



Withstand Tests More than Meets the Eye

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Outline

- Introduction/Motivation
- Length Issues
- Withstand Testing Process
 - Ramp Up
 - Hold
- “Ramp Up” Diagnostic Features
- “Hold” Diagnostic Features
- Recommendations
- Conclusions

Introduction

- Withstand tests are frequently used by utilities who employ diagnostic tests.
 - As of 2006, approx. 33% of CDFI member utilities employing diagnostic tests use withstand techniques.
- Withstand tests have been defined as “Pass/Fail” only.
- Utilities maintain records that are much more detailed.
- Cable Tested in the last five years: > 4495 miles.

Motivation

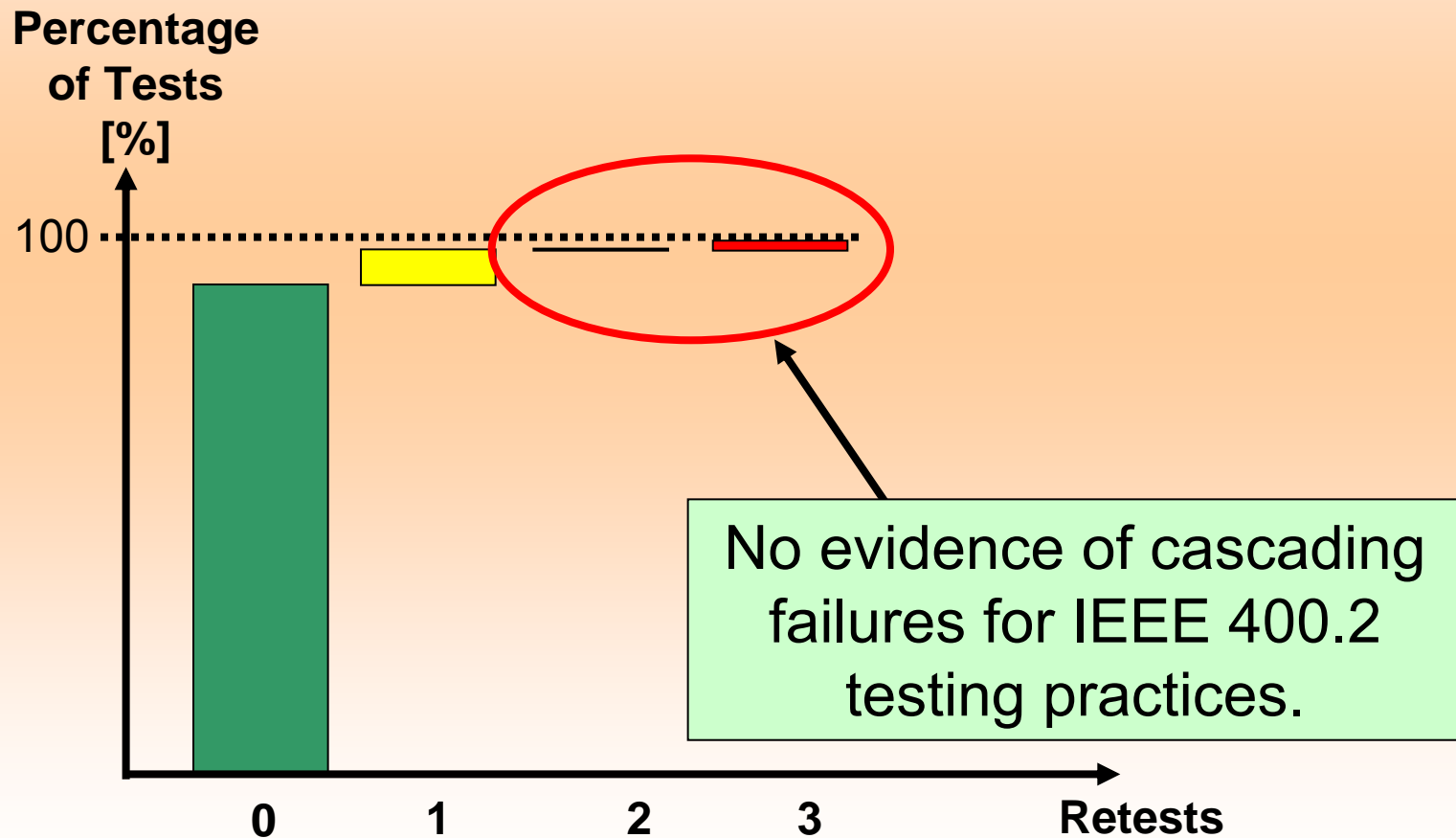
Utility records from withstand tests contain much more information than the result of the test.

- Test Voltage (including voltage at failure)
- Time on Test
- Segment Length
- Segment Insulation
- Segment Location
- Failed Equipment Type

How to use this information in a diagnostic manner?

