Endurance of Medium Voltage Joints under Laboratory Wet Aging Environments

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Outline

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- Test Program
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- Results
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- Conclusions

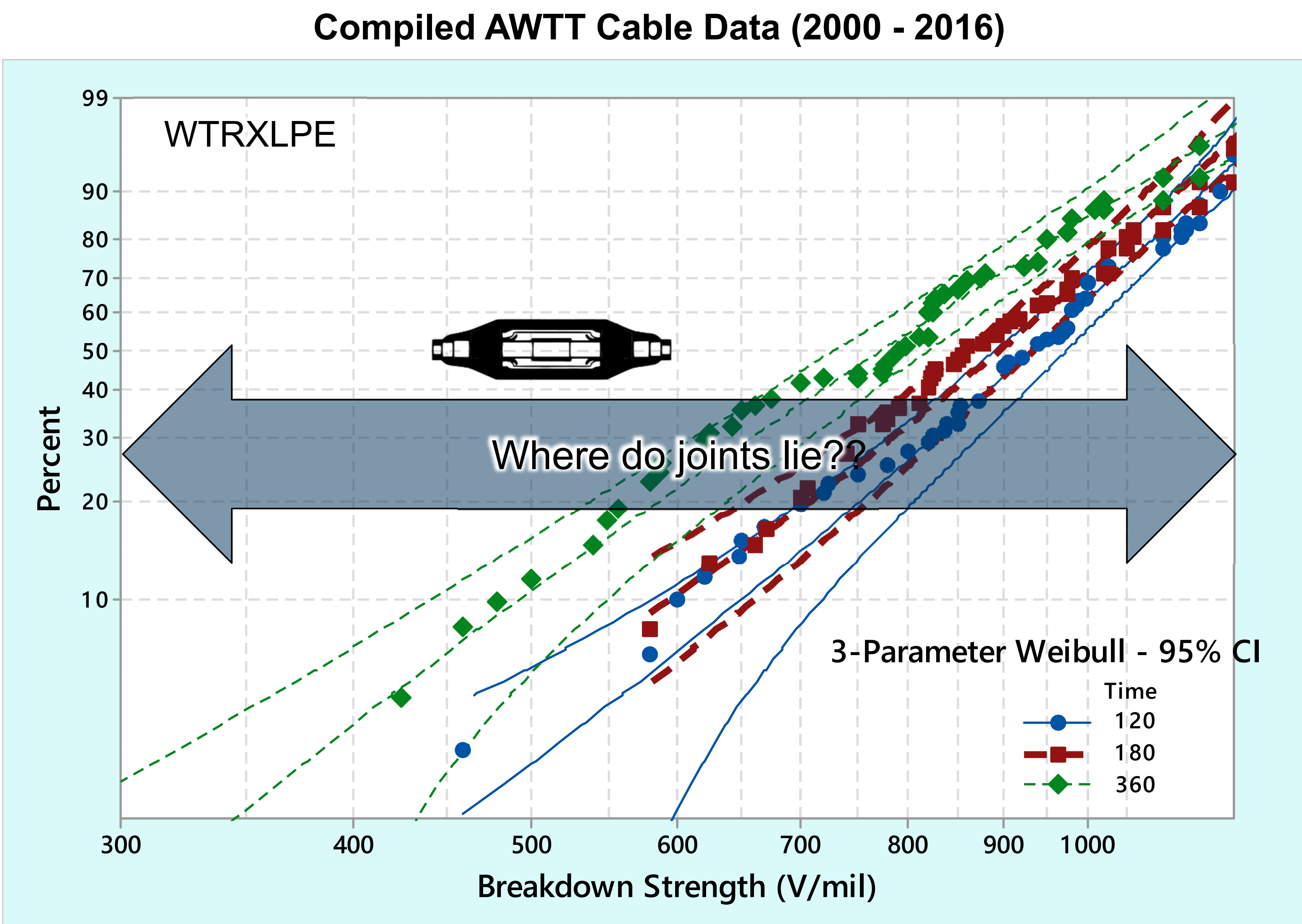
Background

Research work has been conducted on the endurance of MV EPR & TRXLPE cable cores using:

– Accelerated Water Tree Test (**AWTT**) – **time limited** test with results based on Break Down Strength (BDS)

– Accelerated Cable Life Test (**ACLT**) – **open-ended** test time with results based upon Failure On Test (FOT)

