TAMIL NADU ELECTRICITY OMBUDSMAN

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BEFORE THE TAMIL NADU ELECTRICITY OMBUDSMAN, CHENNAI

Present: Thiru. A. Dharmaraj. Electricity Ombudsman

Appeal Petition No. 4 of 2016

M/s K.P. Blue Metal,
No.27A, M.B.T. Road,
Navalpur,
Ranipet   ..... Appellant
                                       (Rep by Thiru. R. Sekar)
                                  Vs

The Superintending Engineer,
Vellore Electricity Distribution Circle,
TANGEDCO,
Gandhi Nagar,
Vellore.   ……. Respondents
                        (Rep by Thiru. Ramachandran/EE/Arcot
                                      on 4.5.16 & 2.6.16,
                        Tmty. A. Selvi, EE/MRT on 2.6.16, 13.7.16 &
                        Thiru. R.Stalin, EE/Arcot on 13.7.16)

Date of hearing: 5.4.2016, 2.6.2016 & 13.7.2016
Date of Order : 17.10.2016

The Petition dt. nil filed by M/s K.P. Blue Metal , Navalpur, Ranipet was registered as Appeal Petition No.4 of 2016. The above appeal petition came up before the Electricity Ombudsman for hearing on 5.4.2016, 2.6.2016 & 13.7.2016. Upon perusing the appeal petition, counter affidavit of the Respondent and after hearing both sides, the Electricity Ombudsman passes the following order.

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1. **Prayer of the Appellant :**

The Appellant has prayed for the following :

(i)   Order may be passed to direct TNEB to refund the compensation charges levied for the month of March 2015 to August 2015 (measurement carried out with poor quality of Grid Supply).

(ii)   Direct the TANGEDCO to maintain stable balanced supply as suggested by the Chief Engineer/Industrial Coordination, R&D, TANGEDCO.

(iii) Direct the TANGEDCO to compensate the losses of 25% incurred by poor quality of Grid Supply.

2. **Brief History of the case:**

2.1   M/s K.P. Blue Metal, Navalpur, Ranipet the Appellant herein is a HT consumer of the Respondent. The Service Connection No. is 1269.

2.2   Harmonics Measurement was carried out in the above HT service on 28.2.2015 and found that the total current Harmonics Distortion (TDD) is 8.405%. which is more than the allowable limit of 8%.

2.3   The licensee levied a compensation charges of Rs.3,58,467/- and the Appellant has also paid the above charges. The Appellant has also carried out necessary corrective measures during August 2015 and   has maintained   the Harmonics level within the value stipulated by CEA.

2.4   The Appellant filed a petition before the CGRF for refund of the compensation charges levied.

2.5   The CGRF has rejected the petition . Aggrieved by the order of the CGRF, the Appellant filed this appeal petition before the Electricity Ombudsman.

3. **Orders of the Forum.**

The CGRF of Vellore EDC has issued its order on 4.12.2015. The relevant paras of the CGRF order is extracted below :

"Findings of the forum

1.   The 3 months notice was already issued as per the TNERC directions to the consumer to provide adequate Harmonic Suppression Equipments so as to avoid dumping of Harmonics into licensee's network beyond the permissible limits as specified by the CEA regulation.

2.   The Harmonic Measurement was carried seen that the Voltage harmonic values are within the permissible limit, but the current harmonic distortion is beyond the permissible limit (o.845%).

3.   The Harmonic compensation charges has been levied from March 2015 to August 2015 (6 days only) for Rs.3,58,467/-

4.   The petitioner could have acted well in advance for mitigating the level of harmonics to avoid such penalty.

5.   The compensation charges during the month of August 2015 have arisen only for 6 days proves that HT consumer has carried out the necessary corrective measure during August 2015 and has maintained the Harmonic limits as per the CEA regulation and maintain of harmonics limits is possible.

6.   The forum is accepted the facts furnished by the Chief Engineer/R&D/Chennai as detailed below :

*   It is well known fact that, availing an industrial service with a fourth wire run from the substation will cause unbalance and may lead to ill effects of unbalance. Having known this fact, the consumer has opted for the 4th wire connection.

*   When the consumer has the patience and will to tolerate all other ill effects of unbalance for sake of continuous supply for the industry, claiming that harmonics alone has increased because of the unbalance is not reasonable.

Orders of the Forum

*   Taking into consideration of the above facts, there is no possibility   of directing the licensee to either withdraw the levy of compensation charges obduracy of harmonics or refund the compensation charges already collected. Hence, forum dismisses the petition. "*

4.   Arguments putforth by the Appellant in the Appeal Petition :

4.1   We are availing continuous supply through fourth wire concept. We are facing great difficulty to run our industry smoothly due to unbalanced voltage problem.

4.2   During the R&C period we are facing severe unbalanced voltage in our service which we believe due to functioning of the Agricultural services & the domestic services (moreover all of them are single phase services). The % of the unbalanced voltage during the R&C period is around 2.5% to 4.7% during 3 phase time it is 2.5% - 2.79% (at the time of harmonics testing) as per BEE standard. IEC 1000-3.3, IEC 1000-3.5 permissible limit is 1%.

4.3   As per Bureau of Energy Efficiency it is recommended that the voltage unbalance shall not exceed 1%. IEC equipment limits (IEC 1000-3-3, IEC 1000-3-5) limits for unbalance.

