



## Our References

Customized Solutions for your Success  
from our Global Technology Network

**SCHAEFFLER**

There are numerous possibilities for optimizing plant availability and reducing overall costs. With our compendium of successful customer solutions, we would like to give you some ideas on identifying potential savings and their successful implementation. We invite you to take inspiration from projects in various market sectors in numerous parts of the world. Why this is worth the effort: The proven savings in the chapters “Bearing Solutions”, “Mounting”, “Condition Monitoring”, “Reconditioning” and “Full Service” amount in some case to several millions of Euros.

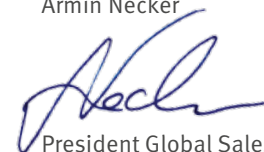
Often, comparatively simple measures can lead to considerable successes. Identifying promising starting points and determining the right steps to be taken requires an experienced partner with creativity and a holistic overview. Give us the challenge!

Our experts have in-depth technical knowledge and, at the same, always have a firm eye on your cost-effectiveness. They can give extensive advice relating to rolling bearings, application engineering, calculation, production processes and maintenance. What this means for you: individual matching of Schaeffler products and services that are adjusted to each other in order to fulfill your requirements. As a result, you can benefit from more reliable running times, security, availability and cost-efficiency.

As always, you are welcome to contact your usual Schaeffler Sales Engineer for on-site assistance. Through our Global Technology Network, he is closely linked to the Schaeffler Technology Centers and Schaeffler experts throughout the world. More information about the topics Schaeffler Technology Center and Global Technology Network can be found from page 6 onwards.

I hope you enjoy reading our stories.

Armin Necker



President Global Sales and Product Management  
SCHAEFFLER Industrial



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# Working together to turn challenges into opportunities

The central topics for every company are:

- ➔ Increasing efficiency
- ➔ Improving the availability of machines and equipment
- ➔ Reducing overall costs: The total cost of ownership (TCO) approach
- ➔ Securing and improving the competitive position in the long term

These are all areas where we can assist you!

As one of the sector leaders in rolling bearing solutions, we work in partnership with our customers worldwide and are thus able to support them in overcoming the challenges that the future brings.

Therefore we bundle our technical expertise in various disciplines and our profound knowledge in over 60 sectors of industry in the Schaeffler Global Technology Network, a worldwide network of experts.





## Local Expertise: Our Schaeffler Technology Centers

Our Schaeffler Technology Centers (STC) are a central part of the Global Technology Network. These are operated by highly-qualified engineers and provide local technical expertise in the regions. There are currently 27 STC worldwide (as of November 2016), which are constantly exchanging information with each other and with Schaeffler experts around the world.



“Schaeffler Technology Center” certification ensures a standardized range of areas of premium expertise in rolling bearings and issues related to rolling bearings. This includes services such as:

- ➔ The selection of the optimum solutions for your specific application, using calculation software such as BEARINX if required
- ➔ the definition of mounting tolerances
- ➔ the calculation of the rating life or lubrication intervals for your products
- ➔ mounting, lubrication, and condition monitoring of your products
- ➔ defect assessment and determination of possible causes of failure
- ➔ training with regard to products, rolling bearing fundamentals, mounting, condition monitoring, defect assessment, etc. for your employees according to DIN EN ISO 9001:2008

and many others.

Regular training courses, workshops, and audits mean this expertise is permanently ensured. Schaeffler thus makes the same high-quality standard of technical solution expertise available throughout the world.



# The Schaeffler Global Technology Network

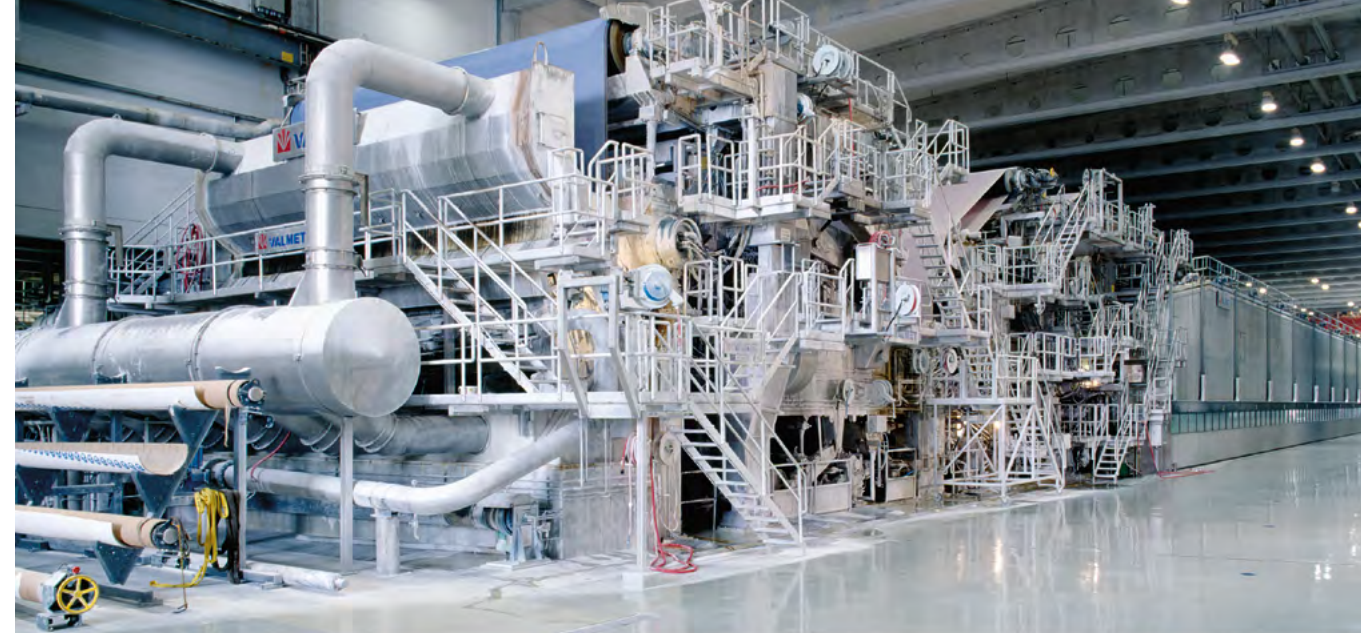
When you have an inquiry, you contact your sales engineer – your local point of contact – as usual.

If the task is a very complex one, our engineering and service experts worldwide also help to develop a solution to suit your requirements. This means that you benefit from Schaeffler's entire scope of expertise.

**Globale expertise –  
local knowledge –  
optimum performance for the customer.**

The result: Innovative and customized solutions of the highest quality.

Examples of these solutions are shown on the following pages, under the headings of Bearing Solutions, Mounting, Condition Monitoring, Reconditioning, and Full Service.



## TORB: Two in One

FAG TORB toroidal roller bearings combine the axial displacement of cylindrical roller bearings with the angular adjustment facility of spherical roller bearings. This makes them ideal non-locating bearings for applications where very high loads lead to shaft deflections.

TORB increase the operating life of your machinery. Benefit from the lower total cost of ownership that results from reduced downtime and maintenance costs with TORB.

To find out more, visit: [www.schaeffler.de/en/torb](http://www.schaeffler.de/en/torb)



# Replacement of Main Trunnion Bearings on BOS Plant Vessels

### Tata Steel Group, Great Britain

The Tata Steel Group has operations in 26 countries and produces 28 million tonnes of steel per year. Port Talbot Works is part of the Strip Products UK business, producing hot rolled, cold rolled and hot dip coated steel.

### Challenge for Schaeffler

Tata Steel Port Talbot has two BOS steelmaking vessels (V1 & V2) in operation. The main trunnion bearings on a BOS (Basic Oxygen Steelmaking) plant at Tata Steel Port Talbot had to be replaced due to a sudden bearing failure on the nondrive side (NDS) of the V2 BOS plant vessel. Loss of operation of a BOS vessel would result in significant lost revenue for Tata Steel.

### Schaeffler Solution

A method statement was drawn up by Schaeffler UK, which specified the sequence and method to replace the bearings and outlined the Tata requirements. Included in this document was a detailed tooling list and a step-by-step procedure for the dismantling and mounting of the drive-side (DS) & non driveside (NDS) bearings. The standard ‘solid’ bearing on the DS was replaced by a special FAG split spherical roller bearing, which is the recommended replacement spare, as this reduces the amount of downtime when installing the replacement bearing. The NDS bearing was to be replaced with a similar solid bearing. In addition, various surrounding components also required replacing, once the secondary damage caused by the bearing failure had been identified.

Technical Information about the Vessels
Original vessel installation:
In the late 1960s
Vessels upgrade:
In 1991/1992
Steel making capacity:
330 tonnes (each vessel)

Technical Information about the Solution
Drive-side bearing:
<ul style="list-style-type: none"><li>Type: FAG split spherical roller bearing (Z-568168.PRL)</li><li>Dimension: 1180 x 1750 x 375/550</li></ul>
Non drive-side bearing:
<ul style="list-style-type: none"><li>Type: Spherical roller bearing (230/1250-B-K-MB-C4)</li><li>Dimension: 1250 x 1750 x 375</li></ul>

### Customer Benefit

After having successfully completed the work in only 10 days, Schaeffler engineers were pleased to be leaving behind a very happy customer. The bearings were fitted to a high standard with expertise provided by Schaeffler throughout the installation process. A further advantage of using split bearings as opposed to solid bearings was that there was no need to disassemble the bull gear unit (i.e. the main drive unit for the BOS plant vessel). During the bearing changeover, several unexpected problems were encountered and were discussed with Tata BOS Plant engineers, Schaeffler engineers from UK and Germany, and Tata Central Engineering Support. Between all parties, solutions were generated, action plans compiled and remedies implemented. Without Schaeffler’s expertise, the bearing change would not have run so smoothly.

Bearing type	Downtime	Cost
Unsplit bearing:	7 days	€ 4,0 M
FAG split spherical roller bearing:	3 days	€ 1,7 M
<b>Savings:*</b>	<b>4 days</b>	<b>€ 2,3 M</b>

\*These savings are dependent upon throughput and steel grade mix.

Speed was a major key to customer satisfaction in this project. If the vessels had been at a standstill for a much longer period, this would have resulted in a significant loss of revenue. Against this background the higher purchasing price of the split spherical roller bearings was of little significance.

### What’s special

After the bearings were installed, the work didn’t finish there. Schaeffler UK prepared a recommended practical maintenance schedule and forwarded this to the BOS engineers, which was well received. Since replacing the trunnion bearings, engineers from Schaeffler UK have also supervised two further BOS vessel bearing changes in a very short time frame of just two months. ◀



BOS steelmaking vessel



Fitting of non-drive spherical roller bearing



Supporting structure for vessel



Fitting of FAG split spherical roller bearing

# Modernization of Four-high Heavy-plate Mill Back-up Rolls



**SMS group GmbH, Germany**  
SMS group GmbH offers metallurgical plant and rolling mill technology from one source. The group’s plants, machines, services and process know-how are used in the steel, aluminum and other non-ferrous metal industry worldwide. Heavy-plate mills from SMS Group GmbH allow steelmakers to cover the entire range of products and to supply plates with tailor-made material properties for every application.

**Challenge for Schaeffler**

At the beginning of 2012, SMS group GmbH received an order from the high performance alloy company VDM Metals GmbH, which produces plates and sheets in Siegen, Germany. The intention was to replace the old plate mill from 1954 with a modern version capable of working with a maximum rolling force of 60 MN and incorporating hydraulic adjustment and work-roll bending. The new rolling mill allows VDM Metals GmbH to supply plates with narrow product tolerances and increased piece weights. Schaeffler was asked to design a bearing for the new plate mill. The introduction of the new stand would result in as few changes as possible to the surrounding structure with reuse of existing plant components.

Technical Information about the new Four-High Heavy Plate Mill
Max. rolling force:
60 MN
Plate width:
Max. 2 600 mm
Max. plate length / thickness:
13 500 m / from 260 mm to 2 mm
Rolling speed:
1,25 m/s – 2,5 m/s
Max. slab weight:
4,5 t

Technical Information about the Solution
Existing bearing:
<ul style="list-style-type: none"><li>Type: CRB (Z-524239.01.ZL)</li><li>Dimensions: 863 x 1 219,32 x 889 mm</li><li>Cage: Pin-type cage</li></ul>
New bearing solution:
Special four-row CRB (F-600047.ZL)
Features of the new CRB F-600047.ZL:
<ul style="list-style-type: none"><li>Dimensions: 900 x 1 220 x 880 mm</li><li>One-piece steel cage</li><li>Can be used for extremely heavy loads, up to a max. rolling force of 60 MN</li></ul>
Schaeffler calculation program:
BEARINX

**Schaeffler Solution**

In order to meet the challenges of higher rolling forces Schaeffler application engineers developed a special four row cylindrical roller bearing (CRB) with larger bore diameter and one-piece steel cage. The bearing was designed with the aid of the Schaeffler calculation program BEARINX. It was particularly important to reuse the existing plant components. To this end, four existing bearings were chromium plated to the new outside diameter of 1 220 mm.

**Customer Benefit**

SMS group GmbH benefited from Schaeffler’s excellent technical support. Using the solution of a special four-row cylindrical roller bearing allowed SMS group GmbH to upgrade the rolling stand operated by VDM Metals GmbH, in order to achieve rolling forces of up to 60 MN. Thereby VDM’s future position as a supplier of plates from high-performance materials is secured. The new stand is designed with just minor changes to the surrounding structure and reusing original plant components. For certain rolling programs the reworked existing bearings and rolls can be reused until the rolls will be worn out.

**What’s special**

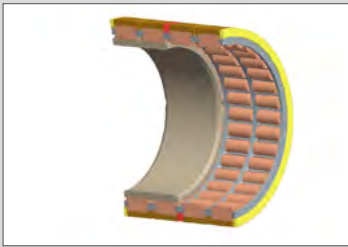
The close cooperation maintained between SMS group GmbH (OEM), the various participating Schaeffler departments from the OEM and MRO sectors and VDM Metals GmbH (MRO) for the duration of the project – from the engineering stage through to final assembly – was of vital importance. The application, which posed a significant technical challenge, placed extremely high demands on the know-how and expertise of all employees involved in the project. ◀



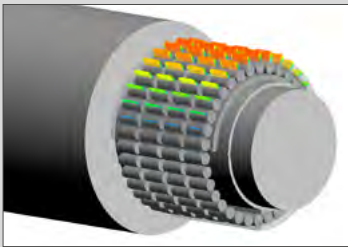
Four-high heavy plate mill



Side view of four-high stand



CAD-modell F-600047.ZL



Herzian pressure calculation with BEARINX

# Considerable Cost Savings through FAG Split Spherical Roller Bearings

### Pilbara Iron, Australia

Pilbara Iron, a member of the Rio Tinto Group, is a world-class asset manager that operates and maintains mining, rail and port facilities in the north-west of Western Australia. Dampier’s Port Operations include two ship-loading terminals each equipped with appliances for train unloading, ore stockpiling, ore blending and ship loading.

### Challenge for Schaeffler

At Pilbara Iron’s Dampier Port Operations replacing the bearings on the bucket wheel excavator drive was a maintenance nightmare. The standard unsplit FAG SGC Pillow Block housing was difficult to access. Normally it would have taken 72 hours to replace the spherical roller bearings. This would have meant costs of idleness of € 1 110 (AUD 2 000) per hour.

### Schaeffler Solution

Schaeffler recommended changing the conventional FAG spherical roller bearings to FAG split spherical roller bearings. The split bearings were fitted into the existing housing without modification or the need to remove the drive shaft. This decreased the installation time by 50 percent and thus resulted in a tremendous reduction in downtime. The price for an FAG standard spherical roller bearing is € 2 780 (AUD 5 000). The cost of an FAG split spherical roller bearing amounts to € 16 670 (AUD 30 000).

#### Technical Information about the Plant

##### Bearing Location:

- Drive shaft
- Grease lubricated
- SGC Pillow Block housing
- Speed: 5,5 RPM

#### Technical Information about the Solution

##### Following FAG bearings and housings were used:

##### Location bearing side:

- BND3160-Z-T-AF-S housing
- 23160-B-MB standard spherical roller bearing

##### Floating bearing side:

- Z-144899.02.SGC3084-Z-BF housing
- 23084-B-MB standard spherical roller bearing

##### Replacement bearing:

- Z-536955.PRL split spherical roller bearing

### Customer Benefit

Through the use of FAG split spherical roller bearings, the downtime is shortened by 36 hours, which corresponds to a cost saving of € 40 000 (AUD 72 000). Once the additional bearing costs for a FAG split spherical roller bearing as well as the reduced labour costs simply for one fitter (€ 39/hour) have been taken into consideration, this gives the following minimum savings for each bearing change:

Minimum savings	
Shortened downtime:	€ 40 000/(AUD 72 000)
- Additional bearing costs:	€ 13 890/(AUD 25 000)
+ Lower labour costs (1 fitter, € 39 x 36 hours):	€ 1 404/(AUD 2 520)
<b>Savings per bearing change:</b>	<b>€ 27 514/(AUD 49 520)</b>

Furthermore, the customer benefits from long term savings in maintenance, since bearing replacement can proceed more easily and more quickly in future through the use of FAG split spherical roller bearings.

