

ETAP FAQ # 15

What is the comparison of NFPA 70E-2000 an IEEE 1584-2002 standards for Arc Flash Analysis?

Description: Arc Flash Analysis calculates the potential arc flash hazard distance and incident energy to which workers could be exposed to while working on or near electrical equipment.

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The ETAP Arc Flash Analysis module estimates the arc flash incident energy under a bolted three-phase short circuit fault and determines the flash protective boundary to live parts for shock protection. The flash protection boundary is the distance a worker not wearing flame-resistant personal protective equipment (PPE) must stay away from a job site involving a possible hazardous arc flash. The arc flash analysis is conducted in conjunction with the ANSI/IEEE and IEC Device Duty calculations.

There are two industry standards relating to Arc Flash:

- National Fire Protection Agency (NFPA) 70E-2000
- IEEE 1584-2002

The ETAP Arc Flash Analysis has the following program features:

- Automatically report a table of arc flash analysis for every faulted bus
- Automatically computes bolted short circuit current for every faulted bus
- Determines the flash protection boundary as a function of arc duration for enclosed and open box configurations
- Determines incident energy exposure (cal/cm²) as a function of distance
- Determines incident energy exposure (cal/cm²) as a function of arc location
- Determines incident energy exposure (cal/cm²) in open air
- Determines incident energy exposure (cal/cm²) in a cubic box

Comparison of NFPA 70E-2000 and IEEE 1584-2002 Standards

	NFPA 70E-2000	IEEE 1584-2002
Unit of Measure	Calories/cm ²	Calories/cm ²
Voltage Range	208 V - 600 V	208 V - 600 V (Empirical)
Voltage Range		15 kV+ (Lee Method)
Current Range	16 kA - 50 kA	0.7 kA - 106 kA
Arc Duration Range	1/4 Cycle - 120 Cycles	1/4 Cycle - 120 Cycles
Installations	Open Air, Cubic Box	Open Air, Cubic Box
Arc Distance	18" - 48"	18" - 48"

Summary of a Results Comparison Between NFPA 70E-2000 and IEEE 1584-2002 Standards

Calculations using the NFPA 70E-2000 and IEEE 1584-2002 standards were done on the same system. The system contained buses at voltage levels varying from 208 volts to 35,000 volts. Based upon the above table, the NFPA standard is designed to specifically handle 208-600 volts and 16-50 kAsc. Therefore, values shown in the 208 V case, 4.16 kV case, and 35 kV case are all extrapolated results for NFPA 70E-2000.

Summary Table

		NFPA 70E-2000	IEEE 1584-2002
208 V, 18"	Open Air, 12.96 kAsc	Conservative	Non-Conservative
208 V, 18"	Cubic Box, 12.96 kAsc	Conservative	Non-Conservative
480 V, 18"	Open Air, 28.99 kAsc	Similar	Similar
480 V, 18"	Cubic Box, 28.99 kAsc	Non-Conservative	Conservative
600 V, 18"	Open Air, 19.50 kAsc	Non-Conservative	Conservative
600 V, 18"	Cubic Box, 19.50 kAsc	Non-Conservative	Conservative
4.16 kV, 18"	Open Air, 27.71 kAsc	Non-Conservative	Conservative
4.16 kV, 18"	Cubic Box, 27.71 kAsc	Non-Conservative	Conservative

For 15 kV and above, the results for open air and cubic box calculations are similar, therefore, we are displaying only the open air values during this comparison.

35 kV, 18"	28.01 kAsc	Non-Conservative	Conservative
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Several trends are displayed via the results of the calculation.

Regardless of the standard selected, the incident energy exposure increases as a function of increased voltage, and decreases as a function of increased distance from the source.

