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POWER QUALITY
ION Solutions

Presentation Outline

1. *Review of PQ definitions*
2. *Types of Power Quality problems*
3. *Metering Equipment*
4. *Locations*
5. *Cases (Voltage Sags)*

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- **Power Quality is not a problem**
- **until**
- **Power Quality is a problem**

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- **Fool me once, Shame on you.**
- **Fool me twice, Shame on me.**

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Definition of PQ

- ***What is Power Quality***
  - ***The concept of powering and grounding sensitive electronic equipment in a manner that is suitable to the operation of that equipment.*** **IEEE 1100-1992**
  - ***The concept of power and grounding electronic equipment in a manner that is suitable to the operation of that equipment (and compatible with the premise wiring system and other connected equipment.*** **IEEE 1100-1999**

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Definition of PQ

- ***The definition of Power Quality cannot be limited to the characteristics of the supply power. The definition must also include the requirements of the load and the neighbouring loads.***

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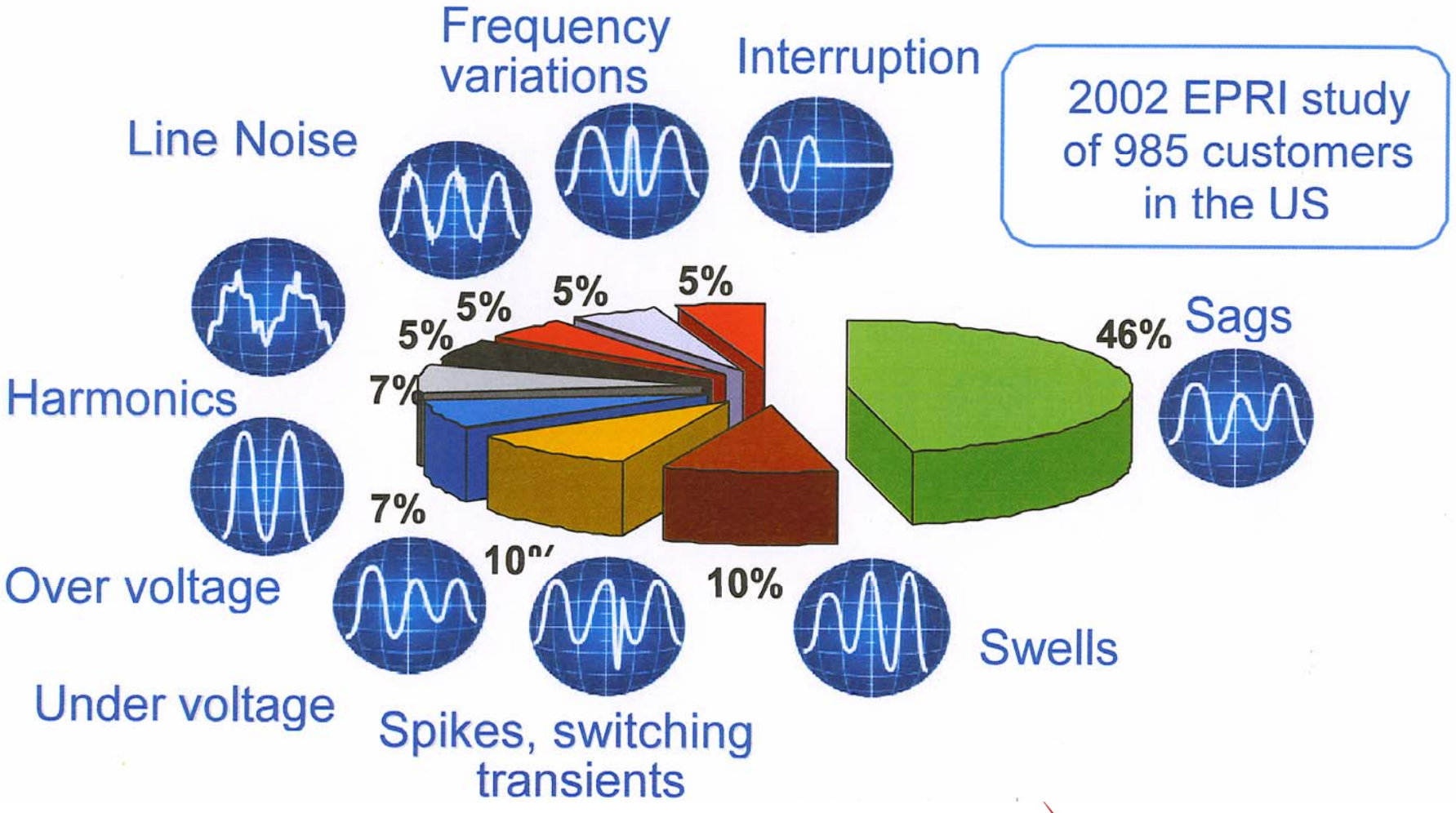
Types of Power Quality Issues



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Types of Power Quality Issues

- ***VOLTAGE SAGS***
- ***VOLTAGE SWELLS***
- ***TRANSIENTS***
- ***HARMONICS***

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PQ – Voltage Sag

- *Complete loss*
  - *Momentary: < 2 seconds*
  - *Temporary: between 2 sec & 2 min.*
  - *Outage: > 2 min*
- *Motor startup*
- *System faults*
- *Load switching.*
- *PF correction.*

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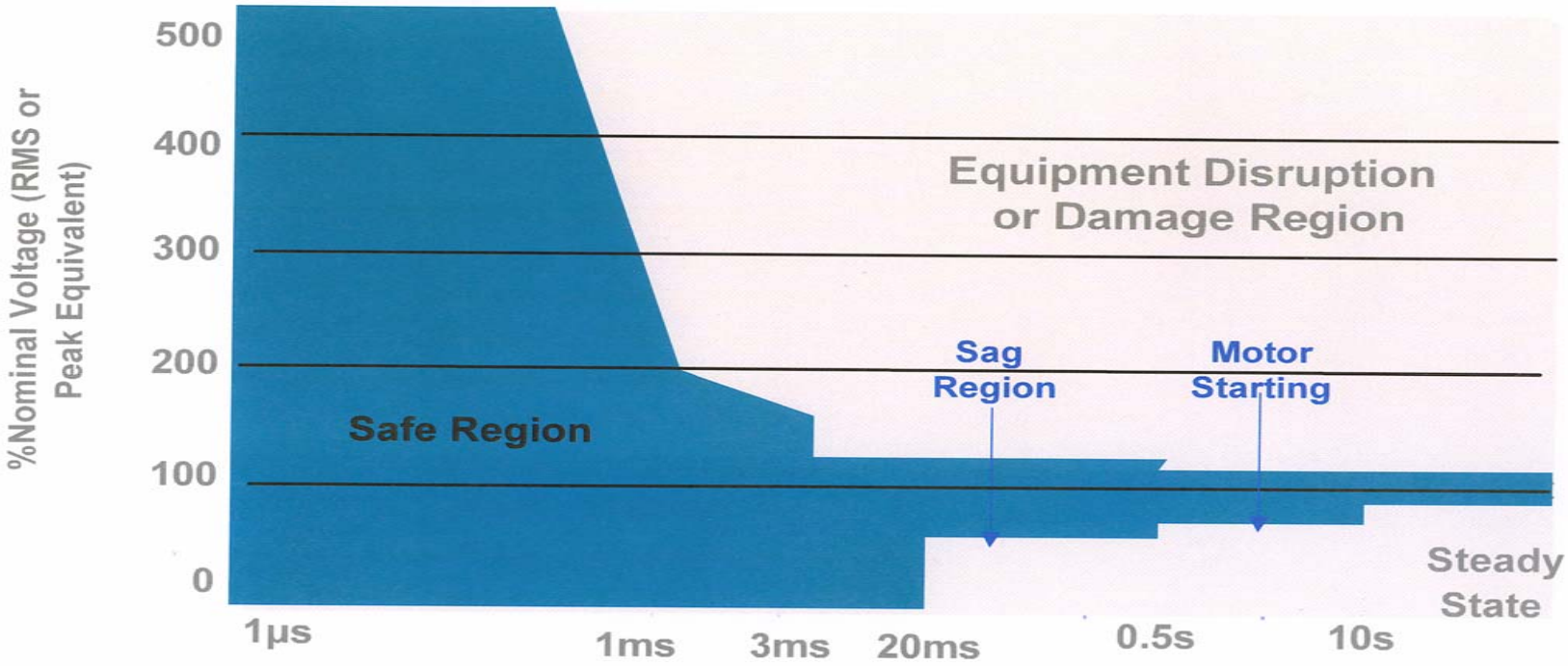
PQ – Voltage Sag

