Mike Herring - SKF

Motor Current Signature Analysis

Dynamic Motor Testing - The Power of Torque

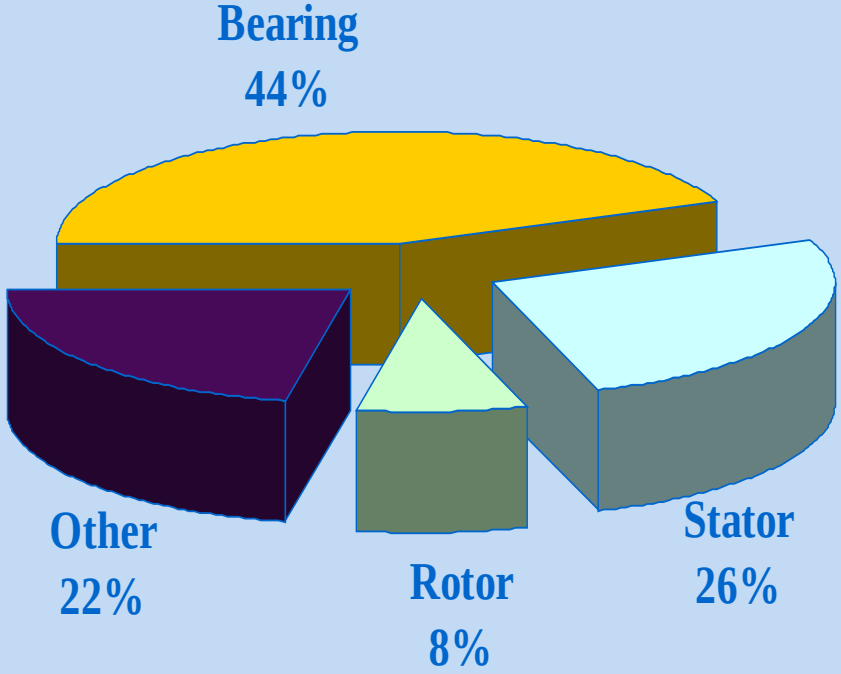
AEMT Conference 2015

Mike Herring

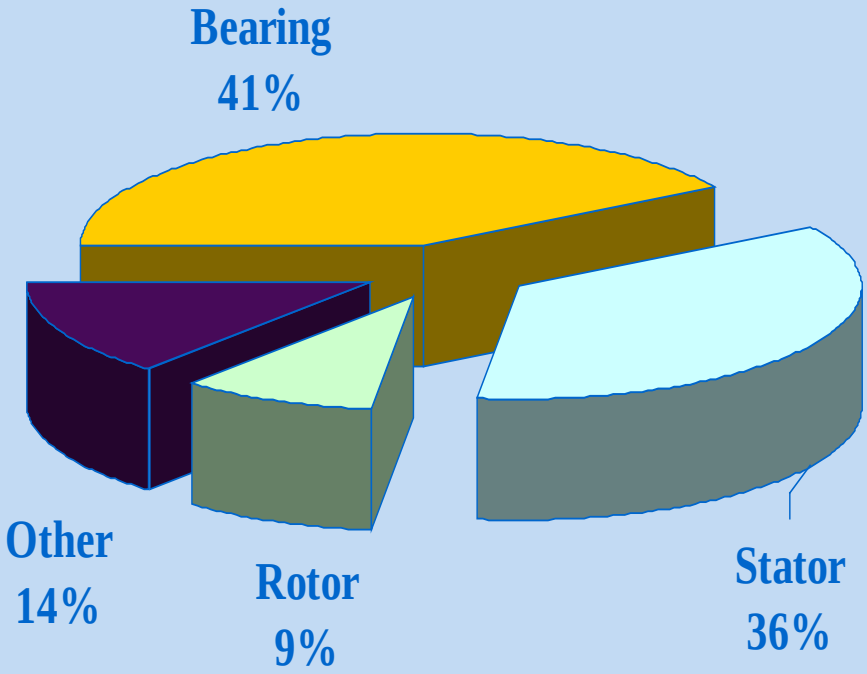
SKF Electric Motor Condition Monitoring

Motor Failure Modes – Why Test Electrically ?

