

802.3 PoE Plus Maximum Power

By Derek Koonce

Support by:
Chad Jones, Cisco



PoE Plus PD Current Approach

- Limiting component of the whole systems
 - Wire – already in place
 - Connectors – already in place
- Non-limiting components
 - Magnetics – designed with new Plus device
 - Limits by cost and performance



PoE Plus – the MAXIMUM

- Fusing current – 24 AWG wire
 - Automatic Electric Company; Chicago, IL
 - $I = K * d^{3/2}$
 - $K=10,244$ for Cu
 - $d=0.0201''$ for 24 AWG
 - 29.2 Amperes

Clearly in excess of comfort for people, but establishes a maximum current.

PoE Plus Current based on Stds

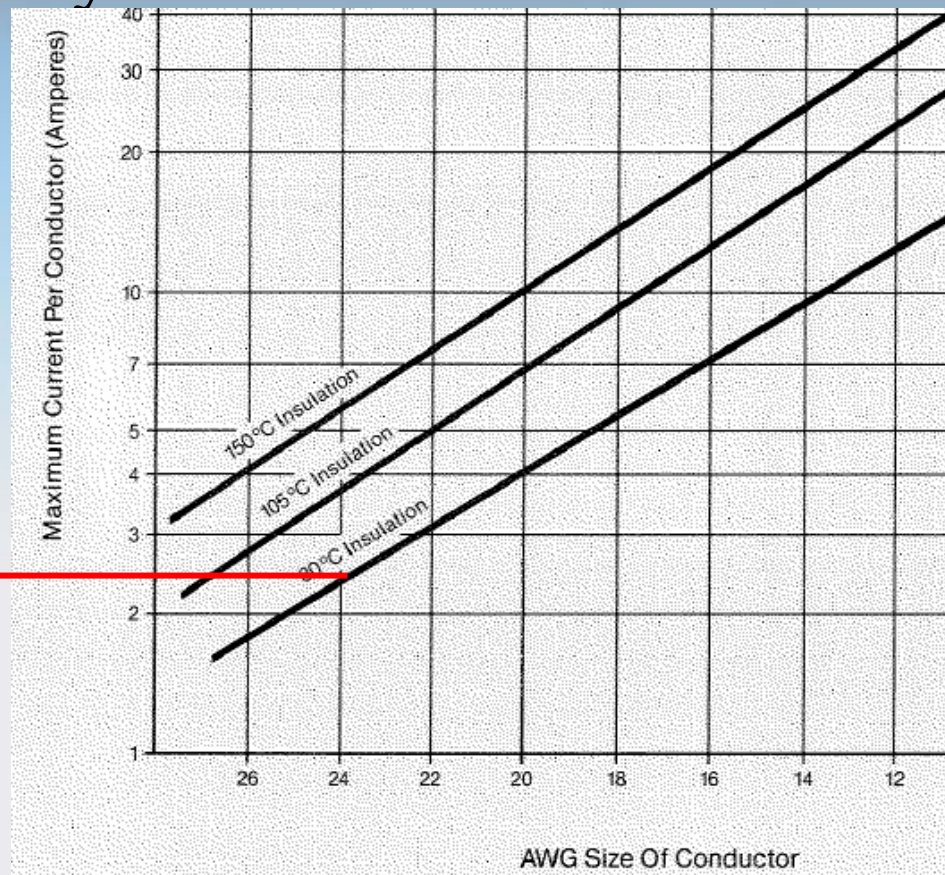
Two standards approach

- First approach
 - MIL-W-5088K, Amendment 1, 21 JAN 1986
 - Now listed as SAE AS50881
 - National Electric Code
- Second approach
 - NASA Technical Memorandum 102179

PoE Plus – MIL & NEC Standards

- Current capability based on National Electric Code
 - 25 °C
 - 60 Hz

2.5 A



PoE Plus – MIL & NEC (cont.)

- Now derate for wire count in bundle & altitude (20 k-feet)

