Orange & Rockland
a conEdison, inc. company

ORU Motorized Operated Air Break Switch with Supervisory Control and Data Acquisition

(MOAB with SCADA)

Oct 9, 2015

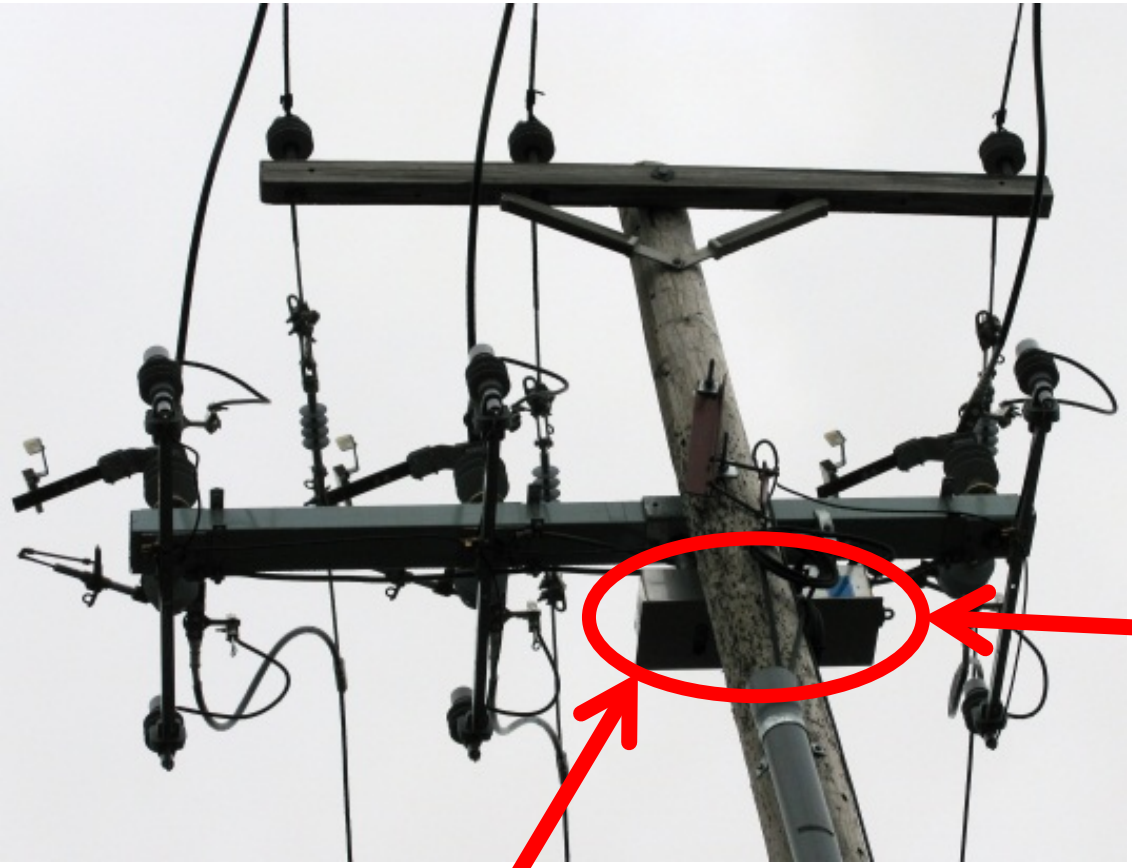
John-Paul Laglenne, PE
Brandon Peifer

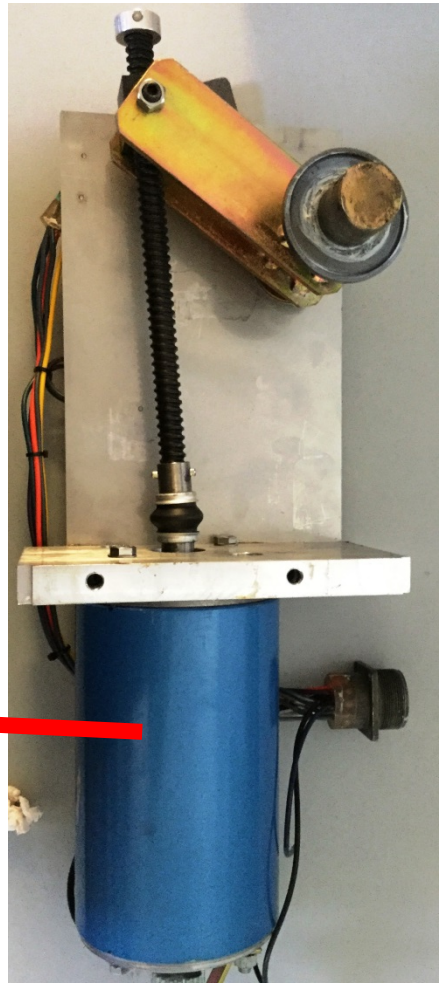
Agenda

- What is a Motorized Ganged Air-Break Switch (MOAB)?
- Product Development – Advanced Automation Tech Lab
- Distribution Automation (DA) Protection highlights & Why a MOAB?
- Conclusions

ORU Gang Operated Air Break Switch (Siemens GOAB)

Motorized Gang Operated Air-Break Switch (Siemens MOAB)





MOAB Motor Enclosure to Operate the Switch without a ground operated handle. Motor provides 600 Ft-Lbs Torque

MOAB – Integrated Current Sensor

- Low profile Current Sensor
- Low Accuracy – plus/minus 5% full scale
- Good for Fault Indication, not used for power calculations

MOAB Control Box

MOAB control box Operates the Switch

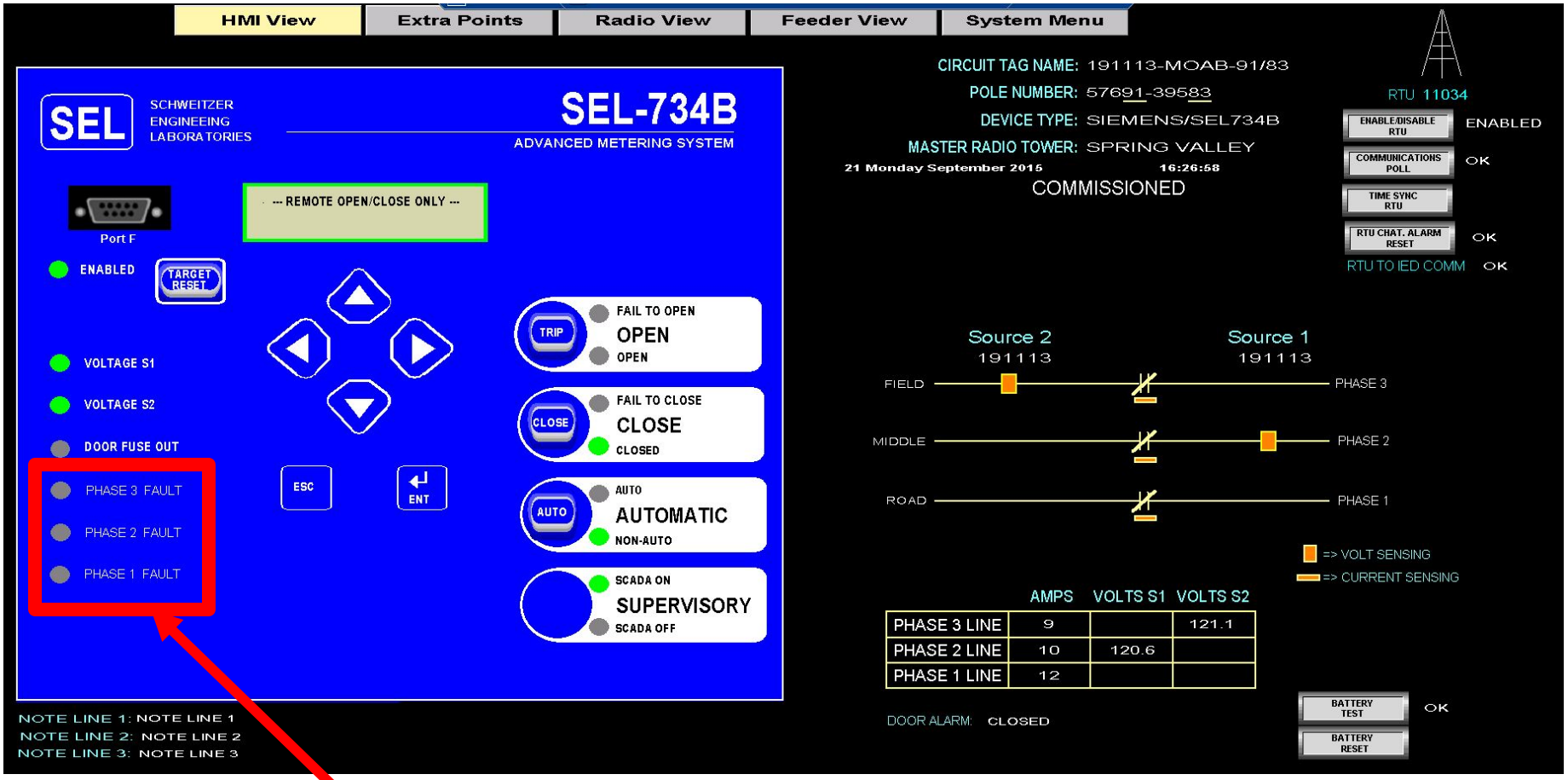
- **Locally via Toggle Switches**
- **Remotely via SCADA**

Schweitzer SEL-734B

- **Still no "DOES EVERYTHING" Microprocessor Controller in advanced distribution automation…**

