicians.

Objectives

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

1. Know the applicable Sub-Chapters and Section to follow during normal and non -normal electrical maintenance procedures.
2. 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.
3. Demonstrate the use of the associated tables for replacement of wire, connective devices and contacts, and associated components, including approved replacements.

Strategies

Normal classroom lecture is used for the majority of the training. The Chapter 20 Manual will be made available to the class so that hands-on exploration of the manual can be achieved.

MODULE B - CHAPTER 20 STRUCTURE:

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

WIRING SYSTEMS LESSON PLAN
MODULE C: INSPECTION

Overview

Through Module C, the instructor lays the groundwork for safe effective maintenance and repair of airplane 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 airplane to be maintained and skills of the technicians.

Objectives

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

1. Know the General Visual Inspection (GVI), Detailed Inspection (DI) and Special Detailed Inspection (SDI), criteria and standards so that the technician knows which tools are used to ensure inspection procedures and standards are achieved which leads to all defects being found.
2. Know the effects of fatigue and complacency during inspection and how to combat their effects (Human Factors).
3. Know the specific zonal inspection requirements related to system affiliation and environmental conditions.
4. Recognize typical wiring system damage, such as hot gas, fluid contamination, external mechanically induced damage, chafing and corrosion of wire, wire bundles and connective devices assemblies.

Strategies

Normal classroom lecture is used for the majority of the training. ATA 117 video and color photos of actual wiring systems damage is recommended to show typical problems found on the airplane. Examples of discrepancies will be made available to the student. The ATSRAC Task Group 3, Final Report should be used to access updated zonal inspection requirements. (Available from FAA)

MODULE C – INSPECTION

1. General Visual Inspection (GVI), Detailed Inspection (DI) and Special Detailed Inspection (SDI) criteria and standards
    a. Tools
    b. Criteria/standards
    c. Procedures of inspection
2. Human Factors in Inspection
    a. Fatigue
    b. Complacency
3. Zonal areas of inspection
    a. Zonal areas of inspection
    b. Zonal inspection procedures and standards
4. Wiring system damage
    a. Swarf / FOD / metal shavings
    b. External mechanically induced damage
    c. Hot gas
    d. Fluid contamination
    e. Vibration/chafing
    f. Corrosion

WIRING SYSTEMS LESSON PLAN
MODULE D: HOUSEKEEPING

Overview

Through Module D, the instructor lays the groundwork for safe effective maintenance and repair of airplane wiring systems by teaching housekeeping strategies. This will keep the wiring system free of contamination and if contamination is found, techniques on removal or cleaning. The Instructor may vary the depth and scope of the topics to be covered, depending on the type of airplane to be maintained and skills of the technicians.

Objectives

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

1. Recognize external contamination and other damage due to external environmental conditions.
2. Know the airplane internal contamination sources, so that inspection processes can be effectively carried out and contamination damage easily recognized.
3. Recognize other possible contamination sources.
4. Know the procedures and processes to protect wiring systems during maintenance and repair.
5. Know the procedures to be followed when carrying out repairs on wiring systems in different parts of the airplane.
6. Know the process of cleaning wiring systems during maintenance and repair.

Strategies

Normal classroom lecture is used for the majority of the training. ATA 117 video and color photos of actual wiring systems contamination are recommended to show typical problems found on the airplane. Relevant Aircraft Maintenance Manual and/or Chapter 20 SWPM procedures will be used. The ATSRAC Task Group 1, Non-Intrusive Inspection Final Report should be used to identify typical housekeeping issues.

MODULE D – HOUSEKEEPING

1. Airplane external contamination sources

    a. De-ice fluids
    b. Water and rain
    c. Snow and ice
    d. Miscellaneous (e.g. cargo spillage)
    e. Air erosion

2. Airplane 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 airplane 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

    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

WIRING SYSTEMS LESSON PLAN
MODULE E: WIRE

Overview

Through Module E, the instructor lays the groundwork for safe effective maintenance and repair of airplane wiring systems 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 airplane to be maintained and skills of the technicians.

Objectives

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

1. Demonstrate the procedure used to identify specific wire types using the airplane manuals.
2. Know from approved data different insulation types and their relative qualities.
3. Know the inspection criteria for wire and wire bundles.
4. Know the standard installation practices for wire and wire bundles (airplane specific).
5. Know typical damage that can be found (airplane specific).
6. Demonstrate the repair procedures for typical damage found on the student's type of airplane.
7. Demonstrate the procedures to fitting differing types of sleeving (airplane specific).
8. Know the procedures for termination and storage of unused wires.
9. Demonstrate the correct installation practices for electrical bonds and grounds (airplane specific).

