



Medium-Voltage Arc Flash

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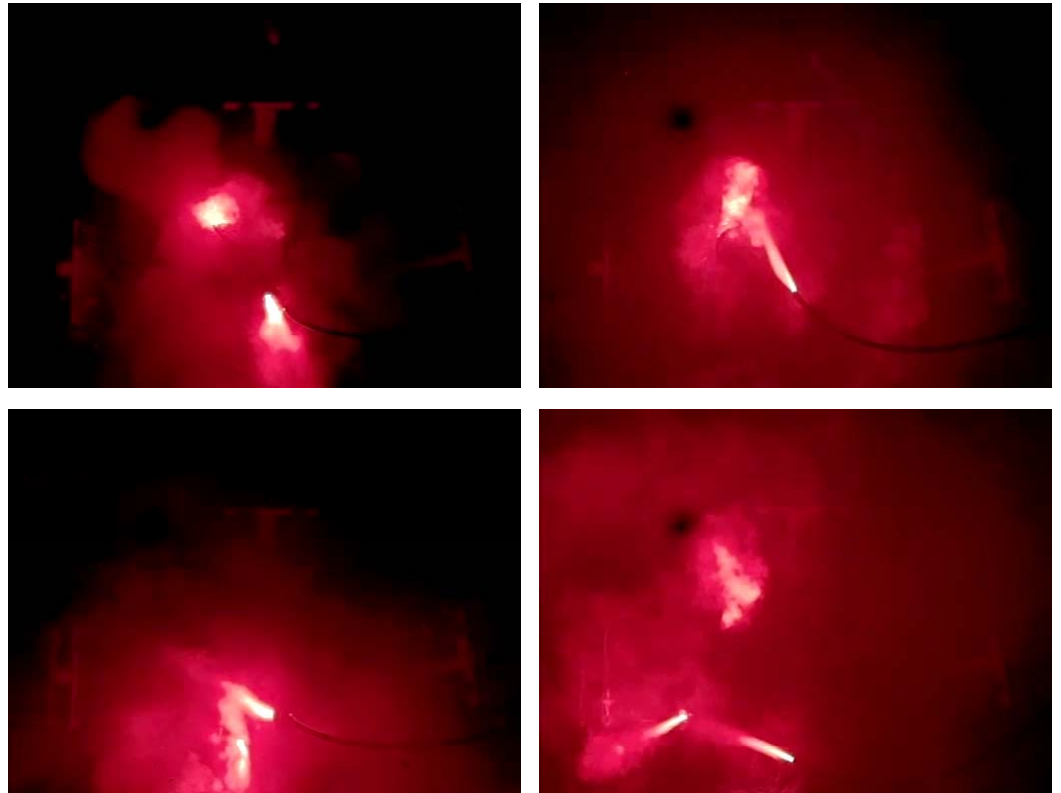
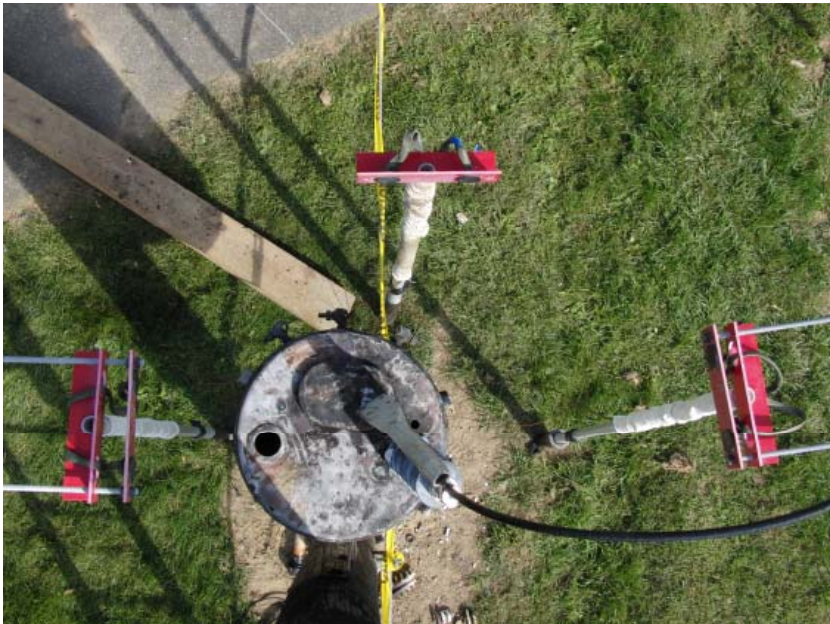




