**BEFORE THE HONOURABLE TAMIL NADU ELECTRICITY REGULATORY COMMISSION**

# M.P. No. 22 of 2020

**IN THE MATTER OF:** In the matter of methodology for measurement of Harmonics in respect of HT/EHT services based on the Central Electricity Authority (1) Technical standards for connectivity to the Grid (Amendment) Regulations, 2019 and (2) Technical Standards for connectivity below 33 kilovolts (Amendment) Regulations, 2019.

Tamil Nadu Generation & Distribution
Corporation Limited,
Represented by its Chief Engineer/
Commercial,
144, Anna Salai,
Chennai - 600 002. …… Petitioner

Vs

- Nil - …… Respondent

**MISCELLANEOUS PETITION FILED BY TANGEDCO UNDER REGULATION 16(1) OF TAMIL NADU ELECTRICITY REGULATORY COMMISSION (CONDUCT OF BUSINESS) REGULATIONS, 2004**

I, U.S. Pongiannan son of (Late) Thiru K. Subbana Gounder, Hindu, aged about 57 years employed as the Chief Engineer/Commercial in Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO) and having office at 144, Anna Salai, Chennai – 600 002, do hereby solemnly affirm and sincerely state as follows:

I submit that, I am the Chief Engineer/Commercial/TANGEDCO and petitioner herein. As such I am well acquainted with the facts of the case from the available files/records.

1. It is respectfully submitted that TANGEDCO is engaged in generation and distribution of Electricity throughout the State of Tamil Nadu.

2. At the outset, it is submitted that this petition has been preferred by the petitioner consequent to the amendments made to the following Regulations on 06-02-2019 by the Central Electricity Authority, a body established under section 3 of the Electricity (Supply) Act, 1948 and exercise functions and perform duties as per the provisions of the Electricity Act, 2003:

1. Central Electricity Authority (Technical Standards for Connectivity to the Grid) Regulations, 2007

2. Central Electricity Authority (Technical Standards for Connectivity of the Distributed Generation Resources) Regulations, 2013 (now renamed as Technical Standards for Connectivity below 33 kilovolts Regulations, 2013)

3. It is respectfully submitted that the Hon'ble TNERC in Order in T.P. No.1 of 2017 dated 11-08-2017 has observed that levying harmonic penalty is not applicable for the HT consumers connected at 11 kV and 22 kV, in accordance with the Judgment dated 05.06.2017 of the Hon'ble High Court of Madras in W.P. No. 25 of 2015 & Others. In the said order, the Hon'ble High Court of Madras had observed that until the Central Electricity Authority (CEA) prescribes any standard for harmonics for 11 kV / 22 kV supply lines consumers and makes them also obligatory for harmonic controls, no obligation can be cast upon the 11 kV / 22 kV supply lines consumers for compliance.

4. It is respectfully submitted that TANGEDCO has filed appeal before the Hon'ble Division bench of High Court of Madras vide W.A.No. 388 of 2018 against the order of the single judge of High Court of Madras in W.P.No. 25 of 2015 & others and the same is pending till date. Further, TANGEDCO has also filed appeal before the Hon'ble Appellate Tribunal for Electricity (APTEL) against the Retail Tariff Order issued by the Hon'ble TNERC vide T.P.No. 1 of 2017, dated 11-08-2017 for non-inclusion of harmonic penalty for 11 kV / 22 kV consumers and the appeal is yet to be numbered. The present miscellaneous petition is filed before the Hon'ble Commission without prejudice to the outcome of the orders of the Hon'ble High Court of Madras and the Hon'ble APTEL.

5. It is respectfully submitted that at present TANGEDCO measures the Harmonics only in respect of bulk consumers (who avails supply at 33 kV or above level) as prescribed by the Hon'ble TNERC vide order in T.P.No. 1 of 2017, dated 11-08-2017 based on the Central Electricity Authority (Technical Standards for Connectivity to the Grid) Regulations, 2007. As per the above Regulations of the Central Electricity Authority, TANGEDCO follows the following limits of Voltage and Current Harmonics in respect of the bulk consumers:

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%.

6. It is respectfully submitted that as per the above retail tariff order of the Hon'ble TNERC, when the consumer fails to provide adequate harmonic filtering equipment to avoid dumping of harmonics into Licensee's network beyond the permissible limits as specified by CEA regulations, the consumer is liable to pay compensation at 15% of the respective tariff.

