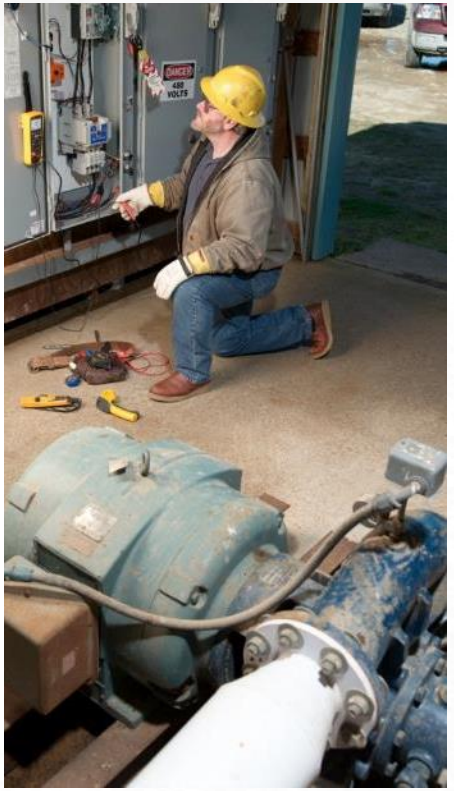
FLUKE®

Keeping your world up and running.®

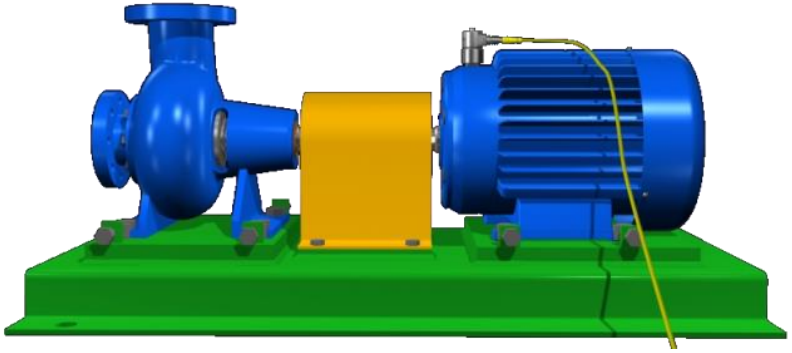
Identify potential causes of motor failures



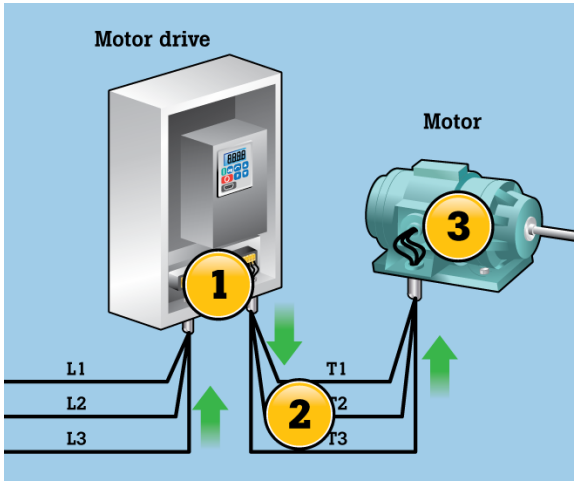
Common Type of Motor systems

Direct-On-Line Motor

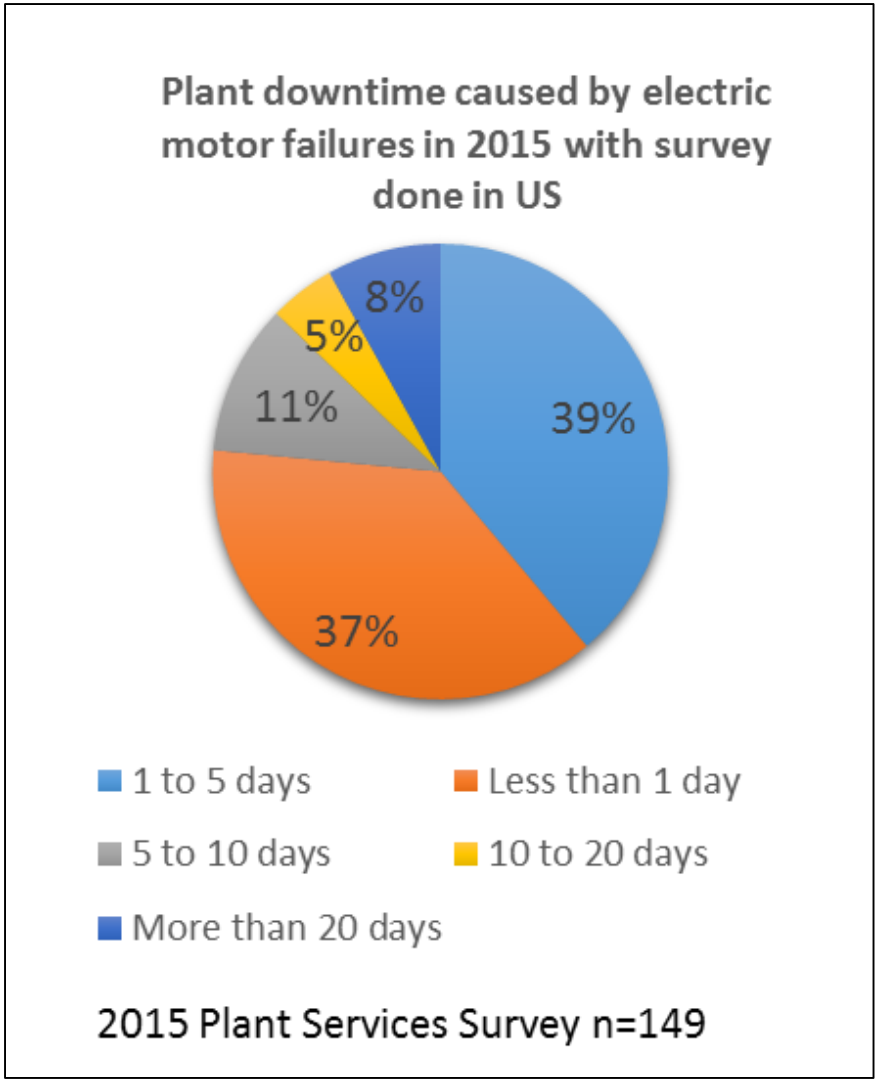


Constant-speed Application.

