CIGRE US National Committee
2022 Grid of the Future Symposium

Extending the Life of Overhead Aging Assets with a Focus on the Energized Portion of Transmission and Distribution Lines

CARL R. TAMM
Classic Connectors, Inc
U.S.A.

What is Happening to Our Electrical Transmission Grid?

What is Happening to Our Electrical Distribution Grid?

Our Grid is Aging

The North American Overhead Electrical Grid is composed of approximately 400,000 miles of transmission and on the order of 2.2 million circuit miles of distribution.

Most of the North American electrical grid was built post World War II through the late1970's and therefore 70% of transmission lines are **40 years Old -** or older.

Empirical data indicates **average connector service life is 40-70 years**, provided they have been installed properly and the circuit is operated within the design parameters originally assigned for a maximum continuous conductor temperature of 75°C (167°F).

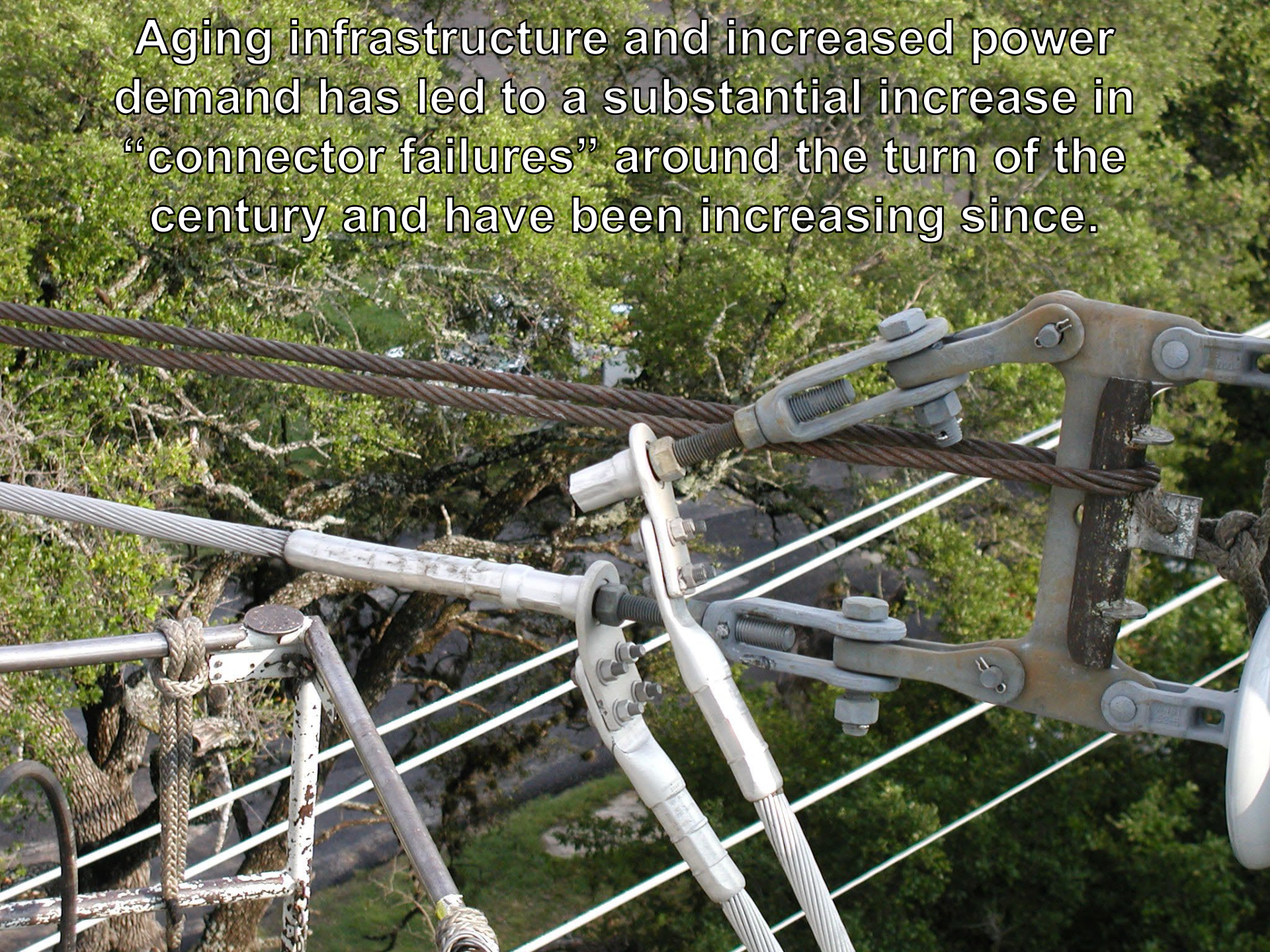
Nothing Lasts Forever Because Forever Is A Really - Really Long Time!

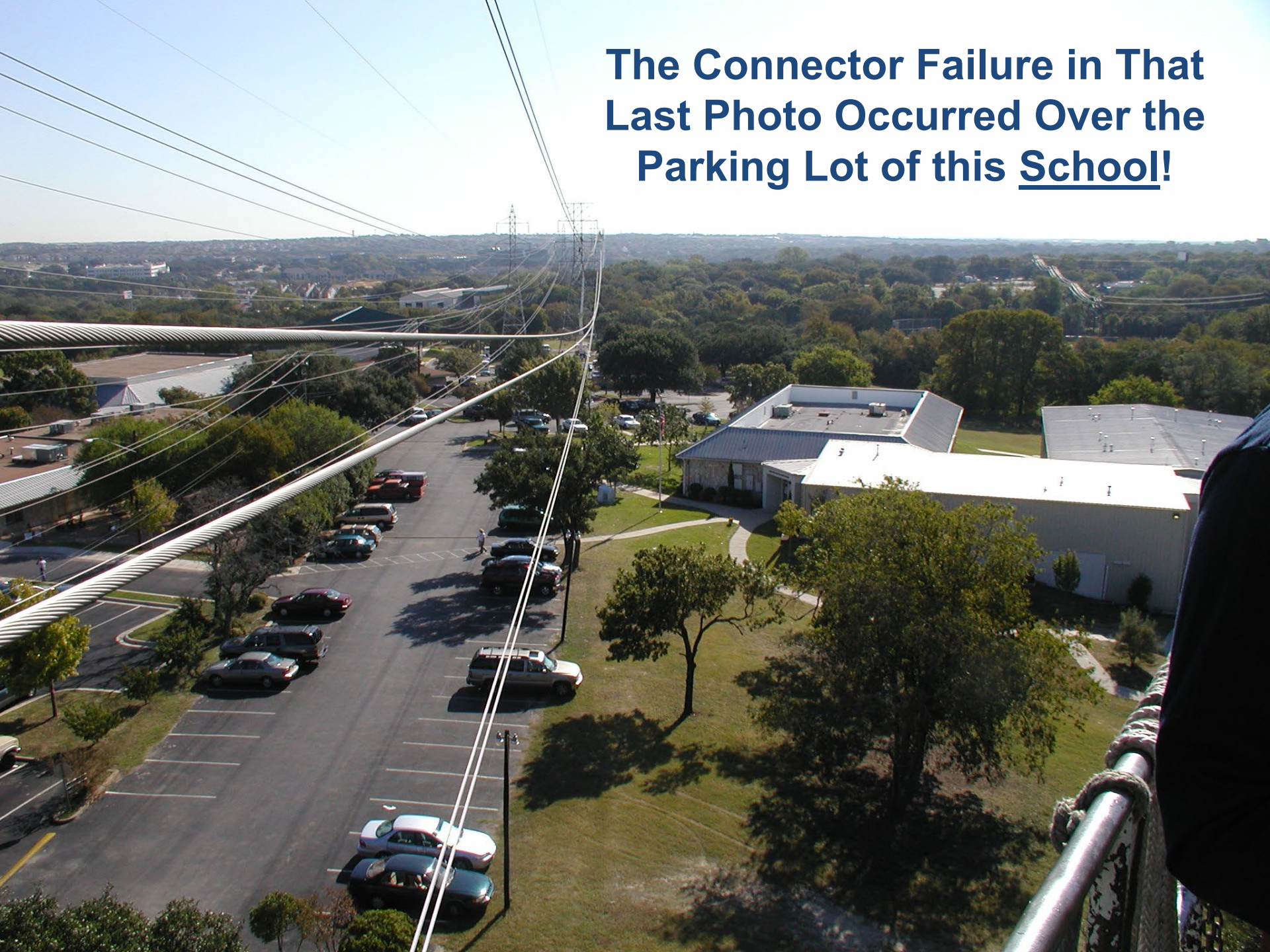
Original Connector Design Parameters – 30 Years @ 75°C

