AC/ACJ for the Subpart H
WS 41-01

Modified in Montreal
Meeting #5 3/18-22/02

25HAC1701 EWIS Definition

For now the group agrees that we do not need advisory material for the EWIS definition.

25.1715 (25HAC611) Accessibility Provisions.

The disposition of EWIS components should be such, as far as practicable, to enable scheduled inspections and/or tests to be made without undue disturbance to the installation.

Consideration, during the design phase, should be given to minimize the amount of aircraft disassembly required to inspect or replace the EWIS components.

25.1717 (25HAC855) Cargo or Baggage Compartments.

~~Wiring~~ EWIS should be installed ~~so the structure affords~~ with protection against its use as a handhold or stepping, ~~and~~ damage from cargo, and protection from moisture and spills. ~~Where the~~ If structure does not afford adequate protection~~, conduit may be used, or~~ a suitable mechanical guard may be provided.

(Further discussion by the WG is required.)

25.1718 (25HAC863) Flammable Fluid Fire Protection.

See paragraph 25.1705 for the ~~segregation~~ separation requirements ~~guidance~~ between electrical wiring interconnection systems ~~components~~ and flammable fluids.

Electrical components located in fuel vapor zones should be qualified as explosion proof in accordance with Section 9 of RTCA/EUROCAE Document DO160/ED-14, "Environmental Conditions and Test Procedures for Airborne Equipment," latest approved revision. Fuel vapour zones are defined by the airplane manufacturer.

25.1707 (25HAC869) Fire Protection: EWIS

The intent of this requirement is to help ensure that the EWIS does not propagate fire and produce hazardous quantities of smoke and toxic fumes

(a) The test methods for the determination of the specific optical density of smoke and the determination of the specific gas components of smoke generated by EWIS components should be agreed with the Authorities. The pass/fail criteria for the optical smoke density and smoke gas components should also be agreed with the Authorities.

(NOTE 1: Recommend to ATSRAC that the exclusion of Fiber Optics should be re-discussed. These should not be exempt from fire, smoke, and toxicity requirements.)

To protect against propagation of ~~an~~ a fire, ~~internal electrical~~ EWIS components other than wire and cable (which must be tested per part 1, appendix F) ~~fire to surrounding locations, electrical components~~ should be designed using non-flammable or self-extinguishing materials as tested to the spirit part 1, appendix F or equivalent. Maximum physical or spatial separation is especially important above the component, or downstream of any consistent, known airflow. See paragraph 25.1705 for the separation requirements ~~segregation guidance~~.

(NOTE 2: Need to recommend to ATSRAC that Appendix F be updated if it is determined that the presented testing methods do not adequately represent current industry standards)

25HAC899 Electrical bonding and protection against lightning and static electricity.
See AC/ACJ899.
It was agreed at WSHWG #5 that the remaining applicable points given below in this section are to be transferred to AC/ACJ899 to keep bonding in one place.

Bonding and grounding ~~points~~ paths ~~must~~ should have sufficient capacity to carry the current without causing heat damage, even under fault conditions. Ground wires or bonding leads which ~~may~~ are ~~be~~ required to carry high energy ~~must~~ should not normally be connected directly to structure.

Ground wires or bonding leads must be as short as is practicable. ~~Where this is not practical due~~ Consideration ~~must~~ should be given to the size of the conductor taking account of the maximum possible fault current.

AC, DC, static and signal circuit grounds ~~must~~ should be identified ~~by markers~~ and ~~separated~~ terminated at independent ground points, including redundant systems.

25HAC1165 (new 1720) Engine Ignition Systems.
No advisory material considered necessary.

25HAC1189 (new 1721)Fuel shut off means.
The location of EWIS components should consider the possible damage that may result to the aircraft following an emergency (or crash) landing.

25HAC1203 (new 1722) Fire Detector System – EWIS
To minimize the occurrences of nuisance fire warnings consideration should be given to separately routing fire detection system wiring within the ~~fire~~ zone to allow more optimum routing and ease of replacement. Particular care should also be exercised with regards to the environmental qualification of the system connectors (e.g Fire resistant, resistance to moisture and fluids etc.).

25HACXXXX Fire Detection Systems – General.
This is a new paragraph decided in WSHWG#5 meeting. Advisory material needs to be developed to make sure that the system can still detect the fire by fire resistant wire or design.