7. It is respectfully submitted that as per the amendments to the CEA Regulations on Technical Standards for Connectivity to the Grid, 2007, all the existing bulk consumers (Consumers drawing power at 33 kV or above level) shall comply with the provisions of maintaining harmonics within the limit as prescribed in the IEEE 519-2014 standards. The Regulations has the following provisions for measurement of Voltage and Current Harmonics:

*"**(3) Voltage and Current Harmonics**.- (i) The limits of voltage harmonics by the distribution licensee in its electricity system, the limits of injection of current harmonics by bulk consumers, point of harmonic measurement, i.e. point of common coupling, method of harmonic measurement and other related matters, shall be in accordance with the IEEE 519-2014 standards, as amended from time to time;*

*(ii) Measuring and metering of harmonics shall be a continuous process with meters complying with provisions of IEC 61000-4-30 Class A.*

*(iii) The data measured and metered as mentioned in sub-paragraph (ii) with regard to the harmonics, shall be available with distribution licensee and it shall also be shared with the consumer periodically.*

*(iv) The bulk consumer shall install power quality meter and share the recorded data thereof with the distribution licensee with such periodicity as may be specified by the appropriate Electricity Regulatory Commission:*

*Provided that the existing bulk consumer shall comply with this provision within twelve months from the date of commencement of the Central Electricity Authority (Technical Standards for connectivity to the Grid) (Amendment) Regulations, 2019.*

8. It is respectfully submitted that as per the amendments to the Technical Standards for Connectivity below 33 kV Regulations, 2013, the limits of injection of current harmonics at the point of common coupling by the user, method of harmonic measurement and other such matters, shall be in accordance with the IEEE 519-2014

standards. This regulation is applicable to all the generating companies or persons owning distributed generation resources, charging stations, prosumers or persons who are connected to or seeking connectivity with the electricity system below 33 kV voltage level. This Regulation has the following provisions for measurement of Voltage and Current Harmonics:

***"11. Standards for distribution generation resources and prosumers, when acting as a generator. –*** *Harmonic current injections from a generating station shall not exceed the limits specified in IEEE 519.*

***11 A. Standards for charging station, Prosumer, or a person connected or seeking connectivity to the electricity system.-***

*(1) The applicant shall provide a reliable protection system to detect various faults and abnormal conditions and provide an appropriate means to isolate the faulty equipment or system automatically.*

*(2) The applicant shall ensure that fault of his equipment or system does not affect the grid adversely.*

*(3) The appropriate licensee shall carry out adequacy and stability study of the network before permitting connection with its electricity system.*

*(4) The limits of injection of current harmonics at the point of common coupling by the user, method of harmonic measurement and other such matters, shall be in accordance with the IEEE 519-2014 standards, as amended, from time to time.*

*(5) The measuring and metering of harmonics shall be a continuous process with power quality meters complying with the provisions of IEC 61000-4-30 Class A.*

*(6) The data measured and metered as mentioned in sub-regulation (5), shall be available with the distribution licensee and be shared with the consumer periodically.*

*(7) The applicant seeking connectivity at 11 kV or above shall install power quality meters and share the recorded data thereof with the distribution licensee with such periodicity as may be specified by the appropriate Electricity Regulatory Commission:*

*Provided that the user connected at 11 kV and above shall comply with the provision of this sub-regulation within twelve months from the date of commencement of the Central Electricity Authority (Technical Standards for connectivity of the Distributed Generation Resources) (Amendment) Regulations, 2019.*

9. In view of the above amendments to the Regulations of the Central Electricity Authority, it is proposed to follow the following methodology for measurement of Harmonics in respect of < 33 kV / ≥ 33 kV electricity service connections of the TANGEDCO:

1. In order to impose new standard for measurement of harmonics as per the IEEE 519-2014, TANGEDCO shall give advance three months notice to all HT/EHT consumers. On measuring the harmonics after three months notice period at the consumer site and if the limit of the harmonics is found in excess of the limit prescribed in IEEE 519-2014, TANGEDCO may levy the penal charges from the date of completion of three months notice period.

2. It is respectfully submitted that till finalization of new methodology for measurement of harmonics, TANGEDCO proposes to follow the existing methodology for measurement of harmonics with the consumers of voltage level of 33 kV or above.

3. The periodicity, method of measurement, etc. proposed by the TANGEDCO considering IEEE 519-2014 standards for both categories of consumers (below 33 kV and 33 kV or above) are as below:

**A. Instrumentation:**

Portable Power Quality Analyzer of Class A type. (Based on IEC 61000 Part 4-7 & IEC 61000 Part 4-30)

**B. Measurement Procedures**

**(i) Point of Evaluation:** (Based on IEC 61000-3-6)

The Point of Evaluation shall be at the Point of Common Coupling or at the control room for measurement convenience due to longer period of measurement and safety of the measuring equipments. When measurement is undertaken at the control room it shall be representative of the voltage class of PCC.