ITIC Curve: Voltage-Tolerance Envelope



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PQ – Voltage Swell

- ***Increase in 2 phases with grounding of a phase in a delta system***
- ***Sudden loss of large load.***

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PQ - Transients

- *Sudden non-power frequency change*
  - *High freq (>500kHz)*
    - *System response to impulse Trans.*
  - *Med. Freq (5kHz → 500kHz)*
    - *Cable switching or cap bank switching*
  - *Low Freq (<5kHz)*
    - *Cap switching on distribution system*
- *Lightning Strikes*

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PQ - Harmonics

- ***Produced by,… Non-linear loads***
- ***A Load is nonlinear if the voltage and current do not have a direct or continuous relationship.***

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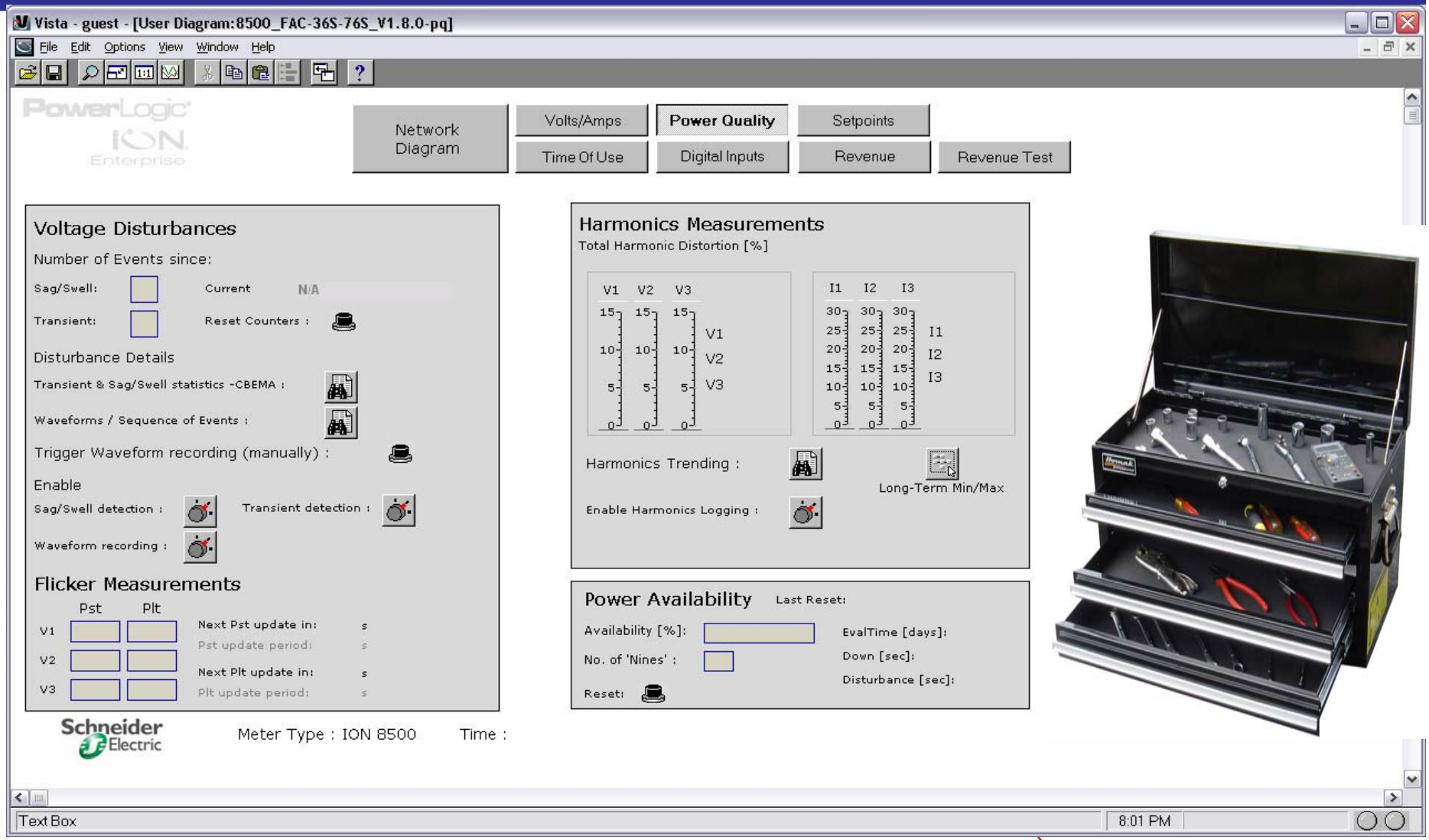
Types of Power Quality Issues