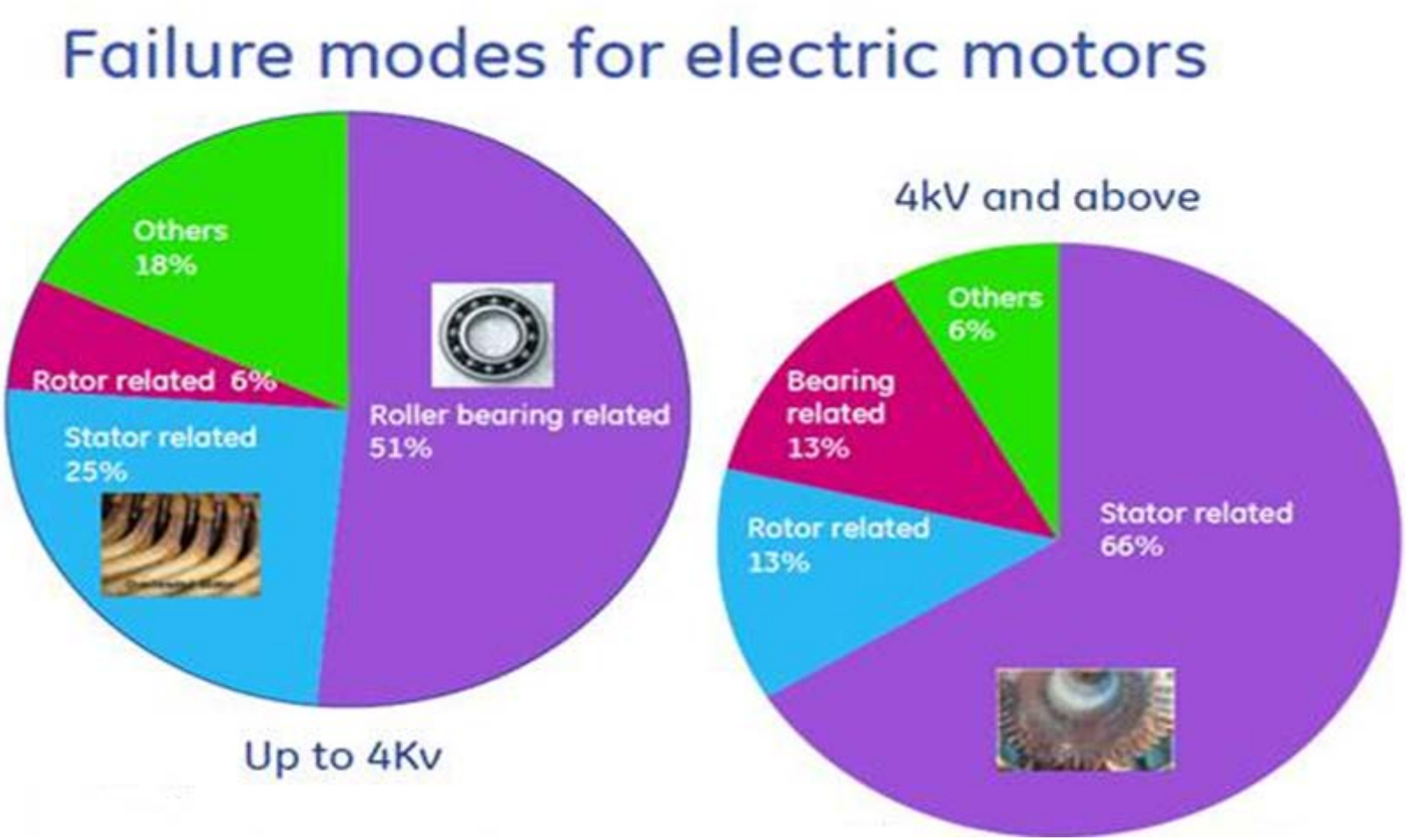
IEEE Study (Early 1990's)



EPRI Study (Mid 1990's)



