

We're working together:

PRÜFTECHNIK and FLENDER SERVICE

PRÜFTECHNIK and Flender Service present *telediagnose.com*, a new magazine that was created as a joint effort to provide you with the most current information in the fields of condition monitoring and general maintenance. Featured topics will range from application

reports to instructive articles and more.

If you're wondering why a service specialist for drive technology and a manufacturer of condition monitoring and alignment systems are publishing a joint customer magazine, find out more on page 6. ►►

Condition monitoring application:

Condition-oriented servicing of an extruder gear

Dr. Becker, Herne

Ah, to be able to predict the winning numbers in a lottery — who hasn't had that dream! Life would be so easy and carefree with a crystal ball. And wouldn't your maintenance job be so much simpler if you could just identify machine damage in time and predict the point at which repairs really become necessary?

According to DIN 31051, condition-oriented maintenance is not limited to inspection, servicing, determination of machine condition and maintenance scheduling. It also encompasses predicting the length of service life remaining for machines and systems. This means it is not always necessary to replace a rolling bearing when an inspection measurement reveals inner race-way frequencies.

This article describes how it was possible to keep a damaged bearing running for several months until the scheduled annual standstill came around — natu-

rally under close observation. Periodical measurements had shown that there had only been a slight change in the envelope spectrum.

But one thing at a time: In January 2000, Flender Service was awarded a contract for the mobile condition mea-

In this issue:

PRÜFTECHNIK AG & Flender Service GmbH decide to concert their efforts

Application report:
Servicing an extruder gear

How does it work?
Machine alarm via eMail and SMS

Level 1: Characteristic vibration values for standard machines

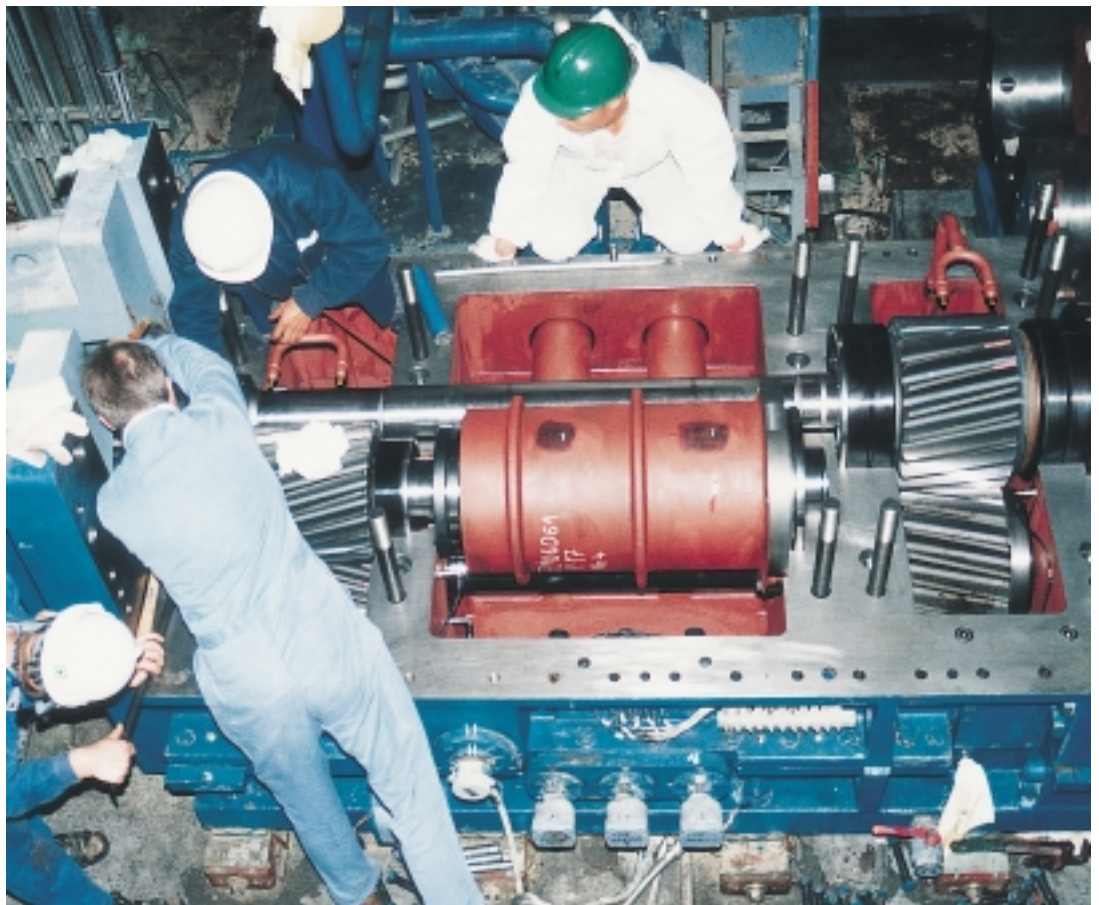
Level 2: Basic rules for measuring frequency spectra

