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Modern Methods of Exothermic Welding, Standard IEEE837 2014

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PENTAIR ERICO

THIS PRESENTATION IS IN 2 PARTS

- 1) Update in IEEE837 2014 Standard
- 2) Comparison on Traditional vs Modern Exothermic Welding Methods

IEEE Standard 837 History

Before 1984

- IEEE 80 was the accepted standard for qualifying grounding connectors for Electrical Substation

Publications of IEEE 837

- Separate standard for testing and pre-qualifying of connections

Revisions	1984	1989	2002	2014

IEEE 80 2000

- The IEEE 80 2000 publication recommends connectors that passed IEEE 837 requirements

Relevance

Not mandatory for Telecom (or for that matter sub-stations)

However, it is the highest benchmark on qualification of connections in USA and indeed globally

IEEE Standard 837-2014

Scope:

"This standard provides direction and methods for qualifying permanent connections used for substation grounding. It particularly addresses the connection used within the grid system, the connection used to join ground leads to the grid system, and the connection used to join the ground leads to equipment and structures."

Purpose:

"The purpose of this standard is to give assurance to the user that a connection meeting the requirements of this standard will perform in a satisfactory manner over the lifetime of the installation, provided that the proper connection is selected for the application and that the connection is installed correctly. Grounding connections that meet the test criteria stated in this standard for a particular conductor size range and material should satisfy all of the criteria for connections as outlined in IEEE Standard 80"

