

Fred Schenkelberg

Fundamentals of Derating



Stress

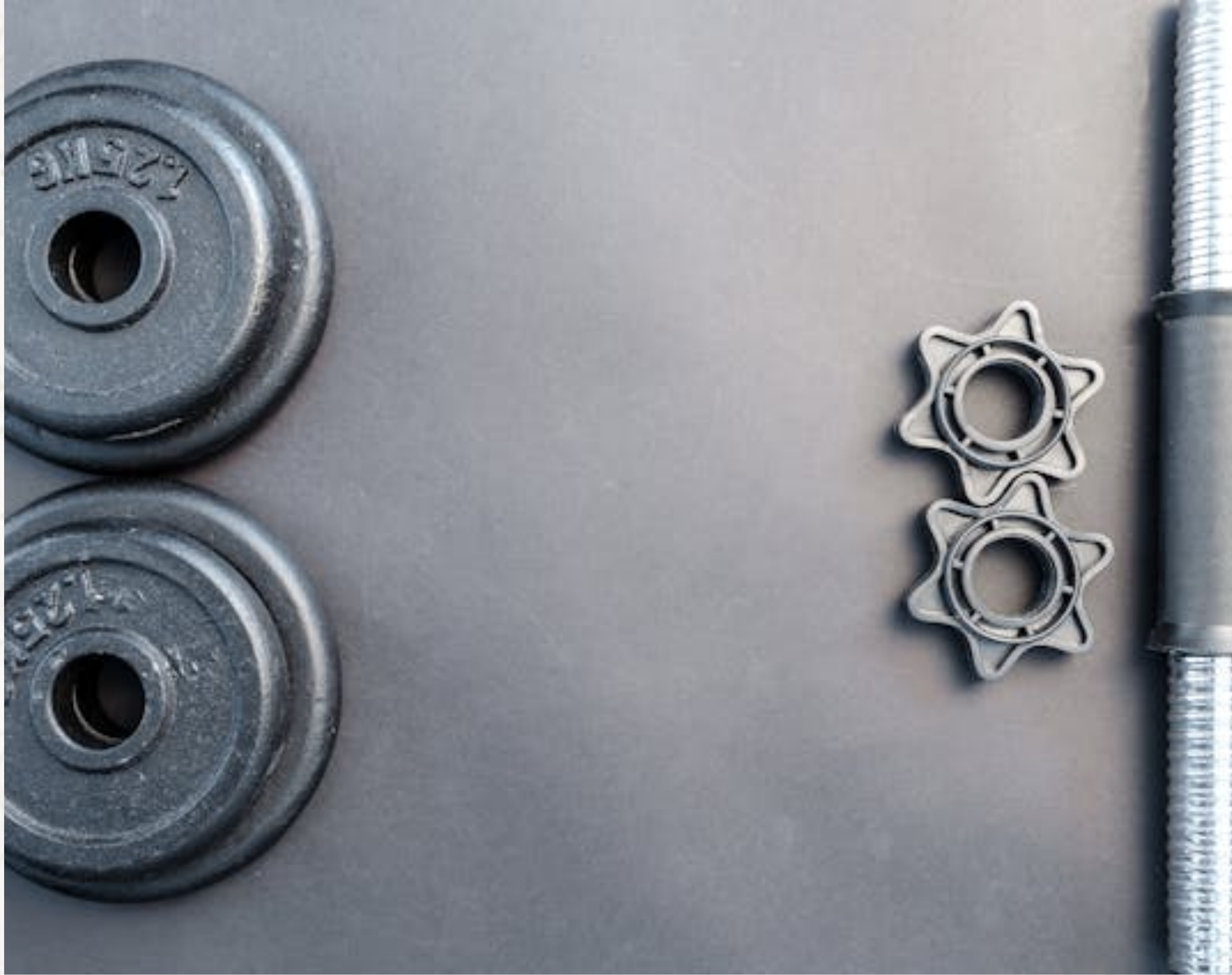




Strength



Do you have a
derating practice?