### What’s special

The range of FAG split spherical roller bearings permits heavy industries such as mining, metals production, pulp and paper and cement companies to reduce production downtime. Moreover these bearings simplify mounting and reduce maintenance costs. ◀



Bucket wheel excavator



Simplified mounting – shortened downtime



FAG split spherical roller bearing



Fitter working on-site



# Split Bearings Simplify Bearing Replacement in Conveyor Belts

The customer is a global company that offers worldwide solutions to all construction industries. The company is one of the leading concrete manufacturers with more than 70 million cubic meters of production. Its annual cement production capacity amounts to 97 million tons. The following project was performed at a Spanish plant with 200 employees and a production capacity of around two million tons of cement.

### Challenge for Schaeffler

In the past, a failure of the standard roller bearings in the conveyor belt would have caused downtimes of at least 22 hours, as replacing these bearings causes a lot of work and takes a considerable amount of time. Thus – although the solution they were using had worked well – the customer was looking for an alternative to shorten replacement time and avoid expensive economic consequences in the event of a failure. As its bearing supplier and service provider at the time was not able to offer an appropriate solution, the plant operator contacted Schaeffler for support.

### Schaeffler Solution

Schaeffler experts presented FAG split spherical roller bearings to the customer. Due to their split design, these bearings can be mounted into the existing housings SNV230-L without major dismounting work and are, therefore, a cost-effective alternative to standard roller bearings. Schaeffler recommended the customer to replace the conveyor belt’s standard bearings 22226K+H3126 with FAG split spherical roller bearings 222SM115-TVPA.

Technical Information about the Plant
Conveyor belt transporting cement from the cement plant to the harbour
Type:
Conveyor belt 4000
Width:
900 mm
Length:
200 m (100 m distance between conveyor centers)
Speed:
1,3 m/sec.

Technical Information about the Solution
Previously used bearings:
Standard bearings 22226K + H3126
Replacement bearings:
FAG split spherical roller bearings 222SM115-TVPA

### Customer Benefit

FAG split spherical roller bearings considerably reduce downtime of machinery and plant, simplify mounting and help to reduce assembly and maintenance costs. The savings realized in the present project are shown by the following comparative calculation.

Bearing replacement using standard bearings	
Downtime:	22 h
Labor costs:	€ 2 600
Bulk carrier chartered to transport cement:	€ 9 000
Production losses:	€ 162 000
Total:	€ 173 600

Bearing replacement using FAG split spherical bearings	
Downtime:	3 h
Labor costs:	€ 500
No alternative way of transportation required:	€ 0
Production losses:	€ 21 600
Total:	€ 22 100
Cost savings:	€ 151 500

### What’s special

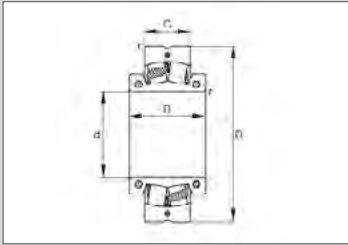
This was the first time the customer used FAG split spherical roller bearings. This solution can be extended to all the other conveyor belts at this plant, and can generally be recommended to all customers with the same application. ◀



Conveyor belt at the harbour



FAG split spherical roller bearing



The split design allows to simplify the mounting



A downtime on the conveyor belt causes high costs

# Six-Figure Savings due to FAG Split Spherical Roller Bearings

The customer is a globally-active specialty chemicals company based in Australia.

### Challenge for Schaeffler

The exhaust gas fan failed in the processing facility of the chemical plant. The plant operator was forced to replace the rolling bearing quickly due to the toxic gases and the resulting explosive atmosphere that occurred in the chemical production process. However, it was very difficult to access the standard spherical roller bearing, with which the fan was originally fitted. Experience had shown that a mounting time of approximately 14 hours had to be expected in such cases.

### Schaeffler Solution

In order to achieve optimum downtime periods and costs, Schaeffler recommended using an FAG split spherical roller bearing. These bearings can be fitted as a direct replacement for conventional spherical roller bearings and the corresponding adapter sleeve; the outside diameter, outer ring width and diameter of the shaft seat are the same. Schaeffler also provided the customer with support during mounting. All detailed planning work was coordinated in close collaboration between Schaeffler Australia and Schaeffler mounting specialists as well as Schaeffler application engineers from Germany. An experienced Schaeffler technician assisted with the mounting and modification work on site.

Technical Information about the Fan	
Fan type:	Radial fan
Drive:	Direct drive with clutch
Speed:	1 180 RPM
Power:	315 kW
Volume of air:	15,94 m³/s at 0,12 bar
Temperature:	60 – 70 °C

Technical Information about the Solution	
Existing bearing with sleeve:	22226-E1-K-C3 and H3126 on drive and fan side
New FAG split spherical roller bearing:	222SM115T

### Customer Benefit

Downtimes during bearing replacement and fitting costs were significantly reduced due to the change from a standard spherical roller bearing to an FAG split spherical roller bearing.

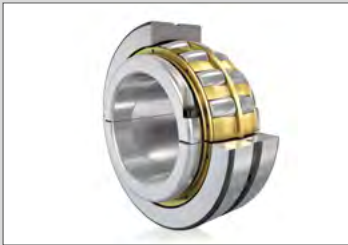
Costs	Unsplit bearing	Split bearing
Downtime:	14 hours	3 hours
Costs of production stoppage (€ 20 000 per hour during stoppage of fan):	€ 280 000	€ 60 000
Man hours:	€ 2 632	€ 564
	(2 persons x 14 hrs/€ 94)	(2 persons x 3 hrs/€ 94)
Alignment:	€ 510	not required
	(3 hrs/€ 170)	
Crane hire:	€ 400	not required
	(4 hrs/€ 100)	
Replacement bearing (drive side, as a precaution):	€ 330	not required
Replacement bearing (fan side):	€ 330	€ 850
Total costs for bearing replacement:	€ 284 202	€ 61 414
Cost savings		€ 222 788

### What's special

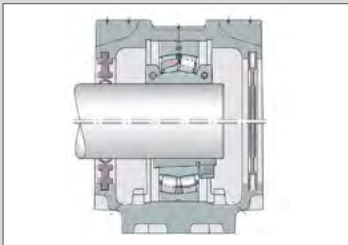
In addition to the direct savings, the use of FAG split spherical roller bearings also makes long-term savings possible, as future bearing replacements can be carried out more quickly. The benefits in terms of costs and time listed above can be achieved from the very beginning if split bearings are considered from the outset when designing new plant and machinery. ◀



Schaeffler mounting expert performing a measurement on site



FAG split spherical roller bearing



Split spherical roller bearings and unsplit bearings with adapter sleeve have the same design envelope



Split bearings fit in existing split plummer block housings



# Coated Rolling Elements to avoid Slippage Damage in Calender Bearings

### Metso Paper, Inc., Finland

In 2004, the Finnish manufacturer Metso Paper, Inc. has delivered the PM 19 paper machine to Shandong Sun Paper Co. Ltd. in China. PM 19 produces wood-free fine paper grades with an annual production capacity of approximately 230 000 tons. Shandong Sun Paper Co. Ltd. was established in 1982 and has several paper and board machines with an annual total production capacity of approximately one million tons.

### Challenge for Schaeffler

The calender consists of two pairs of rolls that are arranged one behind the other. In the top roll position, a combination of low loads of the spherical roller bearings and insufficient lubrication can cause damage to the raceways. The risk of bearing slippage – and thus the risk of slippage damage – had to be reduced.

### Schaeffler Solution

Schaeffler has fitted the thermo rolls with FAG spherical roller bearings 23276-B-K-MB-C4-J48BB-T52BW-W209B with TRIONDUR coated rolling elements, which ensure a longer service life. The specification J48BB in the bearing designation refers to a diamond like carbon coating of the rolling elements. This extremely hard coating protects the bearing from damage even in sliding friction conditions resulting from slippage.

Technical Information about the Plant
Optisoft calender thermo roll
Paper grade:
Fine paper
Web width:
5 400 mm
Speed:
1 300 m/min
Production capacity:
230 000 t/a

Technical Information about the Solution
Bearings:
FAG spherical roller bearings 23276-B-K-MB-C4-J48BB-T52BW-W209B
TRIONDUR-C coating:
J48BB (diamond like carbon coating)
Microhardness:
approx 1 100 HV
Coating thickness:
1-2,5 µm

### Customer Benefit

The Schaeffler solution provides increased protection from wear in slippage and mixed friction conditions, extending the bearings' service life in the thermo rolls and in addition the amount of maintenance required is reduced significantly.

In a three year period, this saves the customer approx € 50 000

### What's special

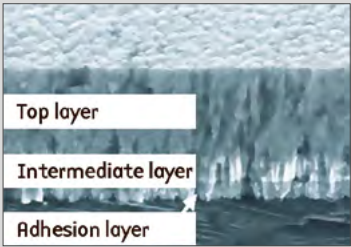
If the bearings had been designed for maximum load, they would be overdimensioned for use in the top roll, which is subjected to very low loads at times. In this position, slippage ( $P/C < 0,02$ ) can occur, which – in combination with inadequate lubrication – can cause early damage to the bearings. ◀



Paper machine PM 19



FAG spherical roller bearings with TRIONDUR coated rolling elements



TRIONDUR coating system – a cost efficient measure for friction reduction



The TRIONDUR coated rolling elements ensure a longer service life

»» *The future belongs to those  
who recognize possibilities,  
before they become obvious.*

*Oscar Wilde (Anglo-Irish playwright)*



### Plummer block housings “on your wavelength”

FAG plummer block housings match themselves ideally to the load situation in the bearing. This means the rolling bearings can last up to 50 % longer. And each housing can be combined in many different ways with components, giving a noticeable reduction in stockholding costs.

[www.schaeffler.de/housings/sns](http://www.schaeffler.de/housings/sns)





# Saving Time and Costs by having a Bearing replaced by an Expert



### Tata Steel, India

Established in 1907, Tata Steel is the world’s fifth largest steel company with an annual crude steel capacity of 32 million tons. India’s largest integrated private sector steel company is now one of the world’s most diversified steel producers. The company has operations in 24 countries and a commercial presence in over 50 countries. Tata Steel’s plant at Jamshedpur has a present capacity of five million tons of crude steel per annum. It was scheduled to grow to ten million tons by 2010.

### Challenge for Schaeffler

At the Jamshedpur plant, the company has three converters. All of them had to be modernised. During the overhauling of converter 2 also its volume inside its brick lining should be increased to 153 m<sup>3</sup>, increasing its output from 140 to 170 tons of liquid crude steel. To ensure a quick and professional mounting of the bearings and housings for converter 2, Tata Steel awarded the contract to Schaeffler.

### Schaeffler Solution

In order to allow efficient mounting on site, intensive and optimum preparation was required. The assistance of experienced application engineers working in the sector management steel of Schaeffler was also called upon. For the mounting of the large size bearings and housings, the customer requested an experienced Schaeffler mounting expert. To make the mounting process easier and more secure, the bearings were heated by using an induction heating device. In relation to the mounting of converter bearings, this operation was new to the customer, since these bearings had in the past always been heated by using an oil bath. After the rolling bearing was moved into place, it was fixed and finally inspected.

#### Technical Information about the Plant

#### Technical Information about Converter 2

Lining:	153 m <sup>3</sup>
Volume:	170 tons
Large bearing installed:	
Type:	FAG spherical roller bearing
Bore diameter:	850 mm
Outside diameter:	1 120 mm
Width:	272 mm
Weight:	720 kg

#### Additional features:

- Four pinion slip-on gear with frequency controlled threephase motors
- Pneumatic emergency drive

#### Technical Information about the Solution

#### Inductive heating device:

FAG HEATER 1200	
Weight:	850 kg
Length:	1 500 mm
Width:	1 100 mm
Height:	1 400 mm

#### Mounted FAG bearings/housing:

- FAG Spherical roller bearing Z-528750.PRL (2 pcs.)
- Drive end housing: F-559046.SGC-SL850-Z-BF
- Non drive end housing: F-559046.SGC-SL850-Z-BL

### Customer Benefit

Thanks to the competent support provided by the Schaeffler mounting expert, the bearings and housings were mounted within seven days. In comparison: The same replacement on converter 1, which had been done by the customer’s own personnel, had lasted ten days. Simply by the induction heating method, the bearings were heated three times faster than with the conventional oil bath heating method. Moreover this procedure is more eco-friendly as no oil and less energy are required. The bearing housings were also mounted directly afterwards without much extra effort.

Mounting of the bearing/housings		Failure cost
Converter 1	10 days	€ 7,7 M
Converter 2	7 days	€ 5,5 M
Savings	3 days	€ 2,2 M

### What’s special

This was the first time a bearing was mounted at Tata Steel with the help of an induction heating device. Schaeffler offers a wide range of FAG heating devices for bearings with a weight up to 3 000 kg. The method is suitable for all large radial bearings. ◀



Converter at the steelworks



Mounting work at bearing housing



Inductive heating device FAG HEATER



Surface treatment at trunnion

# Mounting Service at a Wire Mill reduces Downtime Costs

The customer is a Brazil-based, globally operating steelmaker and a leader in the long steel production industry. It operates hundreds of facilities in America, Europe and Asia with a workforce of more than 35 000. Its products are used for example, in cars, trucks, tractors, houses, bridges, roads or household appliances.

### Challenge for Schaeffler

When the customer called Schaeffler, the company had an unplanned shutdown of its wire mill due to damaged bearings. These bearings had been mounted by the customer’s staff just two weeks before. By comparison, the original bearings being installed in the mill before, had been in service for around four years before they failed. As such downtimes are very expensive, the customer needed support immediately.

### Schaeffler Solution

The very same day Schaeffler received the emergency call, an experienced mounting expert was sent to the customer. He had total flexibility with regard to time and work. So he could provide tailor-made support. The mounting expert detected that the bearings had failed due to wrong mounting. Additionally he supervised the professional fitting of the new bearings. Besides providing this first aid, Schaeffler also conducted a practical training course with the customer’s staff which comprised proper mounting using the right mounting tools.

Technical Information about the Plant	
Wire Mill	
Max. Speed:	
2 122 RPM	
Wire exiting velocity:	
more than 300 km/h	
Wire diameters:	
from 5,5 mm to 22 mm	
Diameters (mm):	
5,5 to 15,0    15,5 to 22,0	
Tolerances (mm):	
± 0,30   ± 0,40	
Max. ovalization (mm):	
0,40    0,50	

Technical Information about the Solution	
Bearings installed:	
• 1 cylindrical roller bearing 804753 (400 x 500 x 46 mm)	
• 2 angular contact ball bearings 7040MP.UA100 (200 x 310 x 51 mm)	

### Customer Benefit

This time – even though Schaeffler provided support in an extremely fast and flexible manner – the shutdown lasted five days as the customer was not very well prepared when the mounting expert arrived. Without Schaeffler support, it would even have lasted about two days more. Thanks to the professional training they received, the customer’s personnel is now also familiar with this type of mounting job and has the right tools at its disposal to ensure much faster repairs and less repair downtime costs in future.

Current case of bearing damage	
Estimated production disruption costs without Schaeffler support:	7 days x € 200 000 € 1,4 M
Actual production disruption costs with Schaeffler support:	5 days x € 200 000 € 1 M
Future cases of bearing damage Production disruption costs with immediate repair by customer’s personnel:	Approx. 2 days x € 200 000 € 400 000
Proper mounting leads to an estimated bearing service life of four years. Thus the customer can realise further savings.	

### What’s special

The customer praised Schaeffler for offering not only products but solution packages – in this case, bearings, failure analysis and mounting service. The high degree of satisfaction is also shown by some statements of training participants: ”The service was 10 out of 10 (points) and exceeded our expectations“. It was an honor to work with a high level company and to learn a lot about the mounting of bearings.“ ◀



Laying head at wire mill



Visualization of a laying head



Expert tools for mounting and dismounting



The still red-hot wire is brought into shape



# Professional Bearing Mounting in Tube Mill

**Compania de Minas Buenaventura, Peru**  
Established in 1953, Compania de Minas Buenaventura is one of the leading Peruvian companies in the mining industry. The four main areas of activity are mining, processing, development and exploration of gold, silver and other metals. One of its seven operations is the plant in Uchucchacua. The plant was founded in 1975 and is located at an altitude between 4 000 and 5 000 metres above sea level. The main products are zinc, silver and lead.

**Challenge for Schaeffler**  
The customer purchased a used tube mill which was delivered in single pieces. The delivery contained – amongst others – four new FAG spherical roller bearings with an outer diameter of more than 1,5 meters. The mounting of such bearings is very complex. Incorrect mounting or damage to the surrounding components can cause compounding downtime losses. The customer had no experience in mounting of large size bearings and therefore asked Schaeffler for support.

**Schaeffler Solution**  
Experienced mounting experts of the Schaeffler Technology Center in Sorocaba worked closely together with the contractors engaged by the mill operator. As a team they defined and implemented a bearing mounting approach. The method applied is field-proven. In addition Schaeffler mounting specialists provided detailed information about the procedure to ensure that the bearings were properly mounted on the trunnions.

