IEEE-519 Background

To minimize the impact of facility harmonic distortion on the utility power system and on neighboring facilities, IEEE-std-519 was developed and published in 1982. It was updated and re-published in 1992, and again in 2014.

Input current waveform
(6-pulse rectifier)

By 1982, it had become evident that power electronics equipment was contributing to power system voltage distortion. The power electronics based energy saving products, such as adjustable speed motor drives, were not drawing current in the normal continuous and sinusoidal manner, but instead were taking discontinuous gulps of current. This current distortion causes power system harmonic voltage distortion. The pulsed current waveforms contained not only the 60hz components but also multiple higher frequencies called harmonics. Effects of the distorted current included high peak current, elevated true rms current and lower total power factor. The bottom line was that although energy saving equipment was being employed, the user was not achieving the maximum energy savings due to the production of wasteful harmonic energy.

Facility managers also noticed that the harmonics could have an ill effect on equipment life. Elevated trms current (thermal current) increased the I^2R losses and increased equipment heating , leading to reduced life of motors and transformers. When the continuous operating temperature of this equipment is increased by only 10 degrees Celsius, it's life expectancy decreases by as much as fifty percent.

IEEE-519 Requirements

IEEE standard 519 provides recommended limits for total harmonic voltage and current distortion. The following chart indicates the limits for harmonic current distortion imposed by this standard. The limits are based upon the ratio of available short circuit current (I_{SC}) to the maximum demand load current (I_L). This analysis is often performed at the point where a facility power system is connected to the electric utility power system. This point is referred to as the Point of Common Coupling or Point of Common Connection (PCC). The standard also allows one to evaluate the harmonics at any point within the facility, where linear and non-linear loads meet. This may be the secondary of a supply transformer.

I_{SC} / I_L Ratio	< 11	$11 \le h < 17$	$17 \le h < 23$	$23 \le h < 35$	$35 \le h$	TDD-I Limit
< 20	4.0	2.0	1.5	0.6	0.3	**5%**
20 < 50	7.0	3.5	2.5	1.0	0.5	**8%**
50 < 100	10.0	4.5	4.0	1.5	0.7	**12%**
100 < 1000	12.0	5.5	5.0	2.0	1.0	**15%**
1000 up	15.0	7.0	6.0	2.5	1.4	**20%**

Table 2 (IEEE-Standard-519)

Explanation of IEEE-519 Distortion Limits

The appropriate Total Demand Distortion (TDD) limit is determined by the ratio of available short circuit current to the demand current (I_{SC} / I_L). The TDD is the RMS harmonic current as a percent of maximum demand load current (15 or 30 minute demand). The standard suggests that the load current (I_L) should be calculated as the average current of the maximum demand for the preceding 12 months. The actual measurement that one takes with a typical harmonic analyzer is a snapshot and provides an instantaneous measurement that is referred to as Total Harmonic Distortion (THD), not TDD. TDD will take into account various operating conditions that take place during operation of multiple pieces of equipment (loads).

The middle section of the chart indicates the maximum allowed magnitude for individual harmonics. For example, if the TDD limit is 15%, then the RMS value of the magnitude of all harmonic currents must be equal to or less than 15% of the fundamental frequency demand current. Additionally, the magnitude of each harmonic frequency below the 11^{th} must be 12% or less, the magnitude of harmonics including 11^{th} thru 17^{th} must be 5.5% or less (with respect to the fundamental frequency demand current).

Voltage distortion limits established by IEEE-standard 519 are:

3% THD-v for hospitals and airports,

8% THD-v for general systems, and

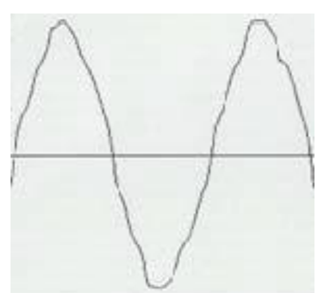
10% THD-v for dedicated systems (where 100% of the load is non-linear).

Complying with IEEE-519 Limits

The objective of the standard can be met by applying harmonic mitigation techniques either at the PCC or at appropriate points downstream from the PCC. Applying harmonic filters near the PCC improves the power quality for all points upstream (the utility and other facilities connected to the same utility distribution system). When the PCC is at the metering point, service entrance, or main transformer, the typical limits for harmonic current distortion are 5% and 8% depending on the transformer impedance and demand current.

When harmonic mitigation equipment is applied closer to the individual harmonic producing loads, the power quality can be improved throughout the facility as well as upstream. For the purpose of improving the internal power quality, IEEE-519, 10.1 states that “within an industrial plant, the PCC is the point between the non-linear load and other loads.” When the PCC is at an individual piece of equipment, the typical limits for harmonic current distortion are 8%, 12% or 15%.

APQ offers a full range of solutions for harmonic distortion. Based on a careful analysis of facility power system and a clear understanding of the customer’s objectives, APQ can recommend the best technical and economical solution. Rather than simply improving the power quality at the utility connection point (with the benefit only going upstream), the installation of harmonic mitigation equipment at major individual loads can meet utility objectives as well as improve the power quality within the facility.



Input current waveform (6-pulse rectifier with APQ Low Pass Harmonic Filter

The potential internal benefits, for filtering harmonics at individual loads, include: increased equipment life, reduced power losses, improved equipment operation, reduced equipment down time, reduced equipment interference, and ultimately — increased productivity and operating profits.