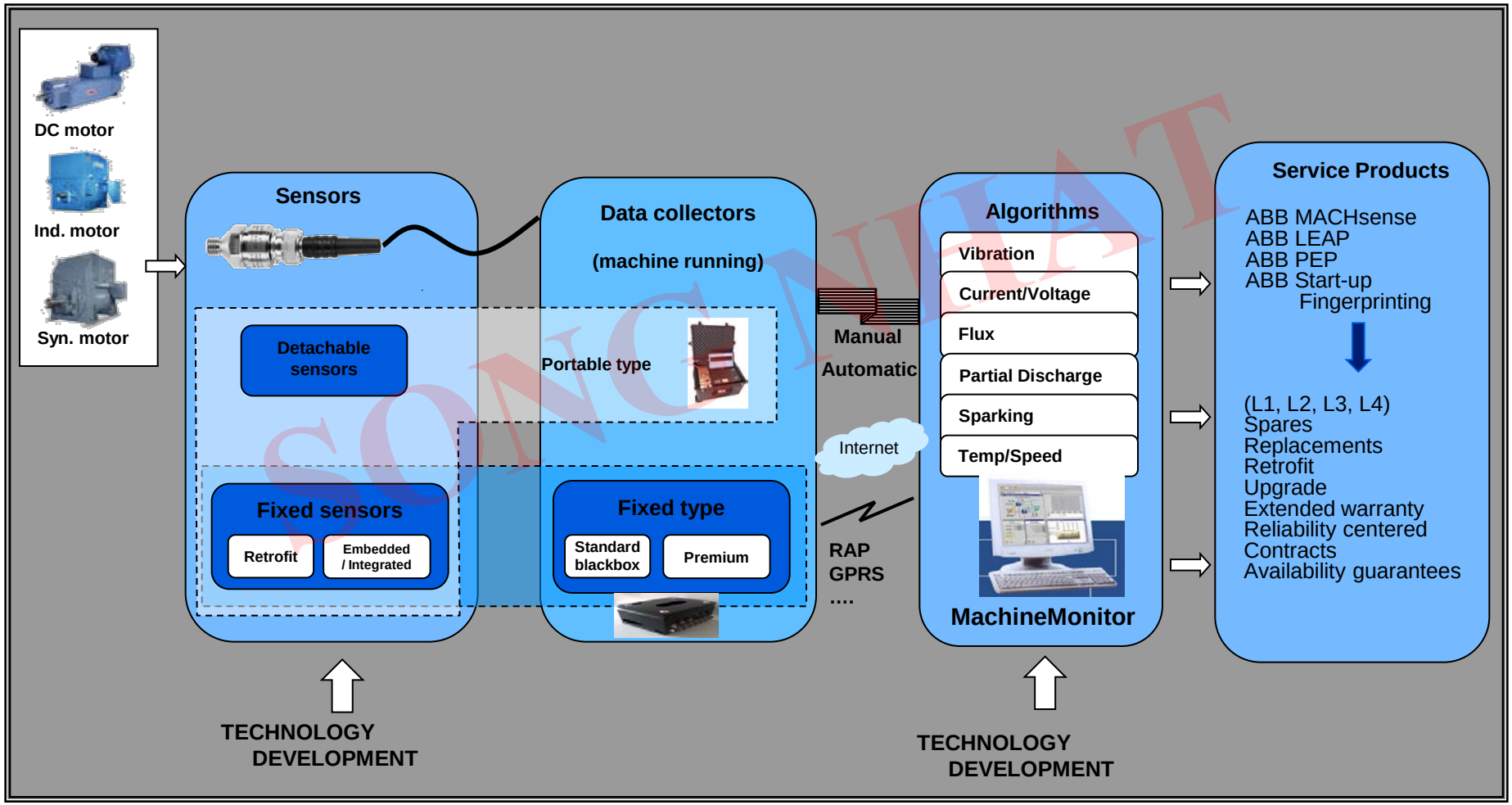
Tran Anh Xuan – Account Manager Machine & Motors – DMMG