IEEE Standard 837

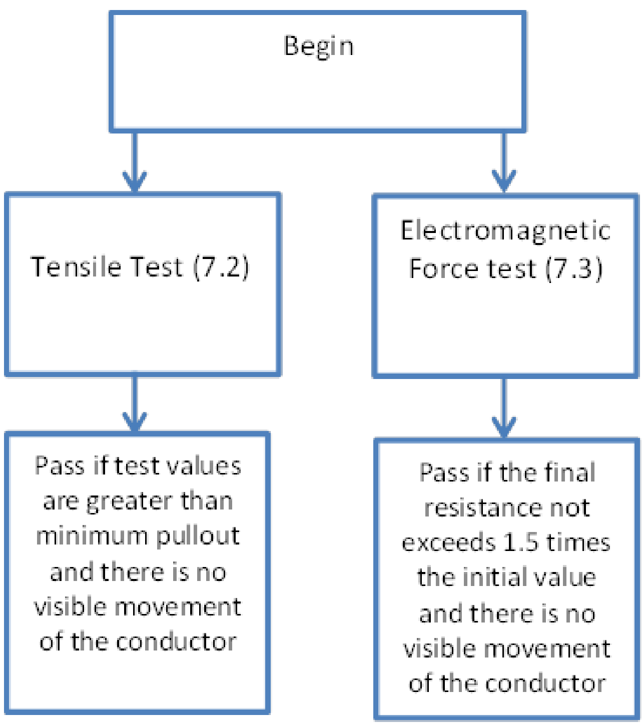
Testing Requirements

1. Mechanical Testing

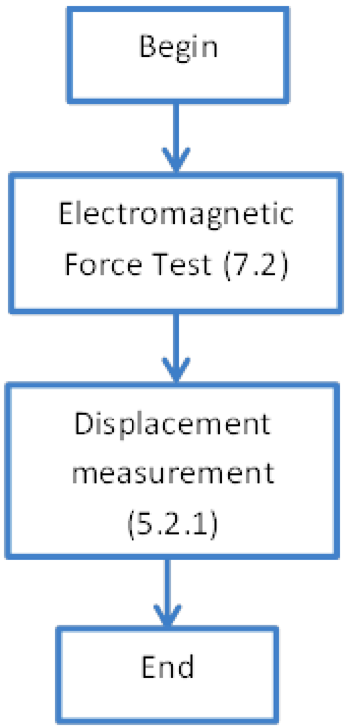
2. Sequential Testing

Mechanical Test

2002

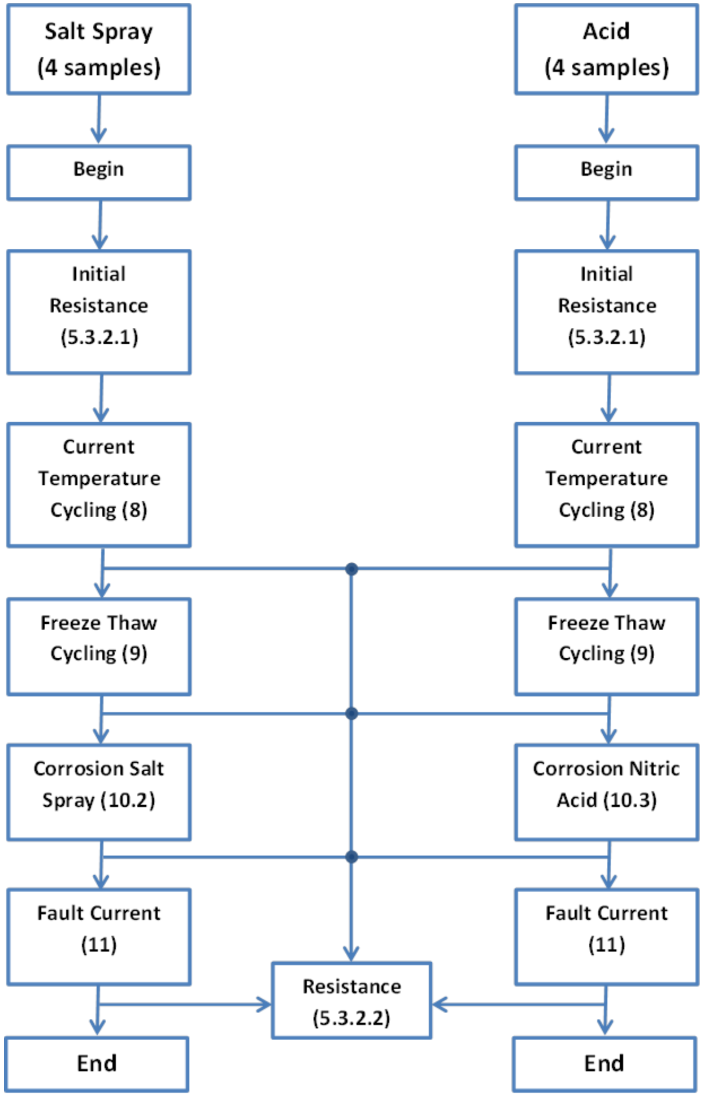


2014



Sequential Test

The order of the sequential test did not changed



IEEE Standard 837

Electromagnetic Force Test Criteria

Test for 4/0 Conductor

More Stringent in 2014

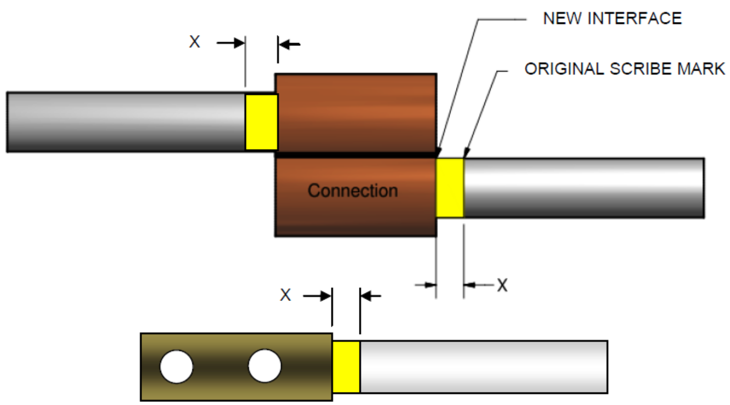
	2002	2014
RMS Symmetrical Current & Duration	T = 1 sec (30.5 kA)	De-rated to 90% fusing (47 kA)
Peak Test Current	Ipeak = 2.7*Irms (82 kA)	Ipeak = 2.69*Irms (126 kA)
Minimum Test Duration	0.2 secs	0.25secs
Fusing	20% of fusing current	90% of Fusing Current
Restraint	Allowed	Unrestrained
Length of Wire	Not specified	Test sample length 1.22m to 1.83m
Pass Fail Criteria	The final resistance shall not exceeds 1.5 times the initial value	Pass/Fail criteria - pull out not exceed 10 mm or the outer ø of conductor which ever is less.