Filtered View

Heat Measurements

3.7 kA, 1.4 sec, 22" distance



Lenox overhead arc flash test

2009-09-10, Test 3

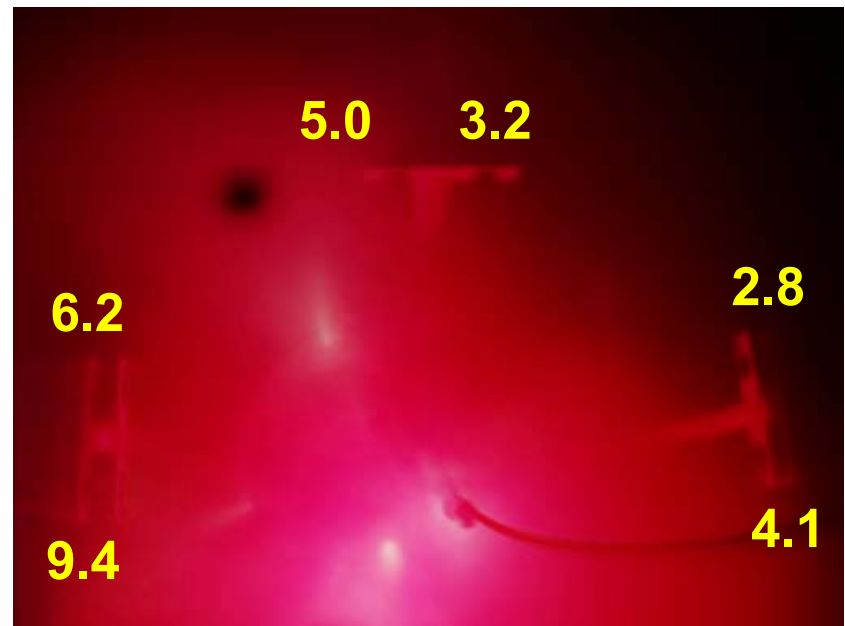
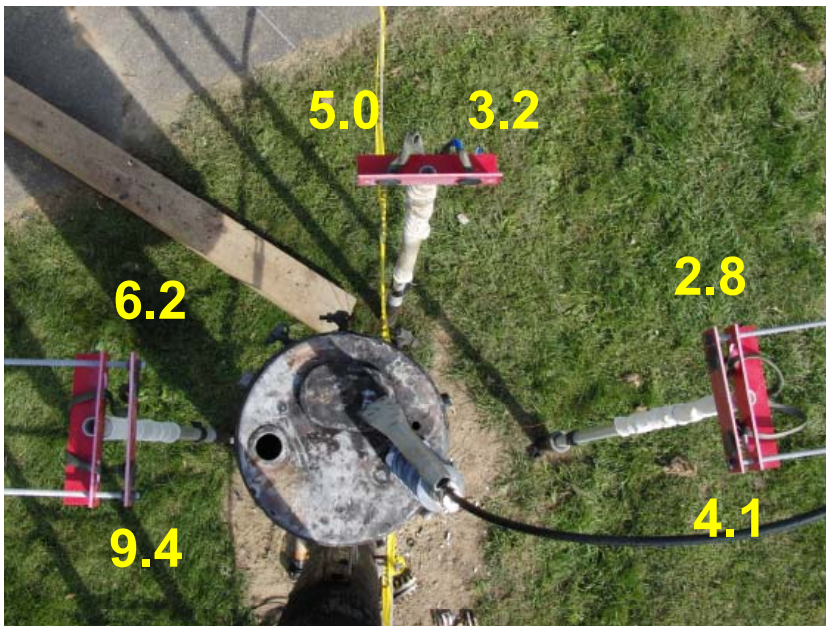
Transformer bushing test

