Arc-Calc
Dominion Energy

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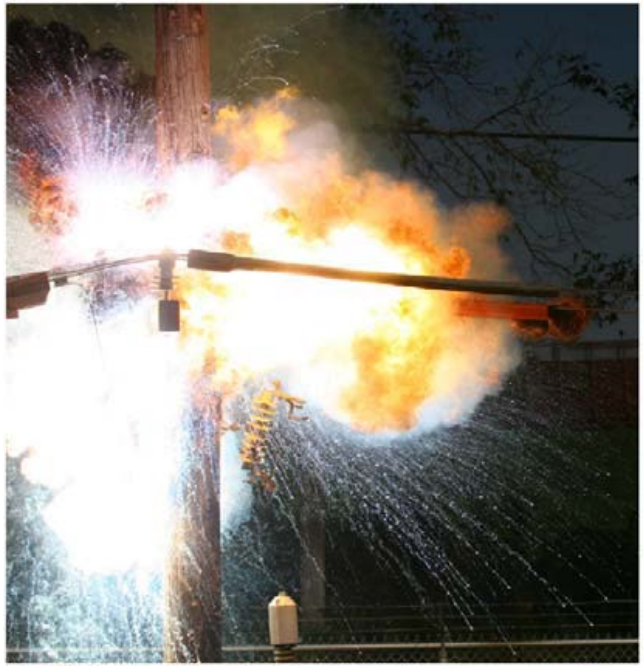
Dominion Energy

Why?

- Personnel Safety
- Ensure PPE rated above maximum energy
- Strive for incident energy < 4 cal/cm^2
- NESC Requirement

Assumptions

- Phase cover up will result in a Single Phase-to-Ground fault
- Open-air fault on bare conductor
- Homogeneous Line Impedance
- No fault impedance at Reach Point



IEEE – “Arc Flash Analysis Approaches for Medium-Voltage Distribution”

Arc Flash Calculations Methods

System voltage (V)	Arc gap (in)	Incident energy, cal/cm^2			
		ARCPRO	Privette Heat Flux	Lee Method	IEEE 1584
Open, single-phase arc, line-to-ground voltages given					
277	1	2.86	1.81	1.9	3.2
7200	2	4.61	3.60	49.5	5.3
14400	4	7.34	7.11	99.1	171.9
19940	6	9.51	10.45	137.2	237.2

IEEE – “Arc Flash Analysis Approaches for Medium-Voltage Distribution”

NESC 410-2 'Clothing and clothing systems' – 1.1-46 kV

Phase-to-phase voltage (kV)	Fault current (kA)	4-cal system	8-cal system	12-cal system
		Maximum clearing time (cycles)	Maximum clearing time (cycles)	Maximum clearing time (cycles)
1.1 to 15	5	46.5	93.0	139.5
	10	18.0	36.1	54.1
	15	10.0	20.1	30.1
	20	6.5	13.0	19.5
15.1 to 25	5	27.6	55.2	82.8
	10	11.4	22.7	34.1
	15	6.6	13.2	19.8
	20	4.4	8.8	13.2
25.1 to 36	5	20.9	41.7	62.6
	10	8.8	17.6	26.5
	15	5.2	10.4	15.7
	20	3.5	7.1	10.6
36.1 to 46	5	16.2	32.4	48.6
	10	7.0	13.9	20.9
	15	4.3	8.5	12.8
	20	3.0	6.1	9.1