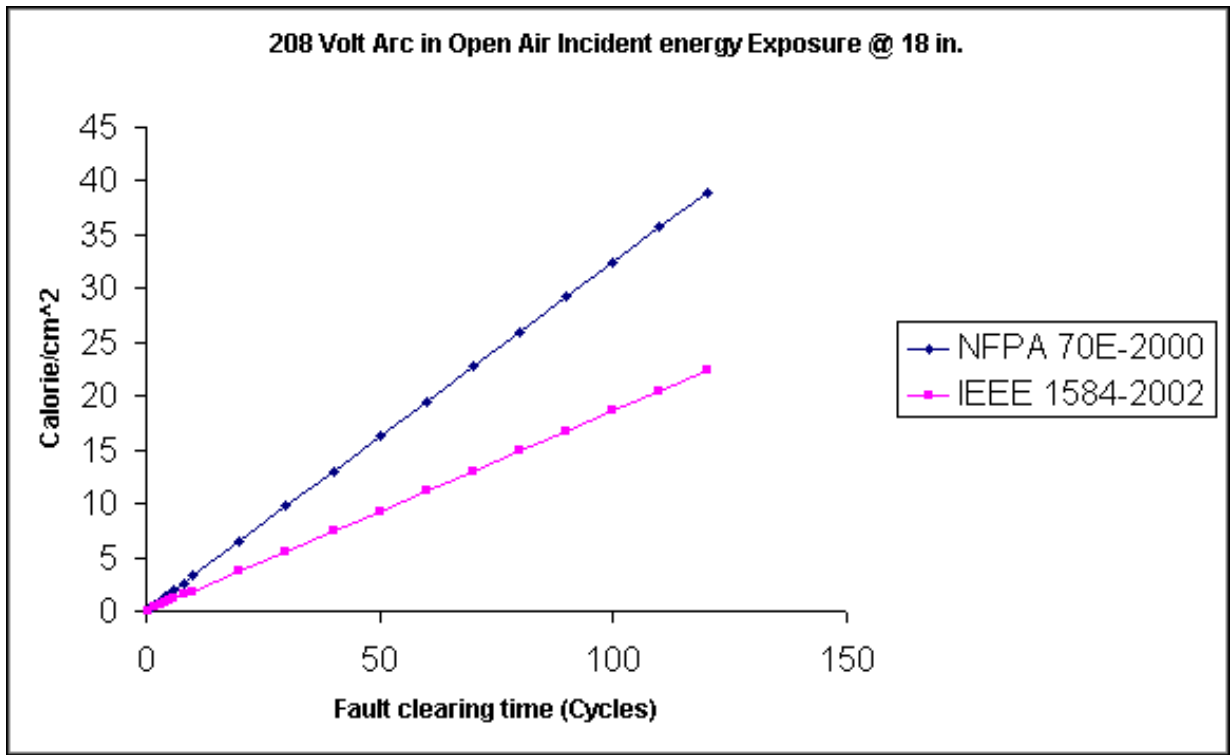
The variation in results due to an enclosure (cubic box) is most severe at lower voltages. As the voltage levels increase, the results become similar. Mathematically, above 15 kV, the formulae become so similar that only the open air results are displayed.

At a fixed distance of 18", NFPA is conservative at lower voltage levels, and becomes less conservative as voltage is increased. The cross-over point between NFPA and IEEE is seen in the test case at 480 volts in open air. IEEE results become conservative at the higher voltage levels.

