



Case Study on Harmonics Mitigation in Newspaper Industry

Background

M/s Uttar Banga Sambad is a regional Bengali daily newspaper published in the state of West Bengal, India. The case study presents harmonic analysis at this newspaper printing press.

The printing press, a drive based system (both AC and DC drives) is the major load in the factory and the major source of harmonics. The problem experienced was high current harmonics i.e. about 36.8% and consequent voltage harmonics of about 9.5%. As a result the customer experienced a poor power factor, and frequent tripping of circuit breakers of capacitor bank (due to high VTHD) leading to loss of incentive from electricity board.

This case study is presented in 4 different parts followed by the conclusions. The four parts are as follows:

- 1. Harmonics study
- 2. Solution sizing
- 3. Harmonic Study post solution
- 4. Tariff System & Bill Comparison

Part I – Harmonic study.

The initial harmonic analysis results were as below.

- 1. Harmonic Analysis was carried out at main LV incomer of 500KVA 11KV/433 V transformer.
- 2. 140 kVAr APFC Panel is installed at site (without detuned reactor)
- 3. Harmonic levels with capacitors ON and OFF were recorded.
 - a. With APFC On: VTHD = 9.5% ; ITHD = 36 %
 - b. With APFC Off: VTHD = 8% ; ITHD = 22 %

Analysis with APFC Panel ON

The following figures are of harmonic study with APFC panel ON.









5th and 7th harmonic are dominant due to AC Drives & 11th harmonic is dominant due to the presence of DC drives



From Figure 6 that the displacement power factor is 0.944 and the true power factor is 0.882. (True PF = Displacement PF X Distortion PF). In this case harmonics are responsible for low distortion PF leading to lower value of true PF

Considering observed harmonic level, it was decided to install AHF at site. Sizing decisions were done as follows

Part II – AHF sizing and installation

The summary of the conducted harmonic study prior to AHF installation is as follows:

- 1. Max Load Current during survey=520A
- 2. Maximum Load=319KW





- 3. VTHD=11% which is beyond permissible limits of 8% as per IEEE-519 (5% for individual VTHD)
- 4. TDD-I=38% (IEEE limit dependent on short circuit ratio)
- 5. Average power factor is 0.89 (instantaneous PF = 0.882)
- 6. 5th ,7th ,11th harmonic currents are predominant
- 7. The above readings were taken with all the capacitors switched on and a reading of: VTHD = 8 % ITDD = 22 % was obtained with the bank switched off.

The actual AHF sizing can be calculated using the "Active Harmonic Filter Selection Tool" in etaPRO v3.0 as indicated below. (etaPRO v3.0 can be downloaded from <u>www.Lntebg.com/etaPRO</u>)

G Active Harmonic Filter Selection		And all the second s	-		
🕝 LARSEN & TOUBRO	Active	Harmonic	Filter	Selection	eta PRO v3.0
1. Full load current	520		A	6. Connected load in	kW 0
2. System Voltage	415	•	v	7. Initial Power Facto	or 0
3. Current harmonics(ITHD %)	38			8. Target Power Fact	or 0.99
4. Is neutral harmonic compensation required?	No			9. Required kVAr	0
5. Is Power Factor Compensation required through AH	F7 No			10. Reactive current	(A) 0
Minimum AHF rating f	or harmonics com or Power Factor co	opensation(A)	237.12 0		Calculate
Total Active Filter ratio	ng (A)		237.12		
Disclaimer - This is an indicative AHF selection. Fe	r accurate AHF se	lection, contact L&T			
Rating (A)	Cat No.		Desc	ription	Qty.
300	AHF300331D2	300 A	3 Ph 3 wire,	400 V Active Filter	1
					2

Figure 7 – etaPRO v3.0 AHF Selection Tool

It can be inferred from above software selection tool that a 300 A, AHF is required for the considered input parameters



Figure 8 – Indicative Installation arrangement





The printing press load is a **complete nonlinear load** responsible for harmonic production. Aux load is the auxiliary load which mainly includes lighting, fans etc.

Part III – Harmonic Study after AHF Installation.

A 300 A, 3 phase 3 wire AHF was installed and following results were obtained.





