Demographics

the challenges posed by ageing assets on the Distribution Systems

Georgia CoOp Engineers Meeting

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May 2026

Distribution Program Overview

Objective

Provide advanced knowledge, technologies, and tools to enable utilities to make

informed decisions

regarding the distribution asset life-cycle

180.001
Overhead Assets

180.002
Underground Assets

180.003
Distribution Automation Assets

180.004
Safety and Work Practices

180.005
Asset and Reliability Analytics

180.006
Wildfire Performance of Distribution Systems

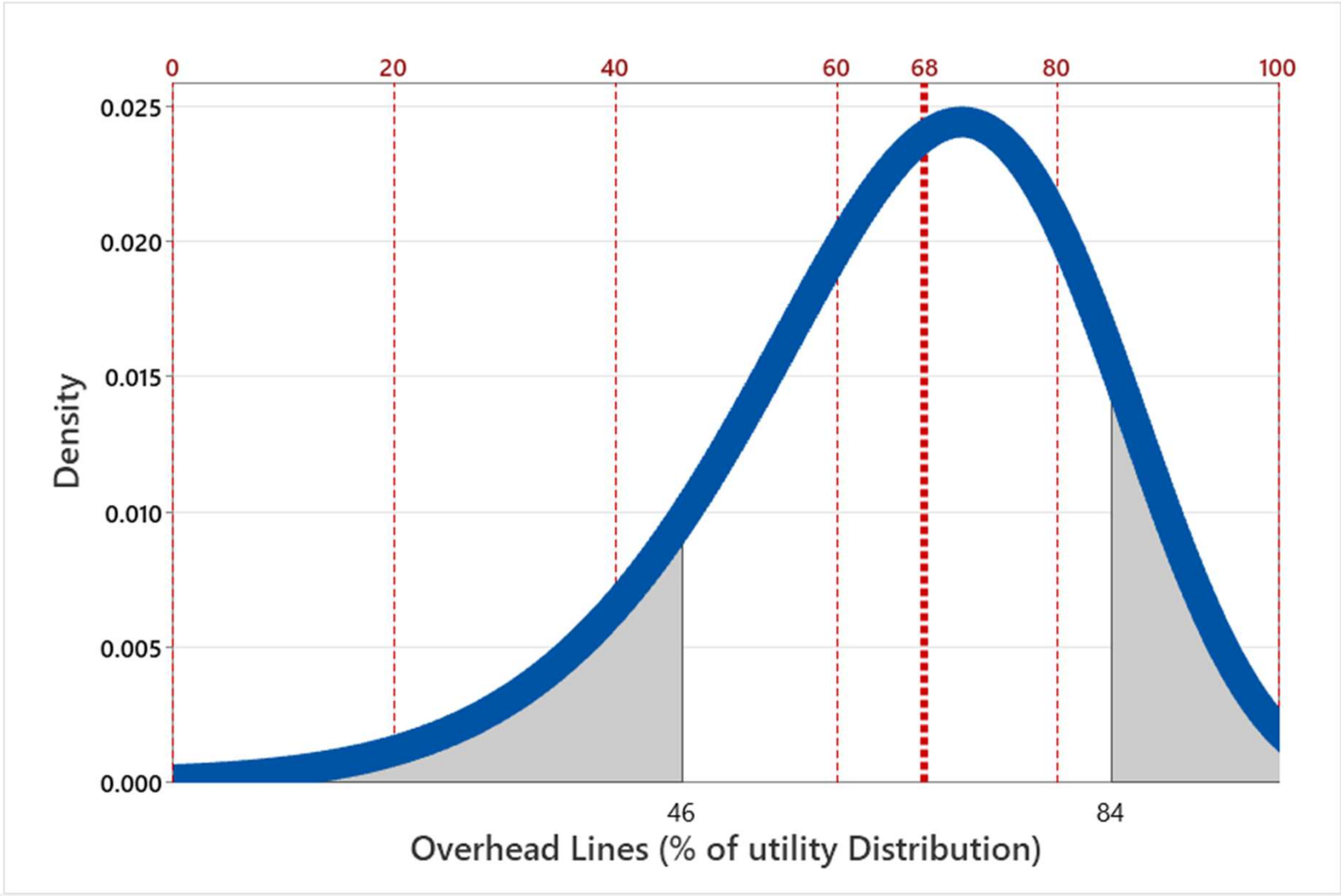
Ageing Infrastructure – what do you need to know?

- How much
- How old
- What is failing
- Is my system failing at a high rate
- What is a typical failure rate
  What does old look like

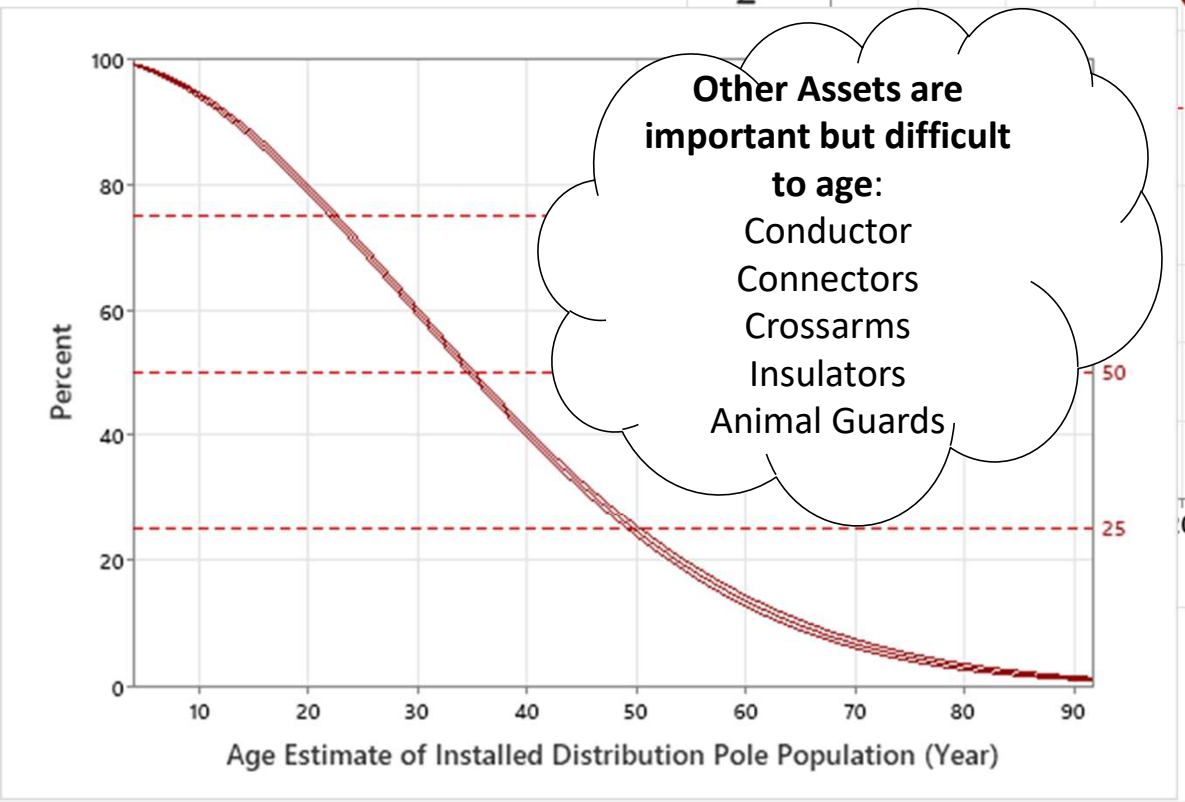
- Generally information is not available in one place within a utility
- It most often resides as “Institutional Knowledge” within the ranks of long term experienced engineers