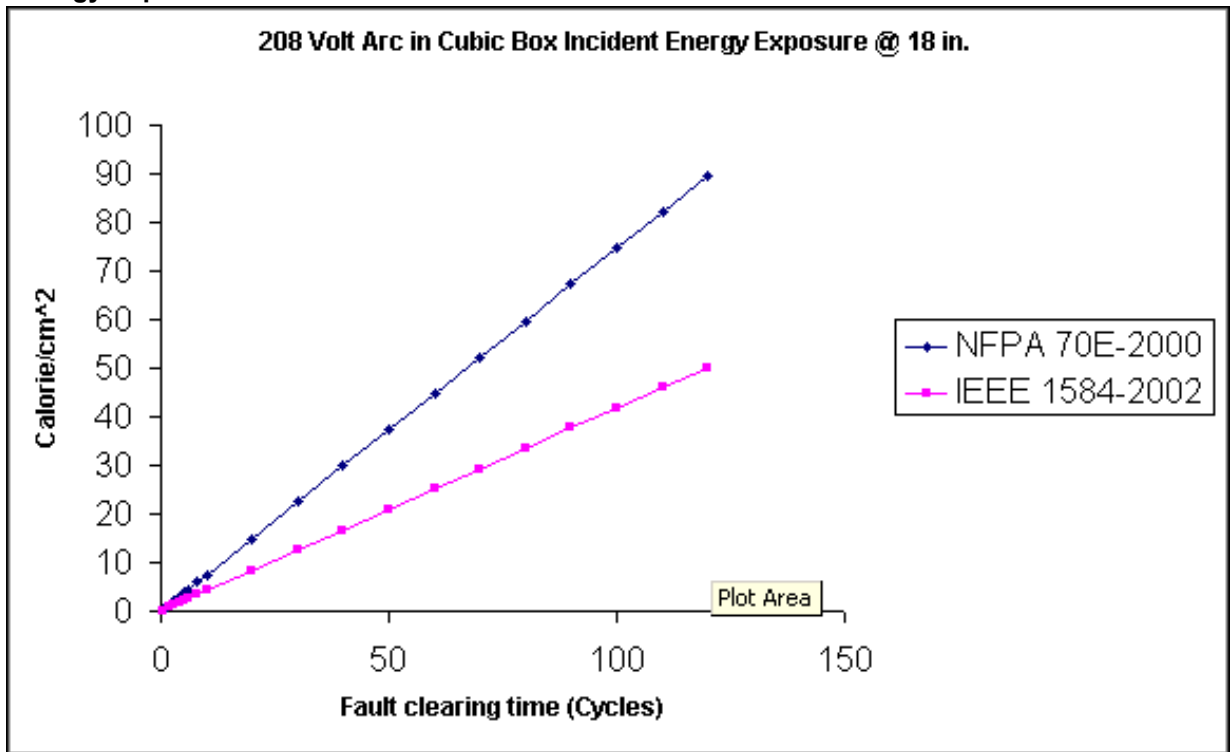
Plots

208 V Open Air

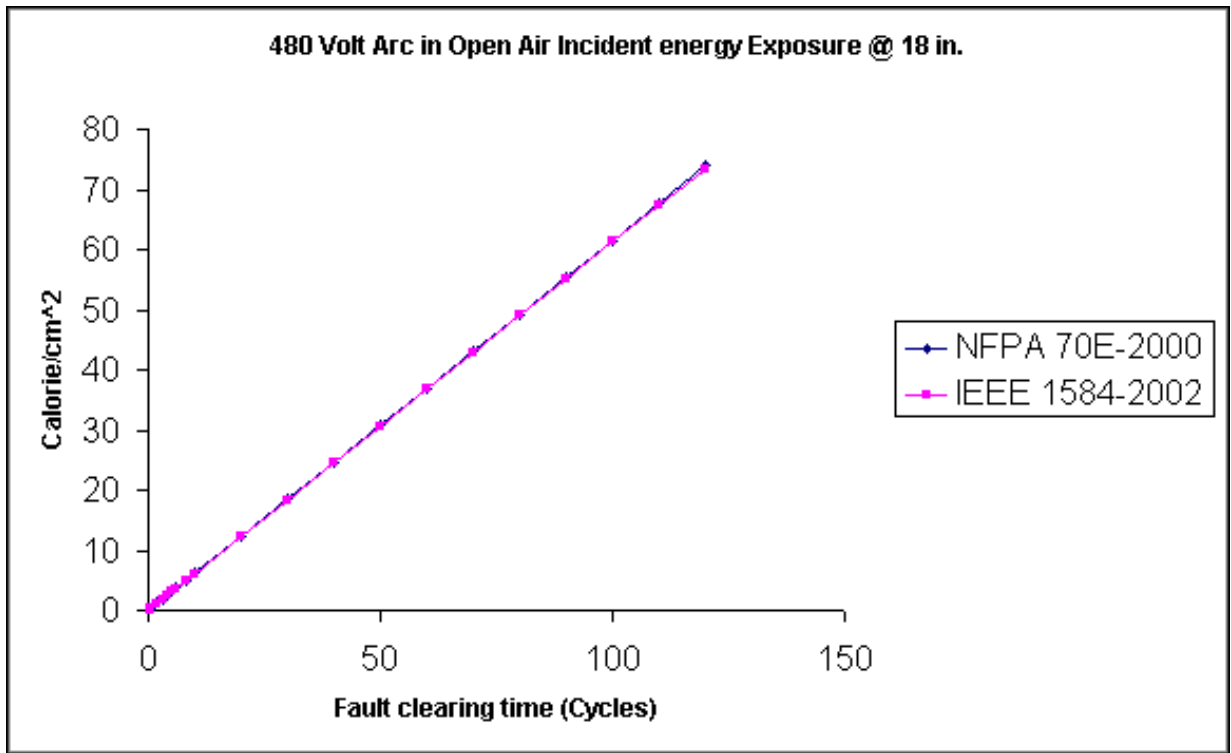
Incident Energy Exposure as a Function of Time for an Arc in Open Air at 208 Volts and a Distance of 18 Inches



