



Connector Theory and Installation

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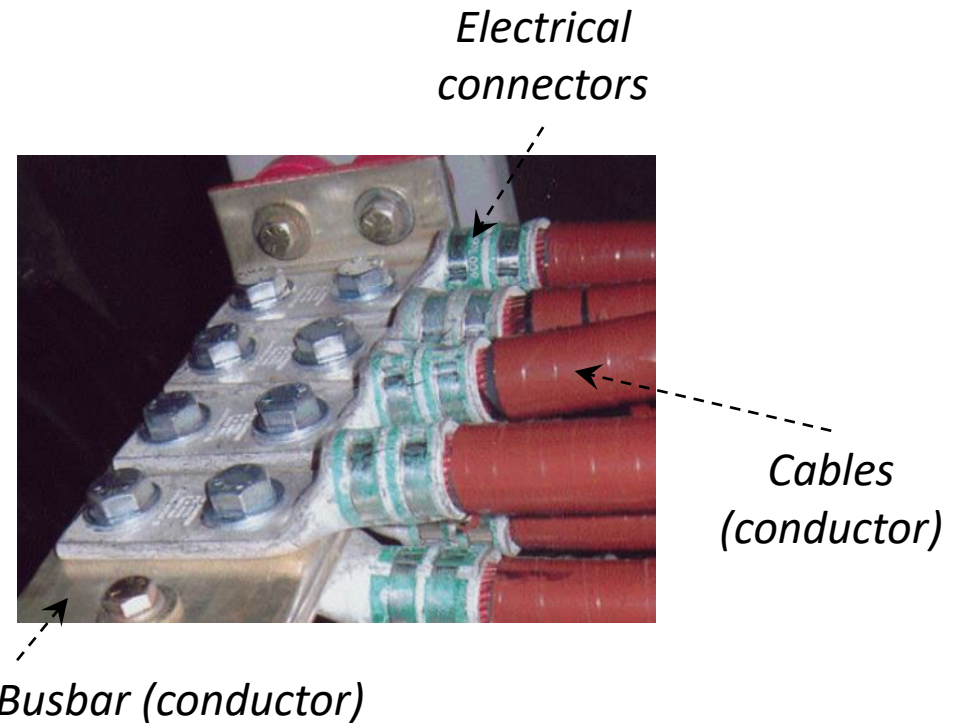
Theory of Connector Technology

Electrical Connector

- In their simplest form, join two or more conductors in a continuous, electrically conductive path

In Addition

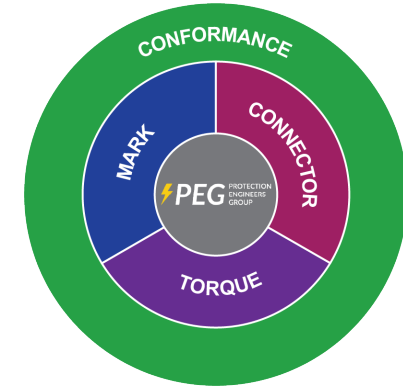
- Satisfy the electrical current requirements
- Satisfy all the mechanical requirements
- Satisfy the electrical and mechanical requirements for the **life of the connection**



Connector Technology - Mechanical

Advantages

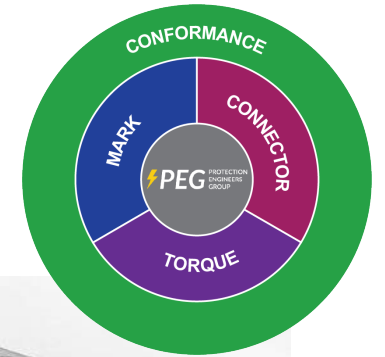
- Install with basic tools – but must be torque indicating
 - Socket or open end wrenches
 - Screwdrivers
 - Etc...
- Require minimal training to install a connector
- Physical exertion is typically not excessive
- Removable connections
- Depending on the condition of the connector, a mechanical connector may be reused (check with the manufacturer for their recommendation on reuse)
- When conditions warrant, mechanical connectors disassemble without damage to the connection components
- Electrical performance meets or exceeds the industry requirements for which they are designed