25HAC1301 (new 1702) Function and Installation

a) (1) GENERAL. EWIS components ~~must~~ should be designed and installed ~~sized~~ so that they ~~(as applicable)~~:

(i) have sufficient ~~mechanical strength~~ to allow for service conditions, and

(ii) Wires and cables do not exceed allowable voltage drop levels, and

be appropriate to for the ~~installed~~ environment to which they are installed.

EWIS components should be ~~specifically~~ qualified for airborne use or specifically assessed as acceptable for the intended use.

Note: The Original Aircraft Manufacturer (OAM) lists approved components in their Manuals. Components, or their approved substitutes, listed in the applicable Manual should ideally be used for maintenance, repair or modification of the aircraft. ~~Alternative components may be selected by an appropriately approved Design Organisation (As per FAR/JAR 21)~~ If alternate components are selected they should be qualified for airborne use and specifically assessed as acceptable for the intended use, be at least equivalent to the original OAM component standards and be approved by the relevant design authority.

a)(2) EWIS Component Selection.
The EWIS components shall be selected and installed with due consideration to their service life. This should not normally be less than that service life of the aircraft structure. Installations should be designed, as far as practicable, to permit a satisfactory level of inspection, test and repair or replacement. If the design requires that EWIS components must be replaced at certain intervals, these intervals should be specified in the ICAW as required by 25.1529.

(i) Wire Selection
The most important consideration in the selection of aircraft wire is properly matching the wire's construction to the application environment. Wire construction that is suitable for the most severe environmental condition to be encountered should be selected. Particular attention should be applied to the type of wire needed for the application. Eg Flexible wire for installations involving movement, airframe wire or interconnect wire, higher temperature installations etc.

In considering the acceptability of wire, reference should be made to industry standards that define acceptable test methods for aircraft wire.
Eg, EN3475, MIL-STD-202?, SAE AS4373 etc. etc. (Details to be advised.)
Note: Alternative OAM standards may also be used.

Cables shall be selected taking account of known characteristics in relation to particular installation and application to minimise the risk of cable damage including any arc tracking phenomena.

Insulation of wires should be appropriately chosen in accordance with the environmental characteristics of wire routing areas. Routing of wires with dissimilar insulation, within the same bundle, is not recommended, particularly when relative motion and abrasion between wires having dissimilar insulation can occur.

The temperature rating of a wire must be defined to permit comparison with the worst case requirements of the application. The location of the cable relative to areas of heat must be known.
Cables have a specified maximum continuous operating temperature, and for many types, this may be achieved by any combination of ambient temperature plus temperature rise due to electrical heating.

In general, it is undesirable to contribute more than 40^{o}C rise by electrical heating. (See paragraph (a)(4) below).

Particular reference should be made to the specified voltage of any cable where higher than normal potentials may be used, examples being discharge lamp circuits and windscreen heating.

(ii) Connector Selection
The connector used for each application should be selected only after a careful determination of the electrical and environmental requirements.

Environment-resistant connectors should be used in applications where they will be subjected to fluids, vibration, thermal, mechanical shock, corrosive elements, etc. Firewall class connectors incorporating these same features should, in addition, be able to prevent the penetration of the fire through the aircraft firewall connector opening and continue to function without failure for a specified period of time when exposed to fire. When EMI/RFI protection is required, special attention should be given to the termination of individual and overall shields. Backshell adapters designed for shield termination, connectors with conductive finishes, and EMI grounding fingers are available for this purpose.

iii) Splice Selection.
Environmentally sealed splices conforming to AS81824/1, or equivalent specification, should be used in all applications, particularly in un-pressurised and SWAMP areas. Pre-insulated splices conforming to AS7928, or equivalent specification, may be used in pressurized areas if approved by the OAM or Design Authority as long as the possibility of fluid contamination can be shown to be remote. However, a post insulated splice may be used provided the splice is covered with a suitable plastic sleeve, preferably a dual wall shrink sleeve, that is permanently secured in position at both ends.

Note: The only environmental splice now available use heat shrink material that needs application of heat. Generally, these heat sources cannot be used on fuelled aircraft without proper precautions. Instructions should therefore be included in the aircraft modification and maintenance documentation.

(iv) Wire bundle clamp selection.
Certain designs that employ adhesive means to fix the bundle support to the aircraft structure are known to work loose during aircraft in service operation, either as a result of improper choice of design or surface preparation. Particular

attention should therefore be given to the methods used for fixing this type of wire bundle support.

a)(3) Mechanical Strength.