Technical Information about the Plant
Tube mill type for ore processing (trunnion supported)
Diameter:
approx. 3,66 m
Length:
approx. 6,1 m
Drive power:
1 500 KW
Speed:
16 RPM

Technical Information about the Solution
Locating and floating bearings:
FAG SRB 239/1180-B-K-MB-C3
Bore diameter:
1 180 mm
Outside diameter:
1 540 mm
Width:
272 mm
Mass:
1 400 kg
Lubrication:
FAG Arcanol LOAD400

**Customer Benefit**  
Due to the competent support provided by the Schaeffler experts, the bearings were mounted quickly and effectively. In this way the customer reduced the risk of unplanned bearing failures caused by mounting mistakes. Such failures can result in a downtime of the tube mill of two to three days and, as a consequence, in production loss. The downtime costs of a tube mill amount to approximately 10 000 euros per hour.

Saving potential	
1 day (= 24 hours) costing € 10 000 per hour:	€ 240 000
2 days costing € 10 000 per hour:	€ 480 000
3 days costing € 10 000 per hour:	€ 720 000
<b>Cost saving for each avoided downtime:</b>	<b>€ 720 000</b>

**What's special**  
To do this excellent job, the Schaeffler engineering team in Peru was supported by Schaeffler's Competence Centre for grinding mills (ASB Competence Centre) headquartered in Melbourne, Australia. This good teamwork shows the close relationship of Schaeffler's experts worldwide and its great industry specific experience in the mining industry. ◀



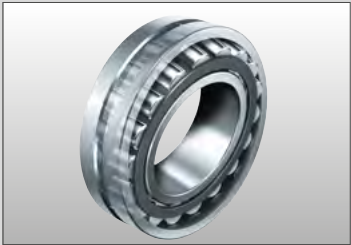
Tube mill



For mounting of large size bearings expert knowledge and expert tools are required



Schaeffler provided professional mounting



FAG spherical roller bearings are designed for high loads

# Special Heating Equipment for extra large Workpieces



**TAKRAF GmbH, Germany**  
TAKRAF GmbH is part of the Tenova Group. As a globally-operating company, TAKRAF develops, designs and supplies equipment for mining applications and conveyor equipment of all types, in particular for overburden removal, raw materials extraction, preparation, storage and homogenization up to transportation and shipping. Companies in industries all over the world use TAKRAF bucket wheel excavators, stackers, crushers, belt conveyors, reclaimers and leach pads as well as treatment plants.

**Challenge for Schaeffler**

One of TAKRAF's newest product areas is the development of roll crushers and the associated gearboxes. These gearboxes comprise large and heavy components such as gears that weigh up to 5 000 kilograms. TAKRAF has always used conventional FAG inductive heating devices that are suitable for workpieces weighing up to 1 200 kilograms for heating their smaller workpieces. Since these devices are not able to heat the large gearbox components, TAKRAF needed a new heating device with considerably more power.

**Schaeffler Solution**

The local Schaeffler sales engineer forwarded the inquiry from TAKRAF to the specialists responsible at the Global Technology Network. Schaeffler engineers in the business unit Service and Application Engineering then designed a device that can generate sufficient electric power required for such large components – the FAG Heater5000. To ensure the heating process is carried out safely and evenly, the brand new Delta T control system technology was used. Two magnetic sensors simultaneously measure the workpiece inside and outside on two measuring points in order to monitor the temperature level and reduce it automatically if the maximum permitted difference in temperature is exceeded.

Technical Information about the Plant
Roll crusher
Throughput:
4 250 t/h (max. 6 500 t/h)
Feed material size:
Max. 2 000 mm
Product material size:
Max. 350 mm
Weight:
160 000 kg

Technical Information about the Solution
FAG heating device:
HEATER5000
Max. workpiece weight:
5 000 kg
Heating temperature:
<ul style="list-style-type: none"><li>Gears: 200 °C</li><li>Rolling bearings: 100 °C</li></ul>
Max. power consumption:
<ul style="list-style-type: none"><li>Time control (100 % power)</li><li>Temperature control with 1 sensor (100 % power)</li><li>Delta T control 2 sensors (automatic power reduction)</li></ul>
Max. power consumption:
100 kVA
Voltage/frequency:
400 V/50 Hz
Vertical ledges (W x H x D):
<ul style="list-style-type: none"><li>100 x 100 x 1 650 mm</li><li>150 x 150 x 1 650 mm</li><li>200 x 200 x 1 650 mm</li></ul>

**Customer Benefit**

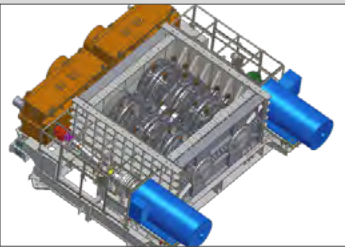
With the FAG HEATER5000 TAKRAF now has a powerful induction heating device for larger workpieces weighing up to a maximum of 5 000 kilograms. Smaller workpieces weighing up to 2 000 kilograms that were previously heated using FAG HEATER1200 can now be heated much more quickly using the new device. This produces a wide variety of applications. The cost and time savings involved as well as the use of resources in terms of personnel vary depending on the application (workpiece type and size, processes in use).

Time savings using a medium-weight gear (2 000 kg)	
Product:	Time:
FAG HEATER1200	6 hours
FAG HEATER5000	20 minutes
Saving:	5 hours 40 minutes

In addition to the Delta T control system with 2 sensors described above, the FAG HEATER5000 has two heating options controlled by setting the temperature (1 sensor) and the time. These are used for components with which there is no risk of changes in the structure during the heating process (e.g. rolling bearings with large radial clearance or thin-walled workpieces).

**What's special**

The FAG HEATER5000 is the largest inductive heating device ever built by Schaeffler. As a special solution, it complements the range of FAG inductive heating devices. As is the case with all heating devices from the HEATER series, FAG HEATER5000 also fulfills the highest standards in terms of quality and safety. This example shows how Schaeffler always meets the individual needs of its customers and develops optimum customer solutions using a high level of engineering and manufacturing expertise. ◀



TAKRAF roll crusher



Size comparison: FAG HEATER5000, the largest heating device ever built by Schaeffler, next to the FAG HEATER10



The heaviest gear weighs almost five tons and has an outside diameter of 1 700 mm



The heating process is controlled using a touchscreen display on the FAG HEATER5000



# Efficient Large-Size Bearing Mounting Using Medium-Frequency Heating



### Subsea 7, Great Britain

As one of the world’s leading subsea engineering and construction companies in the oil and gas sector, the annual revenue of Subsea 7 amounts to two billion US dollars. Seven Navica is one of the largest Subsea 7 vessels and operates as a pipe layer ship within the worldwide fleet.

### Challenge for Schaeffler

The customer had to replace the existing starboard reel bearing, which highlighted a static fault during a condition monitoring test. Based on the test result, Subsea 7 elected to change the starboard bearing, which also gave the opportunity to examine the condition of the journal, in particular its outside diameter. The challenge in this operation was to minimise the time the vessel was in port, thereby reducing pipelay downtime for the Subsea 7.

### Schaeffler Solution

Spezialized Schaeffler fitters supported Subsea 7 during the installation work at the Dusavik fitting yard in Norway. The bearing was heated with the help of a medium-frequency device equipped with flexible inductors. In addition, the Schaeffler experts were always on-hand to offer advice and help in the event of any difficulties experienced with the reel bearing change. Bespoke mounting and dismounting tools were used to ensure accuracy and safety of re-build. To guarantee the operational integrity of the replacement bearing, condition monitoring measurements were conducted. These ensured that a baseline condition for the replacement bearing could be established.

Technical Information about the Vessel
Name and year of construction:
Seven Navica / 1999
Vessel length and width:
108,5 m / 22 m
Tonnage:
5 862 BRT
Reel diameter:
25 m
Spooling capacity:
2 500 t (rigid and flexible pipe)
Consumables:
Pipes diameter from ø 101,60 mm to 457,20 mm

Technical Information about the Solution
Special bearing type:
Spherical roller bearing (240/1120 series)
Heating method:
Inductive heating with medium-frequency
Tools:
FAG tools for bearing mounting and dismounting
Grease:
FAG LOAD 220 used in new bearings and for relubrication

### Customer Benefit

In using the specialist skills available from Schaeffler, Subsea 7 benefitted from the broad bearing and service knowledge of a leading bearing manufacturer. This guaranteed that the fitting procedure was carried out efficiently and with a high degree of accuracy. By using the described heating method, the complete mounting time was reduced by one day. In comparison with other methods which involve further expenditure, such as costs for setting up an oil bath or resources for gas flame heating (4 persons / each working 3 hours) the customer realized the following savings:

Daily stoppage costs of the vessel:	€ 110 000
Coast savings by using medium-frequency heating:	approx. € 8 000
Total savings:	approx. € 118 000

### What’s special

The medium-frequency device with flexible inductors allows the heating of large bearings or large and difficult to access mating parts in a very safe manner. The significant feature of inductive heating in comparison to other heating methods is that the heat is produced directly in the workpiece. This results in significant shorter heating times and lower energy consumption. As a result of this successful cooperation, Subsea 7 has elected Schaeffler as its preferred supplier for bearing products and services for the future. ◀



The Seven Navica



The flexible inductors are wound around the bearing



Bearing measurement



Housing

# Professional Bearing Mounting on an Ocean Liner



**ABB Finland**  
ABB Oy, Marine and Ports is a leading manufacturer of electric power and propulsion systems for ships. The company is a global maritime organization, providing innovative, reliable, safe and environmental-friendly solutions and qualified services to reduce operational cost and ensure optimum vessel lifecycle for their customers.

**Challenge for Schaeffler**  
After 15 years on the high seas, it was time for the cruise ship, „Voyager of the Seas“, to undergo a general overhaul in the dry dock. This was carried out in the dry dock in Singapore. Several thousand employees and mounting personnel were simultaneously involved in renovating the 311-meter-long colossal ship from top to bottom. This also involved replacing the rolling bearings in the ship’s three propulsion systems. ABB, supplier of propulsion systems, got in touch with its local Schaeffler contact in Finland to carry out this challenging mounting operation.

**Schaeffler Solution**  
Only the most experienced of mounting personnel are used to perform this complex mounting work as it requires sound technical knowledge and demands a high level of physical effort. Following internal coordination with the experts of the Schaeffler mounting service in Germany, two mounting personnel from Germany traveled to Singapore to replace the bearings. The Schaeffler mounting personnel worked in alternating day and night shifts under extremely hot conditions with temperatures of between 30-35 degrees even at night. Complying with the strict schedules was essential as each day spent in the dry dock generates considerable costs. The mounting personnel received support from the shipyard workers on site, who operated the cranes, for example.

Technical Information about the Ship
Cruise ship:
Voyager of the Seas
Initial operation:
1999
Ships length:
311 meters
Beam:
48 meters
Draught:
Almost 9 meters

Technical Information about the Solution
The following parts were removed and replaced:
2 x Azipod® type V21
1 x Fixipod
8 x Pinion bearings

**Customer Benefit**  
Thanks to the dedicated and professional work of all those involved in the project, the overhaul was completed within the planned timeframe of one month. This meant that the “Voyager of the Seas” could set sail for its next cruise as planned, and at the same time the shipping company could rest assured that the propulsion systems were in working order. Just one scheduled day spent in the dry dock can quickly generate costs of one million euros or more, which are incurred for rent, logistics, and outlay. If the propulsion becomes damaged during a cruise, for example due to bearing damage, and the speed must be reduced as a result, dry docking is often inevitable. In this case, rebooking and downtime costs can also be added to the expensive dry-docking costs.

**What’s special**  
For years, ABB and Schaeffler have fostered a partnership with regards to rolling bearing solutions for all aspects of propulsion technology. As a sub-supplier, Schaeffler is not only involved in naval projects as an engineering partner of ABB, but also often provides support locally with its services and service products. Roberto Ongano, project manager of propulsion systems at ABB, acknowledged Schaeffler’s performance in the local project by saying:

“Despite the tough conditions on site and the enormous amount of energy and efforts needed, the Schaeffler mounting personnel have shown outstanding professionalism and seriousness which has served as an example to the whole ABB site team. Such a level of professionalism indeed promotes Schaeffler as a trustful partner to us, and I’m looking forward to sharing with you as many projects as possible in the future.”

The Schaeffler industrial service experts offer mounting services for rolling bearings that are applicable across industrial sectors. They have detailed knowledge and extensive experience in all sectors. ◀



Voyager of the Seas



General overhaul in the dry dock



Energy-efficient Azipod® propulsion systems from ABB are proven and established in cruise ships



Mounting work on site – here: shaft and housing unit

There are over  
300 different kinds  
of sand. None of  
them can get into our  
ball bearings.



FAG Generation C  
Deep Groove Ball Bearings



**FAG Generation C Deep Groove Ball Bearings – top quality for your applications.** Our FAG Generation C deep groove ball bearing is designed to handle the toughest requirements of all – yours. Because now it is even more energy efficient, it runs even more quietly, it generates even less friction, and it lasts even longer than before. Which makes it ideal for use in electric motors, household appliances, power tools, and motorcycles. But you don't have to pay a premium price to get this premium quality. Our new manufacturing processes now enable us to offer you the highest production volumes worldwide, along with the very best value for your money.

Find out more at [www.FAG-GenerationC.com](http://www.FAG-GenerationC.com)

»» *Knowledge has to be improved,  
challenged, and increased constantly,  
or it vanishes.*

*Peter Drucker (American economist)*



# Condition Monitoring on a Hot Strip Mill



### ThyssenKrupp Steel Europe

**ThyssenKrupp Steel Europe AG, Germany**  
With a turnover of nearly 13 billion euros, ThyssenKrupp Steel Europe AG (TKSE) is the leading manufacturer of high-grade flat steel products in Germany. TKSE operates a hot rolling mill at their factory in Bochum. With a power rating of 62 500 kW the 7-stand hot strip mill is especially suitable for the production of high-strength and stainless steels.

### Challenge for Schaeffler

The weak spot of the rolling stands in any hot strip mill are the roller bearings on the work rollers. Under extreme operating conditions only relatively short stoppage times are possible. Unplanned stoppages and expensive consequential damage, such as damage to the roller seating or even journal fracture on the work rollers, may be the result. In order to guarantee operations with as few faults as possible TKSE has opted for a vibration monitoring solution.

### Schaeffler Solution

Following the installation of seven FAG DTECT X1 online condition monitoring systems the work rollers are permanently monitored. The vibration sensors were integrated in the customer’s software and the customer’s staff trained to independently operate the condition monitoring system. Schaeffler has access to the TKSE intranet by means of remote software, allowing the vibration experts to evaluate the data in the Schaeffler Online Monitoring Center. One case of bearing damage was immediately detected during test measurements for sensor installation.

Technical Information about the Plant
Finishing mill:
7 x four-high mill stands
Model year:
1966
Work roller diameter:
775/675 mm
Backing roller diameter:
1 530 mm
Power rating:
62 500 kW
Max. final rolling speed:
15,6 m/s

Technical Information about the Solution
Monitored system:
7 x 2 channel FAG DTECT X1
Monitored components:
Roller bearings on the work rollers
Sensors:
<ul style="list-style-type: none"><li>• 14 ICP acceleration sensors</li><li>• 2 sensors per stand at the level of the operating side of the work roller roll chocks</li></ul>
Signal filter:
TP3 module due to large speed monitoring range
Housing:
IP66
Communication:
Com-Server
Additional signals:
Strip speed (conversion to roller and gear speed) „strip in mill“
Alarms:
Red signal lamp on rolling stand, remote monitoring

### Customer Benefit

The number of unplanned stoppages caused by bearing damage on the work rollers and subsequent consequential damage can be drastically reduced. In addition, the project costs have been recovered in less than one year. In tangible terms:

Annual cost before the introduction of condition monitoring:	
Per year 5 repairs part/roller journal of € 21 000 each:	€ 105 000
Per year 5 unplanned roller replacement of 7 minutes each:	€ 35 000
Total:	€ 140 000
Compared to project costs:	€ 100 000

### What’s special

The slow speeds on stand 1 are diagnostically complex to master, where third octave chatter occurs, and the damping of structure-borne noise at the transition of the roll chock to the rolling mill housing. The application is transferable to heavy rolling stands in the hot strip field. Thanks to a new approach to attaching the vibration sensors to the stand, thereby dispensing with mounting/removal of the sensors on the roll chock during roller replacement, TKSE opted for the Schaeffler solution. ◀



ThyssenKrupp Steel Bochum hot strip mill



Damage to rolling element of tapered roller bearing



Condition monitoring with FAG DTECT X1



Hot strip mill in steel production

# Modal Analysis helps to increase Speed of Stretch Reducing Mill

The Spanish customer is a world leading manufacturer of seamless pipes. He offers a wide range of products for different industrial areas, e.g. the oil, automotive and mechanical construction industry as well as the energy sector and the overall construction industry.

