

United States Army Special Operations Aviation Command



160th SOAR(A) Troubleshooting Analysis Group

JTEG Technology Forum
Certification Test Protocol



Certification Test Protocol

- **Automatic Wire Test Set (AWTS) test programs employed:**
 - MH-47G Full Authority Digital Engine Control (FADEC)
 - MH-6M Full Authority Digital Engine Control (FADEC)
 - 45 LRU Test Programs Locally Developed at the Special Repair Activity
- **Near term test programs under development:**
 - MH-60M Digital Automatic Flight Control System (DAFCS)
 - MH-60M Engine Harnesses (YT-706 Engine)
- **Future program development:**
 - MH-47G DAFCS, Digital ICS, ASE, & Common Avionic Architecture System (CAAS)
 - MH-6M Weapons Systems

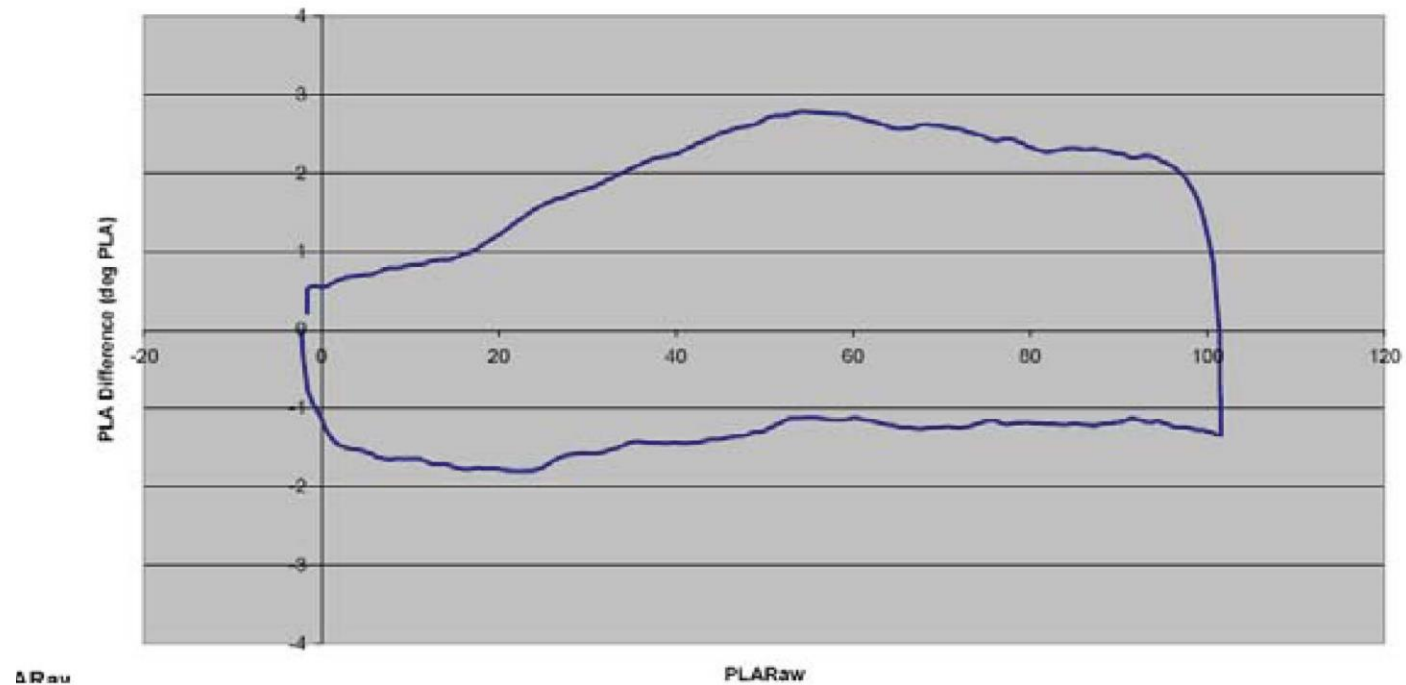


Certification Test Protocol

- **SOF Unique Test Approach**
- **Single-Ended Testing**
 - Purpose of the Single-Ended Test is to detect hard or intermittent failures with minimal disturbance to components and connectors
 - Evaluates engine and airframe components while installed on-wing for DC resistance values per OEM specifications
 - Components evaluated: LVDTs, Stepper Motors, Speed Sensors, Throttle Position Sensors, Relays, Switches, etc.
 - Applies a 10 VDC (5 ma) stimulus for resistive measurements
 - Applies 100 VDC stimulus for isolation testing
 - The test adapter cables are configured for a 4-wire (Kelvin) measurement. This enables the AWTs to apply a alternate path to shunt excess current away from connected devices that might be damaged if an unexpected short circuit is present in the harness or equipment under test
 - Isolation measurements fail at 5 micro-amps to prevent damage



