TRANSFER OF HIGHLY INDUCIVE LOADS
TIME DELAY NEUTRAL VS. INPHASE MONITOR

Among manufacturers of automatic transfer switch equipment, one of the most frequently and fervently contested operational issues involves the method employed to insure safe transfer of highly inductive loads between two non-synchronised power sources. When large motors or transformers are disconnected from a power source, residual voltage is maintained due to the generator effect created by a rotating motor or by the stored energy released from a transformer's windings or core. This residual voltage can cause extremely high inrush currents to occur when such loads are quickly reconnected to a non-synchronised source of power. The resulting effect, frequently described as "bumping" can initiate nuisance tripping of circuit protective devices or in extreme cases, cause mechanical damage to motor shaft and couplings.

Different transfer switch manufacturers address this problem with different operational methods: Time Delay Neutral (or Timed Transition) and In-phase Transfer (In-phase Monitor). A thorough analysis of the advantages/disadvantages of these two methods is outlined in Table 1 of this paper. It should become quite obvious after comparison of the two methods which should be preferred; however, the In-phase Monitor method continues to have acceptance with some specifying engineers. Most often such engineers state the slightly extended transfer time associated with the Time Delay Neutral method as the motivation for specifying the In-phase Monitor even with all of its inherent disadvantages.

The fact that a transfer switch is required in any given application implies the load circuits are critical in nature. The natural assumption seems to dictate that a fast transfer of such loads is more desirable. This reasoning may indeed be justified when transferring life safety load circuits such as life support systems, hospital surgery units, and similar critical care loads where sustained dead bus time is undesirable. However, even under this situation, CSA-Z32.4-M86 (Essential Electrical Systems for Hospitals) allows up to 10 seconds to restore power after interruption of the normal source. (Up to 2 minutes for non vital systems.

Since such loads are usually either purely resistive in nature or are mixed loads of lighting circuits and small motors where any residual voltage created by disconnected rotating motors is instantaneously dissipated through the resistive circuit, a fast transfer of power is permissible without concern for any potential "bumping" effect described

previously. The use of any transfer switch in such applications will yield dead bus times generally 30 cycles maximum which is more than adequate to insure continuity of service.

Conversely, highly inductive motor or transformer loads are less critical equipment loads such as air conditioning where life safety is not a factor. Increased dead bus times from 1 to 5 seconds in mid-transfer is usually more than sufficient to allow such loads to demagnetise to a level where reconnection will not precipitate the high current "bump". Slightly extended dead bus times, introduced by the Time Delay Neutral feature, not only are acceptable when transferring less critical equipment loads, but are desirable in view of the alternative inphase transfer method. It should be noted that proper electrical distribution system design mandates that life safety and equipment loads be served by separate transfer switches. Combining such loads on a common transfer switch could be in direct violation of the Canadian Electrical Code.

A common misconception exists that a fast transfer (10-30 cycles) will maintain continuity to motor loads. In reality most large poly-phase motors are equipped with starters which drop out in approximately 3/4 - 1 cycle when control power is removed. Therefore, the purported fast transfer of inductive motor loads via the In-phase Monitor method will in most cases drop the load during the dead bus transition time requiring the motors to be manually restarted. By the time restart is initiated, the motors will have demagnetised to a point where no bump other than that associated with normal start-up will occur upon reconnection of power. The time required to restart the motors, in effect, becomes an inherent time delay neutral period. The obvious question then becomes, "Why specify a control function (Inphase Monitor), involving a substantial cost addition with added complexity, to the transfer switch, when the only possible benefit is a fast transfer operation which is negated by the fact that motor load circuits may have to be manually restarted anyway?"

Many transfer switch manufacturers offer either method of addressing the transfer of highly inductive loads. In fact, one manufacturer offering both the Time Delay Neutral and In-phase Monitor functions strongly recommends the former due to problems encountered with inphase transfer. Another manufacturer offers the Inphase Monitor exclusively, not as a result of the belief that this method is superior to the Time Delay Neutral, but rather as a result of the design limitation in the power switching panel's inability to achieve a neutral position necessary to employ the timed neutral transfer.

Cutler-Hammer offers one of the fasted transfer times (5 cycles) of any transfer switch manufacturer in the industry by using the Systems POW-R Transfer Switch. We do offer the In-phase Monitor function on this type of switch in order to meet our competitors specifications. However, we recommend that our customer employ the more economical Time Delay Neutral / Load Voltage Decay method of transfer. Transfer to the alternate source is prevented until the load voltage has decayed to 30% of nominal thus assuring safe and reliable transfer of highly inductive loads.

If you wish to avoid intentional interruption of power when both sources of power are available you may wish to consider Cutler-Hammer's all new Closed Transition automatic transfer switch. (Reference #B15A01SE.)

TABLE 1
INPHASE MONITOR

This method of transfer of highly inductive loads relies upon a synchronization check relay to inhibit load transfer until the two power sources are within 15 electrical degrees of synchronism. The transfer switch logic is given a signal by the relay in anticipation of phase angle alignment supposedly resulting in a near synchronous transfer.

Advantages

1. Transfer of load is theoretically accomplished without an appreciable power interruption when the system is properly adjusted.

Disadvantages

1. The lnphase Monitor is a passive control device. The inphase transfer is dependent upon the proper functioning of the emergency generator governor. If a frequency difference greater than 2 Hz exists between the two power sources, a transfer operation cannot occur.
2. The complexity and proper adjustment of the lnphase Monitor complicate its application in an otherwise simple relay control system.
3. The lnphase Monitor typically adds 2-3 times the cost to the transfer switch as compared to the Time Delay Neutral method.
4. Should the connected source fail while the opposing power source is available, there is no protection against an out-of-phase transfer. If the bump associated with such a transfer operation should cause the system's circuit protective device to trip, all power is lost.
5. The lnphase Monitor is ineffective in transferring highly inductive transformer loads since the line waveform of such equipment is not maintained during disconnection.
6. The lnphase Monitor is totally ineffective during manual transfer under load.
7. The lnphase Monitor has no control over the amount of deceleration that occurs when the load is disconnected. A heavily loaded motor will decelerate rapidly thus creating a questionable synchronous transfer.

TIME DELAY NEUTRAL

The Time Delay Neutral method of transferring highly inductive loads eliminates the high current surge by deliberately introducing a neutral position in the transfer operation. This off time allows the load to demagnetize sufficiently so safe reconnection can occur without experiencing the high current bumping effect.

Advantages

1. Successful operation is totally independent of any frequency differential of the two sources of power.
2. Simple relay controls ensure successful operation under all conditions of transfer including manual operation.
3. Low cost addition relative to lnphase Monitor alternative.
4. Effective method of safe transfer of transformer loads.

Disadvantages

1. A slightly extended power interruption in transfer of loads.