Connectors are not an exception to the rule that Nothing Lasts Forever

ALL Connectors will eventually FAIL!

Exception – Properly made “thermal fusion” weld.


Aging infrastructure and increased power demand has led to a substantial increase in “connector failures” around the turn of the century and have been increasing since.


The Connector Failure in That Last Photo Occurred Over the Parking Lot of this School!

80% of Connector Failures Are Related to Inappropriate Installation Practice!

- Lack of Proper Conductor Preparation
- Lack of Sufficient Inhibitor
- Wrong Inhibitor for the type application
- Partial Insertion of Conductor
- Too much torque
- Not enough torque
- Improper Fasteners for the application
- Wrong dies in pressing operations
- Worn dies resulting in incomplete crimp
- Press not calibrated to proper force
- Wrong connector for the application

Recognize that this 80% failure statistic is only the "Weak Link in the Chain" – they will be the first to fail!

Apart from Aging Connectors The Major Issues with Aged Lines are Principally Hardware Related Conductor Damage and Fatigue

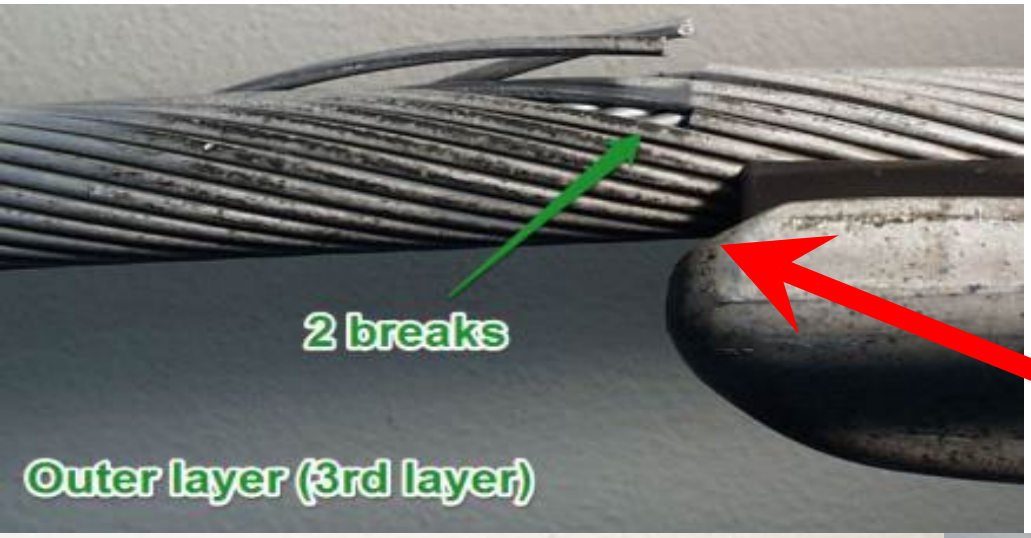
X-Ray Commonly Reveals Broken Strands in Suspension Clamps

Conductor Fatigue is a Major Concern

Broken Strands in Strain Clamps, Spacers, Under Helical Rods

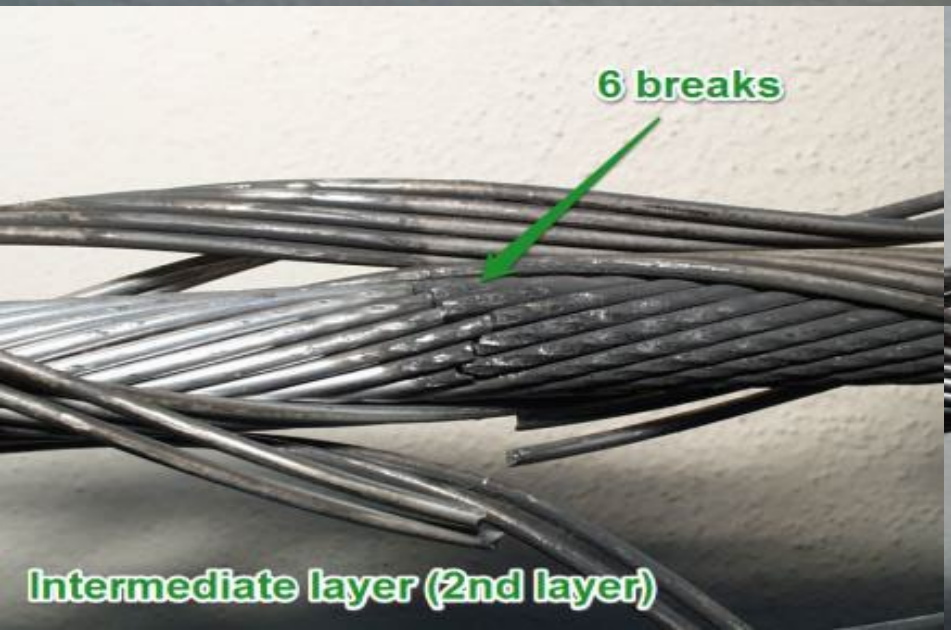
Conductor Fatigue and Corrosion under Rods and helical type Suspension