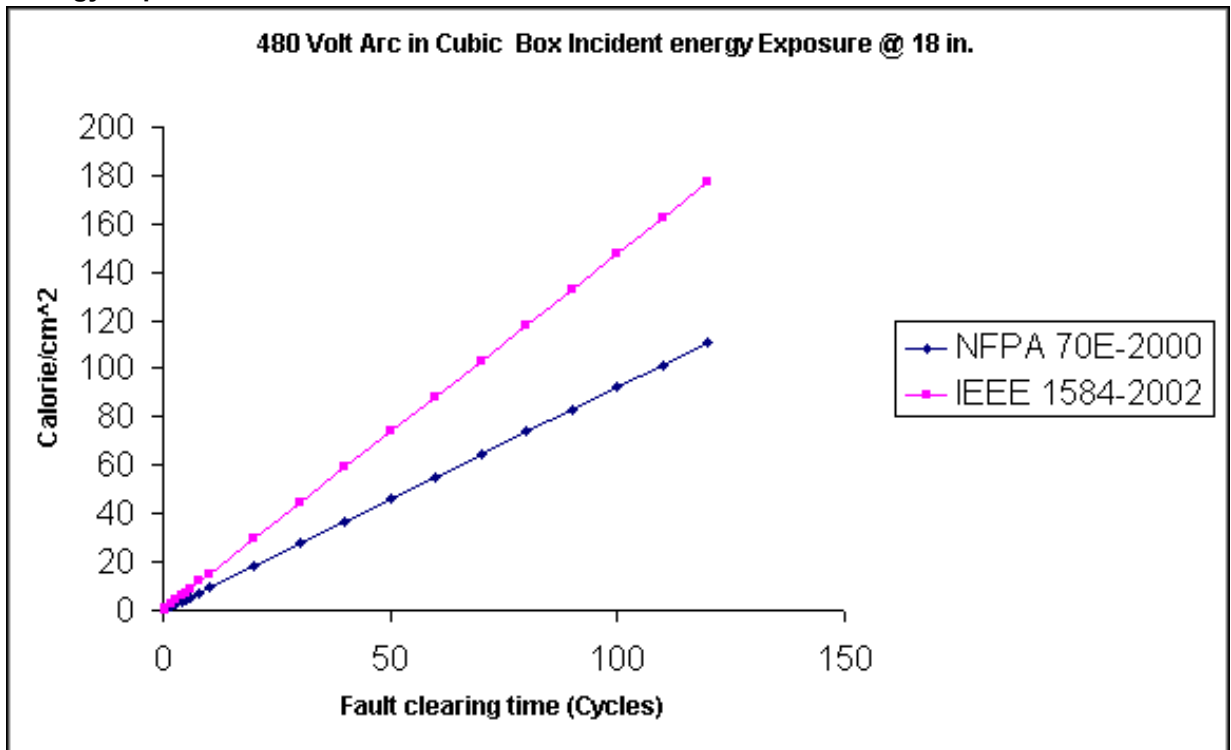
208 V Cubic Box
Incident Energy Exposure as a Function of Time for an Arc in Closed Box at 208 Volts and a Distance of 18 Inches



