Modern Fault Indication

Dispatch to the Fault not the Indicators

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Overhead Fault Indication and Location

Manual Flag Indicator	Electronic Fault Indicator	Smart Fault Indicator	Relay Fault Location	Safegrid Fault Location
• Low Cost • Hotstick Install • No Primary Voltage Limit • Close Proximity Only • Requires Manual Reset • Accuracy determined by number installed	• Medium Cost • Hotstick Install • Primary Voltage Limited • Near Proximity Lights • Automatically reset • Accuracy determined by number installed	• Medium Cost • Monthly Data Charge • Hotstick Install • Primary Voltage Limited • Near Proximity Lights and Remote Status • Requires Integration • Automatically reset • Accuracy determined by number installed	• Possible with existing equipment • New equipment high cost • Primary Voltage Limited • No field indication • Requires Integration • No reset required • Accuracy determined by quality of model and estimation of fault impedance	• Medium Cost • Monthly Data Charge • Requires bucket truck to install • No Primary Voltage Limit (installed on 115kV line, 230kV in consideration) • No field indication • No integration required (but API available) • Accuracy determined by quality of model and algorithm to determine location

Randolph EMC Applications

6 Radial Transmission Lines (100/115kV)

3 Transmission Lines protected by Duke Energy Breaker

- No fault data available

3 Transmission Lines protected by REMC Breaker

- Fault data available via SCADA
- 1 Transmission line splits and feeds two directions

Quest for Fault Indication

Considerations

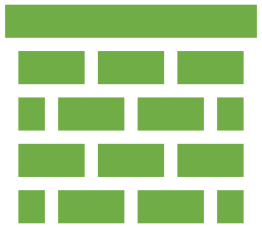
Local vs Remote Indication

Fault Locate Capability

Integrations

Cost

Ease of Use



Prior Device Trials

Integration Difficulty

Harvesting Power requires minimum current (5A)

Failure due to Electric Field Damage

Installation Requirements

New Solution

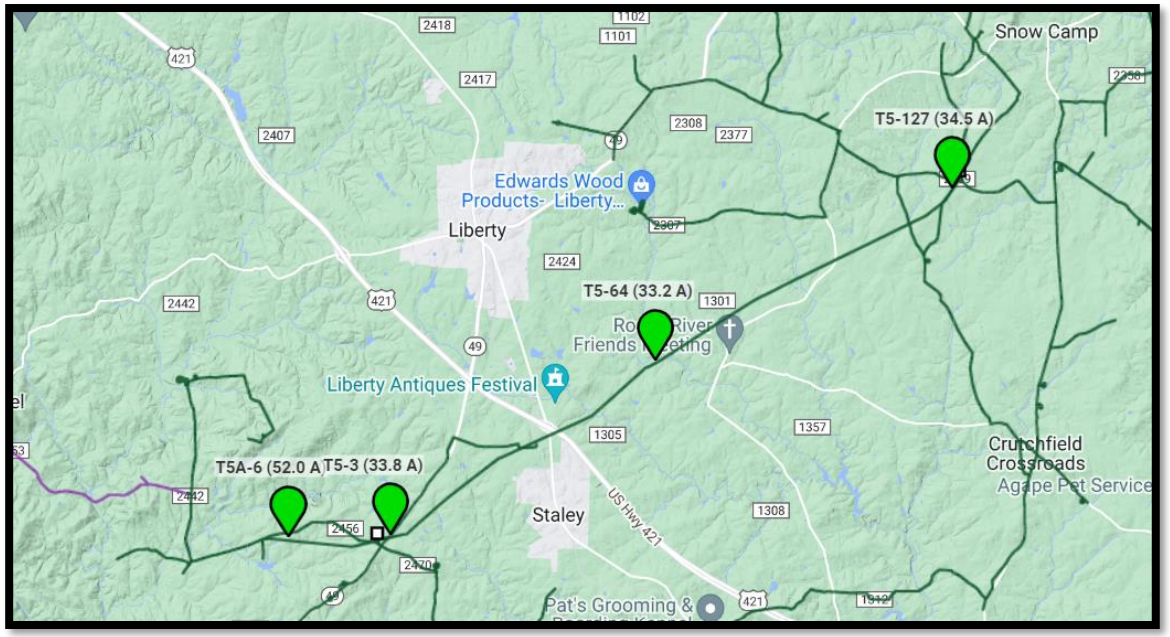
- Safegrid (Finland)
- Transient Based Fault Locate (300ft accuracy)
- Deep learning analytic system
- Preventive Grid Maintenance (failing insulator, ROW issues)

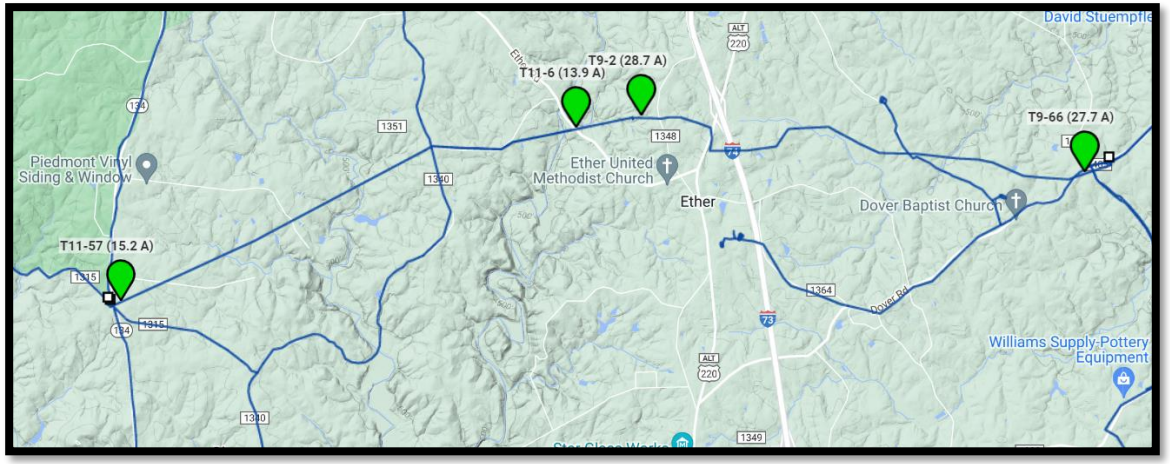
Deployment Strategy

- Two Transmission Lines Chosen
  - One Duke Protected
  - One REMC Protected
- Allows comparison of Relay Fault Locate versus Safegrid Fault Locate
- Distribution Deployment
  - Need to see in action
  - Install at Robbins Substation (5 feeders)
  - Comparison of Relay Fault Locate versus Safegrid Fault Locate
  - More likely to see a fault