### Challenge for Schaeffler

The customer had invested about 80 million euro in its production process with the objective to install a new pipe reduction gear on its main reduction stand. However, for unknown reasons he was unable to increase the machine speed beyond 80 percent capacity for the most important products. Vibration levels rose exponentially and the product quality got worse. The whole system was very complex with the motors in tandem constituting the most critical part.

### Schaeffler Solution

A first examination by Schaeffler revealed that a simple vibration analysis study would not be sufficient. To identify the cause of the high level of vibrations, it was necessary to carry out trouble shooting by means of advanced vibration analysis and modal analysis. The Schaeffler experts ensured that the necessary measurement system arrived promptly on site. After an eight-hour measurement and one week of analysis, they detected the cause of the vibrations: a fault in the motor foundations. In order to resolve the problem, the foundations had to be reinforced, which required rebuilding the base plate. Additionally, the Schaeffler experts recommended adjusting the speed range of two tandem motor frames to avoid resonance frequencies.

Technical Information about the Plant
Stretch reducing mill:
30 stands with 3 rolls each to 120°, with independent movements
Motors:
8 motors with a total power of approx. 5 200 kW
Motor speeds:
Variable, from 700 to 2 000 RPM
Gearbox:
Three gearboxes with 30 output shafts
Mill parameter:
<ul style="list-style-type: none"><li>• Input speed: 0,8-1,5m/s</li><li>• Max. output speed: 11 m/s</li><li>• Max. input diameter: 180 mm</li><li>• Min. output diameter: 25 mm</li><li>• Max. input thickness: 18 mm</li><li>• Min. output thickness: 2,3 mm</li></ul>

Technical Information about the Solution
<ul style="list-style-type: none"><li>• Vibration measurement</li><li>• Transitory measurement</li><li>• Impact test</li><li>• Spectrum analysis</li><li>• Troubleshooting (waterfall, sonogram)</li><li>• Frequency response analysis (coherence, phase, vibratory)</li></ul>

### Customer Benefit

Thanks to the precise failure diagnosis, the customer knows the cause of the defect and can take appropriate measures to fix it. Since then he has been able to run its machines at full capacity. The rise in production by 25 percent has generated a possible increase in profits of more than 750 000 euros, depending on the market demand.

Concrete cost savings after troubleshooting by modal analysis are:		approx. € 155 000
Reduced unplanned downtime costs:		€ 100 000
Avoided damages and repair costs on gearboxes and motors:		€ 55 000

### What's special

The customer's requirements, with regard to the problem identification, were fully achieved by the work of Schaeffler. The excellent performance contributed directly to keep and consolidate the current bearing supply contract and to generate new improvement opportunities in future maintenance services in the plant. ◀



Seamless pipes



Sensor positions at support of the motor for bump test



Schaeffler experts perform troubleshooting



Analysis of measured data done by Schaeffler

# Condition Monitoring of Saw Gearboxes Increases Availability

The customer is a leading manufacturer of hot and cold rolled welded steel pipes and hot rolled steel strips. The company has different types of pipe finishing facilities, such as galvanizing, cutting, beveling, threading and flanging. The current market situation forces the customer to reduce costs, also in maintenance.

### Challenge for Schaeffler

The cutting saws of two different lines are driven by a gear motor system that at the same time drives a cutting disc. The saw drive supports the dynamic forces of the process. Due to the operating conditions it is exposed to an increased danger of wear and damage. The complete equipment is fitted on a monorail guidance system. The customer’s own maintenance detected that the saw gearbox of line 1 was damaged in one of the gear speeds. In the saw gearbox of line 2 some ruptures in the shield were identified. Thus, the company looked for a partner that could provide methods to monitor the damage progress.

### Schaeffler Solution

To get a better understanding of the saw’s gearbox condition, Schaeffler Iberia recommended the customer to monitor the equipment with a condition monitoring device. Schaeffler experts presented the FAG Detector III to the customer, created measuring routes and trained the maintenance staff. The FAG Detector III is an offline vibration measuring device able to measure machine vibrations on predetermined measuring points. By calculating characteristic values it provides important machine information. These helped the customer to ensure that line 1 operated without failures until the next planned downtime and line 2 until the receipt of a required replacement part.

Technical Information about the Plant
Welded steel piping line
Continuous cutting saw:
Line 1 and Line 2
Construction year:
2006
Manufacturer:
Oto Mills
Measuring speed:
160–180 RPM
Linear acceleration:
Variable

Technical Information about the Solution
FAG Detector III functions used by the customer
<ul style="list-style-type: none"><li>Monitoring functions:<ul style="list-style-type: none"><li>- ISO 10816</li><li>- Frequency selective condition monitoring of rolling bearings</li><li>- Gearbox condition</li><li>- Rolling bearing condition</li></ul></li><li>Measuring routes</li><li>In-depth diagnosis on the basis of time signals and frequency spectra</li><li>Free PC-Software</li></ul>

### Customer Benefit

Thanks to the condition-based monitoring the customer has increased its machine productivity. This way the service life was extended, the maintenance plan was optimized and wrong diagnoses as well as consequential damages and follow up costs were avoided.

Costs per production loss Three days of unplanned downtime:	€ 3 x 24 000
Employee costs per unplanned downtime and short term investments for new gearbox:	€ 2 x 35 800
Total costs:	€ 143 600
Costs for condition monitoring measurements (including support from Schaeffler experts, Detector III rental rate):	€ 6 000
Cost savings in case of only one avoided downtime:	€ 137 600

### What’s special

Schaeffler Iberia introduced at the customer’s plant a new maintenance strategy and trained the customer’s staff. Thus, the maintenance staff has obtained a better understanding of the machinery in the process lines. By the gained improvements also stock planning could be optimized and procurement costs were reduced. ◀



Cutting saw



The offline vibration measuring device  
FAG Detector III



Measurements with FAG Detector III



FAG Detector III training



# FAG ProCheck Increased Availability of Stretch Reducing Mill

The customer is a world leading manufacturer of seamless pipes. He offers a wide range of products for different industrial areas, e.g. the oil, automotive and mechanical construction industry as well as the energy sector and the overall construction industry.

### Challenge for Schaeffler

Thanks to a service contract with Schaeffler based on offline vibration analysis some chronic damage had been detected in the tandem motor bearings of the customer's hot strip mill. Schaeffler had determined that these damages were caused by current passage. Since this problem had been solved no further downtime caused by this reason had happened. Satisfied with this result the customer wanted to extend the monitoring to the whole plant in order to increase the overall availability. Thus, he extended the service contract for one more year. In the next step he intended the introduction of online condition monitoring to his mill.

### Schaeffler Solution

In order to monitor the stretch reducing mill permanently, the experts of Schaeffler Iberia recommended the customer to install two FAG ProCheck monitoring systems with eight measuring channels and 8 analog input signals each. FAG ProCheck allows permanent monitoring of critical components, damage detection in an early stage as well as in-depth failure analysis.

Technical Information about the Plant
Stretch reducing mill:
30 stands with 3 rolls each to 120°, with independent movements
Motors:
8 motors with a total power of approx. 5 200 kW
Motor speed:
Variable, from 700 to 2 000 RPM
Gearbox:
Three gearboxes with 30 output shafts
Mill parameter:
<ul style="list-style-type: none"><li>• Input speed: 0,8-1,5m/s</li><li>• Max. output speed: 11 m/s</li><li>• Max. input diameter: 180 mm</li><li>• Min. output diameter: 25 mm</li><li>• Max. input thickness: 18 mm</li><li>• Min. output thickness: 2,3 mm</li></ul>

Technical Information about the Solution
Monitoring system:
8 channel FAG ProCheck: 2 pieces
Sensors:
ICP-acceleration sensors: 16 pieces
Communication:
<ul style="list-style-type: none"><li>• External: Remote server</li><li>• Internal: TCP/IP</li></ul>
Additional signals:
<ul style="list-style-type: none"><li>• Speed</li><li>• Load</li></ul>
Monitored components:
Stretch mill motors: 8 units

### Customer Benefit

With the online condition monitoring systems the customer has enlarged the service lives of the recorded machines and has become able to avoid unscheduled downtimes. Today bearing replacements take only place if a failure has been indicated by the monitoring systems. Further savings arise, if the production loss of only one unscheduled shutdown of the stretch reducing mill is considered:

Production loss costs (estimated 12 hours downtime):	€ 144 000
Annual costs for Schaeffler's service package:	€ 28 000
One-time costs for two FAG ProCheck systems including installation and start-up:	€ 37 000
<b>Cost savings</b>	
• by avoiding the first unscheduled shutdown:	€ 79 000
• from the second avoided shutdown on:	€ 116 000

Additionally, the customer annually saves about 12 000 Euro that were spent for preventive bearing replacements in the past.

### What's special

The project shows how customers benefit from a long-term partnership with Schaeffler. Thanks to the comprehensive condition-based maintenance measures and the close cooperation with Schaeffler experts, the customer is now able to realise enormous cost reductions and to ensure plant availability. Following this good experience, the customer extended the monitoring to 60 other critical machines. ◀



Seamless pipes



FAG ProCheck – modular and flexible



Due to its extremely robust and compact design, this system is ideally suited for use in almost all industrial segments



Analysis of measured data

# Reliable Diagnosis of Damage in Vibrating Screens



**Spaleck GmbH und Co. KG, Germany**

The company Spaleck has more than 50 years of experience in the field of conveying and separation equipment. The product range includes oscillating conveyors, screening machines and customer-specific solutions. In the field of recycling, Spaleck is one of the leading suppliers in the sector.

**Challenge for Schaeffler**

Vibrating screens are central to the production process. Any unplanned stoppage of this equipment, and the associated loss of production, incurs considerable costs for the operator. In order to increase the availability of its own vibrating screens and thus the availability of the equipment to its customers, Spaleck set out to find a reliable monitoring solution. The aim was to allow early detection of bearing damage and prevent touchdown of the screen, for example as a result of spring breakage.

**Schaeffler Solution**

Schaeffler installed the FAG SmartCheck on the end of one shaft in a vibrating screen. This detects radial or axial vibrations depending on the mounting of the sensor. FAG SmartCheck analyses the overall vibration state in accordance with DIN ISO 10816 as well as the key values for bearing and spring breakage monitoring that are particularly relevant to this application. If the permissible vibration values are exceeded, an alarm is triggered. The reason for this alarm can be easily tracked down with the aid of FAG SmartCheck. The alarm notification can be initiated directly on the vibrating screen or at the control panel, alternatively in the machine controller. It is also possible to transmit the data to a remote location such as an external service provider for detailed diagnosis (remote monitoring).

**Technical Information on the Vibrating Screen**

The type of vibratory motion is a significant factor in achieving the optimum conveying and screening results. A distinction is therefore made between two essential designs:

- linear vibrating screens
- rotary vibrating screens

**Technical Information about the Solution**

**Monitoring system applied:**

FAG SmartCheck

**Vibration sensor applied:**

High resolution piezo sensor

**Operating temperature monitored:**

- Bearing temperature
- Ambient temperature
- Speed
- Load

**Diagnostic methods:**

- Time signal
- Envelope curve
- Speed and frequency monitoring
- Spectrum and trend analysis

**Customer Benefit**

FAG SmartCheck proved reliable under the aggressive conditions that predominate in the field of vibrating screens. Thanks to the intelligent measuring system, it was possible to reliably detect the most important vibrating screen characteristics and ensure equipment availability. Depending on the particular production facilities, the costs incurred by stoppage of a vibrating screen can run to thousands of euros per hour. A special characteristic is that the measurement system detected bearing damage on the opposing end of the shaft in a vibrating screen and achieved this when the vibrating screen was either empty or filled. This should be emphasised in particular, since vibrating screens generate continuously high vibration levels during operation. Determining bearing-specific vibration levels from these vibrations is something that can only be achieved by a very small number of systems, which are normally extremely expensive.

**What's special**

In addition to reliable, highly precise monitoring, the FAG SmartCheck was also impressive for its ease of operation and commissioning. For monitoring, it was only necessary to fit one system on the vibrating screen. Other applications that can be monitored using FAG SmartCheck include vacuum pumps and screw compressors. ◀



Screening machine



Vibrating screens are central to the production process



FAG SmartCheck is a small, compact device



FAG SmartCheck in use on a vibrating screen

# Greater Production Reliability on Oil Platforms

The customer is an internationally operating manufacturer of ship propulsions and maritime solutions. Beside his deep product know how the customer offers a global service network. This ensures his customers a professional aftersales service – from installation, up to maintenance and repair.

### Challenge for Schaeffler

Bearing damage and gear failures in the propulsion of an oil platform are extreme costly as oil production may have to be stopped completely for the repair work. For this reason it was of great importance for the customer to increase the operational reliability of these crucial elements and to get always detailed information about the condition of the thrusters. Only this knowledge makes it possible to detect damage at an early stage, preventing serious failures and enormous costs. Therefore, the bearing vibrations inside the thruster should be monitored permanently in future with the help of an online monitoring system. Also, the thruster overhaul intervals required by insurance companies were to be extended from currently five years to up to ten years with the help of the condition reports provided by the system.

### Schaeffler Solution

A thruster is a closed system which is filled completely with hot oil (up to 80°C). If a sensor fails in operation, it cannot be replaced without dismounting the whole thruster. So the vibration experts of Schaeffler decided to provide an additional sensor at each bearing location as well as special seals for the sensors and sensor cables. As the thrusters can rotate 360 degrees, signals must be transmitted from the thruster via a slip ring. The recorded data are analysed by experienced Schaeffler vibration experts via remote access. In addition, the customer’s personnel were trained in the use of the system in various training seminars.

Technical Information about the Thrusters
Drive power: 5,5 MW

Technical Information about the Solution
Monitoring system:
FAG DTECT X1
Sensors:
10 sensors, sealed with cast resin
Sensor cables:
Protected by Viton seals
Communications:
TCP/IP (on the rig), satellite communication to Schaeffler Online Monitoring Center
Slip ring:
10 bands, adapted to the prevailing conditions
Additional signals:
Speed, motor current and the thruster’s angular position

### Customer Benefit

Thanks to the permanent monitoring of the thrusters, emerging damage can be detected at an early stage. This allows to prevent any unscheduled shutdowns. Avoiding a total loss can save the company up to 10 million euros:

Possible savings in the current case	
Cost of a thruster:	€ 2,5 M
Thruster installation (including shipyard cost etc.):	€ 2,0 M
Production losses (14 days x € 400 000 per day):	€ 5,6 M
Cost savings:	approx. € 10 M

The hardware of one online monitoring system per thruster costs about 37 000 euros. The customer uses the possibility of extended overhaul intervals as an additional sales argument, which gives the company a competitive edge.

### What’s special

Due to the extremely harsh ambient conditions in which the sensor system and the monitoring system are used, the Schaeffler vibration experts have developed an especially demanding solution. Its conception allows an easy applying to other ship propulsions around the world. Only the slip ring is always a custom-made item that must be adapted to a customer’s specific propulsion. ◀



Oil platform



3D model of oil platform



Online monitoring system  
FAG DTECT X1



Service experts at Online Monitoring Center



# Condition Monitoring on Offshore Petroleum Platform

The customer is a global group of oil, gas and petrochemical companies that operates a big offshore petroleum platform in Venezuela.

### Challenge for Schaeffler

The customer uses a maintenance strategy that includes condition monitoring of all rotating components of its facilities around the world. Therefore, they were looking for a condition monitoring service provider with extensive experience in petroleum facilities who could do this job in Venezuela. In a tender process, Schaeffler prevailed over two competitors.

### Schaeffler Solution

The condition monitoring service is performed by Schaeffler service employees using the offline vibration measuring device FAG Detector III. The service experts are specially trained and highly qualified with excellent market sector knowledge and profound condition monitoring expertise.

Technical Information about the Plant
Offshore petroleum platform
Location:
Urdaneta West Oil field
Production capacity:
60 000 barrel per day
Current production:
<div><ul style="list-style-type: none"><li>45 000 barrel per day</li><li>Crude 28 API</li></ul>On board of petroleum platform are around 150 applications with rotating parts under regular observation by offline condition monitoring.</div>

Technical Information about the Solution
Condition monitoring device:
FAG Detector III
Monitored equipment:
<div><ul style="list-style-type: none"><li>Motor and centrifugal pump</li><li>Twin screw lube oil pump</li><li>Rotary screw compressor</li><li>Reciprocant compressor</li><li>Fan/ventilator</li><li>Electric motor</li></ul></div>

### Customer Benefit

With Schaeffler the customer has found a service company with considerable experience in condition monitoring. Thanks to the professional supervision, unexpected downtime is avoided while increasing the availability of the rotating equipment on board of the platform. Only a small amount of the money saved this way is reinvested in condition monitoring.

