Circuit Breaker Nuisance Tripping: Demonstrating Onsite Investigation Techniques

by Jude M. Russell / PowerLines

The Problem

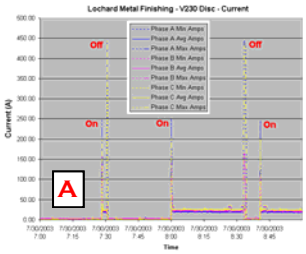
A 480 VAC / 70 Amp circuit breaker, feeding a sheet metal Press Brake, was tripping intermittently during normal equipment operation, resulting in lost data, equipment downtime, and manufacturing process interruption.

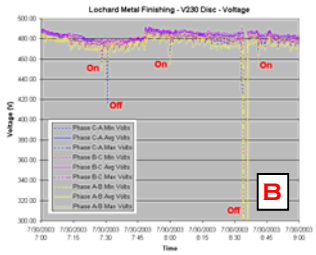
Jude Russell from *PowerLines* visited this site in order to investigate and resolve this problem. Her investigation process, on-site findings, and follow-up research are documented in this presentation.

The investigation touches on:

- ❖ Mains impedance
- ❖ Power Monitoring
- ❖ Thermal analysis
- ❖ Protective Device Trip Curve Analysis

It demonstrates the value of a power quality audit and on-site investigation. An expensive proposed solution (that coincidentally would not have resolved the problem) was avoided and a lower cost solution was implemented as a result of this site visit.





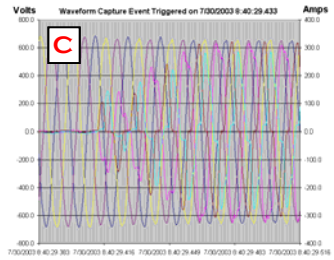
A The RMS Current during several switch off conditions documents the steady-state operating current as well as current swells during system switch-on and switch-off.

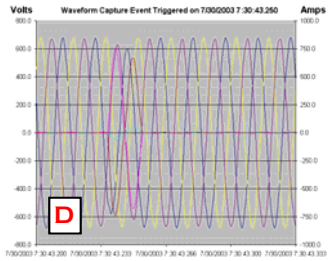
B RMS voltage levels were good. Voltage sags due to current swells are evident as well as one instance of an outage caused by a circuit breaker trip.

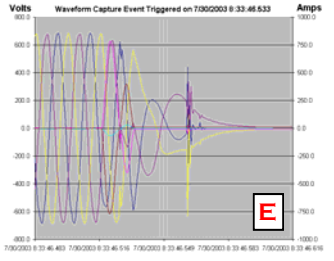
C The current swell recorded during hydraulic system switch-on. The customer did not reported breaker tripping during switch-on .

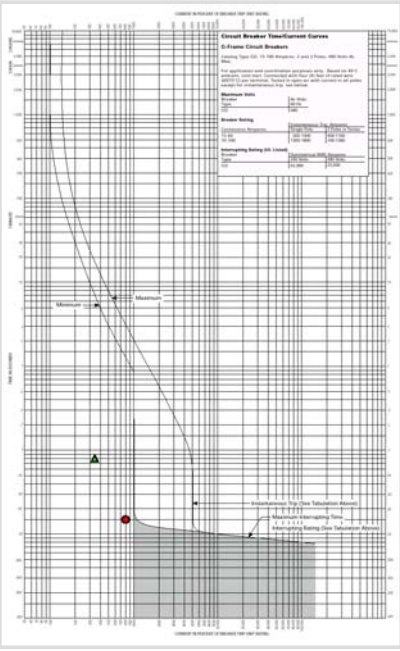
D The current swell recorded during hydraulic system switch-off. The customer reported breaker tripping during switch-off, but this occurrence did not result in a circuit breaker trip.

E A current swell recorded during hydraulic system switch-off, this time resulting in a circuit breaker trip