(a)   LV-MV : 2%

(b)   HV : 1%

Details of the unbalanced voltages recorded by E.B. officials during their routine inspections, monthly & quota checking readings are shown below :

Sl.No.	Date	Time	R1	R2	R3	Avg	% Unbalanced as per STD of Bureau of Energy Efficiency IEC 1000-3-3 permissible limit 1 %.
1.	12.11.14	15:07	109.5	112.5	115.1	112.36	2.55 %
2.	20.11.14	13:18	109.0	112.5	115.1	112.2	2.85%
3.	01.12.14	09:47	105.6	108.9	113.0	109.1	3.51%
4.	31.12.14	10:22	104.3	108.8	114.3	109.13	4.73%
5.	08.01.15	13:16	104.4	107.8	112.9	108.36	4.18%
6.	28.01.15	14:34	107.9	110.7	113.6	110.73	2.59%
7.	31.01.15	10:09	103.5	107.5	110.6	107.2	3.45%
8.	19.02.15	15:15	104.6	107.8	115.5	109.3	5.67%
9.	28.02.15	15:00	104.2	107.8	108.6	106.86	2.50%
10.	28.02.15	15:25	5960	5900	6160	6006.67	2.60%
11.	28.02.15	15:35	5960	5920	6160	6013.3	2.58%
12.	28.02.15	15:45	5980	5940	6190	6036.67	2.55%
13.	28.02.15	15:55	6030	5970	6230	6067.67	2.54%
14.	28.02.15	16:05	6030	5970	6250	6083.3	2.79%
15.	28.02.15	16:15	6090	6040	6290	6140	2.44%
16.	01.03.15	8:22	105.6	110.3	111.0	108.96	3.09%
17.	20.03.15	15:15	103.9	107.2	112.3	107.8	4.17%

From the above statement it is very clear that we are facing unbalanced voltage problem during 2 phase timings (R&C period) as well as 3 phase timing. The % unbalance is always beyond   the permissible limit as per (IEC1000-3-3, IEC 1000-3-5) & also as per Bureau of Energy Efficiency permissible limit is 1%.

4.4   The % Unbalance current drawn by the induction motor will be 6 to 10 times that of the % unbalance voltage in that system (as per Bureau of Energy Efficiency).

4.5   The additional temperature rise in induction motor = 2* (% voltage unbalance)^2. The winding insulating life is reduced by one half for each 10^0c increase in operating temperature.

4.6   Operation of an induction motor above 5% voltage unbalance is not recommended.   If the percentage voltage unbalance exceeds 5% and above the entire system will be tripped. Once the system trips there will be time loss of 30 to 60 mints to set right the machine and restart the system.   This is also a type of production loss which we are facing frequently. Due to derating of motor we are facing loss in production and there-by paying 10-15 % excess of Electricity Charges in our service.(during R&C period).

4.7   Harmonics dumping measurement carried out in HT service no.1269 of M/s K.P.Blue Metal in (HT side) on 28.2.2015 at 3.15p.m to 4.15 pm slots each 10 minutes period. At 3ph supply time the Test results are as follows :

Sl. No.	Time	Unbalanced voltage as per IEC 1000-3-3, 1000-3-5		Unbalanced current measured	Dumping of current harmonics as per CEA Regulation.	
1.	3:25:55	1%	2.6%	26.34%	8%	5.36%
2.	3:35:55	1%	2.58%	28.65%	8%	7.04%
3.	3:45:55	1%	2.55%	31.85%	8%	8.40%
4.	3:55:55	1%	2.54%	34.58%	8%	8.33%
5.	4:05:55	1%	2.79%	31.1%	8%	8.11%
6.	4:15:55	1%	2.63%	29.72%	8%	8.16%

The average value of measured harmonics for the period of 1 hour is 7.5 only.

i.e. 10/60*(0.0536+0.0704+0.084+0.0833+0.0811+0.0816) = 7.56%.

4.8   As per TNERC A6 : Tariff Schedule 6.1 (ii) The TANGEDCO shall implement the compensation provision after 3 months period from the date of measurement if the harmonics measured is more than the permissible limits. In our case TANGEDCO has levied the 15% compensation for the excess over of 0.4% for the dumping of current harmonics for the slot of 10 minute in CC bill from the date of measurement i.e. (March 2015) on wards, which is against the TNERC orders.

4.9   Already we are facing the problem of loss in production from 20-25% due to derating of machines as well as frequent tripping because of the unbalanced voltage

problem. So the levy of compensation for dumping of current harmonics for meager %
of 0.4 excess over is an additional burden for us.

4.10   At the time of harmonic measurement the percentage unbalance voltage is
between 2.54% to 2.79% This shows that the measurement was not carried out with
quality of supply. Otherwise TANGEDCO fails to maintain the quality of supply.

4.11   At the time of measurement of harmonics the voltage unbalance is 2.54% to
2.79%. The additional temperature rise will be 12.5^0 to 15.56^0. The insulation life will
be reduced by 60% of its life period.   The current unbalance at that time of
measurement is between 26.34 to 34.58%. The unbalance current will increase the
motor loss. Current increases in certain phases the loss will increase by $(1.26)^2$ to
$1.34)^2$. i.e. 60% to 80% there by reduces the motor efficiency. Loss due to derating
will be 8%.

4.12   Third harmonics, triplent harmonics are mostly due to unbalanced voltage in the
system.   By neglecting this, the dumping of harmonics   will be well within the
permissible limit of 8%.

4.13   The excess over of 0.4% dumping of current harmonics was only because of
excess over % of   voltage unbalance at the time of dumping of harmonics testing.
Already we are facing the following draw backs.

S.No.	Grid Supply	3 phase timing	2 phase timing
1	Existing unbalance voltage	2.54 % to 2.79%	2.5% to 5.65%
2.	Due to unbalance voltage the additional temperature raise will be	12.5^0 to 15.56^0	12.5^0 to 40^0
3	The motor insulation life period reduced to	40%	Drastically
4	Loss due to derating of motor	8%	25%
5.	The loss increase by	60% to 80%	60% to 200%

Which are accepted   by Chief Engineer/R&D as well as   the CGRF Vellore.
However,   they impose compensation of 15% for the dumping of harmonic is over
burden for us, since it is due to poor quality of grid supply. By considering the above
facts, either by legally or by technically the collection of compensation charges is
against the natural justice.

5. **Arguments furnished in the Counter Affidavit of the Respondent :**

5.1   Complaining about the ignoring of quality supply is not reasonable, since initially the new HT Service No. 1269 was effected on 24.02.2009. Later based on consumer's request, the 4th wire has been provided in the 11 KV Ayilum feeder under DCW Head (Chargeable to consumer) at the Estimate cost of Rs. 2,77,880/- for 3 phase Continuous supply to the HT SC 1269. This facility has been availed from May 2010 on words.