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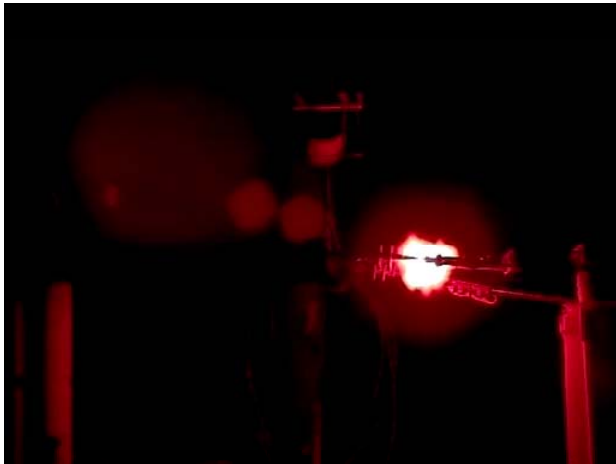
Incident Energies for the Previous Event

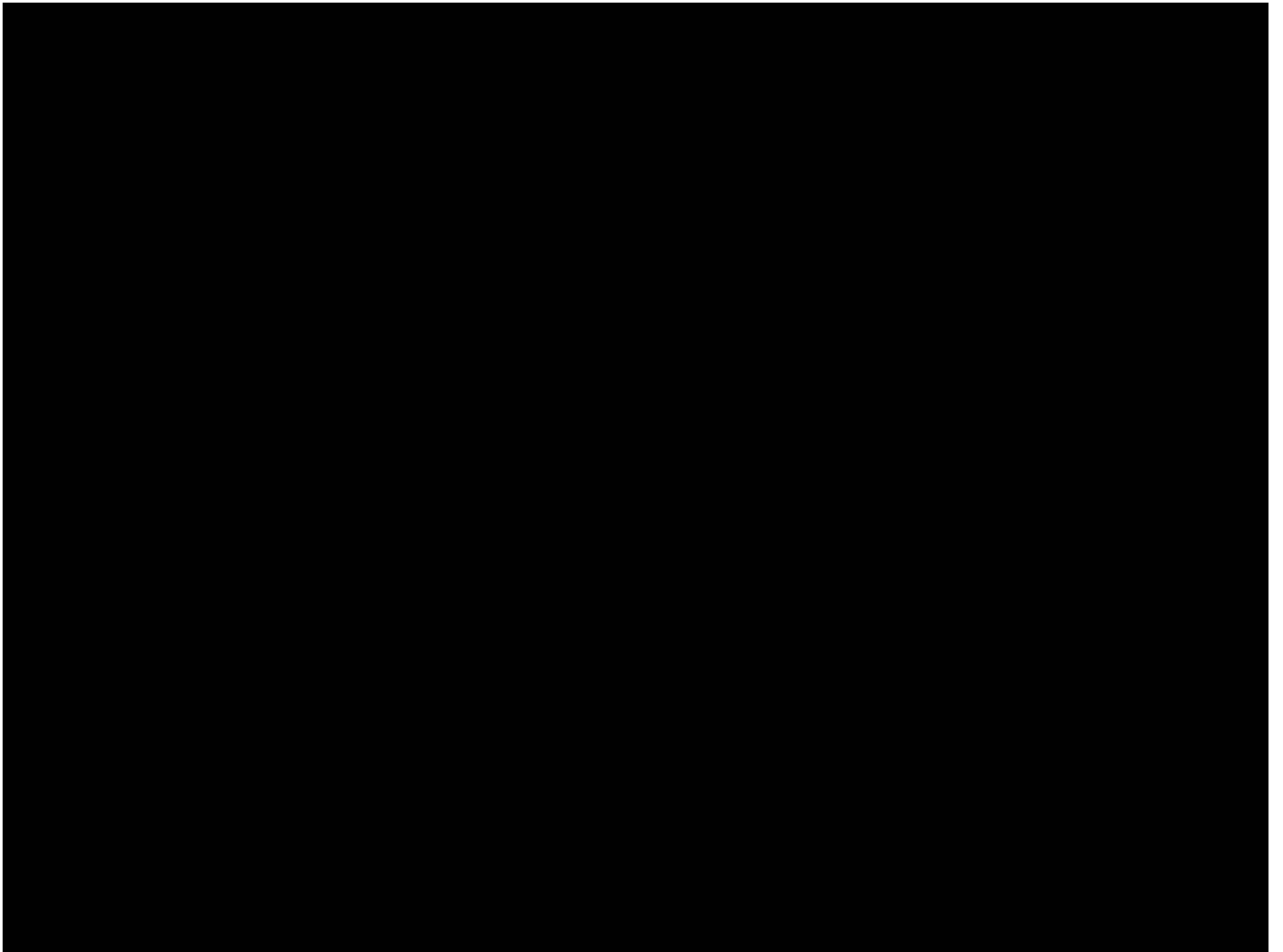
ARCPRO: 2" → 2.3 cal/cm²
 6" → 5.3 cal/cm²
 12" → 8.9 cal/cm²