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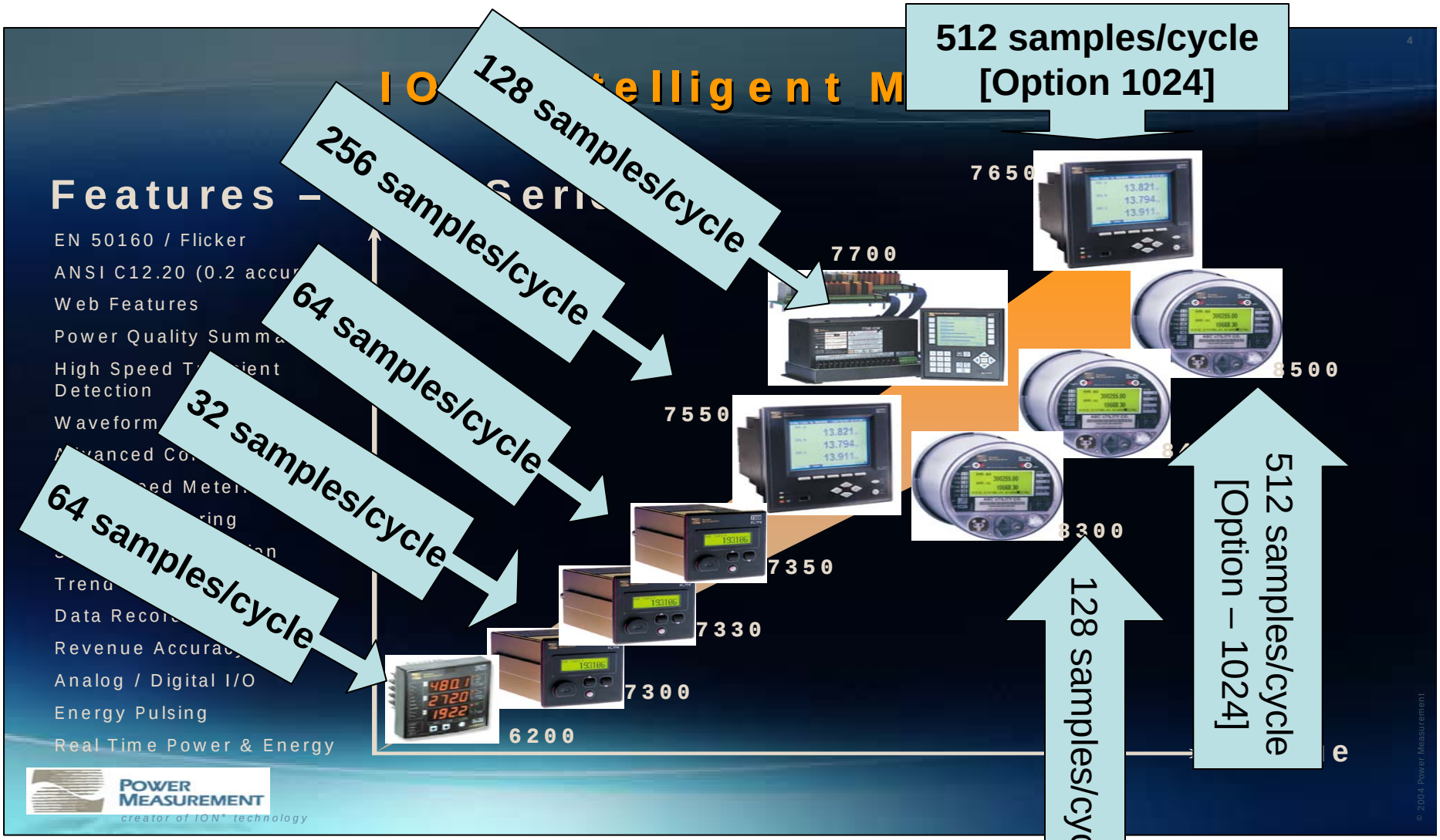
Types of ION METERS



Metering Equipment

- ***Sample rate***
  - **Should have at least 4 samples per ½ cycle in order to capture full transient peak.**
  - **Sample rate based on frequency of interest.**
  - **Ion Meters will sense majority of spikes. The magnitude may not be sensed but information gained is very valuable for PM and troubleshooting.**
- ***Instrument Transformers*** **(bandwidth limited)**
  - **High frequency CT's**

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Metering Location

1. **Point of Common Coupling**
   - **Will assist in determining source of PQ issue**
2. **Critical & Sensitive Loads**
   - **Will monitor what your equipment is sensing.**

If meters / monitors are networked then timeline can be used to match the disturbances as it is seen across the distribution system.

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Metering Location

1. Voltage consideration
   - Match the voltage configuration of your distribution system.
     - If Delta then delta
     - If Wye then Wye.

Loss of phase on delta system will be detected with Ph – Gnd PT setup.

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Threshold Settings per IEEE Std. 1159-1995

- *Sag – 108 Vrms [0.9 p.u]*
- *Swell – 126 Vrms [1.05 p.u.]*
- *Transient – 200 V [approx. 2 times ph-n]*
- *Harmonics – 5 % THD*
- *Phase imbalance – 2 %*
  - *(critical for induction motors)*

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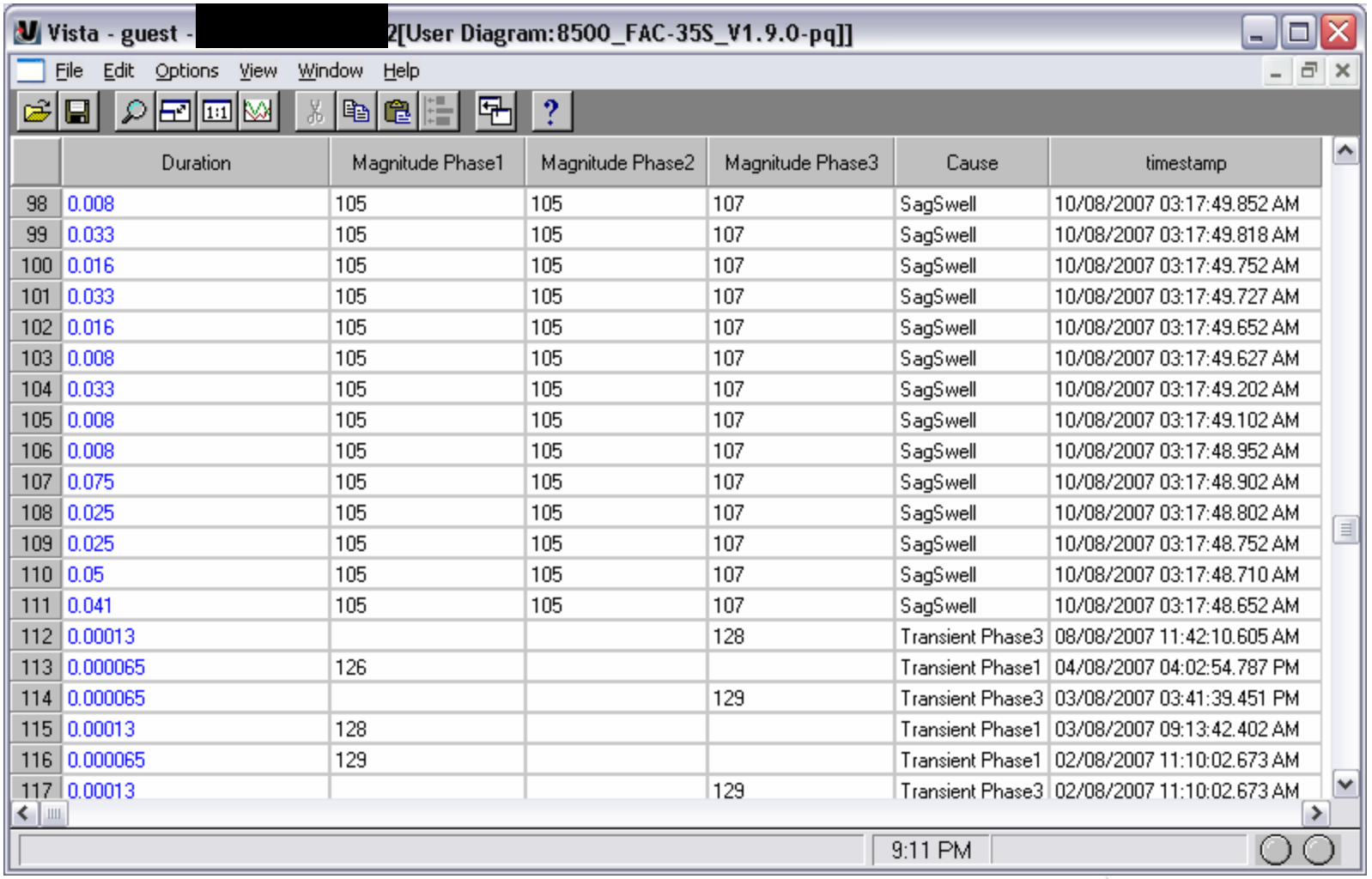
Voltage Sag - Case # 1