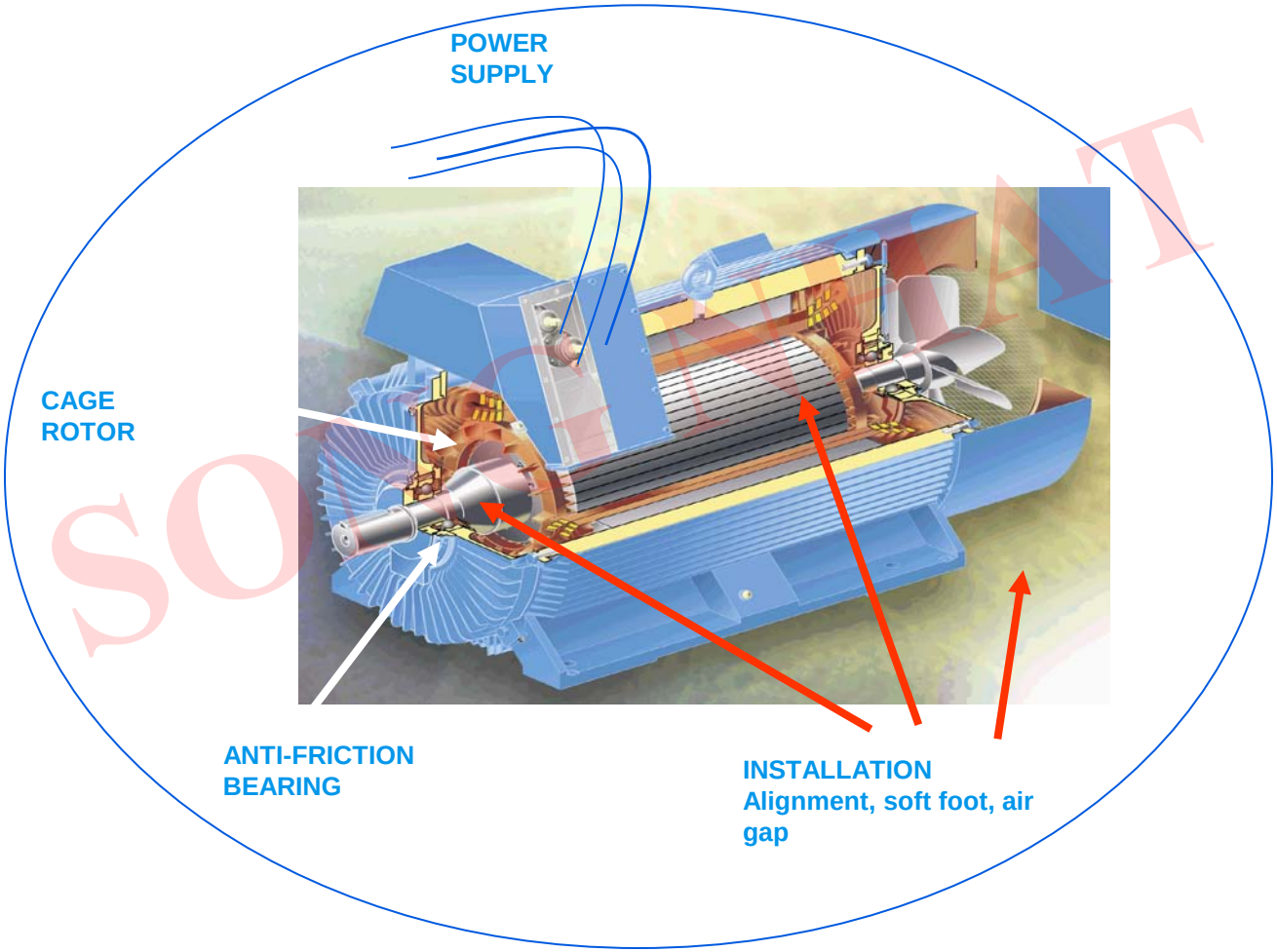
ABB MACHsense-P
Motor & Generator Service

Project: Sixth Sense
Overview



Project: ABB MACHsense-P
Overview

- A walk around condition monitoring service
- Periodic measurements
- Machine in operating condition
- Detection of defects and evolution over the time by periodic measurements
- Preventive maintenance plan based on projected time of defect criticality (over a period of 6 months)



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- Development has been done by ABB Machines Service based on intensive R&D carried out in our corporate research centers
- Measurement is done on the operating machine

Measurements & Analysis of Data & Report

- Measurements are performed by ABB Local Service Centers
- A summary report is delivered automatically on-site
- Detailed report is later delivered by Regional Technical Center (RTC)

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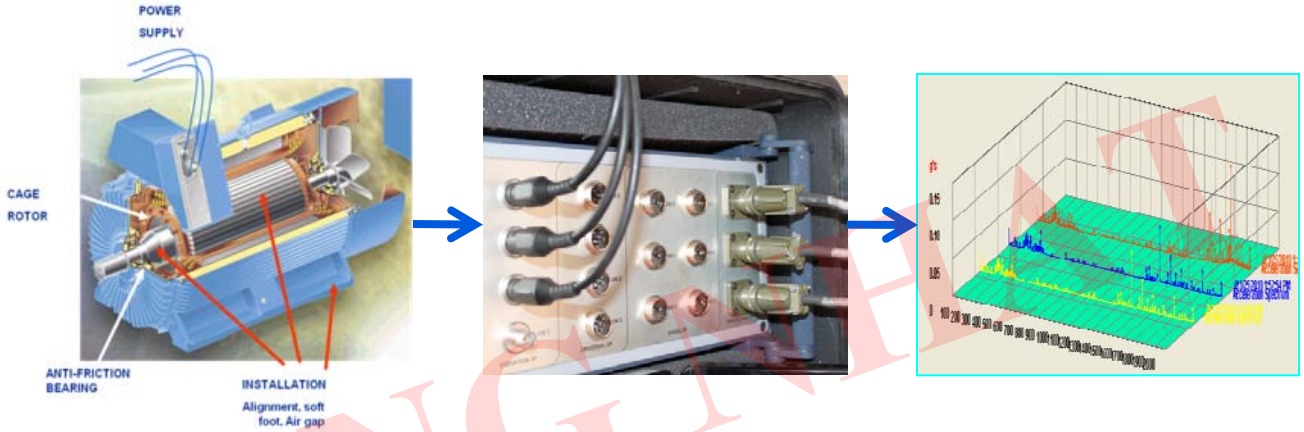
Measurements



Equipment

- A single analyzer for the mechanical and electrical measurements

Measurements

- 4 Vibration Sensors
- 3 Voltage clamps
- 3 Current clamps
- Temperature sensors (optional)
- Speed sensor (optional)

