

SLIDES ONLY
NO SCRIPT PROVIDED

CLEARED
For Open Publication

Aug 01, 2025

Department of Defense
OFFICE OF PREPUBLICATION AND SECURITY REVIEW

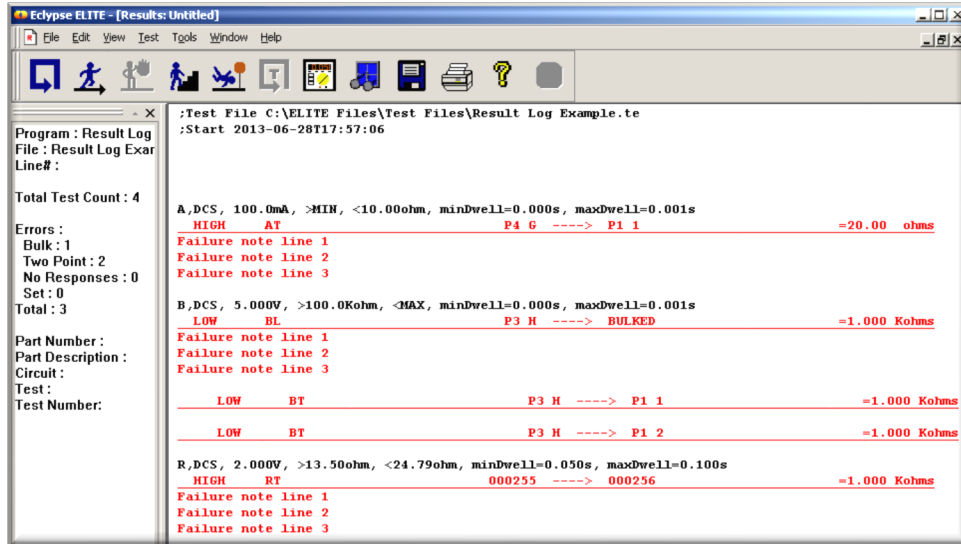
Intermittent Fault Detection and Elimination with AWTs

10-18-2024

Eric Bennett SMSgt(Ret USAF)

Distribution Statement A. Approved for public release: distribution is unlimited.

AWTS is a complete Test system



```

Eclipse ELITE - [Results: Untitled]
File Edit View Test Tools Window Help

:Test File C:\ELITE Files\Test Files\Result Log Example.te
:Start 2013-06-28T17:57:06

Program : Result Log
File : Result Log Exar
Line# :

Total Test Count : 4

Errors :
Bulk : 1
Two Point : 2
No Responses : 0
Set : 0
Total : 3

Part Number :
Part Description :
Circuit :
Test :
Test Number:

A,DCS, 100.0mA, >MIN, <10.00ohm, minDwell=0.000s, maxDwell=0.001s
HIGH AT P4 G ----> P1 1 =20.00 ohms
Failure note line 1
Failure note line 2
Failure note line 3

B,DCS, 5.000V, >100.0Kohm, <MAX, minDwell=0.000s, maxDwell=0.001s
LOW BL P3 H ----> BULKED =1.000 Kohms
Failure note line 1
Failure note line 2
Failure note line 3

LOW BT P3 H ----> P1 1 =1.000 Kohms
LOW BT P3 H ----> P1 2 =1.000 Kohms

R,DCS, 2.000V, >13.50ohm, <24.79ohm, minDwell=0.050s, maxDwell=0.100s
HIGH RT 000255 ----> 000256 =1.000 Kohms
Failure note line 1
Failure note line 2
Failure note line 3
  
```

National Institute of Standards
and Technology (NIST) Compliant

- ▶ All Configurations Provide Test Execution and Development
- ▶ ELITE™ v2.11 software
- ▶ Used at each level of maintenance (I, O, D)
- ▶ Precision Measurements - extremely accurate
- ▶ Records all test measurements, allowing data analysis and trending
- ▶ Meets Mil-PRF-28800 Class 1 and 2.

- ▶ Received Authorization to Operate
 - ▶ Commander Naval Air System Command
 - ▶ “This authority means the AWTS software meets the Navy’s stringent cyber security risk requirements for use in the fleet to help our maintainers conduct electrical testing of aircraft and systems.”
- ▶ Authorized by Army 160th SOAR
 - ▶ For use with Logbooks on Digital Integrated Maintenance Environment (DIME)
- ▶ MAPPING - Ability to implement Self-Learn to map circuits and create a Test Program rapidly.

Applications

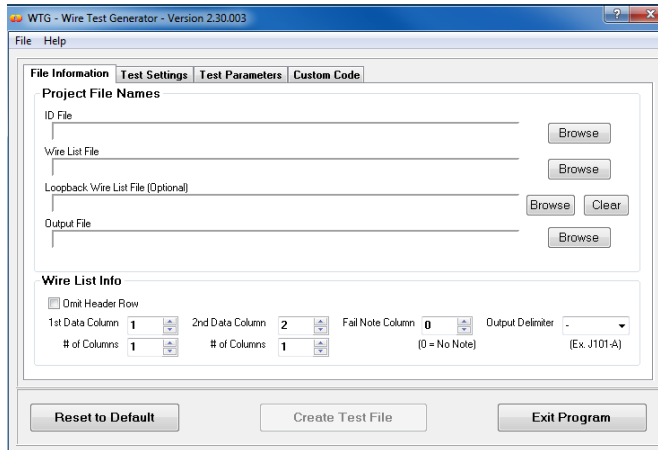
- ▶ Resistors
- ▶ Capacitors
- ▶ Diodes
- ▶ Zeners
- ▶ Transformers
- ▶ Relays
- ▶ Switches
- ▶ Circuit Breakers
- ▶ 1553 couplers
- ▶ Rate Gyro

- Variacs (variable transformer)
- Potentiometers
- LEDS
- Light Bulbs
- Time Delay Relays
- Oscillators
- Operational Amplifiers
- Stepper Motors
- DC Motors
- AC Motors (-03)

- LVDT
- Synchro
- Resolver
- Contactors

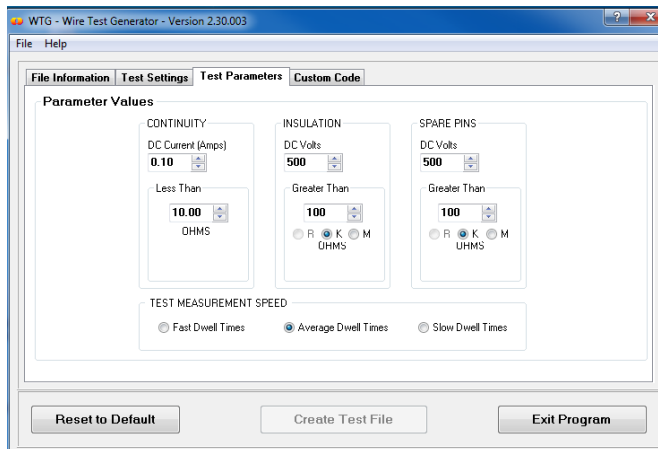


Wire Mapping/Wire Test Generator



▶ Wire Mapping/Self-Learn

- ▶ Will create a TPS by connecting to a known good cable.
- ▶ TPS can then be ran multiple times.



▶ Wire Test Generator (WTG)

- ▶ Will create a TPS from a wire list.
- ▶ Wire list can be created from a schematic diagram.

