Eliminate Unplanned Shutdown, Reduce Operating Costs.

With IIoT enabled

Asset Reliability Management

solutions

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Business Context

Post-COVID 19 era

- Movement of Man and Material is more difficult
- Emergency attendance to breakdowns more challenging

Maintenance waste

- Unnecessary scheduled maintenance
- Change of consumable & spare without ascertaining the need for doing it
- Fixing the breakdown as a consequence of an unplanned shutdown

Shift to CBM: Compelling reasons

Moving from Planned Maintenance to Condition Based Maintenance

- Only 18% of failures can be avoided by following a PMS
- Technology available to address these vital 82% failures
- Cost savings of up to 50% on spares and manpower
- Simplified logistics
- Enhanced reliability
- Early corrective action reduces extent of repairs increasing uptime
- 50% of all machinery failure is due to poor lubrication
- Oil Management system allows extended running hrs of oil and machine- cleaner oil longer equipment life.

Shift to CBM: Operational Efficiency

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Moving from Planned Maintenance to Condition Based Maintenance

- Know the health of your equipment. Deployment advantage
- Extension of running hours
- Trending and estimation of residual life.

Our Approach to CM

Cutting Edge Technologies for ‘very early detection’ of emerging faults

- Torsional Vibration Analytics for engines and rotating equipment.
- Online Oil Quality Monitoring
- Kidney loop filtration systems

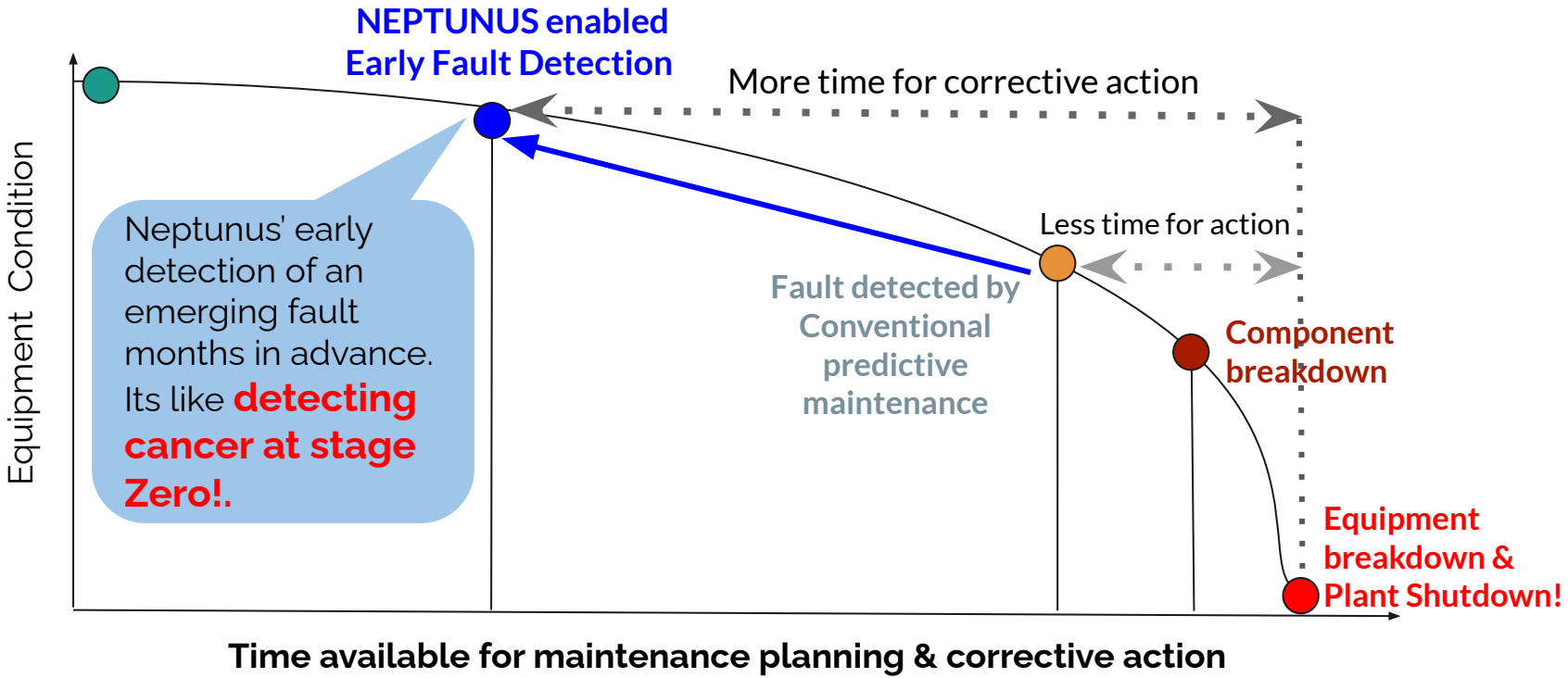
Torsional Vibrations – state of art technology

- Early fault detection in rotating equipment eg. Engines, gearbox, motor, bearings, turbines etc.

Oil Management

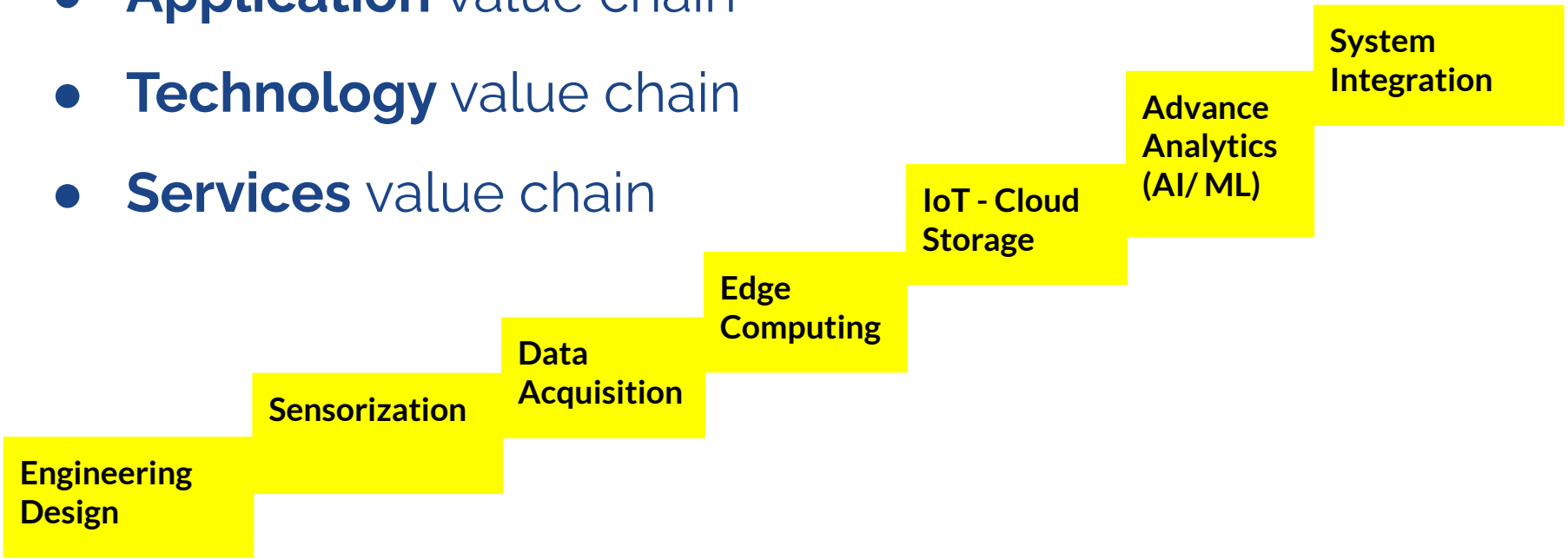
- 54% of all failures are related to bad lubrication
- Kidney loop oil filtration keeps oil clean, equipment healthier
- Online real time oil condition monitoring replaces periodic testing

Detecting Faults at initiation



End to End Solution Engineering

- **Application** value chain
- **Technology** value chain
- **Services** value chain



