

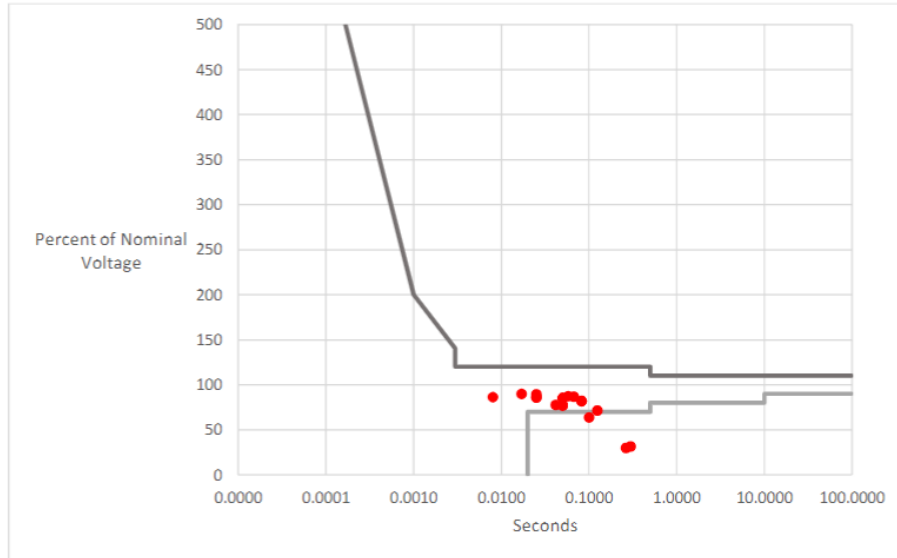
Power Quality Trend Analysis Needs

Salt River Project – September 28th, 2022

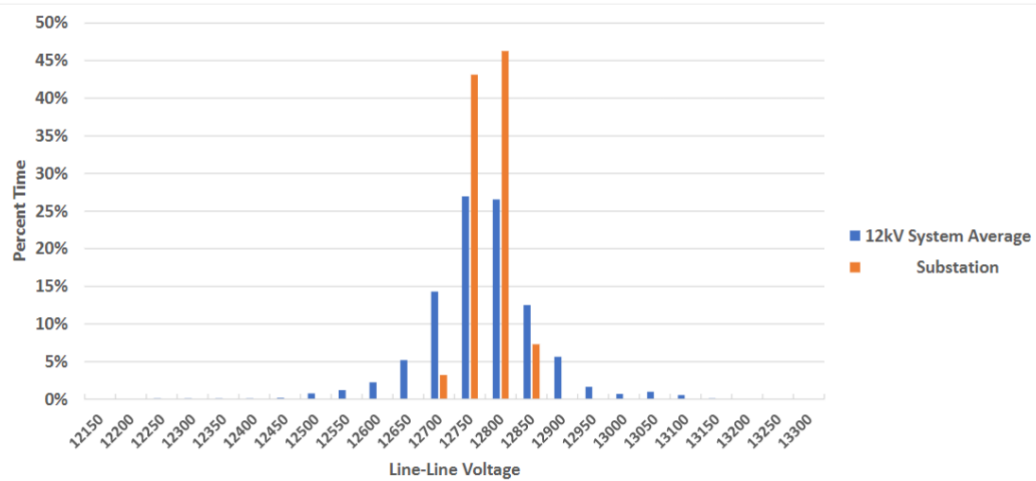
Summary Display

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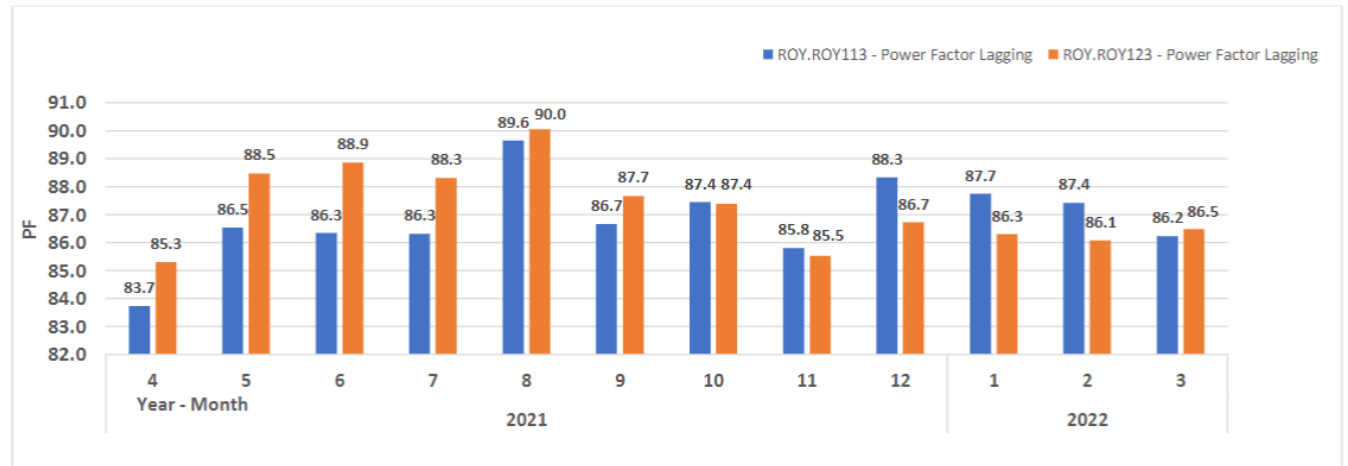
Voltage Sag Conformance to ITIC (April 2021 – March 2022)



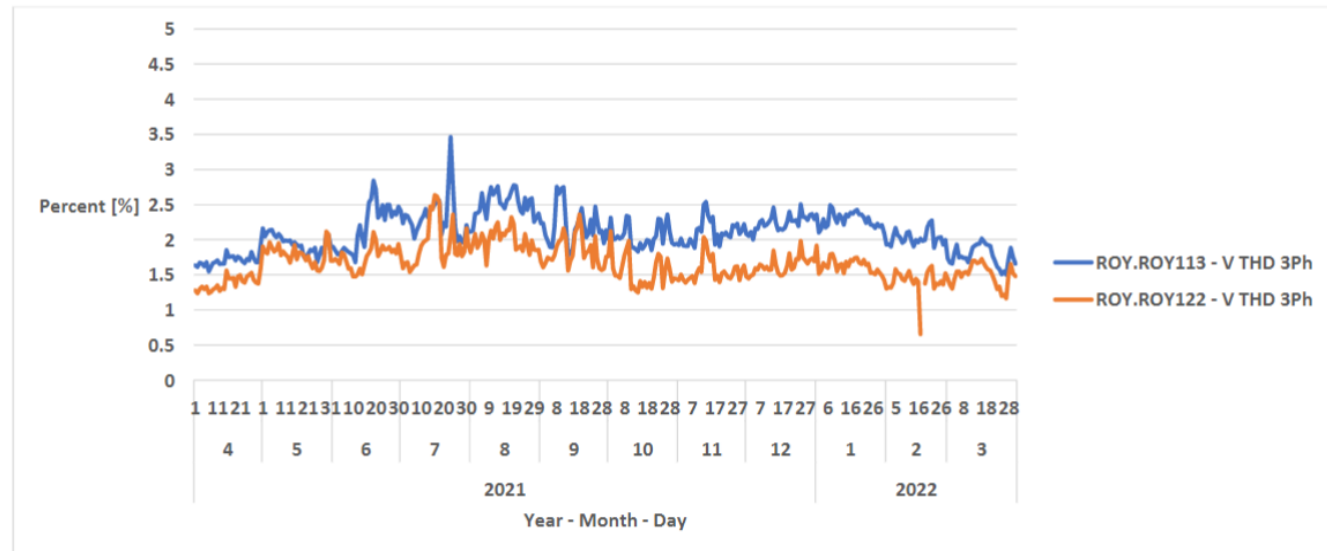
Percent Daily Average Line-Line VRMS (Apr 2021 - Mar 2022)