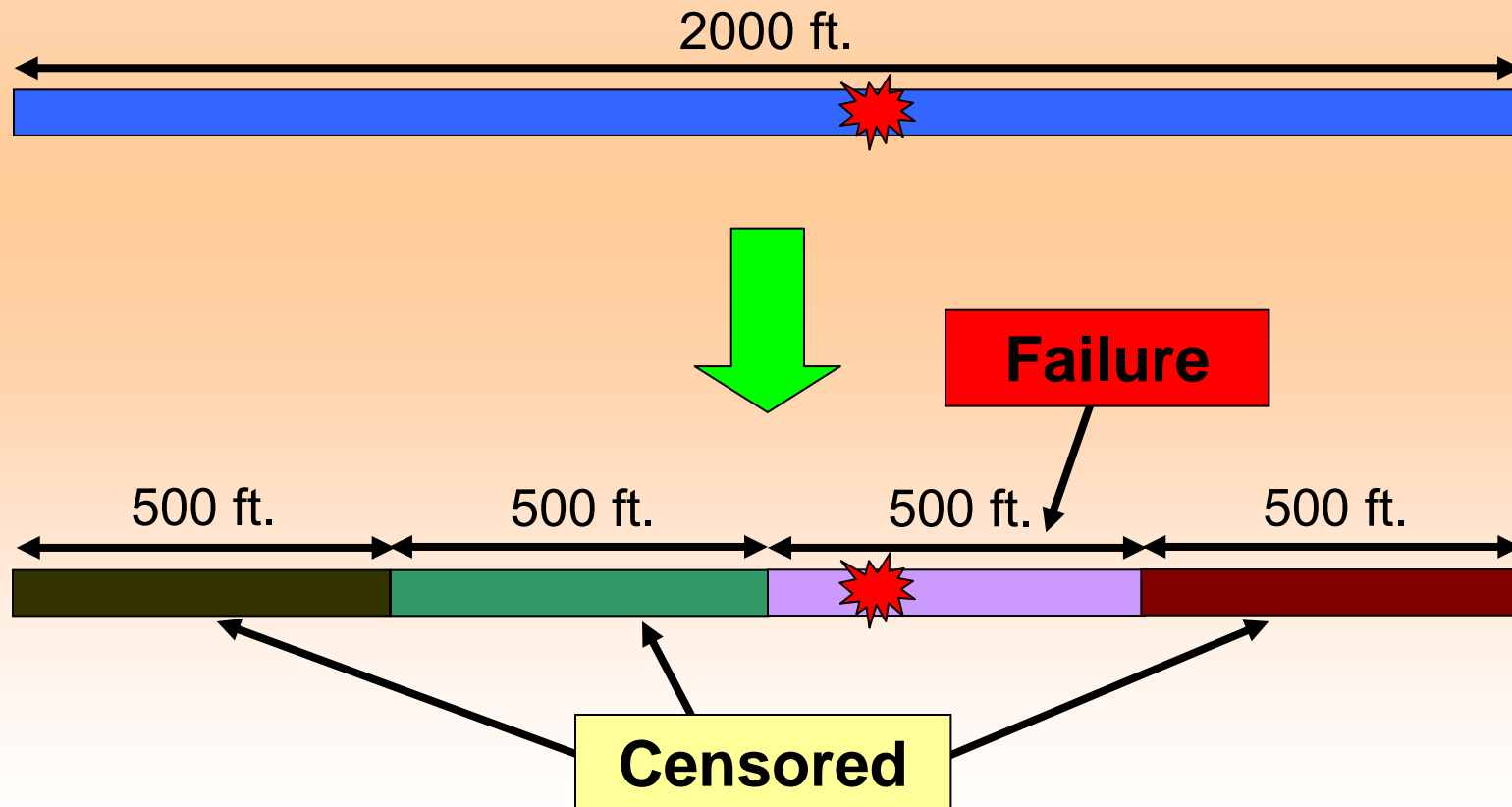
Results of Withstand Tests

618 Conductor Miles Tested
(one utility feeder cable system)

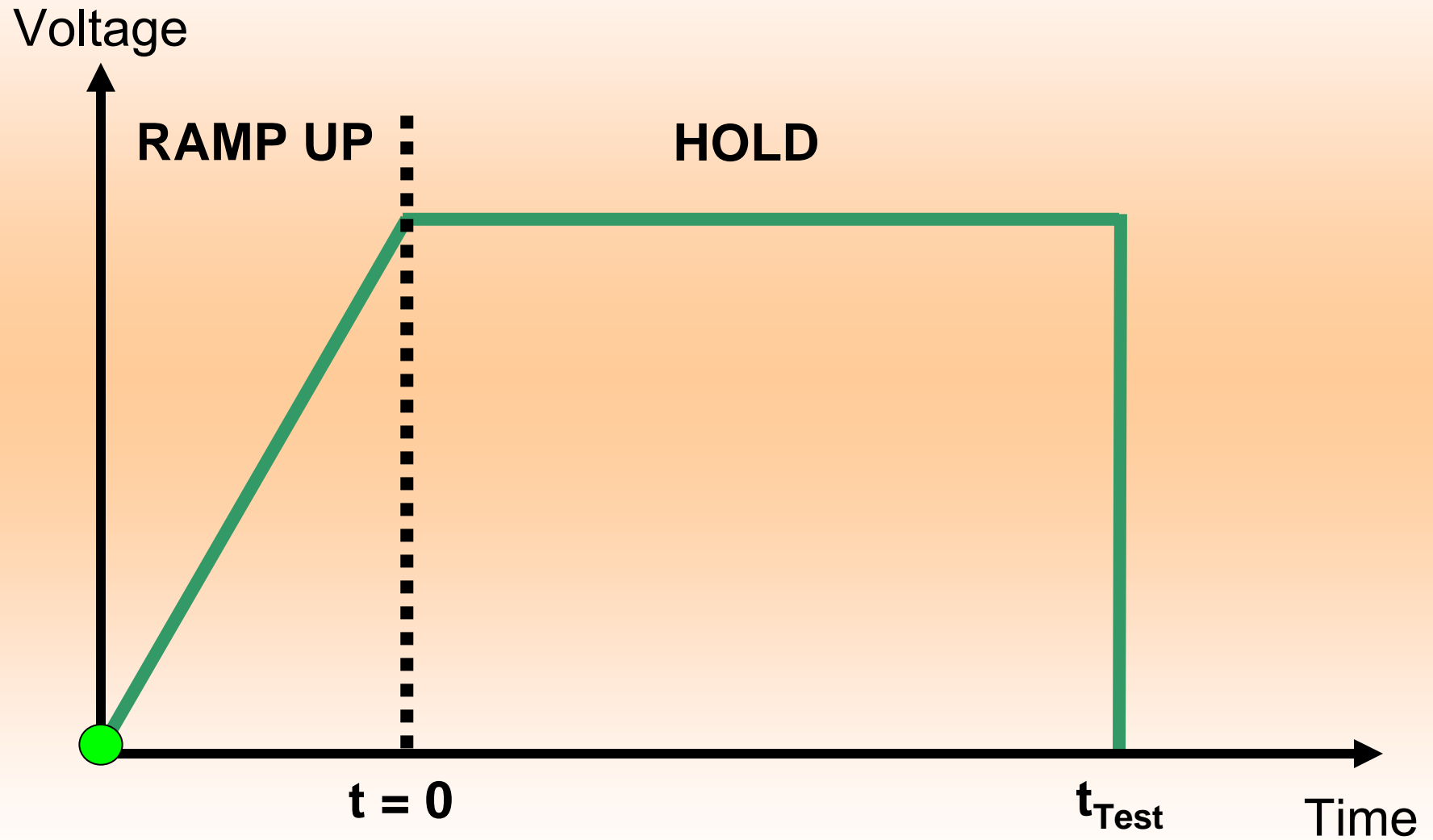


Length Effects

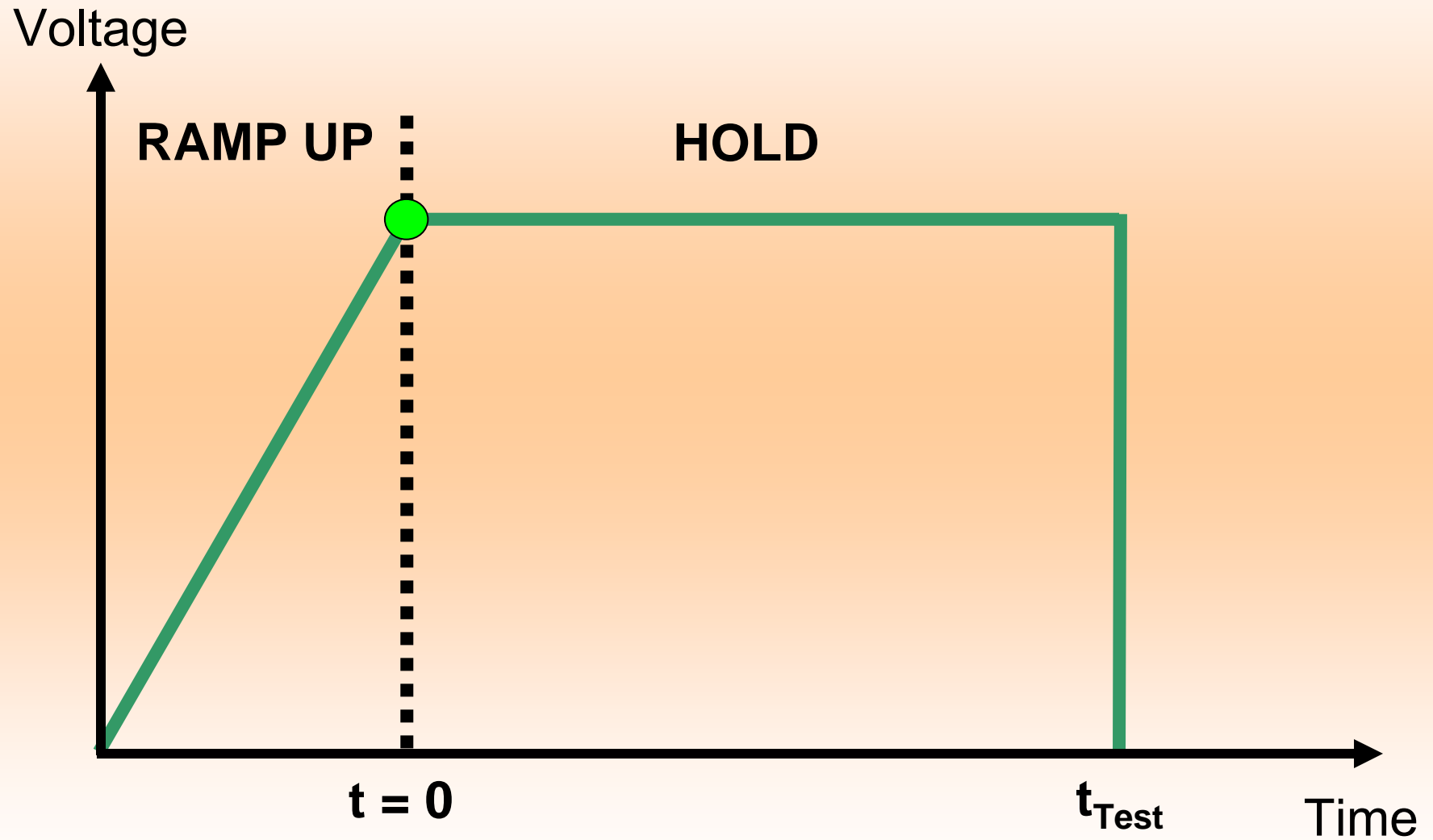
- Withstand tests can be used to test long lengths of cable.
- Comparison of withstand failure on test rates must include length adjustments.