Variable Speed Drives



Variable-speed Application.



Make Complicate Machines Manageable

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In operation, the motor are exposed to

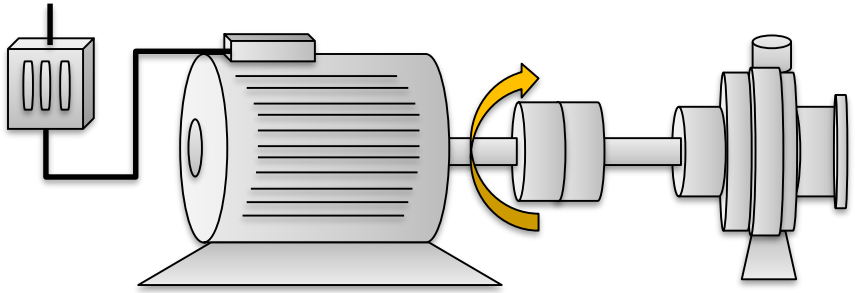
Overall Motor Stresses:
Electrical stresses are *Transient, harmonics and unbalances at the power inputs* and also the **Mechanical stresses** from *misalignment, bearing, looseness and imbalance*. In order to see the real stresses subjected to the motor in your production line, you will need to diagnose your electric motors **online**.

Modern motor analysis tools (Fluke 438-II Power Quality & Motor Analyzer) make it easier than ever to troubleshoot direct on-line electric motors by significantly simplifying the process and reducing the number of components and tools necessary to make critical maintenance decisions.

Common Pain Points & Solutions

	Common Pain Points	Solution
Motor 3-Phase Power (Electrical)	• Operational overloading elevates internal temperature accelerating winding failures • Power quality events degrade winding insulation • Unbalance and harmonic distortion generates excessive heat and stresses windings • Motors operating outside of nominal rated load operating inefficiently, creating waste and increasing operating cost	Measure electrical power quality – eliminate poor power quality as root cause • Power • Unbalance • Harmonics • Power compared to rated power under load conditions
Motor Load (Mechanical)	• Change in process, mass, fluids and materials, up/ downstream processes changes cause un-intended overloads • Mechanical friction, foreign objects or restrictions in rotating elements that cause unknown overload condition • Motors incorrectly sized for their applications are running inefficiently increasing operating cost	Measure motor output power and compare to rated specification, de-rate or adjust load • Power • Speed • Torque • Efficiency

Measure Three Phase Power
Calculate motor output Power, Torque, Speed and Efficiency

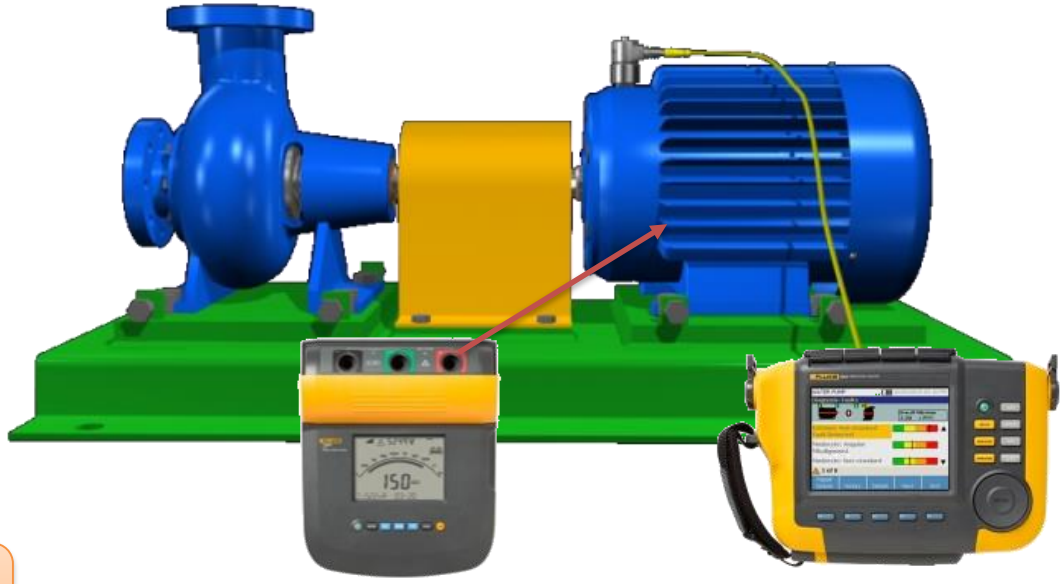


Dynamically measure critical mechanical parameters using 3 phase electrical signals

Motor Systems without VFD

Infrared Camera

Over heating components



Winding Insulation

Insulation breakdown

Mechanical Vibration

Bearing Failure, unbalance, misalignment and looseness

Loss of power or exceeding rated specification

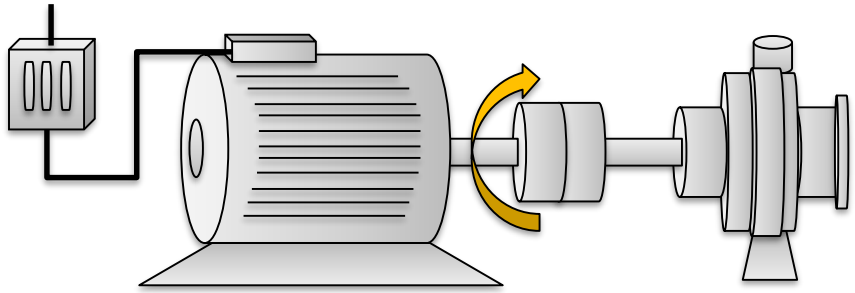
Motor Analysis

- Motor systems which run at constant speed are widely used in any industry.
- Motors without any VFD are referred to as direct-on-line motors