Vista - guest - [redacted]2[User Diagram:8500_FAC-35S_V1.9.0-pq]]

File Edit Options View Window Help

	Duration	Magnitude Phase1	Magnitude Phase2	Magnitude Phase3	Cause	timestamp
98	0.008	105	105	107	SagSwell	10/08/2007 03:17:49.852 AM
99	0.033	105	105	107	SagSwell	10/08/2007 03:17:49.818 AM
100	0.016	105	105	107	SagSwell	10/08/2007 03:17:49.752 AM
101	0.033	105	105	107	SagSwell	10/08/2007 03:17:49.727 AM
102	0.016	105	105	107	SagSwell	10/08/2007 03:17:49.652 AM
103	0.008	105	105	107	SagSwell	10/08/2007 03:17:49.627 AM
104	0.033	105	105	107	SagSwell	10/08/2007 03:17:49.202 AM
105	0.008	105	105	107	SagSwell	10/08/2007 03:17:49.102 AM
106	0.008	105	105	107	SagSwell	10/08/2007 03:17:48.952 AM
107	0.075	105	105	107	SagSwell	10/08/2007 03:17:48.902 AM
108	0.025	105	105	107	SagSwell	10/08/2007 03:17:48.802 AM
109	0.025	105	105	107	SagSwell	10/08/2007 03:17:48.752 AM
110	0.05	105	105	107	SagSwell	10/08/2007 03:17:48.710 AM
111	0.041	105	105	107	SagSwell	10/08/2007 03:17:48.652 AM
112	0.00013			128	Transient Phase3	08/08/2007 11:42:10.605 AM
113	0.000065	126			Transient Phase1	04/08/2007 04:02:54.787 PM
114	0.000065			129	Transient Phase3	03/08/2007 03:41:39.451 PM
115	0.00013	128			Transient Phase1	03/08/2007 09:13:42.402 AM
116	0.000065	129			Transient Phase1	02/08/2007 11:10:02.673 AM
117	0.00013			129	Transient Phase3	02/08/2007 11:10:02.673 AM

9:11 PM

From transient log file

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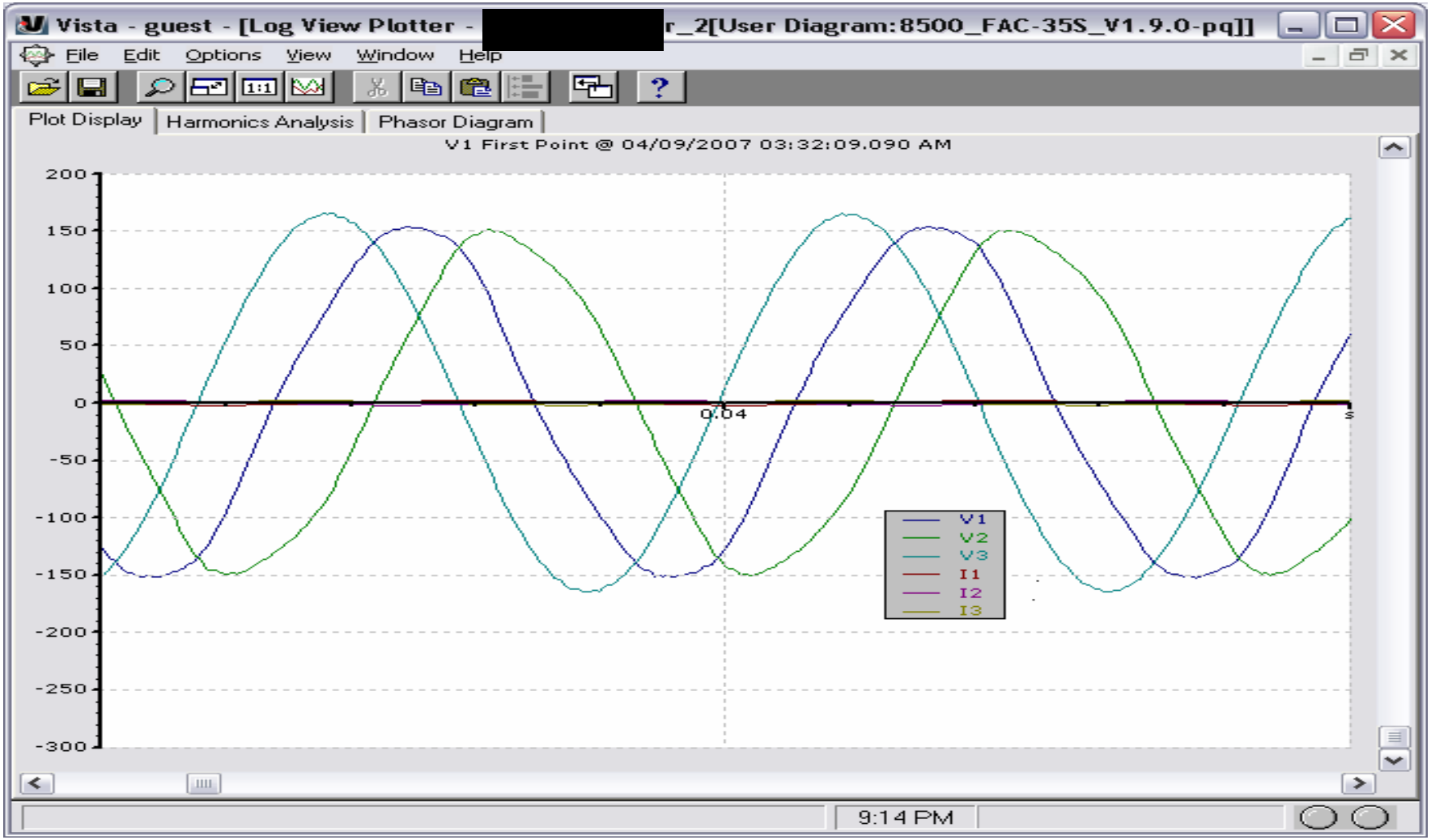
Voltage Sag - Case # 1