Turbine alignment in Spanish

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surement of a double-shaft extruder gear. Before the diagnosis specialist carries out measurements on location, gear construction data are established by way of the factory number, and the bearing frequencies are calculated for the entire drive (Fig. 1). ►►



For this purpose, Flender Service has developed a computer program that is suitable almost all gear types, including variable speed drives.

Having calculated the excitation frequencies, the diagnosis specialist visits the customer to determine the current condition of the drive — which in this case is already seven years old — and to find any deviations. The measuring device used was the 6-channel DriveAnalyzer® which evaluates noise and vibration conditions using high resolution frequency analysis.

Beginning bearing damage was identified during control measurement as a result of distinct, albeit not yet critical, vibrations at an inner raceway frequency that were picked up in the inputshaft area.

Gear condition was recorded and the recommendation to procure replacement parts for the intermediate shaft was made to the operator. The decision as to the whether the bearing needed exchanging was to be made again after at most three months on the basis of further comparative measurements.

Figure 2 shows two envelope spectra that were recorded three months apart at the same measuring point. Because changes were only slight, an immediate replacement of the bearing was not deemed necessary and the decision was made to continue operation until the scheduled annual standstill. The bearing was exchanged five months later by Mr. Schneider, one of 40 chief technicians working for Flender Service (Fig. 3). Upon dismantling the bearing, the damage diagnosed on the inner raceway could be confirmed as expected — 9 months after initial diagnosis. Pittings on the inner raceway are clearly visible in Figure 4. The extruder was back in operation two days later as scheduled.

In hindsight, both the diagnosis and the predicted remaining service time proved to be correct and economically wise. Expensive “crash repair” was unnecessary in this case. And avoiding downtime was almost like picking a “winning number” in the lottery. ■

Lagerfrequenzen (in Hz)							
Lager Art/Bezeichnung	Bemerkung	N	WR	KAFPS	WR	AR	IR
01 N2 N-CC (SKF)	1000	17	19.71	148.81	182.08	236.73	
0204 CC (SKF)	1000	19	19.71	173.27	263.56	266.02	
0204 CC (FAG)	1000	19	19.95	161.11	261.21	271.28	
Lager 1 Zwischenwelle							
Lager Art/Bezeichnung	Bemerkung	N	WR	KAFPS	WR	AR	IR
1806RSU CC (INA)	1000	24	3.90	57.19	79.12	102.83	
18025RSU CC (INA)	1000	19	3.90	44.85	60.17	83.88	
0204 CC im Rad (SKF)	1000	19	9.57	18.71	8.54	10.88	
0204 CC im Rad (FAG)	1000	19	9.57	18.82	8.52	10.87	
Den	Defizient	in			Radinnenfrequenz		
1/WR	-1000 arbeitslos	AR			Radaußenfrequenz		
WR	rotationsfrequenz	IR			Wälzkörperfrequenz		

