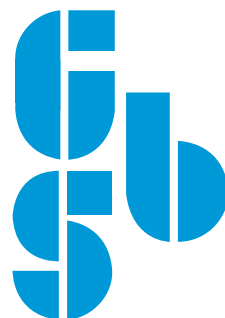


SCHAAF-EN BOORWERK ROTTERDAM ^{BV}

GEARBOX SERVICES ^{INTERNATIONAL}



Machining services
Gearbox inspection and repair
Onsite services - aligning
Troubleshooting



Discipline Machine Diagnostics



BRAND OF SCHAAF-EN BOORWERK ROTTERDAM BV

The services of our Machine Diagnostics:

1. Machinery health or condition inspections
2. On site troubleshooting
3. Machinery commissioning
4. Field trim balancing (single and multi plane)
5. Machinery alignment services
6. Geometrical measurements
7. Thermal growth studies
8. Torque and power measurements by telemetric strain gauge technology



Machinery health or condition inspections

On-site troubleshooting



Our knowledge, experience and equipment allows us to identify potential machinery malfunctions, such as rolling element bearing defects, gear related problems, rums, resonances, etc. Significant and valuable time can therefore be saved to resolve the problem.

Our machinery experts at GBS international are capable of providing inspections on an individual basis or as part of a contractual agreement in order to access the health or condition of your machinery. In some cases these inspections are periodically carried out and will complement your condition based maintenance program. Other examples where we proved to be successful are related to 'end of warranty' inspections. To inspect rolling element bearings or planetary gearboxes we use the latest videoscopes from General Electric. These videoscopes allow us to identify problems, often impossible to see by the naked eye.

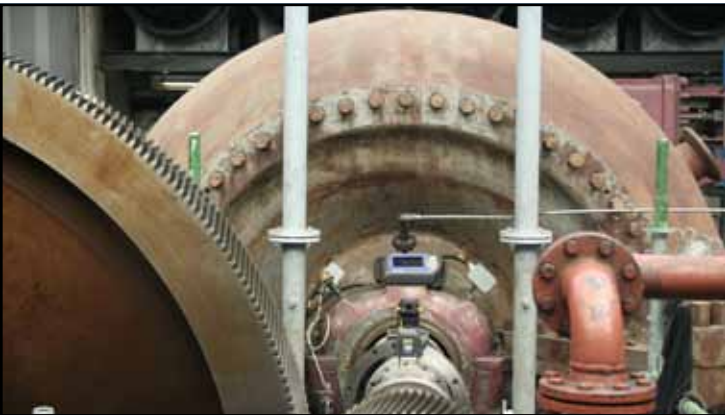
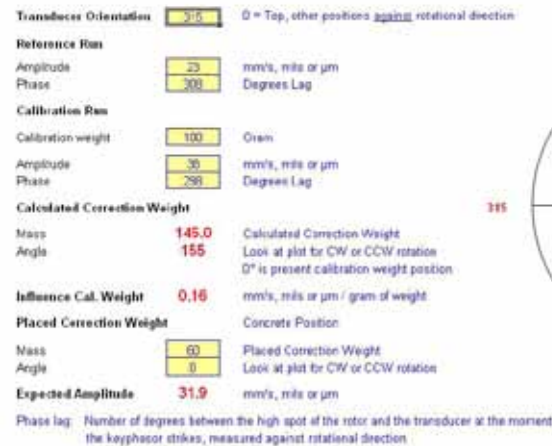


Machinery startup (Commissioning)

Our engineers have extensive experience with advising and assisting the start up of machines after revision, reinstallation, or maintenance outages. Starting up necessitates the gathering of (base line) information and comparative analysis of the information.

Field Balancing

The most common machinery problem is unbalance, which must be confirmed before attempting to balance machinery. Our specialists are trained in isolating unbalance problems and subsequently correcting them either for single plane balancing or multi-plane balancing for complex machines with one or more bearings combined with multiple measurement and correction planes.

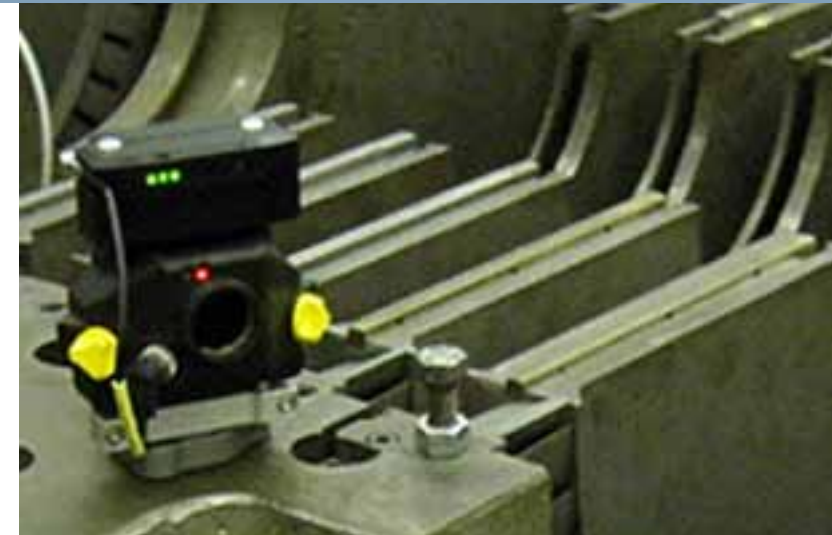


Machinery Alignment Services

Second to rotor unbalance, misalignment is a frequently encountered problem. GBS international is able to handle both hot and cold alignment projects on your machinery as well as reciprocating compressors in addition to rotating machinery. Our services are available from simple two case machine configurations to more complex multi-case situations such as large steam turbine generators.