Transmission System

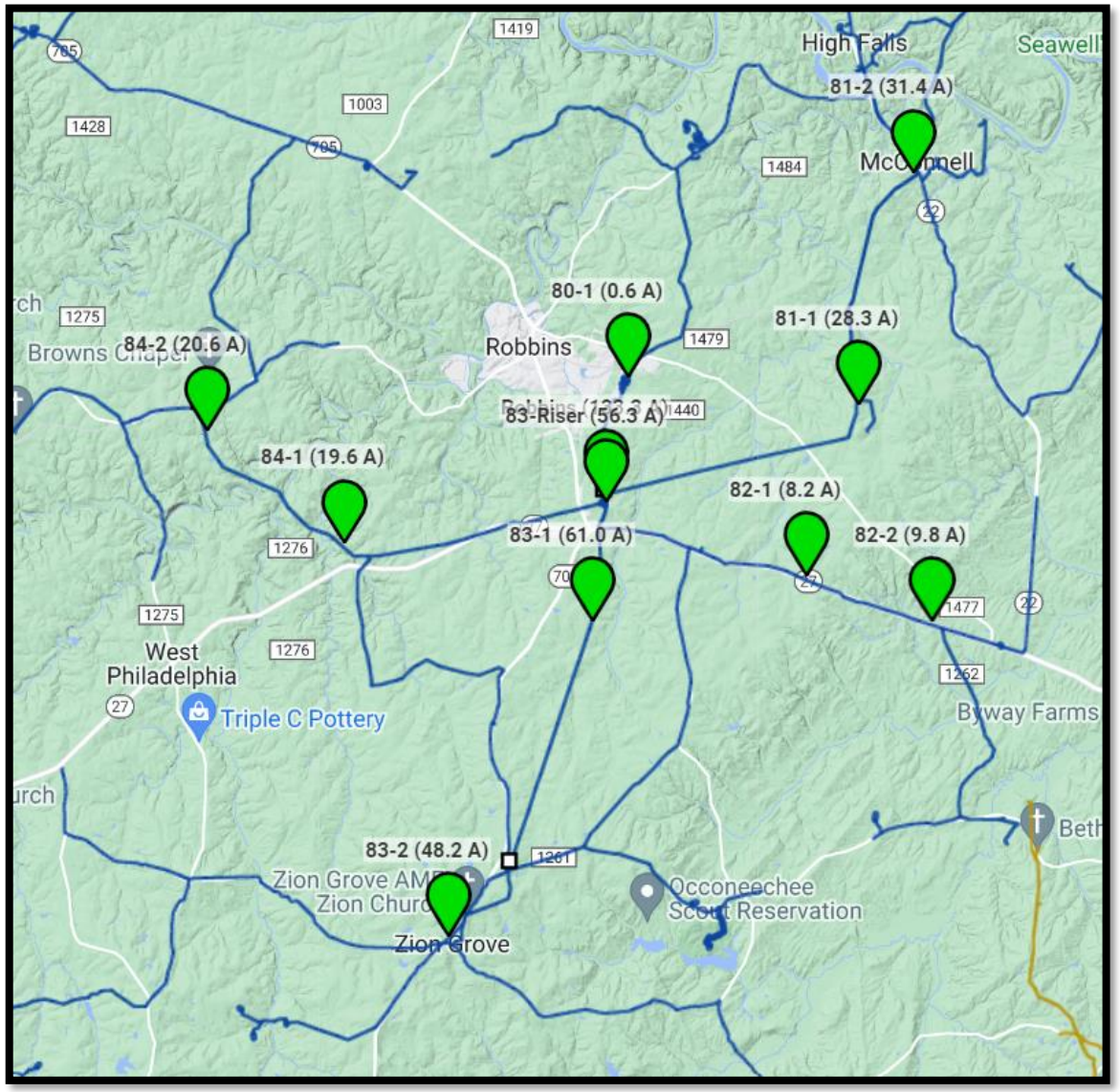
- Liberty POD – Staley – Snow Camp Transmission Line
  - 153 Structures
  - 11.325 miles
- Ether Transmission Line
  - Ether to Dover
    - 71 Structures
    - 4.738 miles
  - Ether to Love Joy
    - 60 Structures
    - 5.005 miles





Distribution System

- Robbins Substation
  - 5 Feeders
  - Long Exit Feeder Getaways
  - Load Pockets near end of line
  - Several Miles Off-road



Timeline


6 Oct. 2022
T&D World
31 Oct. 2022
Quote
12–14 Dec. 2022
Snow Camp and Ether Transmission Line Installation
5 Apr. 2023
Integration Discussion
29 Jun. 2023
Rest API Discussion and Review
Safegrid Meeting
26 Oct. 2022
Installation Planning
21 Nov. 2022
Critical Alert Discussion
13 Jan. 2023
Robbins Distribution Installation
9 May 2023
Rest API Online, Data Integrated with REMC
5 Jul. 2023

Integration Plans

MapEngine (FieldSyte)

- API Call to get Data
- Display on Mobile Map Platform
- Completed 7-5-2023

SCADA (OSI)

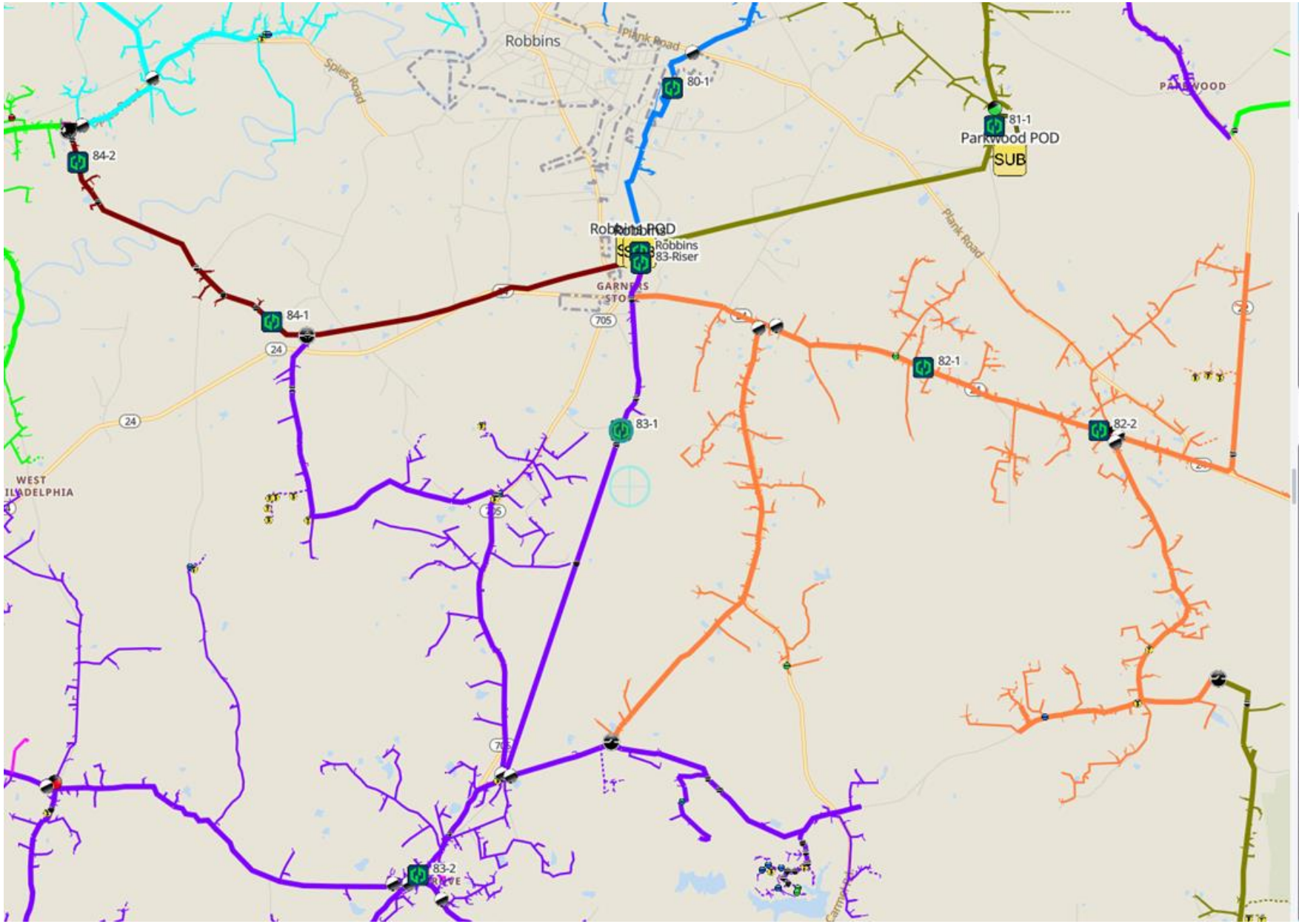
- DNP-3 Protocol
- Display on SCADA Page