Demographics

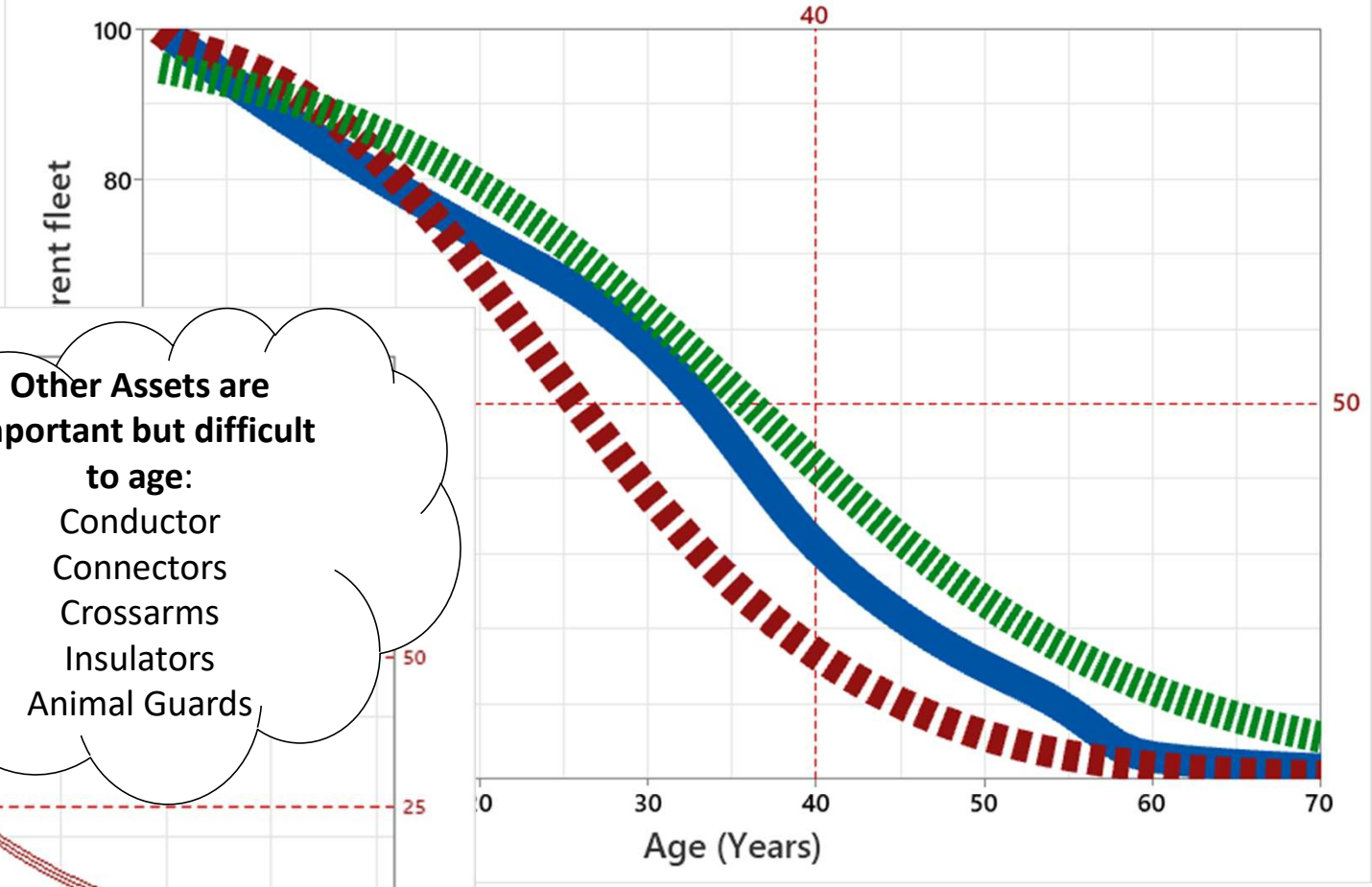
Overhead Distribution – how much



Distribution Asset Demographics



Other Assets are important but difficult to age:
Conductor
Connectors
Crossarms
Insulators
Animal Guards



Wires

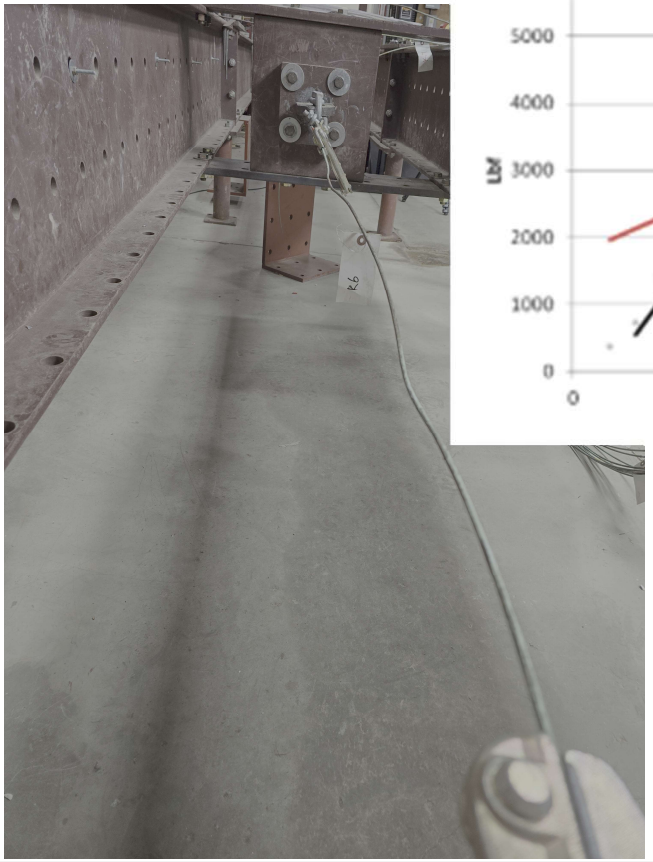
"We have a strong interest in aging overhead conductors"