**(ii) Duration of Measurement** (Based on IEC/TR 610003-6)

a. The duration of measurements shall be 4 hours
b. The duration shall be extended if necessary to capture the harmonics in a minimum of two operating cycle of the respective service.

**(iii) Current at the time of Measurement**

The measurement shall be undertaken while the consumer services are operating at a minimum of 75% of their average maximum demand current of the respective HT / EHT service.

The average maximum demand shall be calculated based on the past 12 months readings or from the number of months for which they were in service, if the service period is less than one year.

**(iv) Parameter to be measured**

The "Average" values of the following parameters shall be measured with 10 minutes aggregation, for the duration specified above.

1) Individual Harmonic distortion - Voltage ($IHD_V$)
2) Total Voltage Harmonics – Voltage ($THD_V$)
3) Total Harmonic Distortion – Current ($THD_I$)

From the value of Total Harmonic Distortion – Current ($THD_I$), through the Power Log software, Total Demand Distortion (TDD) may be calculated by giving $I_L$ (average maximum demand current calculated based on the past 12 months readings) as an input.

95% probability value of the Individual and Total harmonic Distortion of the voltage ($IHD_V$ &$THD_V$) and Total Demand Distortion (TDD) shall be arrived and compared with the limits specified in IEEE 519.

The highest 95% value of a parameter, amongst the phases, shall be reported as the respective harmonic level of that parameter, for the service under measurement.

**C. Limit Values**

The limit of individual and Total harmonic Distortion of the voltage ($IHD_V$ & $THD_V$) Shall be as per Table 1 of IEEE 519, which is given below:

Table1-Voltage distortion limits

| Bus Voltage V at PCC | Individual harmonic (%) | Total harmonic Distortion THD (%) |
|---|---|---|
| $V \leq 1.0$ kV | 5.0 | 8.0 |
| 1 kV < $V \leq$ 69 kV | 3.0 | 5.0 |
| 69 kV < $V \leq$ 161 kV | 1.5 | 2.5 |
| 161 kV < V | 1.0 | 1.5 |

The limit of the Total Demand Distortion of the current (TDD) shall be as per IEEE 519, as rewritten in the following Table:

| $I_{SC}/I_L$ | TDD | |
|---|---|---|
| | 11/22/33 kV | 110 kV |
| <20 | 5.0 | 2.5 |
| 20 < 50 | 8.0 | 4.0 |
| 50 < 100 | 12.0 | 6.0 |
| 100 < 1000 | 15.0 | 7.5 |
| > 1000 | 20.0 | 10.0 |

| $I_{SC}/I_L$ | TDD |
|---|---|
| | 230 kV |
| < 25 | 1.5 |
| 25 < 50 | 2.5 |
| ≥ 50 | 3.75 |

**D. Calculation of $I_{SC} / I_L$**

The value of $I_L$ (average maximum demand current) may be calculated based on the past 12 month's readings. The value of % impedance and the value of upstream source impedance may be considered for the calculation of $I_{SC}$ and the following procedure shall be followed:

1. The rating, voltage ratio, secondary current and % impedance values from the name plate of the upstream transformer (one transformer from which the HT industry under consideration is fed from the respective sub-station) may be noted for calculation.

   For example, let us consider a 11 kV industrial consumer, drawing an average demand current of 25 A fed from a 33 kV source sub-station via a 8 MVA rating, 33 / 11 kV voltage ratio, 420 A secondary current and Z = 7%;

2. The upstream source short circuit apparent power shall be considered from the Table 2 of IEC 60076-5 specified for the 'European Practice', which is reproduced here for immediate reference.

| Rated Voltage | Highest system voltage | Short circuit MVA |
|---|---|---|
| 11, 22 kV | 12, 24 kV | 500 |
| 33 kV | 36 kV | 1000 |
| 110 kV | 123 kV | 6000 |
| 230 kV | 245 kV | 20000 |

### 3. Model Calculation:

| | |
|---|---|
| Rated voltage of the consumer | 11 kV |
| Sub-station voltage, where the consumer is fed from | 33 kV |
| Upstream transformer rating at the sub-station | 8 MVA |
| Rated secondary current of the transformer | 420 A |
| % impedance of the transformer | 7% |
| Short circuit MVA of the 33 kV source as above | 1000 MVA |
| % impedance of the source with respect to the consumer side of the transformer | {8/1000} x 100 = 0.8% |
| Total impedance (Transformer + source) | 7% + 0.8% = 7.8% |
| $I_{SC}$ calculated | {420 x 100}/7.8 = 5385 A |
| $I_L$ (Average demand current) of the industry | 25 A |
| $I_{SC}$ / $I_L$ of the respective industry | 5385 / 25 = 215.4 |
| **Conclusion** | |
| (i) Individual voltage harmonic limit | 3% |
| (ii) Total voltage harmonic limit | 5% |
| (iii) Total demand distortion limit | 15% |