Pass Fail Criteria EMF Test

2002

- The final resistance shall not exceed 1.5 times the initial value
- The resistance values shall be corrected to 20°C

2014



•The maximum allowable movement not to exceed either 10 mm or the outer diameter of the conductor

IEEE Standard 837

Annex C

Conductive Ampacity Calculations

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IMPROVING NETWORK INFRASTRUCTURE
RELIABILITY AND SUSTAINABILITY

2014 Test Loop Practical Examples

Test Assemblies

- The 2002 edition is not specific regarding the test samples lengths
- The 2014 edition instructs that each test sample consist of a 1.22m to 1.83m (48” to 72”) long sections of bare conductor
- Both editions provide the same instructions for test samples used in the Sequential test

IEEE Standard 837

Sequential Test

Sequential Test

- In both editions, the purpose and the structure of this test is the same
- The test determines how connections perform under accelerated aging conditions
- There are only minor differences between the two editions
  - The 2014 edition provides better guidance for acid bath test.
- Pass/fail criteria for all following Sequential tests is the same, the final resistance shall not exceeds 1.5 times the initial value

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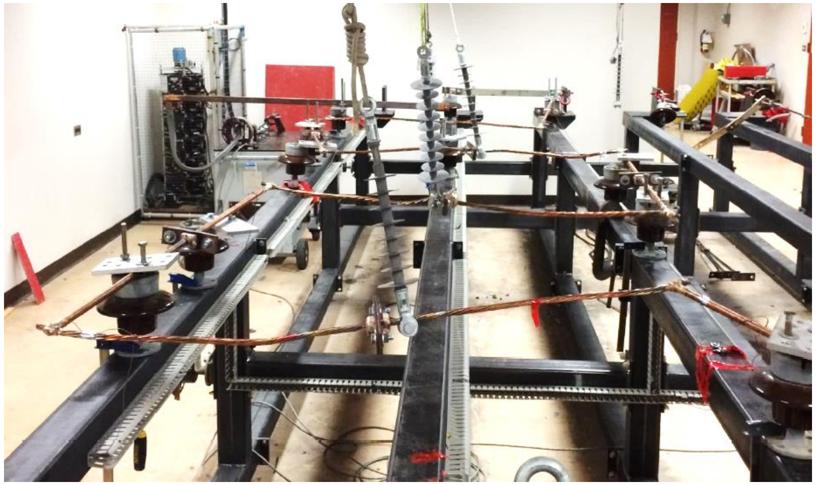
IMPROVING NETWORK INFRASTRUCTURE RELIABILITY AND SUSTAINABILITY

Current Temperature Cycling

Current Temperature Cycling,
4 samples, 25 Cycles from ambient to 350°C for 1 hour and back to ambient.



Freeze / Thaw

- Same samples as for Current Temperature Cycling.
- Freeze-thaw, 4 samples, 10 Cycles; -10°C to +20°C for 2 hours at each cycle

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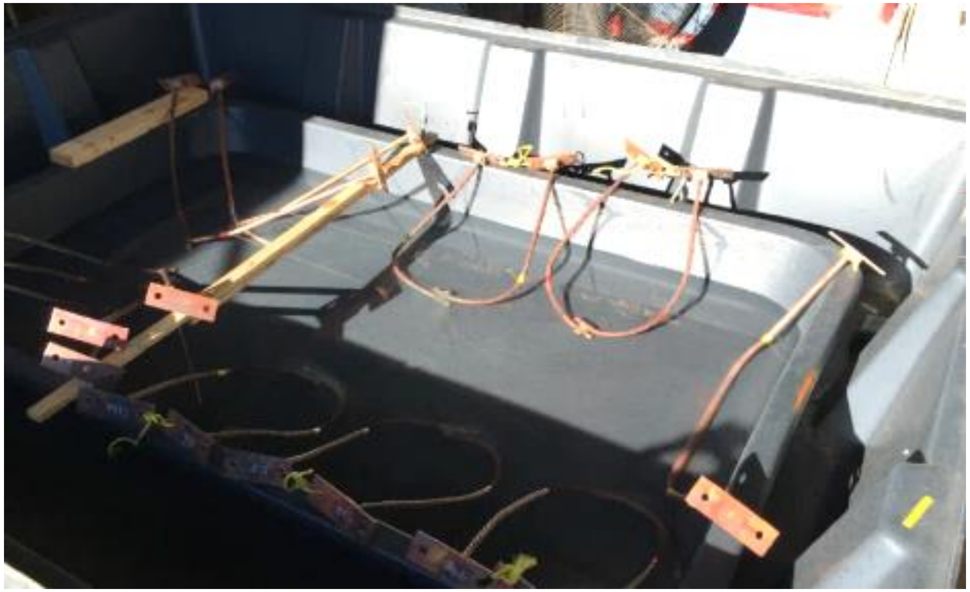
IMPROVING NETWORK INFRASTRUCTURE
RELIABILITY AND SUSTAINABILITY