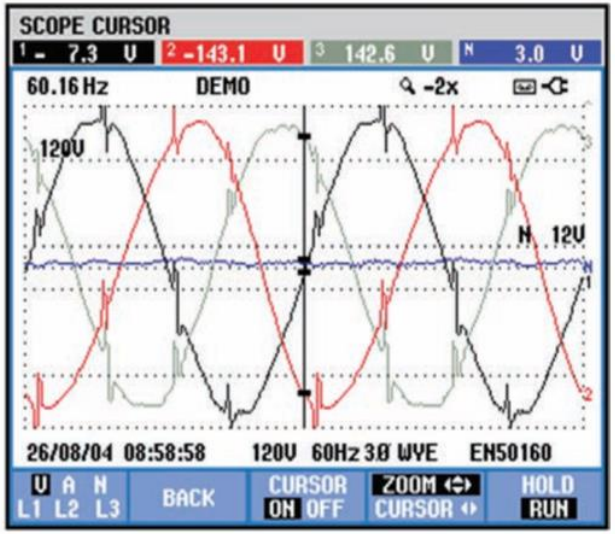
Common Electrical Motor Stresses

Electrical Stresses:

- Transient
- Voltage imbalance
- Harmonics Distortion



Transient



Transient Source:

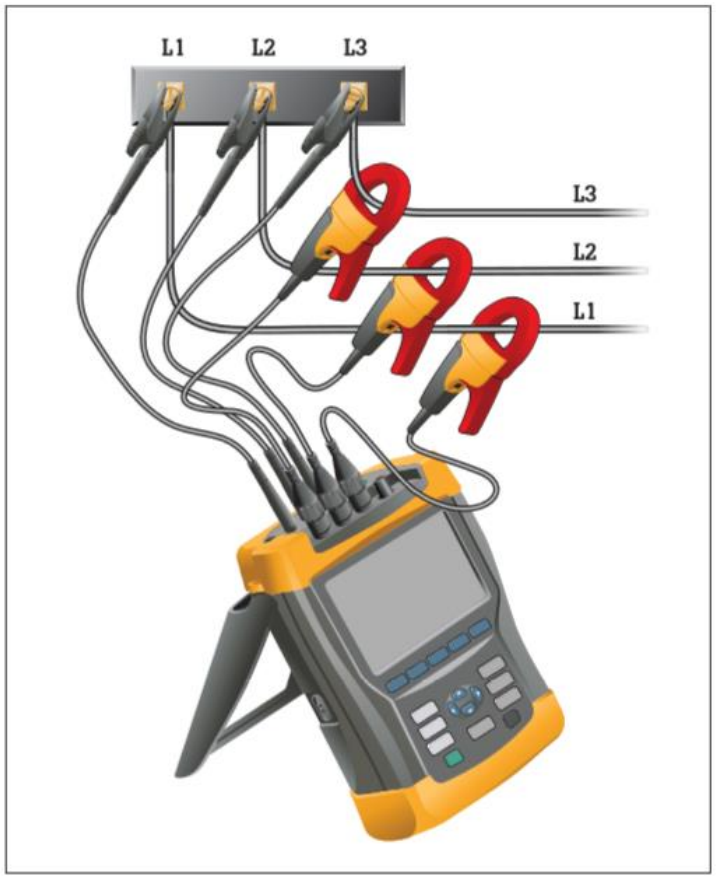
- Transient voltages can come from either inside or outside of the plant.
- Adjacent loads turning on or off
- power factor correction capacitor banks
- Distant weather can generate transient voltages on distribution systems.

Risks:

- These transients, which vary in amplitude and frequency, can erode or cause insulation breakdown in motor windings. Sometimes, a ***transient may appear on control cables that don't necessarily cause equipment damage directly, but may disrupt operations.***

Common Electrical Motor Stresses

Voltage imbalance



Imbalance Source:

- Three-phase distribution systems often serve single-phase loads. An imbalance in impedance or load distribution can contribute to imbalance across all three of the phases. Potential faults may be in the cabling to the motor, the terminations at the motor, and potentially the windings themselves. This imbalance can lead to stresses in each of the phase circuits in a three-phase power system. At the simplest level, all three phases of voltage should always have the same magnitude.

Risks:

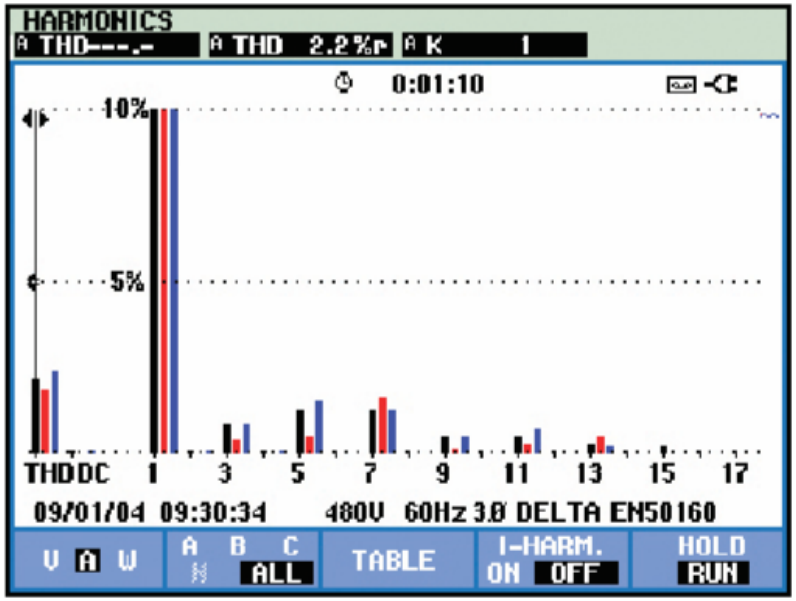
- *Imbalance creates excessive current flow in one or more phases that then increases operating temperatures–leading to insulation breakdown*

Common Electrical Motor Stresses

Harmonic Distortion

Harmonic Source:

- Harmonics are any unwanted additional source of high frequency AC voltages or currents supplying energy to the motor windings. This additional energy is not used to turn the motor shaft but circulates in the windings and ultimately contributes to internal energy losses. These losses dissipate in the form of heat, which, over time, will deteriorate the insulation capability of the windings. Some harmonic distortion of the current is normal on any part of the system serving electronic loads.