Withstand Test Process

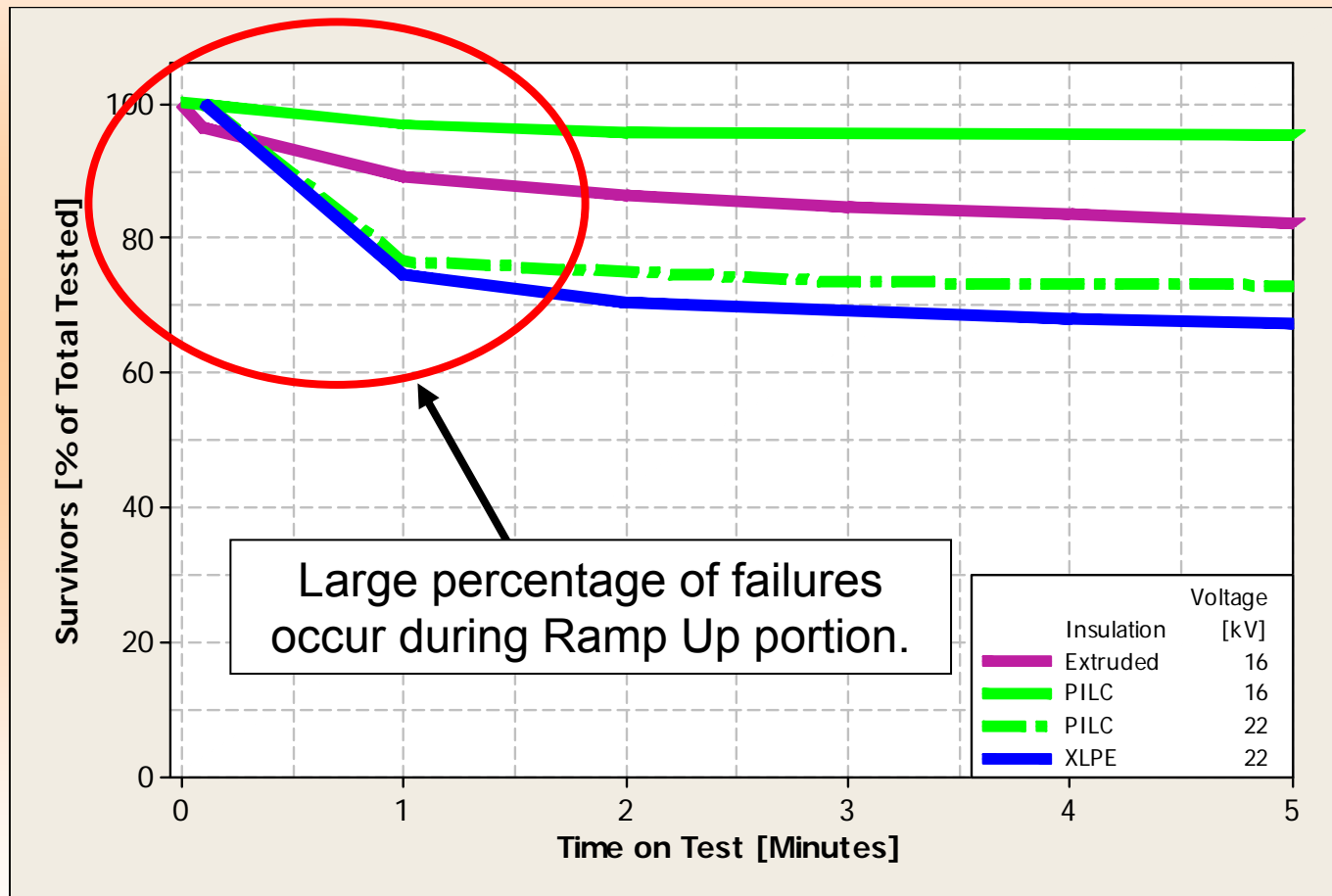


Withstand Test Process



Why “Hold” and “Ramp Up” Phases?

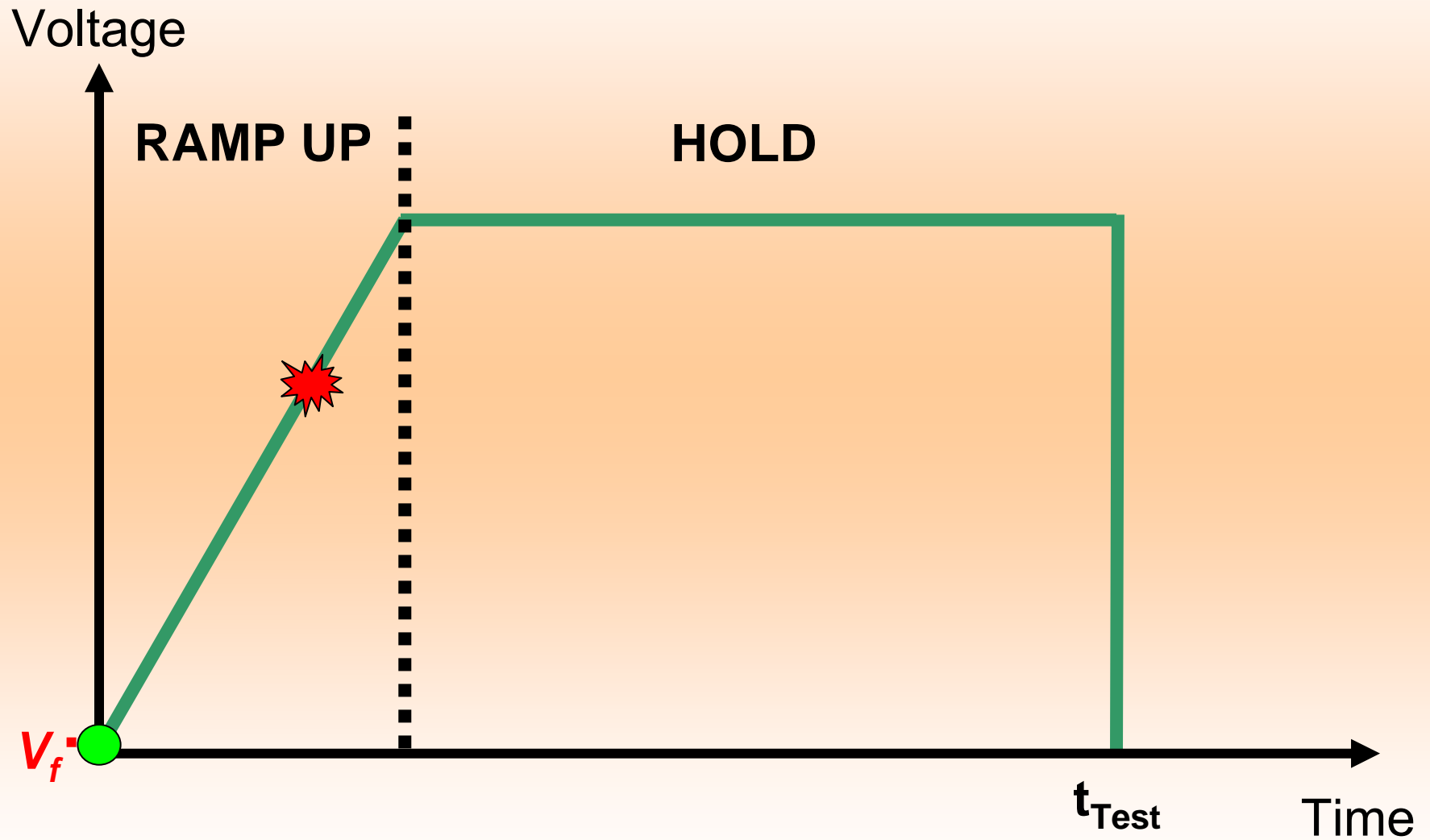
Focus is generally on the “Hold” phase but “Ramp Up” is important too.



