ELECTRICAL LOAD STUDY & POWER QUALITY ANALYSIS REPORT

FOR

AUTOMOTIVE COMPONENT MANUFACTURING COMPANY

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 25533015/16/17
email: sales@saspowertech.com

ACKNOWLEDGEMENT

We are thankful to the management of _____ for giving us an opportunity to conduct power quality analysis at their premises.

We are also thankful to _____ for making available documentation and information of electrical system.

We are also thankful to _____ from Maintenance department for the help and co-operation during Power Quality Analysis.

We do hope you will find our recommendations useful in helping you to improve the power quality of your electrical system

We wish the management success in their Endeavour to improve power quality.

For SAS Powertech Pvt Ltd, Pune

Abhijit Katre

Authorized Signatory

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Details of Equipment Used:

No.	Name of the equipment	SR. No Model	Make	Calibration validity	Use
1	Power Analyzer	C.A. 8333	Chauvin Arnoux	Feb 2016	Electrical Parameter Measurement
2	Power Analyzer	C.A. 8333	Chauvin Arnoux	Feb 2016	Electrical Parameter Measurement
3	IR Camera		Testo	May 2016	

Audit team

SAS Powertech Pvt Ltd

Mr. Narendra Duvedi, (Certified energy auditor)
Mr. Vijay Sonawane
Mr. Amit Jadhav

Certification:

Report Certified by:

Narendra R. Duvedi.
(B.E. Electrical and Certified Energy Auditor Reg No: EA 10859)

Scope of Work

1. Measure existing load and load pattern along with current and voltage Harmonics and Power quality – match the same with last 12 months Average and maximum consumption. (Ref electricity bills)

This part of the scope is now complete and the report is attached here with.

2. Provide suggestions on locating obvious and no cost energy saving opportunities from the collected. Provide harmonic mitigation and reactive power compensation techniques.

This part of the scope is now complete and the report is attached here with.

3. Validation of Cables & Switchgears used.

This part of the scope is now complete and the report is attached here with.

4. Work out proposal to take sanctions from MSEDCL to increase Demand.
5. Work out the Proposal to revamp the LT Panel.
6. Work out the Proposal to revamp the necessary Cables.
7. Work out the Proposal to replace the Transformer (If required).
8. Work out Proposal for Energy Metering & Monitoring System.
2. DETAILED SLD FOR NEW SETUP & DOCUMENTS.

This part of the scope will be taken up after knowing expansion plans and after getting policy decisions from the management regarding acceptance of recommendations in this report and their expected schedule.

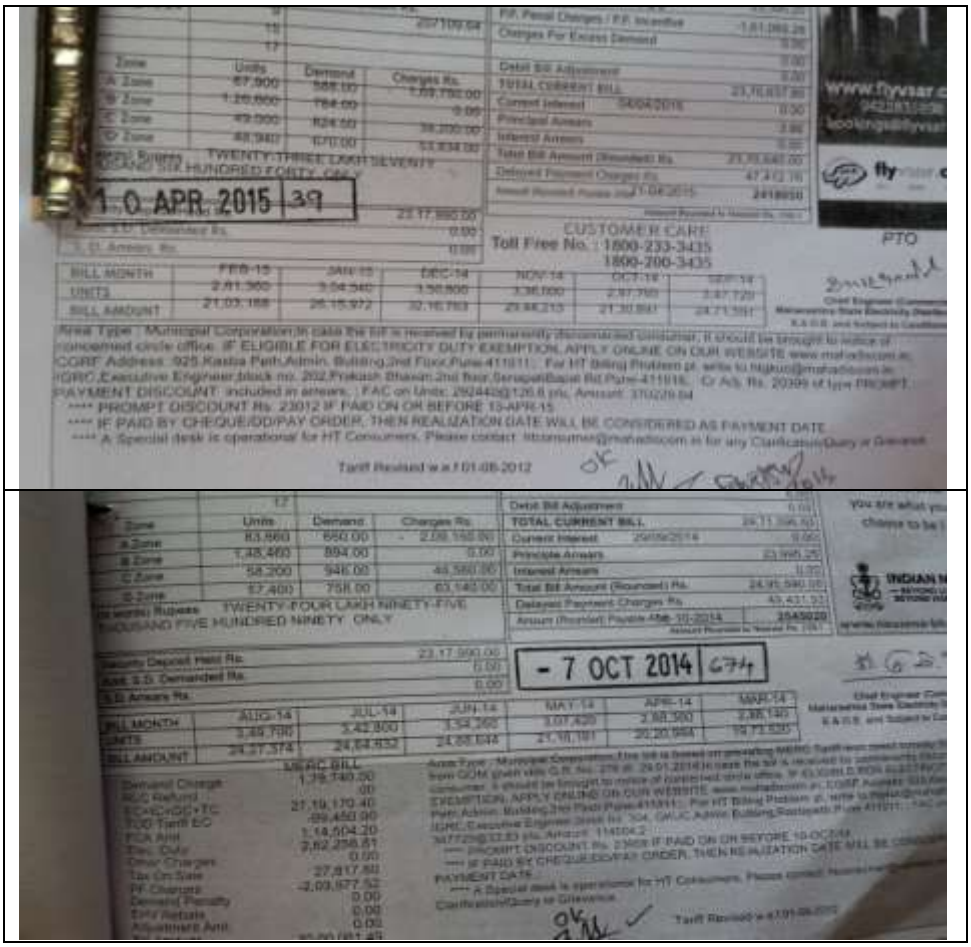
Executive summary

1) Electrical infrastructure is very old and its certain components are obsolete. This needs to be replaced in a planed manner including all major panels.
2) 3 x 500 KVA transformers need “Factory overhauling” to address oil leakage and other related issues. This may be done by disconnecting one transformer at a time. We advice this should be done before increasing the load through expansion. Transformer 1 is overloaded. You may shift one compressor on transformer 3.
3) 1 x 3 HT outdoor infrastructure needs thorough maintenance and replacement of all vital components used, to ensure plant operation without interruption and to safe guard transformers. You have option of 1 x 3 – 22KV indoor substation with GIS switch gear. This will save lot of outdoor space, which can be used productively. In addition to that the plant may not face any uncertainty for next 20 / 25years.
4) Outdoor substation earthing is not good at all and needs new earthing pits using advanced earthing technology which needs to be connected through strips to various components on pole.
5) LT panels are also very old and the spares may not be available. These panels also need phased replacement.
6) The cables which are more than 20years OLD need to be checked for leakage. Cable cross section for current requirement is adequate in almost all the cases. One has to see whether sufficient cable lengths are available while re termination with existing panels to avoid loose contacts or with new panels whenever they are replaced.
7) Infrared Thermography checking has revelled more than 60 problems with temperatures ranging from 60 Deg C to 200 Deg C. These loose contacts exist even on HT side. Apart from fire hazard, this could result into serious power quality issues and malfunctioning of sensitive machinery. This is an indicator of poor preventive maintenance.
8) Plant should have well designed preventive maintenance schedule and necessary shutdowns should be made available for such maintenance. Such scheduled shutdowns will result into zero abrupt shutdowns and associated loss of production.
9) The nature of load will be nonlinear always, so it is recommended that whenever APFC panels are changed, they should be replaced with detuned

thyristor switched filters. This will avoid harmonic amplification and will improve power quality.

Electrical Infrastructure

Spaco Technologies receives 22KV HT from MSEDCL through an overhead TAP OFF situated just outside the premises. With any protection or isolation the HT cable is received in metering cubical. The output of this cubical is taken at approximately 200mtrs and on an outdoor pole structure, where 1 x 3 – 22KV distribution is arranged through 4 numbers of LA – GOD – DO arrangement. The output TAP OFFs supply 3 x 500KVA – 22KV/ 433V transformers. LT side of these transformers feed various shops through LT distribution panels.



These are photographs of MSEDCL bills.

From March 14 to Feb 15, 354000Kwh is maximum consumption.

With 22hours per day and 22 days in a month, this suggests average consumption of 750KW.

The contract demand is 1130KVA and MD recorded is around 950KVA.

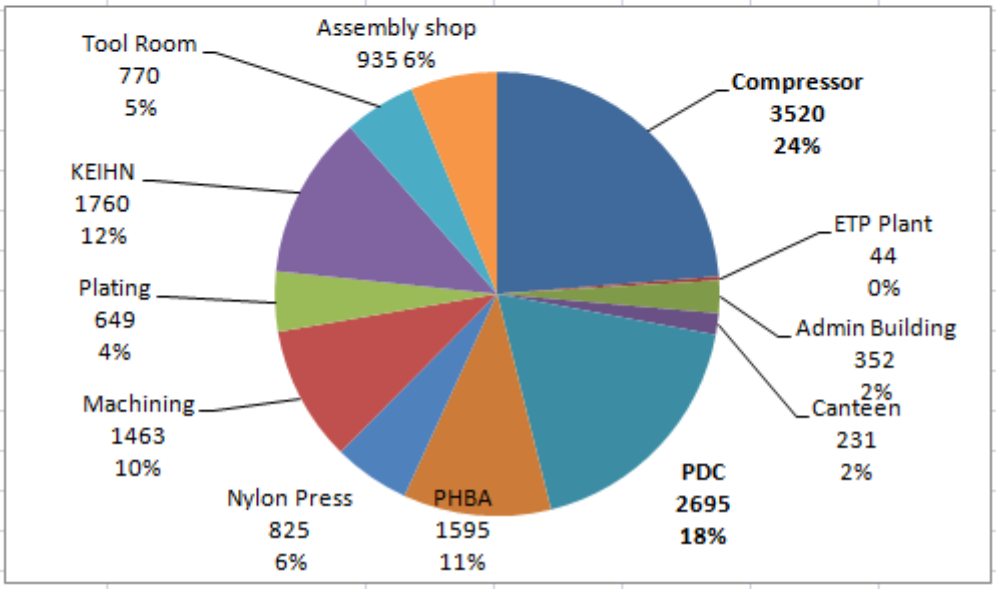
- Total electrical infrastructure appears to be very old and has not received required preventive maintenance.
- Infrared thermography carried out revelled over 60 loses contacts from HT to downstream LT distribution. The lose contact temperatures were ranging from 80Deg C to over 200Deg C.
- Outdoor HT earthing indicated protective earthing to be over 45 ohms at most of the places. Except transformer neutral earth. This may be the cause for lot of issues.
- HT side DO s are replaced by fuse wire and required tension (to avoid lose contact) is maintained by stones hanging to fuse wirer. This is a high risk area.
- Other parts of the structure appear to be rusted and needs repairs / replacement.
- The setup experienced two leaky LAs in past one week, calling for LA failure and HT side bulk tripping halting entire plant operations along with some other nearby units working on same 22KV feeder.
- As per the data recorded, transformer 1 appears to be over loaded and other two are loaded less than 50%.
- At present each transformer has independent APFC panel. These panels are in working condition and are maintaining power factor close to unity.
- It is also observed that about 200KW load is related to compressors which are working on transformer 1 along with other PDC Load. This may be split within other transformers, so that Transformer 1 will not get overloaded.
- All transformers at present are handling about 15 to 20% current harmonic distortion; however voltage distortion is within limit.