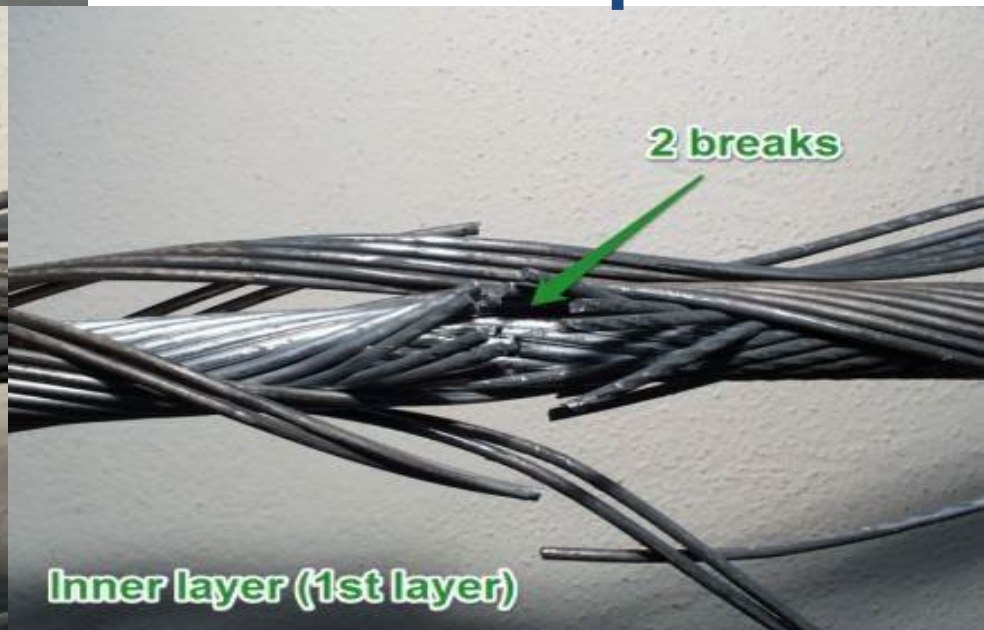
Fatigue Occurs Adjacent “Fixed” Locations such as Clamps, Deadends, and Spacers



Found at the surface, it is generally worse underneath

End of Clamp





Lightning Damage on Overhead Shield Wire and OPGW – Major expense!

Lightning Flashover Damage on Circuit Conductors Adjacent Suspension Clamps

Abraded Conductor & Gunshot Wounds

Our Engineered Electrical/Mechanical Shunts Repair *ALL* These Conditions!

Restoring Full Integrity to Aged Infrastructure!

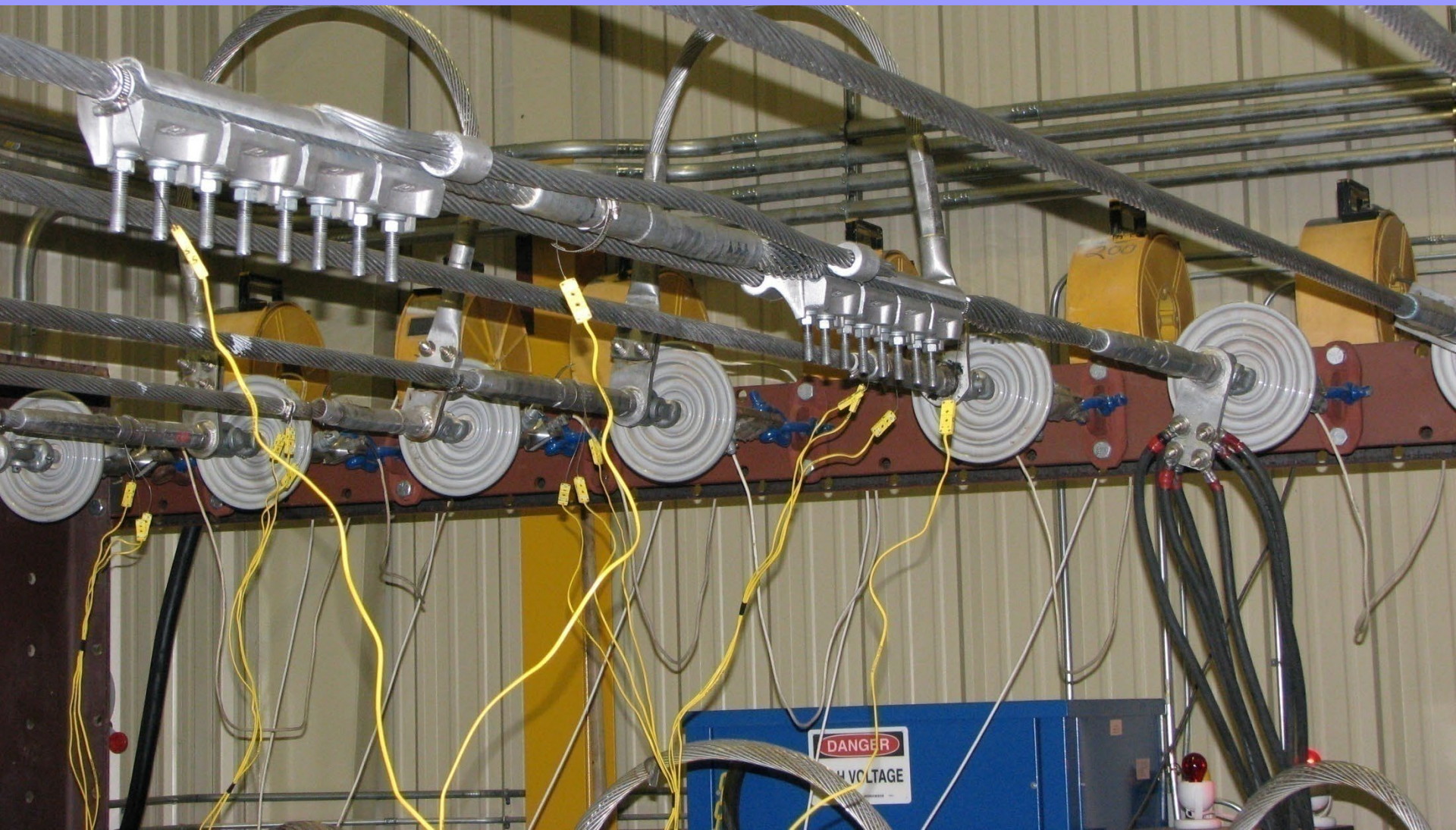
- ***Installed on Live Lines – NO Outage Required!***
- ***Installed with only two linemen*** with simple Hand Tools!
- ***No Jacks***, Come-alongs, or other Hoisting Equipment!
- **Range:** #6 AWG Cu through 2750kcmil Al and ACSR
- ***Rejuvenate & Uprate*** Aged / Failing / Hot Connectors
- ***Restore Full Integrity*** to damaged conductor!
- ***Restore Full Integrity*** to Suspension Systems!
- ***Restore Mechanical Integrity*** to Deadends – Tether!
- ***Increased Line Ampacity*** – Uprate – FERC n-1!
- ***Life Extension*** of circuit to for the duration of the conductor life, perhaps another 30 to 50 years!