Failure Modes for High Voltage Motors



GE Study

SKF®

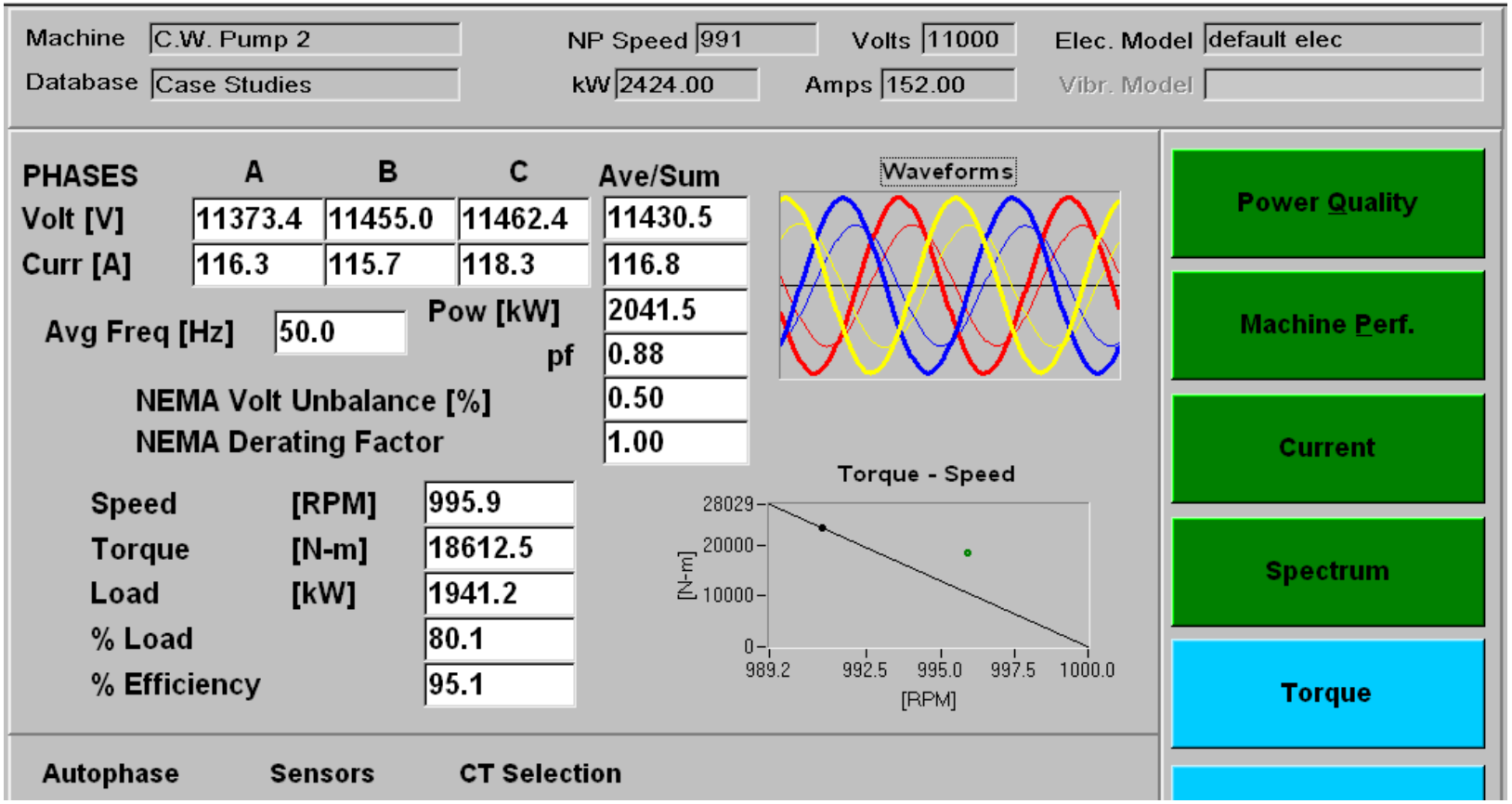
What is Dynamic Motor Testing ?

Dynamic testing analyses the entire driven system by measuring the voltage and current from the motor's three phases:

- Power quality
- Motor condition/performance
- Load condition

Monitoring takes place whilst the motor is operating within it's normal load conditions.

Typical Test Result



Typical Motor Connections

415v Inverter Driven

HV Motor

Important: Use safe working practices during live testing

Connections Without Opening Panel

EP connection module

Torque Calculation

- Uses “dq0” theory – also called two axis theory.

