Lighting Impulse Testing and Insulation Coordination.

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PART 2 of 2

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There are 5 Test Procedures B's.

Procedure B 15/2

Procedure B 15/2M

Procedure B 15/2MPLUS

Procedure B 15/2MF

Procedure B 15/2Ma

Test Voltage Tolerance; IEC 62271-100

Table B.1 – Tolerances on test quantities for type tests

Subclause	Designation of the test	Test quantity	Specified test value	Test tolerances/ limits of test values	Reference to
6.2	Dielectric tests				
6.2.6.1 and 6.2.7.1	Power-frequency voltage tests	Test voltage (r.m.s. value)	Rated short-duration power-frequency withstand voltage	± 1 %	IEC 60694, IEC 60060
		Frequency	--	45 Hz to 65 Hz	IEC 60060
		Wave shape	Peak value / r.m.s. value = √2	± 5 %	
6.2.6.2 and 6.2.7.3	Lightning impulse voltage tests	Peak value	Rated lightning impulse withstand voltage	± 3 %	
		Front time	1,2 µs	± 30 %	
		Time to half-value	50 µs	± 20 %	
6.2.7.2	Switching impulse voltage tests	Peak value	Rated switch impulse withstand voltage	± 3 %	
		Front time	250 µs	± 20 %	
		Time to half-value	2 500 µs	± 60 %	
6.2.11	Voltage test as condition check using standard switching impulse voltage				
		Peak value of switching impulse voltage	See 6.2.11	± 3 %	IEC 60060
		Front time	250 µs	± 20 %	
		Time of half-value	2 500 µs	± 60 %	
	Using TRV circuit of T10	Peak value of switching impulse voltage	See 6.2.11	± 3 %	
		Time to peak	Standard value for T10 (see table 14)	$^{+200}_{-10}$ %	
6.3	Radio interference voltage tests	Test voltage	See 6.3 of IEC 60694	± 1 %	IEC 60060
6.4	Measurement of the resistance of the main circuit	DC test current I_{DC}	--	50 A ≤ I_{DC} ≤ rated normal current	IEC 60694

Test Voltage Tolerance; IEEE C37.09

4. Design tests

The design tests described in this test procedure provide methods of demonstrating the capability of a circuit breaker to meet the ratings listed in IEEE Std C37.04-1999.

4.4.4 Full-wave lightning impulse withstand voltage tests

These tests are made on circuit breakers, under dry conditions, to verify their ability to withstand their rated full-wave lightning impulse withstand voltages. In these tests, both positive and negative, lightning impulse voltages having a peak value equal or greater than the rated full-wave lightning impulse withstand voltage, as specified in ANSI C37.06-1997, shall be applied to the terminals of the circuit breaker.

What is our Goal?

Determine with confidence the Impulse Level that Disruptive Discharges occur 10% of the time!

Have a Repeatable Test Method

Complete tests at reasonable costs

One test for all similar products Worldwide!

