Impacts of High Temperature Operation on Conventional Conductors and Hardware

CIGRE Advisory Group B2-04
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High Temperature: 100 to 200 °C

- Continuous Rating
- Emergency Ratings
- Mitigation Measures
- Monitoring
- Safety and Reliability

Conventional Conductors

- ACSR and AACSR: Aluminum (Alloy) Conductor Steel Reinforced
- AAC and AAAC: All Aluminum (Alloy) Conductor
- ACAR: Aluminum Conductor Alloy Reinforced
- No ACSS: Aluminum Conductor Steel Supported
- Copper ?

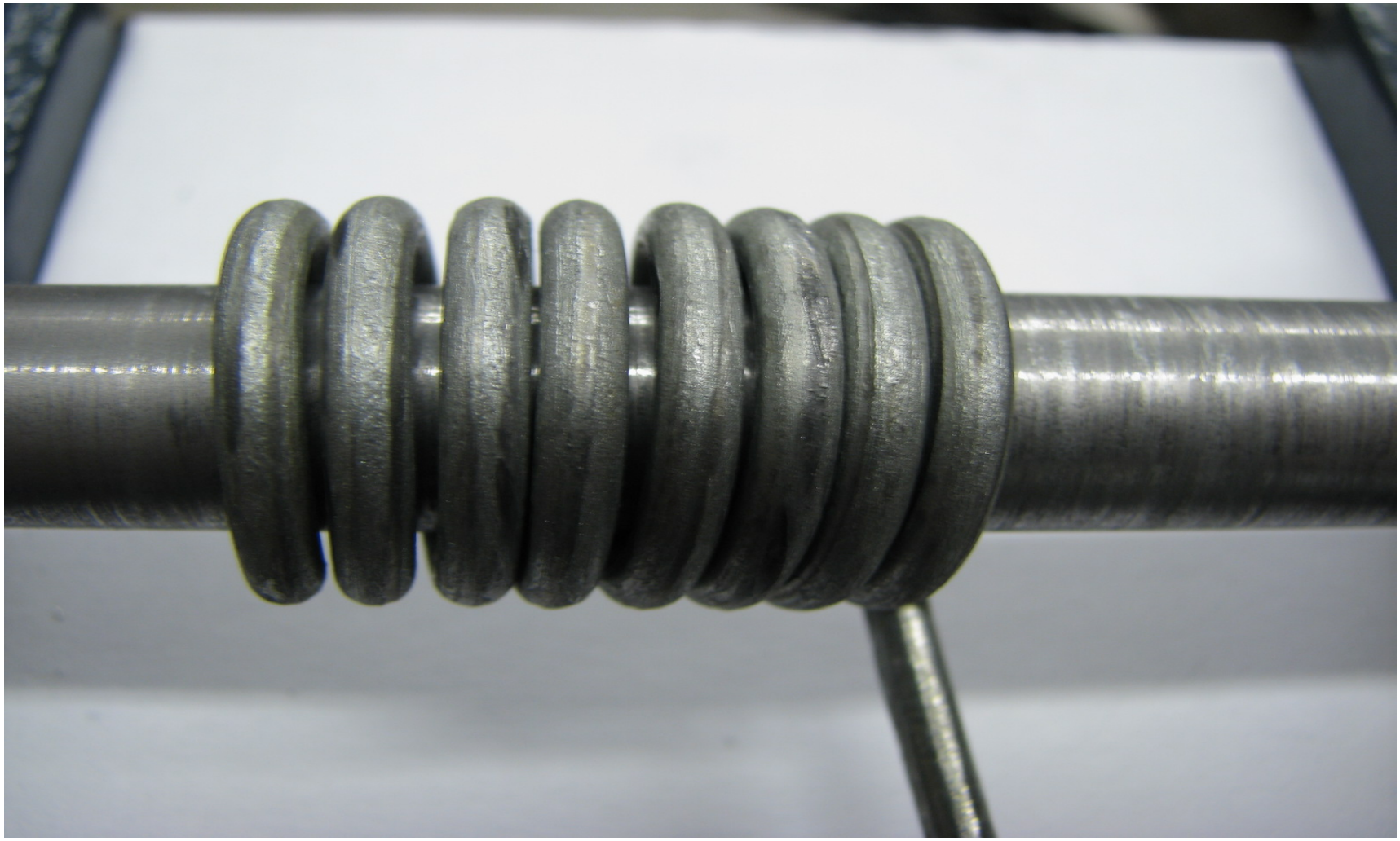
Annealing of aluminum

- Loss of strength
- Changes in Modulus of Elasticity
- References:
  - Loss of Strength of Overhead Electrical Conductors Caused by Elevated Temperature Operation, Working Group 12 of Study Committee 22, Electra, Oct. 1995
  - Effect of Elevated Temperature Operation on the Tensile Strength of Overhead Conductors, V. Morgan
  - The Effect of Temperature on the Loss of Tensile Strength of Overhead Conductors, V.T. Morgan
  - Overhead Electrical Conductors – Calculation Methods for Stranded Bare Conductors, CEI/IEC 1597: 1995

