Active Harmonic Filter (AF3)
Active Harmonic Filter
Improving the Efficiency and Life of System by use of
Digital Active Power Conditioner
HARMONICS

50 Hz, fundamental

100 Hz, 2nd Harmonic

150 Hz, 3rd Harmonic
Main sources of voltage and current harmonics are

- Computers & Electronic ballasts

- Rectifiers
  - AC & DC drives
  - UPS systems
  - Arc furnaces & SCR temperature controllers
  - Battery chargers & Rectifiers
Computer & Electronic Ballast (IT Loads)

Discontinuous current.

Presence of large amount of third and higher order Harmonics

THDi = 80 to 140%
Rectifiers / Chargers

- Six-pulse Rectifier
- Twelve Pulse Rectifier
- Variable Speed Drives
- UPS
- Battery Chargers & Rectifiers

THDi = 30 to 60%
Common Problem caused by Harmonic

• Problems caused by harmonic currents
  • Overloading of neutrals
  • Overheating of transformers
  • Nuisance tripping of circuit breakers
  • Over stressing of power factor correction capacitors
  • Skin effect

• Problems caused by harmonic voltages
  • Voltage distortion
  • Zero-crossing noise
Over Loading of Neutral Conductor

In a three-phase system,

With Linear load the fundamental currents cancel out.

With Non-Linear load the harmonic currents do not cancel.

In fact, being an odd multiple of three times the fundamental, the ‘triple-N’ harmonics, add in the neutral.

The Neutral current goes up to 2.5 to 3 times than the phase current for Non-linear loads.

Neutral conductors get heated.
If we refer the standards, the cable de-rating is about 60% since due to harmonic phenomena.
Overheating of Transformers

Transformers are affected in two ways by harmonics.

- Eddy current losses - 10% normal value at full load.
- Increases the square of the harmonic number.
- With Non-Linear Load Transformer losses would be twice as high as for an equivalent linear load.
- Results in high temperature rise.
- Harmonics in Neutral increases THREE times.
Nuisance Tripping of Circuit Breakers

Nuisance tripping can occur with presence of harmonics for:

- The RCCB may not sum the higher frequency components correctly and therefore trips erroneously.
- Noise suppression capacitor, to suppress noise line, generated due to harmonics, can be sufficient to trip the RCCB.
- Nuisance tripping of RCCB is usually cause due to non-consideration of non-sinusoidal nature of current, during calculations.

RCCB: Residual Current Circuit Breaker
Over Stressing of Power Factor Correction Capacitors

• The impedance of the PFC capacitor reduces as frequency rises, while the source impedance is generally inductive and increases with frequency.

• The capacitor and the stray inductance of the supply system can resonate at or near one of the harmonic frequencies. When this happens very large voltages and currents can be generated, often leading to the catastrophic failure of the capacitor bank system.
Skin Effect

Alternating current tends to flow on the outer surface of a conductor at higher frequencies.

It has very little effect at Power supply frequencies.

But above 350 Hz skin effect will become significant causing additional loss and heating.

Where harmonic currents are present, designers should take skin effect into account and de-rate cables accordingly.
Problems caused by Harmonic voltages

Because the supply has source impedance, harmonic load currents give rise to harmonic voltage distortion on the voltage waveform.

Voltage distortion by non linear load
Problems caused by Harmonic voltages

The non-linear load causes a voltage drop in the cable impedance.

The resultant distorted voltage waveform is applied to all other loads connected to the same circuit, causing harmonic currents to flow in them - even if they are linear loads.
Harmonic Effects and Causes

• Overheating and failure of electric motors

• Overloading, overheating and failure of power factor correction capacitors, distribution transformers and neutral conductors.

• Reduction of efficiency of power generation, transmission and utilization

• Aging of the installation of electrical plant components and shortening of their useful life

• Malfunctioning and failure of electronic equipment
Harmonic Effects and Causes

- High measurement errors in metering equipment
- Spurious operation of fuses, circuit-breakers and other protective equipment
- Voltage glitches in computers systems resulting in lost data
- Electromagnetic interference with TV, radio, communication & telephone
- Damage and disruption to standby generators and associated AVR control equipment
Components Damaged due to Harmonics
**Conclusion:**

Harmonic currents **cause problems both on the supply and within the distribution system.**

The effects and the solutions are very different and need to be addressed separately.