What is an Intermittent System Failure?



“Intermittent System Failure”
is a functional failure that
does not always occur.

The most common Intermittent System Failures occur in the harsh inflight environment, and do not occur on the ground, making detection and repair difficult and often result in a No Fault Found (NFF)/Can Not Duplicate (CND). Thus, the fault often recurs inflight.



Many Intermittent System
Failures are caused by a fault
in the EWIS.

The Fault or root cause of the Intermittent System Failure is not intermittent.

Typical faults corrosion, loose pins, sticky relay etc., are present until repaired.



AWTS CTP detects the root
cause or fault.

Detecting the always present root cause is more reliable than trying to detect the Intermittent Functional Failure which rarely occurs on the ground.

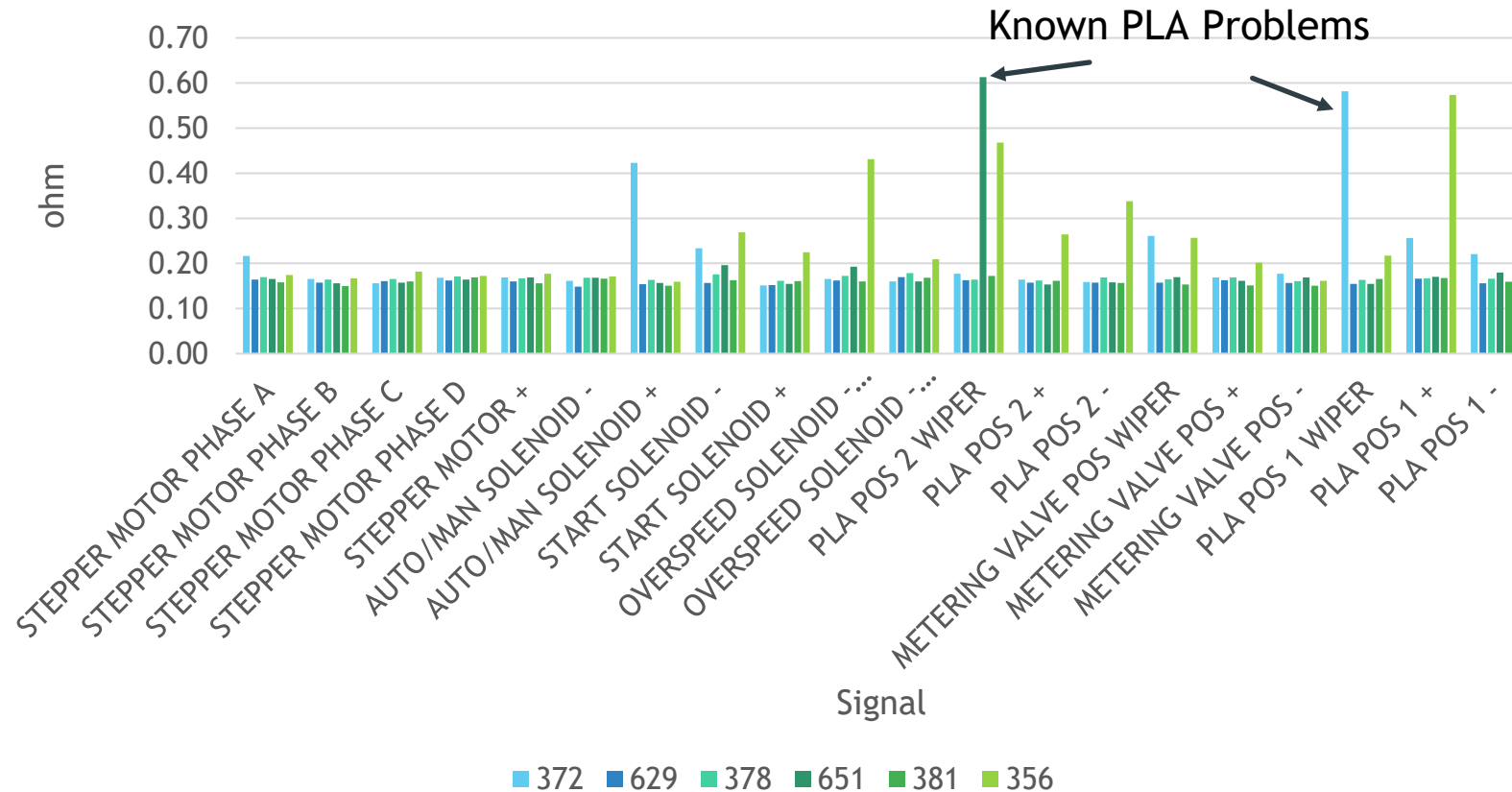
Detecting the Root cause of In-Flight pilot reported discrepancies

- ▶ To detect the root causes of pilot reported discrepancies the AWTS employs multiple testing methods.
 - ▶ First traditional electrical testing methods are used to identify and eliminate existing hard faults in the EWIS system.
 - ▶ Next the AWTS uses precision testing protocols referred to as Certification Test Protocols (CTP).
- ▶ CTP analyzes the physical uniformity of the wiring to identify subtle hard to find anomalies.
- ▶ Using a series of electrical tests, the AWTS constructs a physical uniformity model of a given electrical circuit.
 - ▶ Although thresholds are used to identify the physical uniformity of a given circuit or group of wires, these thresholds do not determine a pass/fail criteria.
 - ▶ Once the physical uniformity of a group of wires is established the “outliers” (those wires that differ in physical uniformity) can be further analyzed to determine the root cause of the physical difference.
 - ▶ That root cause can then be traced back to in-flight reported discrepancies.
 - ▶ Often the root cause is found to be degradation and not hard faults (open/Shorts).

Faults Detected by AWTS - Commonly Root cause of Intermittent Failures

- ▶ Broken wires making intermittent contact
- ▶ Degradation
 - ▶ Contact Resistance
 - ▶ Corrosion in connectors
 - ▶ Salt residue on pins and connectors
 - ▶ Loose connections
 - ▶ Terminal loose nut
 - ▶ Loose connectors
 - ▶ Recessed pin
 - ▶ Loose crimp
 - ▶ Dirty Relay Contacts
 - ▶ Insulation Leakage
 - ▶ Cracked Insulation
 - ▶ Oxide Buildup on Connectors
- ▶ Poor maintenance
 - ▶ Bad Crimps on pins
 - ▶ Bad solder joints
 - ▶ Bad wire splices
 - ▶ Loose connector
 - ▶ Damaged or recessed pin
 - ▶ Mis-wire
 - ▶ Incorrect wire routing
- ▶ **Other Physical Non-Uniformities**

