Advanced mill liner wear measurement and prediction services
A partner for success

Our approach is centred on partnership. We approach each project not as suppliers with products to sell but partners with solutions to offer, ready to work with you to support your milling operations achieve their full potential. Our liner profiling and scanning solutions include:

- 3D scanning.
- Basic wear reporting.
- Advanced wear analysis and reporting.
- Liner replacement forecast.
- Mill liner profile optimisation.
- Mill liner material optimisation.
- Onsite technical advisory and audits.
- Supply and installation of new optimised liners.

How do we do this?

It starts with an understanding of how mill liners wear. And that is where we excel. Our deep process and product expertise – built on more than 135 years of history in the mining industry – gives us unparalleled insight into the causes of wear and how to combat it. Simply put: we know what we’re talking about. And that means we’re your reliable partner for mill wear optimisation.

Add into the mix our advanced 3D scanning, liner profiling, and wear prediction technologies and you have a winning package. We make wear measurement simpler and faster – while keeping it comprehensive – to provide you with the most appropriate solutions to reduce the total cost of ownership of your mill. We help you discover what your mill is really capable of.

Discover performance

Our advanced liner profiling and scanning services use cutting-edge technology to give you the most accurate and actionable information about the condition of your mill liners. We also let you know the steps that can be taken to optimise the liner wear life – empowering you to extend the life of your equipment and better plan maintenance shutdowns.

Key benefits

- Improve mill performance
- Improve operating procedures
- Improve maintenance
- Improve safety
- Reduce costs

The productivity of mining operations depends on a productive milling process. And central to a productive milling process is the wear life of its liners. Unpredictable wear increases maintenance requirements and reduces uptime. But understand how a mill wears and you’re on your way to extending equipment life and better planning maintenance. Which is where our advanced 3D scanning and liner profiling technologies come in.
Workflow process

- Laser technology
- High resolution
- 50 million data points
- Reading time for standard resolution ≤8 minutes
- Linear error ±2 mm at 10 m and 25 m, each at 90% and 10% reflectivity
- Safe and efficient
- Total time <20 minutes

Basic summary
- Mill charge
- Reline date with ±7 days accuracy
- Minimum remaining liner thickness
- Liner wear trend in <2 days

Detailed report
- Liner longitudinal and cross-sectional wearing profiles.
- Colour-coded wear map
- Cross-sectional profile thickness comparison with new liners
- Profile diagrams for each liner
- Functional replacement data for liner performance and expert recommendations in <5 days

Data analysis
- DEM simulation
- Topological analysis
- Optimisation of liner profile
- Suggested mechanical or material changes
- Advisory services
- Audits
- Supply and installation of new and optimised liners

Data transmission
3D data points from the scanner are transmitted to us for analysis via the FLSmidth Cloud Infrastructure Platform. The same platform is also used to transmit the report and recommendations back to the customer.

3D scanning

Our 3D laser scanning technology can capture up to 50 million data points, at levels of accuracy that are simply not possible with physical measurement, to build a profile of the liner.

The scan generates a complete set of 3D cloud point data of everything around the laser to an accuracy of ±2 mm at 10 m and 25 m, each at 90% and 10% reflectivity.

With a scanning time as short as 8 minutes, it can easily be performed during planned maintenance and inspection schedules. Total time – including lock-out and tag, checking-in staff and team, installation, scanning, check-out out of staff and team, and unlock and signalling – is less than 20 minutes.

To ensure our recommendations are appropriate to the real-world conditions of your mill, one of our wear experts – who understands your unique operating practices and process conditions – will also review the analysis. All necessary data and images required to generate the report are obtained during this phase.
Report

The insights provided by the model and subsequent analysis are automatically compiled into a report, which is usually delivered in two phases. A basic summary is sent within two days of the scan; a detailed report then follows within the next three days:

Basic summary:
- Mill volume calculation.
- Reline date (±7 days accuracy).
- Minimum remaining liner thickness.
- Liner wear trend.

Detailed report:
- Liner longitudinal and cross-sectional wear profiles.
- Colour-coded wear map.
- Cross-sectional profile thickness comparison with new liners.
- Profile diagrams for each liner.
- Functional replacement date for liner performance.
- Expert recommendations.

