Harmonic Resonance

in an

Industrial Park

November 13, 2006

Background

- *Smaller electrical customer, approximately 750kW*

- *Manufacturer of injection molded automotive parts*

- *Manufacturer recently installed 320 kVAr filter bank to reduce power factor charges (64kVAr x 5 steps)*

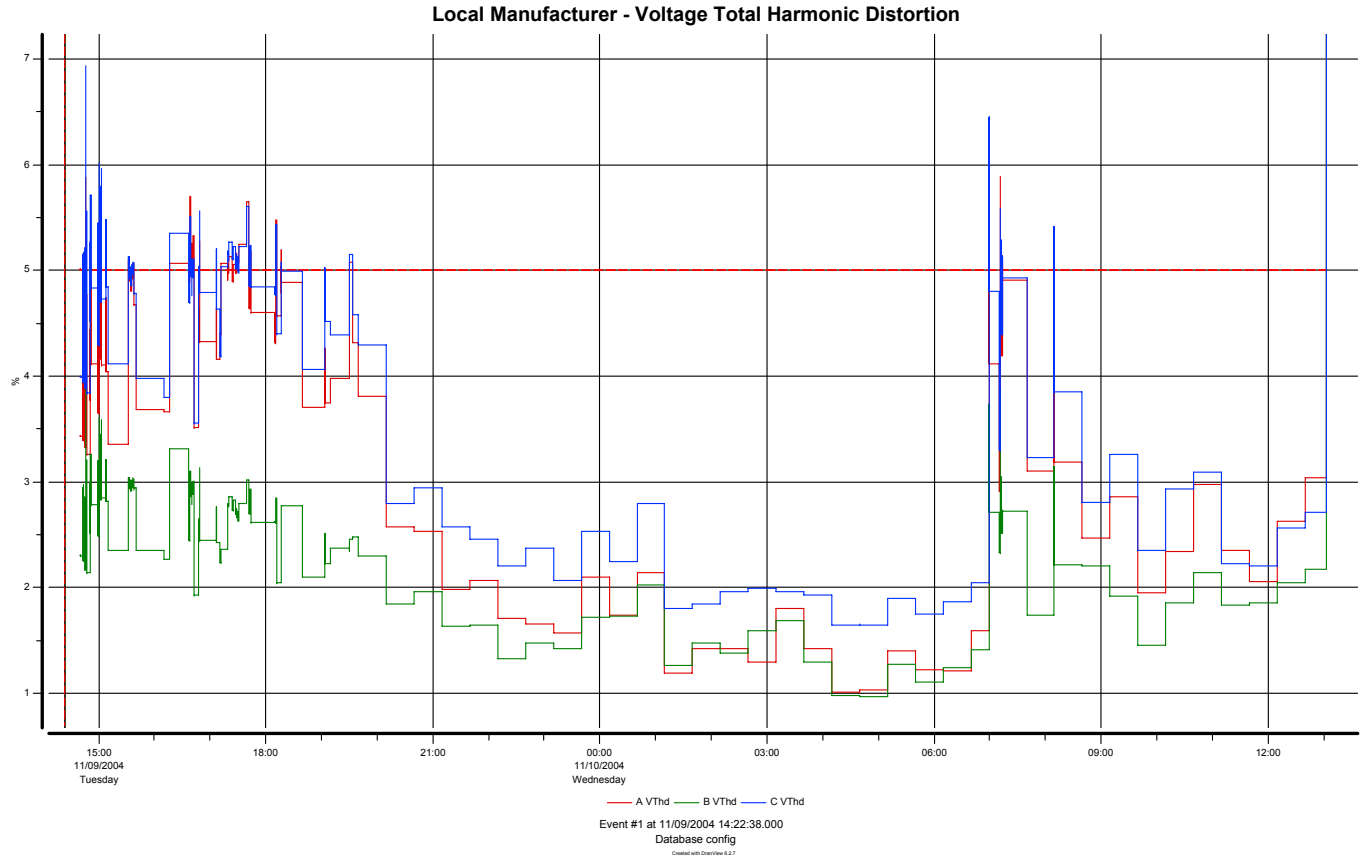
- *Capacitor bank produced error message "Error 10, Parallel Resonance Detected Between Capacitors & Power Source at H5." As a result, capacitor automatically goes offline*