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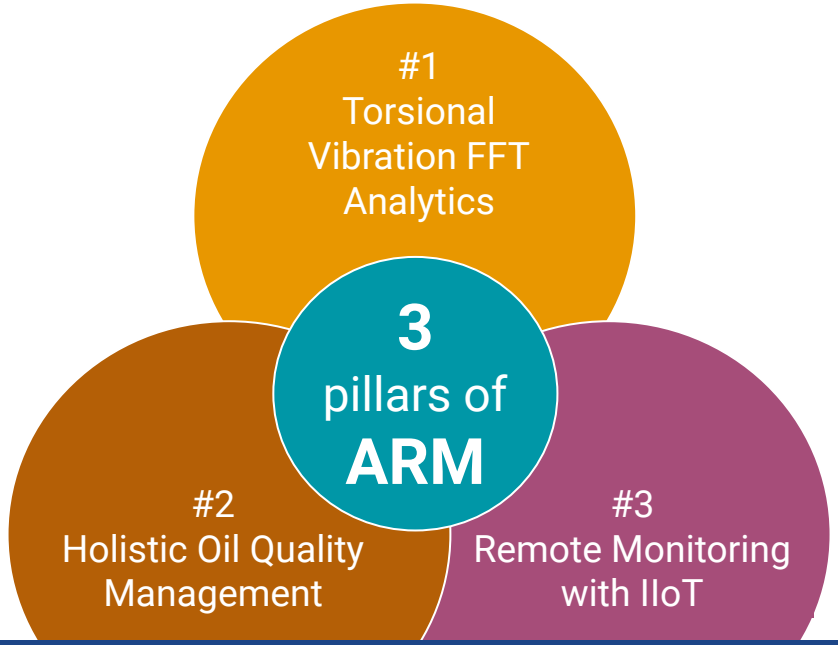
3 Pillars of Neptunus' ARM Solution



The most advanced and unique technology solution brought to you by Neptunus

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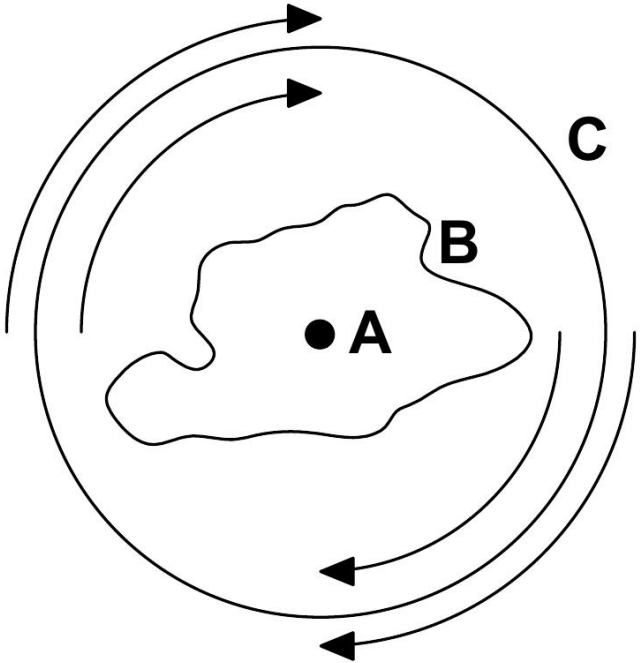
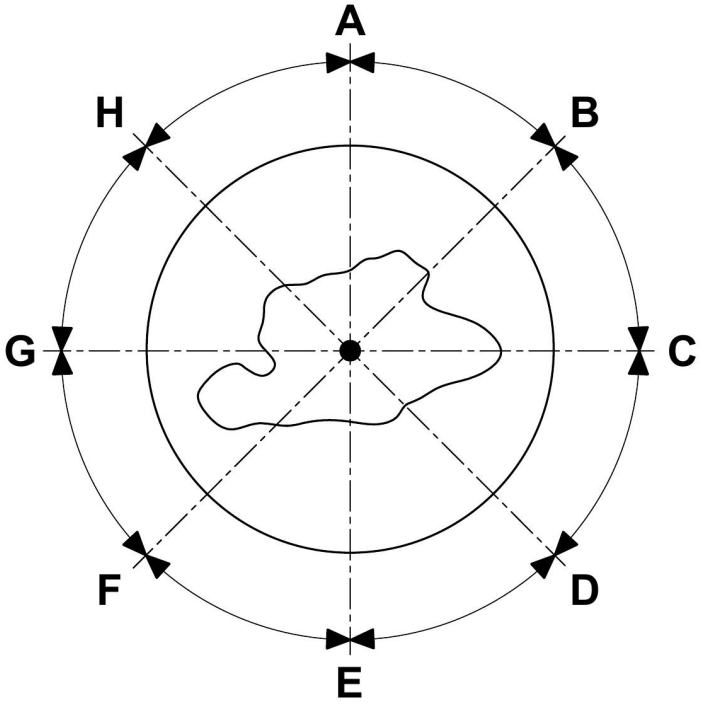
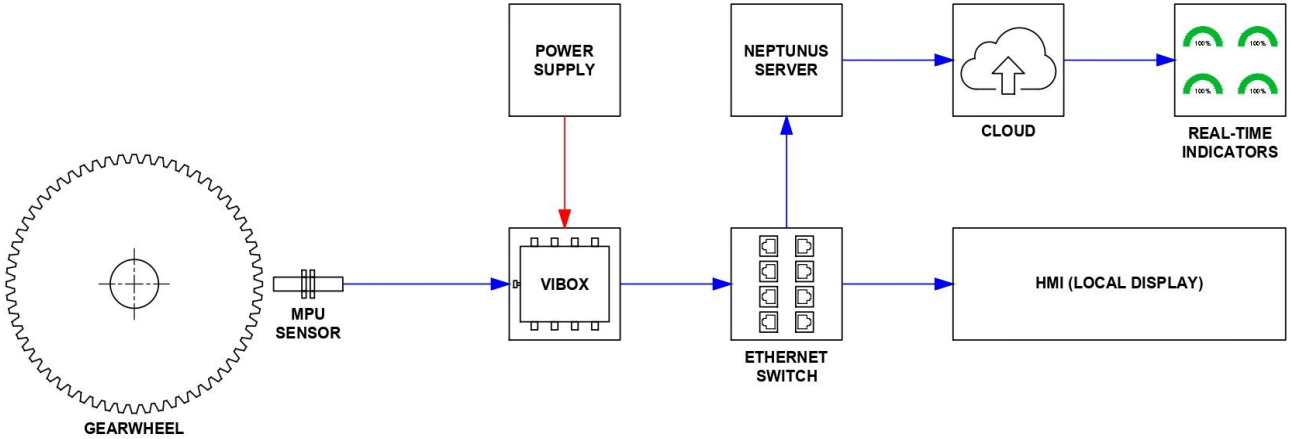
#1 Torsional Vibration FFT Analytics

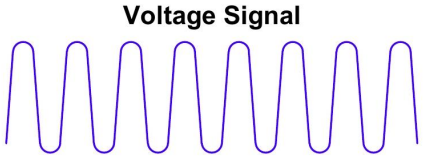
TV simplified





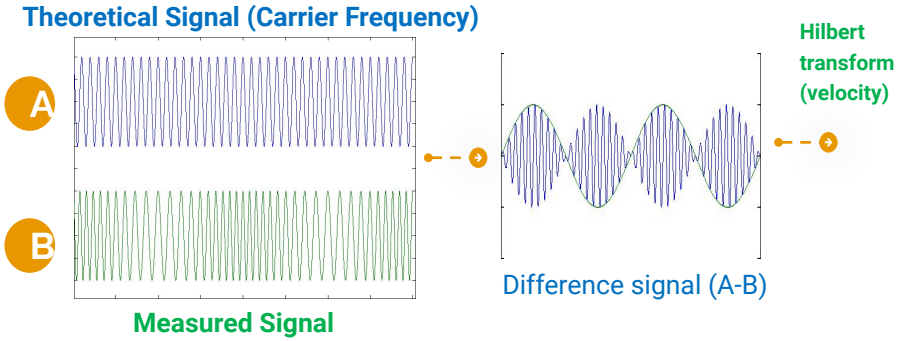
Torsional Vibration: Theory





Torsional Vibration

Torsional Vibration: Theory



Angular Displacement

Phase difference between Hilbert transform & carrier signal)

Angular Velocity

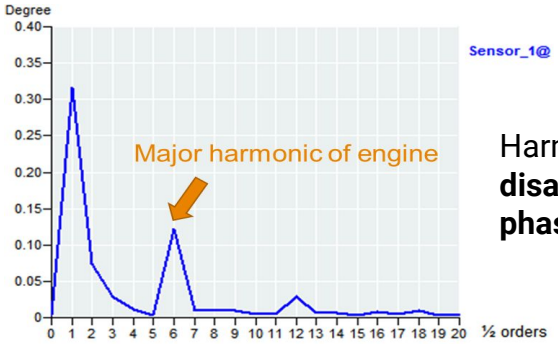
Magnitude of Hilbert transform

Angular Acceleration

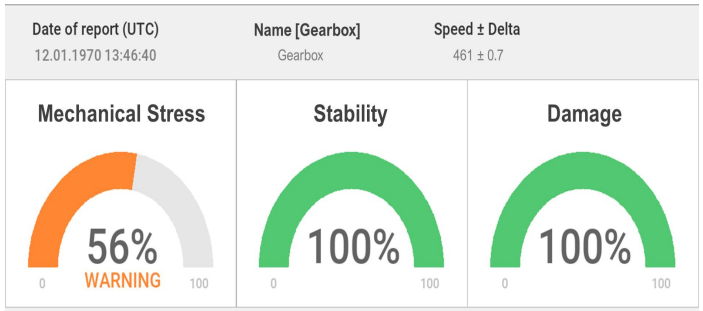
Derivative of velocity

Stochastic computation of statistical moments:

- **Mean**
- **Variance**
- **Skewness**
- **Kurtosis**



Harmonics **appearance** or **disappearance phasing**



Torsional vs Lateral Vibration

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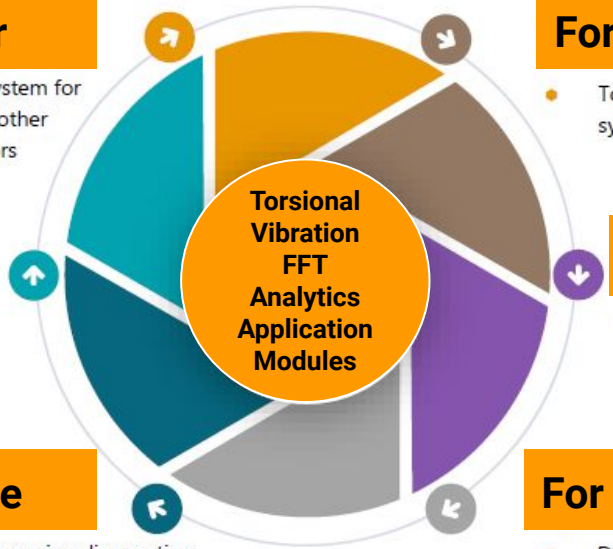
	Lateral Vibration	Torsional Vibration
Definition	Movement or mechanical oscillation about an equilibrium position of a machine or component	Changes in the relative angular displacement between two points on a rotating shaft
Sensor	Accelerometer (mostly)	MPU, Speed sensor, Encoder
Sensor location	Very critical parameter. If location is wrong, lots of false alarm	On rotating shaft
Transmission path/Frequency range	Right accelerometer for target frequency range	Independent of frequency range. Normally speed sensor works from 0-25KHz
Vibration	External disturbance could change the behavior	Independent of external vibration
Repeatability/Calibration	Calibration required	Not required
Result analysis	Analysis compared as par ISO 10816-3 Vibration severity chart.	not compared. In-situ real time diagnostics
Summary	The measurement of lateral vibrations is an **indirect** measurement of the forces of the component that could fail.	The measurement of torsional vibrations is a **direct** measurement of the forces of the component that could fail.

Torsional Vibration

- **FIRST to detect emerging fault**
  - Measures at the root of vibration
- **Component level protection**
  - Application specific software modules
  - Localized fault detection & alarms
- **Simple configuration**
  - Just ONE sensor is enough!
- **Easy to understand and act upon.**
  - No need of experts!

Applications for all types of machines



For motor

- Diagnostic system for traction and other electric motors

For torque

- Torque measurement and diagnostic system

For gearbox

- Diagnostic system for gearboxes

For bearing

- Bearing diagnostics system for rolling-element (ball and roller) bearings, plain (journal and sleeve) bearings

For engine

- Combustion engine diagnostics
- Any type of diesel, natural gas and petrol engines
- 2/4 stroke, inline/V type, up to 30 cylinders

For compressor

- Diagnostic system for compressors, e.g. integral reciprocating compressors.

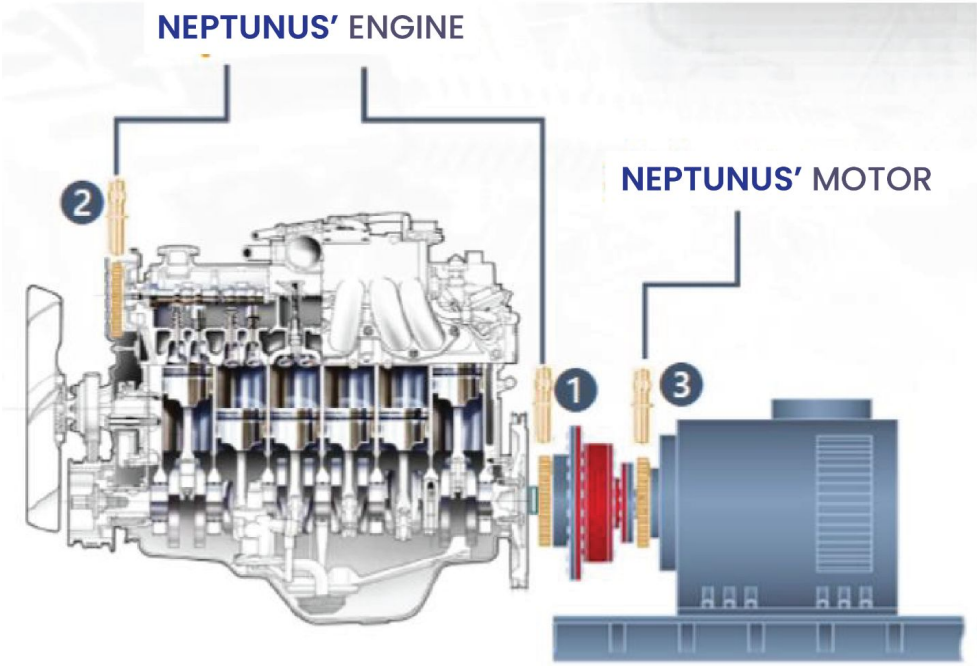
Diesel Engines: Installation

Module consists of :

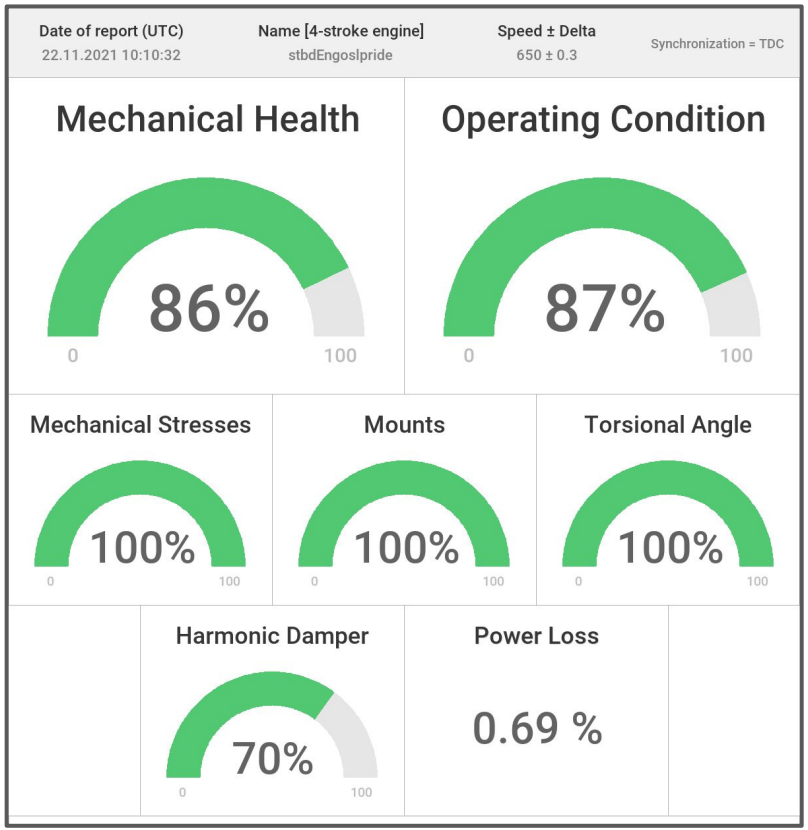
- Diesel Engine Analysis
- Alternator Analysis

Installation :

- Two MPUs to be installed on the Engine
- One MPU to be installed on the Alternator
- Current Monitoring Sensor on switchboard
- MPU measures the Torsional vibration
- TDC Sensor references the cylinders



Diesel Engine Indicators



OVERALL INDICATORS

- Mechanical Health
- Operating Condition
- Mechanical Stresses
- Stresses on foundation
- Torsional Angle
- Power Loss
- Harmonic Damper

