VLF Tests conducted by NEETRAC as part of the CDFI

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Acknowledgements

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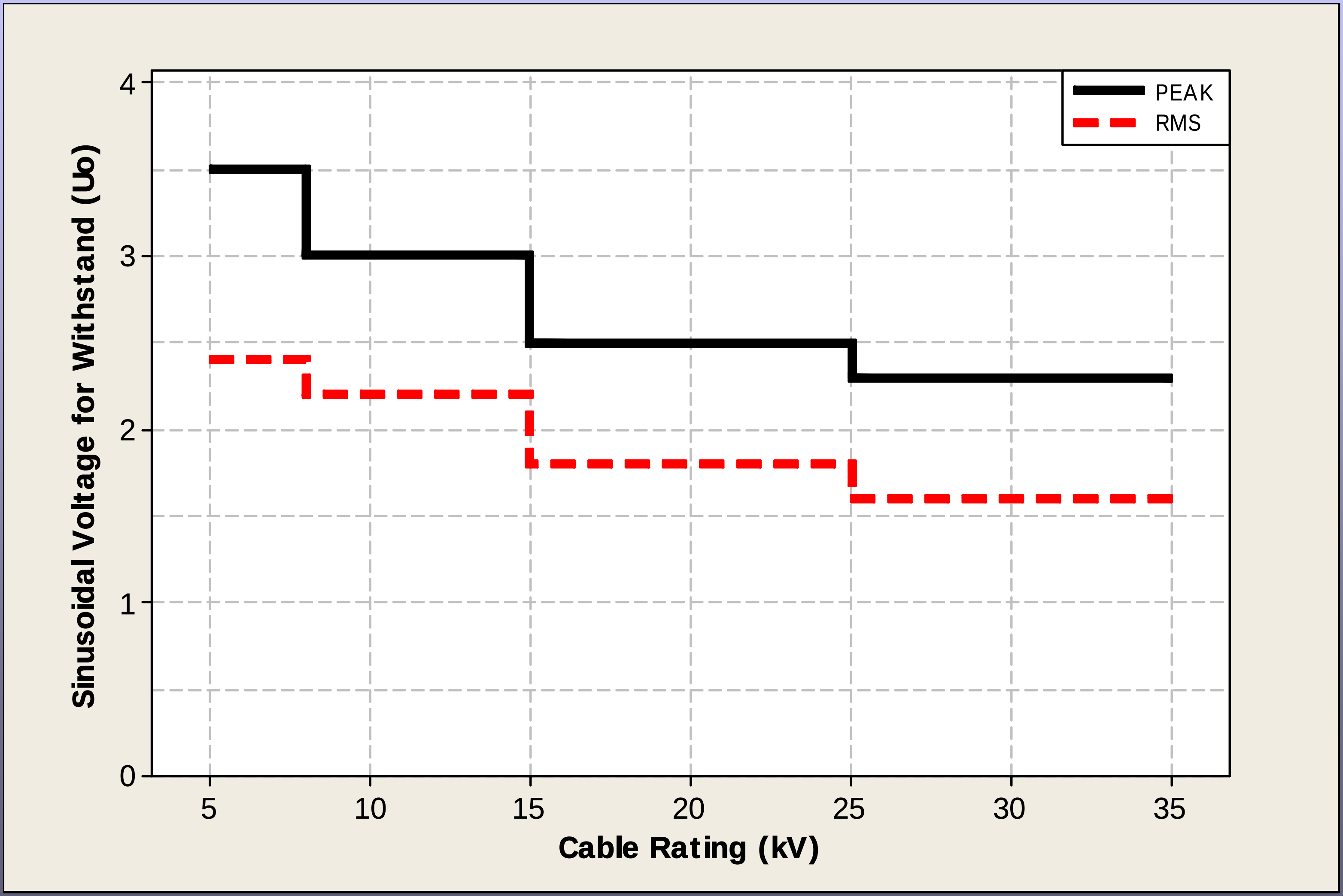
- Any opinions, findings, conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Department of Energy.

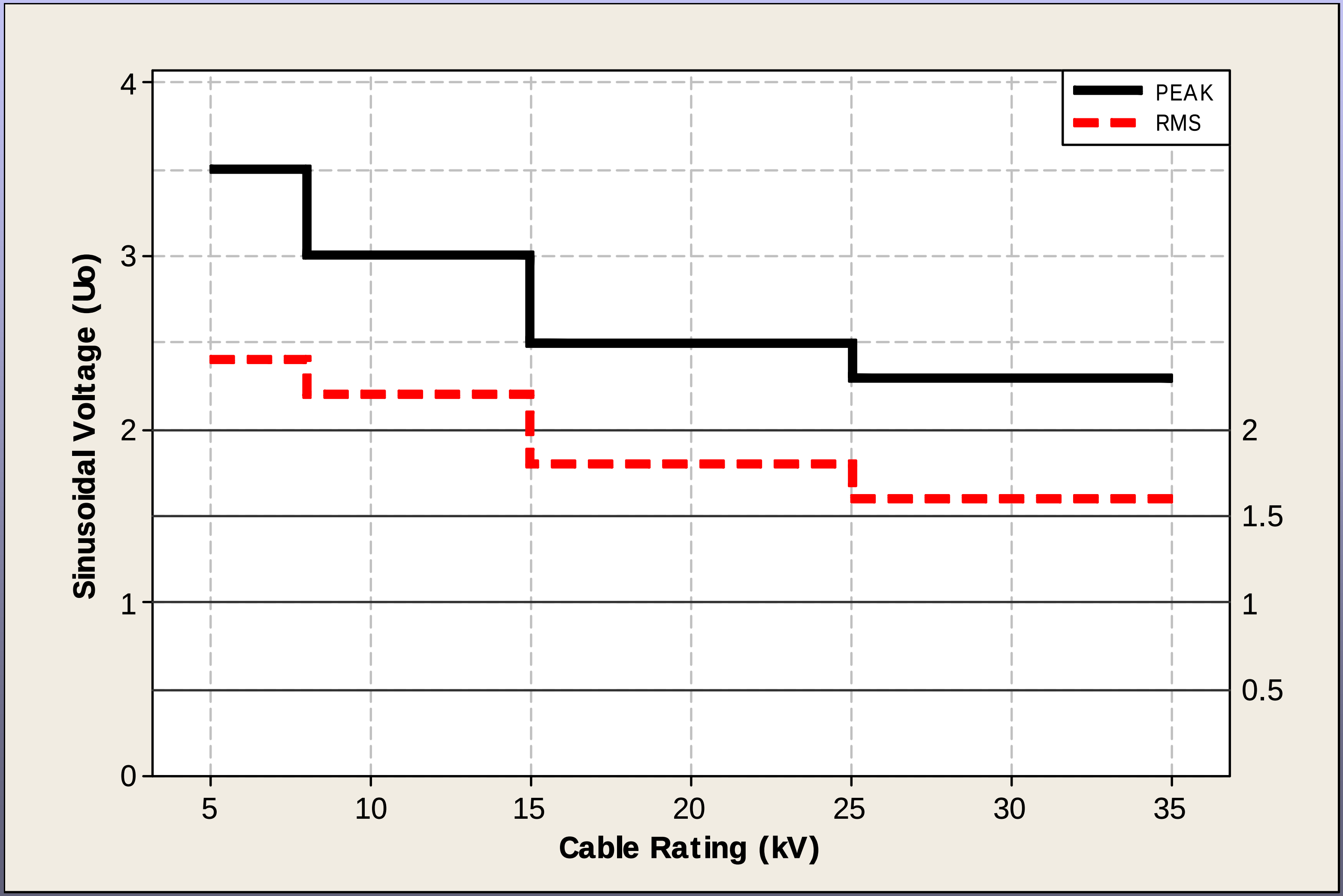
Issues

- Voltage levels for Tan δ
- Tan δ at failure
- Establishing Critical Levels for Tan δ
- Effect of test voltage level on VLF Withstand Tests