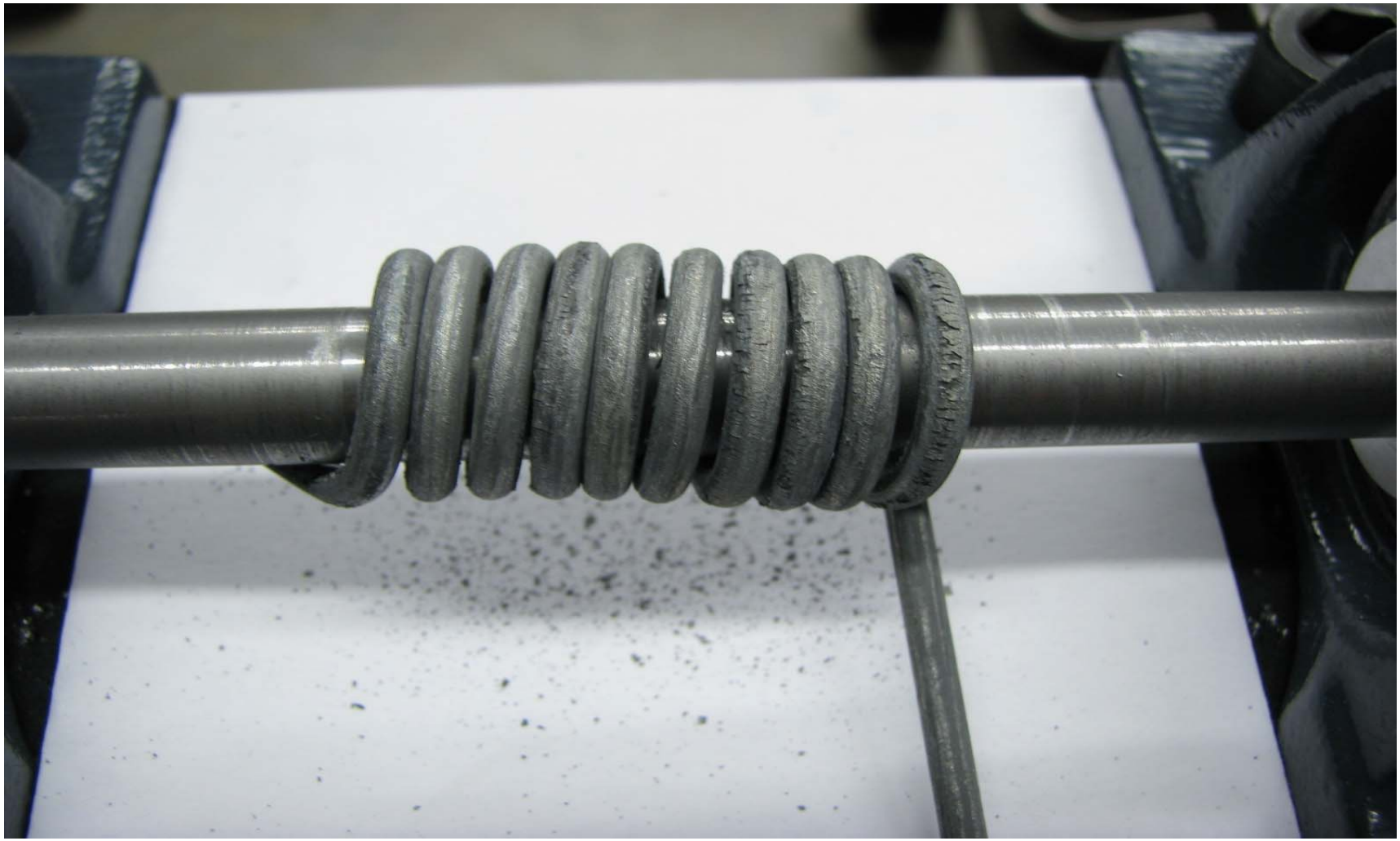
Galvanizing of Steel Core Wire

- Zinc may crack, flake, or peel at higher temperatures
- Wrap test to determine acceptable conductor temperatures (ASTM B498)
- Zinc integrity crucial to long term performance of conductor

Drake core wire after 1500 cycles to 125 °C for two-hour hold



Drake core wire after 1500 cycles for two-hour hold to 233 °C