(i) Wires shall be sufficiently robust to withstand, without risk of failure, all movement, flexing, vibration, abrasion and other mechanical hazards to which they may be reasonably subjected to when installed in the aeroplane and shall be so supported as to prevent mechanical damage. Generally conductor wire should be stranded to minimise fatigue breakage.

(ii) Wire shall also be sufficiently robust to withstand the mechanical hazards to which they may reasonable subjected to during the installation of the wires into the aircraft.

(iii) Wire installed in the same loom shall be able to withstand the wire-to-wire abrasion.

(iv) If it is desirable to use wire sizes smaller than #20, particular attention should be given to the mechanical strength and installation handling of these wires, e.g., vibration, flexing, and termination. Consideration should be given to the use of high-strength alloy conductors in small gauge wires to increase mechanical strength.

(v) Wire bundles should be installed in accordance with the minimum bend radii specified for the largest gauge wire in the bundle. Installation?

(a)(4) Electrical Wire Rating.

Correct Size. To select the correct size of electrical wire, two major requirements must be met:

(1) The wire size should be sufficient to prevent an excessive voltage drop while carrying the required current over the required distance.

(2) The size should be sufficient to prevent overheating of the wire carrying the required current. The basis for determining current rating of wires has been to employ a 40 °C rise as the electrical contribution to operating temperature.

Refer to the appropriate industry standards for the detailed method of selecting wire rating. Eg SAE AS50881 and AECMA EN2853.

(b) See 25AC(J)EWIS Identification.

(c) Installed to limitations

(i) **General**. Wire bundles should be routed in accessible areas that are protected from damage from personnel, cargo, and maintenance activity. They should not be routed in areas in where they are likely to be used as handholds or as support for personal equipment or where they could become damaged during removal of aircraft equipment. Wiring should be clamped so that contact with equipment and structure is avoided. Where this cannot be accomplished, extra protection, in the form of grommets, chafe strips, etc., should be provided. Protective grommets should be used, wherever wires cannot be clamped, in a way that ensures clearance from structure at penetrations. Wire should not have a preload against the corners or edges of chafing strips or grommets. Wiring should be routed away from high-temperature equipment and lines to prevent deterioration of insulation. Protective flexible conduits should be made of a material and design that eliminates the potential of chafing between their internal wiring and the conduit internal walls. Wiring that is routed across hinged panels, should be routed and clamped so that the bundle will twist, rather than bend, when the panel is moved.

(ii) **Areas designated as severe wind and moisture problem** (SWAMP) areas differ from aircraft to aircraft but generally are considered to be areas such as wheel wells, near wing flaps, wing folds, pylons, and other exterior areas that may have a harsh environment. Wires for these applications should have design features incorporated into their construction that address these severe environments.

Note: Reference to the original aircraft manufacturers wire selection should be made prior to the selection of other alternative wire.

(iii) Silver plated conductors. Many high strength copper alloy conductors use silver plating. An electrical fire can result if silver- plated conductors that are contaminated by glycol (de-icing fluid). Accordingly, silver plated conductors should not be used in areas where de-icing fluid can be present unless suitable protection features are employed. Note also that silver plated conductors can exhibit a corrosive condition known as ‘Red Plague’ if the plating has been damaged or is of poor quality and then exposed to moisture. Designers should therefore be aware of these conditions.

(iv) Wires should be supported by suitable clamps, grommets, or other devices at suitable intervals, except when contained in troughs, ducts, or conduits. The supporting devices should be of a suitable size and type, with the wires and cables held securely in place without damage to the insulation.

(v) Fluid contamination of EWIS components should be avoided, as far as practicable. However, EWIS components should be designed and installed assuming that contamination with fluids in the area will occur.
Industry standards, such as RTCA DO-160/EUROCAE ED-14 contain information regarding typical aircraft fluids.
It is particularly important to appreciate that certain contaminants, notably that from toilet waste systems, galleys and fluids which contain sugar, such as sweetened drinks, can induce electrical tracking of degraded electrical wires and unsealed electrical components.

(vi) SLACK. The EWIS should be installed with sufficient slack so that bundles and individual wires are not under tension. Wires connected to movable or shock-mounted equipment should have sufficient length to allow full travel without tension on the bundle. Wiring at terminal lugs or connectors should have sufficient slack to allow two re-terminations without replacement of wires. This slack should be in addition to the drip loop and the allowance for movable equipment.