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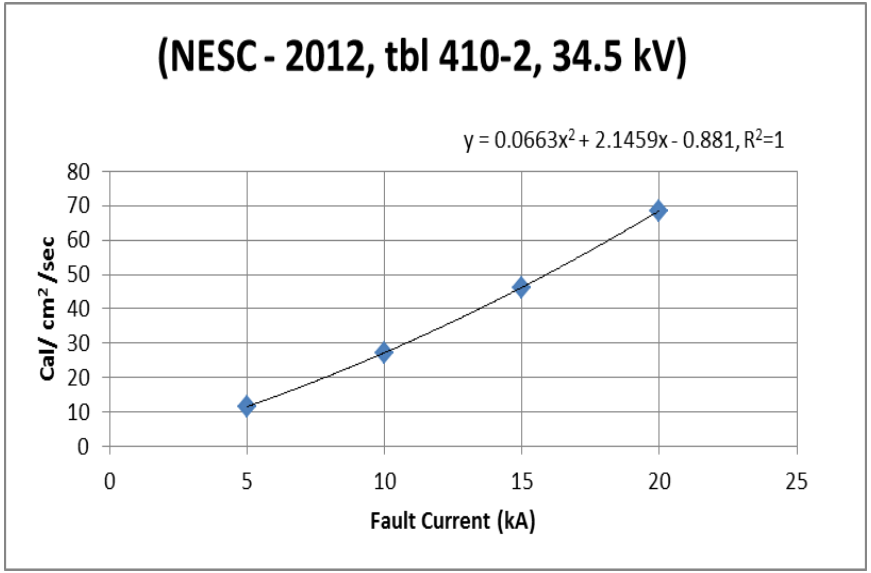
NESC 410-2 'Clothing and clothing systems'
25.1 - 36 kV

Fault kA	Duration cycles	4 Cal System (* cal/ cm² / sec)
5 kA	20.9	11.5 cal/ cm² / sec
10 kA	8.8	27.3 cal/ cm² / sec
15 kA	5.2	46.2 cal/ cm² / sec
20 kA	3.5	68.6 cal/ cm² / sec



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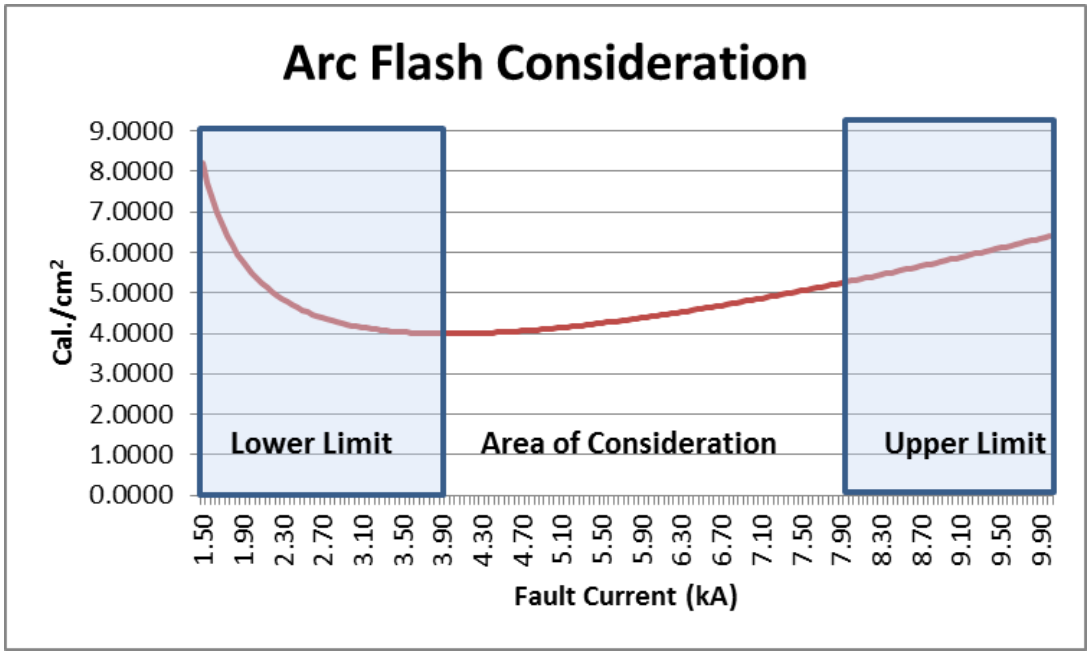
Possible energies
Very Inverse U3 Curve (PU-1000A, TD-1.0)