E-cap construction

Avoiding Failures

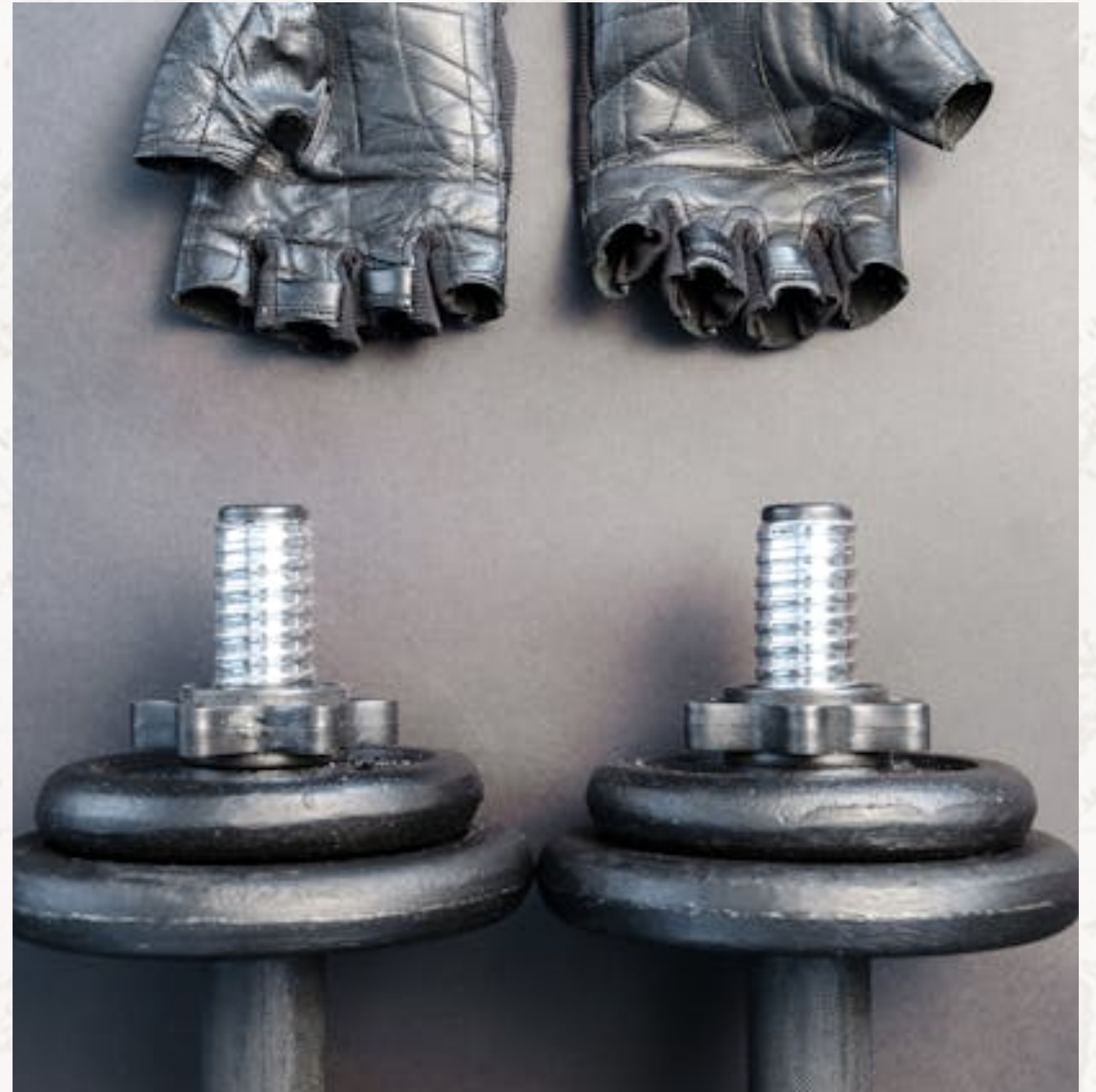
Two rolled up aluminum foil with
dielectric solution separating them