Tan δ Test Levels 1 - Withstand



Tan δ Test Levels 2 – Voltage Stability



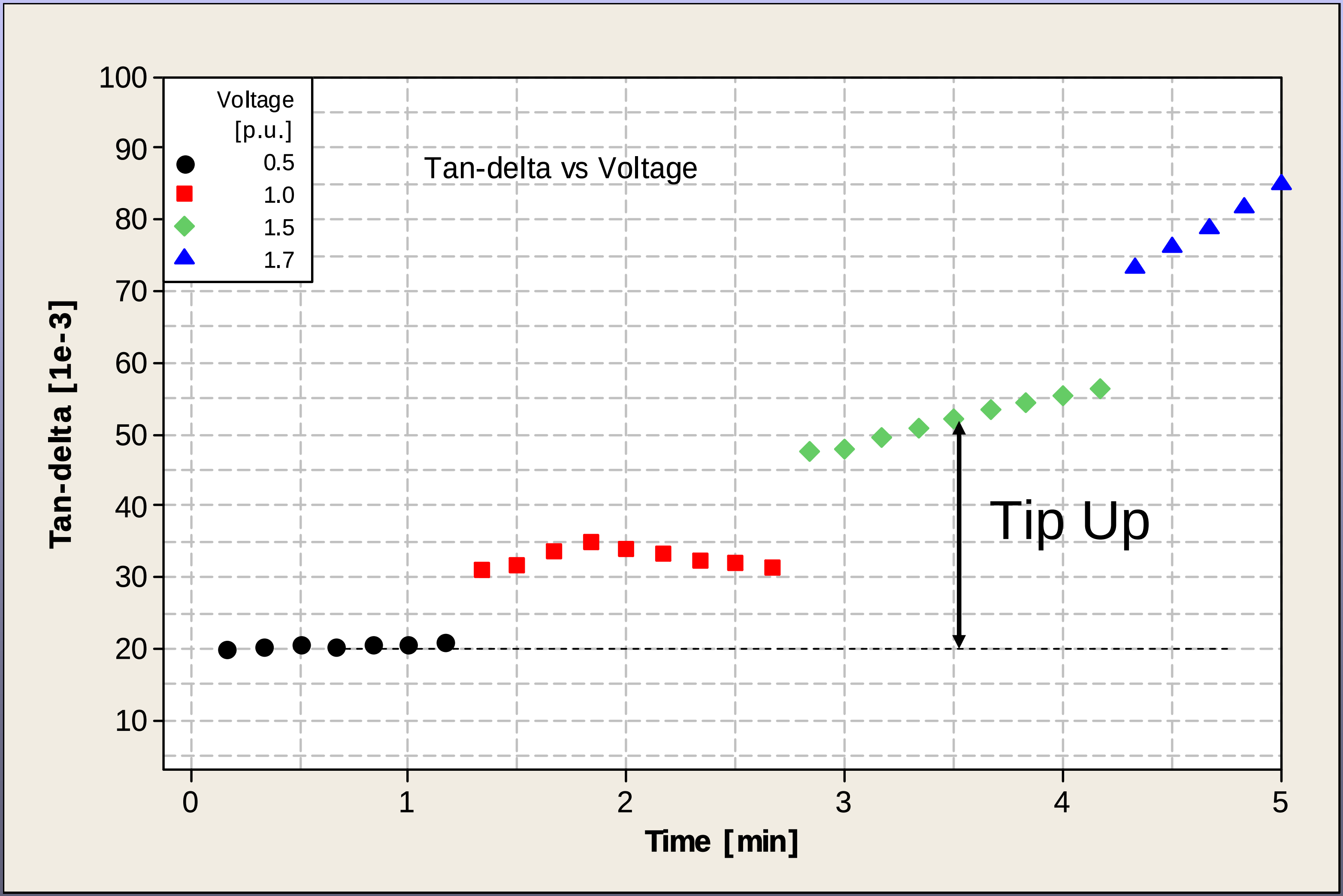
Thoughts

- Should we be recommending test voltages for a Tan δ test (ie one that can be done to determine whether a stability test is done) in the revision of 400.2 that are above the ones used for a stability test

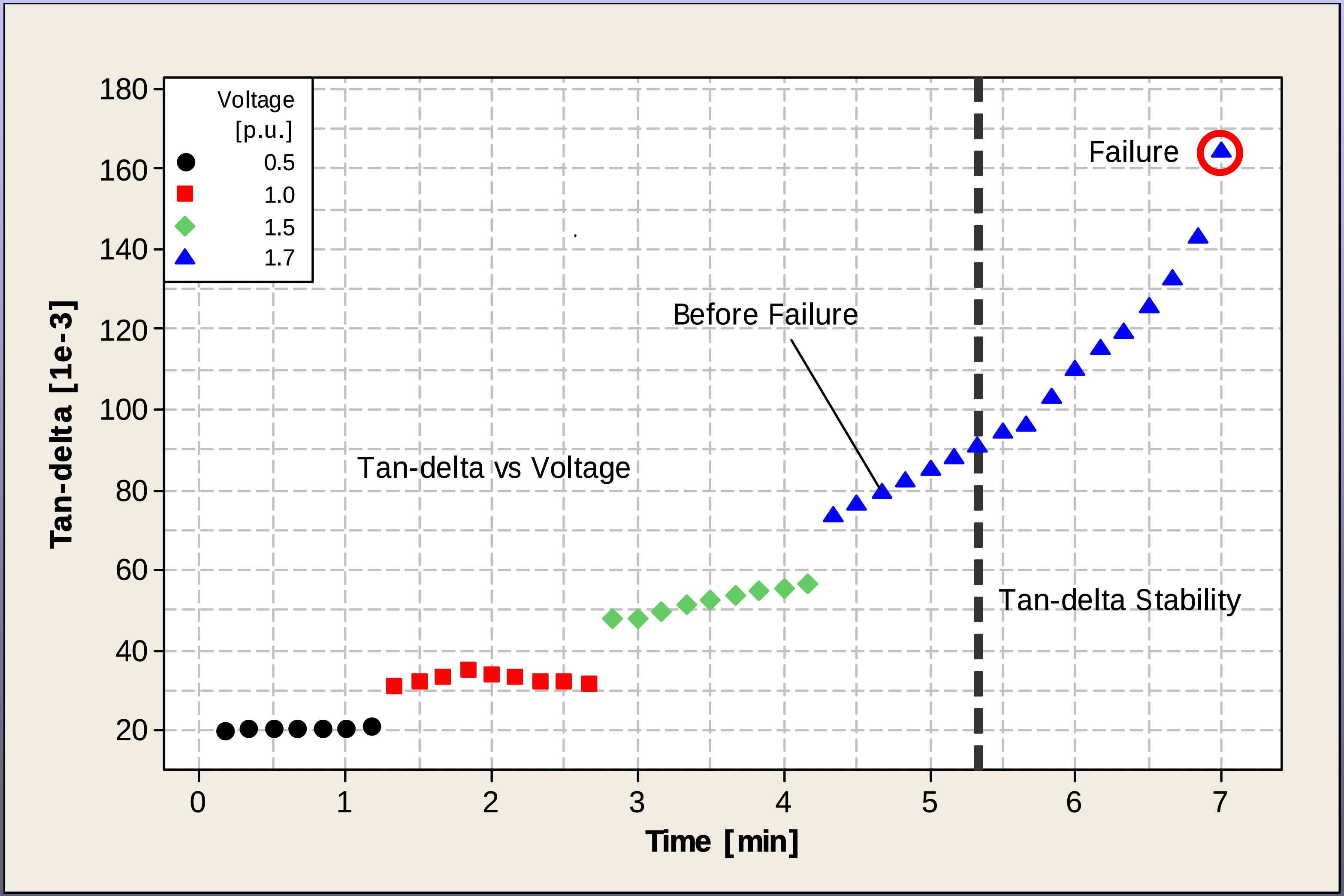
Tan δ At Failure

- Tests carried out at Duke Energy
- 1980's vintage jacketed XLPE URD cable
- Operated at 25kV
- Test location known to have reliability issues – failure rate 3 to 4 time the US national average

