Wire Connections

An overview of current and new technologies

Presented by Alison Durham

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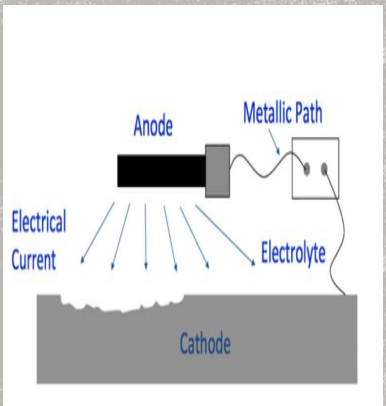
WHY ARE WIRE CONNECTIONS IMPORTANT TO CATHODIC PROTECTION (CP)



Galvanic or Impressed Current Systems require reliable wire connections to complete the electrical circuit and ensure the connection itself does not become the point of corrosion.

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COMMON CONNECTION METHODS

- Exothermic Welding

- Pin Brazing

- Cold Silver Solder Connection

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THE HISTORY OF EXOTHERMIC WELDING

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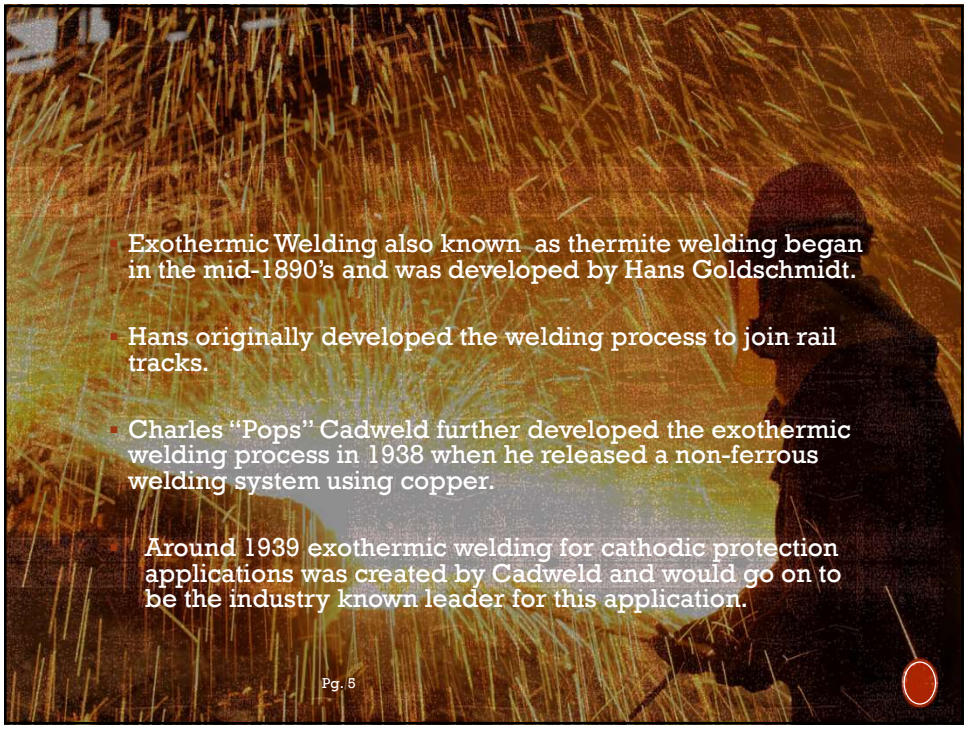
Exothermic Welding also known as thermite welding began in the mid-1890's and was developed by Hans Goldschmidt.
Hans originally developed the welding process to join rail tracks.
Charles "Pops" Cadweld further developed the exothermic welding process in 1938 when he released a non-ferrous welding system using copper.