The measures that are appropriate to control the effects of harmonics within the installation may not necessarily reduce the distortion caused on the supply and vice versa.
EFFECT OF HARMONICS
ON POWER FACTOR
For Non linear load

\[ \text{pf}_{\text{true}} = \frac{\text{pf}_{\text{avg}}}{V_{\text{rms}} I_{\text{rms}}} \cdot \frac{1}{\sqrt{1+\left(\frac{\text{THD}_1}{100}\right)^2}} = \text{pf}_{\text{disp}} \cdot \text{pf}_{\text{dist}} \]

\[ \text{pf}_{\text{disp}} = \text{is a displacement power factor} \]

\[ \text{pf}_{\text{dist}} = \text{is a distortion power factor or} \]

Harmonic Power factor
Maximum True Power Factor vs THDi
ACTIVE HARMONIC FILTER (AHF)
Working Principle of AHF

- Input source current is sensed by DSP.
- DSP calculates harmonic components of the input current and reactive input power. Counter harmonics and reactive power control is generated by DSP and fed to power circuit.
- With this harmonics and reactive power is compensated by Active filter.
Features of Active Harmonic Filter

- Closed loop active filter with source current sensing
- High attenuation up to 96% of individual harmonics
- Programmable selective harmonic elimination
- PF compensation, leading as well as lagging
- Selection between PF and harmonic compensation
- IGBT based inverter design
- **Multiple paralleling**
- Shunt Operation, Self current limiting.
Performance Results of AHF

Test results taken for 6 pulse UPS with 100A filter

Without Active Filter

- Input Current: 164 A
- Voltage: 217 V
- VTHD: 4.8%
- ITHD: 27.4%
- PF: 0.87
- Power KVA: 106.5
- Power kW: 92.7
With filter – only Harmonic compensation

- Input Current: 146A
- Filter Current: 48A
- VTHD: 3.7%
- Voltage: 221V
- PF: 0.92
- ITHD: 4.0%
- Power KVA: 96.79
- Power kW: 90
- Input Current: 135 A
- Filter current: 95 A
- VTHD: 2.2%
- Voltage: 223V
- PF: 1.00
- ITHD: 3.9%
- Power KVA: 90.30 – 16.20
- Power kW: 90.30 – 2.4
CASE STUDY 1
Industrial Application

CASE STUDY 2
IT Application
CASE STUDY - I

Jindal Steel & Power Ltd.
DRI-II, Raigarh (MP)

4 Nos. 150 Amp AHF
at KILN – 8 DY – 1
The major loads in DRI:

- DC Thyristor Drives
- UPSs
- AC Drives
The existing power Distribution in DRI

- No. of KILNs - 4 Nos.
- No. of Power Supply Transformer – 4 Nos.
- Transformer rating – 1.7MVA
- Load Distribution- One Transformer for per KILN.
- Spare Transformer – 1 No.
- Transformer efficiency (@ PF-1, assumed) – 98%
Schematic of Power Distribution at Site
# Initial Recorded Parameters

<table>
<thead>
<tr>
<th>Phase</th>
<th>R</th>
<th>Y</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load Current (A)</td>
<td>640 A</td>
<td>680 A</td>
<td>615 A</td>
</tr>
<tr>
<td>Current T.H.D. %</td>
<td>51 %</td>
<td>49 %</td>
<td>47 %</td>
</tr>
<tr>
<td>Power Factor</td>
<td>0.56</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Comments on Observations

- High Input current
- Harmonic Distortion around 51%
- Input Current waveform distorted
- Low power factor
- High Input currents
Objectives of Load Study

• To reduce input current harmonic to less than 10%.

• To improve power factor from 0.52 to better than 0.9

• To observe the effect of the solution on the existing problems of
  - Cable heating
  - Spurious tripping of breakers etc.

• To record power saving
Problems observed by user (due to Harmonics)

- Cable Over heating

- Transformer over heating

- Frequent failure of electronic PCB’s for unknown reasons

- Frequent tripping of breakers resulting into interruption in process
Tested at JSPL DRI-II