Connector Technology - Mechanical

Disadvantages

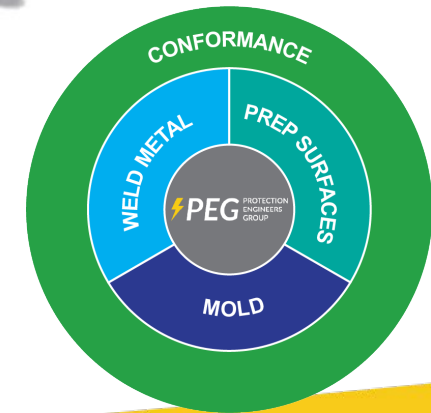
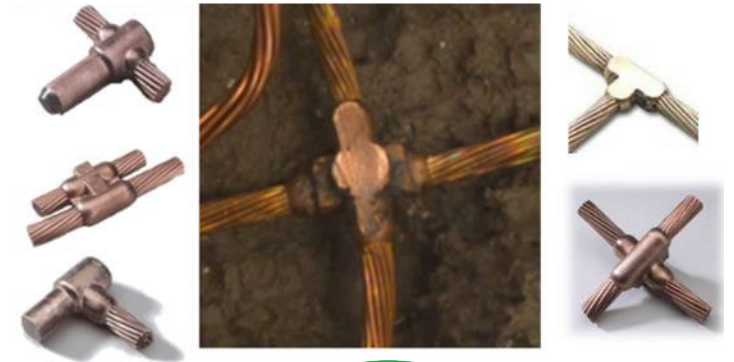
- Specific torque requirements must be followed
- Installers are required to calibrate torque wrenches
- Installation is not generally repeatable without controlled torque.
- General nature of a mechanical connection does not allow for high mechanical holding strength.
- Mechanical connectors in high vibration, like seismic locations, will typically require more some maintenance.
 - New NFPA 70B is a great resource.



Connector Technology – Exothermic Advantages

Advantages

- When properly installed, current carrying capacity is typically greater than the conductor
- When properly installed, connections can withstand repeated high current surges
- When properly installed, connections will not deteriorate with age
- Installation process is repeatable and reliable by a trained installer
- No external power or heat is required to make connections.
- IEEE Standard 837-89 stipulates exothermic connections, when properly installed, are equal to the conductor itself. Today IEEE 837 requires qualification of Exothermic connections





Connector Technology – Exothermic Disadvantages

Disadvantages

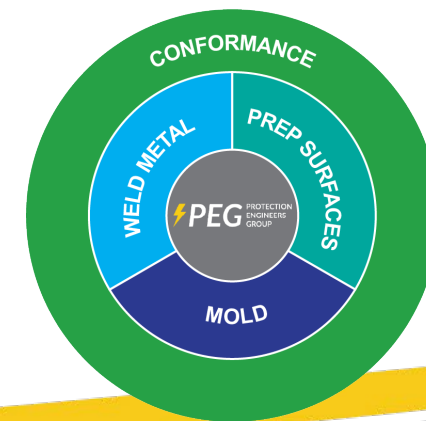
- Cost advantages may be lost in prep time and weather delays.
- The repeatability of the process cannot be easily determined, as the inspection of completed connections is visual for the most part
- Extreme heat generated during the reaction presents several problems:
 - Inherent risks to personnel and equipment
 - Wet molds can produce can safety concern from the rapid vaporization of the moisture
 - Hot molds and the process are a fire hazard that must be addressed
- Due to the annealing of the conductor, exothermic connections cannot be used in mechanical tension applications
- Range taking capabilities of a mold is limited.
- Weld metal is sensitive to improper storage and mishandling



Basic Connection Requirements:

- Torch
- Proper Mold
- Weld Metal
- Steel Disc
- Handle Clamps
- Wire Brush & Accessories

Connection Inspection Go/No Go



Theory of Connector Technology (contd.)

