FAG

FAG SmartCheck

Machinery monitoring for every machine

SCHAEFFLER

Foreword

Reducing maintenance costs

Increasing competition leads to increased cost pressures and drives companies to reduce their maintenance costs. It is therefore vital to avoid unplanned downtime and maximise machine lifetime.
In expensive plant in the steel and paper industries, for example, rolls and the associated bearing arrangements have therefore been fitted for many years with complex and costly continuous online monitoring systems.

In the case of standard machines such as pumps, fans and gearboxes, continuous monitoring is often not applied since an affordable online solution has not been available so far.

Low purchase costs

FAG SmartCheck is a cost-effective, innovative online measuring system for the continuous monitoring of machine and process parameters on a decentralised basis. It offers the performance features of expensive systems but is compact in design, easy to fit and simple to use.
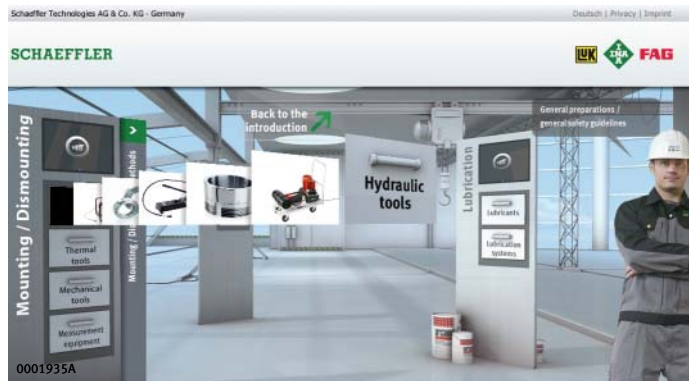
The system can be expanded on a modular basis at any time. Where requirements change, retrofitting can also be carried out at any time.

Important to know

In the interests of rapid assistance, Schaeffler has brought together valuable knowledge relating to the mounting and dismounting of rolling bearings in the Mounting Toolbox. Videos show what must be observed in order to achieve correct lubrication, mounting and alignment. The Virtual Plant makes it possible to watch the work of fitting personnel at close quarters, *Figure 1*.

http://mounting-toolbox.schaeffler.com

Figure 1
Mounting Toolbox

Contents

FAG SmartCheck

Features

FAG SmartCheck is an innovative online system that can be used on numerous machines.

FAG SmartCheck has numerous advantageous features including:

- small and robust
- cost-effective
- intuitive operation
- expandable
- comprehensive information on machine condition taking account of process parameters such as:
  - load
  - pressure
  - flow rate
- condition of machinery shown at a glance in FAG SmartWeb
- information available on the long term development of machine condition by means of the integrated data memory
- connection to control room or controller by means of interfaces
- reliable alarm system by means of alarm threshold adjustment applied for as a patent
- direct system access via Ethernet and Web interface
- protected data by means of a multistage access concept
- free of charge app for smartphones
- complete service for rolling bearings and for machinery diagnostics.

Operation and communication

FAG SmartCheck can be used easily and on an intuitive basis by means of two capacitive keys.

Due to the software FAG SmartWeb integrated in the device, it can be accessed via a Web interface using any standard browser.

The communication protocol SLMP has been implemented specially for Mitsubishi controllers of the L and Q series. This protocol allows direct transfer of information on the status of components such as rolling bearing damage, imbalance, misalignments or temperature variations. This information can be outputted by the controller, for example on operator terminals in the form of text.

The device can be connected via analogue and digital interfaces to, for example, a controller or control station, *Figure 1*.

① Status LED, red, yellow, green
② Membrane key, alarm reset
③ Membrane key, activate teach mode
④ Interface:
Ethernet, power supply, PoE
⑤ Interface:
RS485, power supply
⑥ Interface:
inputs and outputs, analogue and digital

Figure 1
LEDs, keys and interfaces

Function FAG SmartCheck is ready for immediate use as soon as it is delivered. The integrated characteristic value set allows general, reliable monitoring.