Average Monthly Power Factor



Average 3-Phase % THD



Summary Display

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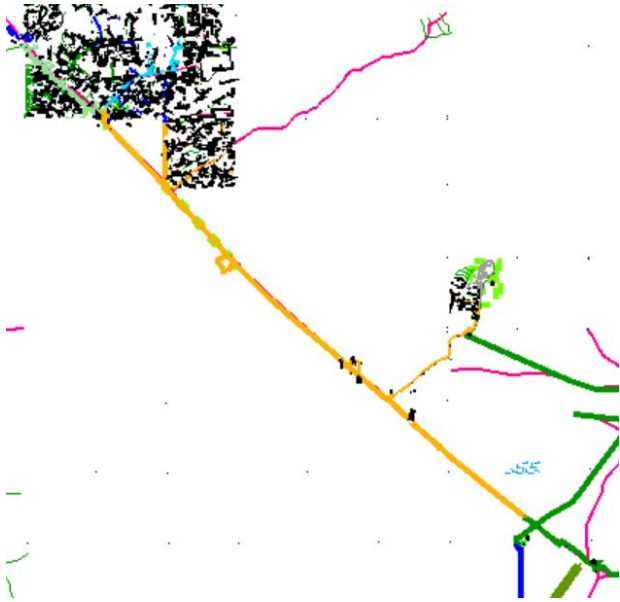
Between April 2021 and March 2022*:

- **Power Factor** typically averaged greater than 0.85 each month and is almost exclusively lagging. Load is minimal on circuits ROY115 and ROY122.
- **Line-line voltages** at ROY were well within ANSI A range and are representative of the 12 kV system average.
- **Average % THD_v** at ROY was typically less than 3.0%, markedly less than the IEEE 519-2014 recommended limit of 5.0%.
- **Individual harmonic** information was unavailable.
- A total of 11 **voltage sags** were recorded between the 2 ROY Bays.
 - o 9 of 11 sags were within the ITIC boundary.
 - o 2 of 11 sags were below the ITIC curve, into the No Damage Region. The 3 sags were 2 isolated events caused by i. bird contact on the 69 kV at WHT and ii. a vehicular incident affecting ROY125.
- Daily average **voltage unbalance** maintained consistently under 0.5 %, well within ANSI C84.1-2006 recommendations of less than 3 %.
- Average **Plt-Flicker** on ROY Bay 1 and 2 was 0.07, well within IEEE Std 1453-2015 recommended limits of 0.7.
- Average **Pst-Flicker** on ROY Bay 1 and 2 was 0.05, well within IEEE Std 1453-2015 recommended limits of 0.9

**All metrics exclude transitory events such as voltage sags, meter testing, substation bay maintenance, etc.*

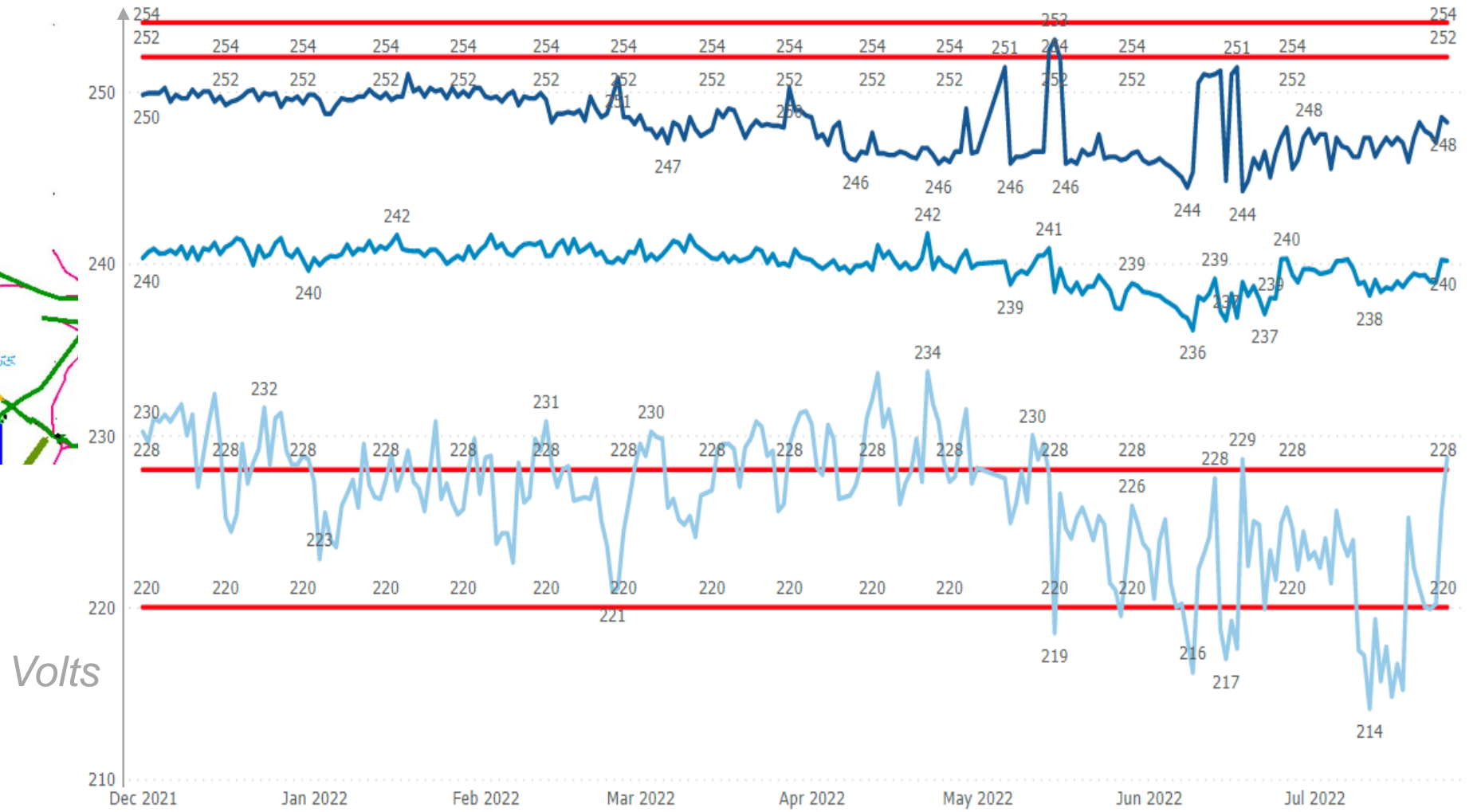
Locational Awareness – 12 kV Feeder

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SPK132

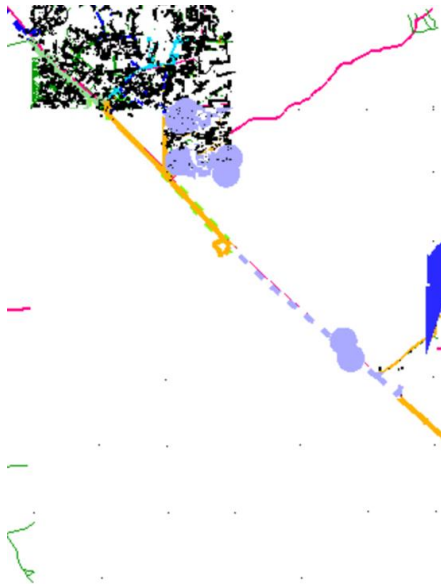
- Max of ANSI B+
- Max of ANSI A+
- Min of ANSI A-
- Min of ANSI B-
- Average of Average Read
- Min of Minimum Read
- Max of Maximum Read