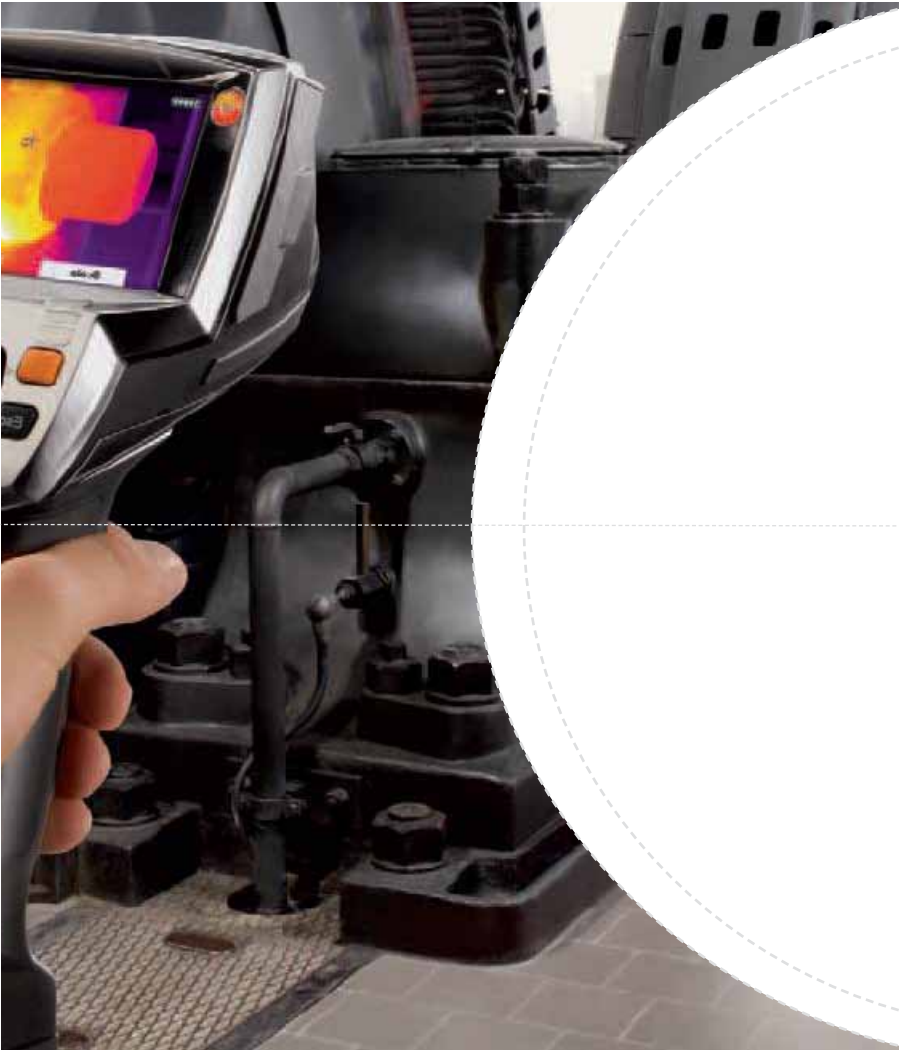
Geometrical Measurements

Our geometrical measurements are performed with the use of a Levalign Ultra rotating laser system from Prüftechnik. This system and the available expertise, an ideal solution for machinery foundations and weak machinery split casings, provide quick and efficient measurements of surface flatness and levelness.



Thermal Growth Studies

We are able to study thermal growth in machines pertaining to normal alignment or differential expansion



Torque and power measurements by telemetric strain gauge technology

The engineers at GBS international successfully have completed many torque and power measurements and analyses projects. In many cases these measurements quickly led to the root cause of failing machinery components. Permanent systems have also been implemented world wide, where the recorded torque data is directly linked to a control system, avoiding overloading of the installation

Our MD service technicians

Roderick Bijkerk:

Education: BS degree motor vehicles, 2005

Experience: Machinery Diagnostic Services, since 2006



Jelle Veenstra:

Education: MS degree mechanical engineering, 2006

Experience: Machinery Diagnostic Services, since 2006



Arjan Visser:

Education: BS degree mechanical engineering, 2000

Experience: Machinery Diagnostic Services, since 2001



Walter Bonnier:

Education: BS degree mechanical engineering, 1995; BS degree metallurgy, 2003

Experience: Machinery Diagnostic Services, since 1991



All engineers have completed the following

- Safety Certificate conform VCA
- Tower Climbing Safety for Wind Turbines
- Offshore Safety Induction
- Advanced training courses for vibration and alignment
- Medical examination

Our organization

Sales



Dennis Janse
verkoop onderdelen en service, specialisatie tandwielkasten
Mobiel 06 20 696 954 Email. d.janse@senbbv.com