Reduction from 38 % to 3 %



Figure 11-Voltage Harmonic Spectrum











W		49.96Hz	1	16/08/17	23:42	
					1	23
P (W)	+296.4k	L.	PF	+0.940	6	3L
			cosΦ	+0.94	7	L1 L2
Q1 (var)	€+100.4k	L .			_	
D (var)	15.6k	L .	tanΦ	+0.33	9	~
S (VA)	313.3k	i.				
W		Wh				

Figure 14- Recorded power Factor

Due to reduction in harmonics, distortion PF has increased leading to the increase in the overall PF to 0.946, indicating distortion PF ≈1



Figure 15 - VTHD variation



Figure 16 – ITHD Variation





Part IV – Tariff System & Bill Comparison

The West Bengal Electricity Board has kWh billing and penalty/ Incentive rates applicable as follows:

11 kV Industrial Consumer E (Bt) type tariff system

	E(Bt) TYPE OF CONSUMERS			Energy Charge P/kWh (Winter)	Demand Charges (Rs./KVA/month)
	06.00 hrs-17.00 hrs.	All Units	Normal	707	
Normal TOD	17.00 hrs-23.00 hrs.	All Units	Peak	849	384
	23.00 hrs-06.00 hrs.	All Units	Off-Peak	530	

Power factor Incentive Scheme Applicable

	Power Factor (PF)	Power Factor Rebate & surcharge On Energy Charge in Percentage For the Year 2015-16				
	Range	For Consumers Under TOD Tariff				
SLAB		Normal Period	Peak Period	Off-Peak Period		
		(6.00 AM to 5.00 PM)	(5.00 PM to 11.00 PM)	(11.00 PM to 6.00AM)		
	PF > 0.99	-8	-9	-6		
Slab 1	PF>0.98 & PF=<0.99	-7	-8	-5		
Slab 2	PF> 0.97& PF=<0.98	-5	-6	-4		
Slab 3	PF>0.96 & PF=<0.97	-4	-5	-3		
Slab 4	PF>0.95 & PF=<0.96	-3	-4	-2		
Slab 5	PF>0.94 & PF=<0.95	-2.25	-3	-1.5		
Slab 6	PF>0.93 & PF=<0.94	-1.5	-2	-1		
Slab 7	PF>0.92 & PF=<0.93	-0.75	-1	-0.05		
Slab 8	PF>0.86& PF=<0.92	0	0	0		
	*Yellow h	nighlights indicate referenc	e slabs as indicated in bill an	alysis below		

The following section is the comparison of the bills of the month of July and September in order to evaluate the savings post AHF installation. The bill calculations are presented and actual bills are attached for the reader's reference. The first major column indicates the parameter and side by side comparison for the months of July and September with **APFC Panel Switched ON**.

	APFO	PANEL OF	NLY	APFC	PANEL + A	\HF
Parameter		July		S	eptember	
Supply Voltage		11 kV 11kV				
Contract Demand		415 kVA		415 kVA		
Fixed Demand charges (Rs/kVA)	384			384		
Percentage Chargeable	85%			85%		
Power Factor	0.8916 0.9743					
Meter Reading	MVAH					
			Off			Off
Time	Normal	Peak	Peak	Normal	Peak	Peak
Present Reading	417.77	527.26	1890.82	441.04	556.44	1991.6





Previous Reading	405.84	512.78	1830.66	429.9	543.35	1944.1
Units Consumed (MVAh)	11.93	14.48	60.16	11.14	13.09	47.5
Net MF	500	500	500	500	500	500
kVAh (Units Consumed * MF)	5965	7240	30080	5570	6545	23725

Meter Reading	MWH					
			Off			Off
Time	Normal	Peak	Peak	Normal	Peak	Peak
Present Reading	311.68	421.67	1537.02	334.38	449.56	1632.69
Previous Reading	300.61	409.15	1483.42	323.4	436.78	1586.61
Units Consumed	11.07	12.52	53.6	10.98	12.78	46.1
Net MF	500	500	500	500	500	500
kWh (Units Consumed * Net MF)	5535	6260	26800	5490	6390	23040
			Off			Off
Time	Normal	Peak	Peak	Normal	Peak	Peak
MVA	0.3138	0.5464	0.7692	0.3072	0.5352	0.6868
MF	500	500	500	500	500	500
KVA (MVA * MF)	156.9	273.2	384.6	153.6	267.6	343.4
			Off			Off
	Normal	Peak	Peak	Normal	Peak	Peak
Electrical Charge(EC) in paisa/KWH	707	849	530	707	849	530
PF Reb (-)/ Sur (+)% on EC	-0.75%	0%	0%	-7%	-6%	-4%
LF Reb (-)(p/KWH)						
Chargeable (KWH)	5535	6260	26800	5490	6390	23040
Amount (Rs)	39132.45	53147.4	142040	38814.3	54251.1	122112
Chargeable(PF)	0.9279	0.8646	0.891	0.9856	0.9763	0.9711
PF Rebate(INR)	-293.493	0	0	-2717个	-3255个	-4884个
	Dema	nd Charge				
Rate(RS / KVA /month)	384			384		
Chargeable (Normal KVA)	385			353		
Addl KVA	0			0		
Energy / Min	234319.9	\uparrow		215177.4	\downarrow	
Rebate on EC	0			0		
Addl EC	0			0		
Total EC (Rs)	234319.9			215177.4		
Demand Charge	147442	\uparrow		133481	\downarrow	
Addl DC	0			0		
Total DC	147442			133481		
	Rebate(-)	/ Surcharge	e (+)	<u> </u>	· · · · ·	
LF rebate	7490			7799.98		
PF Reb(-)/Sur (+)	-293.493	\uparrow		-10856.5	\downarrow	
MCVA Charges 823 paisa / kWh	8876	\uparrow		8031	\downarrow	