From waveform log file

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Voltage Sag - Case # 1

- ***OBSERVATION***
  - **PT fuse failure.**
  - **[high resistance element]**

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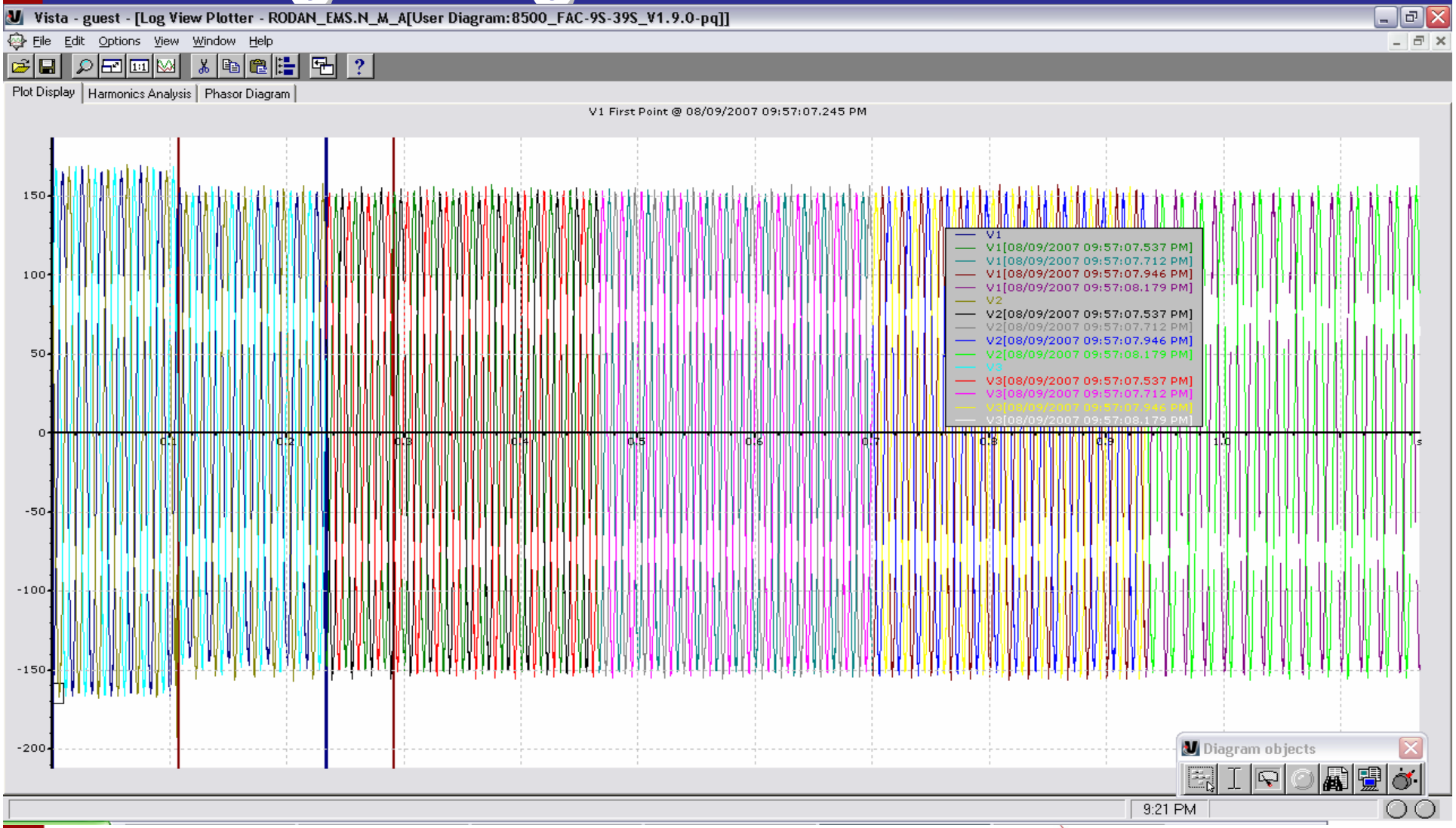
Voltage Sag - Case # 2



From multiple waveform log file

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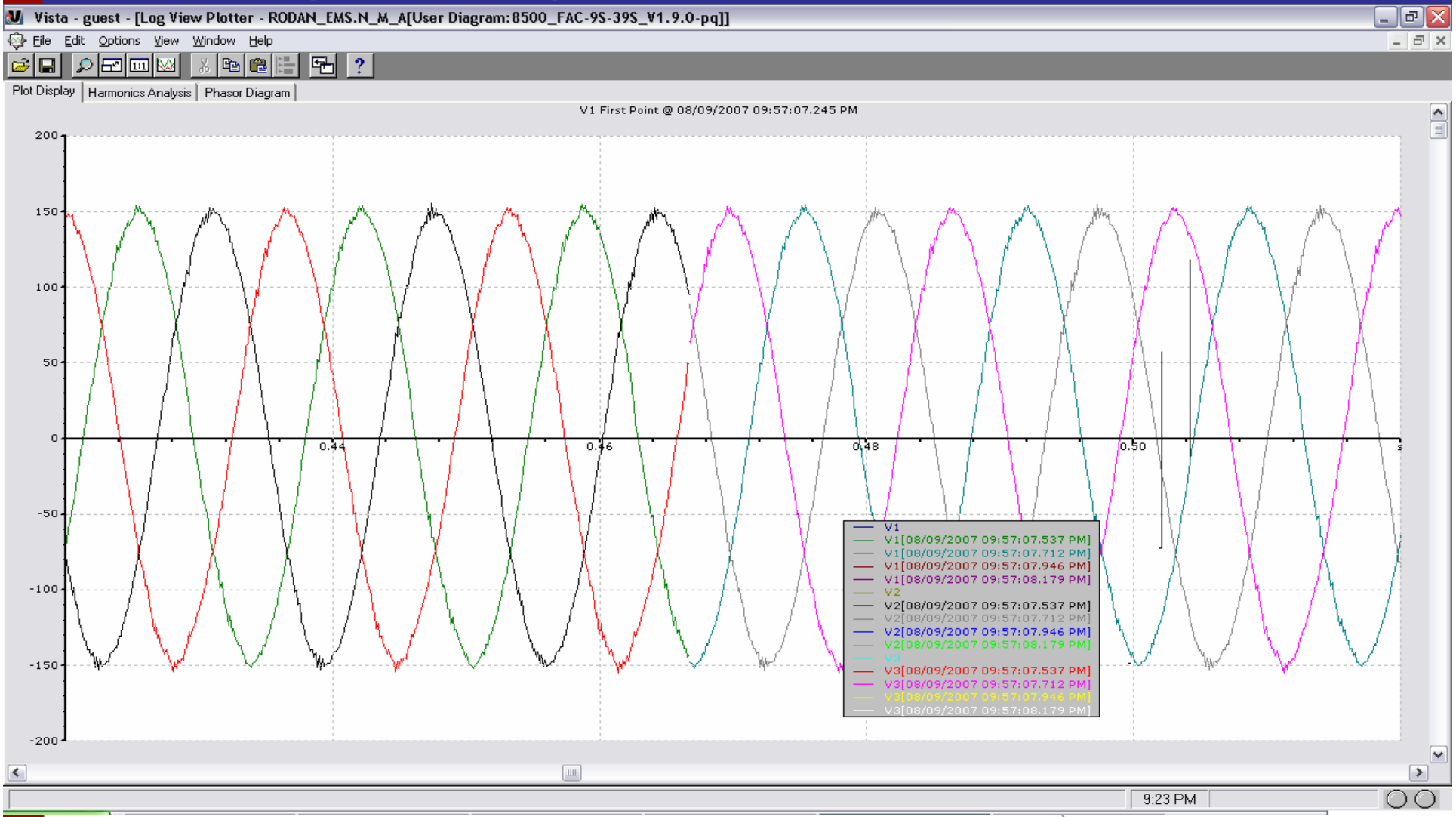
Voltage Sag - Case # 2