~2,000 AMI Endpoints

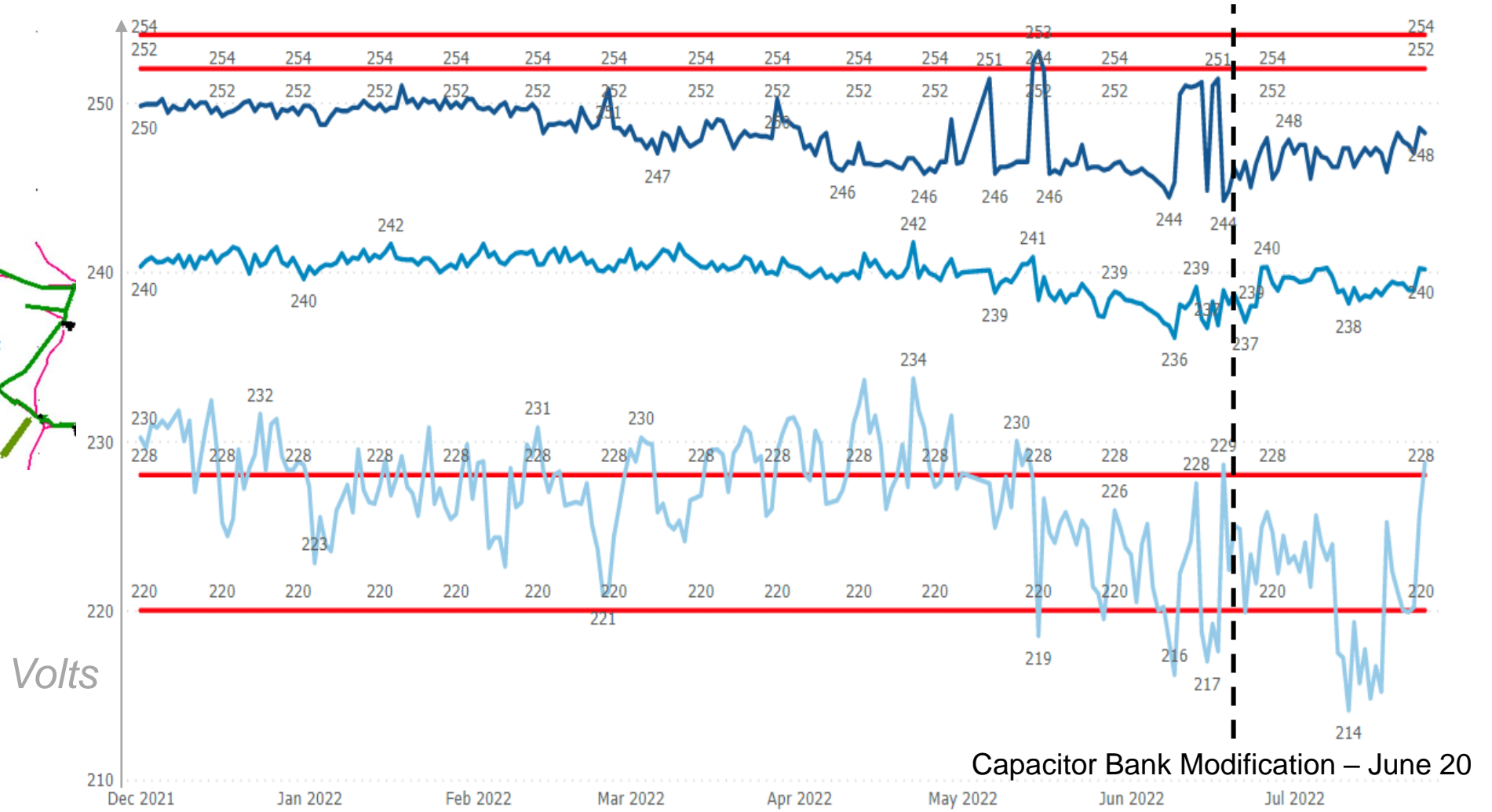
Locational Awareness – 12 kV Feeder

2/10



SPK132

- Max of ANSI B+
- Max of ANSI A+
- Min of ANSI A-
- Min of ANSI B-
- Average of Average Read
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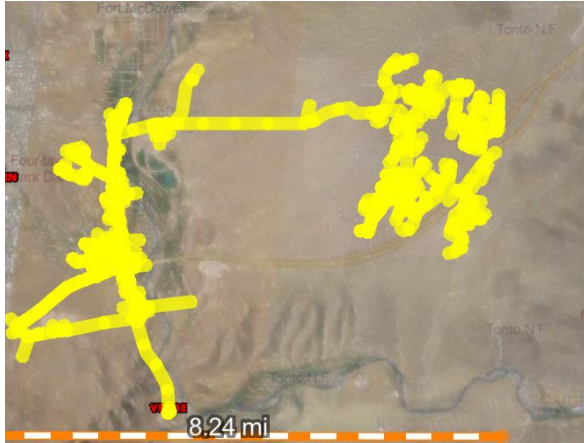