Oxide Layer

Avoiding Failures

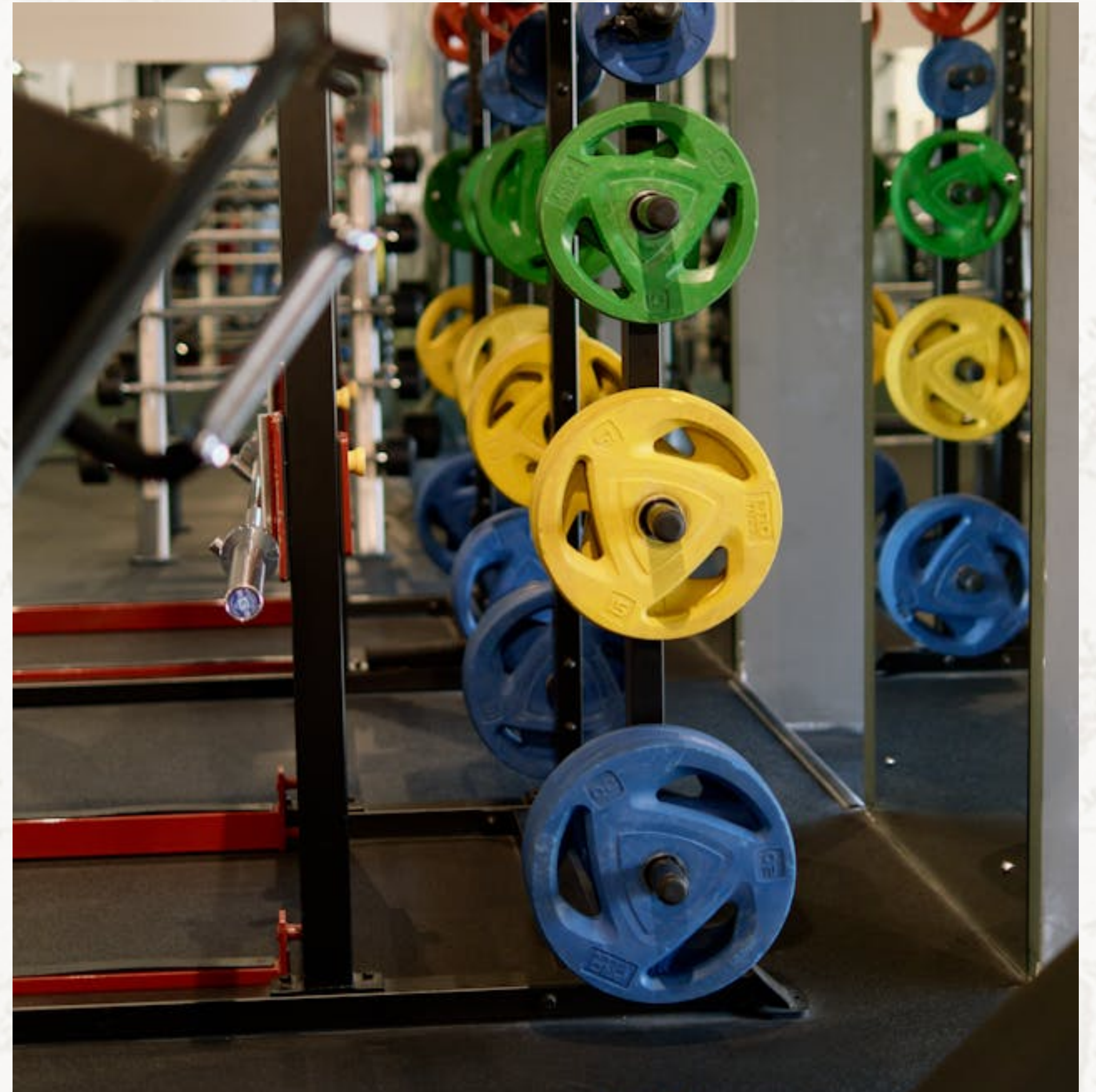
Aluminum oxide forms when a voltage is applied



Dielectric Breakdown

Avoiding Failures

Voltage spikes 'chip away' at the oxide layer – and if strong enough, punch through, causing a short.



Do you know every

failure mechanism?

Derating Concept



Stress-Strength Derating Concept

Let's measure both and plot.