From multiple waveform log file

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Voltage Sag - Case # 2

- ***OBSERVATION***
  - **3000 HP compressor Motor.**
  - **Start up signature curve.**

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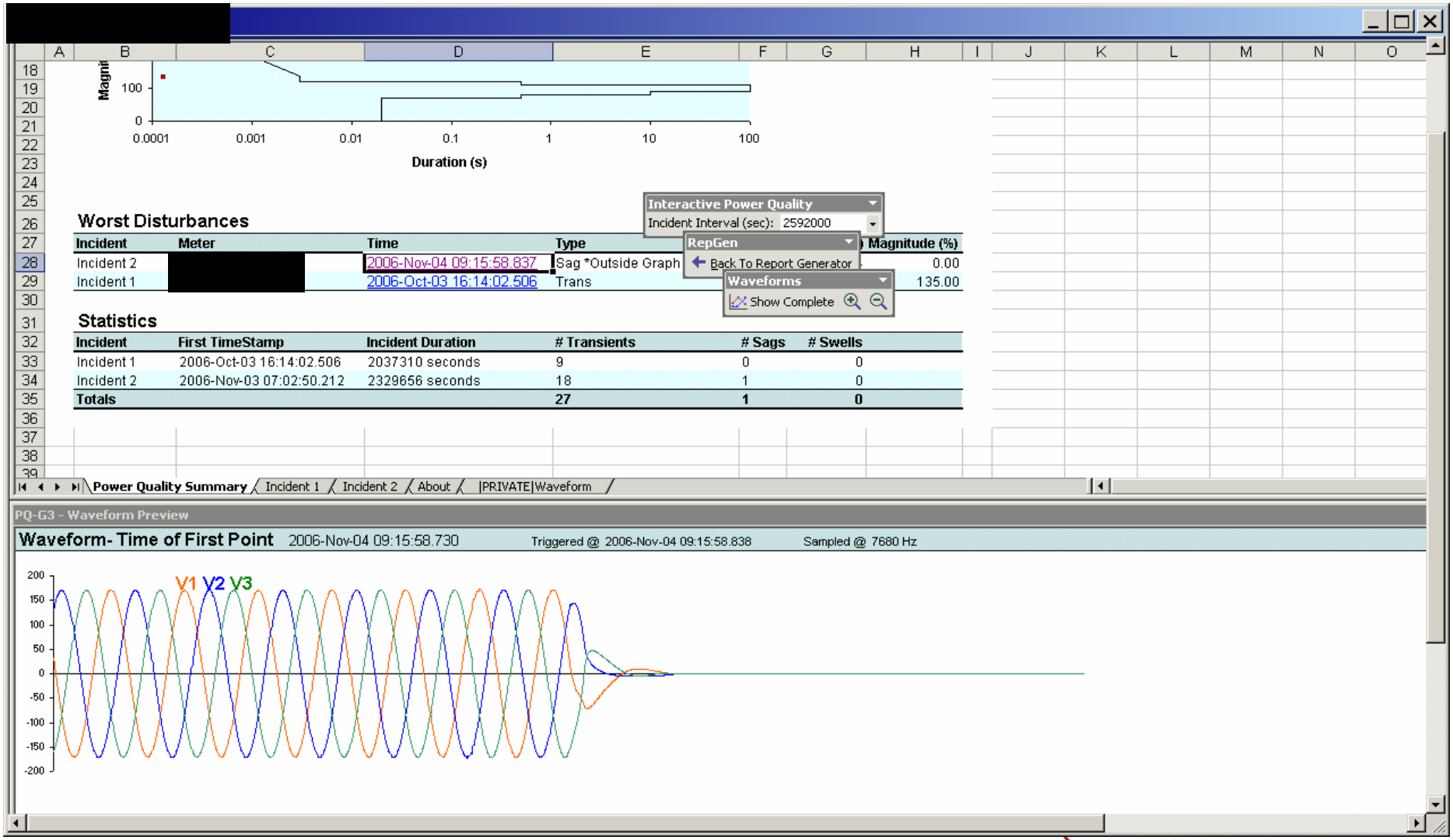
Voltage Sag - Case # 3



From Reporter

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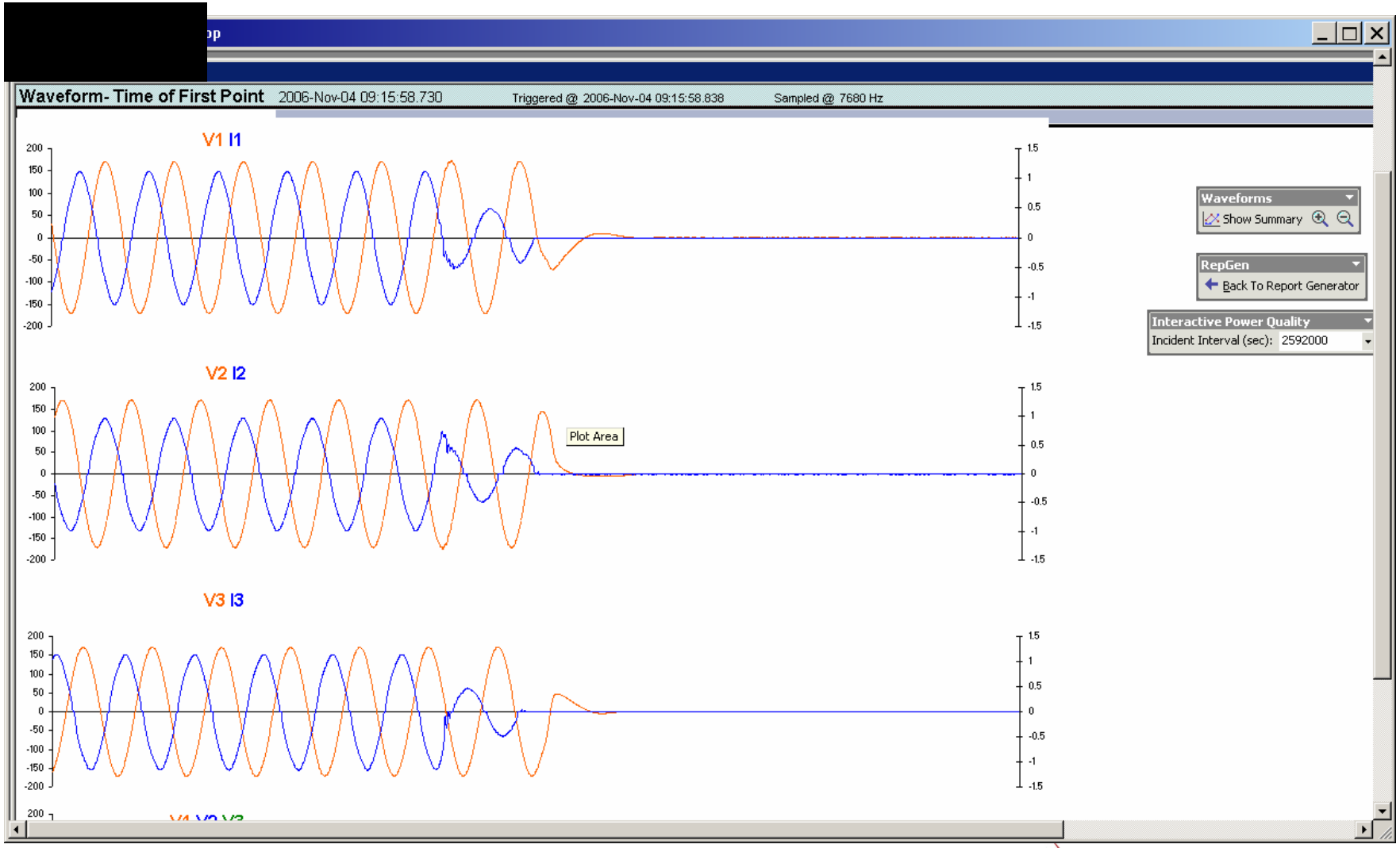
Voltage Sag - Case # 3