Rien Groenendijk
verkoop verspaning en service
Mobiel 06 46 336 219 Email. m.groenendijk@senbbv.com



Marc de Bleser
verkoop verspaning en service - België
Mobiel +32 475 47 20 45 Email. m.debleser@senbbv.com

Projects



Franklin Sodenkamp
Projectleiding / werkvoorbereiding , specialisatie tandwielkasten
Mobiel 06 20 696 847 Email. f.sodenkamp@senbbv.com



Dennis van Geemert
Projectleiding / werkvoorbereiding , specialisatie tandwielkasten
Mobiel 06 23 804 098 Email. d.vangeemert@senbbv.com



Ferry Groenendijk
Projectleiding / werkvoorbereiding, fabricage onderdelen
Mobiel 06 20 696 820 Email. f.groenendijk@senbbv.com

Engineering



Jan de Koning
engineering en techniek
Mobiel 06 20 696 835 Email. j.dekoning@senbbv.com

GBS Gearbox Services international is a brand of
SCHAAF- EN BOORWERK ROTTERDAM B.V.
Postbus 1510, 3260 BA Oud-Beijerland
H.Boerhaavestraat 2, 3261 ME Oud-Beijerland
Telefoon 0186-64 55 55
Telefax 0186-61 44 90
Handelsregister Rotterdam 24099959
ABN-AMRO BANK 47.98.72.724
B.T.W. NR NL 001833698.B.01
IBAN: NL 77 ABNA 04798 72724
E-MAIL: INFO@SENBBV.COM
Internet: www.schaafenboorwerk.nl