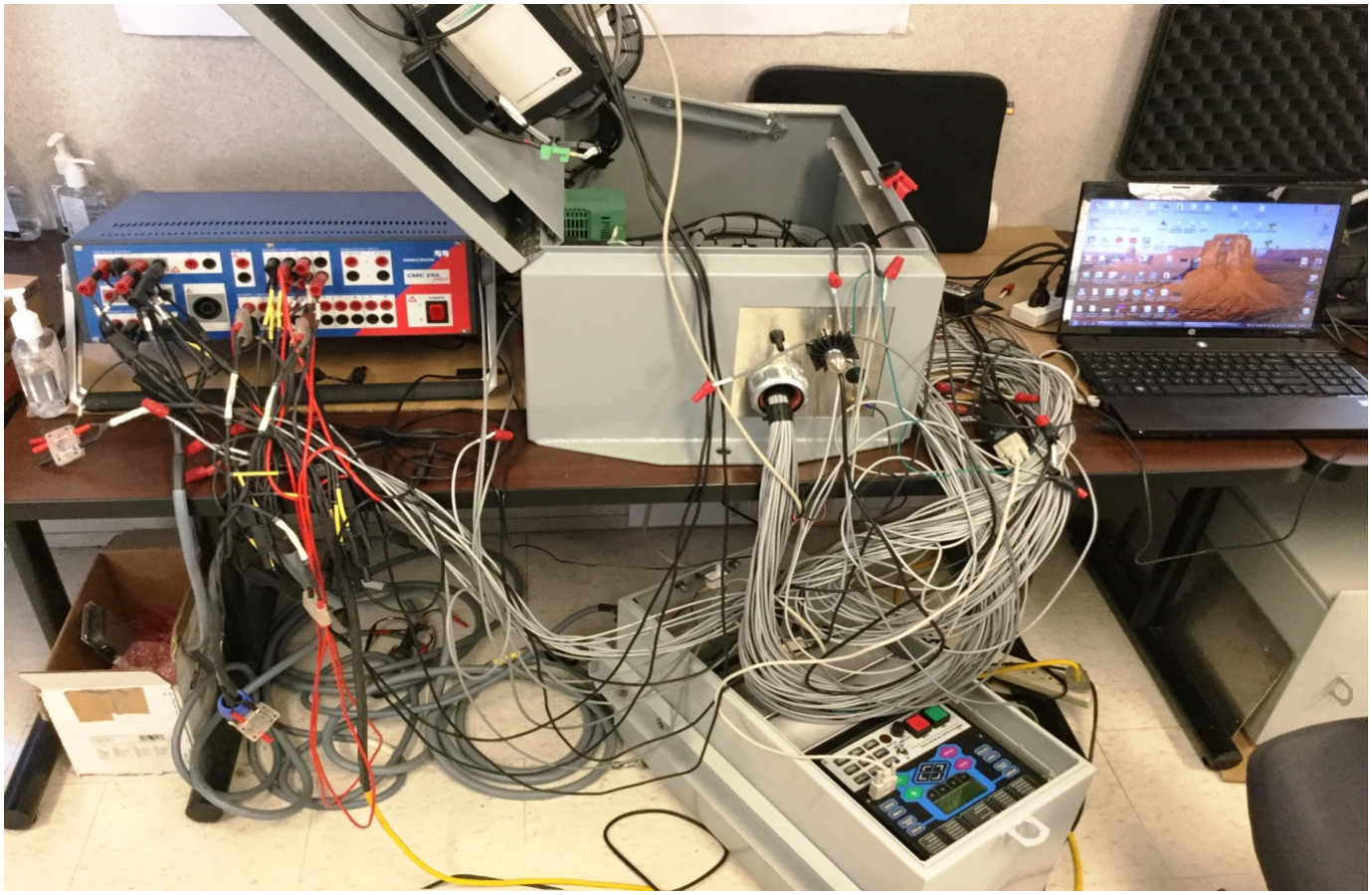
- Customer Programmable with Analog and Digital I/O
- Demand Meter Historical Storage
- Power Quality Meter (Trigger Oscillography, Flicker Meter, VSSI, Harmonics)
- Communications- Serical and Enet SCADA, Local Bluetooth

MOAB SCADA Operations Screen



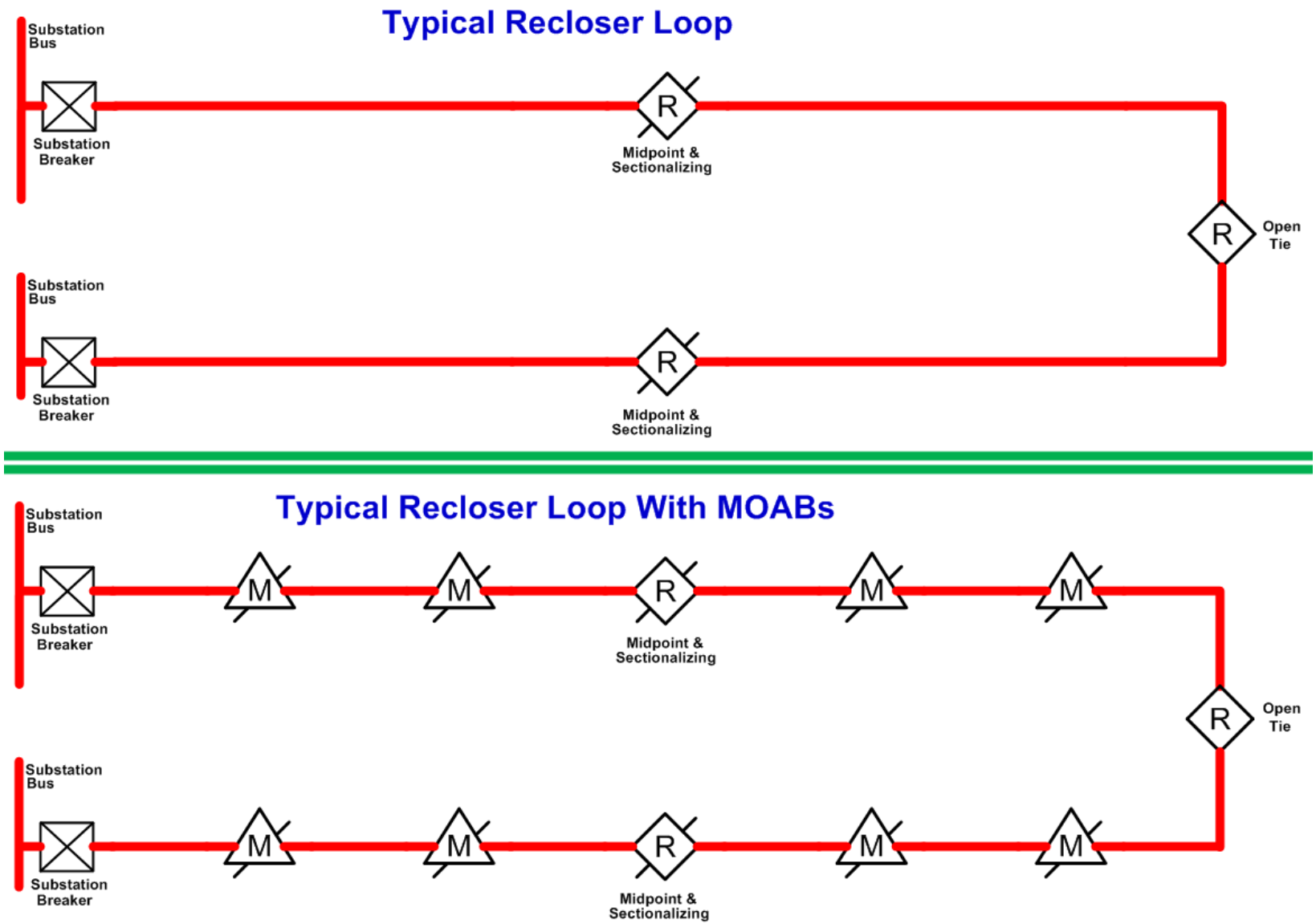
Fault Flags in SCADA

Product Development and Testing

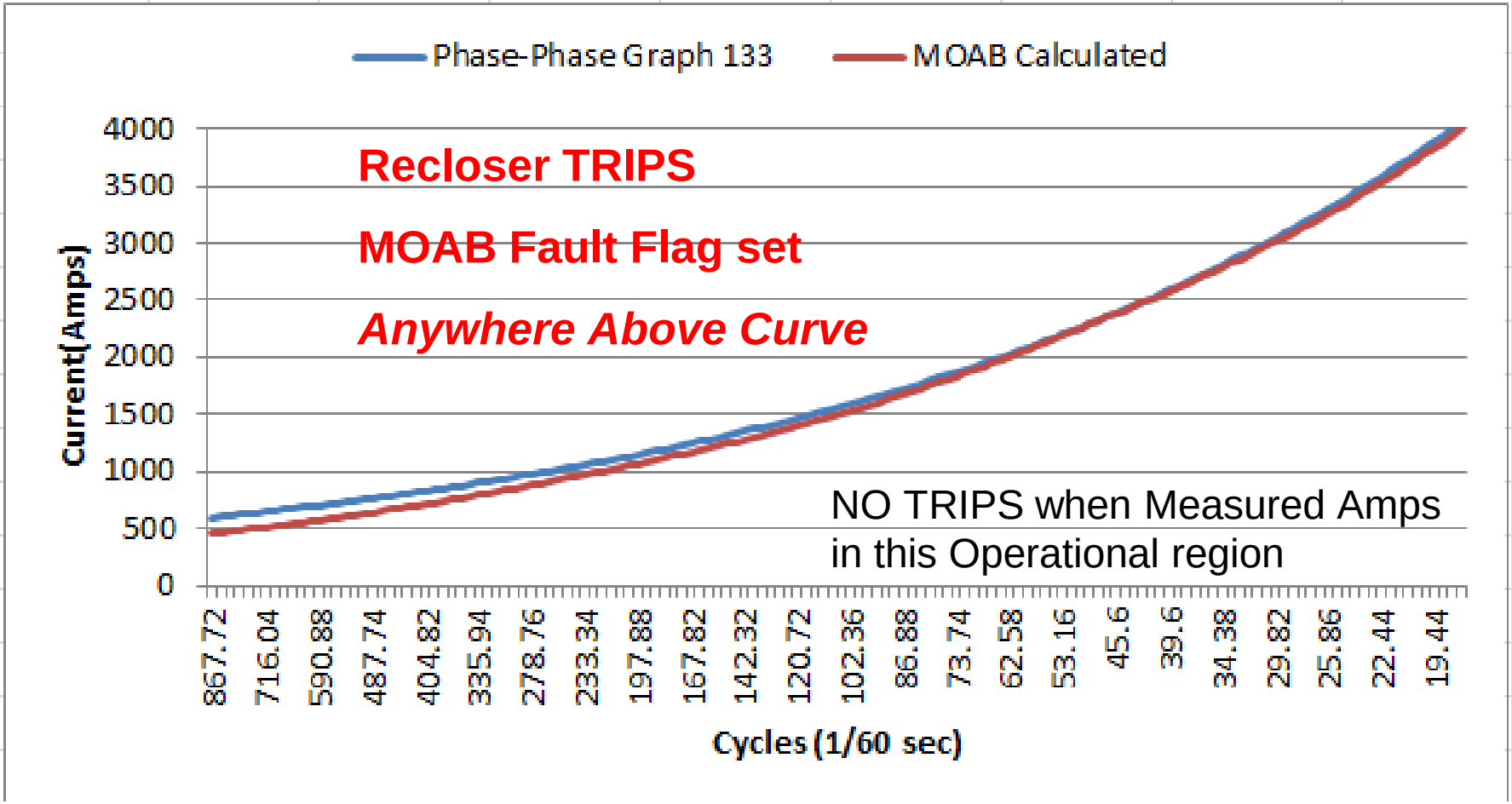


- Lab tested MOAB product from Siemens – hardware changes implemented
- Wrote Operational code, tested product from switch through to SCADA
- Enhanced Fault Flag Curve testing by injecting fault current through both a Recloser and MOAB controller simultaneously to ensure a Recloser Trip = MOAB Fault Flag always