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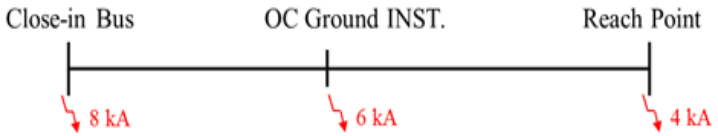
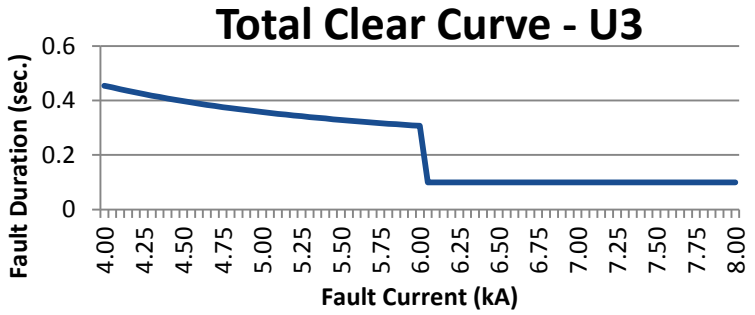
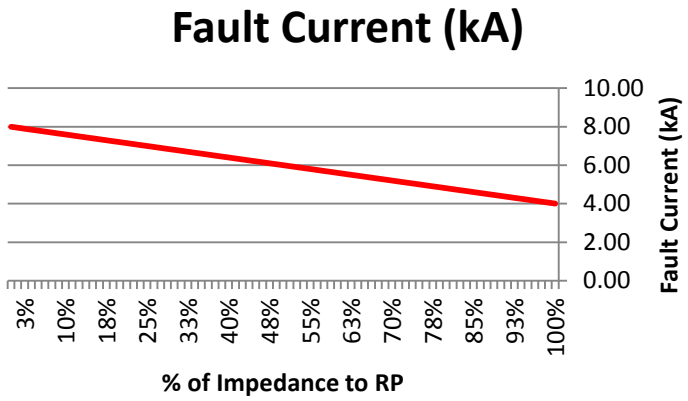
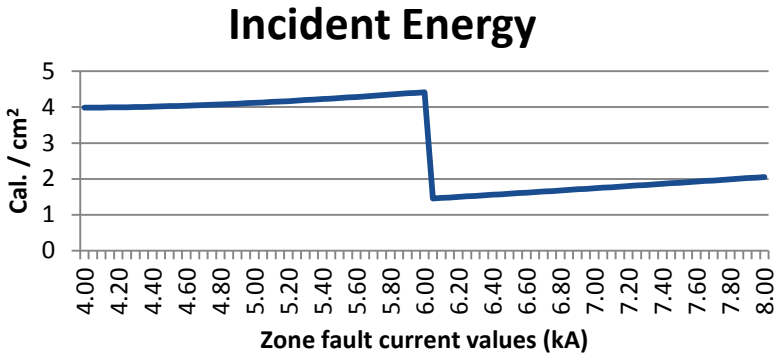
Area of Consideration with Instantaneous Operation









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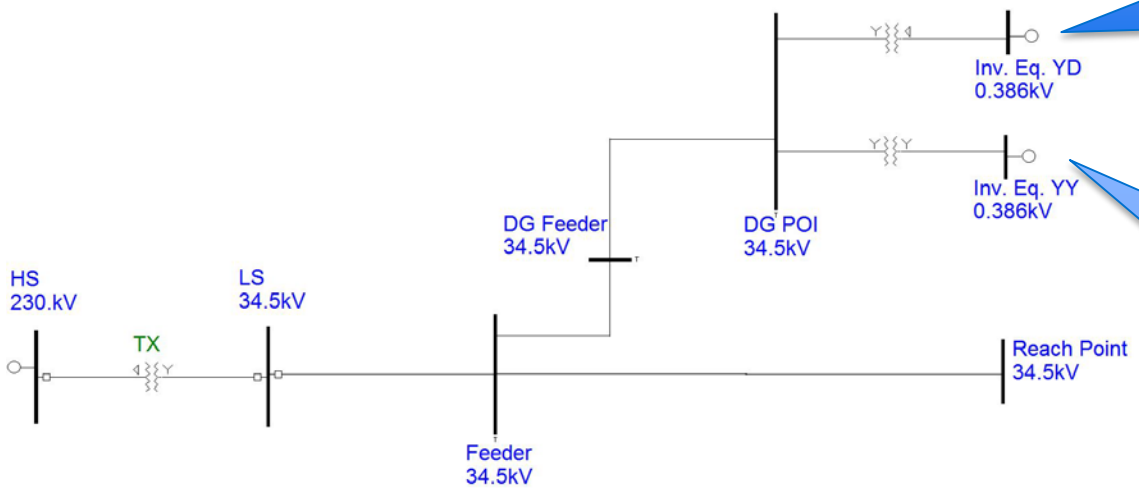
Distributed Energy Resource