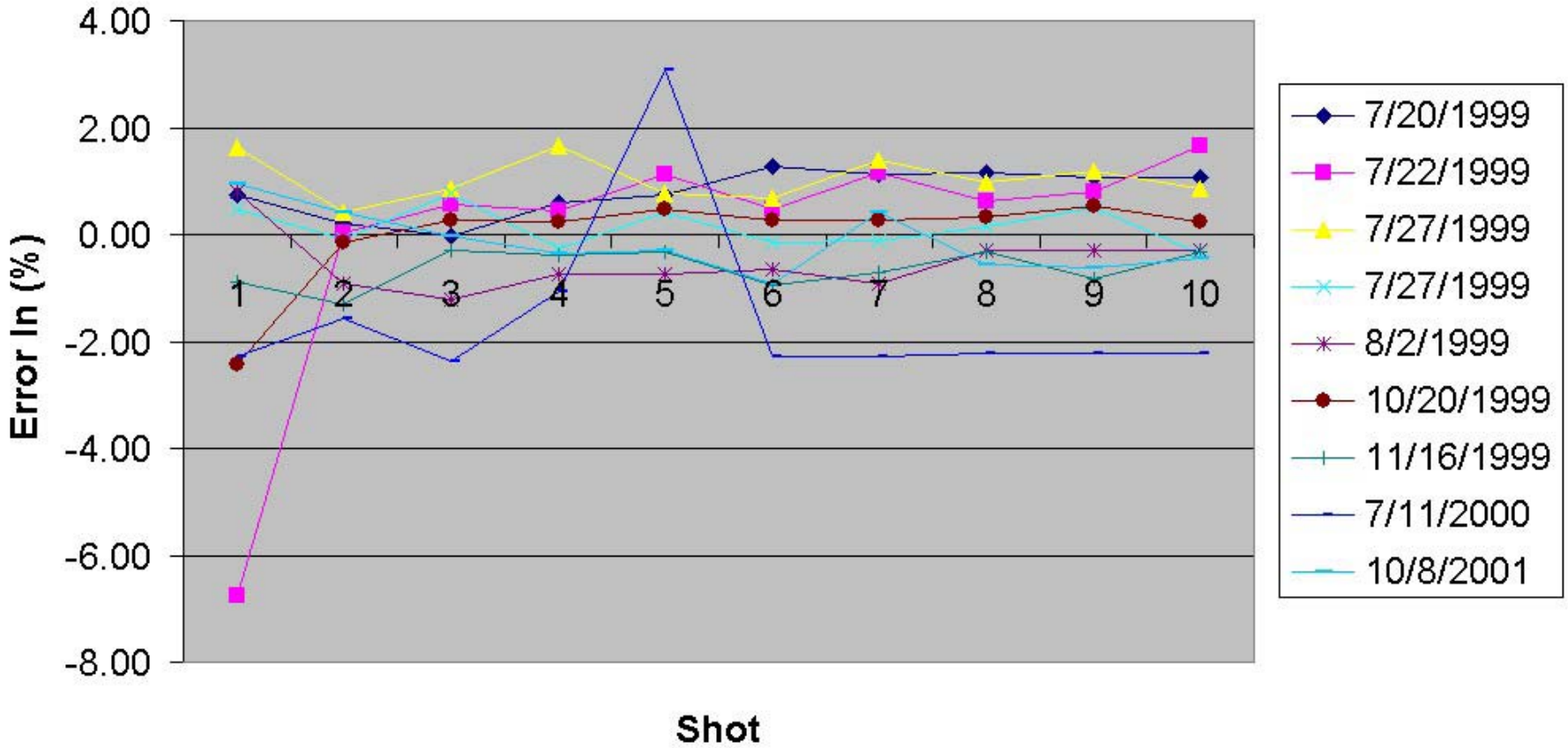
When I Took My Black Belt Training

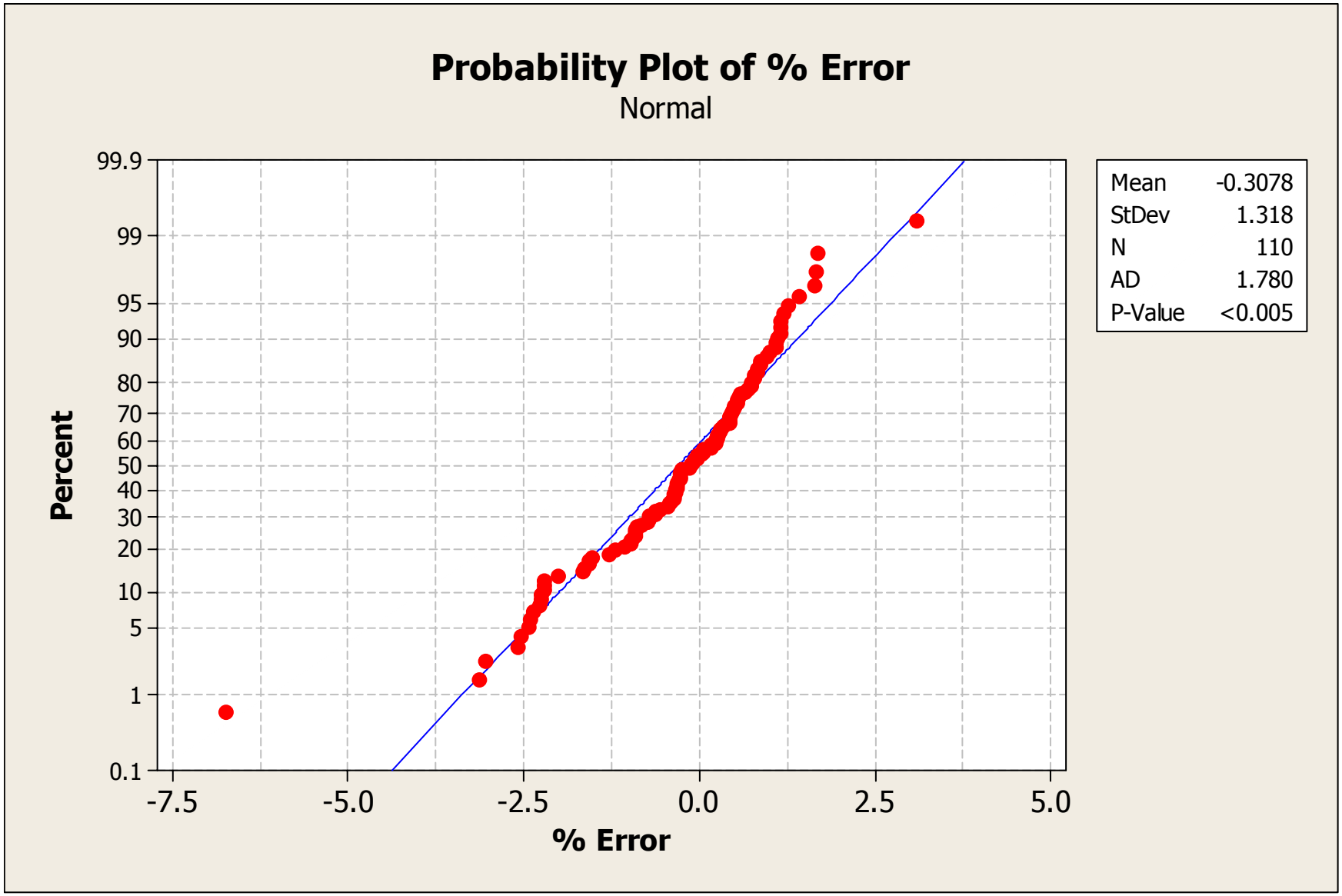
Variation is Caused by two Factors

