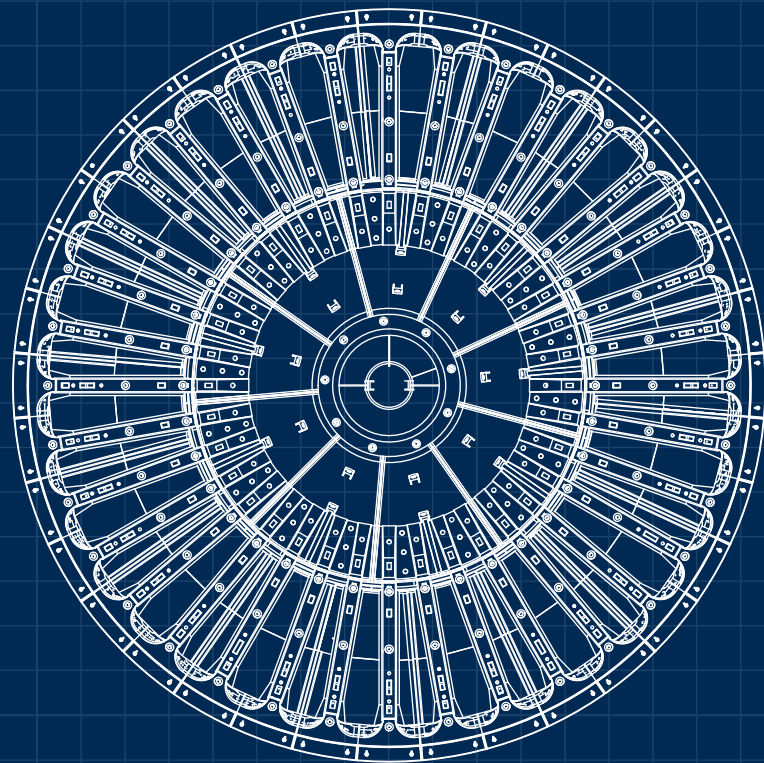


# Advanced mill liner wear measurement and prediction services



# Increase uptime through improved wear and extended liner life

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.



## Key benefits

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

## 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.

### 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.

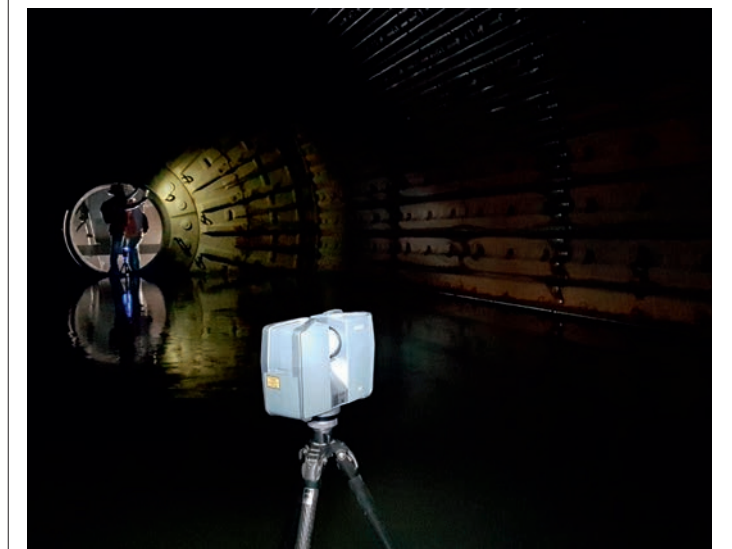
### A partner for success

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.



FARO laser scanner



Recording liner profiles as 3D cloud point data inside the mill chamber



# Workflow process



## 3D Scanning

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

## FLSmidth Cloud

- Data processing and manipulation
- Model generation
- Alignment and segment selection
- Extract deviation
- Wear trends revealed
- Wear pattern mapped
- Operating practices revealed
- Wear life prediction
- Generation of profile images

## Data analysis

### Basic summary

- Mill charge
- Reline date with  $\pm 7$  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 date for liner performance and expert recommendations in <5 days

## Report

## Liner optimisation

- DEM simulation
- Topological analysis
- Optimisation of liner profile
- Suggested mechanical or material changes

## Supply & installation

- Advisory services
- Audits
- Supply and installation of new and optimised liners

# 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  $\pm 2$  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 of staff and team, and unlock and signalling – is less than 20 minutes.