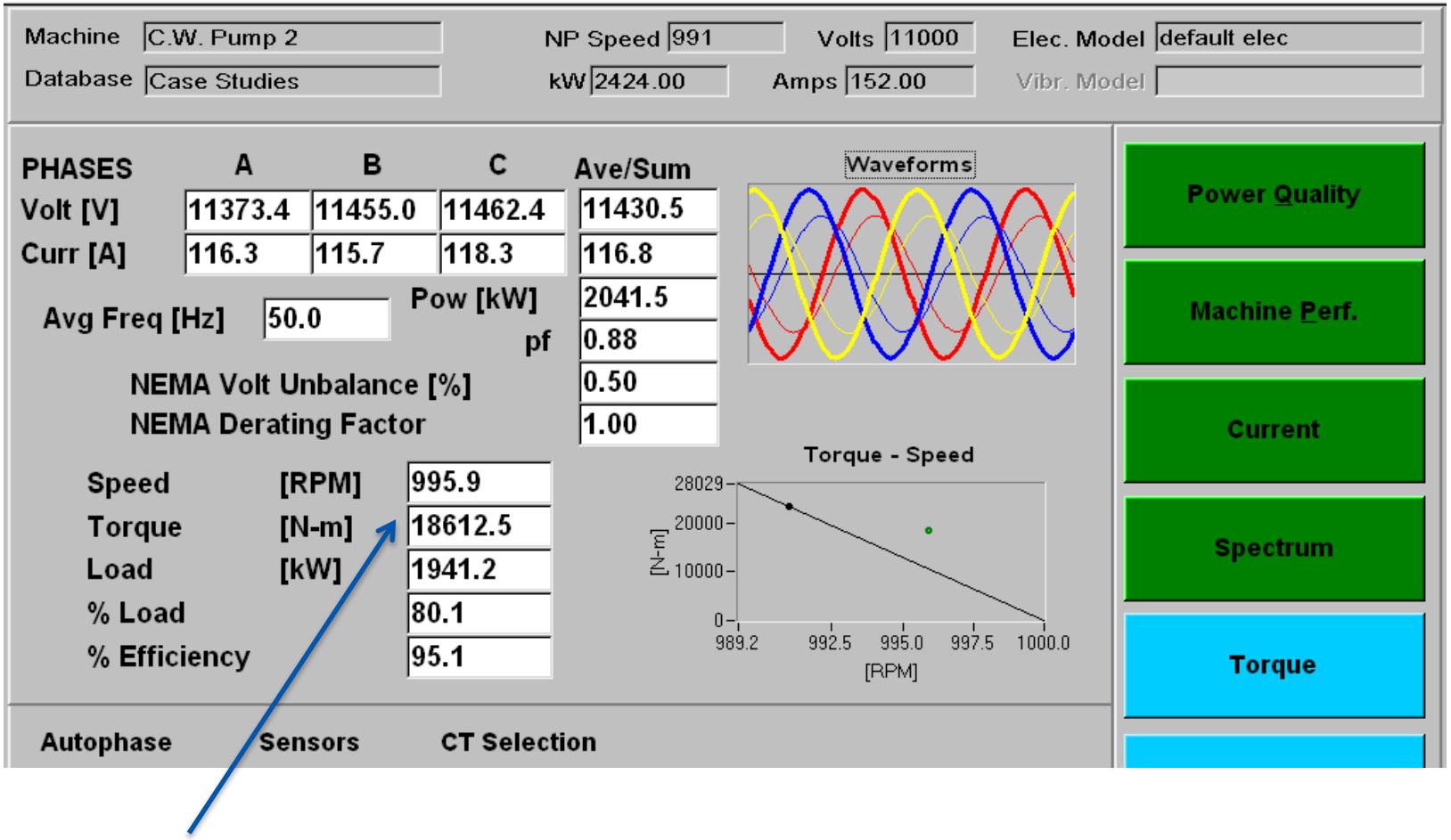
- Theory exists since 1929
  - R.H. Park, “Two-Reaction Theory of Synchronous Machines – Generalized Method of Analysis. Part 1”, AIEEE Transactions, Vol. 48, July 1929, pp. 717-717.
- Used in VFD’s since the 1980s
- E.C. Lee, “Review of Variable Speed Drive Technology”,
- www.powertecmotors.com/avsde4.pdf.

  - T.A. Lipo, A.B. Plunkett, “A Novel Approach to Induction Motor Transfer Functions,” IEEE Transactions on Power Apparatus and Systems. Vol. PAS 93 pp. 1420-1419, 1979.

  - A. B. Plunkett, “A Current Controlled PWN Transistor Inverter Drive,” IEEE/IAS 1979 Annual Meeting, pp 785-792.
- Well documented in motor control texts.

  - P.C. Krause, O. Wasynczuk, S.D Sudhoff, “Analysis of Electric Machinery,” IEEE Press NY, ISBN 0-7803-1101-9, 1995.