From waveform log file

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Voltage Sag - Case # 3

- ***OBSERVATION***

  - **Events following a relay operation reviewed.**
  - **Assist in assessment of faults & on the re-energization**
  - **Restored Power to distribution Equipment in timely manner**

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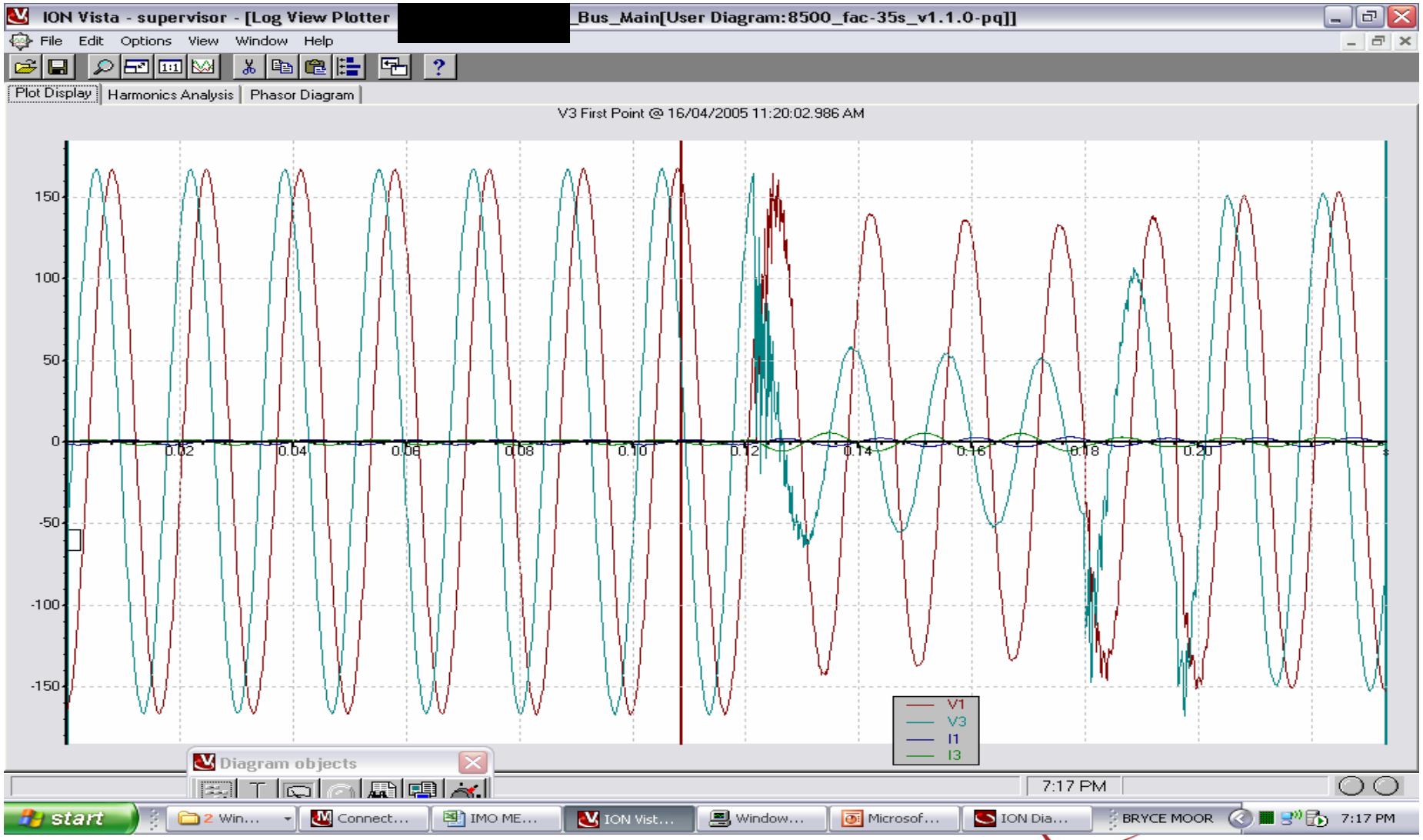
Voltage Sag - Case # 4