Certification Test Protocol





Certification Test Protocol

- Double-Ended Testing
 - Evaluates the EWIS as an LRU or WRA as installed. Establishes individual conductor and harness condition and ensures material uniformity through the use of multiple stimuli
 - The Certification Test Protocol performs a 4-wire DC resistance measurement of each wire. Constant current measurements are taken at 5ma, 100ma, and 1 Amp
 - The test program also compares the values measured during the 1 Amp test and the 100 ma. If the difference is >25 milliohms it is indicative of some conductive degradation
 - Isolation resistance is conducted at 500 VDC with a failure limit set at 5 micro-amps for safety



Certification Test Protocol

- Pass/Fail threshold established by analyses
 - Based on nominal length of wire paths
 - Material specifications of wire, contact types, and connector isolation
 - Data set acquired from one new build aircraft
 - Data acquired from six legacy aircraft
 - The pass/fail threshold was established by calculating the mean value from the data collected with an additional 100 milli-ohm added for in-service degradation.



Certification Test Protocol

- **MH-6M AWTs Test Program Set (TPS) was fielded 15 July, 2015.**
- AWTs is primarily during the 300 HR Phase Inspection
 - 9 Engine Interface Harnesses were replaced due to high series resistance. No repair authorized by PMO
 - Since ~October 15, PMO rescinded “No repair authorized” for these harnesses in favor of repair and retest with AWTs
 - 1 HMA was removed for potentiometer failure detected during single ended test
 - 6 thermocouple terminal blocks replaced due to high series resistance measurement. Root cause determined to be cracks in the ceramic terminal blocks due to over torqueing of nuts