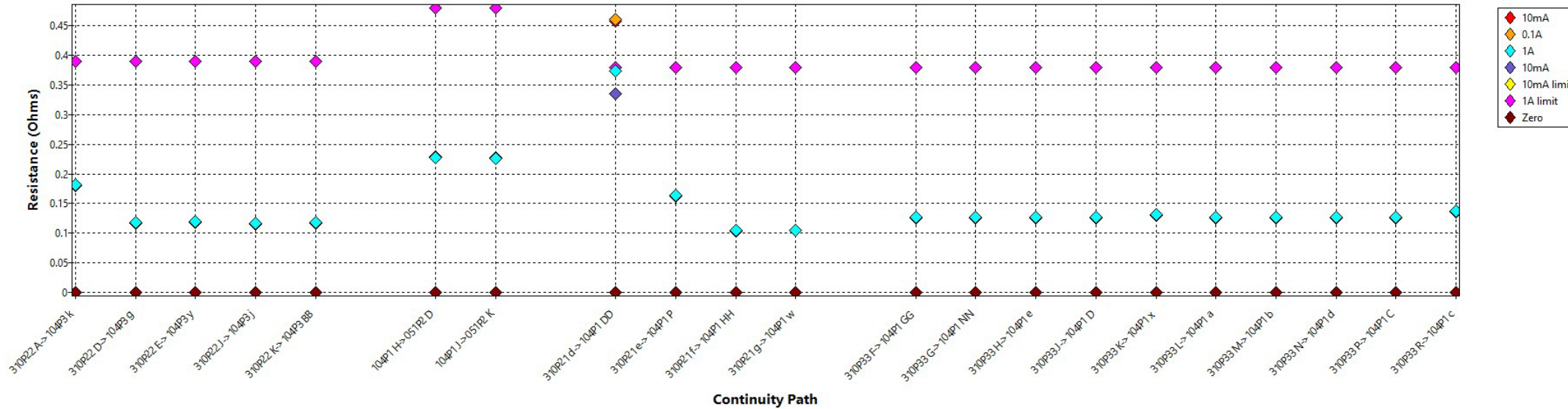
ECU To HMU 4 Wire Resistance



- ▶ Measurement clearly detects 2 aircraft with known Intermittent Symptoms.
- ▶ Functional Failure Limits of 1 to 5 ohm would not detect problem.

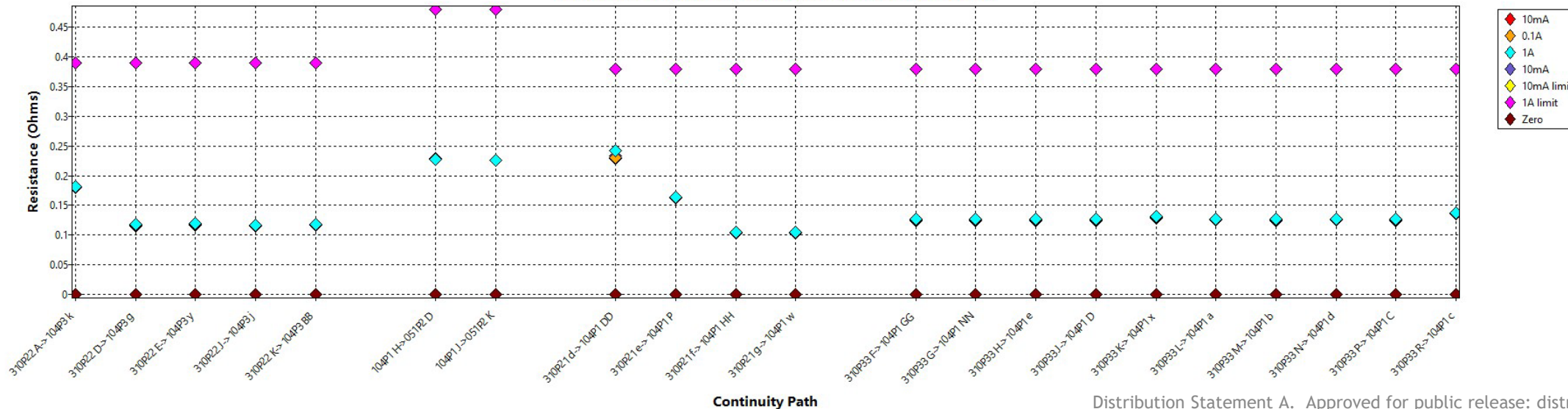
Aircraft 10-08806 - Data Concentrator

Chart #3 CTP Measurements (Serial Number: 10-08806)



Continuity Path

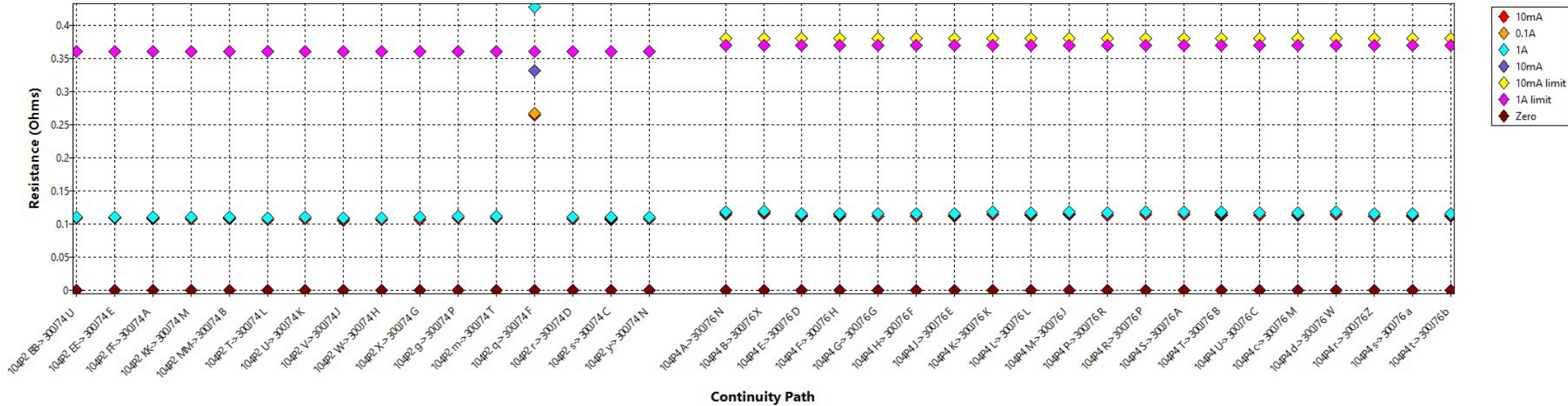
Chart #3 CTP Measurements (Serial Number: 10-08806)



Continuity Path

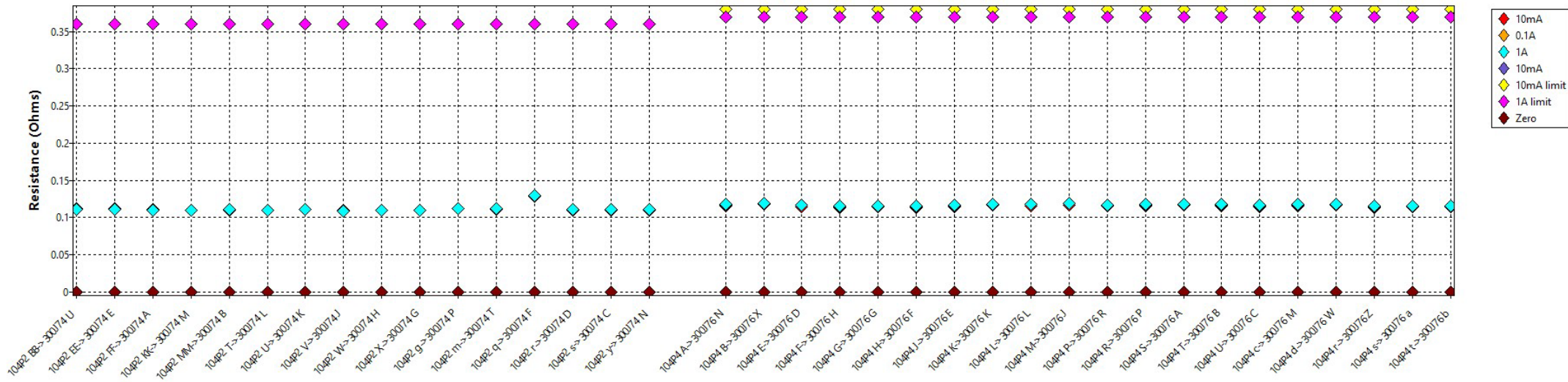
Aircraft 10-08806 - FADEC

Chart #2 CTP Measurements (Serial Number: 10-08806)