1. Sample Variation
2. Measurement Variation

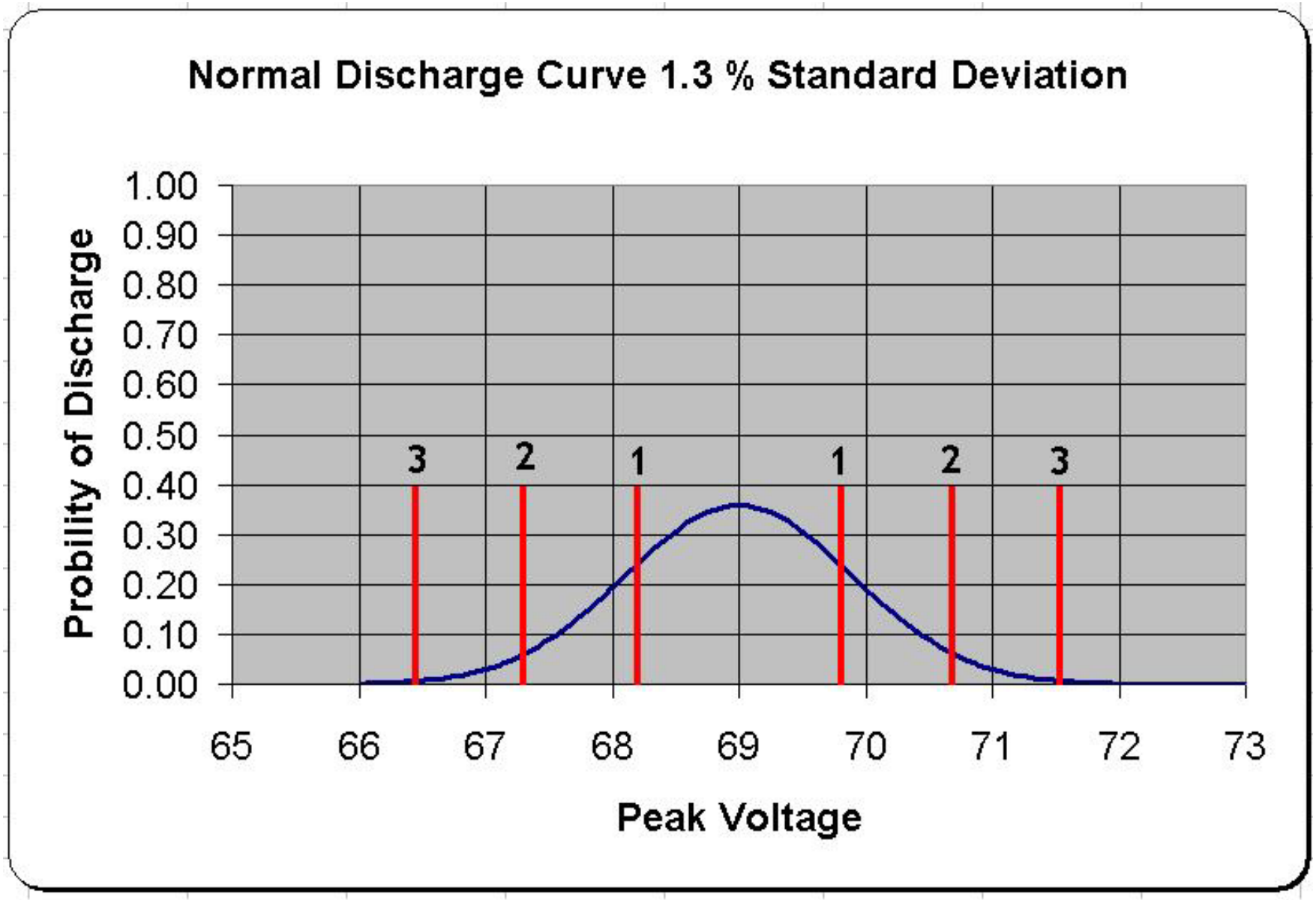
Lets look at Measurement Variation!

Error off Calibration.