Background (Cont'd)



Background (Cont'd)

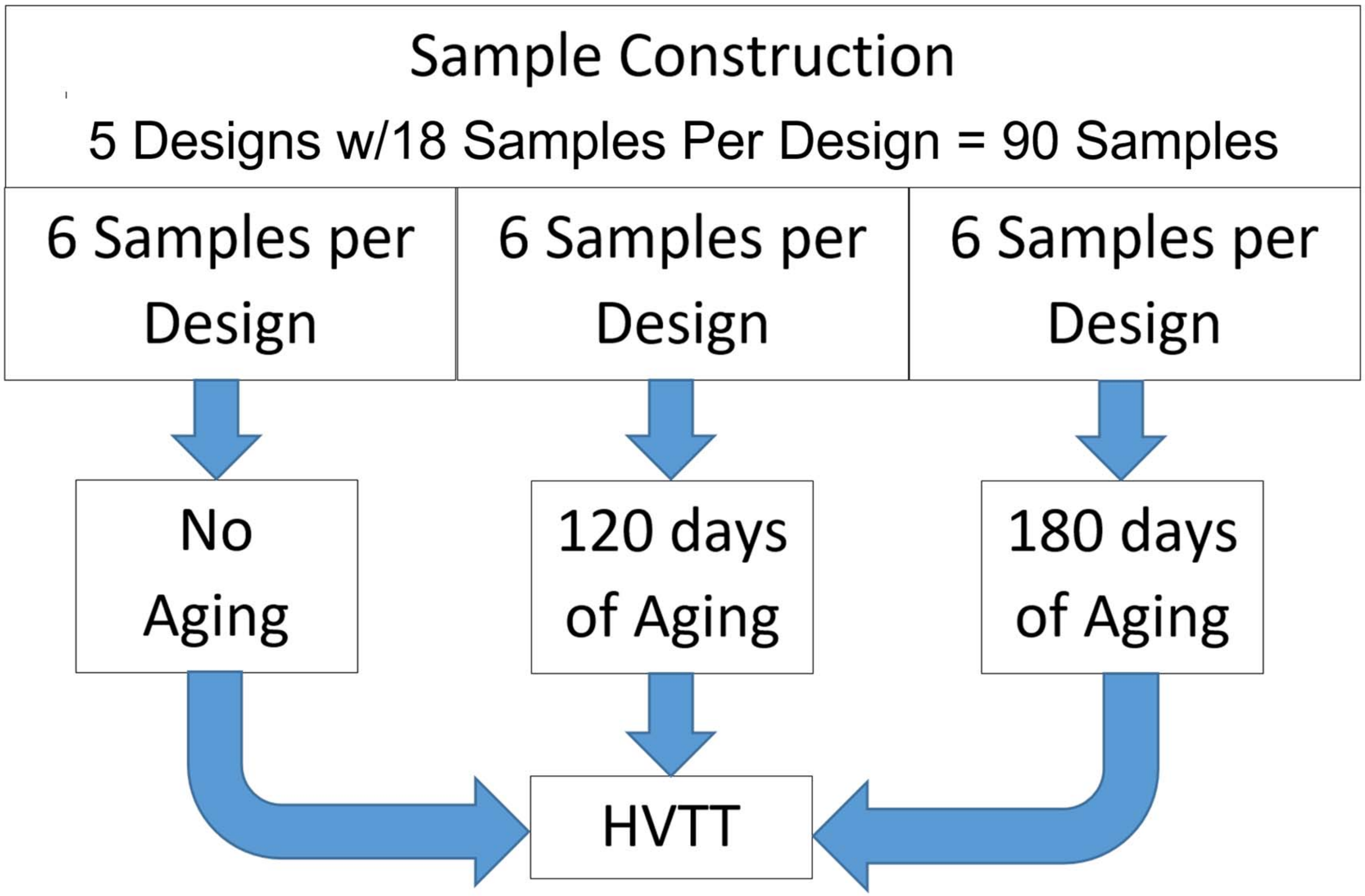
- There is not any endurance data available for joints in the same manner as the cable
- Short term survival data is limited – i.e. 3 samples 30 days at $3U_0$ in IEEE 404
- Need to understand the relative endurances (cable and accessories)