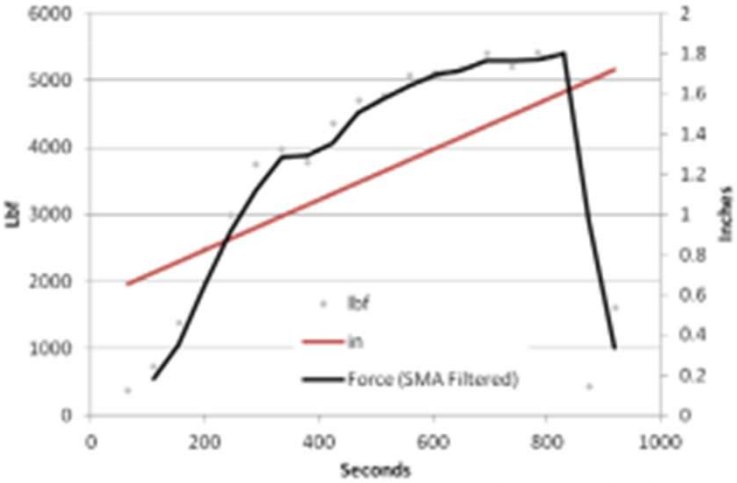
Conductor ageing

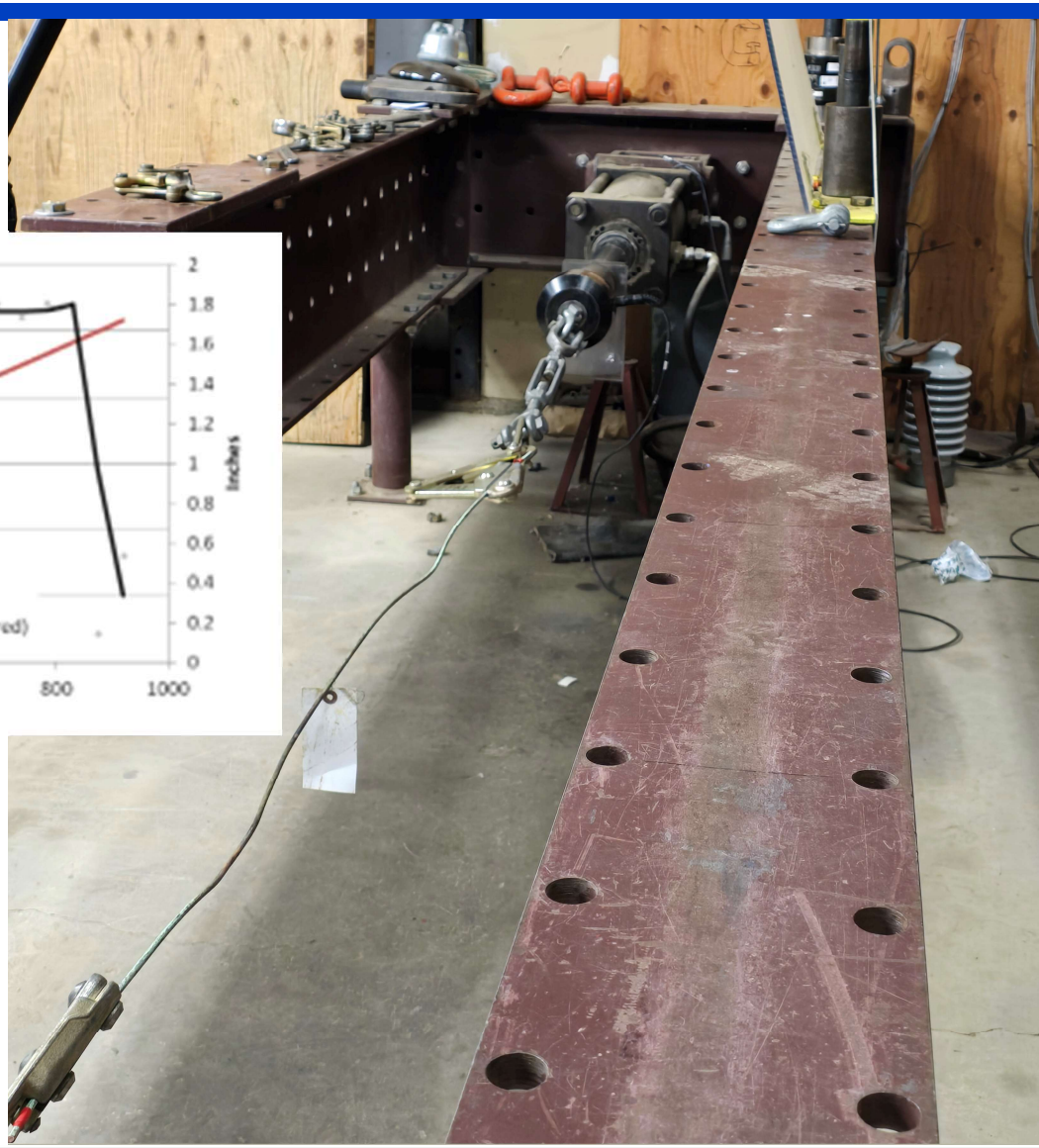
- Overhead conductors age through a combination of mechanisms:
  - mechanical,
  - thermal,
  - electrical, and
  - environmental
- They generally
  - do **not "wear out" uniformly**,
  - accumulate damage in specific ways
- Damage is manifest as
  - increased sag,
  - broken strands, or
  - reduced mechanical margin
- Damage leads to reduced breaking strength

Conductor	Typical Drivers for Reduced Breaking Strength
ACSR	Aluminum creep & annealing (overheating) Hidden steel core corrosion
AAAC	Fatigue of aluminum-alloy strands Annealing)overheating)
ACSS	Steel core corrosion Accessory/interface effects

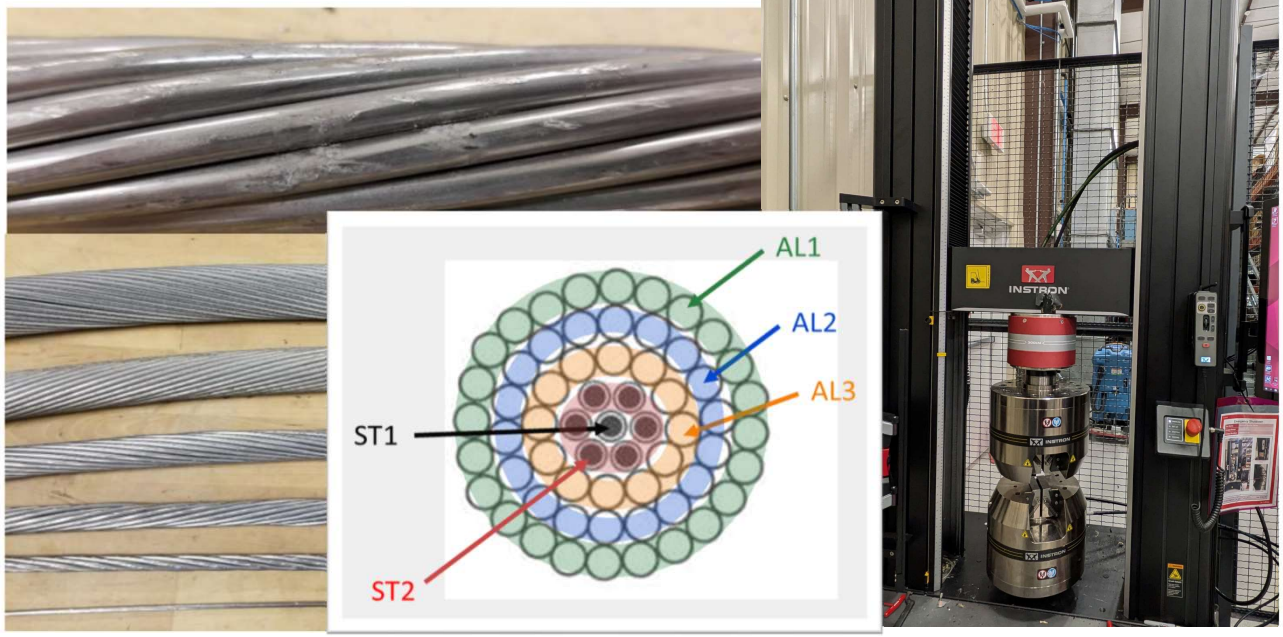
Approach 1
Fullsize Conductor Strength Testing







Approach 2
Component Strength Testing



$$S = F_1 N_1 \widehat{s_1} + F_2 N_2 \widehat{s_2} + F_3 N_3 \widehat{s_3} +$$

Designation: B232/B232M – 11

Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Coated-Steel Reinforced (ACSR)[1]

This standard is issued under the fixed designation B232/B232M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers concentric-lay-stranded conductors made from round aluminum 1350-H19 (extra hard) wires and round, coated steel core wire(s) for use as overhead electrical conductors (Explanatory Note 1 and Explanatory Note 2).