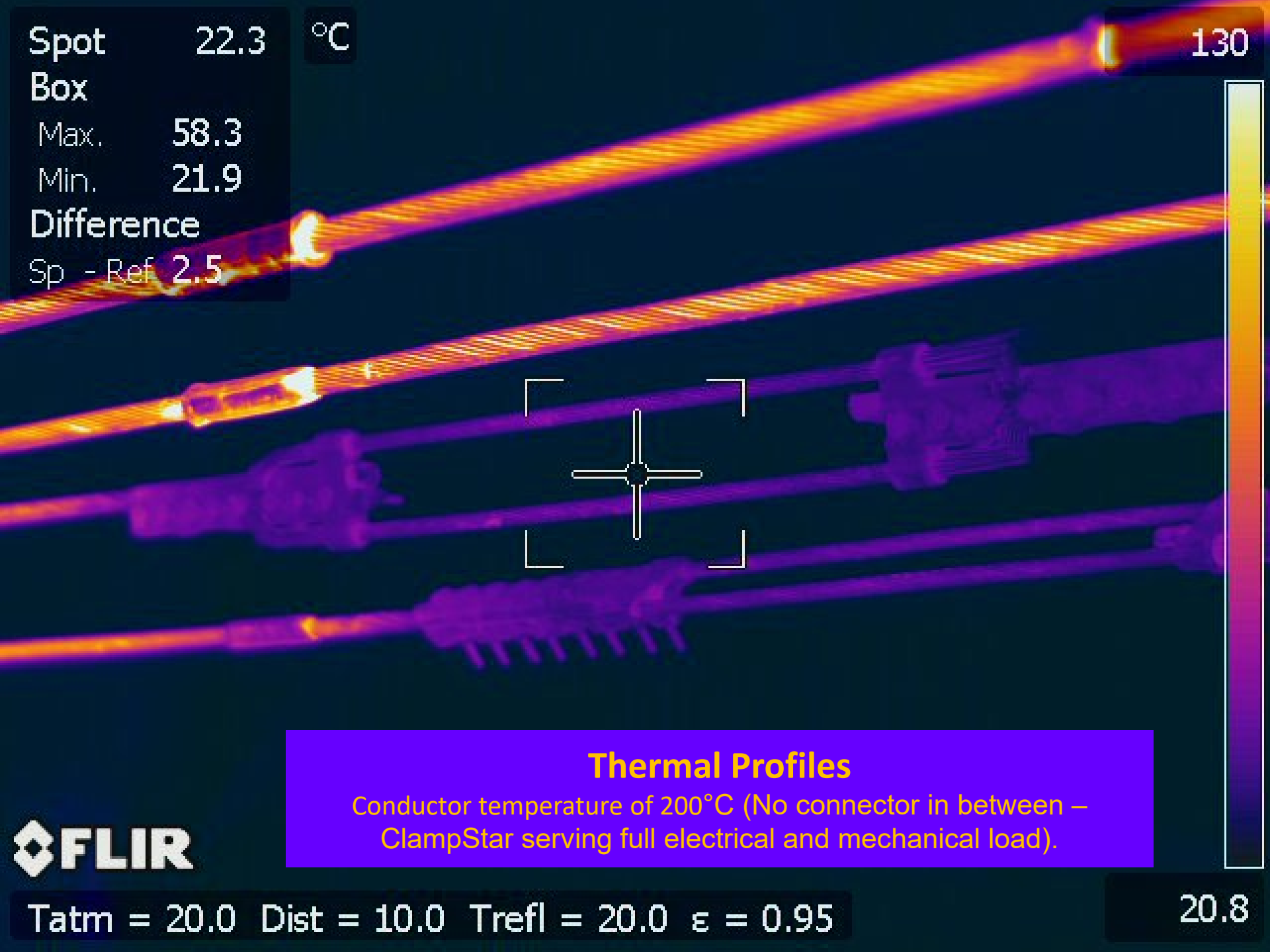
Mechanical and Electrical Testing

2000 Thermal Cycles with conductor at 35.6 kN (8000 lbs) tension, and conductor temperature of **200°C** No connector in between – Electrical/Mechanical Shunts serving full electrical and mechanical load.

Electro-Mechanical Shunt Used to Restore Test at EPRI Lab

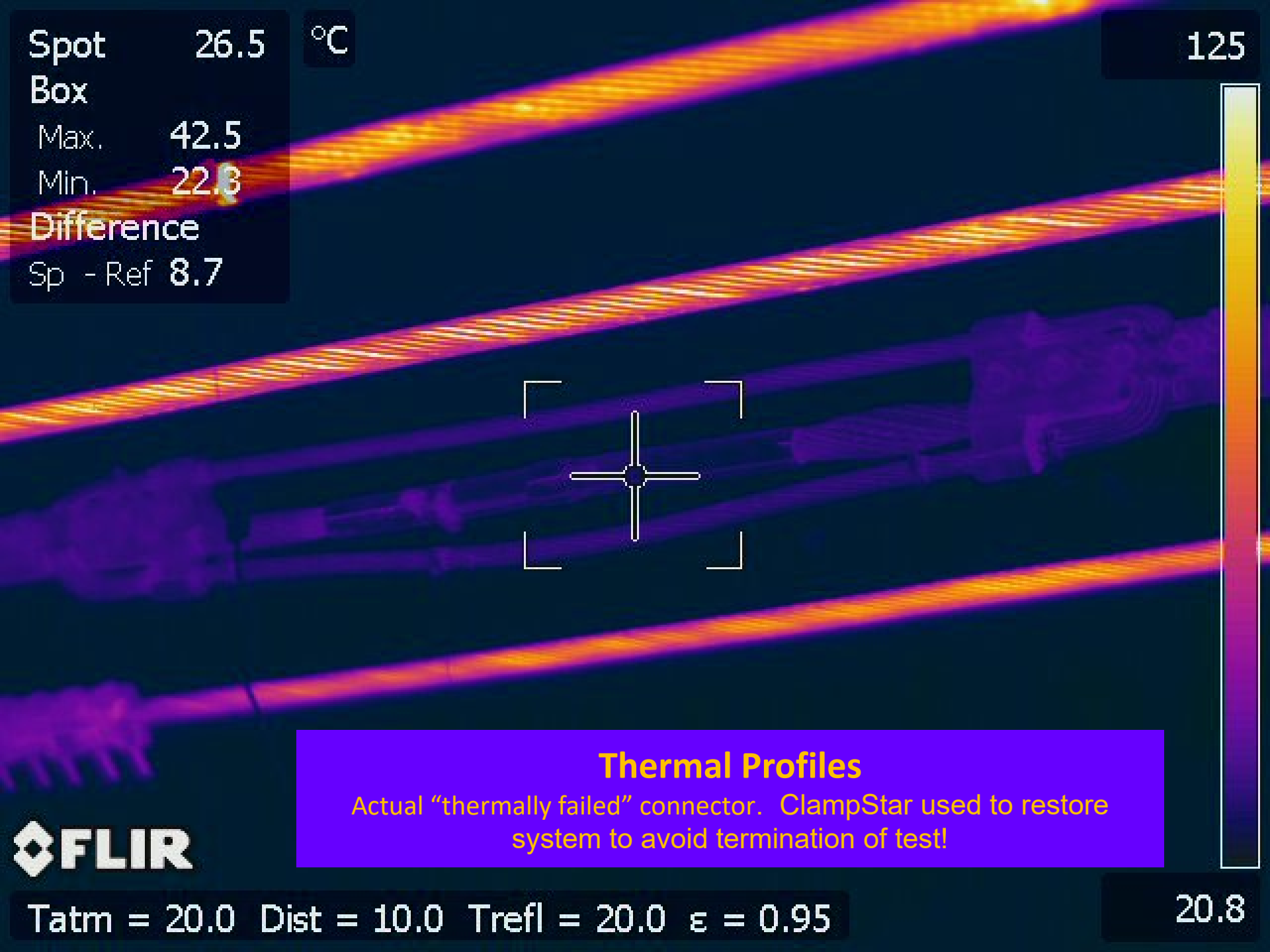
Testing of Single Die Compression Connectors at 200°C. Upon Thermal failure of one splice, rather than terminate the test, EPRI technicians used an Electrical/Mechanical Shunt to continue testing.





