



Power-over-Ethernet Connecting Hardware Durability under Electrical Load

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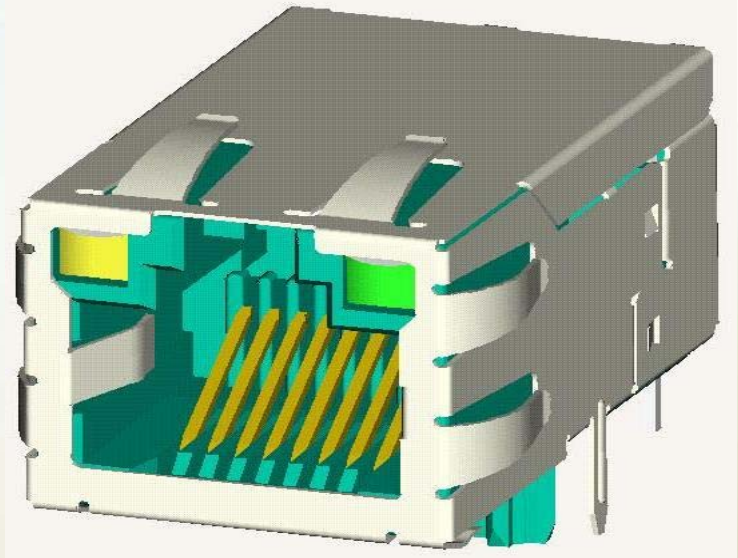
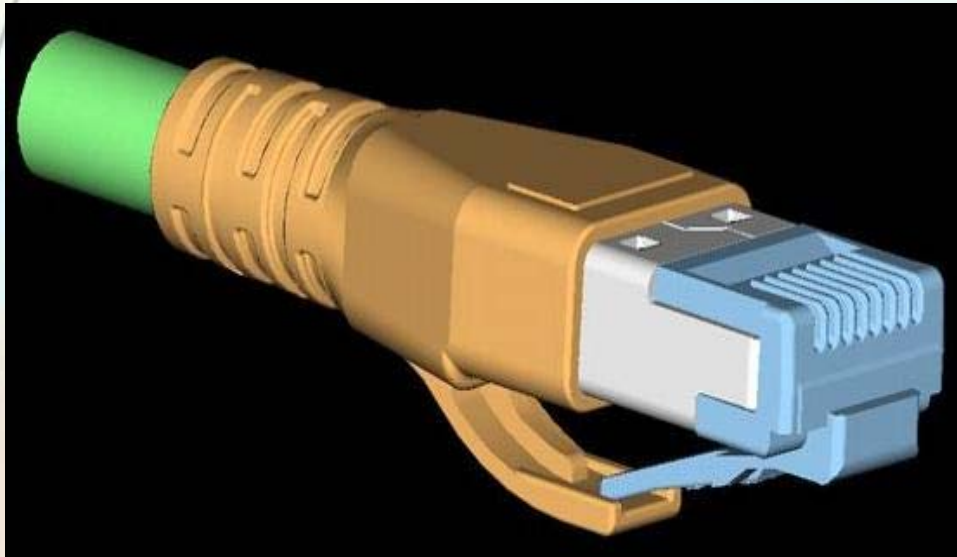
Presentation Contents. Part 1

- 1. PoE and electrical contact interface**
- 2. Acceptance criteria. LLCR (bulk)**
- 3. Test Matrix variable and six test groups**
- 4. Test program, power cycling**
- 5. Test Group 1 results and observations**
- 6. Test Group 2 results**

SUMMARY

PoE = POWER – over –ETHERNET

PoE enables network devices to receive power over the same cable that supplies data and eliminates the need in additional power cables and transformers and AC outlets.



As the result:

the network connecting hardware (RJ45 and ARJ45) are exposed to effects of the power discontinuation similar to the power connectors.

PoE PLUS. CONNECTOR DURABILITY UNDER ELECTRICAL LOAD

**PHYSICAL PHENOMENA
due to
ELECTRICAL CONTACT SEPARATION**

- **Effects caused by mechanical abrasion and environmental exposure**
- **Effects caused by electrical discharge**

SPARK

Fast, single event,
Time independent
Large distinct crater

CORONA DISCHARGE

Relatively slow, time dependent
Multiple events, shallow craters
or pitted surface, erosion

Combination of all

Effects and Acceptance criteria

EFFECTS

Short term

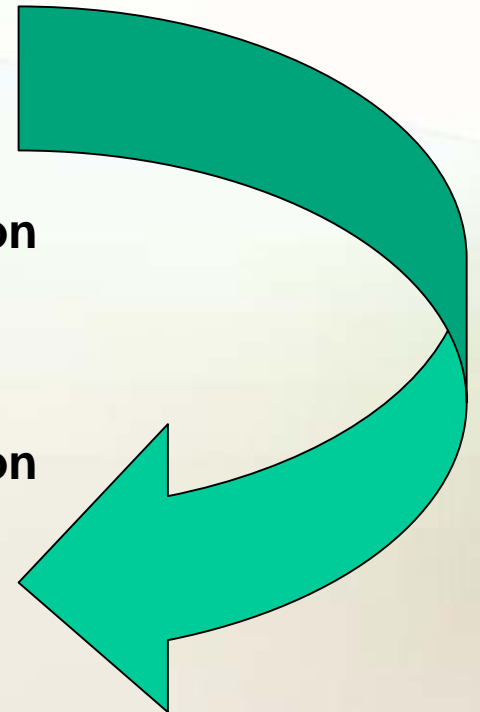
Physical/mechanical damage
Electrical Interface Degradation