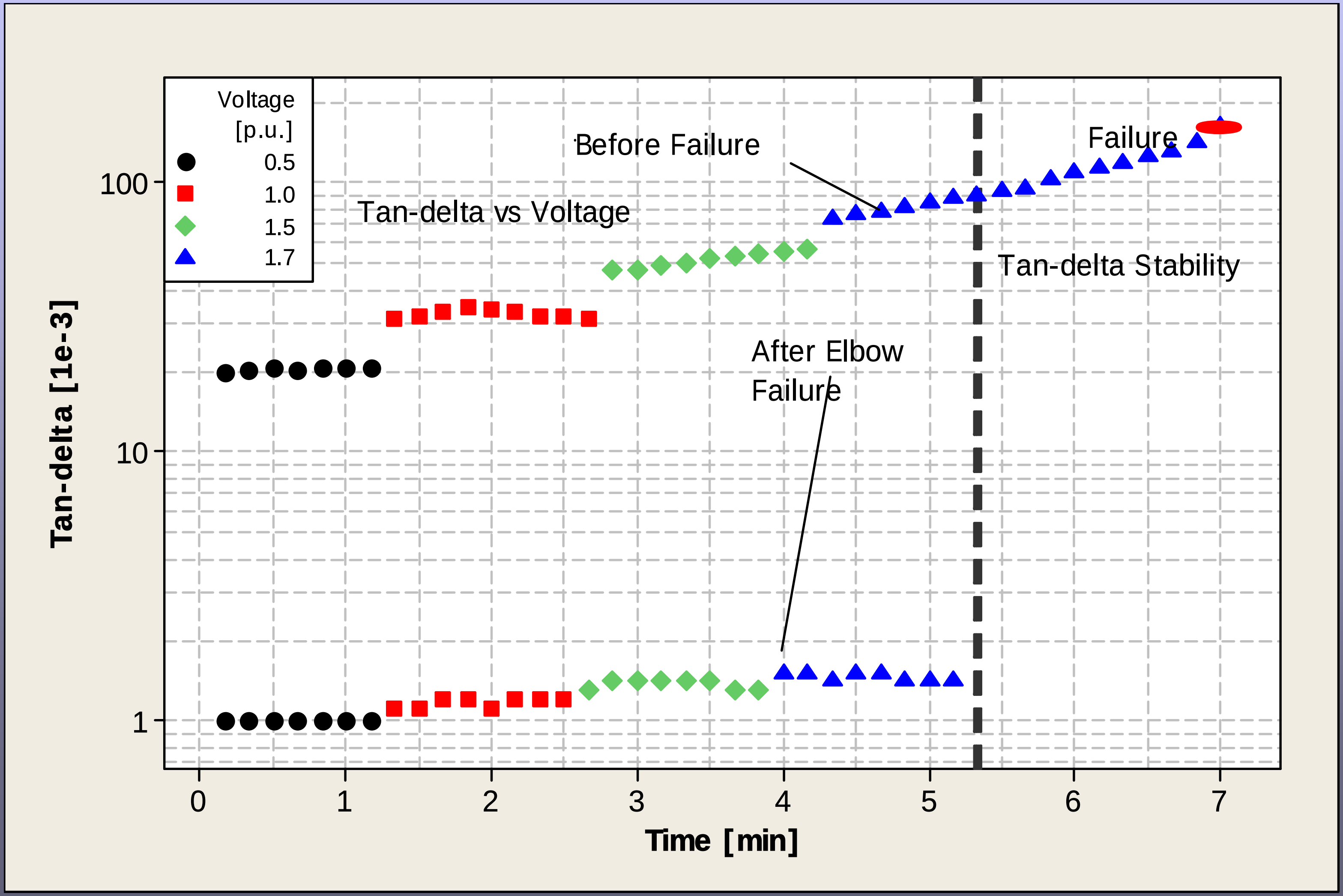
Voltage Stability Test



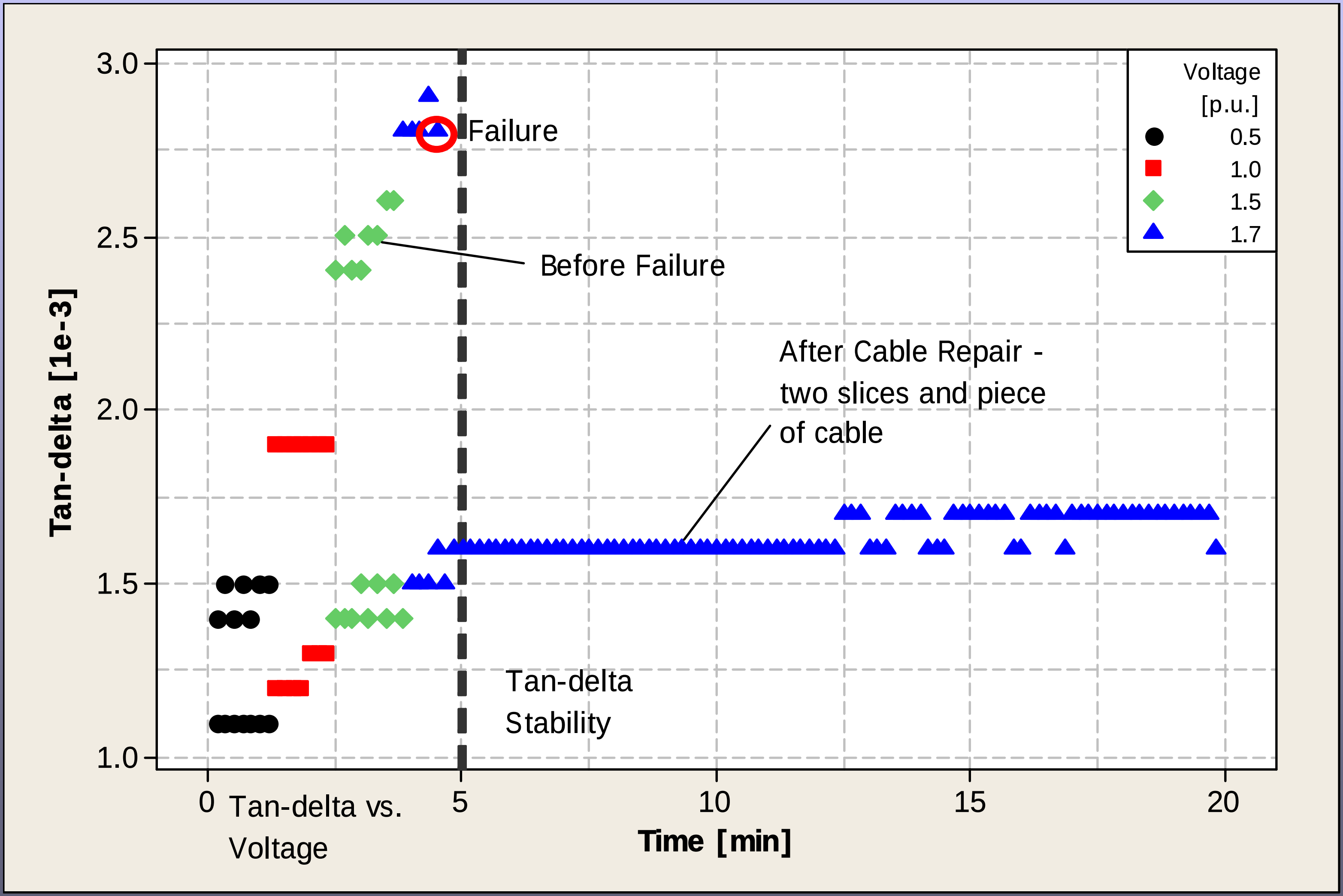
Tan δ Stability (Constant Voltage)