5.2   It is a well known fact that, a fourth wire run from the substation may lead to ill effects of unbalance due to various types of other loads such as domestic, mini OHT and Agricultural. Having known this fact, the consumer has opted for the 4th wire connection.

5.3   Even though claiming unbalance voltage in the HT SC 1269, the consumer has registered HT application on 13.08.2014 for additional demand of 500 KVA and the estimate has been evolved for provision of new 11 KV Industrial feeder by segregating agriculture load in the existing 11 KV Ayilum Feeder for a gross estimate amount of Rs. 30.67 Lakhs, but the proposal was returned from the competent authority stating that sanctioning of new 11 KV Industrial feeder is against the Head quarter's instructions dated 29.06.1993.

5.4   However based on the complaints and for extension of stable and balanced three phase supply to the extent possible in HT SC 1269, an improvement proposal is evolved at the cost of Rs. 16.6 Lakhs and is being under process of getting sanction from the competent authority, which involves major improvement work.

5.5   The petitioner has argued with the Theoretical data published in journal and notes. This will not bind TANGEDCO to follow) The TANGEDCO is following the same and one method as per the instruction in vogue.

5.6   The Executive Engineer/MRT/ reported that the main reason for the total demand Distortion is due to load currents generated by non Linear loads connected in HT Service.

5.7   The R&D report states that:

➢ Sufficient time span has been given to consumer for reducing accessing the harmonics level and rectification and the consumer could have acted well in advance for mitigating the level of harmonics to avoid such penalty.

➢ The claim of the petitioner is not reasonable. However, it is presumed that retest of harmonics must have been done; as it is given that the consumer has maintained the harmonics within the limit during August 2015.

➢ It is also stated that "When the consumer has the 'patience and will' to tolerate all other ill effects of unbalance for sake of continuous supply for the industry, claiming that harmonics alone has increased because of the unbalance is not reasonable.

5.8   The HT consumer has carried out the necessary corrective measure during August-2015 and has maintained the Harmonics limits as per the CEA regulation. Hence, the compensation charges during the month of August-2015 have arisen only for 6 days.

5.9   As per the TNERC directions vide Tariff order petition No.1, dt:20.06.2013, three month notice was issued to the consumer vide Lr. No. SEV/GL/ AE.1 / DM/F.Harmonics/D.123/ 2013, dt. 23.08.2013 to provide adequate Harmonic Suppression Equipments, so as to avoid dumping of harmonics into Licensee's network, beyond the permissible limits as specified by the CEA regulations, failing which HT Consumer is liable for payment of compensation charges at 15% of the respective tariff. Subsequently, the Harmonic Measurement was carried out by the MRT/Vellore on 28.02.2015 during three phase supply time. Hence there is no question of ignoring of TNERC orders.

6.   **Hearing held by the Electricity Ombudsman :**

6.1   To enable the Appellant and the Respondents to putforth their arguments in person, hearings were held before the Electricity Ombudsman   on 5.4.2016, 2.6.2016 & 13.7.2016.

6.2   Thiru. R. Sekar, has attended the hearing on 5.4.2016, 2.6.2016 & 13.7.2016 on behalf of the Appellant and putforth his side arguments.

6.3   Thiru. Ramachandran, EE/Arcot has attended the hearing on behalf of the Respondent on 5.4.2016 & 2.6.2016 and putforth his side argument. Tmty. A. Selvi, EE/MRT attended the hearing on 2.6.16 and 13.7.16 and putforth her side arguments.

6.4   Thiru. R. Stalin, EE/Arcot attended the hearing on 13.7.16 and putforth his side arguments.

7.   Arguments putforth by the Appellant on the hearing dates :

7.1   The Appellant's representative reiterated the arguments furnished in the appeal petition.

7.2   The Appellant argued that the supply voltage to their industry is unbalanced and the unbalance is more than the limit prescribed in the B.EE Standard & IEC. As the test was conducted with unbalanced voltage, he argued that the measurements were taken without quality of Supply.

7.3   He argued that the unbalance current drawn by the motor will be 6 to 10 times of the unbalanced voltage.

7.4   He argued that third and triplent harmonics are generated due to unbalance supply voltage . As there was unbalance voltage more than the prescribed limit, the harmonics have also exceeded the limit. The excess 0.4% current harmonics were only because of excess over % of unbalance voltage at the time of measurement.

7.5   He also argued that due to unbalance voltage varying from 2.54% to 2.79% the following ill effects are experienced in their industry.

(i)   The additional temperature rise will be 12.5^0 to 15.56^0.

(ii)   The motor insulation life period will be reduced to 40%

(iii)   Loss due to derating will be 8%

(iv)   Loss increase by 60 to 80%.

7.6   The Appellants representative also argued that the value of maximum load current taken to arrive the TDD is the average current of previous 12 months maximum demand.   But   as the previous period was under power cut, the demand current calculation is not correct. It would have been more than the I_L calculated based on the previous 12 months average

7.7   He also argued that the MRT has fed the normal calculated current of 13.655A while taking measurement of Harmonics instead of actual current of 16.52 A at 3.35 pm (The demand is 261.800 KVA with a load current of 16.52A) thereby magnified the test results by

$\dfrac{16.52}{13.65}$: A :1.29 times.

The TDD at 3.45 pm is 8.4% as per MRT report. But the actual value is

$\dfrac{8.4}{1.29}$: 6.94% only which is well within the permissible limit of 8%.

7.8   He argued that by definition, I_L will always be greater than I   for Harmonic measurement purpose. Therefore, the TDD and percent of I_L measurement will always be less than THD and percentage of I measurement.

7.9   The Appellant's representative argued that his case may be decided on the merits of testing and he is not insisting the arguments about   the applicability of Harmonics charges for 11KV service and insufficient notice period raised in the appeal petition as there was cases pending on the above issues.

8. **Arguments of the Respondent :**

8.1   The EE/Arcot reiterated their arguments furnished in the counter affidavit of the Respondent.

8.2   The EE/MRT argued that the testing was done as per the procedure laid by the licensee. She also argued that the test results are correct and the Appellant's industry is injecting harmonics into the system more than the limit prescribed.