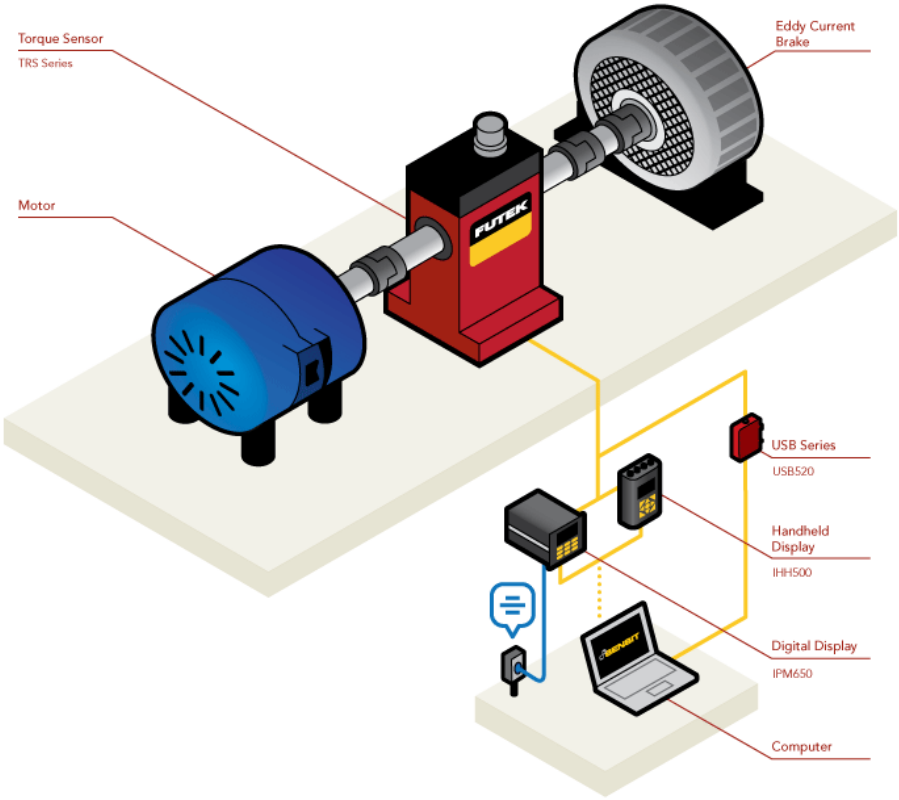


Risks:

- *Decrease in motor efficiency results in added cost and an increase in operating temperatures*

Evaluating Mechanical Output Power

- Measurement of mechanical power usually requires a torque sensing system which requires a sensor, conditioning electronics and acquisition hardware.
- Installing the torque sensors in to existing motors is difficult and time consuming.
- The complexity and cost of these systems is high.
- Systems that also measure electrical power are even more complex.
- Field testing systems are difficult to install, understand and costly.



The Fluke 438-II provides a very affordable alternative delivering easy to understand measurement data on systems that are operating in their typical environment.

Breakthrough Technology

FLUKE®

<u>To quickly discover electrical performance</u>

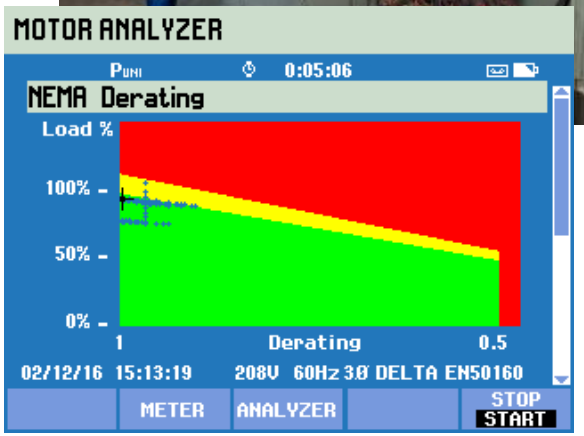
- Electrical Measurements
  - Capture key electrical parameters to compare with motor nameplate – Voltage, current, power, power factor etc.

<u>To quickly discover mechanical performance</u>

- Mechanical Measurements
  - Captured without the need to install mechanical sensors to measure speed torque, mechanical power