Long term

Physical/mechanical damage
Corrosion
Electrical Interface Degradation

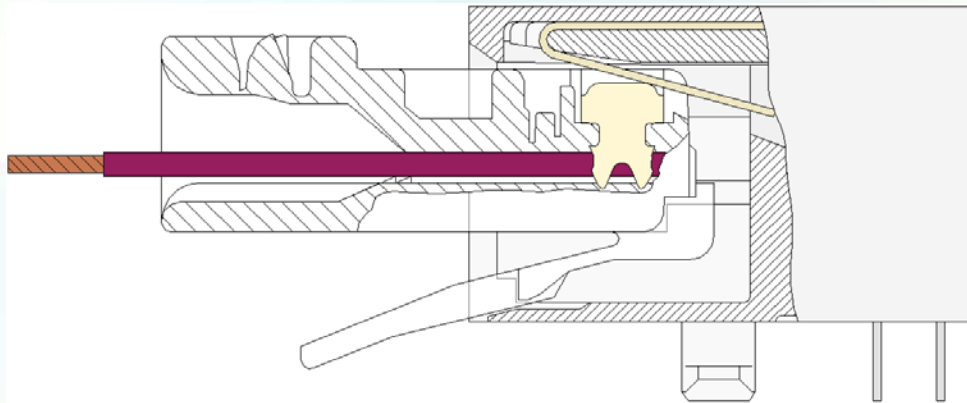
MAJOR ACCEPTANCE CRITERION
LOW LEVEL CONTACT Resistance

LLCR (bulk)



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PoE PLUS. CONNECTOR DURABILITY UNDER ELECTRICAL LOAD



Low Level Contact Resistance (LLCR-bulk)
consists of four components

Plug Conductor Resistance

Plug Blade/Conductor Contact Resistance

Plug Blade/Jack Wire Contact Resistance

Jack Wire Resistance

PoE PLUS. CONNECTOR DURABILITY UNDER ELECTRICAL LOAD

TEST MATRIX OPTIONS

<i>VARIABLE</i>	<i>Units</i>
<i>Speed of Separation</i>	Cycle/Hour
<i>Cable length</i>	meter
<i>Number of Contacts Energized simultaneously</i>	
<i>Plating Thickness</i>	0.001”
<i>Sample population</i>	Contact type
<i>Power per contact</i>	Watt
<i>Polarity</i>	+/- PLUG