- *Large harmonic producing customer nearby (≈20% of substation load)*

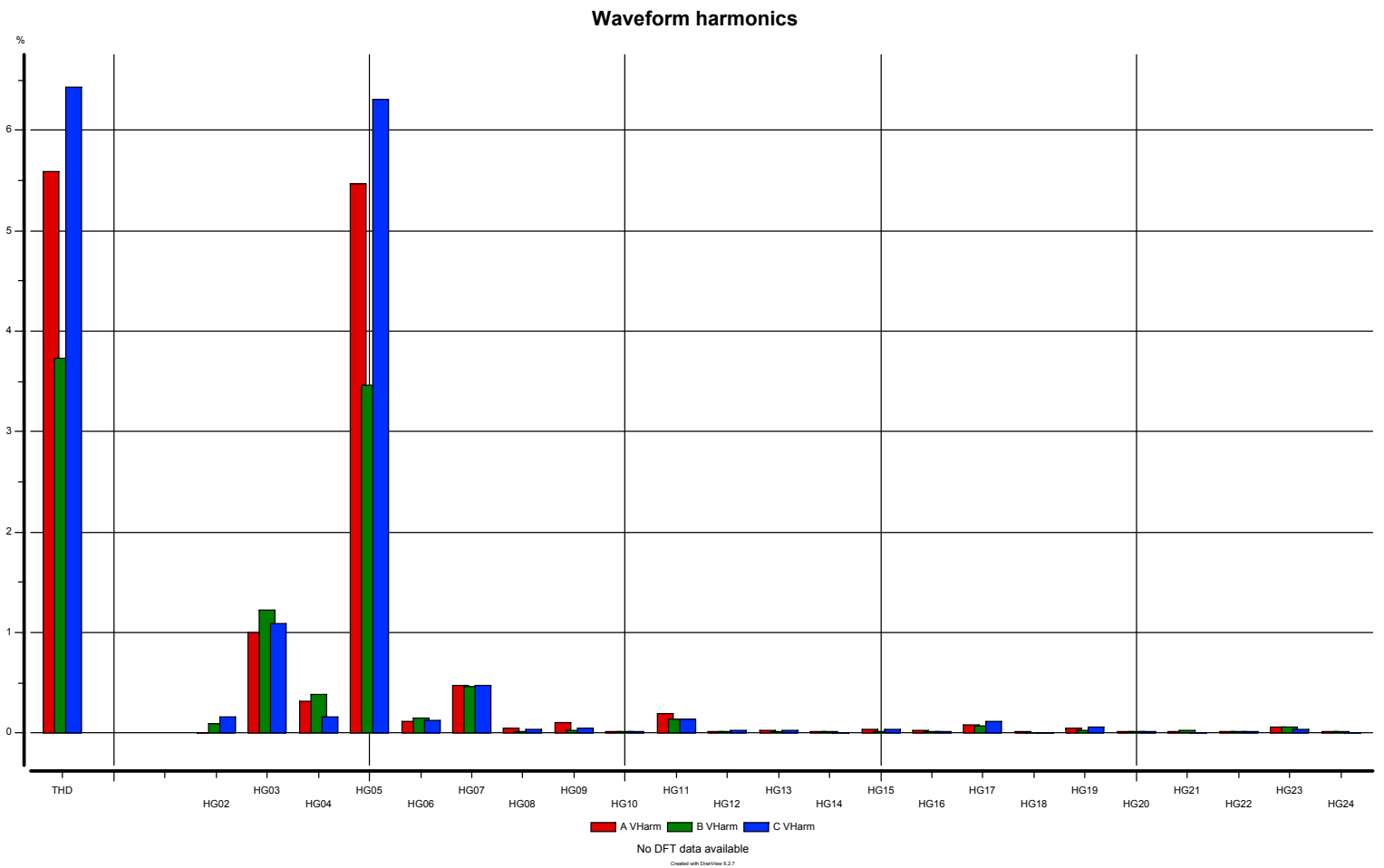
- *Customer continues paying power factor charges*

Power Quality Monitoring…

- Power quality monitoring with a Dranetz 4300 at customers 1,500kVA main transformer showed high levels of voltage distortion