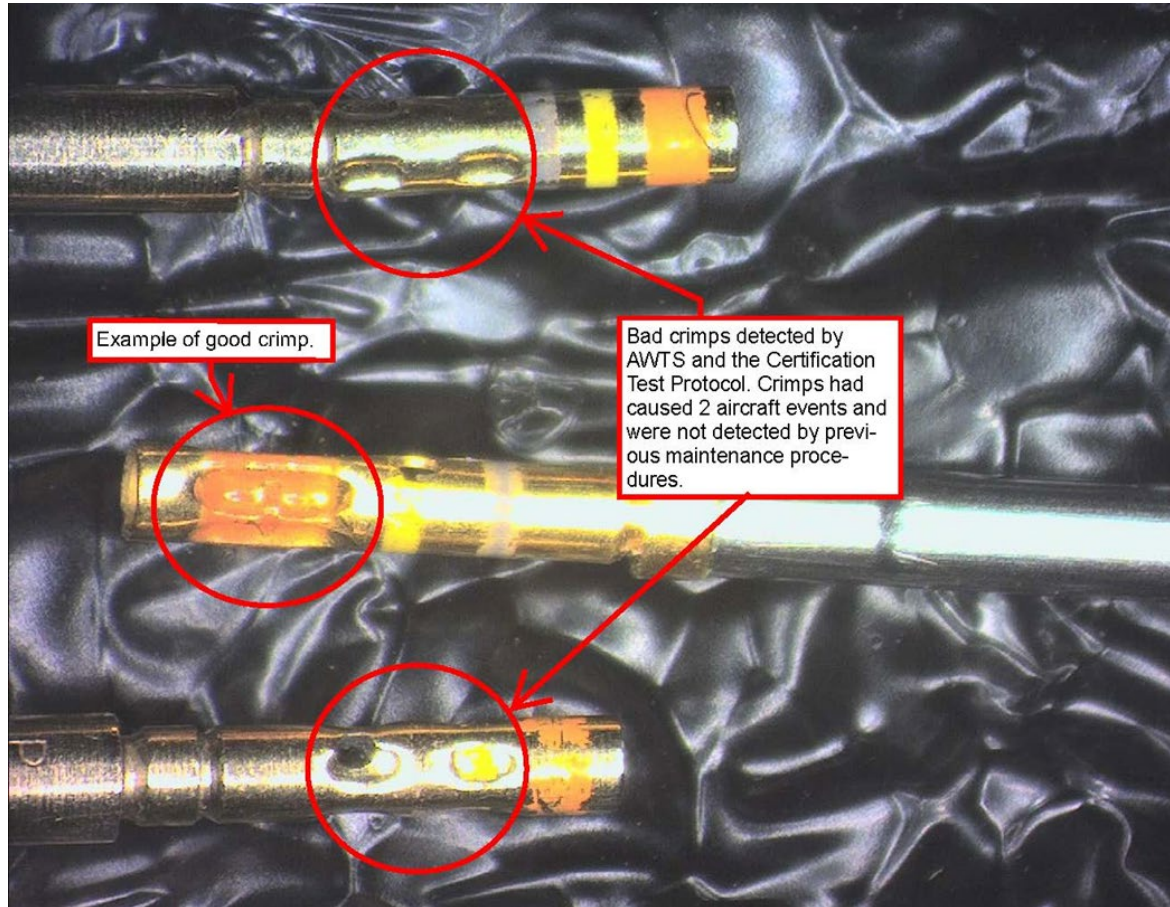
Continuity Path

Chart #2 CTP Measurements (Serial Number: 10-08806)

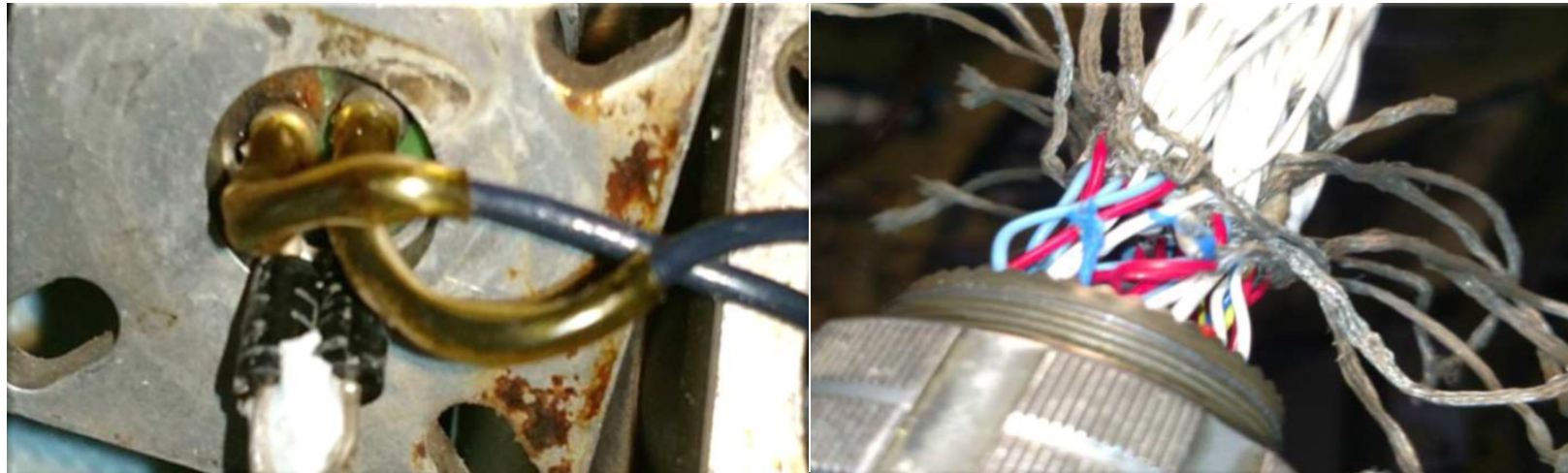


Continuity Path

This caused 2 in-flight events, and 2 NFF/CND
AWTS CTP found fault missed by BIT and ring out

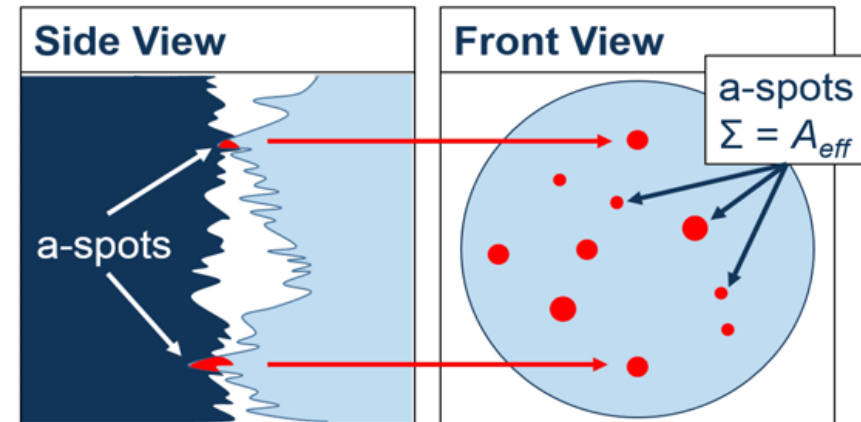


CTP Success



Wire Conditioning

- ▶ Contact Resistance
 - ▶ All material surfaces have jaggedness at the micro or nanoscale, and so two metals are in contact only where microscopic peaks touch on opposing surfaces. These are called “a-spots.”
 - ▶ The a-spots are where the current will flow.