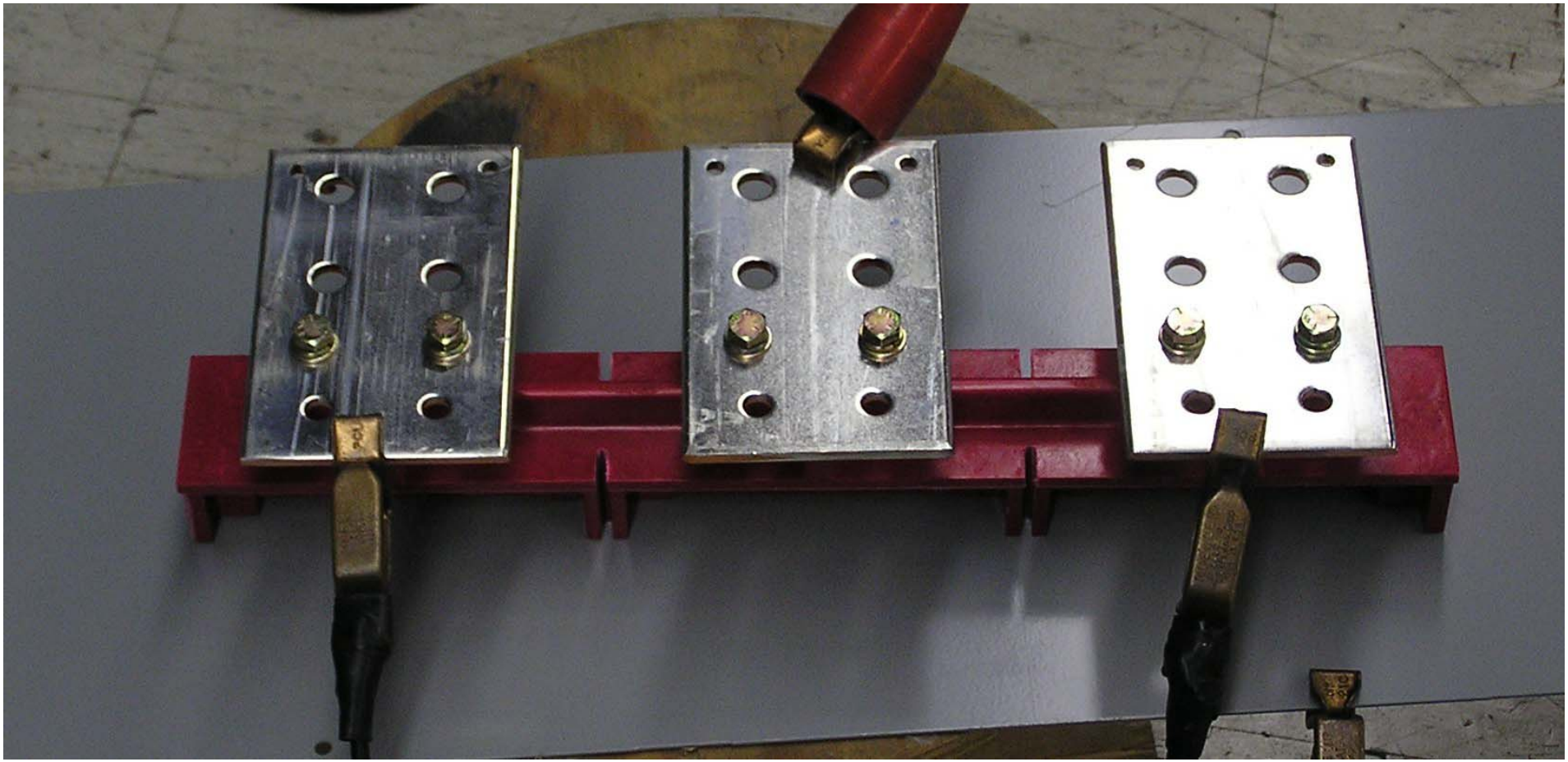



Probability Plot of % Error
Normal
Percent
99.9
99
95
90
80
70
60
50
40
30
20
10
5
1
0.1
-7.5
-5.0
-2.5
0.0
2.5
5.0
% Error
Mean -0.3078
StDev 1.318
N 110
AD 1.780
P-Value <0.005

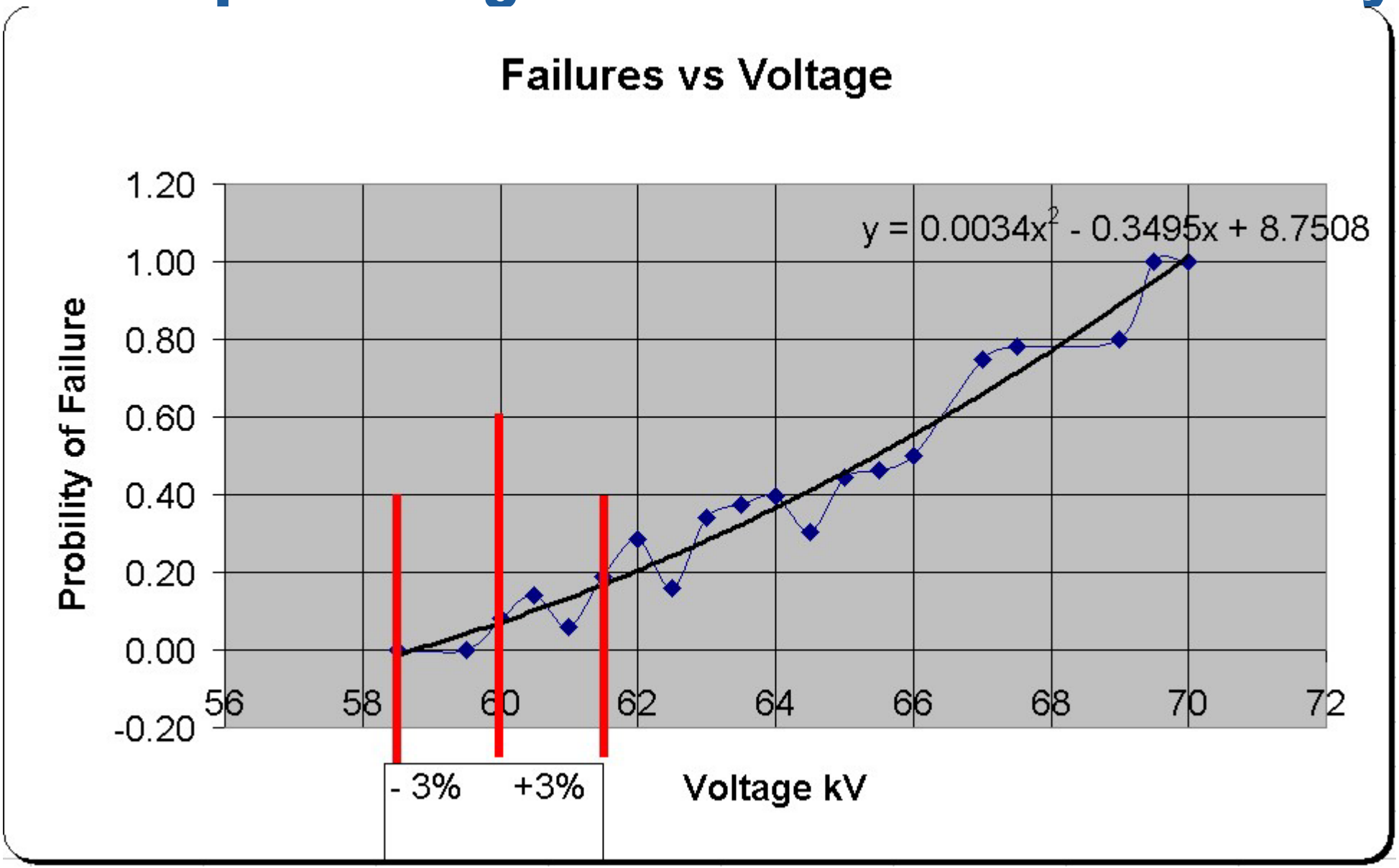
Therefore we can Characterize the Probility as Shown