From waveform log file

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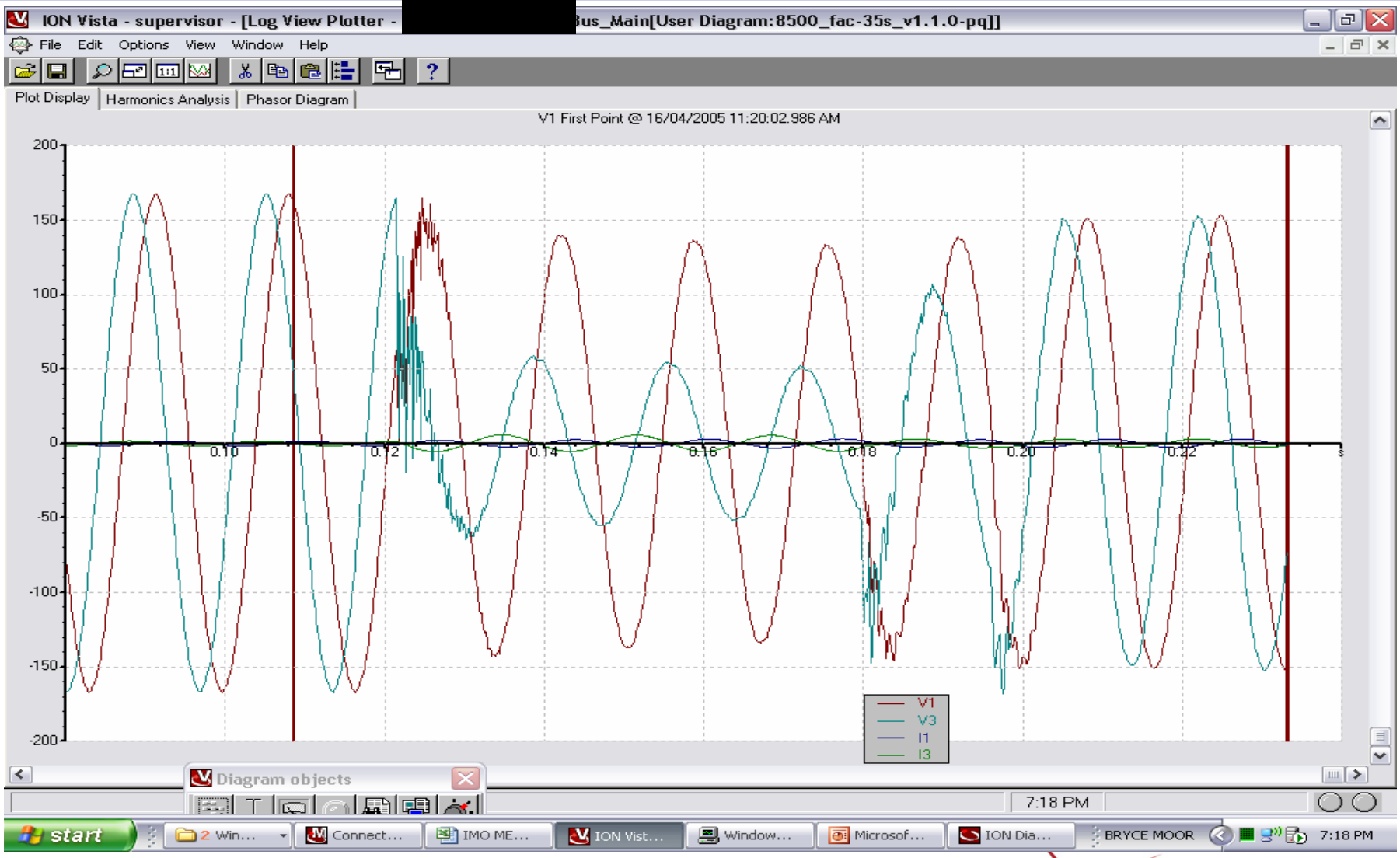
Voltage Sag - Case # 4



From waveform log file from one metering vantage point.

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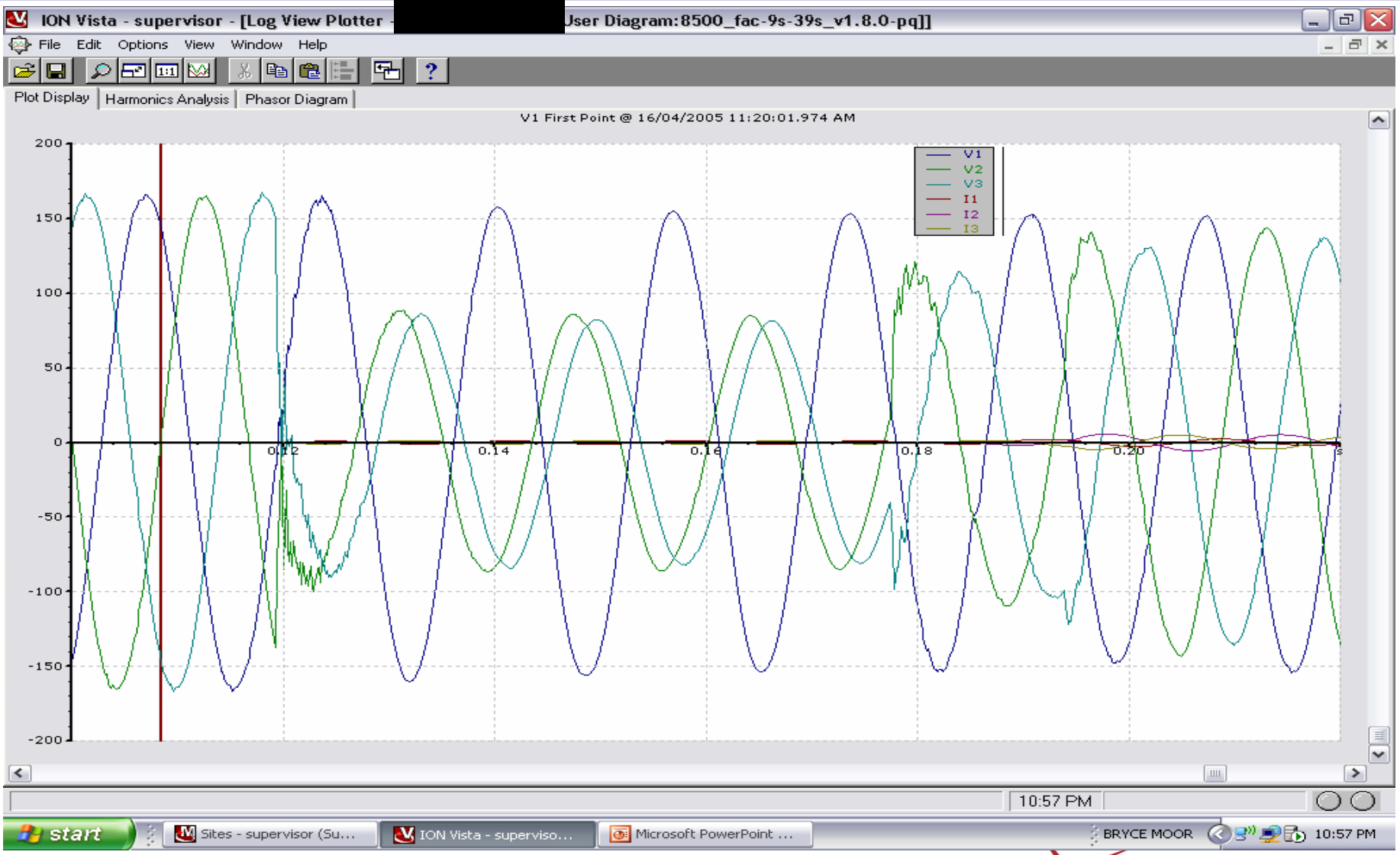
Voltage Sag - Case # 4



From waveform log file of another metering location

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Voltage Sag - Case # 4

- ***OBSERVATION***

  - **Utility phase to phase failure**
    - **Fault seen downstream of 2 step-down transformers.**
    - **Fault seen downstream of 1 step-down transformers.**
  - **Fault was then cleared and system voltage restored.**

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Conclusion

- **Power Quality is not a problem until**
  Power Quality is a problem

Fool me once, Shame on you.

Fool me twice, Shame on me.

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Q&A – Thank you

Bryce Moor

Specialist, Metering & Energy Management Services

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