“Ramp Up” Phase Diagnostic Features

Getting up to test voltage is half the battle

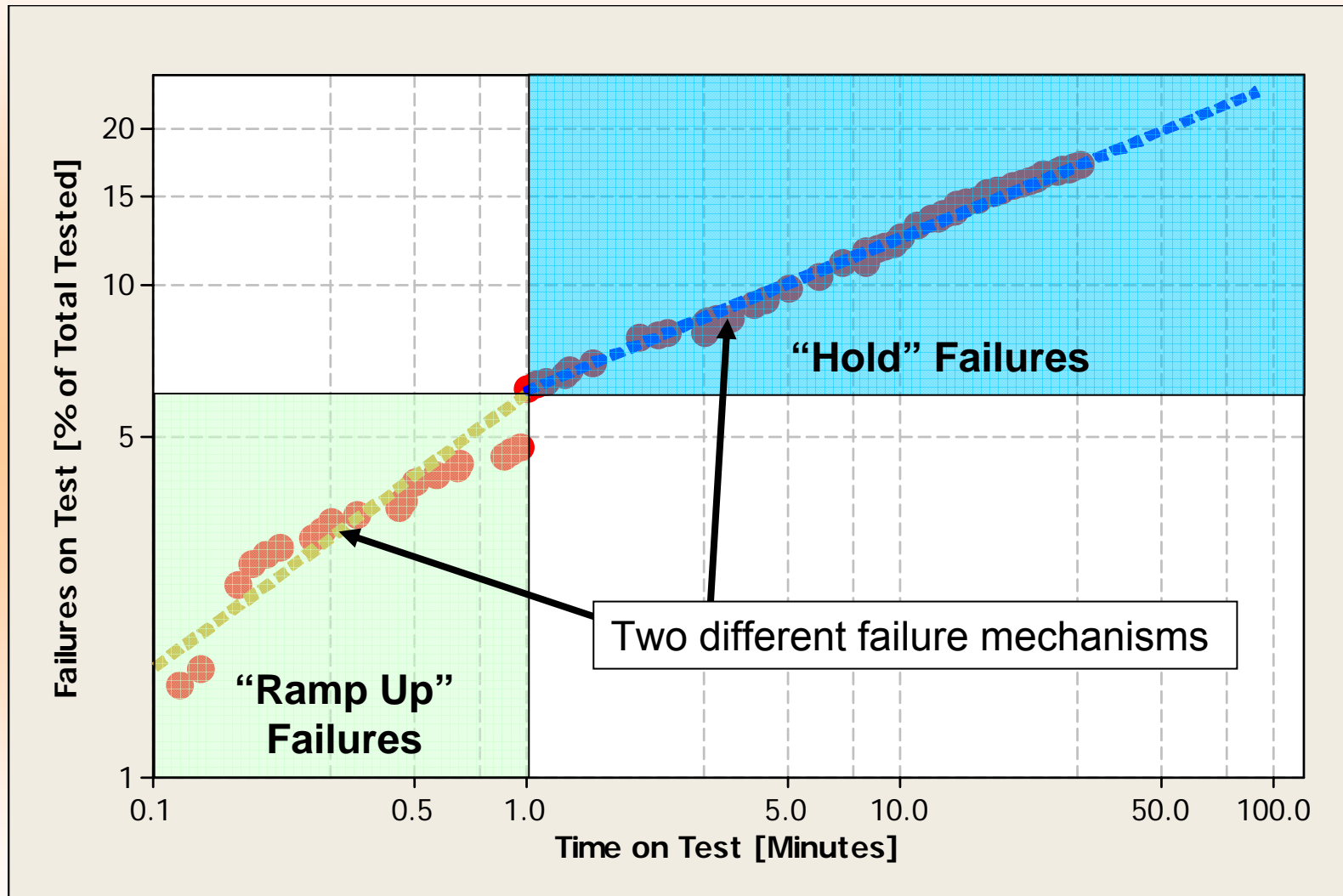
“Ramp Up” Data



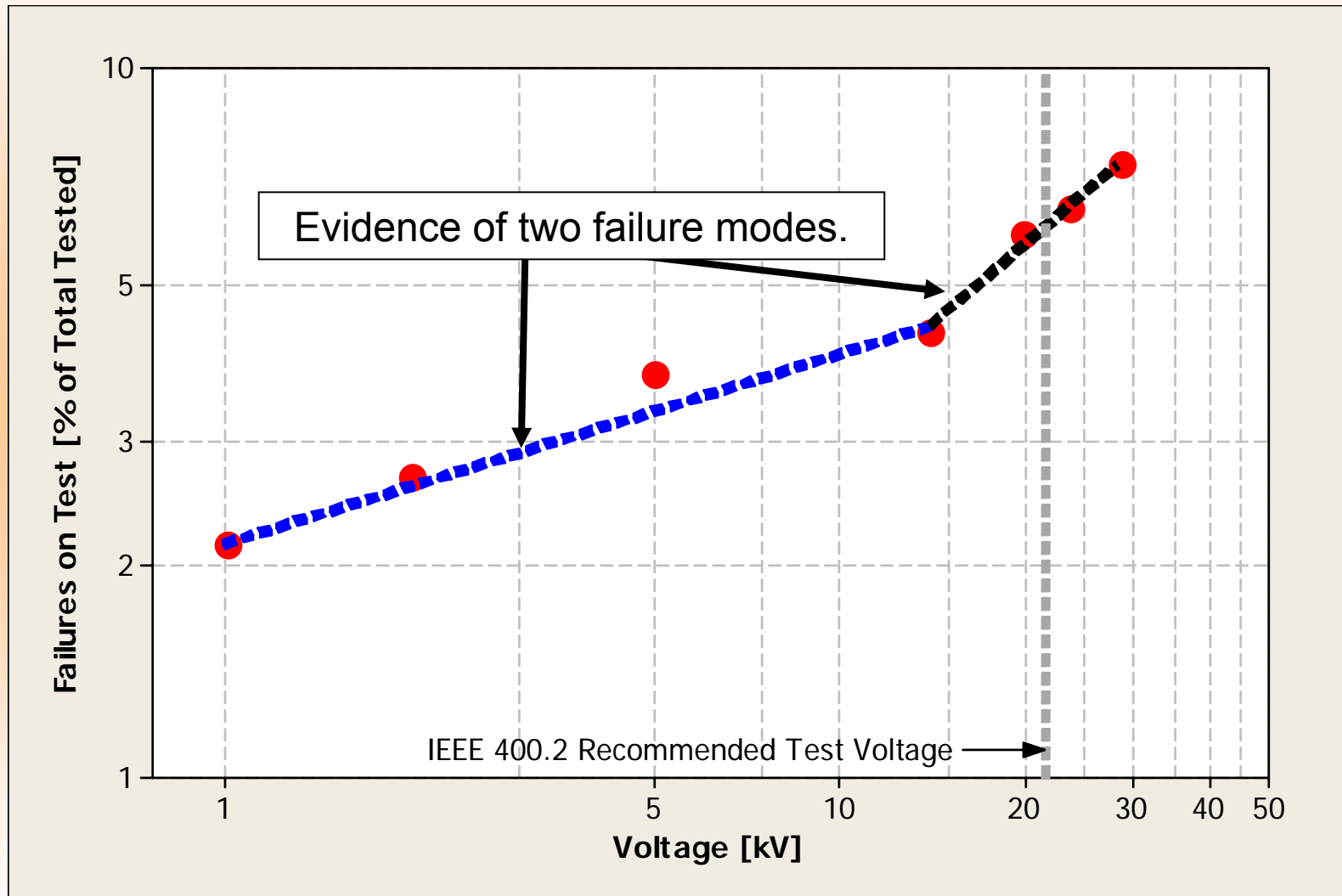
Ramp Up Failures

- Failures during the “Ramp Up” phase have accounted for as much as **70%** of the total failures on test.
- The failure mechanism during “Ramp Up” phase is different from the “Hold” phase mechanism.