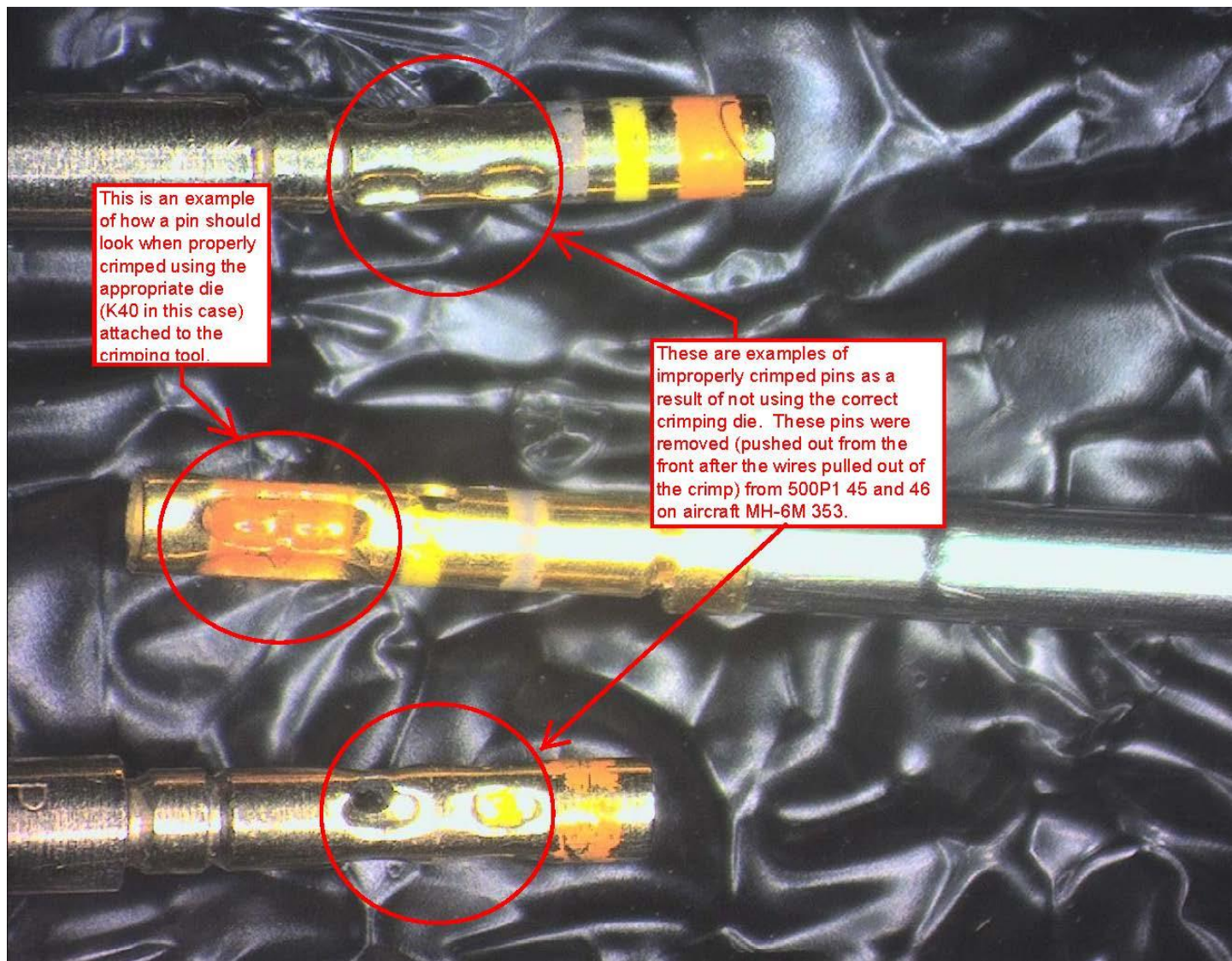
Certification Test Protocol

- **Unscheduled:**

- 3 aircraft had reported FADEC Degrade Cautions. AWTs found high resistance in the AUTO/MANUAL switch path or the ground block. Switch failures caused by flashed gold pins. Ground blocks were improperly torqued or an improper faying surface (ground block installed without removing the zinc-chromate)
- Aircraft was experiencing an intermittent N2 overspeed failure. Differential test failed identified a failure in the N2 path. Two under crimped pins were found during troubleshooting
- Aircraft reported intermittent N2 speed sensor fault. AWTs identified the N2 overspeed switch as the cause of malfunction (loose terminal lug). While testing the N2 overspeed path the AWTs identified a short circuit condition on the Start Relay path, Ignition Relay path, and 28 VDC supply voltage. Remote Control Circuit Breaker (RCCB) in a parallel path was shorted

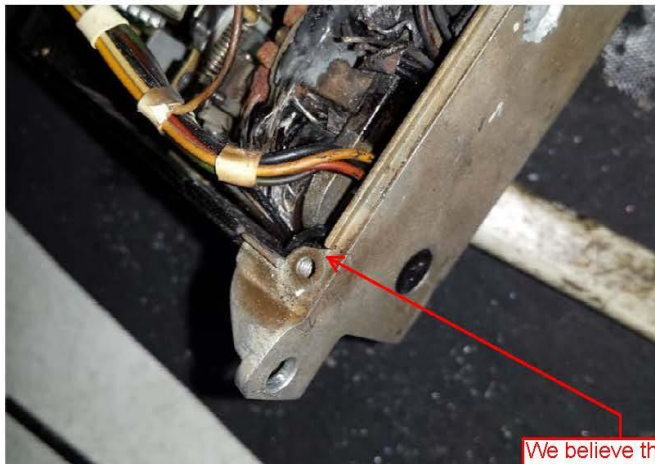


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This is an example of how a pin should look when properly crimped using the appropriate die (K40 in this case) attached to the crimping tool.

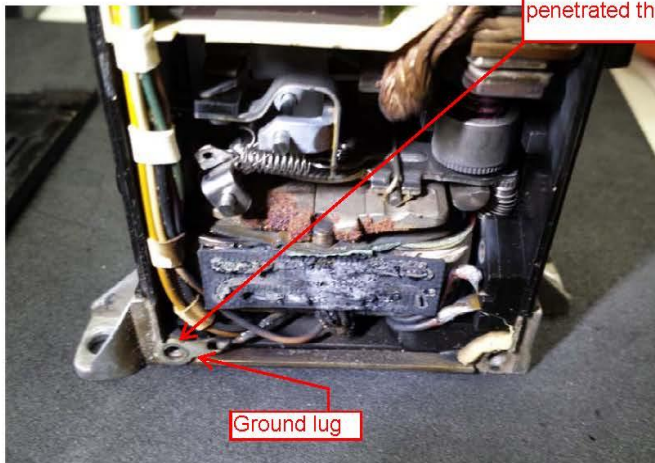
These are examples of improperly crimped pins as a result of not using the correct crimping die. These pins were removed (pushed out from the front after the wires pulled out of the crimp) from 500P1 45 and 46 on aircraft MH-6M 353.