Mill volume calculation

<table>
<thead>
<tr>
<th>Measurement order</th>
<th>Measurement date</th>
<th>Mill load m³</th>
<th>Free space m³</th>
<th>Total mill volume m³</th>
<th>Mill load %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7-Jan-19</td>
<td>96.0</td>
<td>390.0</td>
<td>486.0</td>
<td>19.75 %</td>
</tr>
<tr>
<td>2</td>
<td>13-Feb-19</td>
<td>97.4</td>
<td>390.8</td>
<td>488.2</td>
<td>19.95 %</td>
</tr>
<tr>
<td>3</td>
<td>19-Mar-19</td>
<td>86.0</td>
<td>410.0</td>
<td>496.0</td>
<td>17.34 %</td>
</tr>
<tr>
<td>4</td>
<td>29-Apr-19</td>
<td>100.3</td>
<td>406.4</td>
<td>506.7</td>
<td>19.79 %</td>
</tr>
</tbody>
</table>

Liner wear trend curve

Discharge head grate (lifter & plate)

Forecast for lifter and plate

<table>
<thead>
<tr>
<th>Installation date</th>
<th>Highest wear rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forecast discharge head liner</td>
<td></td>
</tr>
<tr>
<td>Current measurement date</td>
<td>19-Mar-2019</td>
</tr>
<tr>
<td>Accumulated tonnage</td>
<td>3.808 mT</td>
</tr>
<tr>
<td>Average-processed tonnage</td>
<td>52,500 tonne/day</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reline thickness</th>
<th>Accumulation duration of current campaign</th>
<th>Previous campaign duration</th>
<th>Forecast, remaining tons</th>
<th>Forecast, remaining days</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>16.6 Weeks</td>
<td>15.6 Weeks</td>
<td>1.99 mT</td>
<td>38 days</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Control date</th>
<th>Days</th>
<th>Tonnage (mT)</th>
<th>Accumulated Thickness (mm)</th>
<th>Wear rate (mm/mT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>07-Jan-2019</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>13-Feb-2019</td>
<td>37</td>
<td>2,023,000</td>
<td>2.02</td>
<td>119</td>
</tr>
<tr>
<td>19-Mar-2019</td>
<td>34</td>
<td>1,785,000</td>
<td>1.79</td>
<td>110</td>
</tr>
</tbody>
</table>

Discharge head plate (Profile 2800 mm)

Forecast for lifter and plate

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<thead>
<tr>
<th>Installation date</th>
<th>Highest wear rate</th>
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</thead>
<tbody>
<tr>
<td>Forecast discharge head liner</td>
<td></td>
</tr>
<tr>
<td>Current measurement date</td>
<td>19-Mar-2019</td>
</tr>
<tr>
<td>Accumulated tonnage</td>
<td>3.808 mT</td>
</tr>
<tr>
<td>Average-processed tonnage</td>
<td>52,500 tonne/day</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reline thickness</th>
<th>Accumulation duration of current campaign</th>
<th>Previous campaign duration</th>
<th>Forecast, remaining tons</th>
<th>Forecast, remaining days</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>16.6 Weeks</td>
<td>15.6 Weeks</td>
<td>1.99 mT</td>
<td>38 days</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Control date</th>
<th>Days</th>
<th>Tonnage (mT)</th>
<th>Accumulated Thickness (mm)</th>
<th>Wear rate (mm/mT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>07-Jan-2019</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>13-Feb-2019</td>
<td>37</td>
<td>2,023,000</td>
<td>2.02</td>
<td>119</td>
</tr>
<tr>
<td>19-Mar-2019</td>
<td>34</td>
<td>1,785,000</td>
<td>1.79</td>
<td>110</td>
</tr>
</tbody>
</table>
Shell liner (lifter & plate)

Forecast for lifter and plate

<table>
<thead>
<tr>
<th>Control date</th>
<th>Days</th>
<th>Accumulated</th>
<th>Tonne</th>
<th>mT</th>
<th>Accumulated</th>
<th>Thickness (mm)</th>
<th>Loss of thickness (mm)</th>
<th>Wear rate mm/Week</th>
<th>Wear rate mm/mT</th>
<th>Wear rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>07-Dec-2018</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>01-Jan-2019</td>
<td>31</td>
<td>31</td>
<td>1,577,000</td>
<td>1.52</td>
<td>1.52</td>
<td>393</td>
<td>65</td>
<td>14.68</td>
<td>42.85</td>
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<tr>
<td>13-Feb-2019</td>
<td>37</td>
<td>68</td>
<td>2,024,000</td>
<td>2.02</td>
<td>3.54</td>
<td>343</td>
<td>50</td>
<td>9.42</td>
<td>24.60</td>
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<tr>
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<td>34</td>
<td>102</td>
<td>1,787,000</td>
<td>1.79</td>
<td>5.33</td>
<td>254</td>
<td>90</td>
<td>18.47</td>
<td>50.20</td>
<td>0</td>
</tr>
</tbody>
</table>