<u>Check on the state of power quality</u>

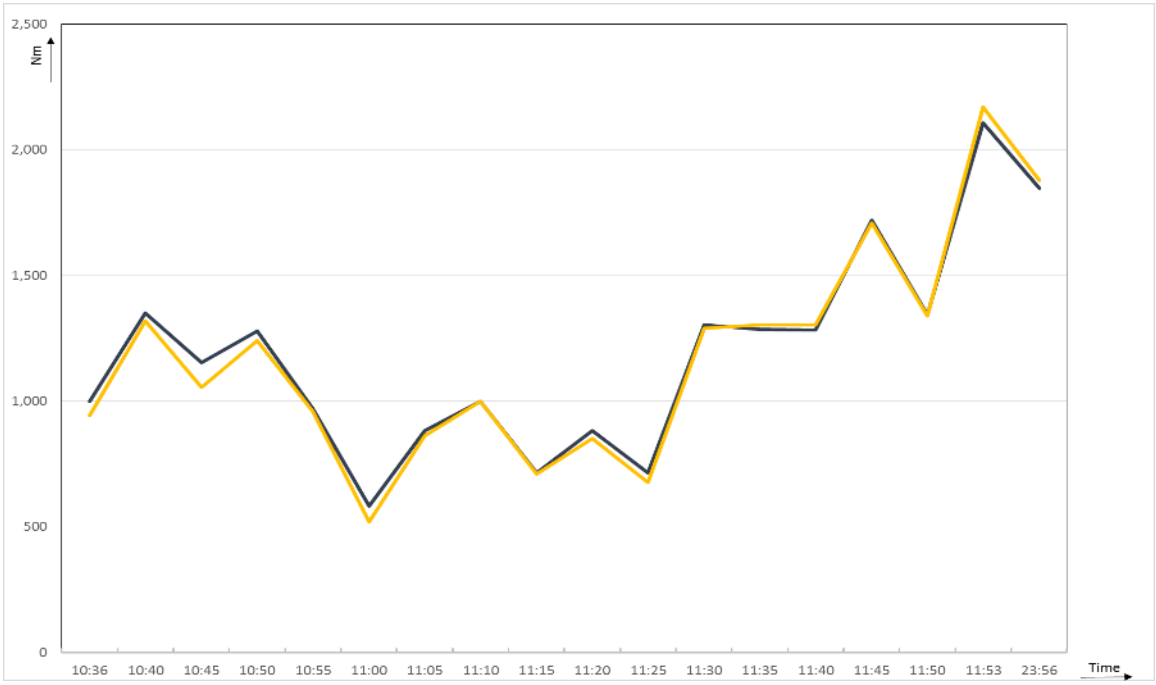
- Unbalance and harmonics matter
  - Ensuring harmonics and unbalance are within reasonable limits is key to ensuring acceptable motor performance
  - Unique NEMA de-rating information screen shows impact of poor power quality

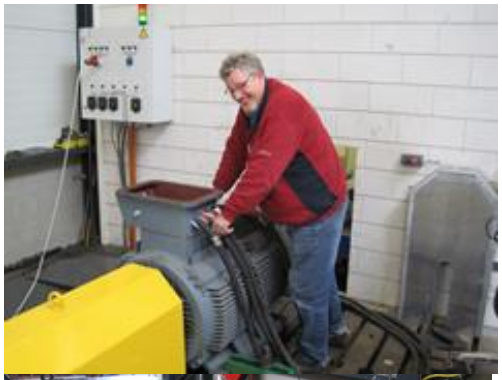


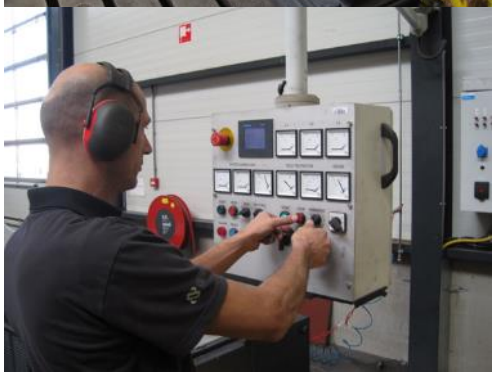
Gets to key motor performance parameters quickly and easily

Proving Fluke-438-II Measurement Methods

Using a 355 kW (475 hp) motor, the output torque from a mechanical sensor was compared to the Fluke-438-II



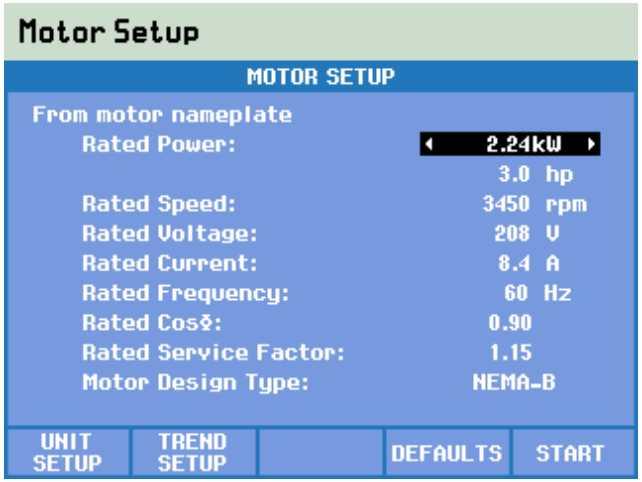


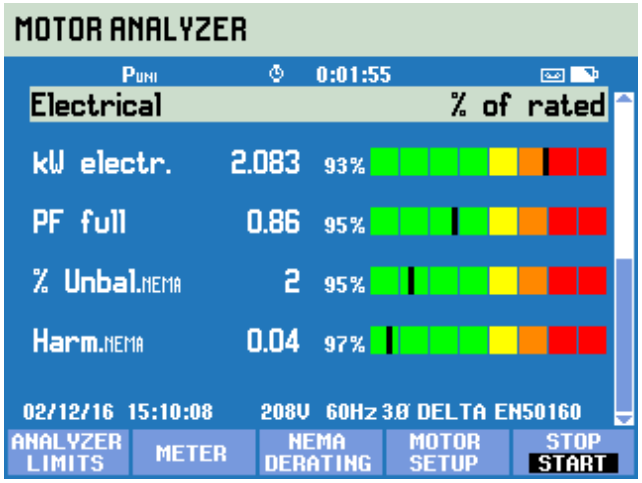


While running with stable torque, delta between torque sensor and Fluke 438-II is < 2%