Recloser Use in ORU Distribution Feeders

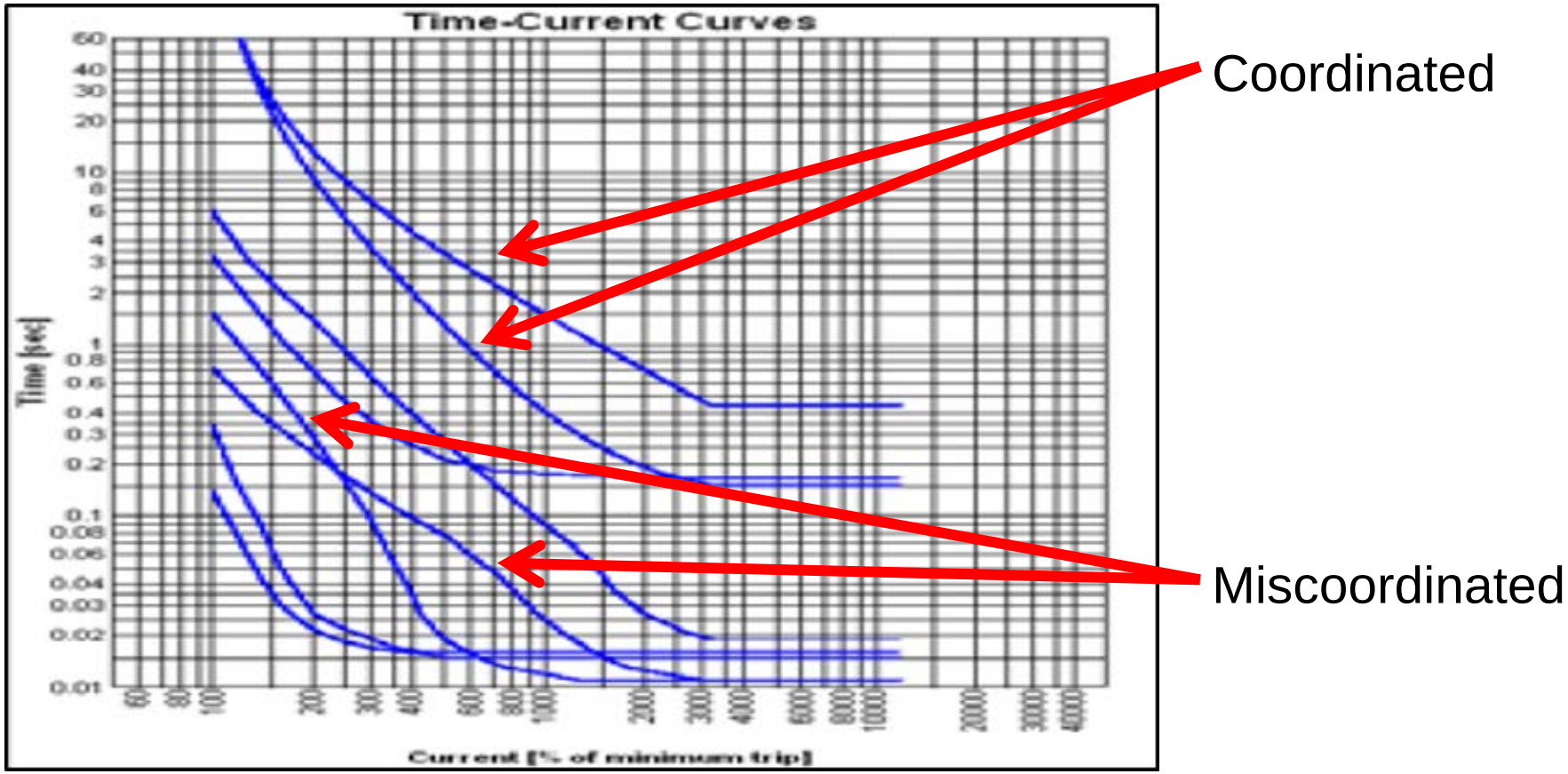


Recloser Time Overcurrent Curve



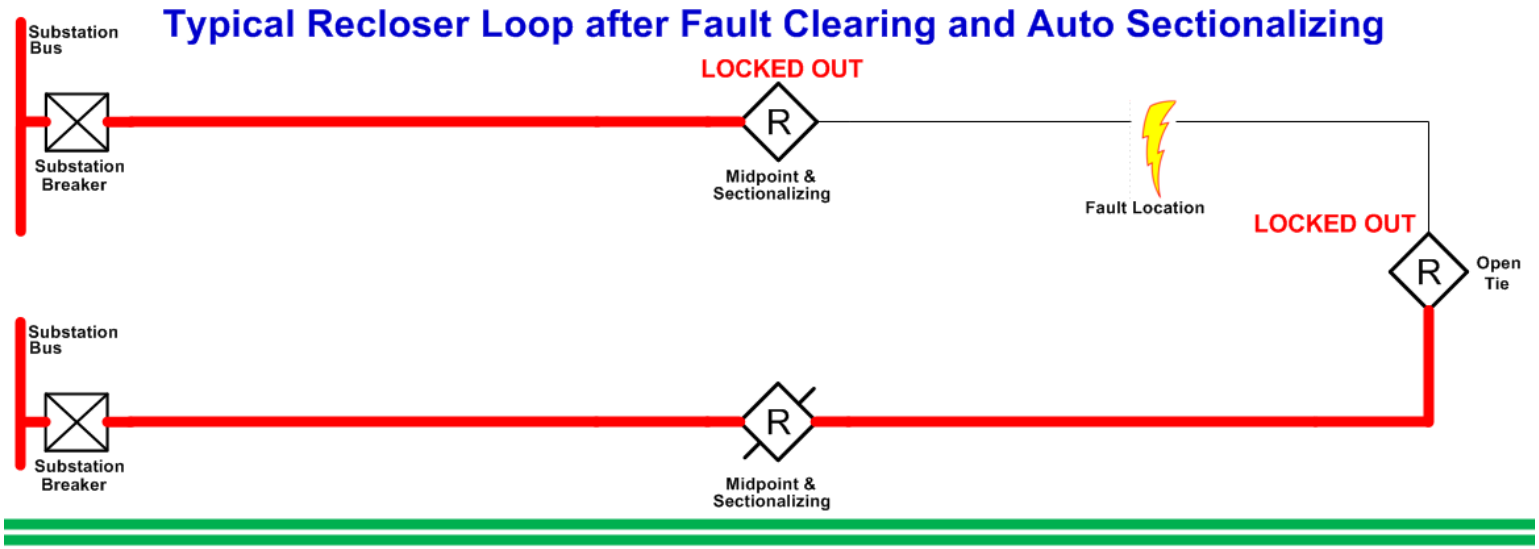
- Time Overcurrent Curve found in Cooper (Eaton) Form 6 Recloser (for Trips only)
- Recloser Controller will trip several times and finally Lock Out Open if Fault Current remains
- Recloser Switch Mode Fault Flags use Pickup Flat line ONLY