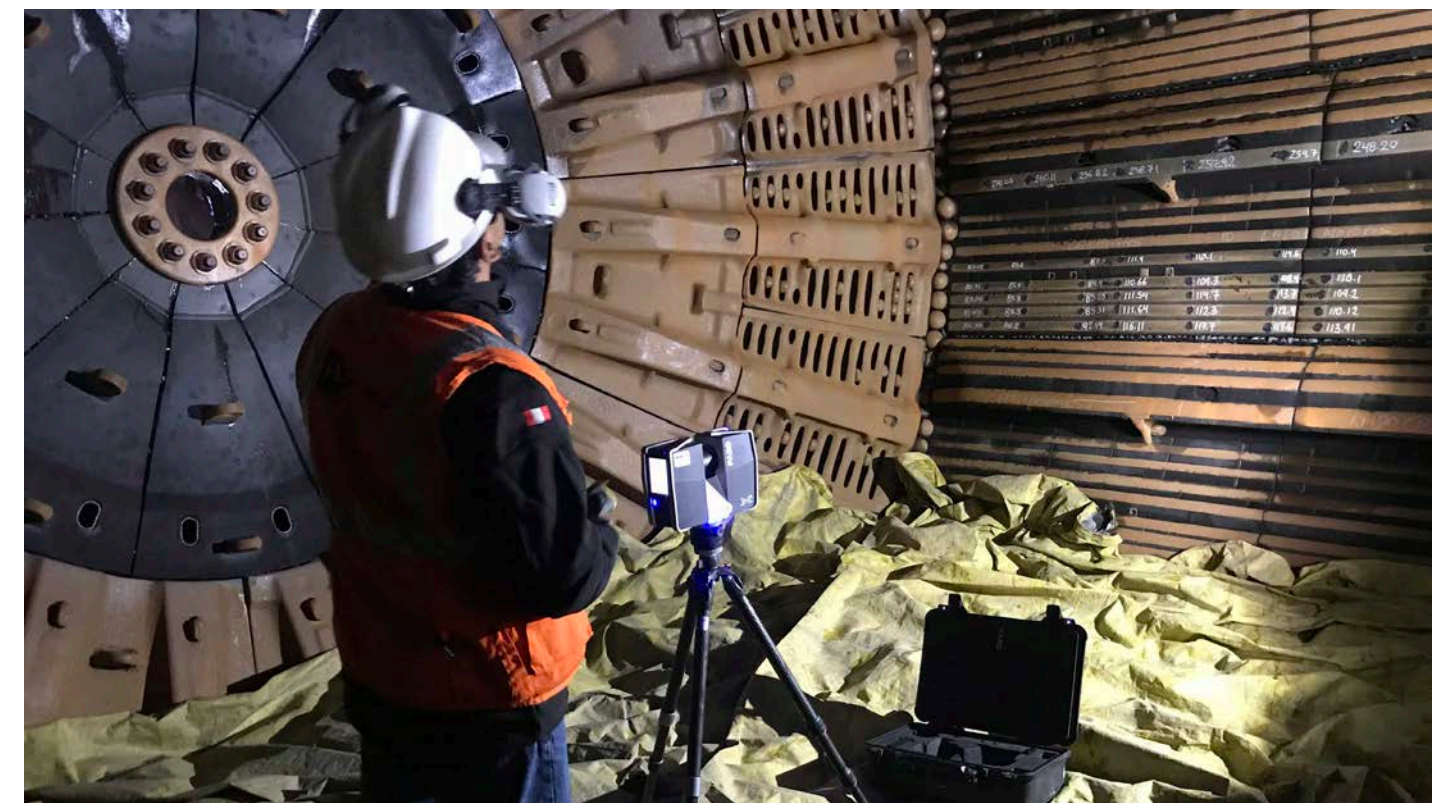
### Data transmission

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.

### Data analysis

Once received, the data is automatically processed, manipulated, and converted into a 3D model. This is then aligned appropriately and compared with a fully-intact stock model of the liner set to highlight deviations. The deviations are then analysed for wear trends and wear patterns, and to forecast relining.

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 ( $\pm 7$  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

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

# Discharge head grate (lifter & plate)

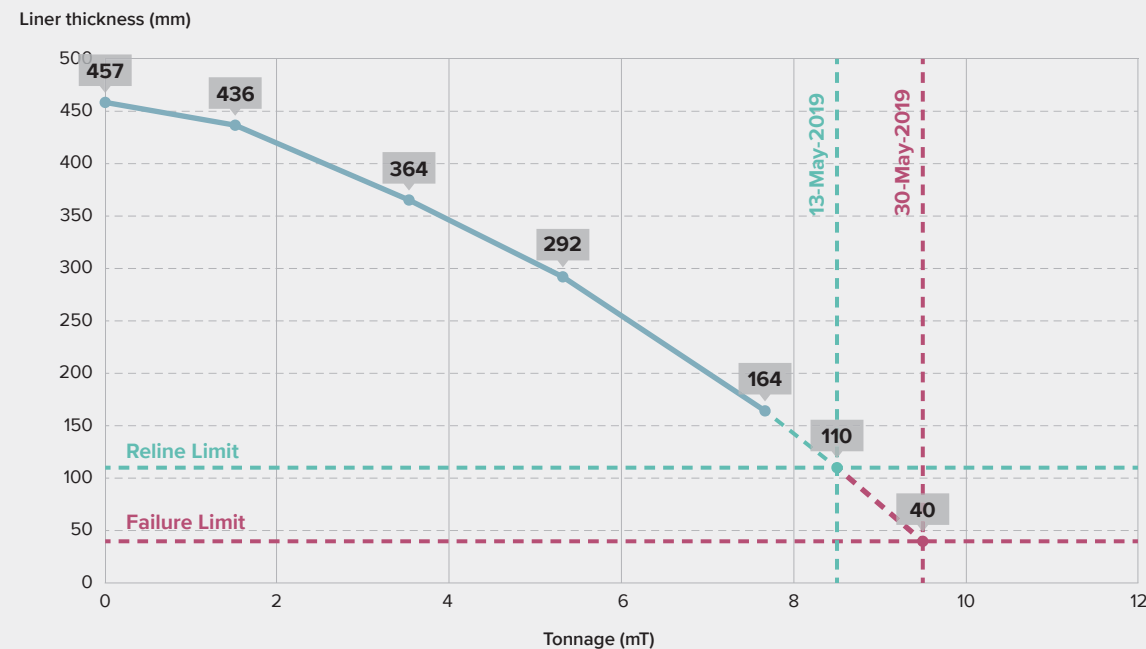
## Forecast for lifter and plate

Forecast discharge head liner			
Installation date	07-Jan-2019	Highest wear rate	
Current measurement date	19-Mar-2019	Lifter wear rate	12.6 mm/mT
Accumulated tonnage	3.808 mT	Plate wear rate	12.3 mm/mT
Average processed tons	52,500 tonne/day		