Fig. 1: Calculated bearing frequencies

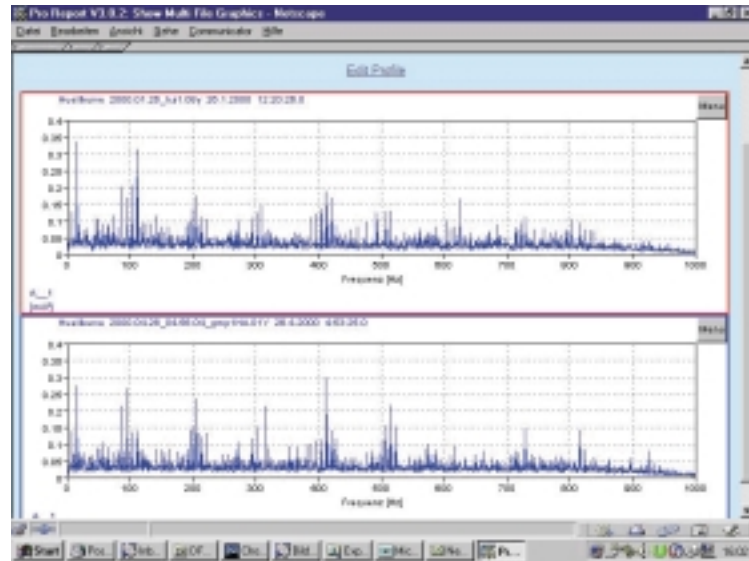


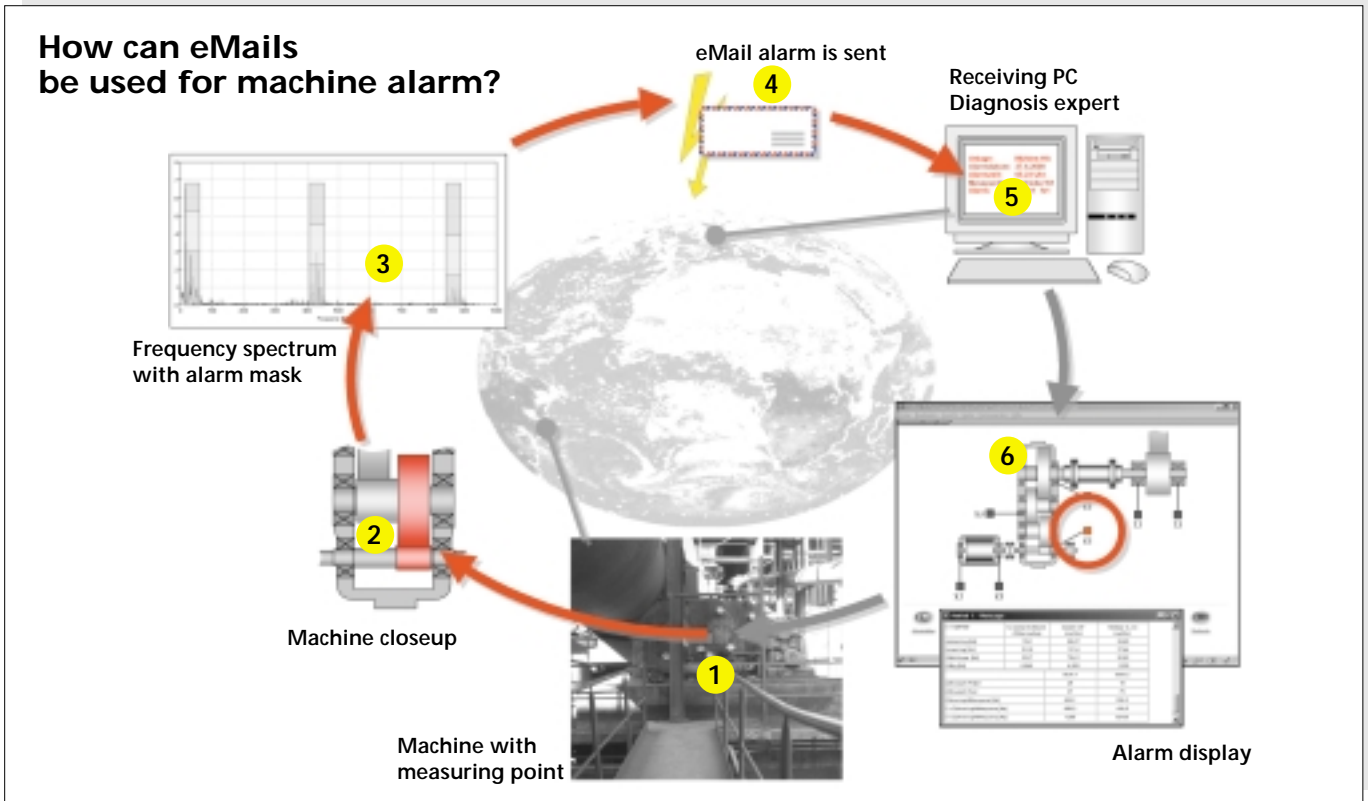
Fig. 2: Measured values recorded at a three-month interval