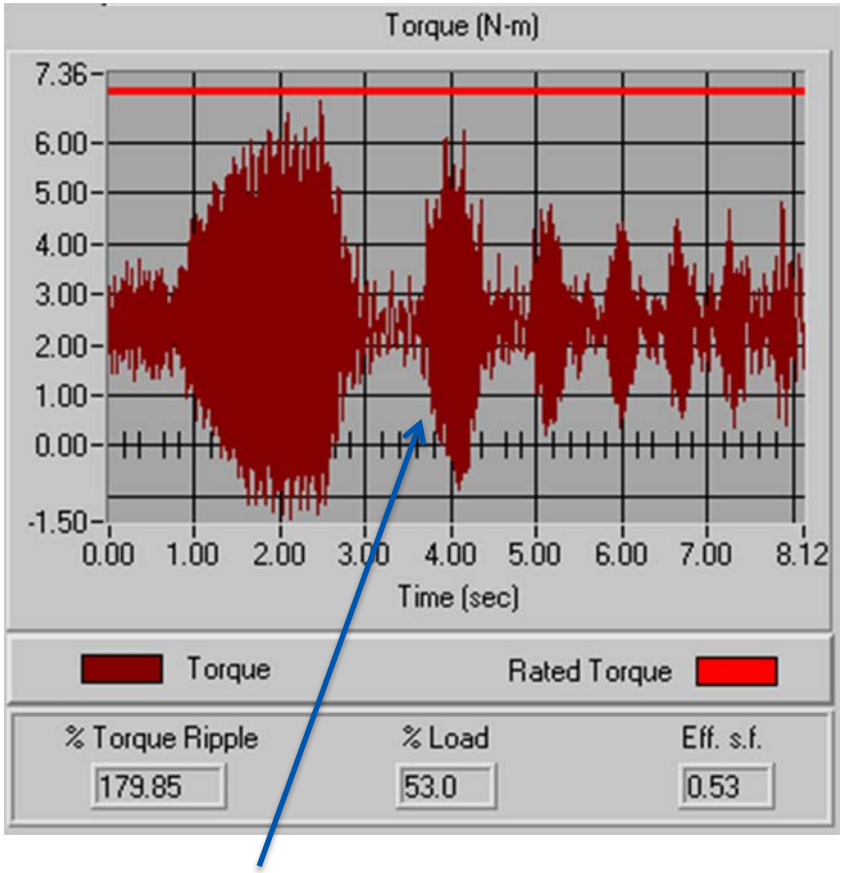
Torque Display



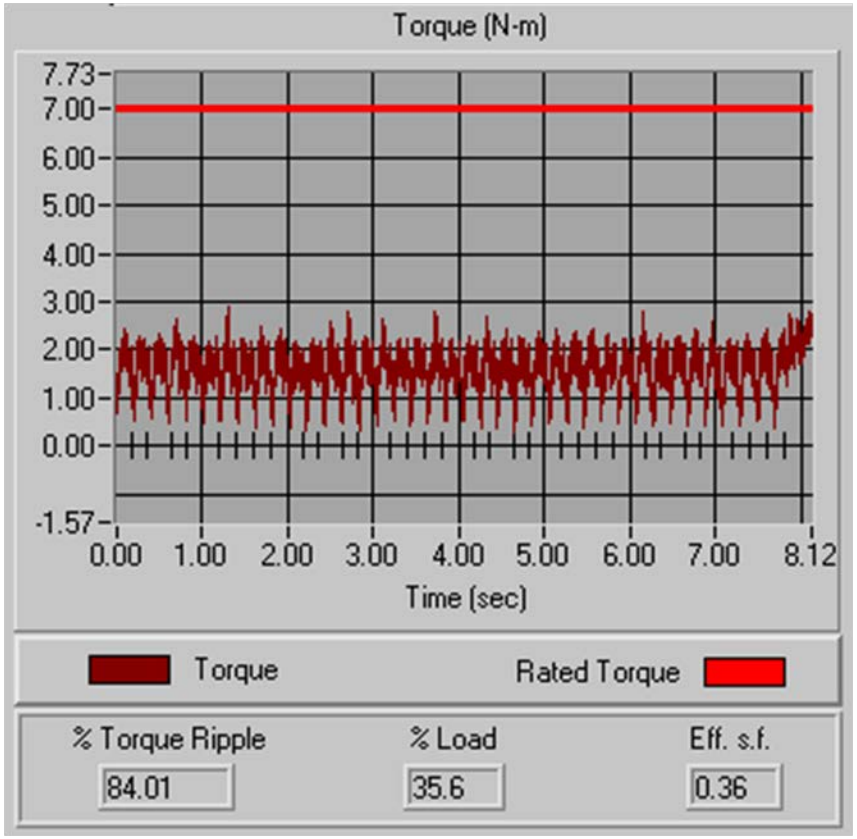
Average torque calculated during electrical acquisition

Torque Ripple

Cavitations



Normal Operation



Torque variations during same period

Torque Ripple

… displays the instantaneous torque requirements of the load. It is the tool which most effectively allows one to separate motor problems from load problems.

