WHITE PAPER

# Swage Grounding Accessories Advantages over Exothermic Welded Connections

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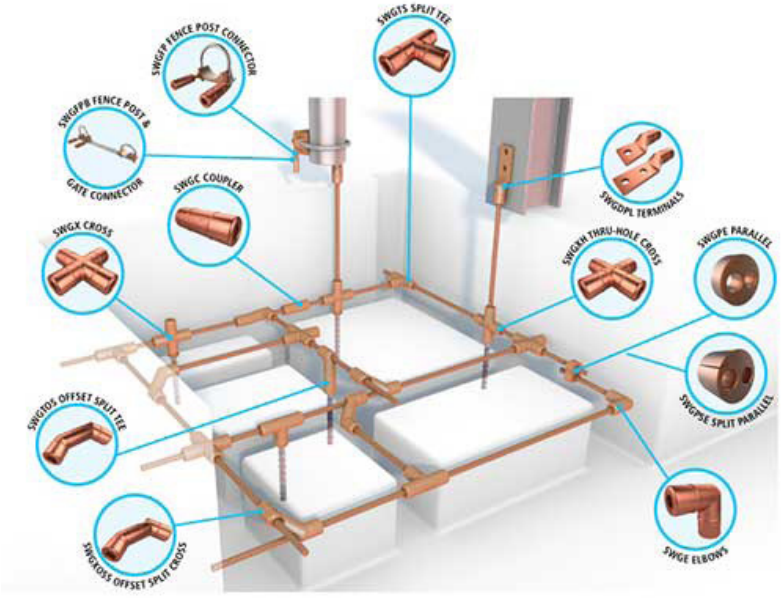



Image: AFL's Swage Grounding Accessories Diagram

## ABSTRACT

Swage grounding accessories provide advantages over exothermic welded connections in electrical grounding systems. Benefits to Swage include:

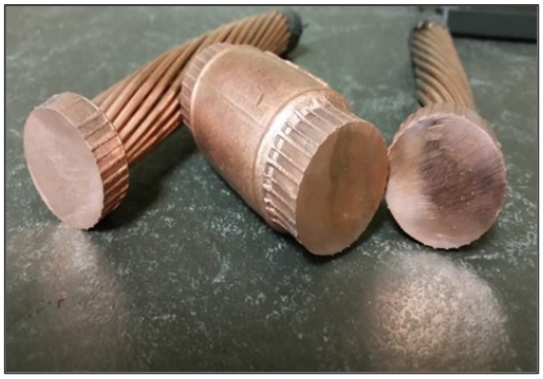
- Tooling lifespan improvements
- Fewer materials, tools and accessories required for swage installations versus exothermic installations.
- Installations may be completed during inclement weather.
- AFL Swage compressions are IEEE 837 2014 certified by third party test lab.

## INTRODUCTION

AFL's family of Swage Grounding Accessories provide utilities with a reliable means of grounding electrical systems, making them ideal for power distribution, telecommunications, and other industries. Swage accessories provide a safe method of installation that does not require a certified welder, or the extreme temperatures and specific processes associated with exothermic welding.

## SWAGE CONNECTORS

Swage Connectors utilize a cold forming process; crimping the connector 360 degrees around the cable, stud, or rod utilized for attachment. A hydraulic press powered by industry standard hydraulic pumps, combined with a selection of dies is used to perform the mechanical compression.



## EXOTHERMIC CONNECTORS

Exothermic connections are also known as thermite welding in industry. They involve a chemical reaction that produces molten metal to weld conductors together, effectively fusing the components as one item.

## SKILL LEVEL

Swage press operation for swage connectors does not require any specialized training for installation. Within fifteen minutes of training, a new operator can safely and efficiently install new connectors. It has been reported that the swage method of connection installation is 200% faster than the same method utilizing exothermic connections.

Exothermic installations require precise measurements of consumables, specific times and temperatures, and associates with specific certifications. Training for exothermic installations is material, time, and labor intensive.

