Our manufacturing and other operational activities are implemented in accordance with our internal quality assurance system and in strict compliance with ISO 9001:2015, ISO 14001:2015 and OHSAS 18001:2007.
For the long-term availability, reliability and security of your system.

For many years, RENK-MAAG has performed non-destructive materials testing of highly-stressed elements of gear units, couplings, complete sets of gear teeth and white metal bearings. These tests have been performed both in RENK-MAAG’s own works and on-site on customers’ premises.

Nowadays a production stoppage means a loss of millions of euros.

Trained staff using the latest technologies and working in close cooperation with the customer perform customer-specific inspection work and make a valuable contribution to the operating reliability of the system.

Magnaflux testing detects changes in the surface of the material. Using appropriate test equipment, this type of testing can be performed on site without problems. Ultrasonic testing is a valuable instrument for inspecting the inner structure of the material. This is the only way by which internal changes within the material, such as very small inclusions, can be detected. Undetected, such inclusions can grow over the years and in the worst cases lead to a tooth breaking or a rotor bursting, with major consequential damage.

RENK-MAAG uses the latest technology. The Epoch 1000i performs tests using both the conventional method and also the Phased Array method.
The safety and availability of systems is of central importance. Nowadays a production stoppage means a loss of millions of euros. Lack of proper maintenance can also lead to injuries to personnel and loss of image.

To guard against these negative variables, RENK-MAAG offers in addition to the proven techniques of visual inspection of gear units “internal inspection” of the gear unit components, all from a single source.

RENK-MAAG recommends material testing of components, especially components of older and heavily stressed gear units and couplings. The best time for this type of test is at the scheduled periodic inspection of the gear unit (major overhaul). The materials test engineer travels to the site after the gear unit specialist and can start work as soon as the gear unit has been opened. Gear unit inspection and materials tests can be performed at the same time without problems. Neither procedure will cause delay to the other.

Certified RENK-MAAG materials test engineers perform the full range of tests using the most modern test equipment including special test heads for gear teeth. Based on their knowledge in the field of materials testing on gear units, a complete test of the gear set and the bearings can generally be completed within 2–3 days – depending on the size of the gear unit and the test method.

Materials test engineers at RENK-MAAG are trained to SN EN ISO 9712 and work all over the world.

RENK-MAAG also performs non-destructive testing on gear units manufactured by other companies and on other system components.

Play it safe:
At the next major overhaul, include an “NDT” inspection.
How are tests conducted in the field? The fields of application of the individual test methods.

<table>
<thead>
<tr>
<th>Test method</th>
<th>Ultrasound</th>
<th>Magnetic particle</th>
<th>Dye penetrant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gear wheel</td>
<td>From approx. gear module 4.5</td>
<td>From gear module 8</td>
<td>Yes</td>
</tr>
<tr>
<td>Pinion</td>
<td>From approx. gear module 4.5</td>
<td>From gear module 8</td>
<td>Yes</td>
</tr>
<tr>
<td>Bearings</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

**Rotors**

(gear wheels / pinions)

- Ultrasound is used to detect cracks within the internal structure of the material. Magnetic particle testing renders even the most minute surface cracks visible. Ideally therefore the two tests should be performed in combination on rotors.
- Magnetic particle testing involves the entrainment / preparation of fluorescent sprays* with metal particles and the facility for darkening the workplace on site so that the gear unit parts can be illuminated with ultraviolet light.
- Ultrasonic testing can however be performed only on gear units with gear modules greater than about 4.5. If the gear teeth are smaller than this, magnetic particle testing or dye penetrant testing are available. The latter method is more suitable for small rotors, since for larger items the quantities of test media (red spray / white spray) required can quickly become very large.
- Depending on the size of the gear module or gear unit, select between the options of conventional ultrasonic testing and the phased array method. The phased array method permits testing with multiple concurrent sound waves. Accordingly it permits a wider section to be tested. The materials test engineer has to apply the test head to the individual tooth less often, so he can work more efficiently. The phased array method is of great interest for testing the larger components of the gear unit, since the cost saving due to the reduced test time can be considerable.