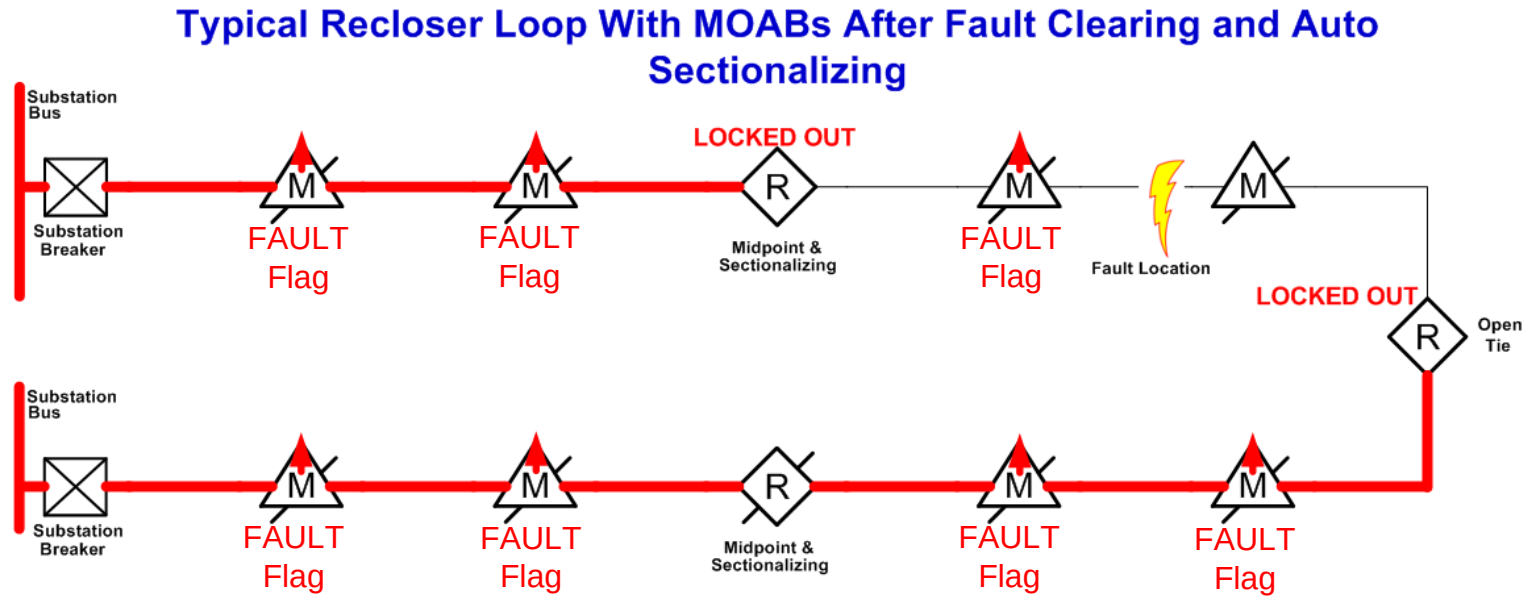
Distribution Protection Coordination



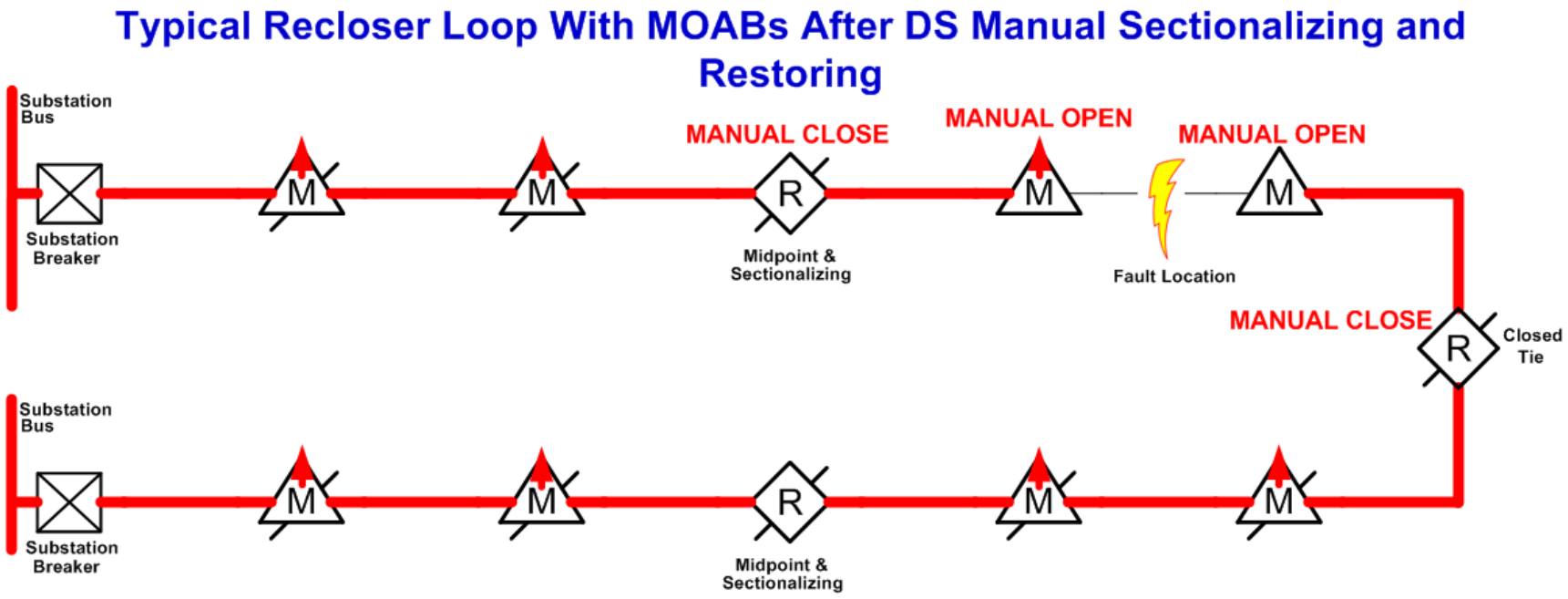
Too many reclosers on one feeder leads to COORDINATION issue.

Recloser Use in ORU Distribution Feeders



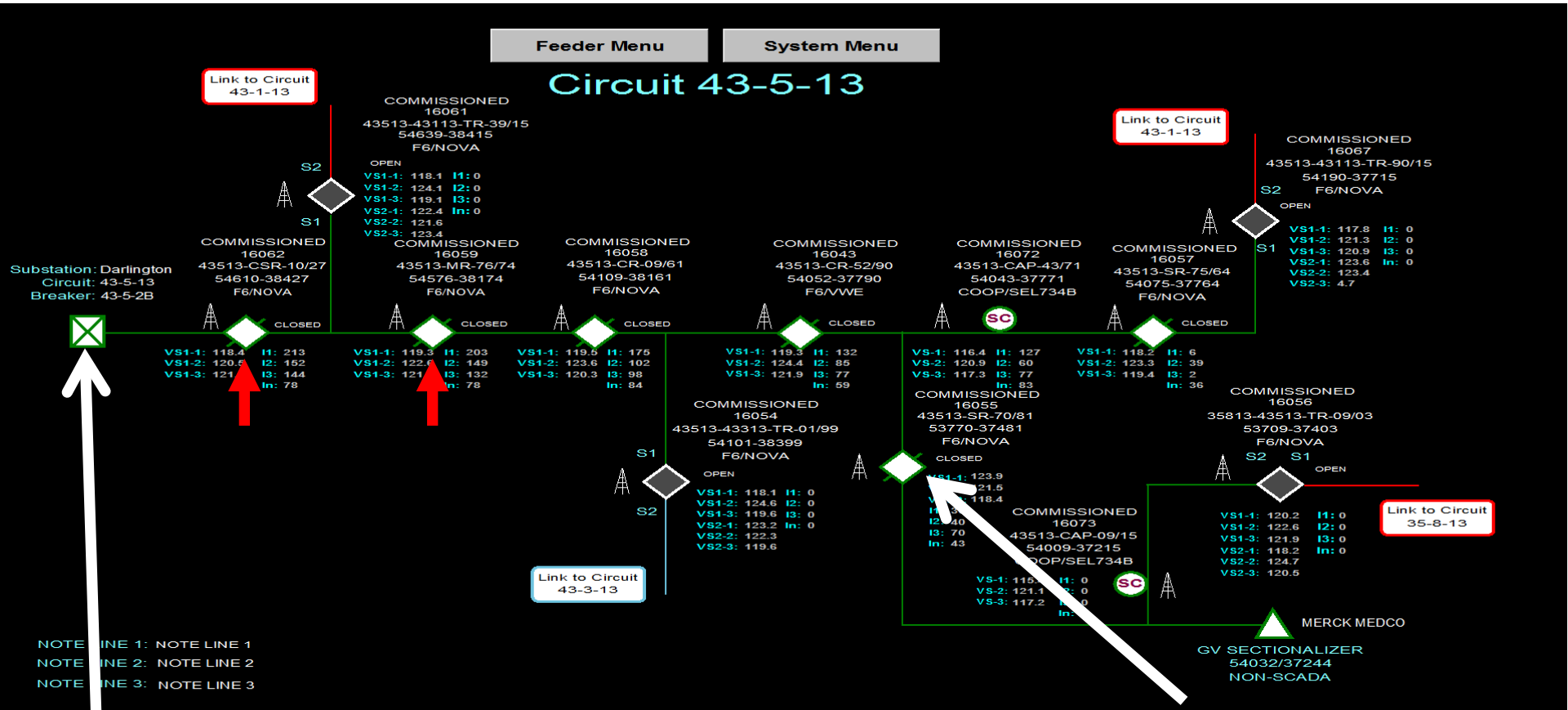


Recloser Use in ORU Distribution Feeders



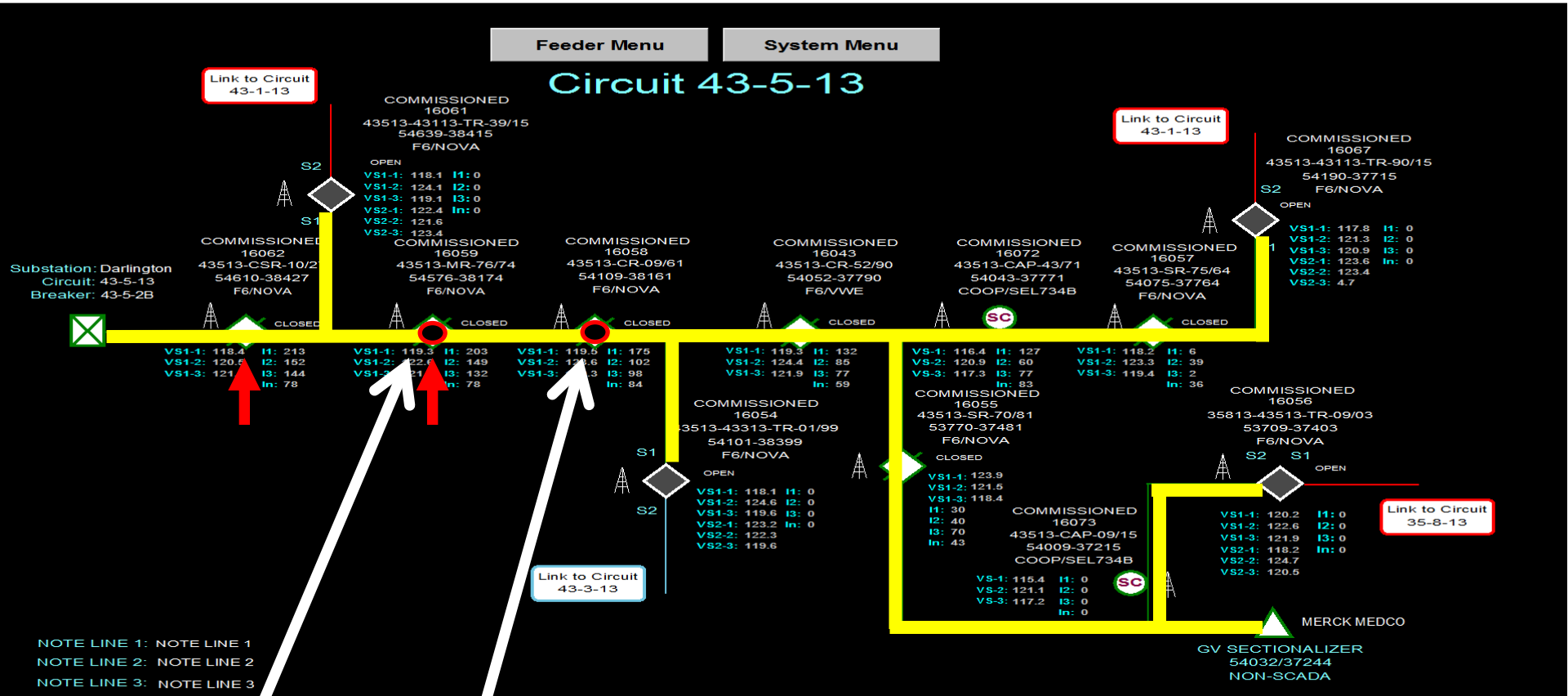
- 1) Find the Loop Midpoint, Sectionalizer, or Substation Breaker in Lock out.
- 2) Look for MOAB Fault Flags down stream of the device in Lock Out.
- 3) Open the last MOAB with a Fault Flag, and the very next device (MOAB or Recloser).
- 4) Restore all available sources by energizing with Reclosers only, put MOABs in desired state while De-energized.