Safegrid Web App

- User friendly
- Well designed
- Minimizes need for integration

Rest API Integration

- Device Data
  - Status (Online, AC Power, etc.)
  - Location Data (Latitude, Longitude)
  - Battery Voltage
  - Last Communicated Timestamp
- Alert Data
  - Criticality
  - Fault Type
  - Location Data (Latitude, Longitude)
  - Text Description of Fault
  - Fault Timestamp



Find Downline Consumers | Recent | Actions

Search | Map Selection | Trace Results

Selection | Live Point | Live Point: undefined

Subtype
SafeGrid

Name
83-1

Status
OK

Info | Meta

Description 1
grayhawk

Description 2
Last Updated - Jul 16 2023 10:06PM

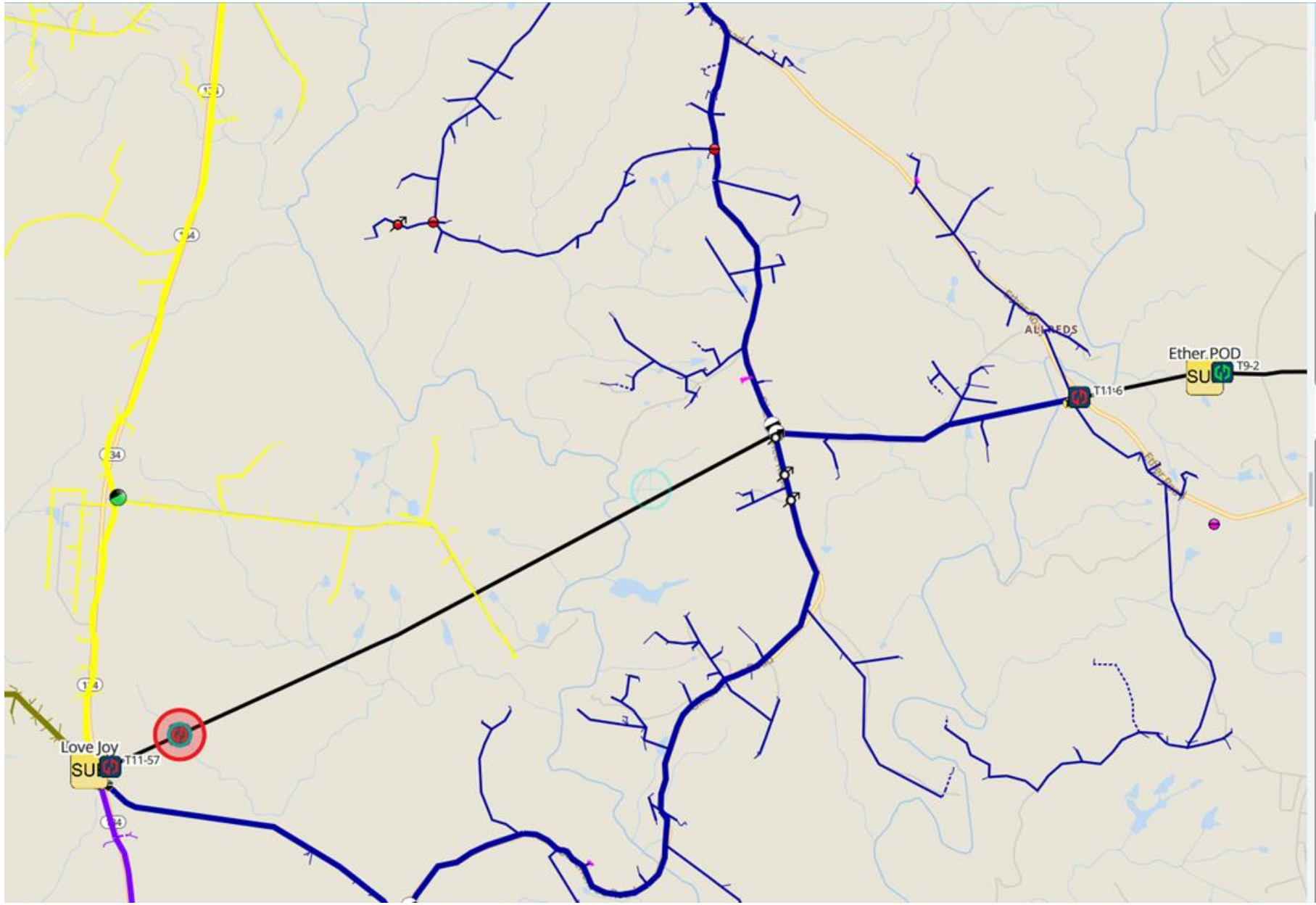
Comment 1
Battery Voltage - 4.16000

Comment 2

Field 1
https://app.safegrid.io/node/3802d9a0-748d-4df8-8f23-37fcefec8721

Field 2

Field 3



Find Downline Consumers | Recent | Actions

Search | Map Selection | Trace Results

All | Custom Live Points | Live Point: undefined