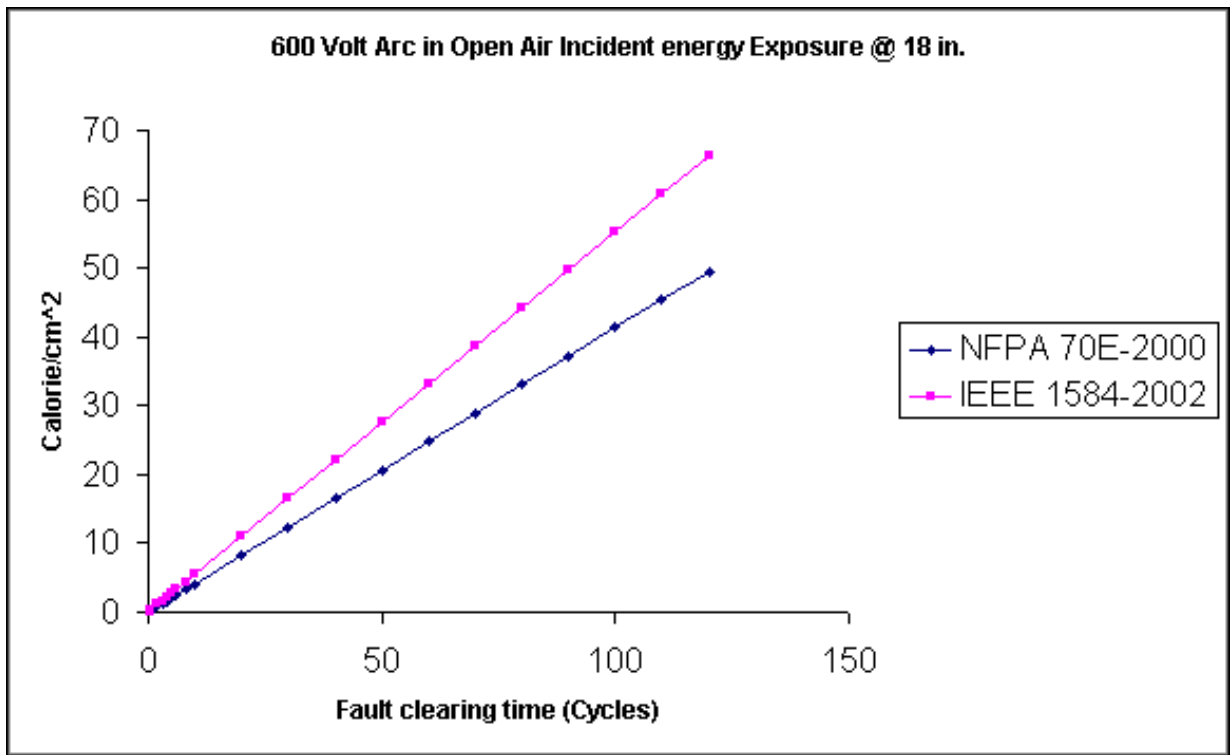
480 V Open Air
Incident Energy Exposure as a Function of Time for an Arc in Open Air at 480 Volts and a Distance of 18 Inches



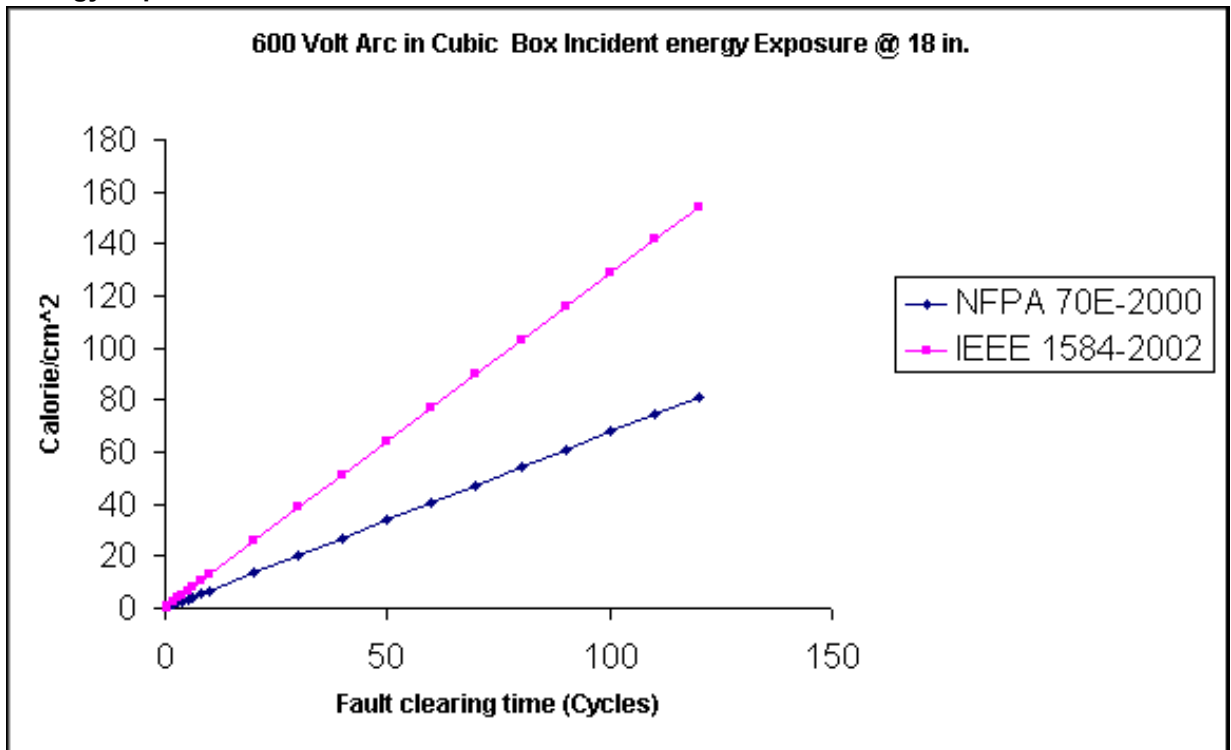
480 V Cubic Box
Incident Energy Exposure as a Function of Time for an Arc in Closed Box at 480 Volts and a Distance of 18 Inches