8.3   The EE/MRT argued that I_L for calculating the TDD is calculated   from the average demand of the previous one year maximum demand recorded. The last year average demand is calculated as 280.16 KVA and the current is 13.655A. She also informed that the total current harmonics distortion measured is 8.405% which exceeds the prescribed limit of 8% given in the CEA Regulation.

8.4   As per the Standards, the I_L shall be previous 12 months average demand current. Accordingly, the test was done and harmonics was calculated. Hence, taking the previous 12 months average demand is confirming to IEE only.

8.5   The testing was carried out as per the procedure in vogue only.

8.6   The EE argued that there is no impact of   unbalanced voltage on the test results. She argued that the unbalanced voltage is maximum at 2.79% at 4.05 hrs and the TDD measured is 8.11% whereas the TDD is 8.40% when the unbalance voltage is at 2.55% at 3.45 hrs. Citing the above she argued that the harmonics measured is depending upon the type of load only and not on the unbalanced   voltage.

8.7   She also informed that the TDD is maximum when the load current is 14.4 amps where as it is less at 5.36% when the load current is 17.66 amps. Hence, Citing the above the EE argued that the Harmonics is depending upon the nature of load put in and not on the total load.   Regarding the tolerance permitted in the IEEC, EE/MRT argued that the results of total TDD is taking into accounts of the tolerance permitted also.

9. **Written arguments of the Appellant :**

9.1   All electrical and electronic equipment's are grouped into one of 4 classes based on the following criteria as evaluated by the IEC committee members.

1.   Number of pieces of equipment in use [how many (volume) are being used by consumers].

2. Duration of use (number of hours in operation).

3. Simultaneity of use (are the same type of equipment used on the same time frame).

4. Power consumption.

5. Harmonics spectrum, including phase (how clean or distorted is the current drawn by the equipment.

9.2 After all the above criteria are taken into consideration equipment are classified as follows.

Class : A :

(a) Balanced three-phase equipment.
(b) House hold appliance, excluding equipment identified by Class D
(c) Tools excluding portable tools
(d) Dimmers for Incandescent lamps
(e) Audio equipment
(f) Everything else that is not classified as B,C or D.

Class B : (a) Portable tools

         (b) Arc welding equipments which is not professional equipment

Class C : (a) Lighting equipment's

Class D : (a) Personal computers and personal computer monitors

         (b) Television receivers

9.3 Our service is not covered in any of the Class, since, our service is working with abnormal unbalanced load condition due to poor quality of TANGEDCO supply. Further there is no any specific limitation for dumping of harmonic for the equipment's working in such abnormal unbalanced condition, Hence the harmonics measurement carried out in our HT service is not reasonable.

9.4 As per standard ITHD: Total Harmonic Distortion of the current waveform. The ratio of the root-sum-square value of the harmonic content of the current to the root-mean-square value of the fundamental current {I).

$$\text{ITHD} = \frac{\sqrt{I_2{}^2 + I_3{}^2 + I_4{}^2 + I_5{}^2 + \dots}}{I_1} \times 100\% .$$

9.5   Current TDD: Total Demand Distortion of the current waveform. The ratio of the root- sum-square value of the harmonic current to the maximum demand load current.{I_L}.

$$\text{ITHD} = \frac{\sqrt{I_2{}^2 + I_3{}^2 + I_4{}^2 + I_5{}^2 + \dots}}{I_L} \times 100\% .$$

9.6   As per standard the maximum demand load current I_L, is calculated by averaging the maximum demand current for 12 consecutive months (information available in billing records) here it is 260 .16 kva /13.655A. It is under normal condition, but our service is comes under power cut period of 9 months in back period of 12 months, otherwise it will 280kva/14.69A and also working under abnormal condition of unbalance load with the tune of 26.34% to 34.5% (permissible limit is 10%) due to abnormal unbalance voltage with the tune of 2.5% to 2.79% (permissible limit is 1%) supplied by TANGEDCO MRT has feed the normal Calculated current of 13.655A while testing instead of actual current Of 16.52A at 3.35 pm the demand is 261.800 kva with load current of 16.52A there by magnified the test results by 16.52/13.65 =1.209 times The TDD AT 3.45 PM IS 8.4% as per MRT report, But the actual value is 8.4/1.209=6.94%only which is well within the permissible limit.

9.7   The details of *test* results of harmonic measurements carried out on 28.02.2015 are as follows:

S. No	Date &Time	Unbalance voltage permissible limit	Measured value	Unbalance current in % Permissible Limit (10%)	Maximum demand in k.v.a.	load current in Amps	Dumping of current harmonics as per C.E.A. Regulation(T.D.D) permissible limit	Actual value of TDD	Measured Value TTD
1	3:25:5 5Pm	1%	2.6 %	26.34 %	269.80	17.66A	8%	4.43%.	5.36%
2	3:35:5 5 Pm	1%	2.58%	28.65 %	261.80	16.52A	8%	5.82%	7.04%
3	3:45:5 5Pm	1%	2.55 %	31.85 %	223.20	14.4A	8%	6.94%	8.4%
4	3:55:5 5Pm	1%	2.54%	34.58 %	207.80	13.52A	8%	6.8%	8.33%
5	4:05:5 5Pm	1%	2.79%	31.1 %	258.70	16.37A	8%	6.70%	8.11%

| 6 | 4:15:5 5Pm | 1% | 2.63 % | 29.72 % | 248.70 | 15.62A | 8% | 6.74% | 8.16% |

10. **Written arguments of the Respondent :**

(i) As per the methodology followed by TANGEDCO, the harmonic measurement has to be taken at a minimum of *75%* of the previous 12 month average load. This has been considered, since the load on the HT industries have seasonal variations. Also, the current harmonics level in terms of Total Demand Distortion will be lesser at lower load and hence the claim of the complainant is not correct.

$I_{TDD} = I_{THD} \dfrac{X\ I_1}{IL}$ (I_{TDD} - Total Demand Distortion $\prime$ I_{THD} - Total Harmonic Distortion

I_1 - Load Current at the time of measurement

I_L - Previous 12 months average Demand Current

If load current I_1 at 15:45 Hr is less than recorded I_{TDD} is also less. So, Harmonics at higher load .will be more than *8.405%.* Hence the claim of the complainant is not correct.