**Bearings**

- White metal is non-magnetic. Therefore bearings can be tested only by means of ultrasound and dye penetrant methods.

Detailed technical information on the individual test methods can be found on the following pages.

All enquiries for materials testing are reviewed by our Quality Department, which prepares a recommendation for the tests that are required, including the time taken by the test engineer. When we prepare quotations we are always careful to offer the customer the best options from the technical and cost-effectiveness points of view.

* Classed as hazardous goods, therefore prohibited from carriage on aircraft.

The phased array method can save up to 50% of the testing time!

Empfehlungen für den weiteren Betrieb

Keine Reduktion auf reduzierte Leistung

Empfehlungen für zukünftige Inspektionen

Nächste Prüfung gemäß RENK-MAAG Wartungsplan

Temporäre Verkürzung der Inspektionsintervalle auf

Extract from a test report with the indications that were found.

Example of a test recommendation

<table>
<thead>
<tr>
<th>Gearbox type: G-36</th>
<th>UT ¹)</th>
<th>UT ²) conventional</th>
<th>MT ²)</th>
<th>PT ³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module: 6</td>
<td>Phased Array</td>
<td>2.6 h</td>
<td>1.8 h</td>
<td>n.a.</td>
</tr>
<tr>
<td>Gear wheel</td>
<td>n.a.</td>
<td>1.5 h</td>
<td>1 h</td>
<td>n.a.</td>
</tr>
<tr>
<td>Pinion</td>
<td>n.a.</td>
<td>0.5 h</td>
<td>n.a.</td>
<td>1.5 h</td>
</tr>
<tr>
<td>Total time in hours</td>
<td>8.9 h</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹) UT: Ultrasonic testing, ²) MT: Magnetic particle testing, ³) PT: Dye Penetrant Testing
Specifically aimed at finding defects in the internal structure of the material.

1. Conventional ultrasonic testing (UT)

Ultrasonic testing permits us to localise and assess defects in the internal structure of the material. Structural cracks such as bonding failures in white metal bearings can reliably be located. Ultrasonic testing is an acoustic procedure which has the special advantage that it permits the user to test the entire volume of a component. The simplest way to describe the principle of ultrasonic testing is to consider it as an impulse-echo procedure. For this purpose the elapsed travel time of the sound wave is measured and sound waves (start pulse, reflected sound waves) are visualised on a screen.

**Impulse-echo procedure**

A test head is placed against the surface of a plane-parallel workpiece that is to be tested. This head acts alternately as an ultrasound transmitter and an ultrasound receiver (Graphics 1–3). The ultrasound device to which the test head is connected measures the time delay of the echo. It then displays whether an echo was received after an ultrasound pulse was transmitted, together with the time delay. If the speed of sound in the material to be tested is known, the measured time delay gives an indication of the distance from the test head of the reflection point of the ultrasound pulse. If this distance corresponds to the thickness of the workpiece, there was no obstacle within the material that hindered the propagation of the sound waves. The test object is thus free of defects (Graphic 2). If however an earlier echo is received back, this must originate from a break in the material or from a defect within the workpiece (Graphic 3).
The test head is moved at definite axial intervals along a test track on the head of the tooth, over the entire length of the tooth. This procedure is followed along both flanks of each tooth. In addition a further ultrasound emission is performed at the head of the tooth (Graphic 1).

Location and determination of the defect (views)
The test device/test head is calibrated and adjusted using a test body (tooth segment) in which there is a flat-bottomed hole of 1 mm diameter. If a defect echo is received from the object being tested, the distance from the test head to the reflection point travelled by the sound wave can be read off on the device. This permits the coordinates of the location of the defect to be determined. If the amplitude of the defect echo exceeds a certain value it is registered on the display as an indication, and is documented in the RENK-MAAG test report. Indications are described in terms of their echo amplitude and extent.