Discipline Machine Diagnostics



BRAND OF SCHAAF-EN BOORWERK ROTTERDAM BV

Example of projects

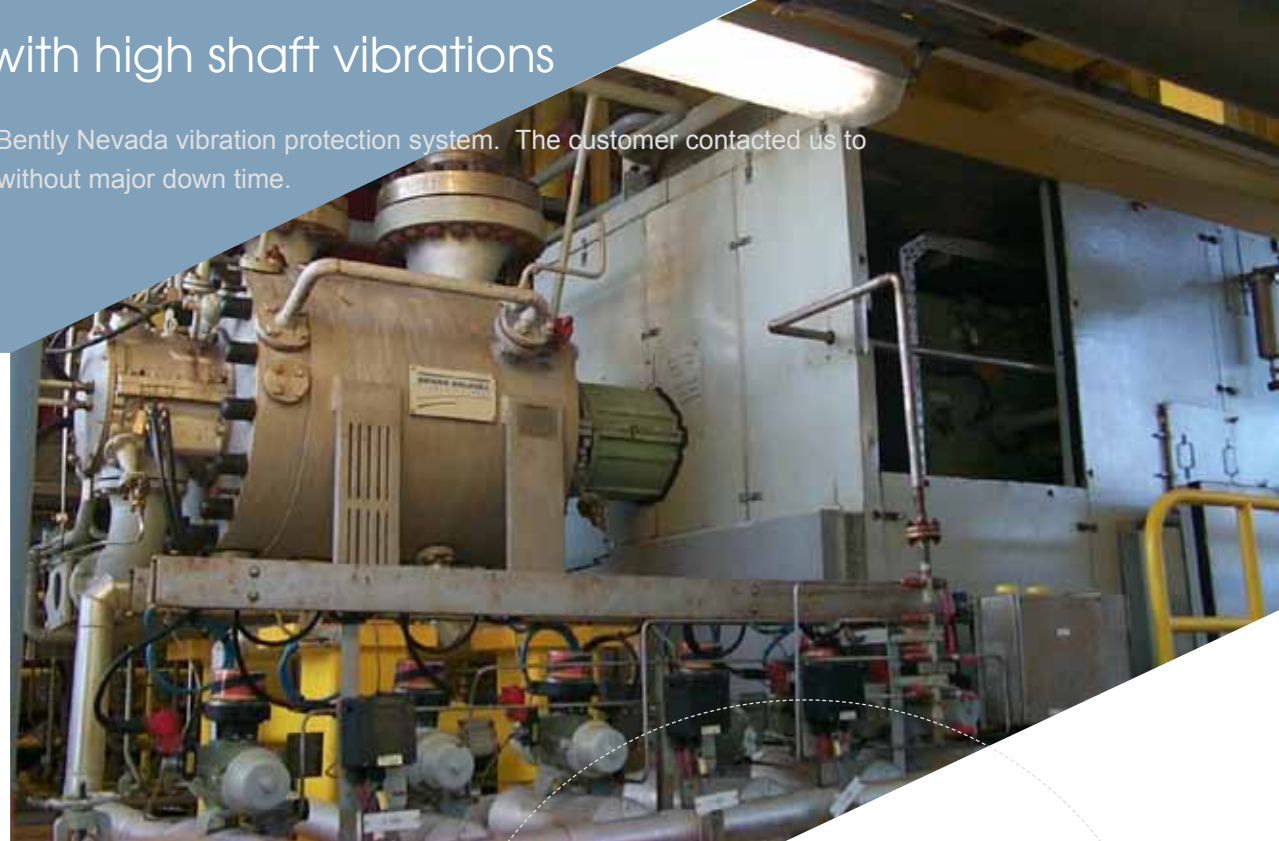


Delaval barrel type Gas Compressor with high shaft vibrations

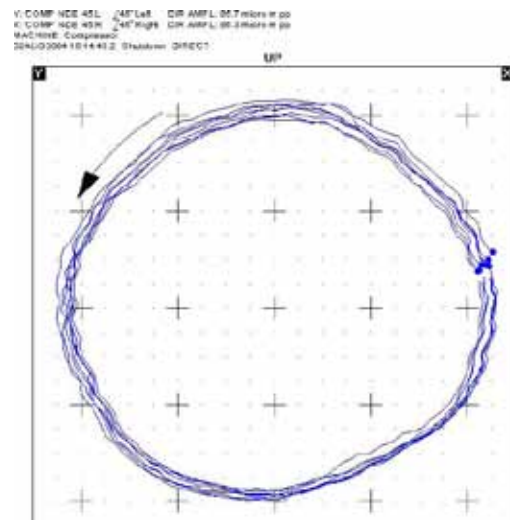
A customer noticed a sudden increase of the shaft vibration level on their Bently Nevada vibration protection system. The customer contacted us to identify the root cause of the problem and if the problem could be solved without major down time.

What GBS international offered:

Our ADRE system was connected to the customers protection system for advanced diagnostic capabilities under different operational conditions. The recorded data had all the characteristics of unbalance. The vibration level was related to speed. The frequency was equal to the rotational frequency of the compressor and the orbit figures were circular on both ends of the rotor. It was decided not to balance the rotor in-situ due to the fact that the increase of vibration level happened suddenly, which suggests that something is stuck inside the rotor, broken of or shifted.



During dismantling of the compressor it became clear that a piece of strainer had entered the compressor and got stuck in one of the impellers.



Luxury yacht with excessive hull vibrations

A specific type of yacht experienced vibration problems which occur at a certain sailing speed. Investigation of this problem was already initiated by the shipyard, leading to several propositions of possible causes. One of those propositions pointed towards the propeller shafts as a vibration source, possibly exciting one of the natural frequencies of the hull.

What GBS international offered:

The propeller shaft manufacturer invited GBS international to investigate the behavior of the propeller shafts. During a sea trial, GBS recorded the propeller shaft displacements, using a set of two Bently Nevada 3300 series proximity probes per shaft. This way, the complete two-dimensional movement of the shaft could be monitored, at a location where vibration amplitudes were expected to be considerable. The vibration data was recorded using a Bently Nevada ADRE 208P data acquisition unit.



The results of the measurement were summarized and presented in a report, which was delivered to the customer within a short period. The results clearly showed the propeller shaft were not the source of the vibration, saving the customer an enormous amount of time and resources in correcting the situation.

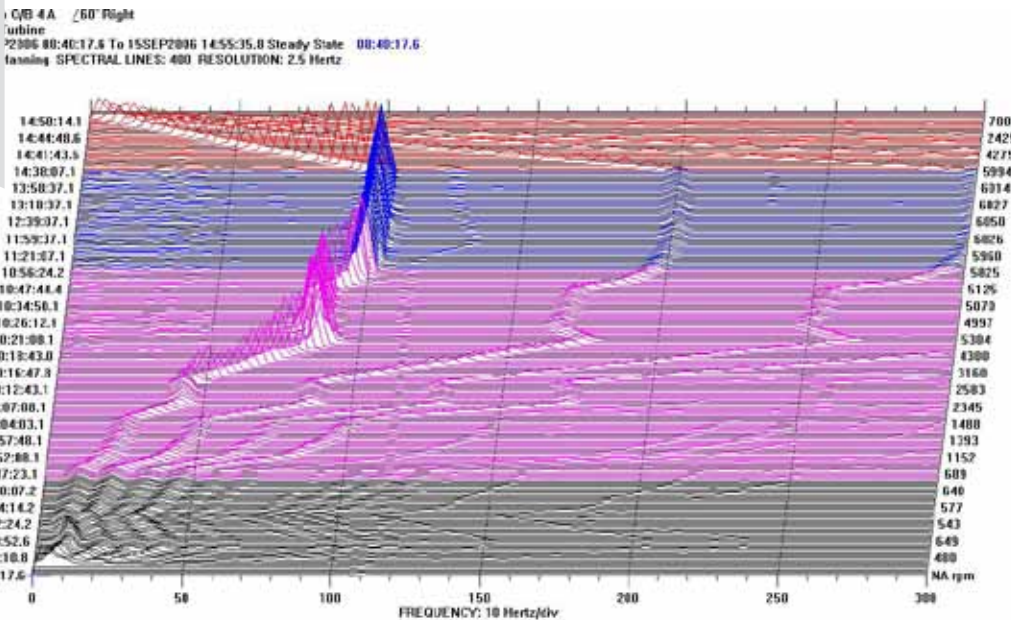
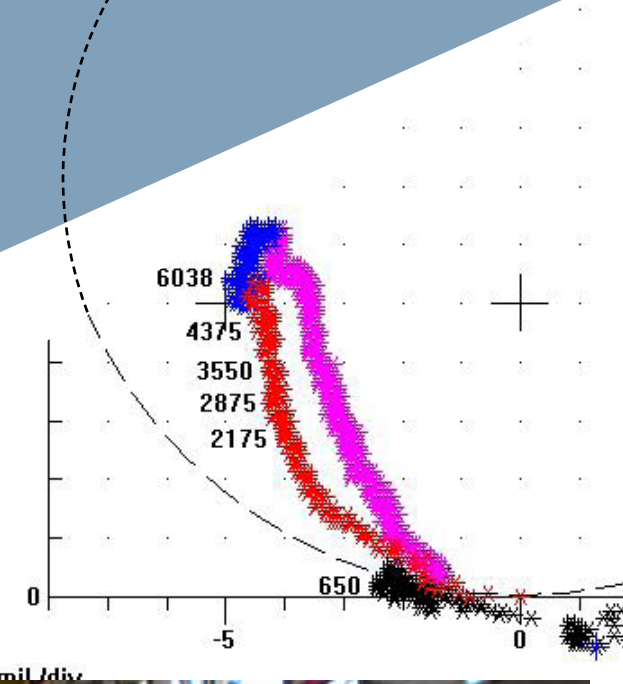


