

Reactive Power Compensation Analysis Report

FOR

Five Star Rating Hotel

Pune, Maharashtra

By

SAS Powertech Pvt Ltd.

101, Gera's Regent Manor, Survey No. 33, Area No. 39/570,
Behind Opulent Car Care Center Baner, Pune 411045

Tel: 020 20253015

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Audit Period: November 2018

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Objective and the details of the equipment

Audit objectives:

1. Detailed analysis of reactive power compensation, PF Incentive – Penalty in the light of latest MSEDCL policies regarding the same.

Details of Equipment Used:

No	Name of the equipment	SR. No., Model	Make	Use
1	Power Analyzer	1645 (CA 8335)	Chauvin Arnoux	Electrical Parameter Measurement
2	Power Analyzer	4377 (CA 8336)	Chauvin Arnoux	Electrical Parameter Measurement

Audit team

SAS Powertech Pvt Ltd : Mr. Narendra Duvedi
Mr. Parimal Kaware

Five Star Rating Hotel : Mr.

Certification:

Report Certified by:

Narendra R. Duvedi.

B.E. Electrical and Certified Energy Auditor Reg No: EA 10859

Chartered engineer

Description of Electrical Infrastructure: -

Hotel xxxxxxxxxxxxxxxx is located at Pune and is a HT consumer for MSEDCL. The electrical infrastructure details are as below –

HV Incoming	11KV From MSEDCL
Transformer	1250KVA, AN, V. ratio=11/0.433KV
Contract Demand	1070KVA
Maximum Demand	788KVA - Oct. 2018
Billed Demand	784KVA
Billed PF	0.969
KWH Consumption	Average 244590 units per month
Billed RKVAH (Lag)	2505 units - Oct. 2018
Billed RKVAH (Lead)	65340 units - Oct. 2018
Billed KWH	266805 units - Oct.2018
DG Rating	750KVA =1no., 625KVA =1no.

APFC and Capacitor details –

Main Incomer APFC-2 Details		Main Incomer APFC-1 Details		HVAC Capacitor Bank Details	
Step Rating	Qty.	Step Rating	Qty.	Step Rating	Qty.
5KVAR	1	5KVAR	2	100KVAR	3
10KVAR	2	10KVAR	2	50KVAR	3
15KVAR	2	15KVAR	2	20KVAR	1
20KVAR	1	20KVAR	2	10KVAR	1
25KVAR	1	-	-	-	-

All three panels are designed to work in APFC mode but APFC 1 (100KVAR) and APFC 2 (100 KVAR) work in Auto mode while HVAC – Capacitor(480KVAR) panel works in manual mode.

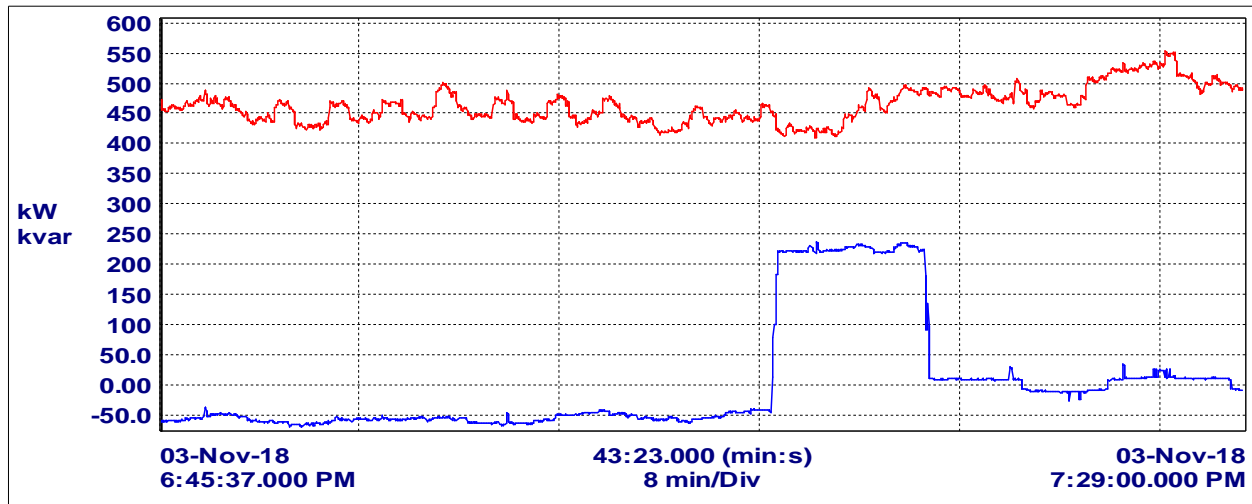
Power Quality Parameters:

Feeder Name	Voltage L-N		Voltage L-L		Voltage THD%		Current		Current THD%		KW		KVAR		PF		FREQUENCY	
	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max
Main Incomer	248	251	427	432	0.88	1.2	673	815	5.2	6.8	464	553	1	237	0.98	0.999	50	50.1
HVAC Panel	248	252	426	433	0.6	1.3	328	375	8.8	13	185	211	-106	108	0.791	0.997	-	-
Load Panel Main incomer	247	250.4	424	430	0.8	1	420	480	6.6	8	257	284	115	125	0.911	0.927	-	-

EXECUTIVE SUMMARY:

Main Incomer:

1. The Maximum recorded demand for Hotel xxxxxxxxxx is **804KVA** in the month of August 2018.
2. The average recorded load of the facility is **464KW** and reactive power is overcompensated by around **50KVAR**.
3. Maximum Reactive power requirement at 500KW load is **240KVAR**.



4. This is reflecting in bill as **excess RkVAH lead (65340)**

CURRENT CONSUMPTION DETAILS						
Reading Date	KWH	KVAH	RKVAH (LAG)	RKVAH (LEAD)	KW (MD)	KVA (MD)
Current 31-10-2018	75367.500	75680.000	1656.000	15562.500	65.340	78.420
Previous 30-09-2018	48687.000	48948.000	1405.500	9028.500		
Difference	26680.500	26732.000	250.500	6534.000		
Multiplying Factor	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000
Consumption	266805.000	267320.000	2505.000	65340.000	653.400	784.200
Add if L. T. Metering	0.000	0.000	0.000	0.000	0.000	0.000
Adjustment	0.000	0.000	0.000	0.000		
Assessed Consumption	0.000	0.000	0.000	0.000		0.000
Total Consumption	266805.000	267320.000	2505.000	65340.000	653.000	784.000

BILLING DETAILS				Amount in Rs.	
Billed Demand (KVA)	784	@ Rs.	350	Demand Charges	2,74,400.00
Assessed P.F.		Avg. P.F.	.969	Wheeling Charges @ 0.78 Rs/U	2,08,107.90
Billed P.F.	969	L.F.	35	Energy Charges	30,68,257.50
Consumption Type	Units	Rate	Charges Rs.	TOD Tariff EC	-35,250.50
Industrial	0	11.5	0.00	FAC @ 121 Ps/U	3,22,834.05
Residential	0	5.73	0.00	Electricity Duty	8,06,053.28
Commercial	2,66,805	11.5	3068257.50	Other Charges	0.00
E.D. on (Rs.)	Rate %	Amount Rs.		Tax on Sale @ 9.04 Ps/U	24,119.17
	9.3			P.F. Penal Charges / P.F.Incentive	0.00
	16			Charges For Excess Demand	0.00
	21	806053.28			0.00
		38,38,348.95			

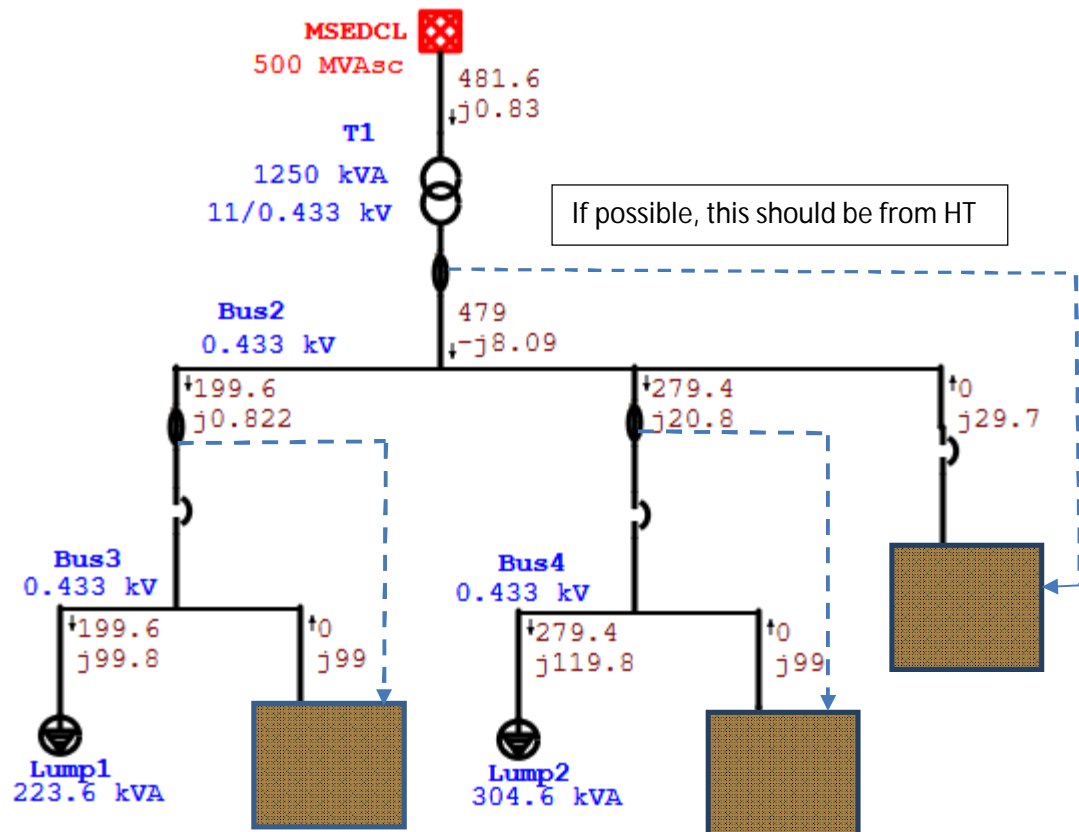
As per recent MSEDCL policy, the Power factor is now calculated as per new formula and related incentive will be available only if **RKVAH Lag >= RVAH Lead**.