(ii) The International Standard IEC 61000-4-30, titled Power Quality Measurement Methods, clearly describes 10m aggregation for the Harmonic measurement for a Class-A type of instruments. Hence, the claim of the complainant is not correct that <u>15/30 min aggregation time is needed instead of 10 min integration.</u>

(iii) As per IEEE 519, the tendency of harmonic current is to flow from the load end towards the upstream, up to the Generator end of the power system. Hence, it has been considered in the methodology in such a way that, any parameter. (V_{THD}, V_{IHD}, I_{THD}) exceeding the prescribed limit in any of the phase is considered to be a failure. As harmonic in each phase is separately measured and equally harmful, there is no specific recommendation in any of the standard to take the average of the readings between phases.

(iv)   In the Class-A Power Quality Analyzer, for every power quality parameter there would be three readings measured viz. maximum, minimum and average. In the methodology, TANGEDCO has not considered maximum and minimum and considered only the average values taken during the 10 minute aggregation time. As aggregation time is already fixed by the Standard, further averaging as requested by the consumer, will deviate the results from the methodology described in the standard. Hence, the claim of the complainant is not correct.

(v)   As per the definitions given by the standards, the Total Harmonic Distortion is the level of distortion that has to be considered from 2nd harmonic level to 50th harmonic level expressed as a percentage of fundamental value. Hence, the Standard doesn't permit to exclude certain harmonics from the calculations.

10.2 The Respondent has furnished the following arguments in their letter dt.15.7.2016.

(i)   The load of the consumer varied between previous to measurement 245KVA and 288 KVA, in the period between 02/2014 to 01/2015. The sanctioned demand of the consumer is 300KVA . Hence TANGEDCO can do the test and measure the harmonics level at Minimum of 75% of the previous 12 month average load and within the sanctioned demand of 300KVA. In the present case, the maximum demand at which the measurements were taken are 269.80KVA, which is well within the contract demand and also below the consumer's consumption during the months 06/14 (273.2KVA), 07/14 (287.6KVA), 08/14 (278.8KVA) & 09/14 (271.6KVA). Hence the claim of the consumer, that the measurements were taken at a higher load than the average demand is not correct.

(ii)   However, it is recommended to calculate the average current of the maximum demand for the proceeding 12months, in IEEE 519 is given only for

the calculation of I_L for arriving the TDD and not for arriving the current at which the measurements are to be made.

(iii)   Had the measurement been done at 288 KVA load (maximum demand recorded during 07/2014), the harmonic level would have been still higher.

(iv)   The details of average load currents during harmonics measurement carried out on 28.02.2015 furnished as follows :

Sl. No	Time	R	Y	B
1	3.25	11.90	15.75	17.69
2	3.35	10.56	16.57	16.46
3	3.45	8.81	14.48	13.90
4	3.55	7.76	13.59	12.80
5	4.05	10.25	16.43	16.34
6	4.15	9.96	15.68	15.60

It may be seen from the above table that the average load current drawn by the consumer, during the measurement period itself is not equal in all the phases and vary about 65% between phases.

In the letter dt.12.8.2016, the Respondent have furnished the following :

(i)   The Harmonic measurement carried out on 28.2.2015, 12.6.2015 and 3.8.2015 and the test values are as follows :

Sl.No.	Harmonic Details	Allowable limit	28.2.2015 without Harmonic filter	12.6.2015 without Harmonic filter	3.8.2015 with Harmonic filter
1.	Individual voltage Harmonic Distortion (max)	3%	0.928	1.00	0.38
2.	Total voltage Harmonic Distortion (THD)	5%	1.09	0.97	0.6
3.	Total current Harmonic	8%	8.405	10.09	4.367

	Distortion (TDD)				
4	12 months average demand/current (I_L)	---	260.16KVA/ 13.65A	255.76KVA /13.42A	264.2KVA/ 13.86A
5.	Average current measured during testing	---	15.4647A	10.58A	14.3807A

The above value reveal that the current harmonics is more than the permissible limit even when the average current during measurement is less than the 12 month average demand/current on 12.6.2015. Hence, the claim of the complainant that the harmonics has crossed the limit only due to measurement taken at higher current is not correct.

Since, after installation of Harmonic filter, the harmonics generated by the load is within the permissible limit on 3.8.2015, it is very clear that the harmonic distortion is purely due to connected load.

(ii) The Unbalanced voltage influence on current harmonics : -

There is no standard to quantify the influence of current harmonics due to unbalance voltage. Generally, the current harmonics are generated by non-linear loads. (example : variable speed driver, SMPS, UPS, Power Electronics, UFD, Arc furnace, Induction, Steel Rolling mills.

The load current variation between phases is found to be 65%, it is already submitted vide reference cited 2 above.

Hence, the current harmonics (total demand distortion) is due to load currents generated by non-linear connected loads.

11. Findings of the Electricity Ombudsman :

11.1 The Appellant prayed for refund of the Harmonics compensation charges collected on the following grounds.

(i)   As per Tariff schedule 6.1(ii), the TANGEDCO shall implement the compensation provision after 3 months period from the date of measurement. But, in their case, the compensation was claimed from the date of measurement which is against TNERC.

(ii)   The test results could not be taken as it was conducted with unbalanced voltage exceeding the limit, I_L value calculated for adoption is wrong etc.,

11.2   The Appellant informed that   he is requesting   refund of the Harmonics compensation charges on the ground of testing procedure and not on other points which are raised in the similar cases pending in the Hon'ble High Court. Hence, the prayer of the Appellant was examined only on the testing procedure.

11.3   The Appellant argued that   the test were conducted when the percentage of unbalanced voltage is in between 2.54 to 2.79% whereas the permitted percentage variation is 1 % as per IEEE standard. Hence, the Appellant's representative argued that the test was conducted without the quality of supply.

11.4   The Appellant's representative also argued due to the above unbalance voltage. The following ill effects will be there.