Strategies

Normal classroom lecture is used for the majority of the training with hands-on practice for Section 6. Chapter 20 will be made available to the class so that hands-on use of the manual can be utilized so that wire identification, inspection, installation and repair procedures can be fully explored. Examples of wire discrepancies will be made available to the student. The ATSRAC Task Group 1, Intrusive Inspection Final Report should be used to identify typical wire issues.

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
    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

5. Typical damage and areas found (airplane specific)

    a. Vibration
    b. Corrosion
    c. Contamination
    d. 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

WIRING SYSTEMS LESSON PLAN
MODULE F: CONNECTIVE DEVICES

Overview

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

Objectives

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

1. Know the general types and positive identification of connective devices and pressure seals (airplane specific).
2. Know the various safety procedures, cautions and warnings prior to inspection.
3. Know the relevant inspection procedures for each type of connector so that any internal or external damage can be found.
4. Recognize typical external and internal damage to the connector.
5. Demonstrate where to find the relevant repair schemes from Ch. 20 for connector repair.

Strategies

Normal classroom lecture is used for the majority of the training. The Chapter 20 Manual will be made available to the class so that hands-on use of the manual can be utilized. Connector identification, inspection and repair procedures will be fully explored. Photographs of typical external damage and internal damage will be made available to show problems on the airplane. The ATSRAC Task Group 1, Non-Intrusive Inspection and Intrusive Inspection Final Reports should be used to identify typical connector issues. (Ch. 7 research recommendations)

MODULE F – CONNECTIVE DEVICES

1. General types and identification
    a. Part number identification
    b. Reference tables
    c. Specific connective devices and pressure seal 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

WIRING SYSTEMS LESSON PLAN
MODULE G1: CONNECTIVE DEVICE REPAIR (BOEING)

Overview

Through Module G1, the instructor lays the groundwork for safe effective maintenance and repair of airplane wiring systems. This module is primarily a hands-on class, emphasizing the repair and replacement of connective devices found on the airplane. This list is an example of connectors for Boeing airplanes, 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 airplane to be maintained and skills of the technicians.

Objective

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

1. Demonstrate the replacement of components on Cannon type connectors.
2. Demonstrate the replacement of components on ITT Cannon type connectors.
3. Demonstrate the replacement of components on Burndy Block F, G and H connectors.
4. Demonstrate the replacement of components on Burndy Block X, Y and Z connectors.
5. Demonstrate the replacement of components on ARINC 600 connectors.
6. Demonstrate the replacement of components on S280W555 Burndy Block F, G and H connectors.
7. Demonstrate the fitting and use of wire wrap tooling on S280UOOO and S2804U1147 connectors.
8. Demonstrate the replacement of components on MTCPQ flat pin connectors.
9. Demonstrate the replacement of components on Radiall EPX Style connectors.

Strategies

This class is primarily a hands-on class to give the student motor skills in the repair of connective devices from their airplane. The Chapter 20 Manual and the appropriate connectors are made available to the class so repair procedures can be fully explored. Photographs of typical internal conditions and external damage will be made available. It is recommended that MODULE F: CONNECTORS should precede this module.

MODULE G1 – CONNECTOR DEVICE REPAIR (BOEING)

1. Cannon Plug Type Round Body Connectors (e.g. 2020-61-11, 12 & 13)
    a. Disassembly
    b. Back-shell maintenance
    c. Pin extract and insert
    d. Crimping pins
    e. Assembly and strain relief

2. ITT Cannon (type DPX, DPD, and DPA) Connectors
    a. Disassembly
    b. Back-shell maintenance
    c. Pin extract and insert
    d. Crimping pins
    e. Assembly and strain relief

3. Burndy Block (type F, G, and H) Junction Connectors

    a. Disassembly from mounting track
    b. Pin extract and insert
    c. Crimping pins
    d. Reinstallation

4. Burndy Block (type X, Y, and Z) Junction Connectors
    a. Disassembly from mounting track
    b. Pin extract and insert
    c. Crimping pins
    d. Reinstallation

5. ARINC 600 Type Connectors

    a. Sizes and insert configurations
    b. Maintenance-Breakout boxes and contact probing
    c. Pin extract and insert
    d. Crimping pins and sockets

6. Burndy Block (type S280W555-()) Junction Connectors

    a. Disassembly from mounting track
    b. Pin extract and insert
    c. Reinstallation

7. Wire Wrap (type S280UOO0 and S284U1147) Connectors

    a. Tooling
    b. Wire wrap removal
    c. Wrapping terminals
    d. Inspection

8. MTCPQ Quick Disconnect Connectors (flat pin contacts)

    a. Disassembly
    b. Insert removal and insertion
    c. Pin and socket extract and insert
    d. Pin and socket crimping
    e. Assembly and strain relief