~2,000 AMI Endpoints

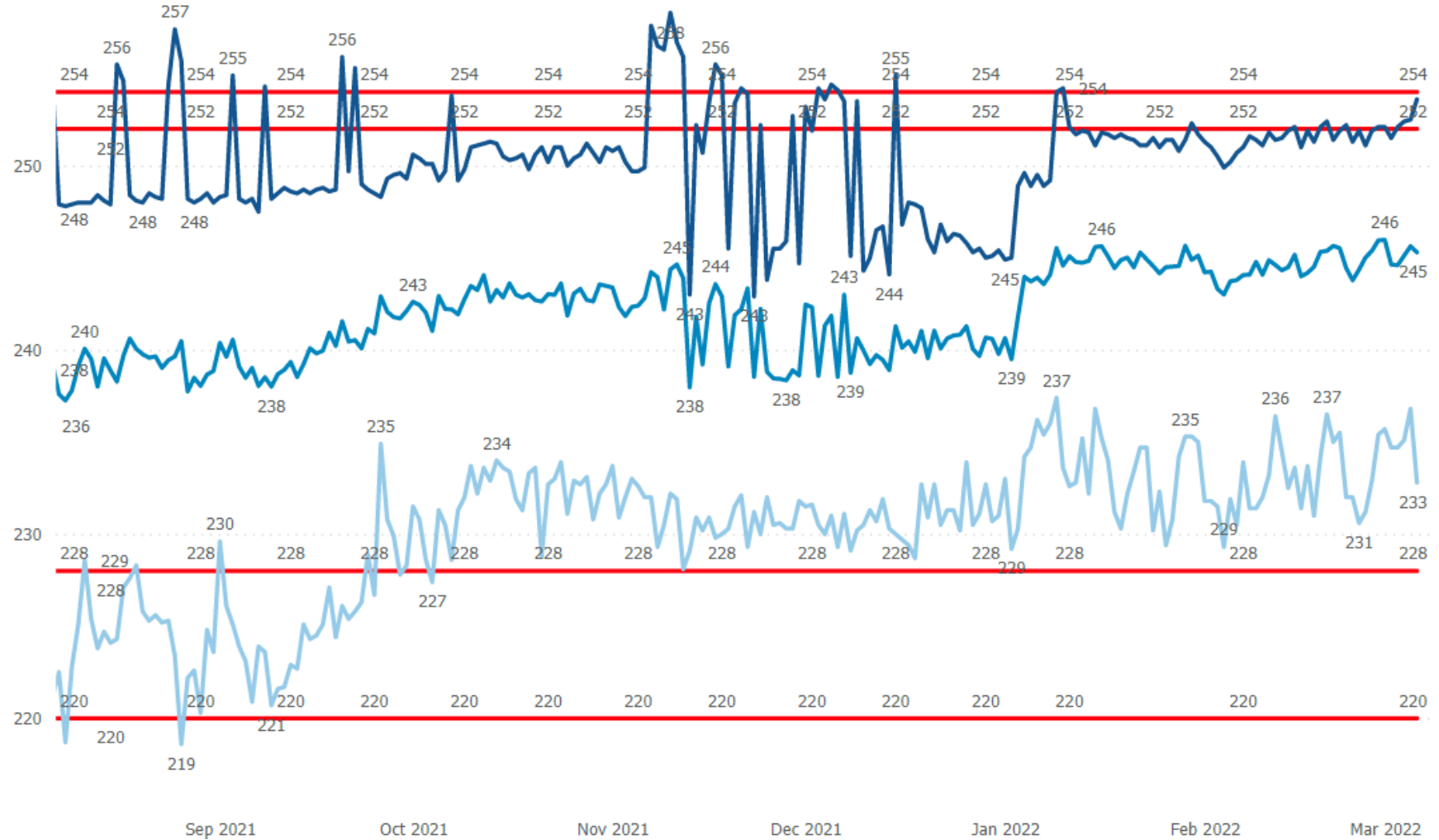
Locational Awareness – 12 kV Feeder

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VE125



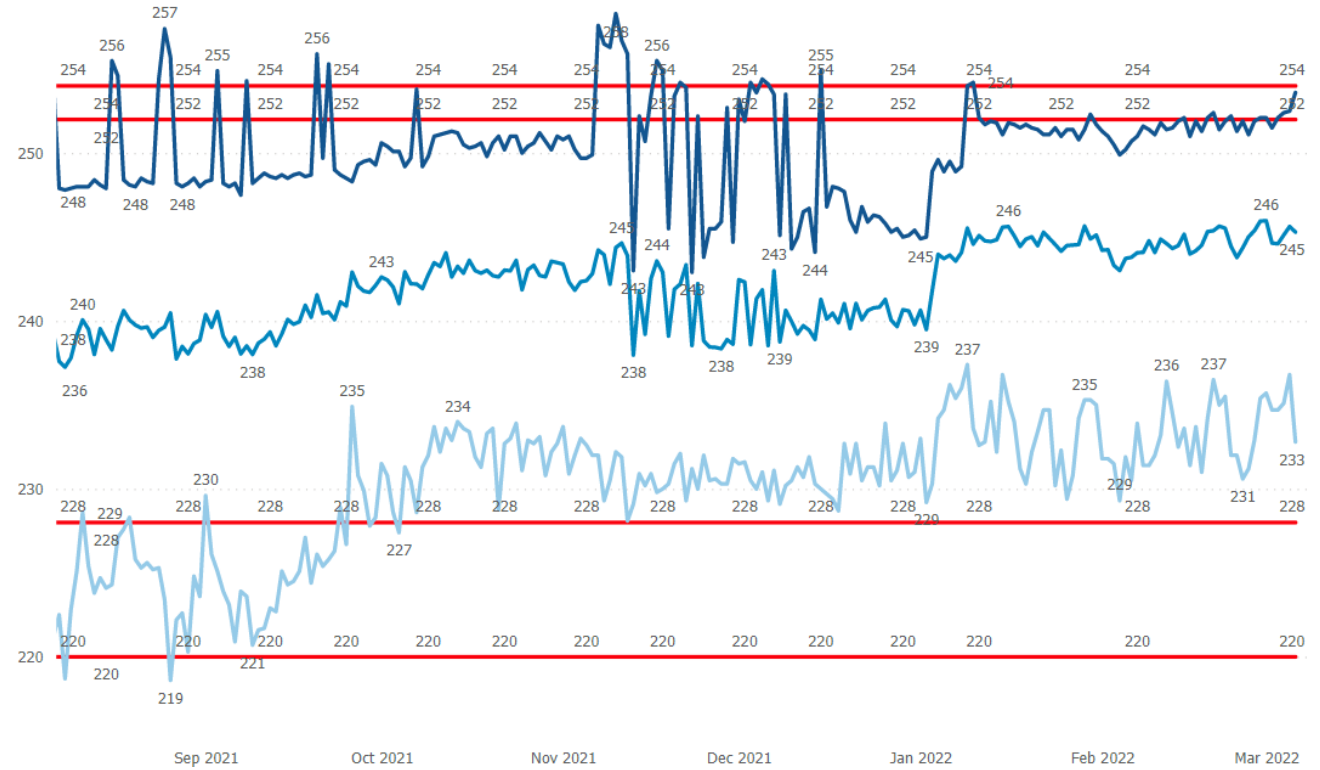
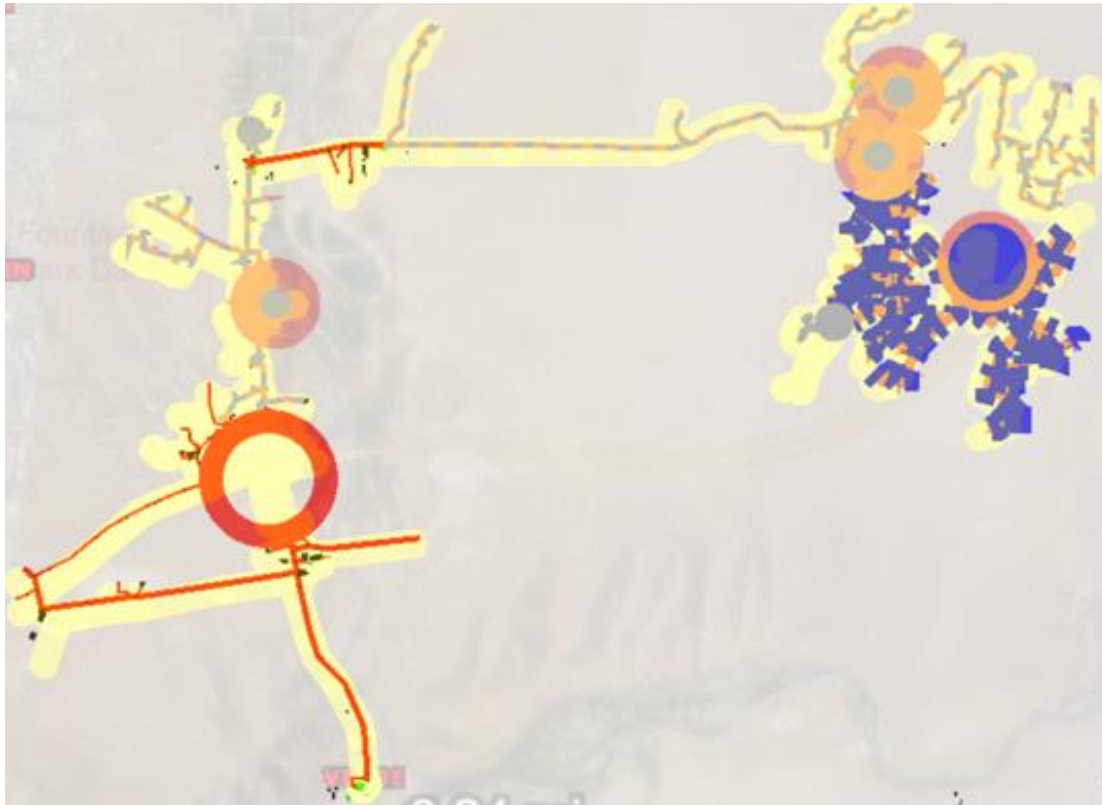
- Max of ANSI B+
- Max of ANSI A+
- Min of ANSI A-
- Min of ANSI B-
- Average of Average Read
- Min of Minimum Read
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Locational Awareness – 12 kV Feeder

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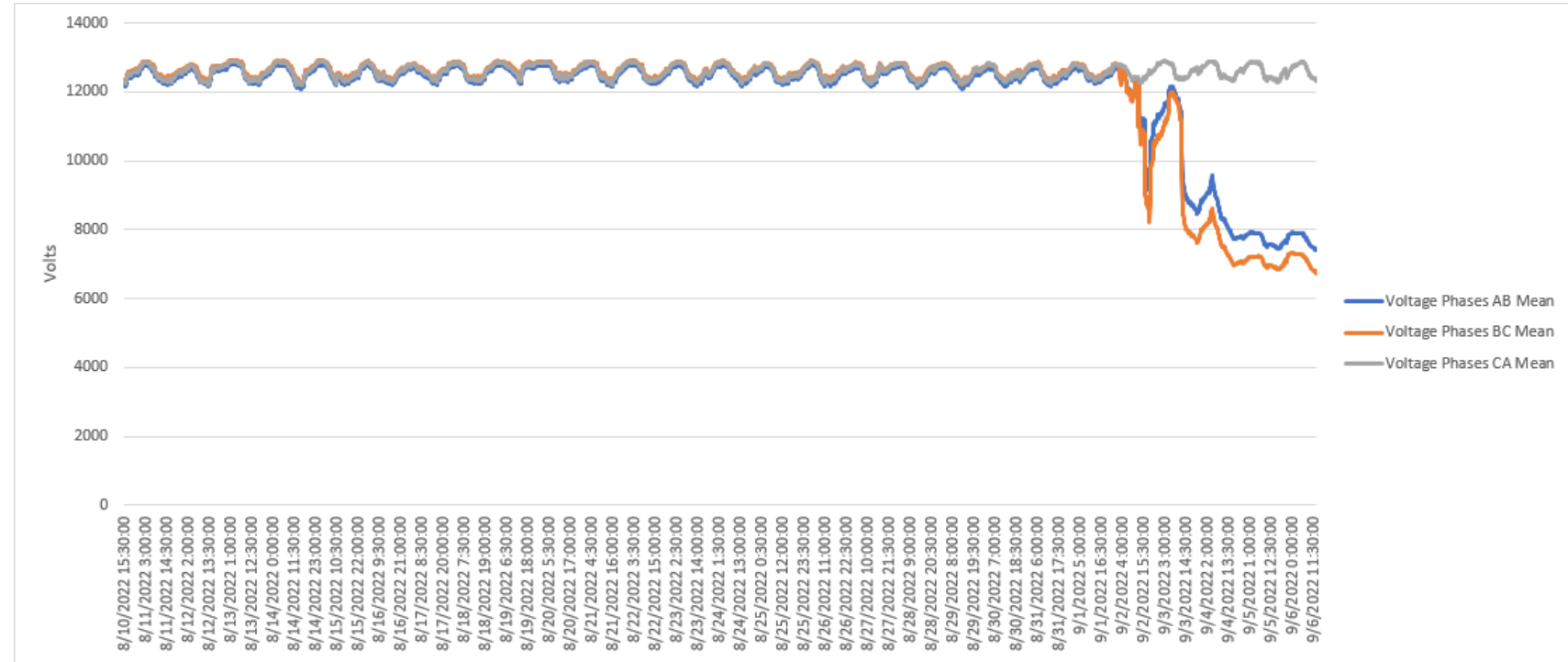
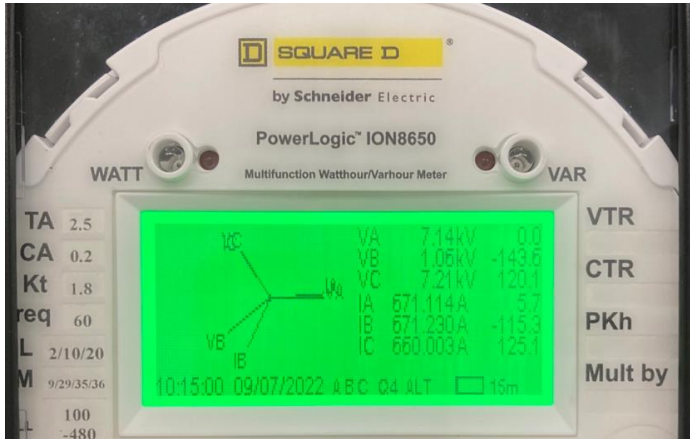
VE125