V-22 Conditioning Stats

- ▶ 97 Total Aircraft Tested
- ▶ 139,404 Total Tests Ran
- ▶ Resistance improved by > 1 ohm: 171 measurements
- ▶ Resistance improved by > 0.1 ohm: 646 measurements
- ▶ 49 Aircraft Improved by > 1 ohm
- ▶ 78 Aircraft Improved by $> .1$ ohm

CV-22 Conditioning Stats

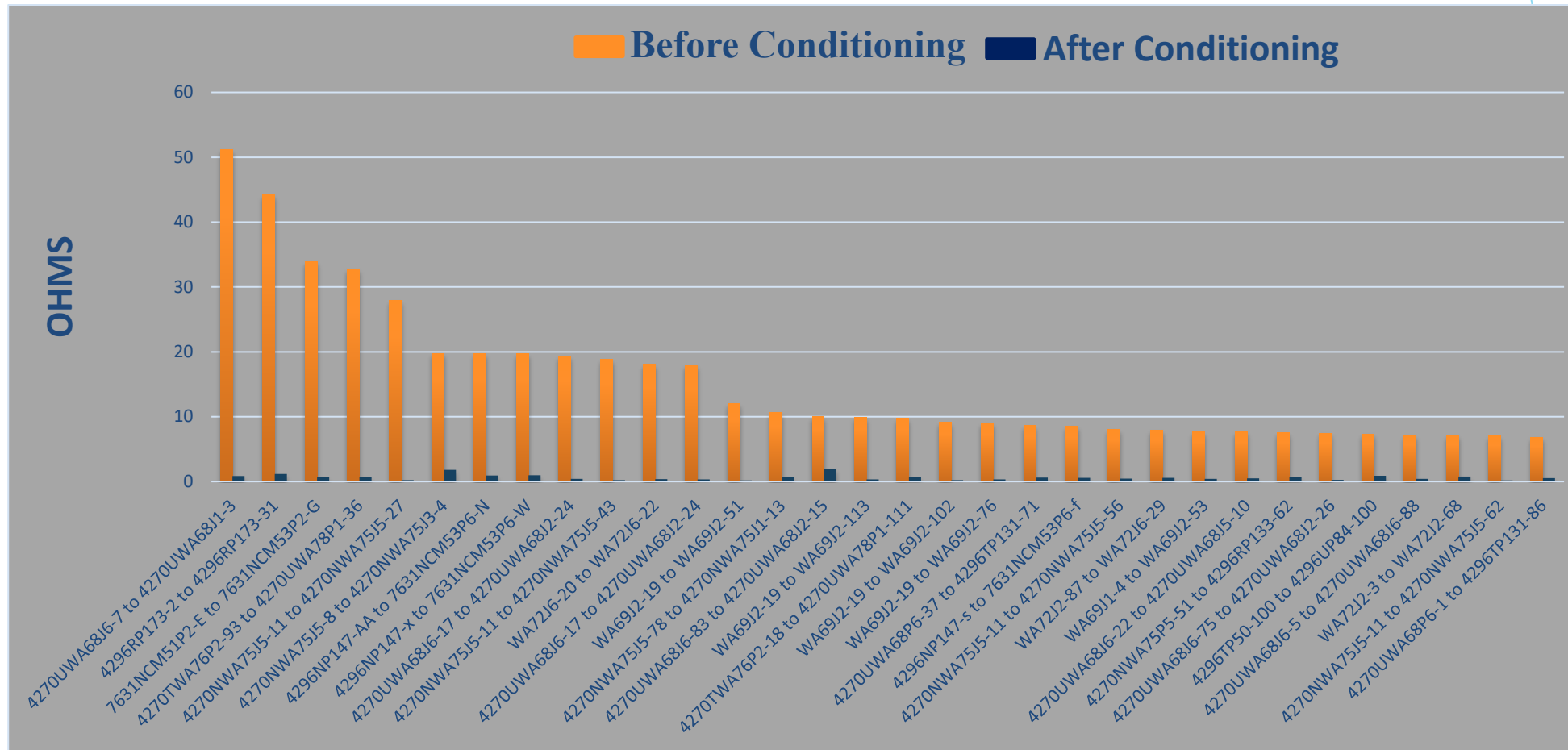


Distribution Statement A. Approved for public release: distribution is unlimited.

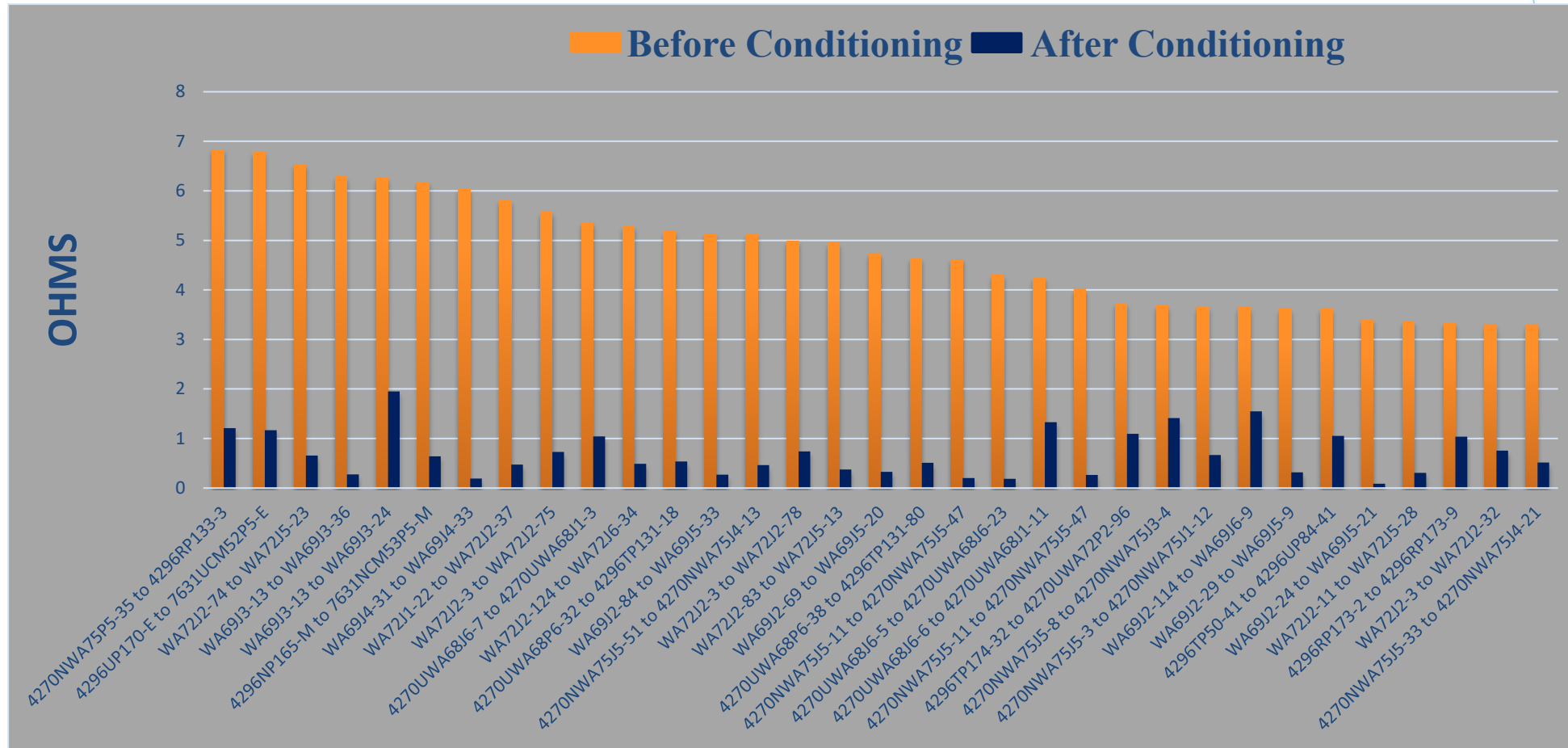
- ▶ **131 Wires Greater than 2 ohms**
 - ▶ Average before Conditioning **6.18 ohms.**
 - ▶ Average after Conditioning **0.74 ohms.**
 - ▶ Average decrease after Conditioning **-5.45 Ohms.**

