AMC 20-23 Effective: 05/09/2008
Annex IV to ED Decision 2008/007/R of 29/08/2008

AMC 20-23
Development of Electrical Standard Wiring Practices documentation

1 PURPOSE

This AMC provides acceptable means of compliance for developing an electrical standard wiring practices document for operators, holders of and applicants for type certificates (TC), applicants for supplemental type certificates (STC) and maintenance organisations. The information in this AMC is based on recommendations submitted to the FAA from the Aging Transport Systems Rulemaking Advisory Committee (ATSRAC). JAA and latterly EASA are participating members of ATSRAC. The information in this AMC is derived from the maintenance, inspection, and alteration best practices identified through extensive research by ATSRAC working groups and Federal government working groups. This AMC provides a means, but not the only means of creating a document that meets the expectations of CS 25.1529 and Appendix H.

2 OBJECTIVE

The objective of this AMC is to promote a common format for documents containing standard practices for electrical wiring, and to provide a summary of the minimum content expected to be contained within that document. Although the title of the document or manual is left to the discretion of the organisation, such a document will be referred to in this AMC as the Electrical Standard Wiring Practices Manual (ESWPM).

Titles in other organisations for such document may be Standard Wiring Practices Manual (SWPM) or Electrical Standard Practices Manual (ESPM).

3 APPLICABILITY

The guidance provided in this AMC is applicable to all operators, holders of and applicants for TC, applicants for STC and maintenance organisations.

4 RELATED DOCUMENTS

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

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[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 RELATED READING MATERIAL

a. EASA AMC-20

- AMC 20-21, Programme to Enhance Aircraft Electrical Wiring Interconnection System Maintenance
- AMC 20-22, Aircraft Electrical Wiring Interconnection System Training Programme

b. FAA 14 CFR Parts

- Part 21, Certification Procedures for Products and Parts
- Part 25, Airworthiness Standards, Transport Category Airplanes
- 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: Airplanes 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 and Rules Governing Persons on Board such Aircraft
- Part 145, Repair Stations

c. FAA Advisory Circulars (AC)

- AC 25-16, Electrical Fault and Fire Protection and Prevention
- AC 25.981-1B, Fuel Tank Ignition Source Prevention Guidelines
- AC 43-12A, Preventive Maintenance
- 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 25.17XX Certification of EWIS on Transport Category Airplanes

d. Reports

- Aging Transport Systems Rulemaking Advisory Committee, Task 1 and 2, Aging Systems, Final Report http://www.mitrecaasd.org/atsrac/final_reports/Task_1&2_Final%20_August_2000.pdf
- Aging Transport Systems Rulemaking Advisory Committee, Task 3, Final Report http://www.mitrecaasd.org/atsrac/final_reports/Task_3_Final.pdf
- Aging Transport Systems Rulemaking Advisory Committee, Task 4, Final Report, Standard Wiring Practices

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[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).

http://www.mitrecaasd.org/atsrac/final_reports/Task_4_Final_Report_Sept_2000.pdf

- 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/atsrac/intrusive_inspection.html
- Aging Transport Systems Rulemaking Advisory Committee Task 7, Final Report, Electrical Standard Wire Practices Manual (ESWPM) http://www.mitrecaasd.org/atsrac/final_reports/Task_7_Final_Report-10-31-2002.pdf

e. Other Documents

- ATA Specification 117 (Wiring Maintenance Practices/Guidelines)
- FAA Policy Statement Number ANM-01-04: System Wiring Policy for Certification of Part 25 Airplanes, June 25, 2001

6 DEFINITIONS

Consumable materials: Materials consumed during the maintenance or repair of EWIS which are not an eventual component of the EWIS.

Drip loop: The practice of looping a wire or wire bundle to provide a point lower than the adjacent connector for moisture to collect.

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

Legacy document: An organisation's ESWPM existing prior to the adoption of the requirements of H25.5(a)(2) of Appendix H to CS-25.

Master Breakdown Index (MBI): An index developed to supplement a legacy document. An MBI provides a means of finding information without the need for reformatting the legacy SWPM. An example of an MBI is presented at the end of paragraph 9 of this AMC.

Separation: Defined as either spatial distance, or physical barrier, between wiring from adjacent structure, systems or wiring; or the practice of installing wiring supporting redundant or multi-channel systems.