Cycle from 07-Dec-2018 to 19-Mar-2019

Discharge head grate thickness as on December 08, 2019

Discharge head grate longitudinal lifter & plate as on December 08, 2019

Discharge head liner wear profile

Original thickness
Scan data 08-Dec-19
Reline thickness: 90 mm

Liner wear trend tonnage
Shell liner thickness chart as on December 08, 2019

Shell liner wear profile

Shell liner longitudinal and cross section as on December 08, 2019

### Feed head liners (lifter & plate)

#### Forecast for lifter and plate

<table>
<thead>
<tr>
<th>Installation date</th>
<th>Highest wear rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>07-Jan-2019</td>
<td>26.1 mm/mT</td>
</tr>
<tr>
<td>Current measurement date</td>
<td>Lifter wear rate</td>
</tr>
<tr>
<td>19-Mar-2019</td>
<td>18.8 mm/mT</td>
</tr>
<tr>
<td>Accumulated tonnage</td>
<td>3.808 mT</td>
</tr>
<tr>
<td>Plate wear rate</td>
<td>20.0 mm/mT</td>
</tr>
<tr>
<td>Average processed tons</td>
<td>52,500 Tons/day</td>
</tr>
</tbody>
</table>

#### Forecast of change in terms of highest wear and critical thickness (lifter)

<table>
<thead>
<tr>
<th>Reline thickness</th>
<th>Reline date</th>
<th>Total Estimation duration of current campaign</th>
<th>Previous campaign duration</th>
<th>Highest wear located in point</th>
<th>Forecast, remaining days</th>
<th>Forecast, remaining thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>110 mm</td>
<td>29-Apr-2019</td>
<td>15.3 Weeks</td>
<td>15.5 Weeks</td>
<td>Worn thickness 110 mm lifter</td>
<td>42 days</td>
<td>5.77 mm</td>
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</table>

#### Forecast of change in terms of highest wear and critical thickness (lifter)

<table>
<thead>
<tr>
<th>Forecaster, remaining tons</th>
<th>Current measurement date</th>
<th>Average processed tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.192 mT</td>
<td>19-Mar-2019</td>
<td>52,500 Tons/day</td>
</tr>
</tbody>
</table>

#### Feed head lifter (Profile 1800 mm)

<table>
<thead>
<tr>
<th>Control date</th>
<th>Days</th>
<th>Accumulated Tonne</th>
<th>Tonne/mT</th>
<th>Accumulated mm/Week</th>
<th>Worn thickness mm</th>
<th>Wear rate mm/Week</th>
<th>Wear rate mm/mT</th>
</tr>
</thead>
<tbody>
<tr>
<td>7-Jan-2019</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>270</td>
</tr>
<tr>
<td>13-Feb-2019</td>
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<tr>
<td>19-Mar-2019</td>
<td>34</td>
<td>1,785,000</td>
<td>1.79</td>
<td>3.81</td>
<td>179</td>
<td>47</td>
<td>9.59</td>
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</tbody>
</table>

#### Liner wear trend tonnage

<table>
<thead>
<tr>
<th>Liner thickness (mm)</th>
<th>Tonnage (mT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>270</td>
<td>2.192 mT</td>
</tr>
<tr>
<td>226</td>
<td>2.192 mT</td>
</tr>
<tr>
<td>179</td>
<td>2.192 mT</td>
</tr>
</tbody>
</table>

Cycle from 07-Dec-2018 to 19-Mar-2019

#### Liner wear trend tonnage

<table>
<thead>
<tr>
<th>Liner wear trend tonnage</th>
<th>Tonne (mT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>226</td>
<td>2.192 mT</td>
</tr>
<tr>
<td>179</td>
<td>2.192 mT</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Liner wear trend tonnage</th>
<th>Tonne (mT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>110</td>
<td>2.192 mT</td>
</tr>
<tr>
<td>90</td>
<td>2.192 mT</td>
</tr>
</tbody>
</table>
Liner optimisation

After thorough data analysis, delivery of the report, and with your consent, we can then go ahead with optimising the liners. This makes sure they offer the best mechanical and materials specifications for improved productivity and longer wear life. Discrete element modelling (DEM) is carried out to simulate throughput based on existing operating parameters and to evaluate how the liner design may be improved to meet your targets.

It’s at this point that our collaborative approach is critical. We understand that there is no one-size-fits-all solution in mining. Your business is unique. So is your process. And so is your equipment. We also understand that you know your business, process and equipment inside and out. To make sure the final results are tailored to your needs, we discuss everything through with you and then incorporate your expert knowledge into the design.

In addition, as a complete OEM supplier of mills and mill parts, we bring experts with deep experience and understanding of mill equipment and processes to the table. This means we can take a holistic view of the mill and how it interacts with the complete milling circuit to provide effective long-term solutions, rather than short-term fixes.

DEM simulations were conducted to ensure the most efficient lining design is recommended.