This is a new RCCB with a gap in the same place as the one removed from 636. This gap is present because of the ground lug as seen in the lower left picture



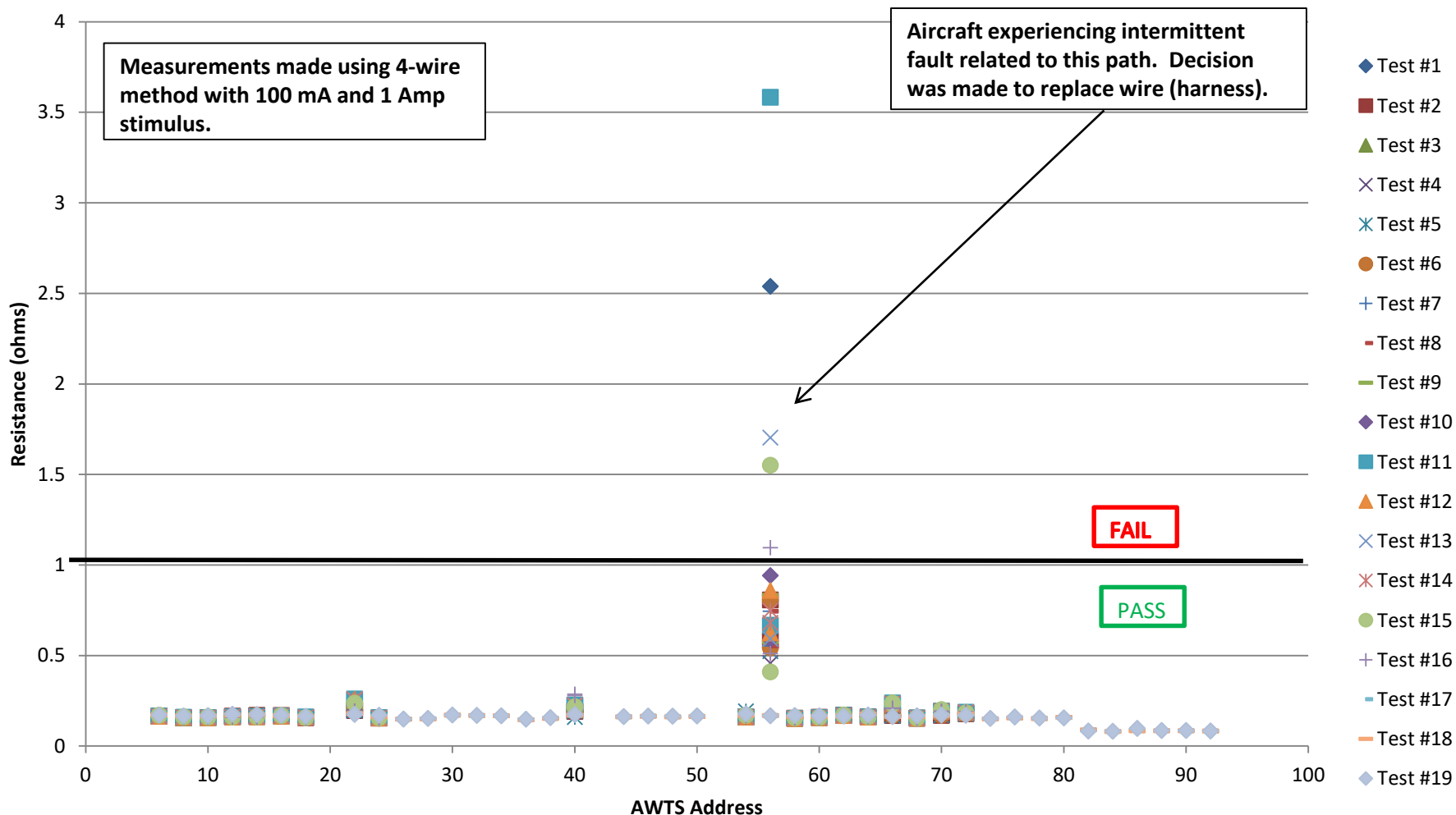
We believe this is the most likely area that the moisture penetrated the RCCB