Standard practices: Industry-wide methods for repair and maintenance of electrical wire, cable bundles and coaxial cables. Procedures and practices for the inspection, installation and removal of electrical systems components including, but not limited to: wire splices, bundle attachment methods, connectors and electrical terminal connections, bonding/grounding, etc.

7 STANDARDISED ESWPM FORMAT

A representative example of the standard format and sequence of major topics included within an ESWPM is contained within Appendix A of this AMC.

8 MINIMUM ESWPM CONTENT

A definition and description of ESWPM minimum content is necessary to ensure that operators and repair stations have at their disposal the information necessary to properly maintain their airplanes. Although the original airframe manufacturer's electrical installation design philosophy concerning components, installation procedures, segregation rules, etc. need not be included within the ESWPM, sufficient minimum information should be provided to enable the end-user to maintain the aircraft in a condition that conforms to the electrical installation design philosophy of the original

manufacturer.

The content of any ESWPM should include, at a minimum, the following:

a. Front Matter

Provide information regarding the content and use of the ESWPM. Describe changes to the document in a record of revisions. Ensure the document contains a table of contents or index to allow the user to readily retrieve necessary information.

b. Safety Practices

Provide general instruction, cautions and warnings which describe safe practices implemented prior to the start of any or all of the specific standard electrical practices contained within the core of the ESWPM. Safety cautions, warnings or notes specific to the procedure shall be placed within the body of the procedure.

c. Cleaning Requirements and Methods

"Protect, clean as you go" philosophy.

- Non-destructive methods for cleaning dust, dirt, foreign object debris (FOD), lavatory fluid, and other contaminants produced by an aircraft environment from wiring systems.
- Wire replacement guidelines when an accumulation of contaminants, either on the surface and/or imbedded in the wire bundle, cannot be safely removed.

d. Wire and Cable Identification

(1) Specify requirements for wire and cable identification and marking to provide safety of operation, safety to maintenance personnel, and ease of maintenance.

(2) Specify methods of direct wire marking. Also, identify specific requirements and cautions associated with certain types of wire marking.

e. Wire and Cable Damage Limits

Specify limits to positively identify the thresholds where damaged wire/cable replacement may be necessary and where repairs can be safely accomplished. Establish limits for each applicable wire/cable type, if necessary.

(1) Include damage limits for terminals, studs, connectors, and other wiring system components, as necessary.

f. Installation Clamping and Routing Requirements

(1) Specify the requirements for the installation of wiring systems with respect to physical attachment to the aircraft structure. These requirements must be compatible with the different environments applicable to aircraft and aircraft systems.

(2) Specify applicable methods of clamping, support, termination, and routing to facilitate installation, repair, and maintenance of wires, wire bundles, and cabling.

(3) Specify minimum bend radii for different types of wire and cable.

(4) Specify minimum clearance between wiring and other aircraft systems and aircraft structure.

(5) Include the requirements for the installation of wiring conduit with respect to physical attachment, routing, bend radii, drain holes, and conduit end coverings.

(6) Emphasise special wiring protective features, such as spatial separation, segregation, heat shielding, and moisture protection that are required to be maintained throughout the life of the aircraft.

(7) Ensure necessary information for the maintenance of bonding, grounding and lightning, high-intensity radio frequency (L/HIRF) provisions is included.

(8) Include information on the use and maintenance of wire protective devices, conduits, shields, sleeving etc. (this bullet is deleted in the FAA AC).

g. Repair and Replacement Procedures

Describe methods to safely repair and/or replace wiring and wiring system components.

(1) Include types and maximum numbers of splice repairs for wiring and any limitations on the use of splices. When splicing wire, environmental splices are highly recommended over non-environmental splices. Guidance should be provided on how long a temporary splice may be left in the wire.

(2) Specify procedures for the repair, replacement, and maintenance of connectors, terminals, modular terminal blocks, and other wiring components.

h. Inspection Methods

In wiring inspection methods, include a general visual inspection (GVI), or a detailed inspection (DET), as determined by the Enhanced Zonal Analysis Procedure (EZAP). Typical damage includes heat damage, chafing, cracked insulation, arcing, insulation delaminating, corrosion, broken wire or terminal, loose terminals, incorrect bend radii, contamination, and deteriorated repairs.

(1) Identify detailed inspections and, where applicable, established and emerging new technologies non-destructive test methods to complement the visual inspection process.