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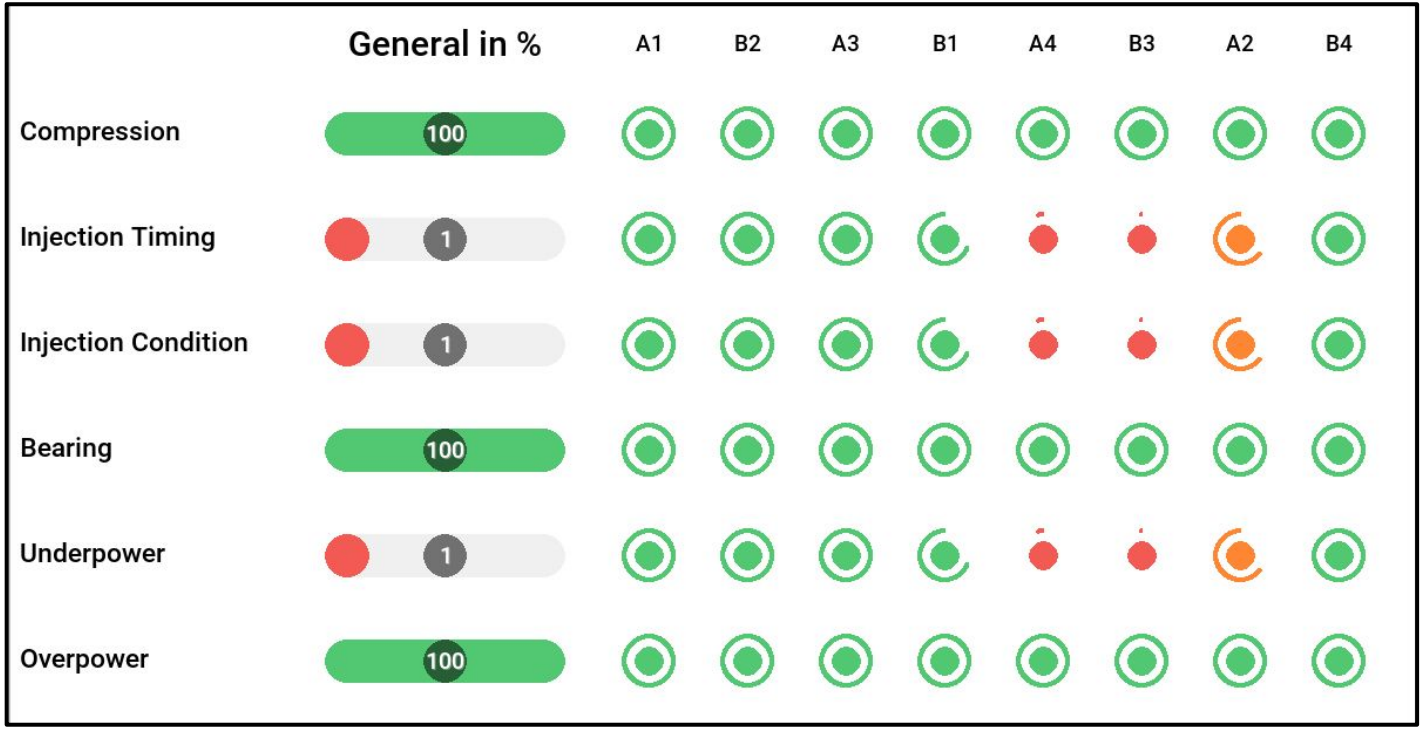
Diesel Engine Indicators

CYLINDER SPECIFIC HEALTH INDICATORS



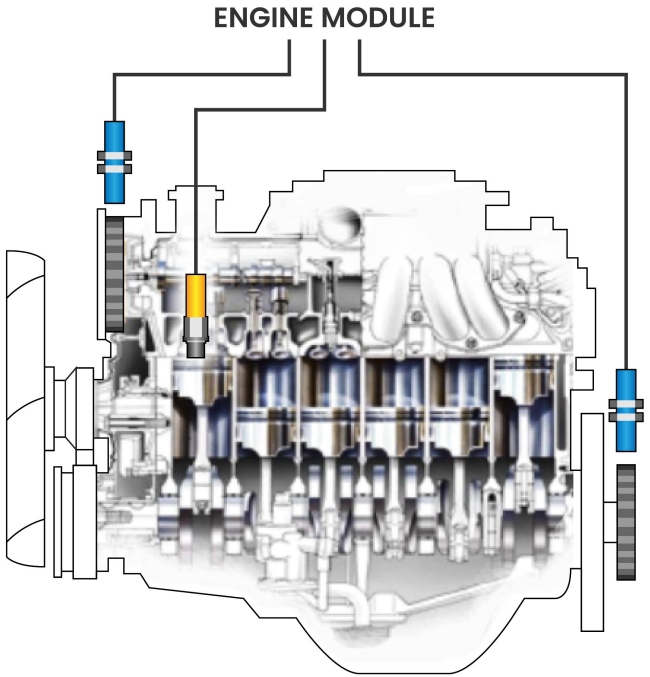
Pressure Sensor Installation

Addition in Engine Module:

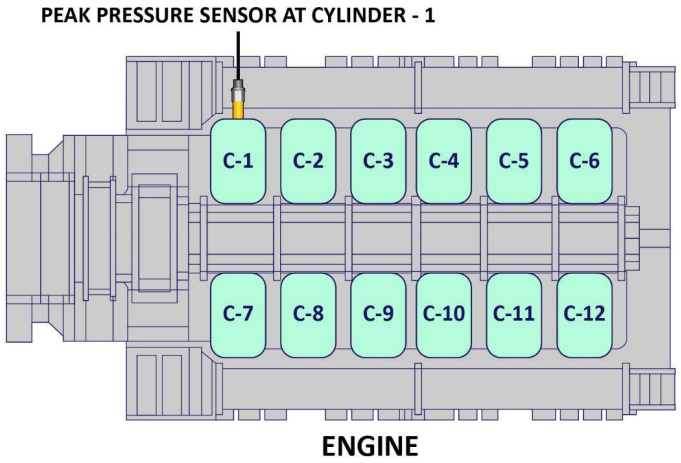
- Peak Pressure Calculation

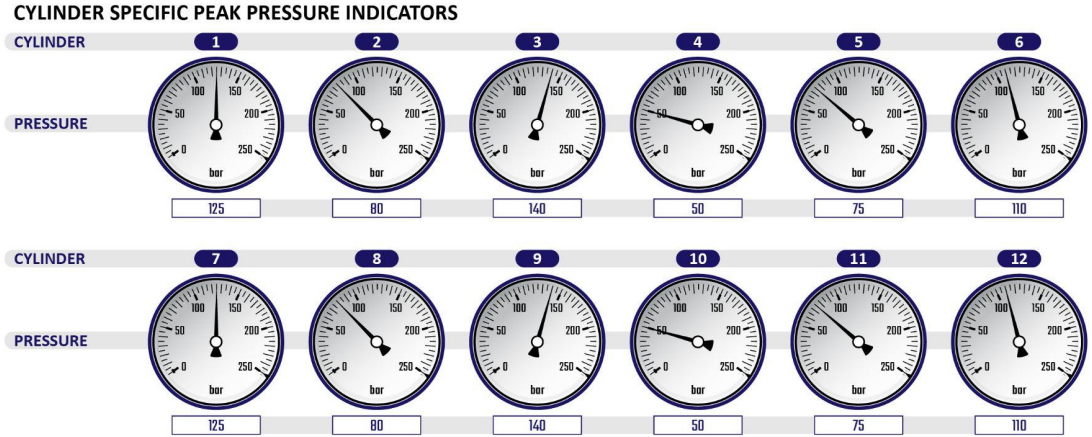
Installation:

- One peak pressure sensor to be installed on top of the indicator cock or safety relief valve of the first cylinder in TDC.
- With one input of peak pressure sensor from the First Cylinder in TDC, Vib360 software will calculate the absolute pressures of each cylinder in the given firing order.



Cylinder Specific Peak Pressure Indicators





Under development: TV incorporating Cylinder Peak Pressures.