For more precise monitoring, a component template stored in the device can be selected for applications such as fans or pumps. The component template is filled with the component data. The device has an integrated rolling bearing database containing data for FAG and INA standard bearings. The user can add further rolling bearings to the database at any time.

Depending on the component template selected, certain parameters can be adjusted, such as:

■ bearing type

■ number of fan blades

■ gear teeth

■ belt lengths.

The characteristic value set thus generated allows highly precise monitoring of the machine.
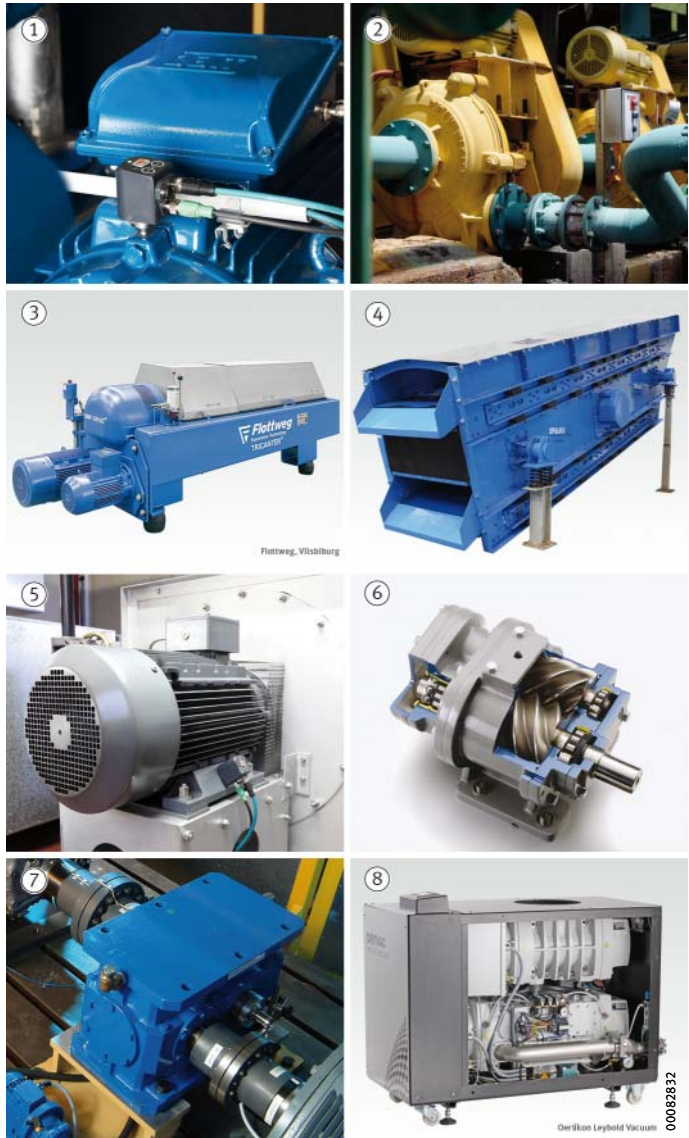
FAG SmartCheck

Configuration With one FAG SmartCheck, it is possible to monitor several compo-
nents of a machine at the same time. A separate configuration can
be generated using wizards by means of a Web browser.
Several component templates are combined in an overall configu-
ration for the machine to be monitored. This configuration can be
copied to any number of devices required.

Monitoring Vibrations and process parameters such as pressure and flow rate
are determined and correlated.

Alarm system The automatic alarm threshold adjustment, for which a patent has
been applied, allows a reliable alarm system. An alarm is indicated
immediately by an LED on the device. The alarm can be transmitted
to the control station by means of interfaces. A free of charge app can
convert any smartphone into an alarm receiver on a WLAN network,
Figure 2.

Figure 2
Smartphone as alarm receiver

Application   The device detects damage to a wide variety of machines at an early stage. A selection is shown in *Figure 3*.

① Electric motor
② Fluid pump
③ Decanter
④ Vibrating screen
⑤ Fan
⑥ Compressor
⑦ Gearbox
⑧ Vacuum pump

Figure 3
Monitored machines

FAG SmartCheck

Standard templates
The standard templates in FAG SmartCheck detect the following damage:
- rolling bearing damage
- imbalance
- misalignment
- impacts.