In figures:

Saving potential	
Planned maintenance activities (due to Schaeffler recommendation):	10 jet pumps
Time spent for maintenance: Production loss for one maintenance day:	5 days 5 000 barrel
Estimated time for unplanned maintenance:	11 days
Avoided production loss due to unplanned maintenance:	55 000 barrel
Time saving: Avoided production loss:	6 days 30 000 barrel

### What's special

Ensuring continuous, safe operation is a particularly significant challenge for oil producers, whose costly equipment is typically located offshore. ◀



Offshore petroleum platform



Offline monitoring system  
FAG Detector III



FAG Detector III can monitor pumps and compressors amongst others



Petroleum platform

»» *The secret of success  
is to understand  
the other one's position.*

*Henry Ford (American entrepreneur)*



## **An easy way to keep an eye on things – with clear condition displays. FAG SmartQB.**

The FAG SmartQB offers an easy way to get started in the condition monitoring of motors, fans, and pumps. It reliably reports any changes via plain text messages and automatically specifies error sources such as bearing damage, imbalance, etc. This way, you can keep an eye on your machines' condition at all times. Initial operation is remarkably simple as well: Everything is preconfigured, so you can start immediately.

[www.fag-smartcheck.com/SmartQB](http://www.fag-smartcheck.com/SmartQB)

**FAG**

**SCHAEFFLER**

# Cost Reduction through condition-based Maintenance



**Industrie Cartarie Tronchetti, Spain**  
Industrie Cartarie Tronchetti (ICT) is a paper company with manufacturing sites in Italy, Spain and Poland. The plant in Spain started operating in October 2005 and manufactures paper with an annual total production capacity of 70 000 tons.

**Challenge for Schaeffler**  
Due to the high technical requirements of a paper plant ICT wanted to introduce condition-based maintenance on its Spanish site. Thus, the company was looking for a partner who could fulfill this demanding task. This partner was supposed to offer maintenance services, products and bearings as well as providing professional training, as ICT also wanted to gain own knowledge in the field of condition-based maintenance.

**Schaeffler Solution**  
Schaeffler offered ICT a customized package consisting of the following four points:

- Monitoring and control of critical machine conditions
- Root cause analysis for critical machines
- Training program for maintenance staff
- Service support on site

Schaeffler started with the monitoring of 73 machines. Most of the monitoring was done offline using an FAG Detector III. On some special applications also the online condition monitoring system FAG DTECT X1 as well as thermography measurements were applied. Additionally, the staff received individual trainings in the field of vibration diagnosis on site.

Technical Information about the Plant
Andritz machine
Product:
Tissue paper
Capacity:
70 000 tons/year

Technical Information about the Solution
FAG Detector III functions used:
Monitoring functions:
<ul style="list-style-type: none"><li>• ISO 10816</li><li>• Condition of gears</li><li>• Condition of rolling bearings</li><li>• In-depth diagnosis based on the signals and frequency spectra</li><li>• Free PC software</li><li>• Measuring routes</li><li>• Automatic measuring point identification by means of RFID technology</li><li>• Static and dynamic balancing on site</li></ul>

**Customer Benefit**  
Through the introduction of condition-based maintenance it was possible to detect several alignment failures and vibration problems on fans, pumps and the forming rolling unit in good times. In case of a later detection these damages would have caused expensive machine shutdowns. Thanks to the customized trainings the internal maintenance team of ICT has gained important maintenance knowledge that enables the company to assess machine conditions also themselves in future. Due to the change to condition-based maintenance all in all the following benefits could be realized:

Yearly savings in maintenance:	€ 250 000
Yearly production growth:	10 %

**What's special**  
The maintenance of ICT has significantly improved since Schaeffler Iberia has started introducing condition monitoring and has provided customized trainings. The customer is that satisfied with the result of the cooperation that he has already extended the contract to further 80 machines. ◀



Industrie Cartarie Tronchetti (ICT)



Balancing Kit FAG Detector III



Vibration measuring device  
FAG Detector III



Condition monitoring in paper industry



# Vibration Diagnosis for Failure Detection on a Paper Machine

The customer is a Spanish cardboard manufacturer with an annual production capacity of 80 000 tons and sales of 25 million euros. The following example takes place in its plant in Northern Spain that employs about 100 people.

### Challenge for Schaeffler

A high plant availability is a key factor for profitable business in paper mills. Unplanned shutdowns cause expensive losses due to production stoppages. In the plant in Northern Spain the customer experienced about four unplanned shutdowns each year. These were caused by unexpected bearing failures in the second press of the wet section. Although the customer had already contacted several companies for help in the past, it had not been possible to solve the problem so far. Thus, he contacted Schaeffler Iberia for support.

### Schaeffler Solution

Schaeffler Iberia recommended the customer to monitor its paper machine with the help of condition monitoring. First, Schaeffler monitored the bearing vibrations of the relevant press using an offline vibration measuring device. In the second step an FAG DTECT X1 was installed on the paper machine. This online system monitored the bearings continuously for a duration of six weeks. The subsequent data analysis revealed that the gearbox had absorbed the axial loads of the machine what had caused bearing damage in the gearbox. With this information the customer was able to take appropriate measures and solve the problem.

Technical Information about the Plant
Location:
Northern Spain
Production capacity:
80 000 t/a

Technical Information about the Solution
Online monitoring system:
8 channel-FAG DTECT X1 with an external multiplexer
Settings und specific values:
<ul style="list-style-type: none"><li>Configurations: 16</li><li>Frequency windows: 12</li><li>Speed tracking of frequency windows</li><li>Envelope detection</li></ul>
Monitored equipment:
Bearings of the second press of the wet section
Sensor position:
2 sensors at the front drive side of the press and 3 sensors at the drive side of the press

### Customer Benefit

By avoiding the average four unplanned shutdowns per year, the cardboard manufacturer realizes significant savings.

Expenses of preventative maintenance:	
Previous average annual costs	€ 13 900
Replacement parts:	€ 90 000
Costs due to production losses:	
Total Costs:	€ 103 900
Costs with Schaeffler solution	
FAG DTECT X1 rent for 6 weeks	€ 4 000
and Schaeffler expert consultancy in the fields of installation and data analysis:	
Replacement parts:	€ 2 300
Total Costs:	€ 6 300
Total savings:	€ 97 600

### What's special

By monitoring the paper machine with the help of the FAG DTECT X1 for a short period the customer supported by Schaeffler could identify and solve a problem that slowed him for years. Customers, who decide to monitor their machines with an online system not only for a short term but on permanent basis, can even extend their availability. By the early alerting it is possible to schedule repairs in accordance with the maintenance plans and increase the plant availability in the long run. ◀



Paper press



Online monitoring system  
FAG DTECT X1



Service experts discussing data diagnosis



Wet section in paper production

# Condition monitoring on the Path to Industry 4.0



### Mitsubishi HiTec Paper Europe GmbH, Germany

Mitsubishi HiTec Paper Europe produces special papers, which are coated using modern methods and used around the world, at its paper factories in Bielefeld and Flensburg. Coating machine 3 (SM3) at Mitsubishi HiTec Paper Europe GmbH's Bielefeld (MPEB) plant gives thermographic paper its special coating.

### Challenge for Schaeffler

SM 3 has 26 fan units that ensure the coated paper can dry without being touched. The fans' high speeds and large mass mean that, over time, they become subject to imbalance. One of SM 3's fans failed due to imbalance that was not detected in time, causing significant damage to both the bearing support and additional components. This resulted in a sudden plant shutdown and consequently a loss of production. In order to identify potential damage at an early stage and prevent unplanned and costly downtimes, the MPEB engineer team needed a solution that would allow them to switch from time-based to condition-based maintenance.

### Schaeffler Solution

Together with its authorized sales partner Werthenbach, Schaeffler developed a service concept for the condition monitoring of all of the paper machine's critical components. This solution comprises 26 FAG SmartCheck systems that continuously monitor the vibrations produced by the fans. An FAG SmartController acts as a bi-directional gateway between the customer's control system and the sensors. The use of Power over Ethernet allowed the cabling outlay to be kept to a minimum – the entire system can be supplied with power and communication ensured with just one cable.

Technical information on Coating Machine SM 3
Production capacity:
100 000 t/a
Max. speed:
1 730 m/min (world record in curtain coating technology since 2007) max. 1 810 m/min
Number of ventilation units:
26 units comprising supply and extracted air fans
Diameter, mass, and speed per fan:
<ul style="list-style-type: none"><li>Supply air fan impeller: d = 922 mm; m = 103 kg; n = 2 115 rpm</li><li>Extracted air fan impeller: d = 650 mm; m = 34 kg; n = 2 270 rpm</li><li>Airtum fan impeller: d = 650 mm; m = 34 kg; n = 2 480 rpm</li></ul>

Technical Information about the Solution
Number of monitoring systems:
<ul style="list-style-type: none"><li>26 FAG SmartCheck units</li><li>1 FAG SmartController based on a Mitsubishi Electric PLC from the MELSEC L series</li></ul>
Power supply:
PoE (Power over Ethernet)
Additional signals:
<ul style="list-style-type: none"><li>Speed (from customer's control system)</li><li>Overall status from FAG SmartCheck to customer control system</li></ul>
Monitored assemblies:
26 fans with 2 plunger block housings and one fan impeller each
Monitored components:
<ul style="list-style-type: none"><li>Bearings</li><li>Imbalance</li></ul>
Monitored operating parameters:
<ul style="list-style-type: none"><li>Temperature</li><li>Speed</li><li>Machine vibrations</li></ul>
Diagnostic methods:
<ul style="list-style-type: none"><li>Speed</li><li>Acceleration</li><li>Envelope</li></ul>
Status display:
Individual visualization by integration of information into the customer's control system using FAG SmartVisual and FAG SmartController

### Customer Benefit

Just a few months after being put into operation, the monitoring system demonstrated its abilities and identified irregularities in two of the exhaust air flotation dryers. Werthenbach's service team recorded the data and carried out an initial analysis, after which the experts from Schaeffler delivered a written report containing the results and a set of recommended actions. The irregularities were caused by impermissibly high imbalance and outer ring bearing damage. Planned maintenance allowed both of these problems to be solved quickly. The early warning system makes lead times of up to several months possible before the actual component failure occurs, so the system downtimes that are needed for repair and maintenance work to be carried out can be initiated accordingly. MPEB has a reliable data history at its disposal, which allows the long-term monitoring of the systems' behavior and targeted improvements to the design. This increases machine availability and process reliability while reducing the overall operating costs. The company plans to use this expandable solution to monitor the entire SM 3 machine in future in order to precisely record the behavior of all rotating parts when their speed increases.

### What's special

"For us, condition monitoring using the FAG SmartCheck is a decisive step towards Industrie 4.0. The FAG SmartController is at the heart of this solution and enables us to forward information from the field-level sensors via the control level and MES to the ERP system where it can be used and to directly implement data from higher levels at the field level", explains Jürgen Heitland, head of Electronics, Measuring and Control Technology (EMSR) at Mitsubishi HiTec Paper Europe GmbH. On the strength of the good results delivered by the pilot project, Mitsubishi HiTec Paper Europe subsequently decided to equip the coating machine at its Flensburg plant with the FAG SmartCheck as well. The supply and extracted air fans at this plant are now monitored by 22 systems. ◀



Coating machine 3 (SM 3)



A SCADA system visualizes the vibration data and status information from the sensors in real time



An FAG SmartController acts as a bi-directional gateway between the customer's control system and the sensors



Ventilation unit: The FAG SmartCheck is fitted to the shaft's bearing support

# Condition Monitoring of Wind Turbines

### Projekt GmbH, Germany

The Project Planning Company for Regenerative Energy Systems (Projekt GmbH) was founded in Oldenburg in 1993. It specializes primarily in the development and realization of wind farm projects. Likewise, the company’s core business includes technical management of wind turbines as well as assessor services at home and abroad. Projekt GmbH has 18 employees. Together with three partner companies, Projekt forms the Oldenburg Consultancy Network Energy and Environment combining know-how in the field of environmentally friendly power engineering for the customer’s benefit.

### Challenge for Schaeffler

Projekt GmbH is responsible for the planning, realization and technical management activities of the wind farm "Oldenbroker Feld". This wind farm set up in late 2001 comprises totally nine wind turbines. Projekt GmbH was looking for a condition monitoring system for the wind farm that met the "Allianz Zentrum für Technik" (AZT) requirements. This is often a requirement for the acception of a condition monitoring system by insurance companies.

### Schaeffler Solution

In 2003, Schaeffler experts installed one FAG WiPro system at each of the nine wind turbines for monitoring the drive trains. Apart from automatic monitoring, this online monitoring system offers the advantage that only a comparatively small amount of data needs to be transmitted for a detailed assessment of a machine’s condition. Only one year later, the system detected a first case of emerging bearing damage.

Technical Information about the Plant
Wind Turbines (WT)
Number:
9 WT
Manufacturer:
Vestas
WT types:
V66 and V80
Total output of the wind farm:
16,6 MW

Technical Information about the Solution
Schaeffler condition monitoring system:
FAG WiPro
Monitored elements:
AWT drive trains
Sensors:
7 or 8 sensors per WT
Communication:
VPN
Additional signals:
Speed and power
Alarm:
Remote- communication via VPN

### Customer Benefit

Thanks to the FAG WiPro, which triggered the alarm in good time, expensive consequential damage – for example to the gearbox or to the generator – was prevented. In each case, consequential damage would have cost the company far more than 100 000 euros.

In concrete numbers:	
Cost of gearbox replacement:	€ 210 000
Cost of timely bearing replacement:	€ 4 700
Cost of gearbox replacement:	€ 140 000
Cost of timely bearing replacement:	€ 3 400
Realized savings:	
Gearbox:	€ 205 300
Generator:	€ 136 600
The non-recurring project costs (acquisition of the nine units plus installation and commissioning) amounted to about 80 000 euro.	

### What’s special

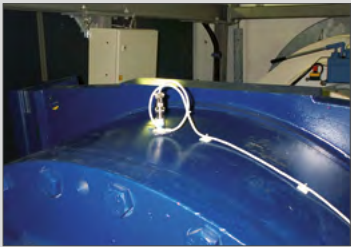
A training scheme consisting of a number of different modules was developed for the customer. With the completion of the various modules, the monitoring activities were step by step transferred from Schaeffler to the customer. Now the customer successfully monitors the Oldenbroker Feld turbines as well as turbines on other wind farms. For particularly difficult data analyses, the Schaeffler experts continue to be at the customer’s disposal to provide assistance. ◀



On the hard to reach wind turbines (WT) remote monitoring is especially worthwhile



Online monitoring system FAG WiPro



Sensor for online monitoring



Experts in Online Monitoring Center



# Cost Savings through Monitoring Package for Wind Turbines



**Geolica, Spain**  
Geolica is a producer of renewable energy in the wind energy sector that currently operates two wind farms in Spain, with an installed total power of 84,8 MW. The wind farms, San Juan de Bargas and Santo Cristo de Magallón, are located in Aragon.

**Challenge for Schaeffler**

An unexpected downtime due to damage to any component in the drive train of a wind turbine can have significant economic consequences in terms of production disruption and repair costs. To avoid that kind of situation, Geolica was looking for a condition monitoring system that would detect any damage at an early stage. In this way the company wanted to avoid unplanned downtimes, become able to plan necessary maintenance measures in good time and save time and repair costs. As Geolica didn't have any experience with condition monitoring and the analysis of vibration data so far, they also required support in this task.

**Schaeffler Solution**

Some years ago Schaeffler Iberia installed 56 FAG WiPro systems, one in each wind turbine, in Geolica's wind park in San Juan de Bargas. The measured vibration data were sent automatically via TCP/IP to Schaeffler's Online Monitoring Center in Germany, where it was analysed by experienced vibration experts. In addition, the wind farm's personnel received customised vibration monitoring training. Already in the second year of use, the Schaeffler vibration experts detected signs of serious damage to a gearbox in one of the wind turbines. To verify the problem Geolica carried out endoscopy measurements that confirmed the diagnosis.

Technical Information about the Plant
Wind Turbines
Numbers:
56 wind turbines
Model:
Made 800
Power:
800 KW
Generator speed:
1 500 RPM
Height:
52 – 59 m

Technical Information about the Solution
Condition monitoring system: :
FAG WiPro
Number of installed units:
56
Channels and sensors:
<ul style="list-style-type: none"><li>8 channels, 6 sensors<ul style="list-style-type: none"><li>– Generator: 2 sensors</li><li>– Gearbox: 3 sensors</li><li>– Main bearing: 1 sensor</li></ul></li><li>2 analog inputs</li></ul>
Online monitoring service:
<ul style="list-style-type: none"><li>Monitoring of the wind turbines' condition</li><li>Monthly reports</li><li>Alarm report is issued if the values are out of the normal range</li></ul>
Endoscopy

**Customer Benefit**

The FAG WiPro systems provide Geolica with detailed information about their wind turbines, permitting condition-based maintenance. Thanks to its large memory capacity, the FAG WiPro also allows storage of data histories of other relevant machine data (e.g. process variables or dynamic behaviour in a wide operating range). The team of the Schaeffler Online Monitoring Center took care of the data analyses until Geolica's maintenance staff had gained enough knowledge to do the monitoring activities themselves. Thanks to the FAG WiPro and the support provided by Schaeffler via online monitoring, expensive consequential damage has been prevented several times. Considering just the costs that would have resulted from the gearbox damage detected at an early stage, the following costs were avoided:

Costs without predictive maintenance	
Costs of a new gearbox:	approx. € 100 000
Costs with predictive maintenance:	
Costs of intermediate speed shaft bearing (IMS) replacement:	approx. € 9 500
Costs of one FAG WiPro system (8 channels) and one year online monitoring:	approx. € 9 000
<b>Total savings:</b>	<b>approx. € 81 500</b>

**What's special**

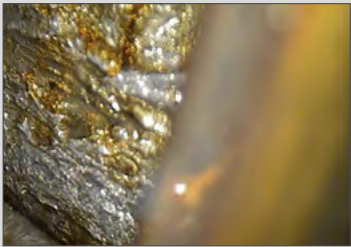
This was the first time that Schaeffler has conducted such a comprehensive online monitoring project in Spain or Portugal. The Schaeffler Online monitoring service allows customers to get permanent support without having the expert knowledge on site. This solution can also be applied to similar applications in the sector of wind power or even other industries. ◀



Wind energy plants



Damage to the raceway of the inner ring



Damage to rolling elements



Monitoring with FAG WiPro allows condition-based maintenance

# Monitoring of Compressors – Saving Maintenance and Energy Costs



**Otto Boge GmbH & Co. KG, Germany**  
Boge Kompressoren is one of the worldwide leading manufacturers of compressors and compressed air systems. Boge not only stands for high product quality made in Germany but also offers complete solutions for efficient supply with compressed air. The family enterprise is one of the oldest compressor manufacturers in Germany and has subsidiaries and sales offices in more than 120 countries around the world. Boge has 600 employees, 400 of them at the company’s headquarters in Bielefeld.