Recorded Parameters at a Glance

Feeder	THDV %	Amps	THDI %	KW	AVG KW	KVAR	Load Type
TX 1							
Total	4%	115 - 880	10 - 30%	100 - 500		+ / - 50	
Screw Compressor	3%	90 - 160	4 - 8%	55 - 90	72.5	60	Linear
New Compressor	3%	160	40 - 50%	80 - 95	87.5	50	VFD
PDC Hot Chember	2.80%	40 - 150	7.5 -22%	10 - 100	55	40	Non Linear
PDC Cold Chember	2.80%	100 - 120	2.50%	60 - 75	67.5	30	Linear
LT Room	2.60%	9	5%	4.25	4.25	2.8	Linear
KEIHN	3%	100 - 225	6 - 8%	60 - 100	80	70	Linear
					366.75		
TX 2							
Total	**1.60%**	**50 - 400**	**5 - 17%**	**100 - 175**		**+/- 50**	
Tool Room	3.50%	40 - 80	2 - 10%	25 - 45	35	25	Linear
Plating	1.50%	45 - 70	5.50%	22 - 37	29.5	25	Linear
Nylon Press	1.50%	40 - 100	3.50%	30 - 45	37.5	25	Linear
Machine shop	1.60%	55 - 100	5%	27 - 42	34.5	45	Linear
ETP Plant	2.50%	4.5	4%	2	2	1.2	Linear
Compressor	1.20%	135 - 150	2.50%	82	82	50	Linear
Canteen	3%	12 - 32	7.50%	8 - 13	10.50	7	Linear
Assembly shop	1.50%	65 - 120	4 - 10%	40 - 45	42.5	45	Linear
					273.5		
TX 3							
Total	1.60%	100 - 275	5 - 15%	20 - 140		+ / - 20	
Scansys Dynamo	1.20%			0.075			
PHBA	1.50%	100 - 250	2 - 5.5%	65 - 80	72.5	100	Linear
Auto - CNC	1.50%	80	2 - 5%	32	32	40	Linear
Admin Building	1.40%	45	25%	16	16	7	Linear
					120.5		

Section wise energy consumption

Load	KW	Kwh/day	Rs./Day
Compressor	160	3520	24640
ETP Plant	2	44	308
Admin Building	16	352	2464
Canteen	10.50	231	1617
PDC	122.5	2695	18865
PHBA	72.5	1595	11165
Nylon Press	37.5	825	5775
Machining	66.5	1463	10241
Plating	29.5	649	4543
KEIHN	80	1760	12320
Tool Room	35	770	5390
Assembly shop	42.5	935	6545
Total	**674.5**	**14839**	**103873**



- **At Spaco, daily cost of electrical energy is around Rs.1Lac.**
- 25% of this is spent on compressed air, while 18% is spent on PDC operation. PDC section consumes PNG for aluminium and zinc melting.
- Accounting for this, top two energy consuming sections would be PDC and Compressed air.
- Any energy saving projects must run in these two sections to give noticeable impact.
- Plant runs in three shifts. So illumination load also must be substantial. You may think about energy efficient light fittings like LED's and induction lamps as per application areas.

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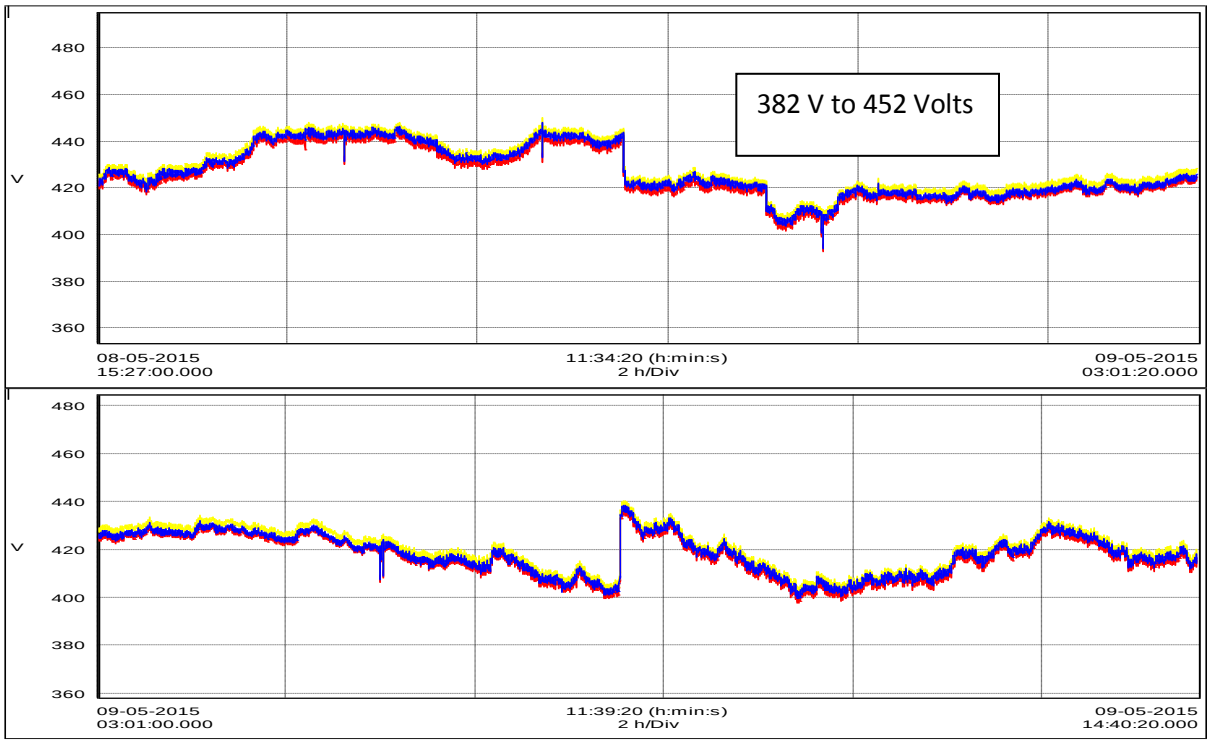
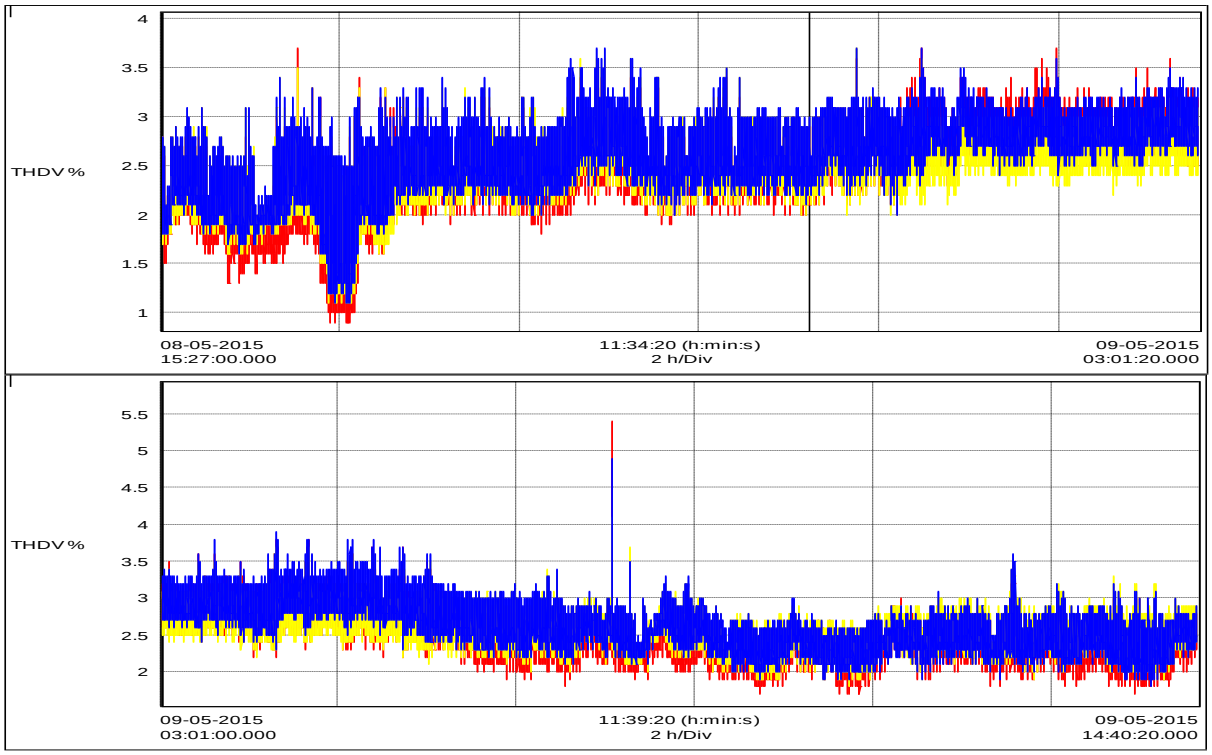
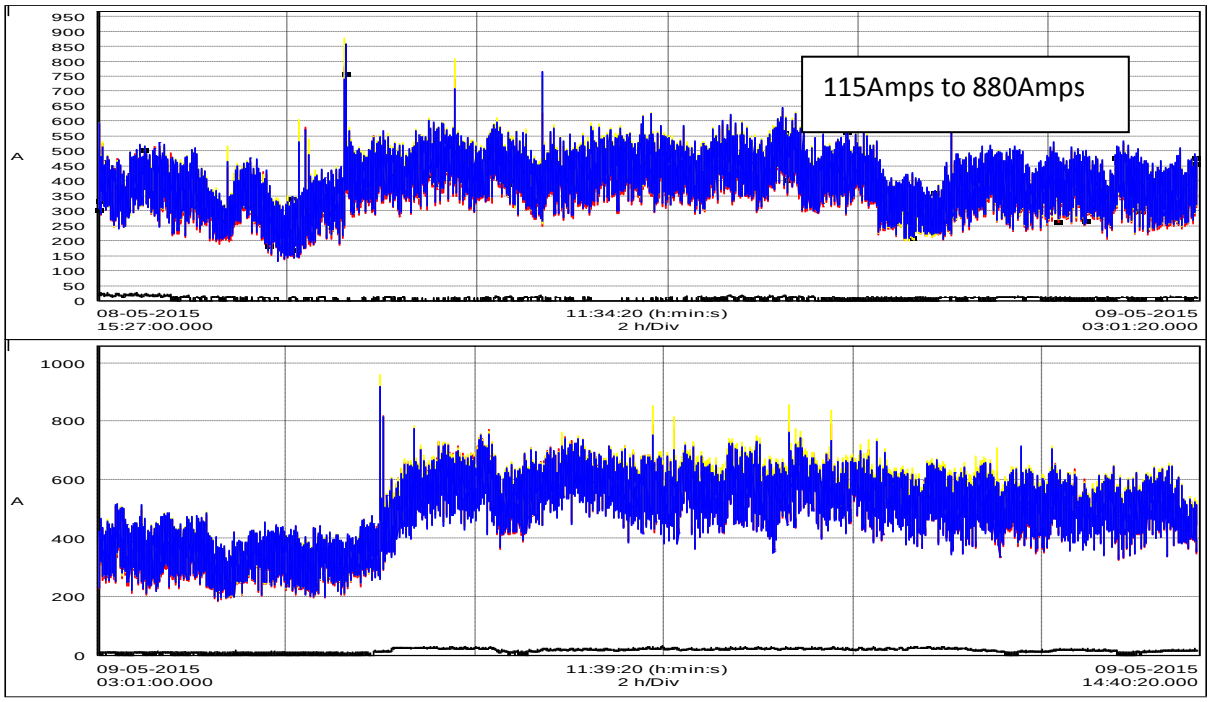
Load pattern recording for three transformers.