Subtype
SafeGrid

Name
SHORTCIRCUIT - 2023-06-24 12:41:25

Status
critical

Info | Meta

Description 1

Description 2
Last Updated - Jun 24 2023 12:41PM

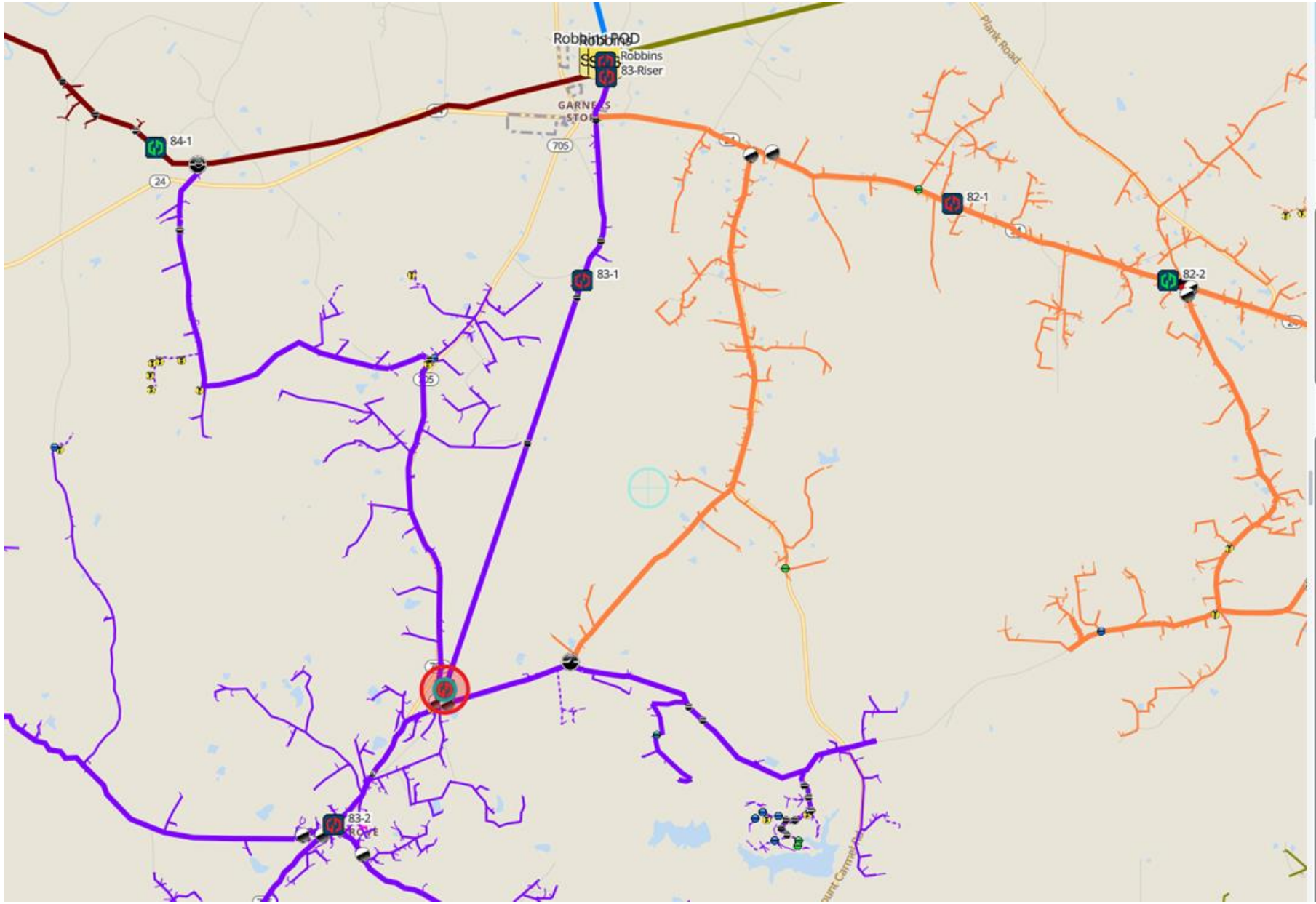
Comment 1
0.521 km from T11-57, 6.576 km from T11-6
Downstream from: T11-57, T11-6

Comment 2
https://app.safegrid.io/eventanalysis#f=efaf877f-3055-4dc9-886f-2971b924db57

Field 1

Field 2

Field 3



Find Downline Consumers | Recent | Actions

Search | Map Selection | Trace Results

All | Custom Live Points | Live Point: undefined

Subtype
SafeGrid

Name
EARTH_FAULT - 2023-05-15 22:08:06

Status
critical

Info | Meta

Description 1
EF_LOAD_REDUCTION

Description 2
Last Updated - May 15 2023 10:08PM

Comment 1
1.941 km from 83-2, 4.55 km from 83-1 Downstream from: 82-1, Robbins, 83-Riser, 83-1

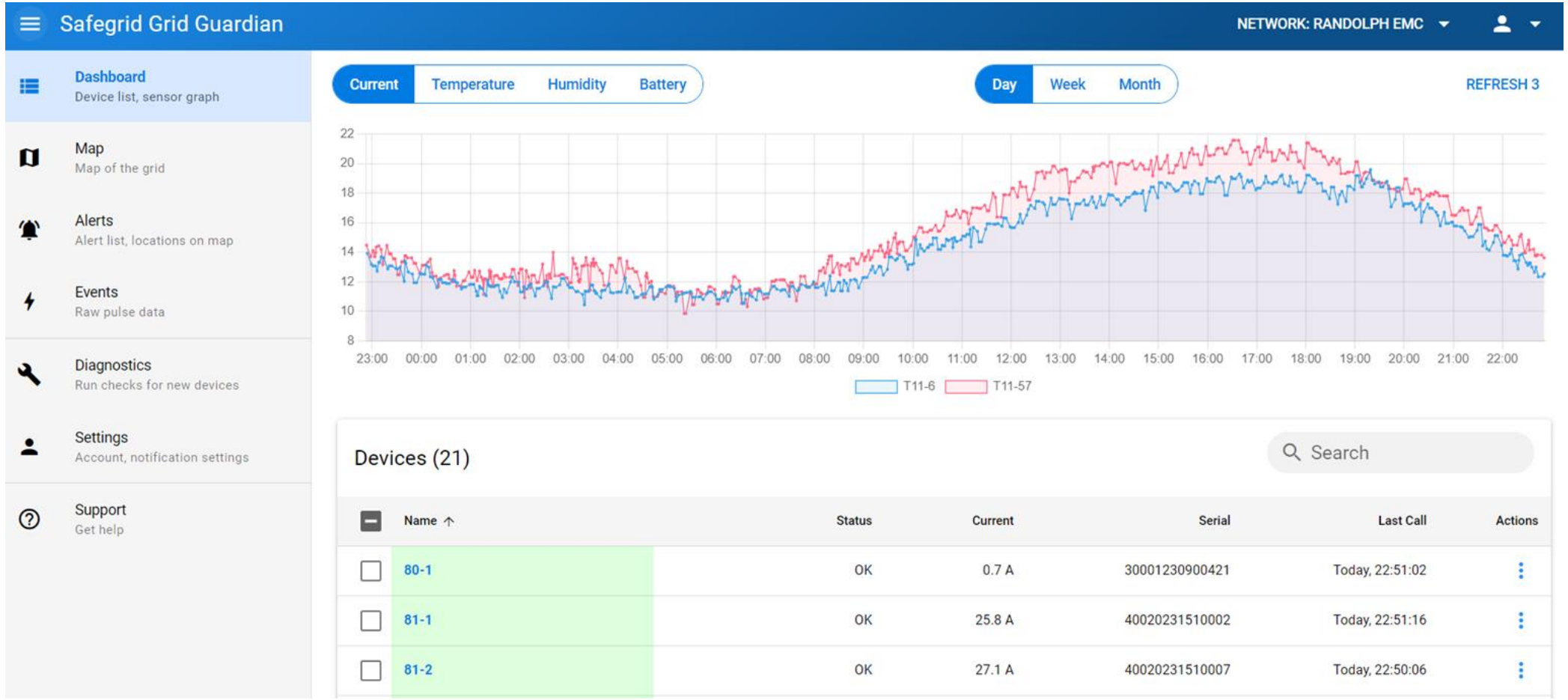
Comment 2
https://app.safegrid.io/eventanalysis#f=e46e2f03-40b7-44f3-b7c9-b49de2ddbfcd