9. Radiall EPX Style (BACC65AA & BACC65AB) (Spec. BAC 5162-72)

    a. Disassembly
    b. Back-shell maintenance
    c. Pin extract and insert
    d. Assembly and strain relief
    e. Pin and socket crimping
    f. Pin and socket insertion and removal
    g. Keyway clocking

WIRING SYSTEMS LESSON PLAN
MODULE G2: CONNECTIVE DEVICES REPAIR (AIRBUS)

Overview

Through Module G2, the instructor lays the groundwork for safe effective maintenance and repair of airplane wiring systems. This module is primarily a hands-on class, emphasizing the repair and replacement of connective devices found on the airplane. This list is an example of connectors for Airbus airplanes, 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 airplane to be maintained and skills of the technicians.

Objective

After this module is complete the technician will have the following skills.

1. Demonstrate the replacement of components - Types NAS 1599, MIL-C-38999, MIL-C-83723 & EN2997 connectors.
2. Demonstrate the replacement of components - Types MIL-C-26482, MIL-C-26500 connectors
3. Demonstrate the replacement of components – Types MIL-C-5015 & EN6047connectors.
4. Demonstrate the replacement of components - Type ARINC 404 and ARINC 600 connectors
5. Demonstrate the replacement of components - Type EN3545 (ASNE0390) & Sub-D type MIL-C-24308 connectors.
6. Demonstrate the replacement of components - Terminal Block Modules NSA937901
7. Demonstrate the replacement of components - Terminal Block Studs NSA937905,ASNE0467
8. Demonstrate the replacement of components - Grounding modules ASNE0425.
9. Demonstrate the replacement of components – Pressure seals DTP types
10. Demonstrate the replacement of components – Pressure seals Compound filled shell types

Strategies

This class is primarily a hands-on class to give the student motor skills in the repair of connective devices from their airplane. The Chapter 20 Manual and the appropriate connective devices will be made available to the class so repair procedures can be fully explored. Photographs of typical internal conditions and external damage should be made available. It is recommended that MODULE F: CONNECTORS should precede this module.

MODULE G2 – CONNECTIVE DEVICES REPAIR (AIRBUS)

1. Circular Connectors (e.g. ASNE0052, ASNE0077, ASNE0545, EN6047, EN2997)
    a. Disassembly
    b. Back-shell maintenance
    c. Contact extraction and insertion
    d. Contact Crimping
    e. Assembly and strain relief

2. Computer Rack Connectors ARINC 404 (e.g. ASNE0097)
    a. Disassembly
    b. Contact extraction and insertion
    c. Maintenance
    d. Contact Crimping
    e. Assembly and strain relief

3. Computer Rack Connectors ARINC 600 (e.g. ASNE0163)
    a. Disassembly
    b. Contact extraction and insertion
    c. Maintenance
    d. Contact Crimping
    e. Assembly and strain relief

4. Rectangular Connectors (e.g. ASNE0390)
    a. Disassembly
    b. Back-shell maintenance
    c. Contact extraction and insertion
    d. Contact Crimping
    e. Assembly and strain relief

5. Terminal Block Modules (e.g. NSA937901)
    a. Disassembly
    b. Contact extraction and insertion
    c. Contact Crimping
    d. Assembly and strain relief

6. Terminal Block Studs (e.g. ASNE0467)
    a. Disassembly
    b. Terminal Lug Crimping
    c. Terminal Lug Stacking
    d. Assembly, torque and strain relief

7. Grounding Modules (e.g. ASNE0425)
    a. Disassembly
    b. Contact extraction and insertion
    c. Contact Crimping
    d. Assembly and strain relief

8. Pressure Seals – DTP (e.g. NSA934502)
    a. Disassembly
    b. Maintenance
    c. Assembly and strain relief

9. Pressure seals – Compound Filled Shell (e.g. NSA934710)
    a. Disassembly
    b. Maintenance
    c. Assembly and strain relief

WIRING SYSTEMS LESSON PLAN
MODULE G3: CONNECTIVE DEVICES REPAIR (LOCKHEED)

Overview

Through Module G3, the instructor lays the groundwork for safe effective maintenance and repair of airplane wiring systems. This module is primarily a hands-on class, emphasizing the repair and replacement of connective devices found on the airplane. This list is an example of connectors for Lockheed airplanes, 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 airplane to be maintained and skills of the technicians.