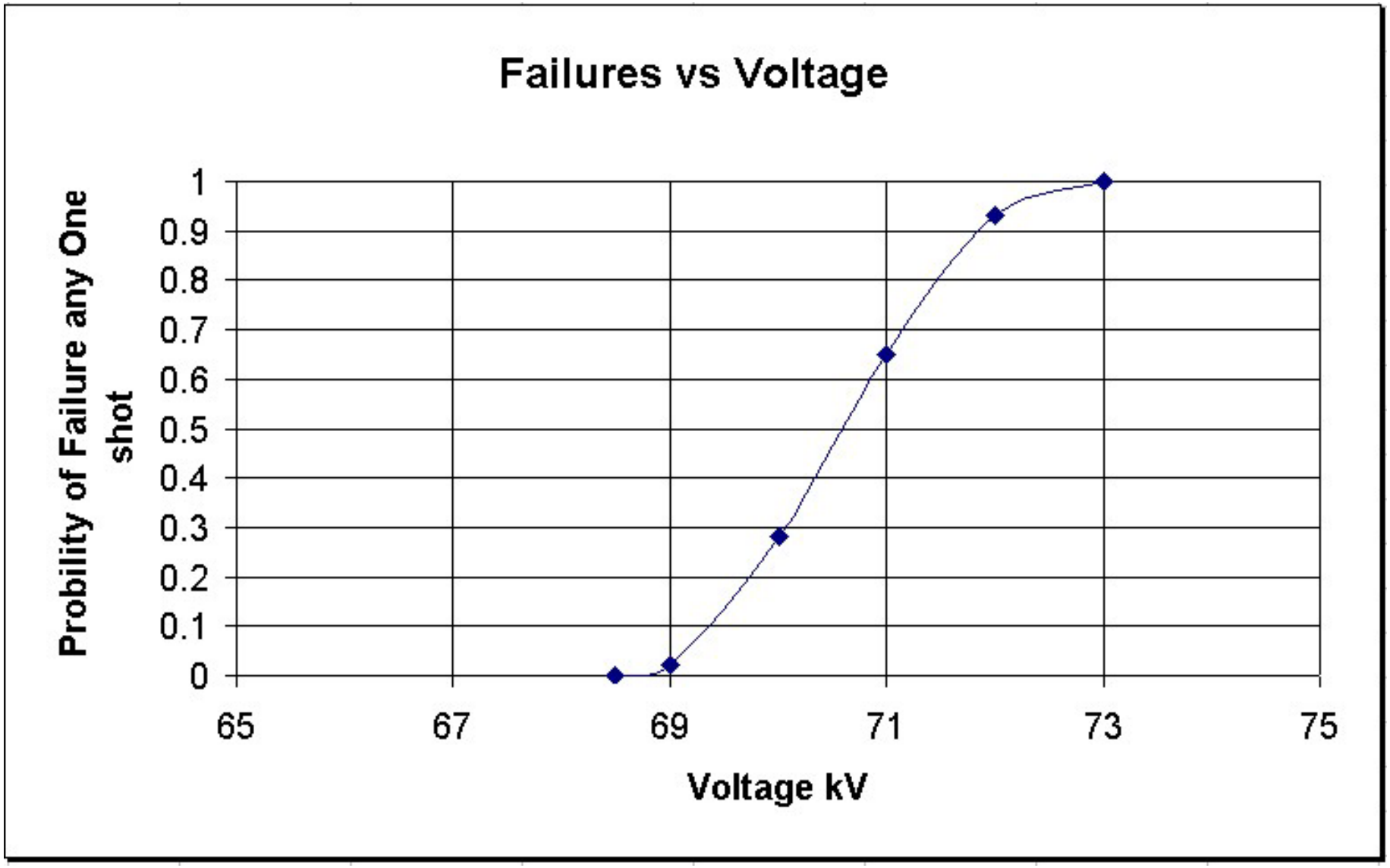
A Simple Test Sample



Simple Configuration Vs Failure Probability

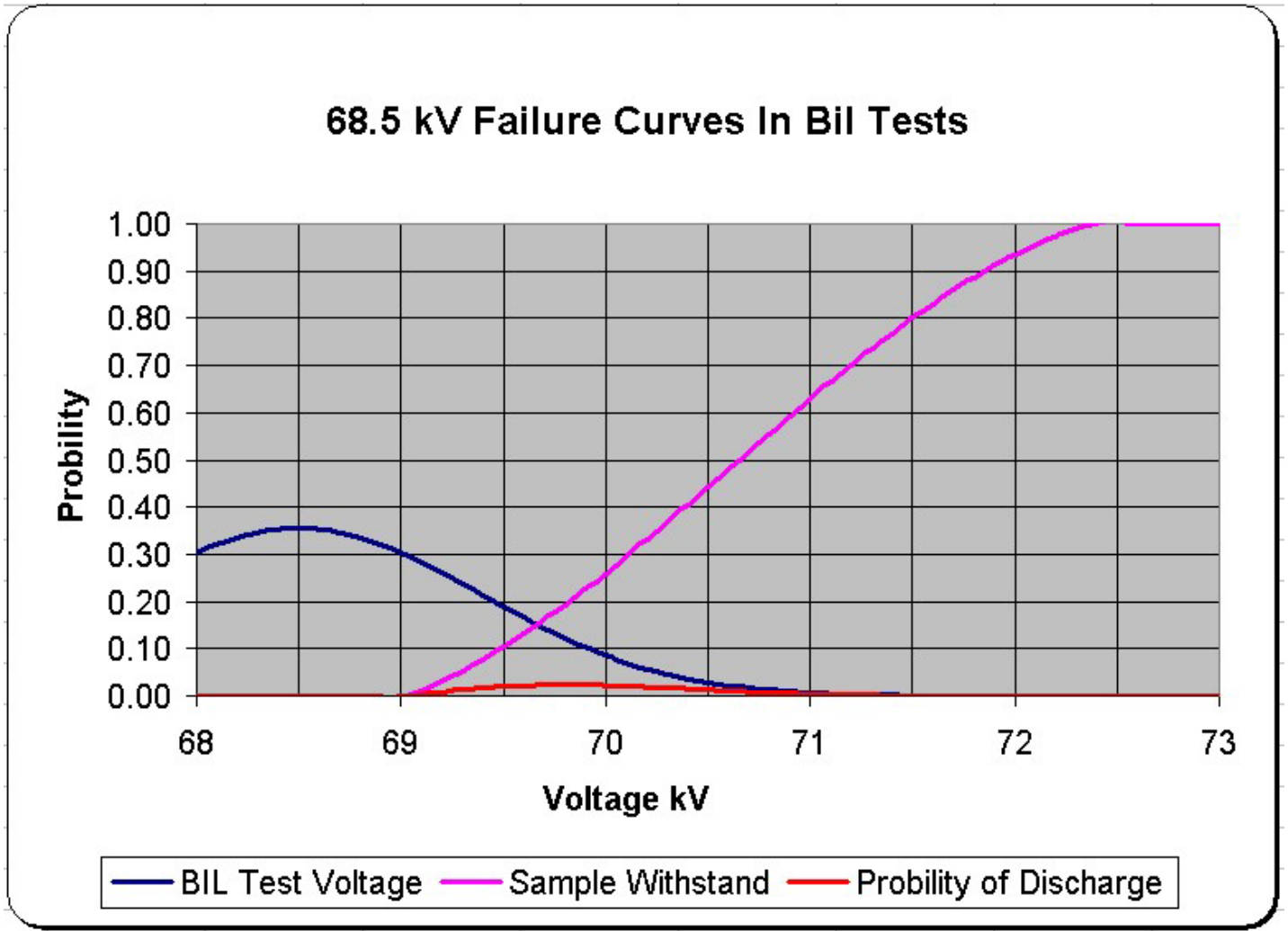