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Measurements

Measurement

- Either 4 vibrations channels or 7 electrical channels simultaneously
- High resolution data collector for quick & high speed data acquisition
- Critical comparisons to be made immediately during measurements (e.g. alignment check)

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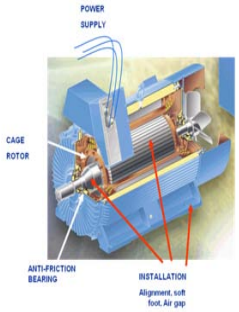
Standard Inspection Analysis



Cage Rotor

- Rotor winding defects
- Air gap eccentricity
- Unbalance
- Looseness
- Static and dynamic shaft bends
- Internal misalignment

Anti-Friction Bearing

- Bearing defects
- Bearing assembly defects
- Lubrication interval estimates

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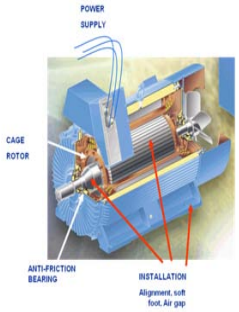
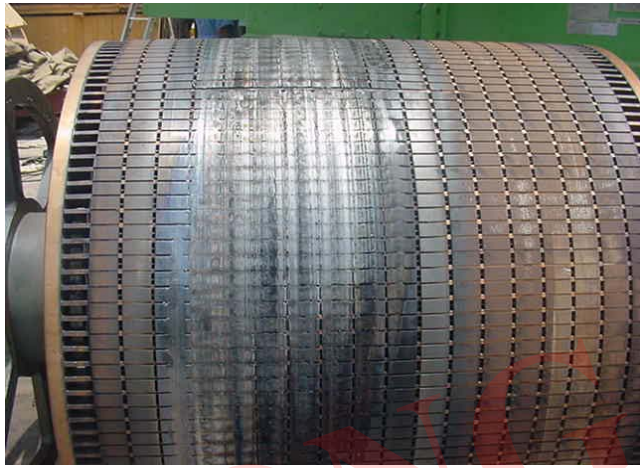
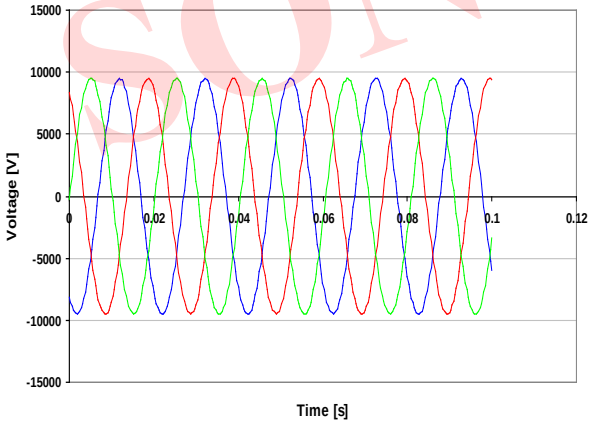
Standard Inspection Analysis







Installation

- Soft foot
- Misalignment
- Foundation resonance

Power Supply Quality

- Harmonics and distortion
- Unbalance
- Over/under voltage, frequency

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Standard Inspections

Solution levels	Inspection	Deliverables	Measurements Requirement	When

• Standard	• Vibration, voltage, current, temperature (winding, cooler, ambient) and speed
	
	• Operation history and maintenance and failures records
		• Cage rotor package
		  • rotor winding defects
		  • air gap eccentricity
		  • unbalance
		  • looseness
		  • static and dynamic shaft bends
		  • internal misalignment
		• Anti-friction bearing package
		  • bearing defects
		  • bearing assembly defect,
		  • lubrication interval estimates
		• Installation
		  • soft foot
		  • misalignment
		  • foundation resonance
		•Power supply
		  • harmonics and distortion
		  • unbalance
		  • over/under voltage
		  • frequency
		• Maintenance and inspections recommendation
			• Measurements of the machine at operating load	• Every six months

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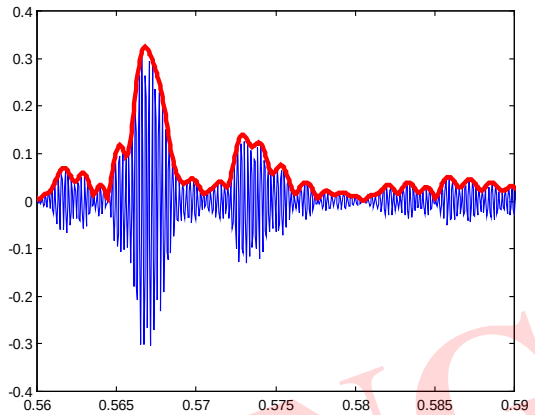
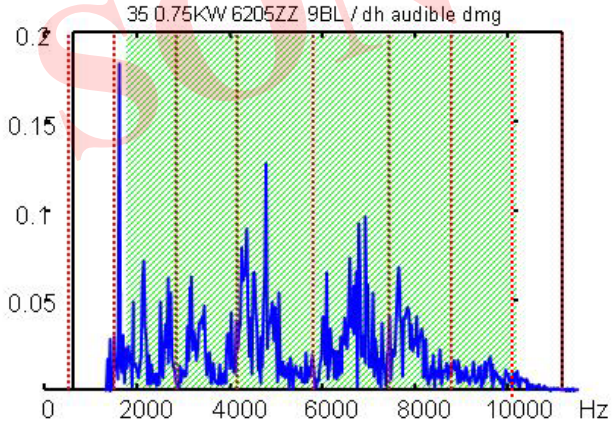
Advanced Inspections