Certification Test Protocol

MH-6M 651 Troubleshoot





Certification Test Protocol

- **MH-6M Success**

- No Mission Aborts associated to wiring since January 2016 on aircraft tested during Phase Maintenance using CTP
- Time to isolate fault condition reduced
- Number of AWTs faults are decreasing with successive phase testing
- LRU replacement significantly down
- LRU NFF/CND significantly down
- Increased mission readiness
- Program Office, BN Commanders, Production Control Officers, and maintainers support development efforts for additional EWIS testing



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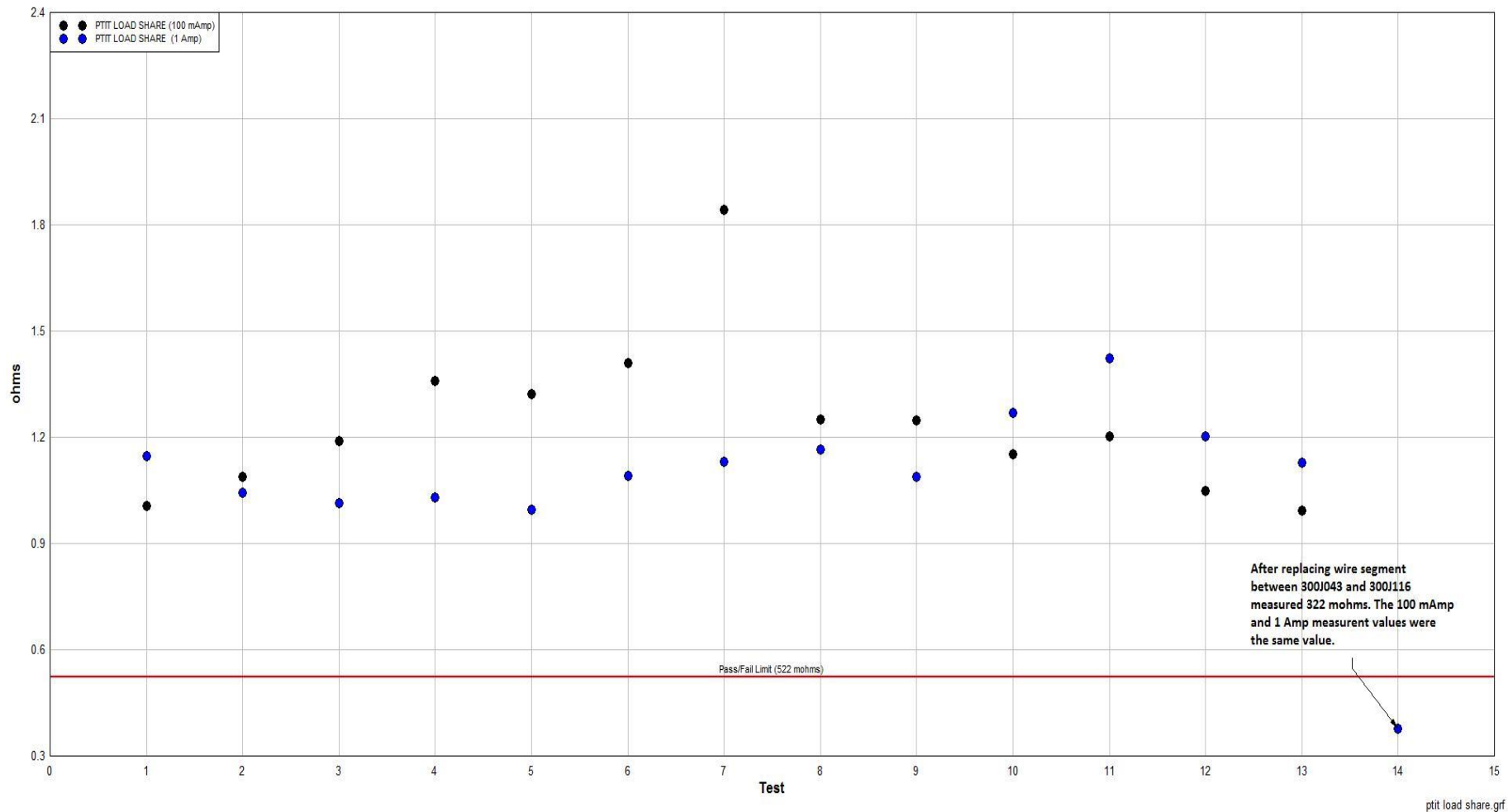
- **MH-47G AWTs Test Program Set (TPS) fielded 1 July, 2017**
- AWTs is primarily used while aircraft is in 300 HR Phase
 - 7 legacy and 2 new build aircraft tested thus far
 - Last 3 aircraft were repaired to determine if the EWIS could be restored to material uniformity
 - 1 HMA removed for potentiometer failure
 - Averaging 30 failures per aircraft on legacy aircraft (5 days to repair) versus 12 on new build (3 days to repair)
 - Backshell shields are the predominant failure paths. 30 Gauge overbraid sock prevents banding on tool-less backshells from achieving proper bond of shields to backshell
 - First aircraft utilizing fielded software presently being conducted. Supporting Phase maintainers on first six aircraft (train-the-trainer)