### Government Subsidy							
## Other Arrears Charges	14275.65			14279			
Electricity Duty							
Net ED	59078.71			52514			
Exemption							
ED (Rs)	2120.53			2120.53			
ED Adjust							
Total ED(Rs)	61199.24	\uparrow		54634.53	\rightarrow		
	Other Charg	es & Outst	anding				
Rent on Meter / motors	2400			2400			
Adjustable Amount	0			-4005			
Total Bill	475715.3	\uparrow		424948	\downarrow		

Conclusion

The conclusions that can be drawn out from the harmonic study are as follows:-

- 1. TDD-I reduced from 36% to 3%
- 2. THD-V reduced from 9.5% to 2.5%
- 3. Harmonic Current reduced from 181 Amp to 14 Amp
- 4. RMS current reduced by 4%
- 5. Maximum demand on transformer reduced by 6%

The results of AHF installation can be seen from the electricity bill also. Following are the main observations.

- 1. Demand charges The maximum demand got reduced from 385 KVA to 343 KVA i.e. lesser than 85% of 415 kVA, leading to direct reduction of INR 13,961
- 2. The average power factor improved from 0.8916 to 0.9743.
- 3. The rebate slabs of PF increase from 0.75, 0, 0 to 7, 6, and 4 in Normal, peak & off- peak time periods respectively, each slab as a percentage of the EC.
- 4. The number of units consumed also reduced considerably
- 5. The overall bill reduced from INR 475715 to INR 424948.

Additional Scope for saving

The AHF can be used to improve the PF further to unity such that the percentage rebate for all times of day falls in Slab-1 as indicated by PF Incentive Scheme Table.

Additional savings of INR 4457 can be obtained from the same.

Payback Calculations

From the difference in the bill it can be seen than, the customer has a saving of INR 54768/ month (average). The 300 A AHF panel has an approximate cost of INR 10,00,000. Hence the **payback period is 19 months**. **The same can be further be reduced if power factor is made unity.**

**Please find attached reference letter from the customer.





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PRODUCT PERFORMANCE CERTIFICATE

To,

L&T Electrical & Automation Electrical Standard Products L&T Business Par, TC- 2, Gate – 5 Powai Campus, Mumbai – 400072 Date: 15-01-2018

Subject: Performance of L&T make Active Harmonic Filter installed in our Siliguri Press

Kind Attn:

Mr Joydeep Banerjee - Sr.Manager – Energy Mgmt., ESP-Powai Mr Biswajit Bhattacharya – Asst.Manager – LV Sales, ESP-Durgapur Mr Siba Shankar Pati – Sr.Engineer – Service, ESP-Durgapur

We are pleased to put on record that L&T make Active Harmonic Filter of 300A rating was installed in our Siliguri Printing press in August 2017 after a thorough power quality study conducted by the L&T Energy Management team.

The filter has been working satisfactorily and reducing the voltage & current harmonic distortion below permissible limits specified by IEEE-519 guidelines. As a result of the installation of the filter, we have been able to operate our Automatic Power Factor Corrections panel during the peak newspaper printing hours to maintain healthy and pf and reduce the maximum demand, resulting in reduction in monthly electricity bills.

We appreciate the technical support offered by the L&T team of engineers during the power quality study, designing and commissioning of the filter solution and the timely after sales support.

We look forward to continue the association with L&T in future.

Thanking You

Yours faithfully For UTTAR BANGA SAMBAD

(EDITOR)

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