Voltage

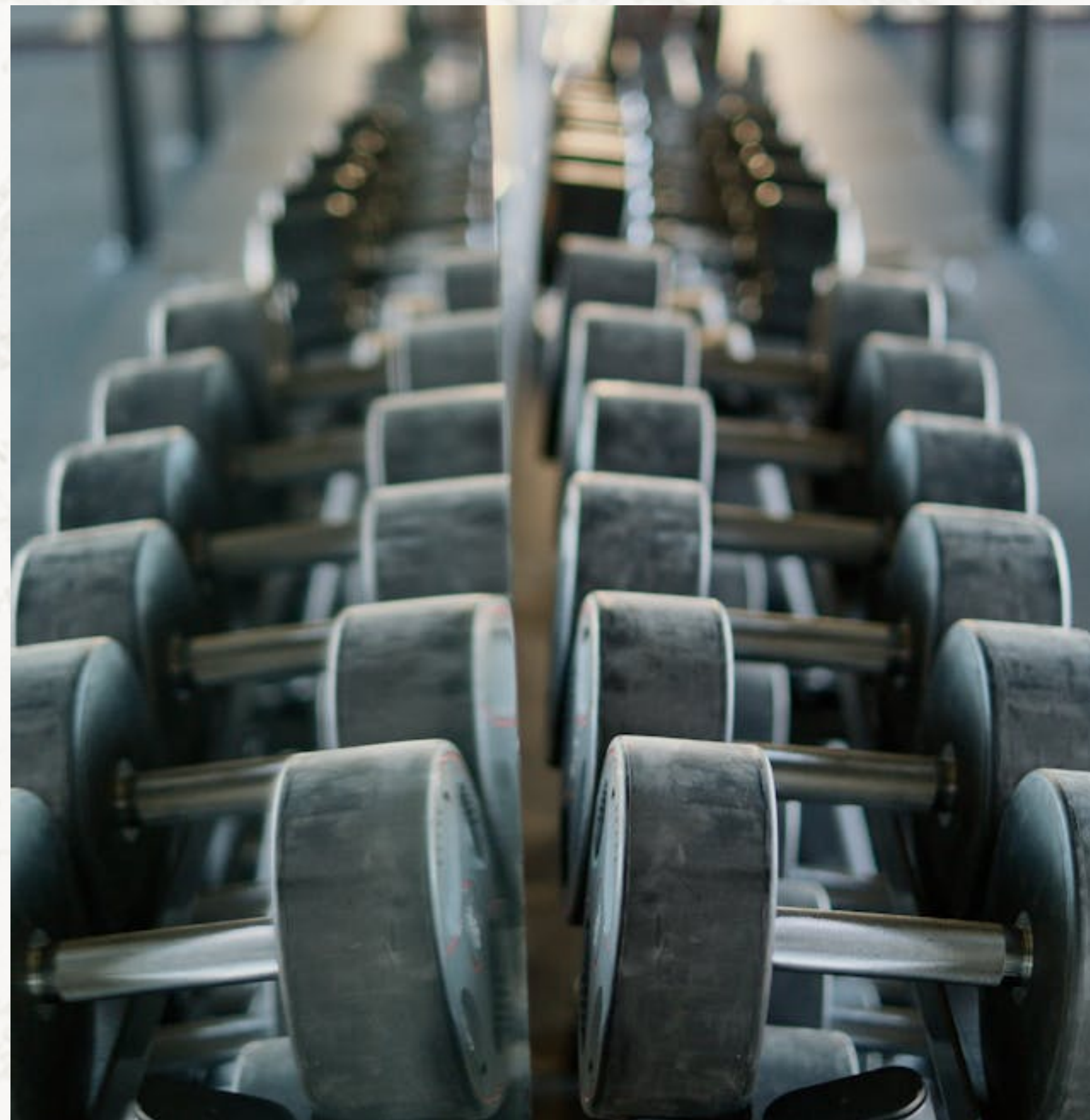


Increase Margin

Derating Concept

A couple of options

Voltage



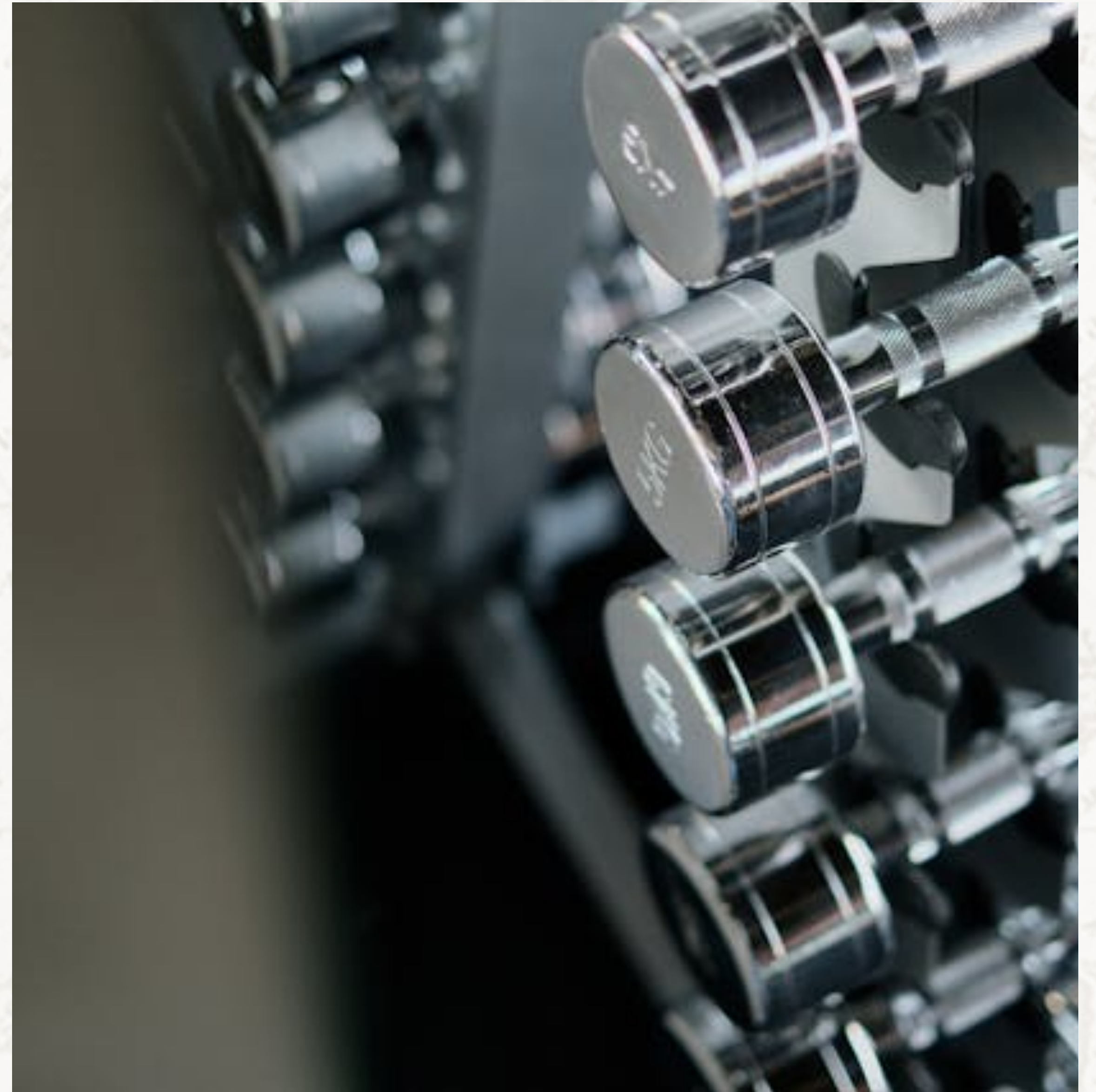
Benefits

Derating Concept

Design discussions on tradeoffs and risks

Robust designs
= improved reliability

Dick Moss told me (and others)
about one group...



How to do you

apply derating?

Methods



Engineer's Judgement

Methods

Each electrical engineer selects the specific component as they wish.

Some may use data sheet recommendations.

Voltage Rating	Maximum Recommended Steady-State Voltage	Maximum Recommended Transient Voltage (1 ms to 1 μs)
−55°C to 105°C		
12.5 V ≤ V _R ≤ 75 V	80% of V _R	V _R
105°C to 125°C		
12.5 V ≤ V _R ≤ 75 V	54% of V _R	67% of V _R

Table 1 – Data sheet showing derating guidelines.



