

Procuero

■ ■ ■ ■ ■ To take care of, to manage

ENERGY SAVING AND EQUIPMENT LIFE PROLONGATION BY VOLTAGE REDUCTION

Background

Electrical equipment has to be designed to accept a range of input voltages about its nominal design centre, but if the actual supply is higher than necessary for proper operation, the equipment will consume more power than needed, and also in many cases life is reduced - both increasing the cost of ownership.

However, the stability of the UK supply mains has always been reasonably good, but is likely to degrade as competition and decreasing profitability forces generators to take capacity off-line and indeed to decommission power stations.

European Voltage Harmonisation

The United Kingdom for many years had a standardised supply voltage of 240V $\pm 6\%$ (415V for three-phase) whereas continental Europe had a nominal supply level of 220V (380V). From 1 January 1995 the nominal voltage across Europe has been 'harmonised' at 230V/400V.

This is not a real change, since the former 240V countries, including the UK, have in the first stage of voltage harmonisation a tolerance of 230V -6% to +10% (i.e. 216.2 - 253V) as compared with the 'old' limits of 240V $\pm 6\%$ (i.e. 225.6 - 254.4V). However, the former 220V countries (most of Continental Europe) have limits of 230V -10% to +6% (207 - 243.8V).

The Electricity Safety, Quality and Continuity Regulations 2002, which came into force on the 31st January 2003, replacing The Electricity Supply Regulations 1998, formally confirm the UK standardised supply voltage tolerances at 230V -6% to +10%.

Plans to harmonise the whole of Europe to 230V $\pm 10\%$ (i.e. 207 - 253V), which were due to be applied from 1st January 2003, have been postponed until 2008 at the earliest. Despite this postponement, any equipment intended for use anywhere in Europe and carrying the 'CE' mark will have to be capable of working over this wide range. Furthermore, the Institution of Electrical Engineers recommended in a 1996 report that for safety all electrical equipment needed to be tested across the range 230V +10% to -14%. This allowed for the lower and higher limits plus an allowance of 4% for voltage drops within the installation.

More significantly, because the old UK limits of 225.6 - 254.4V lie almost entirely within the new limits of 216.2 - 253V, there has been no incentive at all for the suppliers of 415/240V nominal AC mains power to make a real change, just to 're-label' the supply nominal and tolerances.

(Intriguingly, there has been one example of a necessity for a 'real' change: 250V nominal (440/254V three-phase) supplies, found particularly in Scotland, are definitely outside the new limits, and in this case it has made sense to make a genuine reduction, not to 240V but to the new 230V standard.)

Effects on Equipment

The main effect has been that imported equipment which would previously have been made specially for the UK 240V nominal supply is now designed either for the new 230V nominal or in many cases European manufacturers have assumed that equipment really designed for a 220V nominal can continue to be supplied into what is, after all, now a nominal 230V area. Since the real voltage continues to be 240V nominal, however re-labeled, much imported equipment is forced to operate in the UK on a higher voltage than it would in its country of origin - in the case of more recently designed equipment by about 10V but older designs in continued production receive some 20V more.

There is a further problem with equipment of North American origin. Many US and Canadian manufacturers continue to design their 'export models' for 220V but also fail to take adequate account of the supply frequency being 50 Hz as opposed to their 60 Hz. This is particularly seen in the design of power-supply transformers incorporated in such products.

The effects vary according to the type of equipment. Over-heating can occur as incorporated voltage regulators have to work harder. Supply transformers which are designed with minimally sized iron cores can easily go into saturation, especially toroidal designs. This can cause circuit breakers to trip on the excessive inrush current. Incandescent lamps have a non-linear characteristic which means only a small over-voltage can reduce their life expectancy markedly.

In addition, power consumption is unnecessarily high. A resistive load subjected to a 5% overvoltage will consume 10.25% more power. Subjected to a 10% increase in voltage the additional power consumption will be 21%.

It is therefore always worth checking whether equipment will operate at a reduced voltage, with likely beneficial effects both on equipment lifetime and the cost of power consumed. In some cases, if the supply voltage tends to vary this strategy may not be possible as the voltage sags may take the supply below the minimum operating voltage of the equipment. In such cases, stabilising or regulating the supply voltage will enable the equipment to work correctly and will simultaneously allow the supply voltage to be chosen to optimise equipment life and also energy consumption.

Solutions

(a) Voltage Stabilisers

If a voltage stabiliser is fitted, the output voltage setting (usually 240V or more recently 230V in the UK) can be set down to 220V. Even the fact that recently supplied stabilisers will usually be factory preset to 230V rather than 240V will be a help in itself. Because an automatic voltage stabiliser self-adapts, it overcomes the problems caused by the electricity generator reducing the supply voltage to limit demand at peak times.

(b) Distribution transformer tapings

If you have the luxury of 'importing' your electricity at medium voltage (6.6 or 13.2 kV for example) and have your own site distribution transformer, then you can probably also reduce the voltage for energy saving and equipment life prolongation without cost. Distribution transformers are usually fitted with primary taps at, for example, +5%, +2½%, 0%, -2½% and -5% and it may simply be possible to arrange to use taps for a higher nominal MV supply voltage, thus reducing the LV output voltage (e.g. 415V to 400V).