Around 1939 exothermic welding for cathodic protection applications was created by Cadweld and would go on to be the industry known leader for this application.
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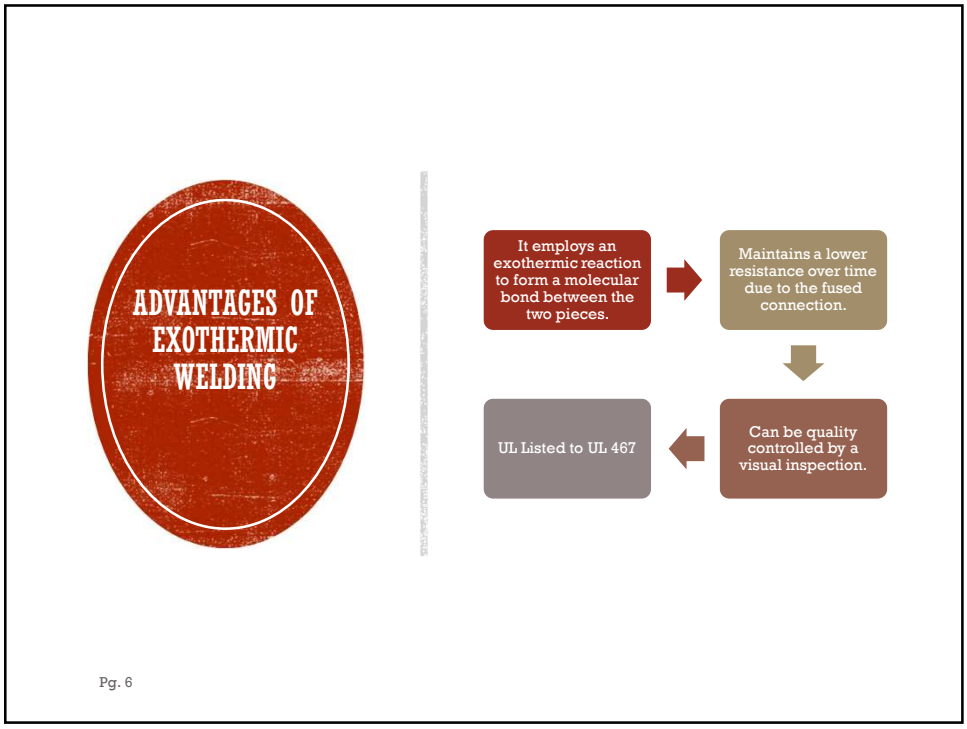
ADVANTAGES OF EXOTHERMIC WELDING
It employs an exothermic reaction to form a molecular bond between the two pieces.
Maintains a lower resistance over time due to the fused connection.
Can be quality controlled by a visual inspection.
UL Listed to UL 467
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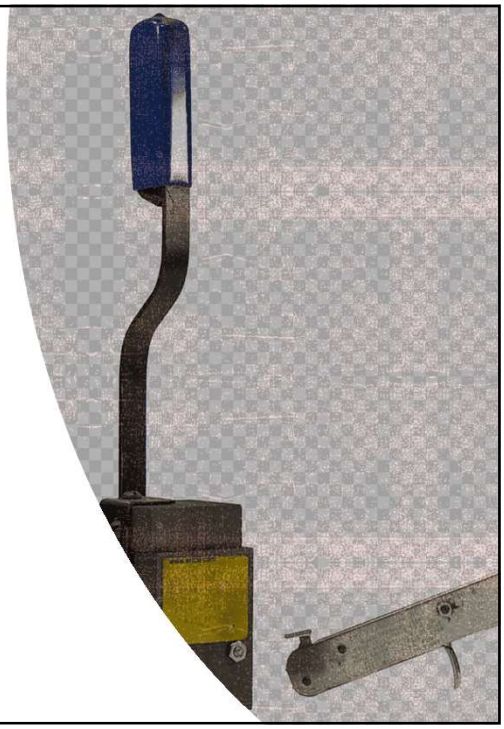
COMPONENTS OF EXOTHERMIC WELDING

- Graphite Mold
- Weld Metal
- Igniter
- Mold Clamps
- Cleaning Tools
- Sleeves, shims, batting



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IMPROVING THE SYSTEM WITH ELECTRIC IGNITERS

Offers a safer application process that typically only takes a few minutes to complete an exothermic connection.