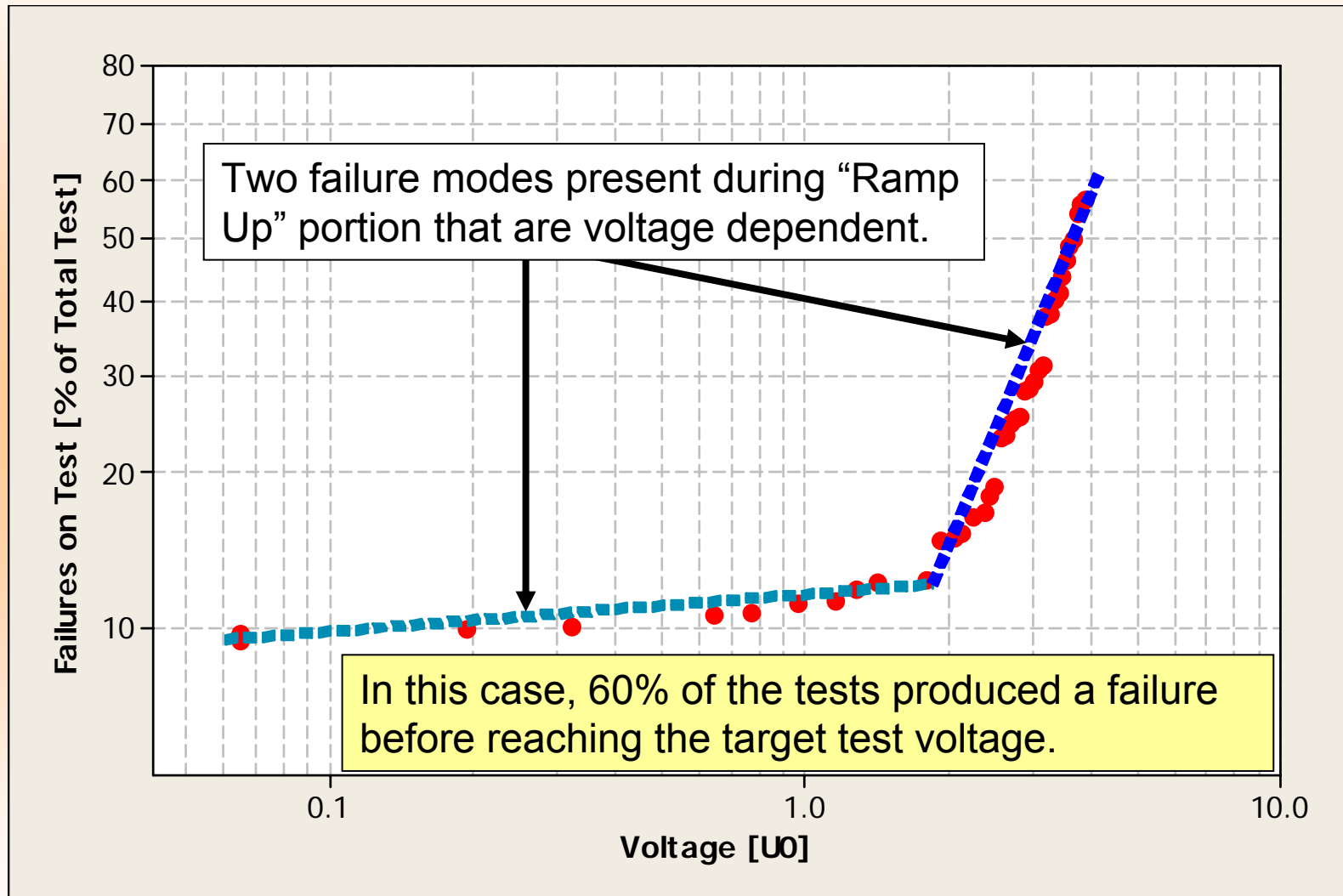
“Ramp Up” and “Hold” Failure Mechanisms



Weibull Curve – “Ramp Up” Failures (VLF)



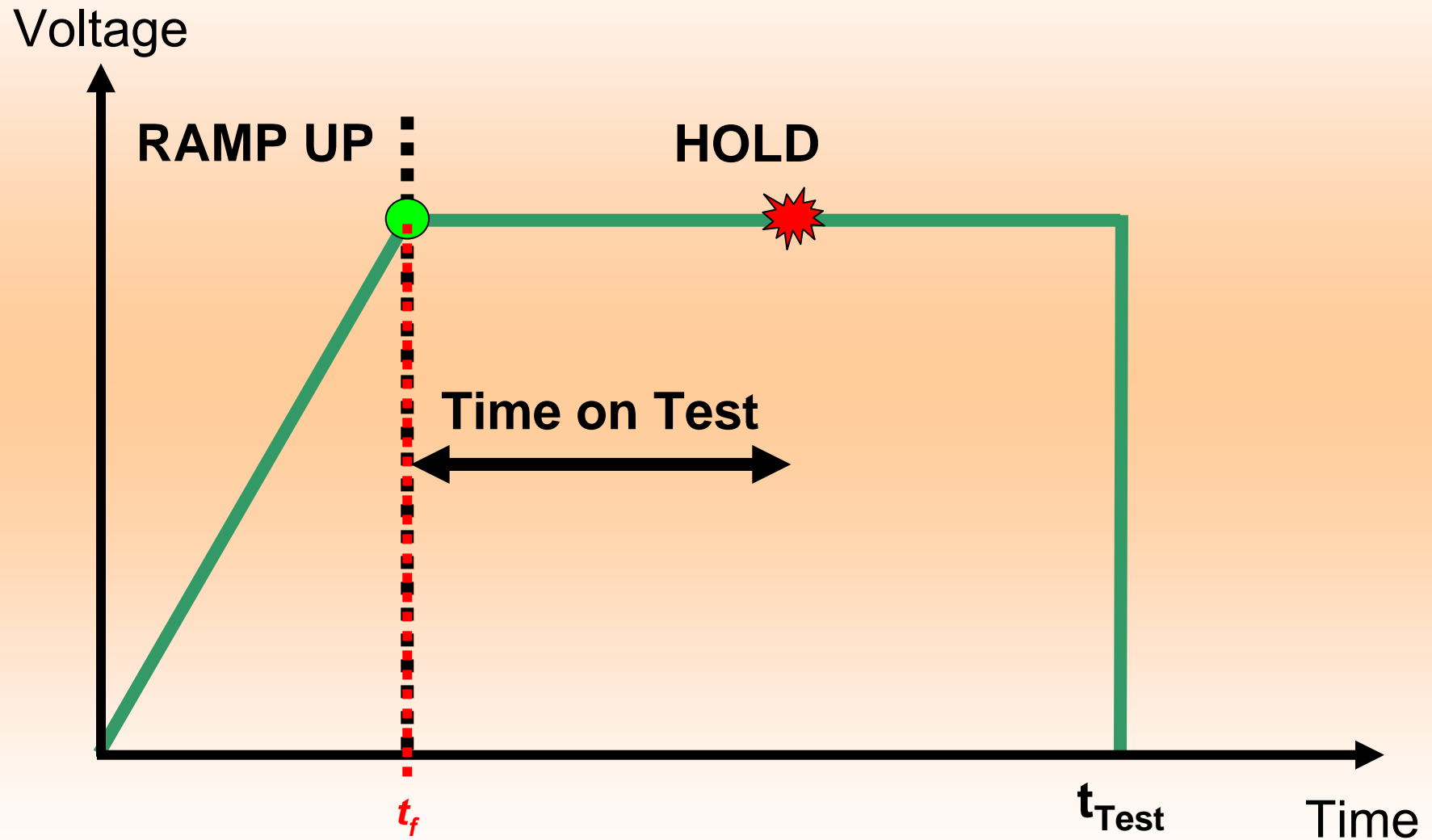
Weibull Curve – “Ramp Up” Failures (DC)