Fig. 3: Dismantling the intermediate shaft



Fig. 4: Inner raceway with diagnosed pittings



Technology

Machine alarm via eMail and SMS

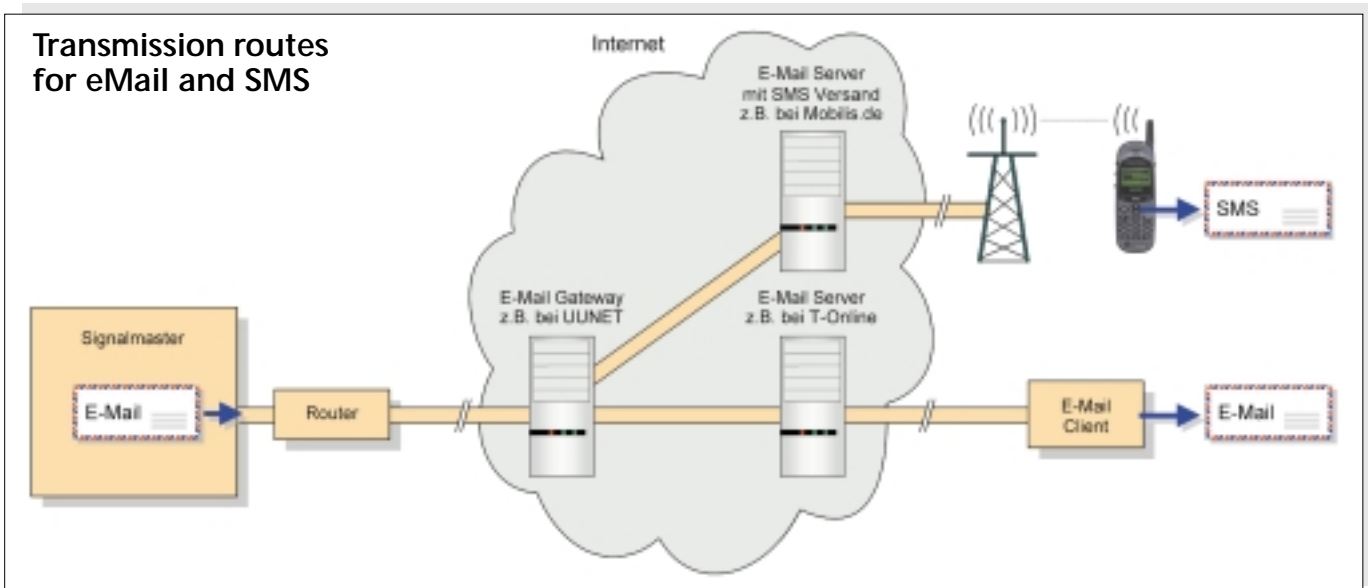
Mathias Luft, Roland Schühle, Franz Lebitsch

A key feature of online machine condition monitoring systems is the automatic and immediate notification of system operators or service personnel. Technicians notified by eMail or SMS about increased damage are able to react without delay.

Today's Internet is basically a global communications network at our finger-

tips. What, then, could be more obvious than to take advantage of the Internet for the communication requirements of condition monitoring systems. Just imagine: The monitoring system automatically sends you an eMail when condition deterioration sets in — along with all of the information you require for damage analysis. Thanks to the extent of

today's wireless communication networks, the service engineer responsible will be notified immediately, regardless of where in the world he may be at that moment. As an online condition monitoring system, VIBRONET® has already been equipped with these new functions and takes advantage of the new web technology. ▶▶





Glossary of technical terms
Did you know?

eMail

Electronic mail is a method of sending messages, or mail, electronically. In order to use eMail, both the sender and receiver must have an eMail address (whose structure is username@provider.de). Moreover, files can be sent as attachments to eMails.

eMail system

The eMail system is based on the concept that eMail servers accept messages, store them temporarily and then forward them to the eMail clients. The eMail client uses a special eMail program capable of SMTP and POP3 protocols to send and receive eMail.

SMTP

SMTP stands for Simple Mail Transfer Protocol and is used to send and forward eMails in the Internet.

POP3

POP3 stands for Post Office Protocol. On the basis of POP3, the eMail program registers with an eMail server using the user name and password of the particular user, queries whether there is any mail and retrieves it if there is.

eMail server

The eMail server provides eMail services to subscribers of these services. Services are requested by the eMail client. While eMail servers are usually located with Internet providers, such as T-Online, UUNET or CompuServe, they can also be located within companies at a central place.

eMail client

A program that uses the services of an eMail server.

eMail file attachment

eMail can contain attachments, or enclosures, in the form of files. In this way, corresponding measured data files can be sent right along with the eMail message.

POP3 protocol

Post Office Protocol Version 3. A protocol for receiving eMail messages from another computer.