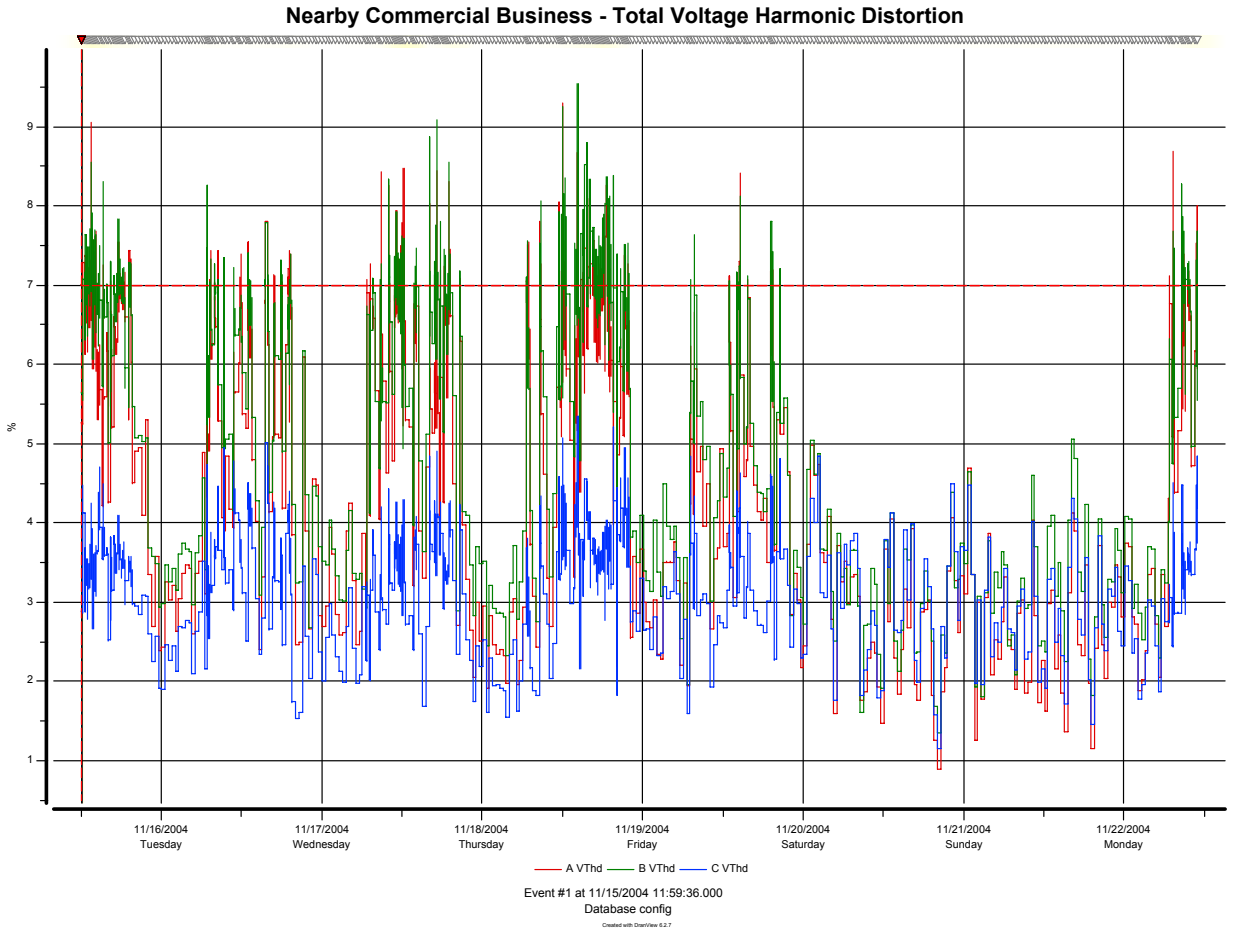


Power Quality Monitoring…

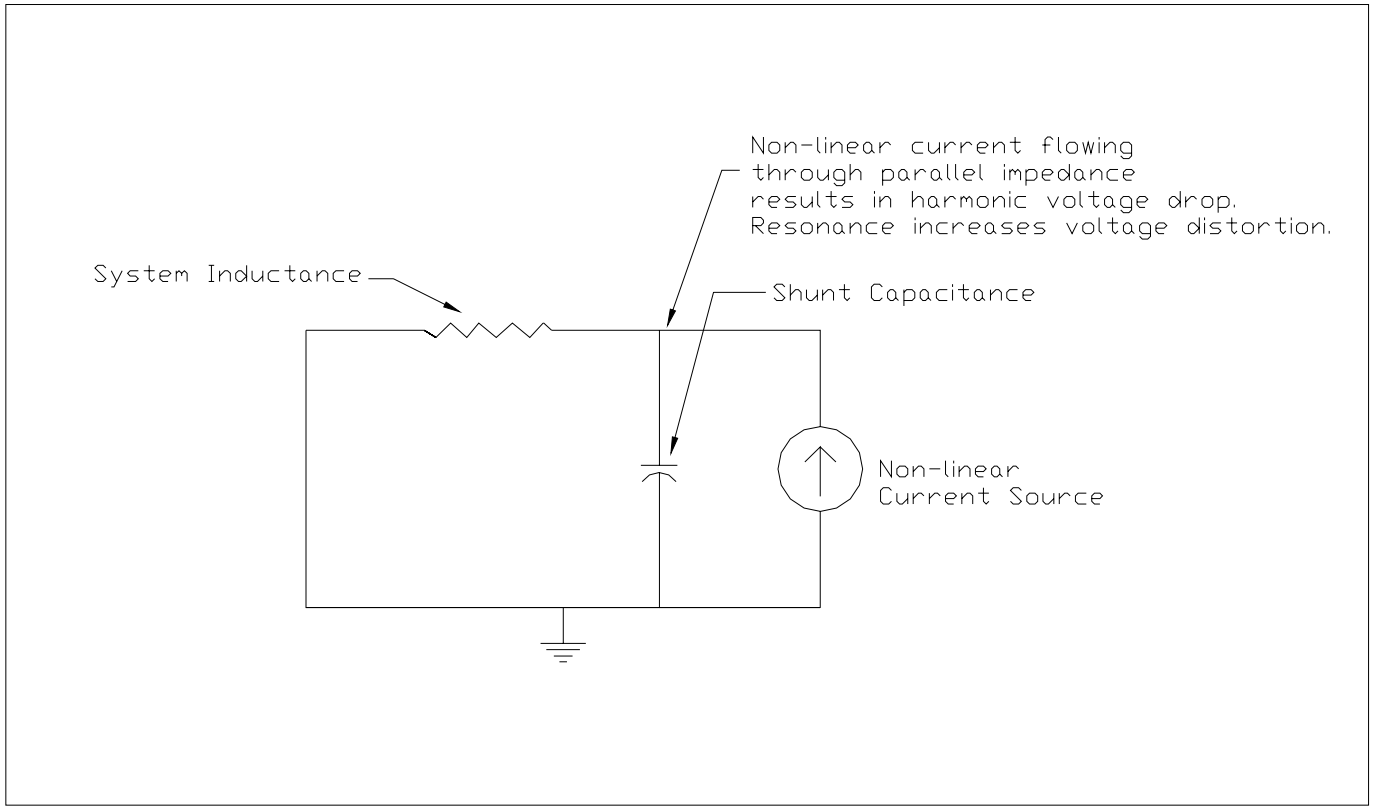


Power Quality Monitoring…

- Additional power quality monitor installed at local commercial business – $V_{THD} > 9\%$