Whenever possible, ensure that inspection methods can detect wiring problems without compromising the integrity of the installation.

i. Customised data

Provide a location and procedures that allow users to include customised or unique data such as that relating to STC, operator-unique maintenance procedures, etc.

A comprehensive listing of the typical content included within an ESWPM, including the minimum required content described above, is contained within Appendix A of this AMC.

9 ALTERNATIVE PROCEDURE FOR LEGACY DOCUMENTS

The definition of a new layout and chapter format may require each organisation with an existing ESWPM to reformat and to republish using the standardised format. Whether the organisation produces a stand-alone manual or provides the electrical standard practices as Chapter 20 of a wiring diagram manual, the resultant reorganisation would cause a significant economical impact for both the authoring organisation and their end-users.

To address this concern, a conversion tool, identified in the last paragraph of this chapter, was devised which takes the following variables into account:

- Effects on manufacturers' current technical document editorial policy as it exists in current legacy documents.
- Costs resulting from an immediate major manual overhaul.
- Inconvenience to end-users who are accustomed to the format they are currently using.

When using a traditional paper format ESWPM, the most efficient method of retrieving standard procedures and maintenance information has traditionally been to search in:

- the table of contents (TOC) and/or
- the indexes (i.e., alphanumerical index and/or numerical index, as available).

The ease and speed with which information may be found with these methods relies heavily on the quality of the TOC and/or the indexes. For aircraft maintenance technicians needing to locate and extract the pertinent and applicable data necessary to

perform a satisfactory design modification or maintenance action, finding relevant data may be time-consuming.

When using an electronic format, a search engine can often be used. This allows the user to bypass the TOC or indexes in finding the needed procedure or data. By searching with such alternative methods, a user can find information without needing to know the rules, such as ATA references, governing assignment of the subject matter to its place in the TOC.

The use of a conversion tool, identified as a Master Breakdown Index (MBI) is one method of achieving a common format until existing legacy documents can be physically altered or digitised to an electronic format. The intent of the MBI is to supplement the TOC and existing indexes by providing to users a method of searching existing documents using topical information rather than by part number, alphabetic subject, or Chapter-Section-Subject reference. The arrangement of the MBI duplicates the standardised format described in Paragraph 7 of this AMC, but does not require complete rearrangement of legacy documents to achieve a common format. The MBI acts as a conversion key used to effectively convert an existing document arrangement into the proposed arrangement. In essence the MBI duplicates in paper form for legacy documents the electronic search engine for HTML-based documents.

This is an example of an MBI which could be used to mitigate the need for legacy documents to be reformatted to achieve the standardised format described above:

GROUP	**MAJOR TOPIC**	**APPEARS IN THIS DOCUMENT AS SUBJECT**
GENERAL DATA	SAFETY PRACTICES	20-10-10
	AIRPLANE ENVIRONMENTAL AREAS	20-20-12
	CONSUMABLE MATERIALS	20-00-11
	WIRING MATERIALS	20-10-13
	COMMON TOOLS	20-00-13
ELECTRICAL WIRING INTERCONNECT SYSTEM (EWIS) MAINTENANCE	EWIS PROTECTION DURING MAINTENANCE	20-10-20
	EWIS CLEANING	20-10-20
	EWIS INSPECTION	20-10-20
	EWIS TESTING	20-10-13
	EWIS DISASSEMBLY	20-10-19
	EWIS REPAIR AND REPLACEMENT	20-20-00
WIRING INSTALLATION	WIRE SEPARATION / SEGREGATION	20-10-11 20-10-12
	ELECTRICAL BONDS AND GROUNDS	20-30-60
	WIRE HARNESS INSTALLATION	20-10-17 20-10-18 Installation of Sleeves on Wiring
WIRING ASSEMBLY	WIRE AND CABLE TYPES	20-00-15
	WIRE MARKING	20-60-01

GROUP	MAJOR TOPIC	APPEARS IN THIS DOCUMENT AS SUBJECT
	WIRE HARNESS ASSEMBLY	20-50-01
	WIRE INSULATION AND CABLE JACKET REMOVAL	20-90-12
	TERMINATION TYPE (SPECIFICS OF TERMINATIONS)	20-61-44
ELECTRICAL DEVICES	DEVICE TYPE (SPECIFICS OF ELECTRICAL DEVICE)	20-80-09 Assembly of Leach Relay Sockets
SPECIFIC SYSTEM WIRING	UNIQUE WIRING ASSEMBLIES/INSTALLATIONS	20-73-00 Fuel Quantity Indicating System
AIRLINE CUSTOMISED DATA	AIRLINE SPECIFIED	20-91-00

