Team A Standards and Regulations Presentation

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Outline

Amazon's proposal for Air Safety Regulations involving small Unmanned Aerial Systems (sUAS)
- What it is about
- Applications
- Main prescription of the standard
- How it applies to Project Pegasus

NASA-STD 8739.4: Crimping, Interconnecting Cables, Harnesses, and Wiring
- What it is about
- Applications
- Main prescription of the standard
- How it applies to Project Pegasus

Amazon's proposal for:
Air Safety Regulations involving small Unmanned Aerial Systems (sUAS)

What it is about

Exponentially increasing sUAS
Need regulation for sUAS safety and air traffic management

Image Source: gcn.com

Applications

1. Package Delivery
2. Agriculture
3. Surveillance
4. Photography
5. Search & Rescue
6. Mining Survey
7. Mapping
8. Security & more

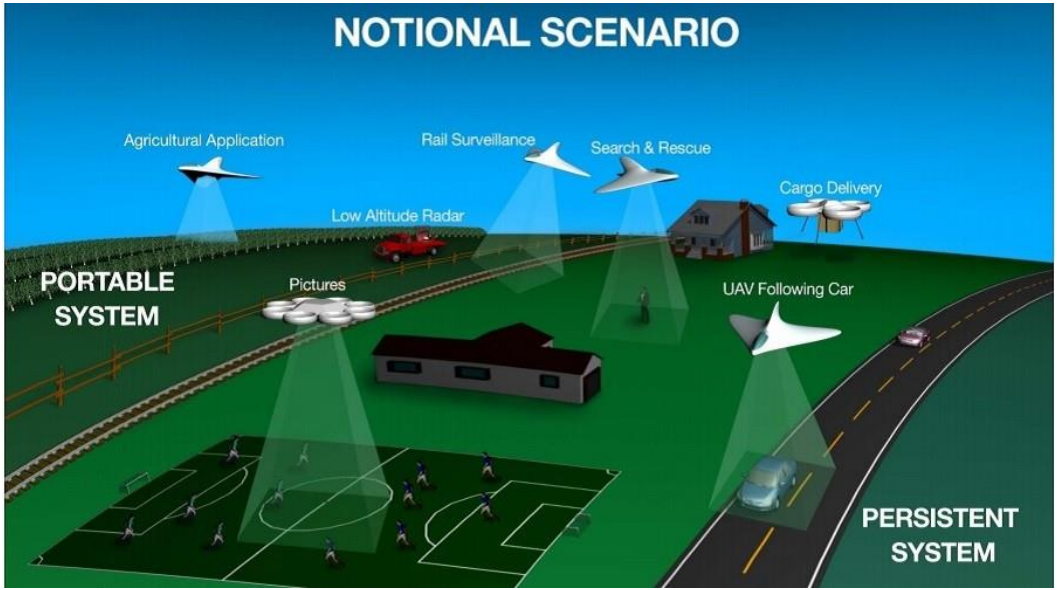


Image source: img.rt.com

What is the proposal about

1. Revising the Airspace Model

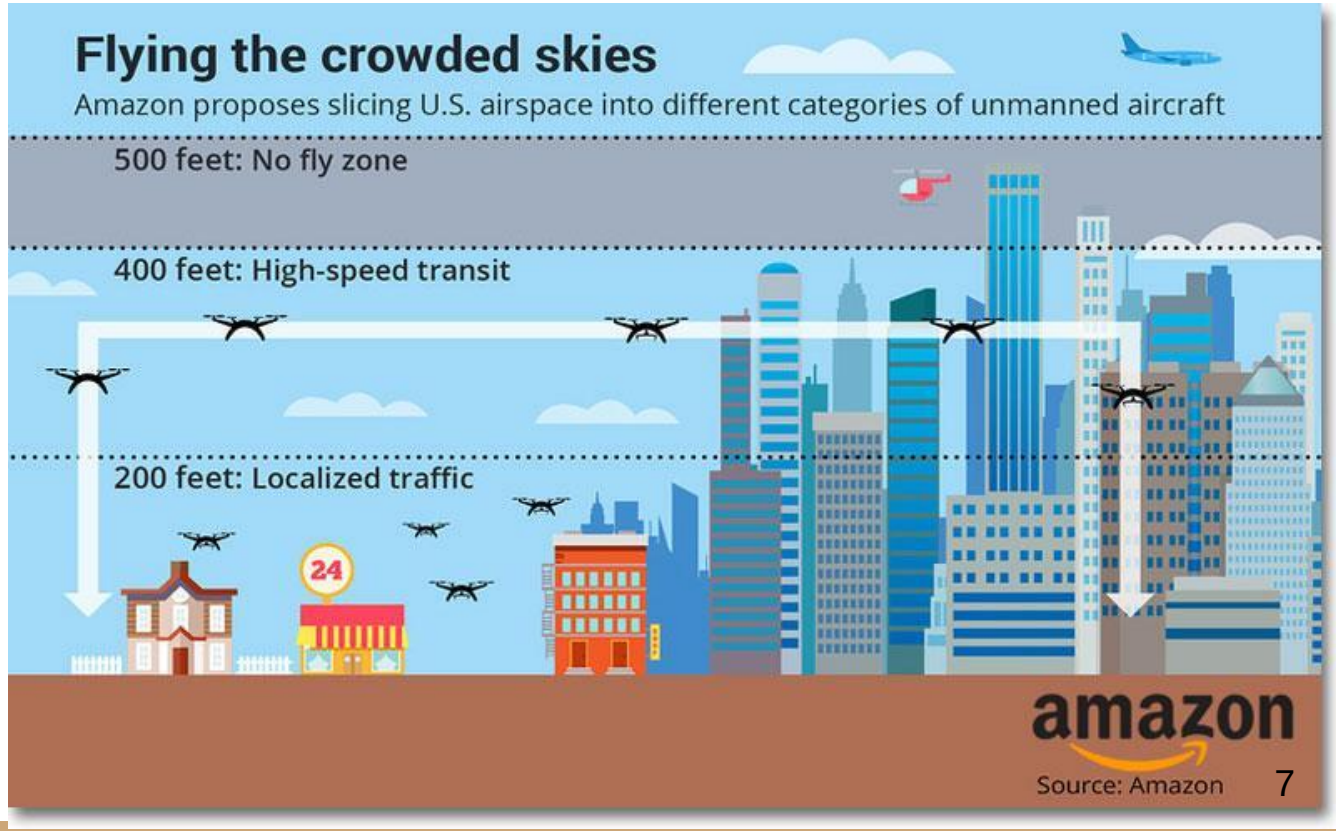
How to incorporate sUAS in the current airspace model

2. Determining Safe Access

How to decide air access for different type of sUAS

Description - Revised Airspace Model

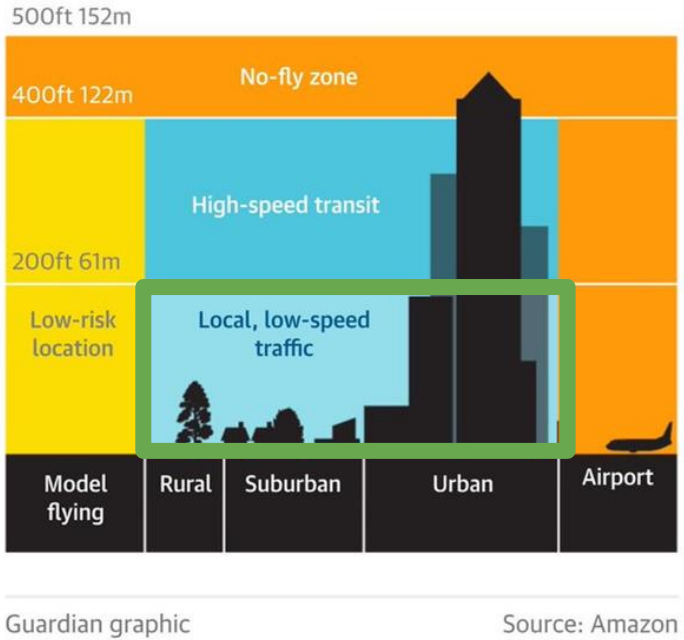
Divide airspace



Description - Revised Airspace Model

Low-Speed Localized Traffic (Below 200 feet)
Reserved for:

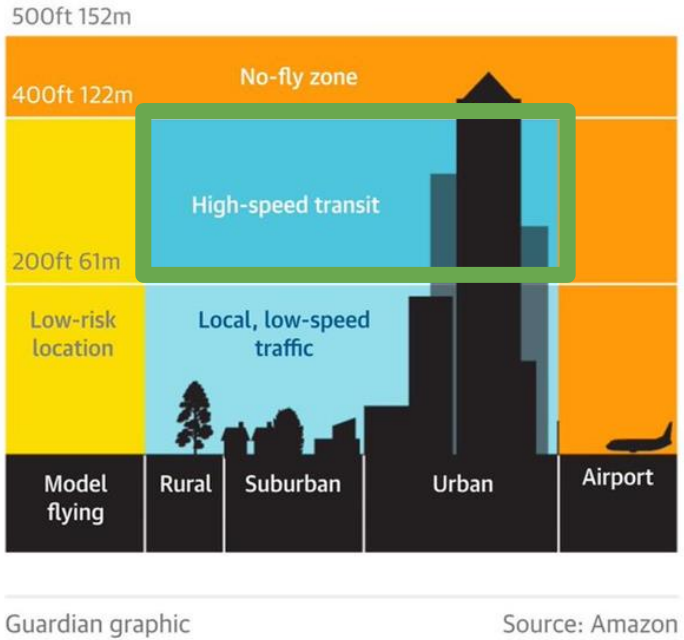
- Terminal non-transit operations like: videography, surveying and inspection
- Lesser equipped vehicles
  - Ones without sense and avoid technology
  - Rural and Suburban area only



Description - Revised Airspace Model

High-Speed Traffic (200-400 feet)
Reserved for:

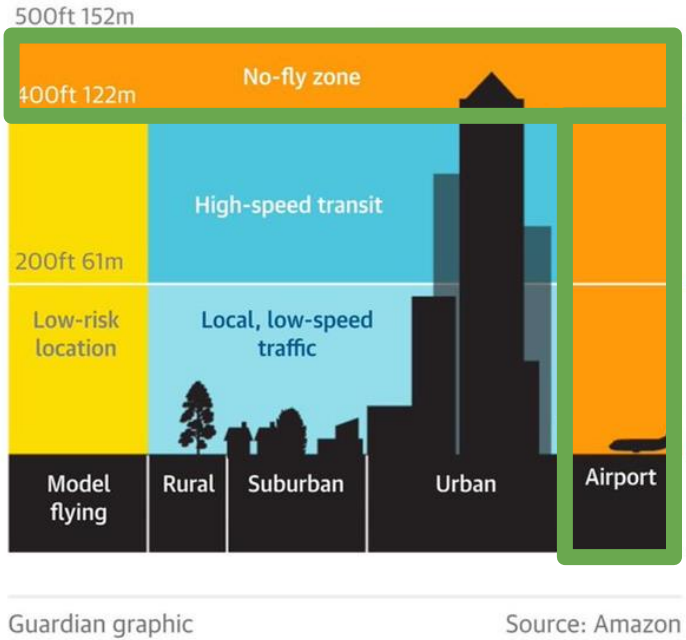
- Well equipped vehicles



Description - Revised Airspace Model

No-fly Zone (400-500 feet)