Repeat Voltage Stability Test



A Similar Story



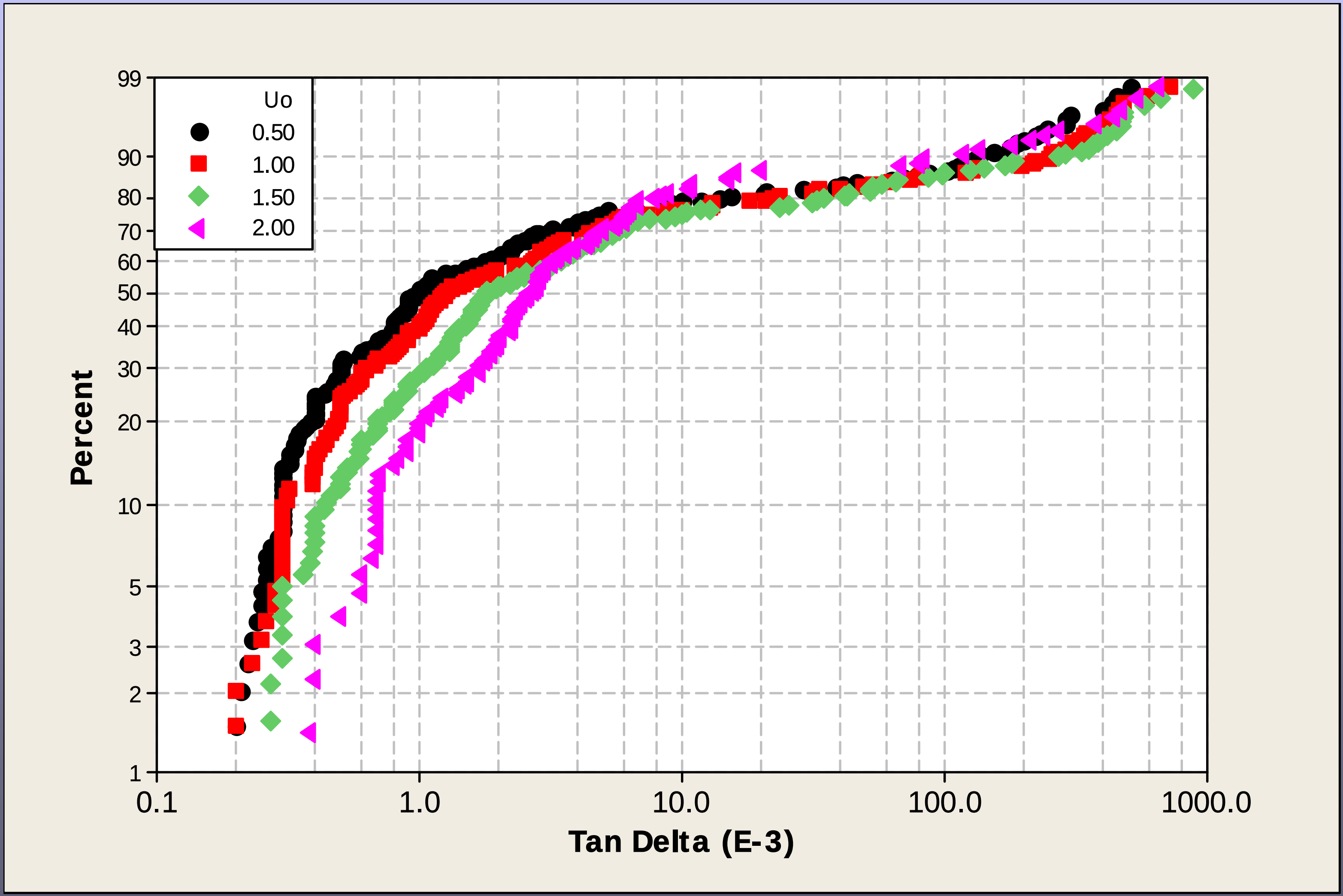
Thoughts

- Monitoring a property during the constant voltage phase does provide information
- Certainly give confidence to utilities
- Have found that it is easier to undertake the longer time tests when there is a monitoring phase

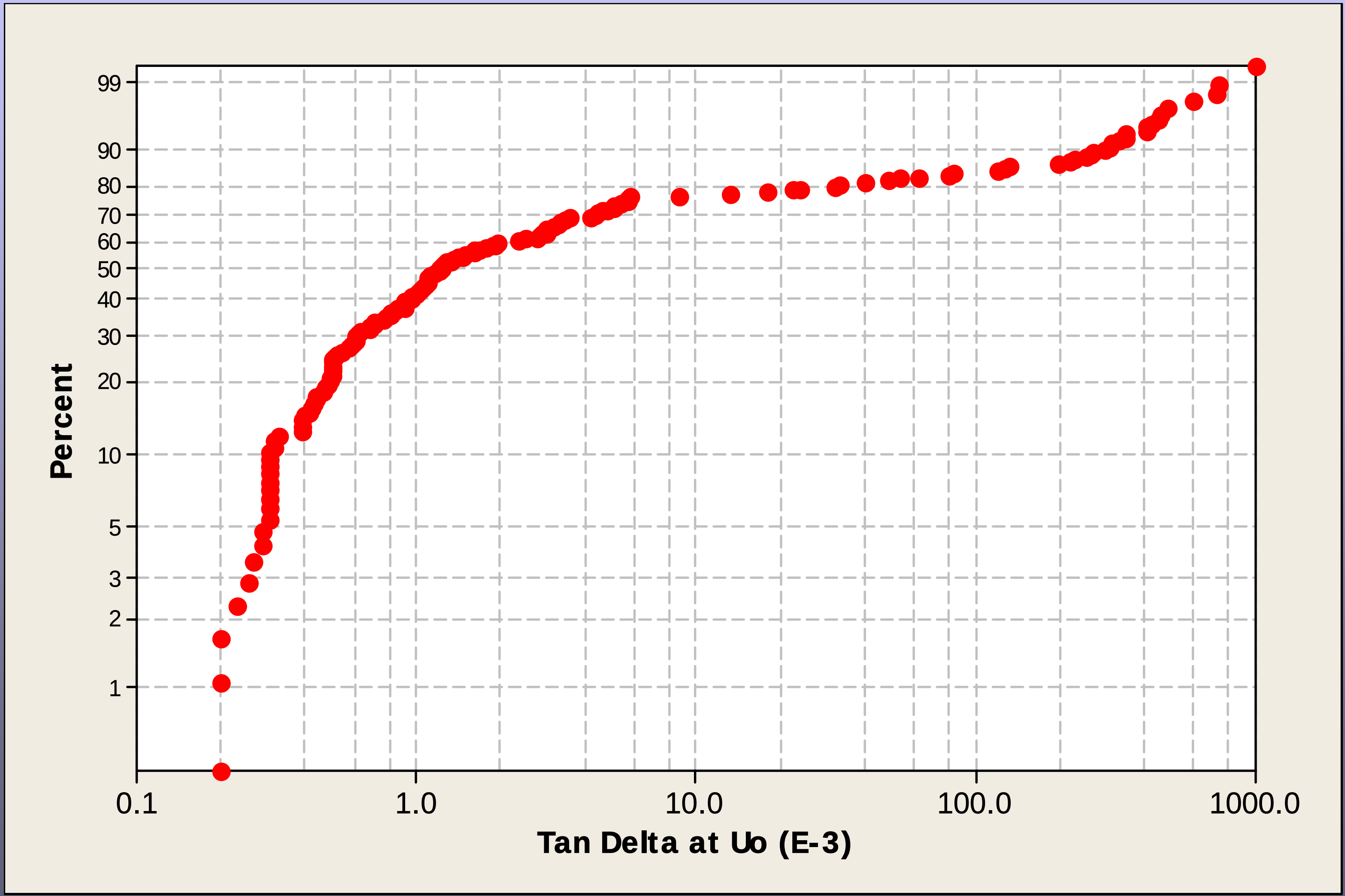
Establishing Critical Levels

- Seems to be general agreement that the present IEEE400 levels do not fully represent the situation
- How to set critical levels
- How to relate Tan δ and Tip Up
- We have started with
  – Approx 200 measurements
  – Measurements <2 Uo