Internet provider

A service provider that gives you access to the Internet. AOL, CompuServe and T-Online are examples of large providers that also offer online services.

eMail – how does it work?

One of the most important Internet applications is eMail, or Mail for short. The fact that Mail is not restricted to letters or texts, but can also be used to transmit files of any type is of particular significance.

Unlike other Internet applications such as WWW, FTP or Telnet, the Mail system does not require a direct connection between sender and receiver. Consequently, the receiver and sender computers do not have to be online at the same time. The Mail system is based on the concept of intermediate mail routers that receive and forward messages. Generally, the sender first directs the message to the Mail router of the Internet provider using suitable Mail software capable of the so-called SMTP protocol. An appropriate Mail software module for the Signalmaster® of the VIBRONET system and for the GearController® is available.

SMTP stands for Simple Mail Transfer Protocol and defines the transmission of messages both by the message sender and between Mail routers. A message is passed from one Mail router to the next until it reaches the router responsible for the receiver mailbox. The first Mail router to accept the mail from the sender functions as the Mail gateway. The Mail router responsible for the receiver mailbox functions as the Mail server.

Once it has reached the Mail server mailbox, the message can be transported to the receiver's target computer. For this to happen, the receiver must retrieve the Mail from the Mail server. This not only has the advantage that you can retrieve your Mail whenever you want, but you can also do so from any computer. Regardless of where you are, if you have Internet access and appropriate software you can access your mailbox at any time. The POP protocol is used for this purpose (Post Office Protocol).

The user PC must have a suitable Mail program that registers with the Mail server by providing a user name and password, and that queries whether there is any mail. The user PC is referred to as the Mail client. Any available Mails are listed and can be downloaded individually by the Mail client via POP.

SMS notification

Mail servers often provide services that supplement the automatic notification system by sending an SMS message to the receiver's cell phone when a Mail arrives.

eMails and condition monitoring

In condition monitoring practice, vibration condition is evaluated using the overall vibration level or alarm masks for frequency-selective monitoring. If the VIBRONET system detects that the limiting value has been exceeded, VIBRONET® can automatically send an eMail via Internet or Intranet. The receiver obtains a clear text message containing the location, date, time and cause of alarm. Information (time or frequency record) about when the damage occurred is attached to the eMail. For additional analyses, the maintenance technician responsible logs into the Internet or Intranet and analyses the system at "local telephone rates" — without travel expenses! ■

Preview

In our July issue you can read about:

CM application: Paper machine drive with a high degree of availability.

Level 1 basic course: Tips on selecting optimal measuring points.

Level 2 basics: Tips on selecting the best filters for envelope analysis.

Technology: Advantages of telediagnosis using web technology.

Application: Laser-optical alignment of vertical machines.

Level 1 Condition monitoring basics

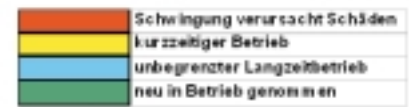
Characteristic vibration values for standard machines

Vibration velocity is the definitive measured value used in all standards and norms concerned with the evaluation of housing vibration in machines with rotating masses and in reciprocating machines. The RMS value of the vibration velocity is usually measured and evaluated in mm/s. In the United States, the peak-to-peak value is expressed in inch/s, the conversion factor being 1 mm/s = 0.03937 inch/s. Vibration is occasionally measured in dBs in the shipbuilding industry and in the final inspection of generator vibration.

Acceleration is usually employed as a supplementary measured value when evaluating bearings, drives with gear mesh frequencies larger than 1kHz, turbogears and special machines. Measurement with piezoelectric accelerometers is state of the art. These devices measure both vibration velocity and acceleration using a single sensor.

Schwingungsgeschwindigkeit 10 - 1000 Hz > 800 rpm (0-1000 Hz > 120 rpm)	mm/s rms								
	11,00								
	7,10								
	4,50								
	3,50								
	2,80								
	2,30								
	1,40								
0,71									
Fundament	starr	weich	starr	weich	starr	weich	starr	weich	
Maschinentyp	Pumpen > 15 kW radial, axial, diagonal				mittelgroße Maschinen 15 kW < P < 300 kW		große Maschinen 300 kW < P < 50 MW		
	direkter Antrieb		Zwischenwelle Riemenantrieb		Motoren 160 mm < H < 315 mm		Motoren 315 mm < H		
Gruppe	Gruppe 4		Gruppe 3		Gruppe 2		Gruppe 1		