Field 1

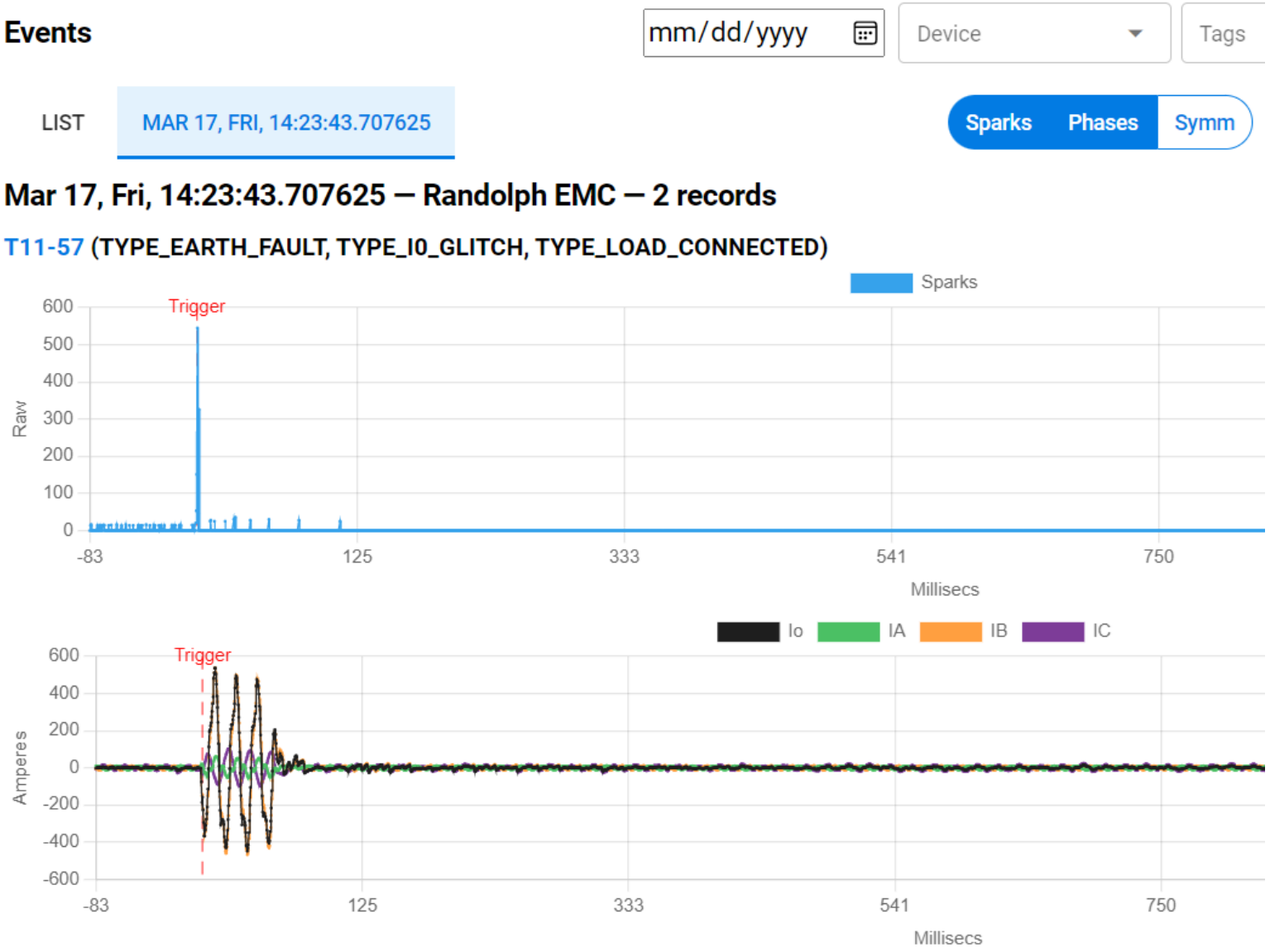
Field 2

Field 3

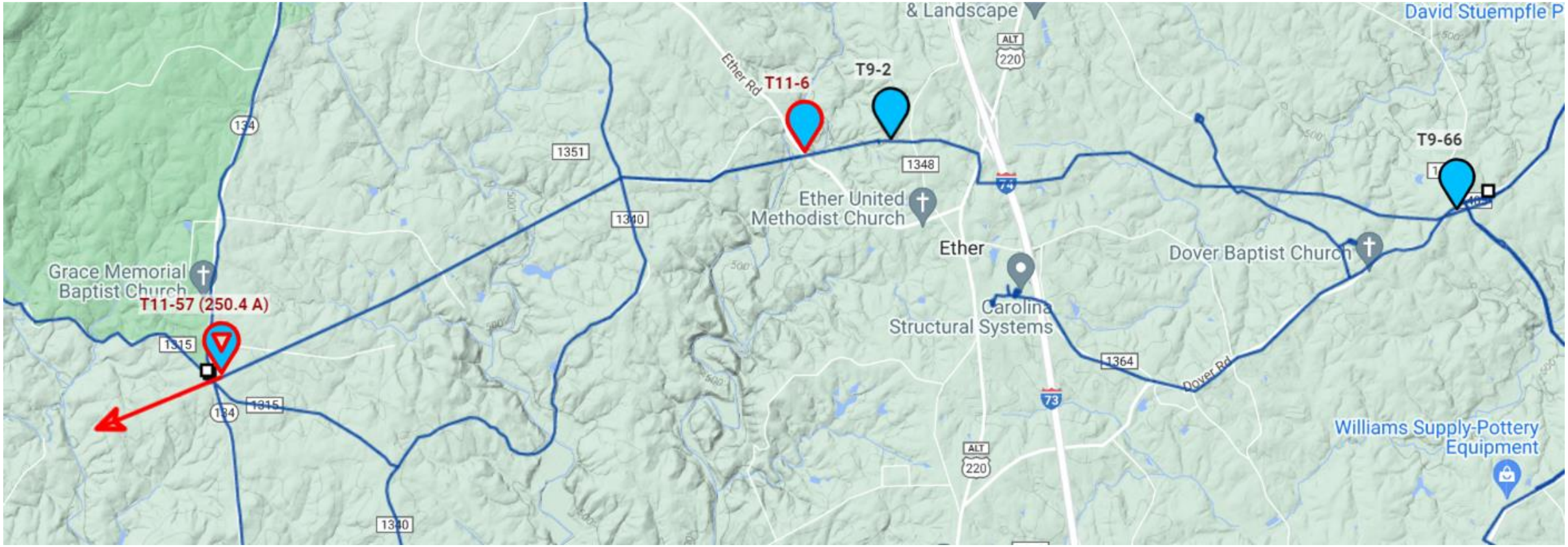
Safegrid Dashboard View



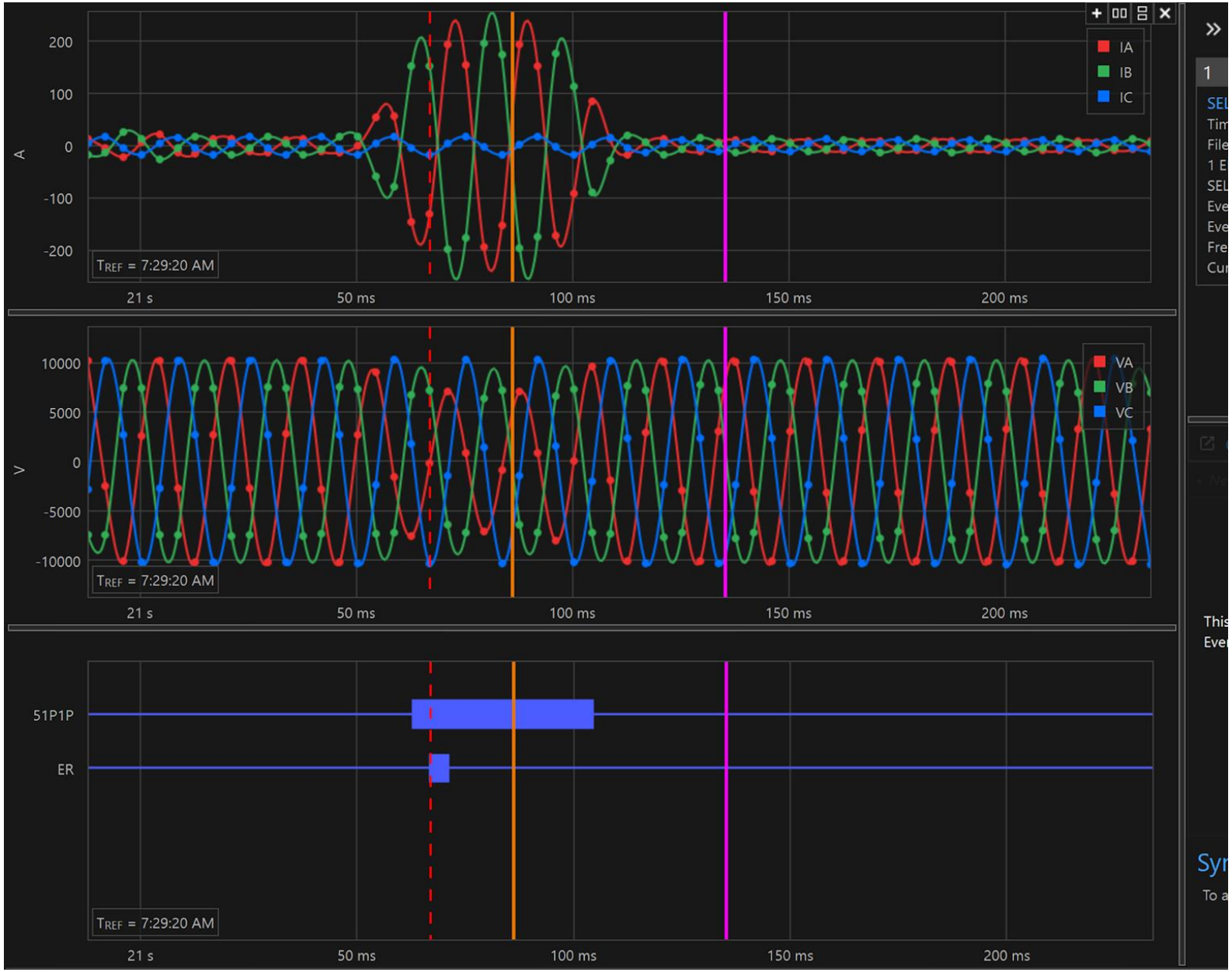