Sample Description

Joint Design	Joint Description	Conductor Connector Description
A	Cold Shrink (Silicone)	Compression
B	Heat Shrink (EPR)	Shear-bolt
C	Cold Shrink (EPR)	Shear-bolt
D§	Molded (EPDM)	Compression
E	Cold Shrink (Silicone)	Shear-bolt
§: Design D did not include jacket restoration		

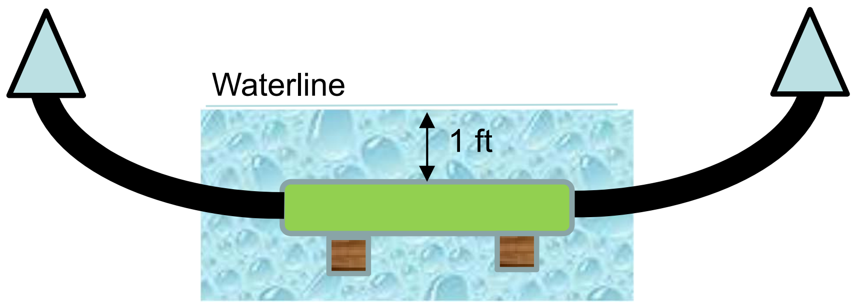
- Joint kits were purchased from a utility supplier and assembled according to manufacturer instructions
- Installed on jacketed 15 kV cable with 1/0 AWG Al water-blocked conductor, 175 mils of TRXLPE insulation, and concentric neutrals

Test Program



Sample Aging Plan

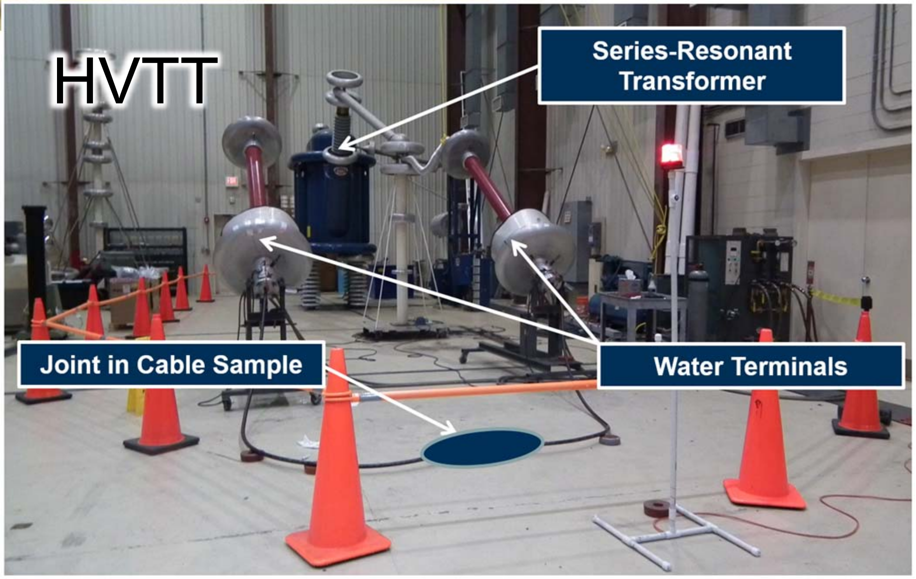
- Sample joints were placed in a tank under 1 ft of water on wooden cross supports to keep them off the bottom of the tank and reduce heat sink to floor in lab