5/12/15 Recloser Fault Flag Use for Sectionalize and Restore via SCADA



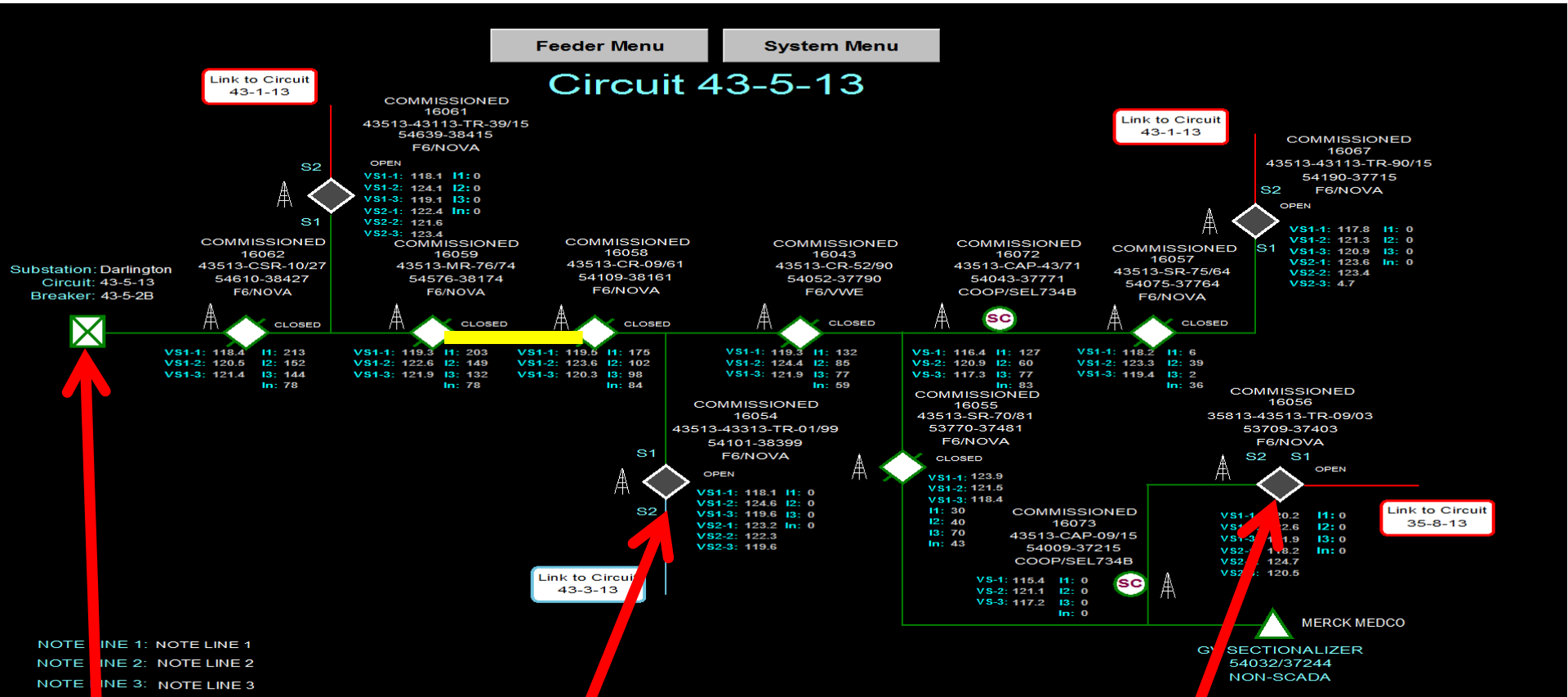
- **Time 17:18 OUTAGE 1366 Customers – Circuit Breaker 43-5-2B & Recloser 70/81 Auto Open**
- **Time 17:18 – Recloser 76/74 ▲DSCADA Fault Flag**
- **Time 17:18 – Recloser 10/27 ▲DSCADA Fault Flag**

5/12/15 Recloser Fault Flag Use for Sectionalize and Restore via SCADA



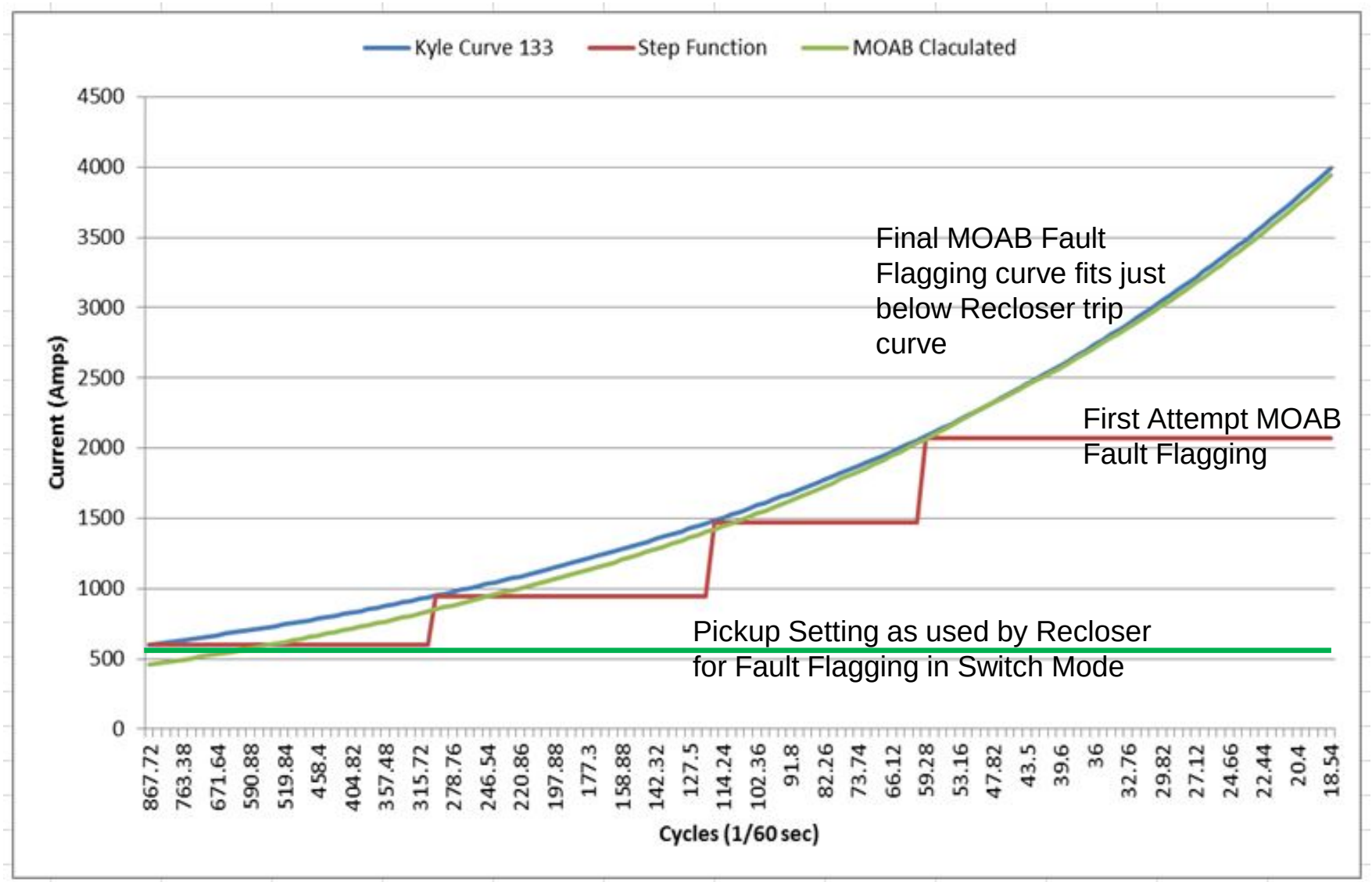
- **Time 17:21 - Recloser 76/74 DSCADA Manual Open by DS Ed Molina**
- **Time 17:23 – Recloser 09/61 DSCADA Manual Open by DS Ed Molina**
- **Outage in YELLOW**