Guideline tables

Methods

RADC-TR-84-254

JPL Derating Guidelines D-8545 (Space)

Intel Derating Guidelines (Commercial)

TE000-AB-GTP-010 (Navy)

MIL-STD-975 appA

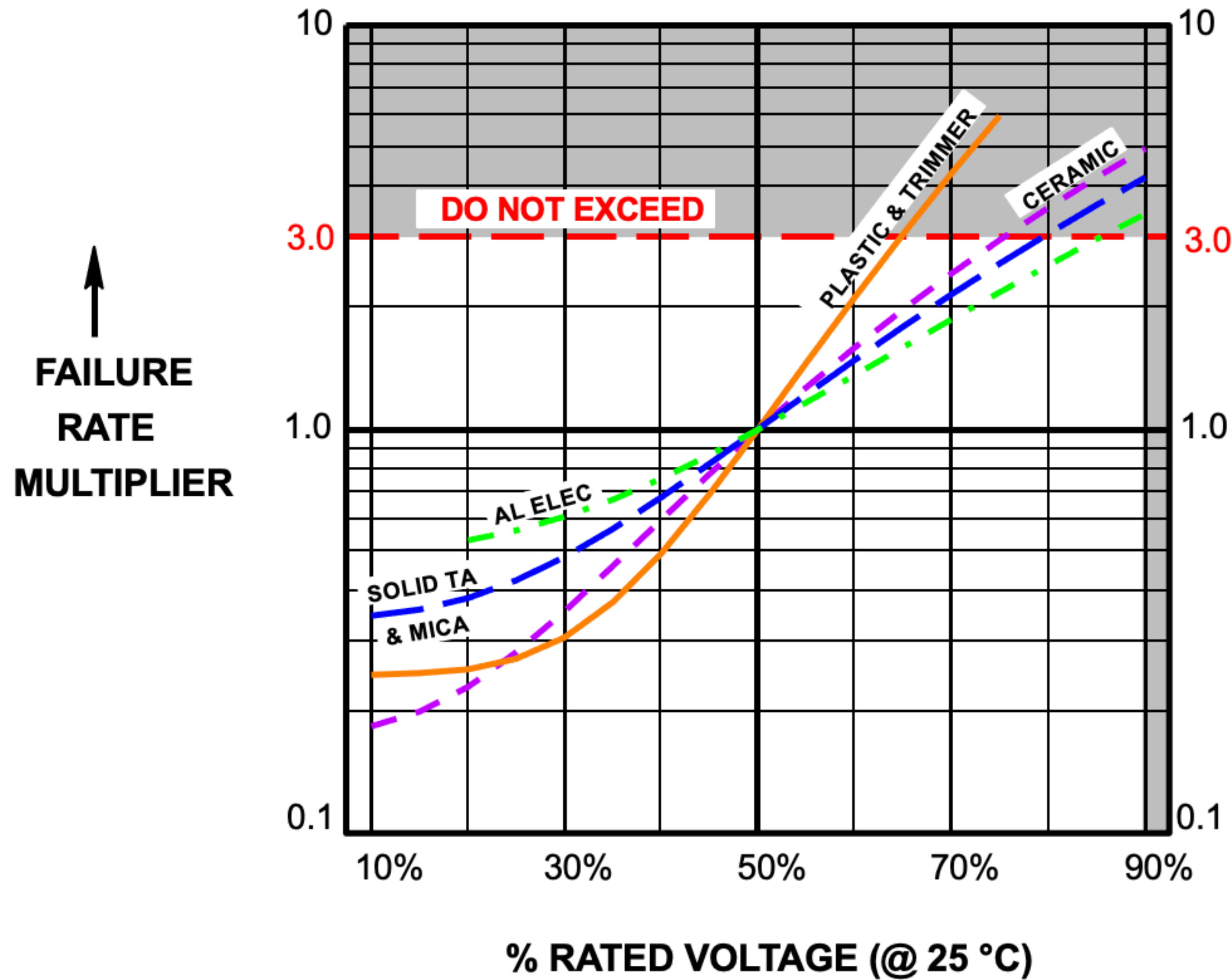
MIL-STD-1547

Examples of part derating values are shown below in Table 6.18 (*RAC Blueprints for Product Reliability, RBPR-3*).

		Environment	
Part Type	Derating Parameter	Severe	Benign
Capacitors	DC Voltage Temp from Max Limit	60% 10° C	90% NA
Diodes	Power Dissipation Max Junction Temp	70% 125° C	90% NA
Lamps	Voltage	94%	94%
Micocircuits	Supply Voltage Fan Out Max Junction Temp	±5% 80% 125° C	±5% 90% NA
Microprocessors	Supply Voltage Fan Out Max Junction Temp	±5% 80% 125° C	±5% 90% NA
Resistors	Power Dissipation Temp from Max Limit	50% 30° C	80% NA