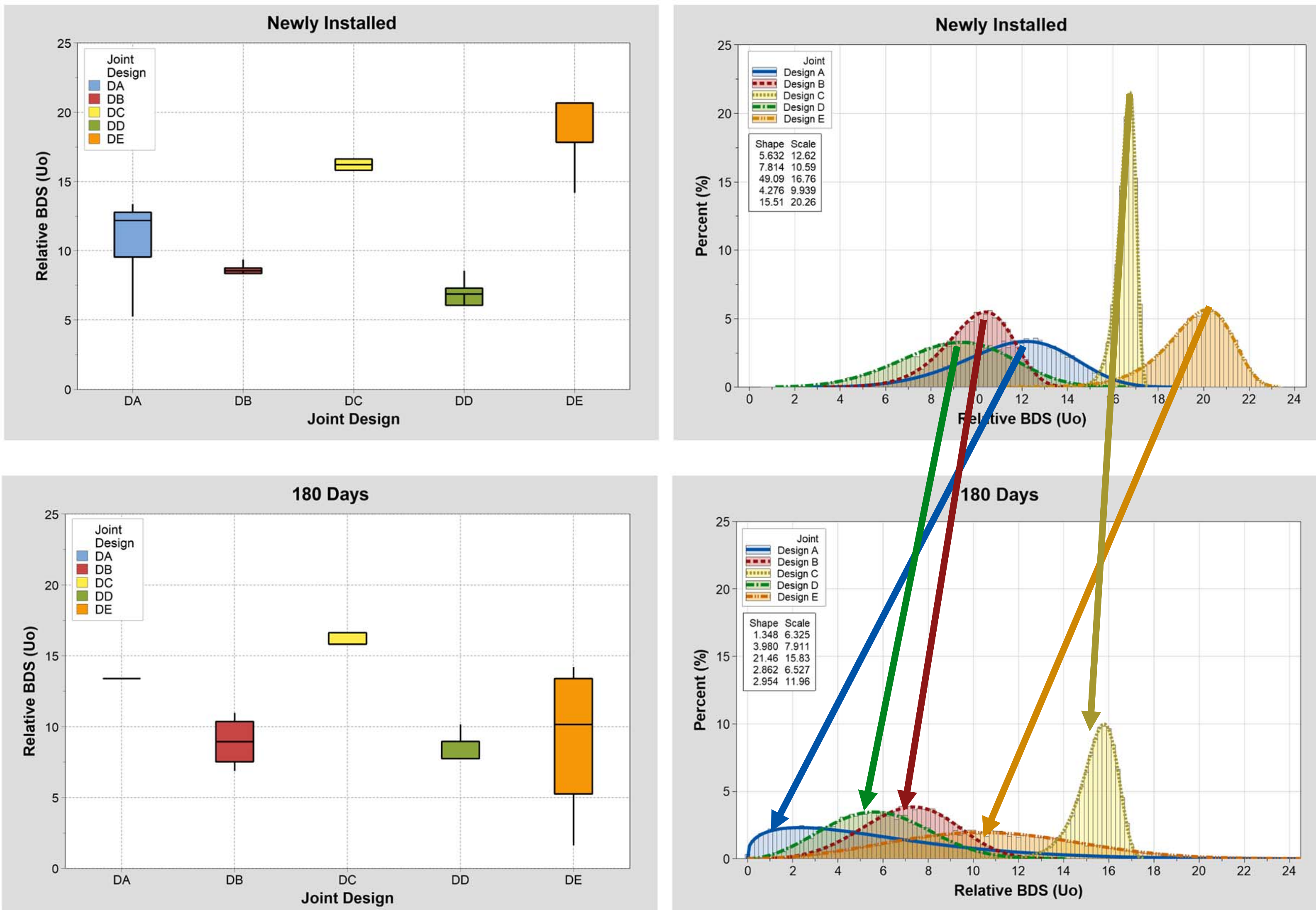
- AWTT style load cycle (24 hours) was used to age samples:
  - Eight (8) hours with current on, 16 hours with current off
  - Current equivalent to cable insulation shield reaching 45 °C ± 3 °C during the last hour of AWTT load cycles
  - Three times rated voltage ($3U_0$ - 26.2 kV) applied to test sample continuously

- High Voltage Time Tests (HVTT) were conducted on samples as in a standard AWTT (0, 120, and 180 days of aging) with verification of joint failure