(vii) Insulating tubing should not be considered as mechanical protection against external abrasion of wire; since at best, it provides only a delaying action. Conduit or ducting should be used when mechanical protection is needed. Note: Insulating tubing is sometimes used to provide additional electrical protection and limited additional mechanical protection or to increase the external wire dimension.

(viii) To avoid damage to the wire insulation the minimum radius of bends in wire groups or bundles should be in accordance with the wire manufacturers specification, OAM recommendations or industry standards such as EN3197 or AS50881.

(ix) Damage to Coaxial cable can occur when clamped too tightly, or when they are bent sharply (normally at or near connectors). Damage can also be incurred during unrelated maintenance actions around the coaxial cable. Coaxial cable can be severely damaged on the inside without any evidence of damage on the outside. The installation design should therefore minimise the possibility of such damage.

AC/ACJ 25H.1309 (new 1703) SAFETY ASSESSMENT

To be added later

25HAC1310 Equipment, systems and installations.

TBD

25HAC1316 System Lightning Protection

TBD

25HAC1351 General.
Separation concept covered by 25HAC EWIS Separation paragraph.

25HAC1353 Electrical equipment and installations.
No text needed. Advisory material included in the separation and identification paragraphs. Can we delete this subpart H requirement paragraph anyway?

25HAC1355 Distribution System

25HAC1357 Circuit Protective Devices

25HAC1360 Electrical Shock and Burn
It was agreed that the concern is already covered by the existing ACJ. Therefore no need for new text.

25HAC1362 (new 1724) Electrical supplies for emergency conditions.
It was agreed that the concern is already covered by the existing ACJ. Therefore no need for new text.

25HAC1365 (new 1725) Electrical Appliances
No additional EWIS text considered necessary.

25HAC1431 (new 1726) Electronic Equipment.
No ACJ or EWIS advisory material necessary.

25HAC1529 New paragraph proposed in WSHWG#5 meeting. Advisory material needs to be considered.

25HAC1706 EWIS Component Identification

A – GENERAL

To ensure that Specific systems remain safe, through availability of identification means for proper recognition during inspection, of original manufacturing design, post-delivery modification of existing systems and the addition of systems , for example by STC, the maintenance shall be able to recognise that the correct part is at the correct place in the correctly separated wiring interconnect system, where system functions are correctly segregated.

Specific system identification principles are part of the general identification principles.

For EWIS components four types of Identification are at least existing and performed at different level of the aircraft life. Each type have its own objectives and its own practical means of realisation.

B - IDENTIFICATION OF EWIS COMPONENTS – COMPONENT MANUFACTURER MARKING – Part Number

In order

- To facilitate the identification & traceability of EWIS components and to ensure compliance to a/c certification envelope,
- To strengthen manufacturing and maintenance processes, quality control, storage, delivery processes,
- To ensure the use of approved/qualified sourcing, in accordance with the certification basis of the product,
- To facilitate the monitoring of aircraft configuration during the aircraft life.

the EWIS components should be identified in accordance with the following:

(1) EWIS components used on aircraft should be identified according to ISO2574 or similar requirements. This identification comprise product part number, manufacturer identification and when possible or specifically required batch identification or year of manufacture.

(2) EWIS Components concerned by (1) above shall at least include: wires, connectors, terminal blocks, bus bars, circuit breakers, clamps

(3) For manufacturer identification: it is also common practice to use the five digit/letter C.A.G.E. code , particularly for wires; size of some components is such than it can be difficult to mark clear

identification, in this case logo can be used.

(4) Ensure that all wires and cables are identified properly at intervals of not more than 380mm (15 inches).

(5) Types of wire manufacturer markings : the marking must be generally of green colour to differ from the OAM black marking, others contrasting colours are also acceptable. The preferred process used are “ink transfer” or “ink jet” process with post burning to increase their resistance to mechanical or chemical aggression. Hot stamp may not be used.

(6) Means used for identification and legibility during the design life must be covered by the component technical specification.