Wye-Delta Step-Up Transformer does provide a Source to Zero Sequence Currents

Wye-Wye Step-Up Transformer does NOT provide a source to Zero Sequence Currents

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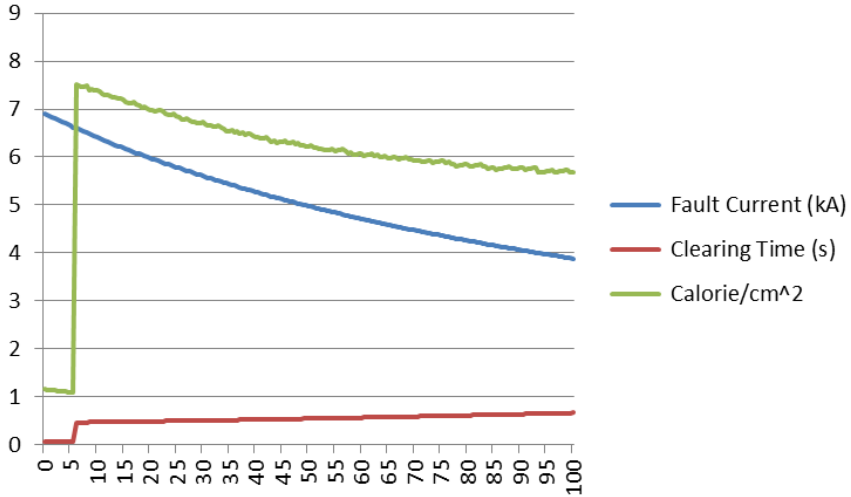
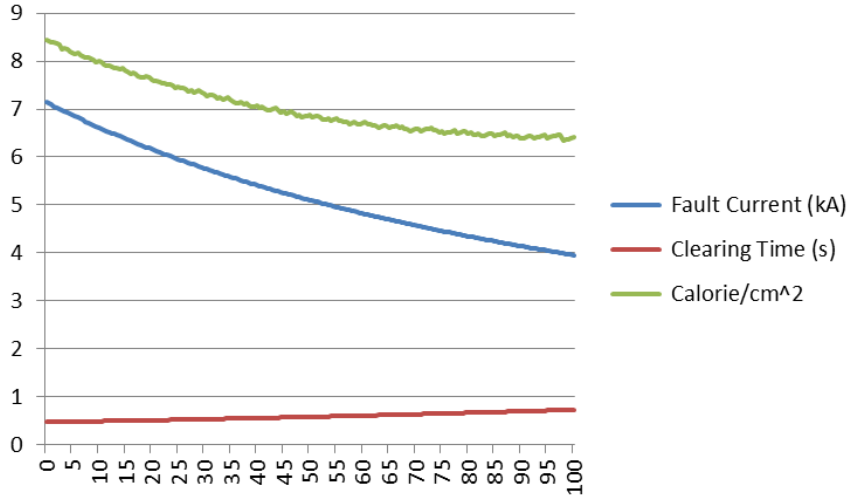
Distributed Energy Resources



WITHOUT DER



WITH DER

DERs with Y-gnd/delta transformers provide zero sequence current source and thus reduce the amount of fault current that feeder relays see

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Take-Aways

+ A method to develop equations for Arc-Flash calculations
+ Wye/ Wye-Grounded DER Step Up transformers are preferred
+ Arc-Flash values change along the circuit
+ With some basic assumptions, a micro-processor relay could clip the current to limit the output to 8 calories.

Why we do this….