Expanded monitoring
The user can apply the standard templates for monitoring.
He also has the option of using templates for specific machines. Specific damage patterns are detected precisely and can be allocated to a component. Examples are shown in the table.

Templates for specific machines

Machine	Characteristics identified using template for specific machines
Electric and geared motors	Winding damage and loose rotor bars
Vacuum and fluid pumps	Wear and cavitation
Ventilators and fans	Blade and vane rotational frequencies
Compressors	Changes to the typical vibration pattern
Gearboxes	Tooth set damage
Separators and decanters	Cavitation, floating imbalance between screw and drum
Vibrating screens	Settling of screen mats, loose springs, spring breakage

Concept Monitoring using FAG SmartCheck can be carried out in three stages. In the first stage, individual machines are monitored on a decentralised basis. If the user selects the second stage, the device is intelligently integrated in the machine controller. In the third stage, the service is provided from a single source by an external service provider. This can include remote access via an Internet connection as well as advice and other services, *Figure 4*.

① Decentralised machinery and process monitoring
② Intelligent process integration
③ Service from one source

Figure 4
Multistage concept

Decentralised machinery and process monitoring Installation and cabling of FAG SmartCheck is a simple process. The device is ready for immediate use. Data can be accessed directly from the device.

Intelligent process integration Intelligent process integration is the option of communication via interfaces. During communication, data are exchanged with, for example, a PLC or control station. User-specific integration in bus systems can be achieved, for example, by means of an RS485.

Service from one source The Web interface for FAG SmartCheck allows remote access to measurement data via an Internet connection. Monitoring can thus be outsourced to an external service provider.

FAG SmartCheck

Software   Each FAG SmartCheck includes the integrated software
FAG SmartWeb. The device can be accessed by means
of FAG SmartWeb using any Web browser.

The software FAG SmartUtility light is free of charge PC software.
The software can be used to configure the Web address, save data
and update firmware.

The paid-for PC software FAG SmartUtility allows unrestricted access
to all the functions in FAG SmartCheck, see table.

Functional scope

Function	SmartWeb	SmartUtility light	SmartUtility
Display characteristic value status	●	–	○
Display system information	●	–	○
Display measurement data	●	–	○
Display trend	●	–	○
Select component templates	●	–	○
Configure inputs and outputs	●	–	○
Configure and activate validator	●	–	○
Configure and activate trigger	●	–	○
Configure user administration	●	–	○
Display input signals in real time	●	–	○
Configure TCP/IP settings	●	●	●
Update firmware	●	●	●
Download and save data	●	●	●
Analyse data	–	–	●
Manage all FAG SmartCheck devices in the network	–	–	●
Load and send configurations	–	–	●

● Executed by this software
– Not supported by this software
○ Can be called up, will be executed by FAG SmartWeb

The use of FAG SmartUtility light and FAG SmartUtility requires
a Windows PC, see hardware requirements in table, page 16.

Data analysis FAG SmartCheck offers extensive possibilities for analysing measurement data and assessing the condition of the machine being monitored.

The following general characteristic values are determined from the acceleration and acceleration envelope signal:

- RMS, broadband
- RMS, frequency-selective
- peak-to-peak value
- crest factor
- periodic value
- W count.

FAG SmartCheck does not, however, only calculate the general characteristic values. In addition, the component templates integrated in the device offer frequency-selective monitoring matched to various components.

Characteristic patterns in components such as shafts, belt pulleys or fan wheels indicate incipient damage at an early stage. In conjunction with process parameters such as torque, load or speed, it is possible to make precise statements relating to the damage progress. Temperature as a characteristic value is determined by an integrated sensor.