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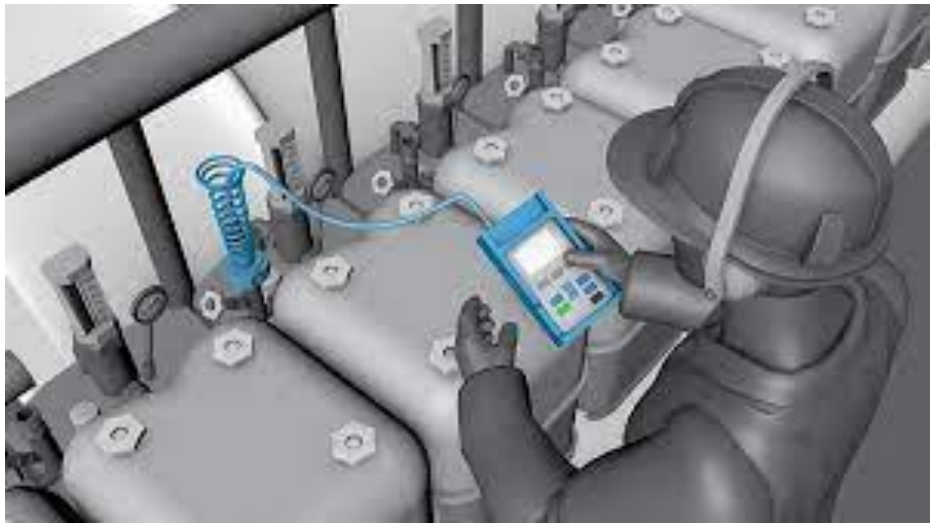
Traditionally, Peak Pressures of cylinders are measured by installation of Sensor on each cylinder during the operation of engine



Our approach

- Install just one peak pressure sensor on any cylinder.
- TV data calculates peak pressures on all cylinders.
- Accuracy of measurement is 98%

NEPTUNUS APPROACH OF PEAK PRESSURE MEASUREMENT

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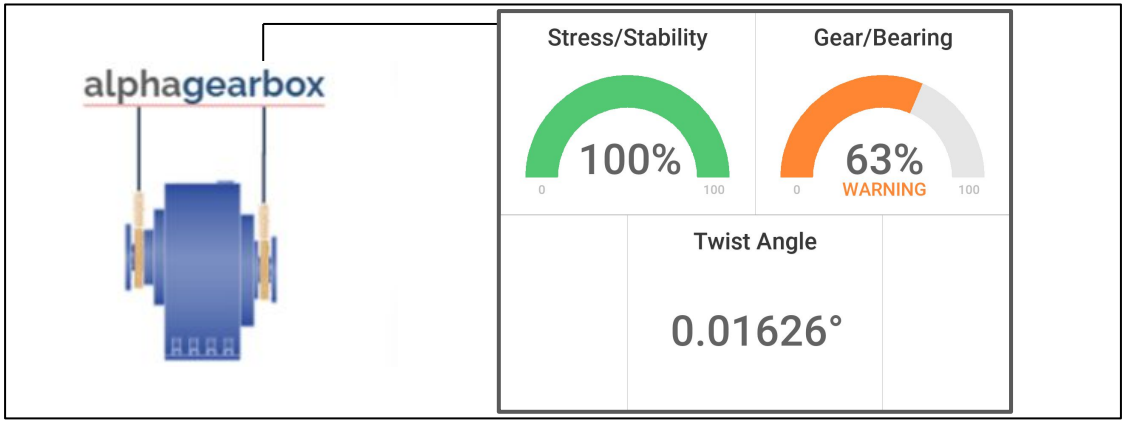
TRADITIONAL PEAK PRESSURE MEASUREMENT	NEPTUNUS PEAK PRESSURE MEASUREMENT
a. Sensor installed during the engine operation	a. Sensor installed with engine in off condition
b. On all the cylinders or one cylinder at a time	b. **Only on one cylinder to derive peak pressure on all the cylinders**
c. Safety issues in offline installation, high cost in online installation	c. Zero Risk, Low cost pressure measurement
d. Only pressure measurement	e. **Overall engine diagnostics** + Peak pressures of all the cylinders

Example: Gearbox Indicators



- **Stability:** Measured: The stability of the speed by measuring shaft speed change in percentage.
- Identifies potential cause of problems:
  - mass unbalance
  - Misalignment
- **Gearbox Damage:** Identify potential problem with all contacts e.g. teeth or bearings.
  - Abrasive frictional wear of bearings
  - Interaction issues of the gearbox elements

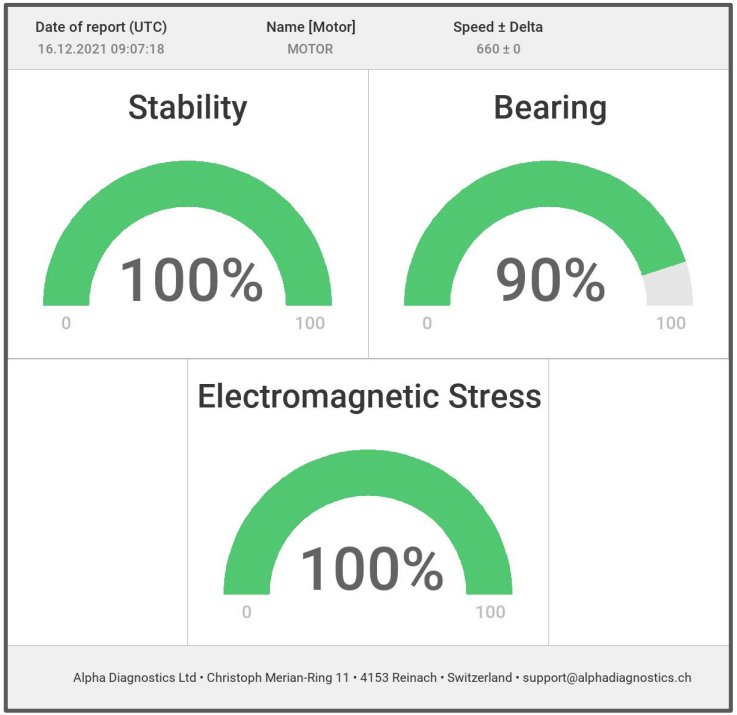
Example: Motor Diagnostics

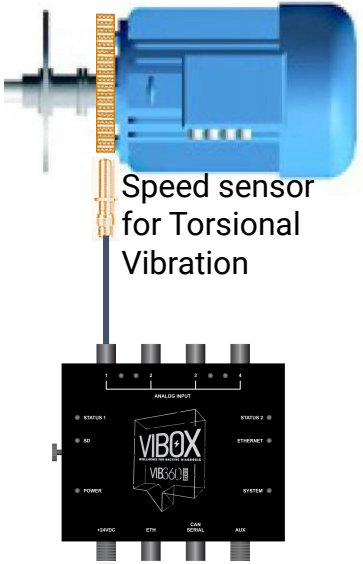
Requirements

- **Just One speed sensor** & encoder (gear wheel/ pole band) on the shaft drive end

How it works?

- Sensor & encoder measure instantaneous speed variation (torsional vibration - TV)
- TV data is processed by the motor diagnostic algorithm in the Vibox
- Real-time operator friendly indication of fault on the system Dashboard

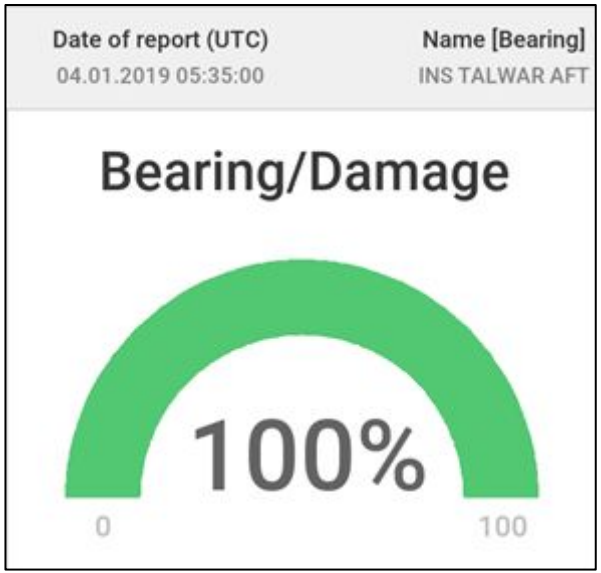




Speed sensor for Torsional Vibration

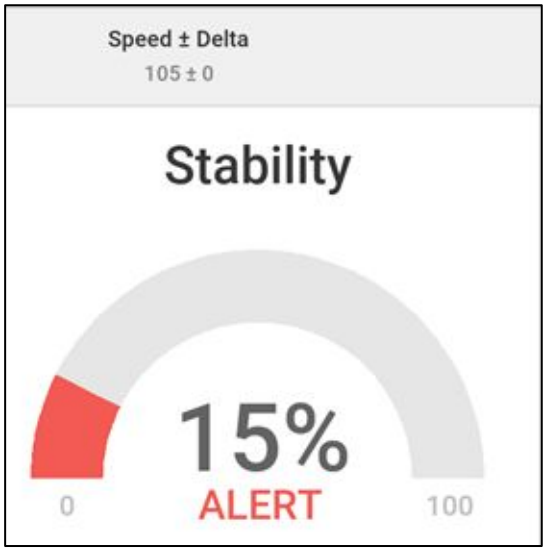
Runs application firmware **Vibox360motor**