Vibration velocity values can be arranged in a table as shown in the ISO 10816-3 diagram, which allows an initial assessment of vibration. Of course, there are limits to the applicability of this table. Particularly in the case of gears, it is necessary to modify frequency ranges or to use frequency analyses as the basis for vibration analysis. ■



Overview of differences to VDI 2056:

- modified machine classification
- newly defined limiting values
- modified range nomenclature
- extended filter range for low-speed machines

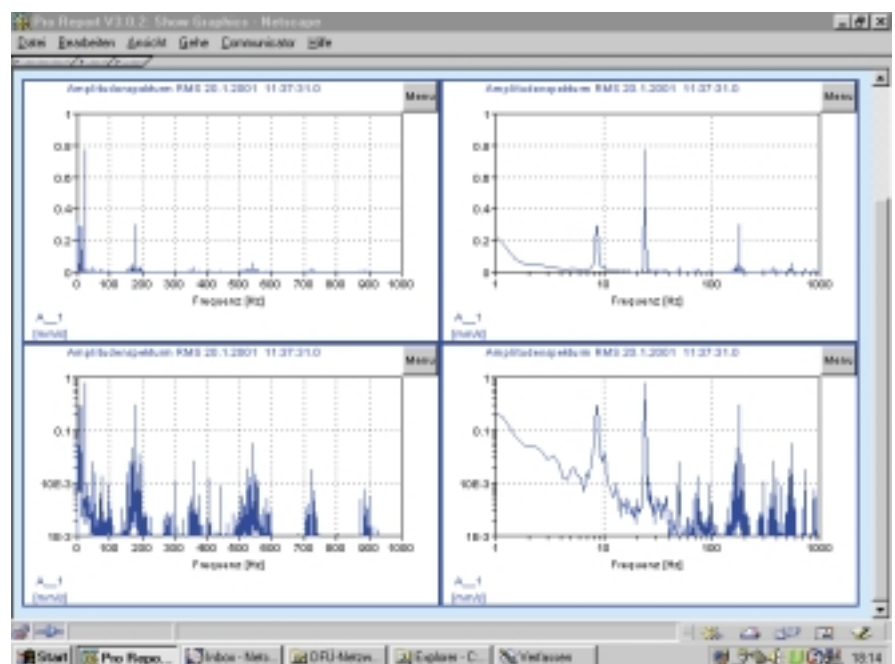
In the next issue we will present important tips on the selection of optimal measuring points.

Level 2 Condition monitoring basics

Basic rules for measuring frequency spectra

Part 1: Representational forms

Frequency analysis is an important method of vibration analysis. It provides information on vibration sources and lets you identify those components in the vibration signal that are often small but nevertheless important for diagnosis. Each vibration can be attributed to a particular excitation source or machine part. Irregularities or damage lead to changes in the appearance of the frequency spectra. Such faults include mechanical or thermal unbalances, characteristic vibrations, changes in alignment, defective bearings, gear tooth damage, changes in play, frictional corrosion, tears, etc. Digital FFT analysers are the state of the art method for analyzing spectra. FFT is an acronym for Fast Fourier Transformation, a mathematical procedure that is performed automatically within the measuring device and produces frequency spectra. ►►



Different representations of frequency spectra

FFT analysers display spectra as line graphs. In order to achieve a high frequency resolution, the number of lines should be as high as possible. While the minimum number of lines required is 800, it is preferable to have more.

The amplitudes of the individual frequencies are displayed during measurement. They can be plotted on a linear or logarithmic scale for each component of the spectrum. The linear display shows only the larger magnitudes while the logarithmic display presents even the smallest vibrations. Prerequisite is that the frequency analyser has sufficiently high amplitude resolution.

The frequency scale can also be either linear or logarithmic. It should be noted that it is virtually impossible to compare frequency diagrams plotted on different scales even if they contain the same information. This is illustrated in the figure on the preceding page. We recommend a linear scale for displaying amplitude and frequency.

In Part 2 in the next issue we will give you tips on selecting the best filters. ■

▶ Continued from page 1: Cooperation of PRÜFTECHNIK and Flender Service

Schuehle Mess- und Kontrollsysteme GmbH of Ravensburg was integrated into the PRÜFTECHNIK group last year to enhance the Condition Monitoring division. Up to that point in time, Schuehle had been an independent system supplier to Flender Service and had been cooperating in the fields of online condition monitoring and telediagnosis for many years.

PRÜFTECHNIK and Flender Service have now decided to continue and intensify this successful cooperation — and the small magazine, *telediagnose.com*, is a result of this joint effort.