Thermal Profiles

Conductor temperature of 200°C (No connector in between – ClampStar serving full electrical and mechanical load).



Thermal Profiles

Actual "thermally failed" connector. ClampStar used to restore system to avoid termination of test!

Connector Thermal History

Properly installed, brand new splice operating at 150˚C on a conductor operating at 200˚C for a few hundred cycles. As it deteriorates, it reaches a peak of 332˚C! NOW, an Engineered Electrical/Mechanical Shunt is installed! It does not just go back to the brand new condition of 150˚C – it drops like a rock to ONLY 42.5˚C – AND it Stays there throughout the remainder of the test, another 800 cycles on a conductor operating at 200˚C! Following this 2000 cycle test, after subjected to these temperatures, this assembly was tested and achieved FULL tension!

Why would anyone consider these devices "temporary" after saving $4-10,000 originally to use the use them – and would spend the money to "cut it out" and replace it with Two substantially inferior compression splices and go back to 150˚C ???

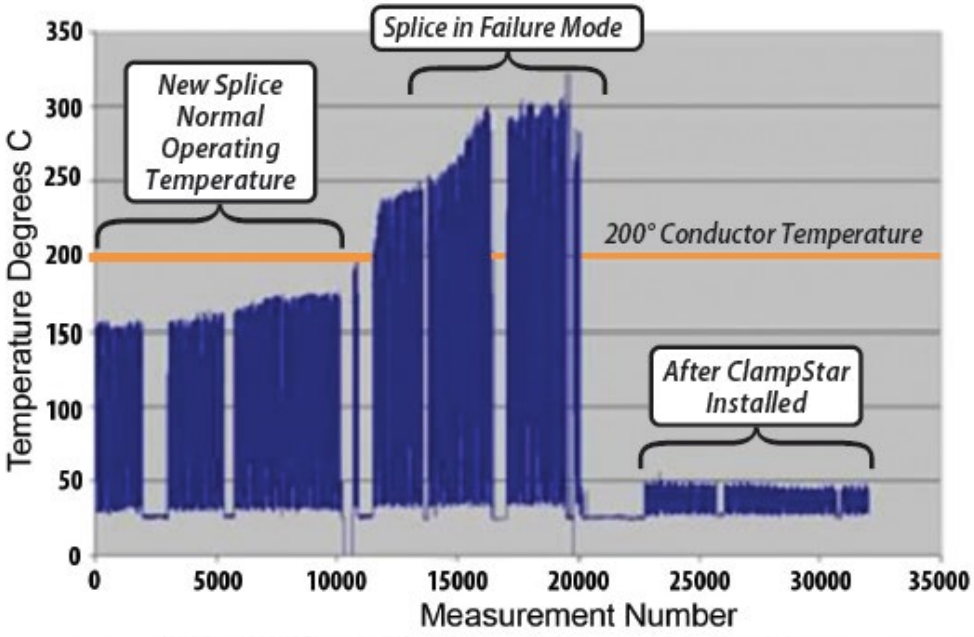
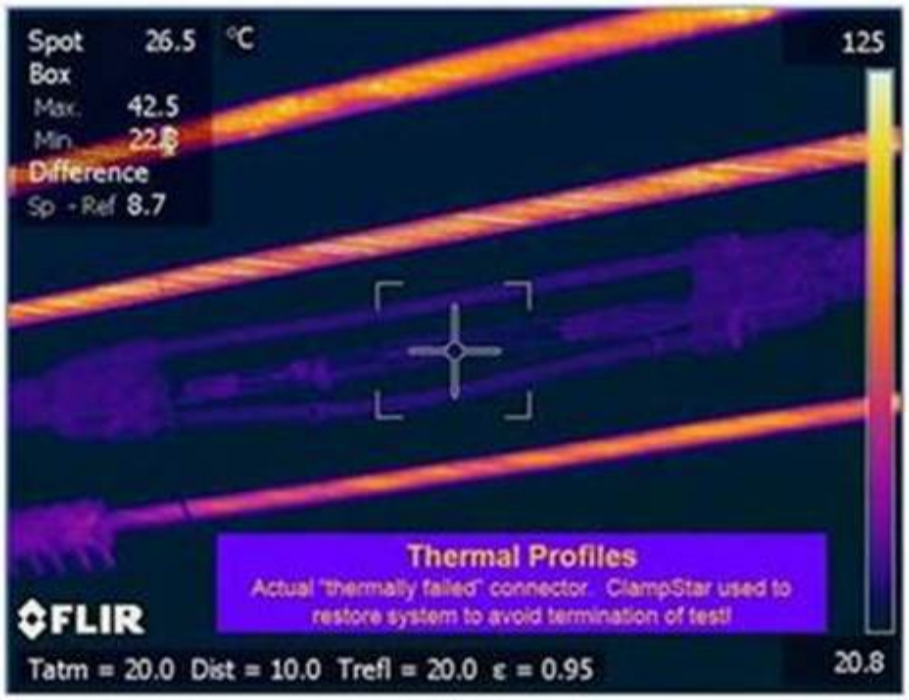
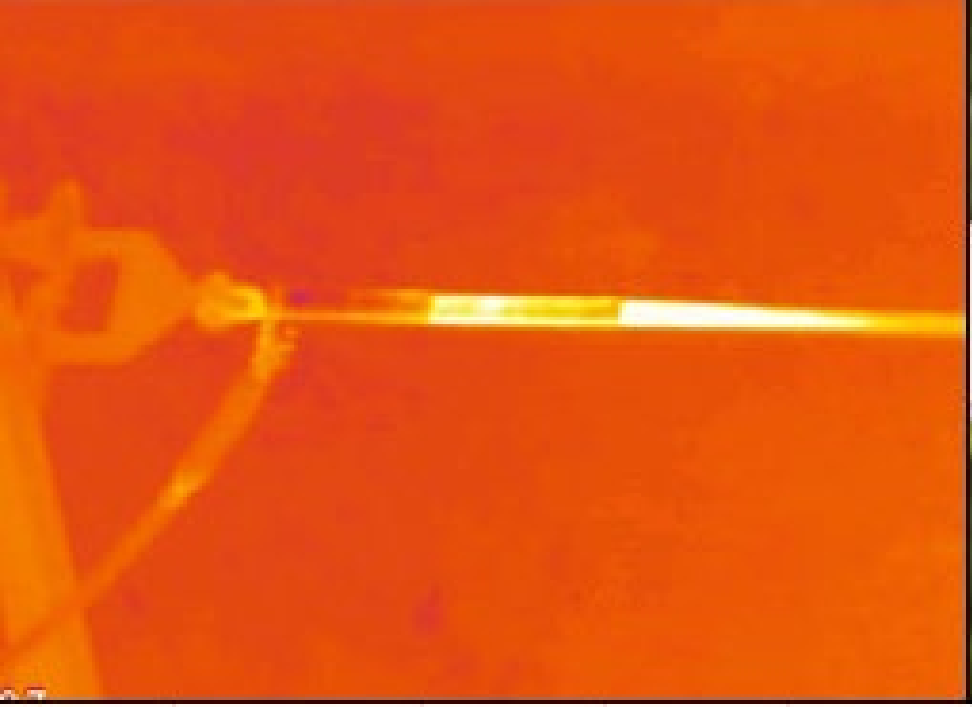