## SAFETY

Being able to install grounding systems in a manner that is safe for the user and environment is of the upmost importance. The use of AFL Swage Grounding Accessories eliminates major safety concerns inherent with exothermic welding, mainly the use of chemicals compounds and high temperatures. Exothermic welding requires a preheating of the crucible to eliminate moisture, which could expose associates to burns. Once the molds have been heated, they must be assembled and clamped together. When beginning the welding process, the flash from the reaction can harm eyes if direct eye contact is made. During the welding process, temperatures may be more than 1400° C. The molten materials not only pose harm to the users but can ignite fires if the work area is not cleared of potential fire hazards. Another safety risk inherent to exothermic welding is that if moisture is present in the mold, the whole assembly has the potential to violently explode.

## CONNECTION RELIABILITY

AFL Swage Couplers have been subjected to testing by multiple third-party facilities. The goal was to provide assurance to end users that Swage Connectors will perform consistently over their lifetime in a manner that will satisfy the IEEE 837 2014 Standard. AFL Swage Connectors passed all the tests outlined in this standard.

IEEE 837-2014 consists of an Electromagnetic Force (EMF) test and a group of sequential tests including Current Temperature Cycling Testing, Freeze Thaw Testing, Corrosion Testing, and Fault Current Testing.

EMF testing involves surging excessive current, up to 90% the fusing current for the conductor, through the connectors to produce electromagnetic force and displacement of the connector is measured.

Sequential testing involves stepping connectors through multiple stages of testing to simulate a worst-case environmental scenario. Resistance measurements and connector integrity are checked at each stage.

First, Current Temperature Cycling is done do simulate the effects of loading and unloading a grounding circuit. For twenty five cycles, the connectors are brought from ambient, up to 350C, then back down to ambient with resistances and temperatures being checked during the testing.

Next, a Freeze Thaw test is completed. Unlike liquid penetrant or x ray testing, the Freeze Thaw test simulates the harsh environments a grounding connector will be subjected to in service by immersing the connection in water and alternating the temperature from -10C to 20C over time, simulating a freezing and thawing of the connection over multiple cycles. Testing has shown virtually no change in resistance of the swage connections after the ten freeze thaw cycles.

After Free Thaw testing, Corrosion tests with salt spray and acid are performed in parallel on samples. In both test versions, samples are inspected for mechanical damage and then tested against the initial resistance measurements.

The last sequential test is a Fault Current test. All samples are subjected to 90% of the fusing current rated for the connector conductor for 10 seconds. This is completed three times and resistance measurements are taken and compared to the control. All Swage Connectors tested by AFL have passed and exceeded the requirements of the specification.

In a separate test unrelated to IEEE 837-2014, 4/0 AFL Swage Connectors, were evaluated on conductor that was prepared in three different methods. The connectors were assessed on new conductor, aged conductor without cleaning, and properly prepped and cleaned conductor. The Swage connectors were also evaluated alongside other industry methods of connecting grounding conductors. These included mechanical couplers as well as exothermic welding. The result of the test showed Swage connectors superiority to mechanically crimped connectors as well as exothermic welded connections in tensile loads.

| **Mechanical Test Results** | | | |
|---|---|---|---|
| **Conductor Type** | **Max Load Held in Pounds** | | |
| | **Mechanical Compression** | **Exothermic Weld** | **Swage** |
| New, Clean Conductor | 1704 | 2041 | 3262 |
| Aged, Prepped Conductor | 1259 | 2461 | 3370 |
| Aged, Non-Prepped Conductor | 1500 | 3124 | 3356 |

## CONCLUSION

Swage connectors offer a range of advantages over exothermic connections in electrical grounding applications. The speed and simplicity of the Swage process is industry proven to reduce downtime, increase installation efficiency, and ensure consistency. Swage has been shown to be a safer alternative to exothermic welding positioning it as the superior option when planning out grounding grid installations.

## RECOMMENDATIONS

For organizations considering alternatives to exothermic welding, it is recommended to evaluate the specific requirements of their grounding systems and consider the benefits of Swage connectors in terms of safety, installation speed, and consistency. Adopting Swage technology can enhance the operation efficiency, safety, and consistency of site installation, contributing to better overall system performance.

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