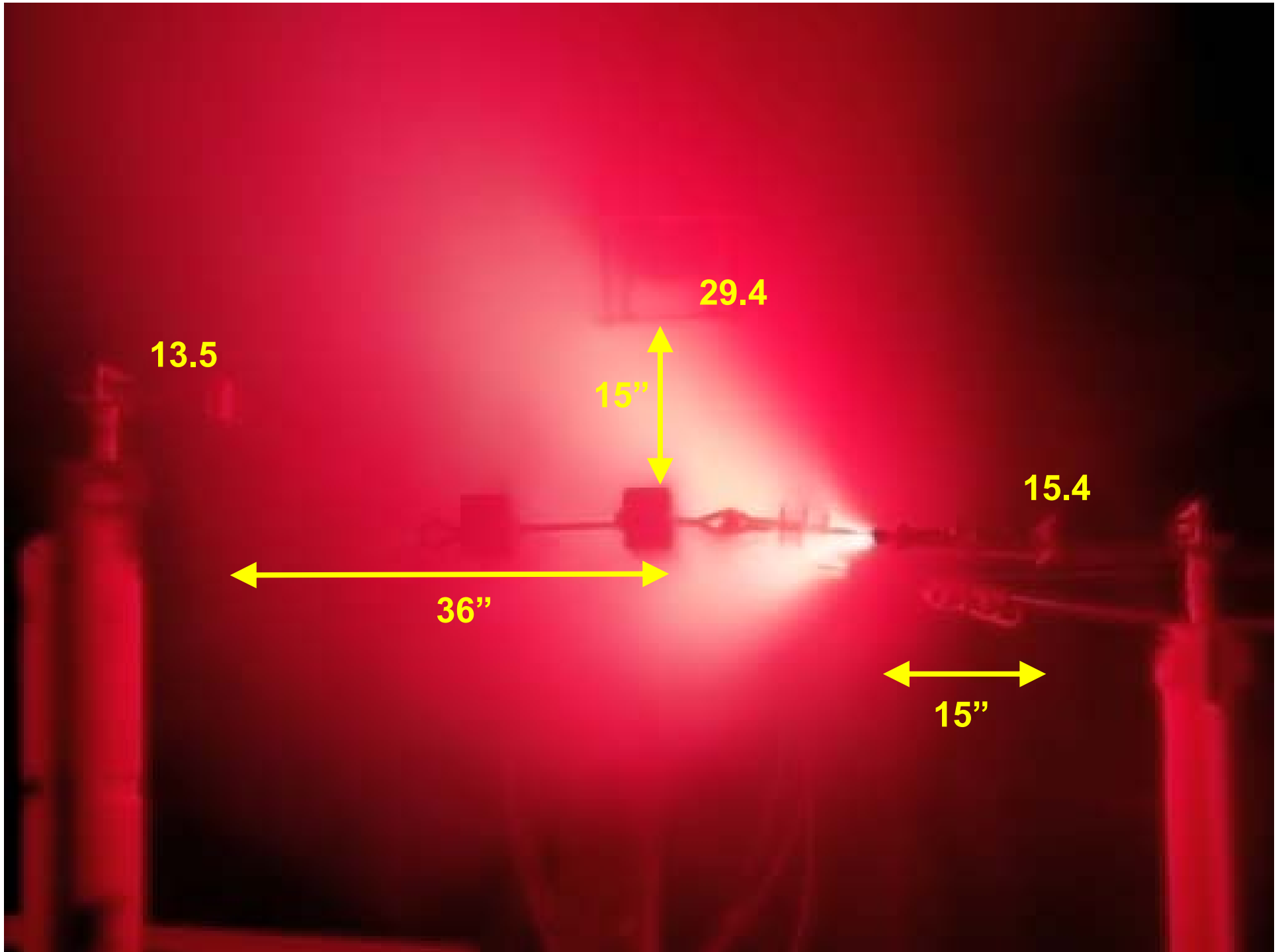


Dead-End 3-Phase Fault

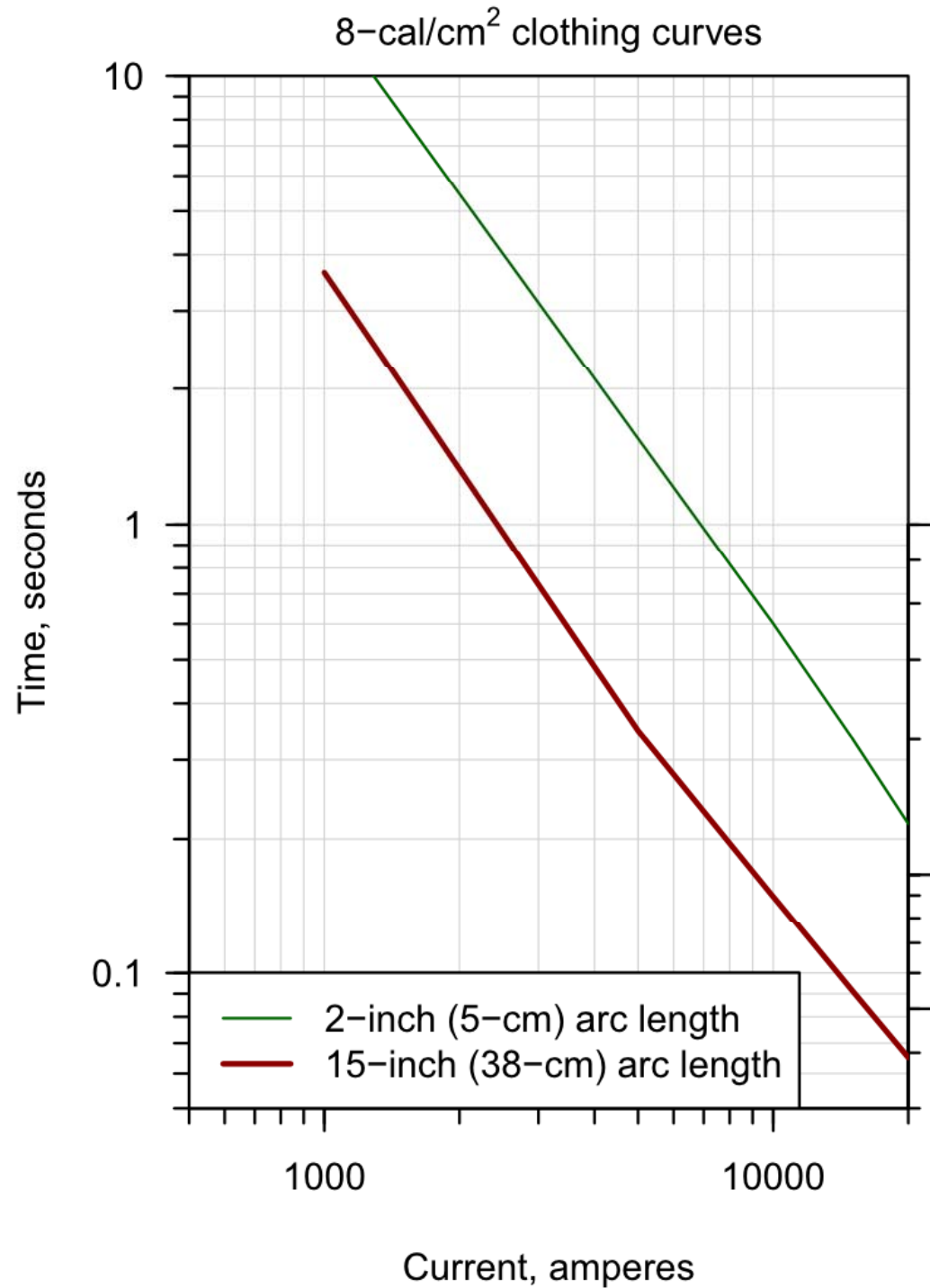
3 kA, 1.3 sec







Impact on Clothing Curves



PMH Switch Testing at PG&E

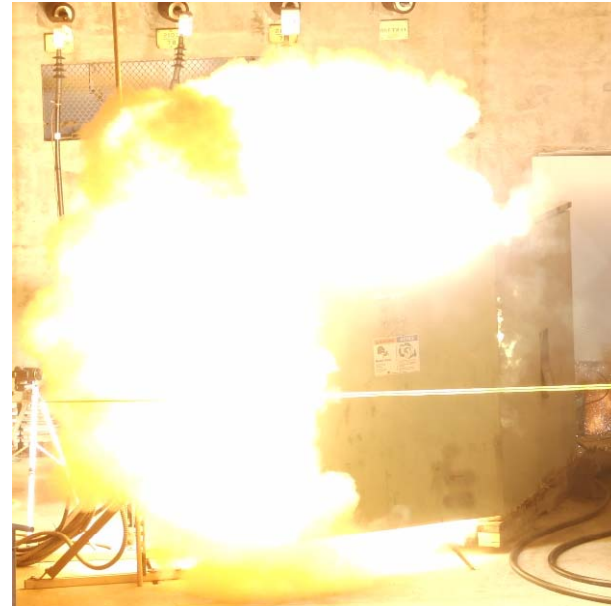