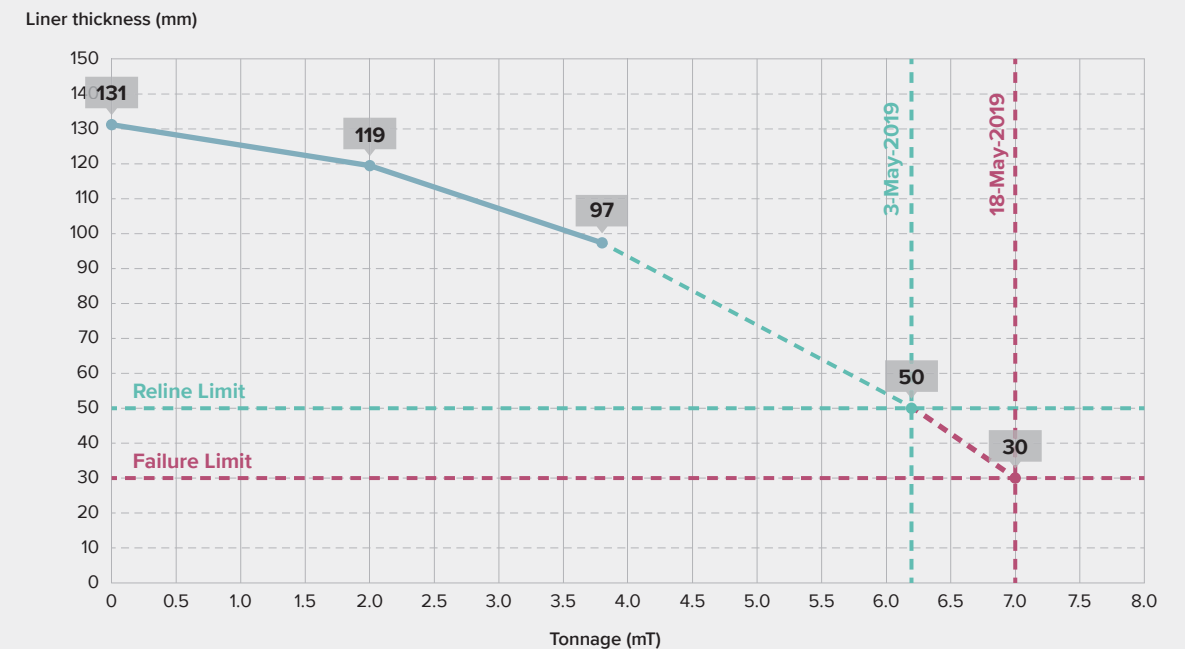
Forecast of change in terms of highest wear and critical thickness (plate)				
Reline thickness	40	Total estimation duration of current campaign	Previous campaign duration	Highest wear located in point N°11 feeding lifter
Forecast, remaining tons	1.99 mT			
Reline date	03-May-2019	16.6 Weeks	15.6 Weeks	Worn thickness 50 mm plate critical thickness
Forecast, remaining days	38 days	6.2 mT	5.24 mT	

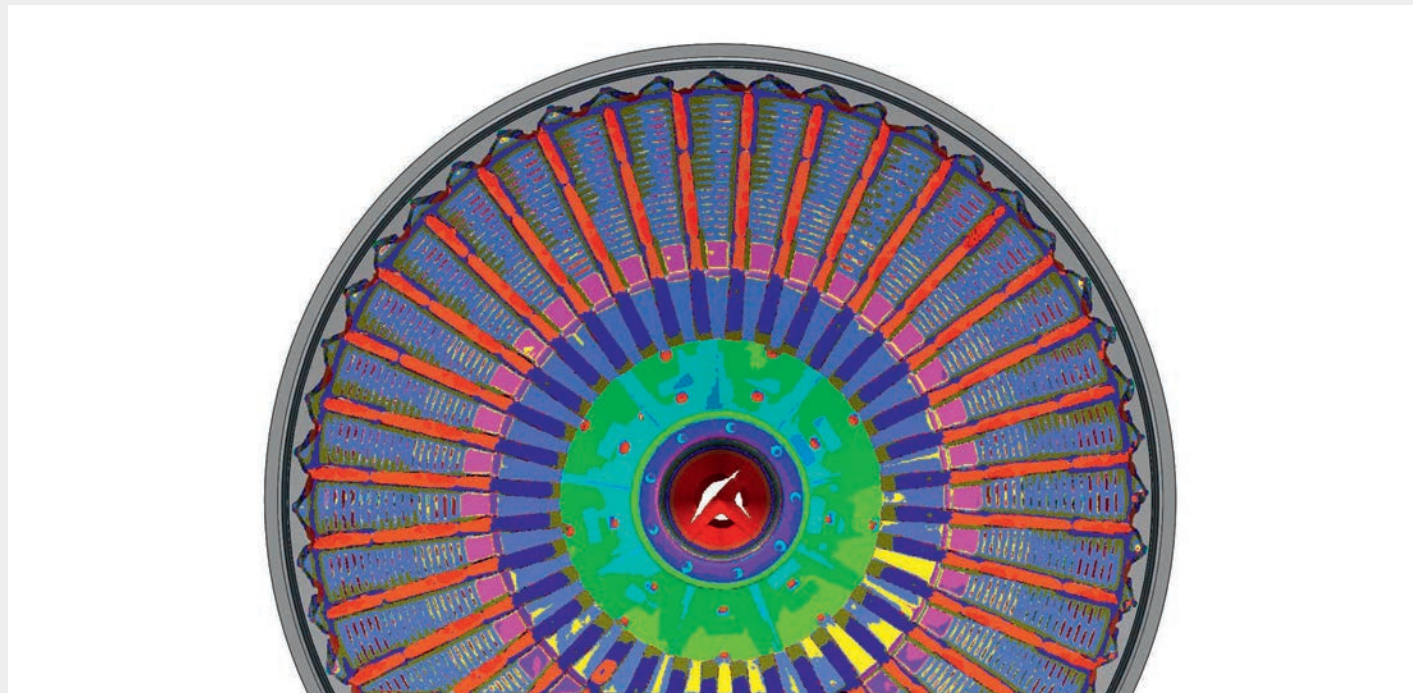
Discharge head plate (Profile 2800 mm)									
Control date	Days		Tonnage			Thickness (mm)	Loss of thickness (mm)	Wear rate	
	Days	Accumulated	Tonne	mT	Accumulated			mm/Week	mm/mT
Cycle from 07-Jan-2019 to 19-Mar-2019									
07-Jan-2019	0	0	0	0.00	0.00	131			
13-Feb-2019	37	37	2,023,000	2.02	2.02	119	12	2.27	5.93
19-Mar-2019	34	71	1,785,000	1.79	3.81	97	22	4.53	12.32