Solution levels	Inspection	Deliverables	Measurements Requirement	When
• Advanced	• Vibration, voltage, current, temperature (winding, cooler, ambient) and speed • Operation history and maintenance and failures records	• Same as Standard • Cooler • Fouling • Root Cause Analysis	• Measurements of the machine at operating load and multiple loads or/and start-up	• When defect is suspected either from standard measurement or from observed problems and there is a need for further investigation

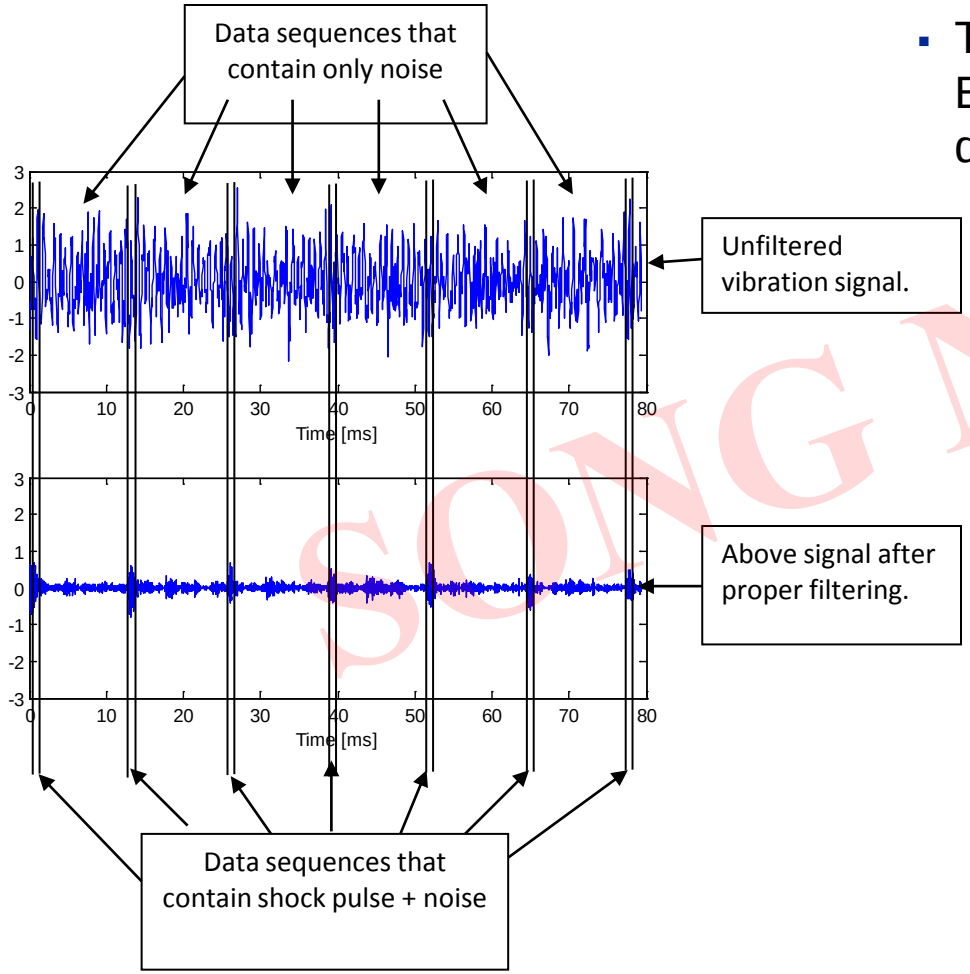
Bearings Vibration Analysis : BeAM®
Technical explanation





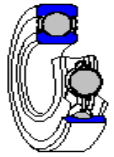
- Common analysis methods use for the envelope method for bearing fault detection
  - The envelop method uses the envelope of high frequency signals generated by defects and compares it to bearing defect frequencies.
- The ABB BeaCon automatic analysis uses:
  - the auto-correlation time-domain method to filter out the noisy signals more effectively that traditional method