Resonant Condition



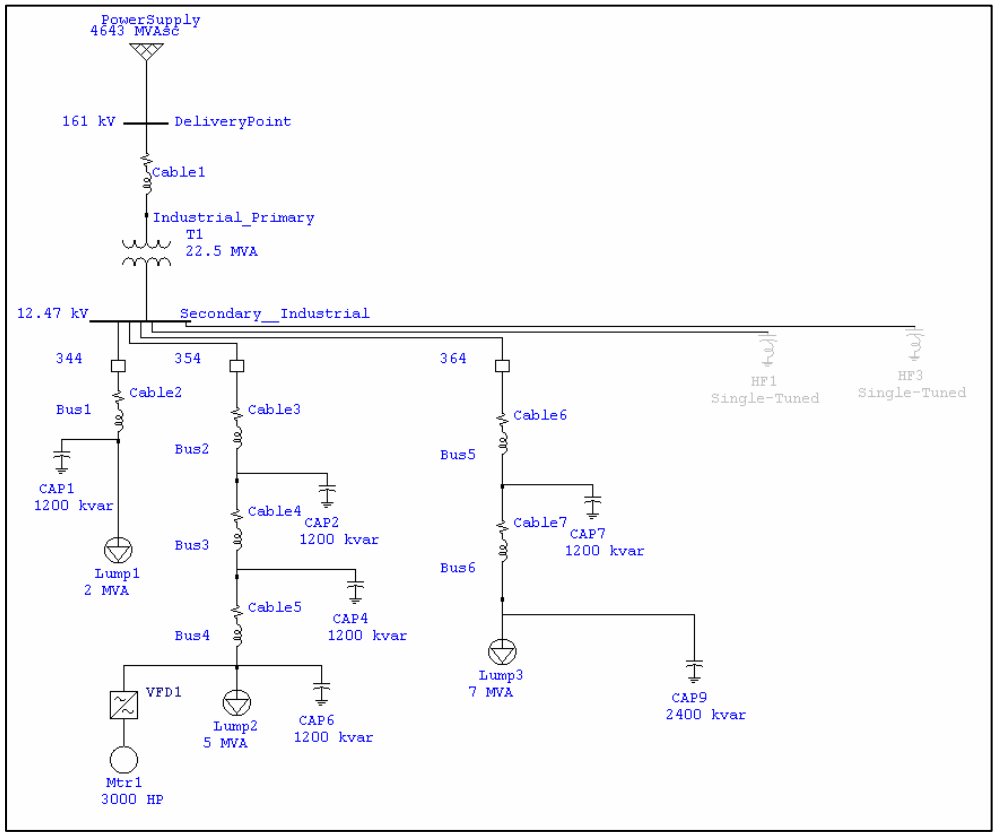
Resonance Condition

- *IEEE Red Book, 9.9.2, "Useful Rules of Thumb"*

$$H_P = \sqrt{\frac{MVA_{SC}}{MVAr_C}} = \sqrt{\frac{188000kVA_{SC}}{7200kVAr}} = 5.1$$

Computer Modeling - ETAP

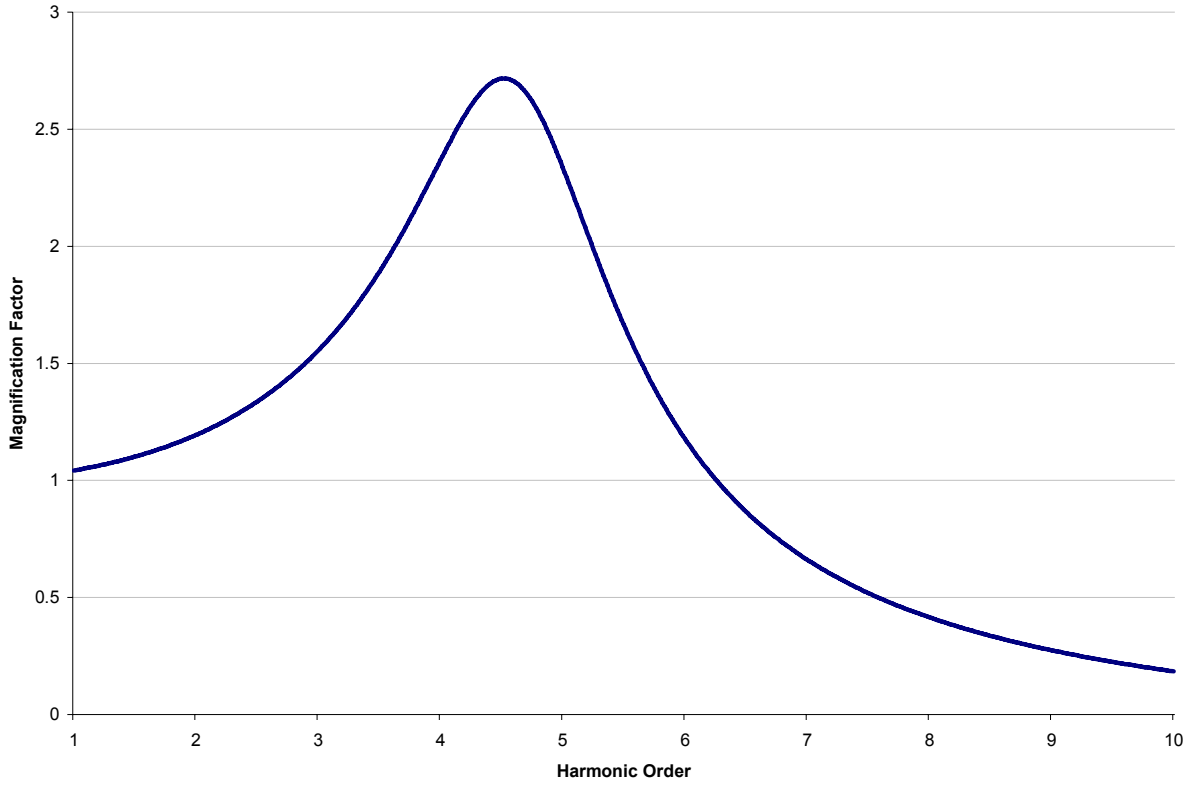
- *Industrial park electrical system modeled using ETAP*
  - *Included all capacitors, distribution lines, and major loads*