4 Nos. 150 Amp AHF
At KILN – 8
## Performance Results of AHF

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Test Condition</th>
<th>Phase</th>
<th>R</th>
<th>Y</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>With One AHF Connected</td>
<td>Load Current (Amp)</td>
<td>558 A</td>
<td>612 A</td>
<td>560 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Current T.H.D. %</td>
<td>27.60%</td>
<td>29.40%</td>
<td>28.50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Power Factor</td>
<td>0.63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>With Two AHF Connected</td>
<td>Load Current (Amp)</td>
<td>540 A</td>
<td>590 A</td>
<td>540 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Current T.H.D. %</td>
<td>7%</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Power Factor</td>
<td>0.72</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>With Three AHF Connected</td>
<td>Load Current (Amp)</td>
<td>480 A</td>
<td>487 A</td>
<td>482 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Current T.H.D. %</td>
<td>8%</td>
<td>7.90%</td>
<td>6.90%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Power Factor</td>
<td>0.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>With Four AHF Connected</td>
<td>Load Current (Amp)</td>
<td>340 A</td>
<td>350 A</td>
<td>344 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Current T.H.D. %</td>
<td>7.80%</td>
<td>8%</td>
<td>6%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Power Factor</td>
<td>0.92</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Summary of AHF Test Results

- Input currents reduced from 680 A to average 350 A per phase.
- Input PF is improved from 0.57 to 0.92
- Input current distortion reduced from 57% to 7-8%
- Input KVA reduced from 489 to 252 KVA
- KVA Released - 237KVA (direct reduction)
- Existing transformer of 1.7 MVA was supporting 0.97 MW load earlier. Now, it can support 1.56 MW load, if Harmonics & PF are controlled.

EMERSON
<table>
<thead>
<tr>
<th>Condition</th>
<th>Date</th>
<th>Time</th>
<th>MVAH Recorded</th>
<th>MVAH Consumption in 48 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without AHF</td>
<td>2 Feb '08</td>
<td>13 hrs</td>
<td>3871.4</td>
<td></td>
</tr>
<tr>
<td>Without AHF</td>
<td>4 Feb '08</td>
<td>13 hrs</td>
<td>3888.3</td>
<td>16.9</td>
</tr>
<tr>
<td>With AHF - 4 Nos.</td>
<td>4 Feb '08</td>
<td>13 hrs</td>
<td>3888.3</td>
<td></td>
</tr>
<tr>
<td>With AHF - 4 Nos.</td>
<td>6 Feb '08</td>
<td>13 hrs</td>
<td>3901.3</td>
<td>13</td>
</tr>
</tbody>
</table>
MVAH Savings achieved

MVAH saved in 48 hrs when AHF was used
16.9 - 13 = 3.9 MVAH

MVAH Saving
= 1.95 MVAH / per Day

= 58.5 MVAH / per Month

= 711.75 MVAH / per Year
# MVAH Savings per KILN Load

<table>
<thead>
<tr>
<th>MVAH per Day</th>
<th>No of Days</th>
<th>Total MVAH</th>
<th>Rate Rs. / MVAH</th>
<th>Total Savings in Rs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.95</td>
<td>1</td>
<td>1.95</td>
<td>6,000</td>
<td>11,700</td>
</tr>
<tr>
<td>1.95</td>
<td>7</td>
<td>13.65</td>
<td>6,000</td>
<td>81,900</td>
</tr>
<tr>
<td>1.95</td>
<td>30</td>
<td>58.5</td>
<td>6,000</td>
<td>3,51,000</td>
</tr>
<tr>
<td>1.95</td>
<td>365</td>
<td>711.75</td>
<td>6,000</td>
<td>42,70,500</td>
</tr>
</tbody>
</table>

Savings at **ONE KILN** = Rs. **42,70,500**

Savings at **FOUR KILN** = Rs. **1,70,82,000**
Transformer Rating 1.7 MVA = 17,00 KVA
Load connected without AHF = 650 A / phase = 467 KVA
Power in KVA
Percentage of Load connect = 28 %
Efficiency of Transformer at full Load (given) = 98%
Copper Loss = 19.5 KW
Iron Loss = 2.2 KW
Loss Calculation at existing load of 28% = 3.73 KW
TRANSFORMER LOSS with Filter connected = 2.5 KW
KW Saved = 1.23 KW
## KVA Savings in Transformer

<table>
<thead>
<tr>
<th>Direct Saving / Day</th>
<th>No. of Days</th>
<th>Total Kwh</th>
<th>Rate in Rs. Per KWH</th>
<th>Total Savings with Commercial Rate in Rs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.15 KW</td>
<td>1</td>
<td>27.6</td>
<td>4.5</td>
<td>124.20</td>
</tr>
<tr>
<td>1.15 KW</td>
<td>7</td>
<td>193.2</td>
<td>4.5</td>
<td>869.40</td>
</tr>
<tr>
<td>1.15 KW</td>
<td>30</td>
<td>828</td>
<td>4.5</td>
<td>3,726.00</td>
</tr>
<tr>
<td>1.15 KW</td>
<td>365</td>
<td>10074</td>
<td>4.5</td>
<td>45,333.00</td>
</tr>
</tbody>
</table>

KW Savings in 1 No. X’MER = Rs. 45,333
KW Savings in 4 Nos. X’MERS = Rs. 1,81,332
Distribution Transformer Loss Calculation -

• The Copper losses reduced to half, as the current dropped from 640 to 340 A

• Core loss decreased due to decrease in harmonics.