Transformer 1 (PDC)






115Amps to 880Amps
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750
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650
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550
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450
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350
300
250
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150
100
50
0
08-05-2015
15:27:00.000
11:34:20 (h:min:s)
2 h/Div
09-05-2015
03:01:20.000
A
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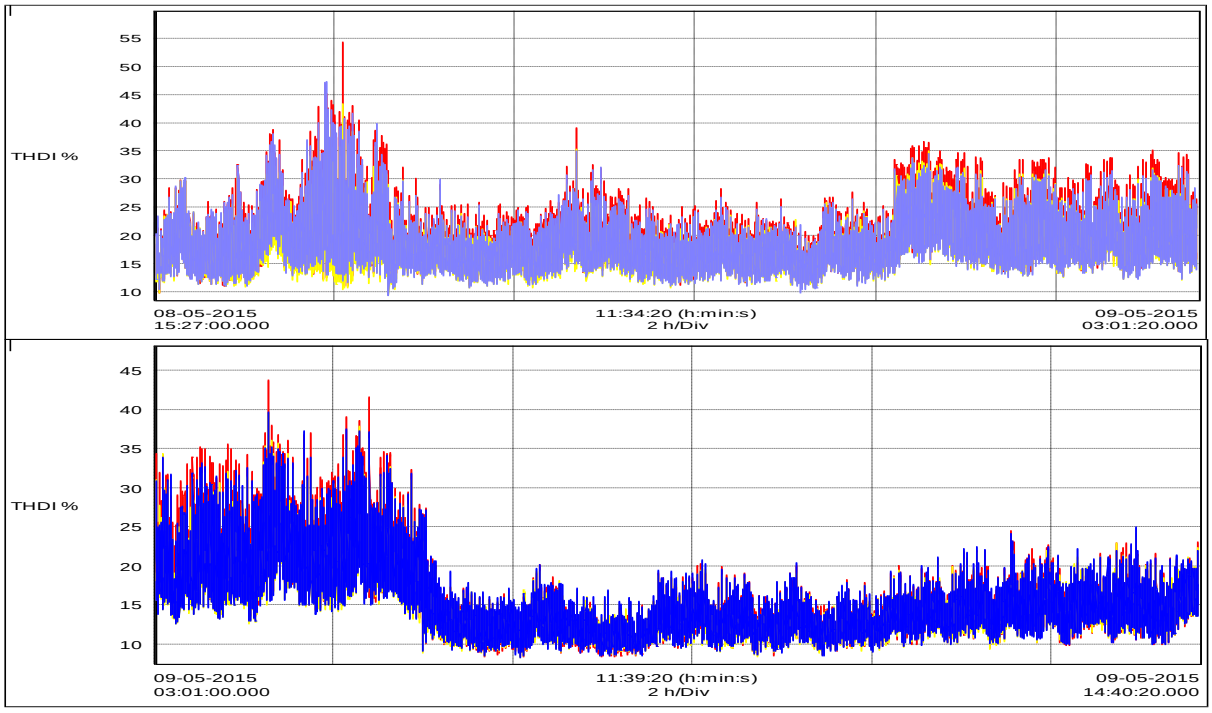
2 h/Div
09-05-2015
14:40:20.000


THDI %
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11:34:20 (h:min:s)
2 h/Div
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03:01:20.000
THDI %
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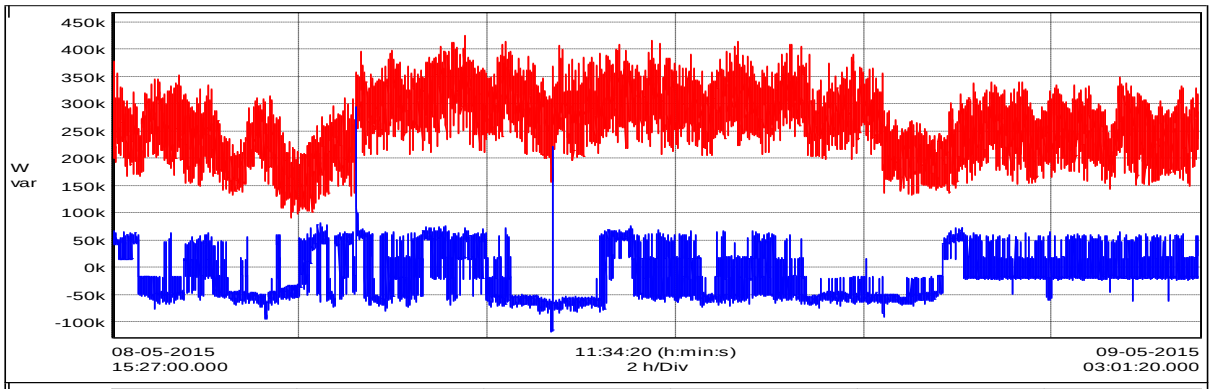
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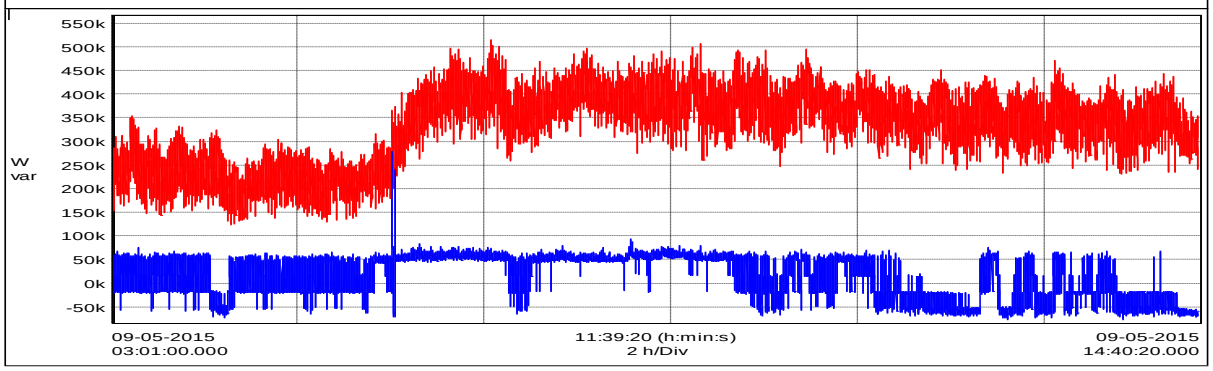
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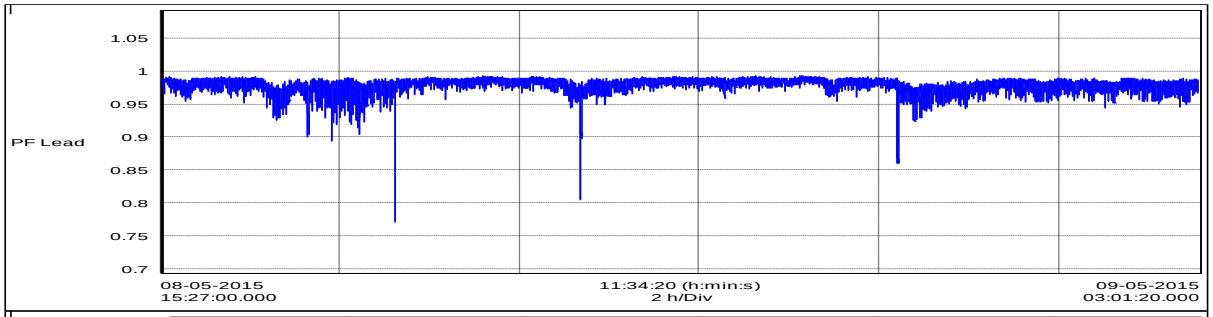
PF Lead
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0.85
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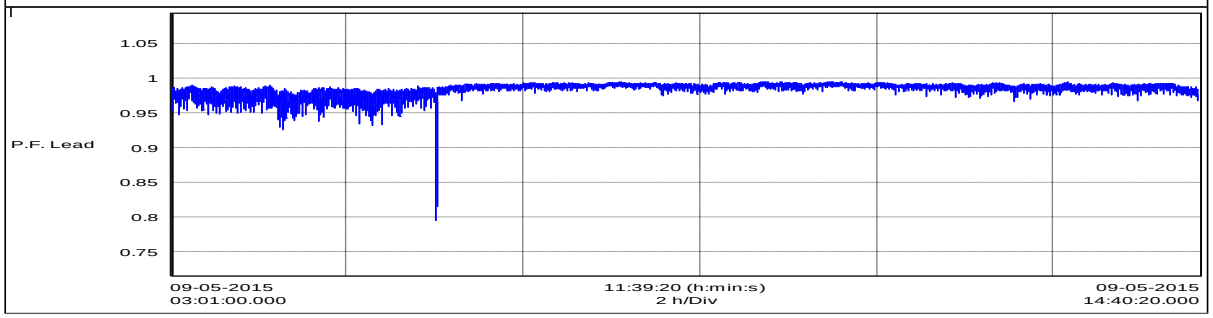
P.F. Lead
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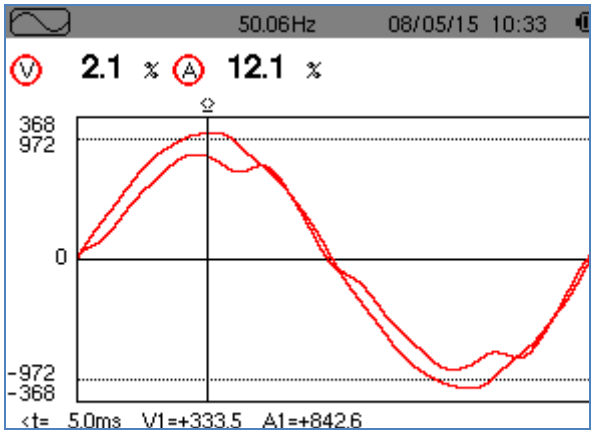
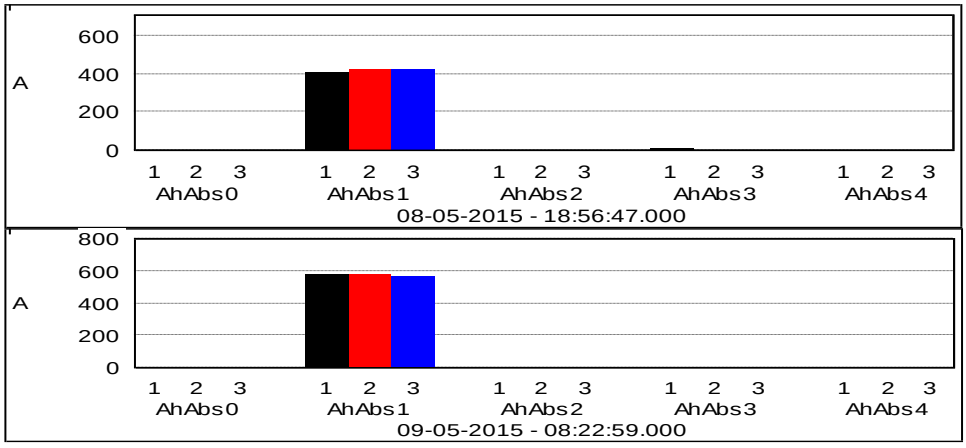