FAG SmartCheck

Presentation of trends

Presentation of trends is a simple and authoritative presentation of characteristic values. A change in the vibration behaviour can be detected at a glance. Even slight changes are visible in the trend pattern, *Figure 5*.
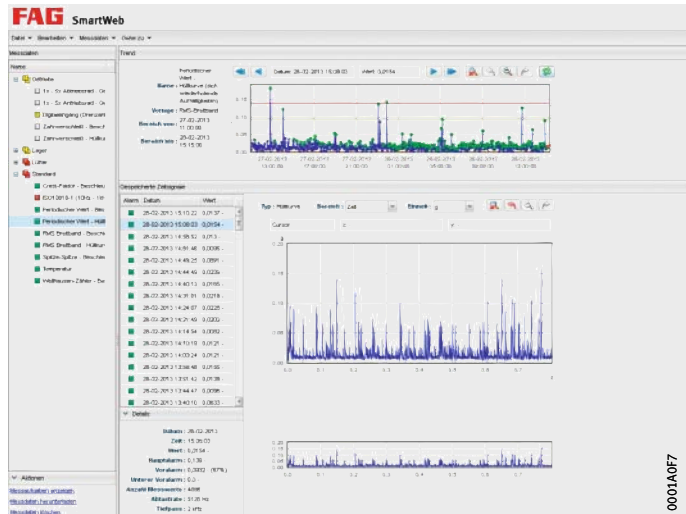

Figure 5
Web interface

In-depth analysis

For this analysis, the Viewer function in FAG SmartUtility is used. The Viewer offers numerous tools that assist the experienced user in carrying out analysis.

Alarm threshold adjustment

In the delivered condition, FAG SmartCheck uses preset alarm thresholds. The vibrations in a machine are decisively influenced by the specific operating condition. In order to adjust the alarm thresholds to match the specific machine, FAG SmartCheck has an automatic teach mode.

The user must start the teach mode at the time of commissioning. The associated vibration value is then measured and allocated for each operating condition of the machine.
Based on the measurement data for vibrations and process values, FAG SmartCheck determines the correct alarm thresholds itself. The dependence of vibrations on several process values is also taken into consideration.

As soon as sufficient measurement data are available, FAG SmartCheck automatically substitutes the newly determined alarm thresholds for the preset values.
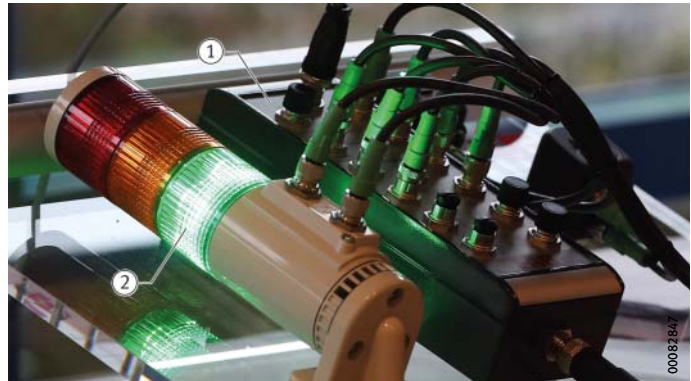
Through the multi-dimensional adaptation of alarm thresholds, critical machine conditions are identified and reliable alarm operation in every machine condition is ensured.

Accessories

The options available with FAG SmartCheck can be expanded by means of accessories, *Figure 6*.

① Connection box
② Lamp

Figure 6
Accessories

Connection box

The FAG SmartConnect Box can be used to distribute voltage and additional signals such as load or speed to a maximum of four FAG SmartCheck devices. The industrial grade housing (IP66) has standard connectors for cables connecting to the FAG SmartCheck accessories. The FAG SmartLamp and an inductive or optical speed sensor can also be connected. The FAG SmartConnect Box and the standard configurations of FAG SmartCheck are matched to each other. No settings or adjustments by the user are necessary.

Lamp

The FAG SmartLamp gives an optical display of the highest alarm status of the FAG SmartCheck connected by cable to the connection box: green (= no alarm), yellow (= pre-alarm) and red (= main alarm). The FAG SmartCheck is supplied with prior configuration that allows the FAG SmartLamp to be commissioned directly for operation.

Controller

The FAG SmartController distributes analogue and digital additional signals to a maximum of 25 FAG SmartCheck devices. He captures the condition of all connected FAG SmartCheck devices and transmits the highest alarm status via the combined alarm function. In combination with a POE switch, only one cable is required per FAG SmartCheck device.