Commissioning / acceptance surveys

Our engineers assisted many customers around the world during commissioning of their newly installed or overhauled installations.

What GBS international offers:

During commissioning we are able to verify if the recorded dynamic behaviour of the machine is conform international recognized standards, such as API or ISO. ADRE is used for data acquisition and is normally connected to the customers vibration protection system. Acceptance reports are made including all relevant machine base-line information. In some occasions the recorded data can be used to discuss corrective actions. We also assisted customers with programming and optimizing their online condition monitoring systems.



Gas turbine balancing, GE Frame 5 (MS 5001)

A customer was operating their compressor close to the vibration alarm setpoint. Our engineers were asked to analyze the problem and if possible reduce the vibration level.

What GBS international offered:

Transient vibration data was recorded with our ADRE system to identify the root cause of the elevated vibration levels. In this case unbalance caused by fouling on the impellers was identified as the root cause. After repeatability of the problem was confirmed and rotor washing did not show any influence it was decided to balance the machine in situ. In situ trim balancing is a very cost effective way to reduce elevated vibration level without taking the machine apart.

Reference list of balance jobs all executed with ADRE equipment:

- GE Frame 5 (MS 5001) gas turbines
- GE Frame 6B gas turbines
- GE Frame 9FA gas turbines
- GE LM 1600 power turbines
- GE LM 2500 gas turbines
- GE LM 6000 gas turbines
- Siemens V64 gas turbines
- Siemens Tornado power turbines
- GE Steam Turbines
- Solar barrel compressors
- Delaval (Siemens) barrel compressors
- Nuovo Pignone barrel compressors
- Elliott horizontal split line compressors
- Kawasaki centrifugal air compressor
- Praxair cryogenic expander
- Flow serve boiler feed water pump
- A large number of ventilators



Rolling element bearing damage

More and more customers are changing from scheduled maintenance towards a condition based maintenance program. Predicting or monitoring the condition of machinery becomes therefore very important.

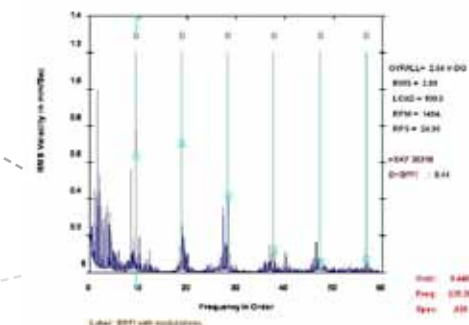
What GBS international offered:

Hundreds of jobs are performed by our engineers to predict the condition of all sorts of gearboxes, such as wind turbine gearboxes, crane hoisting gearboxes, extruder gearboxes, etc. With the use of our instruments and our extensive experience we are able to predict the condition of the gearbox with maximum reliability.

The following techniques are used (often in combination):

- Visual inspection (if necessary with the help of our videoscope)
- Vibration measurements
- Oil sampling and analyzing

A rolling element bearing inner ring defect was identified in the plot right.



Examples of our projects

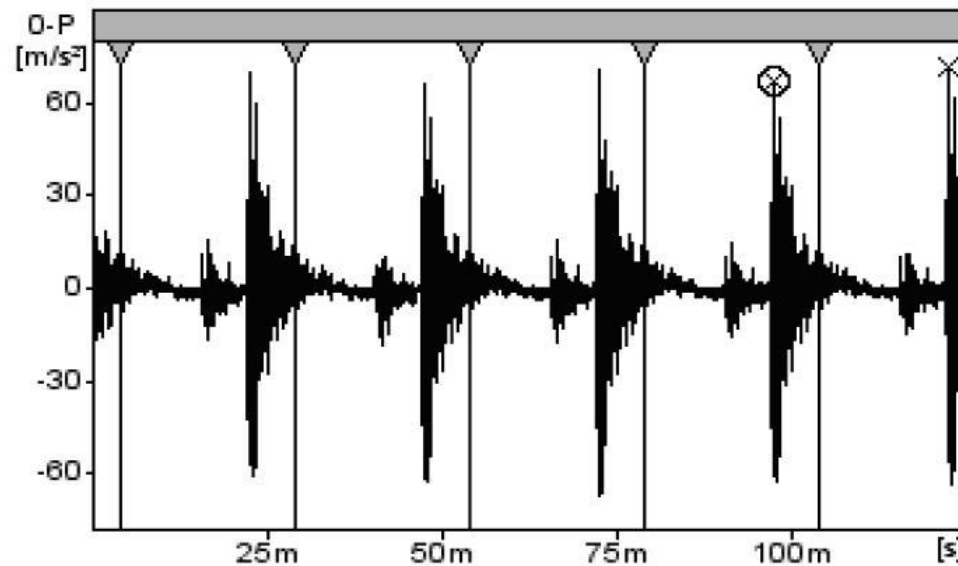
Identification and elimination of a clearly noticeable impact

Overloading or other process related incidents can create local damage to the gears. In some occasions this damage will create noticeable impacts during operation of the gearbox.

