



Multi-Technology Fault Identification

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Industry: Food and Beverage **Technology:** On-line MCA (Initially)

Component: Motor **Part:** Electrical Connections

Time Context

Tuesday, April 16, 2013

Process Information

This asset is a pump used to pump water for the milling process and cannot be shut down for more than 3 hours during the milling process. Shutting down the pump causes operations to have to switch tanks for that period of time and requires constant monitoring to prevent product overflows.

Summary of Action

During routine on-line (energized) motor circuit data collection, test results indicated a 26.5% current imbalance, along with a 35.36% impedance imbalance. Looking at Figure 1, the Power Phasor shows the current imbalance indicated by the shorter current 1 and current 3 lines. Figure 2 shows the imbalance in the current section of the power test results page. Figure 3 is the Current Time Domain showing current 2 higher than currents 1 and 3. Voltage was checked and found to be balanced across the motor starter at 283 VAC phase-to-neutral and 490 VAC phase-to-phase.

Vibration data was collected and found the motor was in alarm for a 2x line electrical frequency, indicating there was a possible electrical issue (Figure 4). An infrared scan was conducted on the electrical enclosures containing the fuses and motor starter. The B phase fuse and connections on the motor starter were operating with an above alarm level temperature differential. A thermographic scan of the motor revealed that the housing was operating hotter than normal, indicating a possible issue within the circuit. Figure 5 is an infrared image taken of the motor soon after the current imbalance was discovered by the on-line test. It shows the motor temperature was running above normal at 215°F, caused by the current imbalance. Figures 6 & 7 are infrared images taken of the motor starter and fuses. The temperature differential of the B phase circuit is caused by the imbalance in the circuit due to the high resistance connection. A work order was written to perform an off-line (de-energized) motor test to isolate the cause of the imbalances.

An off-line test was conducted from the Motor Control Center (MCC) and found a 44.65% phase-to-phase resistive imbalance, along with an 11.65% inductive imbalance. Figure 8 shows the phase-to-phase resistive imbalance and inductive imbalance from the off-line test conducted from the MCC indicating a high resistive connection in the circuit. It was decided that further testing should be done by going to the motor and disconnecting the motor from the circuit to further isolate the cause of the imbalances. Upon opening the motor junction box, a bad connection was discovered (Figure 9). All connections were repaired and another off-line test was conducted from the MCC, which indicated that the repairs had corrected the issue.

Post Notification

Department reliability coordinators and maintenance supervision were notified as soon as it was confirmed that there was an issue and made aware of the motor running hot, creating a potential burn hazard for employees.