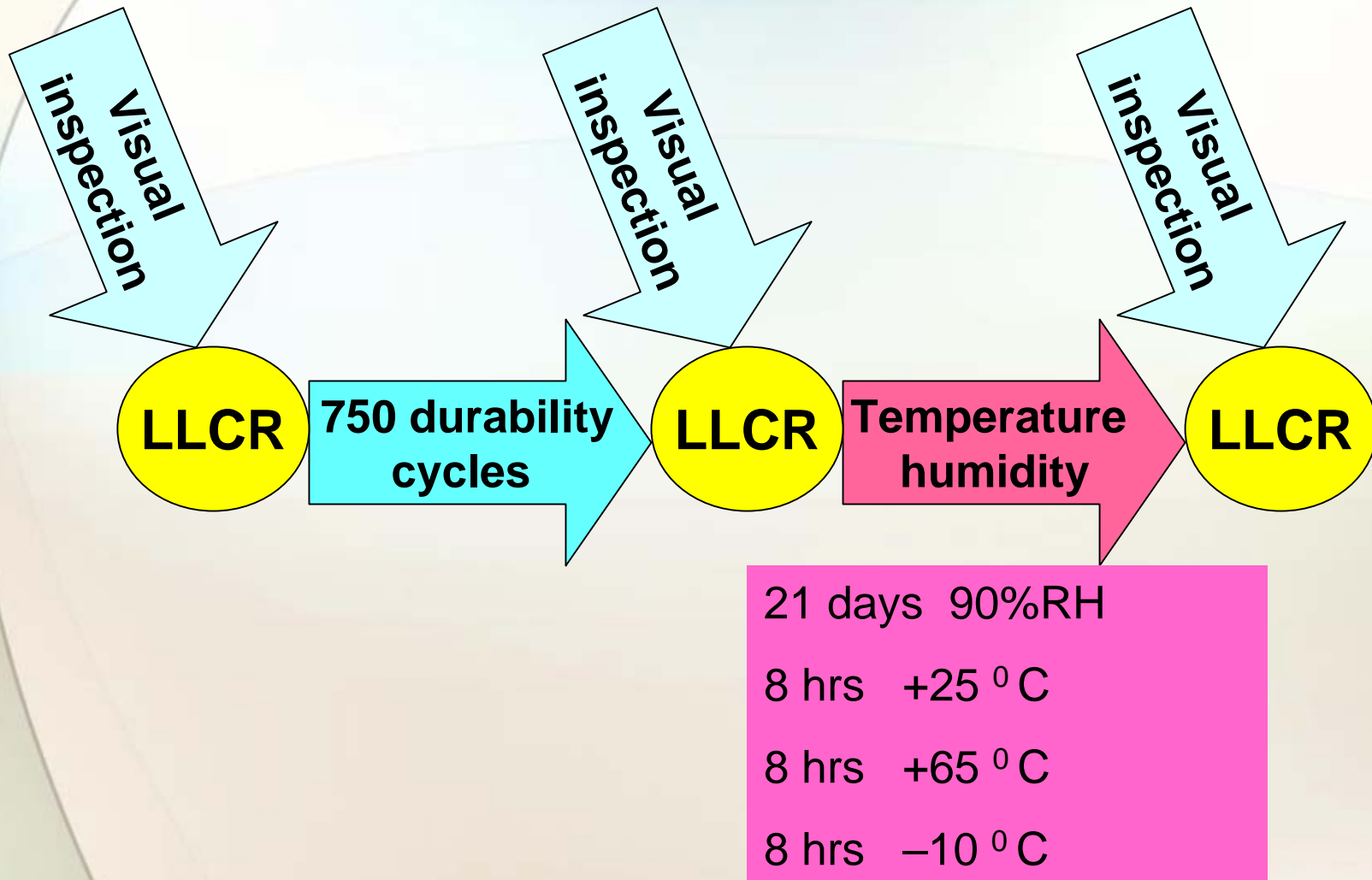
Bel Stewart Connectors

PoE PLUS. CONNECTOR DURABILITY UNDER ELECTRICAL LOAD

VARIABLE	Units	Control	TEST GROUP 1	TEST GROUP 2A	TEST GROUP 2B	TEST GROUP 3A	TEST GROUP 3B
Speed of Separation	Cycle/ Hour	300	300	450	450	720	720
Cable length	meter	2	2	2	10	2	10
Number of Contacts Energized simultaneously		0	1	8	8	8	8
Plating Thickness	0.001"	30	30	30	30	30	30
Sample population	Contact type	8	8	8	8	8	8
POWER per contact	W	0	20	20	20	20	20
Polarity			+PLUG	-PLUG	-PLUG	-PLUG	-PLUG

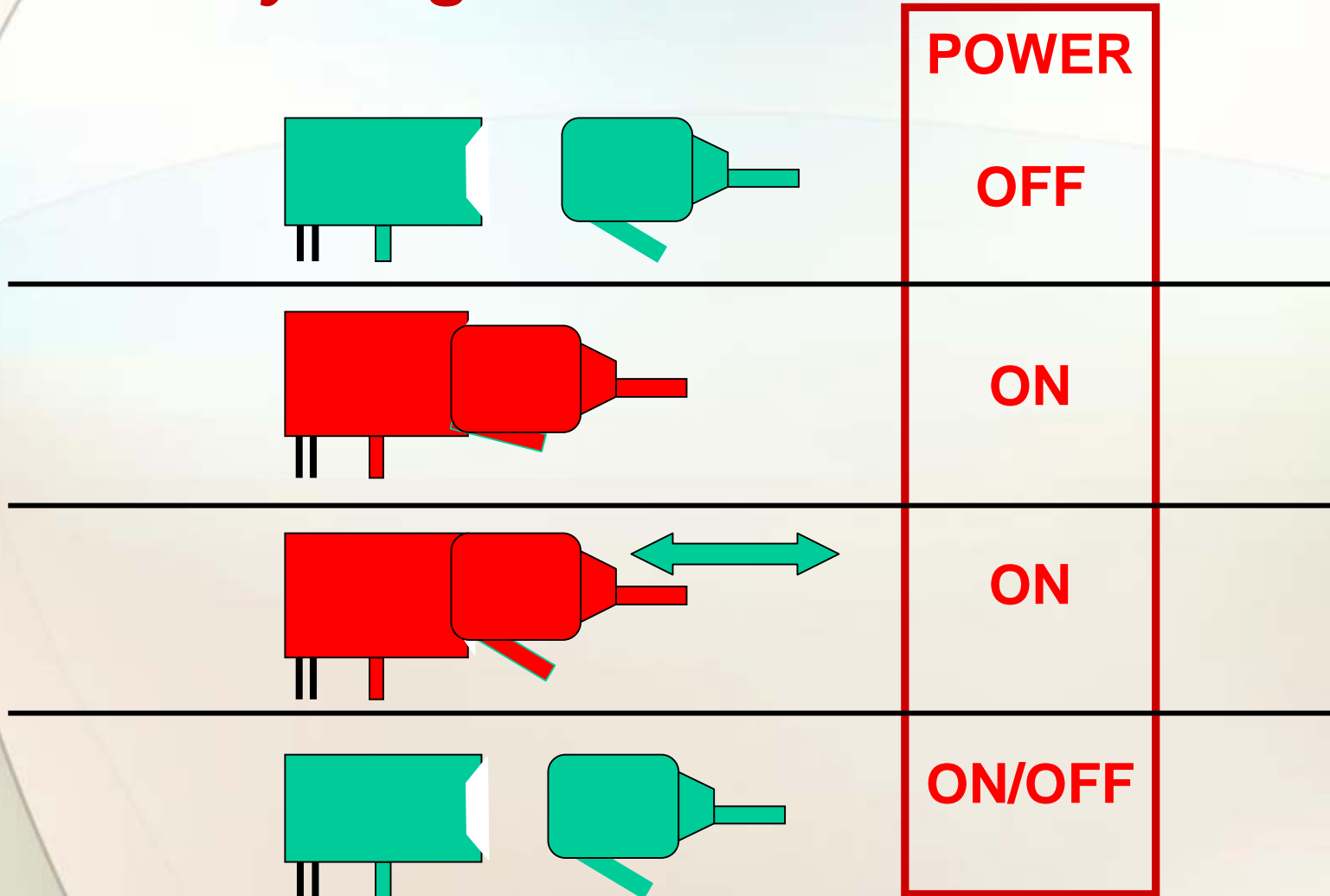
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PoE PLUS. CONNECTOR DURABILITY UNDER ELECTRICAL LOAD