In October bill the calculated power factor is **0.969** and above condition is not satisfied due to over compensation. This has resulted in loss of PF incentive; which was **Rs.2,30,156/- in August 2018** bill.

5. We recommend following actions to avoid this penalty:

- a. Do not use any fixed capacitors.
- b. Present APFC panels should be retrofitted with intelligent APFC controllers and should be used with HVAC feeder and Load Panel individually to control their power factor close to unity. Individual CTs for these panel incomers should be added if required.
- c. 100KVAR/415V or 150KVAR/525V detuned thyristor switched RTPFC should be added with 25KVAR x 2 + 12.5KVAR x 4 steps and should receive current / voltage feedback from HT auxiliary CT/PTs if available or from main transformer secondary side.

6. Proposed Arrangement will be as follows



CAP 1 = 100KVAR APFC existing with new controller retrofitted.

CAP 2 = 100KVAR APFC existing with new controller retrofitted.

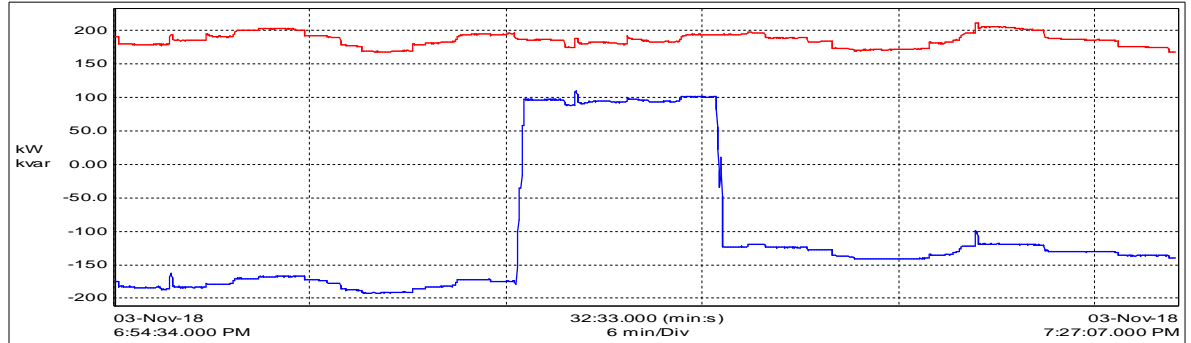
CAP 3 = 100KVAR RTPFC – detuned – thyristor switched

Existing Capacitor panel with HVAC – 480KVAR will not be used.

Audit Observations:

HVAC Panel:

1. The average recorded load on HVAC panel is **185KW** and reactive power is overcompensated by around **170KVAR**. At maximum load of **210KW** also it remains over compensated.
2. At average recorded load of **185KW**, the reactive power requirement is **100KVAR**.
3. It can be concluded that, existing APFC panel is not working properly.

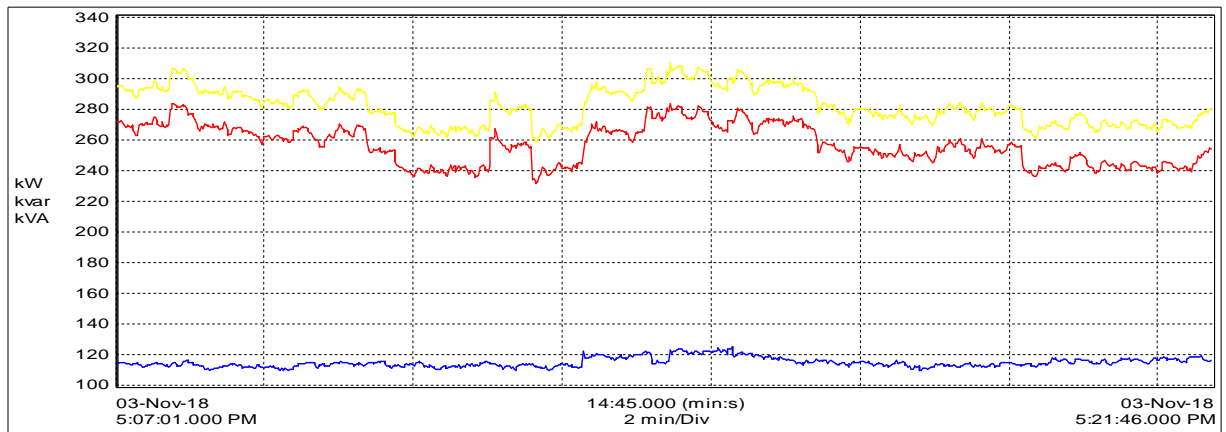


We recommend following actions to get incentive and avoid penalty:

- a. Do not use any fixed capacitors.
- b. Retrofit existing 100KVAR with new controller and use only for HVAC feeder.

Load Panel:

1. The average recorded load on Load panel is **280 KW** and reactive power requirement is 120 KVAR



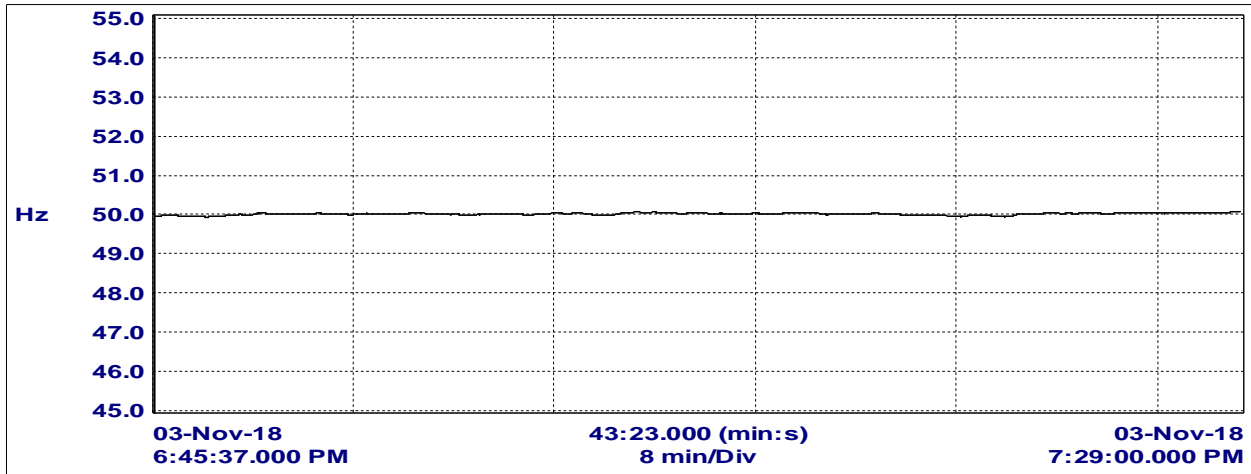
We recommend following actions to get incentive and avoid penalty:

- a. Do not use any fixed capacitors.
- b. Retrofit existing 100KVAR with new controller and use only for HVAC feeder.