Appendix A: Groups, Major Topics, Standardised Sequence and Description of Minimum Content

GROUP	MAJOR TOPIC	DESCRIPTION
GENERAL DATA	SAFETY PRACTICES	Safety regulations and general safety precautions to prevent injury to personnel and damage to the airplane
	AIRPLANE ENVIRONMENTAL AREAS	Definition of types of areas upon which wiring configuration and wiring component selection is constrained
	CONSUMABLE MATERIALS	Wiring maintenance processing materials (solvents, aqueous cleaners, lubricants, etc.)
	WIRING MATERIALS	Materials that become an integral part of the wiring configuration excluding wire and cable, e.g., sleeves, shield material, tie material, sealants, etc.
	COMMON TOOLS	Description and operation of common tools
EWIS MAINTENANCE	EWIS PROTECTION DURING MAINTENANCE	Procedures to protect EWIS during airplane maintenance and modification
	EWIS CLEANING	In support of inspection as well as prevention of degradation and preparation for repair; recommended cleaning materials and procedures based on type of contamination
	EWIS INSPECTION	Criteria for correct installation, correct wiring assembly configuration; damage conditions and limits for wiring components (wire and cable, termination types, electrical devices); factors that warrant disassembly for inspection; determination of cause of damage
	EWIS TESTING	Wiring integrity testing
	EWIS DISASSEMBLY	Data and procedures in support of inspection, cleaning when applicable; also supports new wiring installation
	EWIS REPAIR AND REPLACEMENT	Repair of wiring installation, wiring assembly configuration, wiring components (wire and cable, wiring terminations, electrical devices); wire and cable replacement; wiring functional identification
WIRING INSTALLATION	WIRE SEPARATION/ SEGREGATION	Explanation of separation/segregation categories, separation/segregation identification, and necessary conditions for maintaining separation/segregation
	ELECTRICAL BONDS AND GROUNDS	Bond surface preparation, ground hardware configurations, bond integrity testing
	WIRE HARNESS INSTALLATION	Routing, supports; wiring protection, factors affecting wiring assembly configuration; connection to equipment, new wiring,

GROUP	MAJOR TOPIC	DESCRIPTION
		removal from service
WIRING ASSEMBLY	WIRE AND CABLE TYPES	The principal material component of airplane wiring; includes type identification and basic description; alternative wire types (replacements, substitutions)
	WIRE MARKING	Marking; applicable conditions
	WIRE HARNESS ASSEMBLY	Wiring assembly configuration: Assembly materials, layout, overall protection; factors affecting wiring installation
	WIRE INSULATION AND CABLE JACKET REMOVAL	Wire and cable: Insulation removal, jacket removal; associated damage limits, tool description and operation
	<<TERMINATION TYPE>> e.g., SOURIAU 8950 SERIES CONNECTORS	Wiring terminations and accessories (connectors, terminal lugs, splices, backshells, etc.) grouped by termination type from simple to complex: a. Common data or procedures by group (if any), e.g., tool description and operation, definition of internal damage and limits, internal cleaning, accessories b. By individual type - part numbers and description, definition of internal damage and limits (if not specified by common data), disassembly, assembly, installation
ELECTRICAL DEVICES	<<DEVICE TYPE>> e.g., KLIXON 7274 SERIES CIRCUIT BREAKER	Electrical devices (circuit breakers, relays, switches, filters, lamps, etc.) grouped by device type: a. Common data or procedures by group (if any), e.g., tool description and operation, definition of internal damage and limits, internal cleaning, accessories b. By individual type - part numbers and description, definition of internal damage and limits (if not specified by common data), disassembly, assembly, installation
SPECIFIC SYSTEM WIRING	SPECIFIC WIRING ASSEMBLY	For wiring that has a necessarily specific configuration (e.g. Primary Flight Control, Fuel Quantity Indicator System, etc.): - Applicable conditions for repair and replacement - Disassembly, assembly, installation, assembly integrity testing
AIRLINE CUSTOMISED DATA	AIRLINE SPECIFIED	Reserved for airline use