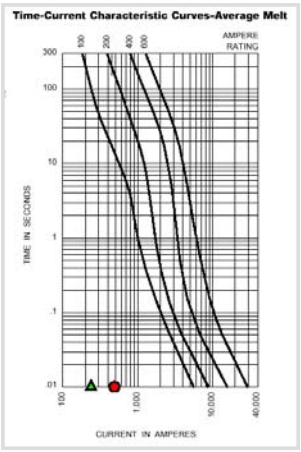




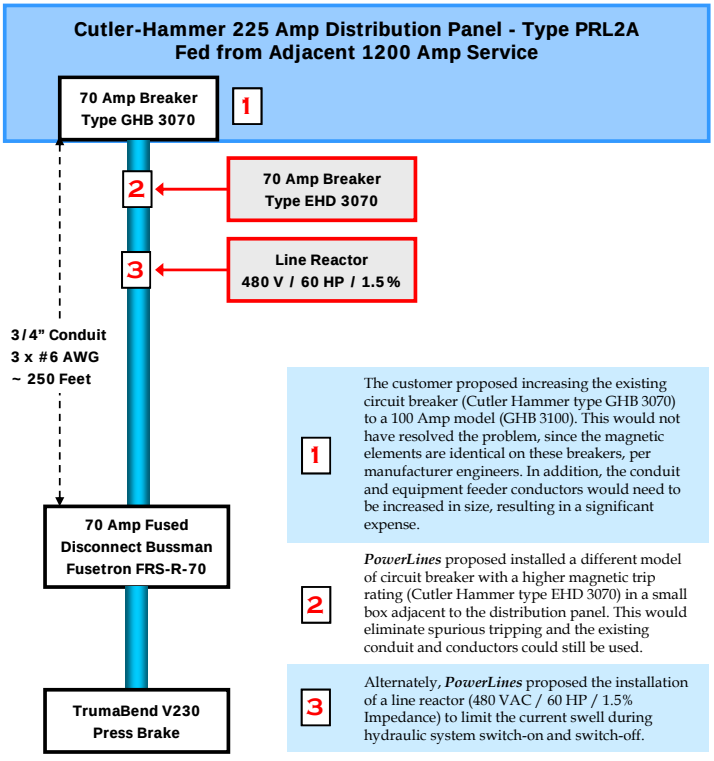


Left: Trip curve of Cutler-Hammer circuit breaker showing proximity of measured inrush currents to lower limit of breaker trip curve.

Below: Trip curve of Bussmann Fuses shows that a trip on this device would be highly unlikely.



- ☑ **Confirm that RMS Voltage level was acceptable**
- ☑ **Rule out excessive voltage THD and voltage phase imbalance**
- ☑ **Rule out transient power quality events (sags, swells, dropouts, impulses)**
- ☑ **Rule out high impedance (soft source) and low impedance (stiff source)**
- ☑ **Rule out current THD and "harmonics"**
- ☑ **Rule out loose or overheating conductors or terminals, and heat transmittal from nearby breakers using an infrared thermometer**
- ☑ **Characterize the equipment normal operating current, and current swells during switch-on and switch-off**
- ☑ **Compare the equipment current swells with the trip curves for the circuit breaker and fuses**
- ☑ **Confirm that current swells being seen were normal for the equipment**
- ☑ **Investigate trip characteristics of higher amperage CB's of the same make and model, and investigate device that will fit into the panel**
- ☑ **Investigate trip characteristics of different circuit breakers of the same amperage (70 A)**
- ☑ **Investigate alternate means of limiting current swells (line reactor)**



1 The customer proposed increasing the existing circuit breaker (Cutler Hammer type GHB 3070) to a 100 Amp model (GHB 3100). This would not have resolved the problem, since the magnetic elements are identical on these breakers, per manufacturer engineers. In addition, the conduit and equipment feeder conductors would need to be increased in size, resulting in a significant expense.

2 *PowerLines* proposed installed a different model of circuit breaker with a higher magnetic trip rating (Cutler Hammer type EHD 3070) in a small box adjacent to the distribution panel. This would eliminate spurious tripping and the existing conduit and conductors could still be used.

3 Alternately, ***PowerLines*** proposed the installation of a line reactor (480 VAC / 60 HP / 1.5% Impedance) to limit the current swell during hydraulic system switch-on and switch-off.

Findings and Resolution

1. The inrush currents as recorded were found to be normal for this piece of equipment. These were perhaps made worse by a particularly stiff, low impedance source.
2. No loose or overheating terminals were found; the CB and terminals were near ambient (30°C).
3. The steady-state operating currents drawn by the Press Brake (25 Amps) were well within the 70 Amp breaker capabilities.
4. The circuit breaker was found to be functioning normally, and the current swell was normal. The current was simply too close to the lower limits of the breaker trip curve.
5. The original customer proposal (increase the circuit breaker to 100 Amps) would have:
   a) Not worked, since the 100A device magnetics were identical to the 70A device magnetics.
   b) Been very costly, as the conductors as well as the conduit for a 250 foot run would have needed to be replaced.
6. *PowerLines* proposed two solutions:
   a) Install a different breaker device with a higher magnetic trip rating, adjacent to the main distribution panel (this was the solution that was successfully implemented).
   b) Install a 1.5% / 60 Amp impedance line reactor to limit the inrush current swell.