Electrical Measurements

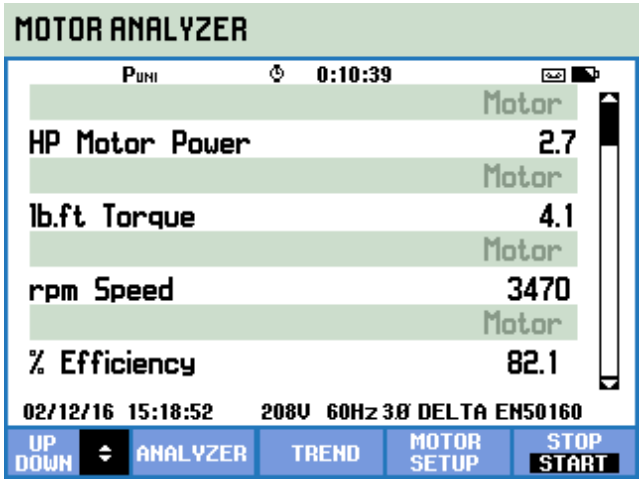
- Three phase measurements
  - Electrical Power
  - Unbalance
  - Power Factor
  - Harmonic Distortion
- Motor Electrical Analysis
  - Directly on line motors only (more than 60% of motors are connected direct on line)
  - Measurement as % of rated nameplate specification
- Measurement Benefits
  - Quickly quantify performance relative to design specification
  - Measure and eliminate poor power quality as source of motor failure

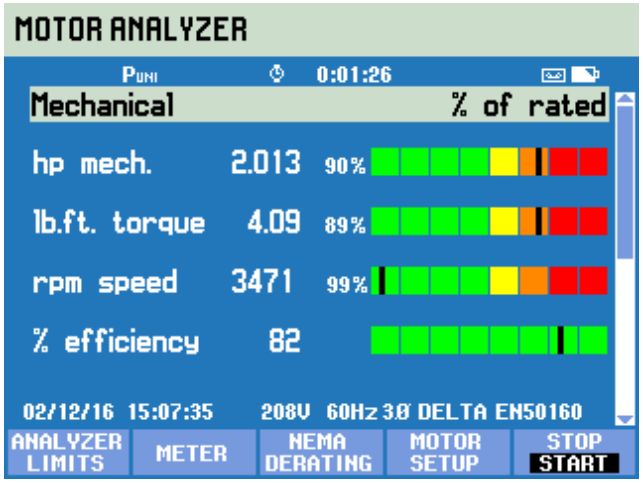




Mechanical Measurements

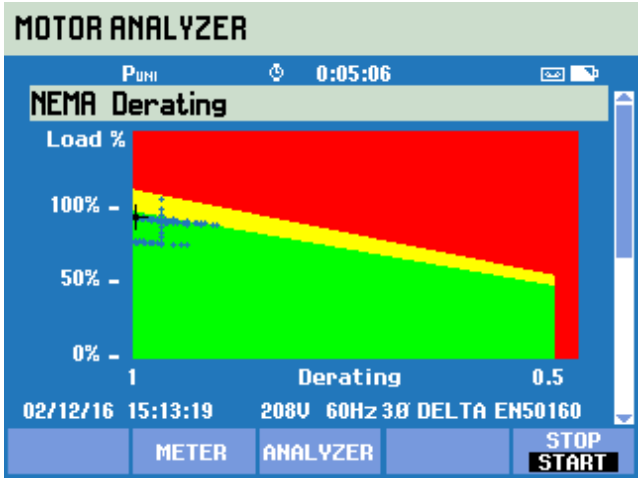
- Calculated Mechanical Measurements using advanced analysis of electrical signals
  - Power
  - Torque
  - Speed
  - Efficiency
- Motor Mechanical Analysis
  - Directly coupled motors only
  - Measurement as % of rated nameplate specification for quick good or bad indication
- Measurement Benefits
  - No load sensor required, save cost and overcome challenges of accessing shaft
  - Quickly ascertain load under operating condition