PoE PLUS. CONNECTOR DURABILITY UNDER ELECTRICAL LOAD

Power Cycling of Connectors



PoE PLUS. CONNECTOR DURABILITY UNDER ELECTRICAL LOAD

*In-process durability comparative experiment
Control and group 1*

Visual
inspection

Visual
inspection

Contact No power applied

Contact with power

LLCR

LLCR

80

160

240

320

400

480

560

640

720

800

LLCR

LLCR

LLCR

LLCR

LLCR

LLCR

LLCR

LLCR

LLCR

LLCR

PoE PLUS. CONNECTOR DURABILITY UNDER ELECTRICAL LOAD

Identify the effects of a pure mechanical operations

vs.

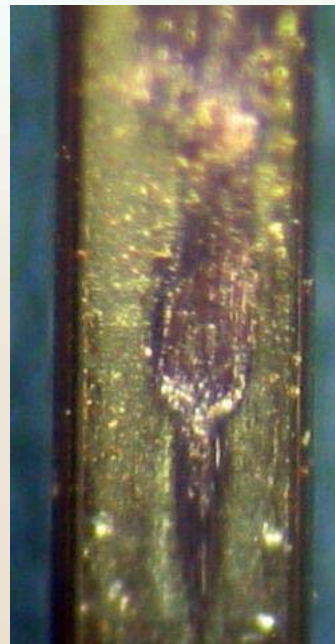
combined effects of both electrical and mechanical factors