## Liner wear trend curve



## Liner wear trend tonnage





Discharge head grate thickness as on December 08, 2019

### Discharge head liner wear profile



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

# Shell liner (lifter & plate)

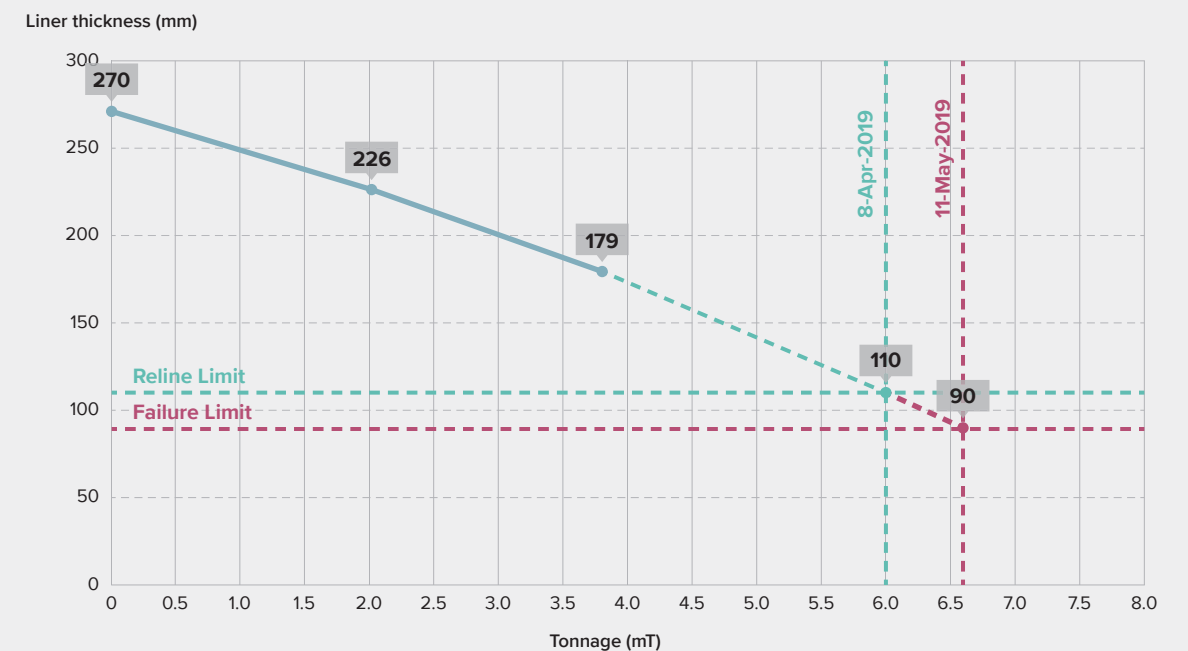
## Forecast for lifter and plate

Forecast shell liner			
Installation date	07-Dec-2019	Highest wear rate	
Current measurement date	19-Mar-2020	Lifter wear rate	50.2 mm/mT
Accumulated tonnage	5.328 mT	Plate wear rate	8.0 mm/mT
Average processed tons	52,560 tonne/day		