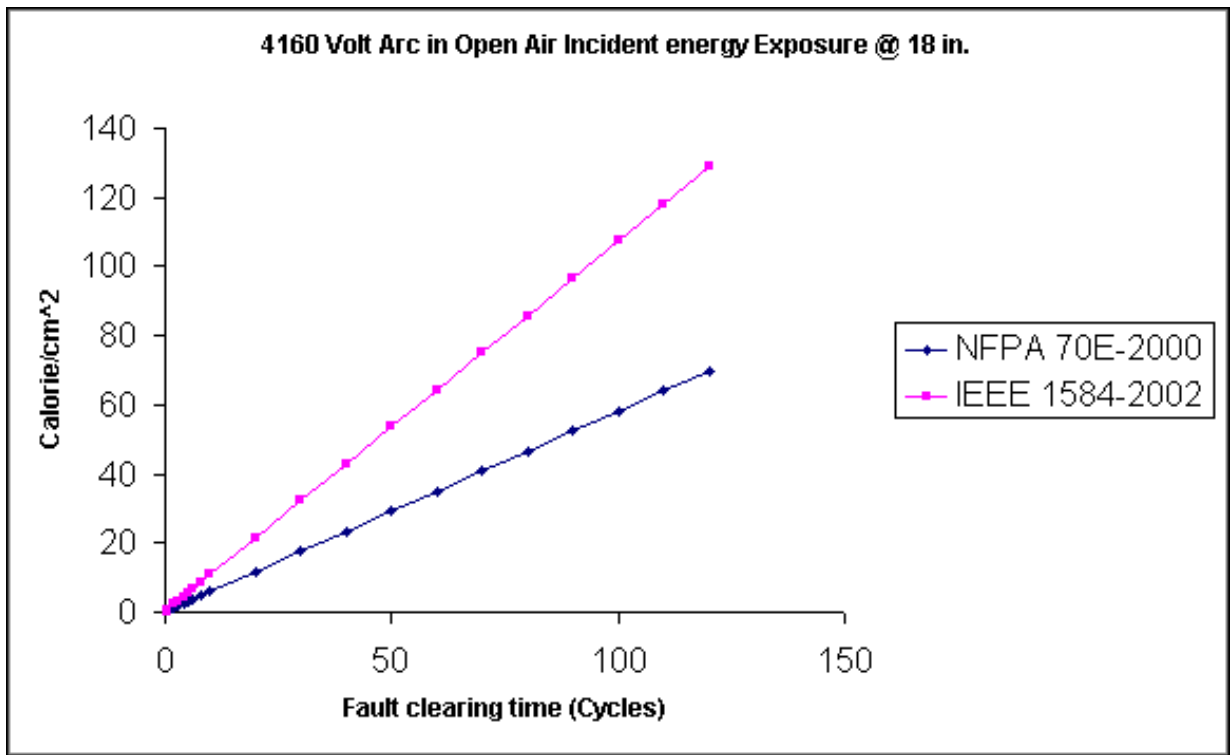
600 V Open Air
Incident Energy Exposure as a Function of Time for an Arc in Open Air at 600 Volts and a Distance of 18 Inches