A More Complex Sample



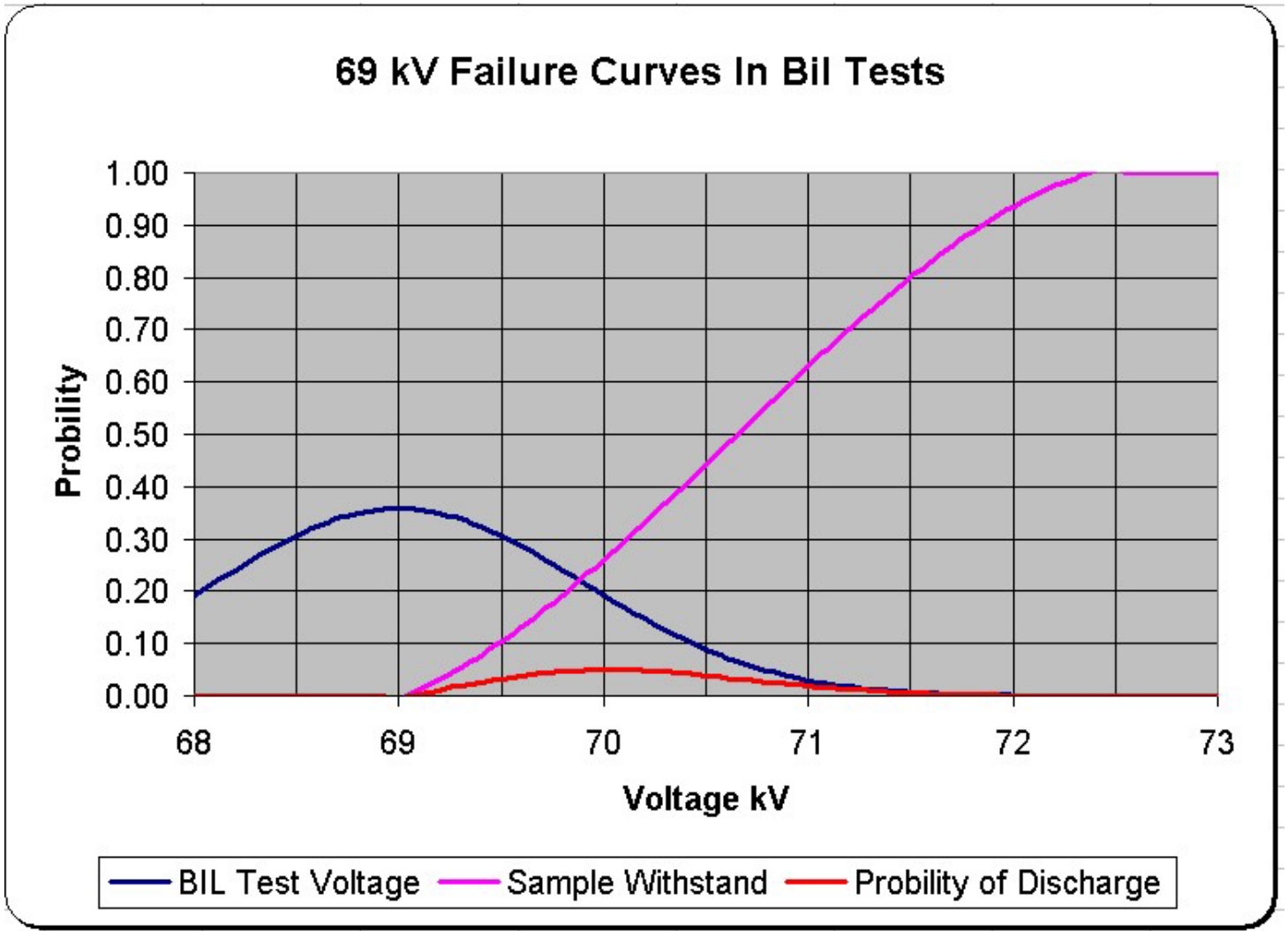
The Probility of Discharge for a 68.5 kV Mean Impulse

A 68.5 kV mean Discharge Voltage has ~10% failure rate.