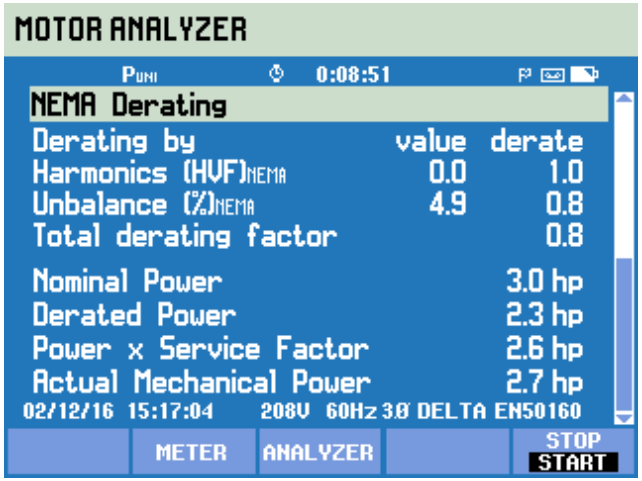




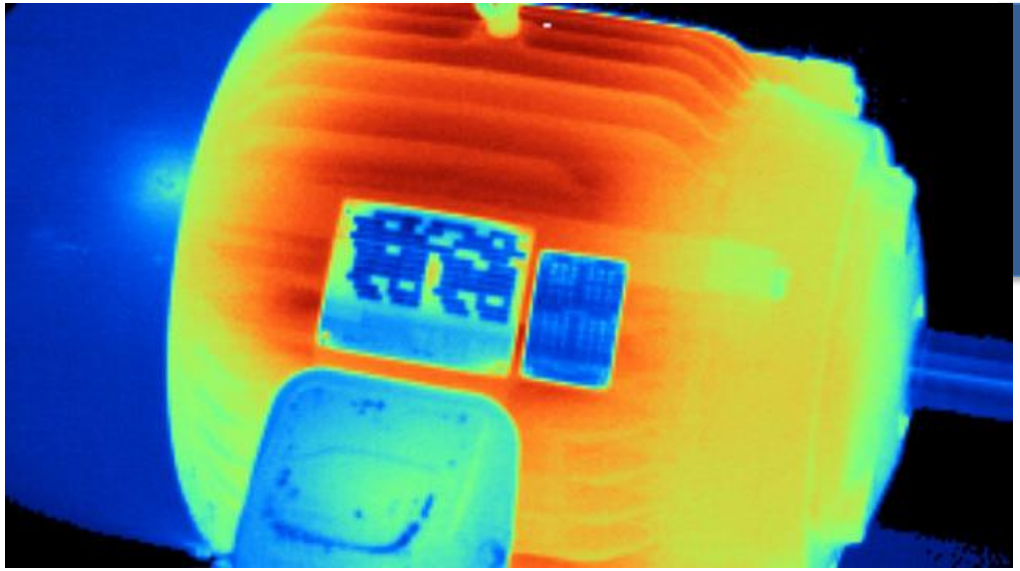
Motor Rated Load

- Calculated real time load factor
  - Operating conditions, load and power quality impact the rated performance of motors
  - To compensate, the motor power must be de-rated to mitigate temperature rise and stress to windings and mechanical components
- Motor Mechanical Analysis
  - Directly coupled motors only
  - De-rating factor calculated according to National Electrical Manufacturers Association (NEMA) standards, taking the impact of poor power quality into account.
- Measurement Benefits
  - Quickly identify motors operating at or beyond limits, make system adjustments to prevent failures
  - Size the motor to save operating cost and prevent downtime





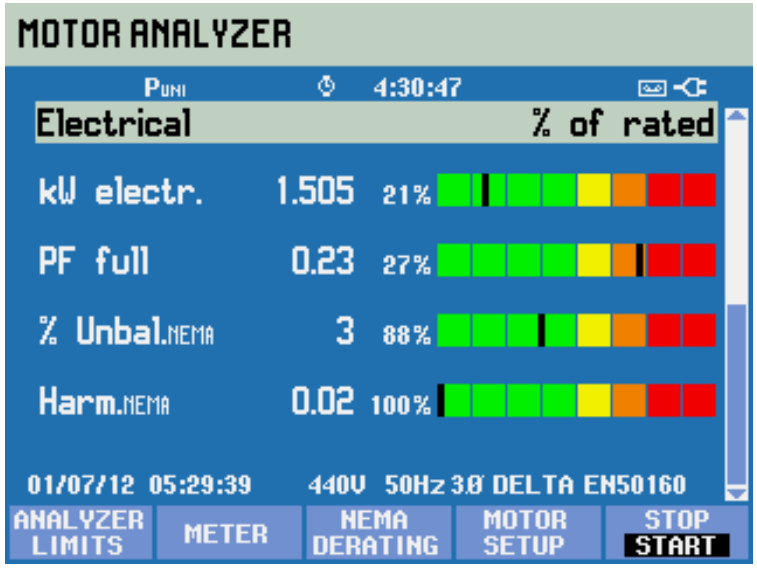
Diagnostic benefits

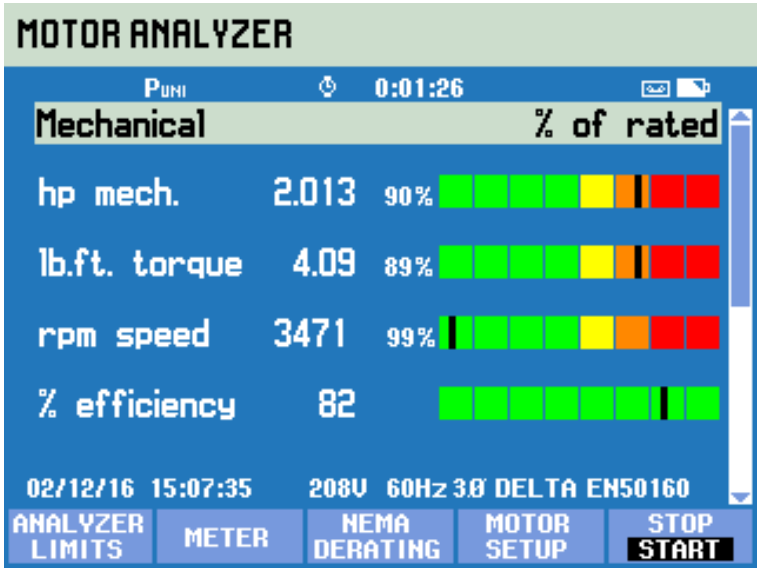


The difference between running a motor within the manufacturer's specification or outside is significant.

- Running motors in mechanically overloaded conditions places stress on all components including bearings, insulation, the shaft and more.
- Running in this mode will shorten the motors life and lower reliability.
- In addition to running according to the specification it's equally important to consider the effects of poor power quality.