Statistical Process Control – Failed Fuse

Example #1

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Solar Generator

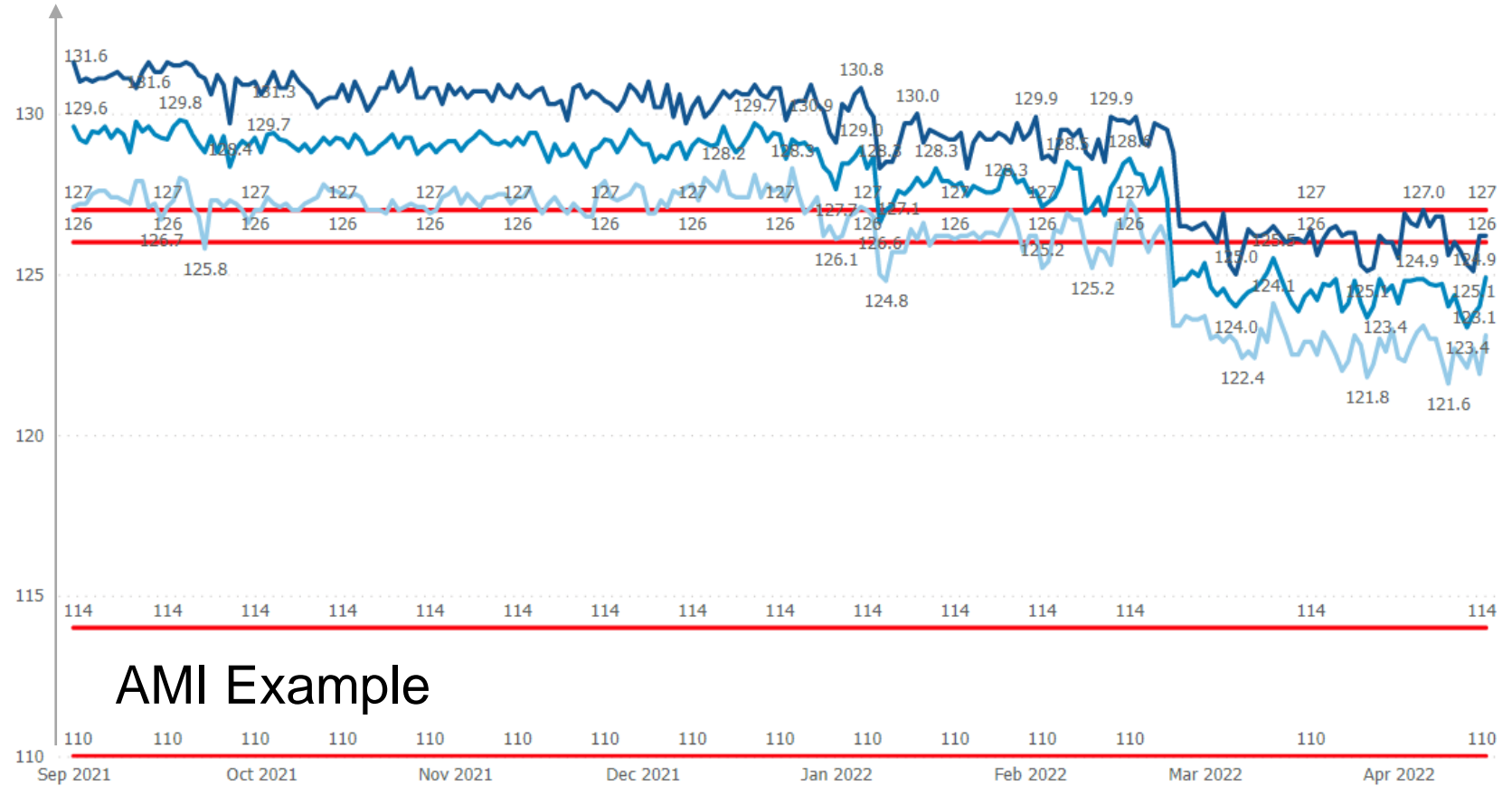
Statistical Process Control – Incorrect Tap

Example #2

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Volts



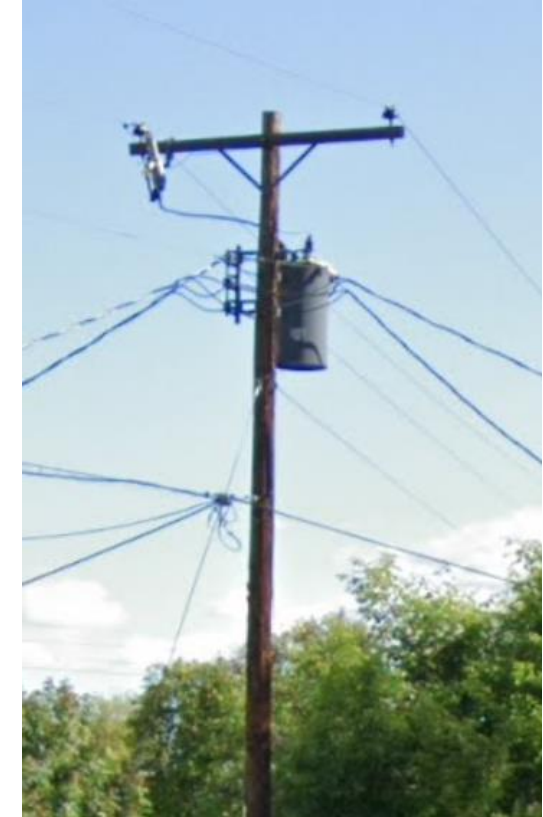
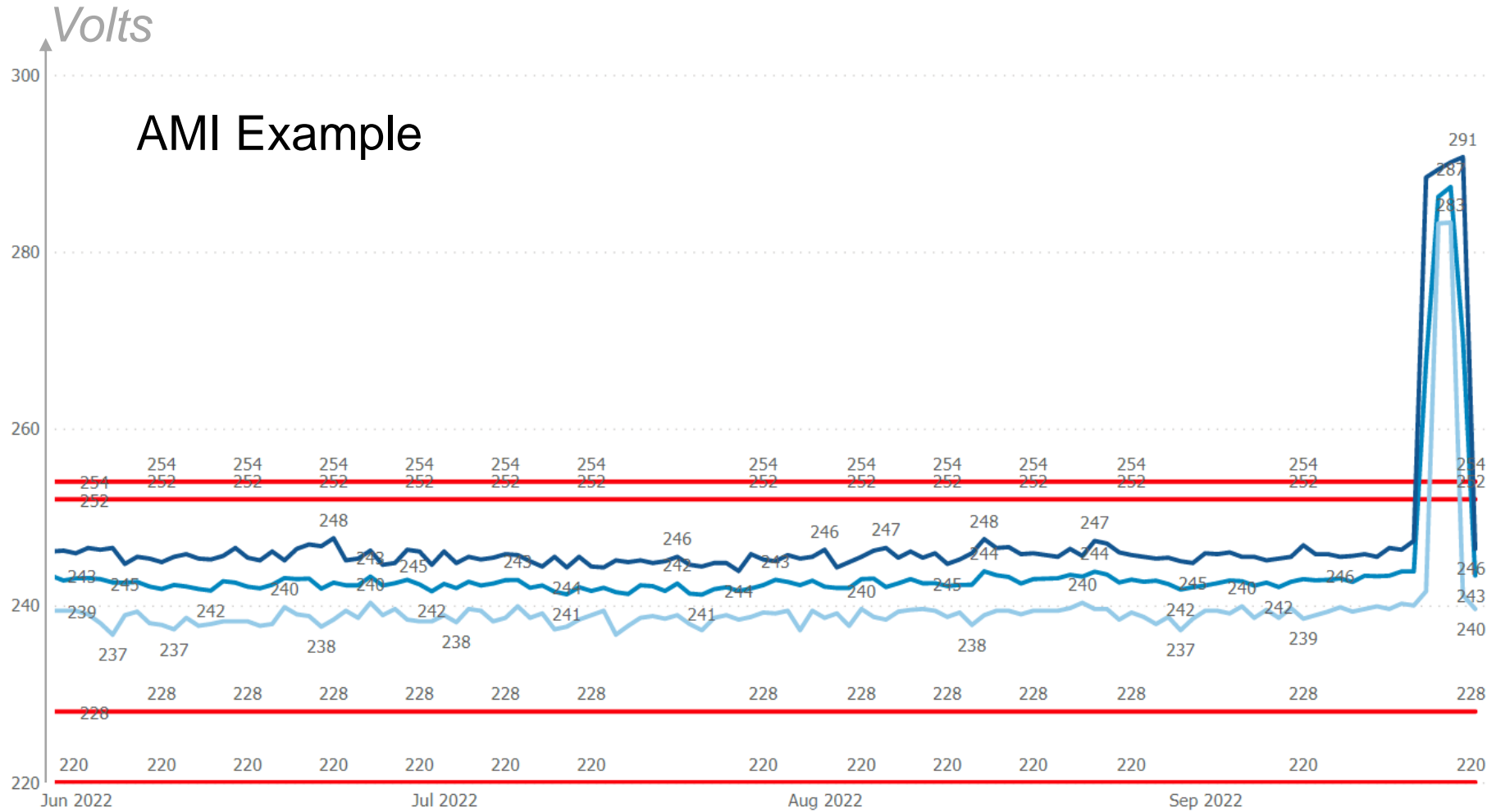
AMI Example