**Challenge for Schaeffler**  
Compressors are needed to move and compress air or other particles. They are subjected to heavy stressing and substantial vibration in operation. These can cause failure of the compressors in no time at all and without any outwardly noticeable signs. To minimize this incalculable risk, and to improve the compressors’ availability, Boge wished to find a reliable and cost efficient monitoring system that is based on vibration diagnosis.

**Schaeffler Solution**  
Boge was one of the first customers in the field of compressors and compressed air systems to install the FAG SmartCheck. The compact measuring system permits online monitoring of the compressor stage with the help of just a single sensor. It is the first of the vibration measuring devices in this price range to permit correlating classic and vibration based parameters and thus comprehensive monitoring of machines. The novel alarm system ensures that operators are informed about any machine damage reliably and at an early stage. As the installation of the FAG SmartCheck requires no mechanical conversion, existing systems can be easily retrofitted as well.

Technical Information about the Product Portfolio
Types:
<ul style="list-style-type: none"><li>• Screw-type compressors</li><li>• Piston compressors</li><li>• Oil lubricated or oil-free compressors</li><li>• Complex systems or single units</li></ul>
Performance parameters:
Motor range: 0,4 – 355 kW Free air delivery: 0,1 – 51,4 m³/min Compressed air: 4 – 40 bar

Technical Information about the Solution
Monitoring system used:
1 FAG SmartCheck per compressor
Vibration sensor used:
High resolution piezo sensor
Operating parameters monitored:
<ul style="list-style-type: none"><li>• Temperature at the compressor housing</li><li>• Motor/engine vibrations during operation</li></ul>
Further options:
<ul style="list-style-type: none"><li>• History data (up to several years)</li><li>• Integration into a control unit or control station</li><li>• Remote monitoring</li></ul>

**Customer Benefit**  
The compressors’ reliability can be increased only through comprehensive monitoring. Both the manufacturer and the operators of the compressors benefit equally from the FAG SmartCheck: They receive a small, modular, cost efficient measuring device that is also ideally suitable for standard equipment. The basic version of the FAG SmartCheck permits real time monitoring and output of measured data at the machine. Higher levels of system integration can be realized easily. Since the system offers all the features of significantly more expensive monitoring systems, it makes an important contribution towards avoiding unscheduled downtimes, that involve considerable production disruption costs. This leads to an increase of operational safety and enables efficient maintenance cycle planning.

**What’s special**  
Compressors must work reliably. Permanent monitoring and analysis of all compressor parameters ensure not only perfect operation. They also provide the basis for long-term optimization of the machines’ design and thus offer an enormous energy saving potential. Further applications that can be monitored with the FAG SmartCheck include vacuum pumps or vibrating screens. ◀



Maintenance of a screw-type compressor of Boge



Monitoring of a screw compressor of Boge



FAG SmartCheck is a cost-effective, innovative online measuring system



The FAG SmartCheck offers many different expansion options — up to remote monitoring

# Online Monitoring of Vacuum Pumps for a long Service Life



**Oerlikon Leybold Vacuum GmbH, Germany**  
Oerlikon Leybold Vacuum offers a wide range of advanced vacuum solutions that are used both in production and analysis processes as well as for research purposes. The company’s core competences centre on the development of application and customer specific systems for creating a vacuum and extracting process gases.

**Challenge for Schaeffler**

Depending on the application, failure of a vacuum pump can cause a whole vacuum line to shut down. So, to protect their customers against such costly downtime and expensive repairs, Oerlikon Leyold Vacuum GmbH wanted to see whether an online measuring device would be suitable for use as a ‘permanent guard’. The device had to be able to generate a report directly to the company’s or to the machine manufacturer’s after sales service department whenever an alarm was triggered. In addition, it was important to the vacuum pump manufacturer that the online vibration monitoring system should be easy to install, easy to operate and available at a price that would make it an option as standard equipment.

**Schaeffler Solution**

The FAG SmartCheck is the optimal solution for cost-effective vibration measurement and thus the condition monitoring of vacuum pumps. It is ideal for detecting problems like bearing wear, imbalance, misalignment and caking on vacuum pumps reliably and cost-efficiently. An FAG SmartCheck with different measurement configurations was installed on a continuously operated Oerlikon Leybold vacuum pump. To make the measured data available to everyone concerned, the FAG SmartCheck was integrated into the company’s network. From there, the measured data could be downloaded easily and sent to Schaeffler for analysis.

Product and Service Portfolio
<ul style="list-style-type: none"><li>• Backing pumps</li><li>• High and ultra high vacuum pumps</li><li>• Vacuum systems</li><li>• Vacuum measuring devices</li><li>• Leak detectors</li><li>• Components and valves</li><li>• Consulting and engineering services</li></ul>
Technical Information about the Solution
Monitoring system used:
FAG SmartCheck
Vibration sensor used:
High resolution piezo sensor
Operating parameters monitored:
<ul style="list-style-type: none"><li>• Bearing temperature</li><li>• Ambient temperature</li><li>• Speed</li><li>• Load</li></ul>
Diagnosis methods:
<ul style="list-style-type: none"><li>• Time signal</li><li>• Envelope</li><li>• Speed and frequency tracking</li><li>• Spectrum and trend analysis</li></ul>

**Customer Benefit**

Oerlikon Leyold Vacuum Pumpen GmbH has satisfied itself that the FAG SmartCheck meets their requirements on the monitoring of vacuum pumps. Critical operating states are identified immediately and visualized on the FAG SmartCheck. In addition, the measuring system passes information about critical operating states for pre-alarms and main alarms on to the control system via an analog output. The control system then visualizes the report automatically. Monitoring is effected constantly in real time. In this way both slowly developing damage and quickly developing problems are identified reliably.

**What’s special**

Depending on the application and level of automation, customers can select the ideal solution from a wide range of monitoring options – from alarms at the machine itself to integration into the control system to remote monitoring. Further applications that can be monitored with the FAG SmartCheck include, for example:

- Compressors
- Vibrating screens
- Liquid pumps
- Electric motors ◀



Vacuum pumps from Oerlikon Leybold Vacuum



Oerlikon Leyold vacuum pump



Continuous real-time monitoring using FAG SmartCheck



In-depth analysis of measuring results on the PC



# FAG SmartCheck ensures Maximum Crane Availability in the Trimodal Port

## RheinCargo GmbH & Co. KG, Germany

RheinCargo GmbH & Co. KG is one of Europe’s leading logistics companies. With seven public ports on the river Rhine, including the Niehl I cargo handling port located on the western bank of the river in Cologne’s Niehl district, the company is also Germany’s second-largest port operator.

## Challenge for Schaeffler

Due to the high degree of utilization and lack of redundancy, the gantry cranes at Cologne’s Niehl I cargo-handling port are among its most critical machines. The hoisting gear trolley is used to transfer containers from land to road transport vehicles and ships. Availability is required 24 hours a day, 7 days a week. Any unplanned downtime by these giant transportation machines leads to major delays in the entire operation and generates enormously high costs. For this reason, the company operating them was very interested in obtaining information about possible component damage in the gantry cranes at an early stage.

## Schaeffler Solution

Schaeffler installed two FAG SmartCheck units on each of the hoisting gear trolley’s two cable drums – one on the motor and one on the gearbox. In addition to monitoring the vibrations that occur, these measuring devices record the speed and direction of rotation in order to allow an informative analysis of the measurement data to be carried out. This additional information is essential due to the short measurement times and the gearbox’s reversing operation. An FAG SmartLamp was additionally installed in the machine room and illuminates red in the event of an alarm situation in order to warn the operator of the onset of damage to the bearings or gear teeth, while an FAG SmartConnect Box allows the power supply and additional signals to be distributed easily.

Technical information on the Niehl I Port
Water surface area:
472 700 m²
Land surface area:
837 300 m²
Port basins:
4
Crane equipment:
13 crane systems, one of which is intermittently out of operation

Technical Information about the Solution
Monitoring systems:
4 FAG SmartCheck
Monitored components:
<ul style="list-style-type: none"><li>Motor</li><li>Gearbox</li></ul>
Status display:
<ul style="list-style-type: none"><li>Via FAG SmartLamp</li><li>LAN and automatic forwarding of the status display to the control station are planned</li></ul>
Signal distribution:
<ul style="list-style-type: none"><li>FAG SmartConnectBox</li></ul>
Monitored operating parameters:
<ul style="list-style-type: none"><li>Direction of rotation</li><li>Speed</li></ul>
Further options:
<ul style="list-style-type: none"><li>Several years of history data can be stored</li><li>Information passed on via control system to the control station</li><li>Remote monitoring</li></ul>

## Customer Benefit

With the FAG SmartCheck, the operator can always be certain of the condition of the bearings and gearboxes installed in the hoisting gear. The onset of damage is detected at an early stage, which makes it possible to plan repair and maintenance measures and thus significantly reduces the risk of unplanned downtime.

Estimated costs for unplanned crane downtime	
Costs for repairing the motor:	€ 10 000
Crane downtime:	€ 5 000
Total cost of downtime:	€ 15 000

Potential savings with the FAG SmartCheck	
Investment costs for monitoring the hoisting gear using the FAG SmartCheck:	€ 5 000
Savings achieved due to early detection of initial damage, minus the investment costs for the FAG SmartCheck:	€ 10 000
Savings achieved through early detection of all subsequent damage:	€ 15 000

With three cranes being monitored and assuming two occurrences of damage per crane each year, an estimated annual saving of approximately € 75 000 is thus achieved.

## What’s special

RheinCargo also plans to integrate the measuring systems into its existing Ethernet in order to make it even easier to obtain information about possible damage. The operator can thus monitor the crane systems’ operating condition from their own control station and also has the option of allowing Schaeffler to perform remote monitoring. ◀



Gantry cranes in container port



Motor and gearbox monitoring using the FAG SmartCheck



The FAG SmartConnect Box allows the power supply and additional signals to be distributed



Simple visualization of the operating condition with the help of the FAG SmartLamp



»» *In the middle of difficulty  
lies opportunity.*

*Albert Einstein (theoretical physicist)*

## Robust and Strong

FAG cylindrical roller bearings now feature a new single-piece, rib-guided MPAX cage that makes them even more resistant to shock loads and vibrations. This solid brass cage delivers significantly higher rigidity in a radial direction and can withstand even the highest centrifugal forces.

FAG cylindrical roller bearings with MPAX cages are therefore particularly suitable for applications that combine extreme loads with high speeds.

[www.schaeffler.de/en](http://www.schaeffler.de/en)

**FAG**

**SCHAEFFLER**



# Reworking and Reconditioning of Support Rollers for the Steel Industry

The customer is a medium-sized French steel manufacturer who has specialised in the production of cold-rolled strip steel. The range of products comprises surface-finished strip steel as well as quenched and drawn steels. The company belongs to an internationally operating steel group from Germany.

### Challenge for Schaeffler

The outside diameters of the support rollers produce the surface of the finished strip material. Six to eight support rollers form a cluster. The surfaces of the support rollers and the minimal variation of their diameters are, therefore, decisive for zero-defect quality and the thickness tolerance of the finished product. That is why the support rollers are completely disassembled, measured, reground and remounted with a total tolerance of 5 µm per cluster as part of regular general inspections. The customer was looking for a new partner who could carry out the reconditioning of the support rollers, meeting the highest quality standards.

### Schaeffler Solution

The support rollers were sent to the Schaeffler reconditioning competence centre for reworking and reconditioning. There, they were disassembled, washed, examined, measured, ground and sorted according to section height groups. After the reworking, the outer rings and inner rings have been assembled again, mounted onto their shafts, packaged and sent back to the customer. In order to ensure a consistent quality of the finished product, the general inspection is carried out twice a year since then.

#### Technical Information about the Plant

Four rolling stands of different configurations in two mills (48 or 32 yoke type track rollers per machine)

#### Technical Information about the Solution

##### Steps of the reconditioning process:

- Dismantling
- Cleaning
- Visual inspection and runout testing
- Regrinding of the outside surface
- Assembly
- Measurement and marking of the section height
- Preservation, packaging, and shipping

### Customer Benefit

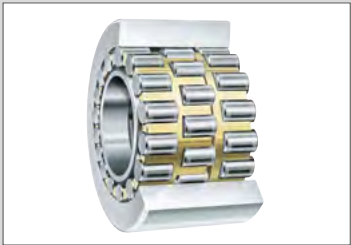
The support rollers’ service lives are extended significantly by the regular reconditioning. The Schaeffler reconditioning team can regrind the outer rings with extreme precision while removing only a minimal amount of material. In the case in hand, it was important to observe the permissible total section height tolerance of 5 µm per cluster. The bearings’ quality is not impaired by the grinding compared to a new bearing. What’s more, costs are significantly lower and delivery periods much shorter.

### What’s special

The intervals at which the support rollers must be changed depend on the degree of stress to which they are subjected and must be determined individually for each customer. It is also possible to recondition every component. In the case of yoke-type track rollers, for example, Schaeffler takes the fully-assembles rollers from the customer and returns them – reconditioned and ready for installation – in the shortest time possible. Defective bearings are replaced with new rolling bearings if needed. ◀



Multi-roll cold rolling mill



Rolling mill back-up roller, 3-row



Inspection of the yoke type track rollers



Mounting the yoke type track rollers



# Reconditioning of the Main Bearing of a Tunnel Boring Machine



**Robbins GmbH, Germany**  
Robbins GmbH is a subsidiary of US-based Robbins Company. Since 1951, Robbins has been engaged in the design and manufacture of tunnelling and mining equipment. From this time on, Robbins tunnel boring machines (TBM) have bored over 3 500 km of tunnel on more than 700 projects worldwide with machines ranging in diameter from 1.6 to 14.4 metre. The company generates annual sales in excess of US\$ 100 million.

**Challenge for Schaeffler**  
After finishing a tunnel boring job in Iceland, the customer wanted to subject a tunnel boring machine to a full inspection and reconditioning. The reconditioning of the main bearing – which had been made especially for this tunnel boring machine – was of particular importance. Delivery periods for new TBM main bearings amounted to about two years at that time.

**Schaeffler Solution**  
The bearing was sent to Wuppertal (Germany) for reconditioning. After it had been cleaned carefully, the reconditioning experts of Schaeffler examined the bearing thoroughly and defined the necessary operations. Immediately afterwards, the reconditioning work was carried out by experienced experts. Only eight weeks after the bearing had been delivered to Wuppertal, the reconditioning work was completed, and the bearing had been restored to a quality that was comparable to that of a new bearing.

Technical Information about the Plant
TBM Main Bearing
Outside diameter:
5 200 mm
Mass:
25 t
Shield diameter:
10 m

Technical Information about the Solution
Reconditioning (Level III)
<ul style="list-style-type: none"><li>• Dismounting, cleaning, examination</li><li>• Definition of the amount of material to be removed by regrinding</li><li>• Sand blasting of the non-functional areas</li><li>• Regrinding of the radial and axial raceways</li><li>• Regrinding and/or honing of the rolling elements</li><li>• Preservation, mounting, packaging</li></ul>

**Customer Benefit**  
By having the bearing reconditioned, the customer realized considerable savings in terms of both cost and time:

Saving potential	
Cost savings compared to the cost of a new bearing:	approx. 60 %
Time savings compared to the delivery period for a new bearing:	> 90 %
The reconditioned bearing was delivered to the customer on the agreed date so that it was available again in time for the next tunnel boring job in China.	