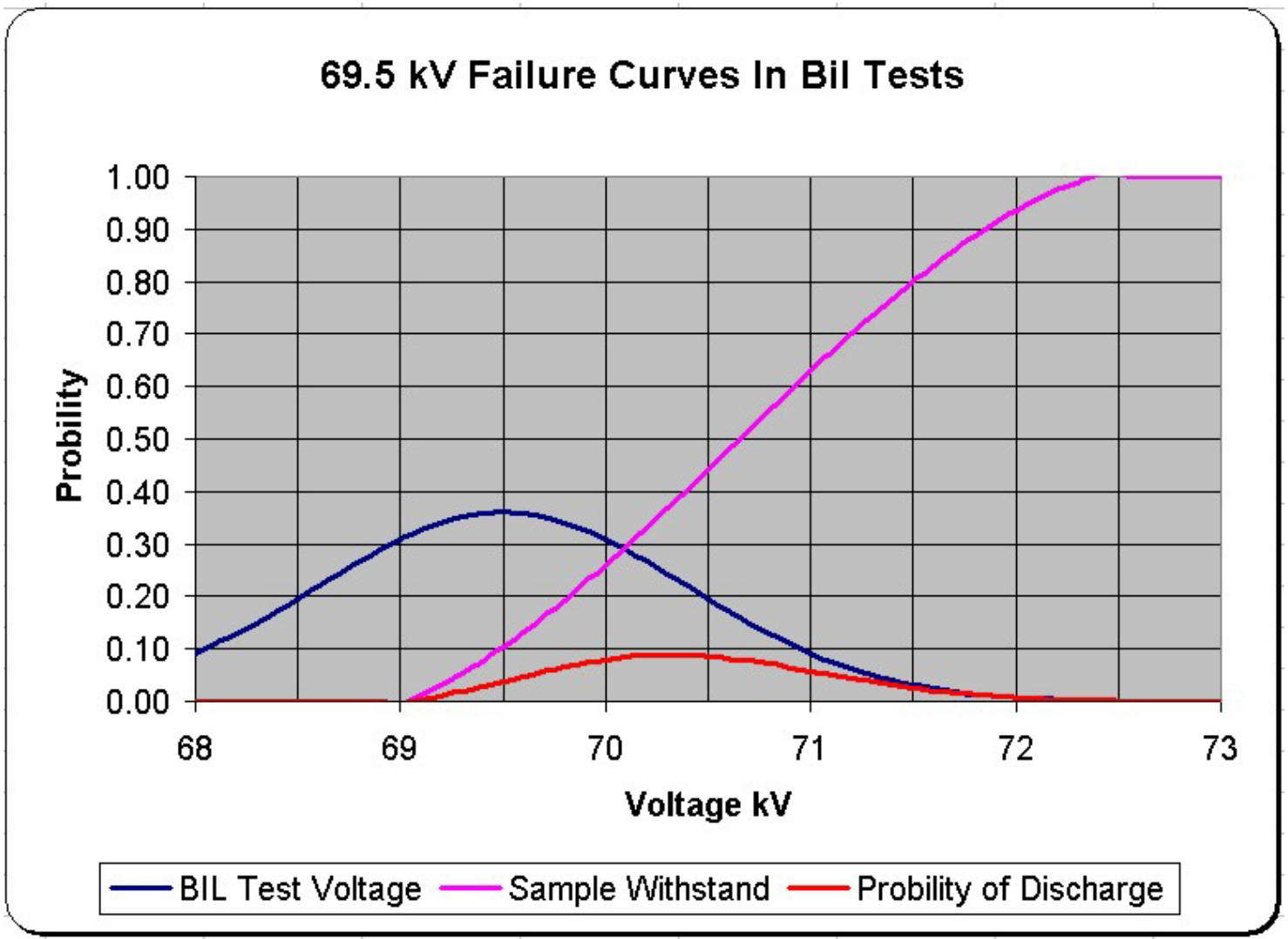
The Probility of Discharge for a 69 kV Mean Impulse

A 69 kV mean Discharge Voltage was ~25% failure rate.