Control samples and test group 1

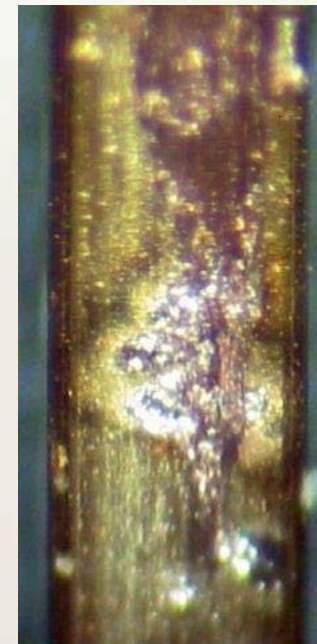
FRESH
Contact



After Mechanical
Cycles without Electrical
Load



After Cycling with
Electrical Load before
Environmental exposure

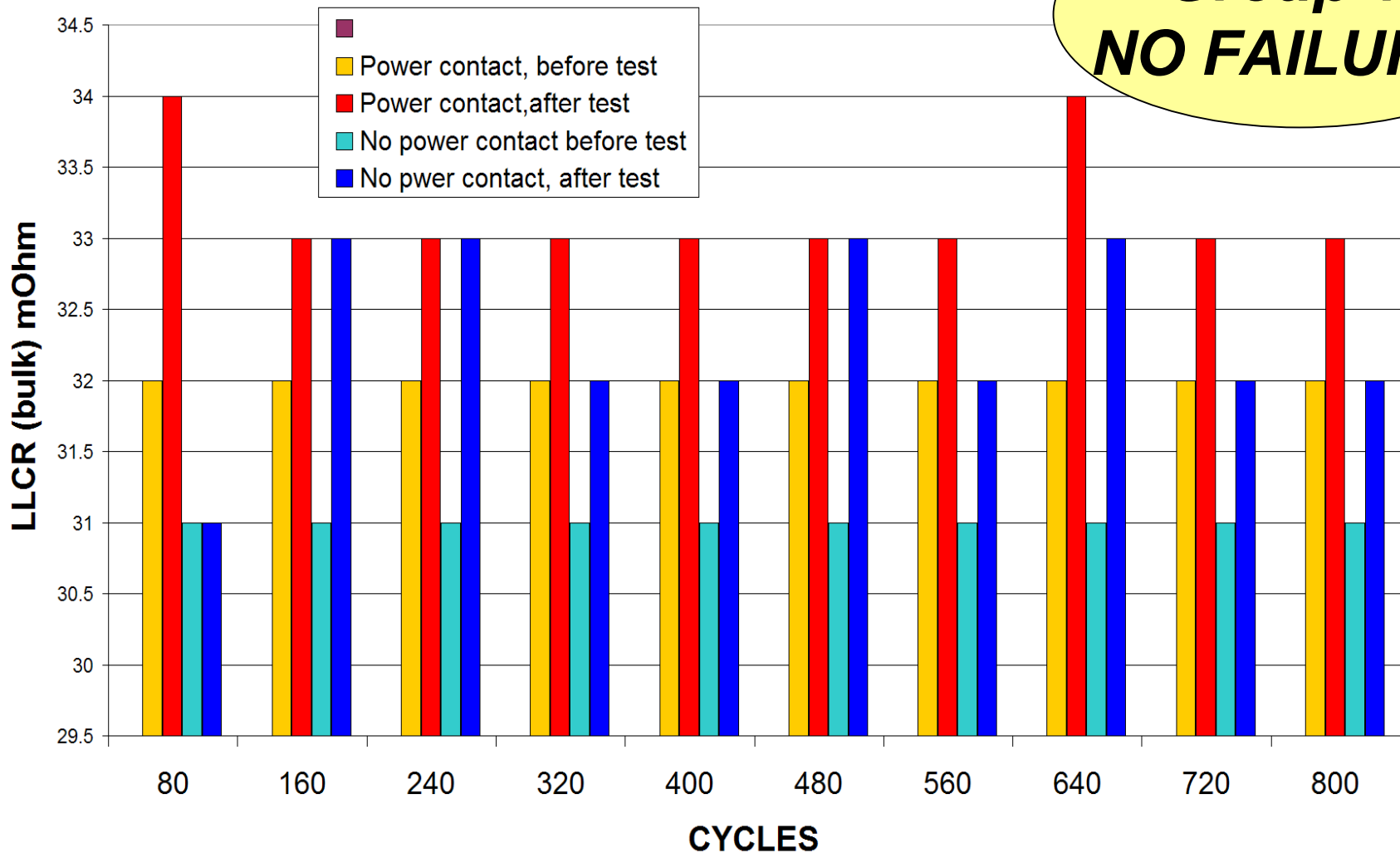


PoE PLUS. CONNECTOR DURABILITY UNDER ELECTRICAL LOAD

TEST GROUP 1. Changes in LLCR during the durability cycling

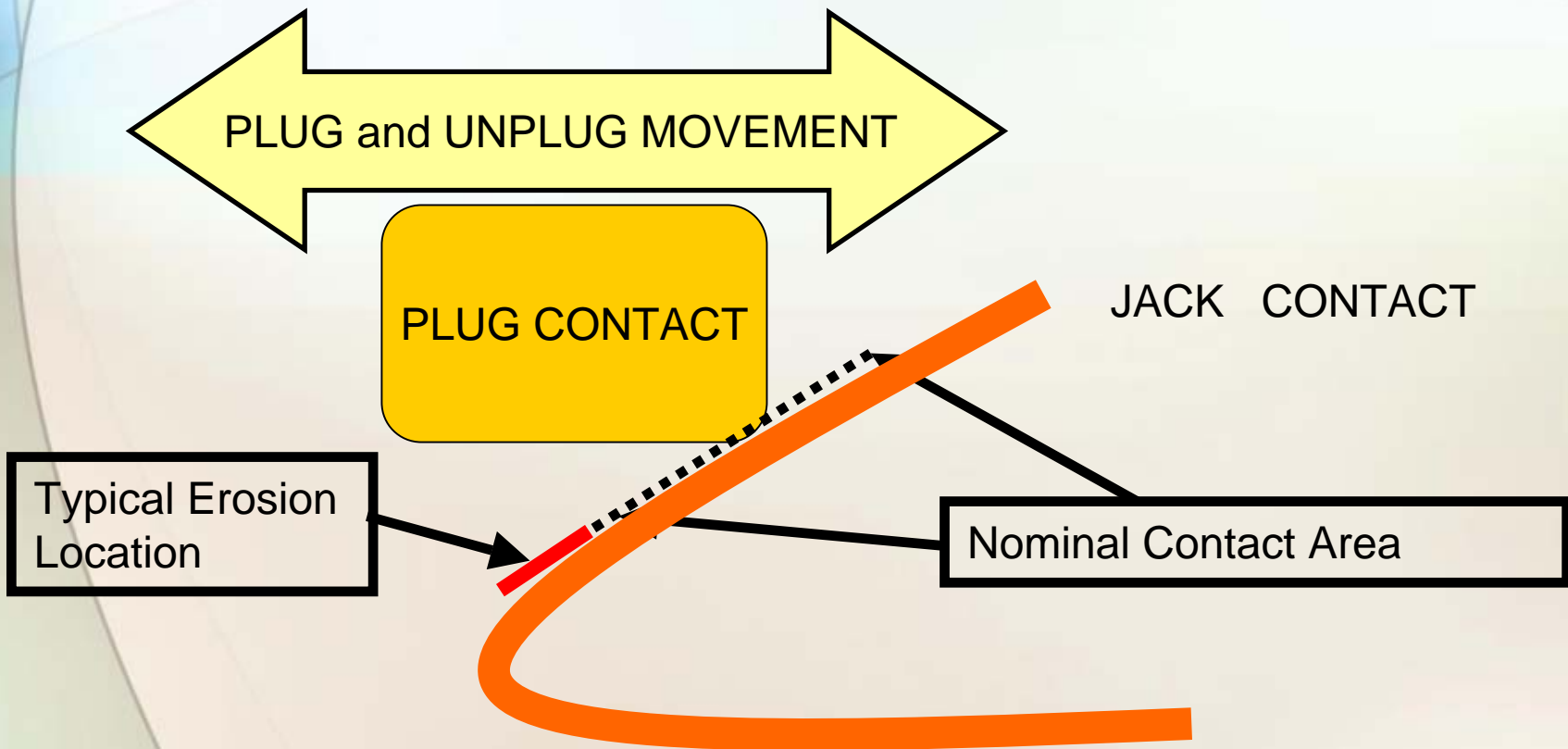
Minor change in LLCR (bulk).

