



# TAMIL NADU ELECTRICITY REGULATORY COMMISSION

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## PRESS RELEASE

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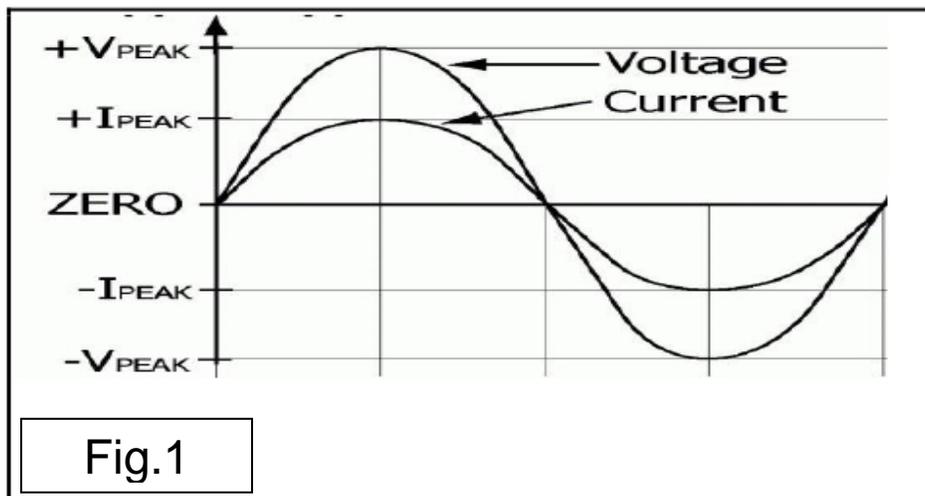
### HARMONIC CURRENTS IN CONSUMER INSTALLATIONS CAUSES, EFFECTS AND REMEDIES

#### What is HARMONICS?

The voltage supplied to the consumer point of supply from the generators will be in pure sine wave form. But the shape of the current wave will be changed in accordance with the electrical loads of the consumer. The voltage fed to the consumer loads such as motors, heaters etc., and the current drawn by them will be in sinusoidal form. Hence these loads are termed as linear loads. The non-linear loads are the causes for Harmonics.

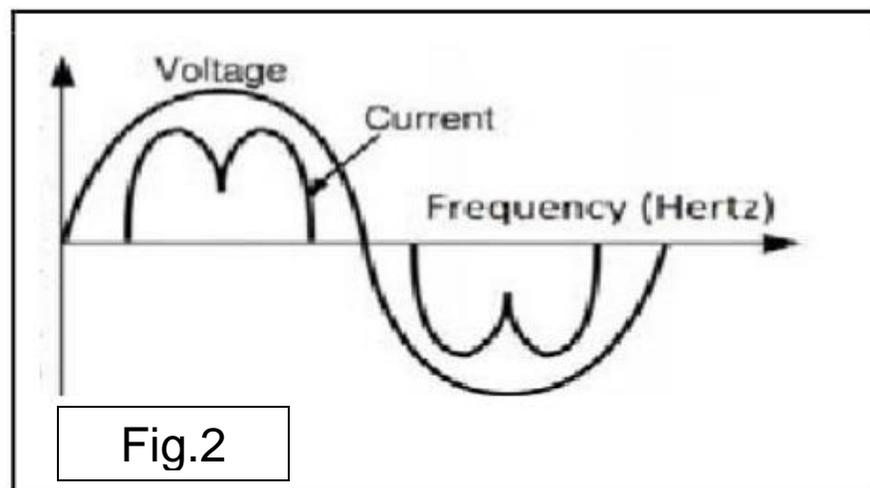
The flow of harmonic currents through system impedances in turn creates voltage harmonics, which distort the supply voltage. The presence of harmonics in electrical systems means that currents or voltages with frequencies that are integer multiples of the fundamental power frequency which are distorted and deviate from sinusoidal waveforms.

The typical voltage and current wave form of linear loads is shown as below:



Nowadays, modern equipment and devices installed at industries, offices, residents and commercial establishment are manufactured with electronic circuits to derive a number of advantages. The equipment and devices comprising electronic circuits are categorized under non-linear loads. These non-linear loads draw a non-sinusoidal current from the sinusoidal supply unlike linear loads without in built electronic circuits. The linear loads, such as heaters, motors, etc., draw current in sinusoidal form.

Instead of that, if the consumer loads have electronic circuits, then the wave form shape of the current wave will be distorted. Hence the loads having electronic circuits are called as non-linear loads. For example, if a non-linear load is supplied with pure sine wave form, it will draw current in distorted wave form as shown below:



The power electronics based devices such as Variable Frequency Drive (VFD), Switched Mode Power Supply (SMPS) and other electronic devices are some of the examples of non-linear loads.

The irregular non-sinusoidal current waves can be mathematically resolved into a number of regular sine waves and each sine wave, leaving the one sine wave with supply frequency called fundamental, could be analysed for their evil effects. These sine waves, other than fundamental, are termed as harmonics.

In a simple description, Harmonics is an unavoidable necessary evil. Anyhow, these Harmonics shall be restricted within the limit prescribed in the IEEE standard 519-2014.