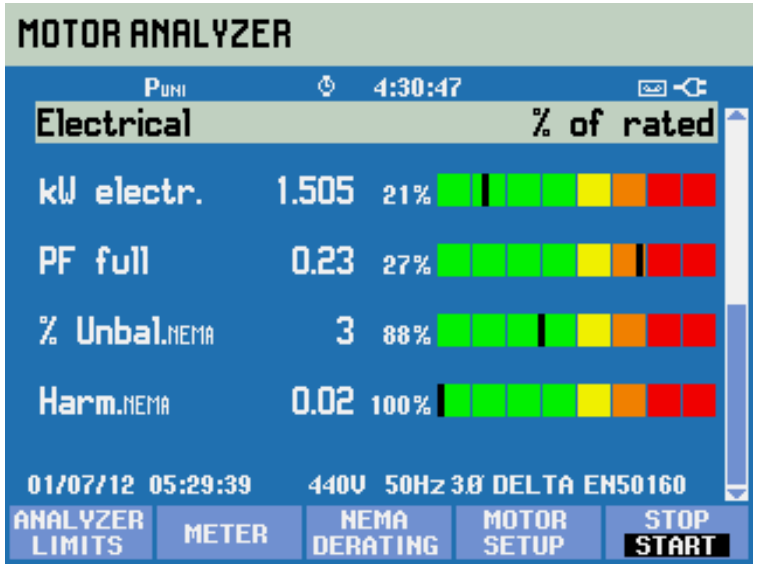
Diagnostic benefits

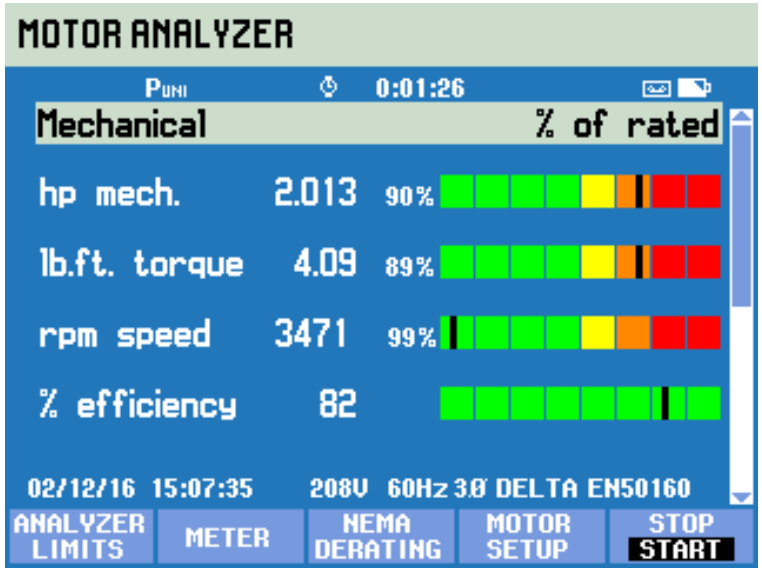




- The 438-II has two important summary screens that show key electrical and mechanical parameters in terms of ‘state of health’ to provide a quick insight on the status of the motors as it operates.
- Measuring torque can give a direct insight into the state of health of the motor, the load and process.
- Reliable operation over time is ensured while minimizing maintenance costs.

Diagnostic benefits

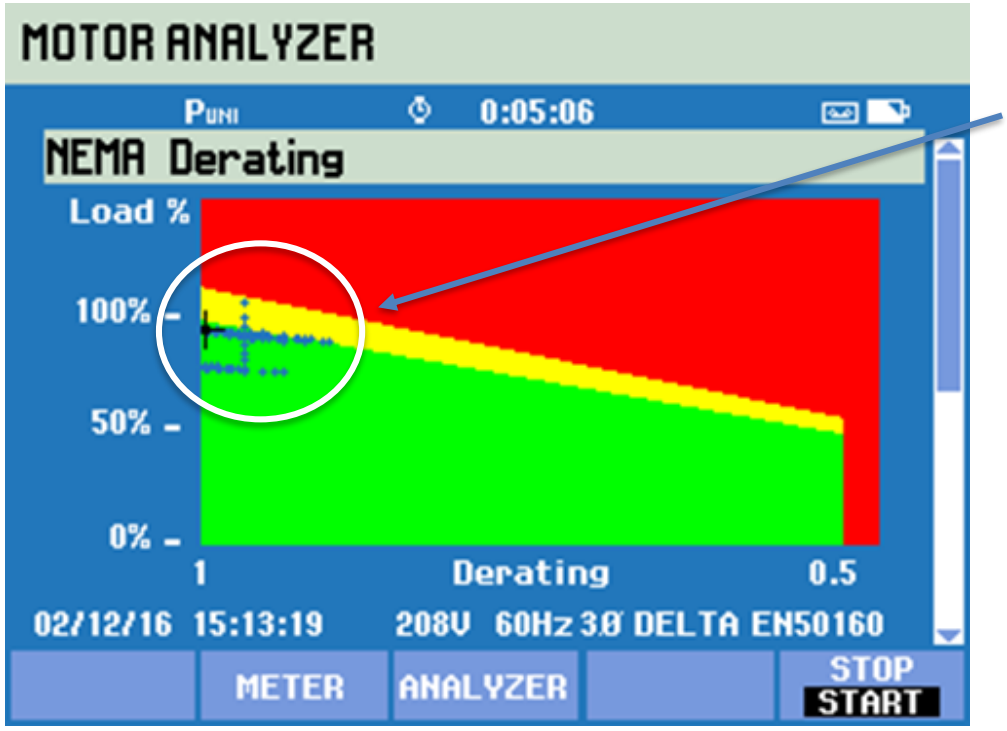




- Analysis of measured data is much simplified by classifying measurements from good (green) to bad (red).
- Where the black indicators are plotted indicated where the motor is operating with optimal or expected performance. The expected performance comparison is in line with the measurement compared to the motor's rating plate data.
- Indicators falling inside the red bars may be due to poor power quality (unbalance and harmonics) or under or overloading of the motor.

Derating motors

When harmonics and unbalance are present the motor is likely to run hotter than the specification, the purpose of the NEMA derating is to ensure that the motors continue to run within specifications.



- The derating curve shows the performance of a motor under test.
- Each of the points shows the performance as the load changes and the state of the power quality.
- Points in the green zone are within acceptable performance limits.
- Operation in the yellow zone is acceptable for short periods.
- Points in the red zone should be avoided as operation in the area may potentially damage the motor

Make Complicate Machines Manageable

- Using known theory of electromagnetic induction with digital signal analysis, key motor performance parameters can be calculated or derived using three phase voltage and current measurements, without the need for mechanical transducers.

Fluke-438-II Motor Analyzer Benefits

- Compare measurements to nameplate specifications to best understand motor performance under operating conditions.
- Quickly determine if motor is running in overload conditions – take action to prevent premature failures.
- Use the de-rating function to correctly size a motor, taking into account load and power quality without manually performing complex calculations.
- Measure the motor efficiency, identify motors that could lead to energy savings

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Q & A