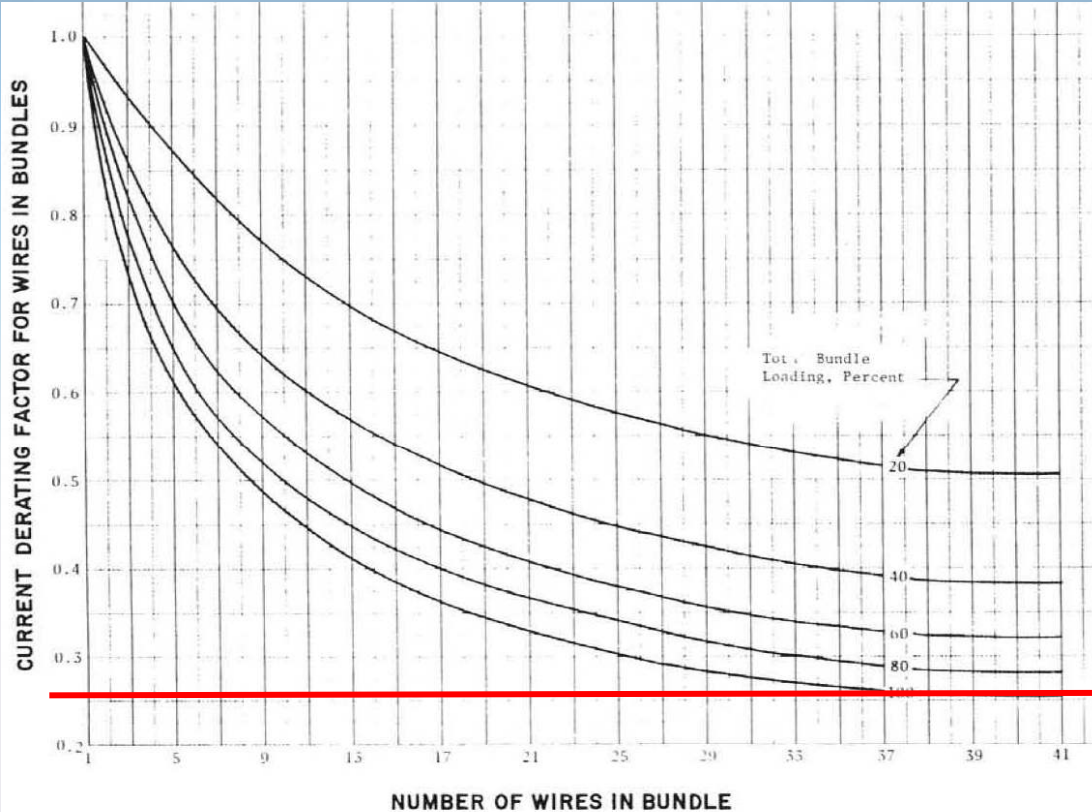


FIGURE 4. Bundle derating curves.
(See 3.8.8.1, 3.8.8.1.1, 6.7)

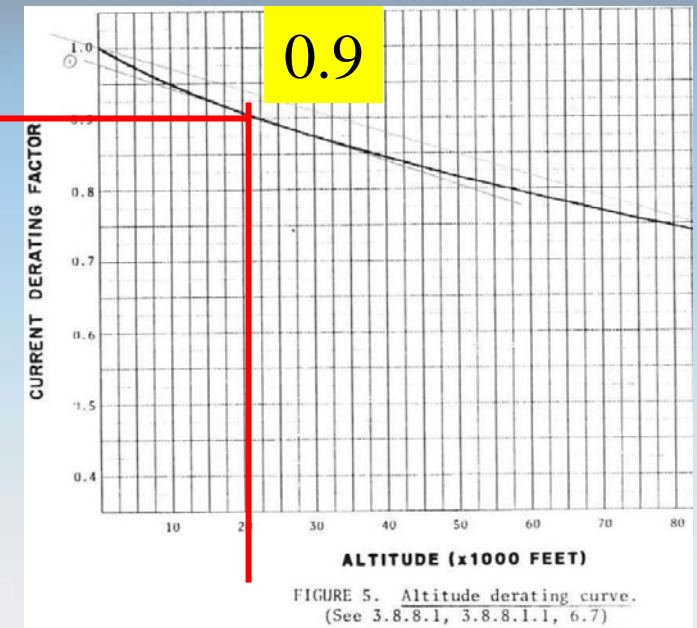


FIGURE 5. Altitude derating curve.
(See 3.8.8.1, 3.8.8.1.1, 6.7)

PoE Plus – MIL & NEC (cont.)

