“Harmonics and Power Quality” Case Studies

MSEDCL

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Reactive Power Compensation

- Penalty / incentive mechanism for power factor improvement
- Maximum 7% incentive on unity power factor
- In metering, kVArh leading = 0
- Industries tend to keep power factor leading “BY ADDITIONAL FIXED CAPACITORS” to avail maximum benefit

Impact of additional capacitors

- Harmonic amplification
- Chances of resonance
- Saturation of transformer and motors due to voltage rise
- Saturated transformer and motors generates more harmonics

Power Quality Impact on Consumer

- Each consumer have practically few or all power quality issues.
- Due to increases non linear loads, harmonic generation is major concern
- Generated harmonics distorts voltage waveform

Power Quality Case Studies

CASE STUDY

PRODUCTIVITY IMPROVEMENT AND REDUCTION IN SEC

PROBLEMS FACED BY THE PLANT

- Regular failure in a Steel Wire Rope Mill
  - High Failure Rate of Motors
  - High Failure rate of control cards
  - Nuisance tripping of circuit breakers
  - Failure of SWG
- SEC was 173 kWh/Ton
- Production cost – INR 1064 per ton

HARMONICS
Before……

- High harmonic content – Vthd and Ithd

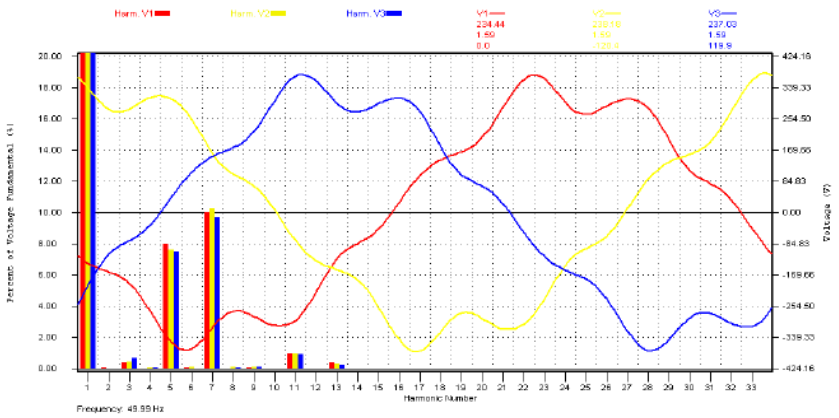
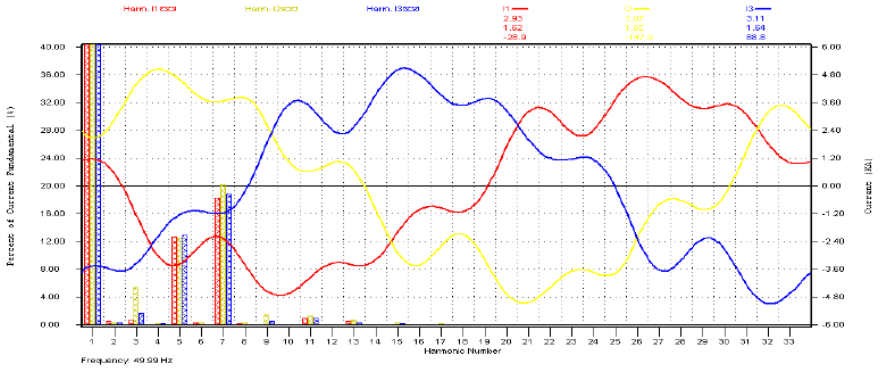