Electrical Connection Objective

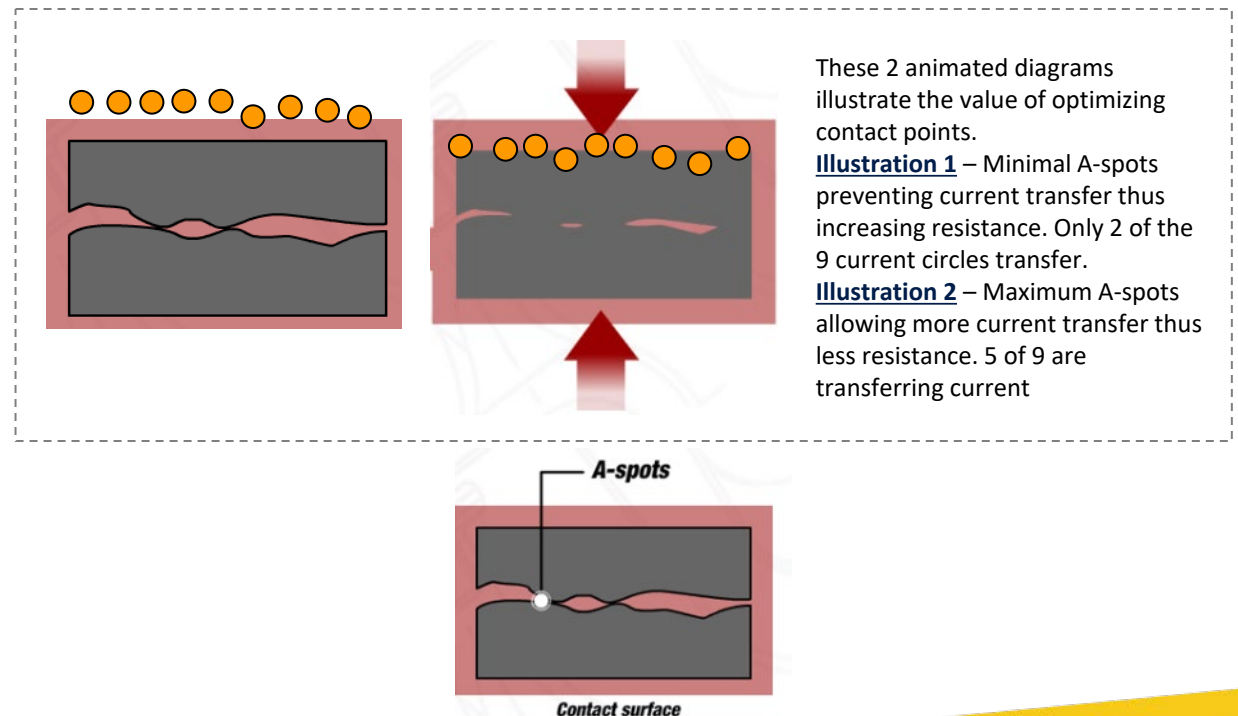
- Provide a path of electrical conduction between the conductors joined

Connection + Inherent Resistance

- An inherent result of this objective, is that the connection must exhibit low contact resistance
- Two conductor surfaces in contact can never be perfectly matched as each surface on a microscopic level is like a rough terrain
- When the surfaces come together random asperities (A-Spots) of contact are established and at those points the resistance is theoretically zero

Resistance has a negative impact on the connectors long-term performance

- Connector must maximize the contact points during installation and for the life of the connections. Less contact points = increased resistance



These 2 animated diagrams illustrate the value of optimizing contact points.

Illustration 1 – Minimal A-spots preventing current transfer thus increasing resistance. Only 2 of the 9 current circles transfer.

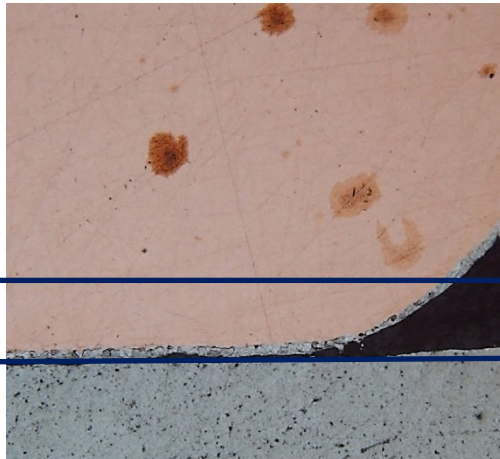
Illustration 2 – Maximum A-spots allowing more current transfer thus less resistance. 5 of 9 are transferring current

A Closer Look...pad to rack/pad?