BEARING Indicators



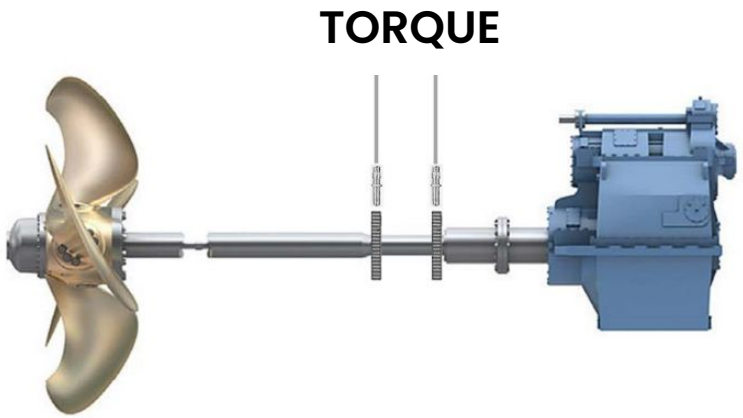
- This indicator measures unexpected stress pulses in movement of rotating system
- Potential problems could be shocks stemming from stress on rotating shaft during operation:
  a. Inadequate lubrication
  b. Misaligned shaft
  c. Insufficient bearing load

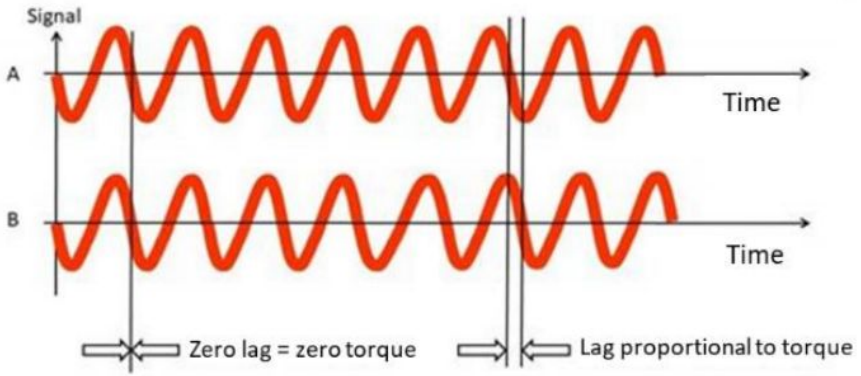
BEARING Indicators



- This indicator measures the stability of the speed by measuring shaft speed change in percentage
- Potential problems could be unbalances of shaft movement due to
  a. Broken rotor bar
  b. Mass unbalance
  c. Air gap eccentricity

Applications: Torque





TORQUE IS CALCULATED BY MEASURING THE PHASE SHIFT BETWEEN SENSOR A & SENSOR B

#2 Holistic Oil Quality Management

Managing Oil is key to reliable operations

- 54% of all machinery failures are due to bad oil
- Current method of sampling and periodic testing is unscientific
- We introduce a single sensor that monitors overall oil health in real time
- Keeping oil clean can enhance machinery life considerably
- Our custom-built filtration systems can keep hydraulic oil clean to NAS 5 and other oils to NAS 8 levels
- **Reduce your environmental footprint!**

How Oil Quality Can Impact Your Business

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NEW CLEANLINESS LEVEL (ISO CODE)

CURRENT CLEANLINESS (ISO CODE)

	20/17		19/16		18/15		17/14		16/13		15/12		14/11		13/10		12/9		11/8		10/7	
26/23	5	3	7	3.5	9	4	>10	5	>10	6	>10	7.5	>10	9	>10	>10	>10	>10	>10	>10	>10	>10
	4	2.5	4.5	3	6	3.5	6.5	4	7.5	5	8.5	6.5	10	7	>10	9	>10	>10	>10	>10	>10	>10
25/22	4	2.5	5	3	7	3.5	9	4	>10	5	>10	6	>10	7	>10	9	>10	>10	>10	>10	>10	>10
	3	2	5.3	2.5	4.5	3	5	3.5	6.5	4	8	5	9	6	10	7.5	>10	>10	>10	>10	>10	>10
24/21	3	2	4	2.5	6	3	7	4	9	5	>10	6	>10	7	>10	8	>10	>10	>10	>10	>10	>10
	2.5	1.5	3	2	4	2.5	5	3	6.5	4	7.5	5	8.5	6	9.5	7	>10	8	>10	9	>10	>10
23/20	2	1.5	3	2	4	2.5	5	3	7	3.5	9	4	>10	5	>10	6	>10	>10	>10	>10	>10	>10
	1.7	1.3	2.3	1.5	3	2	3.7	2.5	5	3	6	3.5	7	4	8	5	>10	6.5	>10	8.5	>10	10
22/19	1.6	1.3	2	1.6	3	2	4	2.5	5	3	7	3.5	8	4	>10	5	>10	6	>10	7	>10	>10
	1.4	1.1	1.8	1.3	2.3	1.7	3	2	3.5	2.5	4.5	3	5.5	3.5	7	4	8	5	10	5.5	>10	8.5
21/18	1.3	1.2	1.5	1.5	2	1.7	3	2	4	2.5	5	3	7	3.5	9	4	>10	5	>10	7	>10	10
	1.2	1.1	1.5	1.3	1.8	1.4	2.2	1.6	3	2	3.5	2.5	4.5	3	5	3.5	7	4	9	5.5	10	8
20/17			1.3	1.2	1.6	1.5	2	1.7	3	2	4	2.5	5	3	7	4	9	5	>10	7	>10	9
			1.2	1.05	1.5	1.3	1.8	1.4	2.3	1.7	3	2	3.5	2.5	5	3	6	4	8	5.5	10	7
19/16					1.3	1.2	1.6	1.5	2	1.7	3	2	4	2.5	5	3	7	4	9	6	>10	8
					1.2	1.1	1.5	1.3	1.8	1.5	2.2	1.7	3	2	3.5	2.5	5	3.5	7	4.5	9	6
18/15							1.3	1.2	1.6	1.5	2	1.7	3	2	4	2.5	5	3	7	4.5	>10	6
							1.2	1.1	1.5	1.3	1.8	1.5	2.3	1.7	3	2	3.5	2.5	5.5	3.7	8	5
17/14									1.3	1.2	1.6	1.5	2	1.7	3	2	4	2.5	6	3	8	5
									1.2	1.1	1.5	1.3	1.8	1.5	2.3	1.7	3	2	4	2.5	6	3.5
16/13											1.3	1.2	1.6	1.5	2	1.7	3	2	4	3.5	6	4
											1.2	1.1	1.5	1.3	1.8	1.5	2.3	1.8	3.7	3	4.5	3.5
15/12													1.2	1.2	1.6	1.5	2	1.7	3	2	4	2.5
													1.2	1.1	1.5	1.4	1.8	1.5	2.3	1.8	3	2.2
14/11															1.3	1.3	1.6	1.6	2	1.8	3	2
															1.3	1.2	1.6	1.4	1.9	1.5	2.3	1.8
13/10																	1.4	1.2	1.8	1.5	2.5	1.8
																	1.2	1.1	1.6	1.3	2	1.6

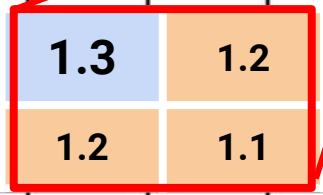

Table Legend

Hydraulics and Diesel Engines	Rolling Element Bearings
Journal Bearings and Turbo Machinery	Gear Boxes and Other