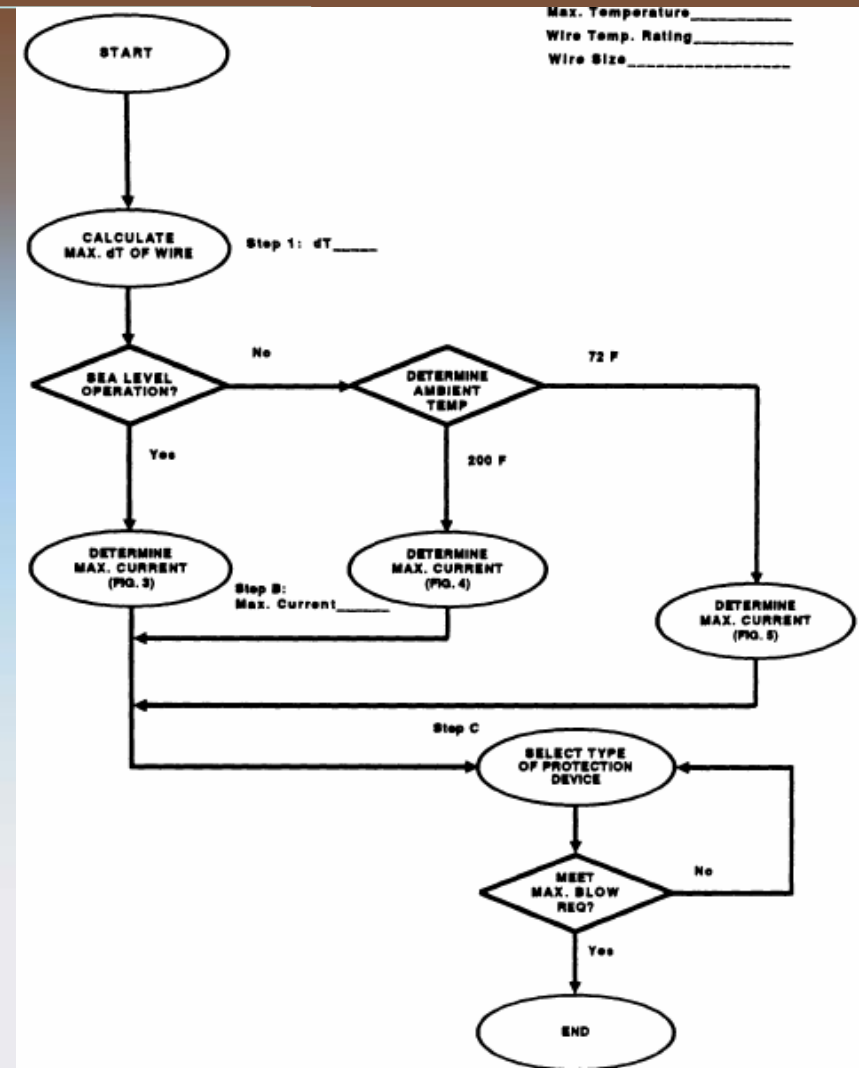
- Current for 24 AWG = 2.5A
- Derate for 41 wires in bundle at 100% loading = 0.25
- Derate for 20,000 feet = 0.9
- Result: $2.5\text{A} * 0.25 * 0.9 = \mathbf{0.56\text{ A}}$

PoE Plus Current based on NASA

- NASA Technical Memorandum 102179, June 1991
 - Selection of Wires and Circuit Protective Devices for STS Orbiter Vehicle Payload Electrical Circuits
 - ... systematic approach to the process of selecting proper wire size and circuit protection for generic spacecraft.
 - ... limited to two ambient pressures: 14.7 psi and 1×10^{-6} TORR
 - ... two temperature levels: 70 °F and 200 °F
 - ... graphs cover stranded, soft-drawn, nickel-plated copper wire in sizes #1/0 AWG to #26 AWG
 - Final selection requires bundle derating per MIL-W-5088 (K)

PoE Plus Current – NASA (cont.)

