NEW WIRE TESTING TECHNOLOGY
AWTS CTP

GREATLY REDUCE IN-FLIGHT PROBLEMS &
REDUCE OR ELIMINATE NO FAULT FOUNDs

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Introduction

• Most No Fault Founds result in another in-flight failure

• Most No Fault Founds are caused by aircraft wire degradation, not bad boxes

• Fix aircraft wire degradation and stop false box removals

• Use your existing DoD approved test equipment for results today

• AWTS and Certification Test Protocol (CTP)
  • NSN: 4920-01-528-5517
SUMMARY

3 ACTIONS THAT WILL REDUCE OR ELIMINATE:

• FALSE BOX REMOVALS
• IN-FLIGHT PROBLEMS
• MISSION ABORTS

• **Fix Before Failure**   Be proactive test and repair before failure
  • Schedule Wire Maintenance

• **Test Physical Uniformity**   (Certification Test Protocol)
  • Physical Non-Uniformity is the best leading indicator of a future functional failure.
  • **Physical degradation typically results in many intermittent in-flight failures before it develops into a hard functional failure.**

• **Test other inline components**   while you are connected
  • Circuit Breakers, Switches, Indicators, Relays, Diodes, etc.
SCHEDULED TESTING PROVIDES BEST ROI

• To reduce or stop serious in-flight events you must test before the in-flight problem occurs and is reported.

• AWA program 2005-2007 provided data indicating need for scheduled maintenance. And all data since has agreed with that study.

• On average, 1 in every 324 wires in your aircraft has physical degradation which is UNKNOWN.
  • Unknown means it has not caused a reported problem.
  • It probably will cause a mission failure or safety event in the future.
TWO IMPORTANT CONCEPTS

• If you keep doing the same thing the results will be the same.
  • Using AWTS to speed up current manual ring out will result in cost savings, more consistent results, and reliable records, but AWTS CTP can do much more.

• Wire physical degradation frequently causes intermittent system failures that only occur in flight.
  • The failure may only occur at specific conditions that only occur in flight.
    • So the system failure can't be detected on the ground.
    • But the physical non-uniformity can be detected on the ground.
PHYSICAL DEGRADATION: CONTINUITY WINS
CONTINUITY 6 INSULATION 1

• Findings indicate most NFFs are due to continuity faults
  • Continuity faults outnumber insulation 6 to 1
  • Mostly on low-level signal wires, less than 30mA
DETECTING PHYSICAL DEGRADATION IN THE CONDUCTIVE PATH

• Detect small changes in resistance
  • 100milliohm sensitivity needed from 10milliohm to 3ohm

• Detect non-linearity
  • Must measure resistance with different stimuli and compare
  • A metallic conductor measures the same resistance for all stimuli

• Detect unstable resistance
  • Resistance should not change with current flow
CLEARLY 350 MILLIOHM LIMIT IS NEEDED
T-700 ENGINE CABLE GOOD VS BAD
REQUIRES 100 MILLIOHM LIMIT
CTP MEASUREMENT REQUIREMENTS

• Test Set must be precise and versatile
  • Measurement speed is not critical, measurement quality is!!!
    • Physical Degradation is not intermittent. Functional Failure is intermittent.
  • Continuity
    • programmable 5mA to 1A stimulus
    • + - 5milliohm accuracy 0 to 3ohm
    • + - 5milliohm linearity from 50mA to 1A (linearity)
    • + - 5milliohm repeatability (stability)
  • Insulation
    • 5 VDC to 500VDC stimulus
    • 1uA leakage detection, from 1 wire to 1000 wires
  • Connect to 15k wires (scalable)
INLINE COMPONENTS NEED TO BE TESTED
AWTS IS CAPABLE – NO NEED FOR OTHER PECULIAR TEST SETS

- Resistors
- Capacitors
- Diodes
- Zeners
- Transformers
- Relays
- Switches
- Circuit Breakers
- 1553 Couplers
- Rate Gyro

- Variacs (variable transformer)
- Potentiometers
- LEDS
- Light Bulbs
- Time Delay Relays
- Oscillators
- Operational Amplifiers
- Stepper Motors
- DC Motors
- AC Motors (-03)
NEED TO LOG MORE THAN MEASUREMENTS