**What's special**  
Almost all TBM bearings can be reconditioned. The only restrictions are those imposed by the available grinding capacity (diameter). ◀



Tunnel boring machine



Tunnel boring machine (TBM) at work



Regrinding of raceways



Setting up grinding machine

# Saving Costs by Reconditioning of Hybrid Deep Groove Ball Bearings

The customer is a leading player in the international paper market. The portfolio comprises newsprint and book paper, magazine paper, fine paper, consumer board, industrial packaging and wood products.

### Challenge for Schaeffler

The customer uses hybrid deep groove ball bearings (made up of ceramic balls and steel rings) in his spreader rolls as these bearings offer numerous advantages, like less lubricant consumption or higher speeds. Although the initial costs of these bearings are significantly higher than those of standard bearings, they still are cost-effective if all influencing factors are taken into account. As reconditioning is a measure that extends the bearings' service lives it must also be included in the calculation of the amortization of the costs of hybrid deep groove ball bearings. So the company, which had not reconditioned any bearings so far, was looking for a qualified service company for reconditioning.

### Schaeffler Solution

At the beginning of the cooperation, the customer sent a batch of hybrid deep groove ball bearings from the spreader rolls to the Reconditioning Center in the Schaeffler plant Schweinfurt. The bearings were cleaned and checked very carefully. Thus it was determined if reconditioning was economically against the background of technical feasibility. Moreover, it was specified which operations had to be carried out.

Technical Information about the Plant
Typical bearing types:
Deep groove ball bearings, e.g. special hybrid deep groove ball bearings F-HC807861.KL

Technical Information about the Solution
Reconditioning Level II:
<ul style="list-style-type: none"><li>• Cleaning</li><li>• Dismounting</li><li>• Wear pattern analysis</li><li>• Dimensional check</li><li>• Decision if bearing can be reconditioned</li><li>• Polishing of raceways</li><li>• Re-assembly with new cage</li><li>• Preservation</li><li>• Statistics</li></ul>

### Customer Benefit

The examination showed that two third of the hybrid deep groove ball bearings could be reconditioned. The reconditioning costs were 60 percent lower than the price of new bearings. In this way the customer has realized enormous savings without any quality losses, a fact that also contributes to amortizing the high initial cost of the hybrid deep groove ball bearings. Moreover, the customer received an inspection report containing detailed statistics of the amount and type of damage detected in the batch.

In numerical terms:

Saving potential	
Initial costs for the batch of hybrid deep groove ball bearings:	approx. € 9 000
Reconditioning costs for the bearings:	approx. € 3 500
Cost savings compared to new bearings:	approx. € 5 000

### What's special

The customer was so satisfied that he keeps sending bearings that require reconditioning. In principle reconditioning is applicable to all types of bearings. ◀



Spreader roll for paper industry



Spreader rolls allow crease-free guiding of material webs



Hybrid deep groove ball bearings with ceramic balls



Visual verification in terms of reconditioning

# Reconditioning of Railway Bearings

### VR Ltd Finnish Railways, Finland

VR Ltd Finnish Railways belongs to VR-Group Ltd, a broad-based Finnish transport company. It serves freight service customers and public transport customers with rail and road transport services. The group employs more than 11 000 employees and is divided into five business areas (Rail Services, Track Construction and Maintenance, Road Services, Catering and Restaurant Services, Telecommunication Services). VR Group’s net profit in 2012 was 54 million Euro.

### Challenge for Schaeffler

For safety reasons, railway companies must have their rail vehicles and especially the wheelsets of their rail vehicles checked regularly. In this context, the reconditioning of bearings, which is a time saving and economical alternative compared to the fitting of new bearings, is increasingly gaining in significance. That is why VR Ltd Finnish Railways has for some time been using the reconditioning service offered by Schaeffler.

### Schaeffler Solution

Every month, approximately 350 railway bearings are sent to Schweinfurt (Germany) for reconditioning. The reconditioning centre is equipped with special mounting and dismantling tools and cleaning facilities. Experienced Schaeffler reconditioning experts perform the following steps of the procedure: Dismounting, washing, examination, measuring, polishing (if necessary), second washing, replacement of spare parts (if necessary), preservation, packaging. Soon afterwards, the axle box bearings are ready for use again. After the reconditioning they offer the same performance as new bearings.

Technical Information about the Rail Vehicles
Railway bearings of types:
<ul style="list-style-type: none"><li>FAG 502472AA</li><li>FAG 526755A</li><li>FAG F-577732.TAROL130/230</li><li>SKF 229750</li><li>SKF 229750/129</li></ul>

Technical Information about the Solution
Reconditioning for axlebox bearings:
<ul style="list-style-type: none"><li>Dismounting</li><li>Washing</li><li>Examination</li><li>Measurement</li><li>Polishing (if necessary)</li><li>Second washing</li><li>Replacement of spare parts (if necessary)</li><li>Preservation</li><li>Packaging</li></ul>

### Customer Benefit

The reconditioning service is offered for bearings from all manufacturers. For customers, this means less logistic effort as bearings of different brands do not need to be sent to different manufacturers. Altogether, every bearing can be reconditioned decisively. This reduces the demand for new bearings to one eighth. A bearing can be reconditioned at around 50% of the cost of a new bearing.

### What’s special

The reconditioning of axlebox bearings is an economical alternative and a Schaeffler service that is available for bearings from all manufacturers. ◀



Rail vehicles have to meet high safety requirements



Wheelset of a rail vehicle



Automated washer

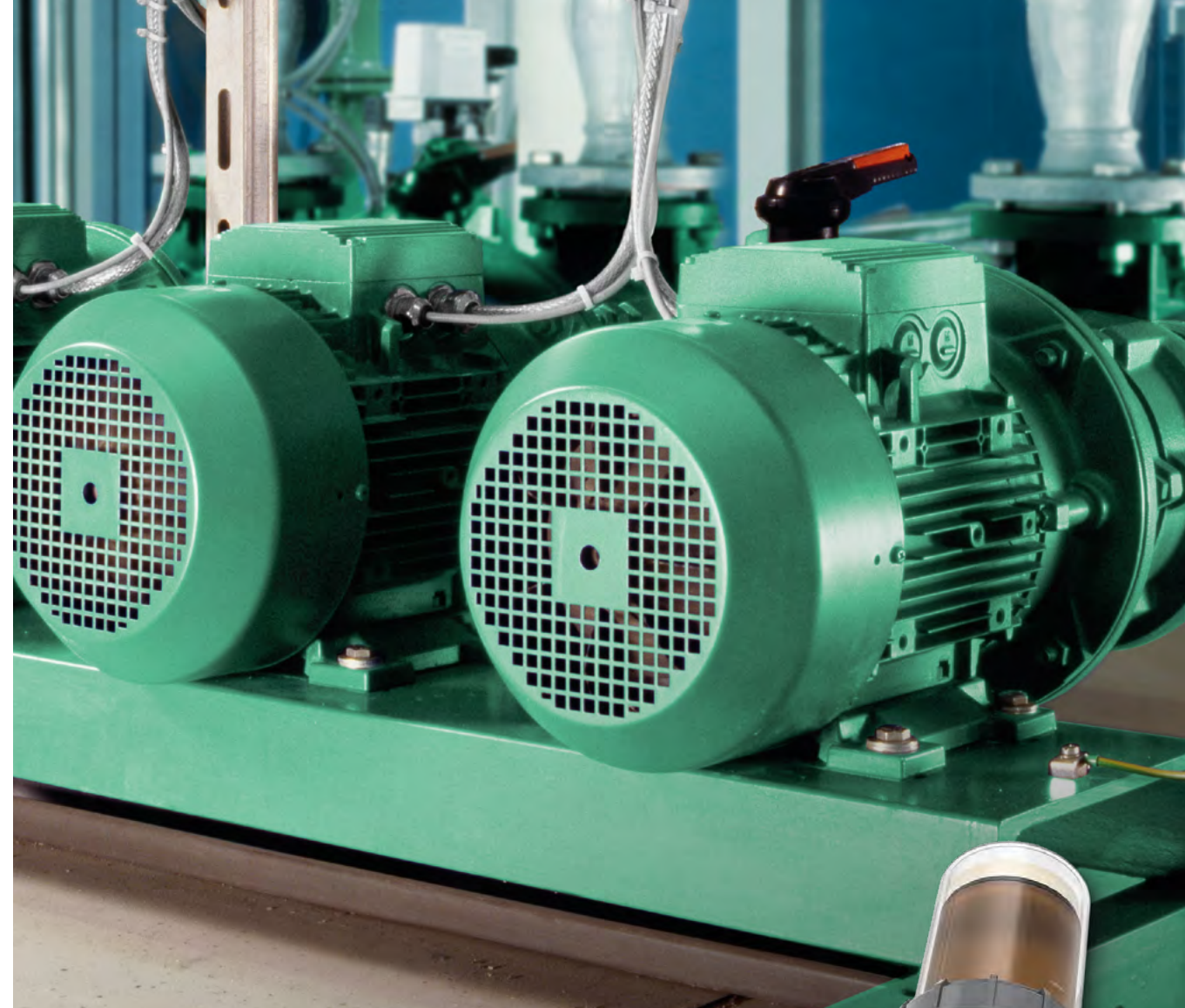


TAROL unit (used and reconditioned)



»» *Don't find fault,  
find a remedy.*

*Henry Ford (American entrepreneur)*



## The Intelligent Lubricator – Two in One

The FAG lubricator CONCEPT2 provides industrial machinery such as fans, motors and gearboxes with precisely the right quantity of grease at the right time. It can supply two bearings even where these have differing lubrication requirements, thus replacing two individual devices. Its design configuration and control options are simple: FAG CONCEPT2 operates independently as a battery-driven version or the 24V DC version can be easily integrated with very little programming work in the machinery operating system.

[www.schaeffler.de/en/services/concept2](http://www.schaeffler.de/en/services/concept2)



**FAG**

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# Troubleshooting Measurements in 4-High Cold Rolling Mill

The customer is one of the worldwide leading manufacturers of flat steel with a comprehensive range of grades, sizes and surface finishes.

### Challenge for Schaeffler

The plant builder had modified the 4-high cold rolling mill to increase its capacity. However, after the modification the steel producer was no longer able to produce high quality strips that matched the customers’ requirements. The finished product was always marred by chatter marks. The cause of these flaws was supposed to be an increased level of rolling stand vibration. As the customer had already had very good experiences with the service and condition monitoring solutions provided by Schaeffler in the past, they enlisted the Schaeffler services to solve the problem.

### Schaeffler Solution

In no time at all, the Schaeffler service division organized the necessary troubleshooting activities. Two experts carried out various vibration measurements and a modal analysis. The results showed an irregularity in the region of the work rolls and a heavy frame deflection in the direction of rolling. The upper chock – and consequently the upper work roll – rotated freely in the frame, causing a cyclic reduction of the roll gap. As a result, chatter marks were produced on the steel strip at regular intervals.

Technical Information about the Plant
4-high rolling stand (Quarto)
Strip width:
700 – 1 300 mm
Strip thickness:
0,15 – 2,0 mm
Maximum coil weight:
25 t

Technical Information about the Solution
Measuring methods used:
<ul style="list-style-type: none"><li>• Modal analysis</li><li>• Operating vibration measurement</li><li>• Bumb test</li><li>• Run up / coast down measurements</li></ul>

### Customer Benefit

Thanks to the troubleshooting carried out by the service experts, the cause of the chatter marks on the rolled strip was determined in no time at all. Directly afterwards, the steel producer initiated the necessary design modifications in collaboration with the plant builder. In this way the problems with the rolling stand were solved quickly, and further costly production losses have been avoided.

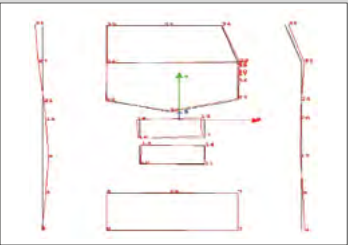
Cost savings realized thanks to fast trouble-shooting service	
Production capacity:	16 coils/day
Coil weight:	at least 20 t
Price of cold rolled steel strip:	€ 685/t
Production losses per day:	€ 200 000

### What’s special

The modal analysis and vibration analysis carried out by our experts provided the plant operator with very important information about the rolling stand’s actual dynamic behaviour. Without this approach, the cause of the chatter marks could have been identified only by trial and error – a method that is not only very time consuming but also very expensive (high labour costs and production loss costs). ◀



4-high cold rolling mill



Lattice model of a 4-high rolling stand



Service experts during analyzing



Vibration measuring device  
FAG Detector III

# „Performance Based Contract“ in the Steel Industry

The customer is a manufacturer of specialty steel strip products, serving a broad industrial sector of the local and international market in Brasil. To the wide range of products contains for example zinc plated products, dozens of thermal and surface treatments and non pollutant products.

### Challenge for Schaeffler

The customer decided to conclude a performance based contract for its plant in Brazil. The aim was to reduce the 874 hours of unplanned downtime (costs: approximately € 50 000/year) as well as the demand for bearings, seals and lubricant (costs: approximately € 500 000/year). This contract was developed by Schaeffler Brazil based on the customer’s demand for bearings, seals and lubricant as well as downtime in the previous year.

### Schaeffler Solution

Schaeffler offered the customer a performance based contract to meet his specific requirements. This included preventive and predictive maintenance on all rotating equipment and machines at the customer’s plant. First, a CMMS (computerized maintainance management system) was implemented. In addition, Schaeffler experts provided bearing maintenance training for the customer’s maintenance team. Thus a training program was established. Since then the maintenance personnel is trained in bearing mounting, laser alignment, lubrication and further aspects related to rolling bearings at least twice a year.

Technical Information about the Plant
Multi purpose four-high reversing cold rolling stand
Sheet thickness:
0,10 to 6,30 mm
Sheet width:
220 to 425 mm
Rolling speed:
500 m/min
Rolling load:
Approx. 20 000 kN
Back-up roll dimensions:
440 x 1 000 mm
Power:
630 kW (1 250 A) per electric motor

Technical Information about the Solution
Online condition monitoring system:
16-channel FAG DTECT X1 (only for two rolling stands: LA27 and LA30)
Offline condition monitoring system:
2 FAG Detector III (for all other machines and equipment)
Additional Schaeffler products, e.g. rolling bearings, lubricants etc. that are replaced in the course of the regular maintenance and repair activities.

### Customer Benefit

Saving potential:	
Reduction in the cost of bearings, seals and lubricant (first year of contract):	from € 500 000 to € 455 000
Reduction in unplanned downtime cost (first year of contract):	from € 50 000 to € 30 000
Savings after the first year projected in the performance based contract:	€ 52 000
Savings after five years projected in the performance based contract:	€ 210 000

### What’s special

A performance based contract ensures that the customer has to pay only a fixed price if a jointly agreed performance is provided. But at the same time, this type of contract includes a bonus/malus provision. That means: if the agreed targets are fallen short of, both parties to the contract share the cost of the failure to perform. If, on the other hand, the targets are exceeded, both parties will benefit. Similar contracts are of interest to customers in nearly all industries and around the world. ◀



Rolling mill



Schaeffler experts support installation of measuring devices and analysis of data



Vibration diagnosis is the most reliable method for indentifying damage at an early stage



Measuring device for offline vibration monitoring FAG Detetor III



# Integrated Bearing and Service Solution for Converters

The customer is a leading European steel manufacturer with several production plants. Its annual production of crude steel exceeds 10 million tons.

### Challenge for Schaeffler

The oxygen steel plant operates two converters. The customer wished to replace converter 1 and – at the same time – increase this vessel’s size to a capacity of 400 tons. This application demanded a highly ambitious solution for the trunnion bearing itself as well as for the newly designed ferrocast housing. As the converter is an absolutely critical bottleneck to the downstream inline production processes and the customer had already had excellent experiences with Schaeffler condition monitoring solutions, the customer decided to have the bearings and gears monitored. However, the process made it impossible to employ a standard vibration measurement solution. So a multitude of different monitoring methods had to be combined into an integrated system.

### Schaeffler Solution

In cooperation with the converter OEM, Schaeffler developed a custom-tailored solution that stands out due to a new ferrocast housing design for highest durability. Split spherical roller bearings as spare parts ensure bearing replacements within the shortest possible time whereby shutdown cost are reduced significantly. The accompanying condition monitoring solution comprises the monitoring of the trunnion bearing with acoustic emission (AE) and online grease analysis, force transmission into the floating bearing housing with strain gauges, axial displacement of the floating bearing, vertical deflection of trunnions, and gearbox monitoring with online oil particle analysis. In addition, the service package included the mounting of the trunnion bearings as well as remote monitoring.

Technical Information about the Converter
Converter capacity:
400 tons
Annual production:
approx. 5 Mio. tons
Operating temperature:
max. 1 750 °C
Year of manufacture:
2013

Technical Information about the Solution
Converter’s floating bearing:
Split spherical roller bearing Z-537284.PRL
Locating bearing:
Spherical roller bearing Z-541835.249/1120-B
Housing:
<ul style="list-style-type: none"><li>F588998.01.KPGZ/491120-FD-A</li><li>KPGZ/491120-I-D-AC</li></ul>
Converter gear bearings:
Cylindrical roller bearing F-605486.ZL
Condition monitoring:
<ul style="list-style-type: none"><li>Acoustic emission</li><li>Online grease analysis</li><li>Oil particle analysis</li><li>Force transmission into housing</li><li>Shaft and bearing displacement</li></ul>
Schaeffler services:
<ul style="list-style-type: none"><li>Mounting</li><li>Remote monitoring</li></ul>

### Customer Benefit

The customer received all-round support in the reconstruction of the converter. This solution included construction, engineering and delivery of a new converter bearing housing of a design that represents an innovative, state of the art solution. Completed by the various condition monitoring solutions, the advantages can be summarised as follows: Longer bearing life due to the innovative housing design. This means lower maintenance and downtime costs for the entire converter.