50.06Hz
08/05/15 10:33
2.1 %
12.1 %
368
972
0
-972
-368
<t= 5.0ms V1=+333.5 A1=+842.6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AhAbs1
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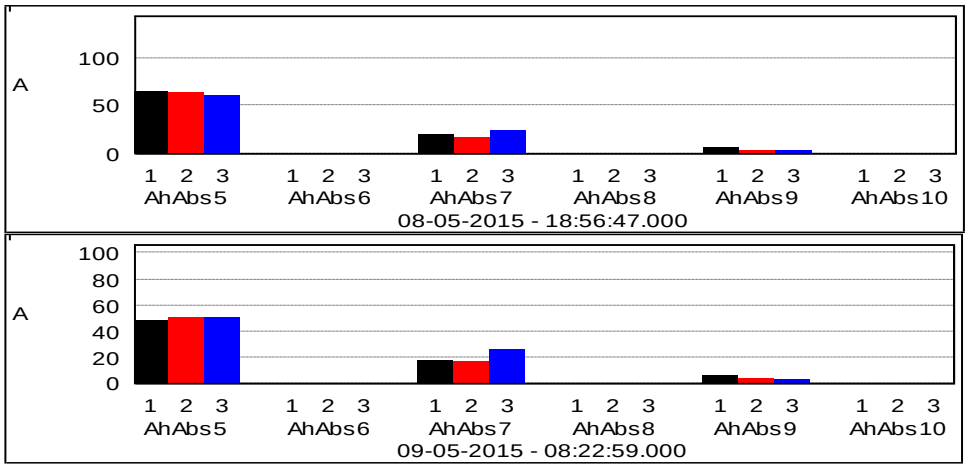
09-05-2015 - 08:22:59.000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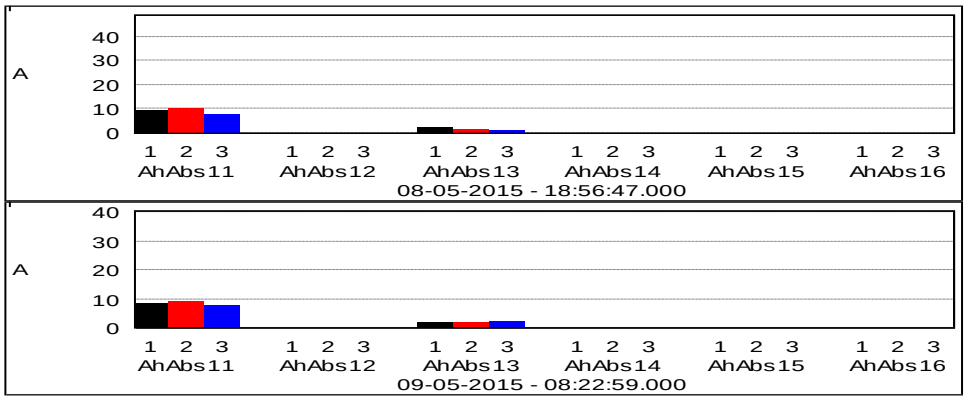
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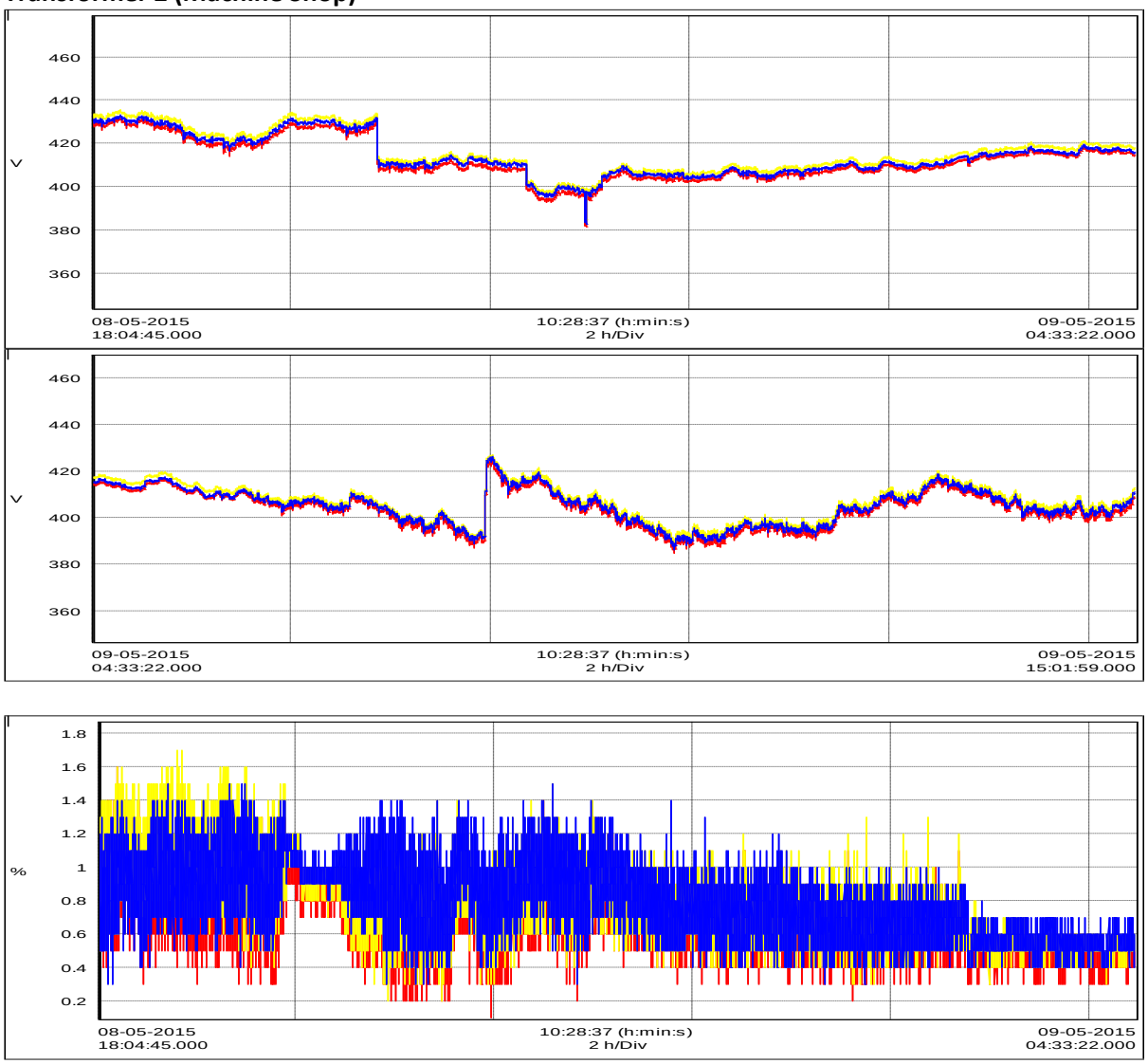
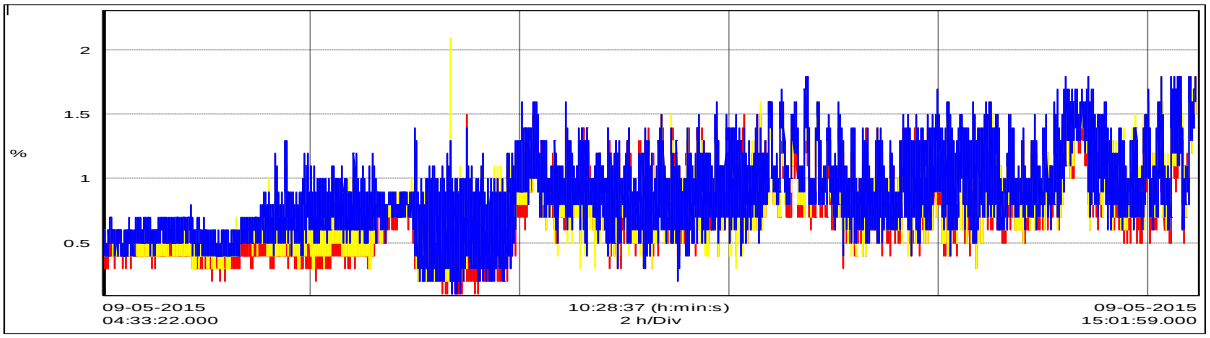
09-05-2015 - 08:22:59.000

Observations:

1) Voltage remains within 400V to 450V RMS with tap-changer upstream. Voltage harmonic distortion is less than 3.5%. These readings are recorded continuously over 24 hours with each reading collected at 1 sec interval. Frequency is stable at around 50Hz.
2) This 500KVA transformer handles about 750Amps current and the same is distorted at 25%. So effective current can be considered as 900Amps. Effective Peak power delivery with these parameters is over 600 KVA. This transformer is clearly overloaded. Most of the time actual RMS wattage handled by this transformer is also almost 450KW.
3) The APFC panel maintains reactive power correction to -50KVAR level always. Harmonic analysis shows predominance of 5^{th} and 7^{th} harmonic currents. Reflected HT side current harmonics may be slightly less.

Transformer 2 (Machine Shop)