• Considering this total transformer loss will be much more than actual figure, and hence the savings will go up to not less than 1.8 kW

• The temperature has gone down drastically
Benefits

Direct
1) Savings in KVA
2) Savings in Transformer losses (KW)

Indirect
1) With AHF two distribution transformers freed for future expansion
2) Cable temperature reduced
3) Stopped frequent & spurious tripping of MCCBs
4) Spurious blowing of fuses in distribution controlled
5) Due to improvement in power quality, the electronic control systems and logics are well protected
6) KVA demand is made free for additional usage
## Case Study: Cooper Foundries Ltd., Satara

<table>
<thead>
<tr>
<th>Sr.No.</th>
<th>Load study point</th>
<th>Input Source Existing</th>
<th>Suggested DAPC only with Existing load</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>KW</strong></td>
<td><strong>PF</strong></td>
<td><strong>THD</strong></td>
</tr>
<tr>
<td>1</td>
<td>Furnace /Melting Furnace -800KW 3PH</td>
<td>2100</td>
<td>0.95</td>
</tr>
<tr>
<td>2</td>
<td>CD Furnace -500KW 3PH</td>
<td>1800</td>
<td>0.94</td>
</tr>
<tr>
<td>3</td>
<td>175KW Power Track Furnace (H1) 3PH</td>
<td>625</td>
<td>0.95</td>
</tr>
<tr>
<td>4</td>
<td>LT PANEL (Furnace 125kw,RT, PFC,Core Shooter,H4 F/C Omega Compressor-75kw)</td>
<td>750</td>
<td>0.54</td>
</tr>
<tr>
<td>5</td>
<td>500KW Panel -Pump House, Foundry Crane AU M/C Office Load,AMH6 01.03</td>
<td>800</td>
<td>0.96</td>
</tr>
</tbody>
</table>

- **Extremely high vTHD Levels at the plant**
## Load Analysis with 150 A Harmonic Filter System

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Parameter</th>
<th>Unit</th>
<th>Without AHF</th>
<th>With AHF</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Frequency</td>
<td>Hz</td>
<td>49.4</td>
<td>49.4</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>Vrms</td>
<td>V</td>
<td>Phase 1: 238.19</td>
<td>231.54</td>
<td>2.8%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Phase 2: 238.96</td>
<td>234.15</td>
<td>2.0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Phase 3: 230.11</td>
<td>233.95</td>
<td>-1.7%</td>
</tr>
<tr>
<td>III</td>
<td>Arms</td>
<td>A</td>
<td>Neutral: 49.6</td>
<td>52.47</td>
<td>-5.8%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Phase 1: 549.31</td>
<td>494.27</td>
<td>10.0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Phase 2: 558.16</td>
<td>497.43</td>
<td>10.9%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Phase 3: 575.11</td>
<td>515.78</td>
<td>10.3%</td>
</tr>
<tr>
<td>IV</td>
<td>vTHD</td>
<td>%</td>
<td>Phase 1: 12.66</td>
<td>3.65</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Phase 2: 12.04</td>
<td>3.59</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Phase 3: 11.8</td>
<td>3.7</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>iTHD</td>
<td>%</td>
<td>Phase 1: 36.14</td>
<td>9.89</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Phase 2: 34.98</td>
<td>9.75</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Phase 3: 31.61</td>
<td>9.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>p.f.</td>
<td></td>
<td>Phase 1: 0.931</td>
<td>0.993</td>
<td>-6.7%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Phase 2: 0.936</td>
<td>0.988</td>
<td>-5.6%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Phase 3: 0.942</td>
<td>0.993</td>
<td>-5.4%</td>
</tr>
<tr>
<td>VI</td>
<td>V Unbalance</td>
<td>%</td>
<td>0.24</td>
<td>0.71</td>
<td>-5.4%</td>
</tr>
<tr>
<td>VII</td>
<td>A Unbalance</td>
<td>%</td>
<td>2.61</td>
<td>2.68</td>
<td>-5.4%</td>
</tr>
<tr>
<td>VIII</td>
<td>kW</td>
<td>KW</td>
<td>Phase 1: 121.96</td>
<td>113.73</td>
<td>6.7%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Phase 2: 124.91</td>
<td>115.19</td>
<td>7.8%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Phase 3: 129.57</td>
<td>119.88</td>
<td>7.5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>TOTAL: 376.45</td>
<td>348.81</td>
<td>7.3%</td>
</tr>
<tr>
<td>IX</td>
<td>kVA</td>
<td>kVA</td>
<td>Phase 1: 130.88</td>
<td>114.48</td>
<td>12.5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Phase 2: 133.415</td>
<td>116.5</td>
<td>12.7%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Phase 3: 137.56</td>
<td>120.705</td>
<td>12.3%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>TOTAL: 401.85</td>
<td>351.69</td>
<td>12.5%</td>
</tr>
</tbody>
</table>