Individual indication without extent (EE)
An individual indication is present when an echo from the reflection point decreases evenly from the maximum in all directions when sampled consistently, see Graphic 4.

Individual indication with extent (EA)
Indications with extent exhibit a decrease in amplitude that is uneven in at least one direction. The determination of the extent is performed using the half-amplitude method. This allows discrimination only between individual indications with extent and individual indications without extent. Conventional ultrasonic testing is laborious and, depending on the size of the toothed gears, may be expensive. Therefore whenever possible RENK-MAAG works with the new phased array test method, which is quicker (can be used from gear module 8).

2. Ultrasonic testing with the phased array method
The phased array method is a further development of ultrasonic testing. Advanced array heads with many elements emit bundles of high-frequency sound into the test body. The echoes returned reproduce detailed representations of the inner structure of the test body. This procedure is supported by a powerful software package. Multiple emission angles can be achieved from a single sound injection position. Using high test sensitivity the entire rotor set can quickly be tested.

The following advantages of phased array testing can be emphasised in comparison to conventional methods:

- The wide angular range from a single sound injection position (additional detection of off-centre defects).
- Time saving when testing large components.
- Easily understandable 3D visual representation.
3. Magnetic particle testing (MT)

Magnetic particle testing (also known as Magnaflux testing, MP testing or MT testing) is another method of non-destructive materials testing. Its purpose is primarily to detect even very fine fissures leading to breaks in the material not visible to the naked eye, both at the surface (e.g. cracks) and in zones close to the surface. Ferromagnetic materials can be tested. For magnetic particle procedures the test section of the workpiece must be magnetised. Optimum detection of defects is achieved when the magnetic field is at right angles to the material defect. The magnetic flux then passes along a ferromagnetic field in the workpiece. The primary direction of the field is a line from one magnetic pole to the other. This can be achieved by a clamping jig. In this way the entire workpiece is magnetised. Hand-held magnets can also be placed on the workpiece; these have the effect of magnetising the area between the two
poles. In order to detect randomly oriented cracks, two or more types of magnetisation can be employed concurrently in a combined procedure.

Coloured or fluorescent magnetic particles are available as test media. Fluorescent magnetic particles have the greatest sensitivity. A distinction is also made between wet testing (using water or oil as a carrier medium) and dry testing. The defect detection capability is greatest using wet testing.

4. Dye penetrant testing (PT)

Dye penetrant testing (also known as red-white testing, PT or FE testing) can be used on ferrous and non-ferrous metals, many plastics, ceramic materials, glass etc. to detect surface defects on components and machines. It can be performed quickly and without great cost. The pre-requirement for selecting dye penetrant testing as a method is that the defects are open to the surface. This procedure finds applications in the testing of weld seams, castings, in shipbuilding, aircraft building, in the automobile industry, and in the building of apparatus and containers etc. A distinction is made between coloured dye penetrant testing and fluorescent dye penetrant testing. Fluorescent dye penetrant testing uses a dye which fluoresces when illuminated by UV radiation. RENK-MAAG works exclusively with coloured dye penetrant testing.

The characteristic of dye penetrant testing is that defects such as cracks, pores etc. become visible and can be detected, even in non-magnetisable materials.

Both dye penetrant testing methods are based on four operations:

1. Preparatory cleaning
2. Application / soaking in of the dye penetrant
3. Intermediary washing / drying
4. Development / assessment

Source for dye penetrant testing: http://www.mr-chemie.de/produkte/eindringpruefung/beschreibung/

Summary

Regular gearbox maintenance in combination with NDT package ensures safe and reliable system operations.