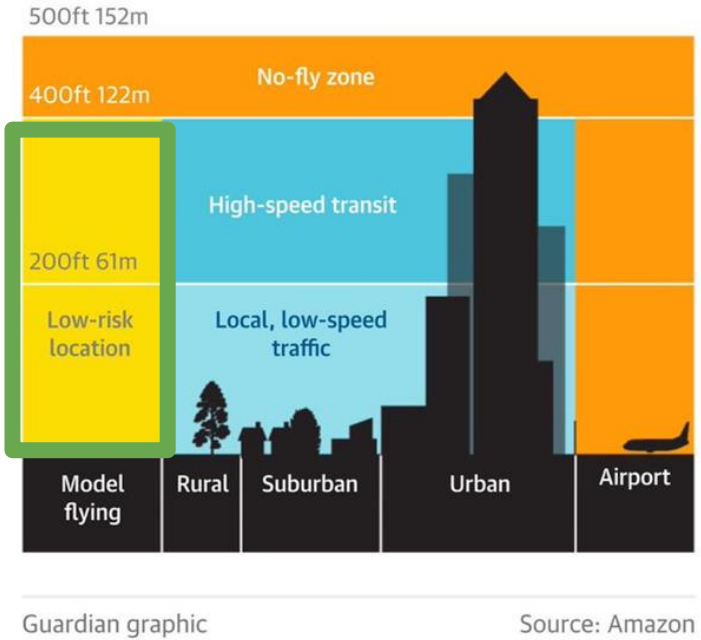
- No sUAS allowed except in emergencies
  - Also includes airport airspace



Description - Revised Airspace Model

Low-risk location

- Altitude and equipage restrictions established in advance by aviation authorities
- Examples - Academy of Model Aeronautics Airfields



Description - Determining Safe Access

Best-Equipped Best-Served Model:
Assign airspace access to sUAS based on vehicle equipment (equipage) and functionality

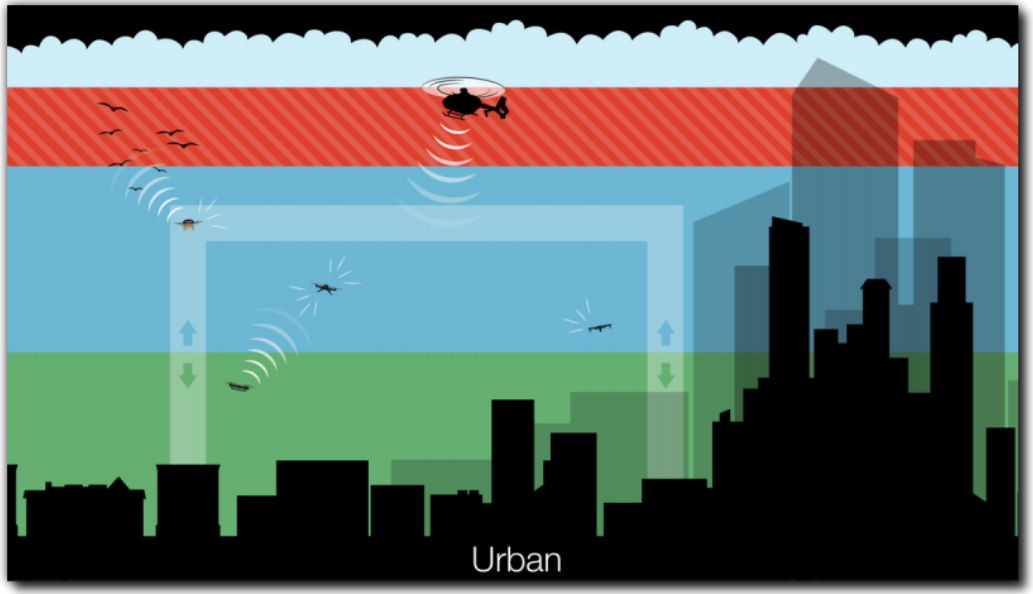


Image source: jdasolutions.aero

Description - Determining Safe Access

Class	Equipage Examples	Airspace Access
Basic	Radio control	Line of Sight (LOS) flight in predetermined low risk locations
Good	Basic+ ● Basic Vehicle to Vehicle Communication (V2V) ● Proximity alerting to operator via V2V ● Receive: ○ air-traffic information ○ weather data ○ GPS ○ wifi ● Internet connection via ground control ● Basic geospatial data	Basic+ ● Daytime LOS access in less than 200 feet rural areas ● Limited operations in suburban areas