Connector / Bonding Device

Nonconductive Layer (Powder Coat)

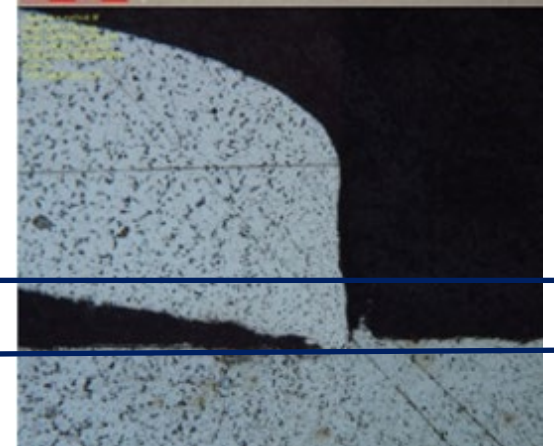
Substrate



Scratch Brushing



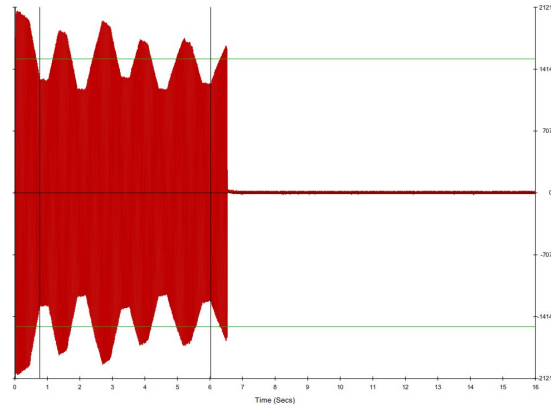
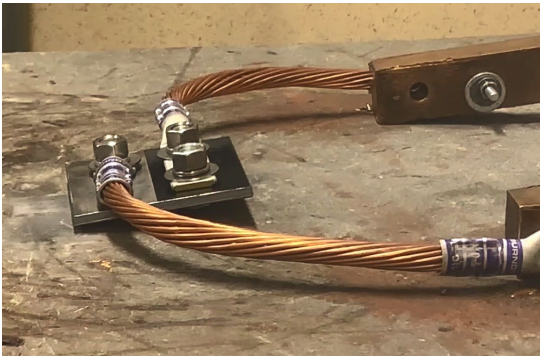
WEED (Washer,
Electrical Equipment Bond)



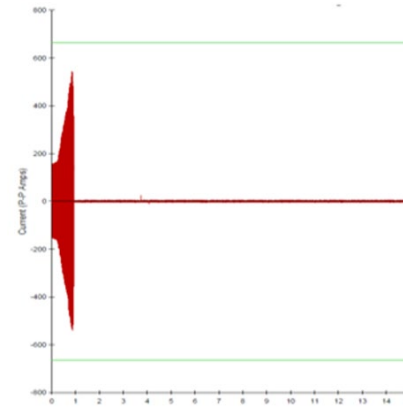
Star Washer
(Lock Washer)

Electrical Results (Short Circuit)

WEEB Samples



Star Washer Samples



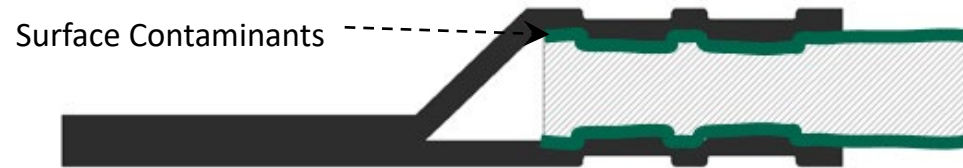
- All WEEB samples carried the 6 AWG fault current for the full duration of the test
 - All samples had electrical continuity after the test

- 2 out of every 3 samples failed to carry the 6 AWG UL 467 fault current
 - Connection points fused causing loss of continuity

Theory of Connector Technology (contd.)

Threats to a good connection

- Surface contaminants or corrosion will interfere with establishing initial contact



- Over time, thermal fatigue can loosen the connector and reduce the number of contact points. Increased voids due to heat cycling = less contact surface = increased resistance = long-term connection failure



- Improper installation = increased resistance due to:
 - Inadequate number of crimps
 - Insufficient torque

