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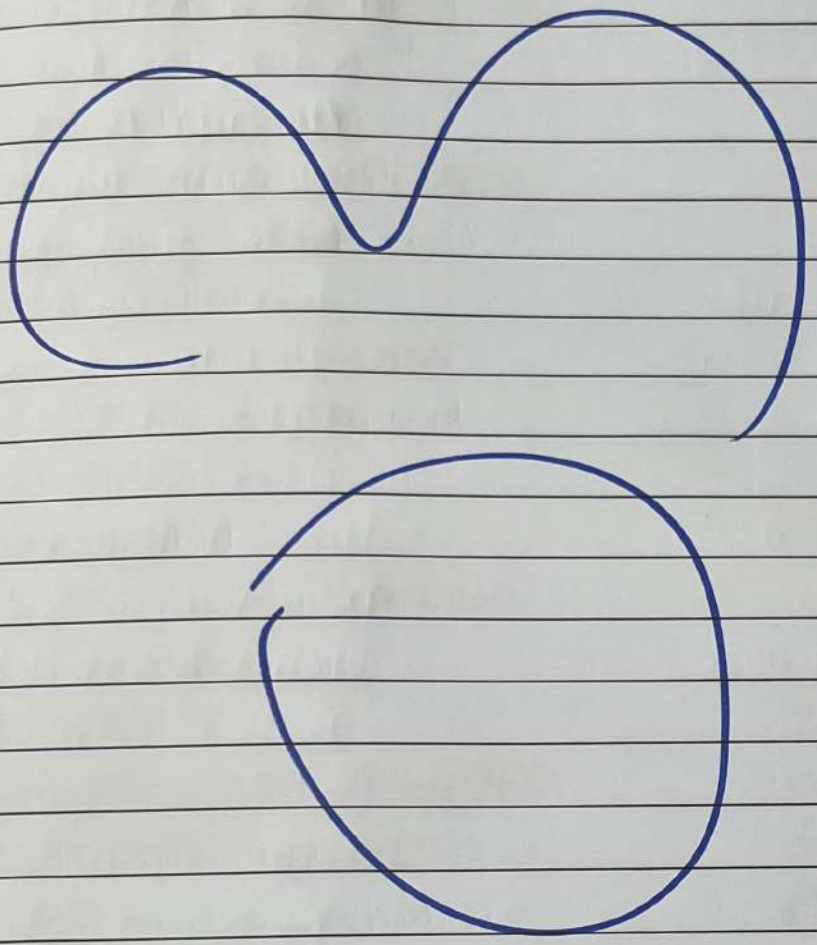

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→ Defective studs:
should be replaced with studs of the same size and material since terminal studs of smaller size may shear due to over tightening the nut.

Replacement:
→ replacement stud should be securely mounted in terminal strip
→ terminal securing nut should be tight

terminal strip:
→ should mounted in such manner that loose metallic objects cannot fall across the terminal or studs.
→ it is good practice to provide at least one spare stud for future circuit expansion or in case stud is broken.

terminal strips that provide connection of radio and electronic system to aircraft electrical system should be
→ inspected for loose connection
→ metallic object that have fallen across terminal strip
→ dirt and grease accumulation

these condition can causes:
arcing which result in fire or system failure.

terminal Lugs:-
should be used to connect wiring to
→ terminal block studs
→ equipment terminal studs
No more than 4 terminal lugs, or 3 terminal lugs and bus bar should be connected to any one stud
terminal lugs should be
→ selected with stud hole diameter that matches the diameter of studs
when terminal lugs attached to stud vary in diameter,
→ greatest diameter should be placed on bottom
→ smallest on top.

Copper wire terminals:
→ solderless crimp style, copper wire, terminal lugs must be used which conform to MIL-T-7928.
→ spacers or washers should not be used between the tongues of terminal lugs.