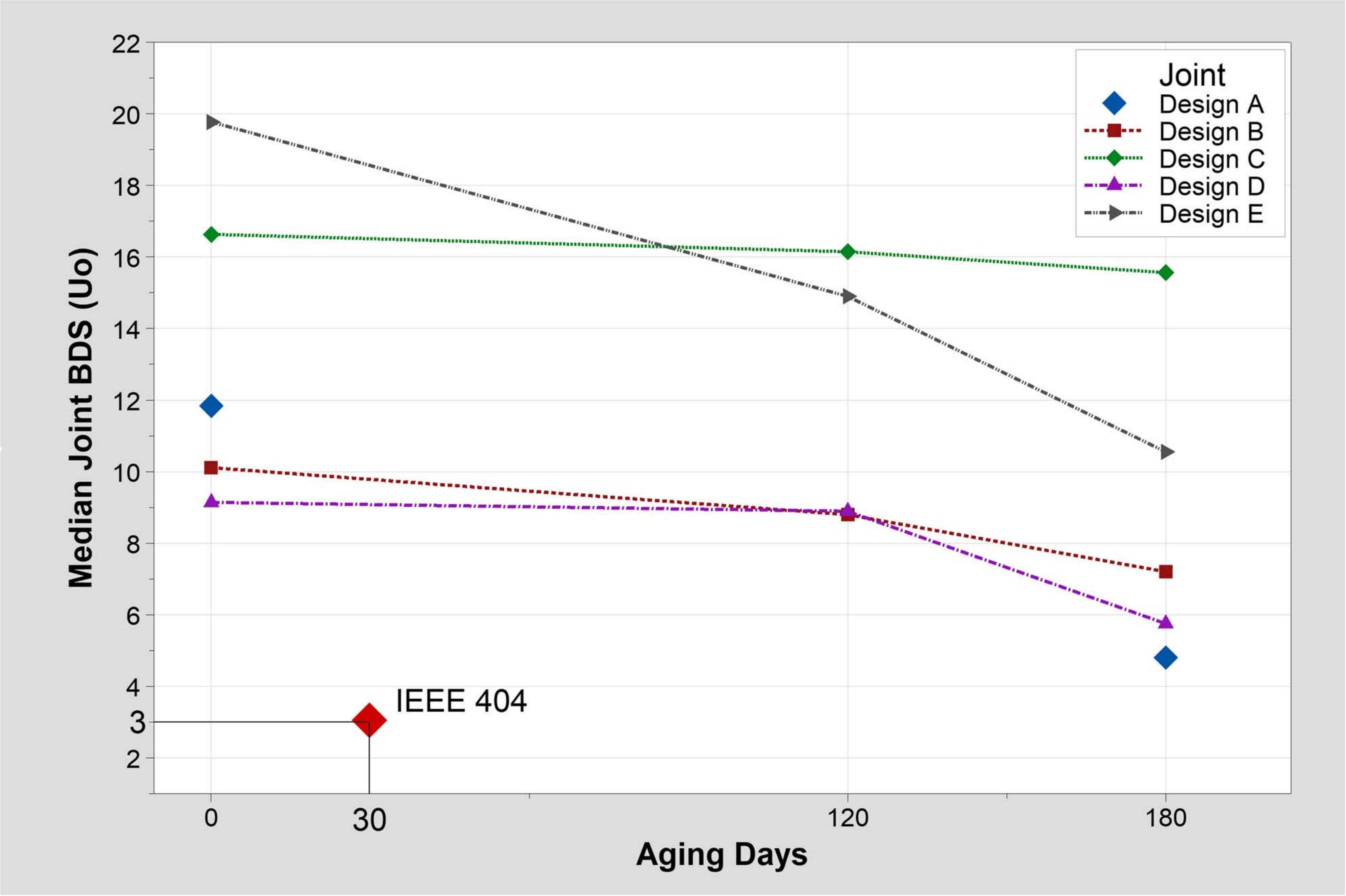
Laboratory Setups



Results – New vs 180 days



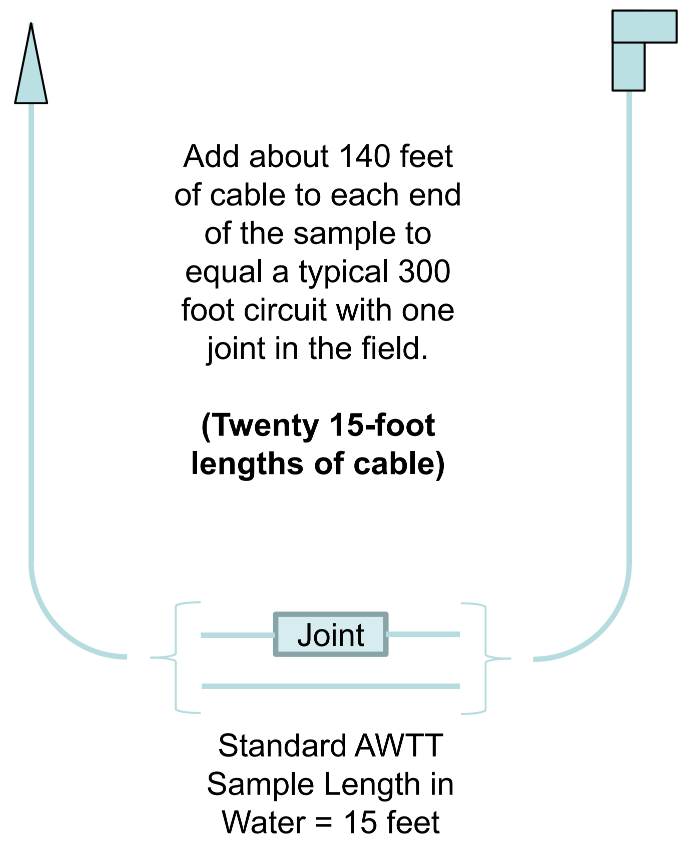
Results – Median BDS