- ▶ **155 Wires Less than 2 ohms but greater than 1 ohm**
 - ▶ Average before Conditioning **1.37 ohms.**
 - ▶ Average after Conditioning **0.55 ohms.**
 - ▶ Average decrease after Conditioning **-.82 Ohms**

Wires Greater than 2 ohms before Conditioning

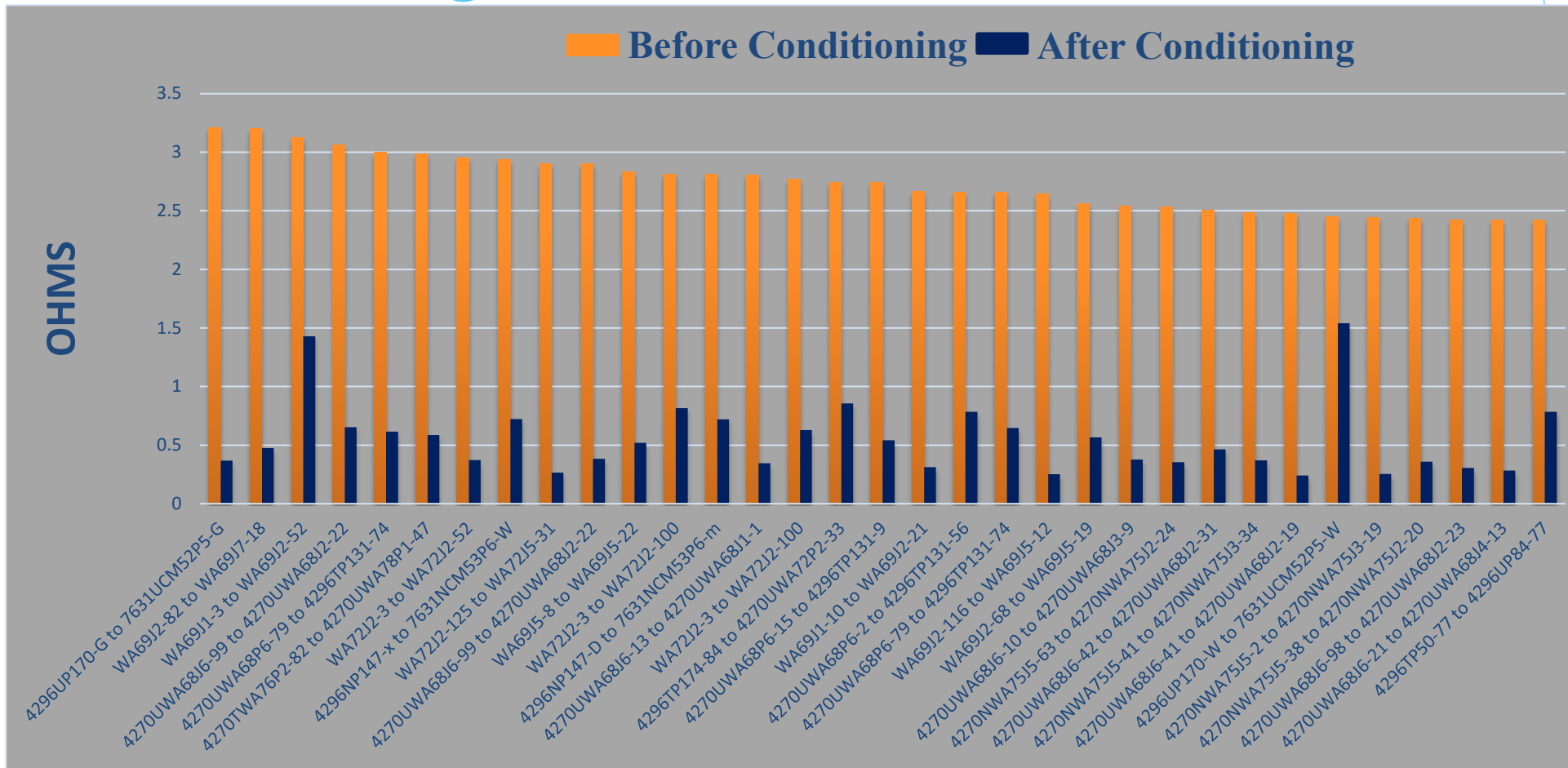


Wires Greater than 2 ohms before Conditioning

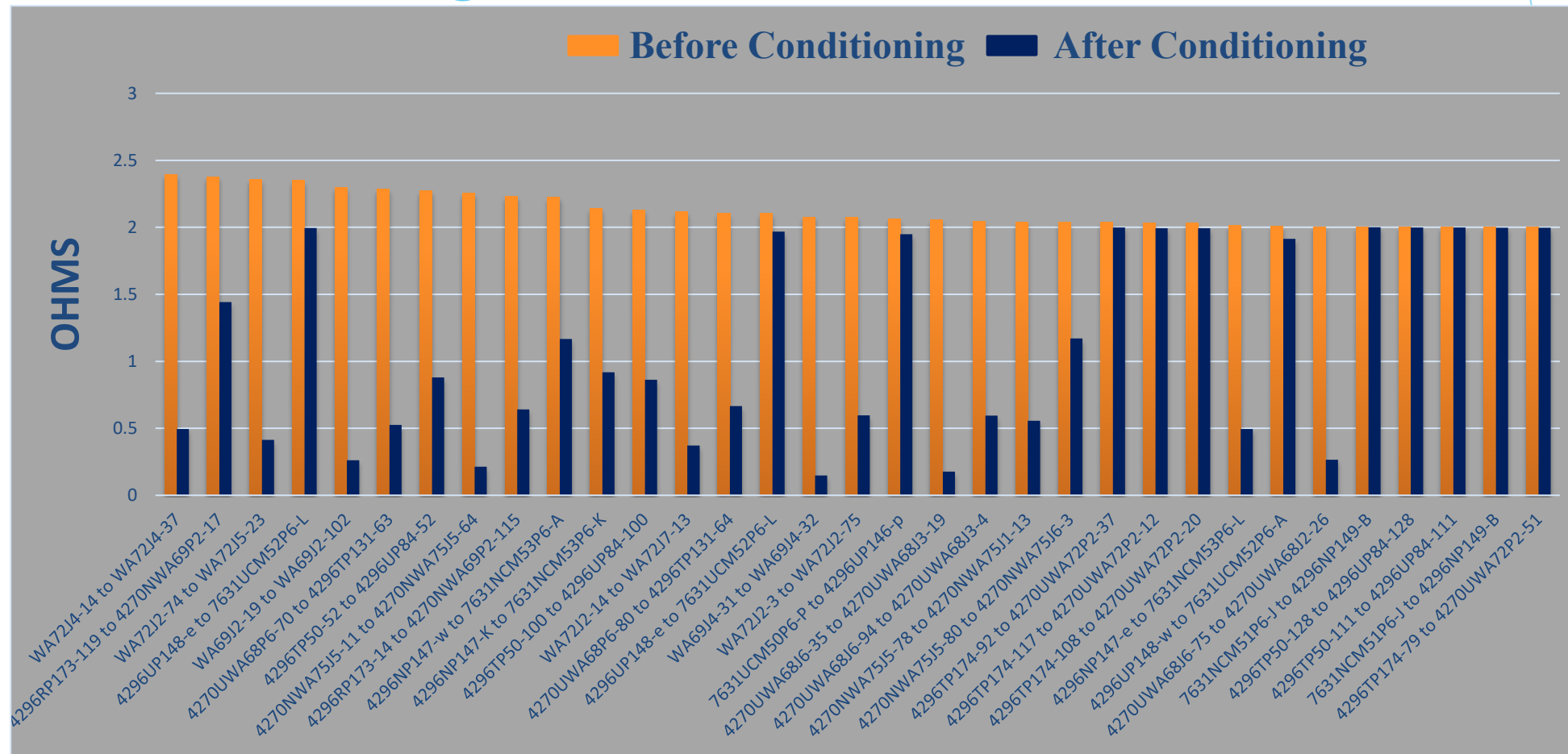




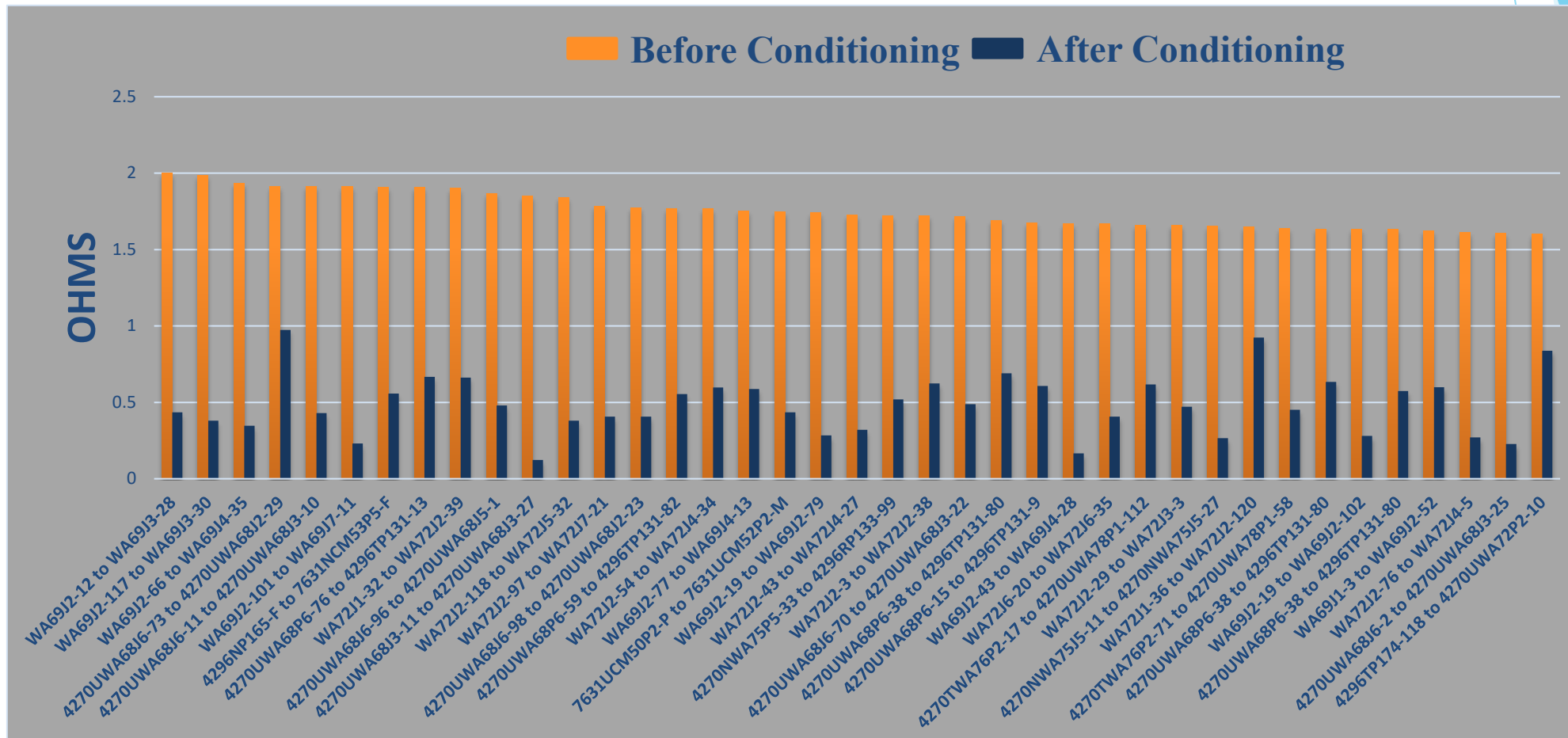
Wires Greater than 2 ohms before Conditioning