%
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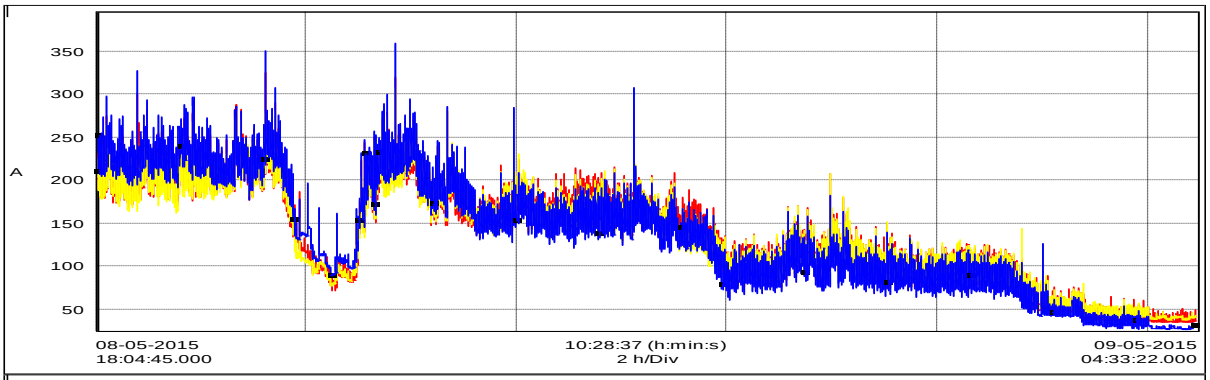
2 h/Div
09-05-2015
15:01:59.000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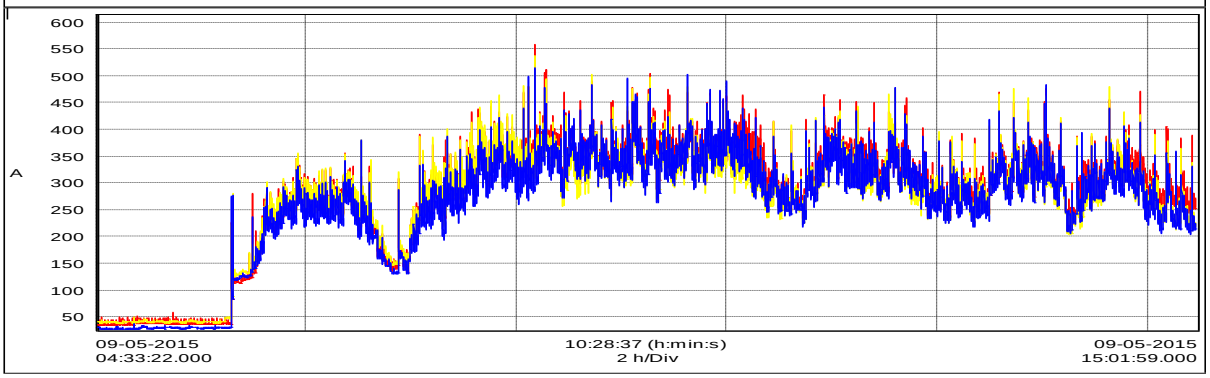
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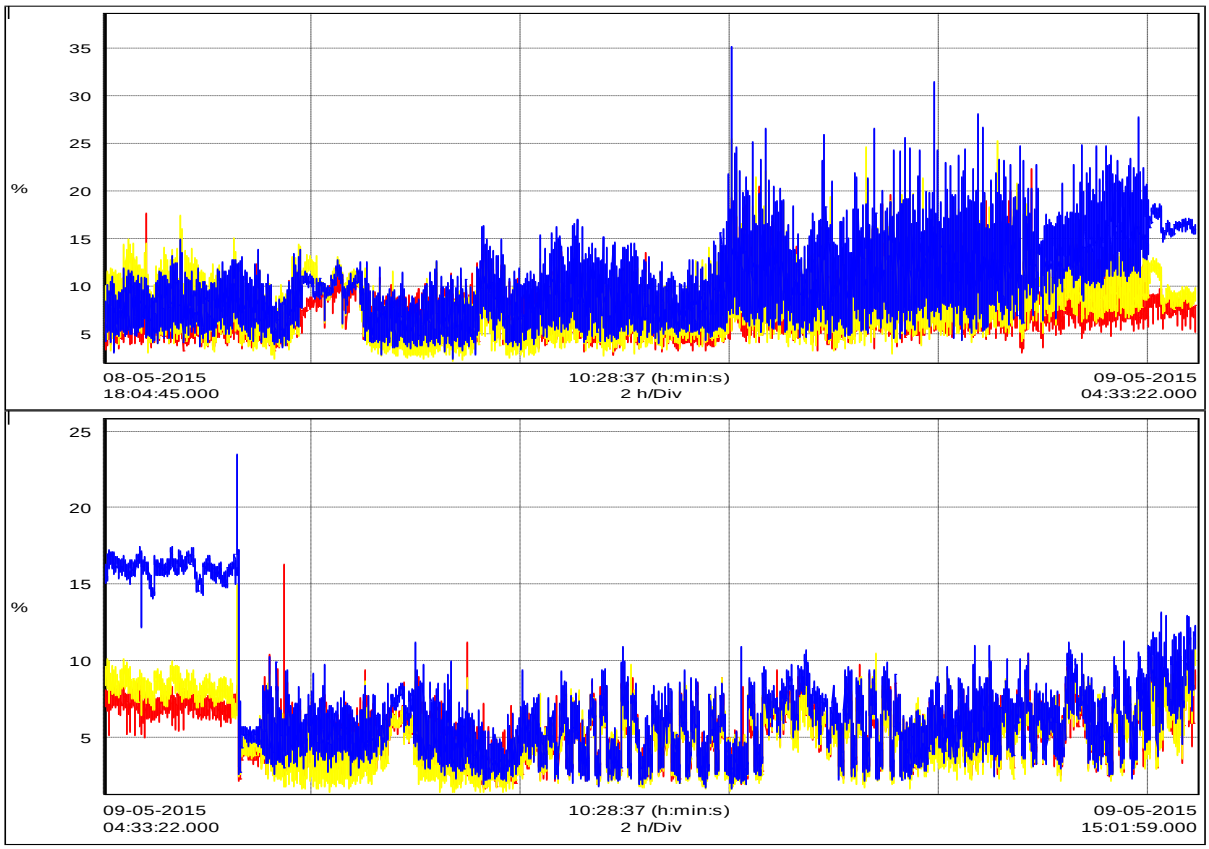
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04:33:22.000
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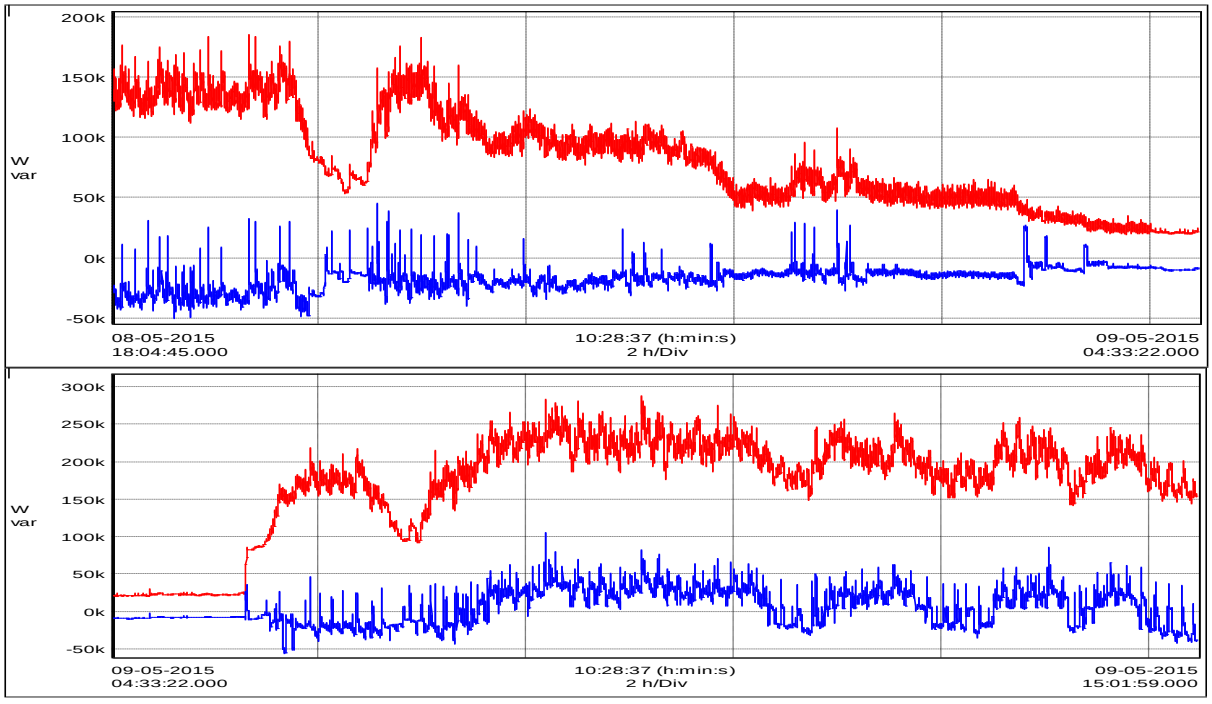
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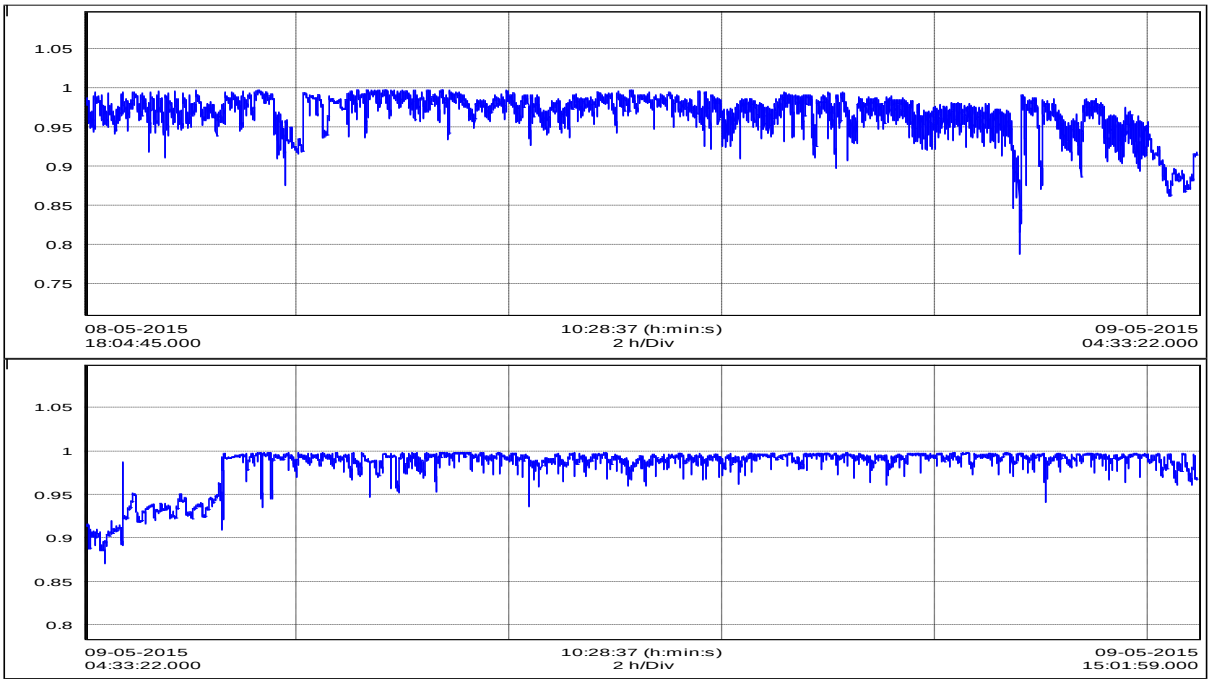
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18:04:45.000
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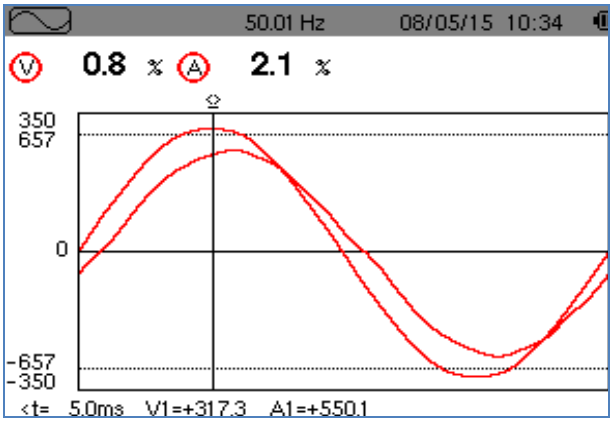
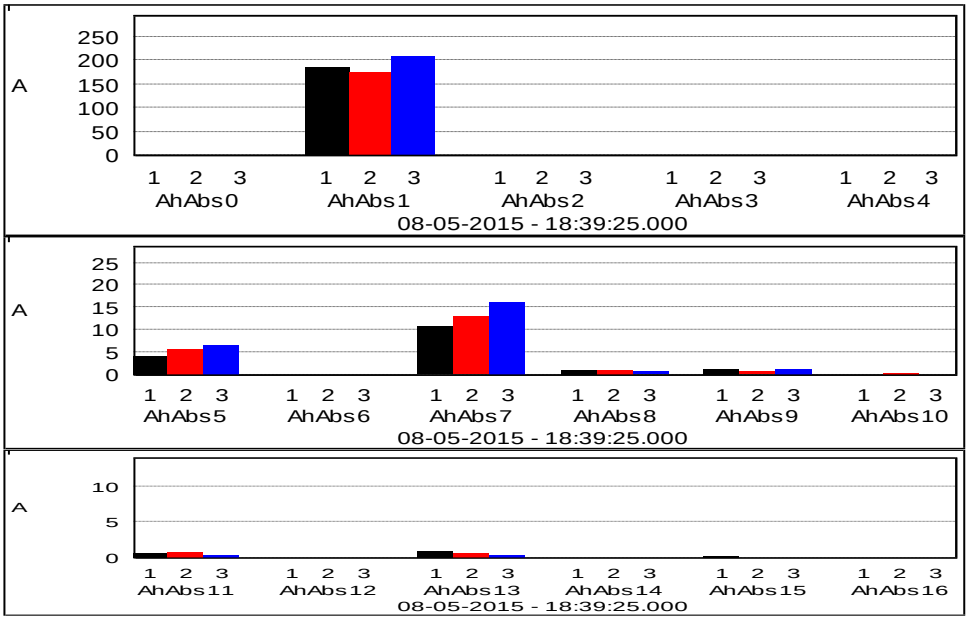
15:01:59.000