Drake core wire after 1500 cycles for two-hours to 246 °C

Increased Sag

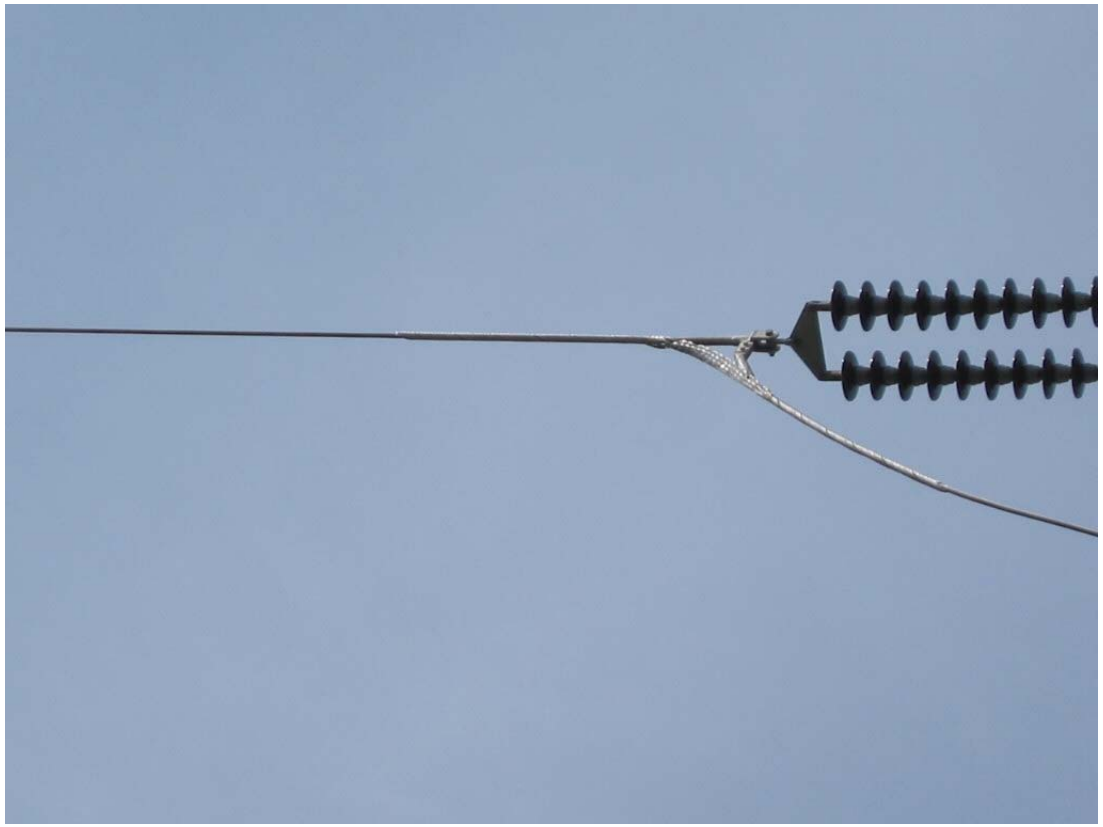
- Higher Temperature Sag/Tension Conductor Models
- Accelerated creep of Aluminum
- Thermal Expansion of Conductor Strand materials
- Thermal Gradient between Aluminum Layers and Conductor Core
- Ruling Span Models