Fault Event – Data View



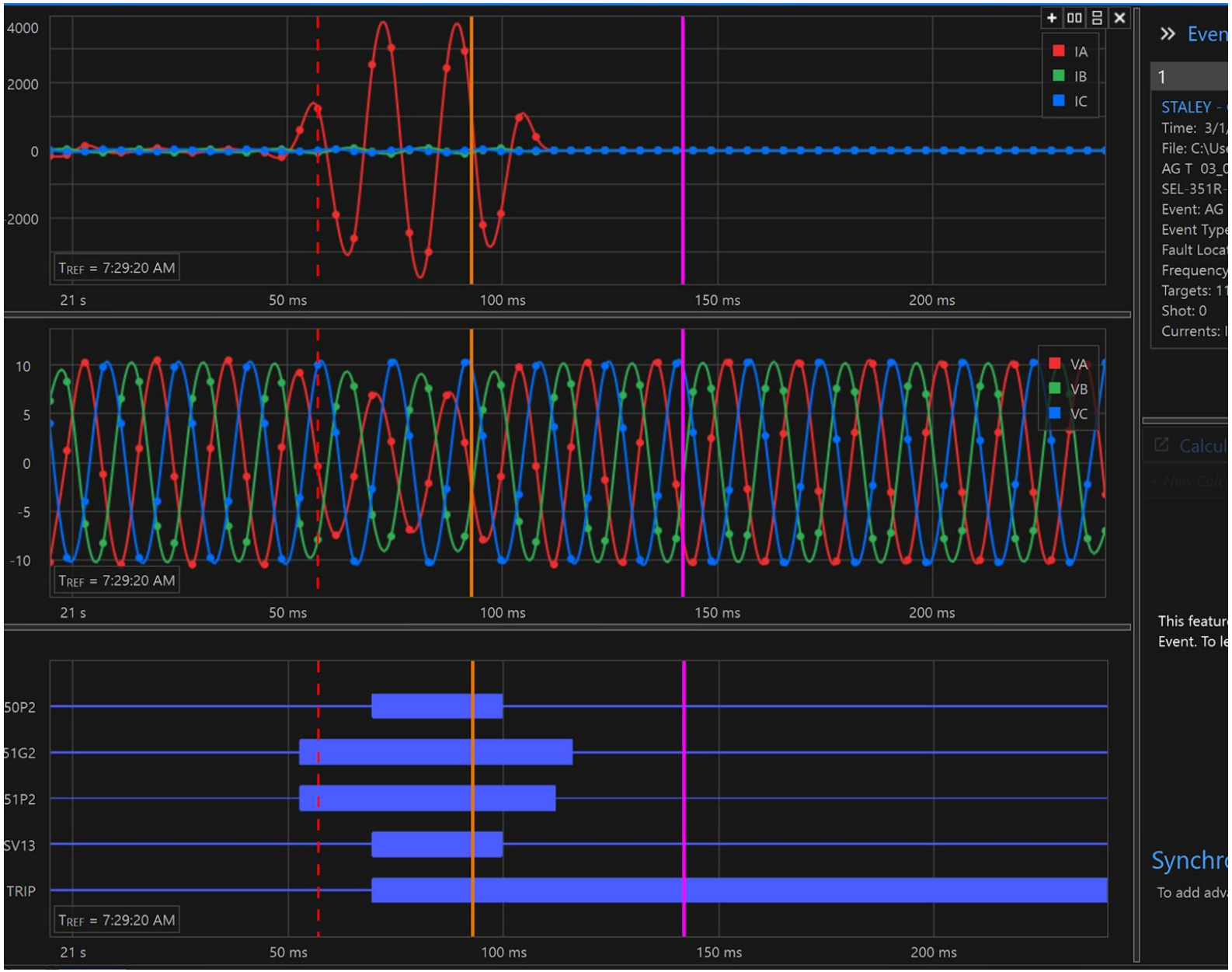
Fault Event – Map View



Fault Event – SEL HV Relay



Fault Event – SEL MV Relay

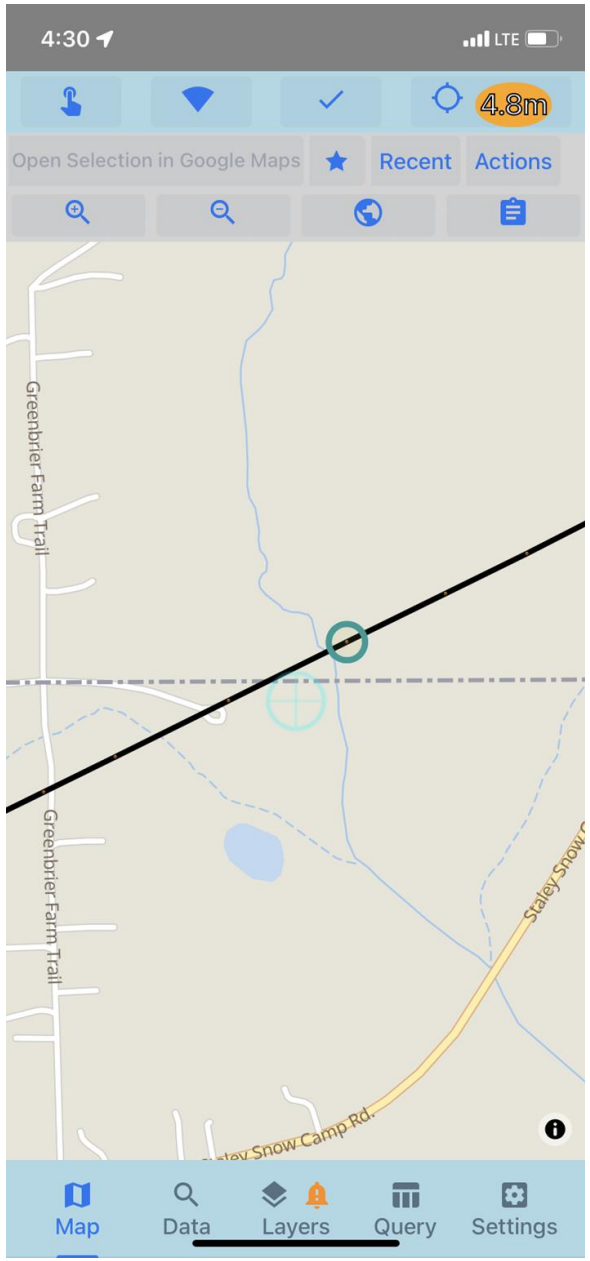