C - IDENTIFICATION OF EWIS <u>COMPONENTS</u> – AIRFRAMER COMPONENT FUNCTION MARKING – <u>Function Identification Number</u>

In order
- To facilitate the inspection of cables runs, and the EWIS system identification
- To strengthen manufacturing , maintenance and modification processes, quality control, storage, delivery processes,
- To allow identification from which system the component belongs to.
- To allow identification of continued safe flight, continued safe landing, egress and specific EWIS components

functions identification shall be provided in accordance with the following:

(1) Functions of EWIS components used on aircraft must be identified ~~by~~ through adequate means, such as markings, labels, tags, placards, etc…

(2) EWIS Components concerned by such request shall at least include: wires, connectors, terminal blocks, bus bars, circuit breakers, electrical conduits, feed-through, pressure seals, splices

(3) In addition to the type identification imprinted by the original wire manufacturer, aircraft wire also contains its unique circuit

identification coding that is put on at the time of harness assembly.

(4) Existing installed wire that needs replacement can thereby be identified as to its performance capabilities, and the inadvertent use of a lower performance and unsuitable replacement wire avoided .

(5) Ensure that all wires and cables are identified properly at intervals of not more than 460mm (18 inches). Coaxial cables are identified at both equipment ends, at least.

(6) Types of wire airframer markings : Hot stamp marking is forbidden. Alternative identification method to mark directly on the wire are : “Laser Printing” preferably, “Dot Matrix”or “Ink Jet Printing” when there is no strong need for chemical or mechanical resistance of the ink. If such methods are not available the use of special sleeves to carry identification marks is possible.

(7) Means used for such identification should be appropriate for the component type. During the design life the marking should be visible and the colour should contrast with the wire insulation or sleeve or support material.

(8) All wires, terminal blocks, and individual studs are clearly identified to correspond to aircraft wiring manuals.

D - IDENTIFICATION OF EWIS <u>BUNDLES</u> – AIRFRAMER IDENTIFICATION – <u>ROUTING</u>

In order
- To facilitate the inspection of bundles, and to identify and maintain physical segregation
- To strengthen manufacturing, maintenance and modification processes, quality control, storage, delivery processes,
- To identify precisely the type of route, route function, (feeder power, radio, continued safe flight, continued safe landing, egress and specific EWIS components),
- To provide a clear identification of physical segregation i.e. to detect the possible mix of different routes/bundles, the mis-routing of a route in an area etc
- To allow identification of routes containing continued safe flight, continued safe landing, egress and specific EWIS components

Identification coding should be available on each bundle with the

following:

(1) Routes or bundles identification coding used on aircraft must be identified by adequate means such as labels, tags, placards, colored ties, bar-codes, ...

(2) In order to ensure awareness of modification designers and maintenance personnel on the defined physical segregation of the different routes of the aircraft model they are working on, electrical drawings should describe wire routings through the entire airplane (for example : incompatibility between routes, minimum distance between routes, absolute ban of mixing) and shall be available in the maintenance documentation

(3) Means used for such identification should be appropriate for the component type . During the design life the marking should be visible and the colour should contrast with the wire insulation or sleeve or support material

(4) The characteristics of all wire cables in each harness shall not be downgraded by the identification process used .

(5) Ensure that all routes or bundles are identified properly at sufficient intervals for installation and maintenance visibility.

(6) Visible Identification of Critical Design Configuration Limitations.

(i) Section **25.981**(b) states that "...visible means must be placed in areas of the airplane where maintenance, repairs, or alterations may violate the critical design configuration limitations." The design approval holder should define a method of ensuring that this essential information will be communicated by statements in appropriate manuals, such as Wiring Diagram Manuals, and be evident to those that may perform and approve such repairs and alterations.

(ii) An example of a critical design configuration control limitation that would result in a requirement for visible means would be maintaining wire separation between FQIS wiring and other high power electrical circuits where separation of the wiring was determined to be a critical design configuration control limitation. Acceptable means of providing visible means

would include color coding of the wiring or, for retrofit, placement of identification tabs at specific intervals along the wiring.

E - IDENTIFICATION OF USER EWIS MODIFICATION OR REPAIR– OPERATORS IDENTIFICATION - CODING

Preliminaries :
- Operators should repair & STC applicants should design wiring modification with respect to OAM wiring philosophy and instructions.
- Modifiers and maintainers of aeronautical products should use practices that reflect the certification criteria applicable to the original airplane manufacturer (OAM). (Ref.. ANM-01-04)

In order to facilitate inspection/monitoring/replacement/repair/modification, eventually implementation, and finally approval :

(1) Repair data package should comprise: configuration, material and production process necessary to repair the wiring installation, including parts identification, location, installation and routing as appropriate, and the temporary or permanent nature of the repair, in accordance with OAM's standard practices instructions or equivalent.