The magazine is directed toward technical personnel from all areas of system monitoring and condition-oriented maintenance: Managers will find the articles on modern maintenance concepts for system management to be highly relevant, and engineers and maintenance specialists on the job will profit from the descriptions of interest-

ing applications and new techniques and technologies. The column exploring basic skills in vibration monitoring and diagnosis will be instructive not only for beginners.

We hope that *telediagnose.com* will appeal to you and provide you with ideas and information that will be of assistance in your professional work. Of course, we would also welcome your contributions in the form of technical articles. Just give us a call.

telediagnose.com will appear three times a year in separate German and English issues. It will be available on the Internet under www.telediagnose.com, where a discussion forum has been set up to give you the opportunity to share your ideas and concerns. ■

Application

Showdown under the sunny skies of Andalusia

What would happen if a service team from one of the world's leading manufacturers of turbines confronted the turbine specialists of PRÜFTECHNIK-Wibrem? What with "dummy shaft or piano string technology" or "laser beam technology", the competition would be bound to be intense.

Exactly the opposite proved to be the case when the two teams met in Andalusia in November. The working relationship between them as they spent a fortnight together in Carnoberas near Almeria, where a 550 MW steam turbine, the property of ENDESA power station, had to be completely overhauled, could only be described as most friendly and congenial.

The overhaul work included the alignment of internal fittings of a high and medium pressure stage and two low pressure stages. The stages were enclosed in a 30 m long housing.

Alignment was carried out using CENTRALIGN®. This optical laser alignment ▶▶



View of open steam turbine (TopsOff)

system uses a laser beam and its inherent high precision as its reference as opposed to the often employed conventional method that utilizes a dummy shaft or piano strings.

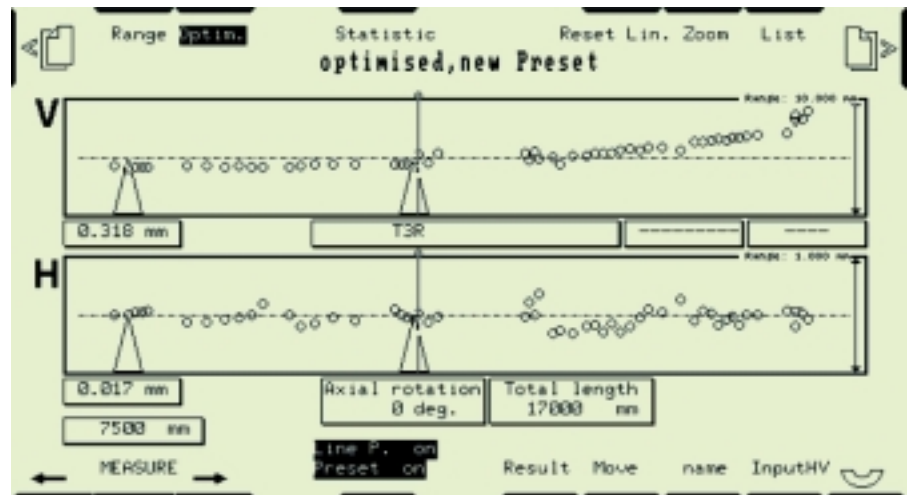
CENTRALIGN® can measure diaphragms, bearings, bearing seals, deflectors, oil guards, circular housings and packings with diameters ranging from 150 mm to 6000 mm with a resolution of 0.01 mm.

Before measurement began, the actual position of all the fittings, i.e. bearing bores, stuffing boxes, seals, packing and housing bores, with the top half removed (TopsOff), was established. The process was repeated with the top half in place (TopsOn). As would naturally be expected, the two positions were not identical. Due to the massive weight of the top diaphragms and the top half, the turbine center line changed. Using the two observed positions, the CENTRALIGN® program was employed to calculate a static alignment configuration for the entire turbine which was then used to carry out the actual alignment.

The results of the measurements taken and the required corrections were discussed and agreed upon by both teams of experts.

A major advantage in using CENTRALIGN® became evident during the alignment process. Using the conventional method, the dummy shaft must be lifted from the turbine before a fitting that requires alignment is removed. Using CENTRALIGN®, the fitting can be measured and moved simultaneously. The Move function shows the actual position of the fitting within the turbine. These characteristics and the capabilities available in CENTRALIGN® enable a drastic reduction in assembly time.