Objective

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

1. Demonstrate the replacement of components on Cannon type connectors.
2. Demonstrate the replacement of components on Deutsch type connectors.
3. Demonstrate the replacement of components on Burndy Block MB24p & 24r connectors.
4. Demonstrate the replacement of components on Burndy Block YHLZ connectors.
5. Demonstrate the replacement of components on Pyle-National connectors.
6. Demonstrate the replacement of components on AN 3116 and MS 274 (67, 72, 73, 74, 84, 87) and MS 27656 circular connectors.
7. Demonstrate the replacement of components on Matrix fluid resistant and Minimate connectors.
8. Demonstrate the replacement of components on Canon general purpose and environmental rectangular connectors.
9. Demonstrate the replacement of components on Coaxial connectors.

Strategies

This class is primarily a hands-on class to give the student motor skills in the repair of connectors from their airplane. The Chapter 20 Manual and the appropriate connectors are made available to the class so repair procedures can be fully explored. Photographs of typical internal conditions and external damage will be made available. It is recommended that MODULE F: CONNECTORS should precede this module.

MODULE G3 – CONNECTIVE DEVICE REPAIR (LOCKHEED)

1. Cannon Plug Type Round Body Connectors (e.g. series CV & FRF)
    a. Disassembly
    b. Back-shell maintenance
    c. Pin extract and insert
    d. Crimping pins
    e. Assembly and strain relief

2. Deutsch (type AFD & DL) Connectors
    a. Disassembly
    b. Back-shell maintenance
    c. Pin extract and insert
    d. Crimping pins
    e. Assembly and strain relief

3. Burndy Block (type MB24p & 24r) Junction Connectors

    a. Disassembly
    b. Back-shell maintenance
    c. Pin extract and insert
    d. Crimping pins
    e. Assembly and strain relief

4. Burndy Block (type YHLZ) Junction Connectors
    a. Disassembly
    b. Back-shell maintenance
    c. Pin extract and insert
    d. Crimping pins
    e. Assembly and strain relief

5. Pyle-National (type ES, FPL, FPK & ZZL) Connectors

    a. Disassembly
    b. Maintenance
    c. Sealing
    d. Assembly

6. AN 3116 and MS 274 (67, 72, 73, 74, 84, 87) and MS 27656 circular connectors.

    a. Disassembly
    b. Back-shell maintenance
    c. Pin extract and insert
    d. Assembly and strain relief

7. Matrix fluid resistant and Minimate connectors

    a. Disassembly
    b. Back-shell maintenance
    c. Pin extract and insert
    e. Assembly and strain relief

8. Canon general purpose and environmental rectangular connectors

    a. Disassembly
    b. Back-shell maintenance
    c. Pin extract and insert
    d. Assembly and strain relief

9. Coaxial connectors (Cannon, Hughes, Kings, TED, & Amp)

    a. Disassembly
    b. Stripping cable
    c. Refitting cable
    d. Assembly and strain relief.

WIRING SYSTEMS LESSON PLAN
MODULE G4: CONNECTIVE DEVICES REPAIR (MC DONNELL DOUGLAS)

TO BE INCLUDED

WIRING SYSTEMS LESSON PLAN
MODULE H: LINE REPLACEABLE UNITS (LRU's)

Overview

Through Module H, the instructor lays the groundwork for safe effective maintenance and repair of airplane wiring systems by teaching the techniques of LRU removal and repair, including BITE. The Instructor may vary the depth and scope of the topics to be covered, depending on the type of airplane to be maintained and skills of the technicians.

Objective

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

1. Know the removal and replacement techniques so that no damage will occur to the LRU or airplane connector.
2. Know the procedures, including correct tooling that are used to test connectors and airplane wiring
3. Know re-occurring problems causing "No Fault Found" on removed LRU's.
4. Demonstrate the use of the applicable Troubleshooting Procedures Manual to resolve current system faults.

Strategies

This module is lecture and hands-on practice to give the student motor skills in the replacement of LRU's and the maintenance and repair of their respective rack connectors. The Chapter 20 Manual, together with examples of rack equipment is made available so that hands on use of the manual will be utilized together with connector inspection and repair procedure practice.

MODULE H – LINE REPLACEABLE UNITS (LRU)

1. Removal and replacement techniques
    a. ESDS protection
    b. Different retention devices
    c. Certification considerations (e.g. CAT 2/CAT3 Landing)
    d. LRU re-racking procedures
2. Testing of LRU connectors
    a. Tooling requirements
    b. Typical test procedures and techniques
    c. Typical damage found
3. "No Fault Found"
    a. Company "No Fault Found " data and policy
    b. Manufacturer fleet data and monitoring
4. Troubleshooting procedures
    a. Built in test equipment (BITE)
    b. The process of repair
    c. Repair procedures.