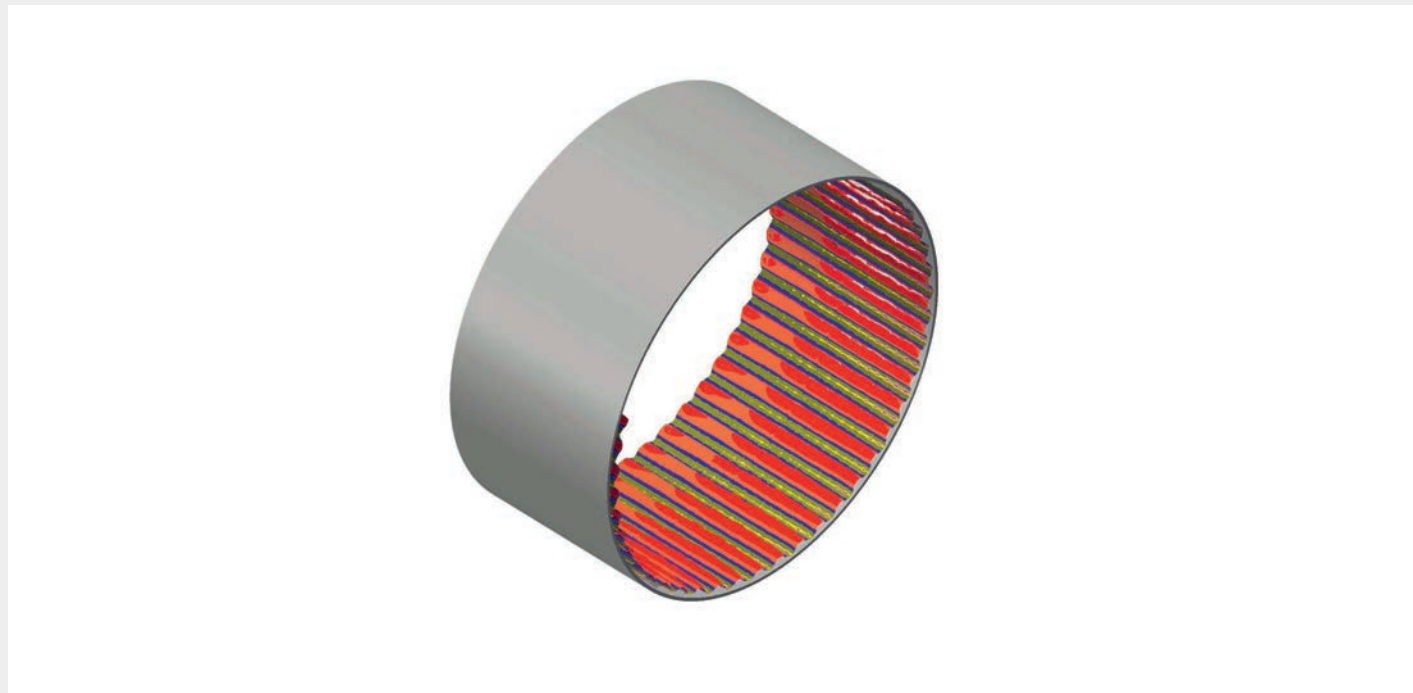
Forecast of change in terms of highest wear and critical thickness (lifter)				
Reline thickness	130 mm	Total Estimation duration of current campaign	Previous campaign duration	Highest wear located in point N°03 feeding lifter
Forecast, remaining tons	2.672 mT			
Reline date	08-May-2019	21.8 Weeks	38.5 Weeks	Worn thickness 130 mm lifter critical thickness
Forecast, remaining days	51 days	8.0 mT	6.70 mT	

Shell FE-Lifter (Profile 1800 mm)									
Control date	Days		Tonnage			Thickness (mm)	Loss of thickness (mm)	Wear rate	
	Days	Accumulated	Tonne	mT	Accumulated			mm/Week	mm/mT
<b>Cycle from 07-Dec-2018 to 19-Mar-2019</b>									
07-Dec-2018	0	0	0	0.00	0.00	458			
07-Jan-2019	31	31	1,517,000	1.52	1.52	393	65	14.68	42.85
13-Feb-2019	37	68	2,024,000	2.02	3.54	343	50	9.42	24.60
19-Mar-2019	34	102	1,787,000	1.79	5.33	254	90	18.47	50.20