What GBS international offered:

To identify the specific gear and even the specific tooth causing the impact we used our portable data acquisition system in combination with an acceleration sensor and a keyphasor. The plot below the result when collecting the data. The vertical line represents the passing keyphasor (trigger) mark, while the impact is shown by a spike in the signal. Calculation of the exact position of the impact is now possible.

Sometimes hand grinding is enough to remove the burrs caused by an indentation. In other occasions it is necessary to re-grind the gears by a specific gear grinding machine.

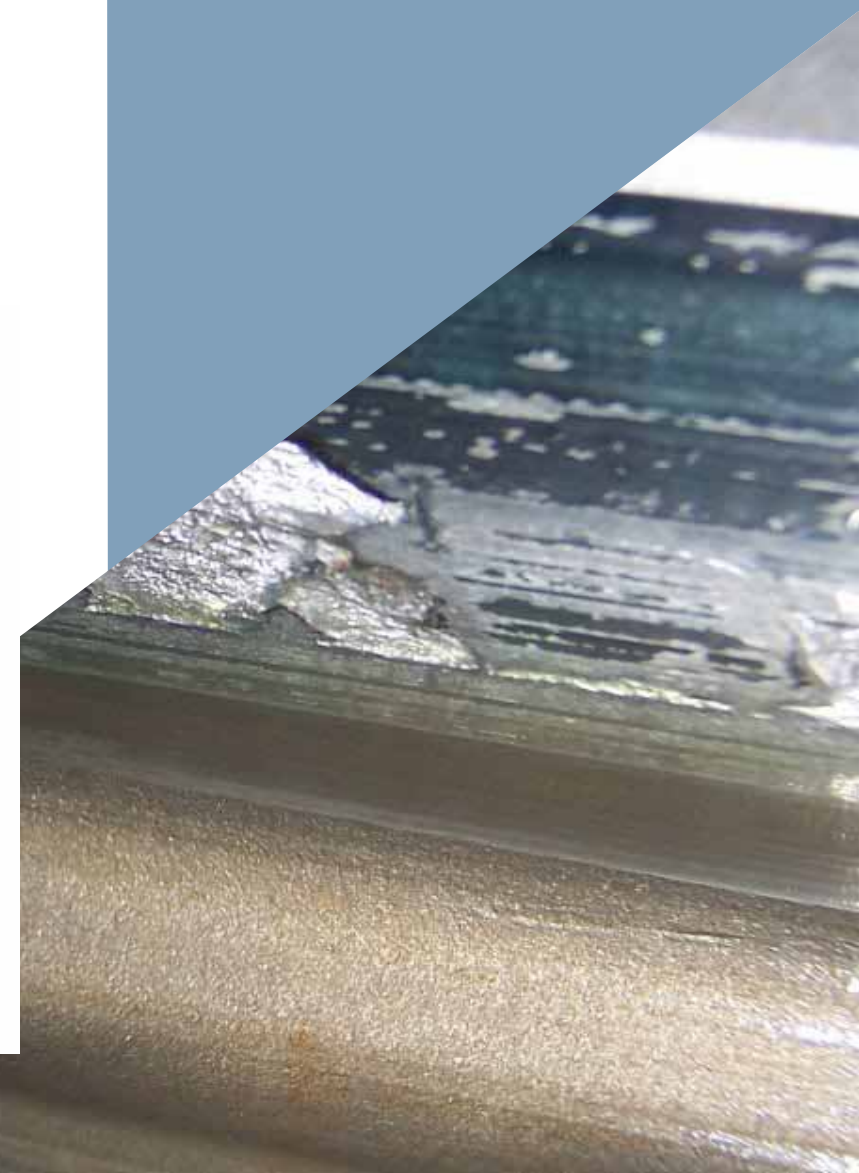
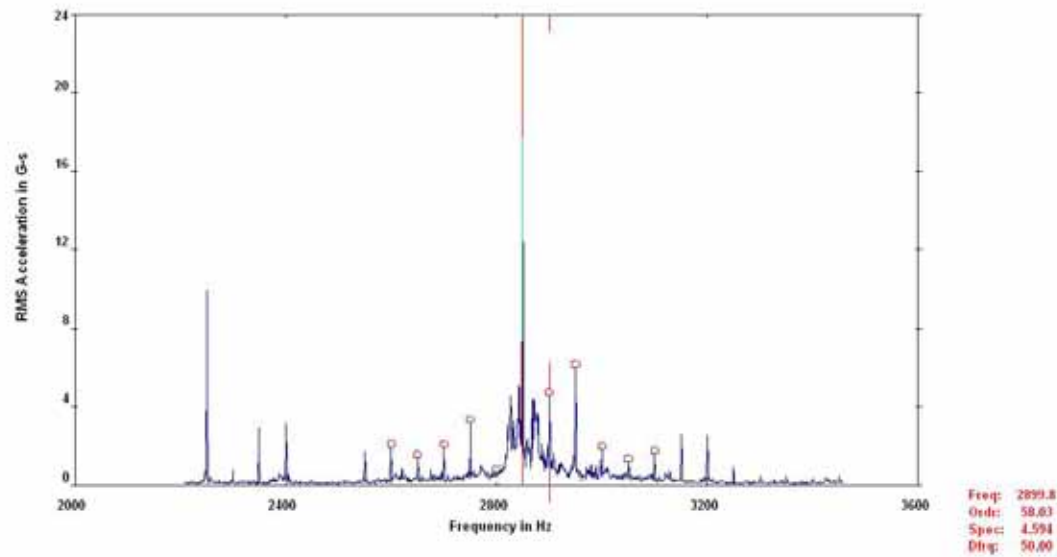


