



U.S. Department
of Transportation

**Federal Aviation
Administration**

Advisory Circular

Subject: DEVELOPMENT OF
STANDARD WIRING PRACTICES
DOCUMENTATION

Date: 11/14/07

AC No. 25-26

Initiated by: ANM-100

1. PURPOSE. This advisory circular (AC) provides guidance for developing an electrical system standard wiring practices document for air carriers, air operators, holders of type certificates (TC), holders of supplemental type certificates (STC), maintenance providers, and repair stations. This AC provides a means, but not the only means, to create a document that complies with the requirements of section H25.5(a)(2) of appendix H to Title 14 Code of Federal Regulations (14 CFR) part 25.

2. APPLICABILITY.

a. The guidance provided in this AC is applicable to all air carriers, air operators, holders of type certificates, holders of STCs, maintenance providers, and repair stations operating under 14 CFR parts 21, 25, 43, 91, 121, 125, 135, and 145.

b. This material is neither mandatory nor regulatory in nature and does not constitute a regulation. It describes an acceptable means, but not the only means, for demonstrating compliance with the applicable regulations. We will consider other methods of demonstrating compliance that an applicant may elect to present. While these guidelines are not mandatory, they are derived from extensive FAA and industry experience in determining compliance with the relevant regulations. On the other hand, if we become aware of circumstances that convince us that following this AC would not result in compliance with the applicable regulations, we will not be bound by the terms of this AC, and we may require additional substantiation or design changes as a basis for finding compliance.

c. This material does not change or create any additional regulatory requirements nor does it authorize changes in or permit deviations from existing regulatory requirements.

d. Terms used in this AC such as “shall” or “must” are used only in the sense of ensuring applicability of this particular method of compliance when the acceptable method of compliance described herein is used.

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3. HOW THIS INFORMATION WAS DERIVED. The guidance in this AC is based on recommendations submitted to the FAA by the Aging Transport Systems Rulemaking Advisory Committee (ATSRAC). It is derived from maintenance, inspection, and alteration best practices identified through extensive research by ATSRAC working groups and Federal government working groups. A list of related regulations and documents is contained in Appendix B.

4. CREATING A COMMON ORGANIZATIONAL FORMAT FOR STANDARD WIRING PRACTICES DOCUMENTS.

a. At the conclusion of the FAA's *Aging Transport Non-Structural Systems Plan* Phase I, the Task 4 Working Group found that the current presentation of standard wiring practices makes it difficult for an aircraft maintenance technician to locate data necessary to perform satisfactory electrical repairs.

b. The objective of this AC is to promote a common electrical system wiring practices document by providing a format and the minimum content expected for that document. Although the title of the document is left to the discretion of the organization, this AC refers to the document as the standard wiring practices manual (SWPM).

5. DEFINITIONS.

Consumable Materials – Materials consumed during the maintenance or repair of electrical wiring interconnection systems that are not electrical wiring interconnection system components.

Drip Loop – Looping of a wire or wire bundle to provide a point lower than the adjacent connector for moisture to collect.

Electrical Wiring Interconnection System (EWIS) – The regulatory definition for EWIS is given in § 25.1701 and is repeated here:

§ 25.1701 Definition.

(a) As used in this chapter, electrical wiring interconnection system (EWIS) means any wire, wiring device, or combination of these, including termination devices, installed in any area of the airplane for the purpose of transmitting electrical energy, including data and signals, between two or more intended termination points. This includes:

- (1) Wires and cables.*
- (2) Bus bars.*
- (3) The termination point on electrical devices, including those on relays, interrupters, switches, contactors, terminal blocks and circuit breakers, and other circuit protection devices.*
- (4) Connectors, including feed-through connectors.*
- (5) Connector accessories.*
- (6) Electrical grounding and bonding devices and their associated connections.*
- (7) Electrical splices.*