Carefree package with RENK-MAAG service technicians
• Offshore training certified for platforms
• Medical certificates and immunisation
• Crane operator certified
• Visa applications with Letter of Invitation
• Other individual information such as requested online trainings / certificates
Everything else you need for maintenance of your gear unit and/or coupling

Additional inspections and analyses

- Scanning electron microscopy: A tooth replica can be used to examine the surface structure of the tooth using scanning electron microscopy. This test is used to explain the causes of slight to major tooth damage such as grey staining, micropitting, electric erosion resulting from creepage current etc.
- Flow rate and pressure measurements on the lube oil system.
- Endoscopic examination of gearbox parts.
- Measuring and aligning shaft trains using laser measuring methods or dial gauges.
- Casing vibration, airborne noise and shaft vibration measurements on the gearbox including the associated analyses.
- Oil analyses.
- Other services.

Field service – Regular maintenance means long operating life

Maintenance schedule
Depending on the number of years of operation or operating hours since commissioning or the last maintenance work, we recommend the following RENK-MAAG standard inspections:

- Run-in Inspection
  Within first year of operation.

- Minor Inspection
  A brief check through the inspection cover provides an overview of the gearbox condition.

- Major Overhaul
  This large-scale check involves dismantling, cleaning and re-assembling the gearbox.

If necessary, individual components or worn parts are replaced. – This will be the right time for a non-destructive testing (NDT).

After each inspection or overhaul, our service technicians will provide you on the spot with a system report containing the following points of importance to safety and optimum availability:

- General condition of the gearbox
- Possible and detected defects
- Recommended spare parts
- Due date and scope of next inspection

Phone +41 52 262 87 62
service@renk-maag.ch

Insurance spare parts on-site

RENK-MAAG recommends holding the following key components in stock:

- 1 spare set of rotors
- 1 spare set of bearings
- 1 spare set of oil scrapers
- 1 spare set of instrumentation

The defective parts can then be replaced immediately, limiting any production downtime to a minimum. Keep in mind that even under the best conditions, it will take several months for spare bearings or rotors to be delivered.
Buy new, repair or modify?

Although defects in RENK-MAAG gearboxes are rare, incorrect storage, improper care, changing operating conditions, inadequate oil quality or poor maintenance can occasionally result in damage. New parts do not always have to be procured in such circumstances.

Why preventive control?
Even if no damage is apparent we still recommend that specific periodic inspections of major components are conducted by RENK-MAAG. Such preventive measures do not necessarily result in repairs. On the contrary, inspections safeguard long-term, trouble-free operation, and extend the service life.
RENK-MAAG repairs or overhauls all RENK-MAAG products where necessary. The same applies for all MAAG turbo and marine gearboxes, couplings and GP pumps for which spare parts are manufactured according to original drawings. RENK-MAAG also maintains individual components such as bearings, rotors, turning gears, etc. and also conducts repairs of third party products.

Repair procedure
A detailed inspection is initially made of the affected parts. This results in an objective report regarding the condition of the parts and any deviations from the norm, as well as a repair proposal. The second step is the repair itself. A test run of each complete gearbox or coupling can be conducted on our state-of-the-art testbed for certification purposes.

Repair goals
- Quick turnaround time
- Original dimensions are maintained where possible
- Reusable as new parts

Damage assessments
RENK-MAAG conducts non-destructive, and if necessary, destructive damage assessments together with external independent experts.

Modifications
RENK-MAAG undertakes modifications of gearboxes after clarification of the technical feasibility. This includes:
- Speed alterations
- Performance modifications e.g. power upgrades
- Additional instrumentation
- Turning gear
- Mounted pumps
- Custom modifications

A repair is possible in the majority of cases.

Contact us all over the world

RENK-MAAG is represented by designated agents in over 35 countries around the world. So we can advise and support our customers on all continents directly – whether on new gearboxes or couplings, modifications, replacements, spare parts, repairs or field service.

The current contact details are readily available on our website: www.renk-maag.ch
Our manufacturing and other operational activities are implemented in accordance with our internal quality assurance system and in strict compliance with ISO 9001:2015, ISO 14001:2015 and OHSAS 18001:2007.