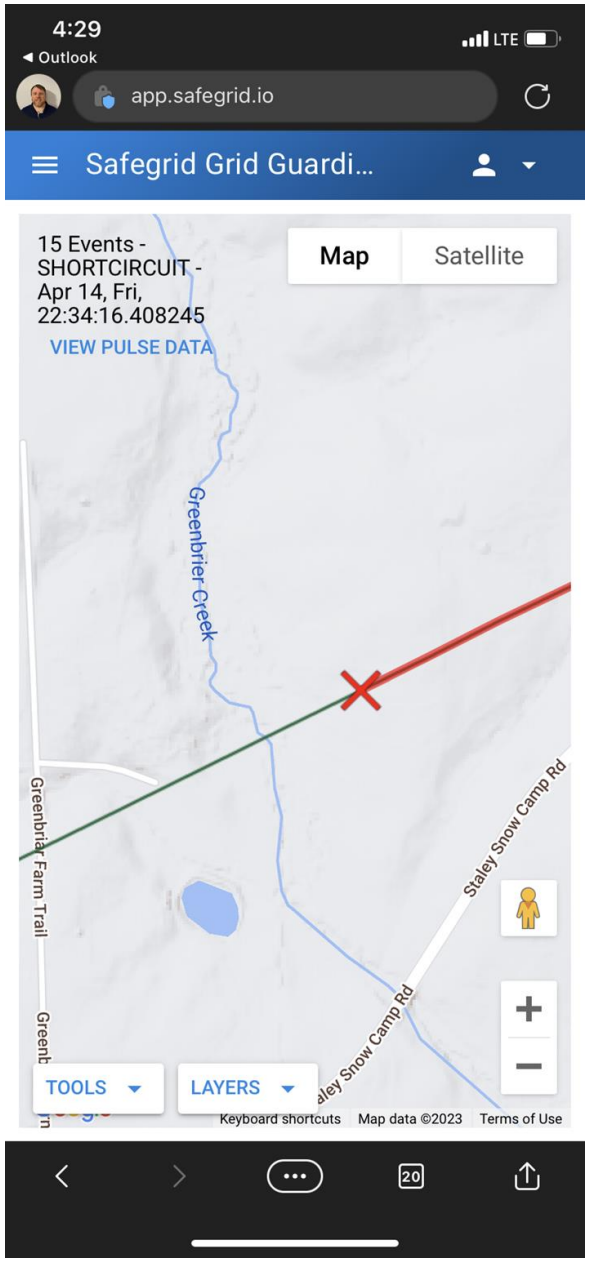
Transmission Line Fault

- Liberty POD – Staley – Snow Camp Transmission Line
- April 15, 2023 Approximately 4:00 am