Connectors

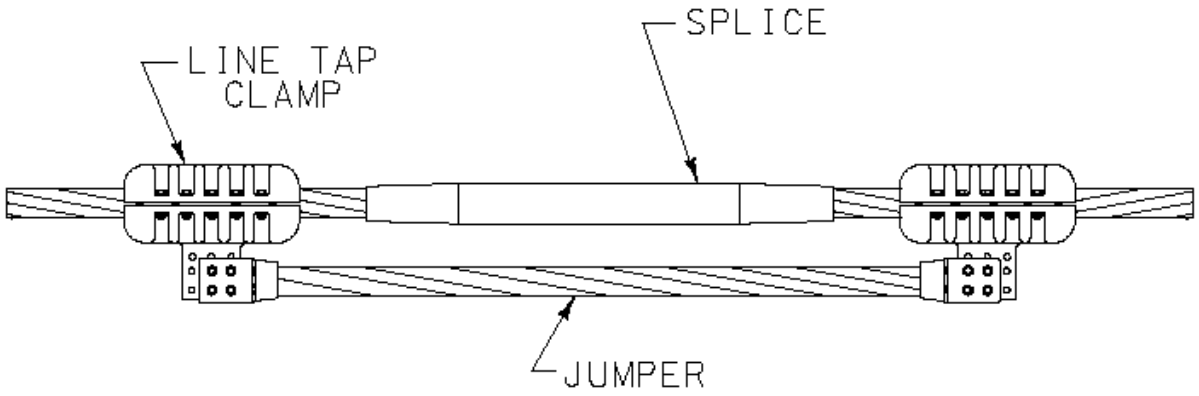
- Limited and Full Tension Connectors
- Electrical, Thermal, and Mechanical Breakdown
- Failure Criteria
- Replacement or Mitigation Measures