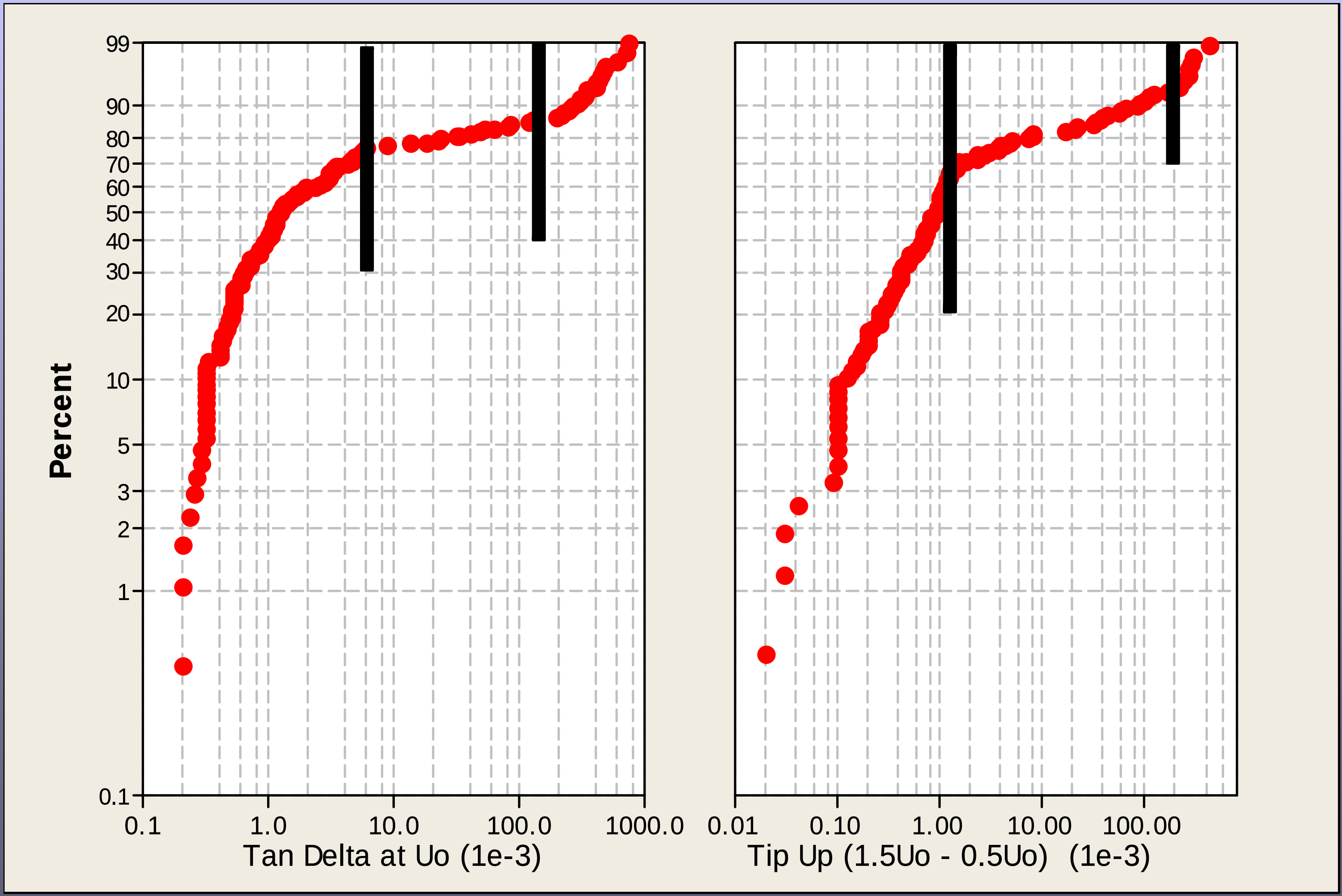
Compiling Available Tan δ Data



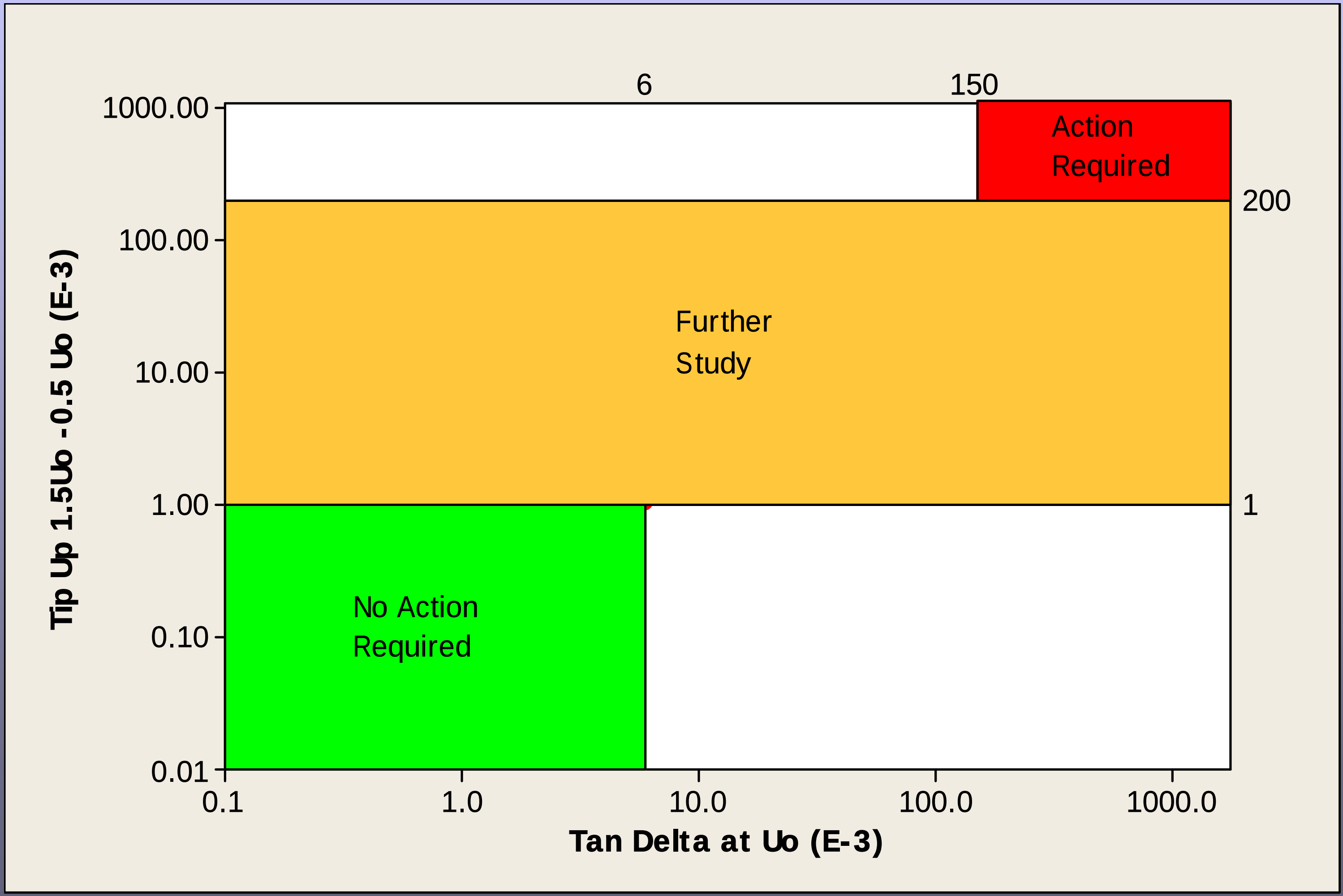
Compiling Available Tan δ Data (Uo)