5/12/15 Recloser Fault Flag Use for Sectionalize and Restore via SCADA

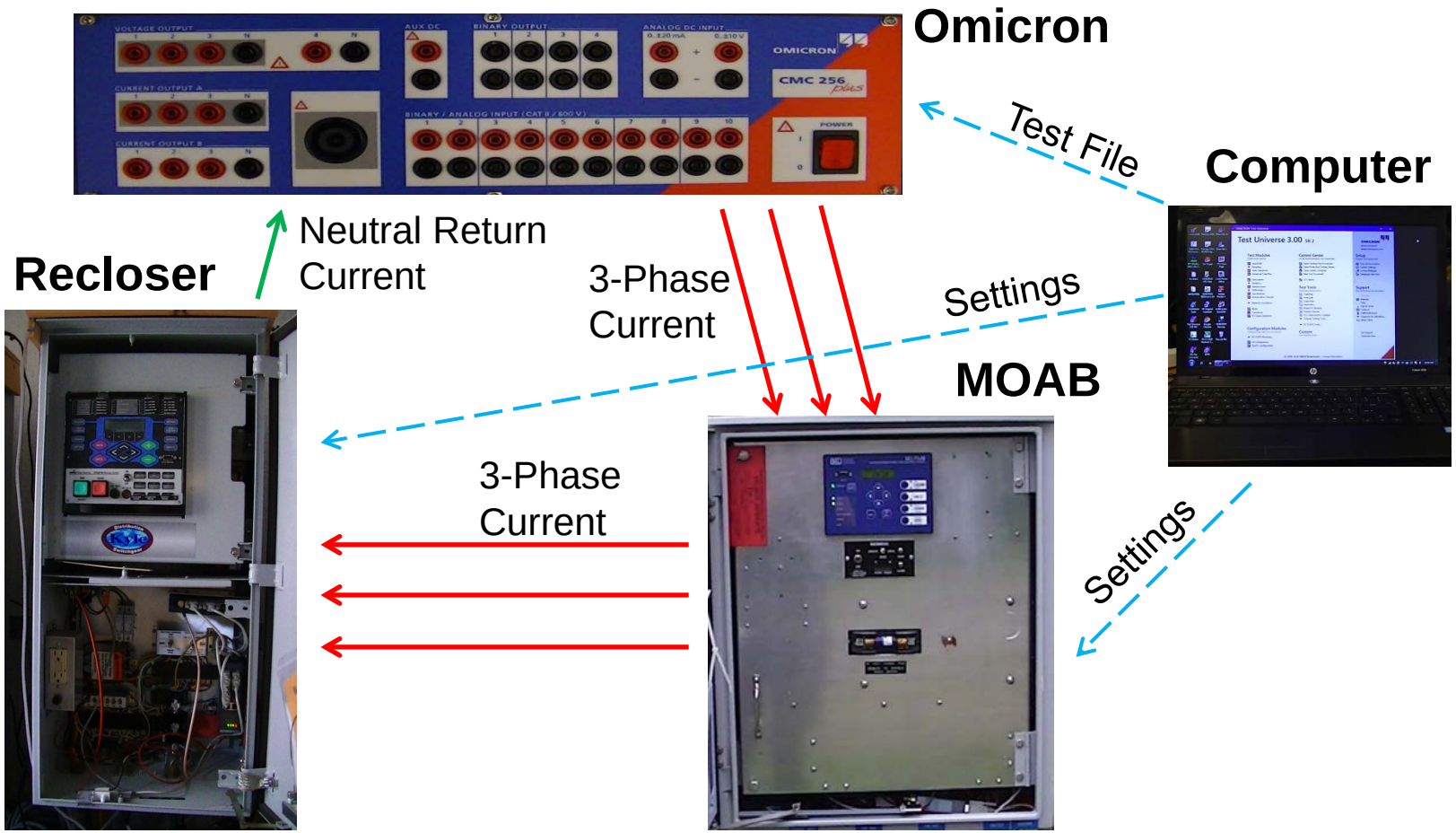


- **Time 17:30 RETURN 129 Customers – Circuit Breaker 43-5-2B Manual Close by SO**
- **Time 17:33 RETURN 209 Customers – Recloser 09/03 Manual Close by DS**
- **Time 17:35 RETURN 779 Customers – Recloser 01/99 Manual Close by DS *(1117 of 1366 power restored in 14 min)***

Recloser & MOAB Fault Flag Curves



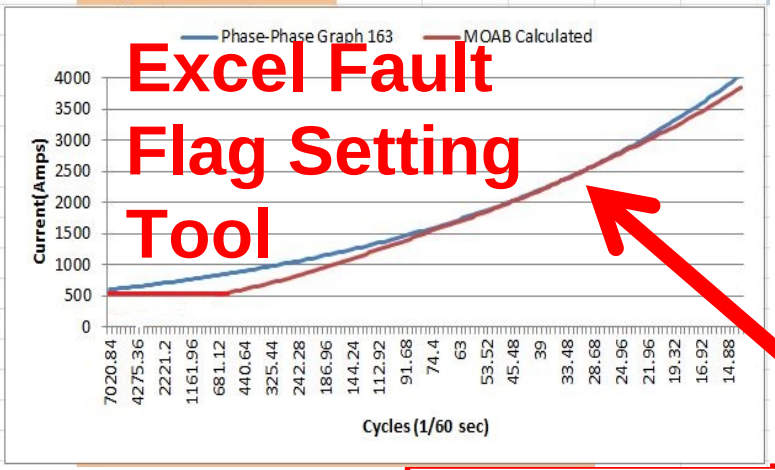
Recloser & MOAB Fault Flag Testing



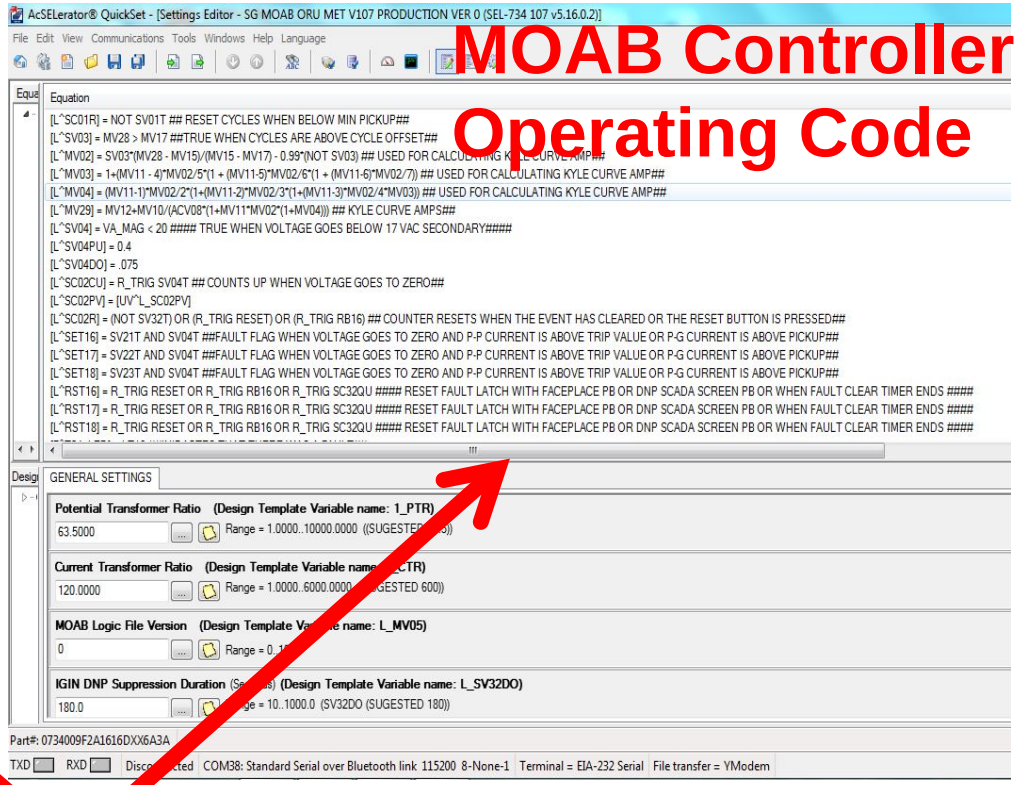
Omicron Generator created fault current that flowed through the MOAB & Recloser to test each fault setting.

Product Development and Testing

					SCADA	Field
Phase-Phase Graph	163					
Minimum Trip	600	Amps		Amplitude	150	1.5
				Cycle Offset	5	0.05
Phase-Ground Graph	Not Used			Exponent	530	5.3
Minimum Trip	480	Amps		Current Offset	10	0.1
				Minimum Trip	600	6
Time Multiplier	2			Ground Min Trip	480	4.8
Time Adder		sec		Calculation Point	225	2.25
Min Rsp Time	Not Used	sec		Calculated Value	1763	17.63
					Output Values	
Min Trip Mult						
Time Delay	Not Used	sec	Blank Inputs means disabled			
Change Values Above						