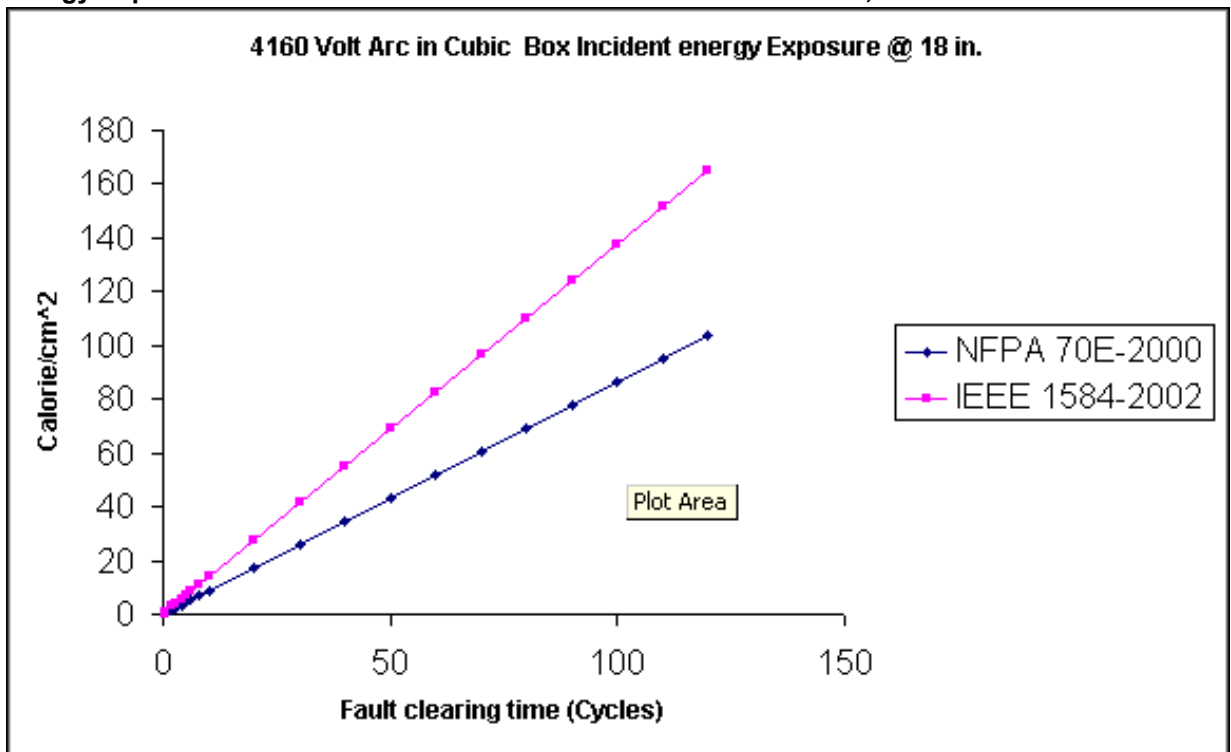
600 V Cubic Box
 Incident Energy Exposure as a Function of Time for an Arc in Closed Box at 600 Volts and a Distance of 18 Inches



4.16 kV Open Air
 Incident Energy Exposure as a Function of Time for an Arc in Open Air at 4160 Volts and a Distance of 18 Inches



4.16 kV Cubic Box Incident Energy Exposure as a Function of Time for an Arc in Closed Box at 4,160 Volts and a Distance of 18 Inches



35 kV Incident Energy Exposure as a Function of Time for an Arc in Open Air at 35 kV and a Distance of 18 Inches

For voltage levels above 15,000 Volts the theoretically derived Lee Method is used by IEEE 1584-2002, the incident energy exposure equations used for the NFPA 70E are only valid below 600 Volts.

The values shown below are well outside the allowable range.