Software

By means of the software FAG SmartVisual, the status of several FAG SmartCheck devices can be displayed on the PC.
Each user can create an individual display by hierarchy-based linking of individual views.

FAG SmartCheck

Service   Schaeffler offers extensive services ranging from strategy development through commissioning to remote monitoring.

Commissioning   In partnership with the customer, the suitable monitoring strategy is determined, devices are mounted and reference measurements are carried out.

Training courses   Employees are trained as a function of their prior knowledge and requirements. The training covers handling of the device and use of the software.

Operation   We are pleased to offer our experience at any time. For example, our experts can assist in the assessment of measurement results. If the measurement results indicate any damage, they can provide advice on further action.

Remote monitoring   If the necessary expert knowledge is not available or trained employees are not present on site, remote monitoring may be advantageous, *Figure 7*.
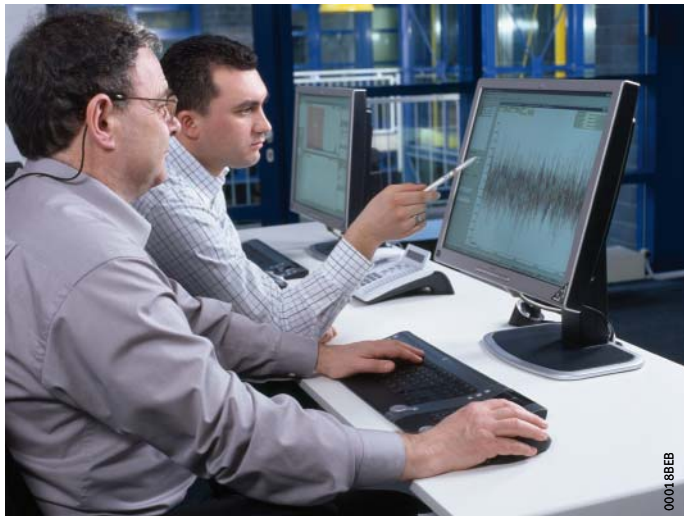
Figure 7
Remote monitoring
with data evaluation by Schaeffler

If Schaeffler is tasked with remote monitoring, the customer receives regular reports on the machine condition and recommended actions for improving plant availability. If FAG SmartCheck detects incipient damage, the customer is informed immediately. Repair can then be planned and replacement parts sourced in good time.

Further information can be found at www.FAG-SmartCheck.com or by simply contacting us.

FAG SmartCheck

FAG SmartCheck	
Features	Description
Size (W×H×D)	44 mm×57 mm×55 mm
Mass	≈ 210 g
Housing material	Glass fibre reinforced plastic
Fixing method	Screw M6
	Contact surface on the machine: ⌀ 25 mm
Protection class	IP67
Power supply	DC 11 V to DC 32 V
	Power over Ethernet (in line with IEEE 802.3af; Mode A is supported)
Maximum power consumption	200 mA at 24 V
Operating temperature	−20 °C to +70 °C
Operating system	Embedded Linux
Software (languages: German, English, Chinese)	FAG SmartWeb (recommended: Windows XP: Internet Explorer 7, Firefox 16; Windows 7: Internet Explorer 8, Firefox 16)
	FAG SmartUtility light

Interfaces	
Features	Description
Control elements	2 keys for teach mode, alarm reset, restart, default settings
Display elements	1 LED for status and alarm display
	1 LED for confirmation of keys
	2 LEDs for communication display
Communication	Ethernet 100 MB/s RS485
Electrical connections	3 polarity protected M12 push-fit connectors for power supply, RS485, analogue and digital inputs and outputs, Ethernet

Memory	
Features	Description
Program and data memory	64 MB RAM, 128 MB Flash

Internal vibration sensors	
Features	Description
Piezoelectric accelerometer	25 mV/g
Frequency range	0,8 Hz to 10 kHz
Measurement range	±50 g
Resolution	200 μg