Excel Fault Flag Setting Tool



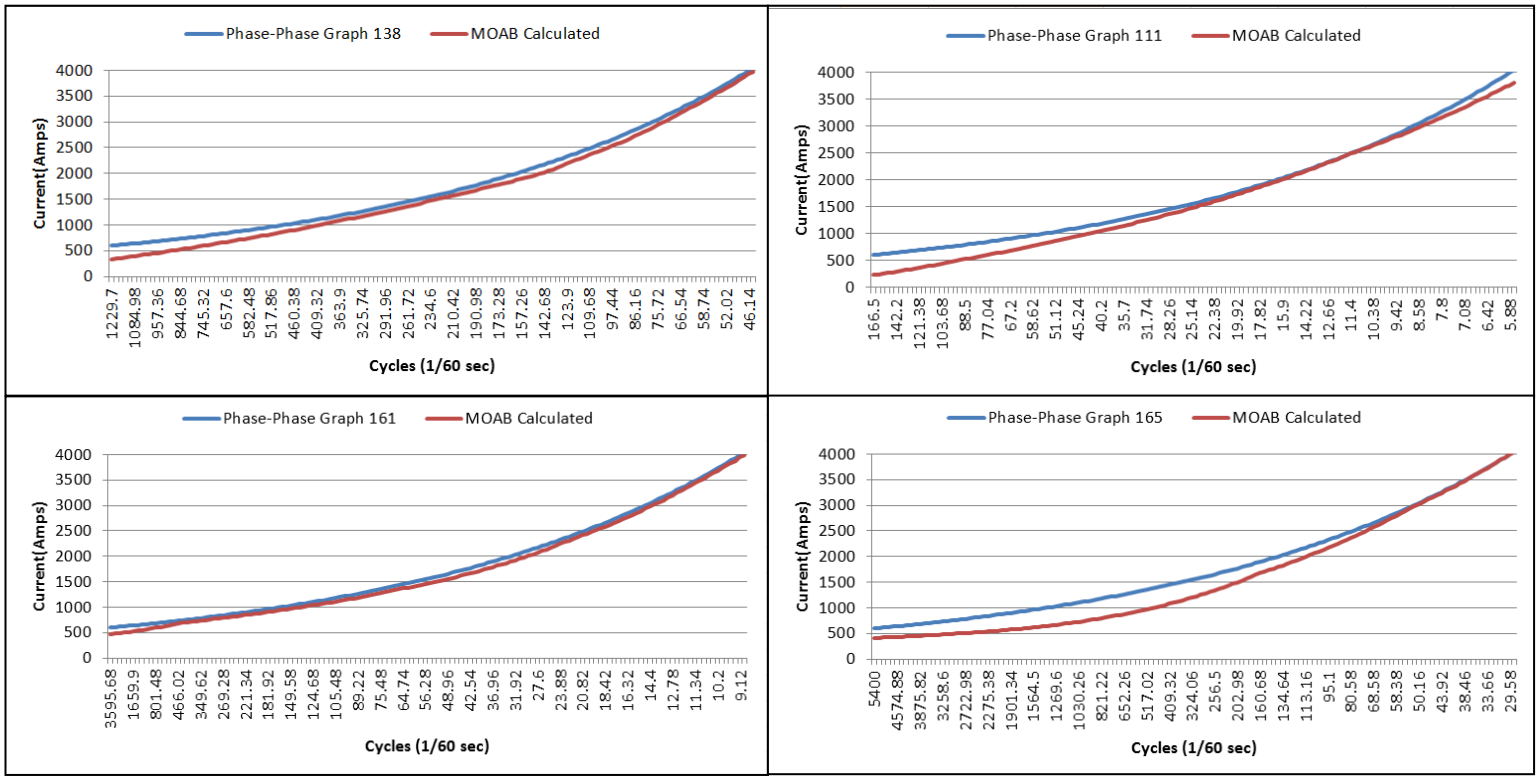
MOAB Controller Operating Code

$$Current = \frac{A}{(cycles - x)^k} + y$$

- This Equation is used in the Excel Tool and in the Schweitzer MOAB Controller to generate Fault Flags simultaneously when the upstream recloser trips

Curve Examples

$$Current = \frac{A}{(cycles - x)^{k}} + y$$



Blue – Recloser Curve

Red – MOAB Curve

MOAB Fault Flagging Process

Due to limitations in the SEL-734B programming, the Taylor Series of the Equation had to be used.

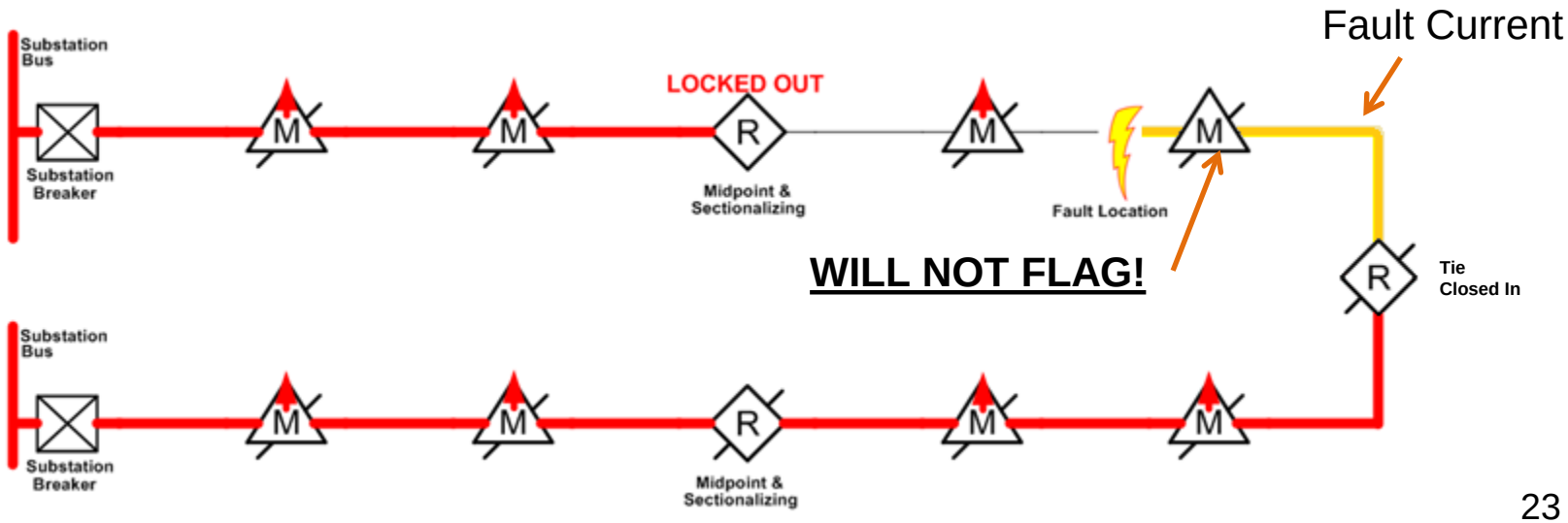
$$Current = y + \frac{A}{b * (1 + \frac{k * (c - a)}{a - x} * (1 + \frac{(k - 1) * (c - a)}{2 * (a - x)} * (1 + \frac{(k - 2) * (c - a)}{3 * (a - x)} * (1 + \frac{(k - 3) * (c - a)}{4 * (a - x)} * (1 + \frac{(k - 4) * (c - a)}{5 * (a - x)} * (1 + \frac{(k - 5) * (c - a)}{6 * (a - x)} * \left(1 + \frac{(k - 6) * (c - a)}{7 * (a - x)}\right)))))))$$

c = cycles

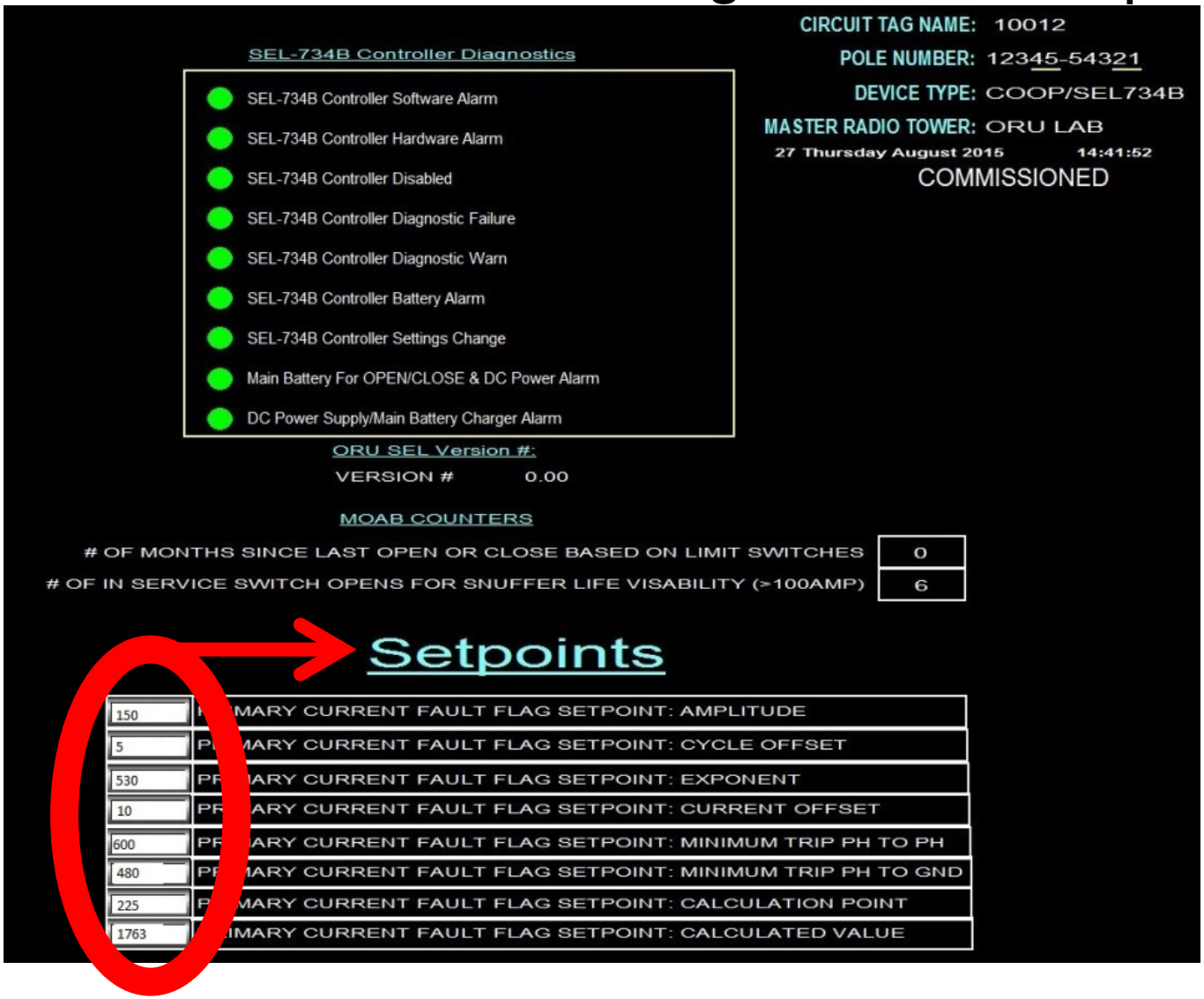
MOAB Fault Flagging Process

Begins counting the amount of cycles when it is over the minimum trip current level.

The MOAB will only fault flag if there has been at most two losses of voltage. This ensures that the MOAB will not flag when the tie recloser closes back into the fault.



MOAB SCADA - Fault Flag Curve Setpoints



- Enter the setpoints to characterize the Fault Flag curve per location from SCADA

Recloser Settings based on Protection Engineering Study Analysis

- 39-2-13 SR 64/02 Proview Settings

Simplified Setup

Operations Sequence

	TCC1	TCC2	Min Trip	Trip #1	Trip #2	Trip #3	Trip #4
Ph	163	163	600	TCC1	TCC2	TCC2	TCC2
Ph Rcls Interval #1, #2, #3				0.6	17	32	
Gd	163	163	600	TCC1	TCC2	TCC2	TCC2
Gd Rcls Interval #1, #2, #3				0.6	17	32	

Trips to Lockout: 3

Reset Time: 75

Complex TCC

		Time Multiplier		Time Adder		Min Rsp Time	
TCC1	Ph	2	☑ En	0	☐ En	0.013	☐ En
	Gd	2	☑ En	0	☐ En	0.013	☐ En
TCC2	Ph	2	☑ En	0	☐ En	0.013	☐ En
	Gd	2	☑ En	0	☐ En	0.013	☐ En

Auto-Calculation of MOAB Fault Curve Settings Based on Recloser Settings

MOAB_Fault_Curves Ver00.xlsx - Microsoft Excel

File | Home | Insert | Page Layout | Formulas | Data | Review | View | Acrobat

L8

Orange & Rockland

This Excel Sheet provides data values for the fault flags in Orange & Rockland Utilities' MOAB Devices using the Cooper Kyle Curves.