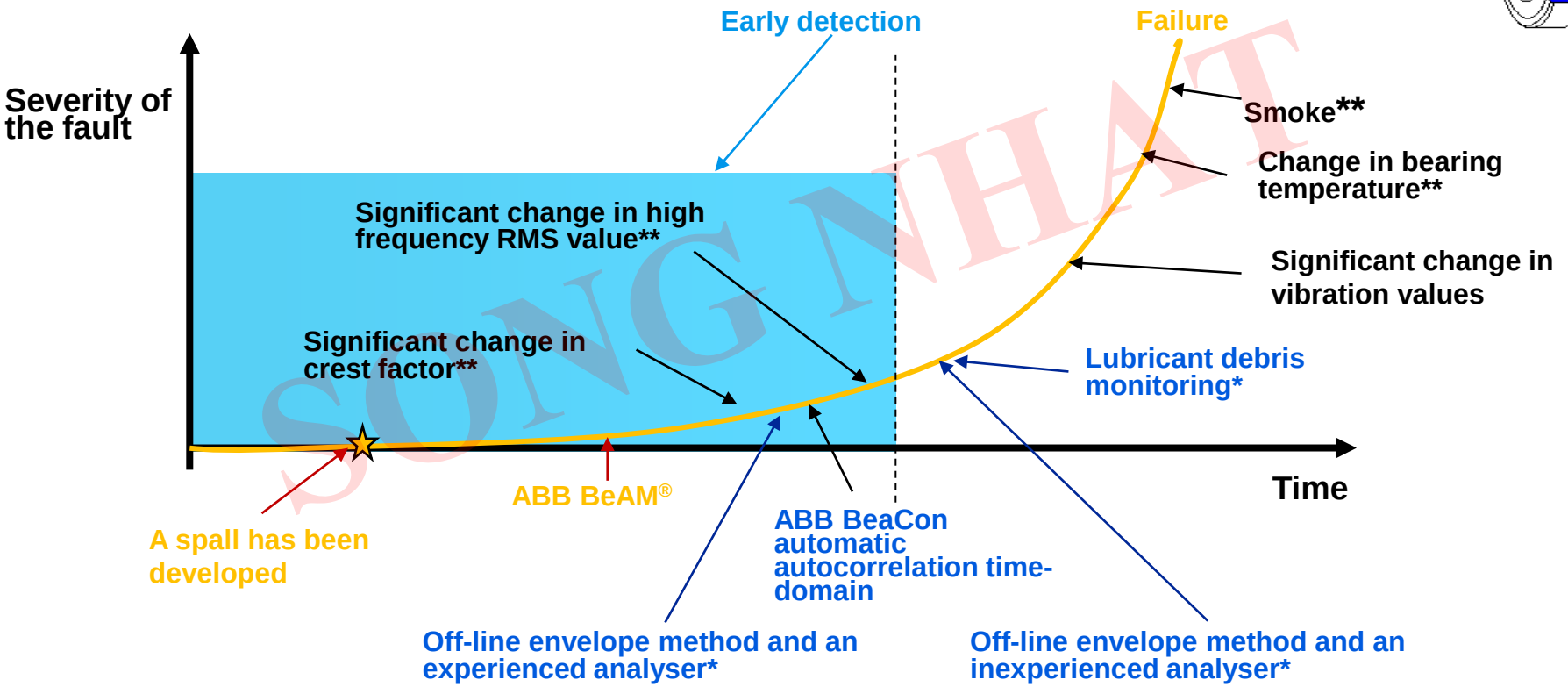
Bearings Vibration Analysis : BeAM®
Technical explanation



- The ABB BeAM® in addition to the ABB BeaCon automatic autocorrelation time-domain analysis:
  - Perform early shock pulse detector analysis which only extract the shock pulses related to bearing defects using special signal processing methods such as adaptive filtering and likelihood ratios to improve the signal sensitivity.
  - Estimates the following parameters to evaluate the condition of the bearing:
    - Kurtosis , high frequency RMS, maximum energy per shock pulse & integrated energy calculations

Sensitivity of different methods to detect bearing faults

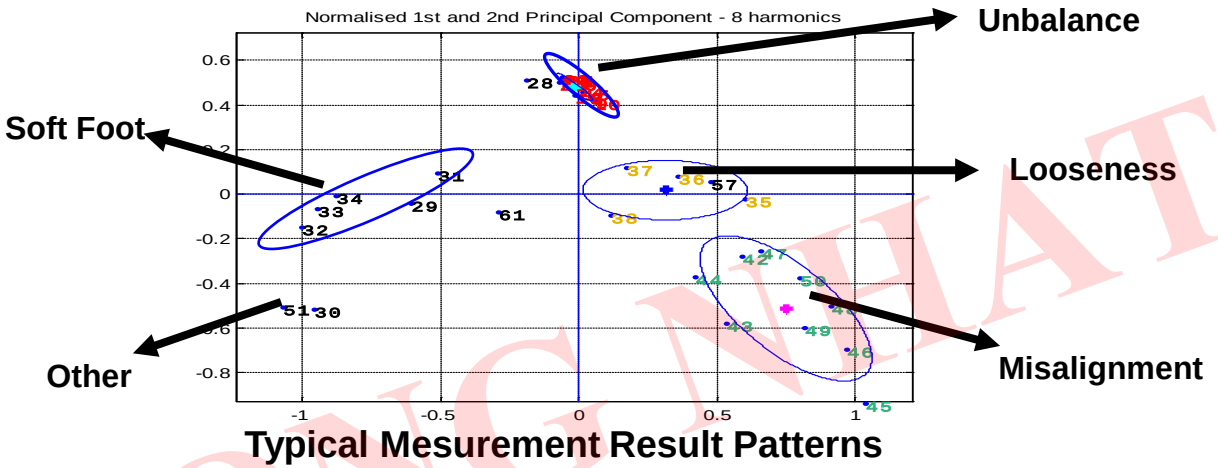




•Commonly used methods for bearing faults analysis

** Non-specific methods

Analysis of other vibration causes



Typical Mesurement Result Patterns

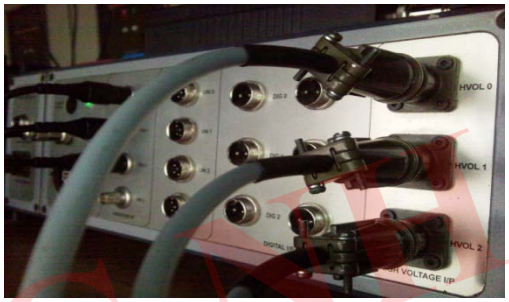
Analysis

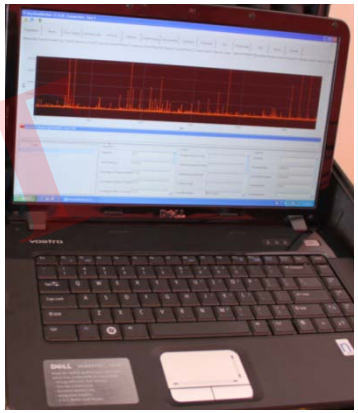
- Automatic analysis for the identification of misalignment, unbalanced, looseness and soft foot using Principal component Analysis (PCA)