Transformer

Statistical Process Control – Failed Winding

Example #3

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Large Sets of Data

12 kV Performance

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Settings openXDA X

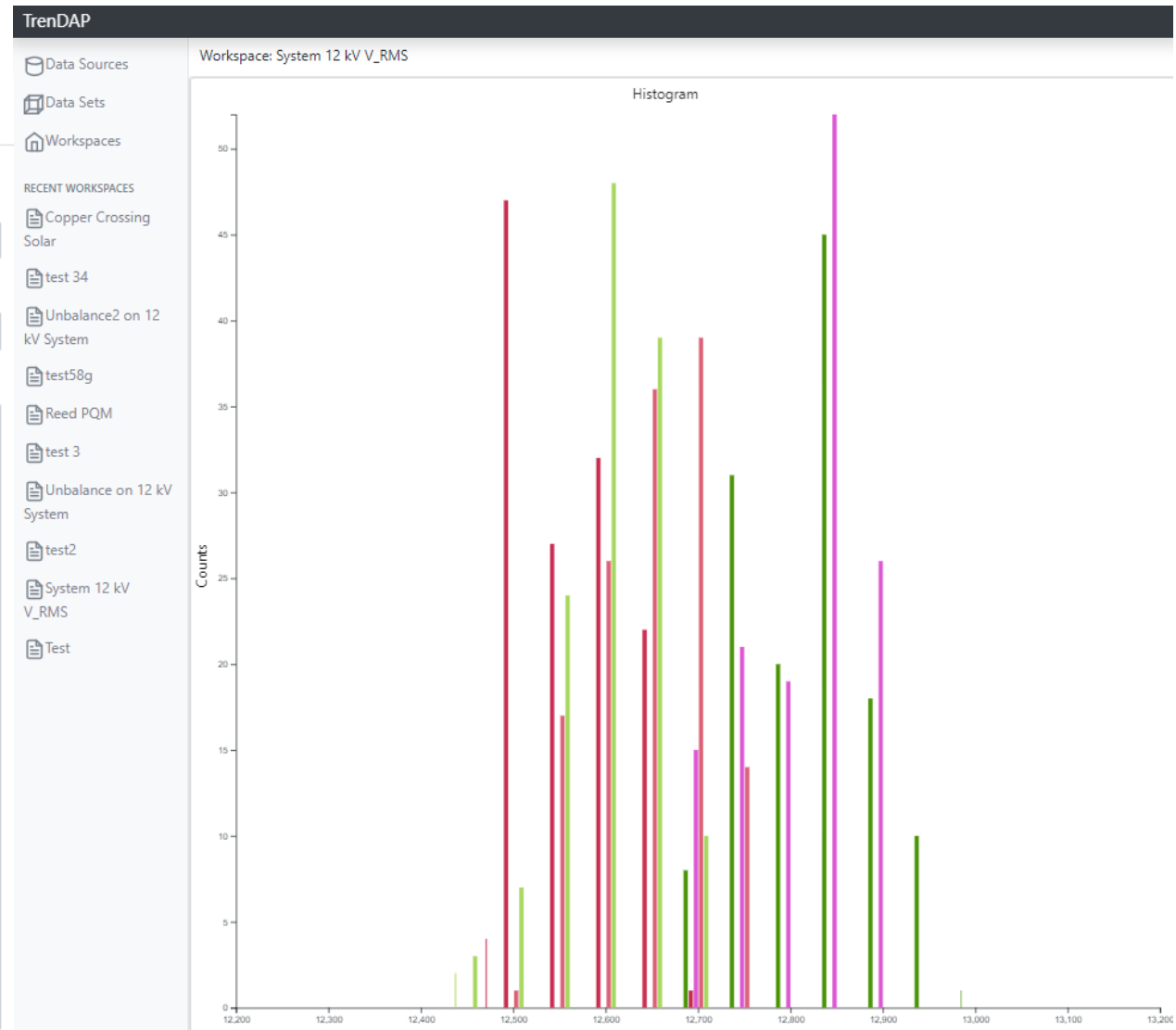
Quick View

Aggregate
None

By
Meter

IDs

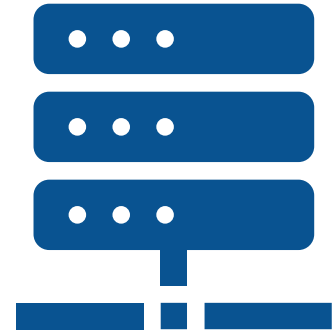
- AH3
- BL3
- BW2
- CA5
- CAL2
- CHM2
- CP1
- CRN1
- CW3
- CXS1
- CXS2
- EV1
- FC1
- GB2
- HU3
- KE3
- LE2
- LUA1
- LUA2
- LUA3
- LUA4
- MGS2
- MGS3
- MGS4
- MGS5
- MGS6