Although already familiar with CENTRALIGN®, the turbine manufacturer engineers found the sensor holder, also referred to as a large bore bracket, awesome. They were fascinated with the holding device and its ability to be applied comfortably on the 3 m bores in the low pressure housing. Its flexibility was impressive.



The entire work, which included three TopsOff and three TopsOn measurements and the alignment of 42 diaphragms and nine stuffing boxes, was completed within ten days - use of the conventional method would have required twice as much time. And the alignment was to within the turbine manufacturer's standards. In this particular instance, an accuracy of ± 0.03 mm of the reference line was attained.

To the joy of both teams of experts, the alignment parameters at recommissioning were exactly the same as those determined by the CENTRALIGN® alignment system. This gratifying situation speaks volumes for the working together of the two teams in future turbine overhauls. ■

News

GearController® monitors complete vertical mill



GearController® was developed to monitor gears in systems with a high degree of availability and to diagnose changes in machine alignment, bearings and gearing at an early stage. But why stop at drive components? The first pair of tediagnose systems for vertical mills was delivered a few weeks ago. Their performance will extend to monitoring vibrations and temperature of large bearings in grinding wheels and of separator bearings. ■

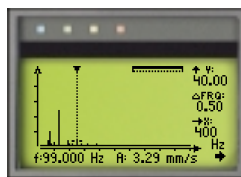
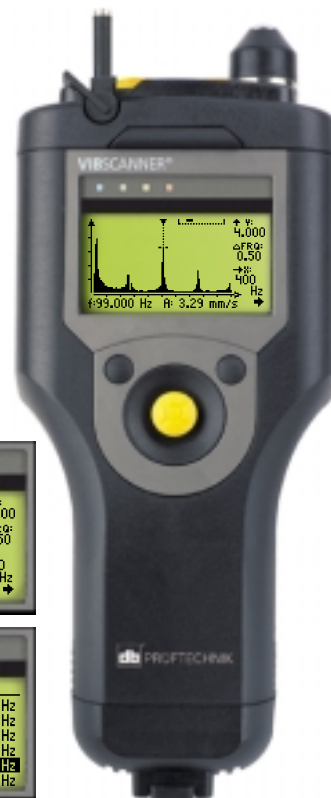
VIBSCANNER® – now with FFT analysis and balancing

VIBSCANNER is a measuring instrument and data collector for offline machine condition monitoring. PRÜFTECHNIK now presents two new software modules for this exceedingly successful handheld measuring device.

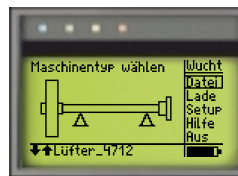
The new FFT module (VIB 5.485-FM) lets you record and analyze frequency spectra of up to 5kHz for bearing, gear and machine diagnosis. The measuring range is adjustable to frequencies from 0 to 100 / 200 / 400 / 1000 / 5000 Hz. The spectrum, which may contain up to 3200 lines, can be evaluated by zooming in and out as required in both the X and Y directions using the joystick. The new 'Max 10 Zoom' function lets you magnify the frequency range around the 10 strongest lines of the spectrum at the touch of a key. All measurements are performed using optimized setups that have already been implemented in the basic module and have proved to be very useful.

VIBSCANNER can be equipped with the 'Balancing' (VIB 5.486-FM) firmware module for balancing in one or two planes. The intuitive, graphics-driven user interface makes for a remarkably

user-friendly program that guides the user through the balancing procedure one step at a time. The components required for balancing are contained in a supplementary Transducer Set (VIB 5.846-HW). This set and the two new firmware modules are optional. Thanks to the modular structure of the firmware, you can activate the two firmware modules already within the device by simply entering a password. ■



Max10		
1.	23.43 mm/s	49.50 Hz
2.	9.18 mm/s	25.50 Hz
3.	8.16 mm/s	24.00 Hz
4.	3.83 mm/s	75.00 Hz
5.	3.29 mm/s	99.00 Hz
6.	2.37 mm/s	73.50 Hz



Events

Trade fairs and exhibits:



Visit us at the Hannover Trade Fair from the 23rd to the 28th of April 2001: PRÜFTECHNIK in Hall 8 Booth D22 Flender Service in Hall 26 Booth F12

England with PRUFTECHNIK LTD. MAINTEC Exhibition 2001 20th - 22nd of March in Birmingham



Nederlands with PRUFTECHNIK N.V. and Flender Service: Industrial Maintenance from the 3rd to the 6th of April 2001 in Ahoy /Rotterdam

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