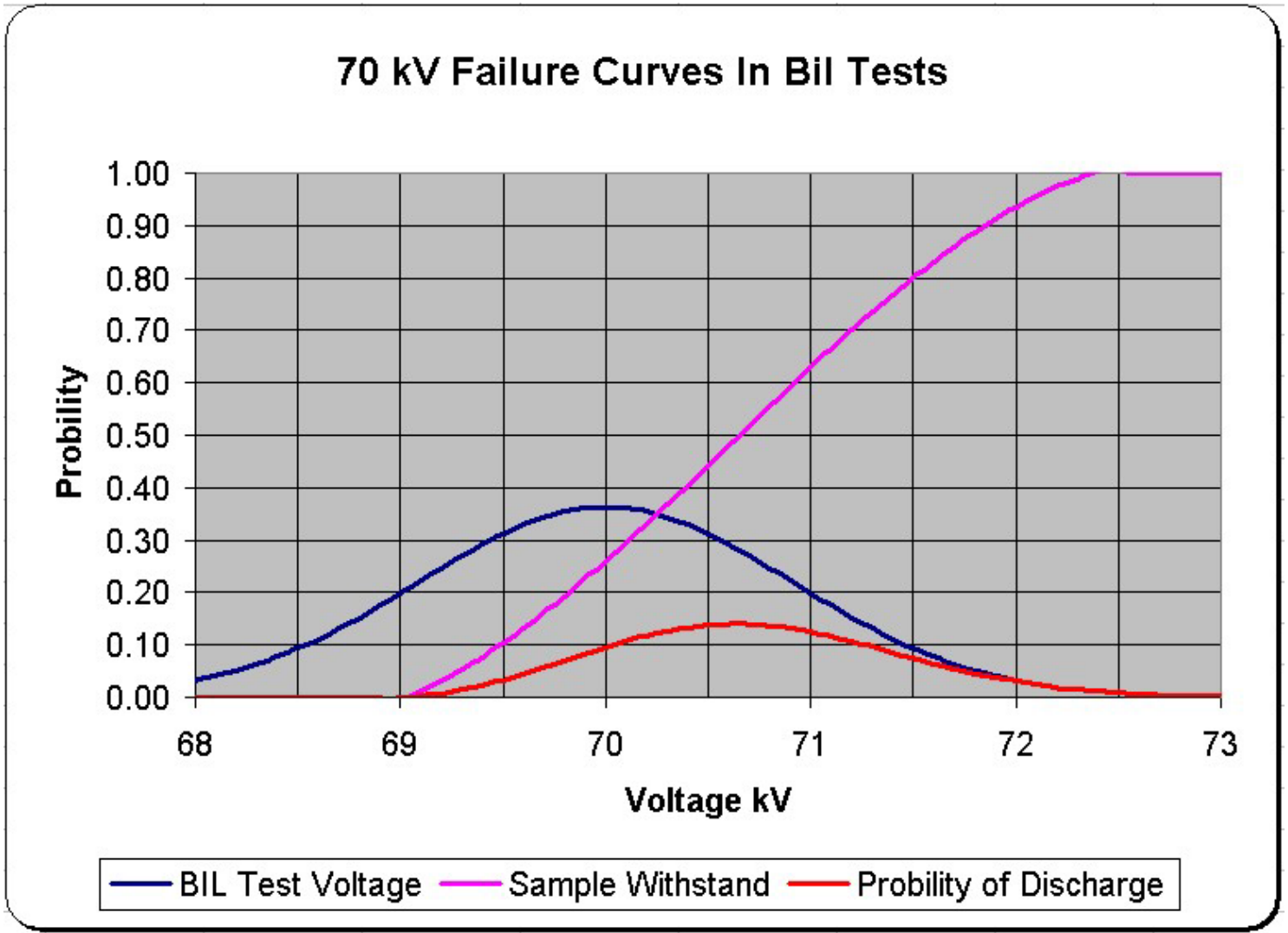
The Probility of Discharge for a 69.5 kV Mean Impulse

A 69.5 kV mean Discharge Voltage was ~35% failure rate.



The Probility of Discharge for a 70 kV Mean Impulse

A 70 kV mean Discharge Voltage was ~50% failure rate.



To Summarize.

- Lets see a 68.5 kV mean Discharge Voltage has ~10% failure rate.
- A 69 kV mean Discharge Voltage was ~25% failure rate.
- A 69.5 kV mean Discharge Voltage was ~35% failure rate.
- A 70 kV mean Discharge Voltage was ~50% failure rate.

- A ~2% Change in Mean Discharge Voltage was ~40% Change in Failure Probility!

Lets Apply The Sample Limits

1. ANSI/IEEE –0% + Any

2. IEC +- 3%

Lets Apply These Sample Limits For a 10% Probability of Failure