NOTE: This is not a replication of the Kyle Curves. It is a best fit representation of it.

File Name: MOAB_Fault_Curves Ver00

Excel Sheet and Mathematics created by: Brandon Peifer, Temp Aide Orange & Rockland Utilites 2015

Curve Optimization performed by: Daniel Holton, Temp Aide Orange & Rockland Utilities 2015

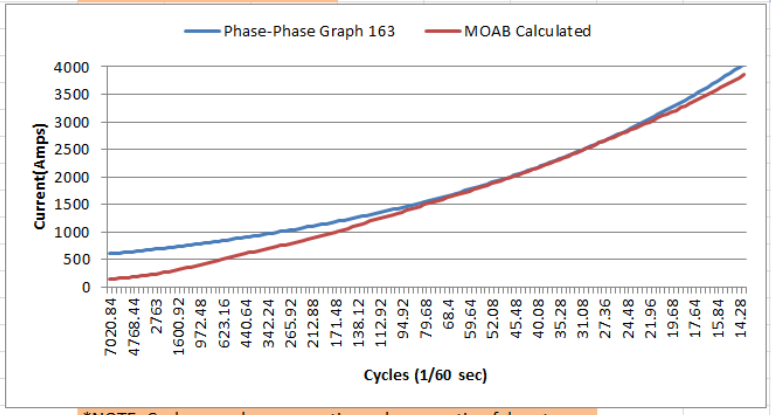
					SCADA	Field
Phase-Phase Graph	163					
Minimum Trip	600	Amps		Amplitude	150	1.5
				Cycle Offset	5	0.05
Phase-Ground Graph	Not Used			Exponent	530	5.3
Minimum Trip	480	Amps		Current Offset	10	0.1
				Minimum Trip	600	6
Time Multiplier	2			Ground Min Trip	480	4.8
Time Adder		sec		Calculation Point	225	2.25
Min Rsp Time	Not Used	sec		Calculated Value	1763	17.63
					Output Values	
Min Trip Mult						
Time Delay	Not Used	sec	**Blank Inputs means disabled**			

Change Values Above

Instructions

1) Input the Both Graphs & Minimum Trips desired (Required)
2) Input any other recloser values that are enabled (Blank cells mean disabled)
3) Take the points in light green and input them into SCADA or the light blue and input them into AcSELerator in the same order as shown

$$Current = \frac{Amplitude}{(Cycle - Cycle\ Offset)^{exponent}} + Current\ Offset$$



Settings of the Recloser closest to the Breaker on the Circuit should be imported into this sheet. The Minimum Trip might need to be adjusted to account for impedance.

*NOTE: Cycles may have repeating values creating false steps

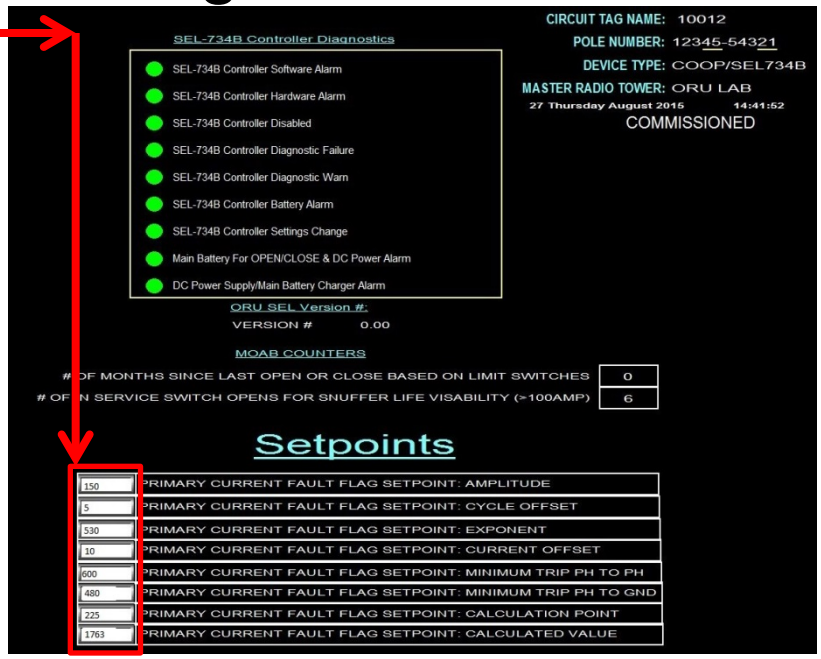
Leveraging Recloser Settings for MOAB

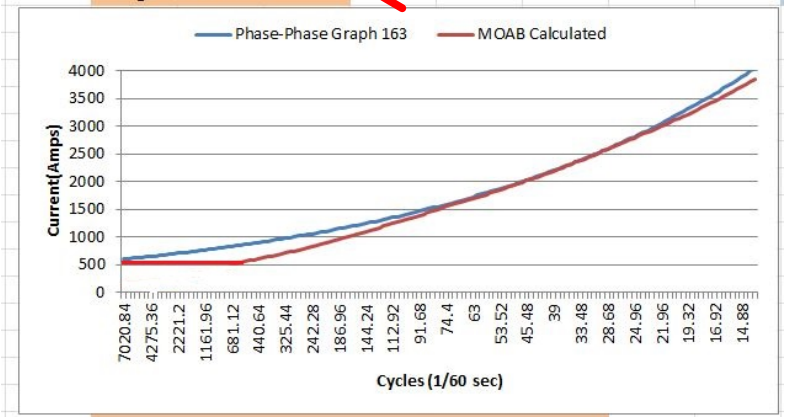
Phase-Phase Graph	163	
Minimum Trip	600	Amps
Phase-Ground Graph	Not Used	
Minimum Trip	480	Amps
Time Multiplier	2	
Time Adder		sec
Min Rsp Time	Not Used	sec
Min Trip Mult		
Time Delay	Not Used	sec
Change Values Above		

Blank Inputs means disabled

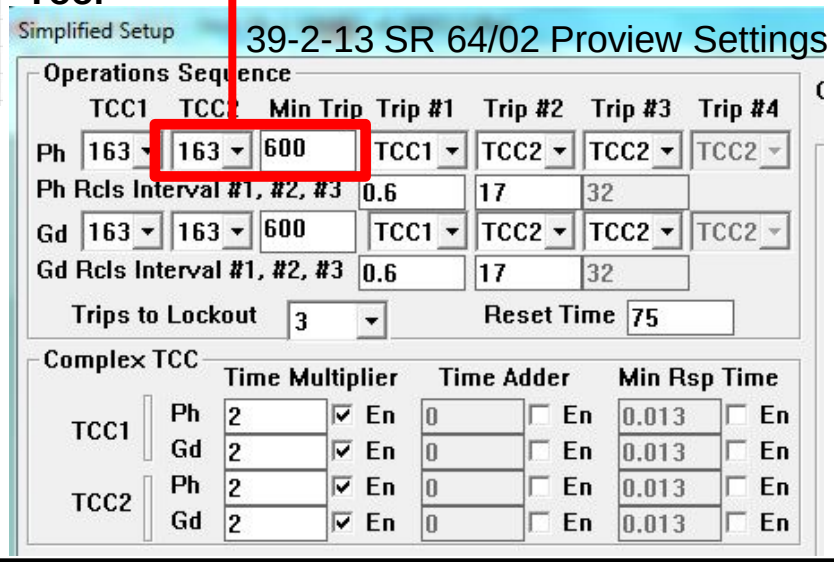
	SCADA	Calc
Amplitude	150	1.5
Cycle Offset	5	0.05
Exponent	530	5.3
Current Offset	10	0.1
Minimum Trip	600	6
Ground Min Trip	480	4.8
Calculation Point	225	2.25
Calculated Value	1763	17.63
	Output Values	

2) Enter Calculated Values into SCADA





1) Enter Recloser Values into Excel Tool



Costs & Features of MOAB, GOAB, & Recloser

Features	GOAB	MOAB	Recloser
Installation Cost	$16,500	$52,485	$76,604
Ground Operation	YES	YES	YES
Visible in SCADA	NO	YES	YES
SCADA Operation	NO	YES	YES
Load-Breaking	YES	YES	YES
Fault-Breaking	NO	NO	YES
Fault Detection	NO	YES	YES
Visible Break	YES	YES	With By-Pass
Visible Break from SCADA	NO	YES	NO

Installation Cost includes: Purchasing Equipment and Hardware, Crew Rates, Installation, Functional Testing, and SCADA Commissioning (If Applicable)

MOAB Implementation

- To Date: Installed and SCADA Commissioned over 20 MOABs out of about 30 total planned.
- Engineering/Training Dept held multiple training sessions for company and contractor crews on MOAB Installation, Operations, SCADA Commissioning, and for engineering, Fault Flag curve configuration.
- Engineering, Operations, and the Control Center visited Coned several times where over 100 MOABs with SCADA have been in service since 2012 for information sharing and lessons learned.
- 30 More MOABs on order with Siemens to continue MOAB implementation.

MOAB Advantages

- 30% less installed cost as compared to a recloser; simpler to install, operate, commission, and maintain.
- Visible Air-break for line crews from SCADA; no bucket truck needed to open Recloser Source/Load/Bypass switch.
- All Yearly MOAB Maintenance can be performed from SCADA, no crews required at the pole.
- Power Quality meter built into the MOAB controller; ready for High Accuracy Current and Voltage measuring devices.
- 250 customer (or less) between SCADA switchable devices without the complicated local automation settings and configuration after Loop Scheme events.
- Fault Flag more securely on a curve, not pickup.
- MOAB Opens and Closes with 4X the available torque of a GOAB.

Questions?

Thank You