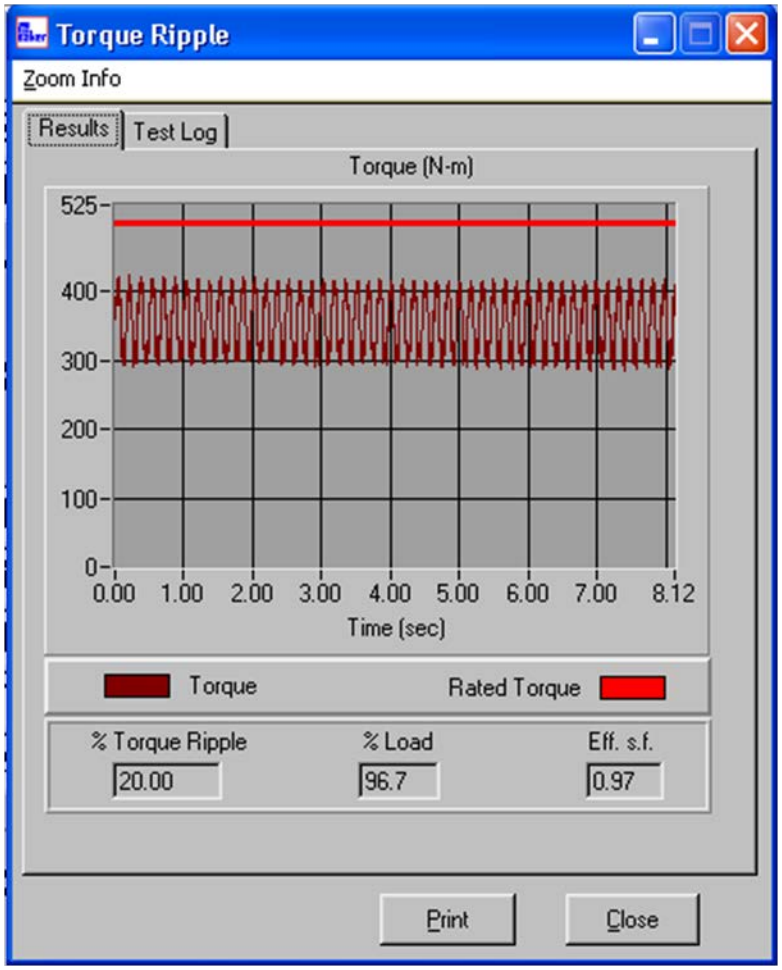
Torque Ripple is defined as the division of maximum torque divided by average torque during the acquisition period.

Torque ripple value (%) is trended, as are many other parameters.

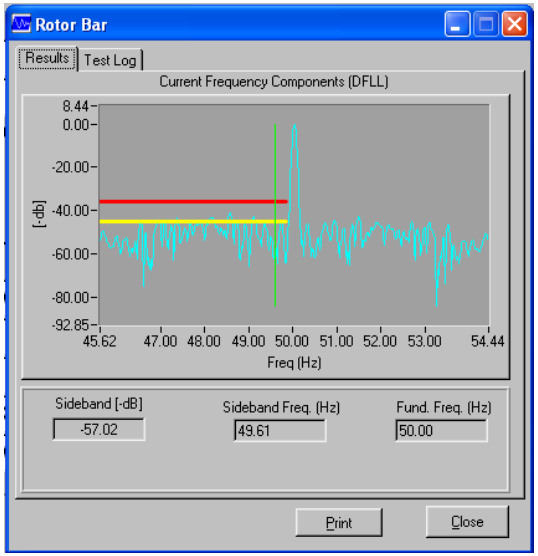
Torque Shows What the Load is Doing

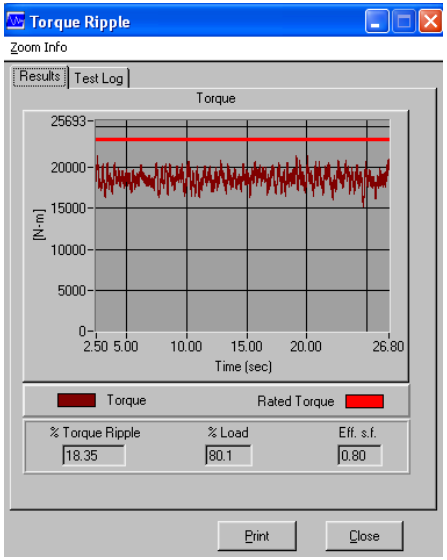
- Variations in torque indicates a problem with the smooth operation of the motor and or load.
- Intermittent load variations -> T(t)
- Repetitive load variations -> T(freq)

- To the right: Fan with a flapping belt causing excessive bearing wear on both motor and fan pillow blocks.