How Oil Quality Can Impact Your Business

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LEM - MOISTURE Level

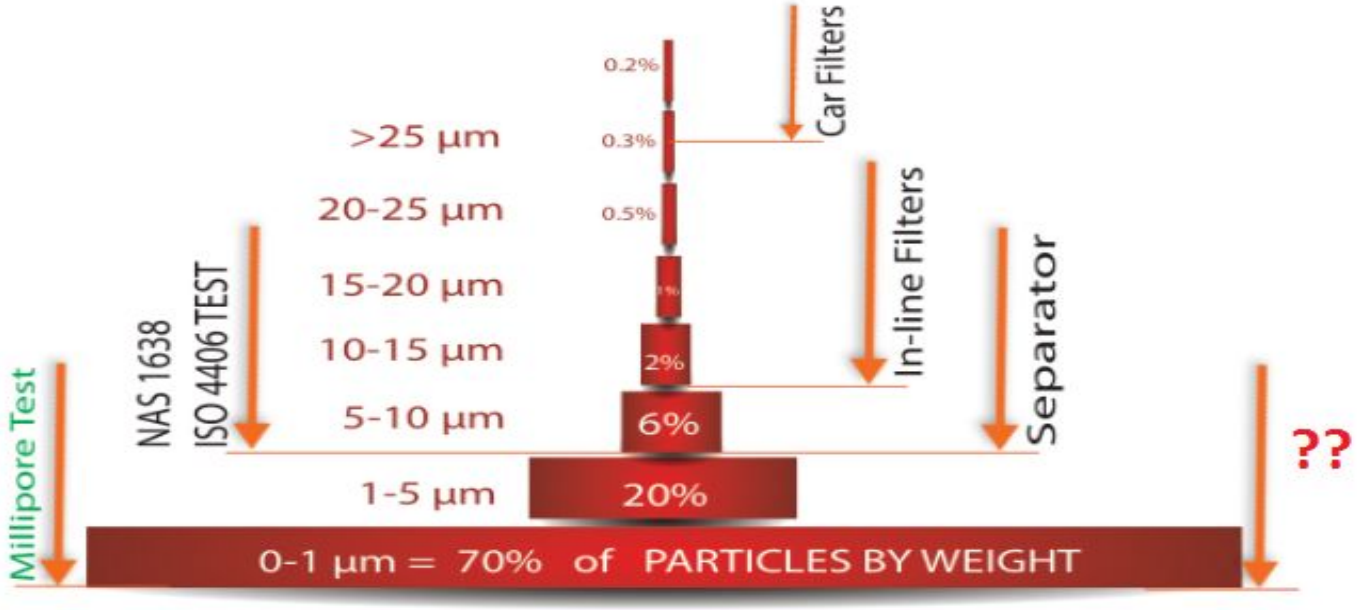
Source: Noria Corp.

Current Moisture Level, ppm	Life Extension Factor								
	2	3	4	5	6	7	8	9	10
50,000	12,500	6,500	4,500	3,125	2,500	2,000	1,500	1,000	782
25,000	6,250	3,250	2,250	1,563	1,250	1,000	750	500	391
10,000	2,500	1,300	900	625	500	400	300	200	156
5,000	1,250	650	450	313	250	200	150	100	78
2,500	625	325	225	156	125	100	75	50	39
1,000	250	130	90	63	50	40	30	20	16
500	125	65	45	31	25	20	15	10	8
260	63	33	23	16	13	10	8	5	4
100	25	13	9	6	5	4	3	2	2

1% water = 10,000 ppm. • Estimated life extension for mechanical systems utilizing mineral-based fluids.

Example: By reducing average fluid moisture levels from 2500 ppm to 156 ppm, machine life (MTBF) is extended by a factor of 5.

Why Micro / Nano filtration ?



90% of particulate matter are less than 5 microns

70% of particulate matter are less than 1 microns

Holistic Oil Quality Management

- Measure to manage
- Filtration removes sources of oxidation and keep the oil continuously clean
- Follow the optimal oil replacement period, not based on OEM recommendations
- Get detailed oil quality data based on several key oil quality indicators.
- Provide remote accessibility of oil health data

Custom solutions for different applications

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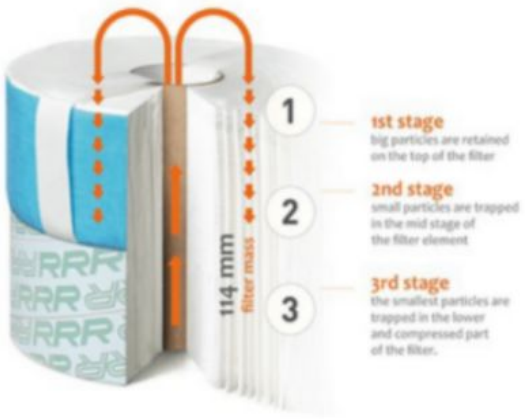
Applications

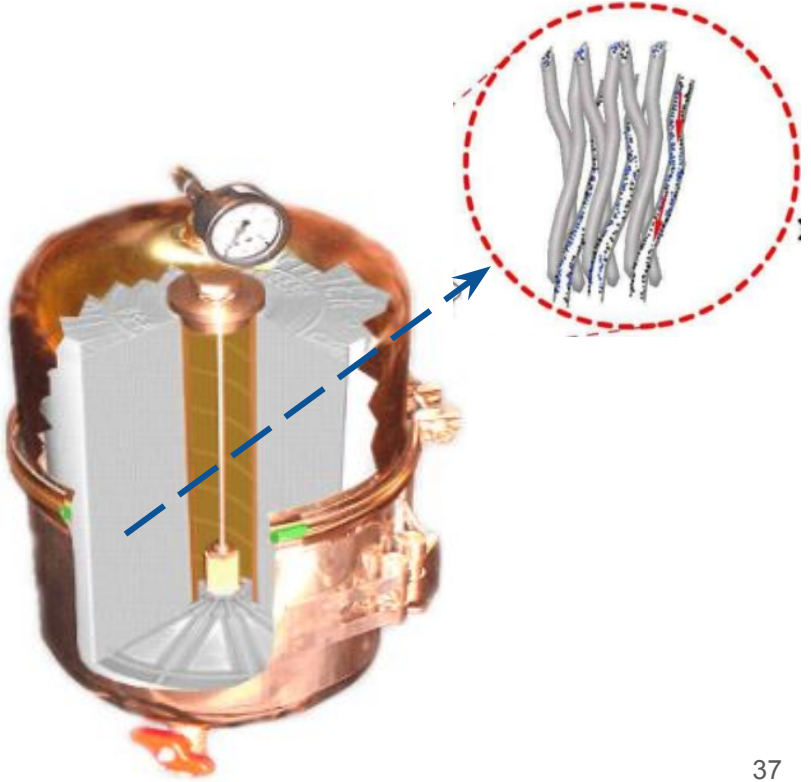
Gearboxes with oil of 420 cst	**10 micron filtration**
Engines and general application	**3 micron filtration**
Hydraulic oil	**0.1 micron**

Superior Filtration technology

- Employs bypass loop (kidney loop) to increase the effectiveness of filtration
- Is a highly efficient filtration systems (**β3 >929**), capable of removing water, solid particles, resins, oxidation sludge, varnish and other organic contaminants from oil
- Oil Flow is Axial, not radial
- Uses a patented Depth filtration technology to capture maximum number of contaminants
- Based on cellulose filter technology, it is a unique product in the market
- Ultra filtration, removes particles down to < 0.1 micron
- Reduces water, bound, free and emulsified water
- Reduces oxidation by 99%

Depth filtration





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Tan Delta Online Oil Condition Monitoring

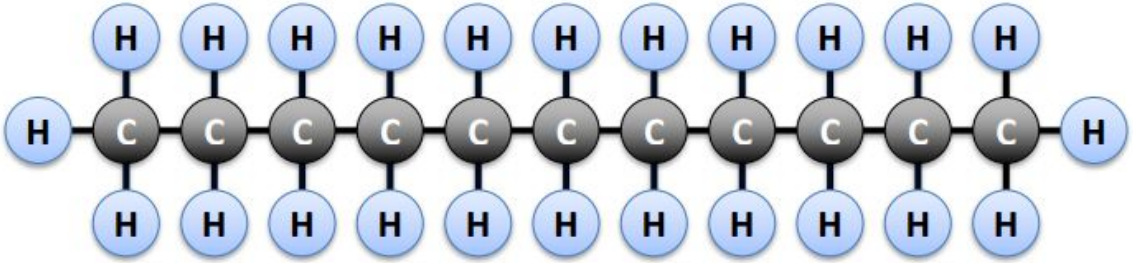
Online real time Oil health

Principle of operation:

- The sensor generates an electric field within the oil
- Ratio of capacitance and conductance of oil is calculated by the sensor
- This ratio is compared with our oil database and a TDN (Tan Delta Number) is generated
- TDN is a measure of exact oil quality and ranges from 0 to 1200

The Technology - Tan Delta

Any industrial oil has



A base oil type
- Mineral
- Semi-Synthetic
- Synthetic

Various additive packages
- Bases
- Extreme Pressure
- Anti Foaming
- Anti Wear
- Anti Corrosion
- Specialised

And a Viscosity
- Low - Hydraulics
- Mid - Industrial
- High - Worm Gears

Individual Electro-Chemical Fingerprint

"Therefore every oil has a unique chemical make-up"