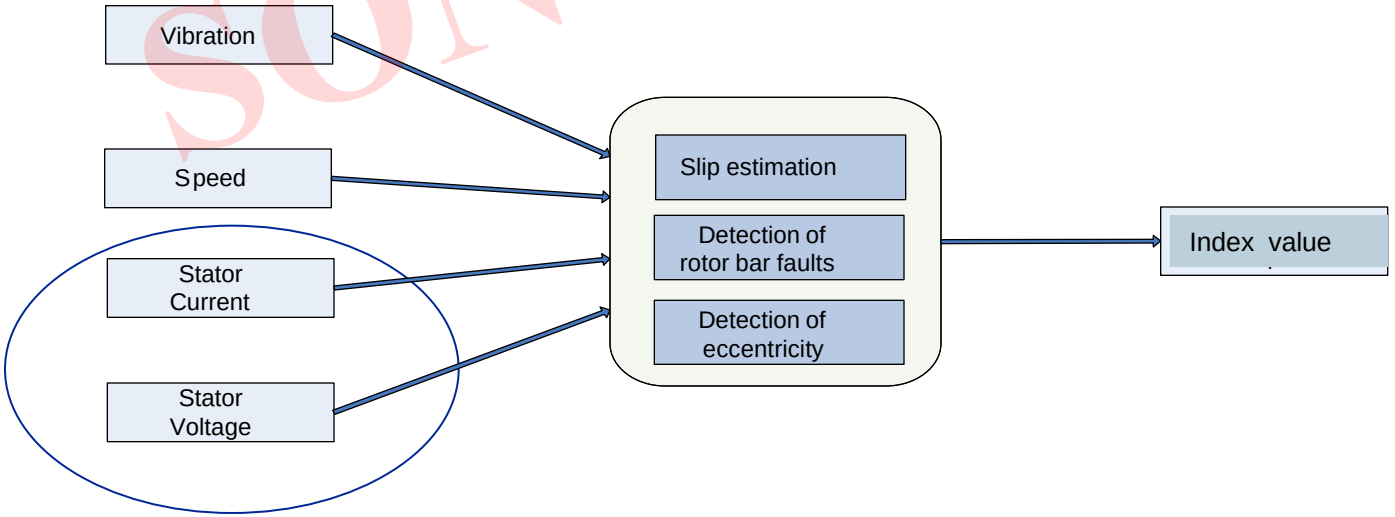
Electrical measurements

Analysis

- Rotor winding defects
- Air gap eccentricity problems
- ABB Motor Current Signature Analysis (MCSA) and voltage measurements







Advantage of ABB MACHsense-P Technology

Index and fault criticality are specific to each machine.