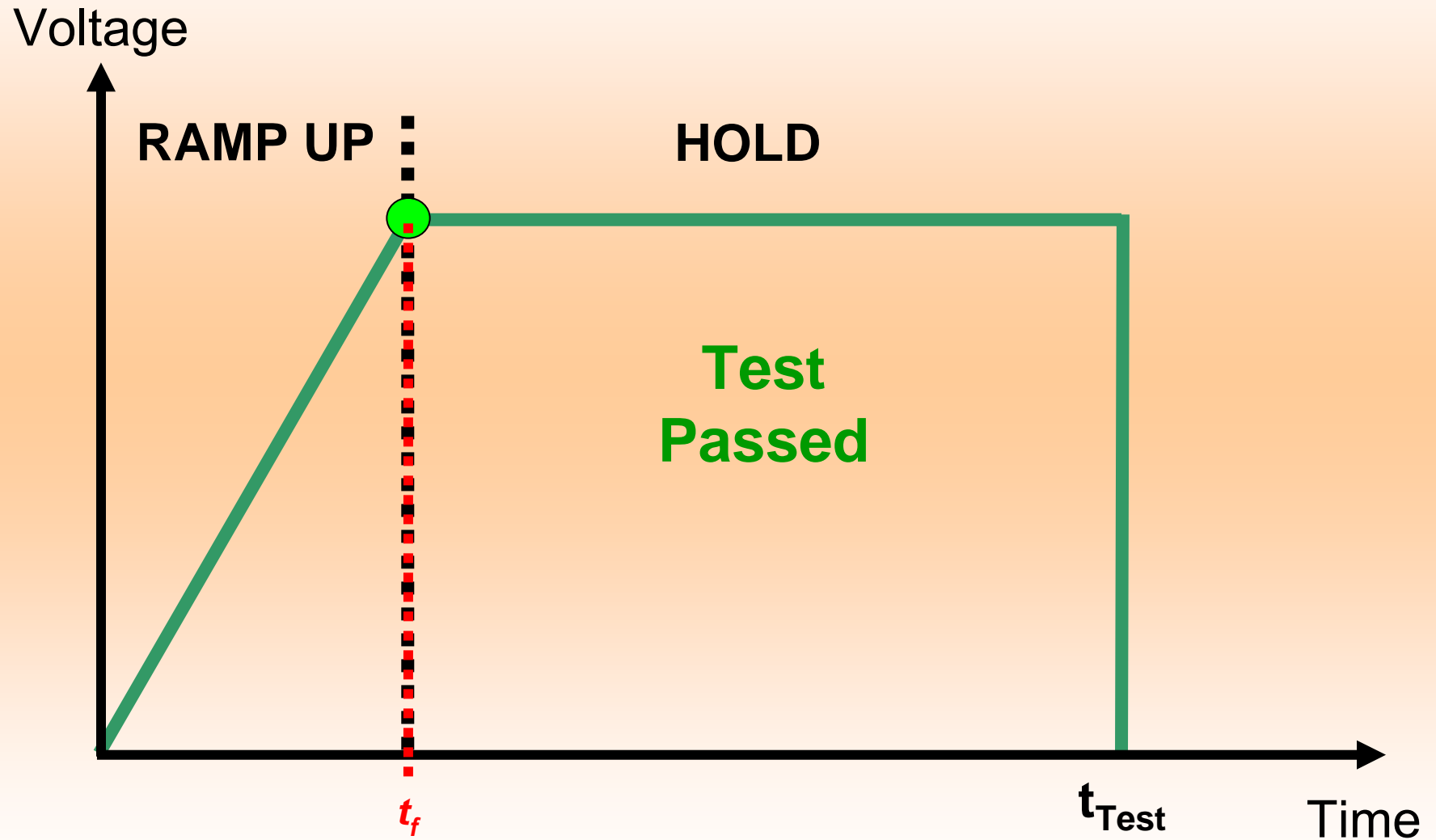
“Hold” Phase Diagnostic Features

Time is everything

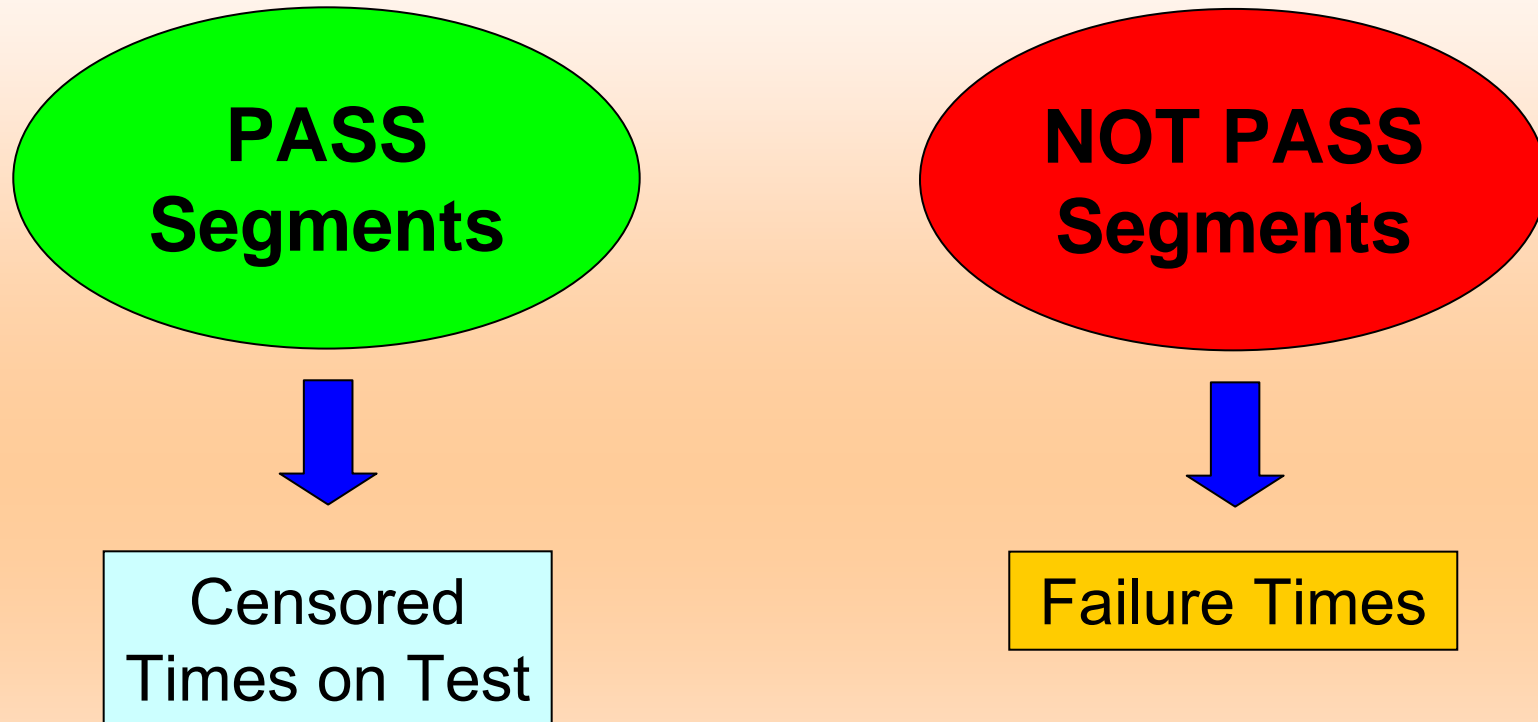
“Hold” Data – Failure During Test



“Hold” Data – Test Passes