**E. Compensation charges:**

Compensation charges shall be imposed, as per the recommendation of Hon'ble commission, if the values of the measured harmonic parameter exceed the limit stipulated in IEEE-519, in any of the following in any phase of the consumer service:

- Total Demand Distortion as % of $I_L$
- Individual Voltage Distortion as a % of fundamental V.
- Total Voltage Distortion (THD) as a % of fundamental V.

**F. Periodicity:**

Measurement to be carried out once in a year or as per requirements in specific cases.

10. It is respectfully submitted that in the suggested methodology for measurement of harmonics, the Committee after studying the entire procedure prescribed in IEEE 519-2014, has suggested a slightly modified procedure, which is suitable for practical implementation and requires approval of the Hon'ble Commission and the suggested procedure will not have any drawbacks to the consumers. The proposed modifications are summarized as below:

1. Instead of measuring individual current harmonics, TANGEDCO proposes to measure only Total Demand Distortion (TDD) since TDD is a collective representative of all the individual current harmonics. Further, converting the individual current harmonic measured with the base of fundamental current to the base of $I_L$ (Maximum average demand load current for 12 months) will be a cumbersome process.

2. **Statistical evaluation -** The IEEE 519-2014 states that very short and short time harmonic values should be accumulated over periods of one day and one week, respectively. For very short time harmonic measurements, the 99$^{th}$ percentile value should be calculated for comparison with the recommend limits. For short time harmonic measurements, the 95$^{th}$ and 99$^{th}$ percentile values should be calculated for comparison with the recommended limits. These statistics should be used for both voltage and current harmonics with the exception that the 99$^{th}$ percentile short time value is not recommended for use with voltage harmonics.

   To study the measurement variations in different durations, a Committee was formed by TANGEDCO comprising officers from the various wings and the Committee made the following observations:

   The measurement readings taken for 24 hours along with the split readings in the 6 x 4 hours were taken for analysis. During the analysis, it was found that the harmonic readings are not deviating much at 24 hours sample and 4 hours sample. Therefore, considering the practical feasibility and considering the safety of the measuring equipments at the consumer premises, the Committee suggested having 4 hours measurements with 10 minutes aggregation and with 95 percentile probability is suitable.

11. The Petitioner/TANGEDCO pays a sum of Rs.10,000/- as per TNERC Fees & Fines (Amendment) Regulations 2011 dt.04.02.2011, vide Canara Bank Cheque No. 290668, dt:24-02-2020.

Under these circumstances, the TANGEDCO humbly prays that this Hon'ble TNERC may be pleased to:-

(i) Approve the new methodology discussed in para 9 above for measurement of Harmonics with the HT / EHT consumers as per the following Central Electricity Authority Regulations:
   1. Technical standards for connectivity to the Grid (Amendment) Regulations, 2019 and
   2. Technical Standards for connectivity below 33 kilovolts (Amendment) Regulations, 2019;

(ii) Fix the compensation at 15% of the respective tariff in respect 11 kV and 22 kV consumers as fixed for bulk consumers of voltage level of 33 kV or above, when the consumer fails to provide adequate harmonic filtering equipment to avoid dumping of harmonics into Licensee's network beyond the permissible limits as specified by CEA regulations;

(iii) To instruct all the HT/EHT consumers by the TANGEDCO to install power quality meters by themselves within 12 months from the date of commencement of the amended Regulations as prescribed in this CEA Regulations so as to share the recorded data with the TANGEDCO as per the periodicity specified by the Hon'ble Commission as stipulated in the CEA amended Regulations.;

(iv) To effect new HT / EHT service connections by the TANGEDCO only on installation of power quality meters by the applicant in their premises;

(v) Pass such further or other orders as the Hon'ble TNERC may consider deemed fit and proper and thus render justice.

Sd./-xxx
Chief Engineer/Commercial
Before me

Solemnly affirmed at Chennai on this )
26th day of February 2020 and the )
deponent has signed his name in my )
presence. )

Sd./-xxx
Advocate

**BEFORE THE HONOURABLE TAMILNADU ELECTRICITY REGULATORY COMMISSION, CHENNAI**

**M.P. No. 22 of 2020**

**Affidavit filed on behalf of the Petitioner TANGEDCO**

**M/s. M. GOPINATHAN**
**COUNSEL FOR TANGEDCO**