

Harmonic voltages can cause problems in user equipment. AC motors, for instance, can overheat as they have a tendency to absorb harmonics. That's actually quite a positive thing about AC motors, providing they can tolerate the absorption, they have the effect of cleaning the system. But that's only if you're using completely conventional magnetic AC motors. Then you've got power-factor circuits that can go wrong, as they don't like harmonics.

The position in law is that harmonics are tolerated from phase-angle dimmers because it is the prevailing technology and if they had been forbidden there wouldn't be any dimming, for the most part. So while it is permitted to connect this harmonic polluting equipment, you have to have both a concession from the electricity authority, and a low enough impedance power supply to minimise the harmonic voltage.

You can measure harmonics; it is possible to purchase a meter with probes that you just put on your facility and it will give you readings directly of how many percent of which given harmonic you've got.

Total harmonic distortion (THD) is a term that you might come across. And unlike normal ranges of distortion, in this case it can go above 100%. It's the proportion of harmonics relative to the fundamental. If you don't have much fundamental, the THD can be very high. If you've got *no* fundamental, the THD can be infinite.

You can't eliminate harmonic current coming out of a phase-angle dimmer. There is nothing that can be done about it. You can't filter it; there's nothing you can do. What you can do is you can minimise the effect that it has on the system in producing harmonic voltages that can interfere with equipment, and essentially you do that by getting the impedance of the power supply as low as possible. Filtering doesn't work, because the harmonics vary according to the settings of the dimmers. If you designed a filter that was tuned for, say, the 3rd harmonic, to reject it at one level, you could set all your dimmers at another level and the harmonics would all be completely out of phase, and that filter could, in fact, make the situation worse. It could even resonate and actually produce more pollution. And in any case, it would be absurdly big – by which I don't mean the size of a dimmer rack, I mean the size of the whole dimmer room – to filter the sort of currents that are often in use in theatres.

Large installations must obtain consent from the electricity supplier:

- The supplier has the right to refuse connection of a large dimmer system to an unsuitable supply.
- The criteria measured is the 'RSCE' or the ratio of short-circuit current to service current. High short-circuit current indicates a low supply impedance.

A low-impedance supply is the most important aspect in a new theatre building or in a new installation of dimming equipment. You need to have a very direct route with heavy wiring to the substation transformer. There are other systems available. The Royal Opera House, for instance, has a very large power supply system which is feeding IT equipment and machinery and so on. It has harmonic cancelling amplifiers installed. These are devices that sense what is being put onto the mains as a harmonic current and literally inject the reverse phase current of that particular harmonic to cancel it out. They're quite expensive, they're quite difficult to set up and they're not really necessary if you've got a good low-impedance supply.

You may come across harmonic cancelling transformers, but in fact they don't work with dimmers; they're designed for fixed loads, and like things worse on won't be tuned to the combination of harmonic on the dimmer. Pass on chokes and conditioners will have a huge variation of levels from dimmer

Also, do ensure There could be 2 neutral than you

Specify over-sized neutrals; at least the next size up from the calculated correct size for the phases. Use 3-pole circuit breakers with hard neutrals or, if you're going to use a 4-pole circuit breaker expect it to have only about 80% of its rating. And run private wiring for dimming separated from other supplies to prevent pollution interference. Run separate feeds for the dimmers all the way from the 'point of common coupling'. And if you are providing new supply transformers, specify 'K' rated types with enhanced harmonic tolerance.

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*Theatre people often use things about which they only have skant knowledge and this chapter gives some real background to electrical power, power factors and costs, before going on to examine electrical harmonics and the effect they can have on electrical supplies and distribution wiring. The effects of both dimmers and variable motor drives are examined and the chapter ends with a paper on safety and earthing.*