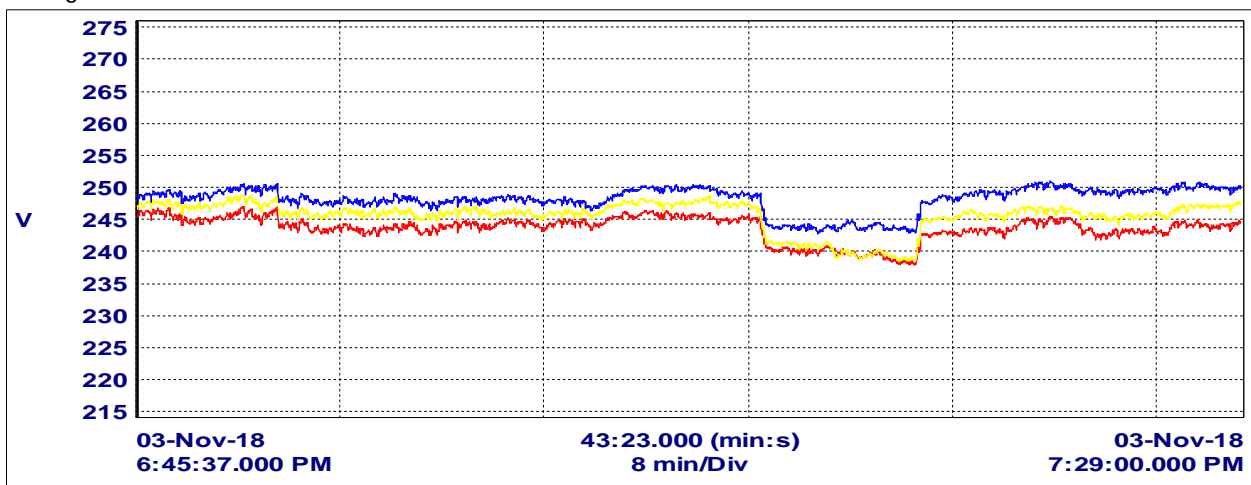
Recorded Data:-

Main Incomer:

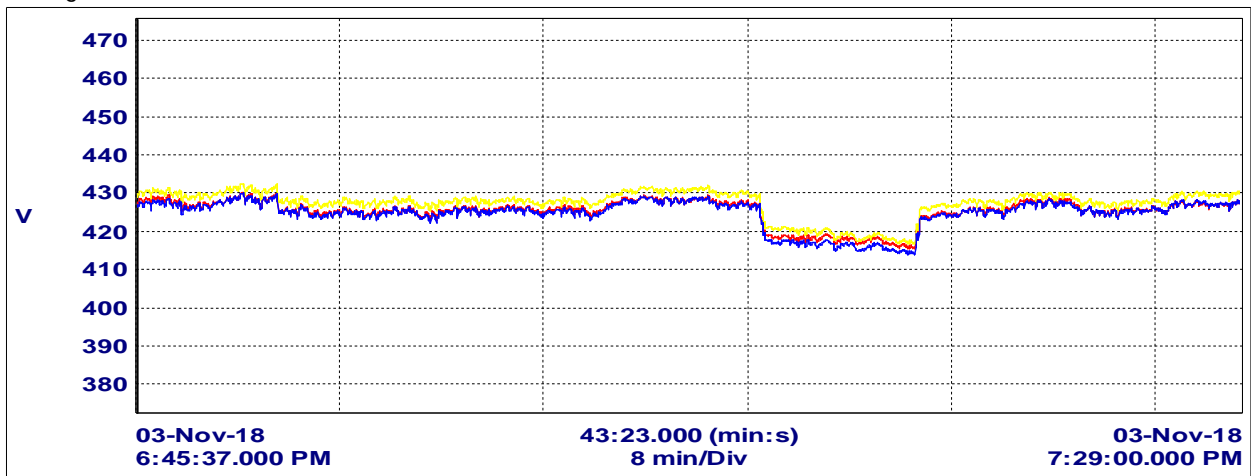
Frequency



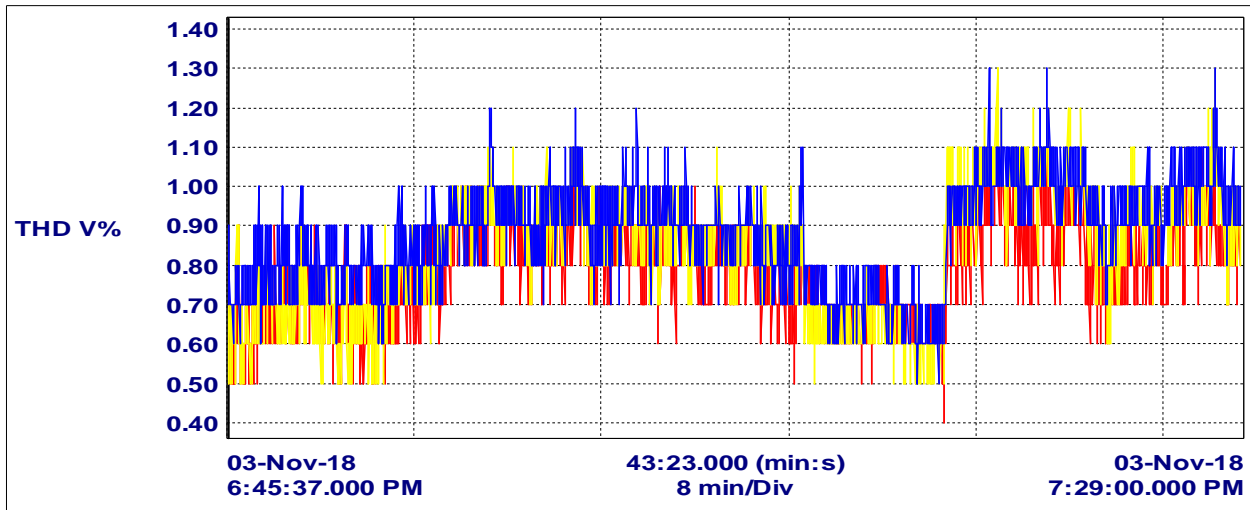
Voltage L-N



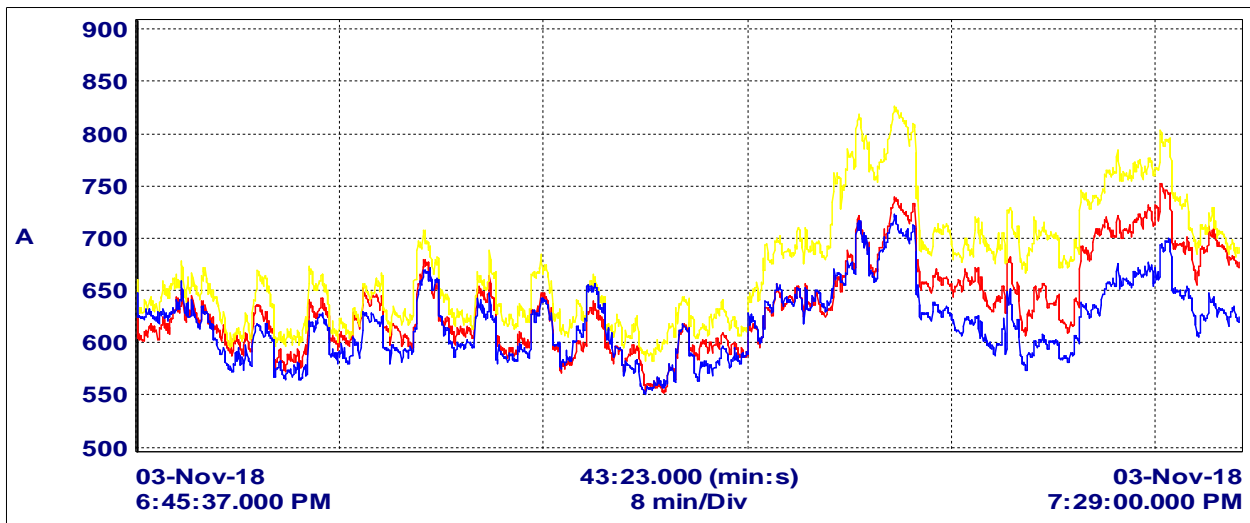
Voltage L-L



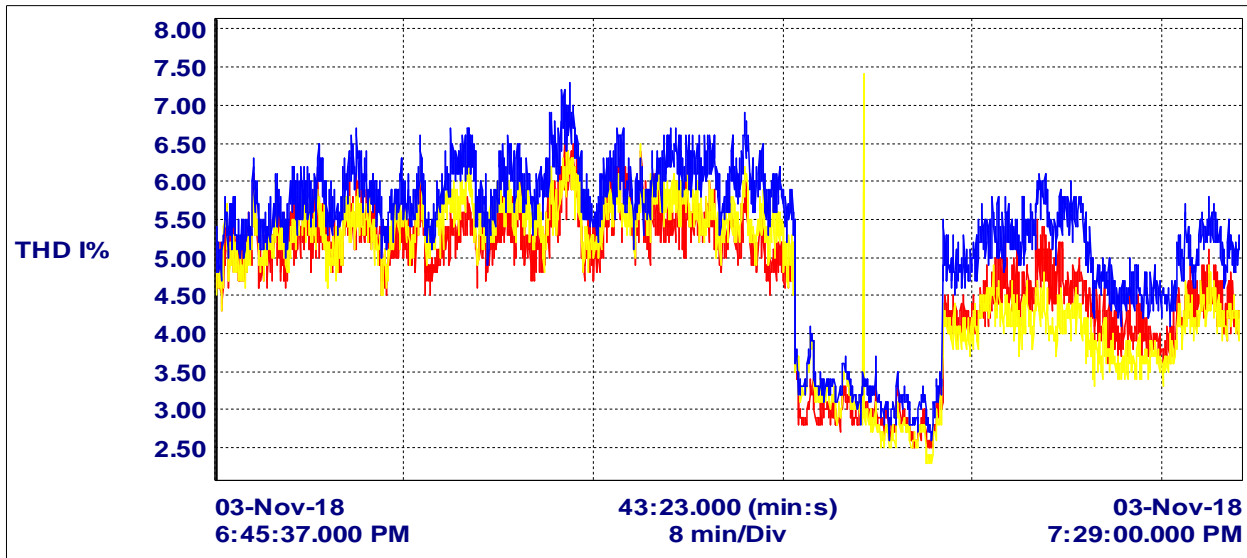
Voltage Harmonic Distortion



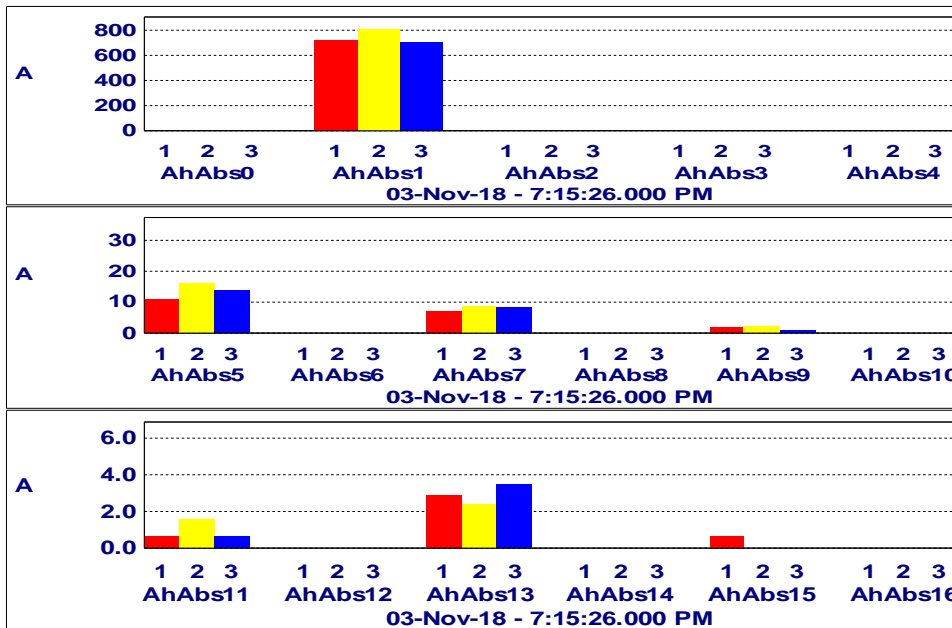
Current



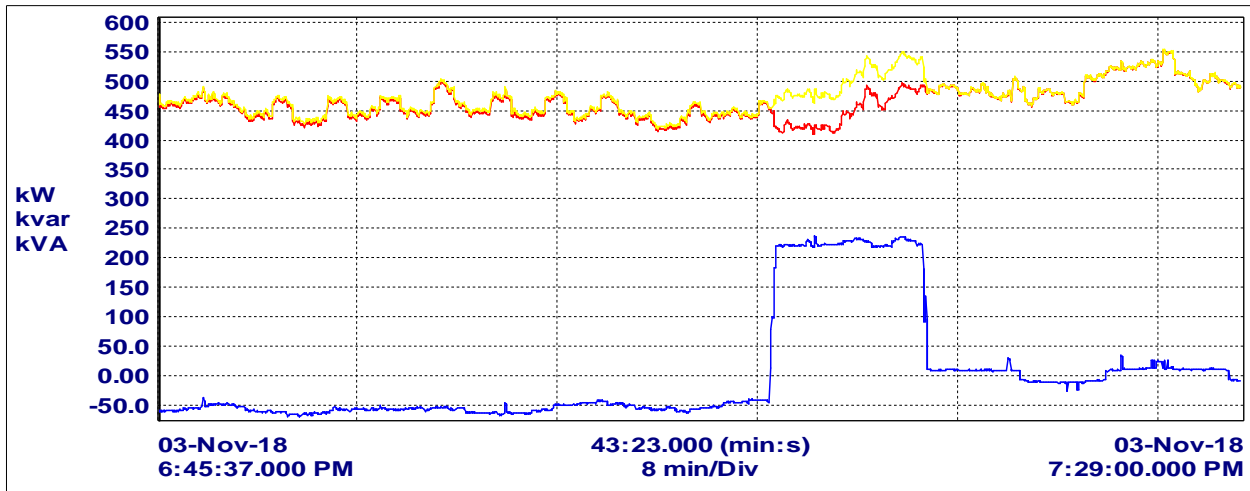
Current Harmonic distortion