### Liner wear trend tonnage

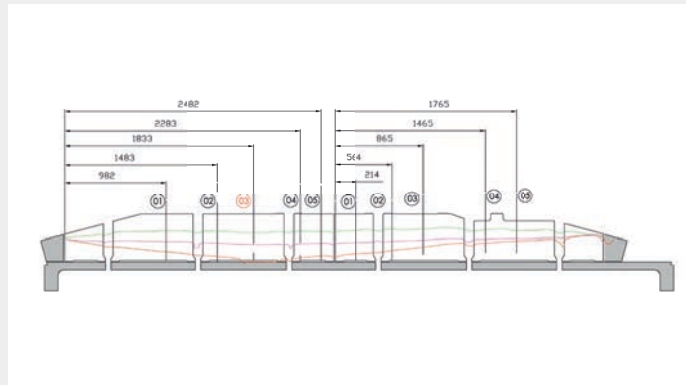




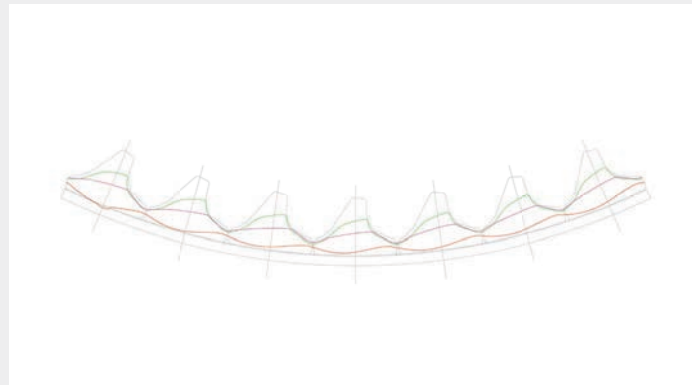


Shell liner thickness chart as on December 08, 2019

### Shell liner wear profile



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



# Feed head liners (lifter & plate)

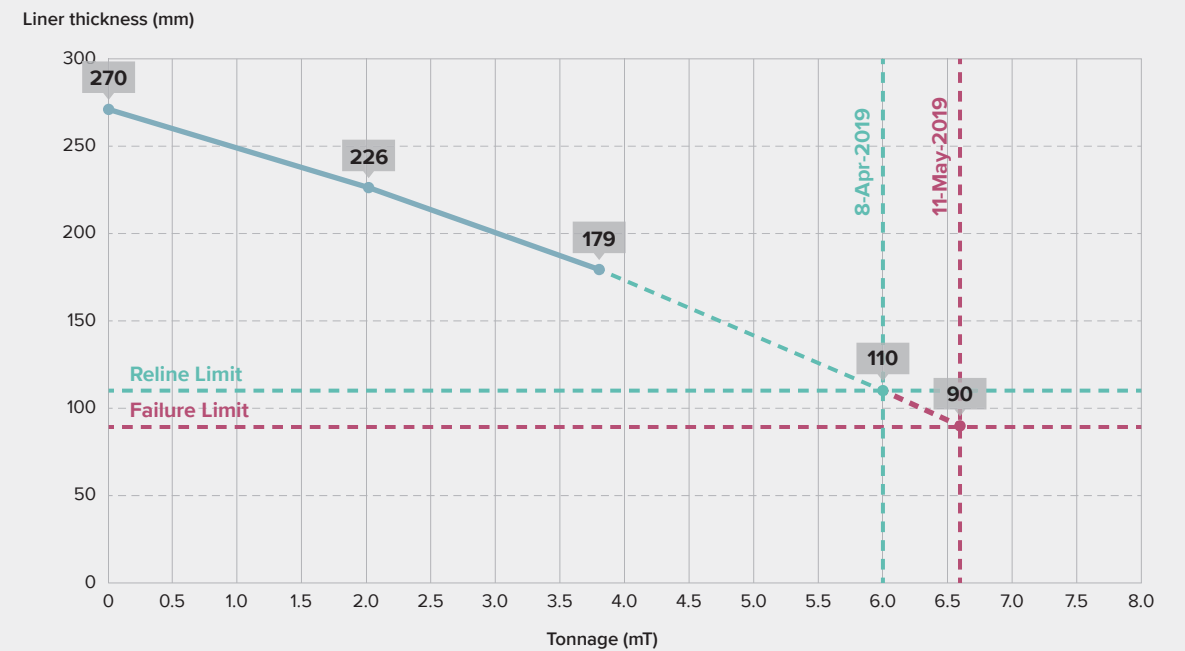
## Forecast for lifter and plate

Forecast feed head liner			
Installation date	07-Jan-2019	Highest wear rate	
Current measurement date	19-Mar-2019	Lifter wear rate	26.1 mm/mT
Accumulated tonnage	3.808 mT	Plate wear rate	18.0 mm/mT
Average processed tons	52,500 Tonne/day		

Forecast of change in terms of highest wear and critical thickness (lifter)				
Reline thickness	110 mm	Total Estimation duration of current campaign	Previous campaign duration	Highest wear located in point N°04 feeding lifter
Forecast, remaining tons	2.192 mT		15.3 Weeks	Worn thickness 110 mm lifter critical thickness
Reline date	29-Apr-2019	16.1 Weeks	5.77 mT	
Forecast, remaining days	42 days	6.0 mT		

Feed head lifter (Profile 1800 mm)									
Control date	Days		Tonnage			Thickness (mm)	Loss of thickness (mm)	Wear rate	
	Days	Accumulated	Tonne	mT	Accumulated			mm/Week	mm/mT
Cycle from 07-Dec-2018 to 19-Mar-2019									
7-Jan-2019	0	0	0	0.00	0.00	270			
13-Feb-2019	37	37	2,023,000	2.02	2.02	226	44	8.40	21.95
19-Mar-2019	34	71	1,785,000	1.79	3.81	179	47	9.59	26.11

## Liner wear trend tonnage

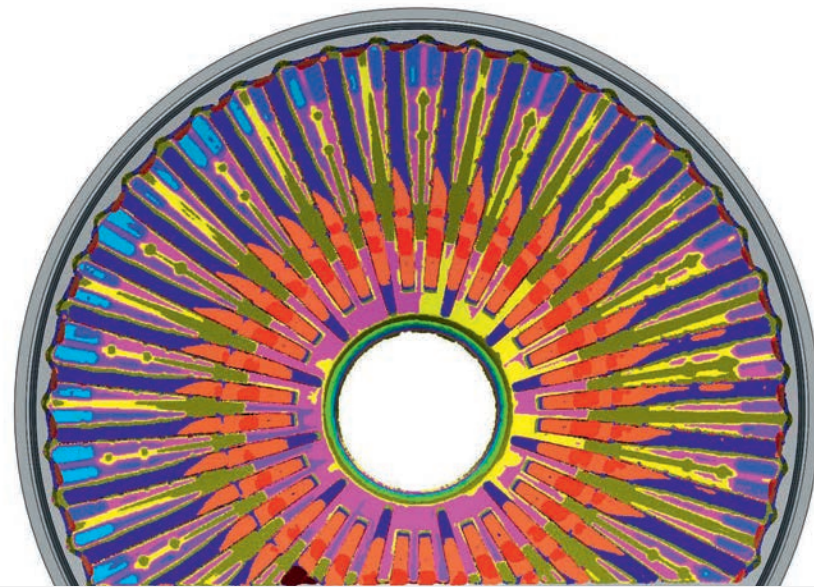


# Liner optimisation

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.