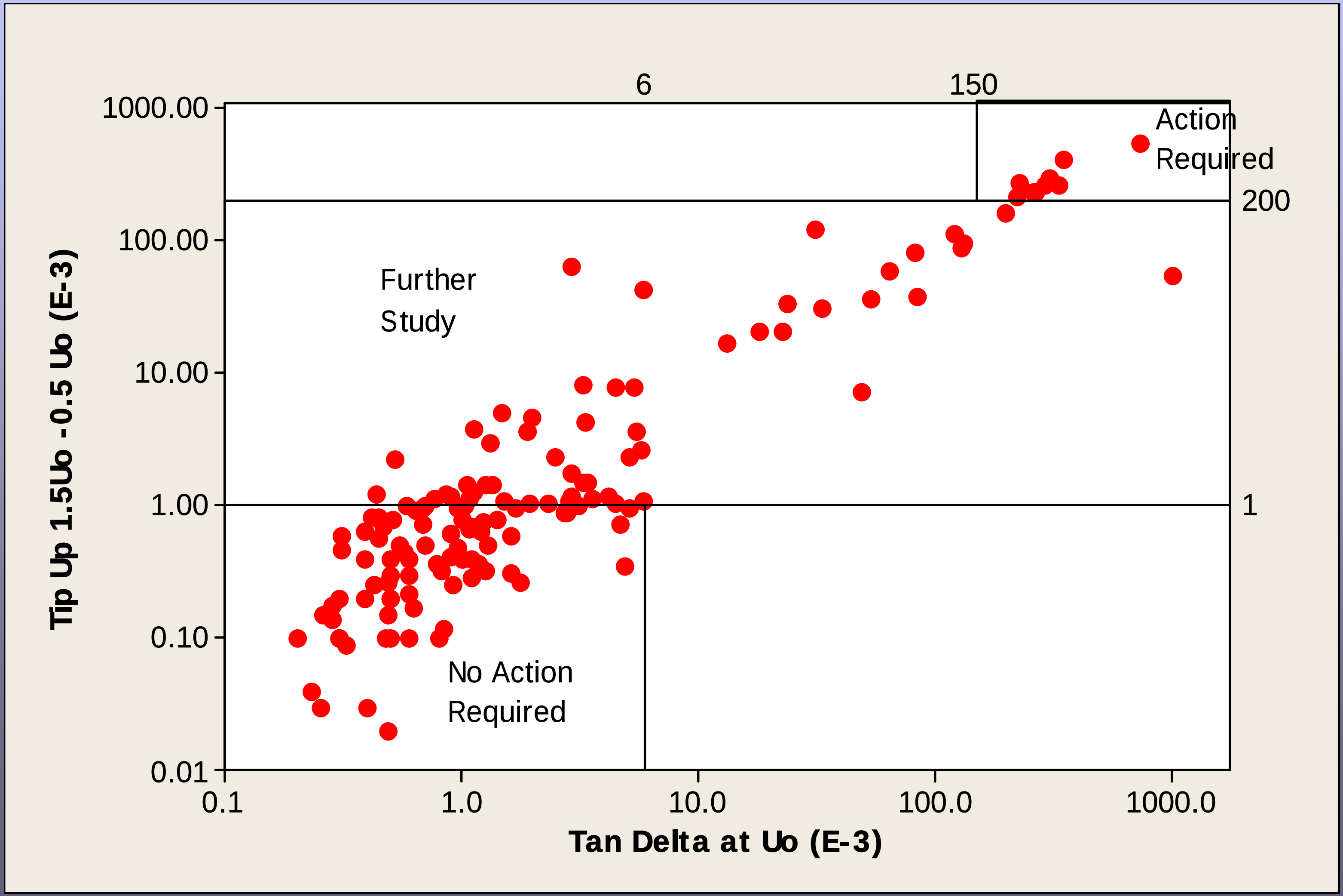
Empirically divide Tan δ and Tip Up



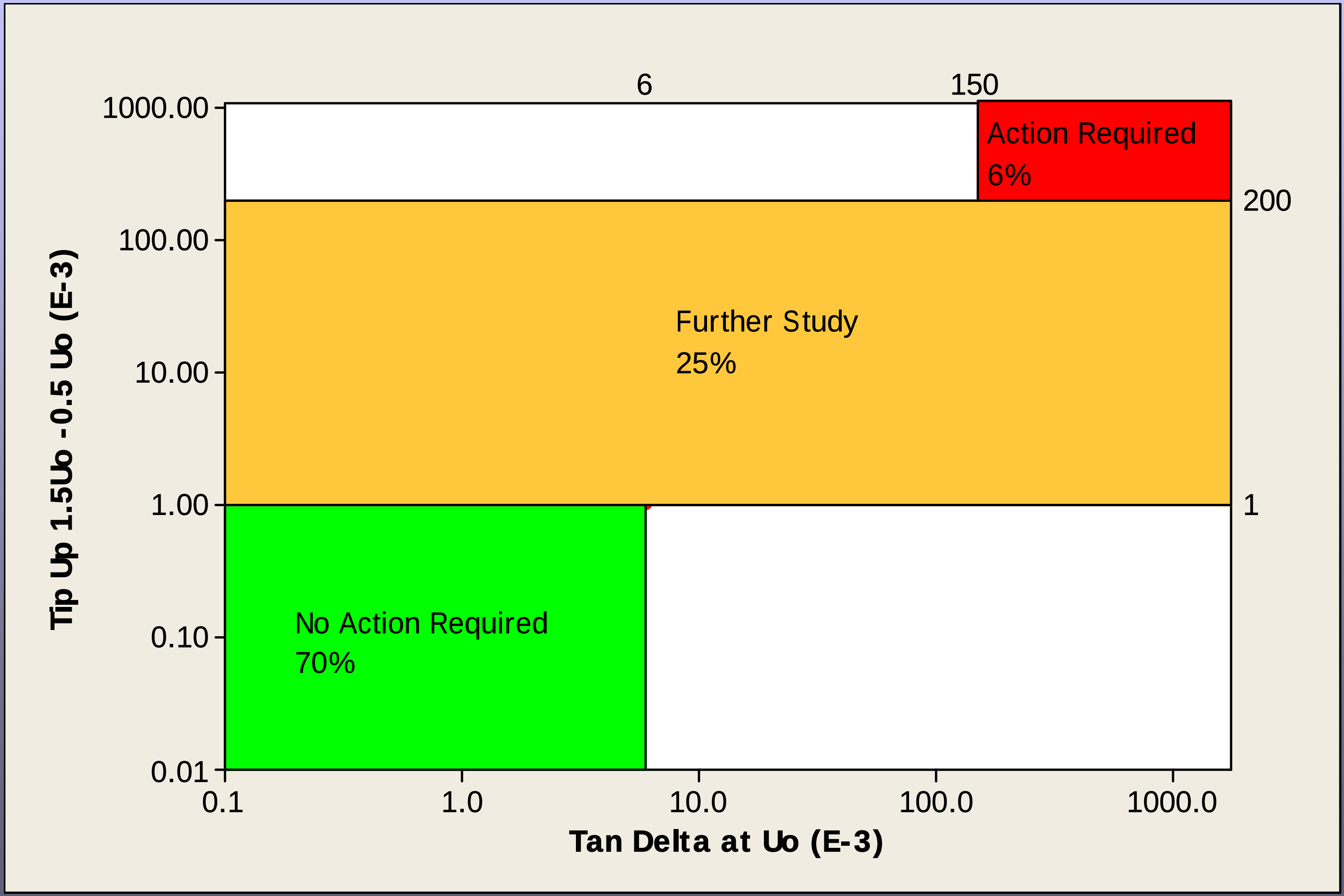
The division gives a “map”



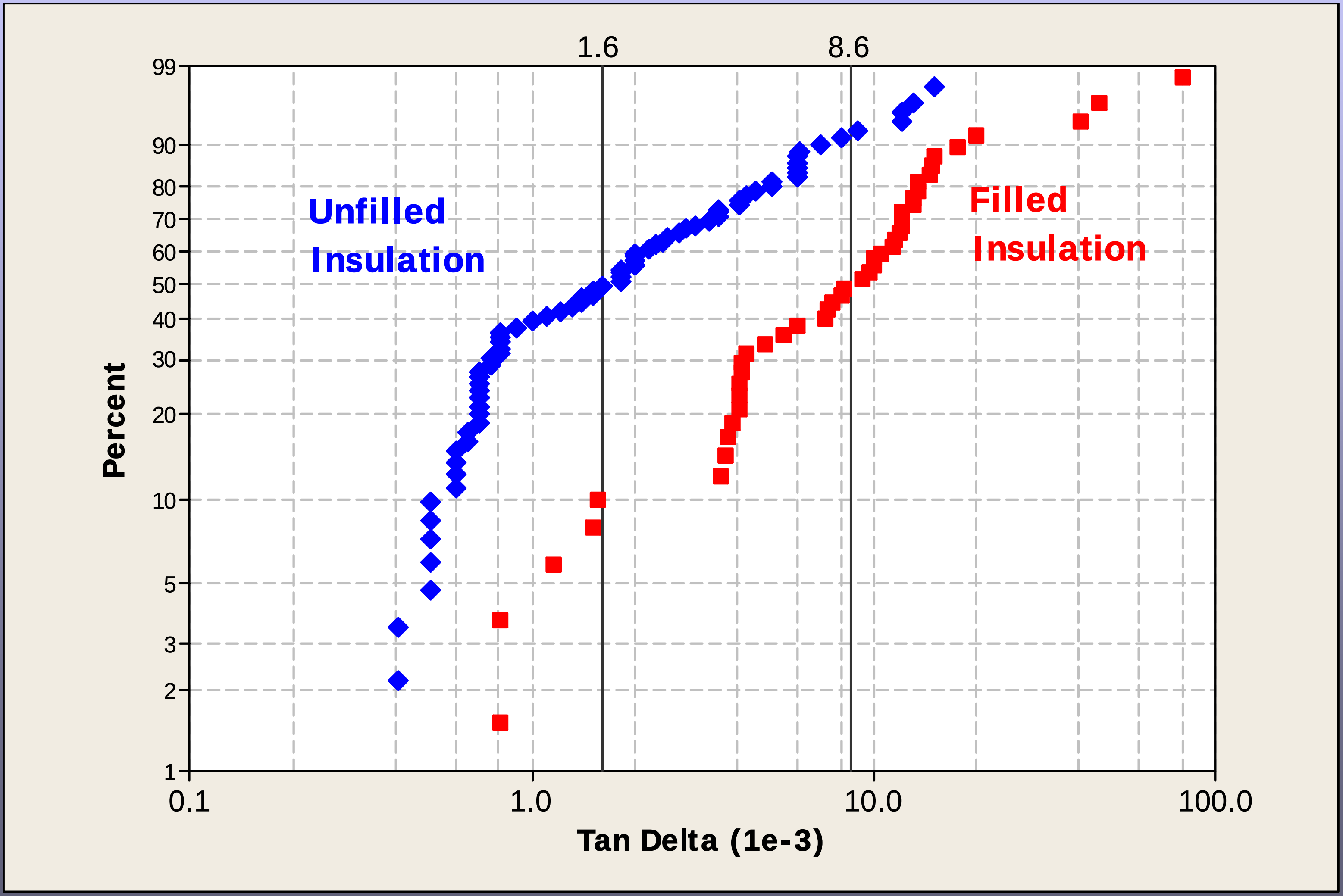
Diagnostics map with presently data – PE based insulations