What makes a good connection – compression focused

Controlled Variables

Connector Design

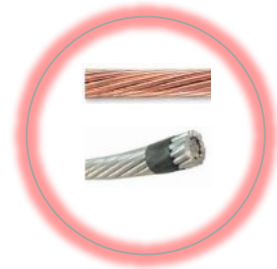


Connector Manufacturing Processes & QA

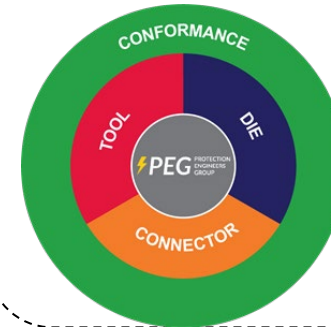


Customer Controlled Variables

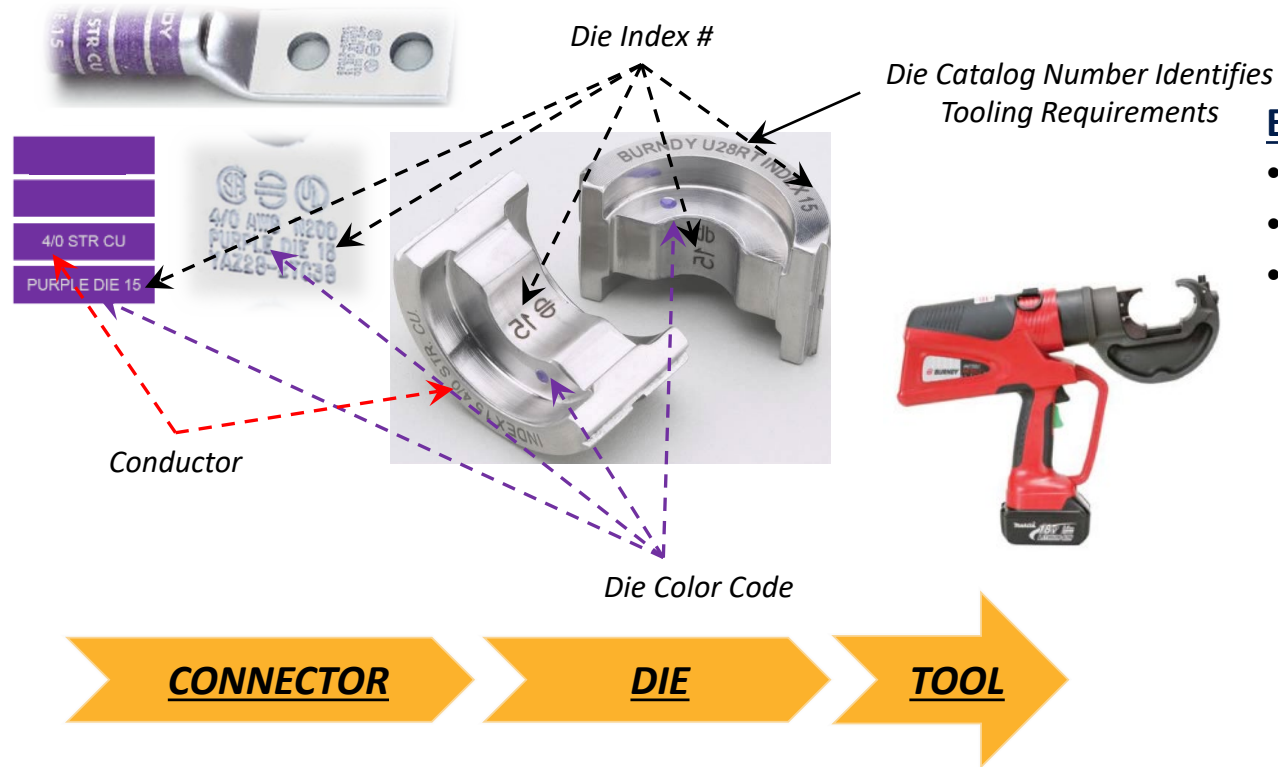
Connector-to-Conductor Material Selection