Supporting Data

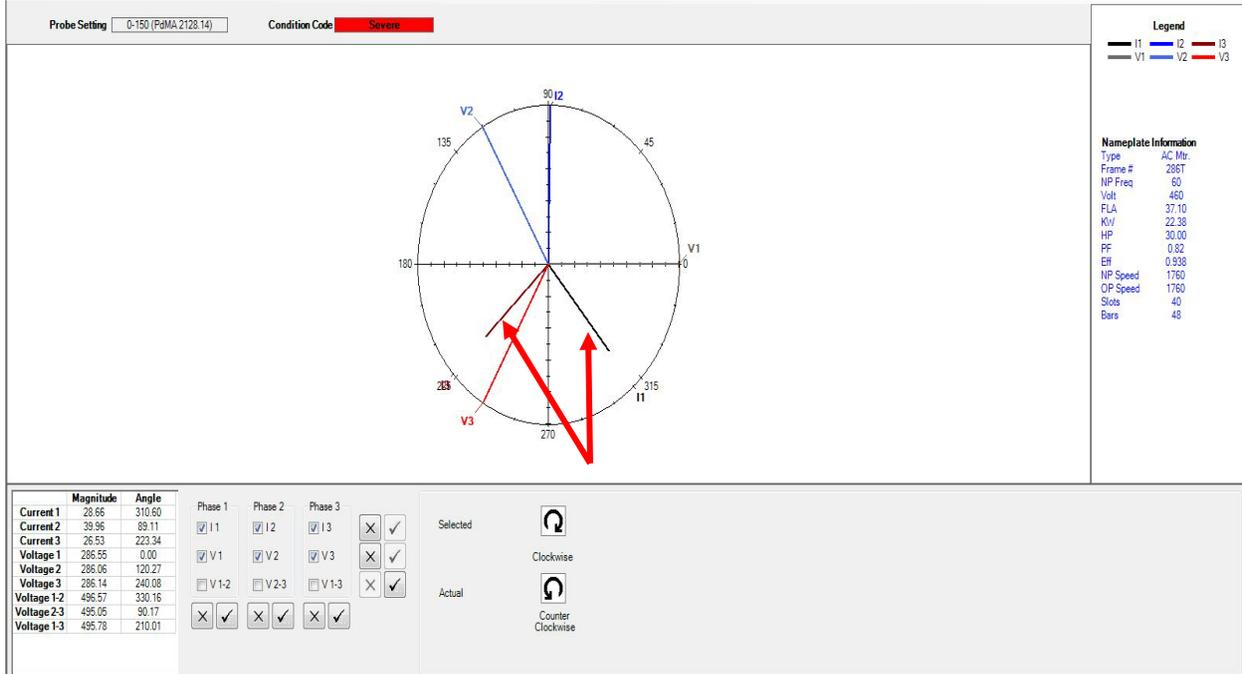


Figure 1: Power Phasor Shows Both Current 1 and Current 3 Lower Than Current 2

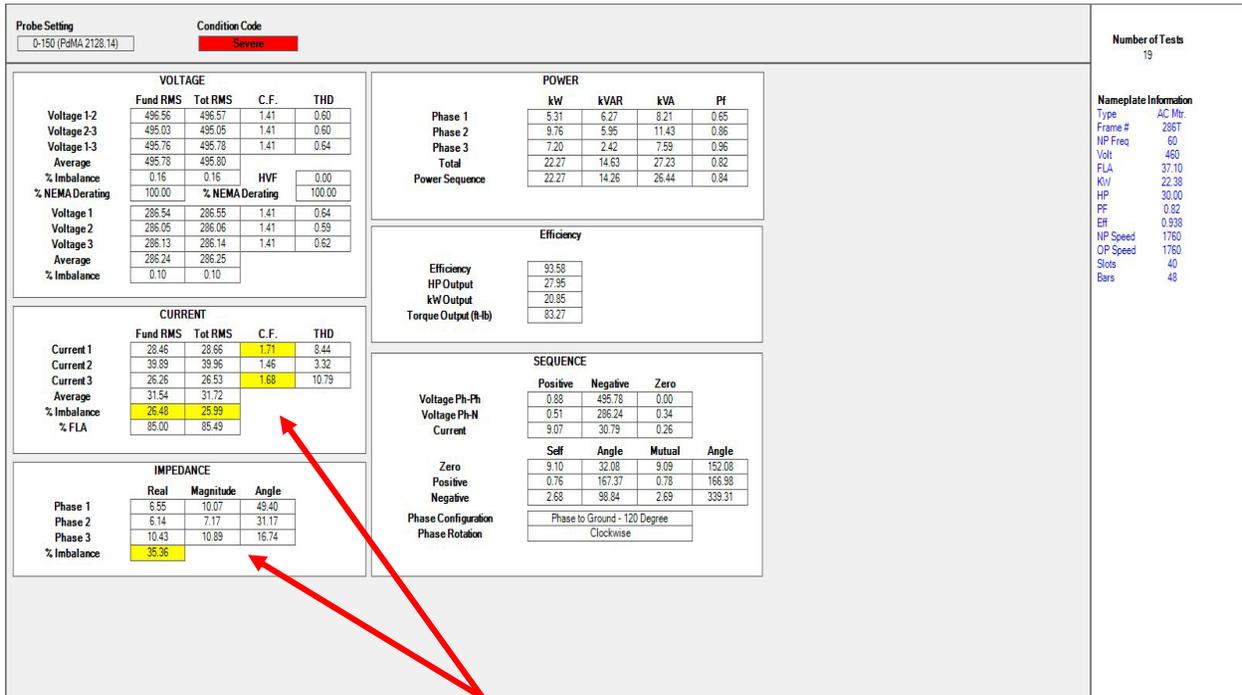


Figure 2: Power Test Results Showing the Current and Impedance Imbalances

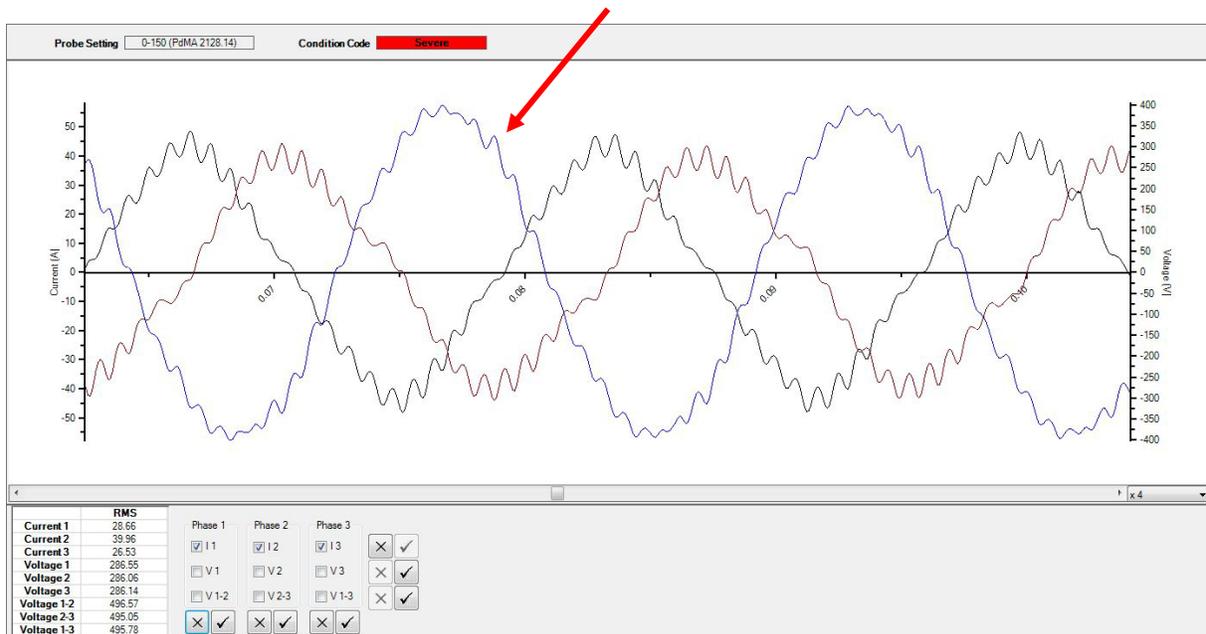


Figure 3: Current Time Domain Showing Current Imbalance

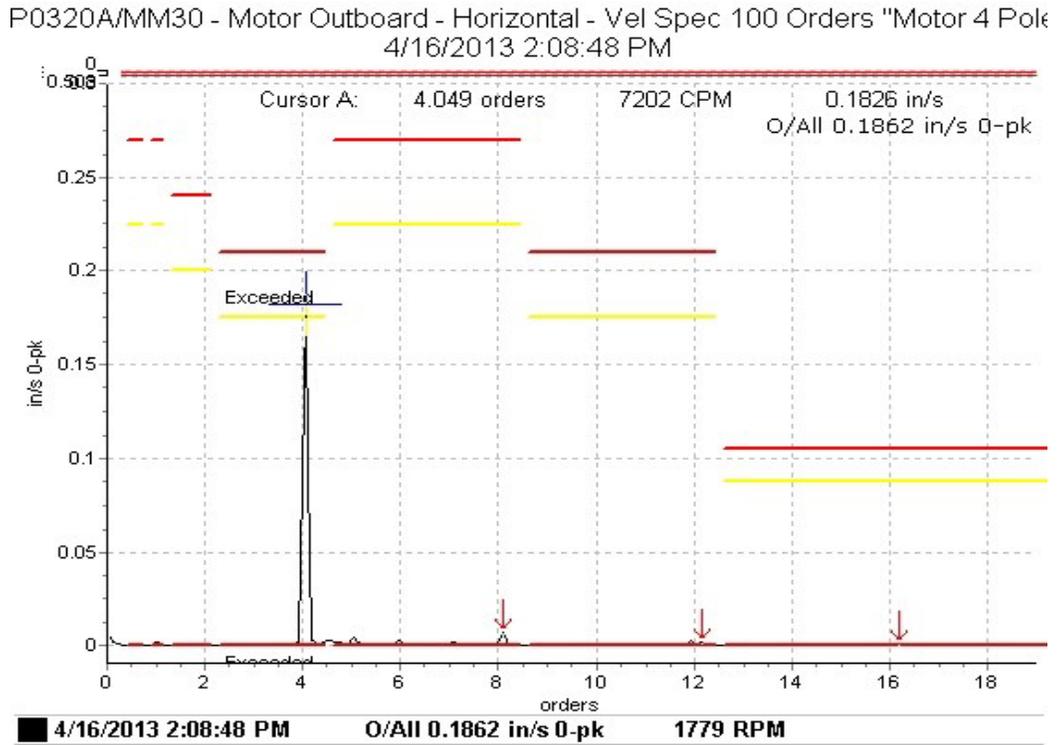