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HOW IT'S DONE

1.Insert Cadweld Plus cup into mold (may require use of a cover/baffle).

2.Attach control unit termination clip to ignition strip.

3.Press and hold control unit switch and wait for the ignition.

4.Open the mold and remove the expended steel cup—no special disposal required.

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IN THE FIELD APPLICATIONS

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APPLICATION DISADVANTAGES

- Initial setup cost potential is high depending on the equipment required including molds, welding powder, and tools.
- Additionally, graphite molds essential for the process degrade over time and need to be replaced periodically.
- Requires specialized training to ensure operators handle and execute the process correctly.
- Involves high temperatures and the use of flammable materials, posing significant safety risks.
- Exothermic welding is highly sensitive to environmental conditions. It is not able to be performed in explosive environments or near flammable components. Outdoor welding is also limited by adverse weather conditions such as high winds, rain, or moisture.
- Thin wall pipe can be a concern due to high temperatures.

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IN THE FIELD FAILS

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WHAT ELSE IS THERE?

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THE HISTORY OF PIN BRAZING

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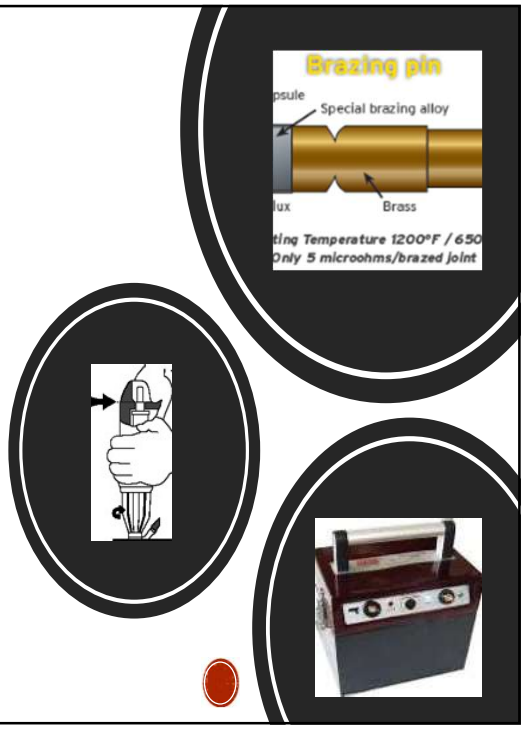
- Pin Brazing was developed in Sweden during the 1950s for on-site electrical bonding of cables and fittings to rail.
- The technique is based primarily upon 'Drawn-arc Silver Brazing' using a specially designed portable pin brazing unit, a hollow brazing pin containing silver solder and flux.