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783 Side 2.csv

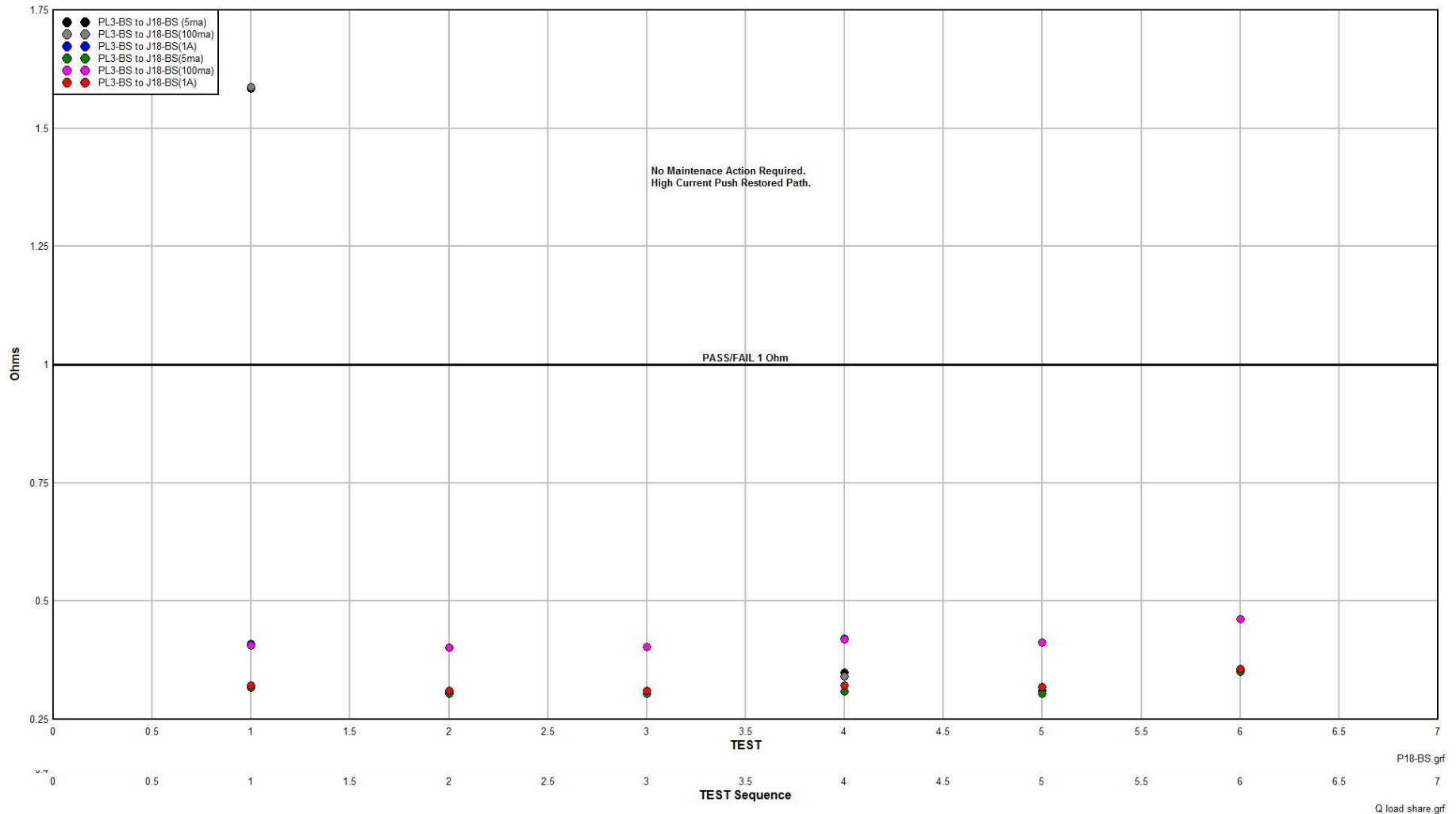