Al wire terminals:
→ Al terminal lugs should be crimped to Al wire only.
→ tongue of Al terminal lugs or total number of tongues of Al terminal lugs when stacked, should be sandwiches between two flat washers when terminales on terminal studs

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-> spacers or washer should not be used between tongues of terminal lugs

important :

special attention should be given to Al wire and cable installation to guard against condition that result in

-> excessive V drop

-> high resistance at connection may lead to failure of connection

Example of such condition are improper installation of terminal and washer :

-> improper torsion (torque) of nuts

-> inadequate terminal contact areas.

pre-insulated splices

pre-insulated lugs and splice must be installed using high quality crimping tool.

such tool are provided with positioners for wire size and are adjusted for each wire size.

it is essential that the crimp depth be appropriate for each wire size.

if crimp is too deep, it may break or cut individual strands

if crimp is not deep enough it may not be tight enough to retain the wire in terminal or connector.

crimps that are not tight enough are also susceptible to high resistance due to corrosion build up between the crimped terminal and wires.

Emergency splicing Repair

Broken wires can be repaired by means of

-> crimped splices,

-> using terminal lugs from which the tongue has been cut off.,

-> by soldering together

-> putting broken strands.

These repair are applicable to copper wire.

Damaged Al wire must not be temporarily spliced.

These repair are for temporary (emergency) use only and must be replaced with permanent repairs.

manufacturer instruction should always be consulted.

Crimping tools

what are available for crimping terminal lugs, Hand, portable, stationary power tools.

These tools crimp the barrel to the conductor, and form the insulation support to wire insulation

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hydraulic crimping tools may also be used, especially when dealing with large size and cable.

→ has four position upper die
→ lower die for crimping terminal wire sizes 9, 6, 4 and 2

To operate:

1. open the tool by passing the latch
2. pull back the rest lock
3. turn the thumb lock until the required die appears.
4. the lock spring into place
5. position wire → terminal assembly in die and close the hand.
6. Rotate the reservoir handle clockwise to close the hydraulic fluid pressure return port.
7. when handle moves, hydraulic fluid is then pumped and the die begin to close.
8. sudden ↓ in effort indicate that the crimping is completed
9. Rotate reservior handle anti-clockwise to release the hydraulic pressure and open the die.

Inspection and testing of Crimped joints

crimped joint:

should be very strong.

wire and insulation:

should not slip or move when tension load is applied

Both contacter and insulator must be correctly inserted in the terminal end fitting.

only contacter material should be in the crimp barrel.

Neither the contacter or insulator should appear damaged in any way

with insulator material gripped by the insulation crimp so that the contacter is not visible.

Actual testing of crimps is not performed on installation made with proper crimping tool.

crimping tools should be

→ inspected annually

→ on condition if excessive play is detected.

crimp made with a tool can be checked using go no go ~~gauge~~ gauges supplied by tool manufacturer

Connecter pin removal and insertion

There is a wide variety of electrical connectors used in aircraft electrical / avionics systems.

plastic removal / insertion tools

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higher

→ press the wire of contact to be removed against serration of the plastic tool and pull both the tool and contact wire assembly out of connector.

Adjacent location

Many of adjacent connectors should not be possible adjacent connector pair. must be different in

1. Shell size
2. Coupling means
3. insert arrangement
4. keying arrangement

when such means is impractical

→ wire should be routed

→ clamped so incorrectly mated pair cannot reach each other

Reliance on marking or color stripes is not recommended as they are likely to deteriorate with age.

Testing

Coaxial Cable :

~~what are vulnerable to certain types of damage?~~

~~Coaxial and triaxial cables~~

Simple coaxial cable can be done by ohmmeter

it can be performed before the ends terminals are

1. installed to simply check the cable itself
2. check can be made with end terminal installed

There must always be

→ low R, basically zero R, when ohmmeter probes are touched to inner connector.

→ There should always be infinite R when the probes are touched to the connector and shielding.

in other word:

→ connector and shielding should be electrically isolated at all times

→ required shielding

→ there should be no resistance between shielding

Wire protection : cable looms, support, clamps, heat, shrink wrap and shielding.