Corrosion Test - Salt Spray

- Test is intended for above ground connections
- Same samples as for Current Temperature Cycling and Freeze and Thaw tests
- Salt Spray per ANSI/ASTM B117, at least 500 hours.

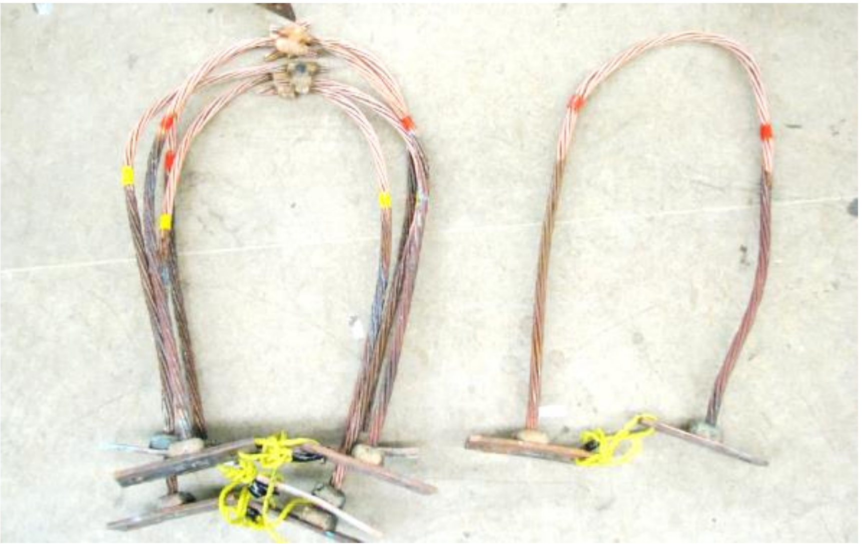
Corrosion Test - Acid Bath HNO_3

- Test intended for connectors in direct burial applications
- Same samples as for Current Temperature Cycling and Freeze and Thaw tests
- Solution - 10% by volume of nitric acid (HNO_3)



Corrosion Test - Acid Bath HNO3

- For copper conductors, each connector and 80% of the conductor between equalizers are submerged in the acid solution until there is a 20% reduction of the cross sectional area of the control conductor
- When copper clad steel conductors are used, the test loop is submerged until resistance of the control conductor is increased by 25%



Fault Current Test

- The test loop is subjected to 90% of the calculated fusing current of the remaining cross-section of the conductor for a 10 second duration
- This current is applied three times
  - Conductor is allowed to cool down below 100°C prior to the application of the subsequent fault current

Summary IEEE 837 2014

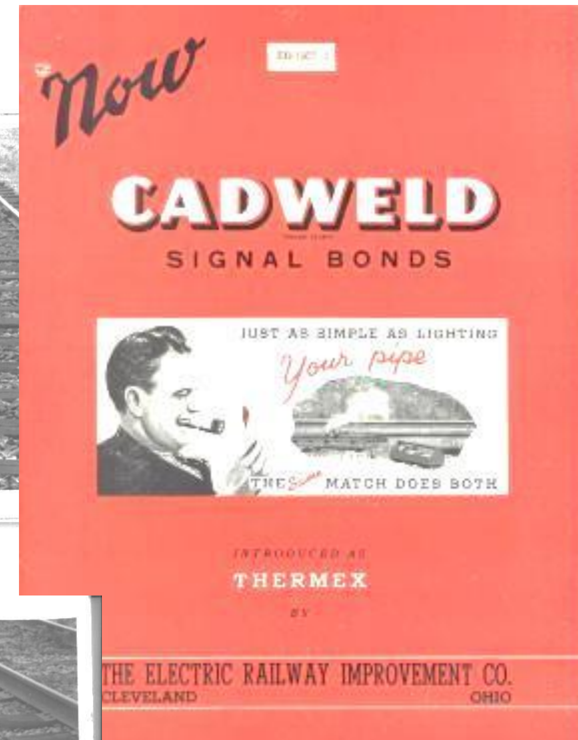
- The 2014 edition has more stringent test procedures
- The mechanical EMF test simulate physical movement under fault current
- Sequential test simulate ageing in alkaline and acidic condition
- By far the most comprehensive test method of connectors
- Cost of Testing $200K+