Identification of gear related problems

Gear damage is often a secondary effect of another problem, such as overloading, misalignment between the gears, degraded lubrication oil properties, etc. The progression of gear damage, such as micropitting can be stopped if the root cause of the problem is found and corrected in time.

What GBS international offered:

By recording the gearbox casing vibrations we were able to identify the particular gear that was causing the increased vibration level. In this case the damage was too severe and the gear had to be re-placed. In other cases however with minor damage it might be sufficient to replace the bearings when excessive bearing clearance is the root cause.



Examples of our projects

Overloading of a crane hoisting gearbox

On a harbor crane, used to unload bulk goods, the input shaft of the hoisting gearbox was failing repeatedly. Strength calculations indicated that the design of the shaft and pinion should be able to withstand the applied torques during normal operation. The load indication of the electric motor showed no overloading condition of the hoisting drive.

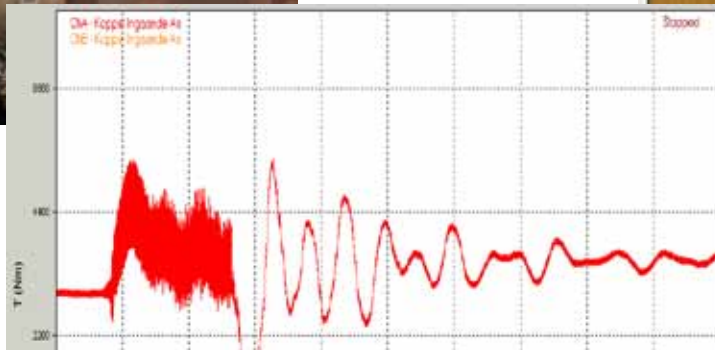
What GBS international offered:

We installed a torque measurement system on the gearbox input shaft between the gearbox and the brake drum. The torque signal was monitored and compared to the motor current indication. During a full day of measurements under normal production conditions, we observed two major shortcomings in the system:

- The motor current indication setup was incorrect, the indicated motor torque was too low.
- The gearbox was systematically being overloaded, especially during rough operation of the crane in a nearly empty ship.

Based on the results, the motor current indication could be calibrated. This way, overloading of system by rough handling could be noticed by the crane driver. Also, the design of the input shaft pinion was modified, so it could withstand greater loads.

A torsional resonance over the flexible coupling was identified. The customer sent the report to the coupling manufacturer, who could redesign the coupling elements to avoid the resonance.



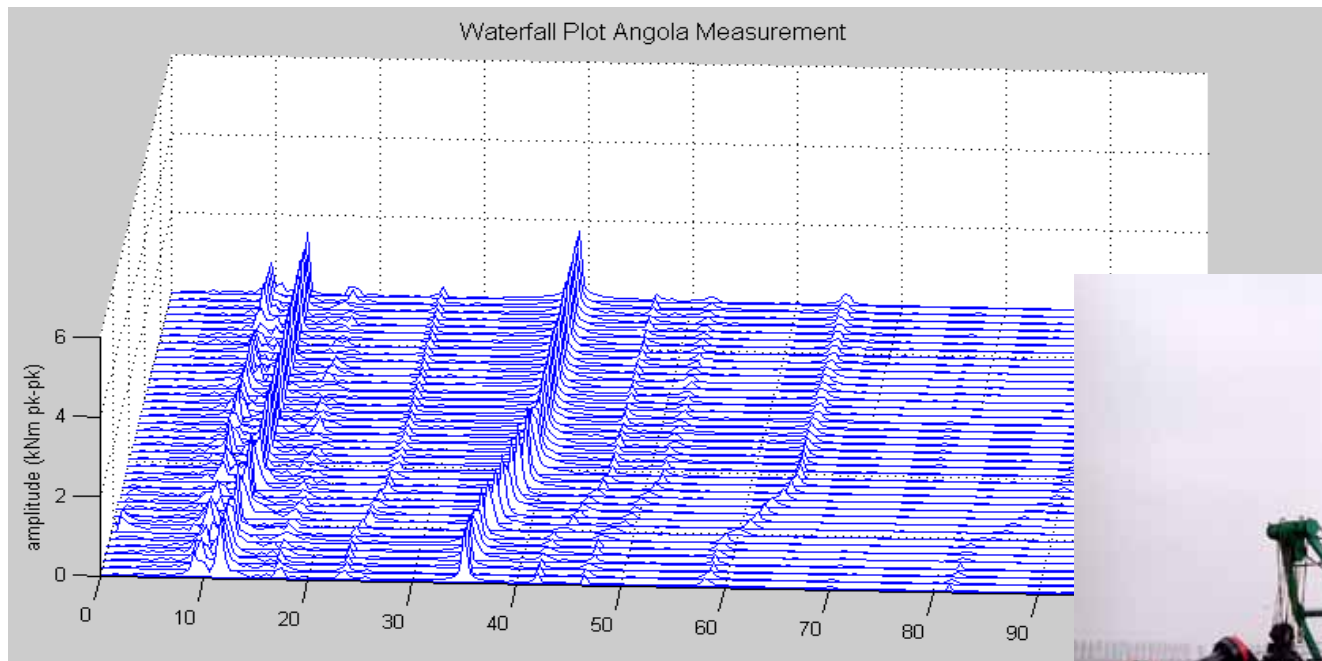
Identifying torsional vibration in a flexible coupling