→ interconnecting wire :

→ used in point to point open harnesses.

→ in interior or pressurized fuselage

→ with each wire providing enough insulation to resist damage from handling and service exposure

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Bend Radii

The minimum radius of bends in wire group or bundle must

not be less than 10 times the outside diameter of largest wire or cable.

except that

the terminals strips where wires break out at termination or reverse direction in bundle.

where wire is suitably supported, The radius may be three times the diameter of wire or cable.

Where it is not practical to install wiring or cable within radius requirment,

→ the bend should be enclosed in insulating tubing.

The radius of thermocouples wire

→ should be done in accordance with manufacturer recommendation

→ should be sufficient to avoid excess losses or

→ damage cable.

Ensure that:

RF Cables (Coaxial and triaxial) are bent at radius no less than SIX times the outside diameter of cable.

Wire protection

protection against chafing

wires and wire group should be

→ protected against chafing or abrasion in those location where contact with sharp surface or other wires would damage the insulation

→ chafing could occur against the airframe or other component.

→ damage to insulation can cause

1. short circuit
2. malfunction
3. inadvertent operation of equipment.

protection against high Temperature

Wiring must be routed

1. routed away from high T equipment and lines to prevent deterioration of insulation
2. routed so, the conductor T remains within wire specification mark when ambient T and heat rise related to current carry in capacity are taken

The residual heating effect caused by exposure to sunlight when aircraft are parked for extended period should also be taken.

wires such as, these used in fire detection, fire extinguishing, fuel shutoff, and fly by wire flight control system must be

-> operate during and after fire
-> selected from type that are qualified to provide circuit integrity after exposure to fire for specified period.

wire insulation deteriorates rapidly when subjected to high temperature.

to prevent insulation breakdown

-> separate wires from high temperature equipment such as : resistors, exhaust stacks, heating ducts.

insulate wires that must run through

-> hot areas with high T insulation material such as fiberglass or PTFE

Avoid high T areas when using cable with soft plastic insulation such as polyethylene because these materials are subject to deterioration and deformation at elevated T.

many coaxial cable have this type of insulation.

protection against solvent and fluids:

An arcing fault between

-> electrical wires
-> metallic flammable fluid lines

may puncture the line and result in fire.

to avoid this hazard:

by physical separation of wire from lines and equipment containing : O_2, fuel, oil, fuel, hydraulic fluid or alcohol.

A minimum of

-> 5 cm must be maintained between wiring and such lines and equipment
-> except when wiring is positively clamped to maintain at least 1.25 cm separation, or
-> when it must be connected directly to fluid carrying equipment.

These clamps should not be used as means of supporting the wire bundle

Additional clamps should be installed

-> to support the wire bundle,
-> the clamps fastened to same structure used to support the fluid line to prevent relative motion

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back of clamp
should be rested against
structural member
what we could use to maintain
clearance between wires and
structure ?
Stand-offs
clamps must be installed in
such manner that the
electrical wires do not come
in contact with other parts
of aircraft when subjected
to vibration.
When wire bundle is clamped
into position, if there is less than
1 cm of clearance between
the bulkhead cutout and the
wire bundle,
a suitable grommet should be
installed
grommet may be cut at
→ 45° angle to facilitate
installation,
→ provided it is cemented
in place
→ The slot is located at
the top of cutout.

inspection of wires and cable clamp:

inspect:
→ wires and cables for proper tightness.
where cable pass through structure or bulkhead
→ for proper clamping
and grommet
→ for sufficient slack
between the last clamp
and electronic equipment
to prevent strain at cable
terminals and to minimize
adverse effect on shock
mounted equipment.
wires and cable are
supported by
suitable clamps, grommet
or other device at intervals
of not more than 60 cm.
→ except when contained in
troughs, ducts, or conduits

To maintain clearance
between wires and structure
use metal stand offs.
Tape and rubber
is not acceptable as
alternative to stand off
for maintain clearance.
install:
→ phenolic blocks, plastic
liners, rubber grommet in
holes
→ bulkhead, floor, or
structure member where
it is impossible to install
off angle clamps to
maintain wiring
separation.

properly:

1. secure clamp retaining bolt so the movement of wires and clamps is restricted between
   1. point of support
   2. not on soldered
   3. mechanical connection at terminal posts or connectors.