50.01 Hz
08/05/15 10:34
0.8 %
2.1 %
350
657
0
-657
-350
<t= 5.0ms V1=+317.3 A1=+550.1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08-05-2015 - 18:39:25.000
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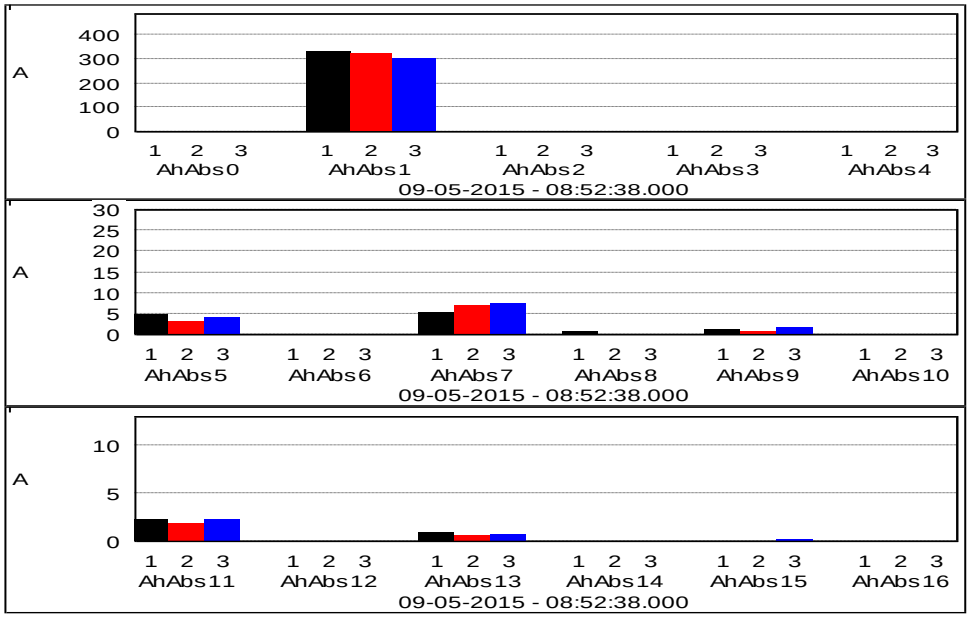
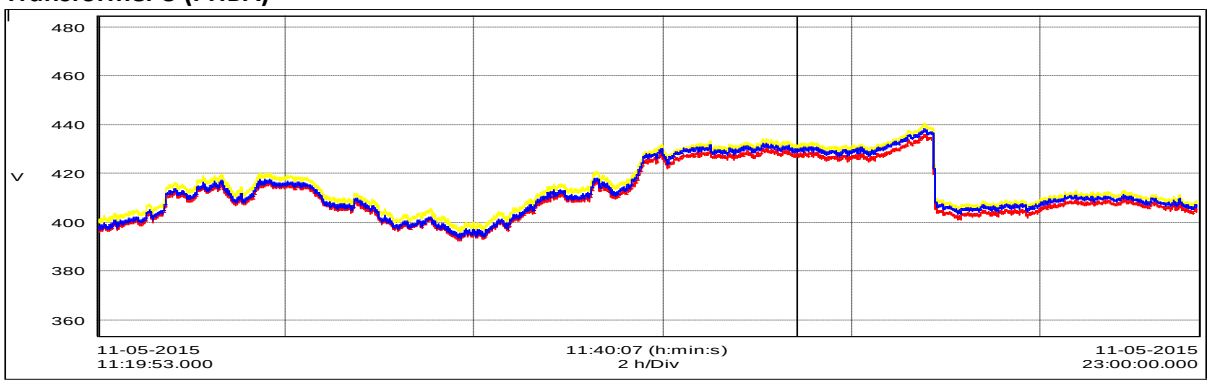
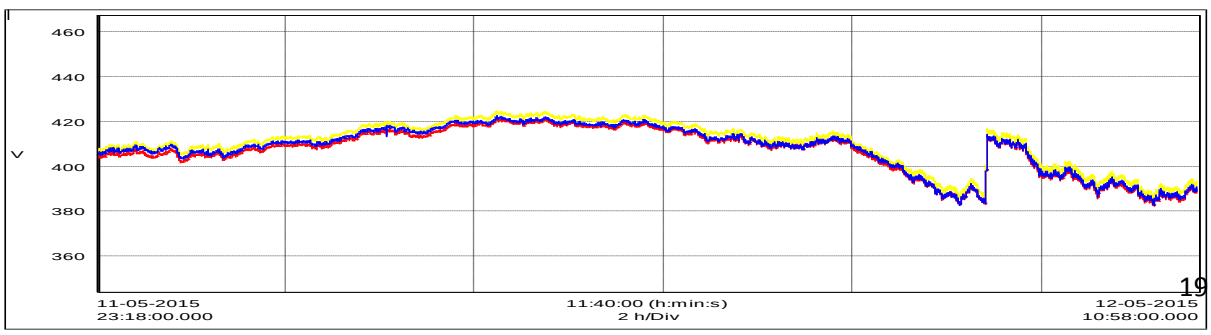


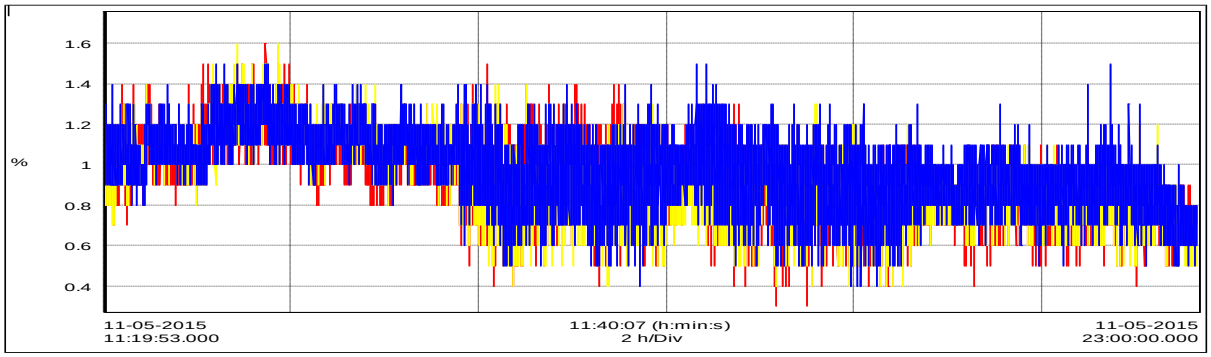
Observations:

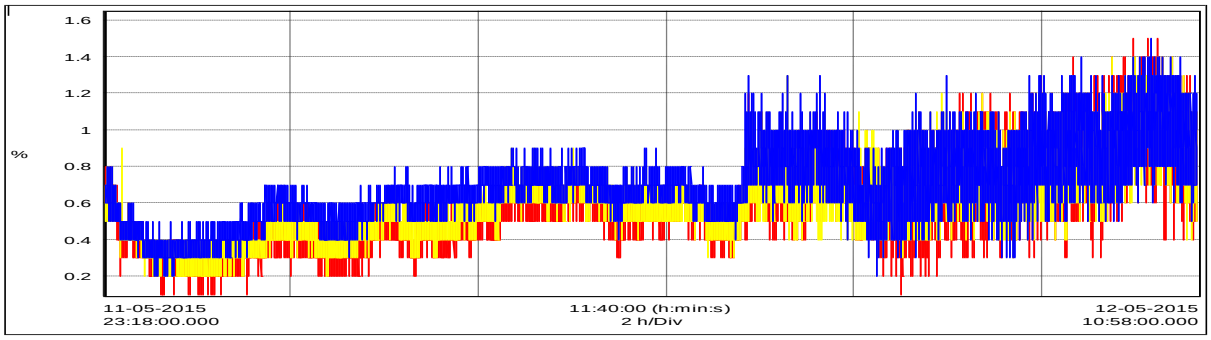
1) Voltage remains within 390V to 430V RMS with tap-changer upstream. Voltage harmonic distortion is less than 1.7%. These readings are recorded continuously over 24 hours with each reading collected at 1 sec interval. Frequency is stable at around 50Hz.
2) This 500KVA transformer handles about 450Amps current and the same is distorted at 17%. So effective current can be considered as 600Amps. Effective Peak power delivery with these parameters is over 450 KVA.. Most of the time actual RMS wattage handled by this transformer is also almost 250KW.
3) The APFC panel maintains reactive power correction within + / -50KVAR level always. Harmonic analysis shows predominance of 5^{th} and 7^{th} harmonic currents. Reflected HT side current harmonics may be slightly less.

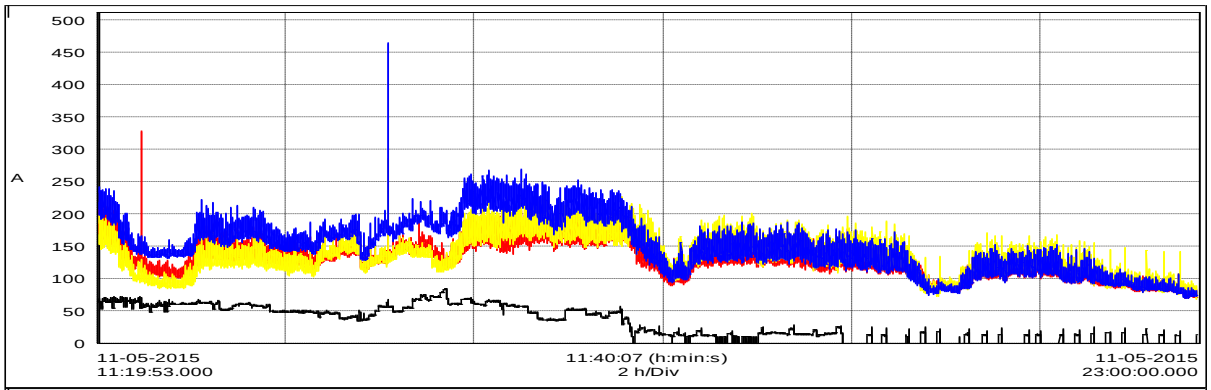
Transformer 3 (PHBA)