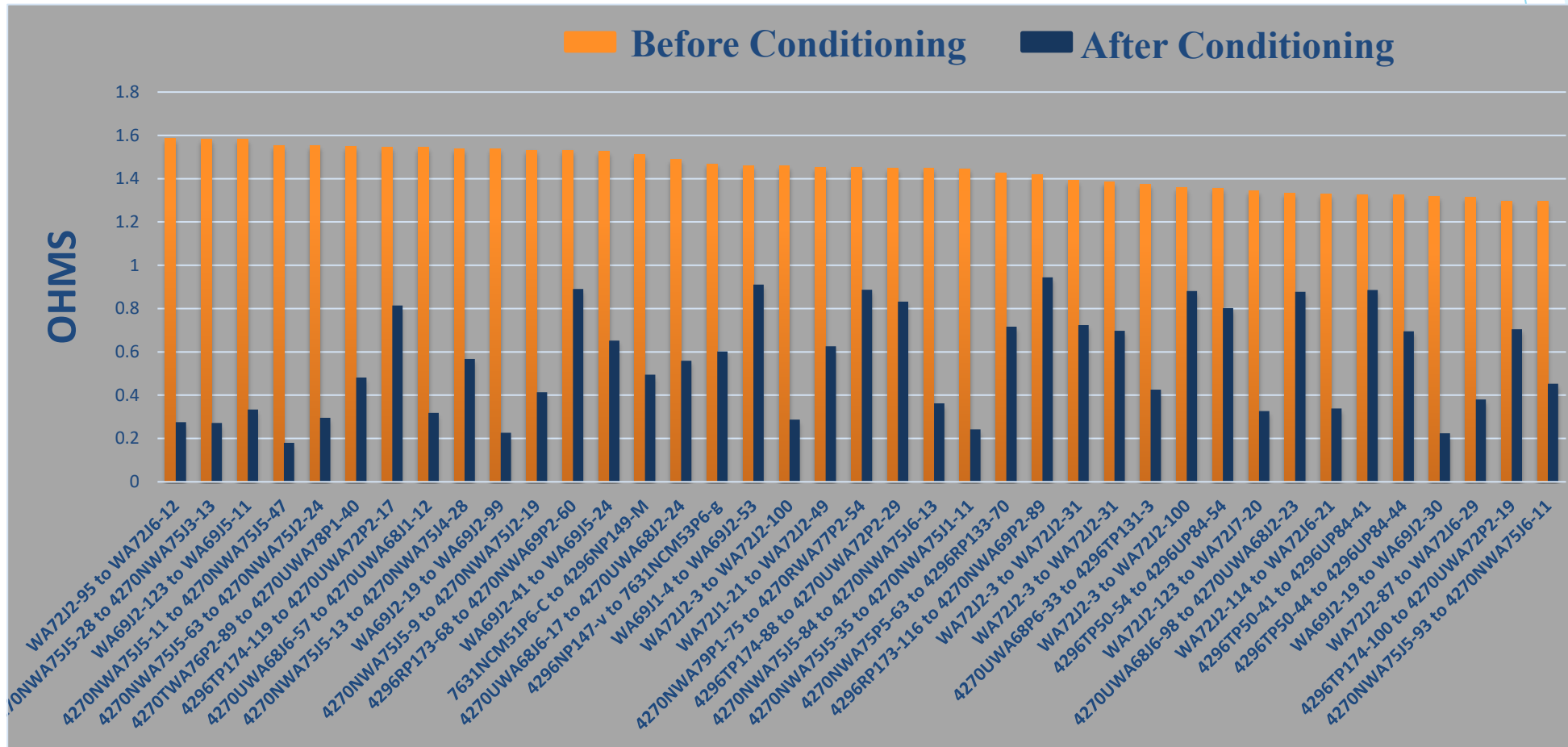
Wires Greater than 2 ohms before Conditioning



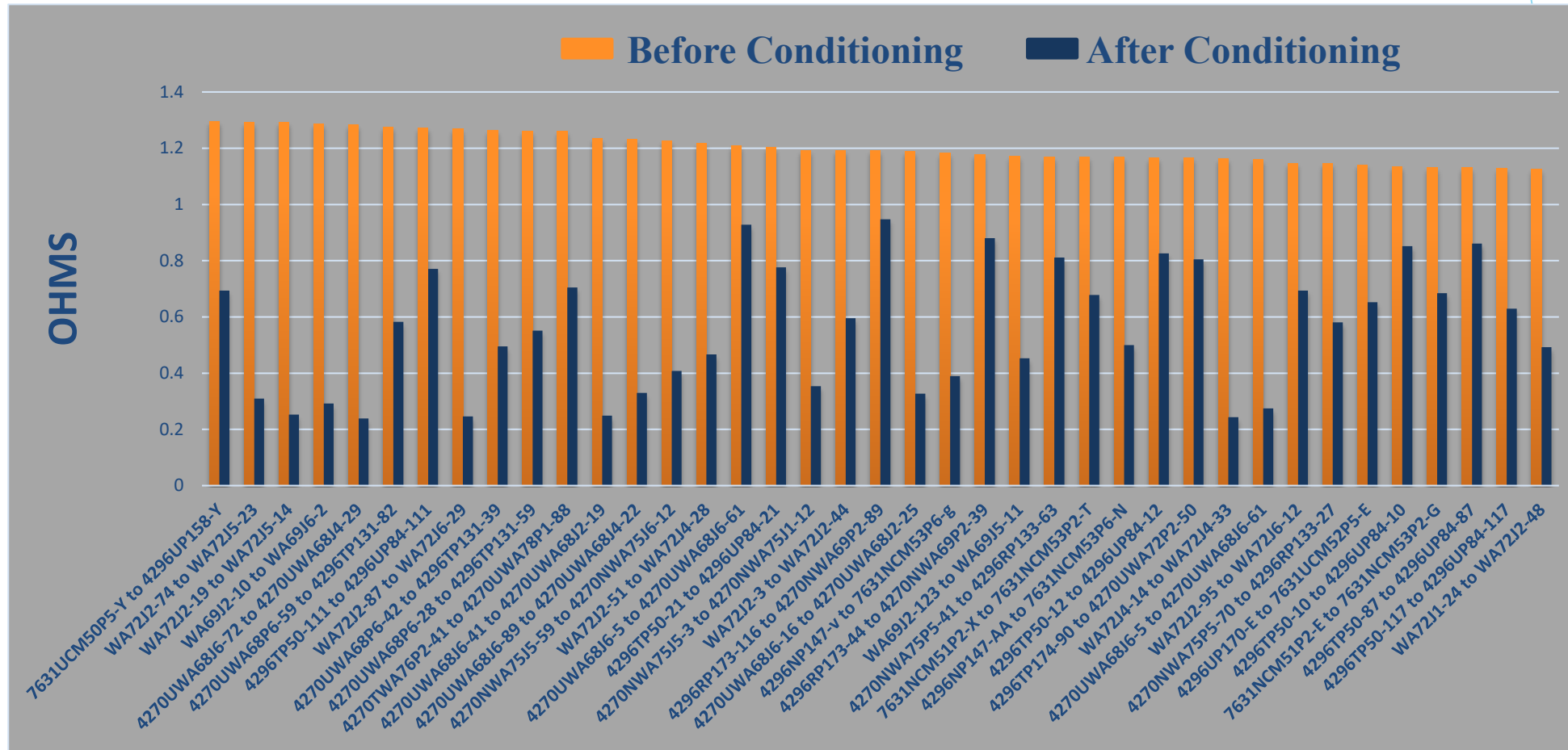
Wires LESS than 2 ohms But Greater than 1ohm before Conditioning



Wires LESS than 2 ohms But Greater than 1ohm before Conditioning



Wires LESS than 2 ohms But Greater than 1ohm before Conditioning



Conclusion:

- ▶ Elimination of Intermittent System Faults
 - ▶ To Eliminate Intermittent faults the EWIS needs to be addressed

- ▶ Certification Test Protocol (CTP)
 - ▶ Finds Root Cause of EWIS Intermittent System Faults

- ▶ Wire Conditioning
 - ▶ Rejuvenates troubled wiring
 - ▶ Ultimately makes system wiring better.



ECLYPSE
INTERNATIONAL
www.eclipse.org



Questions?