Measurements	
Features	Description
Measurement functions	Acceleration, velocity and displacement by integration
	Temperature and process parameters such as speed, load and pressure
Diagnostic methods	Time signal, envelope curve
	Speed and frequency tracking
	Spectrum and trend analysis
Characteristic values in time and frequency range	Defined characteristic values: DIN ISO 10816
	Calculated characteristic values: RMS, frequency-selective RMS, DC, peak, peak-to-peak, crest factor, W count, condition guard
Special features	Other user-defined characteristic values are possible

FAG SmartCheck

Signal processing

Features	Description
Frequency resolution	1 600 lines, 3 200 lines, 6 400 lines, 12 800 lines
Measurement accuracy	24 Bit, A/D converter
Frequency range	0,8 Hz to 10 kHz
Low pass filter	50 Hz to 10 kHz
	Stages: 50 Hz, 100 Hz, 200 Hz, 500 Hz, 1 kHz, 2 kHz, 5 kHz, 10 kHz
High pass filter, envelope curve only	750 Hz, 1 kHz, 2 kHz
Special features	Other filters available by agreement

Inputs and outputs

Features	Description	
Inputs	2 analogue inputs, 12 Bit, frequency range 0 Hz to 500 Hz:	
	Voltage:	0 V to 10 V, 0 V to 24 V
	Input resistance:	10 kΩ
	Current:	0 mA to 20 mA, 4 mA to 20 mA
	Input resistance:	500 Ω
	1 pulse input:	0 V to 30 V, 0,1 Hz to 50 kHz
Outputs	1 analogue output, 12 Bit:	
	Voltage:	0 V to 10 V
	Minimum load resistance:	1 000 Ω
	Current:	0 mA to 20 mA, 4 mA to 20 mA
	Maximum load resistance:	250 Ω
	1 switching output:	Open collector, max. 1 A, 30 V
Special features	Electroplated separation of inputs and outputs and electroplated separation of the power supply for inputs and outputs	

Accessories

Ordering designations	Description
SMART-CHECK. CONNECT-BOX	Connection box: Power supply and distribution of additional signals
SMART-CHECK.LAMP	Lamp: Dispaly of alarm status for FAG SmartCheck
SMART-CHECK. CONTROL	Controller: Capture and distribution of additional signals to a maximum of 25 FAG SmartCheck devices
SMART.VISUAL	PC software: Visualisation of FAG SmartCheck
SMART-CHECK.CABLE-POW-P-M12-OE-10M	Power supply cable: 10 m, 8 pin, M12 socket on free connection end
SMART-CHECK.CABLE-ETH-P-M12-RJ45-10M	Ethernet cable: 10 m, M12 plug on RJ45
SMART-CHECK.CABLE-IO-P-M12-OE-10M	Input/output cable: 10 m, 8 pin, M12 plug on free connection end
Special features	Other accessories available by agreement

Software

Ordering designations	Description
SMART.UTILITY	Paid-for PC software for system management

System requirements for the use of FAG SmartUtility and FAG SmartUtility light

Features	Description
System architecture	Windows 7
Processor speed	1 GHz or faster
RAM (minimum)	2 GB (recommended 4 GB)
Screen resolution	At least 1 024×768, font size normal
Free space on hard disk	40 MB
Browser	Internet Explorer 8, Mozilla Firefox 14

FAG SmartCheck

Product variants	
Ordering designations	Description
SMART-CHECK	FAG SmartCheck including Web interface, FAG SmartWeb and PC software, FAG SmartUtility light
SMART-CHECK-KIT-003	1×FAG SmartCheck with accessories (starter configuration, cable and basic manual)
Special features	Other product variants available by agreement