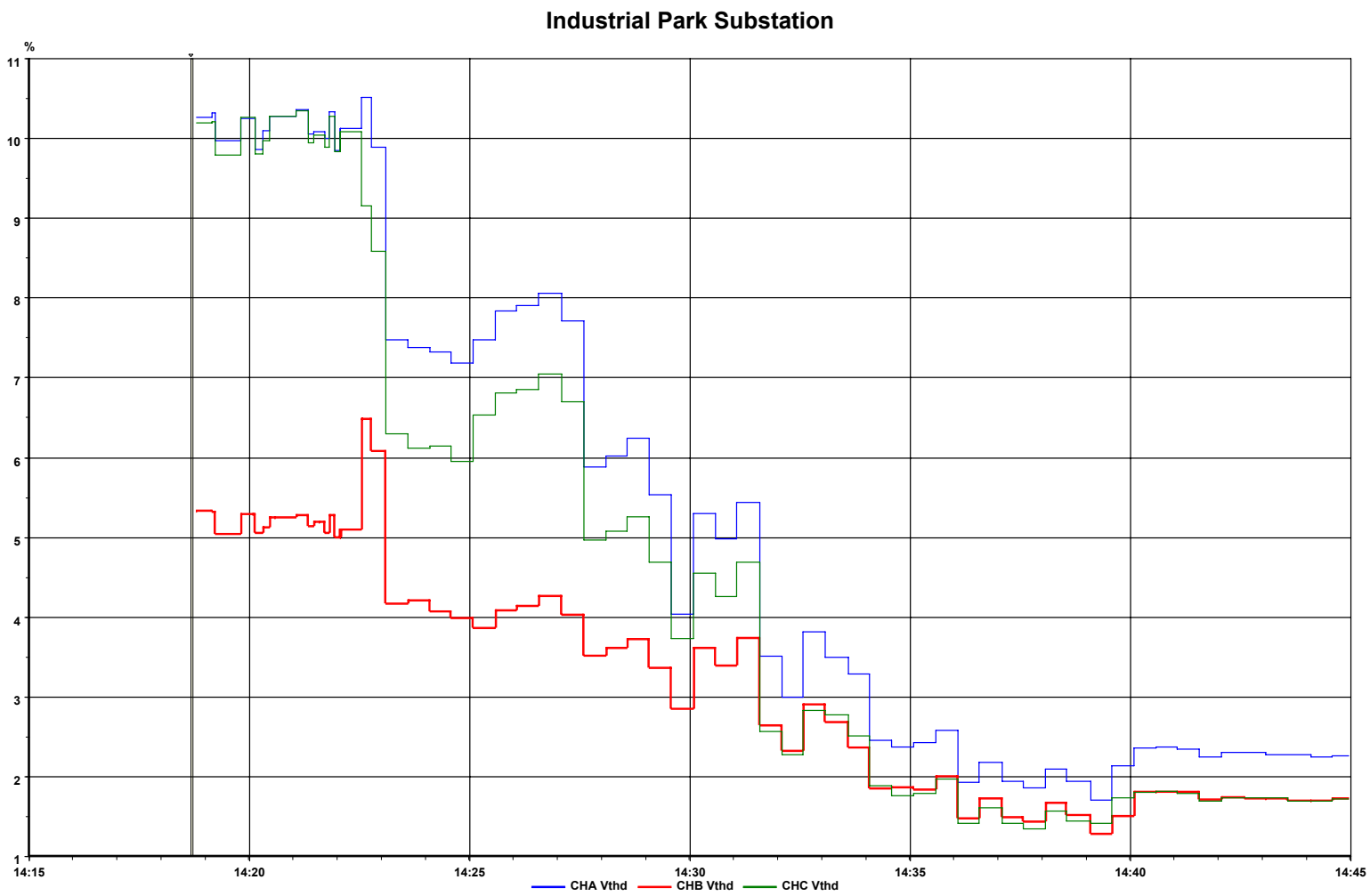
Computer Modeling - ETAP

- *Frequency scan performed; resonance confirmed*

- *Interested in magnification factor, ratio frequency scan with caps online to frequency scan with no caps online*



Capacitor Interaction



Recommendations

- *A pole-mounted harmonic filter was recommended; minimizing installation costs*

- *Distributor opted against harmonic filter; instead installed approximately 1 mile of overhead conductor, placing customer on different substation*

- *Resonant condition was not present; capacitor bank operated as designed*

Questions??

Any Questions?