Connector Installation

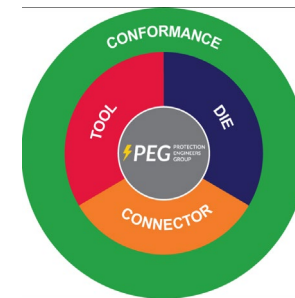


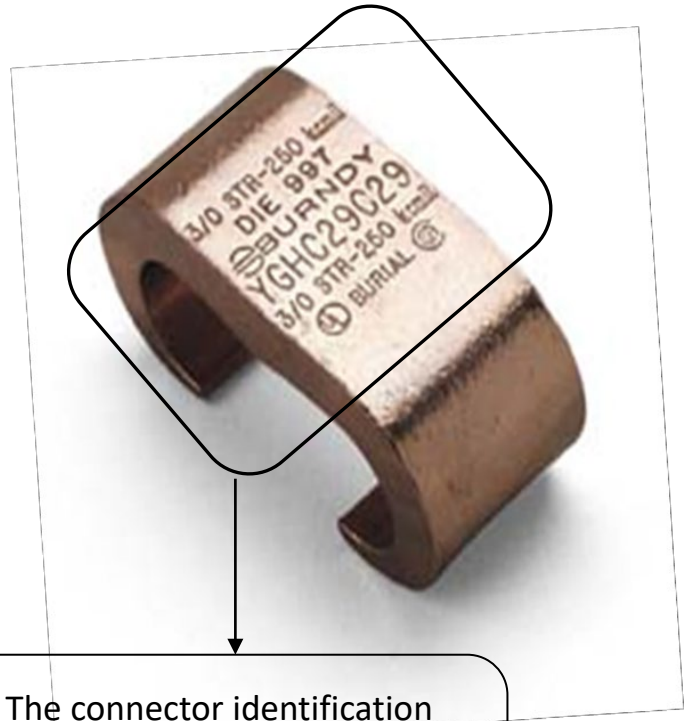
Engineered System



Engineered System:

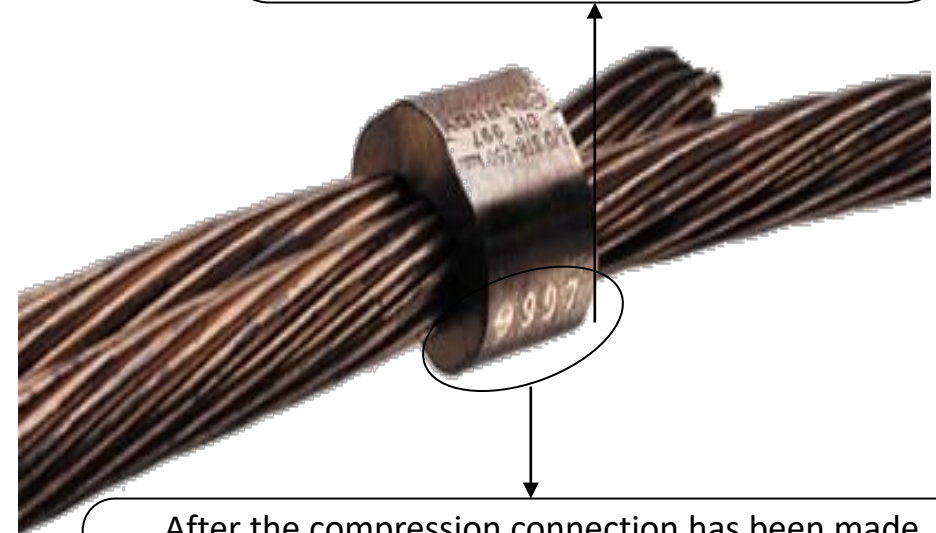
- CONNECTOR: YAZ282TC38
- DIE: U28RT
- TOOL: PAT750 or others recommended by the Connector Manufacturer





The connector identification markings including Item Catalog #, Conductor ranges and Installation die

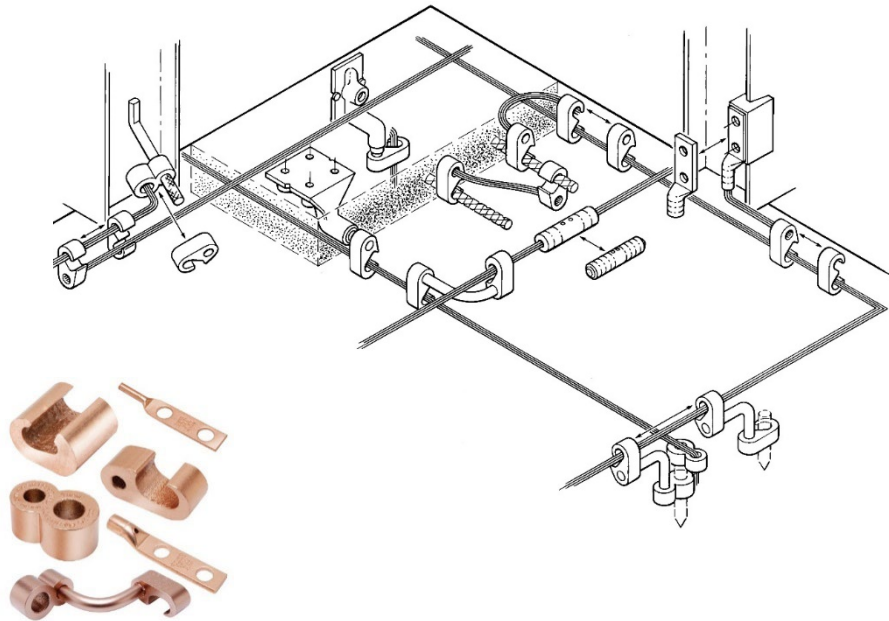
Embossed Number shows that output force used to make compression connection was correct.