Saving potential	
Price of crude steel:	€ 250 t
Volume of one batch:	400 t
Price of one batch:	€ 100 000
Production volume per day:	20 batches
Unplanned bearing damage and downtime:	5-7 days
Production loss:	€ 10-14 M

### What’s special

Thanks to the close cooperation between the OEM and all Schaeffler departments involved, the customer received a solution that was perfectly matched to its needs. This was made possible by a tailor-made housing design, which features ready-to-use mounting points allowing immediate installation of the acoustic emission unit as well as the FAG GreaseCheck. ◀



Converter in oxygen steel plant



A standard KPGZ plummer block housing was modified in accordance with the application requirements



Electronic analysis system and grease sensor



The recorded data is remote-analysed by the Schaeffler remote monitoring service

# Schaeffler Integral Solution Improves Performance of Petrochemical Plant



**Pequiven, Venezuela**  
Pequiven is a state-owned company which was founded over 30 years ago. It produces and markets petrochemical products, mainly for the domestic market. The customer specializes in the production of fertilizers and chemical products as well as olefins and other synthetic resins.

**Challenge for Schaeffler**  
At its phosphoric acid plant, Pequiven wanted to improve the running time of a conveyor belt that separates the solids from the phosphoric acid mixture. The bearings in the conveyor belt were regularly failing after only fifteen days, and the supplier was not listening to the customer’s complaints rather kept trying to change the existing solution for a different one. As the customer was planning to increase its production capacity, they needed a partner which was able to provide integral solutions to the bearing problem including maintenance products and services.

**Schaeffler Solution**  
Schaeffler Venezuela recommended to use a coating material like Corrotect to improve the quality of the housing material. Also it was noticed that manual grease lubrication in the excessive corrosive environment was seldom done properly. So the experts gave a recommendation to use an automatic lubrication system for controlled relubrication. This ensures that a sufficient quantity of fresh grease is constantly supplied to the contact points inside the rolling bearings. With this arrangement, the bearings lasted more than twice the time but still not long enough. So the latest recommendation was to provide a thermoplastic housing with a stainless steel bearing.

Technical Information about the Plant
Foundation:
1977 (modernization in 1990)
Capacity:
250 tons/day of P <sub>2</sub> O <sub>5</sub>

Technical Information about the Solution
First:
INA plummer block housing: RASE40-N-FA125
Lubrication system:
ARCALUB.LC250-MULITITOP-KIT
Later:
INA plummer block housing: RASEY40-TV-VA Stainless steel bearing: GYE40-KRR-B-VA
Automatic lubrication system:
FAG Motion Guard CHAMPION

**Customer Benefit**  
Thanks to the automatic lubrication system and the new housing solution, the customer has been able to reduce both its maintenance times and its maintenance cost significantly. What’s more, in Schaeffler, the customer has found a full service provider who does not only supply innovative products but also takes overall responsibility for the machines. The Schaeffler experts have developed a customized maintenance scheme with individualized solutions which enable the customer to increase its production efficiency even further.

**What’s special**  
Up to this time the use of coatings on bearings was practically unknown in the Venezuelan industry. The solution developed in this case can be applied to all other machines that are subject to a very high level of corrosion and which are suitable for the use of stainless steel and coatings like Corrotect. ◀



Phosphoric acid plant in Pequiven, Venezuela



The plummer block housing gives possibility of connecting lubrication systems



Service expert explains automatic lubrication system



INA plummer block housing with automatic lubrication system

# Spectacular operation on the high seas – Special large spherical plain bearings of X-life quality

A gas platform in the North Sea off the coast of Scotland had already been expanded by the addition of a satellite platform. In order to increase efficiency, this was now to be expanded further by means of a module extension. For reasons of space, it would not be possible to install the module extension either on the main platform or on the satellite platform. The only way of realising this expansion was by construction of a single-leg platform, known as a “mono column”.


### Challenge for Schaeffler

After several meetings with the customer and their contractor, it was clear that a unique design of bearing was required that offered both a very high level of reliability and zero maintenance due to the fact that the customer’s solution involved mounting the column on one of the four main platform feet anchored to the seabed. Further calculation work indicated that joints had to be incorporated into the final design of the extension column to allow for movement caused by wave and tidal current relative to the main rig.

### Schaeffler Solution

For this special application, Schaeffler developed two large spherical plain bearing units that can securely support and transmit the swivel, rotary and axial movements of the mono column. As a basis for the bearing arrangement, maintenance-free large radial spherical plain bearings of X-life quality with a bore diameter of one metre were selected. In comparison with the standard design, the bearings were matched to the customer’s requirements.

Technical Information about the Plant
<b>Mono column:</b>
Single-leg platform acting as an extension to a gas platform
<b>Module extension (on the mono column):</b>
Size: Approximately the size of a normal house
<b>Point of installation:</b>
21 metres above sea level
<b>Fixing to the main platform:</b>
<ul style="list-style-type: none"><li>Welded latticework extension column made from steel tubes</li><li>2 spherical plain bearings at the top end of the mono column</li></ul>

Technical Information about the Solution
<b>Bearing type:</b>
Maintenance-free large radial spherical plain bearings of X-life quality

<b>Bearing bore diameter:</b>
1 000 mm
<b>Customer-specific bearing adaptations:</b>
<ul style="list-style-type: none"><li>Lining of the outer and inner area with ELGOGLIDE-W11</li><li>Additional components (covers and seals)</li><li>Special offshore coating as protection against corrosion and wear</li></ul>

### Customer Benefit

Thanks to the close cooperation between Schaeffler UK and Schaeffler Germany, the customer received not only the two spherical plain bearings but a complete solution – starting from development and proceeding via the production process to offshore bearing installation. An installation trial was carried out onshore, making it possible to identify any weakpoints and develop remedial measures in good time. Offshore installation was carried out by two experienced Schaeffler fitters from Germany who had the necessary safety training for offshore work. It was important first to hold the mono column to the main platform by means of an ancillary construction. After this, the spherical plain bearings and sleeve units could be installed on the main platform with the aid of a crane. Optimum cooperation between all those involved in the project ensured a smooth process, which meant that the project was completed to the full satisfaction of the customer. The lead construction engineer was particularly grateful to the two Schaeffler fitters whose committed service contributed to completion in accordance with the deadlines.

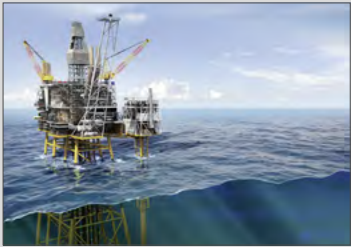
### What’s special

The bearing development was decisively influenced by the following factors:

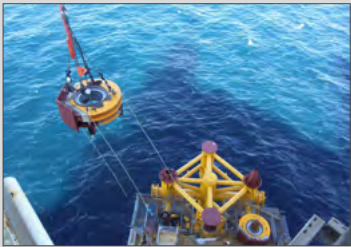
- Freedom from maintenance and high reliability, even under extreme environmental conditions.
- Additional seals and low friction values: the bearings have a lining of ELGOGLIDE-W11 on the outer and inner ring as well as additional components such as covers with seals.
- Anti-corrosion protection: All the surfaces not directly included in the sealed environment are protected against corrosion by means of a special offshore coating. This coating is a combination of proven twin-component coatings based on epoxy resin or epoxy resin/micaceous iron oxide and polyurethane final coating. ◀



Large radial spherical plain bearings unit of X-life quality



Gas platform in the North Sea



The second unit is lowered into place by a crane



During installation, the fitters had to work to millimetre accuracy



# Friction Disk Spindle Bearing Failure Analysis



### Oerlikon Barmag, China

Oerlikon Manmade Fibers with its product brand Oerlikon Barmag is the world market leader in the development and manufacture of filament spinning systems and equipment for producing manmade fibers such as polyester, nylon and polypropylene, as well as for texturing machines.

### Challenge for Schaeffler

A Chinese textile manufacturer had installed around 30 Oerlikon Barmag texturing machines featuring INA-brand friction spindles in 2012. Even during the first and second years after commissioning, the company experienced several failures of friction disk spindle bearings. Approximately 200 spindles were affected. Schaeffler received a customer complaint for all mounted friction disk spindles (in total 7 200 pieces), as such damage affects the spindle accuracy and thus the customer’s product quality.

### Schaeffler Solution

An initial failure analysis by a Schaeffler China quality engineer revealed that the bearing bottom raceways showed spalling, possibly caused by contaminant particles close to the bottom raceways. The customer was not convinced by this conclusion as he had carried out machine maintenance himself for many years. Thus, another expert from the Schaeffler Global Technology Network, a Schaeffler application engineer for textile machinery from Germany, was called in. He took further failure samples and sent them to the Schaeffler failure analysis department in Germany. Following in-depth investigation, the experts found white etching cracks (WEC) underneath the surface of the raceway. These were caused by the passage of current and the use of a grease containing lithium, which did not correspond with the original grease. A mixing of grease and oil occurred due to relubrication with the incorrect grease, which also contributed to the damage. During their next visit, the Schaeffler experts checked the machine in operation and detected static electricity.

Technical Information about the Texturing Machine
Machine Manufacturer (OEM):
Oerlikon Barmag
Texturing machines:
1. FK-6 2. EFK
Number of Oerlikon Barmag texturing machines:
30 pieces (each equipped with 240 spindles, 7 200 spindles in total)
Speed:
7 000 – 9 000 RPM

Technical Information about the Solution
Number of friction disk spindles affected:
200 of in total 7 200 pieces
Bearing affected:
INA-brand friction unit bearing F-221502.06
Schaeffler recommendations:
<ul style="list-style-type: none"><li>• The grease used for relubrication should be the same as the recommended one used for initial greasing</li><li>• If a different type of grease is to be used, its miscibility and compatibility must be checked in advance</li><li>• Relubrication after 1 year</li></ul>
Operation conditons:
<ul style="list-style-type: none"><li>• 50 – 60° C</li><li>• 20 – 30 N belt load</li></ul>

### Customer Benefit

Thanks to the inter-site international cooperation within the Global Technology Network, Schaeffler was able to identify the root cause of the friction disk spindle bearing failures. The affected 200 spindles were replaced immediately. Subsequently, the customer received specific recommendations on how to prevent such failures in the future, for example by relubrication at the recommended intervals, as well as by checking for static electricity and avoiding its build-up in the first place. Thus, he is now able to prevent such lengthy downtimes in the future. The textile manufacturer was so satisfied with the service provided by Schaeffler that he plans to equip his new machines too with INA-brand spindles. OEM Oerlikon Manmade Fibers was also very satisfied with Schaeffler’s support as it helps the company to keep the textile manufacturer as a satisfied customer.

### What’s special

WECs are changes in the material’s microstructure that develop beneath the surface of the component. As a result of the influence of various external stress factors, cracks form that can cause premature bearing failure. These cracks occur both in through-hardened and case-hardened rolling bearings. Schaeffler has an exceptionally high level of expertise in materials science and tribology, and a team of specialists particularly qualified to analyze bearing damage. Innovative solutions from Schaeffler help to improve the bearings’ resistance to white etching cracks and to prevent premature bearing failure. With the Global Technology Network, Schaeffler combines its local and global competencies. Thus the customer always receives the best solution, anywhere in the world. ◀



Barmag texturing machine with INA-brand friction spindles



Manual vibration check on texturing units with friction unit spindles



INA-brand friction unit spindle F-221502.06 & F-220501.06



“White etching cracks” (WEC) underneath the raceway material



INA X-life large spherical plain bearing

## Lasts longer.

INA X-life large spherical plain bearings increase operating life by up to 15 % under the same loading conditions. Alternatively, this allows bearings in existing applications to support higher loads. In new designs, optimized dimensions and reduced weight are possible.

For product designs that deliver higher performance and machines that operate more cost-effectively, take advantage of the performance edge offered by our X-life roller bearing and linear products:

∞ X times longer service life

kg X times greater load-carrying capacity

⦿ X times more efficient use of space

[www.schaeffler.com/X-life](http://www.schaeffler.com/X-life)

»» *Your task is not to foresee the future,  
but to enable it.*

*Antoine de Saint-Exupéry (French writer)*



**SCHAEFFLER**





# Warning: Counterfeit!

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With original products from SCHAEFFLER

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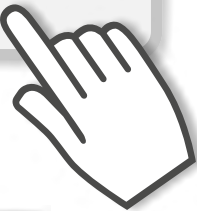
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Counterfeit

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FAG Arcanol greases

	Designation	Characteristic applications	Operating temperature °C from to		Continuous limit temperature °C	Thickener	Base oil	Consistency NLGI	Base oil viscosity +40 °C mm²/s	Temperatures low high		Low friction, high speed	High load, low speed	Vibrations	Support for seals	Relubrication facility
Multipurpose greases	MULTITOP	Ball and roller bearings in rolling mills, construction machinery, automotive engineering, spinning and grinding spindles	-50 <sup>1)</sup>	+140	+80	Lithium soap	Partially synthetic oil	2	82	++	+	+	++	+	•	++
	MULTI2	Ball bearings up to 62 mm diameter in small electric motors, agricultural and construction machinery, household appliances	-30	+120	+75	Lithium soap	Mineral oil	2	110	+	•	•	•	•	•	++
	MULTI3	Ball bearings from 62 mm diameter in large electric motors, agricultural and construction machinery, ventilators	-30	+120	+75	Lithium soap	Mineral oil	3	80	+	•	•	•	+	+	+
High loads	LOAD150	Ball, roller and needle roller bearings, linear guidance systems in machine too	-20	+140	+95	Lithium complex soap	Mineral oil	2	160	•	+	—	++	+	+	+
	LOAD220	Ball and roller bearings in rolling mills, rail vehicles, paper machinery	-20	+140	+80	Lithium/ calcium soap	Mineral oil	2	245	•	+	—	++	+	+	+
	LOAD400	Ball and roller bearings in mining machinery, construction machinery, main bearings for wind turbines	-40	+130	+80	Lithium/ calcium soap	Mineral oil	2	400	•	•	—	++	+	+	+
	LOAD460	Ball and roller bearings, wind turbines, bearings with pin-type cage	-40 <sup>1)</sup>	+130	+80	Lithium/ calcium soap	Mineral oil	1	400	+	•	—	++	+	—	+
	LOAD1000	Ball and roller bearings in mining machinery, construction machinery, cement plant	-30 <sup>1)</sup>	+130	+80	Lithium/ calcium soap	Mineral oil	2	1000	•	•	—	++	+	+	+
Wide temperature ranges	TEMP90	Ball and roller bearings in couplings, electric motors, automotive engineering	-40	+160	+90	Polycarbamide	Partially synthetic oil	3	148	++	+	•	•	•	+	+
	TEMP110	Ball and roller bearings in electrical equipment, automotive engineering	-35	+160	+110	Lithium complex soap	Partially synthetic oil	2	130	++	++	+	•	•	•	•
	TEMP120	Ball and roller bearings in continuous casting plant, paper machinery	-30	+180	+120	Polycarbamide	Synthetic oil	2	400	+	++	—	++	•	+	•
	TEMP200	Ball and roller bearings in guide rollers in baking machinery, kiln trucks and chemical plant, piston pins in compressors	-30	+260	+200	PTFE	Alkoxy fluoro oil	2	550	+	++	—	+	•	•	•
Special greases	SPEED2,6	Ball bearings in machine tools, spindle bearings, rotary table bearings, instrument bearings	-40	+120	+80	Lithium complex soap	Synthetic oil	2 - 3	25	++	•	++	—	—	•	•
	VIB3	Ball and roller bearings in blade adjusters in wind turbine rotors, packaging machinery, rail vehicles	-30	+150	+90	Lithium complex soap	Mineral oil	3	170	+	+	—	+	++	+	—
	FOOD2	Ball and roller bearings in applications with food contact (NSF-H1 registration, kosher and halal certification)	-30	+120	+70	Aluminium complex soap	Synthetic oil	2	150	+	—	•	•	•	•	++
	CLEAN-M	Ball, roller and needle roller bearings as well as linear guidance systems in clean room applications	-30	+180	+90	Polycarbamide	Ether oil	2	103	++	++	•	•	•	•	+
	MOTION2	Ball and roller bearings in oscillating operation, slewing rings in wind turbines	-40	+130	+75	Lithium soap	Synthetic oil	2	50	++	•	—	+	++	+	•

<sup>1)</sup>Measurement values according to Schaeffler FE8 low temperature test.

Definition of symbols | ++ extremely suitable | + highly suitable | • suitable | — less suitable | — not suitable

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\* as of Nov. 2016

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