783 Side 2





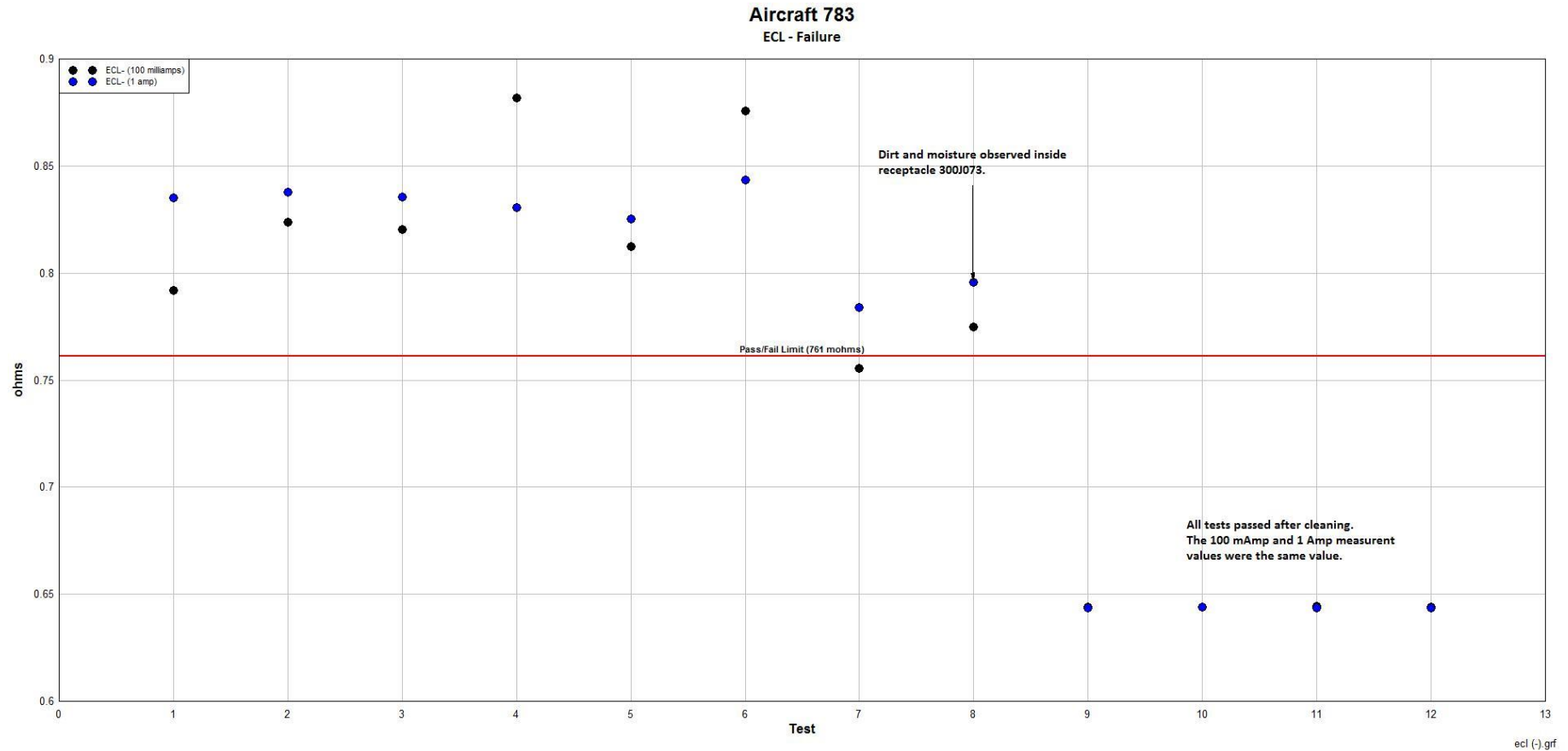
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MH-47G