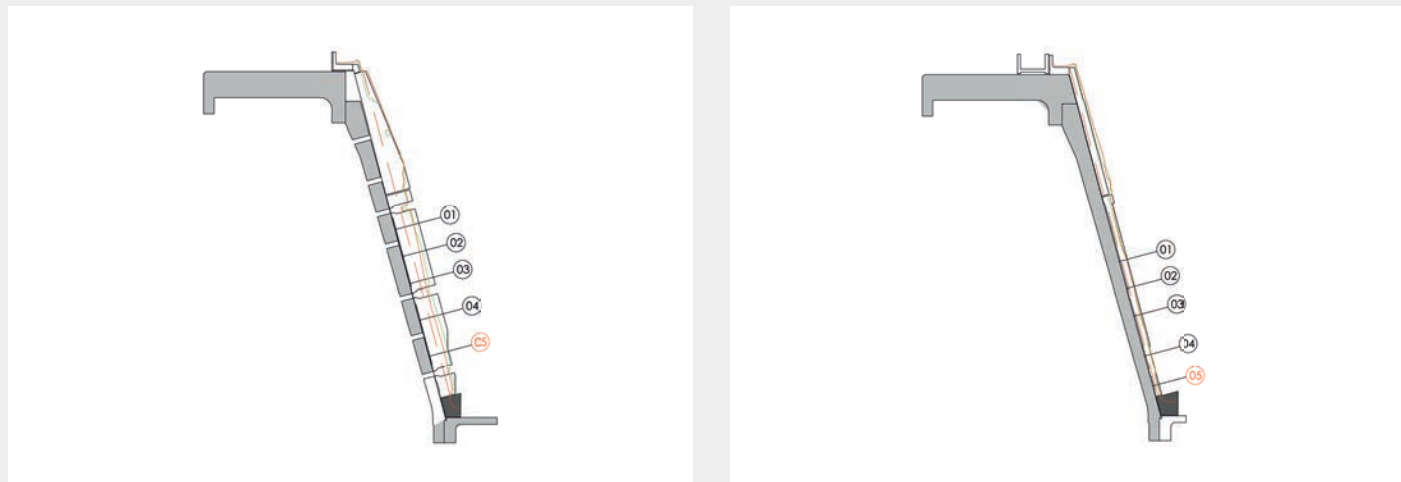
It's at this point that our collaborative approach is critical. We understand that there is no one-size-fits-all solution in mining. Your business is unique. So is your process. And so is your equipment. We also understand that you know your business, process and equipment inside and out. To make sure 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.



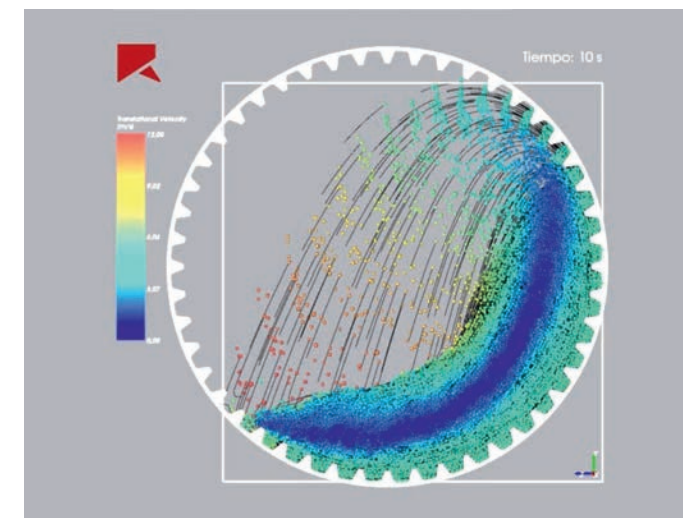
Feed head liner thickness chart as on December 08, 2019

## Feed head liner wear profile

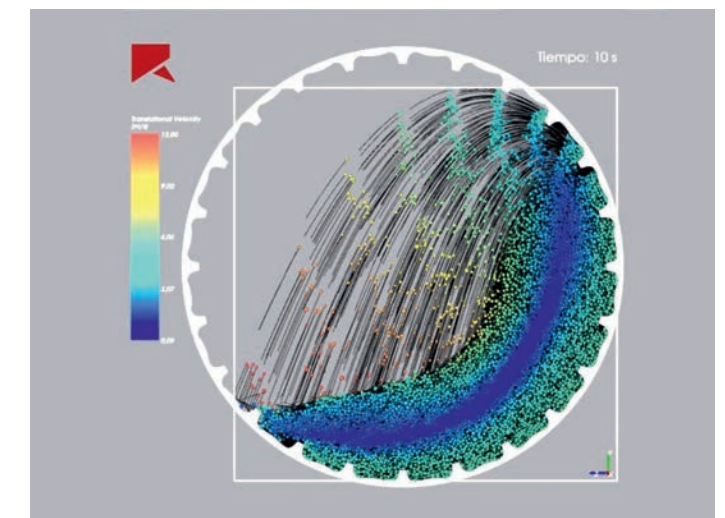


Feed head longitudinal lifter and plate as on December 08, 2019

## DEM simulation



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.