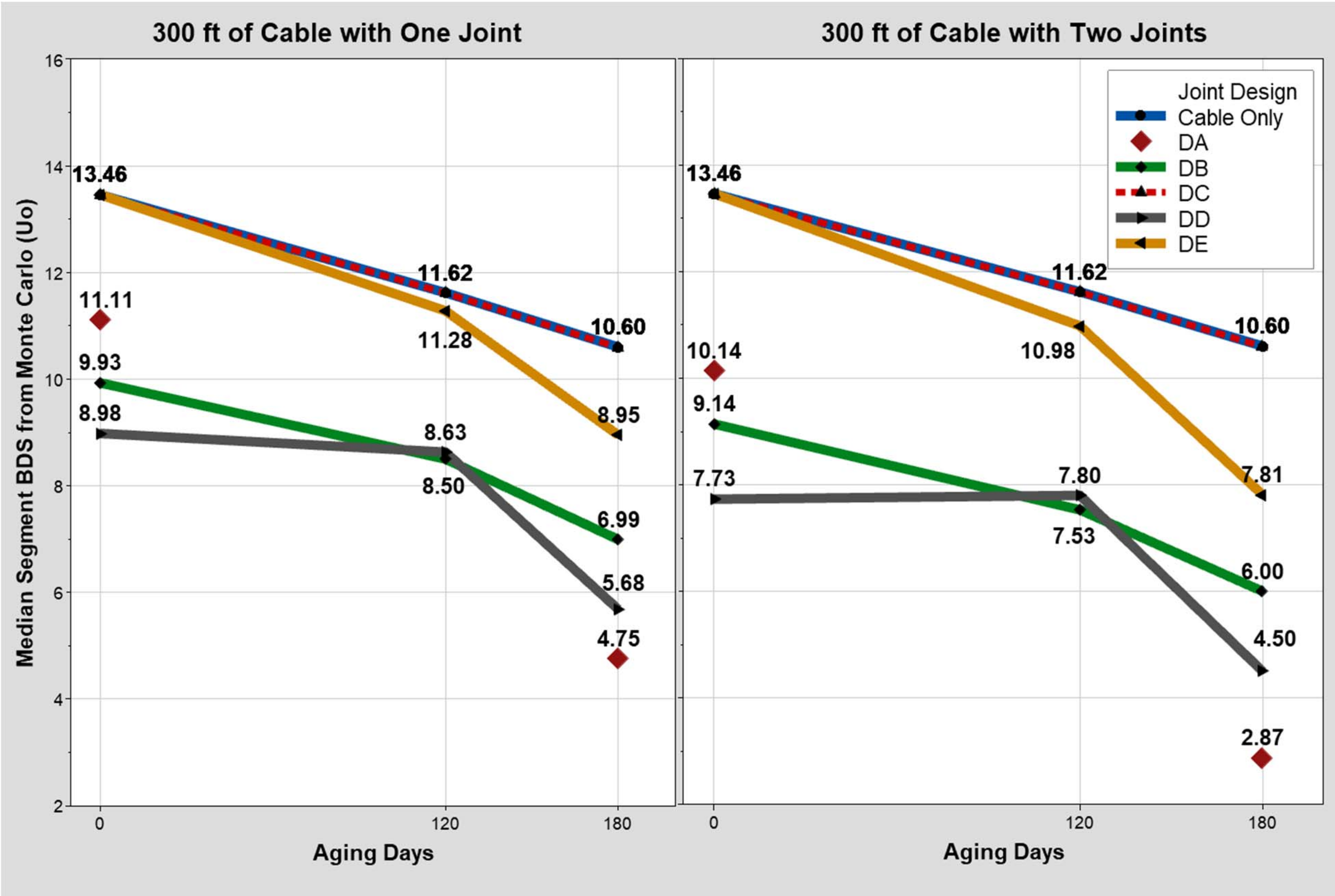
Field Circuit Relevance

To relate the results to a field circuit, laboratory test lengths are compared to typical cable lengths in the field