1.2 ACSR covered by this specification has nine types of coated steel core wire which are designated by abbreviations as follows (Explanatory Note 2):

1.2.1 *ACSR/GA or ACSR/GA2—ACSR* using Class A zinc-coated steel wire,

1.2.2 *ACSR/GC or ACSR/GC2—ACSR* using Class C zinc-coated steel wire,

1.2.3 *ACSR/MA or ACSR/MA2—ACSR* using Class A Zn-5A1-MM coated steel wire,

1.2.4 *ACSR/HS or ACSR/GA3—ACSR* using Class A zinc-coated high-strength steel wires,

1.2.5 *ACSR/MS or ACSR/MA3—ACSR* using Class A Zn-5A1-MM coated high-strength steel wires,

1.2.6 *ACSR/GA4—ACSR* using Class A zinc-coated extra-high-strength steel wires,

1.2.7 *ACSR/MA4—ACSR* using Class A Zn-5A1-MM coated extra-high-strength steel wires,

1.2.8 *ACSR/GA5—ACSR* using Class A zinc-coated ultra-high-strength steel wires,

1.2.9 *ACSR/MA5—ACSR* using Class A Zn-5Al-MM coated ultra-high-strength steel wires.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

2. Referenced Documents

2.1 The following documents of the issue in effect on date of material purchase form a part of this specification to the extent referenced herein:

2.2 *ASTM Standards:*[2]

B230/B230M Specification for Aluminum 1350–H19 Wire for Electrical Purposes

B263 Test Method for Determination of Cross-Sectional Area of Stranded Conductors

B354 Terminology Relating to Uninsulated Metallic Electrical Conductors

B498/B498M Specification for Zinc-Coated (Galvanized) Steel Core Wire for Use in Overhead Electrical Conductors

B500/B500M Specification for Metallic Coated or Aluminum Clad Stranded Steel Core for Use in Overhead Electrical Conductors

B606 Specification for High-Strength Zinc-Coated (Galvanized) Steel Core Wire for Aluminum and Aluminum-Alloy Conductors, Steel Reinforced

B802/B802M Specification for Zinc–5 % Aluminum-Mischmetal Alloy-Coated Steel Core Wire for Aluminum Conductors, Steel Reinforced (ACSR)

B803 Specification for High-Strength Zinc–5 % Aluminum-Mischmetal Alloy-Coated Steel Core Wire for Use in Overhead Electrical Conductors

B957 Specification for Extra-High-Strength and Ultra-High-Strength Zinc-Coated (Galvanized) Steel Core Wire for Overhead Electrical Conductors

B958 Specification for Extra-High-Strength and Ultra-High-Strength Class A Zinc–5% Aluminum-Mischmetal Alloy-Coated Steel Core Wire for Use in Overhead Electrical Conductors

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

[1] This specification is under the jurisdiction of ASTM Committee B01 on Electrical Conductors and is the direct responsibility of Subcommittee B01.07 on Conductors of Light Metals.

Current edition approved Oct. 1, 2011. Published November 2011. Originally approved in 1948. Last previous edition approved in 2009 as B232/B232M – 09. DOI: 10.1520/B0232_B0232M-11.

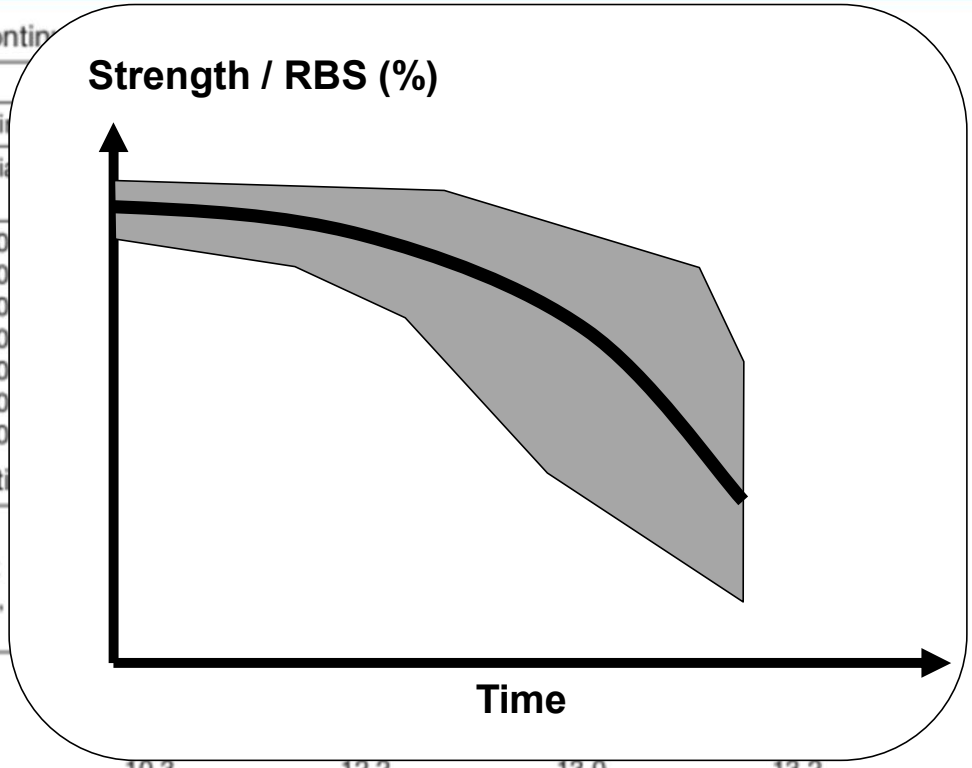
[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

TABLE 1 Contin

Size		Code Words[A]	Class	Stranding Design Aluminum/ Steel	Alumi	
cmil	AWG				Number	Di
167 800	000	Pigeon	AA, A	6/1	6	0
159 000	. . .	Guinea	AA (HS)	12/7	12	0
134 600	. . .	Leghorn	AA (HS)	12/7	12	0
133 100	00	Quail	AA, A	6/1	6	0
110 800	. . .	Minorca	AA (HS)	12/7	12	0
105 600	0	Raven	AA, A	6/1	6	0
101 800	. . .	Petrel	AA (HS)	12/7	12	0

TABLE 3 Conti

Size		Class	Stranding Design Aluminum/Steel	ACSR/GA2 ACSR/MA2, kips				
cmil	AWG							
159 000	. . .	AA (HS)	12/7	16.0				
134 600	. . .	AA (HS)	12/7	13.6				
133 100	00	AA, A	6/1	5.30				
110 800		AA (HS)	12/7	11.3	10.3	12.2	13.0	13.2
105 600	0	AA, A	6/1	4.38	4.12	4.65	4.85	4.91
101 800	. . .	AA (HS)	12/7	10.4	9.46	11.2	11.9	12.1
83 690	1	AA, A	6/1	3.55	3.34	3.76	3.92	3.98
80 000	. . .	AA (HS)	8/1	5.20	4.89	5.73	6.04	6.15
66 360	2	AA, A	7/1	3.64	3.39	3.90	4.09	4.15
66 360	2	AA, A	6/1	2.85	2.68	3.01	3.14	3.18
41 740	4	AA, A	7/1	2.36	2.20	2.52	2.64	2.68
41 740	4	AA, A	6/1	1.86	1.76	1.97	2.05	2.07
33 090	5	A	6/1	1.49	1.41	1.57	1.64	1.66
26 240	6	AA, A	6/1	1.19	1.12	1.26	1.30	1.32