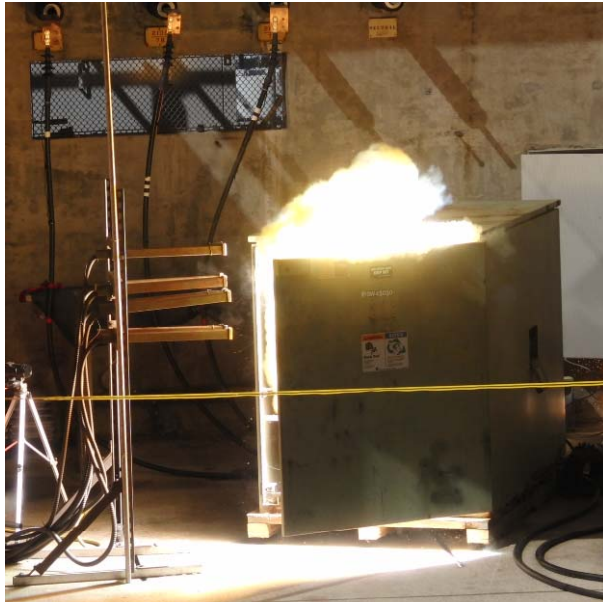


Fault Initiation





Test with a Partial Door Opening



Heat rate = 16.9 cal/cm²/sec

working distance = 48"

$I_{\text{arc}} = 6.3 \text{ kA}$

$V = 21 \text{ kV}$

Another Test with the Door Opened Properly



Heat rate = 19.5 cal/cm²/sec
working distance = 48"

$I_{\text{arc}} = 6.0 \text{ kA}$

$V = 21 \text{ kV}$

Comparisons of Tests and Predictions

Test:

48" working distance

20 cycles duration

6.3 kA

Results: 6 cal/cm²

ARCPRO

4" arc

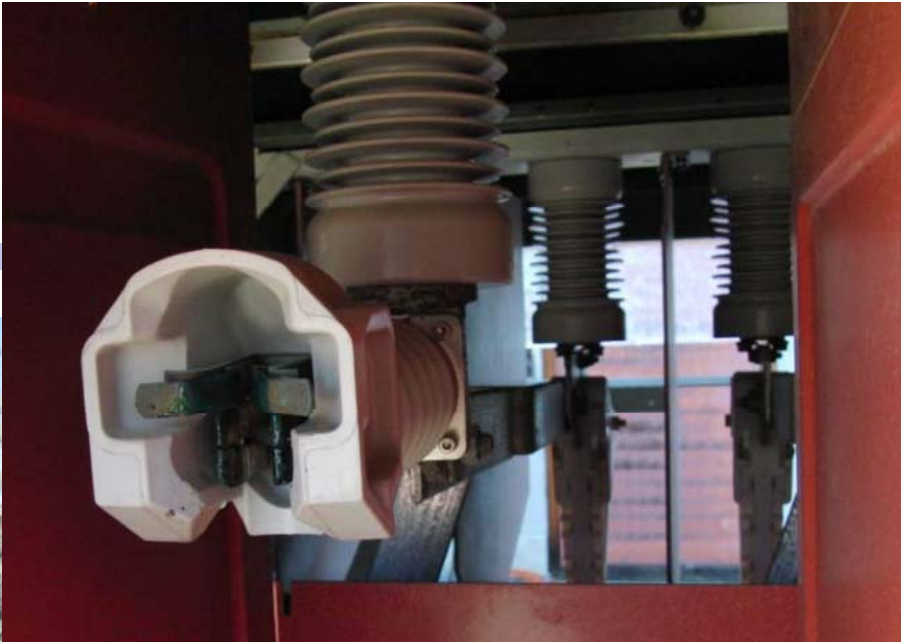
Results: 0.38 cal/cm²

IEEE 1584

Grounded; switchgear

Results: 1.9 cal/cm²

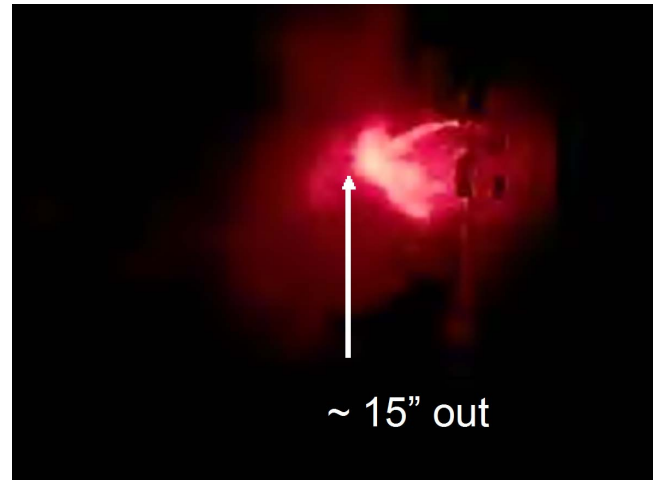
PMH-9 Tests



Test Results



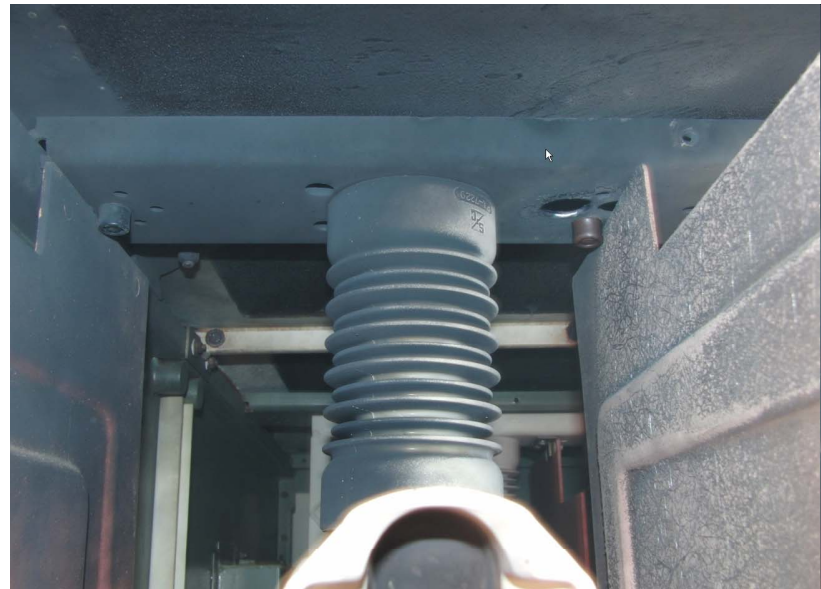
21" out



~ 15" out

Single Phase versus Multiphase Faults

- Unit #1 – Went multiphase 20 cycles into the third test
- Unit #2 – Went multiphase 2.3 cycles into its third test
- After that, assume single phase faults