Machine Driven

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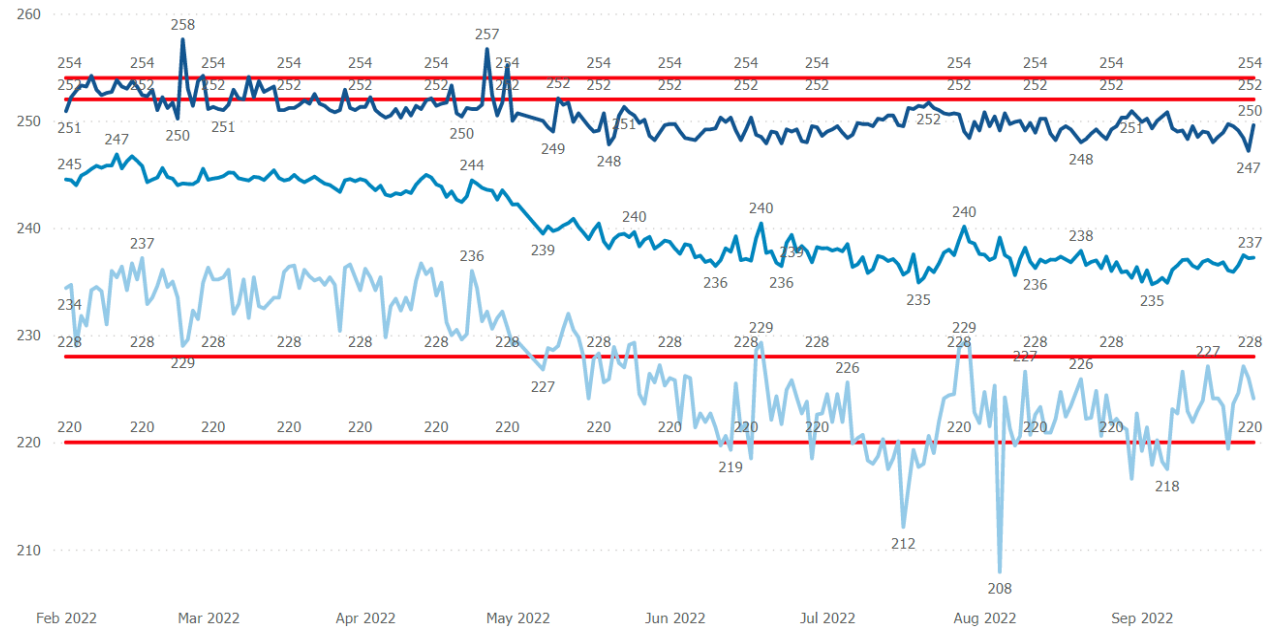
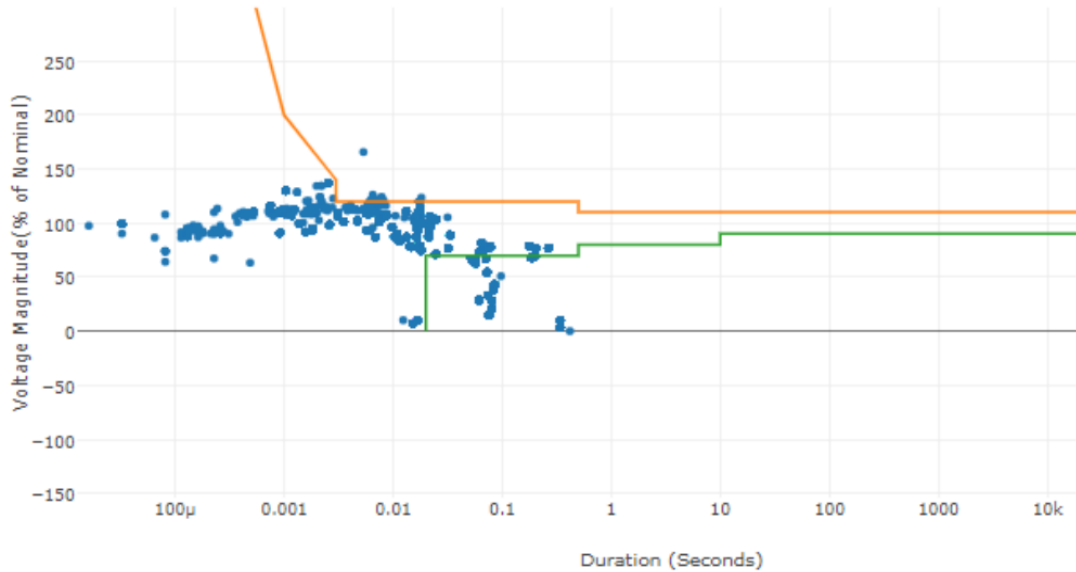
- What stories can a machine tell me about my system that I didn't think of or wasn't looking for?
- Most analytics tools require the user to drive the analysis.
- Doesn't need to be machine learning.
- Could be a scripted PQ analysis that evolves with utility input that, when given a warehouse of data, identifies and prioritizes concerns.



Standard Comparison

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Disturbance Magnitude Duration Scatter Plot



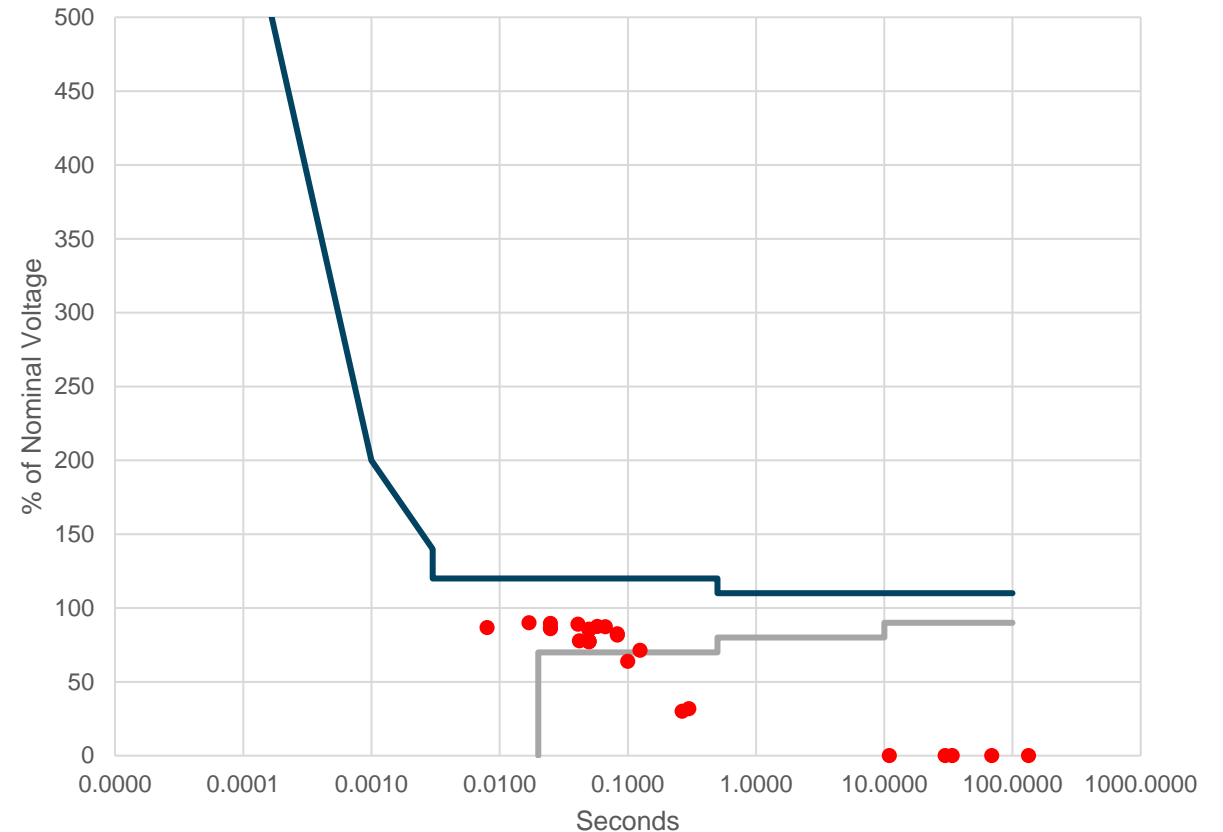
User-customizable limits as an option.

Data Validation (VEE)

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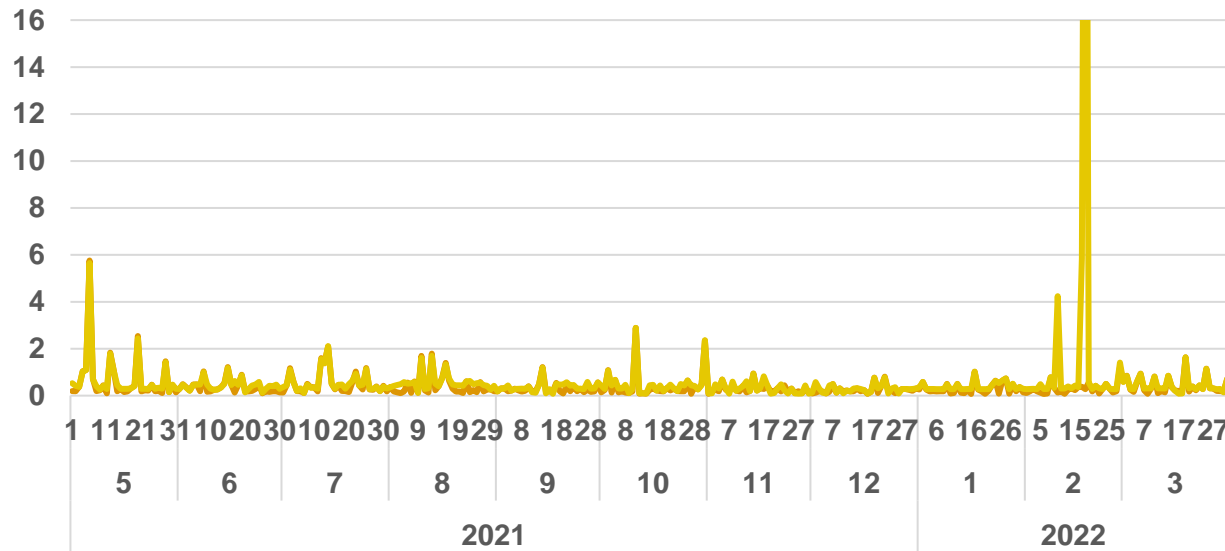
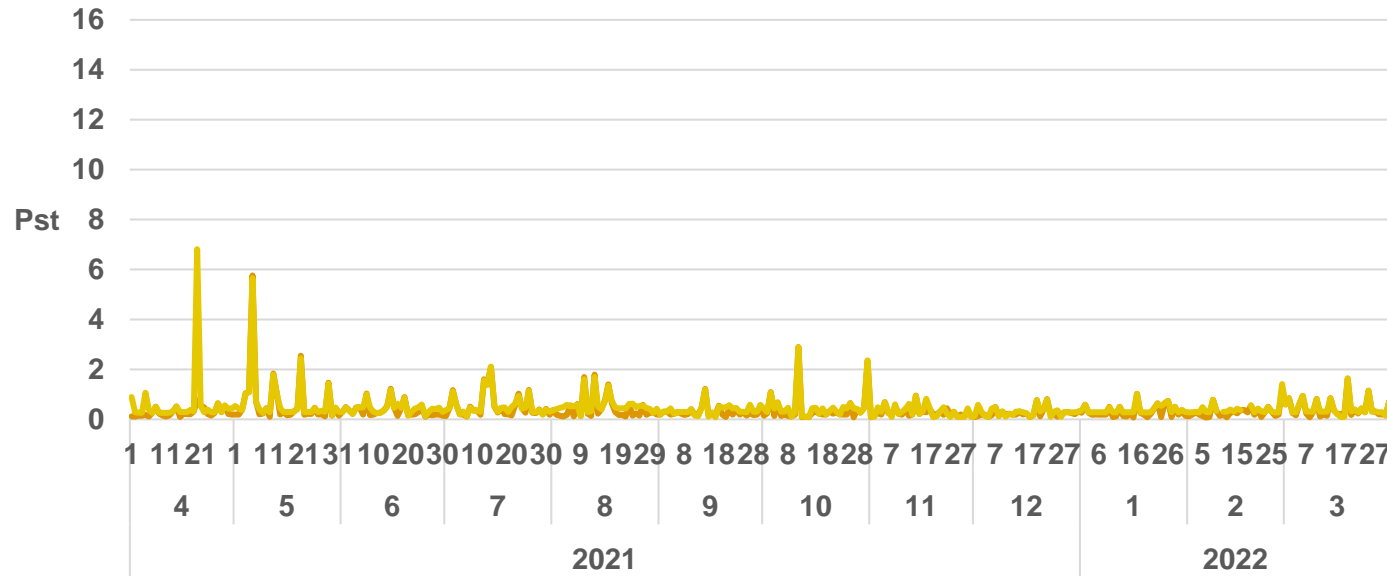
VEE = Validation, Estimation, and Edit