After the compression connection has been made, embossed die set number should match exactly as noted on the connector. This confirms that correct die set has been used for making the connection.



Compression Direct Burial Systems



Accommodates

- Wire to Wire
- Wire to Structural Steel
- Wire to Ground Rod
- Wire to Rebar
- Wire to Bus Bar



Sponsored by:



UL Classified tools can't be used for PEG applications....



Competitor Crimp Tools

**SAFETY, RELIABILITY, CONFORMANCE
WORTH THE RISK?**


UL486A-486B ZMVV	UL486A-486B ZMOW	UL467 KDER	WARRANTY	TECHNICAL SUPPORT
Code Terminals <input checked="" type="checkbox"/>	Code Pin Adaptors <input checked="" type="checkbox"/>	HYGROUND <input checked="" type="checkbox"/>	Connectors <input checked="" type="checkbox"/>	Connectors <input checked="" type="checkbox"/>
Code Splices <input checked="" type="checkbox"/>	Flex Pin Adaptors <input checked="" type="checkbox"/>	Terminals <input checked="" type="checkbox"/>	Crimp Tool <input checked="" type="checkbox"/>	Crimp Tool <input checked="" type="checkbox"/>
Flex Terminals <input checked="" type="checkbox"/>		Splices <input checked="" type="checkbox"/>	Crimp Dies <input checked="" type="checkbox"/>	Crimp Dies <input checked="" type="checkbox"/>
Flex Splices <input checked="" type="checkbox"/>		Splice Reducers <input checked="" type="checkbox"/>	Connection <input checked="" type="checkbox"/>	Connection <input checked="" type="checkbox"/>
Code Splice Reducers <input checked="" type="checkbox"/>		H-Taps <input checked="" type="checkbox"/>		
Flex Splice Reducers <input checked="" type="checkbox"/>				
Code E-Line Terminals <input checked="" type="checkbox"/>				
Code Breakaway Terminals <input checked="" type="checkbox"/>				
Code Parallel Splices <input checked="" type="checkbox"/>				
Code H-Taps <input checked="" type="checkbox"/>				
Flex H-Taps <input checked="" type="checkbox"/>				

No 467....No Grounding or Bonding
 No Flex cable stranding for Power 486 or 467
 No connection warranty.....



Installation Summary/Safety

- Proper PPE per your location – always. For Compression and Mechanical, we recommend the basic close toe shoes, safety glasses and gloves.
- Choosing the correct conductor, connector, die and tool, connection system is imperative to mechanical and electrical performance of a compression connection
- Incorrect tooling and die selection can lead to over and under crimped connections - "A few thousandths does matter"
 - Over crimped connections can damage the conductor strands or leave excess flash that can heat a connection causing for a shortened connection life expectancy
 - Under crimped connections will minimize the number of contact points between the conductor and connector causing for a low mechanical strength and high resistance causing for a shortened connection life expectancy and increased resistance during that time
 - Mechanical connections must be properly torqued and marked for vibration effects. NFPA 70B is an excellent reference now.
 - Exothermic welds require proper and consistent preparation and strict process compliance.



Annex material for
reference- not presented



Electrical Protection of Communications Networks

March 5-7, 2019
Northbrook, IL





Detailed training/installation videos are available at:

- [\(165\) Burndy LLC – YouTube](#)
- <https://www.youtube.com/c/burndy/videos>

Copper Connectors – How Many Crimps? Read the details for your connector supplier. Example of two types of tools and dies and the instructions.

Crimping a Code Lug (YA282N)

W28RT (4 crimps)

- Due to the crimp die plow width



U28RT (2 crimps)

- Due to the crimp die plow width



Copper Connectors (contd.)

Crimping a Flex Lug (YAZV282TC38FX)

W28RT (4 crimps)

- Due to the crimp die plow width



U28RT (2 crimps)

- Due to the crimp die plow width