Transmission Line Fault

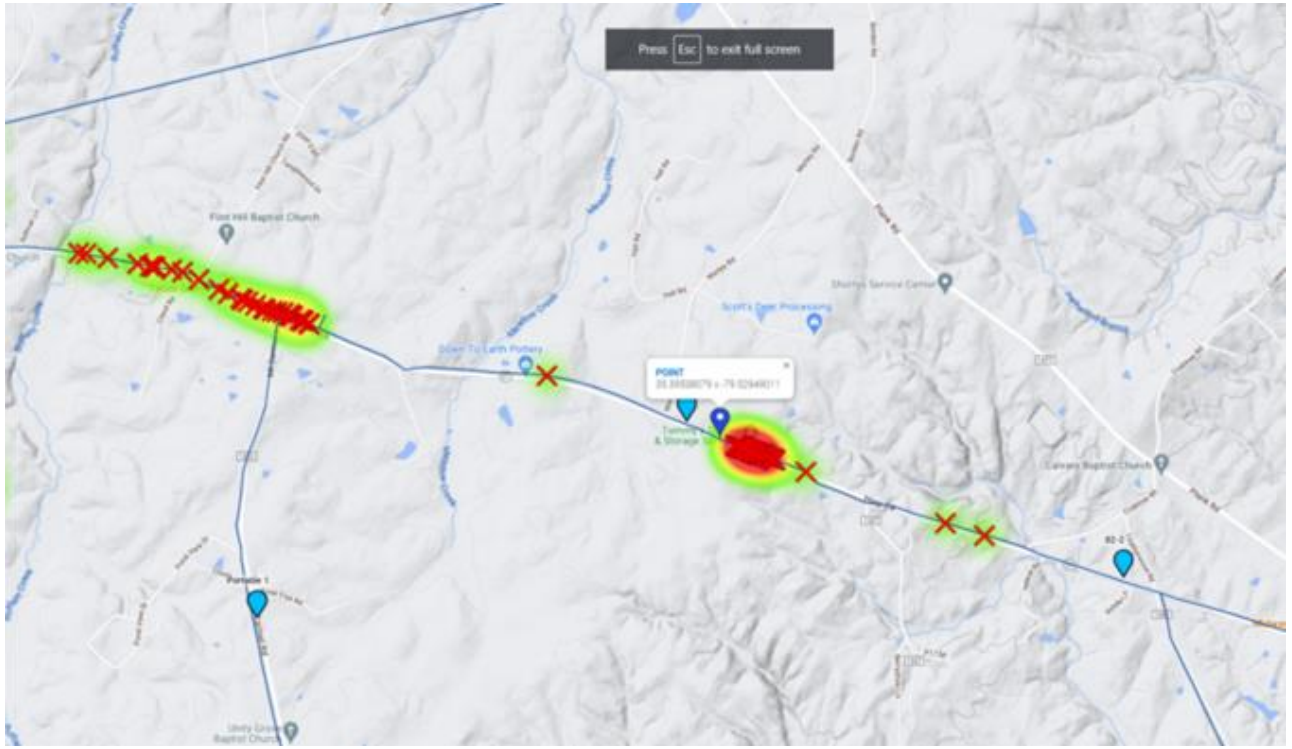
- Fault Location was spot on
- Within one span





Preventative Maintenance Application

- Work in-progress
- Circuit 82 Partial Discharge Detected (2 Locations)
- Field Identified Source using RFI and Ultra-Sonic Equipment:
  - Location 1 – Loose Ground Strap on Lightning Arrestor
  - Location 2 – Failed Lightning Arrestor



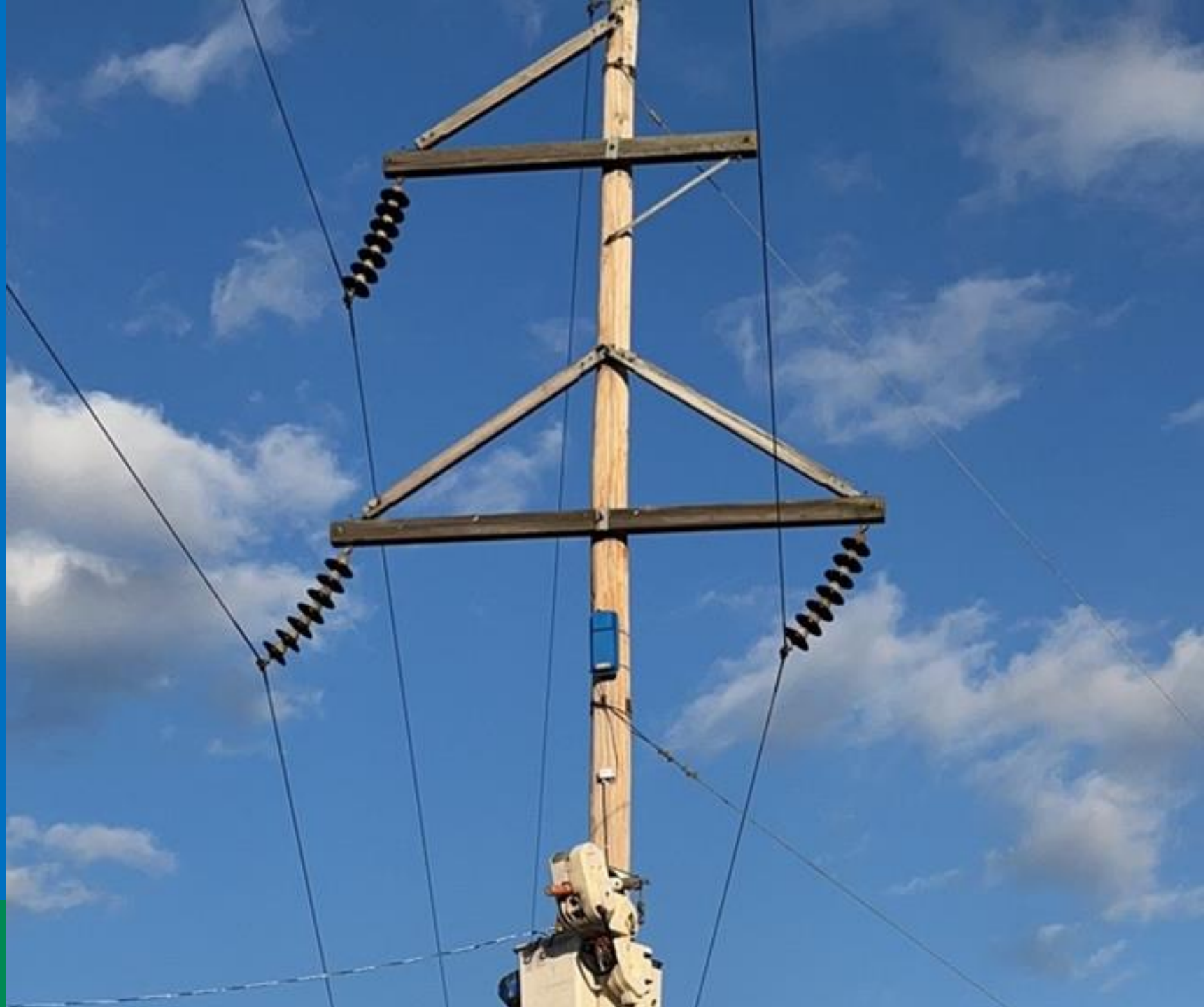
Installation

Randolph EMC

Installation

Randolph EMC

Installation



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Cost and Sales Info

Cost (these are not the TEMA prices)

- GrayFox: $1500 per unit, installation 2-3 miles apart
- GrayHawk: $2200 per unit, installation 3-6 miles apart
- Setup and commissioning: $3000-5000 for a Utilities system
- Monthly Fee (including Cell communications, firmware updates, licensing) $19/month per device or $228 per device annually.

Pilot install estimates (including all equipment and setup costs):

- 15 unit pilot: under $37k, covers 45 to 90 line miles
- 20 unit pilot: under $48k , covers 60 to 120 line miles

Sales Info

- Jake Rudisill Associates
- Lantz Critel
- (704) 910-9227
- lantz.critel@jakerudisill.com

Questions