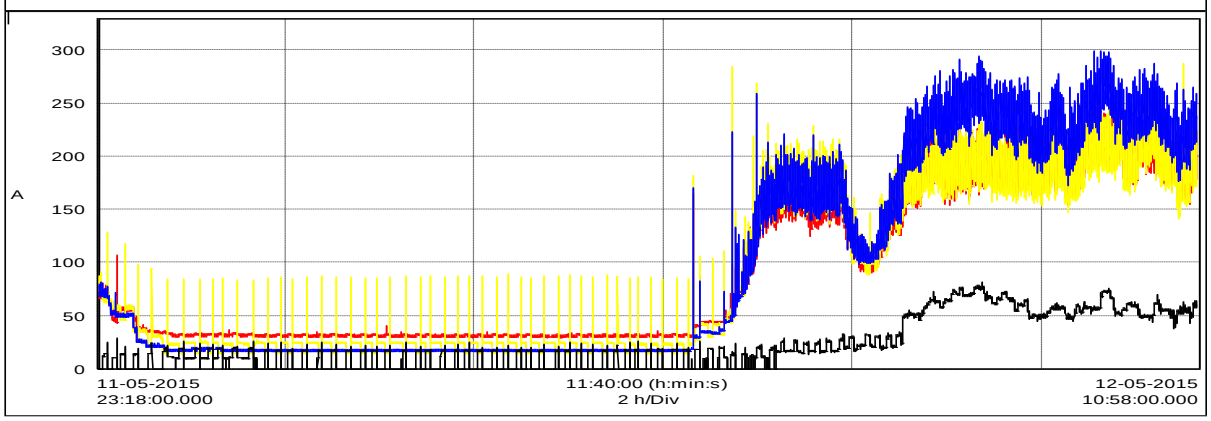


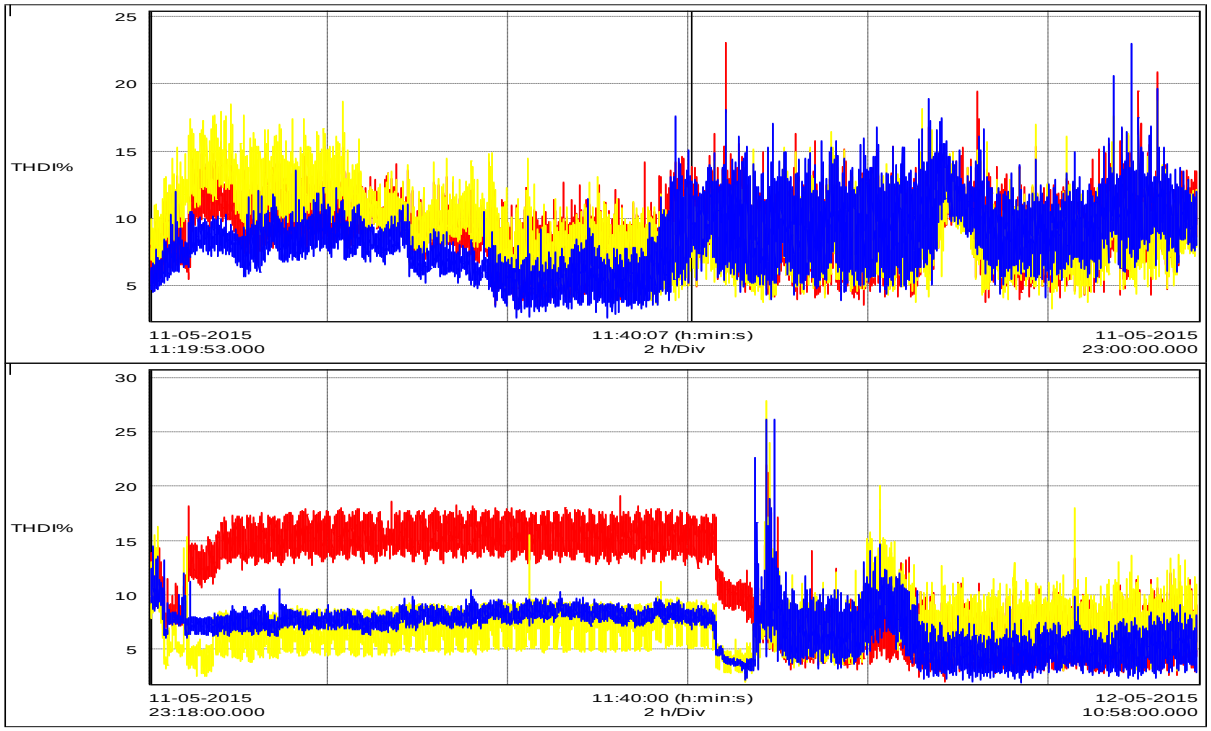


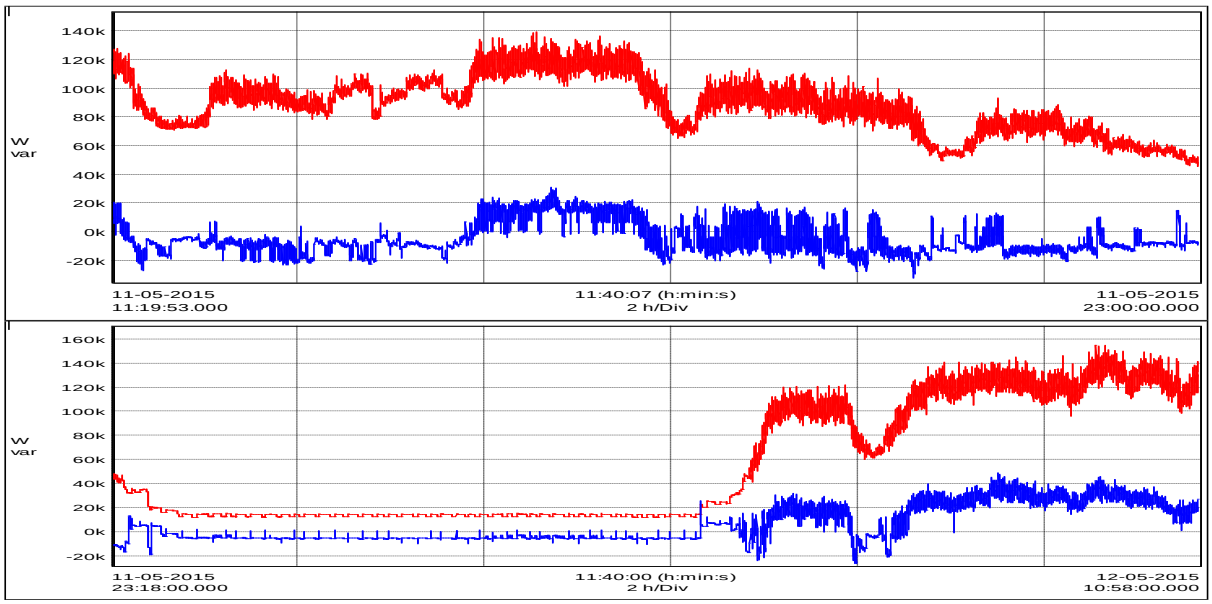

%
1.6
1.4
1.2
1
0.8
0.6
0.4
11-05-2015
11:19:53.000
11:40:07 (h:min:s)
2 h/Div
11-05-2015
23:00:00.000

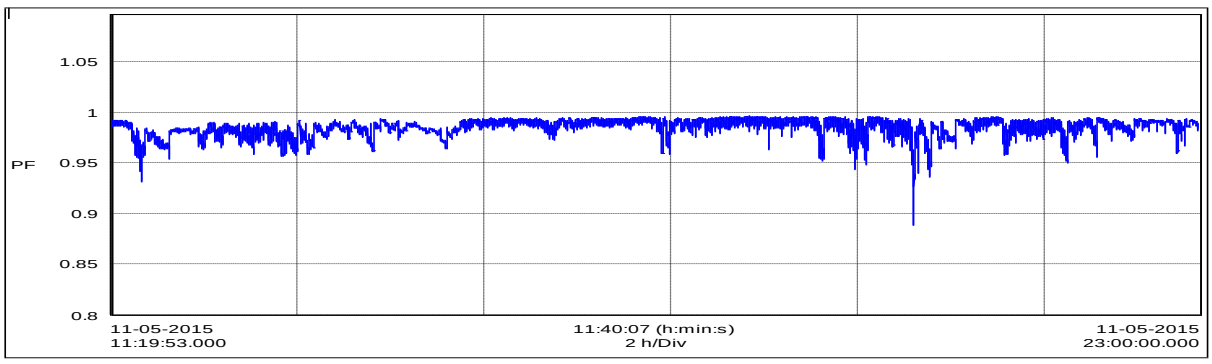

%
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
11-05-2015
23:18:00.000
11:40:00 (h:min:s)
2 h/Div
12-05-2015
10:58:00.000

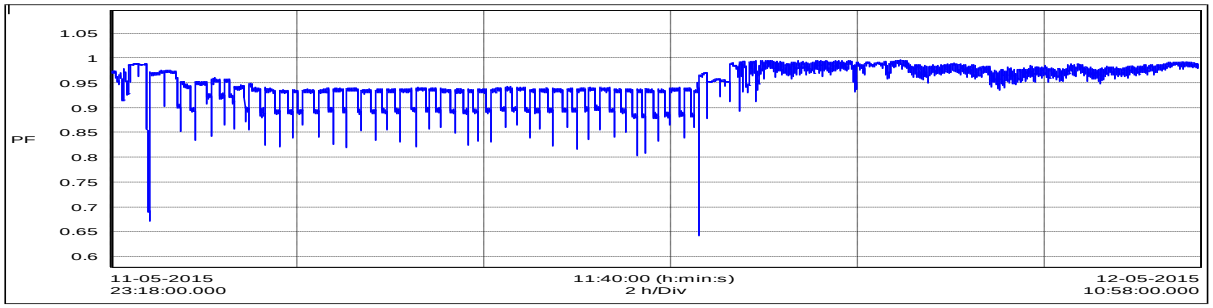

A
500
450
400
350
300
250
200
150
100
50
0
11-05-2015
11:19:53.000
11:40:07 (h:min:s)
2 h/Div
11-05-2015
23:00:00.000

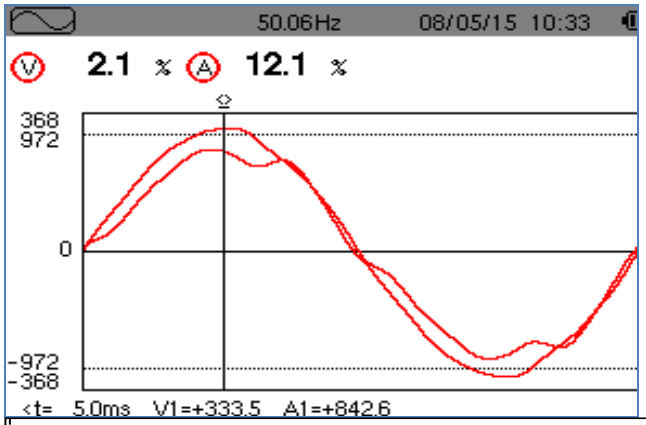

A
300
250
200
150
100
50
0
11-05-2015
23:18:00.000
11:40:00 (h:min:s)
2 h/Div
12-05-2015
10:58:00.000

