



Arc Flash



It has been said that we only use 10 percent of our brain. Here is some information to help you fill the other 90 percent.
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The worksheets are from the class “How to Perform and Arc Flash Study” taught by Jim Phillips, P.E. and are used to simplify the manual calculation process. Detailed instructions are not provided since it is expected that the user has either attended the class or has a good working knowledge of arc flash calculations.

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The worksheets are derived from formulas published in IEEE 1584-2002 and as listed in Annex D of NFPA 70E – 2004.

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For information about available training courses or Jim Phillips, P.E. call: 1-800-874-8883 or visit: www.jimphillipspe.com

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To determine the incident energy at the worker location:

$$\text{Log } E_a = k_1 + k_2 + [1.081 \times (\log I_a)] + 0.0011G$$

$$E_a = 10^{\text{Log } E_a}$$

E_a is normalized for 0.2 s and 610 mm gap, for actual E :

$$E = 4.184 \times C_f \times E_a \left[\left(\frac{t}{0.2} \right) \times \left(\frac{610^x}{D^x} \right) \right]$$

I_a = arcing current in kA

G = conductor gap in millimeters (mm)

K_1 = open air or in a box factor

K_2 = ground / unground factor

C_f = calculation factor

X = distance exponent

t = arcing time in seconds from time current curves

Metric conversions: 1 Inch = 25.4 millimeters 0.24 cal / cm² = 1 Joule/cm²



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System Voltage (kV)	Type of Equipment	Typical Conductor Gap (mm)	Distance X-Factor
0.208 to 1	Open-air	10 – 40	2.000
	Switchgear	32	1.473
	MCC's and panels	25	1.641
	Cables	13	2.000
>1 to 5	Open-air	102	2.000
	Switchgear	13 – 102	0.973
	Cables	13	2.000
>5 to 15	Open-air	13 – 153	2.000
	Switchgear	153	0.973
	Cables	13	2.000

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Predicted Incident Energy at Working Distance (Empirically Derived – Use This Table) NFPA 70E D.8.3(a) and (b) Based on IEEE Std. 1584 tm 2002 Incident Energy Worksheet A - Normalized Energy, Must be Corrected with Worksheet B			
I _a = 3 Ph. Arcing Short Circuit Current kA G = Conductor gap (mm)		K1 = - 0.792 for open air arcs K1 = - 0.555 for arcs in a box	K2 = 0 for ungrounded or hi Z K2 = -0.113 for grounded
Step 1	1.0811 x Log (I _a)	1.0811 x Log ()	
Step 2	0.0011 x G	0.0011 ()	
Step 3	Add K1	K1 = - 0.792 for open air arcs K1 = - 0.555 for arcs in a box	-
Step 4	Add K2	K2 = 0 for ungrounded or hi Z K2 = -0.113 for grounded	-
Step 5	Log (E _a) = Step 1 + Step 2 + Step 3 + Step 4		
Total E _a ⁽¹⁾	10 ^{log (E_a)} For most calculators enter: 10 Y ^X (Step 5)		J/cm ²

(1) Energy is normalized for arc time of 0.2 Seconds and working distance of 610 mm (24 inches)

E_a must be adjusted for other than 0.2 Seconds and working distance of 610 mm buy using worksheet B

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Adjustment from Normalized Data of Predicted Incident Energy at Working Distance (Empirically Derived NFPA 70E D.8.3(a) and (b) Based on IEEE Std. 1584tm 2002

Incident Energy Worksheet B - For Correcting Normalized Energy Calculated in Worksheet A

D = working distance in mm (Inches x 25.4)		CF = 1.0 for V > 1kV	X = distance exponent -Table D.8.2
t = arcing time (Seconds) from time current curve		CF = 1.5 for V ≤ 1kV	E _a = normalized incident energy in J/cm ² from worksheet A
Step 1	$610^x / D^x$	() / ()	
Step 2	t / 0.2	() / 0.2	
Step 3	4.184 x Cf x E _a	4.184 () x ()	
Total E	Step 1 x Step 2 x Step 3		J/cm ²
Total E	Total E in cal/cm ² = 0.24 x () J/cm ²		cal/cm ²