Figure – 3A Vthd and Voltage waveform without harmonic filter at

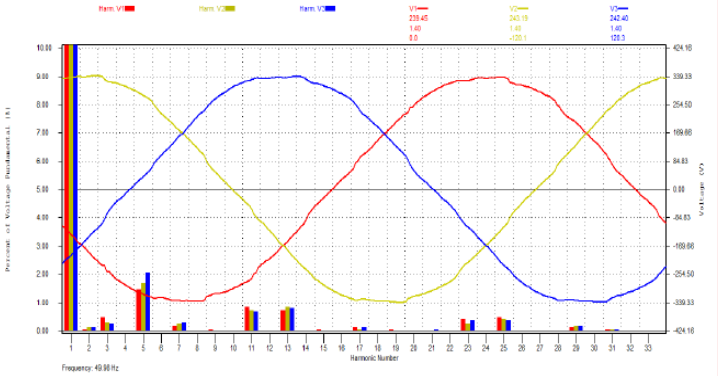
Vthd - Transformer A – 12%
Transformer B - 15%

Ithd - Transformer A – 21%
Transformer B - 60%



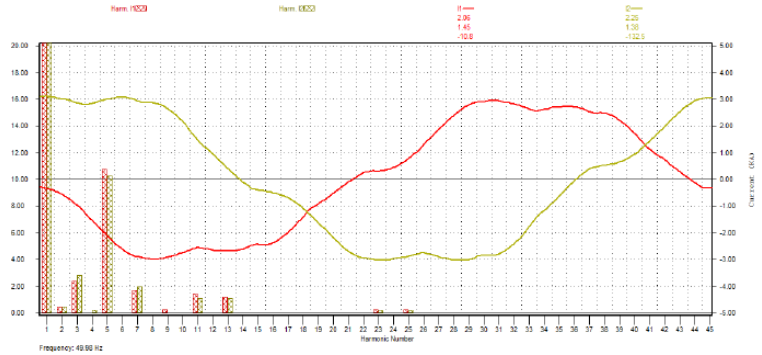
HARMONICS
After ……

- After installation of passive filter



Vthd - Transformer A – 2.1%
Transformer B - 1.2%

Ithd - Transformer A – 11.2%
Transformer B - 7.2%



BREAK DOWN ANALYSIS

Component Failure Trend										
		Before HF			After HF					
Component	Ratings	FY 13	APR 13	MAY 13	JUN 13	JUL 13	AUG 13	SEP 13	OCT 13	NOV 13
No of Motors Failed	< 3 KW	14	2	1	0	0	1	0	0	0
	3-5 KW	11	1	1	0	0	0	0	1	0
	5-10 KW	2	1	1	0	0	0	0	0	0
	10-25 KW	4	4	2	1	0	0	1	0	0
	>25 KW	2	3	1	0	0	0	0	0	0
	Total	**33**	**11**	**6**	**1**	**0**	**1**	**1**	**1**	**0**
No of Drives Failed	< 1 KW	4	0	0	0	0	1	0	0	0
	1-11 KW	45	2	1	0	1	0	1	0	0
	> 11 KW	7	1	1	0	0	1	0	0	0
	Total	**56**	**3**	**2**	**0**	**1**	**2**	**1**	**0**	**0**
No of PLCs Failed	< 1 KW	9	0	0	0	0	1	0	0	0
	1-11 KW	6	0	2	1	0	0	0	0	0
	> 11 KW	8	1	0	0	1	0	0	1	0
	Total	**23**	**1**	**2**	**1**	**1**	**1**	**0**	**1**	**0**

SUMMARY OF BREAKDOWN ANALYSIS

Component	Annual failure rate before Harmonic filter – FY 2012-13	June-Nov 2013 Failures	Extrapolated - Annual failure rate after harmonic filter	Change in failure rate	
Motors	43	4	8	-81%	Reduced by 81%
Drives	52	4	8	-85%	Reduced by 85%
PLC's	22	4	8	-64%	Decreased by 64%

- Average monthly cost saving of 240,000
- Average increase in production time 98 hours per month

SPECIFIC ENERGY CONSUMPTION & PRODUCTIVITY

SPECIFIC ENERGY CONSUMPTION			
Parameter	**Monthly Average - FY13**	**Monthly Avg Jun-Oct13**	**% Change**
Finish Machine Production in tons	10935	11632	↑ by 6.4%
KWH/Ton of Production (JSEB)	173	153	↓ by 11.6%
Rs/Ton of Production	1064	951	↓ by 10.6%

