Example: Terminal Stacking

To prevent corrosion from dissimilar metals, put a cadmium washer between aluminum and copper terminals.
Example: Lock Washers, cont.
AC 43.13-1b Topics Covered

- Electrical load determination
- Breaker and wire sizing/selection
- Routing/clamping/bend radii
- Splicing
- Wire terminals

- Grounding and bonding
- Wire marking
- Connectors and conduits
- Wire insulation properties
Grounding Definition

Grounding is the process of electrically connecting conductive objects to either a conductive structure or some other conductive return path for the purpose of safely completing either a normal or fault circuit.
Grounding

- Types of grounding
  - AC returns
  - DC returns
  - Others

- Avoid mixing return currents from various sources
  - Noise will be coupled from one source to another and can be a major problem for digital systems
Grounding, cont.

- Design of ground path should be given as much attention as other leads in the system.
- Grounding should provide a constant impedance.
- Ground equipment items externally even when internally grounded.
  - Avoid direct connections to magnesium structure for ground return.
Grounding, cont.

Heavy current grounds

- Attach to individual grounding brackets attached to aircraft structure with a proper metal-to-metal bond
- Accommodate normal and fault currents of system without creating excessive voltage drop or damage to structure
- Give special attention to composite aircraft
Bonding

- Equipment bonding
  - Low impedance paths to aircraft structure required for electronic equipment to provide radio frequency return circuits
  - Facilitates reduction in EMI for most electrical equipment
    - Cases of components that produce EMI should be grounded to structure
Metallic surface bonding

- Electrically connecting conductive exterior airframe components through mechanical joints, conductive hinges, or bond straps
- Protects against static charges and lightning strikes
AC 43.13-1b Topics Covered

- Electrical load determination
- Breaker and wire sizing/selection
- Routing/clamping/bend radii
- Splicing
- Wire terminals
- Grounding and bonding
- **Wire marking**
- Connectors and conduits
- Wire insulation properties
Wire Marking

⇐ Necessary for:

- Safety of operation
- Safety to maintenance personnel
- Ease of maintenance/troubleshooting

⇐ To identify performance capability, use wire material part number and five digit/letter code identifying manufacturer
Wire Marking, cont.

- Wire identification ID should identify wire type, circuit, and gauge size.
- Markings should be legible in size, type, and color at 15-inch maximum intervals along the wire [directly on wire or indirect (sleeve/tag)].
- <3 inches needs no marking
  - Readable without removing clamps, ties, or supporting devices.
Example: Marking a Wire Bundle
AC 43.13-1b Topics Covered

- Electrical load determination
- Breaker and wire sizing/selection
- Routing/clamping/bend radii
- Splicing
- Wire terminals
- Grounding and bonding
- Wire marking
- Connectors and conduits
- Wire insulation properties
Connectors

- Many types of connectors, however crimped contacts generally used
  - Circular type
  - Rectangular
  - Module blocks

- Selected to provide max. degree of safety and reliability given electrical and environmental requirements
  - Use environmentally-sealed connectors to prevent moisture penetration
Circular Connectors
Example: Lock Wire Installation

Wired in Counter Clockwise direction

incorrect
Example: Lock Wire Installation, cont.

Clock wise direction

Correct
Rectangular Connectors
Module Blocks (Terminal Blocks)
Terminal Block Grommet Distortion

View A
Acceptable

View B
Unacceptable

Wire

Grommet
Exercise: Grommet Distortion
Conduits

 месяц

Purpose

- Mechanical protection of wires and cables
- Grouping and routing wires

Standards

- Absence of abrasion at end fittings
- Proper clamping
- Adequate drain holes free of obstructions
- Minimized damage from moving objects
- Proper bend radii
Review Exercise 7: Bend Radius

Calculate the minimum bend radius for this wire bundle (assume it is supported at one end only).

Select an answer:

a. 1 inch  
b. 5 inches  
c. 7 inches  
d. 8 inches  
e. 7.4 inches
AC 43.13-1b Topics Covered

- Electrical load determination
- Breaker and wire sizing/selection
- Routing/clamping/bend radii
- Splicing
- Wire terminals
- Grounding and bonding
- Wire marking
- Connectors and conduits
- Wire insulation properties
Wire Insulation Selection

Choose characteristics based on environment

- Abrasion resistance
- Arc resistance
- Corrosion resistance
- Cut-through strength
- Dielectric strength
- Flame resistant
- Mechanical strength
- Smoke emission
- Fluid resistance
- Heat distortion
<table>
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<tr>
<th>Polymer</th>
<th>Mil Spec</th>
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<tr>
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<tr>
<td>ETFE</td>
<td>22759/16</td>
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<td>81381</td>
</tr>
<tr>
<td>Composite</td>
<td>22759/80-92</td>
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</table>
How to Choose Wire Insulation

Seek the best balance of properties:

- Electrical
- Mechanical
- Chemical
- Thermal

Plus

- Nonflammability and low smoke
Conclusion on Insulation

- Aircraft designer can choose among many polymeric materials
- Physical and chemical properties are equally important
- Safest system combines “balance of properties” with inherent flame and/or smoke resistance
AC 25-16: Electrical Fault and Fire Detection

- Supplements existing guidance provided in AC 43.13-1b
- Should apply to new airplanes, as well as modifications
- Not intended to take the place of instructions or precautions provided by aircraft/equipment manufacturers
Arc Tracking and Insulation Flashover
(Caused by multiple circuit breaker resets)
Wire Separation

➤ Regulatory requirements
  ■ Sections 25.1309(b), 25.903(d), 25.1353(b), 25.631

➤ Manufacturers’ standards
  ■ Power/signal wire separation
    ➤ EMI concerns
Clean-as-you-go Philosophy

- Keep wiring clean throughout the life of aircraft
  - Protect wiring during routine maintenance
  - Clean wiring periodically (vacuum, light brushing, etc.) during heavy maintenance when hidden areas are exposed
Focus Areas

**Clamping points**
- Improper installation
- Clamp/wire damage
- Clamp cushion migration

**Connectors**
- Worn seals
- Loose connectors
- Lack of strain relief
- Drip loops
- Tight wire bends
Focus Areas, cont.

✈ Terminations
  ■ Lugs/splices

✈ Backshells
  ■ Improper build-up
  ■ Lack of strain relief

✈ Damaged sleevings and conduits

✈ Grounding points
  ■ Tightness
  ■ Cleanliness
  ■ Corrosion
Wiring Inspection Locations

- **Wings**
  - Exposed wiring on leading/trailing edges during flap/slat operation

- **Engine/APUs/pylon/nacelle**
  - Heat/vibration/chemical contamination
  - High maintenance area

- **Landing gear/wheel wells**
  - Environmental/vibration/chemical
Wiring Inspection Locations, cont.

- **Electrical panels/line replacement units (LRU)**
  - High density areas
  - High maintenance activity
  - Prone to broken/damaged wires

- **Batteries**
  - Chemical contamination/corrosion

- **Power feeders**
  - Feeder terminations
  - Signs of heat distress
Wiring Inspection Locations, cont.

- Under galleys and lavatories
  - Susceptible to fluid contamination
  - Fluid drainage provisions
- Cargo bay/underfloor area
  - High maintenance activity
- Surfaces, controls, doors
  - Moving and bending wire harnesses
- Near access panels
  - Prone to accidental damage
Questions ??
Thank You