Machine design and construction aspects are accounted for in the calculation

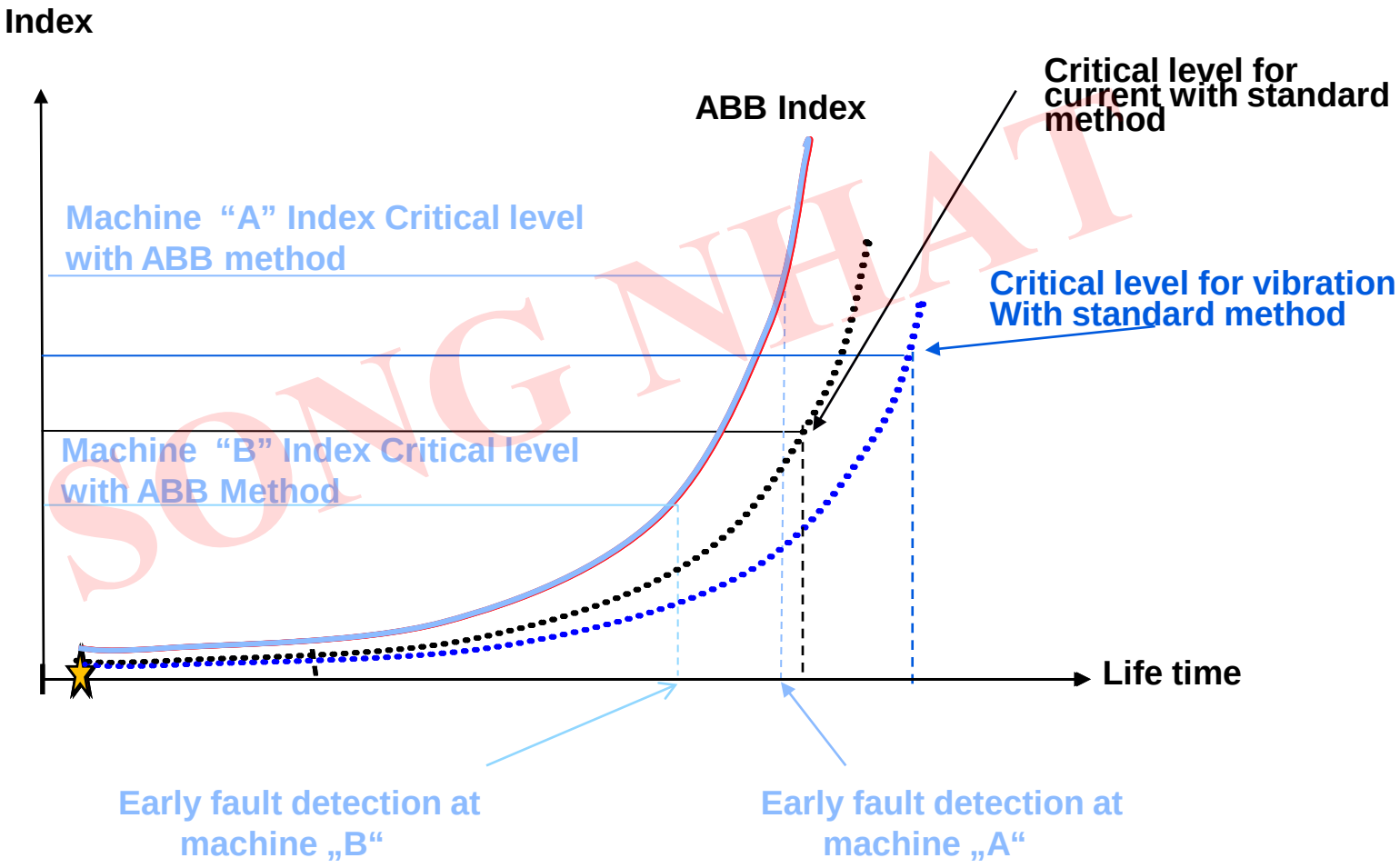
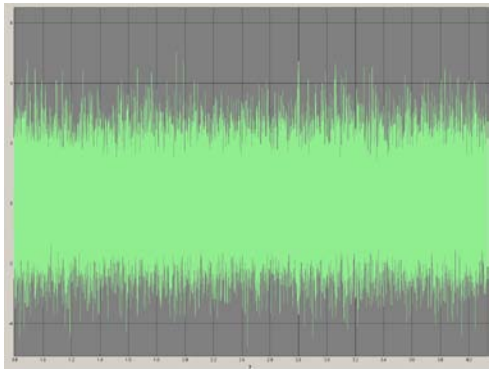
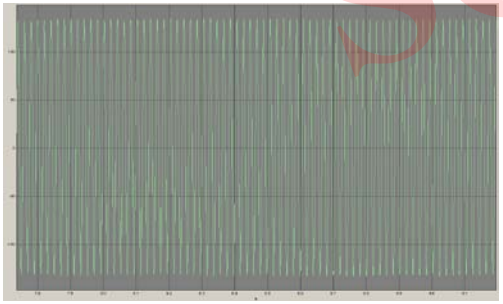


ABB MACHsense-P
Advantages





Rotor analysis

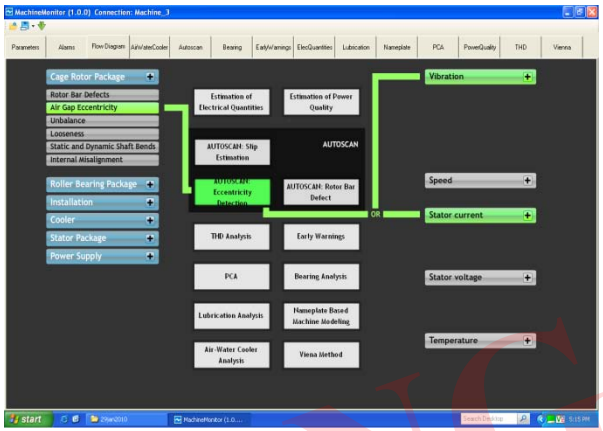
- Simultaneous presence of different defects can be isolated and analyzed separately
- Even if machine is loaded below 50%, rotor bar defect detection is possible
- Double cage or deep bar defects at the slot top can be easily identified
- Early detection of defects

ABB MACHsense-P
Advantages

ABB Motor Current Signature Analysis (MCSA)

- Our diagnostic method reduces the effect of
  - torque oscillations, variations and dips caused by power supply and loads
  - Winding connections
  - Rotor construction
- Our diagnostic method is suitable for large machines and takes into account
  - Low slip
  - Larger air gaps

Advantages of ABB MACHsense-P vs. other methods



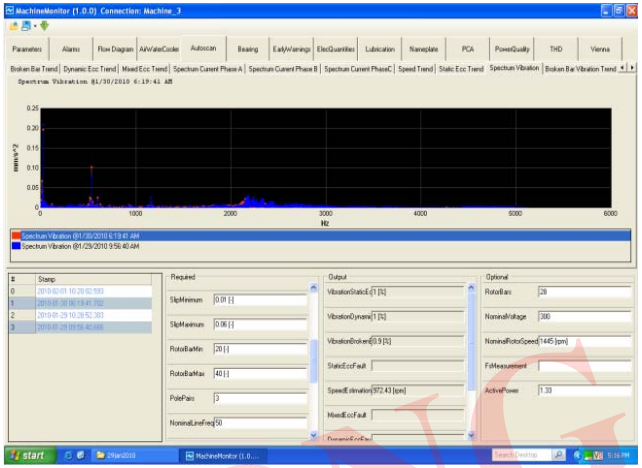
Model Based Analysis

- Increases reliability of defect identification
- Quantifies defect severity

Combined Analysis of current, vibrations, and torque

- Improves diagnosis accuracy
- Takes into account machine design & construction aspects to estimate defect indices & defect criticality