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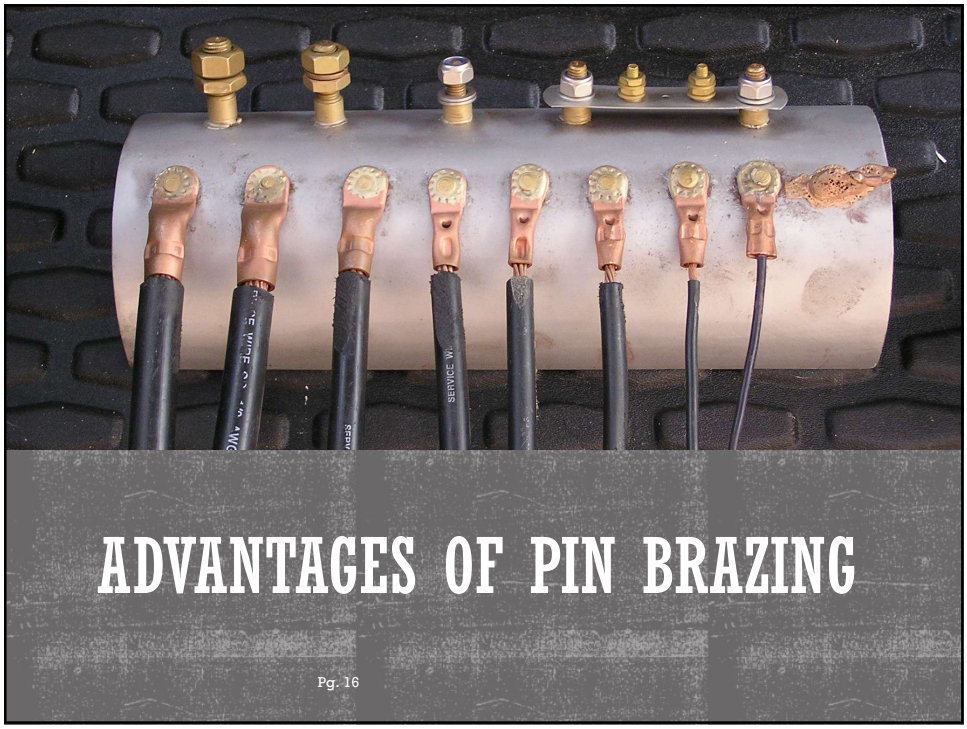

ADVANTAGES OF PIN BRAZING

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- Speed
- Temperature is lower than Cadwelding
- Weather
- Safety
- Versatility
- Positioning
- Bond Strength
- Low Resistance Connection

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COMPONENTS OF PIN BRAZING

- Pin braze gun
- Battery box
- Earth device
- Battery charger
- Tool kit
- Direct brazing pin holder
- Direct brazing ferrule holder
- Cables for gun
- Consumables sold separately

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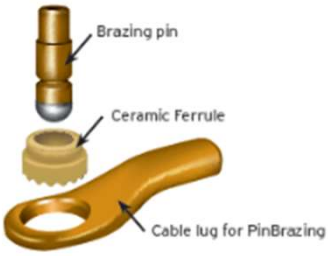

CONSUMABLES

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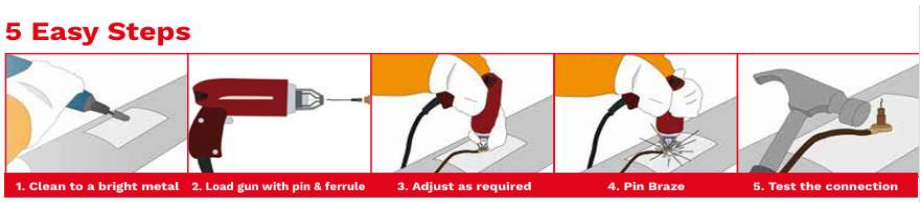

INSTALLATION INSTRUCTIONS

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FIELD APPLICATIONS

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APPLICATION DISADVANTAGES

- Initial setup cost potential is high depending on the equipment required including complete kit and consumables. Depending on the project size, multiple kits may be required.
- Batteries are sensitive and require additional care and maintenance. If not properly cared for, the unit will not work.
- Requires specialized training to ensure operators handle and execute the process correctly.
- Involves high temperatures and the use of flammable materials, posing significant safety risks..
- Thin wall pipe can be a concern due to high temperatures.

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APPLICATION FAILS
LONG BRAZING TIMES
BATTERIES NOT WORKING
GUN MISFIRES

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WHAT ABOUT OPTIONS WITHOUT HEAT AT ALL?

- Does that exist? Yes!
- Cold Silver Solder Applications

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WHY DO WE NEED AN ALTERNATIVE TO HEAT?