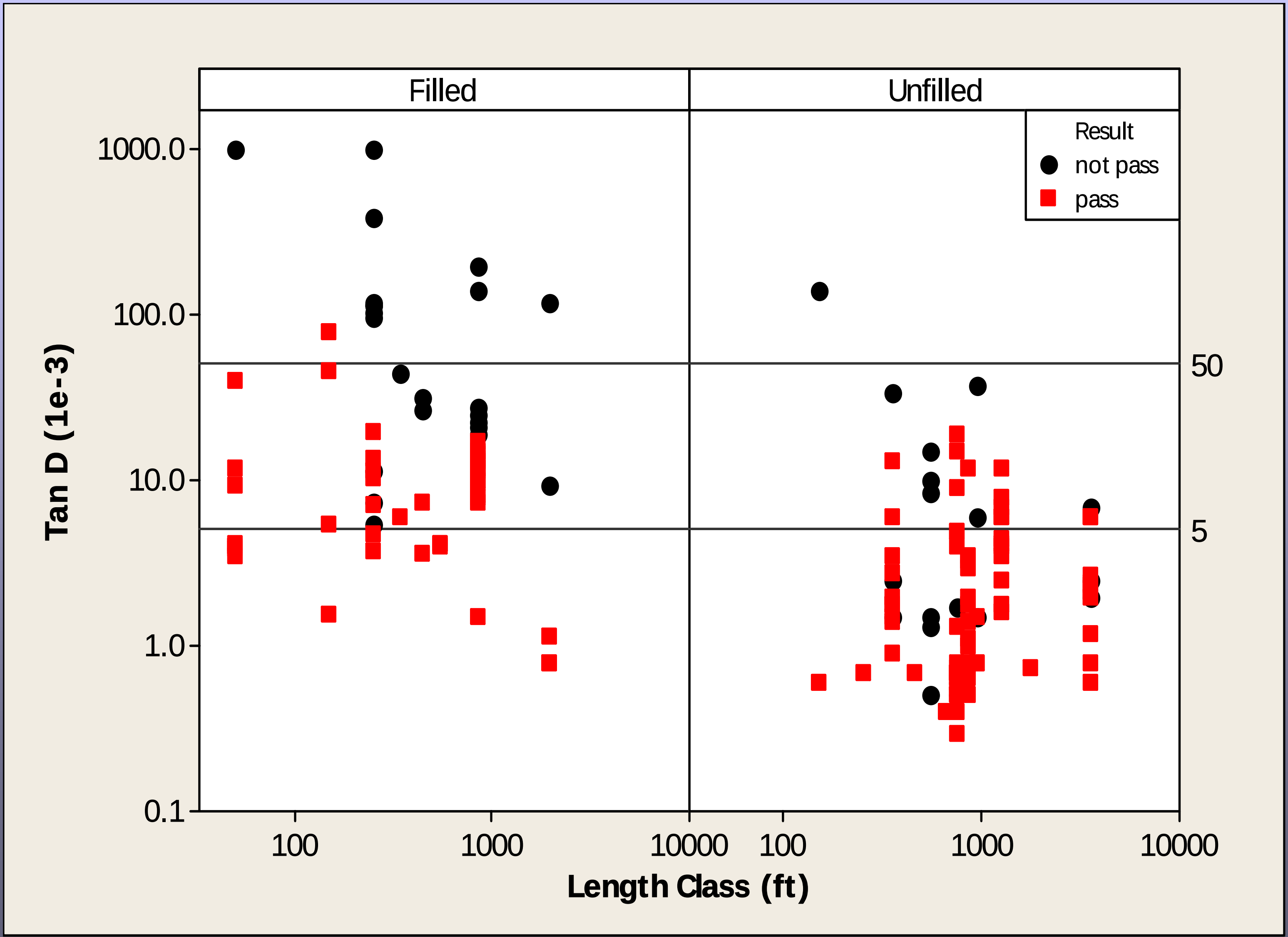


Overall Results For PE Based Insulations



Filled and Unfilled Insulations




Filled
Unfilled
Result
not pass
pass
1000.0
100.0
10.0
1.0
0.1
50
5
100
1000
10000
Tan D (1e-3)
Length Class (ft)

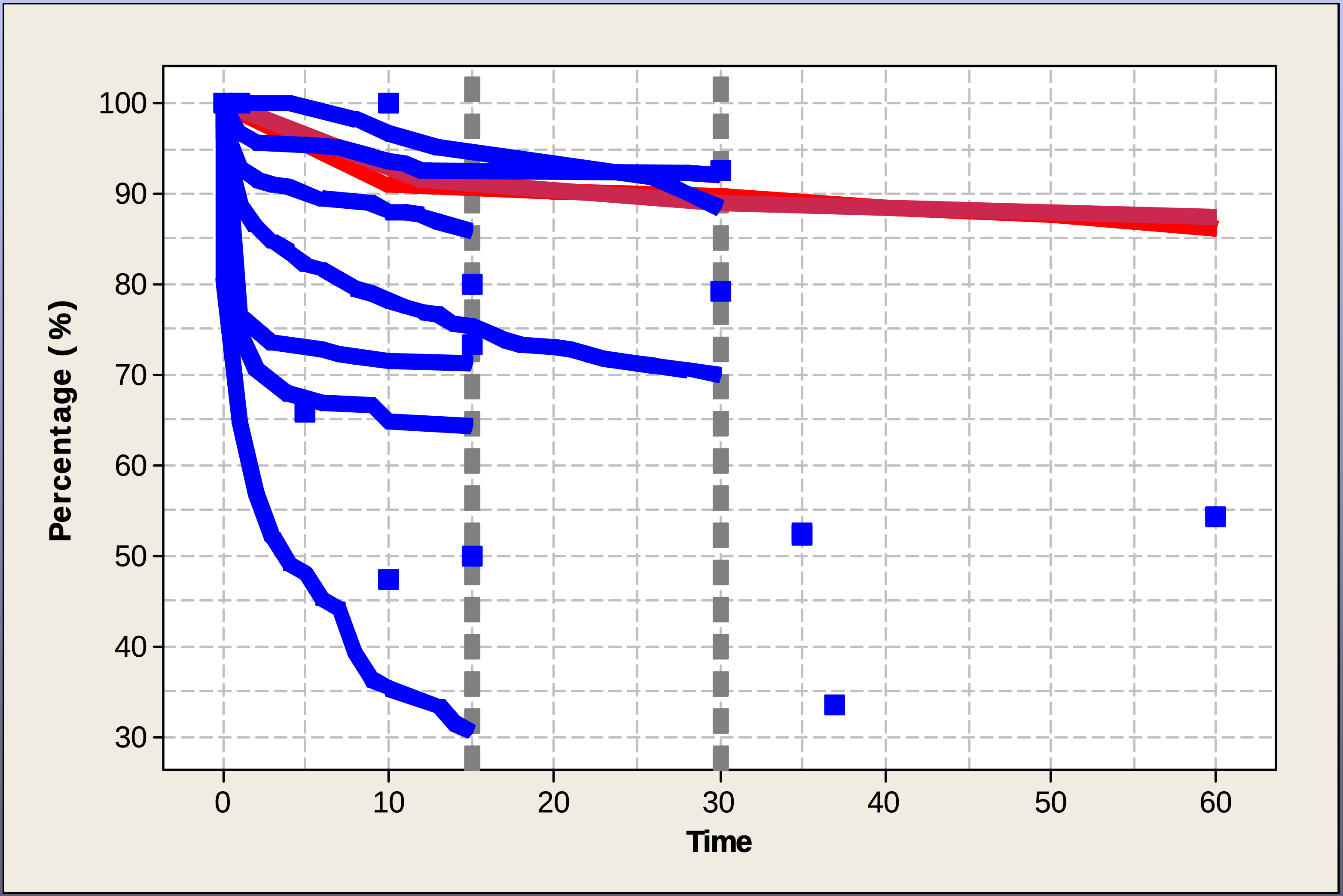
Thoughts

- We propose a way to determine critical levels
- We see little difference between HMWPE, XLPE & WTR XLPE insulations
- Would expect the lower Tan δ limit to be a little higher for Filled insulations (Vulkene & EPR); do not expect the Tip Up and upper Tan δ limits to change
- Could be used as the basis for IEEE400.2 levels
- Work underway on the recommendations for "Further Study"