Movable controls wiring precautions:

clamping of wire routed near moveable flight controls must be attached with

→ steel hardware

↔ must be spaced so that failure of single attachment point cannot result in interference with controls

The minimum separation between wiring and movable controls must be at least 12.7 mm when bundle is displaced by light hand pressure in direction of controls.

Conduit:-

conduit:

is manufactured in metallic and nonmetallic material and in both rigid and flexible forms

purpose:

is for mechanical protection of cables or wires.

size:

should be selected for specific wire bundle application to allow for

1. ease in maintenance
2. possible future circuit expansion
3. by specifying the conduit inner diameter (ID) about 25% larger than maximum diameter of wire bundle.

How can we avoid conduit problems:

1. Do not locate conduit where passenger or maintenance personnel might use it as handhold or footstep.
2. provide drain holes at the lowest point of conduit run. Drilling burrs should be carefully removed
3. support conduit to prevent chafing against structure and to avoid stress in its end fitting.

Rigid conduit:-

Damaged conduit section should be repaired to preclude injury to wires or wire bundle but must not consume as much as 80% tube wire

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Kinked or wrinkled bends in rigid conduit are not recommended and should be replaced.

Tubing bends that have been flattened into ellipse and have minor diameter of less than 75% of nominal tubing diameter should be replaced.

because the tube area has been reduced by at least 10%.

Tubing that has been formed and cut to final length should be deburred to prevent wire insulation damage.

when ~~installing~~ installing replacement tube section with fitting at both ends. care should be taken to eliminate mechanical strain.

Flexible conduit :-

Flexible Al conduit conforming to specification MIL-C-6136 B

Available in two types;

- Type I, bare flexible conduit
- Type II, rubber-covered flexible conduit.

Flexible brass conduit conforming to specification: MIL-C-7931 is available and normally used instead of flexible Al, where necessary to minimize radio interference. Also Available is plastic tubing (MIL-T-8191A.

Flexible conduit may be used where it is impractical to use rigid conduit such as area that have motion between conduit ends or where complex bends are necessary.

When cutting flexible tubing with hacksaw to minimize fraying of braid, The use of transparent adhesive tape is recommended

Steps;

1. Tape centered over cutting reference mark with saw cutting through the tape
2. The transparent tape should be removed.
3. Frayed braid ends trimmed, burrs removed from inside the conduit
4. Coupling nut and ferrule installed.

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Heat Shrink Wrapping

Heat shrinkable Tubing:

may be an appropriate alternative to flexible conduit

Various types are available for different purposes such as

1. identification
2. color coding
3. strain relief of wire
4. termination
5. cable jacketing
6. repair work.

Each type has dielectric rating and operating temperature range which must be considered before usage.

→ comes in a variety of diameters so

→ can be ~~slipped~~ slipped over the wire or cable.

→ As a heat source: use hot air gun or compressed air heater.

Note:

→ electric heat guns: are not explosion proof, and are not approved for use in hazardous location

→ pneumatic powered gun: is preferred.

→ use caution to: not overheat the wrap, or wires inside.

→ polyurethane coated wires: release irritating gasses when the T exceed 315°C

Wire shielding:

Shielding:

→ is the process of applying metallic covering to wiring and component

→ to eliminate electromagnetic interferences [EMI]

EMI is caused when electromagnetic field (radio wave) induced high frequency (HF) voltage in wire or component.