1" PE pipe that was inserted in 1-1/4" steel pipeline. Damage from Exothermic Weld

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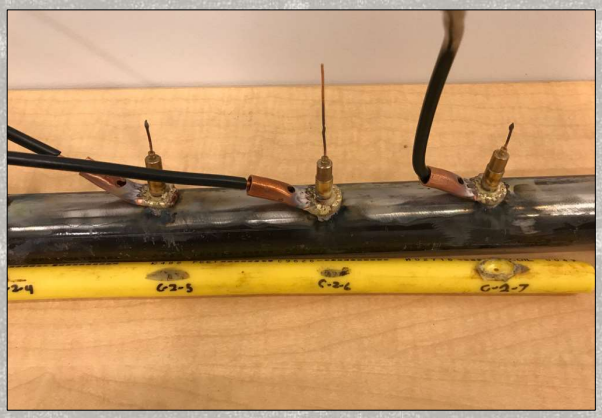
FURTHER TESTING WITH PIN BRAZING



½" PE pipe inserted in ¾" steel pipeline. Damage from Pin Brazing.

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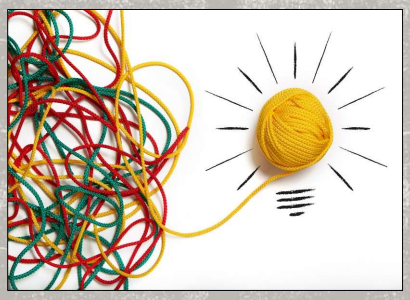
THE CHALLENGE

- Develop a method of attaching test lead wires without using typical methods of wire attachment that utilize heat during attachment.
- Perform this new method through a keyhole operation to allow more efficient installations.



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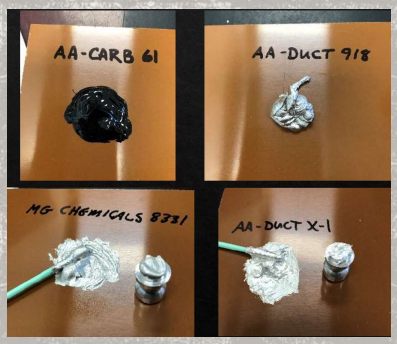
TESTING AND TRIALS- CONDUCTIVE EPOXY

Epoxy Testing

- Various conductive epoxies were chosen to test based on TDS sheets



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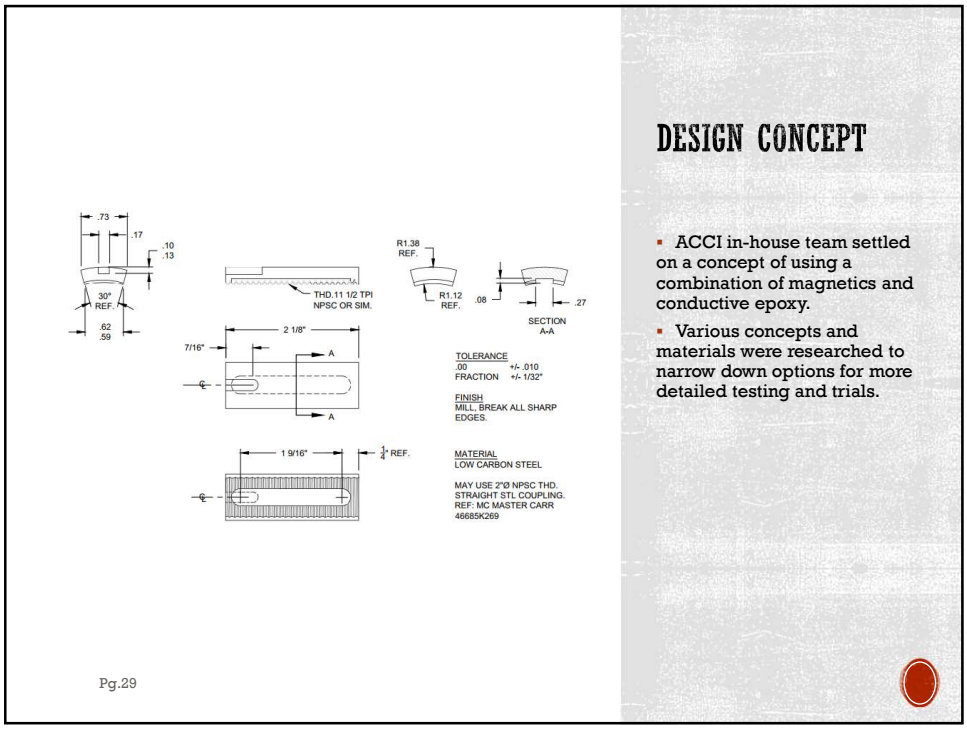