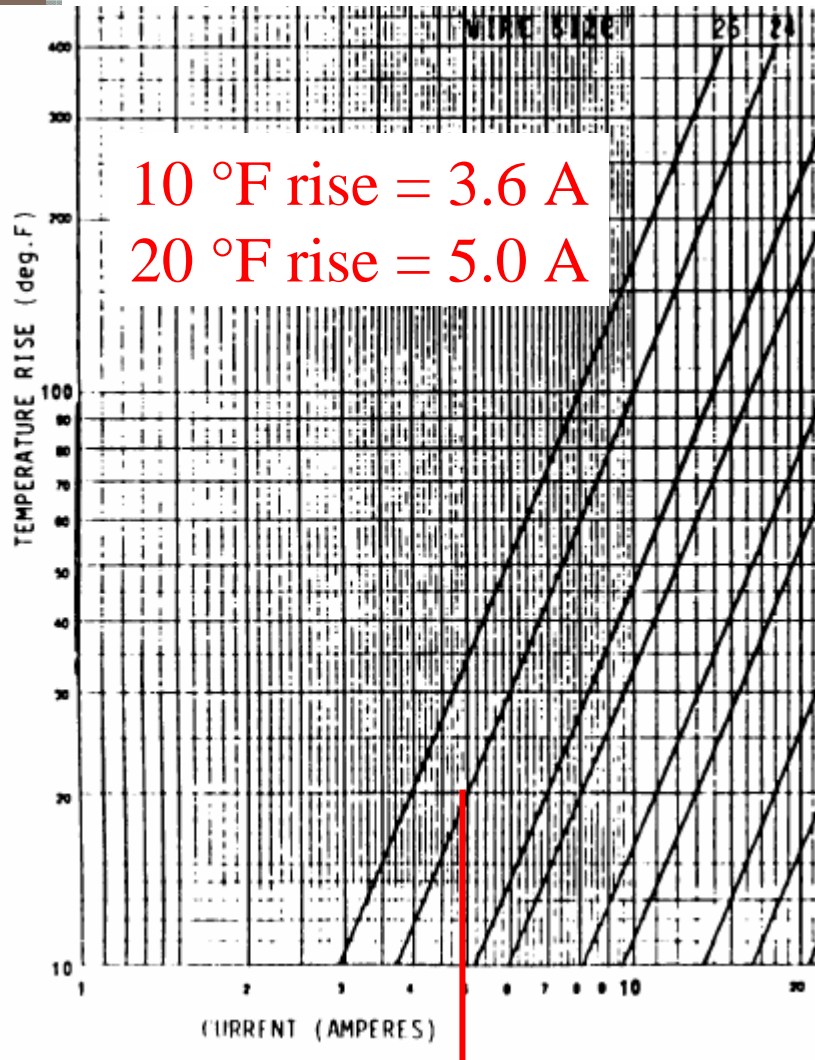
- Use NASA charts to select current
- Derate per MIL curve



PoE Plus Current – NASA (cont.)

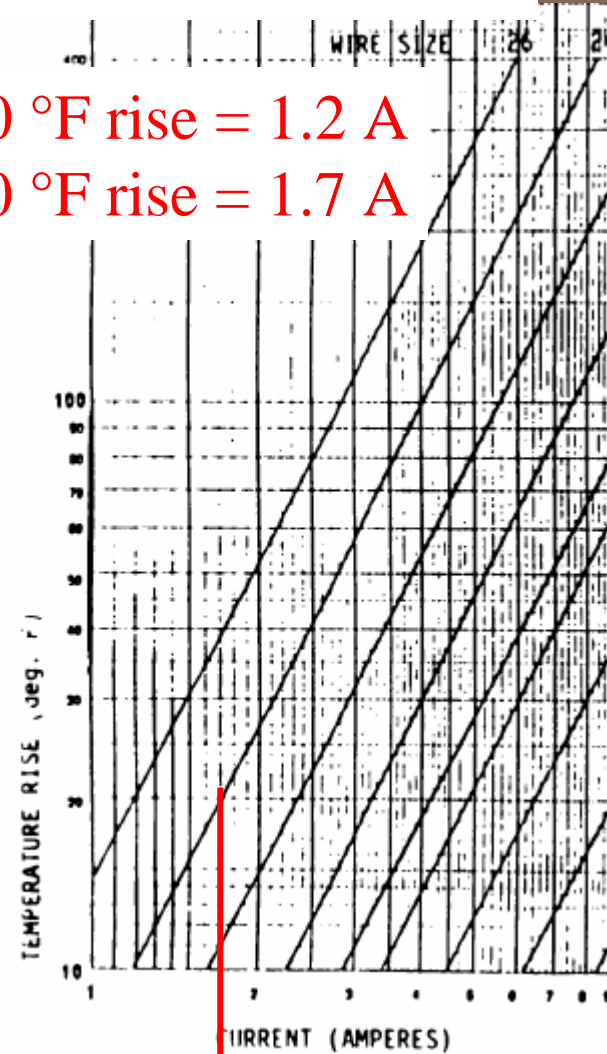
Pick choice and then derate 0.25 per MIL curves

Figure 3. Single Wire in Free Air



10 °F rise = 1.2 A
20 °F rise = 1.7 A

5. Single Wire in a Vacuum at 72°F Ambient



PoE Plus Resulting Power

		(4 pairs)
<u>Method</u>	<u>Current / wire</u>	<u>Power @ 51V</u>
MIL / NEC Stds	0.56 A	114 W
NASA (10°F, vacuum)	0.3 A	61 W
NASA (20°F, vacuum)	0.43 A	88 W

PoE Plus Current based on Cable-PD Power

Point past which power dissipated in cable exceeds power delivered to the load occurs when $P_{PD} = P_{Cable}$

- $I^2 * R = V_{PSE} * I - I^2 * R$
- $V_{PSE} * I = 2(I^2 * R)$

$$I_{Peak} = V_{PSE} / 2R$$

PoE Plus Current Cable-PD (cont.)