Figure 4: Vibration Spectrum Showing 2x Line Electrical Frequency

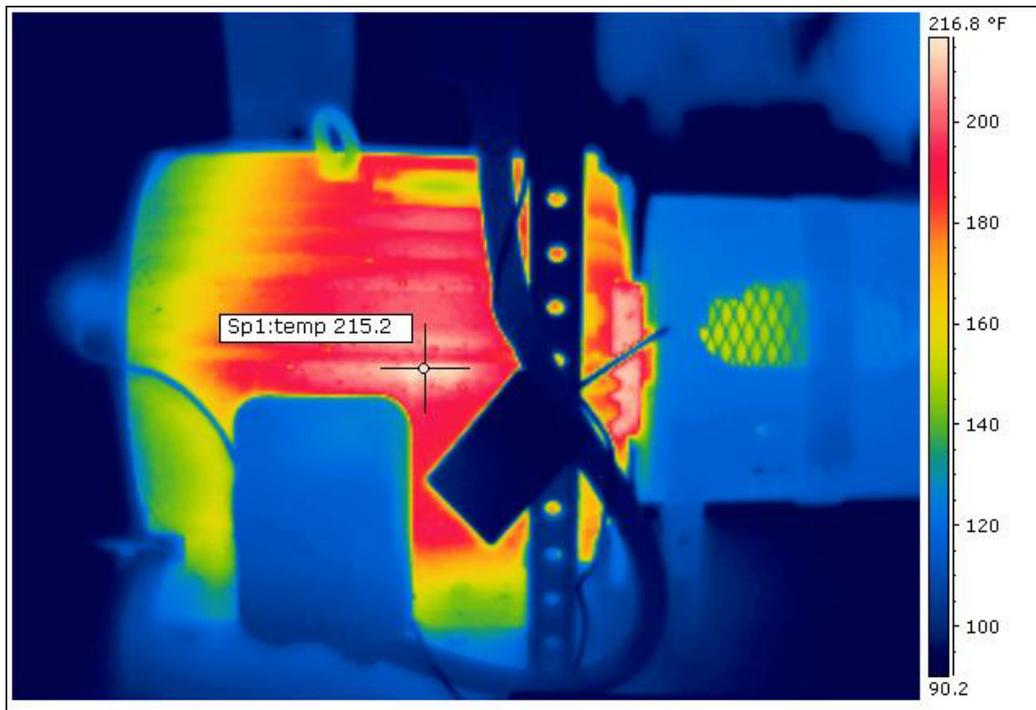


Figure 5: Infrared Image of Motor Indicating a Maximum Temperature of 215°F



Figure 6: Infrared Image of Motor Starter Showing B Phase Connection at 147°F

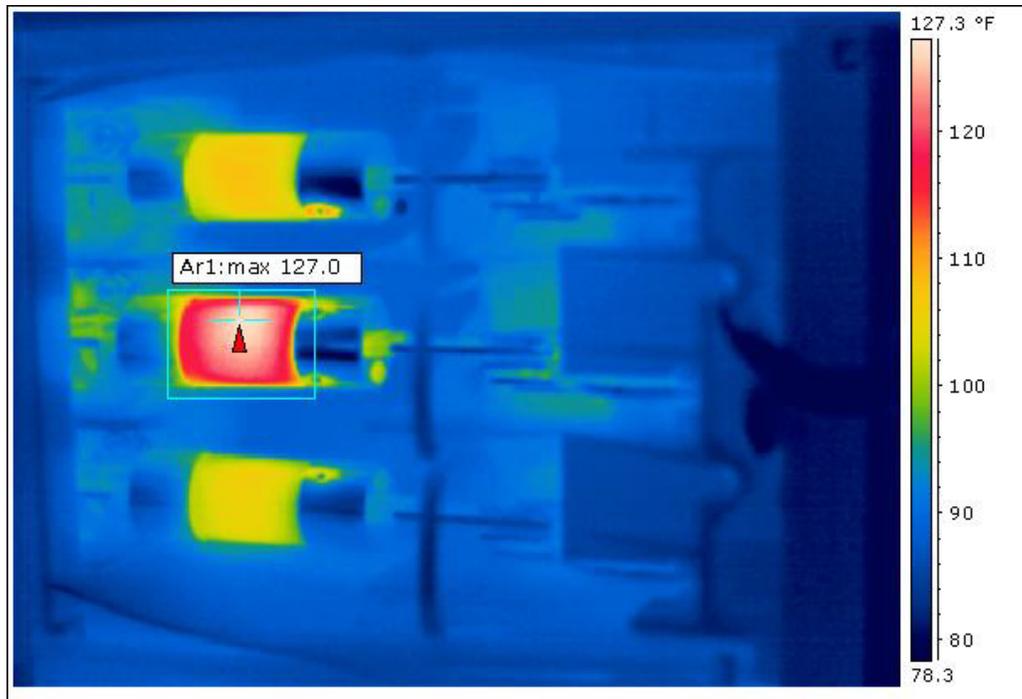


Figure 7: Infrared Image of Fuses Showing the B Phase Fuse at 127°F

MCE		All Tests			
Stator	AC Standard	Polarization Index	RIC	Step Voltage	