DESIGN CONCEPT

- ACCI in-house team settled on a concept of using a combination of magnetics and conductive epoxy.
- Various concepts and materials were researched to narrow down options for more detailed testing and trials.

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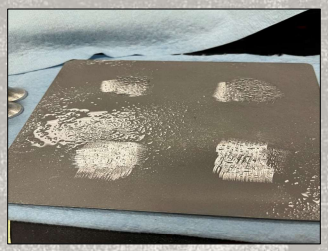
ADHESION TESTING DRY AND WET SURFACES



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TESTING AND TRIALS- SALT WATER BATH

Saltwater Bath Testing

- Applied 60mA CP current through four connections for 2 months.
- Looking for possible failures.

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TESTING AND TRIALS- TESTING OF SAMPLES COATED BEFORE FULL CURE

4 CONCLUSIONS

4.1 COATING APPLICATION DOES NOT PREVENT THE EPOXY FROM CURING

It was shown during testing that the epoxy was able to harden after the application of the coatings. This indicates that the conductive epoxy was able to fully cure after a coating had been applied.

4.2 USE OF EPOXY DOES NOT INDUCE LOCAL CORROSION

No by-products of corrosion were discovered on any of the test samples. This is indicates that the outgassing of the conductive epoxy during cure time will not lead to local corrosion.

4.3 EPOXY MAINTAINS CONSISTENT DIMENSIONS THROUGHOUT THE CURING PROCESS

Observations made of the epoxy, with and without a coating, showed no indications of shrinkage, warping, or change in volume. The adhesion of the epoxy was acceptable in all observed situations. Any change in volume or shape experienced by the epoxy during the curing process did not indicate a significant impact on its performance or adhesion to the coatings tested in this experiment.

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FINAL PRODUCT-COMPONENTS

- Metal Saddle- Carbon steel with curvature to seat well on any size pipeline
- Wire Connection- 20-feet of #12 solid copper with HMWPE insulation. Silver soldered with a copper sleeve and sealed with heat shrink
- Magnet- Neodymium embedded
- Conductive Epoxy- MG Chemicals 8831D Conductive Adhesive. A "COLD SILVER SOLDER".
- Keyhole applicator- Modified magnetic jig with extendable pole to 9-feet

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FINAL PRODUCT-KEYHOLE APPLICATOR TOOL

- Keyhole Tool
- Magnetic Jig
- Rotates to engage and disengage
- Extends to 9-feet

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COLD SILVER SOLDER ATTACHMENTS ON PIPELINE

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COLD SILVER SOLDER APPLIED TO CASING

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APPLICATION DISADVANTAGES

Design is new to the industry and not written into specifications for many pipeline operators.

Potentially costly option for large pipeline bonding projects.

Still developing in field application feedback and environmental affects.

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RECAP

- All applications have their benefit when used properly and for the right application
- Qualifying your project before deciding on your application will help prevent costly mistakes. Talk to your local expert before purchasing or writing an application into your scope of work.
- None of these products or applications will ever replace the other in my opinion but will be better alternatives to each other in the right application.

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