Establishing the maximum number of impacts per second using DEM simulations.
**Optimised mill liners**

- Specially selected geometry to ensure proper comminution and power draw.
- Composite materials highly resistant to abrasion and impact.
- Rubber and hardened steel inserts make a lighter and longer-lasting part.
- Iterative process to refine and improve designs best suited for each customer’s mill and application.
- Operational support to select appropriate ramp-up curves and equipment settings.
- Designs vetted through multiple simulations to select the most effective mechanical and material design.
- Increased capacity with optimised design.
- FLSmidth field experts use 3D scanning technology to identify the critical wear areas to calculate and extend the wear life.

**Supply and installation**

When the time comes to replace the mill liners, every second of downtime is lost production – and lost profits. Our relining service teams comprise highly-skilled engineers and technicians that help ensure the mill is back up and running as quickly as possible. Our relining and maintenance service teams are based regionally but backed by our global pool of leading process knowledge experts. Our service engineers and product specialists can also provide audit and advisory services.
Digitalizing the grinding circuit

By digitalizing your grinding circuit, you can boost productivity and energy efficiency by 5% and decrease process variability by 30%.

**INTERNET AND CLOUD SOLUTIONS**
Connect your assets to our secure cloud infrastructure. It seamlessly integrates data and signals, enabling greater visibility to identify operational improvements or potential bottlenecks that may impact productivity. Access your data anytime and anywhere — even on your mobile device.

**CONTROL ROOM**
Monitor and control your mill or entire grinding circuit from one central control room — onsite or remotely.

**REMOTE OPERATIONS AND SERVICES**
Protect your assets by monitoring or controlling your entire plant or single mill. The FLSmidth 24/7 Global Remote Service Center makes our expertise and know-how available to maximise your performance.

**CYBER SECURITY**
Connect your equipment to the internet via our secure infrastructure and optimise remotely.

**EQUIPMENT MONITORING**
Get easy and direct access to information on your mill health and performance with our intuitive HMS or on your mobile device.

**CONNECTIVITY**
Monitor, control and optimise remotely

- **SiteConnect**
  Real-time data on your mobile device. Instant notifications in case of unexpected events, and live access to performance data.
- **ECS/Product Control**
  Integrated product control enables faster commissioning, fewer programming errors and better overall performance. The integrated controls also provide you with the "ecosystem" for plug and play future upgrades and services.
- **24/7 Global Remote Service Center**
  Reduce unplanned downtime through insightful analytics and 24/7 monitoring by subject matter experts.
- **Cyber Security**
  Keep your connected IT updated, safe and unbreachable. Cyber security is an integrated and fundamental capability of our digital portfolio.

**ASSET HEALTH**
Keep your equipment healthy and your processes running smoothly

- **LoadIQ**
  Smart sensor technology that will automatically determine and maintain the optimal mill load while simultaneously accounting for liner wear and ore body changes in real-time. Maximise efficiency, avoid liner damage, and increase throughput rates.
- **ECS/UptimeGo**
  Get insights to identify causes of equipment failure and eliminate downtime root causes.
- **ECS/ProcessControl**
  Delivers complete and reliable automated control of your grinding circuit, optimises performance, ensuring you are operating at your maximum potential. It also supports quicker and smarter troubleshooting of faults by your operators and maintenance engineers, reducing downtime and lost production. And it provides the tools, data and connectivity needed to unlock the value of Industry 4.0.
- **Augmented Field Engineer**
  Allows our engineers to remotely assist with your operations from anywhere in the world and eliminate downtime root causes.
- **On-Stream X-ray Analyzer**
  State-of-the-art sensitivity and short analysis cycle times for monitoring slurry process streams.
- **SmartCyclone™**
  Optimizes the cyclone process and predicts and controls cyclone maintenance schedules.

**PERFORMANCE OPTIMISATION**
Boost your productivity

- **ECS/Plant Data Management**
  From single equipment to entire plants, our digital solutions uses data intelligence to optimise your performance, boost your productivity and reduce your energy usage.
- **ECS/ProcessExpert™**
  Advanced process control system to improve grinding circuit productivity and energy efficiency.
- **SAGwise™**
  Minimise critical impacts to prevent liner damage, avoid shutdowns and cut energy costs.
- **PERI Automatic Ball Charger**
  Controlled, continuous supply of balls to ensure your mill operates at optimum charge level.

**Key benefits**

- On-demand information in the control room or on your mobile
- Expedite remote support
- Enable faster decisions and actions
- Real-time insights available to top management
- Increase uptime and availability by decreasing unplanned breakdowns
- Maximise productivity and reliability
- Reduce environmental impact
- Cut operating costs
- Control and optimise operations
How you will benefit from our advanced wear measurement and prediction services

- Increase uptime and enable higher utilisation rates, throughput and productivity
- Empower better operating decisions with wear trending report and analysis
- Better forecast wear to inform maintenance planning
- Lower maintenance requirements limit personnel’s interaction with mill
- Lower cost of production with improved energy efficiency and extended uptime