AUTOMATIC TRANSFER SWITCH

OVERLAPPING NEUTRAL CONTACTS

ENGINEERING BRIEF

Numerous articles have been written concerning the presence of dangerous voltage transients that supposedly occur whenever the neutral conductor of an automatic transfer switch is switched from one source of power to the other without the benefit of an overlapping neutral contact arrangement. These claims are totally unfounded.

To attribute the possibility of load damage to simultaneous switching of all power conductors, including the neutral conductor, indicates lack of understanding of the transient phenomena attendant to the use of high speed interrupting devices. A static voltage unbalance would occur only as the result of long term neutral open conditions. Such is not the case for a properly designed automatic transfer switch, regardless of the manufacturer.

Switching Time

It is essential to put the circuit analysis into proper perspective with regard to contact switching time - the most important element so often overlooked.

The duration of the switching action is so short with respect to the period of the 60 HZ waveform, that the duration of any voltage unbalance is inconsequential. A transfer switch that is designed to switch all poles simultaneously provides a foolproof and completely safe transfer of all load conductors.

Neutral Contact Erosion

It has been stated that neutral contact arcing and erosion can result in eventual discontinuity at the neutral pole. This of course, is no more true for the neutral pole than for any of the phase poles!

It is safe to assume that if the switching device in question operated slowly enough to allow even a close approximation of the open neutral static unbalanced conditions described, the contacts of the switch could fail. It is a well-known fact that successful operation of any disconnect device, especially under reactive load conditions, is extremely dependent upon rapid "make" and "break" contact action with properly supported arc extinction. Therefore, any transfer switch maker must ensure that all switching contacts are adequately rated.

Generation of Transient Voltages

In order to generate transient voltages, there is a prerequisite that the load have the capability of storing electrical energy. Resistive load has no such characteristic, and therefore we will consider only the case of the inductive load. The energy stored in the transformer primary, secondary, and leakage reactances is certainly a small contributor to the transient situation. The largest contributor to possible transient voltage generation would be energy stored in large motor windings, or similar loads. However, inductive tests substantiate that no appreciable voltage transients occur upon switching of inductive load. It is quite apparent that the transient voltages normally found in distribution circuits in industrial or commercial installations are far more severe than those that might be generated in switching the neutral.

AC Power System Transients

It is a widely accepted fact throughout the electrical and electronic industry that power line transients occur randomly at all levels of distribution and may involve high lines as well as 115 volt branch circuits. They have been observed, recorded, and documented, particularly by manufacturers of sensitive electronic equipment which is dependent upon commercial power for normal operation. Crest voltages as high as 2500 volts have been recorded on 120 volt distribution lines. Induced voltages as high as 6KV from nearby lightning strokes have also been observed.

Fortunately, the majority of power system loads have inherent immunity against damage to power line transients, and the remaining critical loads can usually be economically protected by the manufacturer or user. Due to the immensity of modern industrial and residential AC power system grids and the complexity of randomly distributed transient - prone loads, it is impossible for utilities do not assume responsibility for transient phenomena for the most part.

Needless to say, the presence of voltage transients on power line conductors is not unusual under normal conditions, nor could it be construed as being abnormal during any routine switching action.

Need for True 4-Pole Switching

There may be a need to switch all conductors including the neutral to preserve the integrity of GFP (Ground Fault Protection) Systems when the ground fault detection must be applied on each source independently (as opposed to the load side of the transfer switch). It is important for the power system designer to select an automatic transfer switch designed to provide symmetrical switching of the load, regardless of initial normal load voltage and current balance or power factor.

Summary

1. The statement presented that neutral switching is dangerous unless accomplished with "overlapping contacts" is without foundation.

2. The assumption that erosion of a load switching contact will result in discontinuity and eventual disconnection of the neutral conductor is totally unrealistic , since the very same criticism must be applied to the other poles in the same switch.

3. Laboratory tests using resistive load circuitry as well as highly inductive loads switched by deliberately misaligned contacts are fully documented. Photographic proof clearly reveals the absence of any significant transient overvoltages or overcurrents at the loads in question.

4. The magnitude of AC voltage transients found on most all industrial, commercial, and residential power systems far exceeds anything which could be accountable to 4-pole transfer switches.

5. The neutral contact rating should have the same current and withstand capacity as the power poles to ensure system integrity. It should be noted that, if a manufacturer employs an overlapping neutral contact, it may be based upon cost-saving efforts, since the neutral contact is inferior to the phase contacts (it has no switching capability).