**Group 1.
NO FAILURES**



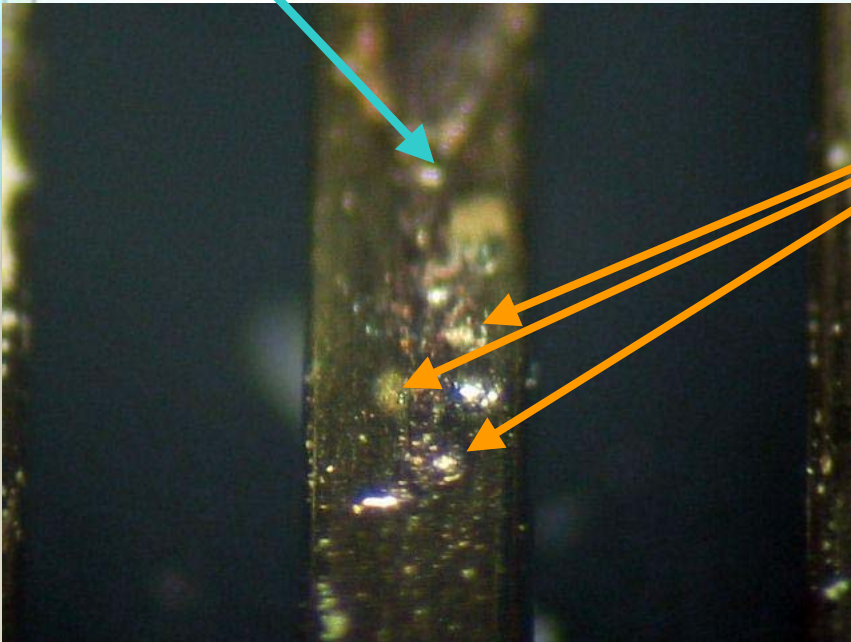
PoE PLUS. CONNECTOR DURABILITY UNDER ELECTRICAL LOAD

LOCATION of EROSION TYPICALLY OUTSIDE OF NOMINAL CONTACT ZONE (WIPING ZONE)



PoE PLUS. CONNECTOR DURABILITY UNDER ELECTRICAL LOAD

Wiping zone starts here

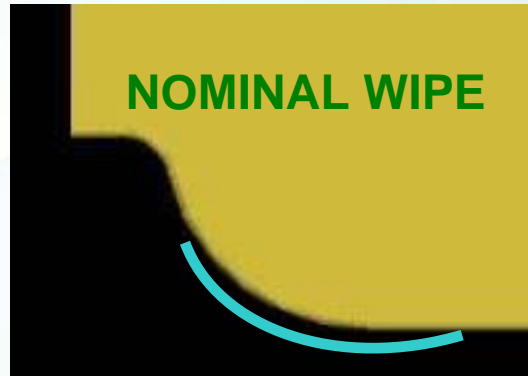
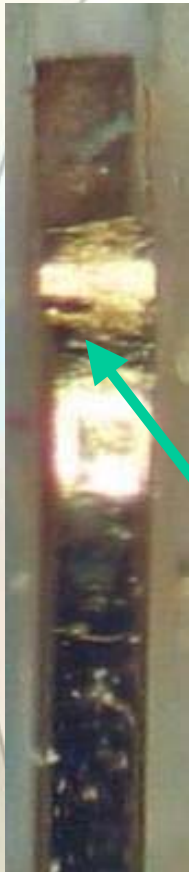


CORONA DISCHARGES
(possible)

Relatively slow,
time dependent
Multiple events,
shallow craters ,
pitted surface, erosion

Observed multiple craters are outside or on the border of wiping zone. **NO** significant plating damage.