- Aircraft Or UUT ID (serial number)
- Final UUT PASS Or FAIL
- Purpose of Test
- Test Set Temperature
- Measured Values
- Test Number or ID
- Test Program Version
- Operator Inputs

- Test Set ID
- Job Control Number
- Operator ID
- Date and Time
- UUT Part Number
- Each Test Result
EFFECTIVENESS OF USING AWTS WITH THE PRESENTED TESTING TECHNIQUES

• MH-6M FADEC
  • Reduced FADEC events from 2 to 6 per month <1 per year
  • No repeat tail numbers
  • No Fault Founds are gone
  • No False Box Removals
  • Huge cost saving has been achieved
  • Program Manager wants more wire tests for his aircraft

• Similar results for MH-47G appear likely
  • Based on using these test methods on a couple of “problem aircrafts” which have since flown without incident
AWTS CTP DETECTS MORE THAN OPENS AND SHORTS

- Corrosion
- Bad Crimp
- Cold Solder Joint
- Loose Connector
- Loose Terminal
- Contamination
THIS CAUSED 2 IN-FLIGHT EVENTS, AND 2 NFF AWTS CTP FOUND FAULT MISSED BY BIT AND RING OUT
ANOTHER UNREPORTED PROBLEM FOUND AS A RESULT OF PHYSICAL UNIFORMITY TESTING

• This was detected as a result of “testing everything possible while connected”.
• This is not part of the system being tested.
• Other aircraft were visually inspected and corrected as required.
CURRENT AWTS CTP EFFORTS

- Eclypse is currently involved in projects to incorporate CTP into:
  - Existing test programs
    - No Test Adapter Cable modifications required.
  - And Other Aircraft
    - MH-60 (NCMS) and B-1B
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BACKUP SLIDES
AWA PROGRAM TPS VALIDATION

INDICATES THE NEED FOR SCHEDULED WIRE TESTING TO REDUCE THE NUMBER OF UNKNOWN WIRE FAULTS.

2005-2007
## Platforms and TPSS Included in This Analysis

<table>
<thead>
<tr>
<th>Platforms</th>
<th>TPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>H46</td>
<td>ALQ-157, AFCS</td>
</tr>
<tr>
<td>E6</td>
<td>AutoPilot, Fuel Qty, Anti-Skid, Flight Control</td>
</tr>
<tr>
<td>H53</td>
<td>AFCS Cabin, AFCS Cockpit, ICS Cabin PreBlock, ICS Cabin PostBlock, ICS Cockpit PreBlock, ICS Cockpit PostBlock</td>
</tr>
<tr>
<td>S3</td>
<td>STCU, FLIR, ARMCOS, ESM</td>
</tr>
</tbody>
</table>
AWA VALIDATION STATISTICS

• Number of aircrafts that were tested (a test file finished running and results were analyzed) during Val/Ver: 17

• Number of aircrafts with wire or connector errors detected during Val/Ver: 13

• 76.5% of the aircrafts used in Val/Ver had wire or connector errors detected during Val/Ver.
AWA VALIDATION STATISTICS

• Total number of wire segments tested: 10,177
• Total number of paths tested: 6,175
• Total number of wire errors found: 22
  • (86% were unknown!)
  • Indicates need for scheduled wire maintenance
• Total wire error rate across the platforms = 22/10177 = 0.22%, which means on the average, 0.22% of aircraft wiring is not as designed
• Total path error rate across the platforms = 22/6175 = 0.36%, which means on the average, 0.36% of the aircraft electrical interconnect is not as designed.
• On average 1 in every 325 electrical paths has an unknown fault
E6 WHOLE AIRCRAFT ESTIMATION

• Estimated number of wire segments in the aircraft of E6: 72,000 (according to E6 ETM)

• Total number of wire segments tested by E6 TPSs (AutoPilot, Fuel Qty, Anti-Skid, and Flight Control): 1,036

• Number of wire errors detected by E6 TPSs: 3

• All 3 wire errors detected in E6 were unknown to customer.

• Estimated number of wire errors in each E6 is calculated as:

\[
\frac{3}{1036} \times 72000 = 209
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