- 300 ft for URD
- 5,000 Monte Carlo simulations

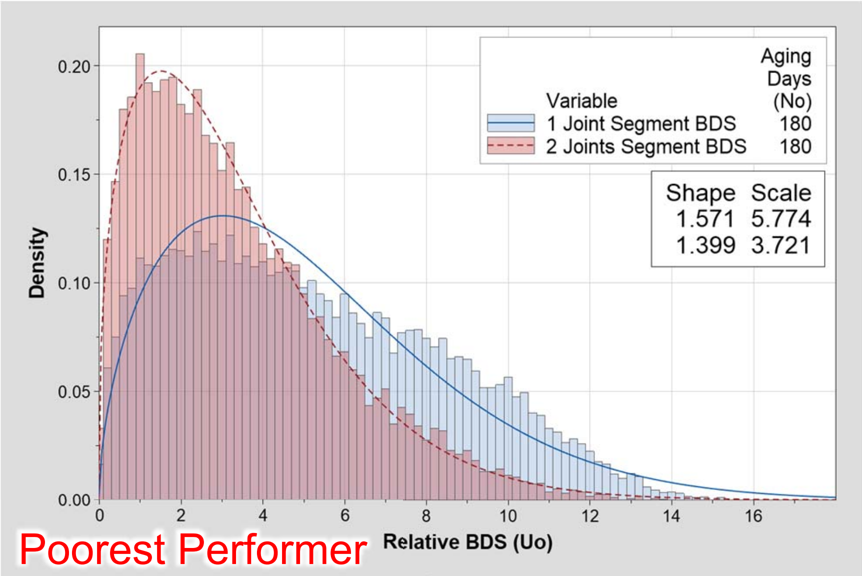


Field Circuit Relevance (Cont'd)

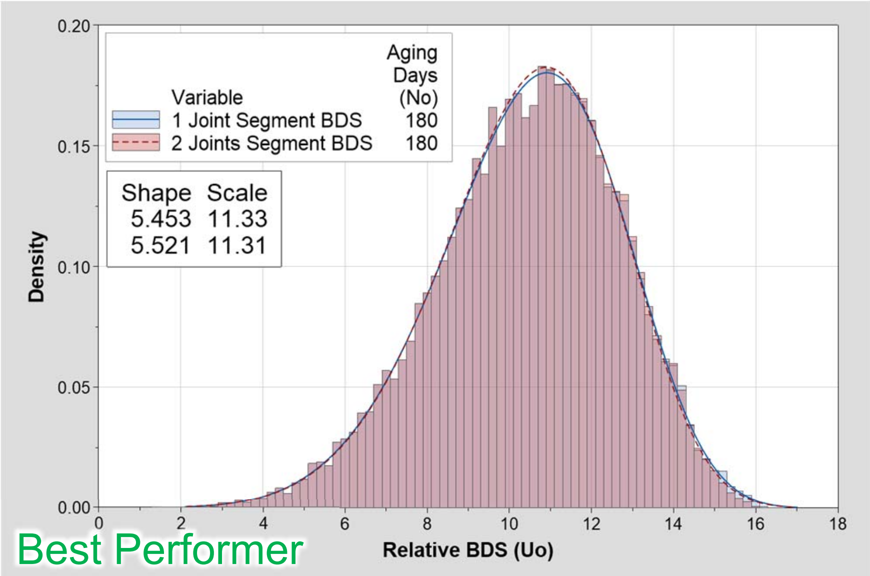


Field Circuit Relevance - Comparison

Design A



Design C



Conclusions

- Long term aging of MV joints in a wet environment can be conducted with existing methodologies
- The aging rate for joints was generally larger than for cable and varied across joint designs
- Joints of one design did fail during aging, but the failures seemed to all be caused by the overheating of the connector provided by the manufacturer
- Short term single factor evaluations of electrical performance (e.g. IEEE Std. 404) are unlikely to assess all the elements, such as those seen here, that are important for long term reliability of joints
- The work presented here can be expanded by considering different joint embodiments as well as accelerated aging conditions
- The impact of poor workmanship was not investigated in this study