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- (8) *Materials used to provide additional protection for wires, including wire insulation, wire sleeving, and conduits that have electrical termination for the purpose of bonding.*
 - (9) *Shields or braids.*
 - (10) *Clamps and other devices used to route and support the wire bundle.*
 - (11) *Cable tie devices.*
 - (12) *Labels or other means of identification.*
 - (13) *Pressure seals.*
 - (14) *EWIS components inside shelves, panels, racks, junction boxes, distribution panels, and back-planes of equipment racks, including, but not limited to, circuit board back-planes, wire integration units, and external wiring of equipment.*
- (b) *Except for the equipment indicated in paragraph (a)(14) of this section, EWIS components inside the following equipment, and the external connectors that are part of that equipment, are excluded from the definition in paragraph (a) of this section:*
- (1) *Electrical equipment or avionics that are qualified to environmental conditions and testing procedures when those conditions and procedures are—*
 - (i) *appropriate for the intended function and operating environment, and*
 - (ii) *acceptable to the FAA.*
 - (2) *Portable electrical devices that are not part of the type design of the airplane. This includes personal entertainment devices and laptop computers.*
 - (3) *Fiber optics.*

Environmentally Sealed Splice – A wire splice that ensures that moisture or fluid will not penetrate the spliced area.

Legacy Document – An organization’s standard wiring practices manual existing prior to the adoption of the requirements of H25.5(a)(2) of Appendix H to 14 CFR part 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 8 of this AC.

Separation/Segregation – Either a physical distance between wiring and adjacent structure, systems or wiring, or a barrier that provides at least the equivalent of the protection of the applicable physical distance.

Standard Practices – Information detailing procedures and practices for the universal repair and maintenance of electrical wire, cable bundles, and coaxial cables. Standard practices include procedures and practices for the inspection, installation, and removal of electrical systems components or other EWIS components including methods of bundle attachment, wire splices, connectors and electrical terminal connections, and bonding/grounding.

6. STANDARDIZED SWPM ORGANIZATION. A table outlining the standard organizational format of an SWPM and the sequence of major topics that should be included is contained in Appendix A of this AC.

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7. MINIMUM SWPM CONTENT.

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

b. To ensure that the SWPM contains the information operators and repair stations need, it should be consistent with the following minimum guidelines on areas of content and types of information to be included.

(1) Front Matter. Provide information about content and use of the SWPM. Describe changes to the document in a record of revisions. Ensure the document contains a table of contents or index to allow users to retrieve necessary information quickly.

(2) Safety Practices. Provide general instruction, cautions, and warnings describing safety precautions to be taken before starting any or all of the specific standard electrical practices contained in the core of the SWPM. Safety cautions, warnings, or notes specific to a procedure would be placed in the text describing that procedure.

(3) Cleaning Requirements and Methods.

(a) Encourage "Protect and clean as you go" philosophy.

(b) Identify non-destructive methods for cleaning dust, dirt, foreign object debris (FOD), lavatory fluid, and other contaminants produced by an aircraft environment from wiring systems.

(c) Specify wire replacement guidelines when an accumulation of contaminants, either on the surface and/or imbedded in the wire bundle, cannot be safely removed.

(4) Wire and Cable Identification.

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

(b) Specify methods of direct wire marking. Identify specific requirements and cautions associated with certain types of wire marking.

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(5) Wire and Cable Damage Limits.

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

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

(6) Installation, Clamping, and Routing Requirements.

(a) Specify requirements for wiring system installation relating to physical attachment to aircraft structure. Requirements must be compatible with the different environments applicable to the aircraft and aircraft systems.

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

(c) Establish minimum bend radii for different types of wire and cable.

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

(e) Include requirements for wiring conduit installation relating to physical attachment, routing, bend radii, drain holes, and conduit end coverings.

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

(g) Include necessary information for the maintenance of bonding, grounding, and protections against lightning and high-intensity radio frequency (L/HIRF).

(7) Repair and Replacement Procedures. Describe methods to safely repair and/or replace wiring and wiring system components.

(a) Include types and maximum number of splice repairs for wiring. (When splicing wire, environmentally sealed splices are highly recommended over splices that are not environmentally sealed.) Guidance should be provided on how long a temporary splice may be left in the wire.

(b) Specify procedures for the repair, replacement, and maintenance of connectors, terminals, modular terminal blocks, and other wiring components and the type of tools to be used.

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(8) Inspection Methods.