(a)   Additional temp rise

(b)   The motor insulation life will be reduced.

(c)   The motor capacity has to be derated.

(d)   The loss will be increased.

11.5   The Appellant's representative also argued that third harmonics and triplent harmonics will be dumped into the system due to unbalance voltage. Hence, if the harmonics due to unbalance voltage are neglected the Harmonics of the service will be within the permissible limit.

11.6   The Appellant argued that as per IEC 5% excess over then the permitted level is allowable (ie) the consumer can go upto 8 x 1.05= 8.4%. As the recorded value is 8.40% if we allow the 5% excess variation, the value will be within the permissible limit only and hence argued that the Appellant has not exceeded the limit.

11.7   The Appellant argued that the test result furnished by MRT are magnified test results. As per the standard the maximum demand load current. I_L is calculated by averaging the maximum demand current for 12 consecutive months. Here it is 260.15 KVA/13.655A. The MRT has fed the calculated average demand current of 13.655A while testing instead of actual current of 16.52A at 3.35 PM. The demand at the time is 261.8KVA with the load current of 16.2A, there by magnified the test result by $\frac{16.52}{13.65}$ = 1.209 times.

The TDD at 3.45 pm is 8.4% as per MRT, But the actual value will be 8.4/1.209= 6.94% only which is well within the permissible limit. He also argued that by definition I_L will always be greater than I_1, for Harmonics measurement purpose.

11.8   The Appellant also argued that the maximum demand current was worked out as 13.655A considering the previous 12 months average demand recorded in the said service. But, the period considered for arriving the above value is with power cut for 9 months. Hence, he argued that the maximum demand has to be taken   as 280 KVA/14.69amps Had it been taken the value of TDD would be less.

11.9   The Respondent's representative   argued that the following (i) There is no stipulation that the harmonics   measurement has to be done at balanced voltage in the system.

(ii)   The average load/demand is calculated as per the IEEC stipulation. As the previous year, average load is only 260.15KVA/13.655A, the same was taken which conform to the specification only.

(iii)   The resultant value of TDD displayed in the Harmonics   analyser used by the dept is after taking into account of the tolerance of 5% permitted by the IEC only.   The resultant was only 95% of the TDD of the system. Hence, giving 5% tolerance again on the 95% value of the Harmonics measured means giving 10% tolerance . Hence, it is not reasonable.

(iv)   The load of the consumer varied between 245KVA and 288KVA in the previous period from 2/2014 to 1/2015.   The sanctioned demand is 300 KVA.   Hence, TANGEDCO can do the test and measure the harmonics level at minimum 75% of the previous 12 months average load and within the sanctioned demand of 300 KVA. In the present case, the maximum demand at which the measurements were taken are 269.80 KVA which is well within the contract demand and also below the consumption of the consumer recorded during the month of 6/2014 (273.2 KVA), 7/2014 (287.6 KVA) 8/2014 (278.8 KVA) & 9/2014 (271.6KVA). Hence, the claim of the consumer that the measurements were taken at the higher load than the average demand is not correct.

(v)   The Respondent also argued that as per IEEE 519, the average current of maximum demand for the preceding 12 months , is given only for the calculation I_L for arriving TDD and not for arriving the current at which the   measurement are to be taken. Had the measurements been done at 288 KVA load, the harmonics level would have been still higher.

(vi)   The Respondent also furnished the average load currents during the harmonics measurement and argued that the current drawn by the Appellant in all the phases are not equal and are varying upto 65% (ie) The Respondent argued that the load of the consumer itself is unbalanced one.

(vii)   The Respondent also argued that the TDD value given is only average value in a phase and among the above value the maximum of the average value measured in any phase is taken as the TDD. Hence, taking average value of all the phases does not arises and not as per standard.

11.10 As the issue here is TDD is more than the limit, I would like to refer the definition of total harmonics distortion (THD) and total demand distortion which are given below:

Total Harmonics Distortion :

The ratio of the root sum square value of the harmonics content of the current to the root mean square value of the fundamental current.

$$I_{THD} \; : \quad \frac{\sqrt{I_2{}^2 + I_3{}^2 + I_4{}^2 + I_5{}^2 + \ldots}}{I_1} \times 100\%$$

Total Demand Distortion :

The ratio of the root square value of the harmonics current to the maximum demand load current.

$$I_{TDD} \; : \quad \frac{\sqrt{I_2{}^2 + I_3{}^2 + I_4{}^2 + I_5{}^2 + \ldots}}{I_L} \times 100\%$$

11.11 The CEA (Technical Standards for connectivity of the Grid) Regulations 2007, set limits of voltage & current Harmonic in regulation 3 of Part IV. The same is extracted below :

> "Voltage and Current Harmonics
> (1)   The total harmonic distortion for voltage at the connection point shall not exceed 5% with no individual harmonic higher than 3%
> (2)   The total harmonic distortion for current drawn from the transmission

system at the connection point shall not exceed 8%

      (3)   *The limits prescribed in (1) and (2) shall be implemented in a phased manner so as to achieve complete compliance not later than five years from the date of publication of these regulations in the official gazette."*

11.12 On a careful reading of the regulation, it is noted that the following are the maximum permissible limits.

(a)	Total harmonic distortion for voltage at the connection point shall not exceeds	5%
(b)	Individual harmonics shall not be exceed	3%
(c)	Total harmonic distortion for current drawn from transmission system at the connection point shall not exceed	8%

11.13 Further, I would like to refer the Commission's view given in the para 2.422 of the Tariff order No.1 of 2013 dt.20.6.2013.

"The Railways have requested the Commission to defer charging of harmonics surcharge since there is no standard procedure available for measurement of harmonics. The harmonics norms have been fixed by the CEA in its Regulations notified on 21-02-2007. The Regulation specifies that the norms shall be implemented and complied with not later than 5 years from the date of publication of the regulation. Accordingly, the Commission only implemented the provision in its Order T.P. No. 1 of 2012. The measurement of harmonics has already been done jointly by Salem Steel Plant and TANGEDCO as per the norms of the CEA and this has been recognized by the Commission in its order on MP No. 22 of 2011 dated 28- 9-2012."