In the pump drive train of a cutting suction dredger, a customer in Angola experienced a repeatedly failing flexible coupling. The rubber elements of the coupling started chipping after only months of operation. Replacing the elements did not permanently solve the problem.

What GBS international offered:

By installing a torque measurement system on the carbon fiber drive shaft, connecting the diesel engine to a gearbox, we could monitor the torsional vibration during many different operational conditions. On the output side of the gearbox, a second system was installed. Using the two signals, we were able to map the dynamic behavior of the complete drive train.

A torsional resonance over the flexible coupling was identified. The customer sent the report to the coupling manufacturer, who could redesign the coupling elements to avoid the resonance.



Examples of our equipment

Rotalign Ultra Laser Alignment system

Our ROTALIGN Ultra is the number 1 tool in laser alignment equipment. This high-performance system incorporates exclusive measurement modes that provide very accurate results for any application, and enables simultaneous live monitoring of both vertical and horizontal machine corrections. Specialist analysis tools like the soft foot diagnostic tool have also been integrated for an accurate assessment of the machine condition.



Levalign Ultra

LEVALIGN Ultra is a flatness measurement system featuring a rotating laser in conjunction with the ultra-modern ROTALIGN Ultra computer. The system provides the ideal solution for quick and efficient measurement of surface flatness and levelness. The computer's large colour backlit display shows all relevant information, including a context sensitive menu, in a self-explanatory manner. As an example, in the result screen, the colored tolerance code for each measured point indicates if and to what extent tolerances are met. The system provides an accuracy of 0.02 mm/m up to a diameter of 40 m.

Industrial applications

- ☐ Levelness of machine foundations
- ☐ Flatness of machine beds and tables
- ☐ Parallelism of machine surfaces
- ☐ Flatness of circular and rectangular flanges
- ☐ Foundation levelness of wind towers
- ☐ Surface profile of tower segments, rotor blades, hub flanges and cam wheel on wind turbines
- ☐ Fitting of machine half casings
- ☐ Flatness of crane slewing rings

Examples of our equipment

Dual channel portable data collector / signal analyzer

Our VIBXPERT is a high performance, fully-featured 2-channel FFT data collector and signal analyzer. This instrument is most frequently used by our engineers on medium and low speed machinery running on rolling element bearings, such as found in the petrochemical, pulp and paper industries, as well as on wind turbines.

This VIBXPERT 2-channel data collector is particularly well suited for:

- Identification of rolling element bearing problems
- Identification of gear related defects
- Looseness problems
- Periodic condition monitoring of large numbers of machinery
- Simple in-situ single plane balance jobs
- Analyzing vibration problems in harsh environments, such as wind turbines and harbour cranes.



Manner Telemetry Systems for Torque Measurements

GBS international regularly performs torque measurements on rotating shafts, using Manner telemetry systems. Many problems with machines (overloading, torsional resonances or unwanted torque reversals) can be identified by performing a torque measurement.

By using a set of strain gauges, bonded to the shaft, the torque in the shaft is measured and transferred using a wireless link. Because there is no need to use batteries, the system can run autonomously for an unlimited time. The Manner telemetry system delivers the data with great accuracy and a high sampling rate, making it well suited for dynamic measurements.

Manner Telemetry systems can also be installed as torque transducers on a permanent basis: SB World-wide Gearbox Services has installed and provides worldwide support for systems for a number of maritime customers.



Multichannel data acquisition system from Bently Nevada



Our Bently Nevada ADRE system is one of the most commonly used and recognized diagnostic data acquisition systems available. The emphasis of the ADRE system is focused towards Turbo Machinery, but as described below, other jobs have also been performed with great success. Our team of engineers has over 40 years of combined experience and is well trained on the ADRE equipment.

The ADRE system is particularly well suited for:

- Turbo Machinery commissioning jobs
- Field balancing
- Troubleshooting, to identify:
 - Stiffness and damping related problems
 - Fluid induced instabilities
 - Rubs
 - Process related problems
 - Thermal problems
 - Unidirectional preload related problems such as misalignment