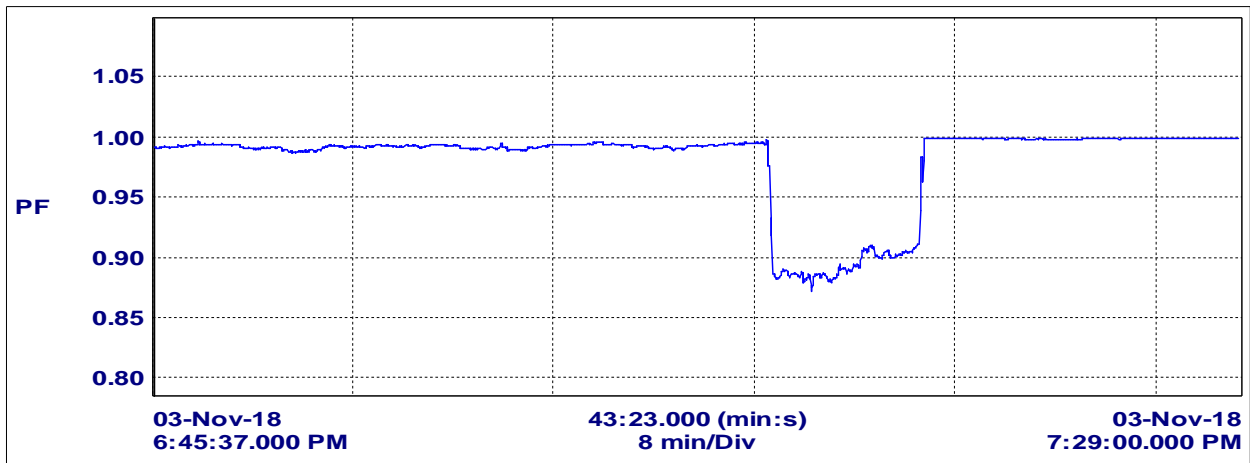
Individual Current Harmonics



KW, KVAR & KVA

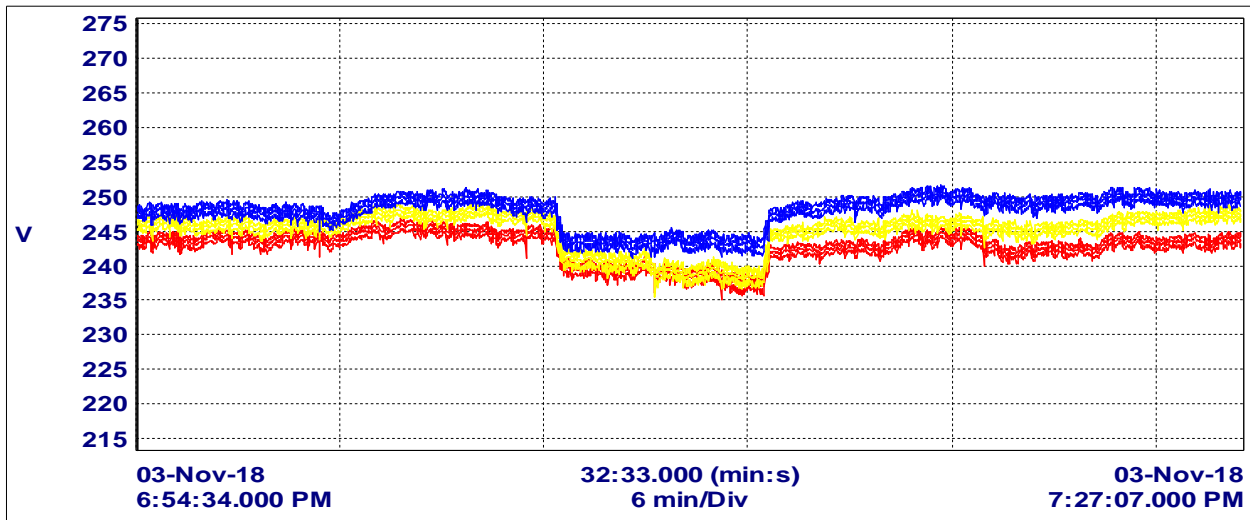


PF



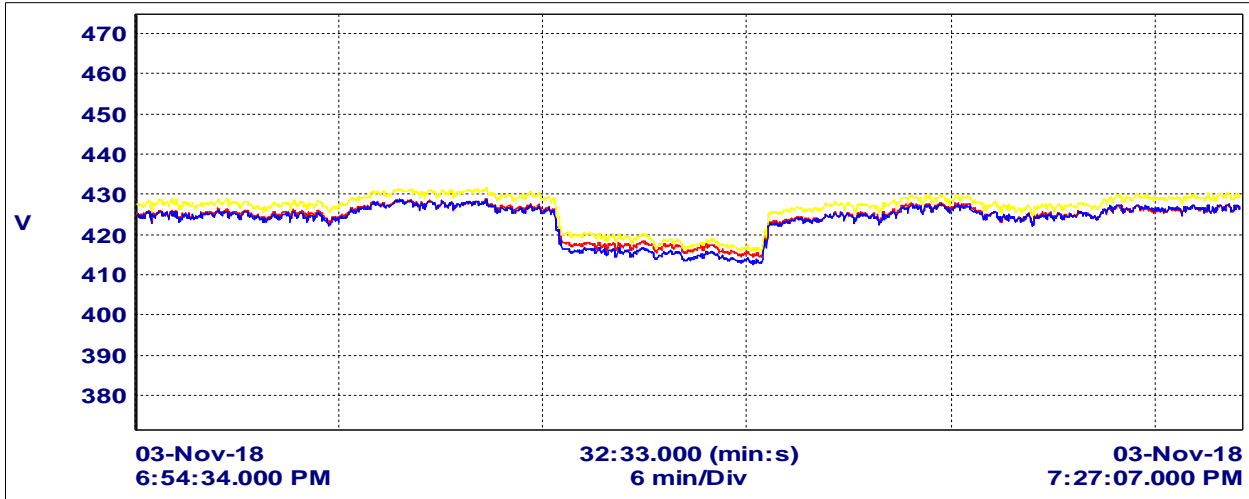
HVAC PANEL:

Voltage L-N

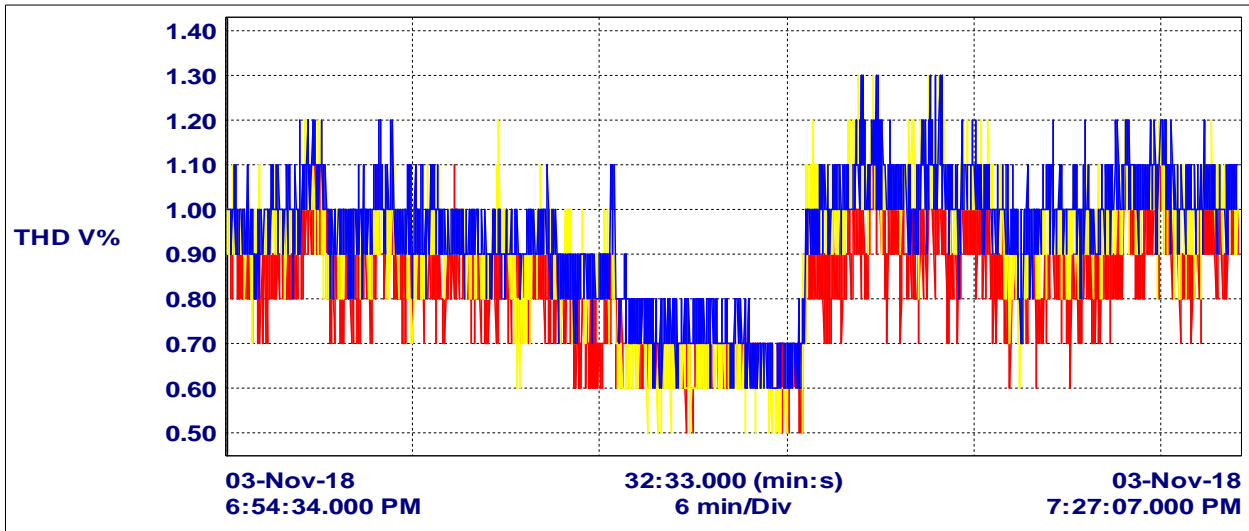


Voltage L-L

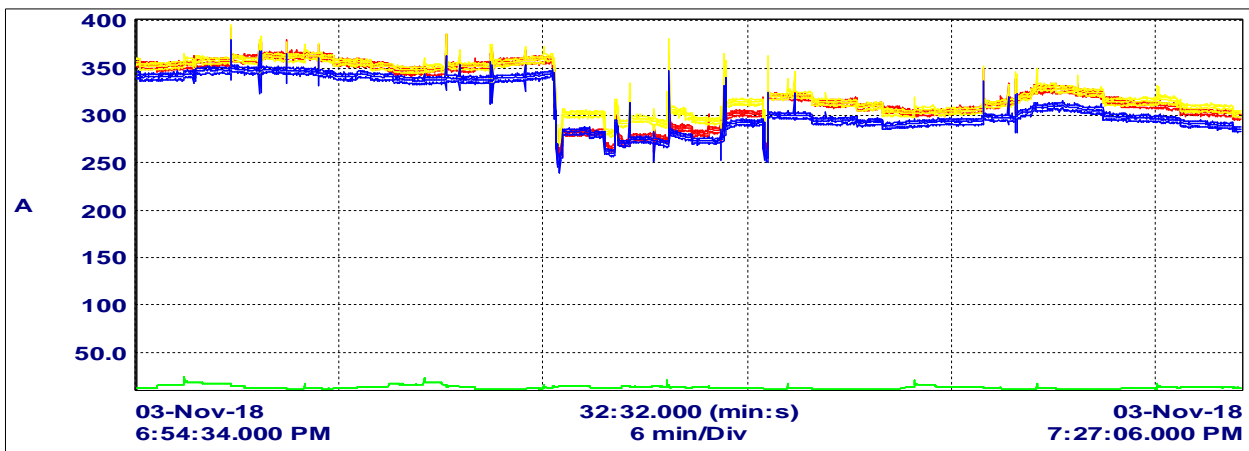
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solutions@saspowertech.com