		A	B	C	D
Test Date		7/24/2008	11/16/2011	5/14/2012	4/16/2013
Test Time		11:06:59 AM	4:39:03 PM	6:41:31 AM	6:30:42 AM
Test Location		T-Leads	T-Leads	T-Leads	T-Leads
User		Administrator	Administrator	Administrator	Administrator
Tester Serial					15
MTap ID					
Frequency		1200	1200	1200	1200
Charge Time		60	60	60	60
Voltage		1000	1000	1000	1000
Motor Temp		22	8	14	94
Measured Mohm		764.30	60220.00	35705.29	N/T
Corrected Mohm		219.00	6600.00	5900.00	N/T
pF Ph 1 to Ground		26500	23500	25200	9000
ohm Ph 1 to 2		0.3210	0.3120	0.3152	0.5653
ohm Ph 2 to 3		0.3220	0.3125	0.3166	0.5681
ohm Ph 3 to 1		0.3215	0.3140	0.3185	1.0554
mH Ph 1 to 2		24.3	23.5	26.9	30.9
mH Ph 2 to 3		24.2	25.0	25.8	33.3
mH Ph 3 to 1		24.5	23.5	27.0	38.0
Average Inductance		24.337	23.980	26.570	34.072
% Res. Imbalance		0.16	0.37	0.55	44.65
% Ind. Imbalance		0.75	4.13	2.82	11.65