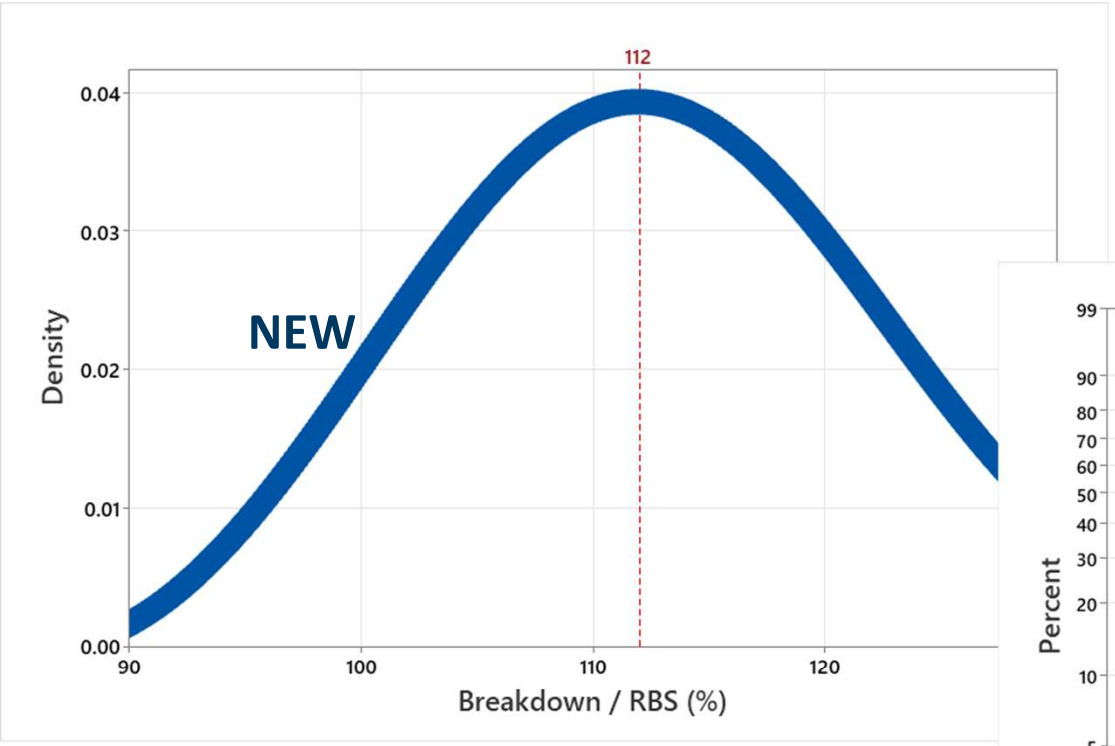


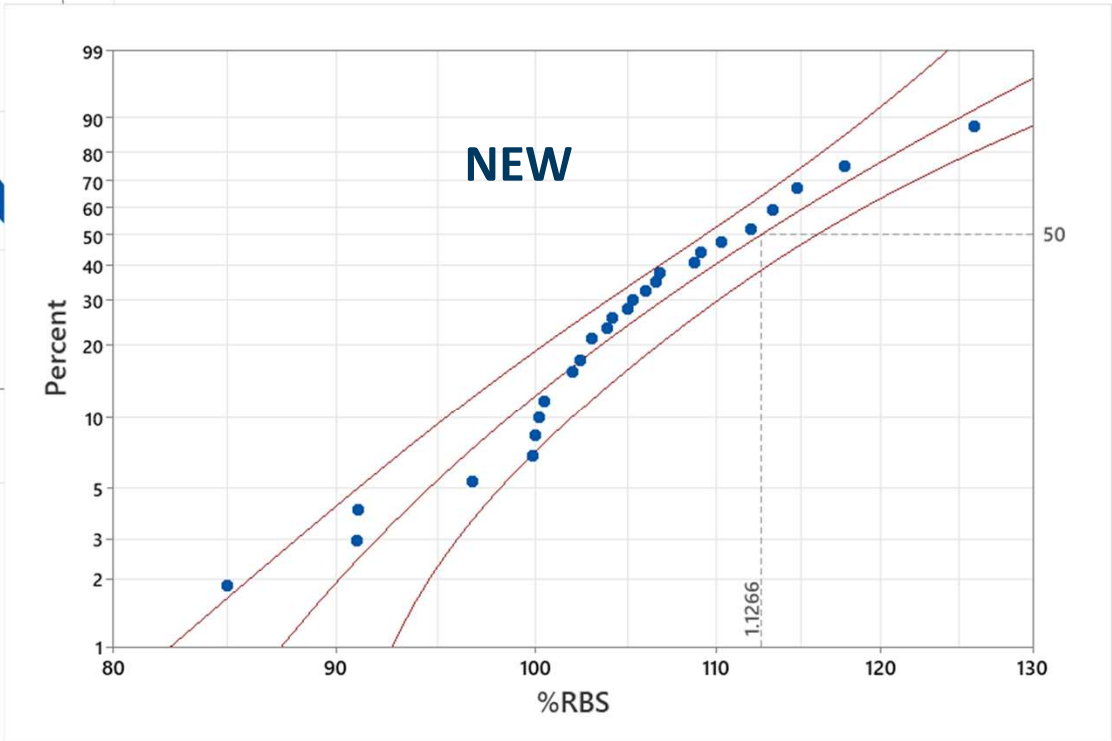
All the results you will see come from:

- Conductors provided by utilities
- Connectors installed by utility crews
- Aged samples are between 10 and 60 years old
- Distribution sized conductors
- As far as we know none of these come from
  - CoOps
  - Georgia