**Average Values**

**Improvements in**

vTHD / iTHD & KW/KVA
CASE STUDY – 2

For Software Development Company

Sutherland Global Service, Chennai

Audit Done with : Manaco Power Analyser
Problems Experienced

- Frequent failure of Electronic Boards in Servers and Work Station areas
- Slow down of Network for reason unknown
- Tripping of Generator
- Distribution Transformer getting overheated
Site Condition

Installed Power = 640 KVA

Generator Capacity = 300 KVA
Load Current and VTHD  measured in UPS panel

<table>
<thead>
<tr>
<th>Phases</th>
<th>Load Current without AHF</th>
<th>Load Current with AHF</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>237 A</td>
<td>182 A</td>
</tr>
<tr>
<td>Y</td>
<td>208 A</td>
<td>168 A</td>
</tr>
<tr>
<td>B</td>
<td>187 A</td>
<td>150 A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Phases</th>
<th>VTHD without AHF</th>
<th>VTHD with AHF</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>7.8%</td>
<td>2.6%</td>
</tr>
<tr>
<td>Y</td>
<td>8.3%</td>
<td>2.5%</td>
</tr>
<tr>
<td>B</td>
<td>7.6%</td>
<td>2.5%</td>
</tr>
</tbody>
</table>
### iTHD measured in UPS panel

<table>
<thead>
<tr>
<th>Phases</th>
<th>iTHD without AHF</th>
<th>iTHD with AHF</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>62%</td>
<td>12.7%</td>
</tr>
<tr>
<td>Y</td>
<td>62.8%</td>
<td>14.5%</td>
</tr>
<tr>
<td>B</td>
<td>64.8%</td>
<td>16.5%</td>
</tr>
</tbody>
</table>
## PF Correction due to Harmonic Reduction

<table>
<thead>
<tr>
<th>Phases</th>
<th>Power Factor without AHF</th>
<th>Power Factor with AHF</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>0.65</td>
<td>0.81</td>
</tr>
<tr>
<td>Y</td>
<td>0.59</td>
<td>0.74</td>
</tr>
<tr>
<td>B</td>
<td>0.63</td>
<td>0.84</td>
</tr>
</tbody>
</table>
Summary of Audit

- Input current reduced from 237 to 182 A / phase
- KVA demand reduced from 50.51 to 43.18 VA
- Due to current reduction copper losses ($i^2r$ losses) in the cables & transformers will be substantially reduced which we could not measure.
Summary of Audit

- Input Voltage distortion is reduced from 8.3% to 2.5%
- Input current distortion reduced from 64% to 16%
- Input PF is improved from 0.65 to 0.81
- Harmonic Level in MV Panel before connecting AHF is 27% iTHD
- After connecting AHF it was 3% iTHD
Effect in kVAR

Initial value of PF capacitor was 370 KVAR in MV Panel.

PF value = 0.97

With AHF connected required PF capacitor value is 230 KVAR @ 0.99 PF

Due to this the circulating current in capacitors is reduced from 137 to 119 A

Difference is around 18 A per phase
Results

- Substantial **KVA DEMAND** reductions to **32.16 KVA**
- **Issues** related with the **NOICE, EMI and RFI** in the facility was **ELIMINATED**
- **FAILURE OF ELECTRONIC BOARDS** in the Server **STOPPED completely**
- **GENERATOR AND EB TRANSFORMER HEATING** issues resolved
- Generator **CAPACITY REQUIREMENT REDUCED TO HALF**
Thank you for your attention for further details

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Mobile #