(2) Type design data package should comprise: configuration, material and production process necessary to produce each part in accordance with the certification basis of the product, any specification referenced by the required drawings, drawings that completely define location, installation and routing of all equipments etc (Ref FAA Policy Statement Number ANM-01-04, System Wiring policy for Certification of Part 25 Airplanes)

(3) modifications and repairs shall be identified in accordance with the approved OAM's identification process standard or recorded according to efficient and acceptable methods.

(4) All EWIS components shall be identified.
When replacing wiring or coaxial cables, identify them adequately at both equipment power source ends at least.
All wires, terminal blocks, and individual studs are clearly

identified to correspond to aircraft wiring manuals.

(5) Identification should be available all along the wire (at 460mm, 18 inches maximum). the defined pattern as defined by the OAM). Identification means at each wire extremity is only acceptable when the physical identification on the wire cable cannot be achieved at [OAM] defined pattern due to e.g. wire length restriction.

(6) Types of wire airframer markings : see C(6)

(7) Means used for such identification should be appropriate for the component type ~~be qualified~~. As long as it is installed on the aircraft the marking should be visible and the colour should contrast with the wire insulation or sleeve or support material , e.g. a temporary repair/identification mean using a non-hydraulic resistant material in an hydraulic bay could remain on the aircraft for some days, knowing that the material is not suitable on the long term.

(8) The characteristics of all EWIS components shall not be downgraded by the identification process used .

(9) Replace worn stencils and missing placards in the concerned area

25HAC EWIS Separation

Proposed New 25H AC/ACJ For FAR25H_EWIS_Separation (Has not been discussed in the WG meeting)

A. GENERAL

Wiring designs used on transport airplanes vary significantly between manufacturers and models, therefore it is not possible to define a specific universal separation distance or means of providing a barrier between wiring. If physical separation of system wiring from other wiring or mechanical structure and systems is used, then the minimum physical separation (or equivalent barriers) of these wires should be established based upon analysis of design and installation of specific features including:

- ***The electrical characteristics, power, and criticality of the signals in the wire bundle and adjacent wire bundles, and***
- ***Installation design features including the number, type, and location of support devices along the wire path, and***
- ***The maximum amount of slack wire resulting from wire bundle build tolerances***

and other wire bundle manufacturing variability's, and

- *Probable variations in the installation of the wiring and adjacent wiring, including position of wire support devices and the amount of slack wire that is possible, and*
- *Expected operating environment including the amount of deflection or relative movement that can occur and the effect of a failure of a wire support device, or a broken wire, or other methods used to maintain physical separation, and*
- *Expected maintenance practices as defined by the airplanes manufacturer's standard wiring practices manual and the instruction for continuing airworthiness required by § 25.1529.*

Physical separation must be achieved through separation distance or an appropriate barrier. Other means of physical separation may be used if it is shown to be at least equivalent to separation achieved through the use separation distance or a barrier.

Some airplane types may have localized areas where maintaining the minimum physical separation distance is not feasible (e.g., where the wire must go through a pressure seal). When the applicant justifies the need to go below the established minimum physical separation distance or other means to ensure the physical separation may be acceptable. The applicant must demonstrate that the proposed means is equivalent to the minimum separation distance or barrier as determined using the above criteria. Additionally, means must be provided to allow for the direct visual inspection of the wiring and barriers. To facilitate identification of specific separated system bundles, see the guidance provided in "25H AC/ACJ EWIS Identification" paragraph. Non-destructive inspection aids may be used where it is impracticable to provide for direct visual inspection if it is shown that the inspection is effective and the inspection procedures are specified in the maintenance manual required by § 25.1529.

B. SYSTEM SEPARATION

EWIS and wires of redundant aircraft systems should be routed in separate bundles and through separate connectors to prevent a single fault from disabling multiple systems. Wires not protected by a circuit-protective device, such as a circuit breakers, current limiting devices or, fuses, should be routed separately from all other wiring. Power feeders from separate power sources should be routed in separate bundles from each other and from other aircraft wiring, in order to prevent a single fault from disabling more than one power source. The ground wires from aircraft independent power sources should be grounded individually to the airframe at separate points so that a single ground failure will not disable multiple power sources. Wiring that is part of electro-explosive subsystems, such as cartridge-actuated fire extinguishers, rescue hoist shear, and emergency jettison devices, should be routed in shielded and jacketed twisted-pair cables, shielded without discontinuities, and kept separate from other wiring at connectors. Separation distances (or equivalent barriers) should be determined considering the factors listed in GENERAL paragraph A above.