11.14 On a careful reading of the said para, it is noted that the Commission has recognized the test conducted jointly by TANGEDCO and Salem Steel Plant.

11.15 The Appellant argued that the licensee has taken the previous 12 months average demand reached to calculate the I_L. As there was power cut in about 9 months, the Appellant argued that the I_L calculated based on power cut period is less than their real maximum demand reached.

11.16 As per the test procedure followed by the licensee, the I_L shall be calculated on the average of the maximum demand for the past 12 months. As the Respondent has

followed the above procedure, I am of the view that it is as per the procedure in vogue only. Further, as per the procedure, the harmonics measurement are made once in 12 months, or as per the requirements of in specific cases. As the periodicity is given once in twelve month, I am of the view that the previous one year average maximum demand is taken for arriving I_L is reasonable only.

11.17 In clause 10.4 of IEEE, it has been recommended that the load current I_L be calculated as the average current of the maximum demand for the preceding 12 months. As the calculation of I_L by the licensee is based on the maximum demand of previous 12 month, I am of the view that the I_L calculated by the licensee is conforming to the specification.

11.18 The Appellant argued as per IEC, a 5% excess over in TDD is permitted. Hence, if a tolerance of 5% is allowed, the percentage of TDD allowed is 8.4% and hence argued that his service is within the limit prescribed.

11.19 The Respondent argued that the instrument in which the TDD was measured is actually displaying the 95% of the measured value only and hence argued that the tolerance was taken care.

11.20 In this connection, I would like to refer the testing procedure given by the licensee. The para (iv) is extracted below:-

(iv)   Current Harmonics :

The 95% value of the total harmonic current (average value of the harmonic current is RSS measured during every 10 minutes interval of the measurement duration) in absolute value,   is divided by I_L (The load current I_L is to be calculated as given I the note below) to arrive   at   the maximum harmonic current distortion in percent of I_L (TDD) at the POE. This will be the percentage I_{THD} for the service. The calculated value is compared with limit value defined in CEA, which is 8%.

NOTE:

1. *In the case of arc furnace industries or industries having one or two harmonic rich continuous process loads (which does not have other substantial loads) the calculation of I_L shall be based on their sanctioned load.*

2. *For all other industries, the I_L shall be calculated based on the average maximum demand for past 12 months or the number of months for which they were in service, if the period is less than one year.*

11.21 On a careful reading of the licensees instructions, it is noted that 95% value of the total Harmonic current in absolute value is divided by I_L to arrive at the max harmonics current distortion in percent of I_L (TDD at POE). The calculated value will be compared with the limit value defined by CEA which is 8%.

11.22 In this regard, I would like to refer the clause 13.6 Statistical analysis of the measured data of 61000-4-30 of IEC – 2008 which is extracted below :

"B.6 Statistical Analysis of the measured data :

A suitable statistical analysis method shall be chosen for the data. Different statistical methods may be selected depending on the power quality parameter and measurement objectives, but the methods can be roughly divided into :

- *methods that count the number of events that exceed some threshold, and*
- *methods that summarise large numbers of quasi-steady-state measurements into a single number or a few numbers.*

For the latter methods, various possible numbers may be chosen as the most useful summary value; maximum value, 99%, 95%value, average value, minimum value etc., In many references the 95% probability value has been found to be useful."

11.23 On a careful reading of the above clause, it is noted that in statistical analysis of the measured data various possible numbers may be chosen as the most useful summary value, maximum value 99% value, 95 % value, average value, minimum value etc., In many references the 95% probability value has been found useful.

11.24 As the licensee has chosen 95% value of the total Harmonics current in absolute value to arrive at the maximum harmonics current distortion in present of I_L at POE. I am of the view the measurement done as per standards only.

11.25 Further, it is to be pointed out that as per the CEA (Technical Standard for connectivity of the Grid) Regulations 2007, clause 3(2), the total harmonics distortion for current drawn from the transmission system at the connection point shall not exceed 8% and no tolerance has been specified in the above regulations. Hence, this point is decided against Appellant.

11.26 The Appellant argued that the T_{DD} has exceeded the limit only at 3.45m if average is taken for all the six readings then their value will be only 7.5%. Hence, argued that they have not exceeded the limit.

11.27 The Respondent argued that as per IEEE 519, the tendency of harmonic current is to flow from the load end towards the upstream upto generator end of the power system. Hence, it has been considered in the methodology in such a way that, any parameter (V_{THD}, V_{IHD}, I_{THD}) exceeding the prescribed limit in any of the phase is considered to be failure. As harmonic in each phase is separately measured and equally harmful, there is no specific recommendation in any of the standard to take the average of the reading between phase.

11.28 The Respondent also argued that in the class A power quality analyser for every power quality parameter there would be three readings measured (viz) max, min and average. In the methodology, the TANGEDCO has not considered max and min and considered only the average values taken during 10 minute aggregation time. As aggregation time is already fixed by the standard, further averaging requested by the consumer will deviate the results from the methodology described in the standard. The average value alone taken for levying the compensation, Further the EE/MRT argued that as per the procedure in vogue, violation in any one phase is to be treated as exceeding the harmonic, limits for the said service.

11.29 As the Harmonics exceeded in any phase has to be taken as exceeding the limit and only average values of each phase are taken I am of the view that the argument of the Appellant is not acceptable.

11.30 The Appellant argued that the supply voltage itself is unbalance and is beyond the permissible limit of 3% prescribed by CEA & 1% prescribed in BEE. The unbalance voltage will cause third and triplent harmonics. The T_{TDD} includes the third and triplent harmonics also. Hence, he argued that excess over of 8% is only due to the presence of third & triplent Harmonics. Citing the above, the Appellant argued that the compensation claimed has to be refunded as the excess over is due to unbalanced voltage supply of the licensee. However, he informed that exact value of current Harmonic distortion due to unbalance voltage could not be worked out.

11.31 The Respondent argued that there is no precondition to measure the Harmonics with balanced voltage and there is no standard to quantity the influence of current Harmonics due to unbalance voltage. Further, the Respondent argued that the Harmonics generated are due to the non linear load of the Appellant.