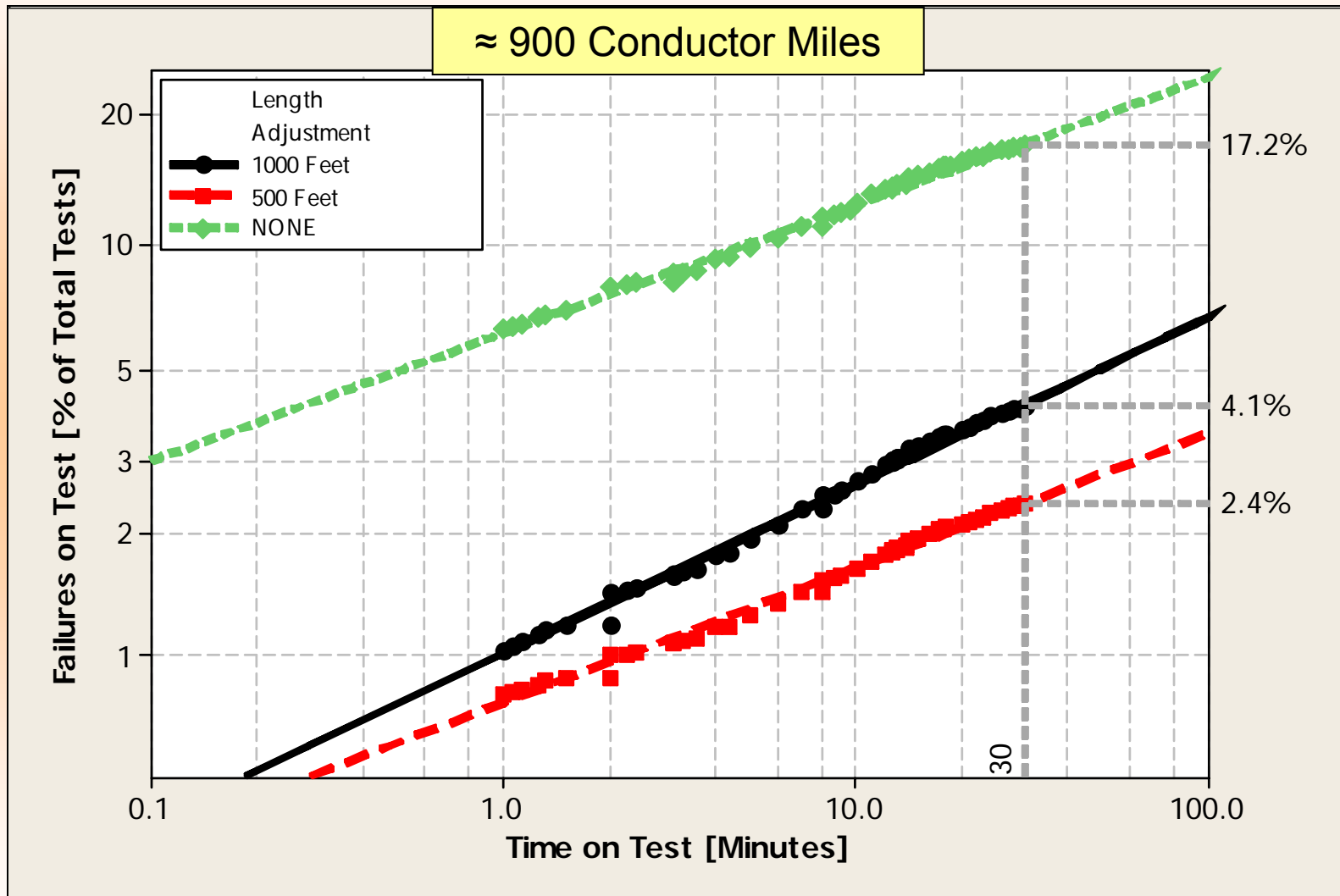


Analysis of Times on Test

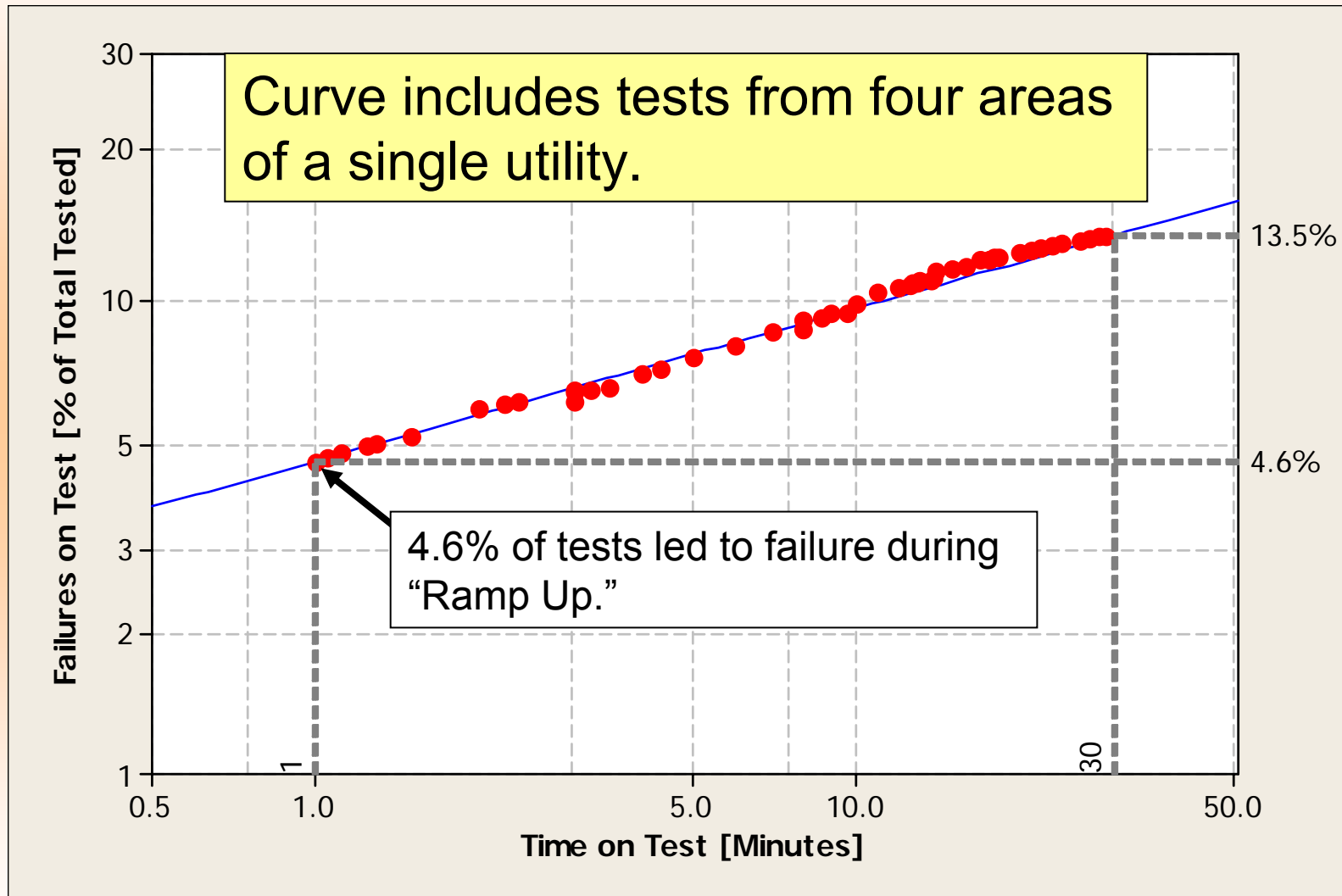


Use data to construct Weibull curves for different areas
These curves represent a diagnostic feature.