FINANCIAL ANALYSIS

Financial Analysis		
Part A - Reduction in specific energy consumption		Unit of Measurement
Rs/Ton of Production in FY13	1,064.00	INR/Ton
Rs/Ton of Production on 31.10.13	951.00	INR/Ton
Net Gain in Rs/Ton of Production	113.00	INR/Ton
If Avg Monthly Production remains	11,000.00	Tons
Avg Monthly Monitory Gain	1,242,226.00	INR
Average annual monitory gain - A	**14,906,714.00**	**INR**
Part B - Reduction in maintenance, repair and replacement		
Average monthly reduction in maintenance cost	240,000.00	INR/Month
Annual reduction in maintenance cost - B	**2,880,000.00**	**INR/Year**
Total (A+B)	**17,786,714.00**	**INR/year**
Investment	9,800,000.00	INR
Simple Payback	7	Months

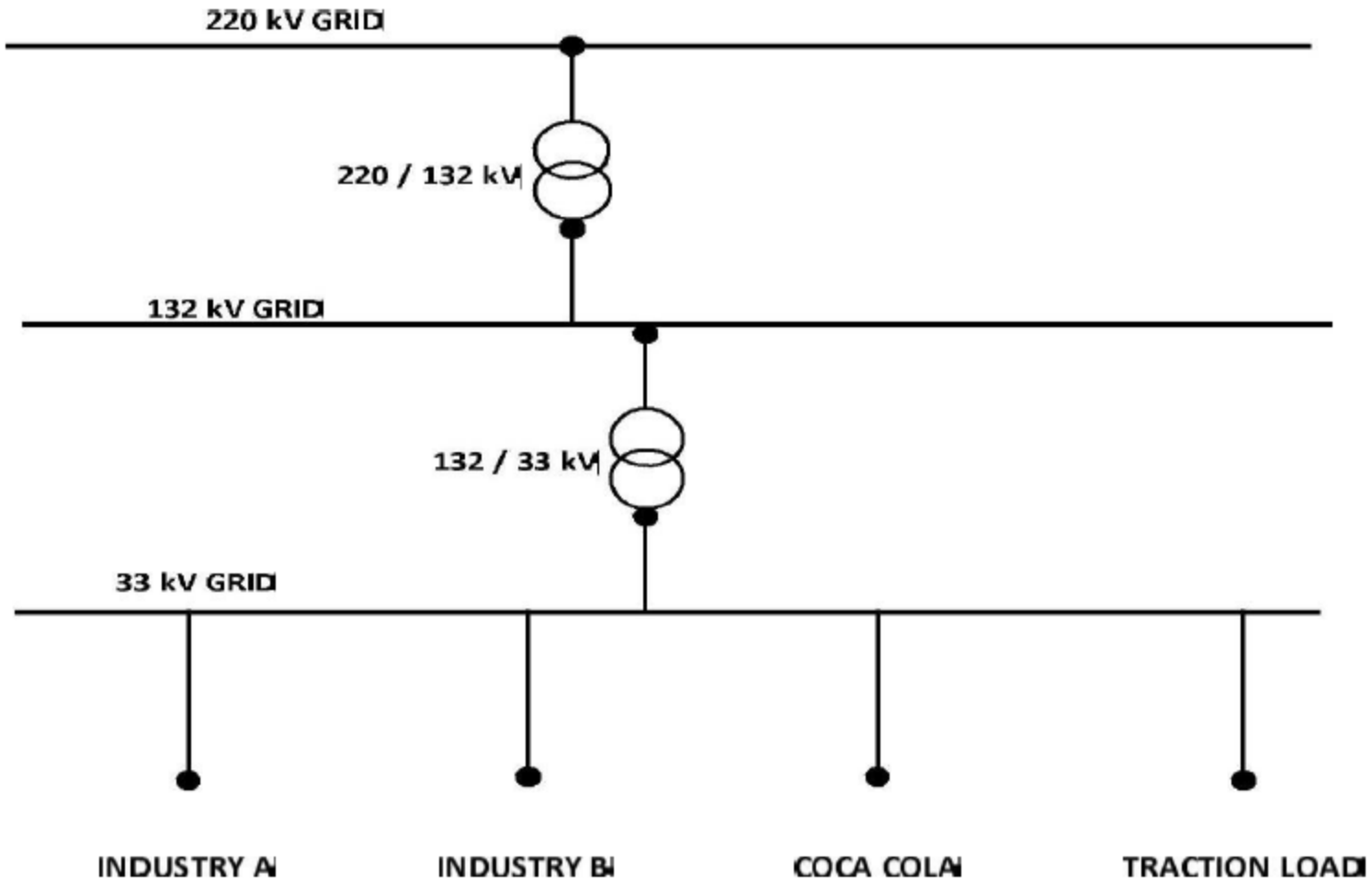
CASE STUDY -

Distribution Network Voltage Related Power Quality Issues

Distribution Network Voltage Issues
Coca Cola

- Coca Cola – Leading beverage manufacturer, one of the plant at Khurda, Orissa
- Receives power from 220 kV grid – 25 KM from plant
- Same grid also supplies to traction load

SLD of Grid Distribution System



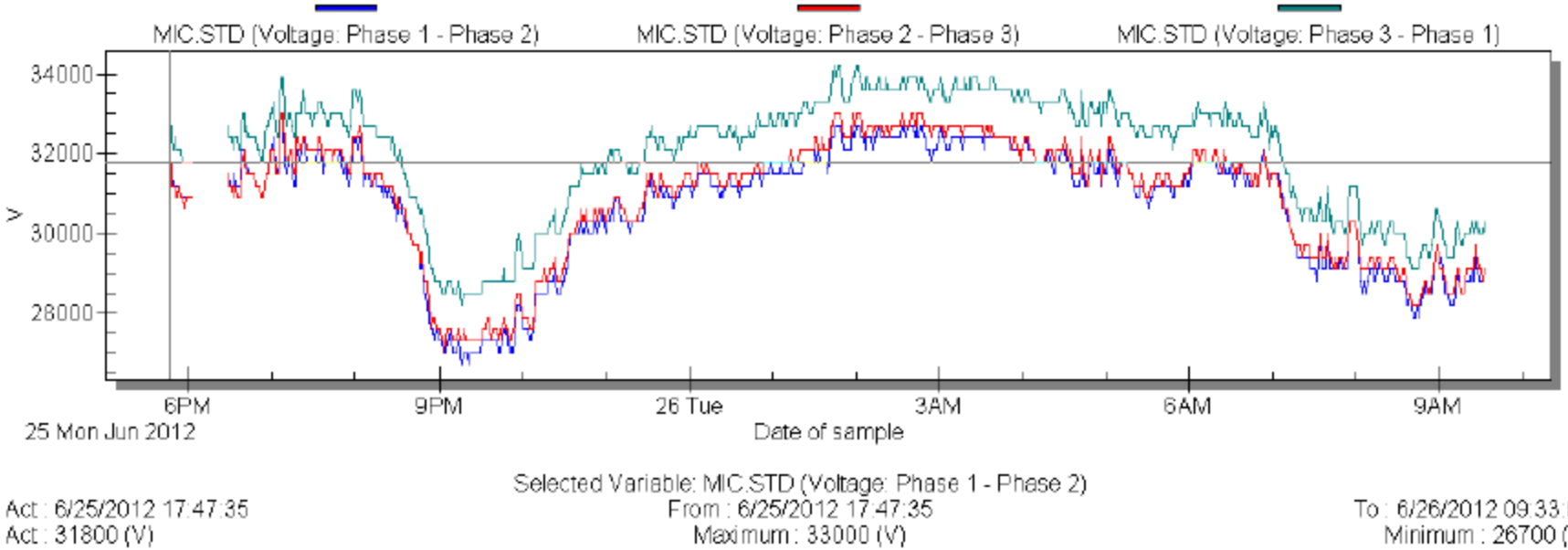
Problem Faced

- Unscheduled power cuts and voltage unbalance
- Un balanced voltage

Month	Unscheduled Power cut	Unbalanced Voltage	Total No of Occurrences
	No. of Occurrences	No. of Occurrences	
January'14	10	9	19
February'14	17	8	25
March'14	45	42	87
April'14	68	51	119

