Confirming Performance of Shield Systems!

Establishing ageing performance of different shield systems

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Confirming Performance of Shield Systems!

Semicon Performance Remains Critical

12.4 mil

[Graph showing percent vs. protrusion height (micron)]
Do the semicon improvements deliver better performance?
Accelerated Water Tree Test

AWTT

AWTT
Cores in water - tubes
1 year of ageing
Breakdown metric – with criteria
Multiple defined times
• 120D
• 180D
• 360D
Small samples (# & length)
Water Tree Assessment
Outline

• How big is the difference in performance?
• How certain can we be that the difference is real?
• What does this mean for the lengths of cables placed into service?
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Meta Analysis – Spring 2017 ICC

Source: CTL & NEETRAC Testing
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Traditional Approach

- Ageing: 0 & 360 days
- One Insulation
- One Conventional
- One Supersmooth
- 3 samples
- 15ft
- 12 breakdowns
How big is the difference in performance?

How certain can we be that the difference is real?
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Thermally Conditioned – no ageing

Weibull - 95% CI

Semicon
Small Difference
Not significant

Conventional
Supersmooth
0 Days
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0 & 360 day Ageing

Ageing
Big Difference
Significant
Semicon
Moderate Difference
Not significant
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Ageing with 95% Conf Limits

Conventional
Supersmooth

0 Days

Conventional
Supersmooth
360 Days
Expand Traditional Approach

- Ageing: 0 & 360 days
- Two Insulations
- Two Conventional
- Two Supersmooth
- 3 samples
- 15ft
- 24 breakdowns
- 200% of original
360 days – Four Systems

Semicon
Moderate Difference
Not significant

Semicon
Moderate Difference
Not significant
Difference and Significance

- Size of Difference (%)
- Certainty of Difference (%)
Non Traditional Approach

- Ageing: 0, 360, 720 days
- Two Insulations
- Two Conventional
- Two Supersmooth
- 5 samples
- 15ft
- 60 breakdowns
- 500% of original
Non Traditional Approach

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What does this mean for the lengths of cables placed into service?

Because it is convenient,
We test lengths of approx. 15 – 20 ft
We install lengths between 300 ft and 2000 ft
Approaching Service Length Weibull Scale

Sensible lengths?

\[ \alpha_L = \alpha_l \left[ \frac{l}{L} \right]^{1/\beta} \]

30 to 2000
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Results for Testing out to 720 Days

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CONVENTIONAL

SUPERSMooth
Confirming Performance of Shield Systems!

Length Extrapolation on 720 Day Results

Supersmooth 15 ft

Supersmooth 300 ft

Frequency

Breakdown Strength (V/mil)
Impact of Length on Median Strengths

- 0 Day Conventional
- 720 Day Supersmooth
- Conventional
In Conclusion

- Utilities remain interested in life expectancy and verification of benefit – important for the business case
- Standard tests are not particularly useful for verifying differences in performance, even though they may seem attractive from a “standardisation perspective”
- Key augmentations to standard tests
  - Increase in number of samples – 5 or more for each category
  - Focus on conditions where ageing occurs 360 days or longer
- Translation of results to field conditions is essential as
  - More meaningful
  - Better discrimination
More Information

- The New Weibull Handbook – Bob Abernethy
- Statistical Treatment of Fatigue Experiments – Leonard Johnson
- Water Treeing – Fred Steenis