Description - Determining Safe Access

Class	Equipage Examples	Airspace Access
Better	Good+ ● Vehicle avoidance via V2V ● On-vehicle internet ● Automatic Dependent Surveillance Broadcast (ADS-B) Out capability	Good+ ● Daytime ● LOS ● Less than 400 ft ● In suburban area ● Further limitations in urban areas
Best	Better+ ● On-board non-collaborative vehicle avoidance ● On-board long range obstacle avoidance ● 4D trajectory planning ● Alternate landing execution ● ADS-B In/Out capability	Better+ ● Daytime/Nighttime ● BeyondLOS ● Less than 400 feet in all operating area ● Good/Bad weather based on sensor capabilities

Description - Determining Safe Access

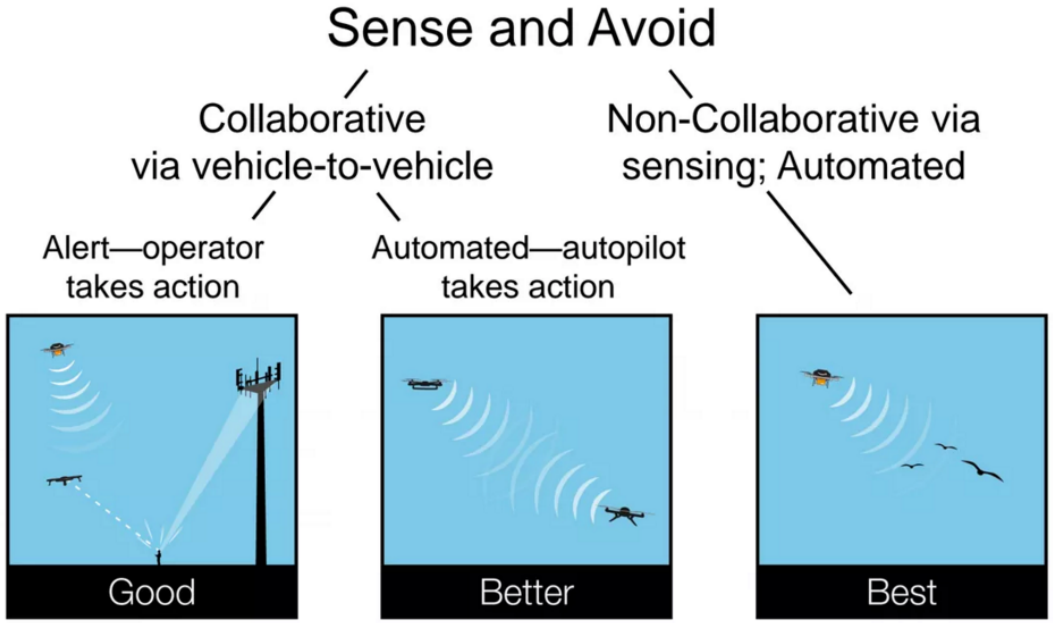


Image source: theverge.com

- LOS
- Daytime
- Full access Rural
- Upto 200 feet

- LOS
- Daytime
- Full access Suburban
- Upto 400 feet

- Beyond LOS
- Daytime/Night
- Full access Urban
- Upto 400 feet

How it applies to Project Pegasus

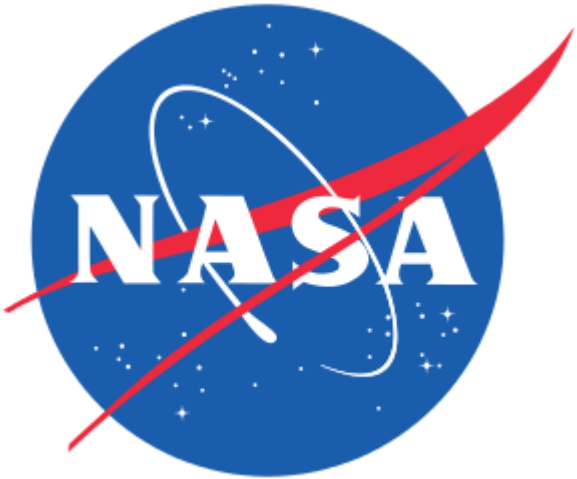
For package delivery application, accessibility requirements:

- Regions - Rural, Sub-urban, Urban
- Beyond Line Of Sight
- Up To 400 feet height

- Required sUAS class: Best

- Required Equipage:
  - **On-board obstacle avoidance**
  - **4D trajectory planning**
  - **Alternate landing execution**
  - V2V communication
  - On-board Internet connection
  - On-board non-collaborative vehicle avoidance
  - ADS-B In/Out capability

NASA-STD 8739.4



What is it about

What product or market it is applicable to

What the main prescriptions and standards are

How the standard can be applied to Project Pegasus

What is it about

This standard applies to

“process and end-item requirements for reliable crimped connections, interconnecting cables, harnesses, and wiring […] that connect electrical/electronic and electromechanical components.”

What product or market it is applicable to

NASA: Employees, Partners, and Contractors

Anyone seeking extreme reliability in electrical connections and wiring

Topics Covered

Training

Facilities and Tools

Testing, Inspecting, and Quality Assurance

Best Practices

- Design
- Interconnecting Cables & Harnesses
- Forming Wires into Cables & Harnesses
- Insulation and Shielding
- Crimping
- Connectors
- Splicing

Relevant prescriptions and standards

9.10: Long Lengths of Shrinkable Sleeving
19.9: Soldered Western Union/Lineman Splice
20.1: Quality Assurance

Long Lengths of Shrinkable Sleeving

- Long lengths of shrinkable sleeving installed over interconnecting harnesses and cables shall provide protective coverage of the designated area without leaving residual stress in the material (Requirement).
- The sleeving shall be in contact with the interconnecting harness or cable along its length (Requirement).

Note from Page 49: "*Medium to long lengths of harnesses/cables with shrink sleeving are extremely difficult to bend and coil without damage.*"

Controlling Reduction in Length

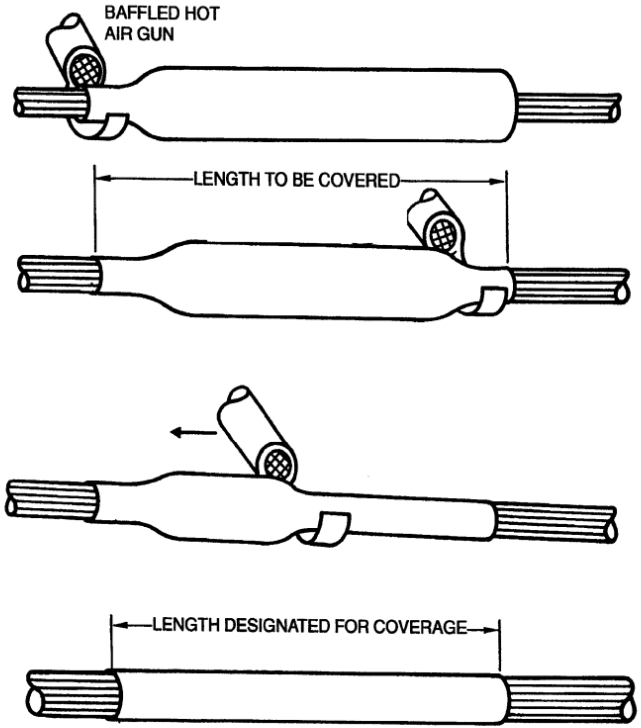


Figure 9-14. Installation of Long Lengths of Sleeving to Achieve Controlled Dimensions

Soldered Western Union/Lineman Splice

“The soldered western union/lineman splice is a splice where each conductor is wrapped around the other conductor prior to soldering”

Figure 19-14. Western Union/Lineman Splice

Preparation

- The conductors shall be pre-tinned (Requirement).
- There shall be at least 3 turns around each conductor and the wraps shall be tight with no gaps between adjacent turns (see Figure 19-15) (Requirement).
- The wraps shall not overlap and the ends of the wrap shall be trimmed flush prior to soldering to prevent protruding ends (Requirement).
- Conductors shall not overlap the insulation of the other wire