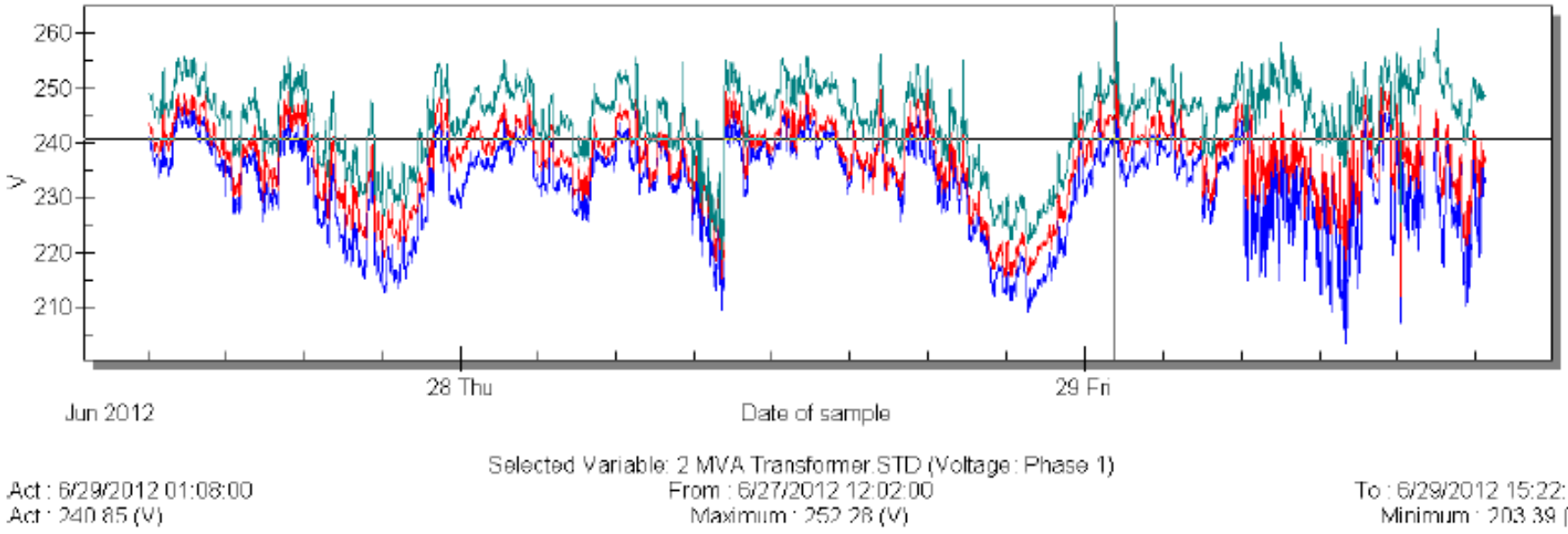
Problem Faced …contd

- Voltage variation – On 33 kV incomer variation is from 26.7 to 34.2 kV



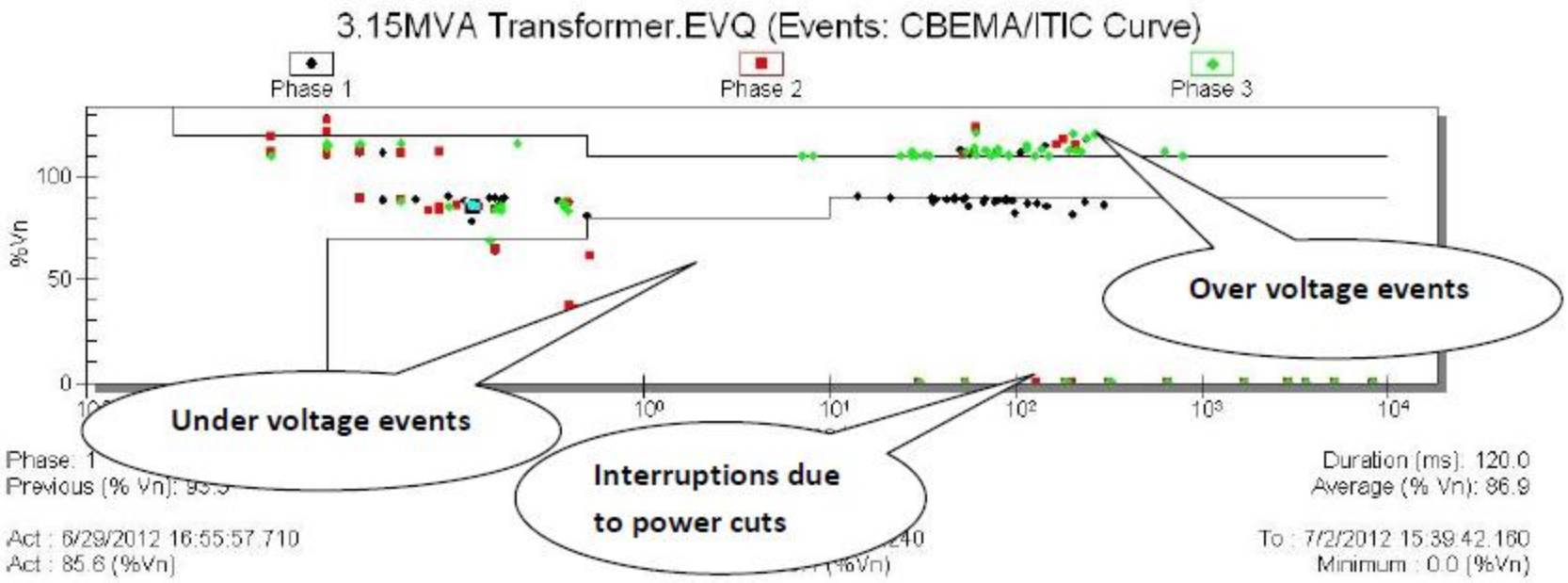
Problem Faced …contd

- Voltage variation – On LT Side incomer variation is from 203 to 252 V
- SCADA recorded voltage dips as low as 20 Volts