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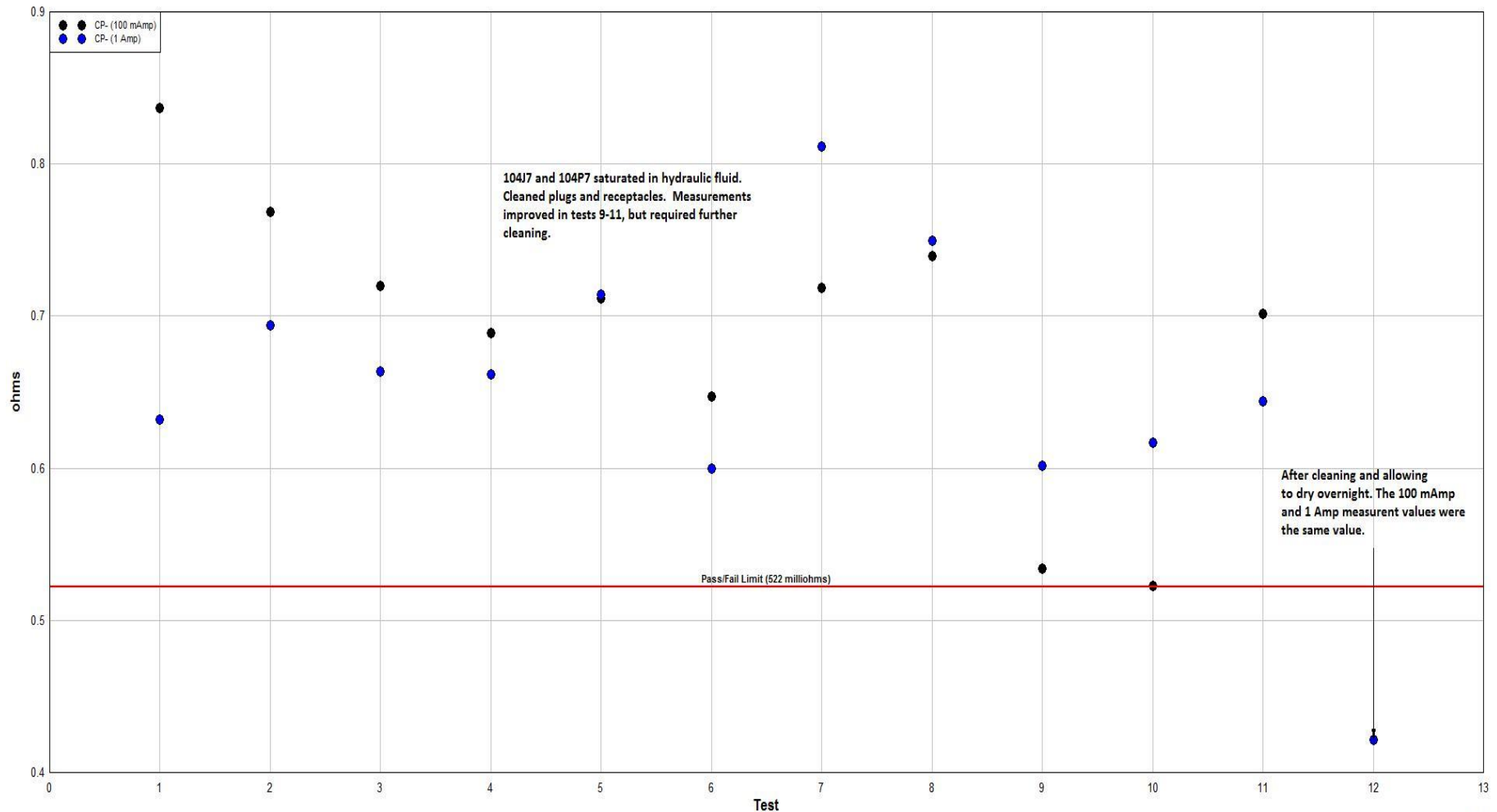




Certification Test Protocol

Aircraft 783

CP - Failure



cp(-).grf



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QUESTIONS?