Preparation

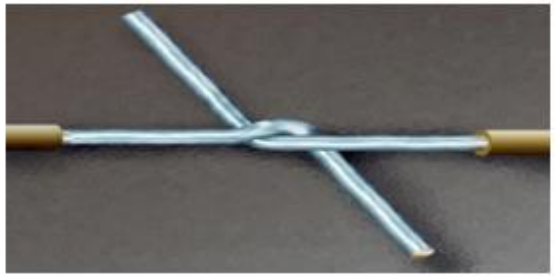


Figure 19-15. Initial Wrap for Western Union/Lineman Splice

Figure 19-16. Completed Wrap for Western Union/Lineman Splice

Soldering

- The termination shall comply with all the requirements of NASA-STD-8739.3 for a solder termination (Requirement).
- Solder shall wet all elements of the connection (Requirement).
- The solder shall fillet between connection elements over the complete periphery of the connection (Requirement).

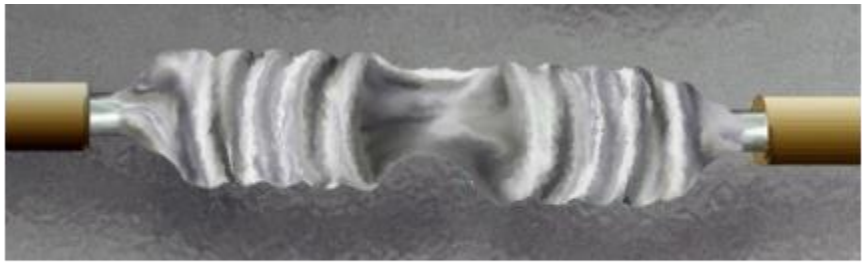


Figure 19-17. Soldered Western Union/Lineman Splice

Quality Assurance

- Is defined as “a program for the systematic monitoring and evaluation of the various aspects of a project, service, or facility to ensure that standards of quality are being met” (Merriam-Webster Dictionary)
- 20 of 114 pages cover “QA”

Cable and Harness Assemblies Inspection Criteria

(1) Connectors are not damaged.
(2) Pin/sockets meet retention force requirements and are not damaged.
(3) Even distribution of tension throughout cable and harness.
(4) Length of wire twist is between 8 and 16 times the outer diameter of the harness.
(5) Cable and harness ties are properly spaced.
(6) Clamps are properly placed.
(7) Cable and harness are not distorted by ties or clamps.
(8) Minimum crossover.
(9) Proper bend radius of breakouts.
(10) Proper identification.
(11) All exposed metal is covered as defined on the applicable drawing.
(12) Heat shrinkable sleeving or nonconductive tape extends at least 5.1 mm (0.2 inch) beyond exposed metal.
(13) Sleeving is uniformly shrunk.
(14) Sleeving is free of cracks, punctures, and charred or burned areas.
(15) Location of shield terminations on wire as per engineering documentation.
(16) Braid is terminated properly.
(17) Cable or harness dimensions and configurations are in accordance with engineering documentation.
(18) Cable or harness is clean.
(19) Unused wires properly terminated.
(20) Routing does not expose cables and harnesses to abrasion, cold flow, or cut-through.
(21) Spiral sleeving with plastic straps are installed correctly.
(22) Protective separator applied over wire bundle beneath metal braid shielding, if required.
(23) Connector back shells and strain relief clamps are tightened as specified by engineering documentation.
(24) High strength copper alloy is used for AWG 24 and smaller conductors.
(25) Proper handling and protection.

How the standard can be applied to Project Pegasus

- Damage to the drone in-flight is the largest and mostly costly risk
- 2 Major Sources of In-Flight Malfunctions

1. Software
2. Electrical

- Failure due to electrical problems are common, costly, and avoidable
- Having a Quality Assurance plan ensures consistency of results

Questions?