Figure 4.1: Shunt installed due to single-stage splice slipping.





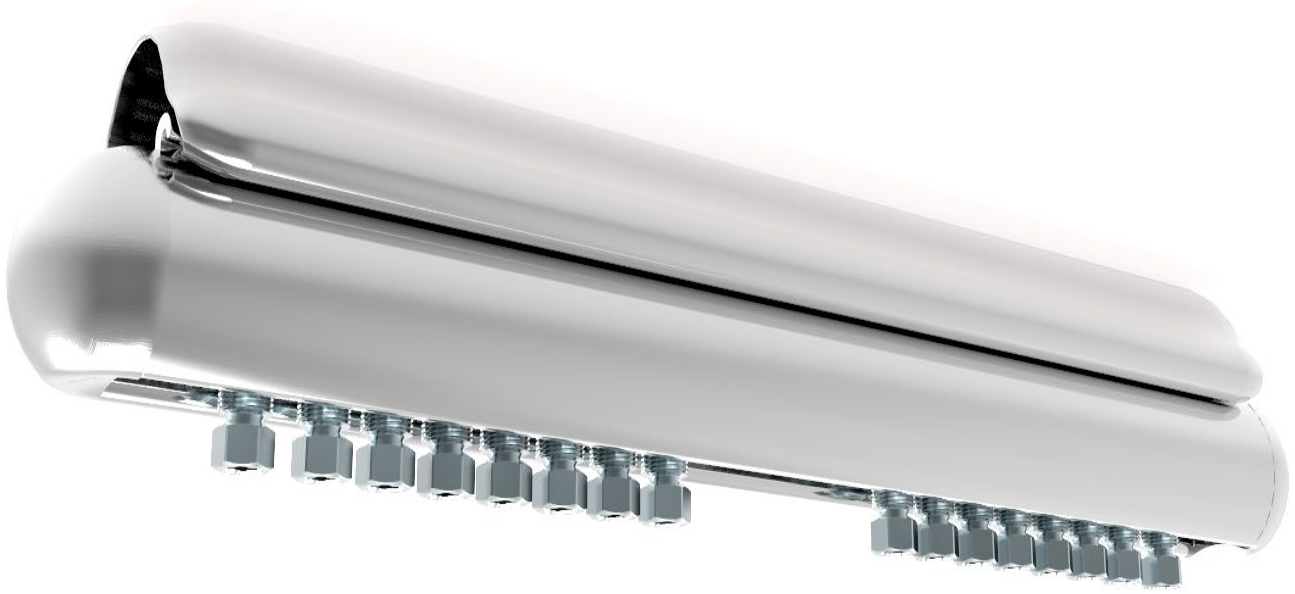
E/M Shunt Applications on Splices 266 to 2750 kcmil from buckets and helicopters

Installation by Haverfield for Alabama Power – Bonded on 8 Minutes & 28 Seconds!

Electrical/Mechanical Shunts - **CRU**

Conductor Repair Units

Larger CRU series (Conductor Repair Unit) is the safest and quickest permanent system to restore 100% electrical and mechanical properties to damaged conductors, on energized lines at any voltage while avoiding the need for a service interruption.



ClampStar CRU – Before and After EHV

EHV Applications to 765kV!

Twin Bundle Deadend with Safe-T-Link Tethers - Australia

CSS-1302 Twin Bundle Deadend 330kV - Australia

Installing an Electrical/Mechanical Shunt On an Energized Line With Sticks!