Failure Rate Multiplier

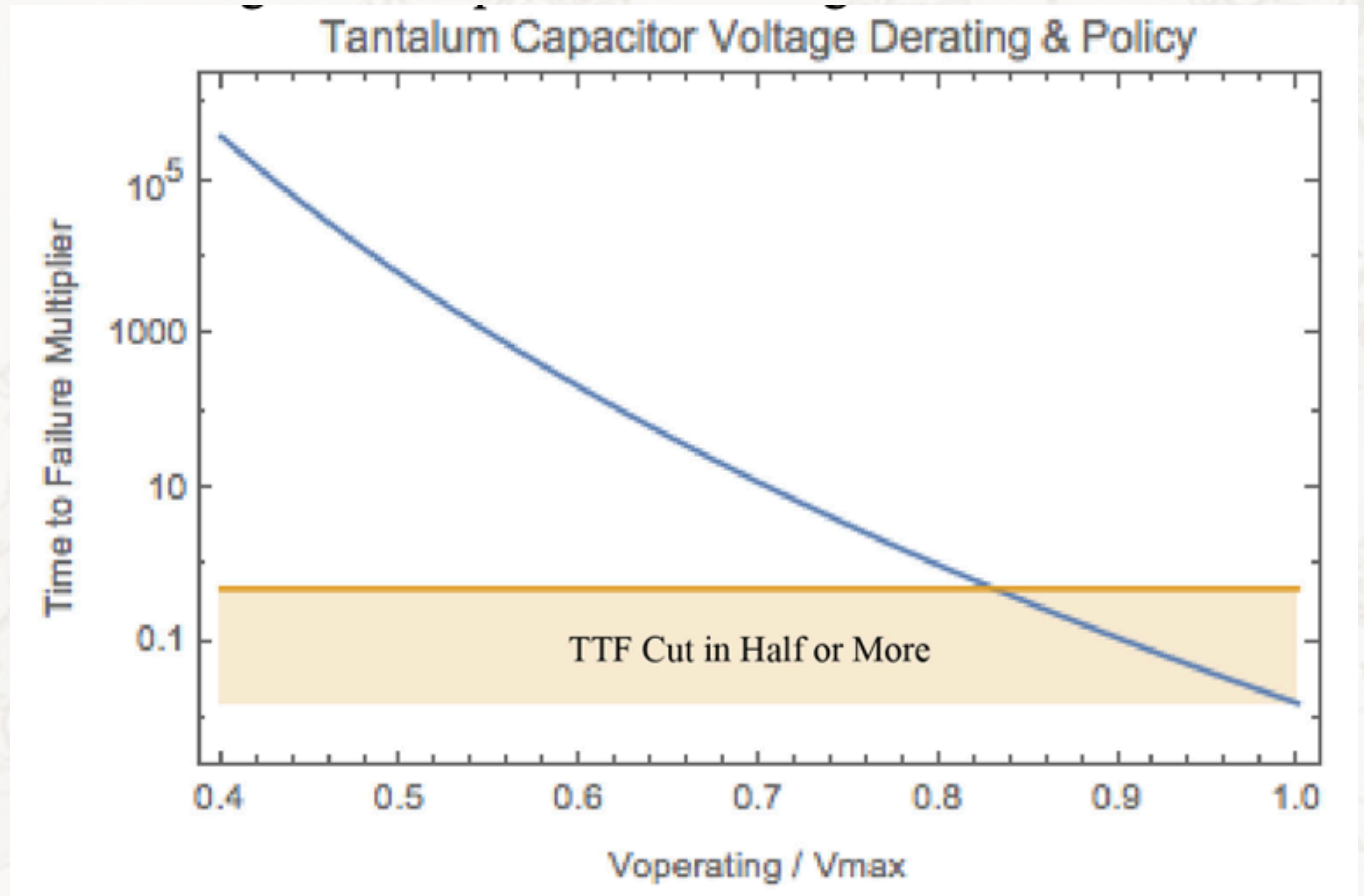
Methods



Derating Curves

Methods

Use a suitable time to failure model for each stress to plot the relationship between the multiplier and the derating ratio



Schenkelberg, Fred. "Creating meaningful derating graphics."

In *2017 Annual Reliability and Maintainability Symposium (RAMS)*, pp. 1-6. IEEE, 2017.

Is derating working

in your organization?

Additional Comments and Questions

Thanks

see more at AccendoReliability.com