Calculating Max Power Delivered to the Load

- Know I, finding I^2R is simple:

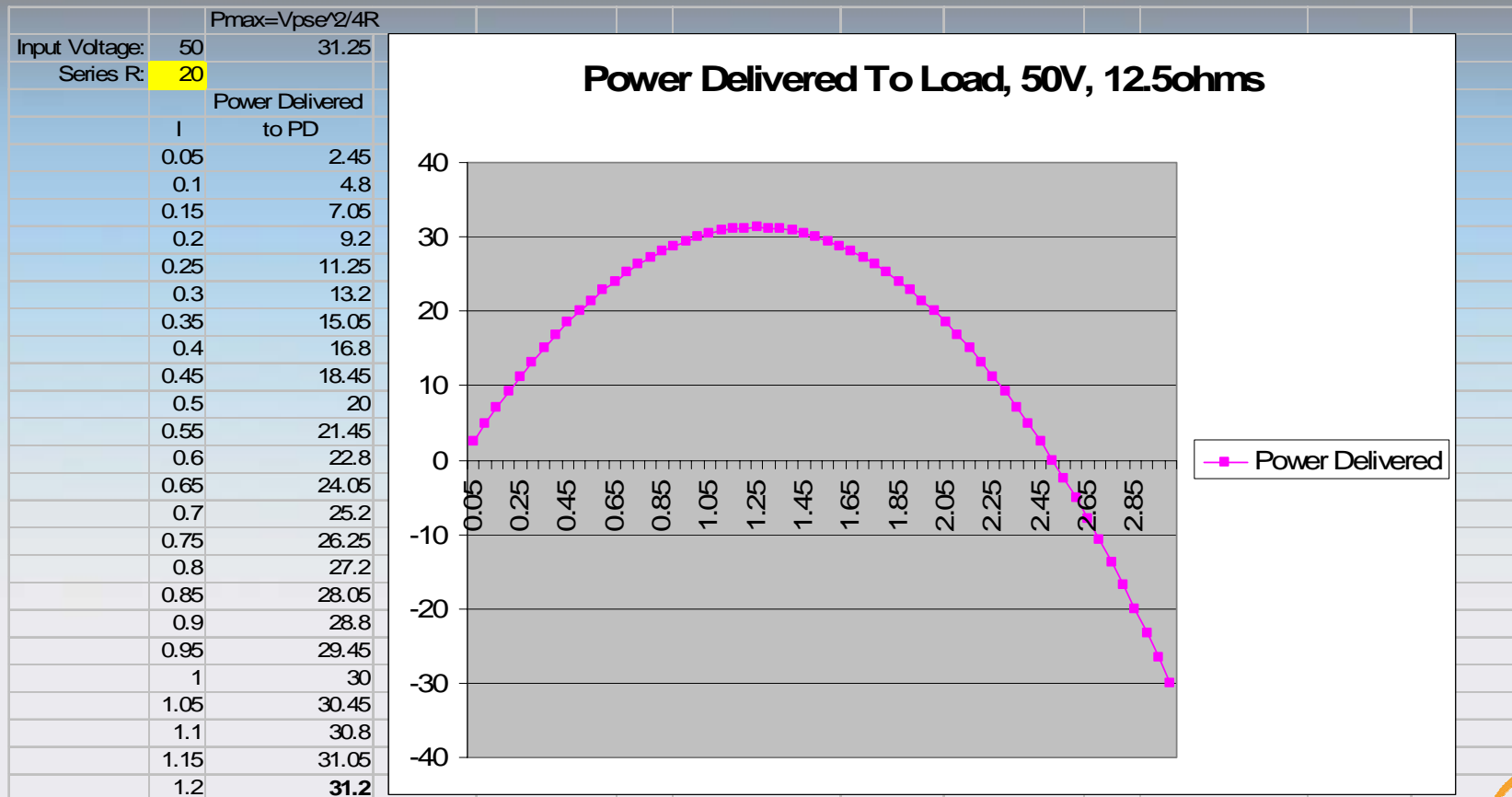
$$P_{\max} = (V_{\text{PSE}})^2 / 4R$$

- Example:

- Assuming 50V at PSE and 12.5ohm cable loss:
- $I_{\text{Peak}} = 50\text{V} / 2 * 12.5\text{ohm} = 2\text{A}$
- $P_{\max} = 50\text{V} * 50\text{V} / (4 * 12.5\text{ohm}) = 50\text{W}$

PoE Plus Current Cable-PD (cont.)

Spreadsheet Example





Discussion