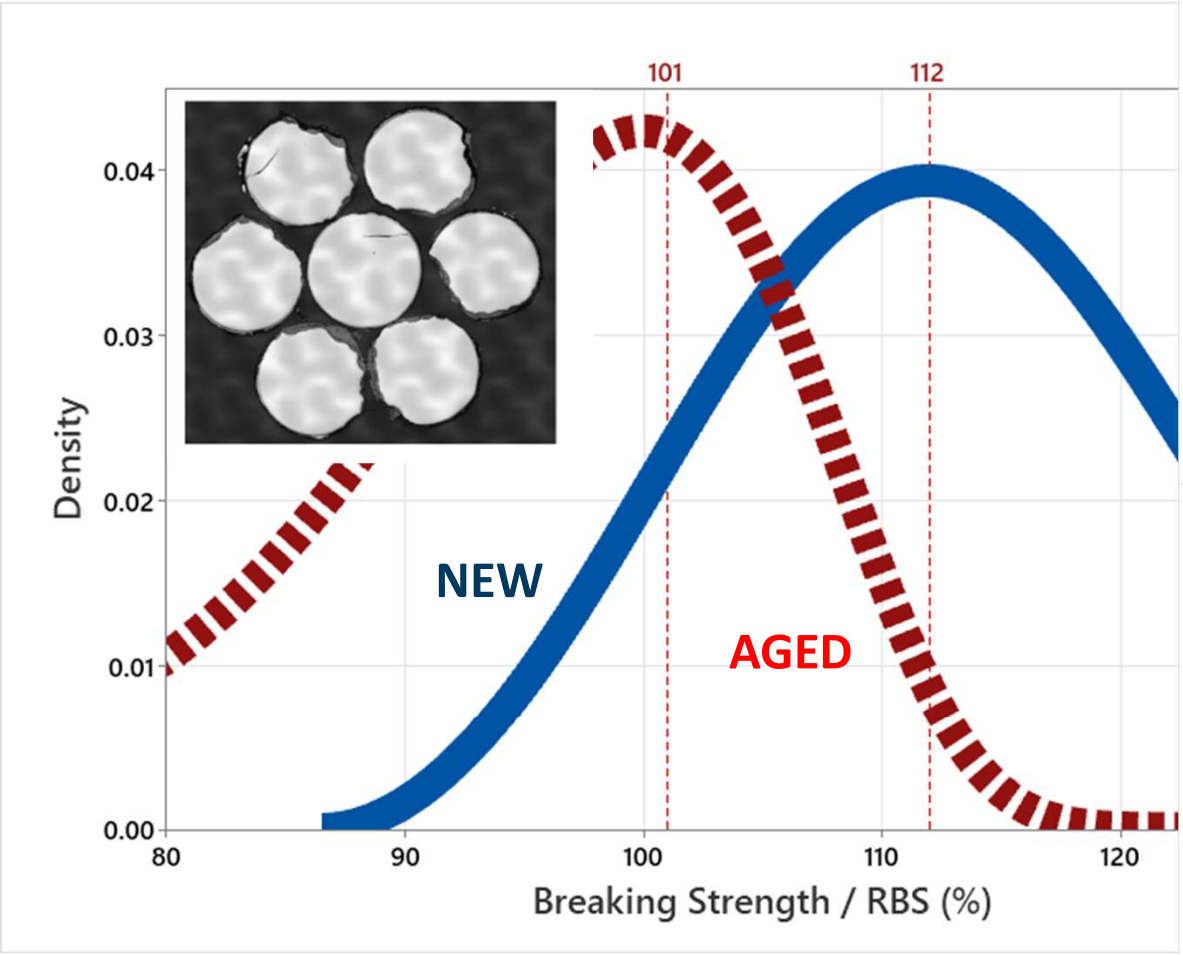
140 samples of wire

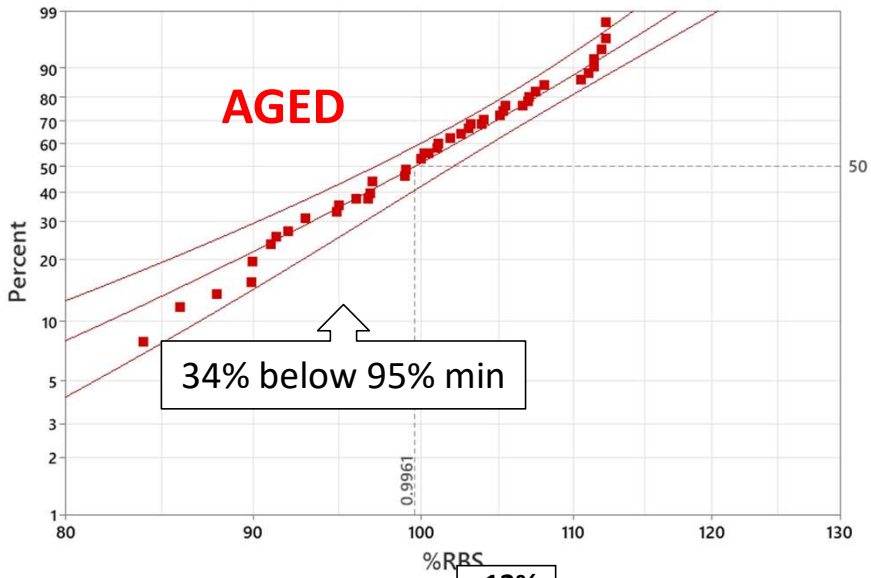
New Conductor Strength

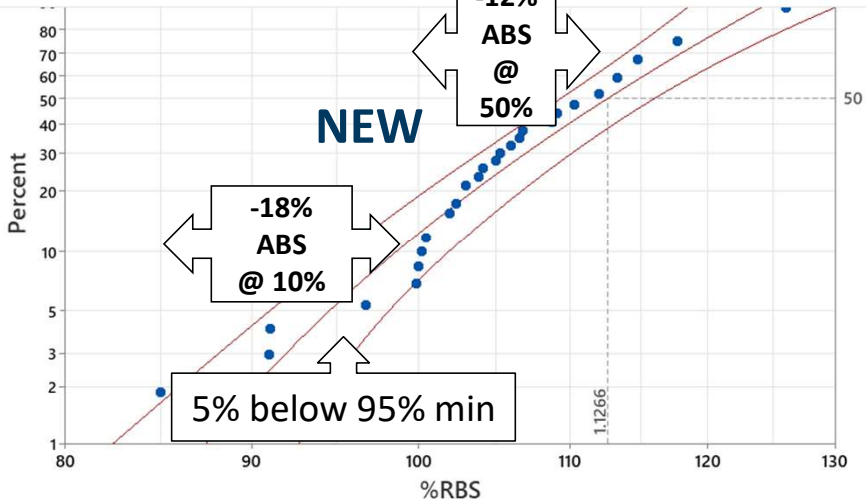




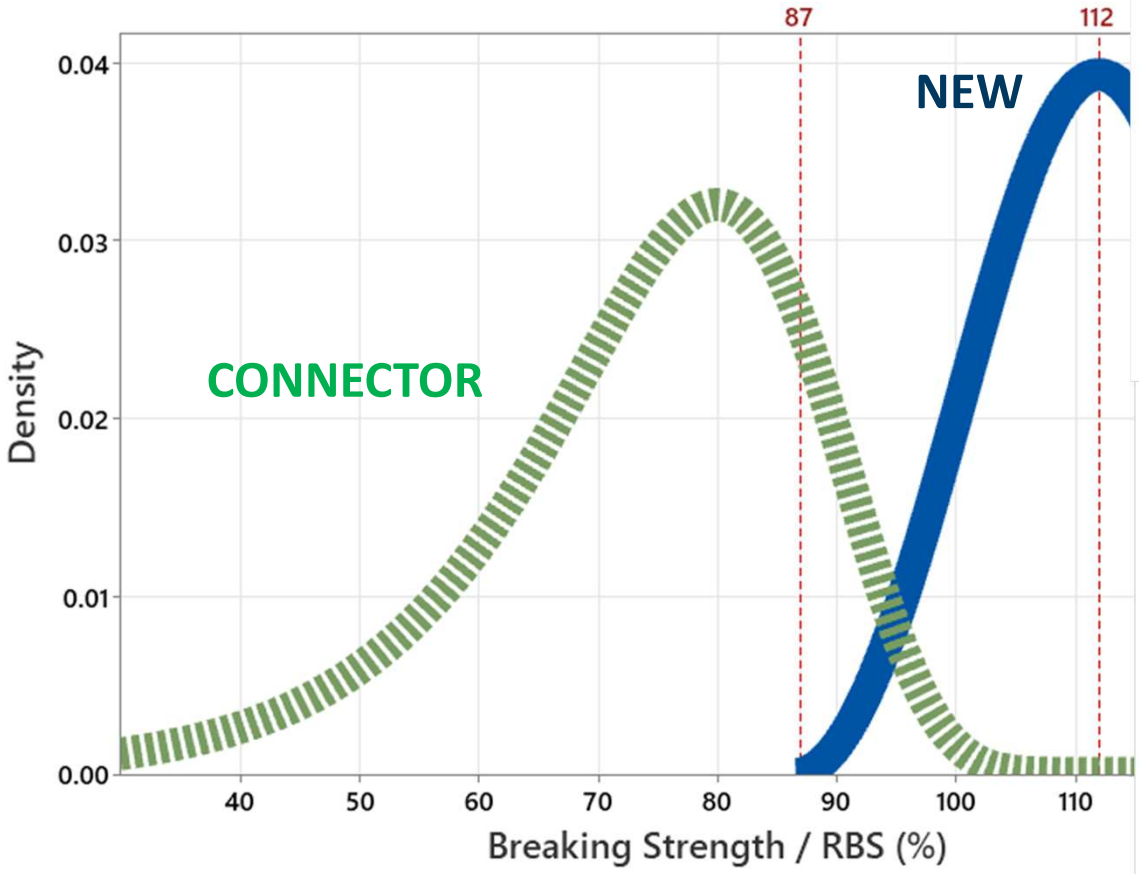
New & Aged Conductor

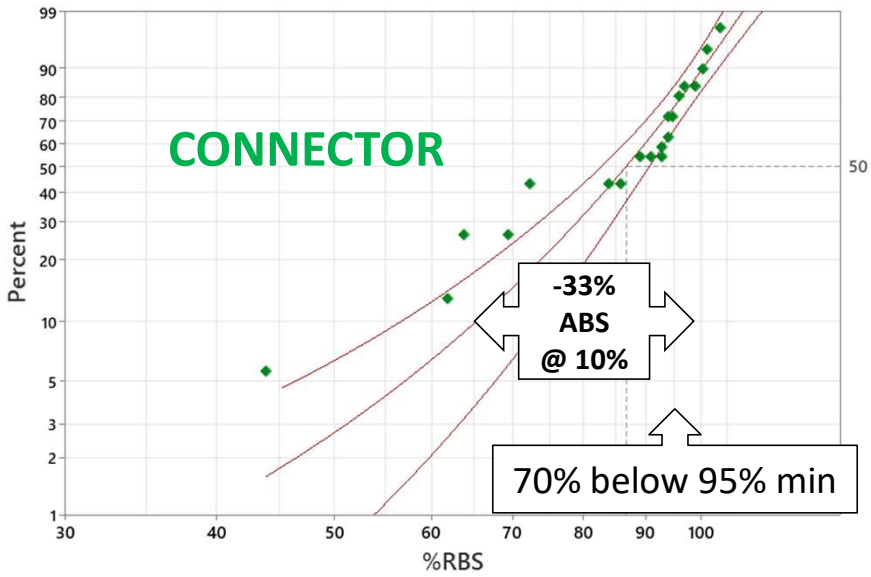


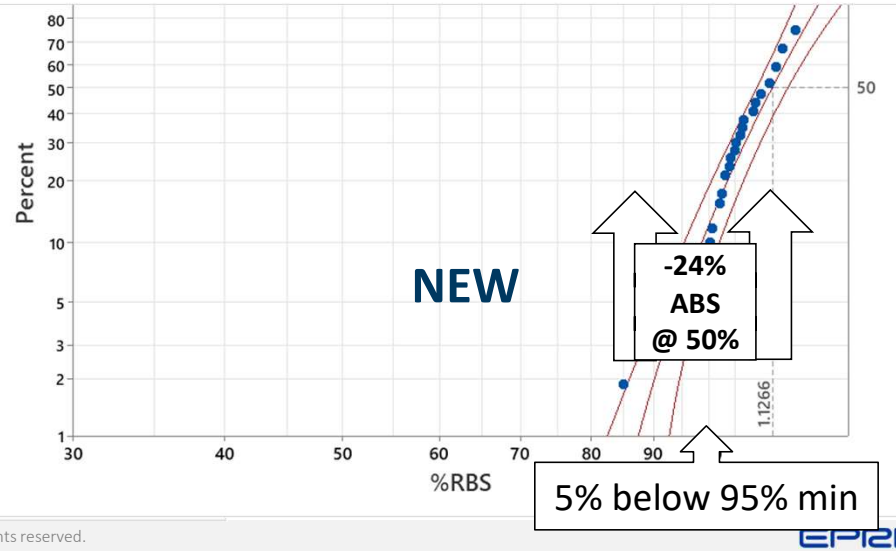




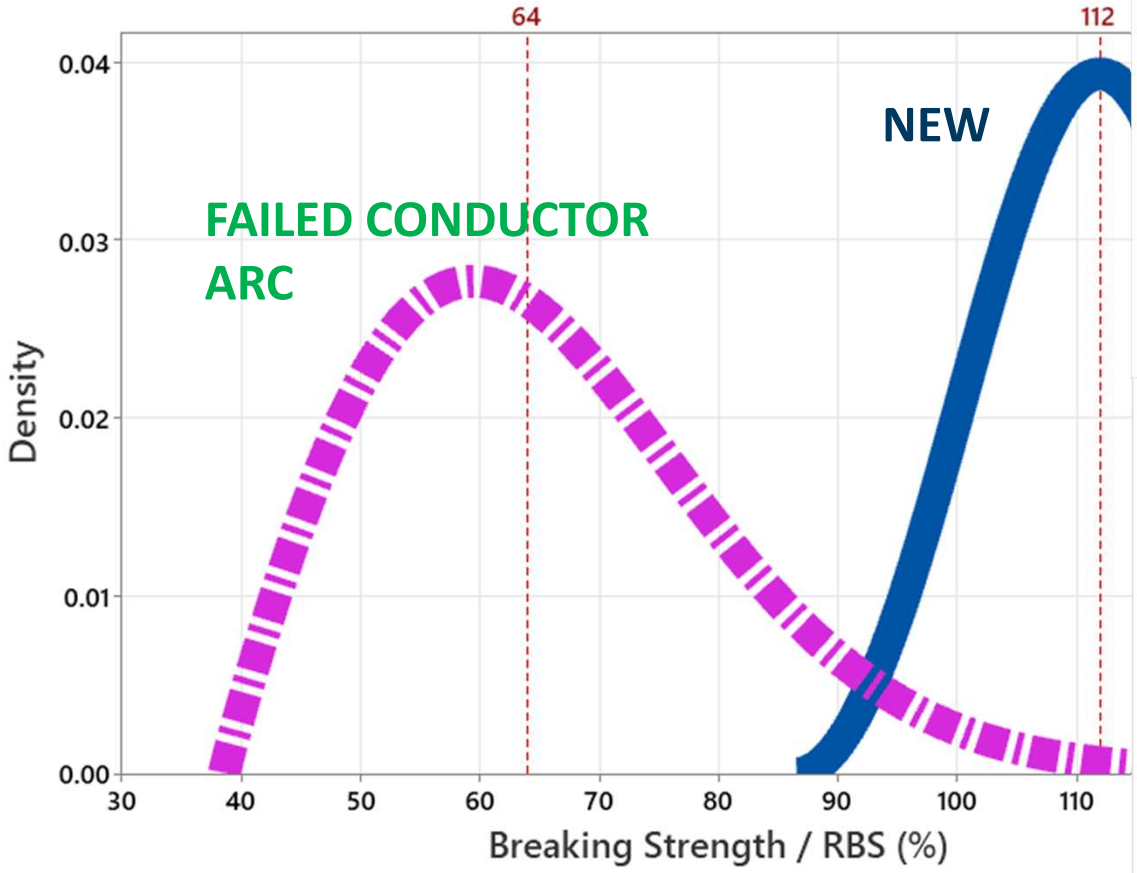
Wire with Connectors

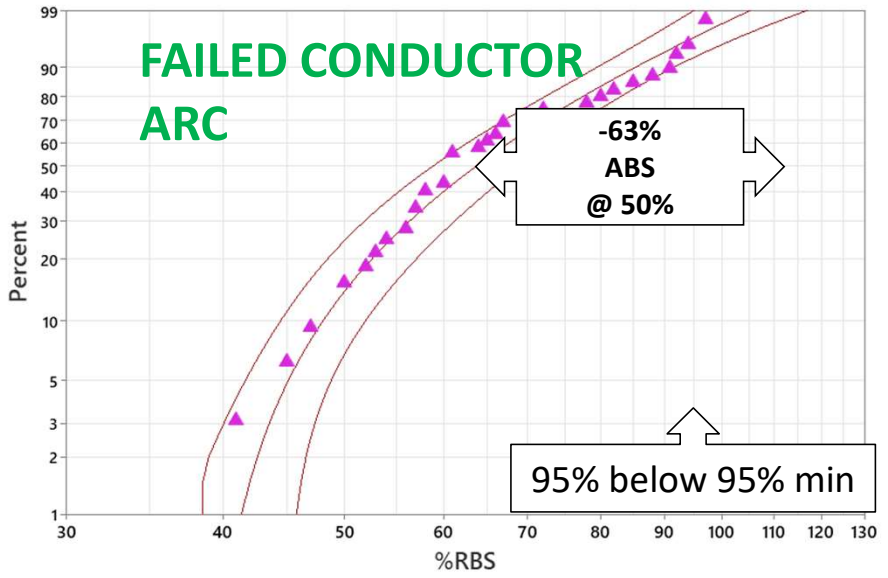


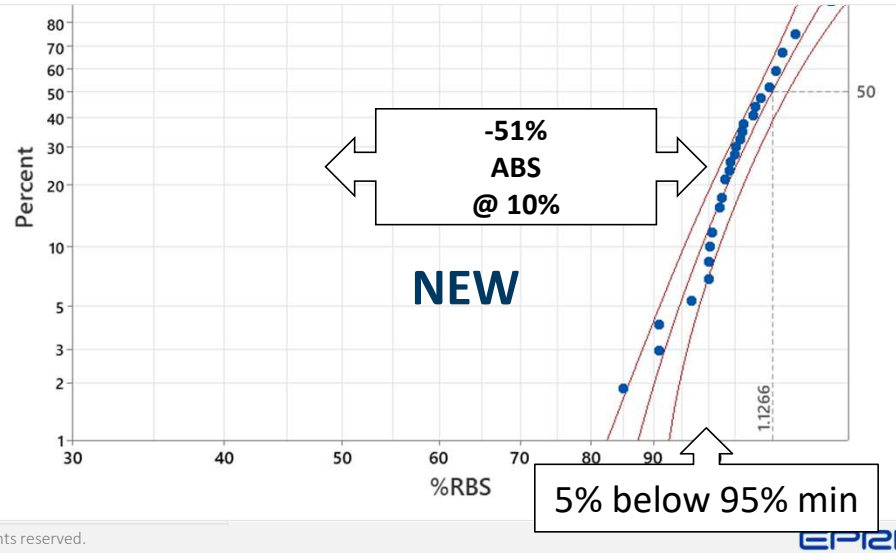




Wire failure
– sections surviving arc

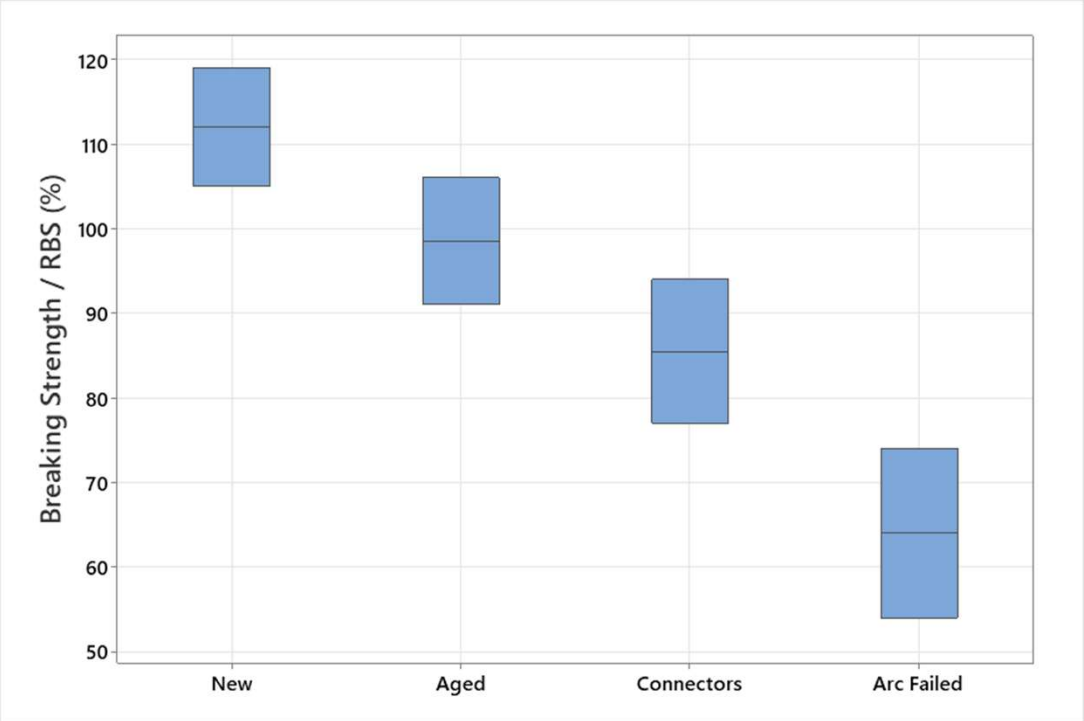