C. ELECTROMAGNETIC INTERFERENCE (EMI)

EWIS and wiring of sensitive circuits that may be affected by EMI must be routed away from other wiring interference, or provided with sufficient shielding to avoid system malfunctions under operating conditions. EMI between susceptible wiring and wiring which is a source of EMI increases in proportion to the length of parallel runs and

decreases with greater separation. EMI should be limited to negligible levels in wiring related to systems necessary for continued safe flight, landing and egress. Function of systems should not be affected by the EMI generated by the adjacent wire. Separation distances (or equivalent barriers) should be determined considering the factors listed in GENERAL paragraph A above.

D. SEPARATION FROM PERSONNEL AND CARGO

EWIS in general and wiring in particular must be installed so the structure affords protection against its use as a handhold and damage from cargo. Wires and wire bundles should be routed or otherwise protected to minimize the potential for maintenance personnel to step, walk, or climb on them. Where the structure does not afford adequate protection, other protection means should be used, or a suitable mechanical guard should be provided. The wire bundles should be routed along heavier structural members whenever possible. Sharp metal edges must be protected by grommets to prevent chafing. Wires should not be routed between aircraft skin and fuel lines. Avoid running wires along the bottom of the fuselage, over the landing gear, in areas of the leading edge of the wing where fuel spillage is anticipated, or adjacent to flammable fluid lines or tanks. EWIS components in the passenger cabin should be protected from possible damage by passengers. Wiring routed to, and on, seats, should be protected so passenger luggage, feet, or other possible contact by the passenger does not damage the wire. Separation distances (or equivalent barriers) should be determined considering the factors listed in GENERAL paragraph A above.

E. SEPARATION FROM HIGH TEMP EQUIPMENT

EWIS in general and wiring in particular must be routed away from high-temperature equipment and lines to prevent deterioration of the EWIS and wire insulation. Wires must be rated so that the conductor temperature remains within the wire specification maximum when the ambient temperature, and heat rise, related to current carrying capacity are taken into account. The residual heating effects caused by environmental operating condition exposure to sunlight should also be taken into account. Wires in fire detection, fire extinguishing, fuel shutoff, and fly-by-wire flight control systems that must operate during and after a fire, must be selected from types that are qualified to provide circuit integrity after exposure to fire for a specified period. Separation distances (or equivalent barriers) should be determined considering the factors listed in GENERAL paragraph A above.

F. SEPARATION FROM FLIGHT CONTROLS

EWIS in general and wiring in particular must be physically separated and clamping of wires routed near movable flight controls must be attached and must be spaced so that failure of a single attachment point can not result in interference with flight controls cables, components or other moveable flight control surfaces or equipments. Separation distances (or equivalent barriers) should be determined considering the factors listed in GENERAL paragraph A above.

G. SEPARATION FROM FLAMMABLE FLUIDS

An arcing fault between an EWIS in general and electrical wire in particular and flammable fluid line may puncture the line and result in a fire. Every effort must be made to avoid this hazard by physical separation of the EWIS from lines and equipment containing oxygen, fuel, hydraulic fluid, and other flammable fluid lines. Separation distances (or equivalent barriers) should be determined considering the factors listed in GENERAL paragraph A above. EWIS should be routed and installed with a maximum achievable separation as determined considering the factors listed in GENERAL paragraph A above whenever possible. Further, other means of protection (e. g. drip shield) must be provided to prevent potential leaking fluids on EWIS.

H. SEPARATION FROM WATER/WASTE

Leakage from these systems can cause damage to EWIS components and adversely affect their integrity. Every effort should be made to design and install EWIS so that leaking fluid does not contact the wiring or electrical connectors. Wiring and other EWIS components should be routed with a maximum achievable separation as determined in GENERAL paragraph A above. Further, EWIS should be designed and installed so that some means of protection from potential leaking fluids is provided (e.g., drip shields).

I. INSTRUCTIONS FOR CONTINUING AIRWORTHINESS

Required inspections, EWIS component replacement, non-destructive testing, and any other actions required to maintain separation between the EWIS of the airplane systems required for continued safe flight, landing, and egress must be addressed in the instructions for continuing airworthiness as required by § 25.1529.