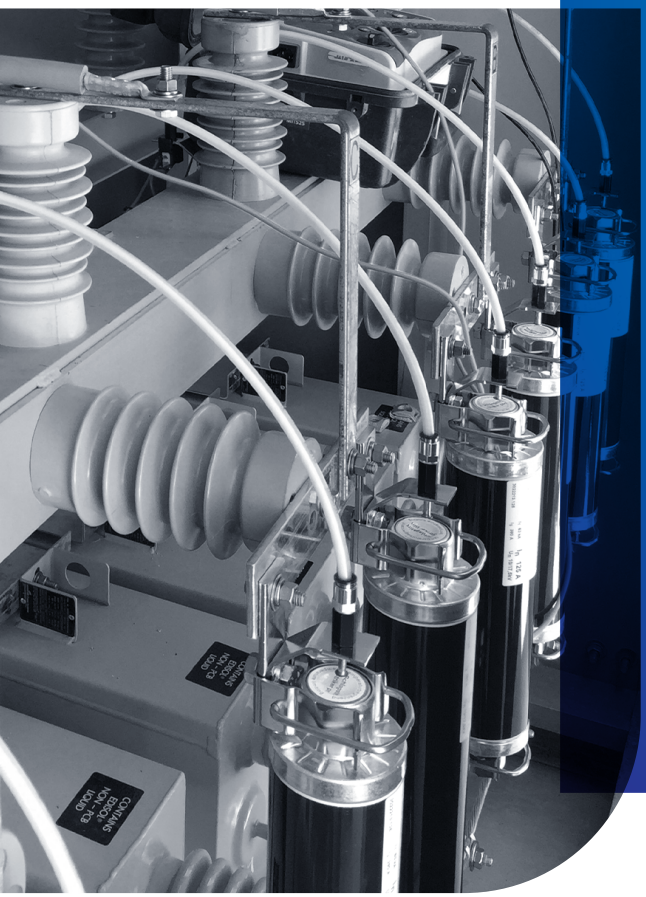
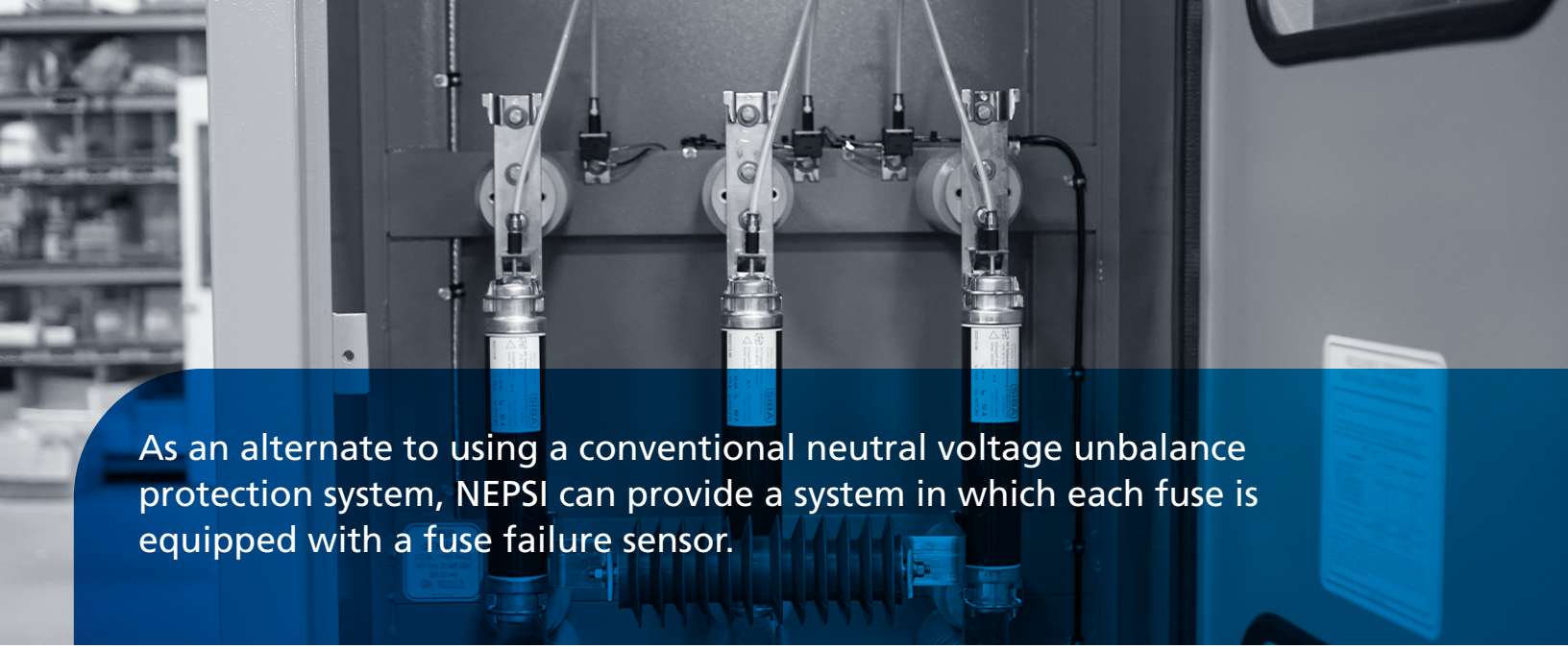
nepsi®

technical note

an alternative to neutral voltage unbalance protection systems in ungrounded wye capacitor banks





As an alternate to using a conventional neutral voltage unbalance protection system, NEPSI can provide a system in which each fuse is equipped with a fuse failure sensor.