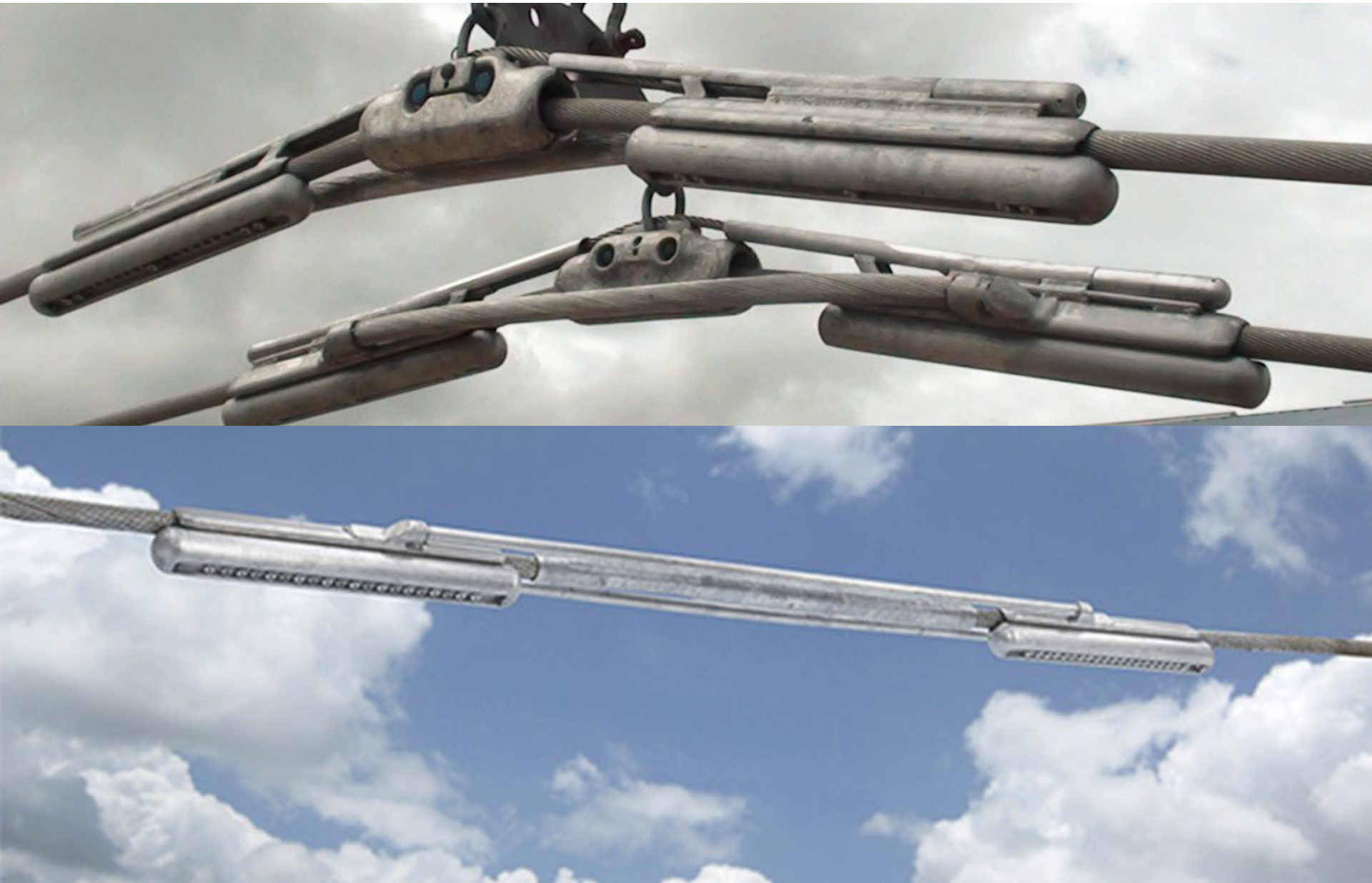
Ball Cap

Ball Cap Tether Attachment for ANSI 52-5 Ball/Socket Fittings and also for IEC U100BL and U210BP

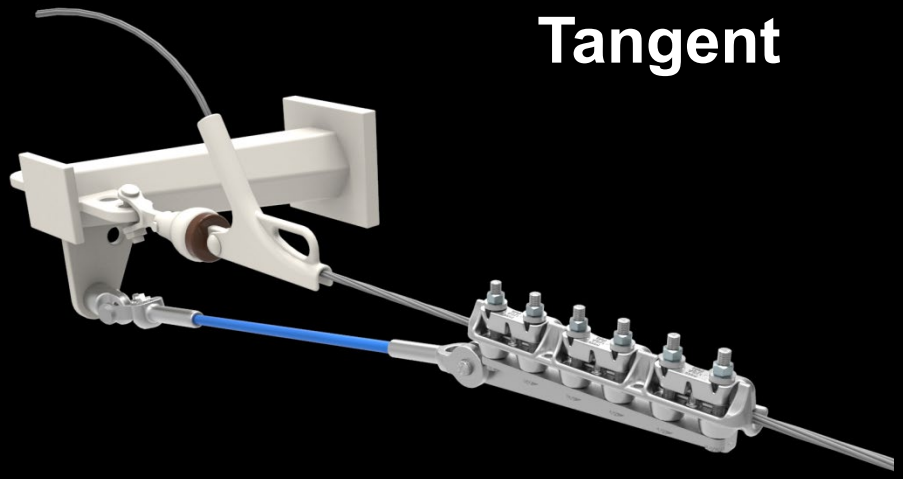
EHV Ball Cap

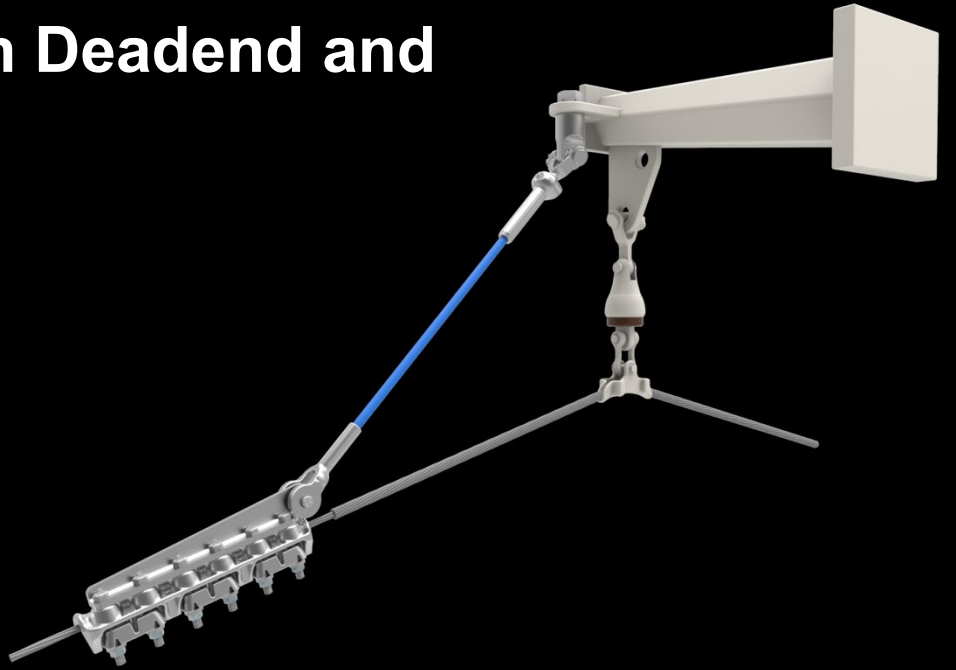
Typical Ball Cap application, 477 Hawk with armor rods – broken strands under rods.

New – Transmission Class Electrical/Mechanical Shunts corona free through 800kV AC and 500kV DC!