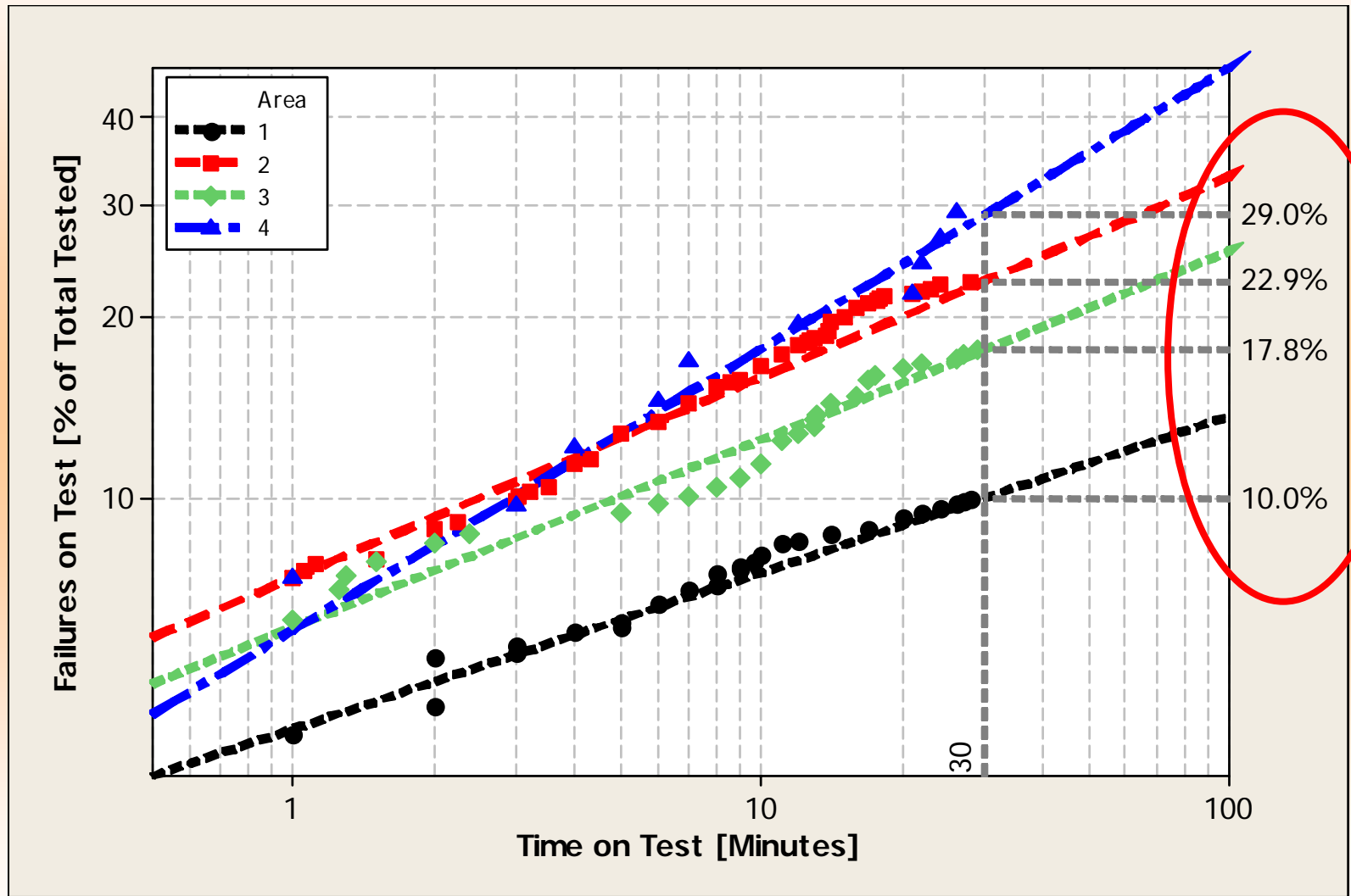
Length Effect on Failures on Test



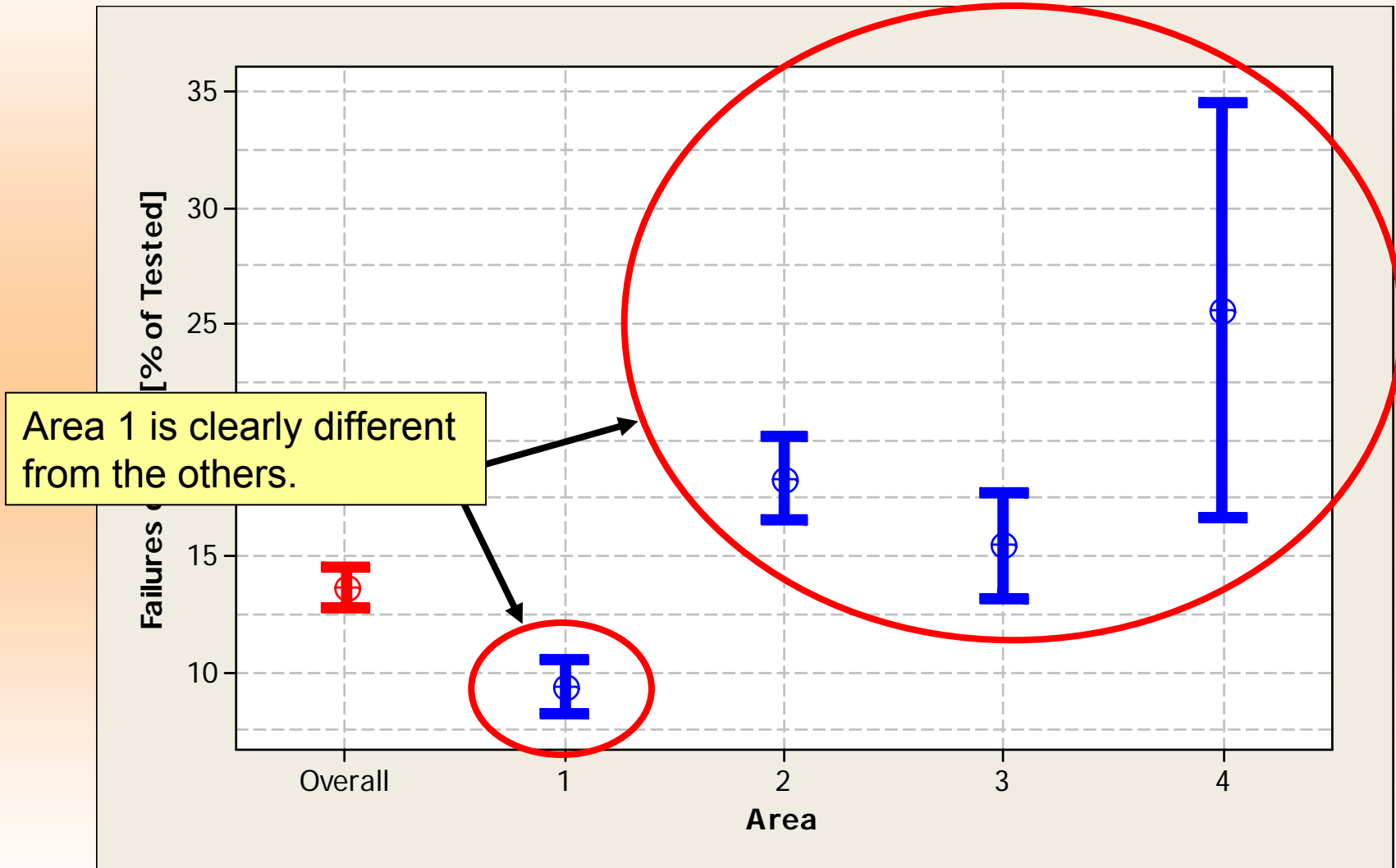
System Subset (Length Adjusted)



Weibull Curves by Area (Length Adjusted)

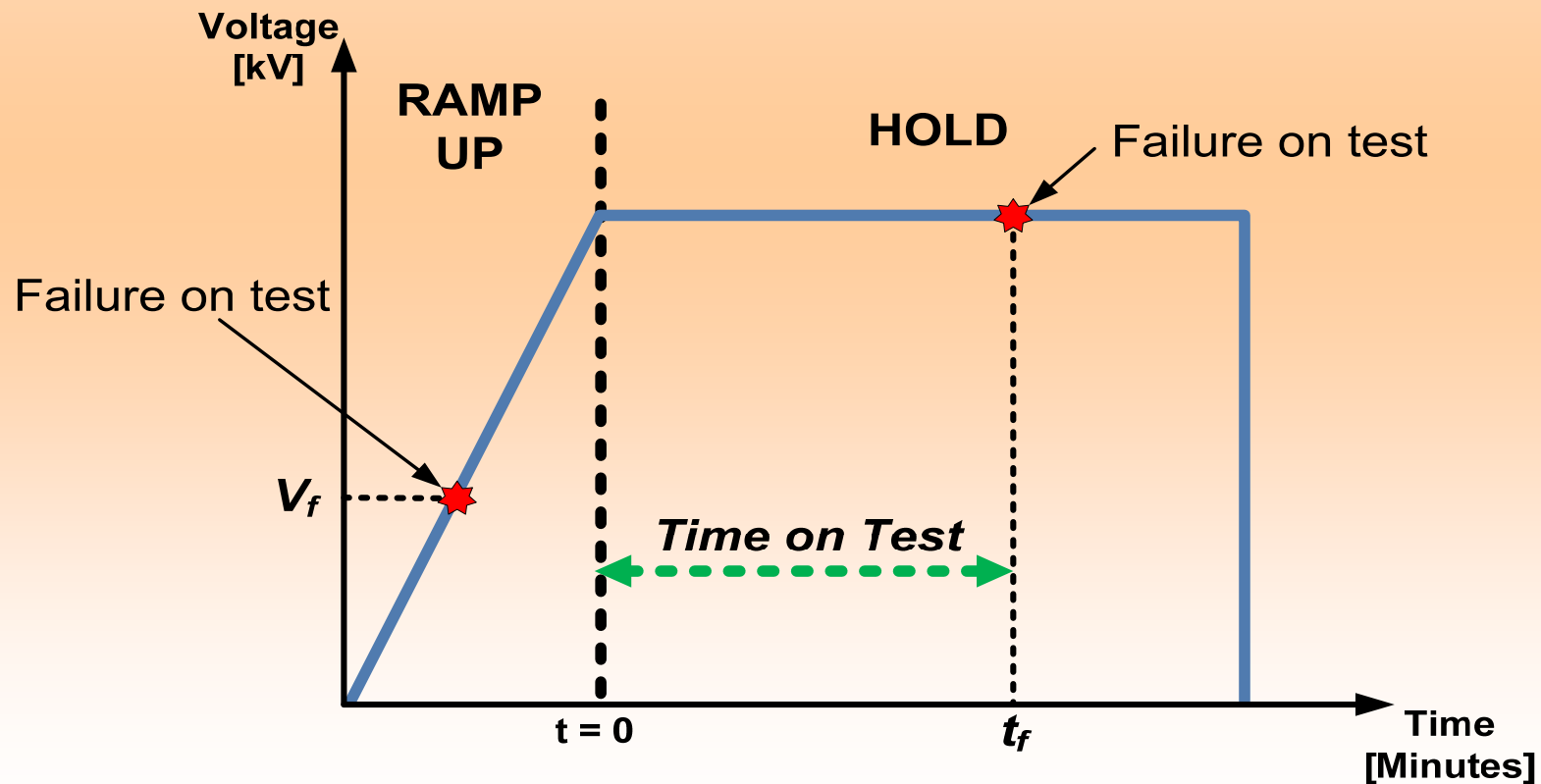


Separation of Regions



Recommendations

- Defined “Ramp Up” procedure should be employed with each test.
- Detailed records should be maintained.



Conclusions

- Withstand tests consist of two phases:
 - “Ramp Up”
 - “Hold”
- A significant percentage of failures occur during “Ramp Up” phase.
- Useful diagnostic features can be derived from withstand data.
 - Voltage at failure (“Ramp Up”)
 - Time on test at final test voltage (“Hold”)
- Results can be used to prioritize areas for action.