Splice Shunt

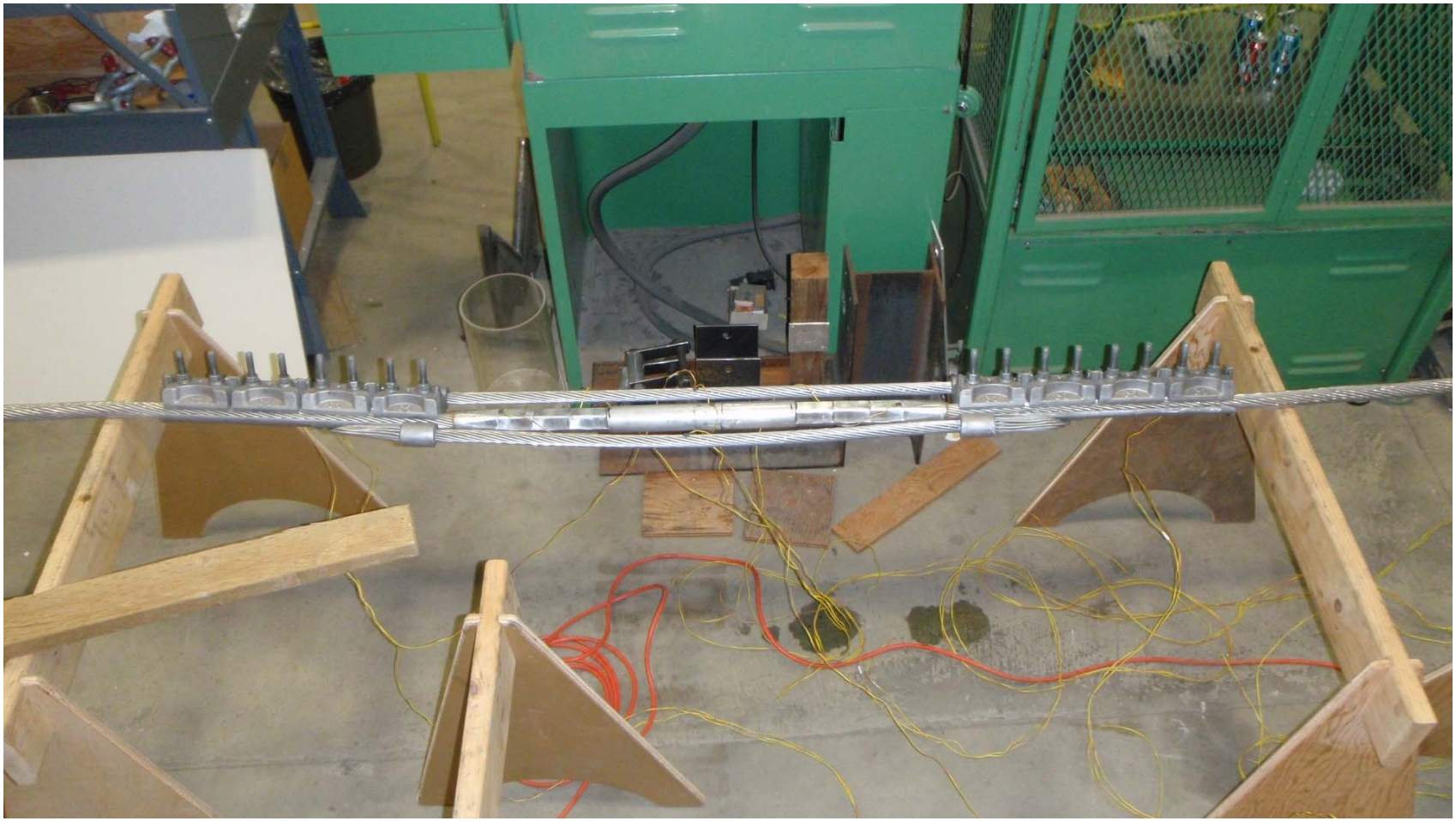
Deadend Shunt



Alternate Shunt



ClampStar Bolted Shunt



BPA Drake Lab Test (20 °C ambient, no wind)

- 1070 A Continuous <u>Summer Rating</u>

Conductor: 90°C Rise

Splice: 60°C Rise (now)

Splice with Shunt: 20°C Rise

Shunt: 25°C Rise

Shunt with Splice: 20°C Rise

- 1500 A Emergency <u>Summer Rating</u>

Conductor: 180°C Rise

Splice: 110°C Rise

Splice with Shunt: 40°C Rise (now)

Shunt: 40°C Rise

Shunt with Splice: 40°C Rise

Conductor Hardware

- Ferrous Conductor Hardware
- Non-Ferrous Conductor Hardware
- Non-Metallic Conductor Hardware

Suspension Clamp without Armor Rod

- **Heat Profile (Bare 795 Suspension Clamp)**

Suspension Clamp with Armor Rod

Heat Profile (795 Suspension Clamp w/ ARMOR Rods)

Questions and Comments?

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