The non-sinusoidal current drawn by the electronic circuits produce evil effects to

- (1) Respective consumers possessing non-linear loads,
- (2) Power supply Generators/Distributors, and
- (3) Other consumers.

### **EVIL EFFECTS OF HARMONICS:**

The following evil effects are caused by the harmonics to (1) the consumer who possess the corresponding non- linear loads (which is the very cause of harmonics), (2) the power supply generators/Distributors and to (3) other consumers:

- Very high current flow in neutral conductor due to which cable with 3.5 Core could get punctured.
- More voltage between neutral and earth instead of zero, which reduces the electrical safety.
- Reduction in current carrying capacity of the conductor. Hence higher sized conductors are to be used.
- Reduced life of transformers.
- Reduced power factor and failure of power factor correction capacitors.
- Inaccurate meter readings.
- Higher losses in motor, more heating and development of cracks in motor shaft.
- Nuisance breaker tripping.
- Mal function of protective relays.
- More losses and hence higher electricity bills.
- Due to distorted current, the sinusoidal voltage wave form also gets distorted resulting in low quality power supply and inefficient distribution system.
- Increased maintenance costs etc.,

**Mitigation/Remedies of Harmonics:**

To mitigate this evil effect completely, the consumer requires more investment, besides some technical reasons. The harmonics can be brought down by installing suitable Harmonic filters to a desirable level / limits. They cannot be eliminated altogether in view of techno-economic reasons.

The IEEE (Institute of Electrical and Electronics Engineers Association) standard organization has released IEEE 519-2014 standard comprising Harmonic definition and its control. To find out and mitigate the evil effects of Harmonics, and to design the required Harmonic filters, the distorted sine wave shapes have been analyzed and mathematically resolved using Fourier transformation. The harmonics up to 50<sup>th</sup> order is derived. The harmonics above 50<sup>th</sup> order is least significant.

Based on the IEEE 519-2014 standard and the corresponding Harmonic control guidelines issued by CEA, New Delhi, the Tamil Nadu Electricity Regulatory Commission, (TNERC) has notified Regulations for Harmonic control and Gazetted in Tamil Nadu Government Gazette on 21.09.2022 for implementation.

**MANDATORY REGULATIONS IN LIMITING THE HARMONICS:**

Tamil Nadu Electricity Regulatory Commission has provided a mandatory regulation in the supply code for current harmonic control with detailed procedure for measurement of harmonics, limits applicable, time for installing filters, time with penalty and ultimately disconnection of supply for non-compliance. This regulation is applicable as below:

- (1) All bulk consumers of 33kV and above voltage level,
- (2) All consumers and prosumers at 11kV and 22kV,
- (3) Charging stations.

The licensee shall measure the harmonics level at the point of common coupling of a consumer/prosumer/charging station to assess, if the harmonics is higher than the prescribed limit mentioned in the IEEE standard 519-2014;

- (1) If the measured value exceeds the limits, Licensee shall issue a notice to the consumer to reduce the harmonics level within the prescribed limit by installing adequate harmonic filters within six months.
- (2) The notice shall also convey that in case of non - compliance, penalty at the rate mentioned in the following table will be levied by the Licensee for the subsequent 12 months and there after supply to the service shall be disconnected in case of noncompliance even after the said 12 months.
- (3) A penalty of a maximum of 10% in steps of 1% increase will be levied on the monthly current consumption charges as shown below;

| TDD excess over and above the limit | Penalty on the monthly current consumption charges |
|-------------------------------------|--|
| Up to 3%                            | 1%   |
| Above 3% up to 6%                   | 2%   |
| Above 6% up to 9%                   | 3%   |
| Above 9% up to 12%                  | 4%   |
| Above 12% up to 15%                 | 5%   |
| Above 15% up to 18%                 | 6%   |
| Above 18% up to 21%                 | 7%   |
| Above 21% up to 24%                 | 8%   |
| Above 24% up to 27%                 | 9%   |
| Above 27% up to 30%                 | 10%  |
| Above 30 %                          | 10%  |

- (4) In case the harmonics is not brought within prescribed limits even after 12 months, the Licensee shall issue a 30 days supply disconnection notice to the consumer/prosumer/Charging station for non-compliance.
- (5) In case the harmonics is not brought within the prescribed limits within the above notice period, the Licensee is at liberty to disconnect the supply under report to the Commission.
- (6) For new service connection, the intending consumer/prosumer shall attach a self declaration form along with the application for installation of the harmonic filter. After 12 months from the date of giving new service connection, the Licensee

shall measure the harmonics level and if it is not within the prescribed limit, the further procedures shall be as per (1) to (5) summarized above.

(7) This regulation is not applicable to HT tariff IV (Lift irrigation).

Even though the non-linear loads are the main cause for current harmonics, due to the following benefits, the usage of non-linear loads are unavoidable.

- (a) Higher efficiency
- (b) More savings.
- (c) Less machinery heating.
- (d) Less maintenance cost.
- (e) Good controllability.
- (f) Remote operation etc.,

However, by installing the appropriate harmonic filter equipment, the harmonics can be controlled within the prescribed limit and penal charges can be avoided. As a result, all consumers will get quality power supply.

-Sd/-  
(Dr. C. VEERAMANI),  
Secretary,  
Tamil Nadu Electricity Regulatory Commission.