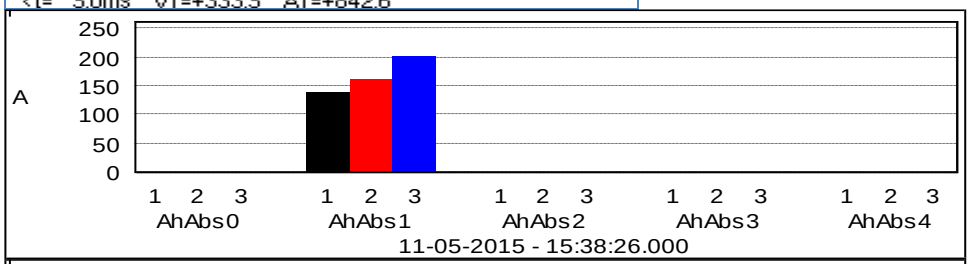

THDI%
25
20
15
10
5
11-05-2015
11:19:53.000
11:40:07 (h:min:s)
2 h/Div
11-05-2015
23:00:00.000
THDI%
30
25
20
15
10
5
11-05-2015
23:18:00.000
11:40:00 (h:min:s)
2 h/Div
12-05-2015
10:58:00.000

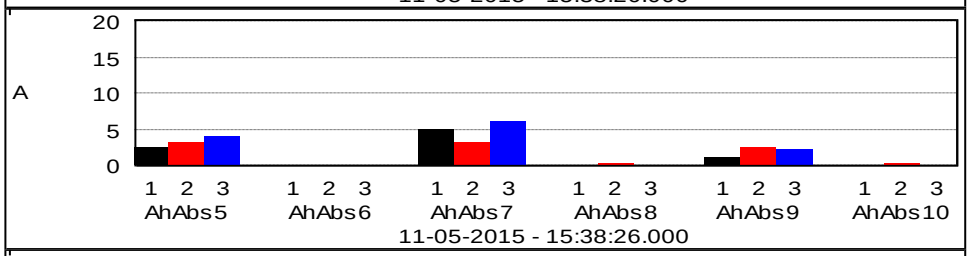

W
var
140k
120k
100k
80k
60k
40k
20k
0k
-20k
11-05-2015
11:19:53.000
11:40:07 (h:min:s)
2 h/Div
11-05-2015
23:00:00.000
W
var
160k
140k
120k
100k
80k
60k
40k
20k
0k
-20k
11-05-2015
23:18:00.000
11:40:00 (h:min:s)
2 h/Div
12-05-2015
10:58:00.000

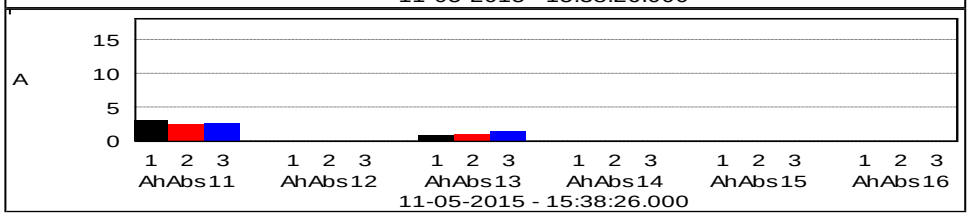

PF
1.05
1
0.95
0.9
0.85
0.8
11-05-2015
11:19:53.000
11:40:07 (h:min:s)
2 h/Div
11-05-2015
23:00:00.000

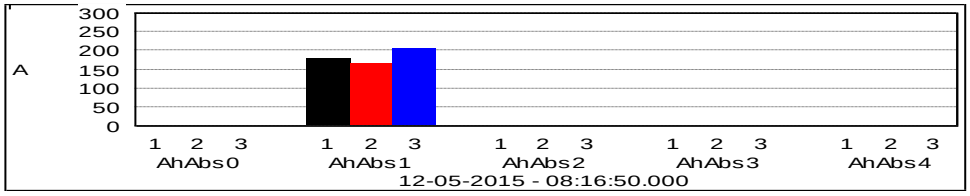

PF
1.05
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
11-05-2015
23:18:00.000
11:40:00 (h:min:s)
2 h/Div
12-05-2015
10:58:00.000

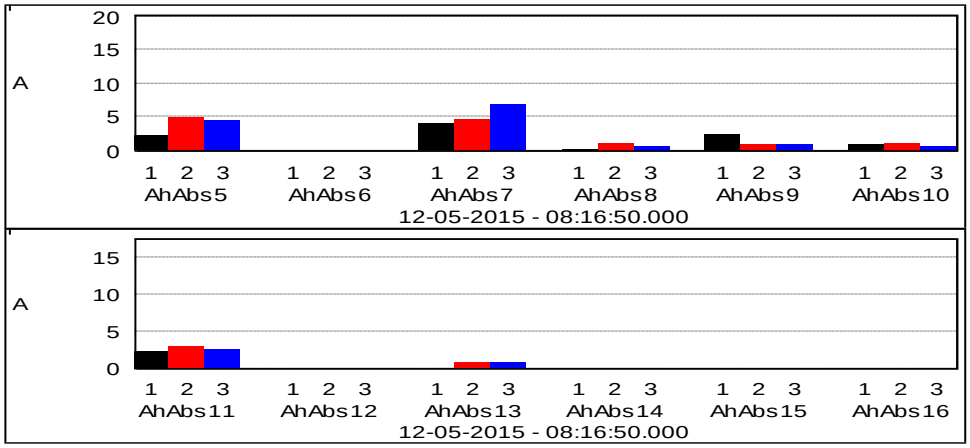

50.06Hz
08/05/15 10:33
V
2.1 %
A
12.1 %
368
972
0
-972
-368
<t= 5.0ms V1=+333.5 A1=+842.6


A
250
200
150
100
50
0
1 2 3
AhAbs0
AhAbs1
AhAbs2
AhAbs3
AhAbs4
11-05-2015 - 15:38:26.000


A
20
15
10
5
0
1 2 3
AhAbs5
AhAbs6
AhAbs7
AhAbs8
AhAbs9
AhAbs10
11-05-2015 - 15:38:26.000


A
15
10
5
0
1 2 3
AhAbs11
AhAbs12
AhAbs13
AhAbs14
AhAbs15
AhAbs16
11-05-2015 - 15:38:26.000


A
300
250
200
150
100
50
0
1 2 3
AhAbs0
AhAbs1
AhAbs2
AhAbs3
AhAbs4
12-05-2015 - 08:16:50.000



Observations:

1) Voltage remains within 380V to 440V RMS with tap-changer upstream. Voltage harmonic distortion is less than 1.6 %. These readings are recorded continuously over 24 hours with each reading collected at 1 sec interval. Frequency is stable at around 50Hz.
2) This 500KVA transformer handles about 300Amps current and the same is distorted at 15%. So effective current can be considered as 450 Amps. Effective Peak power delivery with these parameters is over 350 KVA. Most of the time actual RMS wattage handled by this transformer is also almost 150 KW.
3) The APFC panel maintains reactive power correction to -50KVAR level always. Harmonic analysis shows predominance of 5^{th} and 7^{th} harmonic currents. Reflected HT side current harmonics may be slightly less.

Cable Validation For All Mejor Cables					
Sr.No	**Transformer 1 (PDC)**	**Current Avg.A**	**Current Max. A**	**Current Harmonics %**	**Cable**
1)	Main Incomer	580	707	17.1	400sq/3.5/AL/3
2)	New Compressor	146	157	53.7	240sq/3.5/AL/1
3)	LT Room	8	9	5.8	50sq/3.5/AL/1
4)	PDC Hot Chamber	99	185	33.6	300sq/3.5/AL/1
5)	KEIHIN (Davenport)	172	240	11.7	300sq/3.5/AL/2
6)	Screw Compressor	141	156	9.2	300sq/3.5/AL/1
7)	APFC Panel	147	156	12	400sq/3.5/AL/1
8)	PDC Cold Chamber	93	117	10	240sq/3.5/AL/1
9)	Dynamo1	NA	NA	NA	95sq/3.5/AL/1
10)	Scansys2	NA	NA	NA	70sq/3.4/AL/2
Sr.No	**Transformer 2 (Machine Shop)**	**Current Avg.A**	**Current Max. A**	**Current Harmonics %**	**Cable**
1)	Main Incomer	382	457	20.1	400sq/3.5/AL/3
2)	Canteen	29	29	7.6	240sq/3.5/AL/1
3)	Machine Shop	74	99	10.1	240sq/3.5/AL/1
4)	Tool Room	68	88	11.1	240sq/3.5/AL/1
5)	Plating	56	67	5.5	300sq/3.5/AL/1
6)	Assembly Shop	94	106	17	240sq/3.5/AL/1
7)	ETP Plant	4	5	4.1	70sq/3.4/AL/1
8)	APFC Panel	123	126	33.1	400sq/3.5/AL/1
9)	Nylon Press	68	144	3.4	240sq/3.5/AL/1
10)	Compressor	140	142	2.8	300sq/3.5/AL/1
Sr.No	**Transformer 2 (PHBA)**	**Current Avg.A**	**Current Max. A**	**Current Harmonics %**	**Cable**
1)	Main Incomer	230	259	12.2	400sq/3.5/AL/2
2)	Scansys + Dynamo 2	0.15	0.16	49.3	70sq/3.4/AL/1
3)	PHBA	193	224	9.4	240sq/3.5/AL/2
4)	Auto CNC	75	128	8.2	240sq/3.5/AL/1
5)	Admin Building	36	41	25.3	240sq/3.5/AL/1
6)	APFC Panel	187	188	11.6	400sq/3.5/AL/1

Observations

This survey shows that all the cables are adequate for the current they are carrying. The issue is whether their insulation is up to the mark, and for any further modification in electrical system, whether the cable lengths are sufficient for re termination. This may be assessed after the replacement budget and schedule is finalized.

At present terminations as shown in IR Thermography report need to be attended immediately to avoid loose contact and possible flashovers.

Switchgear Validation For All Mejor Breakers				
Sr.No	**Transformer 1 (PDC)**	**Current Avg.A**	**Current Max. A**	**Switchgear Rating**
1)	Main Incomer	580	707	1000 A
2)	New Compressor	146	157	400 A
3)	LT Room	8	9	63 A
4)	PDC Hot Chamber	99	185	400 A
5)	KEIHIN (Davenport)	172	240	250 A
6)	Screw Compressor	141	156	400 A
7)	APFC Panel	147	156	400 A
8)	PDC Cold Chamber	93	117	250 A
9)	Dynamo1	NA	NA	250 A
10)	Scansys2	NA	NA	250A
Sr.No	**Transformer 2 (Machine Shop)**	**Current Avg.A**	**Current Max. A**	**Switchgear Rating**
1)	Main Incomer	382	457	1000 A
2)	Canteen	29	29	200 A
3)	Machine Shop	74	99	200 A
4)	Tool Room	68	88	200 A
5)	Plating	56	67	200 A
6)	Assembly Shop	94	106	200 A
7)	ETP Plant	4	5	200 A
8)	APFC Panel	123	126	400 A
9)	Nylon Press	68	144	200 A
10)	Compressor	140	142	200 A
Sr.No	**Transformer 3 (PHBA)**	**Current Avg.A**	**Current Max. A**	**Switchgear Rating**
1)	Main Incomer	230	259	800 A
2)	Scansys + Dynamo 2	0.15	0.16	400 A
3)	PHBA	193	224	400 A
4)	Auto CNC	75	128	400 A
5)	Admin Building	36	41	400 A
6)	APFC Panel	187	188	400 A

Observations

As per above survey, all switchgear ratings are sufficient for the current they are handling. The major issue is in all main LT panels, most of the switches are Switch Fuse units and not MCBS. Most of them are individual change over switches. The panels have become complex as each feeder switch receives main and emergency supply and selects the available supply

for load manually. There are lot of bus-bar connections which facilitate such distribution. The spares for such switches may not be available now.

Few photographs of present situation in LT panels

Transformer Oil Leakage

Main cable termination in LT panels