Figure 8: MCA AC Standard Test Showing the Phase-to-Phase Resistive and Inductive Imbalances

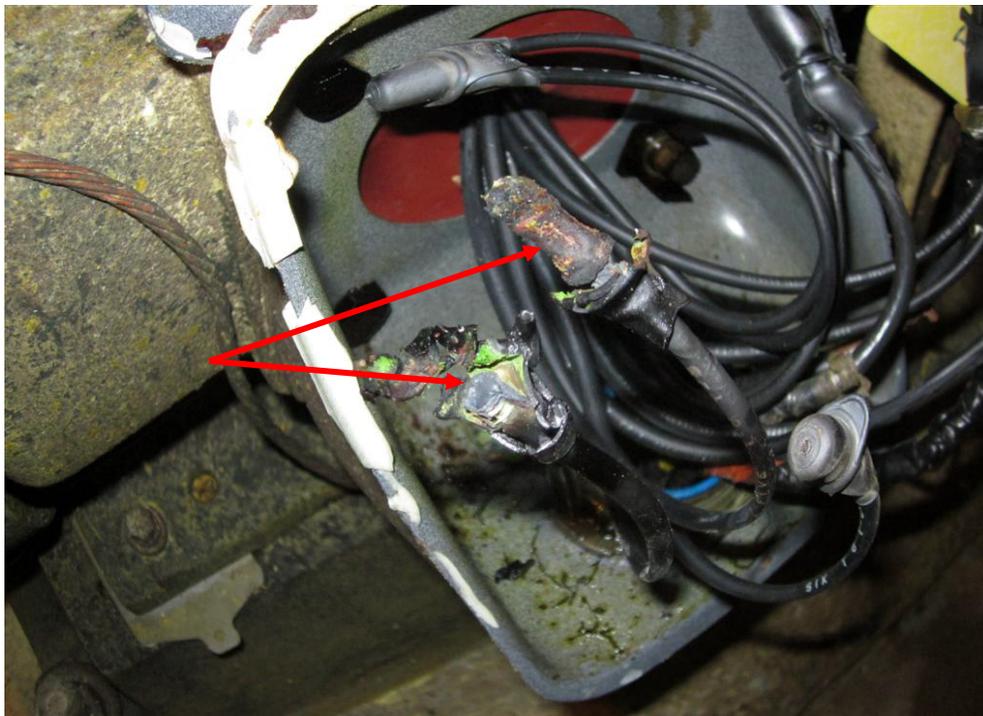


Figure 9: Image of Bad Connections Found After Opening the Motor Junction Box Cover



Plan of Action

Monitoring with MCA both on-line and off-line will help to identify this type of issue before it can damage equipment or injure personnel.

Conclusion

Not only is this type of condition shortening the life of the motor, but is also a potential hazard to personnel in the form of a shock hazard or burn hazard. If the connections were touching any part of the motor frame and the motor was not properly grounded, an individual who happened to touch the motor would become the least path of resistance to ground and could be seriously injured, suffering burns from the motor running hot, or worse, loss of life.

By using the multi-technology approach to reliability – on-line/off-line motor circuit analysis, vibration analysis, infrared analysis, and other reliability technologies including oil analysis and ultrasonic analysis – this type of anomaly, as well as others, can be detected early and help reduce unexpected downtimes, production losses, and most importantly, safety concerns for a facility's personnel.