11. What other forms of harmonic treatment are available for VFDs?

There are various methods presently available for treatment of VFD harmonics. Each has its advantages and disadvantages but none can achieve the price/performance level of the LINEATOR™.

Reactors and chokes are a relatively low cost solution but are only moderately effective and their high impedance can introduce trouble-some voltage drops.

Conventional tuned or trap filters, as their name implies, require tuning to a specific harmonic frequency. Their effectiveness is marginal unless multiple tuned elements are incorporated. Also, they are prone to problems such as resonance with other system components, importation of harmonics from upstream non-linear loads and a leading power factor.

By treating a wider spectrum of harmonics, broad-band filters are more effective than tuned filters but can also be more expensive. Although they address some of the issues associated with tuned filters, they are not trouble-free. Specifically, their large series inductor necessitates the use of a large capacitor bank to compensate for the voltage drop. These capacitors create a leading power factor which has been known to cause excitation control problems with generators.

	REACTOR	TUNED FILTER	LOW-PASS FILTER	MULTI PULSED	PHASE SHIFTING	ACTIVE FILTER	LINEATOR AUHF
Current Distortion	< 35%	< 15%	< 12%	< 12%	< 15%	< 5%	< 8%
Effective without Multiple Loads	Yes	Yes	Yes	Yes	No	Yes	Yes
Meets IEEE 519	Rarely	Maybe	Maybe	Maybe	Maybe	Yes	Yes
Attracting Upstream Harmonics	No	Yes	No	No	No	No	No
Engine Generator Compatibility	Partial	No	No	Yes	Yes	Yes	Yes
Inherent Transient Suppression	Yes	No	Yes	No	No	No	Yes
Efficiency	High	Moderate	Moderate	Moderate	Moderate to High	Low	High
Reduction in TIF Factor	Moderate	Moderate	High	Moderate	Moderate	High	High
Physical Size	Small	Large	Large	Very Large	Moderate to Large	Very Large	Moderate
Connection	Series	Parallel	Series	Series	Series	Parallel	Series
Price	Low	Moderate to High	High	High	Low to moderate	Very High	Moderate

Figure 11-1: Comparison Table of Various Forms of Harmonic Treatment for VFD's

In multi-pulsed systems, the drive manufacturer will phase shift between multiple front-end rectifiers to cancel harmonics. Some 18 and 24 pulsed systems can achieve Total Harmonic Current Distortion (THID) of < 8%, but they require a larger footprint and can become quite expensive.

Phase shifting transformers can be a very cost effective method of harmonic treatment but require multiple 6-pulse rectifier loads operating simultaneously. A quasi 12-pulse scheme (ie. cancellation of 5^{th} & 7^{th} harmonics) can be created by phase shifting one VFD against a second similar VFD. 18 and 24 pulse schemes require three and four VFD's respectively.

Active filters treat harmonics by measuring the level of harmonic current present in the system and injecting currents of opposite polarity to cancel them. Excellent performance can be achieved but reliability is sometimes an issue and their high cost normally makes their use prohibitive.

Table 11-1 provides a comparison of the various forms of VFD harmonic treatment for different parameters.