Only the start - lots of things that we would like to know

- Differences between ACSR / AAAC / Cu
- Impact of different ages: 20 – 30 years, 50 – 60 years etc
- How to best splice repair a broken conductor – excise weak parts
- Coastal environment
- Impact failures
- Connectors
  - New connectors on new wire
  - New connectors on old wire
  - Old connectors and old wire
  - Automatics / Compression



Distribution Resource Center

Overhead Assets
Research on distribution overhead asset performance

Underground Assets
Research on underground practices, systems, and equipment

Distribution Automation Assets
Research on distribution automation practices, systems, and equipment

Safety and Work Practices
Improve safety and work methods with research on practices, PPE, and new technologies

Asset, Reliability & Resiliency Analytics
Improved decisions through data analytics tools & techniques

Distribution Asset Wildfire Performance
Research on designing and maintaining distribution infrastructure, considering the risk of wildfire

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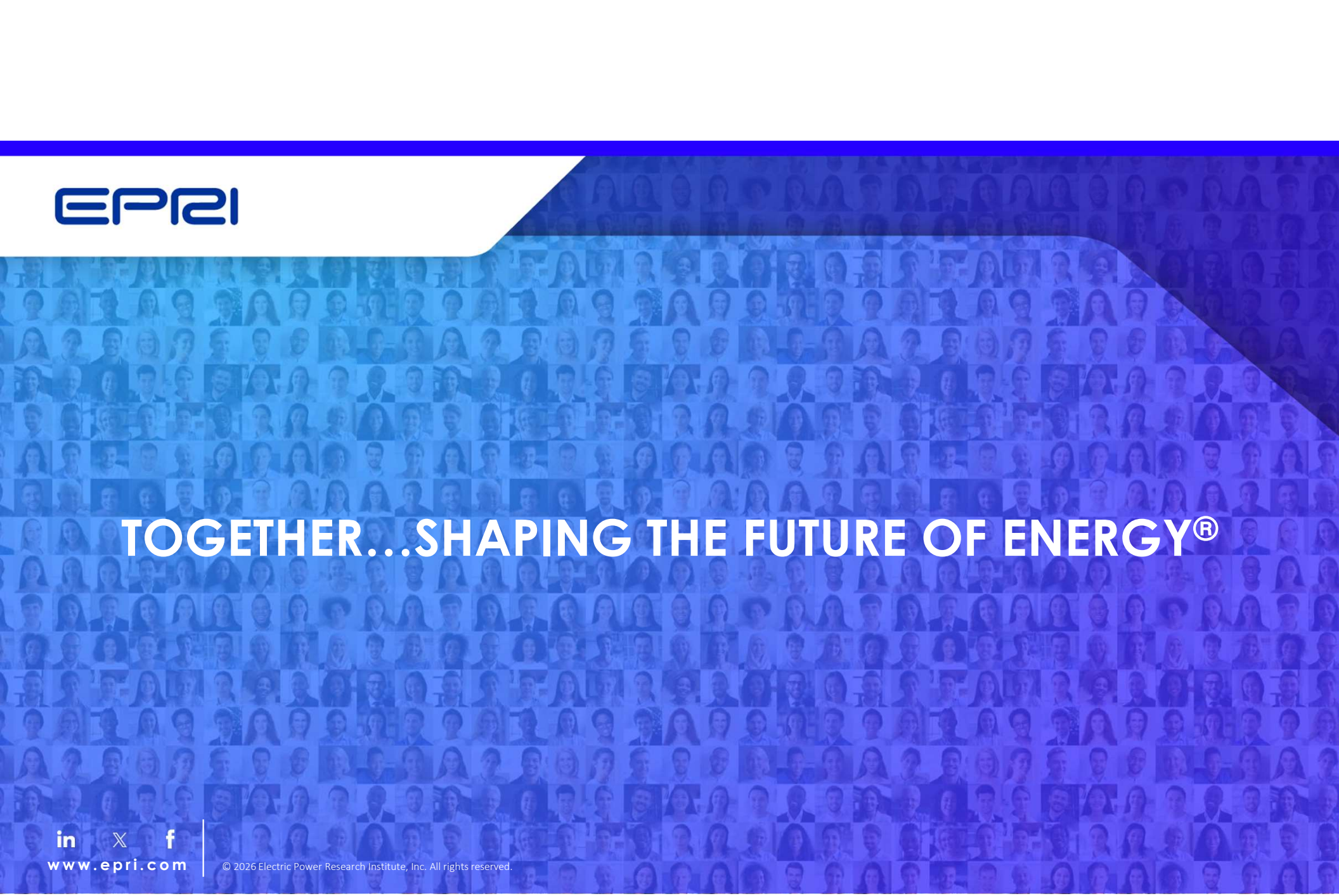

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