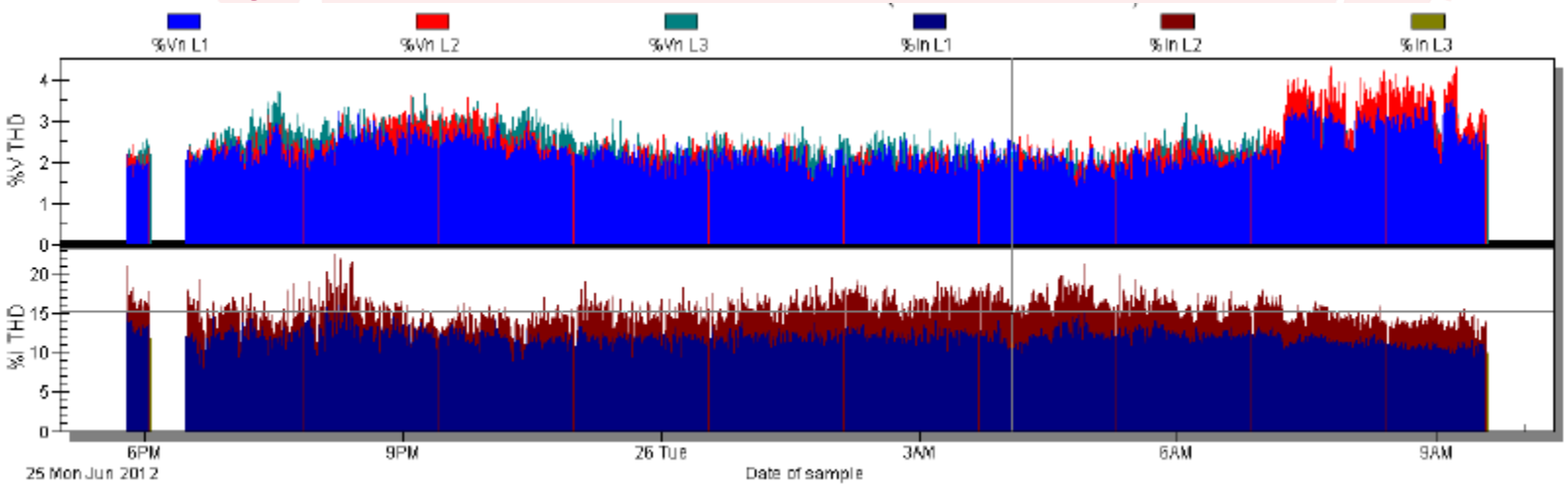
Problem Faced …contd

- Voltage Sags and Swells



Problem Faced …contd

- Voltage & Current Harmonics 4.3% & 22.7%



- Voltage harmonics close to limit specified by IEEE – 519 as 5%
- Current Harmonics on higher side

Impact on Productivity and Financial Loss

- With each interruption and event of power quality, plant was facing production loss

Sl No	Line	Line running time after power resume in mins	Production Capacity per hour (No of cases per hour)	Load factor	Actual Cases Lost	Monetary Loss in Rs per event
1	Krones	15	1500	80%	300	3168
2	Maaza	12	1500	80%	240	2534.4
3	RGB	10	1500	80%	200	2112
4	Kinley	10	300	80%	40	422.4
5	PET-140	15	933	80%	187	1970.496
Total Loss						10207

Temporarily PQ Mitigation Adopted

- Use of DG set instead of grid power
- Use of UPS for critical machines – almost 1.8 MVA

Annual Monetary Loss

- Annual loss is through:
  - Loss in productivity
  - Additional cost due to continuous operation of DG set
- Annual loss suffered by plant in terms of loss in productivity and higher energy cost is **INR 62.5 Million** per year.

Asia Power Quality Initiative

- Program initiated in Asia with the background of the European Experiment (LPQI) – Continuing Professional Development

- A ***neutral collaborative platform*** shared by National Support Network (**NSN**) Partners to promote **education and awareness** and facilitate policy changes.
- **Objective**:
  - help industries in Asia **address Power Quality issues** as a means to enhance their competitiveness in terms of better production output quality, reduced production costs, reduced production line interruption and batch losses.

  - **Building up capacity** of industry / service sector in identifying and addressing PQ issues as a means to enhance their continuous quality delivery

  - Facilitate policy changes and market transformation towards '**Safe and Quality Power for All**'.

APQI India

A neutral collaborative platform shared by National Support Network (NSN) Partners to promote education and awareness and facilitate policy / regulatory changes.

APQI India - National Support Network

• Business intermediaries	→ Reach out to manufacturing industries
• Professional associations, institutes, societies	→ Reach out to electrical engineers and designers
• Academics, consultants, PQ advocates	→ Provide technical content
• PQ equipment suppliers, contractors	
• Specialized media, event organizers	→ Support dissemination
• Policy makers, utilities	→ Provide official endorsement, Lead policy and regulatory activities

Learning from APQI : A focus around 3 Missions

A **reference** for all PQ matters in Asia	**Education & training** fine tuned for individuals	Lead the dynamic through adequate **knowledge management & E-dissemination**
A network of European /Asian PQ experts (standardization/certification body participation)	Print publications	Website
		Forums
	Electronic library	Seminars
		Webinars
Leads appropriate PQ study (PQ Survey, PQ Regulation report)		

Ensuring High Power Quality is every professional's responsibility

High Power Quality benefits all

It increases productivity, profitability & competitiveness,
It improves customer relationship & ensures better employee loyalty

Visit : **www.apqi.org**