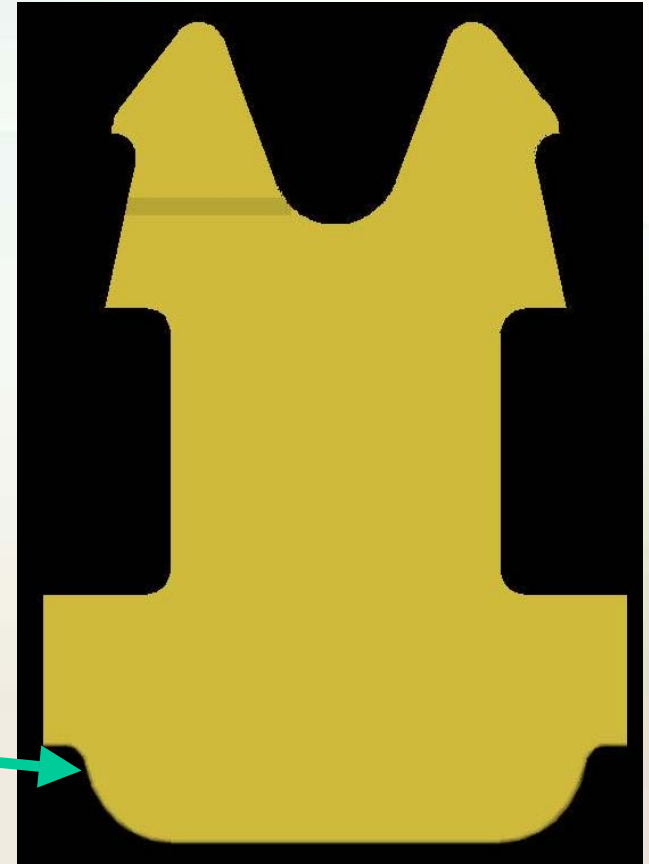
PoE PLUS. CONNECTOR DURABILITY UNDER ELECTRICAL LOAD



PLUG CONTACT

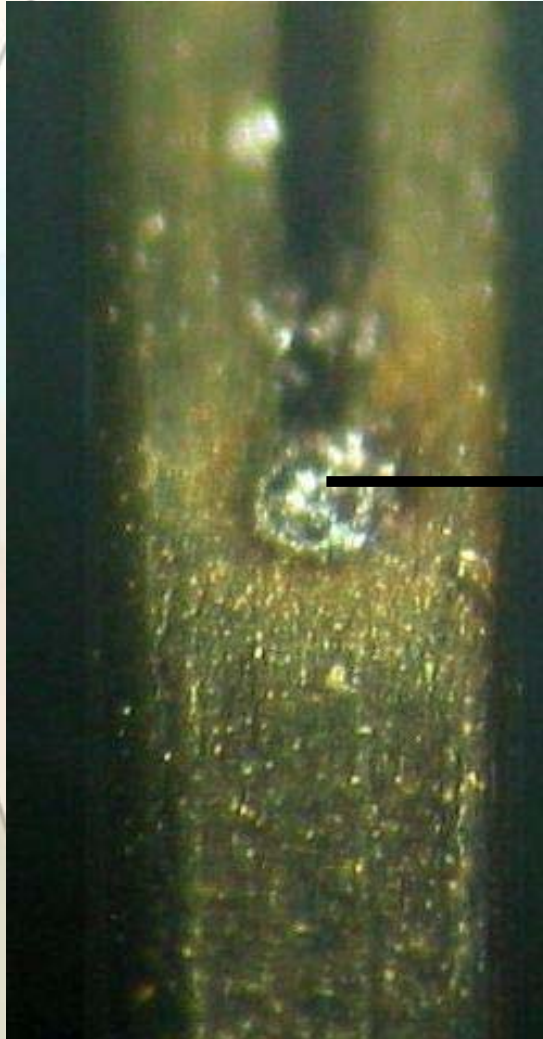
Typical Erosion Location

**Outside nominal
wiping area**



Bel Stewart Connectors

PoE PLUS. CONNECTOR DURABILITY UNDER ELECTRICAL LOAD



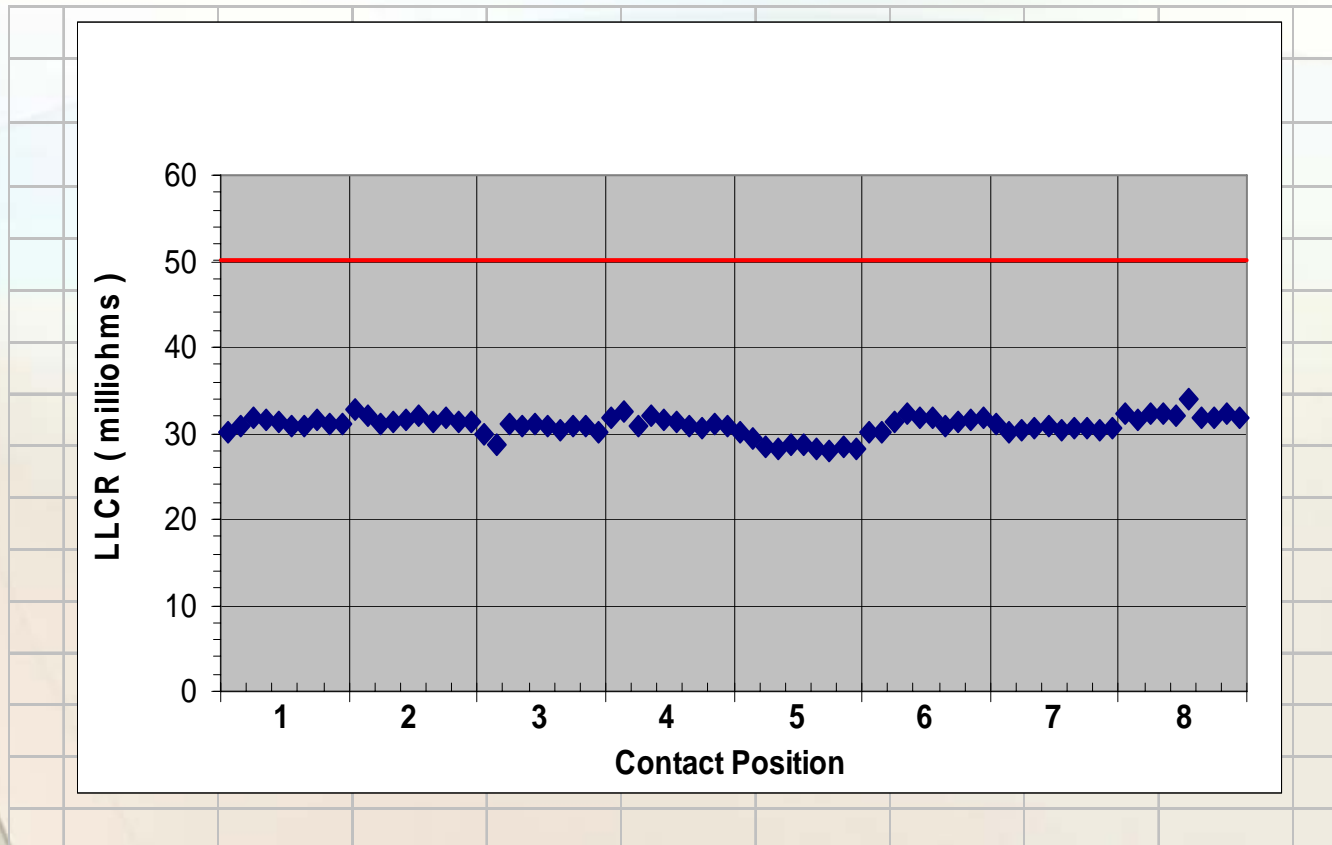
Connector Wiping Zone

SPARK

Fast, single event,
Time independent
Large distinct crater

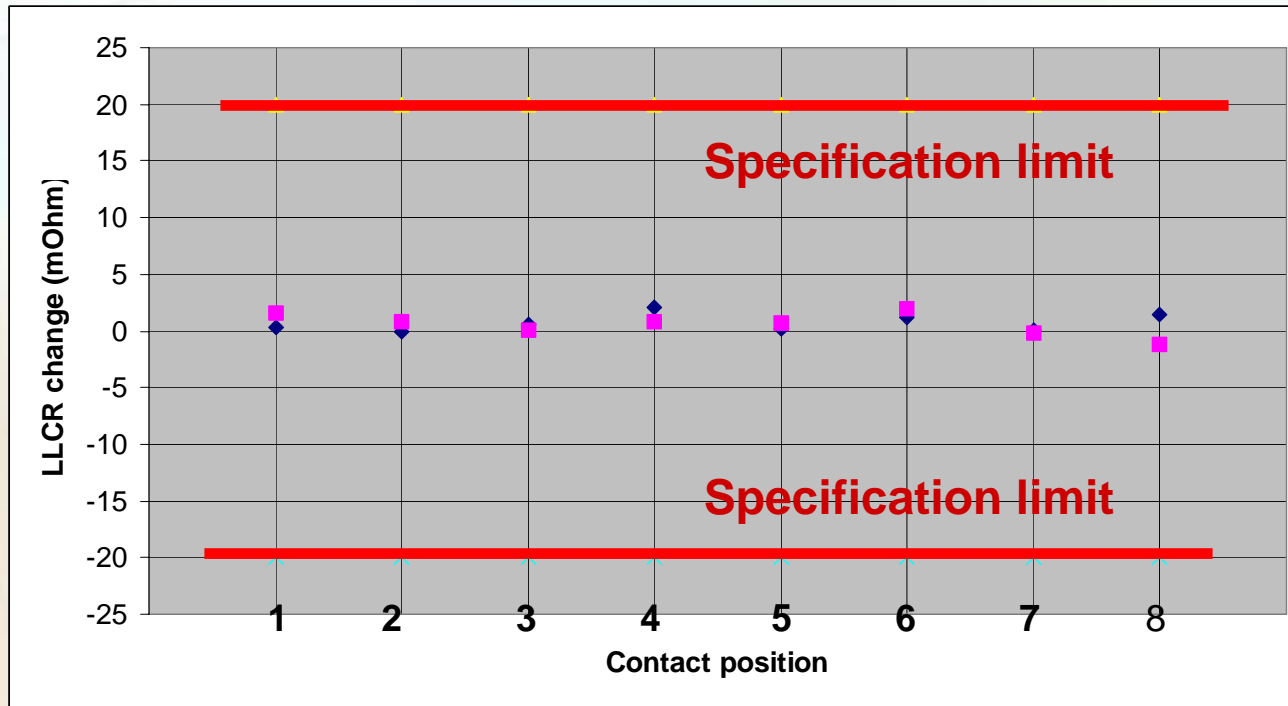
SPARK CRATER located outside
of nominal wiping zone

TEST GROUP 2. INITIAL LLCR (bulk)



PoE PLUS. CONNECTOR DURABILITY UNDER ELECTRICAL LOAD

TEST GROUP 2. LLCR (bulk) change (mOhm)
2 m cable. 750 cycles. ■ 420 cycles/hr ■ 720 cycle/hr



No noticeable effect due to separation speed

SUMMARY and PRELIMINARY CONCLUSIONS

The experimental study on the effects electrical load on durability of connecting hardware is in progress

The test data demonstrated no damage as measured by Low Level Contact Resistance on performance of BSC connecting hardware at 20 watt per contact.

Initial observation indicated that the effects of electrical discharges are typically outside a nominal connector wiping area.