- Trending and data analytics is corrupted by
 - Relay and meter testing, line upgrades, line faults, meter circuit failures
 - Multiple hours to sift through iTOA outage reports and fault data



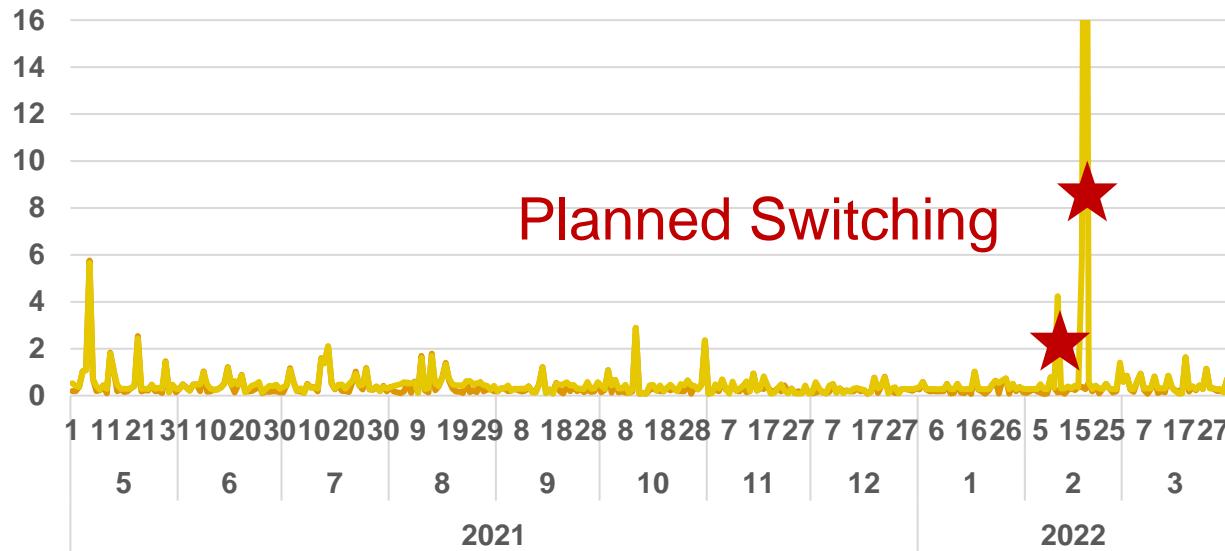
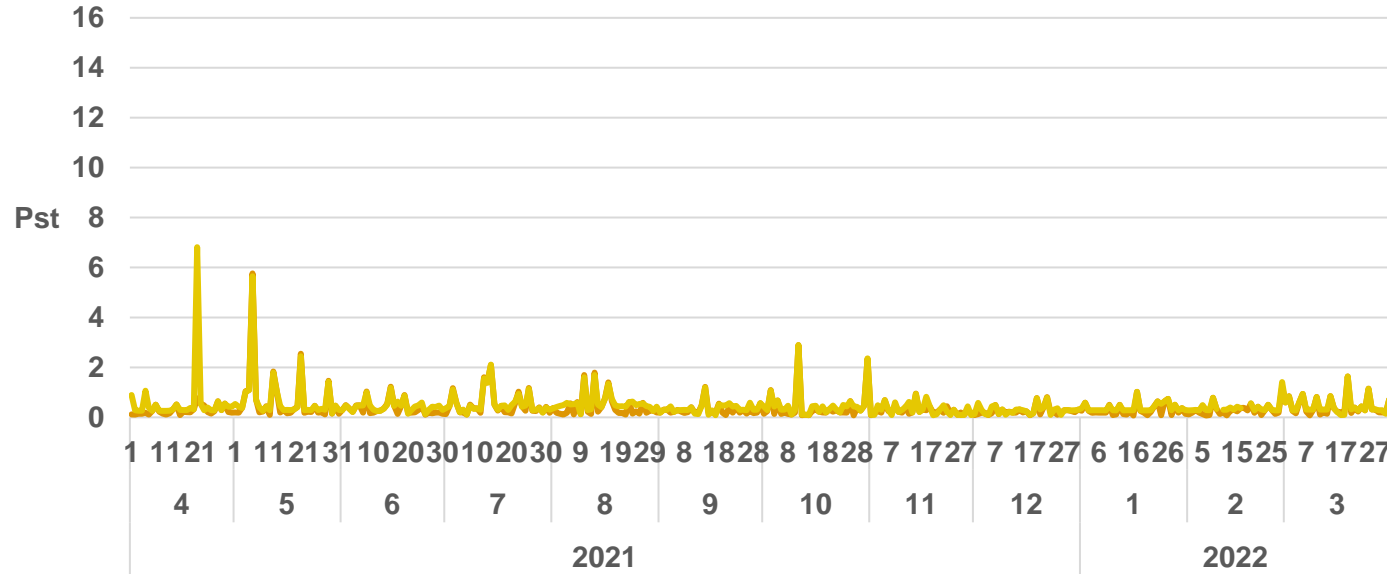
Data Validation (VEE)

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Overlay

Time Series Data overlaid with fault and EMS data can help explain anomalies



LTC failures



69 kV Capacitor Banks



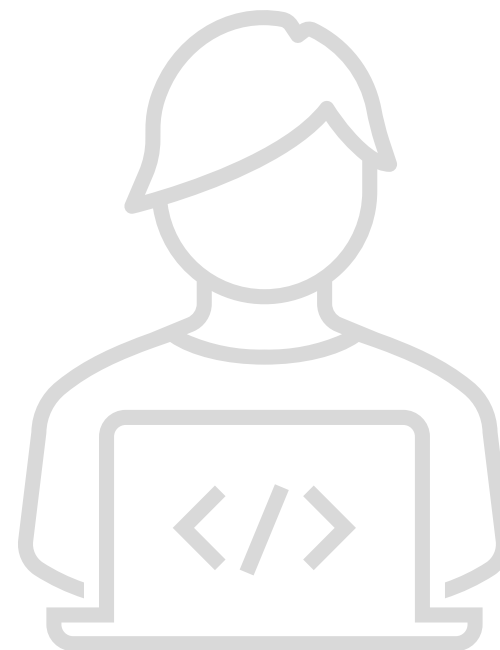
Incipient Failure Detection



2nd Harmonic – UG faults

Failing fuses

Cyber Security



Trend Analysis Needs

Summary Display

Location Awareness

Statistical Process Control

Large Sets of Data

Machine Driven

Standard Comparison

Data Validation

Overlay

Incipient Failure Detection

Cyber Security