11.32 The EE/MRT informed that the TDD is max at 8.4% when the percentage voltage difference is 2.55% where as the % TDD is less when the percentage voltage unbalance is more (i.e.) 8.11% at 2.79% voltage unbalance. The percentage I_{TDD} is 5.36 at 2.6% voltage unbalance The above percentage variation of unbalance is in between the previous two values discussed, but the percentage I_{TDD} is the lowest at 5.36%. Citing the above, the EE/MRT argued that the effect of unbalance voltage and the percentage TDD has no linear relationship.

11.33 As per the above details, the percentage voltage unbalance and TDD has no linear relationship. Hence, I am of the opinion that the Appellant has not established that the Harmonics measured over and above 8% is due to the unbalanced voltage supplied by the licensee.

11.34 The Respondent also argued that as per the definition given by the standards, the total Harmonics distribution is the level of distortion that has to be considered from 2nd Harmonics level to 50th Harmonic level expressed as a percentage of fundamental value. Hence, the standard does not permit to exclude certain Harmonics from the calculation.

11.35 The argument of the Respondent that as per standards, the total Harmonics Distortion is the level of Distortion that has to be considered from 2nd to 50th Harmonics and the standards does not permit to exclude certain Harmonic above from calculation is acceptable to me. Therefore, the argument of the Appellant that the third and triplent Harmonics has to be excluded for arriving the I_{TDD} is not acceptable to me.

11.36 The next argument put forth by the Appellant is the I_L taken for arriving the TDD is less than load current at which test was conducted. As I_L will be in the denominator for calculation of I_{TDD}, the resultant will high if I_L is smaller.

11.37 In this regard, the Respondent argued that the I_L was calculated as per the guidance given in the standards. The testing has to be done at 75% or more of the average max demand. The max demand so calculated is 260.16 kVA/13.655Amp. The measurements were taken 269.80 kVA which is well within the sanctioned load of 300 kVA and also below the max demand of 273.2 kVA(6/14); 287.67 kVA(7/14), 278.8 kVA 8/14 abd 271.6 kVA (9/14). Further, he has also argued that the IEEE 519 has specified how to calculate I_L, but has not given any standard for arriving the current at which measurement has to be made.

11.38 The general theory is if measurement is done at low load, the total harmonic distortion will be more in terms of percentage. Hence, the testing was done at higher load only. However, the Harmonics will depend up on the nature of the load. Hence, the Respondent has given the details of current in each phase while testing was done which are extracted below:-

Time	Max Demand in KVA	Rph current	Y ph current	B ph current
3.25	269.8	11.90	15.75	17.69

3.35	261.8	10.56	16.57	16.46
3.45	223.2	8.81	14.48	13.90
3.55	207.80	7.76	13.59	12.80
4.05	258.70	10.25	16.43	16.34
4.15	248.70	9.96	15.68	15.60

11.39 On a careful analysis of the load current furnished by the Respondent, it is noted that the load is not balanced and the variation between the min & max is from 48.7% to 75.12%. It is also noted that the Appellant is having a 55 HP adjustable speed drive with 6PWM.

11.40 As per the statement furnished by the Appellant the TDD is max at 8.4% when the demand is 223.20 kVA which is less than the Average demand of 260.16 kVA. The demand TDD details are furnished below :-

Sl.No.	Time	Demand in kVA	Measured values TDD
1	3.25.55 pm	269.80	5.36%
2	3.35.55 pm	261.80	7.04%
3	3.45.55 pm	223.20	8.40%
4	3.55.55 pm	207.80	8.33%
5	4.05.55 pm	258.70	8.11%
6	4.15.55 pm	248.70	8.16%

11.41 It could be seen from the above values when the demand is max at 269.8 KvA, the TDD is 5.36% but it is 8.40% when the load is 223.20 KVA and is 8.33 when the demand is at 207 kVA. Therefore it is noted that there is no linear relationship between the load and the TDD. The Harmonics is depending up on the type of load and its quantum (ie) whether the load connected to the system is Harmonic generating type or not is the main criteria.

11.42 The load current and TDD as furnished by the Appellant is detailed below:

Sl. No.	Time	Average current measured during testing	TDD
1	3.25.55 pm	17.66 A	5.36 %
2	3.35.55 pm	16.52 A	7.04%
3	3.45.55 pm	14.40 A	8.40%
4	3.55.55 pm	13.52 A	8.33%
5	4.05.55 pm	16.37 A	8.11%
6	4.15.55 pm	15.62 A	8.16%

11.43 The Appellant argued that due to adopting a value of I_L less than the testing currrent is the cause for higher value of TDD. But on a careful examination of the current value and the TDD measured, it is noted that the T_{DD} is less at 5.36% when the load current is at 17.66A (i.e) the current at the time of measurement is more than the average load current (I_L) of 13.655 Amps where as it is 8.33% when the actual load is 13.52A (i.e) less than the average load I_L.

11.44 It is noted that Harmonics measurement were subsequently taken on 12.6.2015 also. In that measurement, the total current Harmonics Distortion (TDD) is 10.09%. The average current measured is 10.58A and the 12 months average Demand current is 13.42A. The I_L is more than the current at which testing was done. But, the percentage T_{DD} is more.

11.45 Hence, I am unable to accept the argument of the Appellant that due to adopting the I_L value less than the current at which testing was done has caused higher Harmonics value. But the value is depending upon the nature off the load put on to use.

11.43 In view of my discussion in the paras above, I am of unable to accept the contention of the Appellant that the test results are not acceptable.

12.   Conclusion:

12.1   In view of the findings in para 11 above, I am unable to interfere with the order of CGRF of Vellore, EDC.

12.2   As the prayer (ii) & (iii) are not raised before the forum, they have not been considered   in the appeal petition.

12.3   With the above findings, the AP No. 4 of 2016 is finally disposed of by the Electricity ombudsman. No cost.

                                                                      (A. Dharmaraj)
                                                            Electricity Ombudsman

To
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2) The Superintending Engineer,
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3) The Chairman,
(Superintending Engineer) ,
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