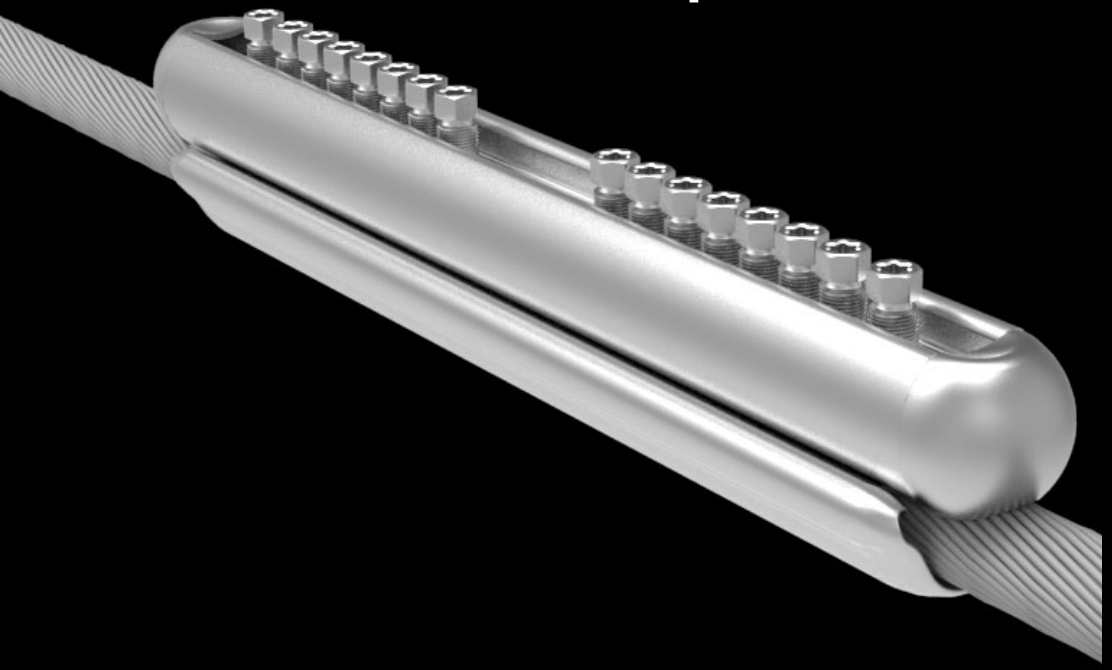


Safety Catch for OHSW – Both Deadend and Tangent

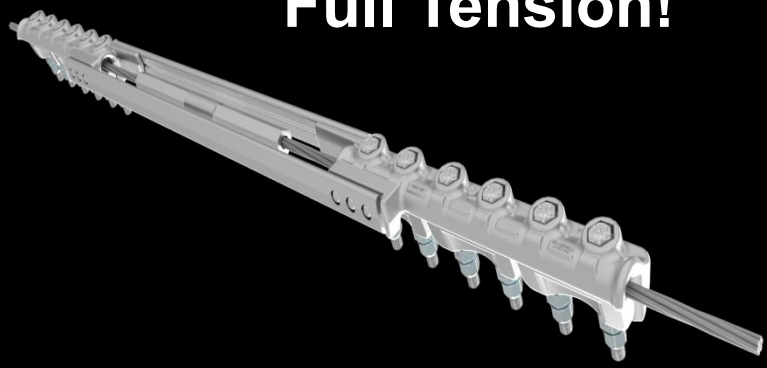




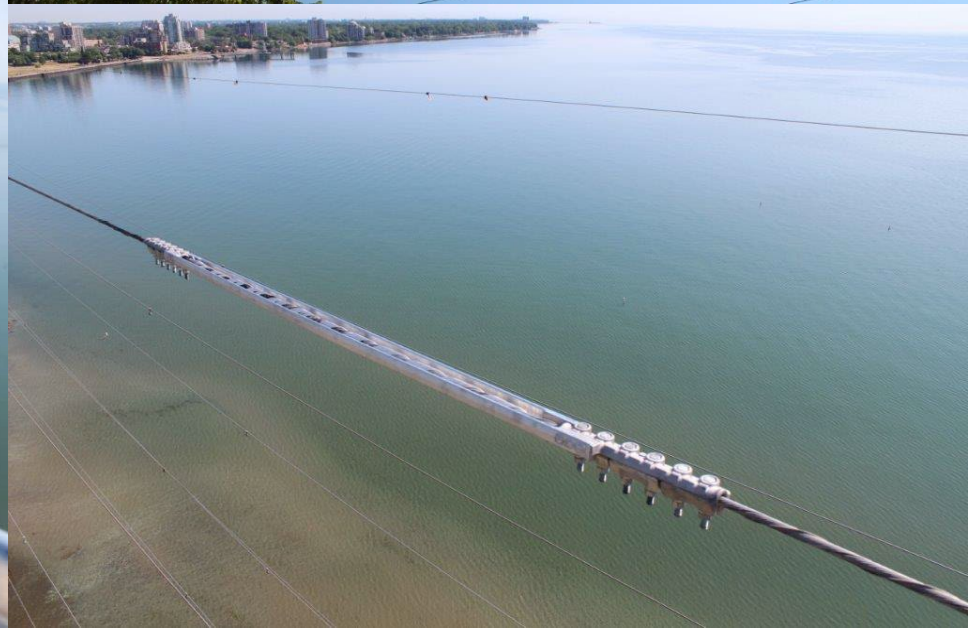
Conductor Repair Units – OHSW Splice Correctors



Full Tension!



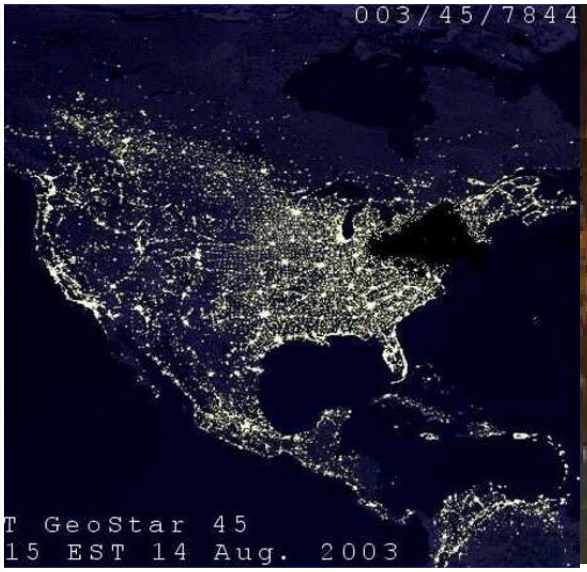
OPGW Mid-Span Full Tension Repair



A Properly Installed Automatic on a Distribution System – Caught in the Nick of Time!

Mitigation of Splices to Prevent Downed Lines

Firefighters work on a burning snag on the Curve Fire



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Thank You!

Questions?

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