(a) Specify a general visual inspection (GVI) or a detailed inspection (DET), as determined by an enhanced zonal analysis procedure. Typical damage to inspect for includes heat damage, chafing, cracked insulation, arcing, delaminated insulation, corrosion, broken wire or terminals, incorrect bend radii, contamination, loose terminals, and deteriorated repairs.

(b) Identify, where applicable, established and emerging new technologies for 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.

(9) Customized Data. Provide a location and procedure to allow users to include customized or unique data such as that for supplemental type certificates, operator-unique maintenance procedures, etc.

8. ALTERNATE PROCEDURE FOR LEGACY DOCUMENTS.

a. The adoption of a new layout and chapter organization may require each organization with an existing SWPM to reorganize and republish that document using the new standardized format. Whether the organization produces a stand-alone manual or provides the SWPM as chapter 20 of a wiring diagram manual, this reorganization would result in a significant economic impact on both the authoring organization and end-users.

b. To address this concern, a conversion tool, identified in paragraph e. below, 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.

c. When using a traditional paper format SWPM, the most efficient method of retrieving standard procedures and maintenance information has traditionally been to search by using—

- the table of contents (TOC) and/or
- the indexes (alpha-numerical 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

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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.

d. 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.

e. Use of a conversion tool, identified as a master breakdown index (MBI) is one way of presenting a standard means for finding SWPM information until existing paper legacy documents can be physically altered or digitized to an electronic format. The intent of the MBI is to supplement the TOC and existing indexes. It gives users a way to search existing documents using topical information rather than part number, alphabetic subject, or chapter-section-subject reference. The arrangement of the MBI duplicates the standardized format described in Appendix A of this AC, but does not require complete rearrangement of legacy documents to achieve a common way of finding information. The MBI acts as a conversion key to effectively convert an existing document arrangement into the standardized arrangement. In essence the MBI duplicates in paper form for legacy documents the electronic search engine used in HTML-based documents.

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This is an example of an MBI that could be used to mitigate the need for reformatting legacy documents to achieve the standardized format discussed in this AC.

MASTER BREAKDOWN INDEX		
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 INTERCONNECTION 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
	WIRE HARNESS ASSEMBLY	20-50-01

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MASTER BREAKDOWN INDEX		
GROUP	MAJOR TOPIC	APPEARS IN THIS DOCUMENT AS SUBJECT
	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 CUSTOMIZED DATA	AIRLINE SPECIFIED	20-91-00

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Appendix A

APPENDIX A

**STANDARDIZED ORGANIZATION FOR STANDARD WIRING PRACTICES MANUALS (SWPM)
(Groups, Major Topics, 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 within 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	To support 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 for 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.

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**STANDARDIZED ORGANIZATION FOR STANDARD WIRING PRACTICES MANUALS (SWPM)
(Groups, Major Topics, Sequence, and Description of Minimum Content)**

GROUP	MAJOR TOPIC	DESCRIPTION
	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, removal from service.
WIRING ASSEMBLY	WIRE AND CABLE TYPES	Principal material components of airplane wiring, including type identification, basic description, and 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: <ul style="list-style-type: none"> 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.

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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. Devices 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.): a. Applicable conditions for repair and replacement. b. Disassembly, assembly, installation, assembly integrity testing.
AIRLINE CUSTOMIZED DATA	AIRLINE SPECIFIED	Reserved for airline use.

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APPENDIX B

RELATED REGULATIONS AND DOCUMENTS

a. REGULATIONS. You can download an electronic copy of 14 CFR from the Internet at <http://www.gpoaccess.gov/cfr/>. A paper copy can be ordered by sending a request to the U.S. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402-0001, or by calling telephone number (202) 512-1800; or by sending a request by facsimile to (202) 512-2250.

- | | |
|----------|---|
| 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 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; and Rules Governing Persons on Board Such Aircraft. |
| Part 129 | Operations: Foreign Air Carriers and Foreign Operators of U.S.-Registered Aircraft Engaged in Common Carriage. |
| Part 145 | Repair Stations. |

b. Advisory Circulars (AC). You can download an electronic copy of the latest version of the following ACs from the FAA Internet at <http://rgl.faa.gov>.