UK 11kv CW Pump Problem

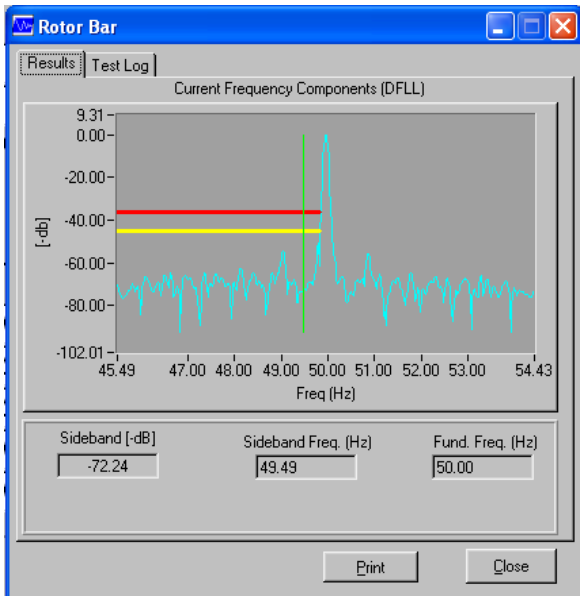




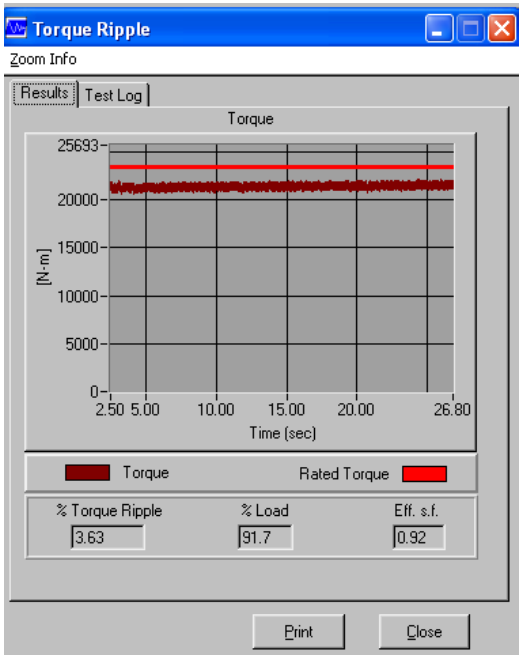
Rotor assessment

Torque profile

Problem Solved



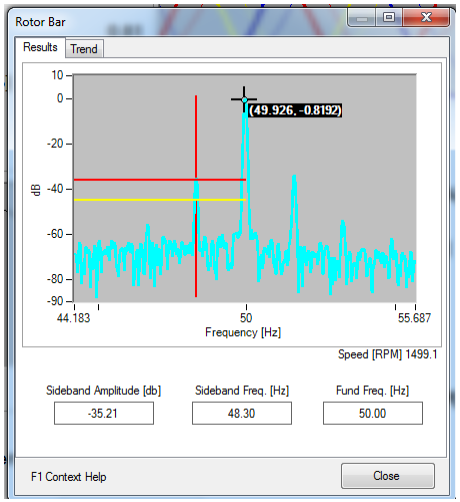
Rotor assessment



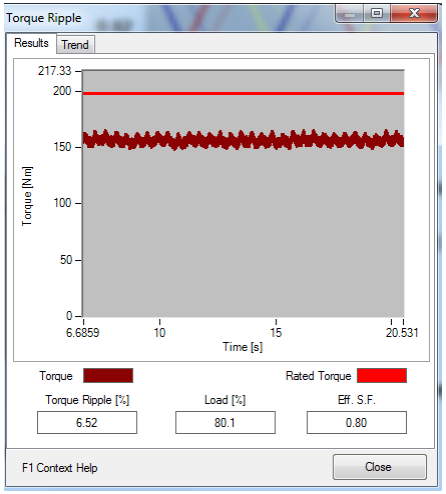
Torque profile

Cause: air in system following seal replacement

30kw Pump With Rotor Bar Problem



Rotor assessment

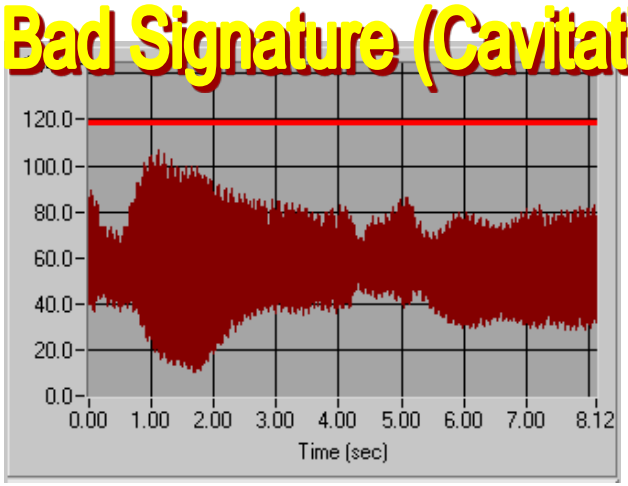


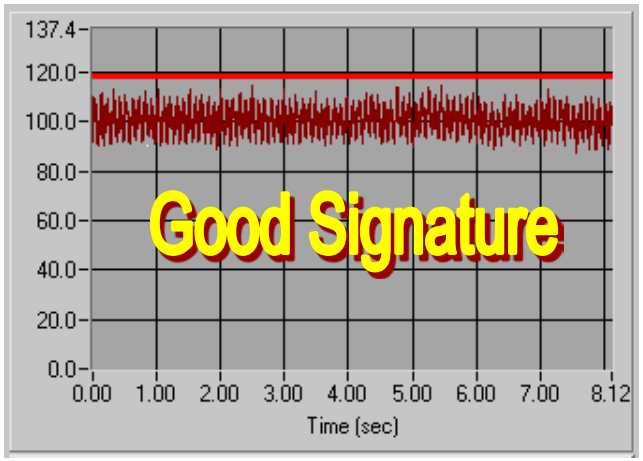
Torque profile

Problem: Bad quality brazing to end ring

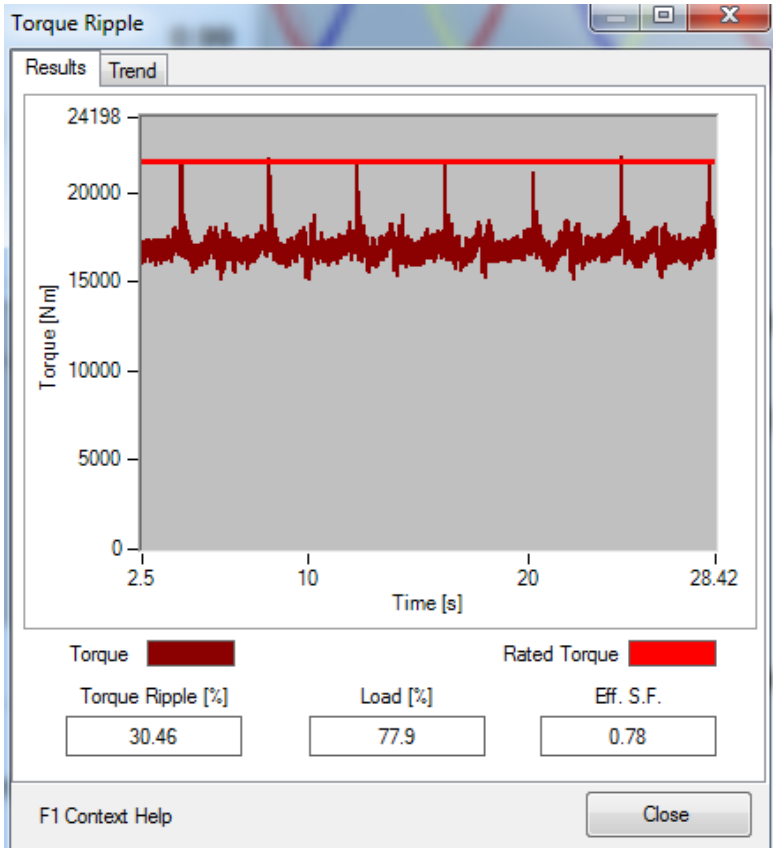
US 4160V Pump Problem

4160V submersible pump





Damaged Tooth on Pinion Gear



6kv 2.25MW Ball Mill Motor - Turkey

MCSA vs Dynamic Testing ?

MCSA – Motor Current Signature Analysis:

Analysis of motor current only

Dynamic Motor Testing:

Analysis of motor voltage and current, with calculation of average torque and variation of torque.

Fan/pump manufacturers often need to know the torque value

Analysis of voltage adds ability to understand how the power quality maybe affecting the insulation life.

Questions and Comments?