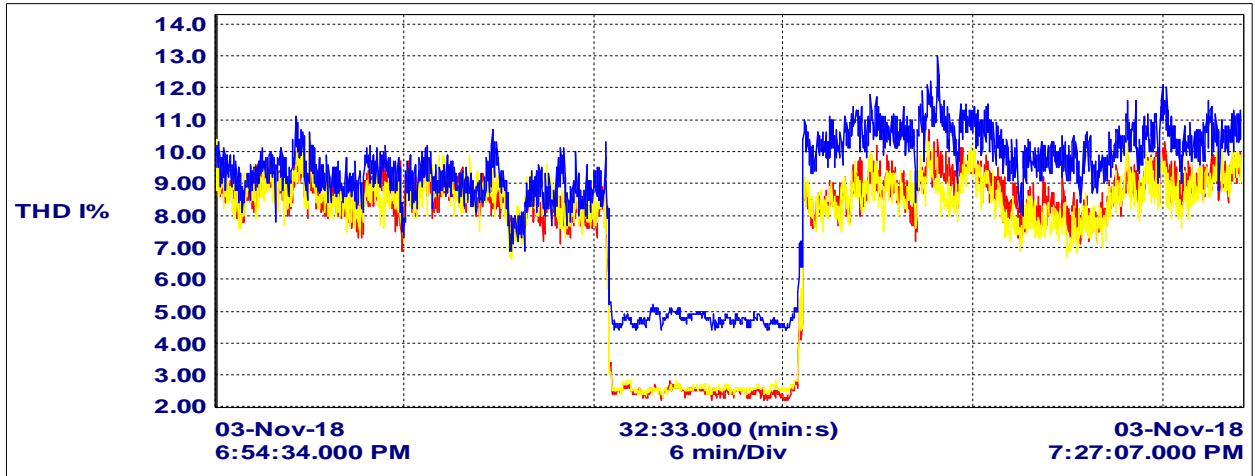
Voltage Harmonic Distortion



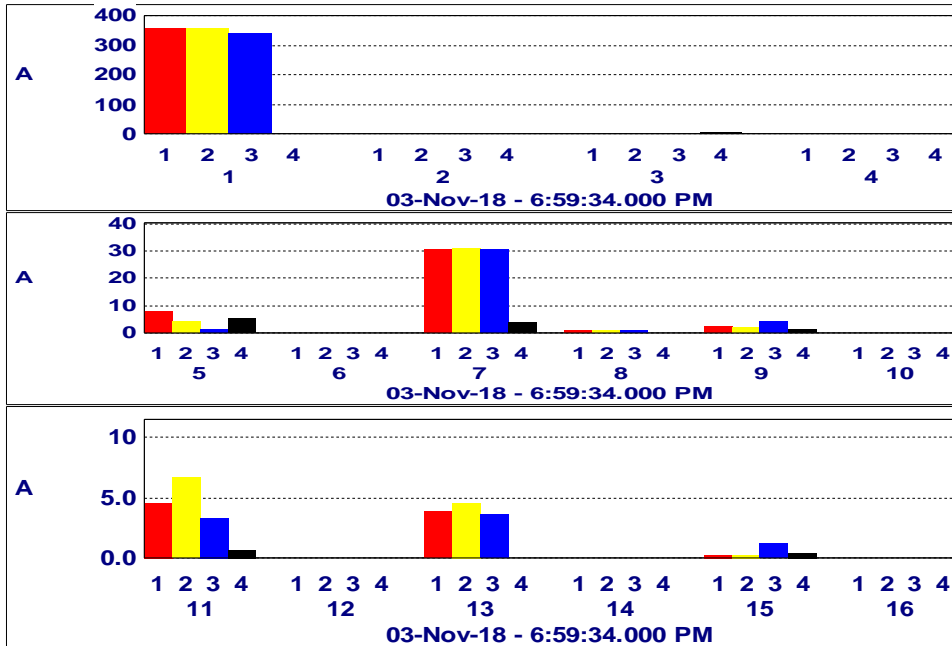
Current



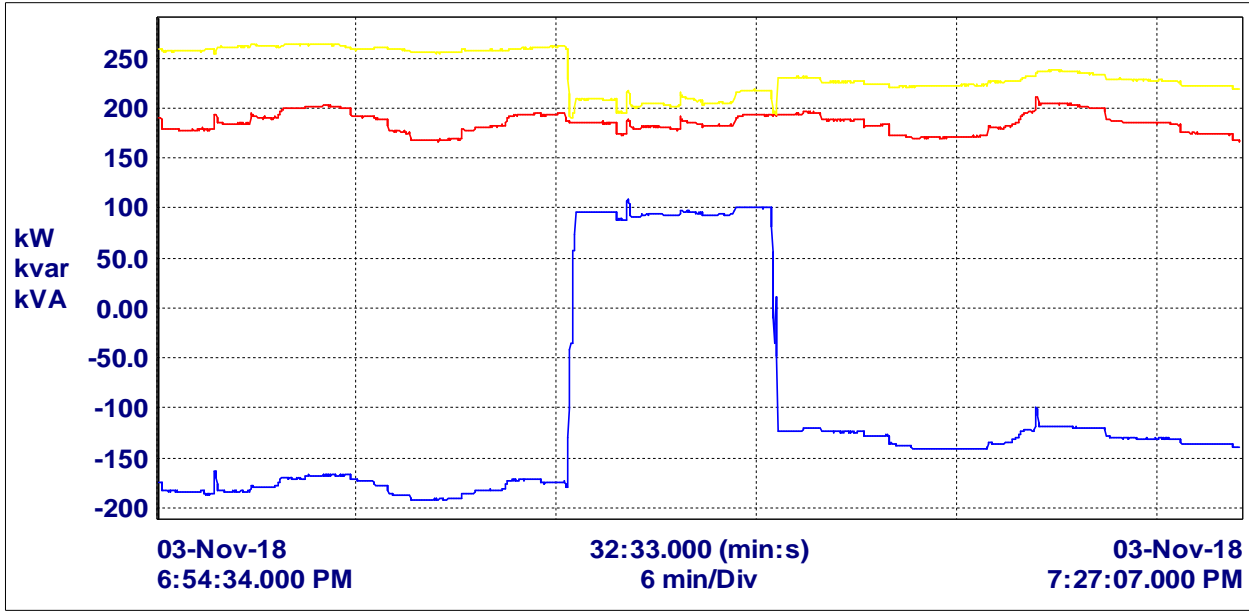
Current Harmonic distortion



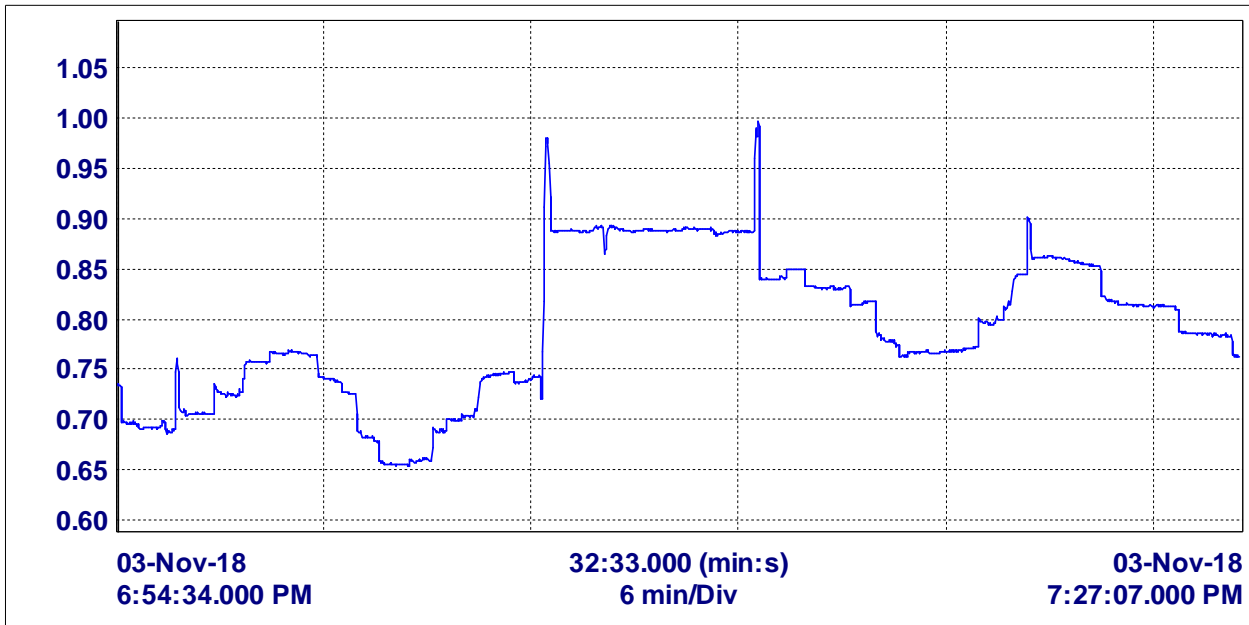
Individual Current Harmonics



KW, KVAR & KVA

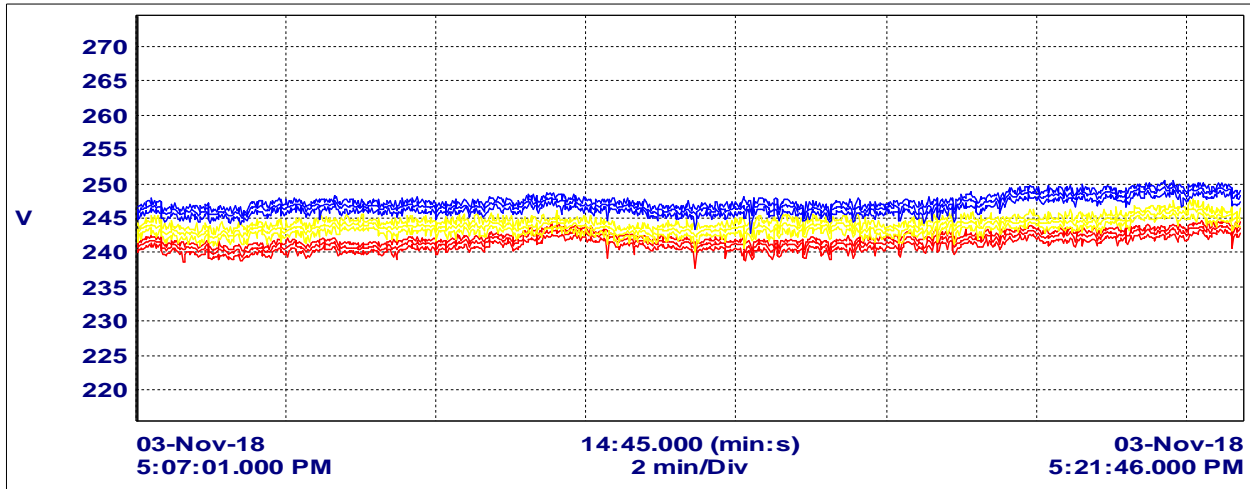


PF

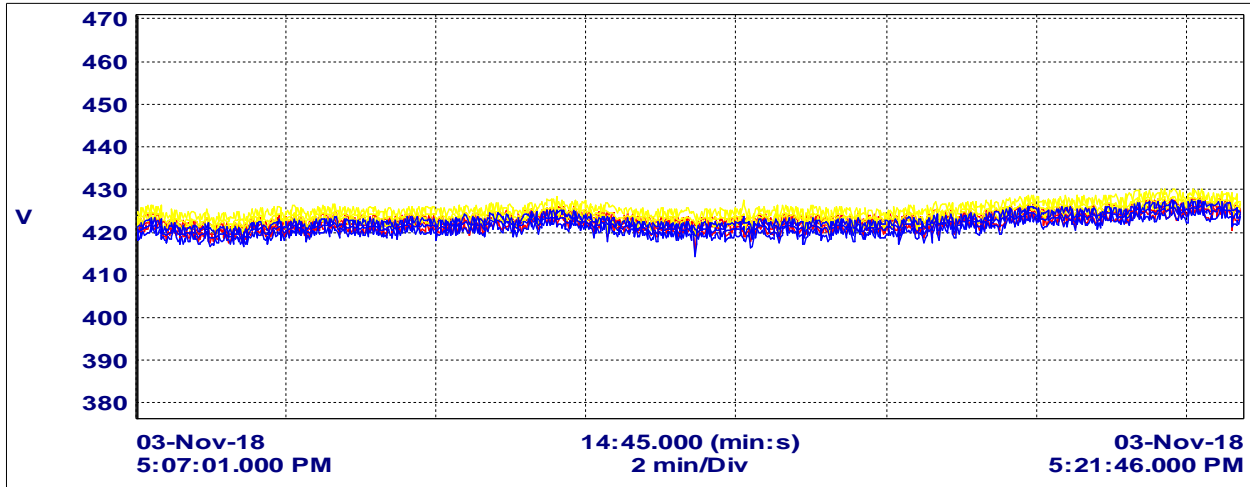


Load Panel Main Incomer:

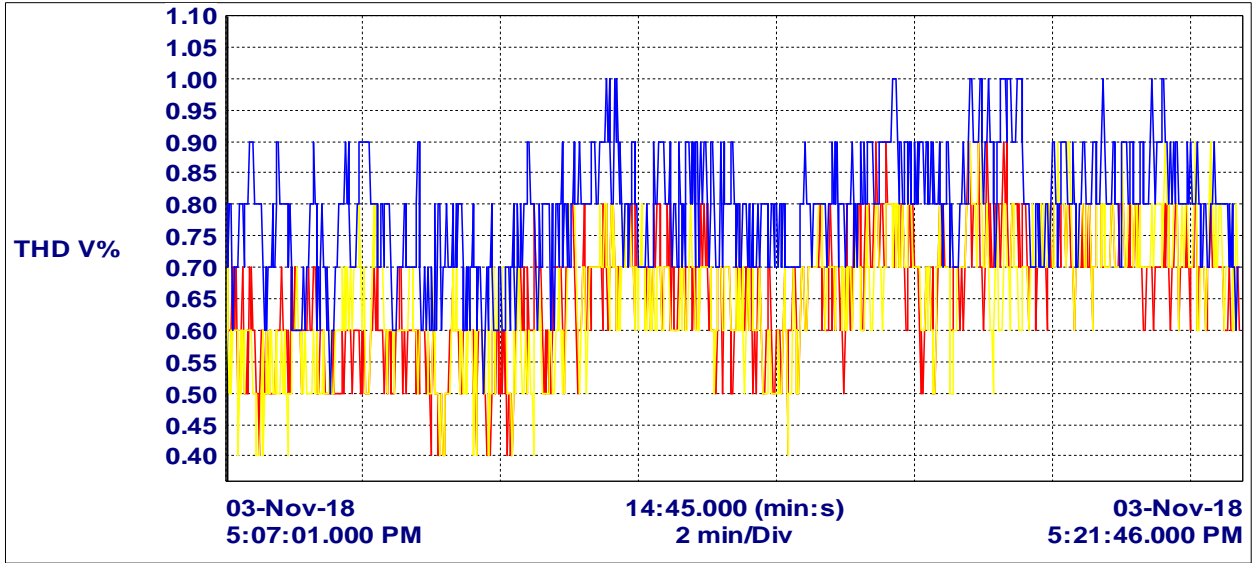
Voltage L-N



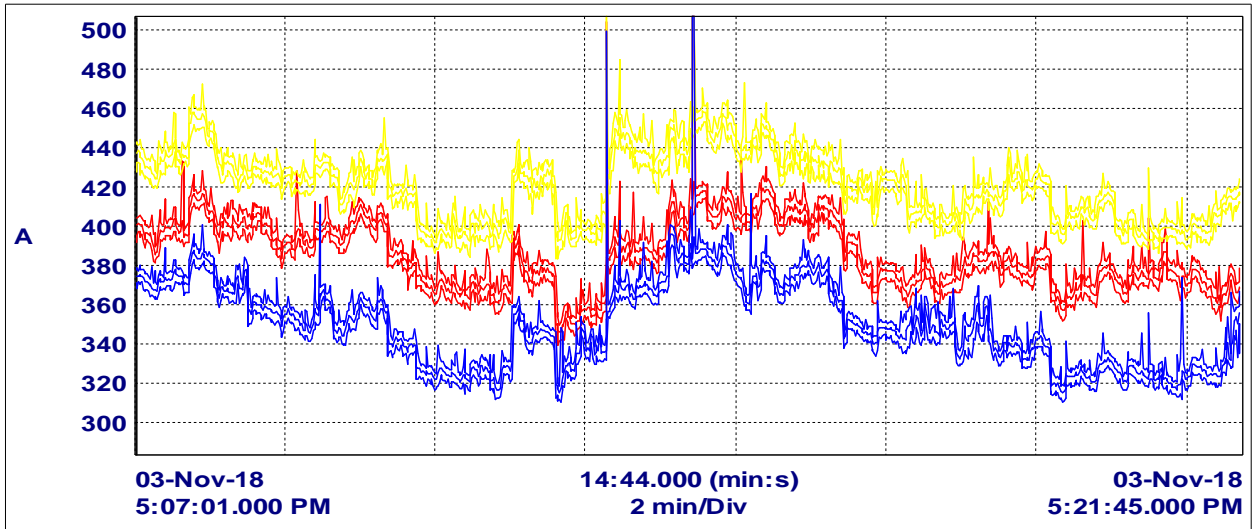
Voltage L-L



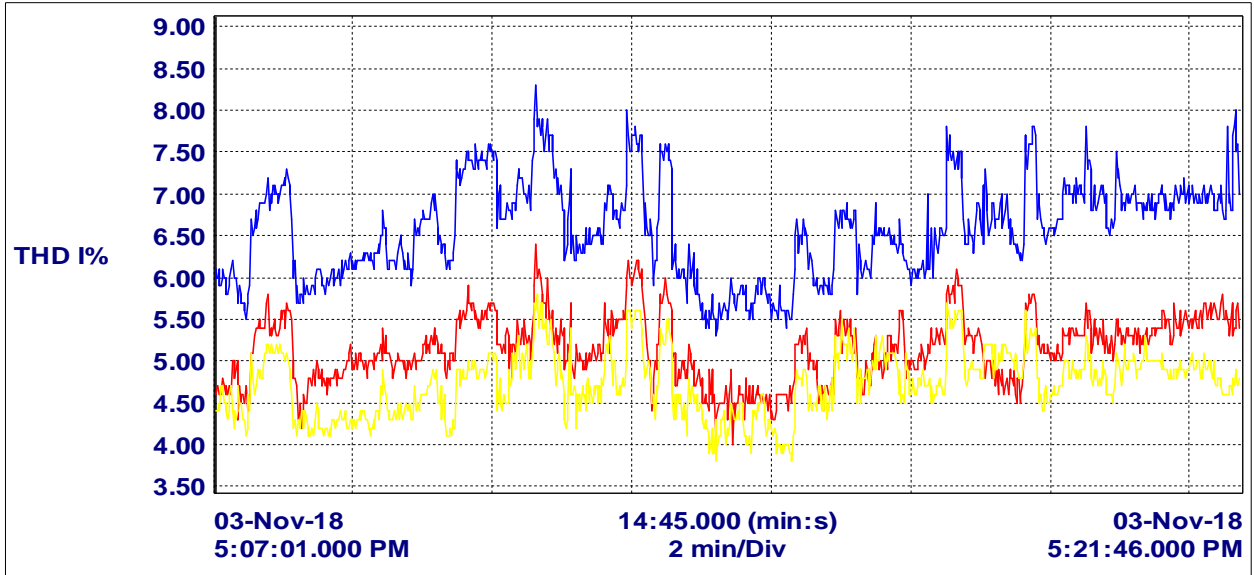
Voltage Harmonic Distortion



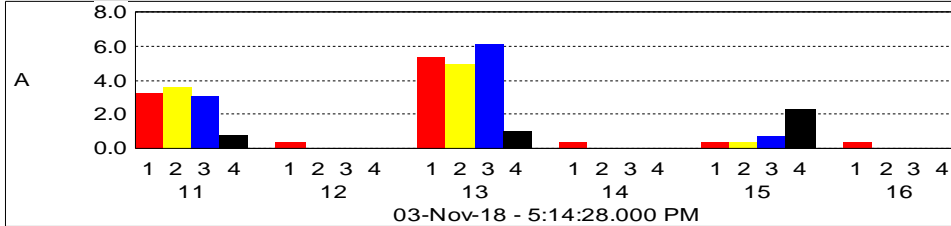
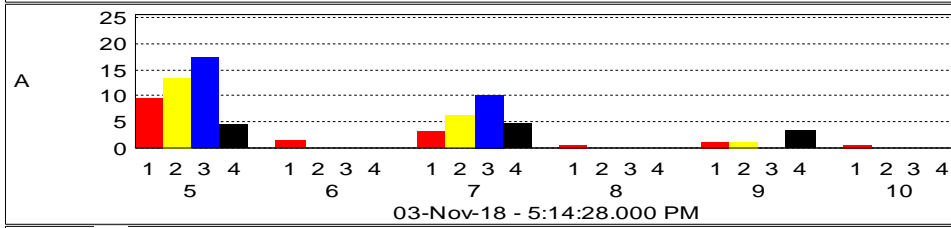
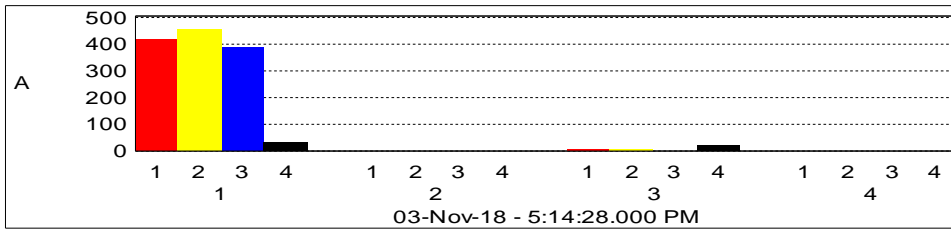
Current



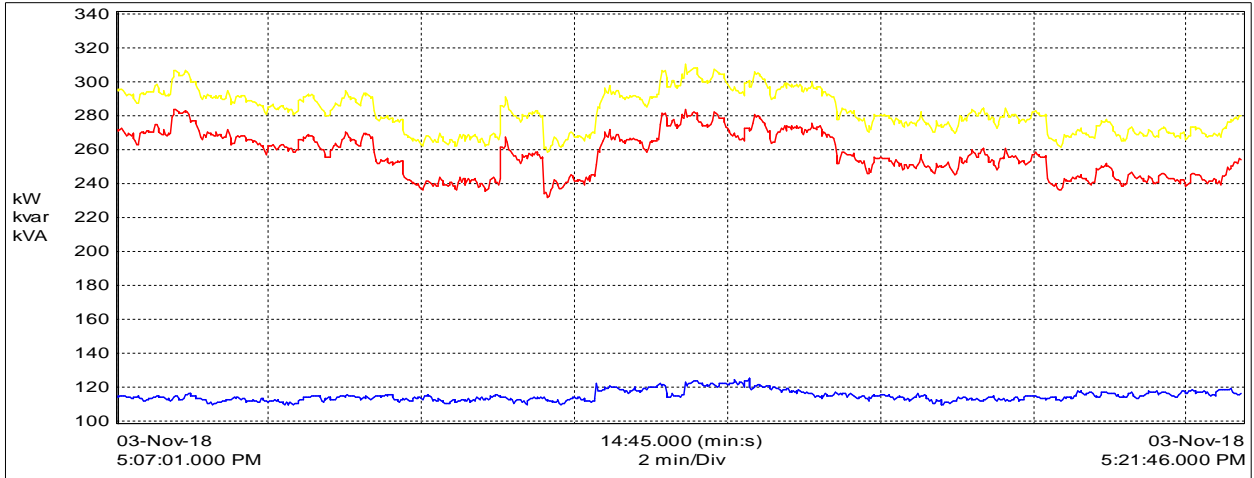
Current Harmonic distortion



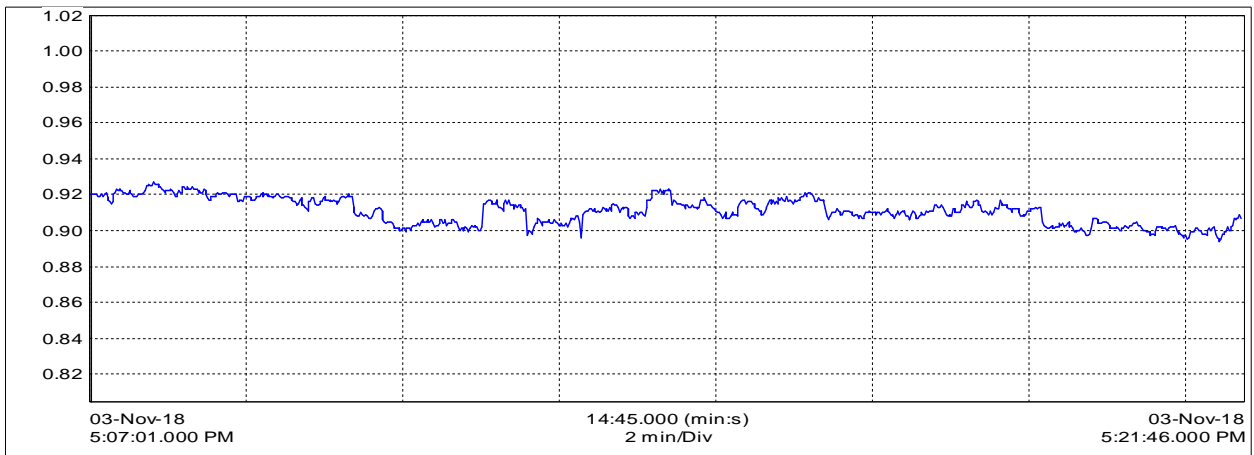
Individual Current Harmonics



KW, KVAR & KVA



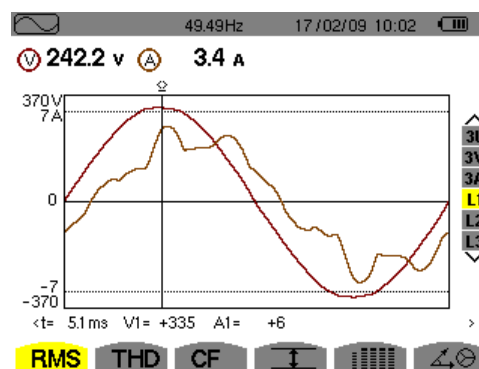
PF



A note on Power factor, current and voltage harmonic distortion

1. Power factor is characteristics of load and varies from -1 - 0 +1. Resistive loads like bulbs, heaters etc take current at unity power factor (i.e.1).Other loads like electric motors, computers, UPS systems, tube lights etc take current at power factors which are less than 1.
2. Electrical Power = $V \times I \times \text{Cos}\phi$ (PowerFactor)
3. One can take 100 watts of electrical power at 100 volts by taking 1 Amp current, if power factor is 1, while if power factor is 0.5, then the current required will be 2 Amps for delivering same power of 100 watts.
4. One unit of electricity = 1Kilowatt x 1 Hr. If we use 1 KW for 1 hour then the utility meter advances by 1 unit.
5. It is clear from above that if power factor is low, utility company (Like MSEDCL) has to supply us more current while delivering same power but gets same revenue from us.
6. Infrastructure investment done by utility company is more for delivering more current, so for these commercial reasons, they insist on better power factor and offer incentives.