- AC 25-16 Electrical Fault and Fire Protection and Prevention
- AC 25.981-1 Fuel Tank Ignition Source Prevention Guidelines
- AC 25.1701-1 Certification of Electrical Wiring Interconnection Systems on Transport Category Airplanes
- AC 43-12 Preventive Maintenance

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- AC 43.13-1 Acceptable Methods, Techniques and Practices—Aircraft Inspection and Repair
- AC 43-204 Visual Inspection For Aircraft
- AC 43-206 Inspection, Prevention, Control, and Repair of Corrosion on Avionics Equipment
- AC 65-15 Airframe & Powerplant Mechanics Airframe Handbook [Chapter 11, Aircraft Electrical Systems]

c. Reports. You can download an electronic copy of the following reports from the “Final Reports” section of the Aging Transport Systems Rulemaking Advisory Committee (ATSRAC) website: www.mitreaasd.org/atstrac.

- “Aging Systems Task Force, Aging Transport Systems, Task 1 and Task 2 Final Report,” dated August 1, 2000.
- “Aging Transport Systems Rulemaking Advisory Committee, Task 3 Final Report,” dated March 26, 2001.
- “Final Report ATSRAC Task Group 4,” dated September 28, 2000.
- “Final Report, ATSRAC HWG Task 7, Electrical Standard Wire Practices Manual (ESWPM),” dated October 31, 2002.
- “Transport Aircraft Intrusive Inspection Project (An Analysis Of The Wire Installations Of Six Decommissioned Aircraft), Final Report,” The Intrusive Inspection Working Group, dated December 29, 2000.

d. Other Documents.

- Air Transport Association (ATA) Specification 117 (Wiring Maintenance/Practices/Guidelines). You can download an electronic copy of this ATA document from <http://www.airlines.org/>.
- FAA Policy Statement No. PS-ANM100-2000-00105 (also numbered ANM-01-04). System Wiring Policy for Certification of Part 25 Airplanes, issued June 25, 2001. You can download an electronic copy of this policy memorandum from the FAA Internet at <http://rgl.faa.gov>.

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APPENDIX C

Following are the discussions of Appendix H 25.5 published in the *Federal Register* on October 6, 2005 (70 FR 58508), in Notice of Proposed Rulemaking No 05-08, Enhanced Airworthiness Program for Airplane Systems/Fuel Tank Safety (EAPAS/FTS), at the time this rule was proposed.

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Appendix H to Part 25 – Instructions for Continued Airworthiness

The proposed Appendix H 25.5 would also require that the following information be included in ICA applicable to EWIS:

- Standard wiring practices data.
- Wire separation design guidelines.
- Information to explain the airplane's EWIS identification method required by the proposed § 25.1711.
- Electrical load data and instructions for updating that data. Such information will help ensure that those modifying, repairing, or installing new EWIS will not perform any action that will adversely affect previously certified systems and unintentionally introduce potential hazards.

Standard wiring practices are defined as standards developed by the specific airplane manufacturer or industry-wide standards for the repair and maintenance of EWIS. They include procedures and practices for the installation, repair, and removal of EWIS components, including information about wire splices, methods of bundle attachment, connectors and electrical terminal connections, bonding, and grounding. Although a standard wiring practices manual is not a design manual, and those designing a new EWIS modification for a specific model airplane should not use it as such, it does provide the designer with insight into the types of EWIS components used by the TC holder and the procedures recommended by the manufacturer for maintenance or repair that supports continued airworthiness of the components.

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**Paperwork Reduction Act
Required information, use, and respondents**

(6) The proposed revision to part 25 Appendix H would require that future manufacturers include acceptable EWIS practices in their ICA, presented in

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a standard format. This information would be used by maintenance personnel for wiring maintenance and repairs. The requirement is necessary because information about cautionary tasks during maintenance that can prevent situations that could compromise safety need to be available to maintenance personnel. Standard wiring practices manuals, in which this information is presented, often differ from manufacturer to manufacturer and so are difficult for maintenance personnel to find specific information in. The requirement for a standard format is meant to correct this. Because of this proposal, manufacturers would change their Standard Wiring Practices Manuals (SWPM).