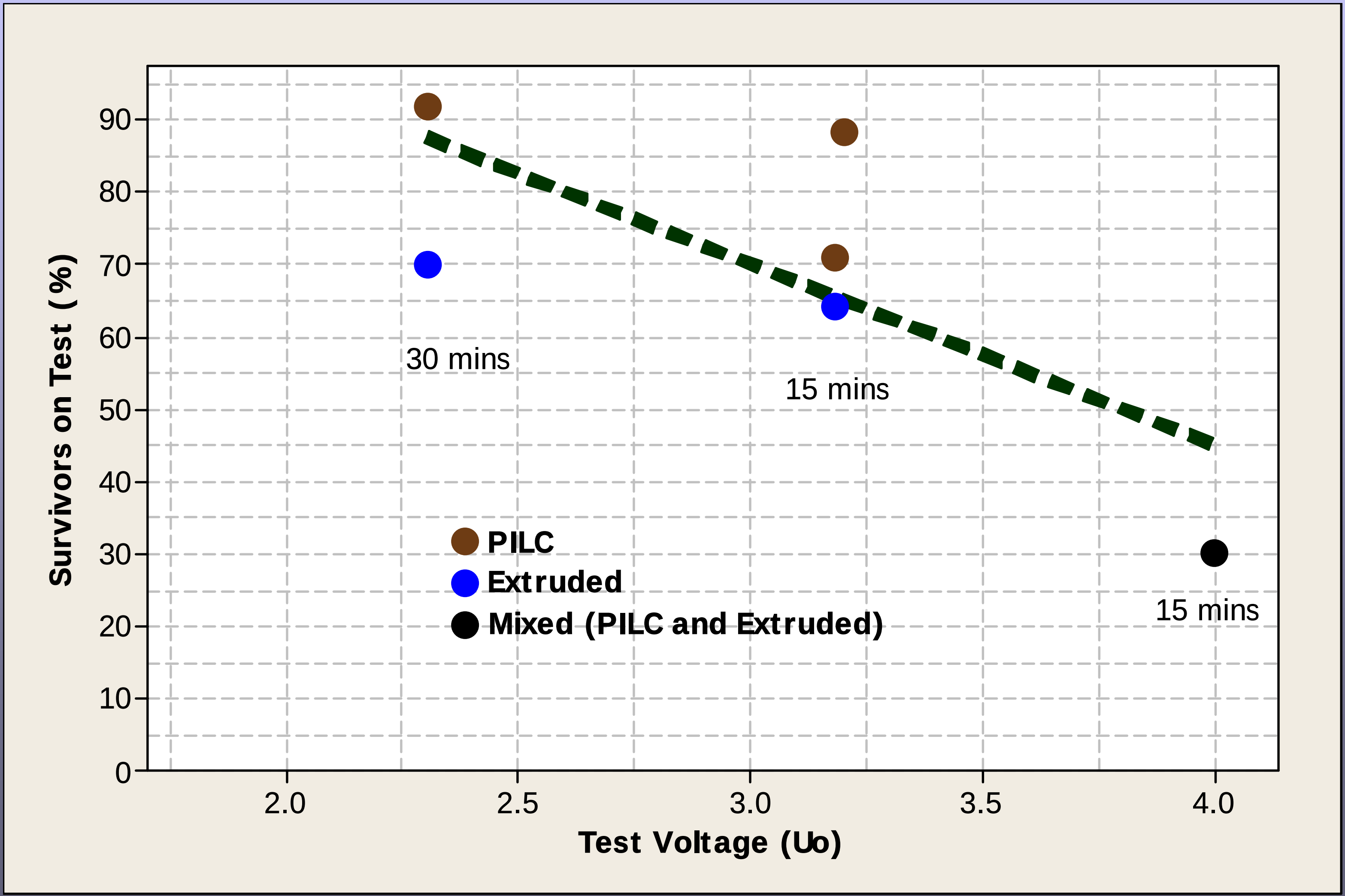
VLF Withstand Results

- At previous meetings we have presented a collation of the US experience of the VLF withstand tests
- Analysis showed that the time to failure in service is much higher if a 30 min rather than a 15 min test is used
- We have extended the analysis to look at the effect of test voltage on the failures that occur under test

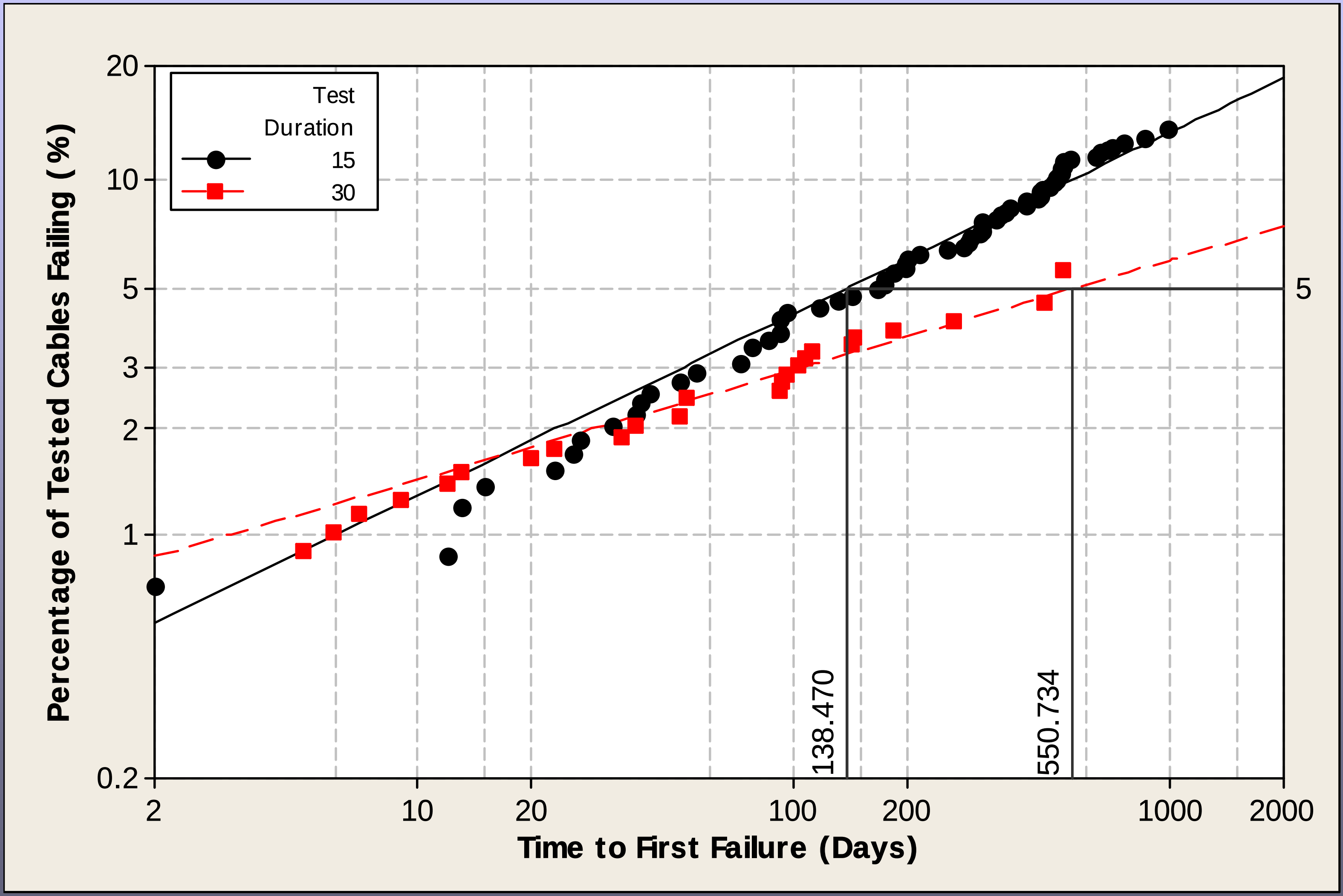
Present Status



Effect of Test Voltage



Times to 1st Failure: 15 & 30 Minutes



Thoughts

- Test voltage has a profound effect on the failures under test
- Test time has a profound effect on the failures after test
- Great care is needed if the IEEE400.2 voltage levels are exceeded