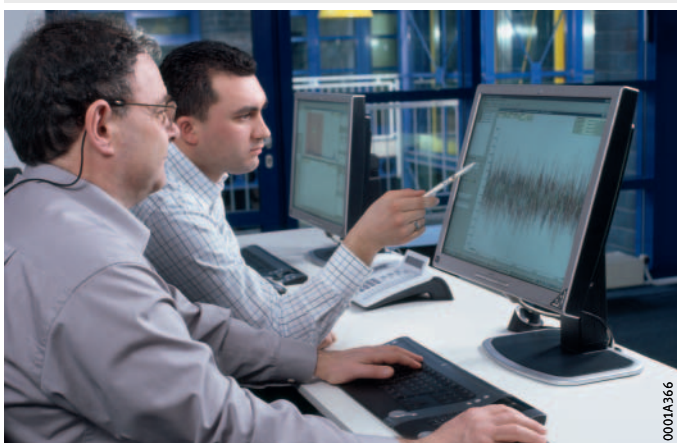| Services	
Ordering designations	Description
SMART-CHECK-SERVICE-001	Preparation of an application-specific or machine-specific monitoring strategy in consultation with the customer
SMART-CHECK-SERVICE-002	Preparation of a monitoring configuration based on templates in FAG SmartCheck
SMART-CHECK-SERVICE-005	Mounting and commissioning of FAG SmartCheck
Special features	Other services available by agreement

Mounting

MOUNT-HOUR

Lubrication

ARCA-PUMP

Condition monitoring

CM-HOUR-ENGINEER

Services

In addition to alignment as a service, Schaeffler can provide numerous solutions for your specific requirements. Here are some examples from the product portfolio of Schaeffler Industrial Aftermarket.

Mounting

Our experienced fitters can support you in the mounting and dismounting of rolling bearings and advise you on the selection of suitable mounting tools. Correct mounting is an essential precondition for achieving the maximum operating life of bearings. In the case of the London Eye, Schaeffler supplied the rolling bearings and carried out the mounting operations, *Figure 1*.
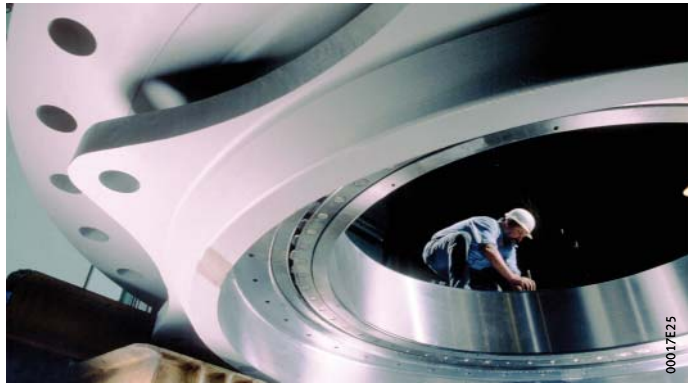
Figure 1
Double row FAG spherical roller bearing in the London Eye

Lubrication

Unsuitable lubrication can impair the operating life of rolling bearings and cause damage. In order to achieve the most suitable lubrication, Schaeffler can provide specifically designed and tested greases, *Figure 2*.

Figure 2
Rolling bearing grease for every bearing arrangement

Services

Rolling bearing grease Arcanol

The 18 different greases cover almost all applications.
They are developed by experienced application engineers and are produced by the best manufacturers in the market. Different greases are used depending on the particular application. At high operating temperatures, the thermally stable special grease Arcanol TEMP120 is used.

Rolling bearing greases under the name Arcanol are subject to 100% quality inspection. The inspection methods at Schaeffler are among the most demanding in the market.
As a result, rolling bearing greases Arcanol fulfil the highest quality requirements.

Condition monitoring

The malfunction-free and optimised operation of complex machinery and plant can only be achieved by means of condition-based maintenance. The monitoring of grease condition in ongoing operation can be achieved, for example, using FAG GreaseCheck, *Figure 3*. Due to its special electronic evaluation system, relubrication is no longer carried out as a function of time but as a function of condition. Relubrication is not carried out too early – this saves on costs and prevents downtime. Equally, relubrication is not carried out too late – this means always staying one step ahead of rolling bearing damage. The grease sensor gives higher plant availability, optimised grease quantities and relubrication intervals, maximum bearing life and is particularly suitable for use with rolling bearings that are difficult to access.

① Grease sensor
② Electronic evaluation system

Figure 3
FAG GreaseCheck