Flint ignition vs Electronic Igintion

TRADITIONAL VS MODERN CADWELD

ELECTRIC RAILWAY IMPROVEMENT COMPANY - 1936

- First public Demonstration in 1936
- ERICO Railway IMPROVEMENT COMPANY Later called ERICO
- Safety Standard were lower
- Breakthrough at the time as railway industry struggled with mechanical connections under vibration conditions
- Invented by Dr Charles Cadwell hence the CADWELD Brand



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TRADITIONAL EXOTHERMIC

- Used Graphite mold – used today
- Ignited with Flint Ignitor
- Very early had magnesium as starting material
- Later a finely ground weld metal as staring powder
- Chemical reaction (still same)

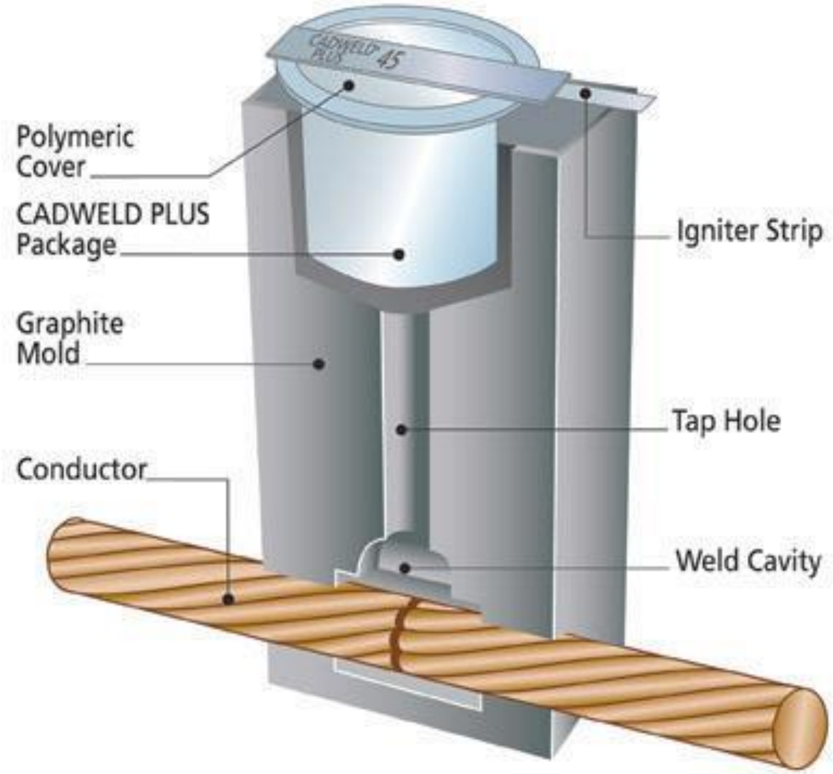
$$3\ \mathrm{Cu_2O} + 2\mathrm{Al} \longrightarrow 6\ \mathrm{Cu} + \mathrm{Al_2O_3}$$

AND lots of **HEAT** **(exothermic)**

https://www.youtube.com/watch?v=u3p9Py0QO8Y

MODERN EXOTHERMIC - Electronic Ignition

- The Modern Electronic Ignition System offers all the benefits of Exothermic
- Consists of disposable, moisture resistant welding material cup.
- Electronic Control Unit means no starting material is required and makes ignition very easy
- Long leads as opposed to small flint ignitor gives increased flexibility in hard to reach areas & safety distance