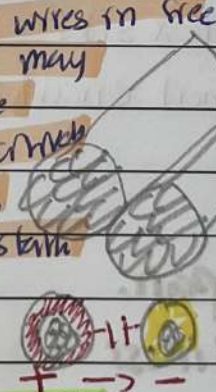
Induced voltage can causes

→ system inaccuracies or

→ even failure.

is recommended to use shielding with 85% coverage or greater.

Coaxial, triaxial, twinaxial or quadraxial cable should be used, airframe grounded structure may also be used as EMI shield



→ when wire come close together, they can couple enough interference to cause detrimental upset to attached circuitry

This called crosstalk

→ The potential of crosstalk is real.

only way to prevent crosstalk is to shield the wire.

Charge on 1st wire induce opposite charge on 2 wires

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Junction boxes :-

Junction boxes are used for :

→ collecting, organizing and distributing circuit to appropriate harnesses that are attached to equipment.

→ used to conveniently house miscellaneous component such as relays, diodes

→ used in high T areas

→ should be made of stainless steel

Replacement of junction boxes :

→ fabricated

→ using same materials as original or

→ from fire resistant, nonabsorbant material such as Al or acceptable plastic material.

what prevent oil-canning of box sides but could result in internal short circuit:

Rigid construction

EWIS installation, Repair, maintenance, and cleanliness

EWIS standard :-

→ was a brought to address

→ incidents and accidents

→ incidents and accident were happening due to

→ fit and forget mentality

wire degradation due to

→ stress, chemical absorption, time, design errors,

contributes directly to aircraft system problems.

The following was found to improve / address EWIS

1. Aircraft operators are required to inspect EWIS / aircraft wiring parts / equipment regularly
2. provide better / on going training to employees for repair / inspection techniques
3. cultural training on the importance of electrical wiring system as important.

EWIS potential problem

potential EWIS areas of concern :

1. chemical degradation due to fluids, fuel, hydraulic, water, oil —
2. improper routing of cable
3. Clamps and termination
4. FOD from maintenance action [drill filing]
5. poor repair to wires
6. Heat and vibration
7. moisture
8. malfunction of adjacent system / 9. Corrosion

EWIS inspection

1. General visual inspection (GVI)
   -> A mirror maybe necessary
   -> inspection is done under normal light conditions, daylight hangger light, flashlight, droplight
   -> inspect enterior and exterior aren
2. Stand alone GVI
   -> inspection of particular aren not part of GVI
   -> is normally called maintenance schedule to draw attention to particular part of sub assembly
3. Detailed inspection (DET)
   -> is of specific item is called for the manufacturer or aircraft maintenance manual (AMM)

inspection zone areas:

1. clamping point
2. connectors
3. Termination
4. Backshells
5. Damaged bleeding and conduits
6. Grounding points.

inspection locations:

-> Wing -> Engine, pylon, Nacelle Area
-> APU -> landing gear - Wheel wells
-> Electrical pannel and line Replaceable units (LRU)
-> Batteries -> power feeders
-> under galleys and lavtories.
-> Cargo Bay / underfloor
-> Surface, controls, door
-> Accesses panels

EWIS Cleaning Requirment and methods

manufacturer and operaters are required to
-> identify non destructive methods for cleaning dust, dirt, foreign object debris (FOD), lavatory fluid and other contaminents produces by aircraft environment from wire system.
They must specify wire replacement guidlines when
-> accumulation of contaminents, either on surface and/or embedded in wire bundle, cannot be safely removed.
For maintaing clean EWIS follow manufacturer and operator guidance.

1. EWIS inspection is (GVI)
   -> General visual inspection
   -> stand alone
   -> Detailed inspection (DET)

2. two advantage of coaxial cable
   1. highly resistance to electromagnetic interference,
   2. shielded against electrostatic and magnetic field.
   3. easy to install with high bandwidth capacity

2. do not radiat energy, They will not pickup any energy. and be influenced by other strong field