Metal-enclosed power capacitor banks and harmonic filter banks are normally equipped with blown fuse detection systems. The primary purpose of this detection is to: (a) prevent damage to the remaining capacitors on the stage with the blown fuse (this problem occurs on ungrounded banks with fewer than four capacitors per phase), (b) alert plant personnel of a blown fuse condition, and (c) prevent unbalance var support that can lead to system voltage unbalance.

Background on Neutral Voltage Unbalance Protection Systems

A Neutral Voltage Unbalance Protection System normally consists of a neutral voltage sensor and an over-voltage relay. Figure 1, shown on the right, depicts a 3-stage capacitor bank that is equipped with a neutral voltage sensor on each stage. Under normal operation, the neutral voltage of each capacitor stage will be near zero volts as each capacitor has nearly the same capacitive reactance (assuming healthy capacitors and balanced system voltage). During and after fuse operation, the neutral voltage will shift in accordance with the impedance unbalance caused by the failing or failed capacitor. The neutral voltage sensor (either a resistive voltage divider or a transformer) output is monitored by an overvoltage-relay that trips when the voltage exceeds the relay trip value for a prescribed length of time. Typically, the over-voltage relay has a definite time characteristic and is equipped with one or two relay outputs. Larger banks having stages consisting of 5 or more capacitors can operate with a blown fuse. For these banks, the first set-point is used for alarm, while the second is used for tripping under conditions where the bank can be damaged.

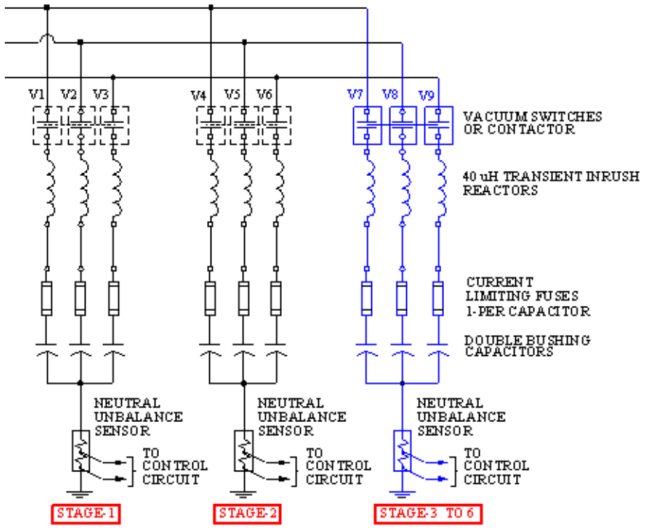


Figure 1 - Blown Fuse Detection System Utilizing Neutral Unbalance Voltage Detection

Shortcomings to Blown Fuse Detection Utilizing Neutral Voltage Unbalance

For metal-enclosed banks with fewer than five capacitors per stage, blown fuse detections using neutral unbalance voltage detection has the following shortcomings:

1. False trips due to line-to-ground faults where ground fault clearing times exceed the delay time of the unbalance protection relay.

2. Inability to detect fuse failure due to overheating. Unlike low-voltage fuses, medium-voltage current limiting fuses do not protect against over-load. The medium-voltage fuse standard only requires that a general-purpose current limiting fuse to properly clear for currents that melt their elements in 1-hour or less.

   Fuse melting times greater than an hour result in excessive fuse tube temperatures (greater than 400°C), fuse housing damage and improper clearing. Improper clearing normally results in flash-over and total bank shutdown.

   Fuse over-heating is more prevalent in ungrounded banks consisting of 1 to 4 capacitors per stage. This is because a faulted capacitor will result in a fuse current of three times the load current rating of the stage/bank. This current is relatively low in comparison to the Time-Current Characteristic Curve and is more likely to result in fuse failure.

3. Fuse operation is detected by indirect sensing, thus relying upon the proper setting and operation of both the relay and the control system.

Alternate Blown Fuse Detection System

As an alternate to using a conventional neutral voltage unbalance protection system, NEPSI can provide a system in which each fuse is equipped with a fuse failure sensor. This blown fuse sensor will operate when the fuse reaches 130C or when it operates due to a fault. Upon operation of the fuse sensor, the stage associated with the blown fuse is tripped off-line and locked out until it is checked over by the owner. The combination of the thermal sensor in addition to the direct fuse sensing offers the following advantages over blown fuse detection using neutral voltage sensing:

1. False trips will not occur due to line-to-ground faults

2. Fuse failure will not occur as the blown fuse sensor will actuate when the fuse temperature reaches 130°C and trip the stage off-line.

3. Fuse operation is detected by direct sensing and therefore is more reliable.

Conclusion

Engineers specifying blown fuse detection systems on metal-enclosed banks consisting of 4 or less capacitors per stage should consider the merits of using NEPSI's blown fuse sensors as an alternative to indirect sensing using neutral voltage unbalance detection. This document presents compelling reasons to consider the alternate design.

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