Failure Modes - Tan Delta

The sensor will detect the following failure modes:-

- Oxidation
- TAN changes
- TBN changes
- Additive depletion
- Particulate contamination
  - Wear debris
  - Process related (product)
  - Environment related (dust, sand)
  - Partially burnt fuel
  - Soot
- Fluid contamination
  - Water/Coolant ingress
  - Process related (product)
  - Fuel dilution
- Major viscosity changes
- Poor oil changes
- Incorrect oil type

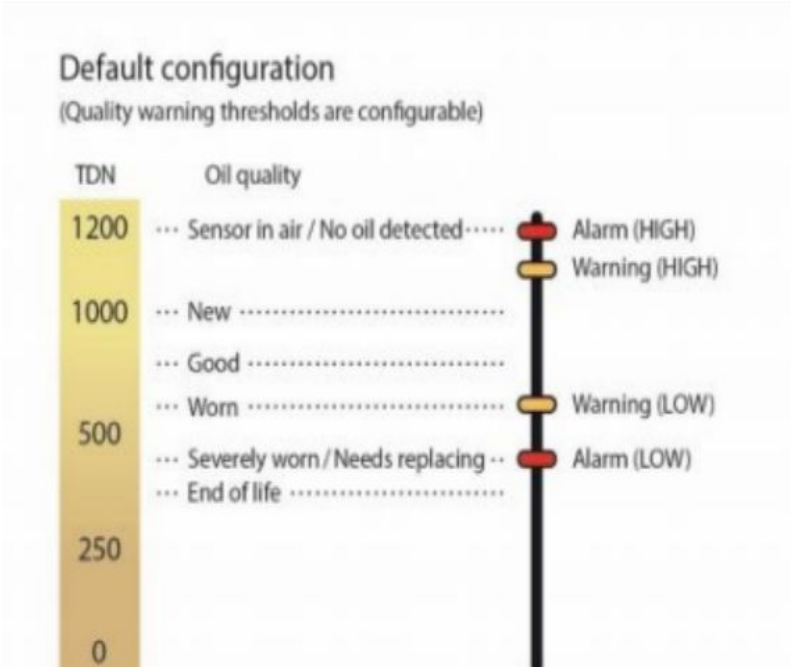
ANY CHANGE IN THESE PARAMETERS, SINGULARLY OR IN COMBINATION WILL ALTER THE CHEMICAL FINGERPRINT OF OIL AND WILL BE DETECTED & INDICATED BY THE SENSOR

Using TDN to monitor oil quality

- TDN reflects the overall health of the oil on a scale of 1200 - 0. Higher the number, better is the oil quality.
- 1000 - Fresh sealed oil, around 600
- is the replacement levels

We monitor:

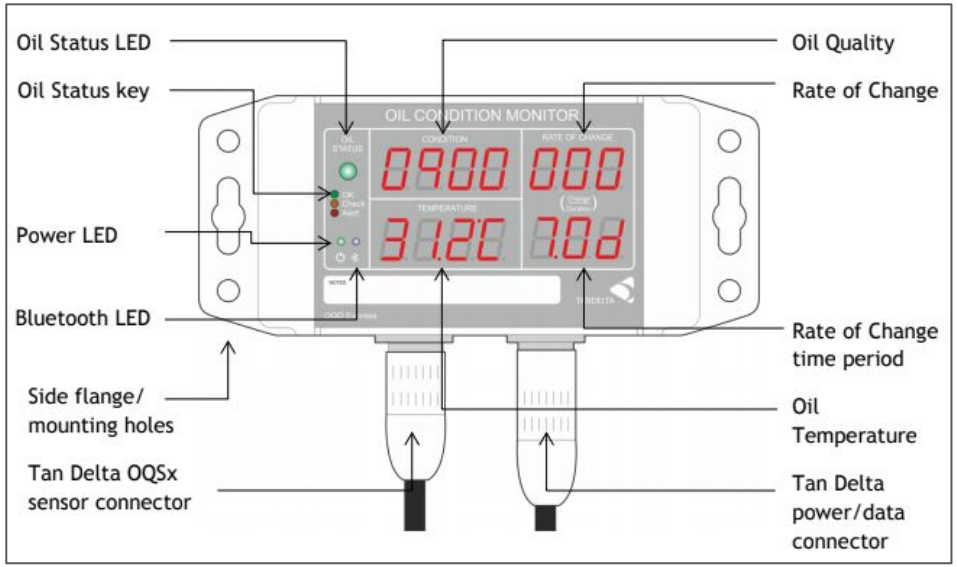
- TDN number
- Oil temperature
- ROC every 6 hours



Data Monitoring Options

Tan Delta provides the below-mentioned oil quality data monitoring options:

- Local Display
- Monitoring on PC or Laptop
- Wireless remote monitoring through Cloud
- Analog (4-20 mA) to a PLC
- MODbus (RS485) and CANbus



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#3 Remote Monitoring with IIoT

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IOT Capability:

- **INTEGRATION**: Neptunus can integrate all the types of signals (4-20mA, NO-NC signals, Modbus RTU, Modbus TCP/IP, MQTT, Rest API, HTTP, PROFIBUS, PROFINET, ETHERCAT, CELLULAR, ZISBEE, etc) from Individual field devices, OPC server, SCADA panel, Historian 61 of Cement Processes into cloud in completely encrypted format.

- **SECURITY**: Neptunus complies with ISO 27018 - Data Security Laws

Why Neptunus?

- **The Machine Reliability Expert**
- **25+ years** of delivering reliable engineering solutions
- More than **2000 assignments** completed across segments
- A strong & committed team of **~100 people**
- Customers in **25 countries**

ISO 9001:2015 by LRQA

ISO Certified since 1999

Lloyd's Register

Current issue date: 26 August 2019
Expiry date: 31 December 2020
Certificate identity number: 10216229

Original approval(s):
ISO 9001 - 17 September 1999

Certificate of Approval

This is to certify that the Management System of:

Neptunus Power Plant Services Pvt. Ltd.

Plot A-554/555, TTC Industrial Area, MIDC, Mahape, Navi Mumbai, 400701, Maharashtra, India

has been approved by Lloyd's Register Quality Assurance Limited to the following standards:

ISO 9001:2015

Approval number(s): ISO 9001 – 0047581

This certificate is valid only in association with the certificate schedule bearing the same number on which the locations applicable to this approval are listed.

The scope of this approval is applicable to:

Repowering, Maintenance and Reliability Engineering Solutions and Supply of Spare Parts for Heavy Engineering Equipment, Engine Based Power Plants and Propulsion Systems. Recycling of non-ferrous metals. EPC Projects and Project Management Services.

Rated BBB and A2 by ICRA

We are Trusted by OEMs

Neptunus is **the sole authorised distributor of**:

- **Niigata** - Engines and Z-pellers [in India, Sri Lanka and Qatar]
- **Diesel United** - 2 stroke marine engines [in India]
- **IHI** - Gas turbines for Data Center applications [in India]
- **EMD** engines (a Caterpillar/ MAK group company) [in India]

  (in discussion with MAK for taking-up as authorized Engine service partner for India)
- **Vib360 software Technologies -** Torsional Vibration FFT Analysers [in Asia and Middle-East]
- **Tan-Delta -** Online oil condition monitoring sensors [in India]
- **Triple R & Europafilter -** Oil cleaning filtration systems [in India]
- **AuraMarine** - Fuel supply systems [in India]
- **Metaline** - Surface protection coating solutions [in India]

You can count on us for delivering **RELIABLE** solutions!

For more details, contact
Neptunus Power Plant Services Pvt. Ltd.

Email : info@neptunus-power.com
Call : +91-95944-10707
Website: www.neptunus-power.com

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Proven Track Record: Key Customers

Marine & Defense Segment

- Adani Ports
- GreatShip
- Indian Coast Guard
- Indian Navy
- JSW Group
- Milaha Shipping Qatar
- Ocean Sparkle Ltd.
- Pacific Radiance S'pore
- PMS Egypt
- Polestar
- Reliance Group
- Samson Maritime
- Stanford Marine UAE
- Major Shipyards in India, Middle-East & SriLanka

Oil & Gas Segment

- Aban Offshore
- Abraj Oman
- Dynamic Drilling
- Essar Oil
- Greatship
- Jagson
- Jindal Drilling
- John Energy
- Nabors Drilling
- ONGC
- Quippo
- Shelf Drilling
- Transocean

Industrial Segment

- Bajaj Auto
- BPCL
- Greaves Cotton
- Hindalco
- HPCL
- IOCL
- Saint-Gobain
- Sigma Electric
- Sterlite
- Tata Metaliks
- Tata Steel

Turnkey EPC

- Balkrishna Industries
- Bridge Data Center
- Calvalley, Yemen
- Kenya Navy
- Natco, Yemen
- Nxtra Data Center
- Surat Municipal Corporation

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Industries That We Serve