MODERN EXOTHERMIC - Electronic Ignition

- Electronic ignition
- Encapsulated Weld Metal (Not loose)
- https://www.youtube.com/watch?v=u3p9Py0QO8Y

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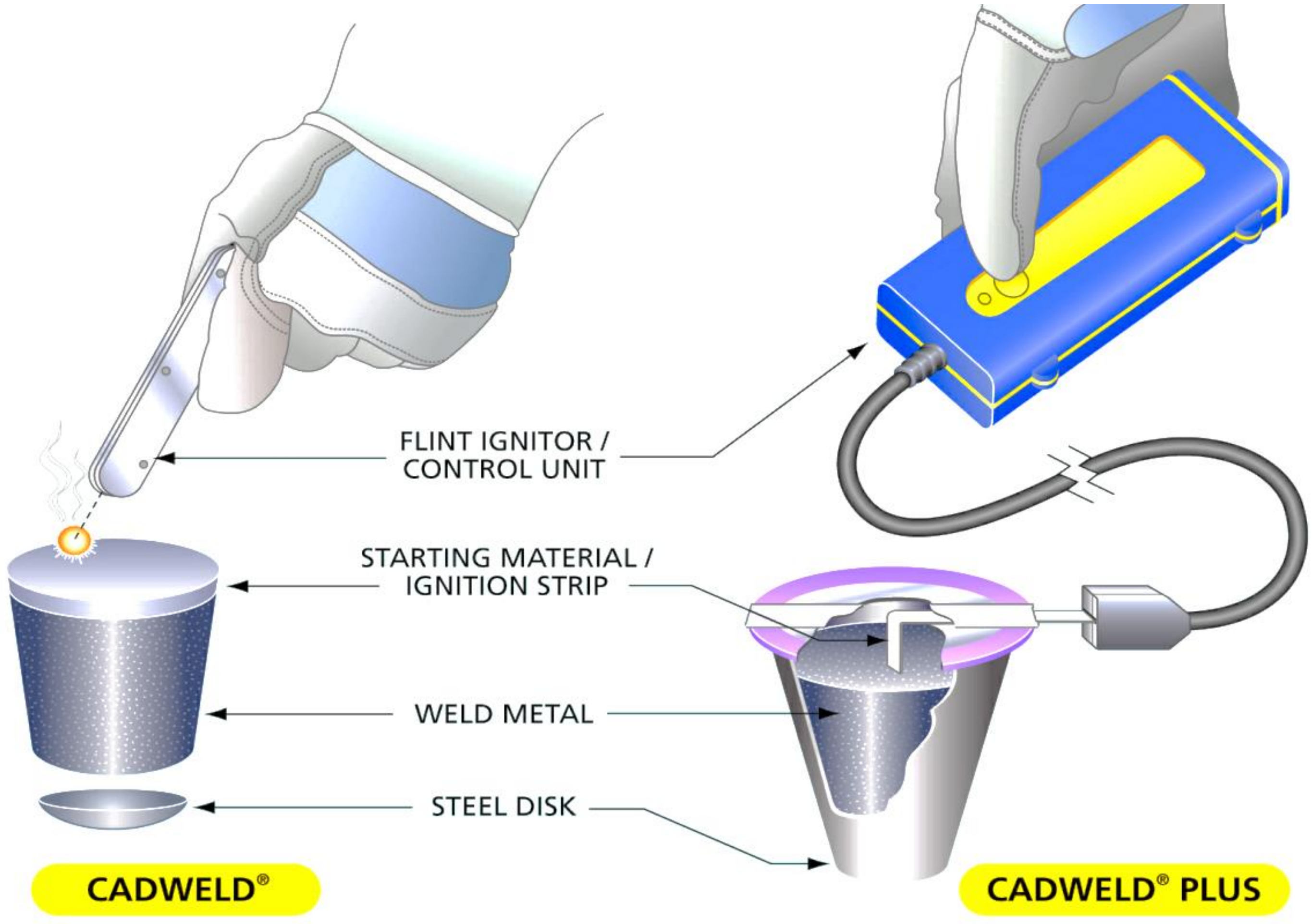
EXOTHERMIC TRADITIONAL vs MODERN



Thank You