Incident Energy as a Function of Current, Working Distance, and Duration

$$E = 3547 \frac{I^{1.50}}{d^{2.10}} t^{1.35}$$

E = Incident energy, cal/cm²

I = fault current, kA

d = working distance, inches

t = duration, sec

Fault Progression



t = 0 cycles



t = 4 cycles



t = 8 cycles



t = 12 cycles

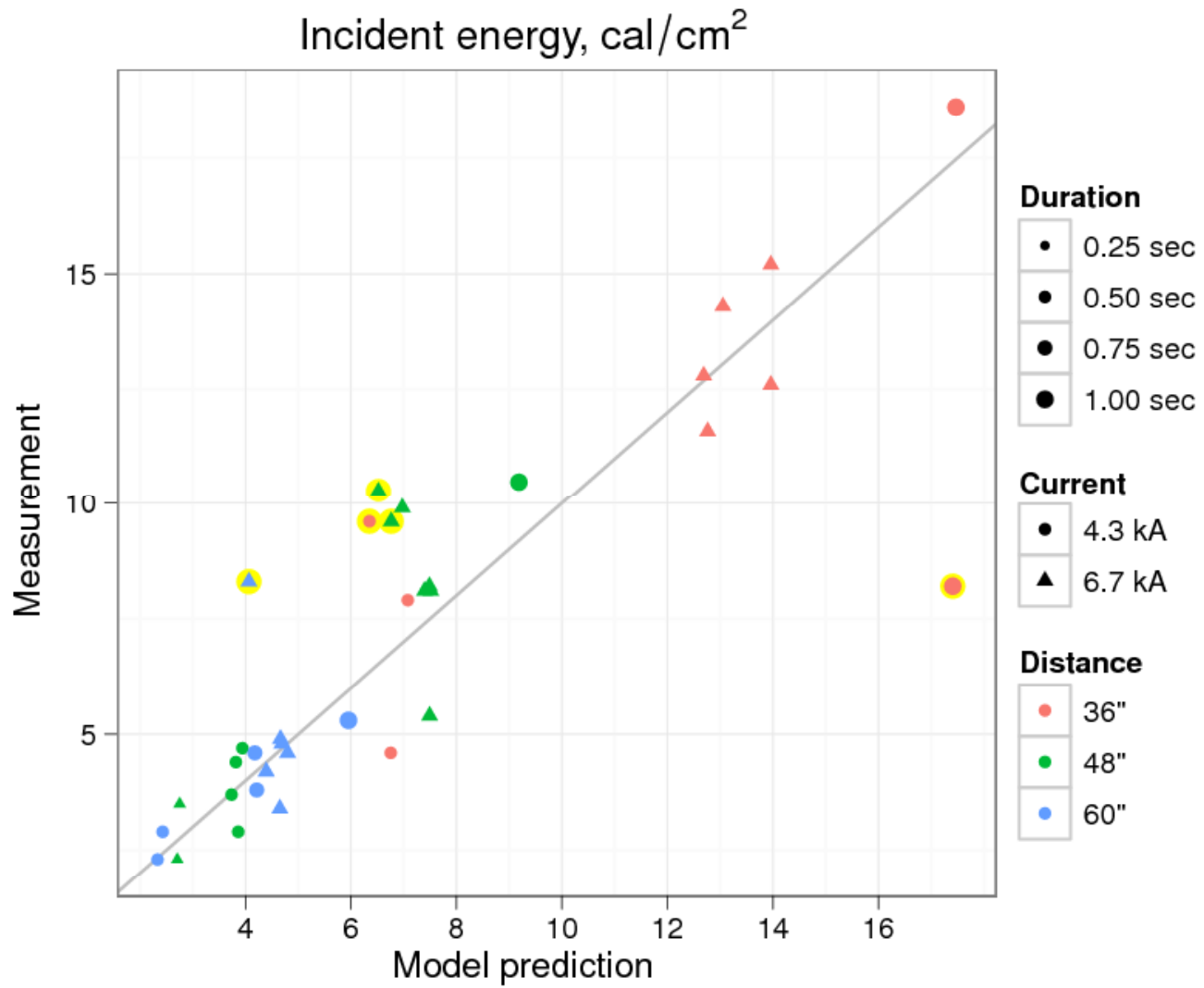


t = 16 cycles



t = 20 cycles

Model Results



Clothing Curves

8-cal clothing

For 48" distance:

$$t = \frac{4.07}{I^{1.11}}$$