Non linear loads like computer power supplies, VFDs, UPS systems, electrical arc furnaces, Plating rectifiers, and Battery chargers take non sinusoidal current while sinusoidal voltage is applied to them. This is shown in waveforms bellow.



Mathematically it can be proved that these non sinusoidal currents are made up of sinusoidal currents having frequencies which are integral multiples of fundamental frequency i.e. 50 Hz. These ($3^{\text{rd}} = 150\text{Hz}$, $5^{\text{th}} = 250\text{Hz}$, $7^{\text{th}} = 350\text{Hz}$ etc) currents cause overheating of transformers, cables, switchgears etc due to increased losses requiring their derating for normal operation. Excessive current harmonics cause voltage harmonics distorting the voltage waveform. This can further cause harmonic currents in linear loads. This causes increased losses, vibrations in electrical motors, malfunctioning of electronic controls due to generated electromagnetic noise, Unwanted erratic tripping of circuit breakers due to overheating etc.

In electrical distribution networks, having presence of harmonic currents, if only capacitors are added to improve system power factor, there is a possibility of amplification of these harmonics due to resonance created by transformer inductance and these capacitors. This should be avoided by using detuned L – C filters or harmonic filters in place of capacitors. Utility companies also make it mandatory for consumer to control harmonics generated by his load as it improves their revenue potential by avoiding derating. Active filters also could be another solution to suppress harmonics. These are specially designed power electronic circuits, which take anti phase current from source which is equal and opposite of non linear component of load current. These filters are very costly and as such are not very popular as yet.