Advantages of ABB MACHsense-P vs. other methods



- Unique motor specific analysis tool
- Comprehensive analysis
- Current, voltage and vibration in a single automated analysis
- Summary status report issued on site
- Application specific preventive maintenance plan with final detailed report
- Reduction in unplanned downtime
- Early warning provides adequate time for maintenance plan
- ABB service network available
- Improves accuracy of diagnosis

ABB Condition Monitoring
Case study - Bearings

- Vibration measurement were taken for two identical Boiler Feed Pump motors. Both measurements were taken for 50 % of machine load.
- Nameplate details:

Power	Voltage	Current	Speed	Frequency	Poles
2000 kW	6.6 kV	204 A	1487 rpm	50 Hz	4

- Overall vibration readings in Motor BFP 3C, serial number: 3991201-1
- Velocity: 1.02 mm/s
- Acceleration: 0.46 g

- Overall vibration readings in motor BFP 3B, Serial Number: 3991201-2
- Velocity: 1.3 mm/s
- Acceleration: 1.36 g

ABB condition monitoring
Case studies – Bearings: Early Warning

BEARINGS STATUS:

Crest factor	High frequency RMS	Kurtosis	Modified crest factor	Peak to peak
5.43	0.459	3.32	2.32	4.99

Likelihood ratio energy analysis (BeAM): 19.26

Time domain analysis (Beacon): 0.07424

Machine BFP 3C

- Bearing OK
- Suggested action:
  - action category: preferred
  - next measurement: in six months

BEARINGS STATUS:

Crest factor	High frequency RMS	Kurtosis	Modified crest factor	Peak to peak
5.06	1.36	3.33	2.67	13.8

Likelihood ratio energy analysis (BeAM): 281.7

Time domain analysis (Beacon): 1.837

Machine BFP 3B

- Bearing faulty
- Suggested action:
  - action category: mandatory
  - change bearing as soon as possible but not later than 3 months

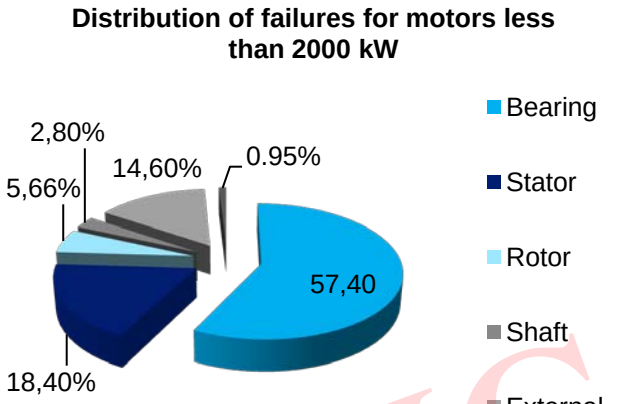
ABB condition monitoring
Case study : Recommendations
Explanation of Terminology

Action Category

	Probability of Fault Occurrence - Time Scale	Service Schedule	Measurement Frequency
No action			Measurements should be repeated between 6 months to a year
PREFERRED Action	within months to years.	Schedule service based on changing fault severity over time.	Measurements should be repeated every 6 months
CRITICAL Action	within weeks to months.	Scheduled service at next available outage.	The machine should be secured or monitored very closely*
MANDATORY Action	likely failure within days to weeks.	Perform service as soon as possible.	The machine should be secured or monitored very closely*
			* special short term monitoring schedule

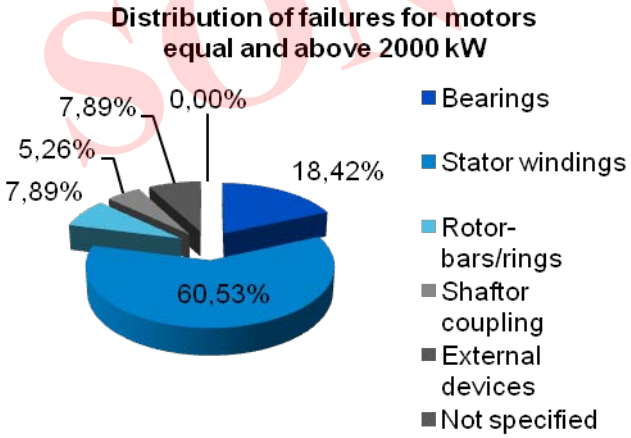
Target machines with ABB MACHsense-P

- Failure Statistics:
MV Motors Petrochemical Industry 1999
- Source:
IEEE TRANSACTIONS ON INDUSTRY APPLICATIONS . VOL. 35. NO. 4. JULY/AUGUST 1999



- for machines less than 2000 kW anti-friction bearings are main failure reason

  -> ABB MACHsense-P



- for machines above 2000 kW sleeve bearings are often used which are less likely to fail.
- main failure reason is stator winding.

  -> ABB LEAP for stator

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