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

Composite materials highly resistant to abrasion and impact

Designs vetted through multiple simulations to select the most effective mechanical and material design

Increased capacity with optimised design

Extended wear life through the use of engineered ceramic matrix

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.

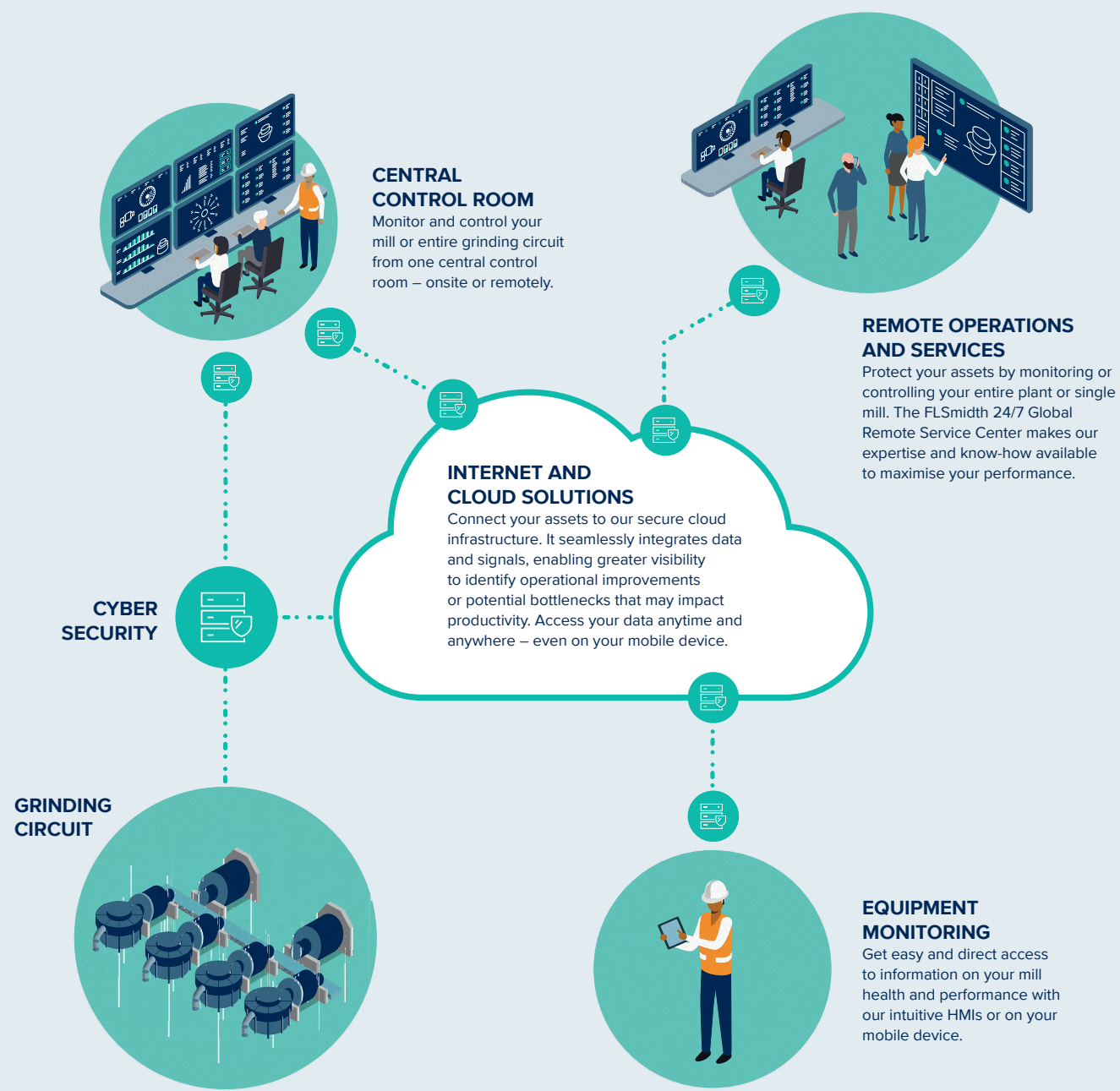
Our relining and maintenance service teams are based regionally but backed by our global pool of leading process knowledge experts. Our service engineers and product specialists can also provide audit and advisory services.





# Digitalizing the grinding circuit

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



## CONNECTIVITY

### Monitor, control and optimise remotely

Connecting your equipment to the internet via our secure infrastructure is the prerequisite for harvesting the benefits of digitalization.

#### 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

Remote condition monitoring of wear parts and equipment protects your assets and mitigates risks to secure optimal process flow.

#### 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 operational issues. A hands-free remote collaboration tool enables you to share vision of your equipment with our field service technicians. Results in faster resolution of incidents, reduced cost of service delivery and increased availability.

#### Online Condition Monitoring Services

We use secure and advanced cloud analytics, coupled with our local and global experts, to provide you with actionable insights to avoid losses associated with unexpected downtime and breakdowns.



## PERFORMANCE OPTIMISATION

### Boost your productivity

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. 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.

#### SmartCyclone™

Optimise the cyclone process and predict and control cyclone maintenance schedules.

#### On-Stream X-ray Analyzer

State-of-the-art sensitivity and short analysis cycle times for monitoring slurry process streams.

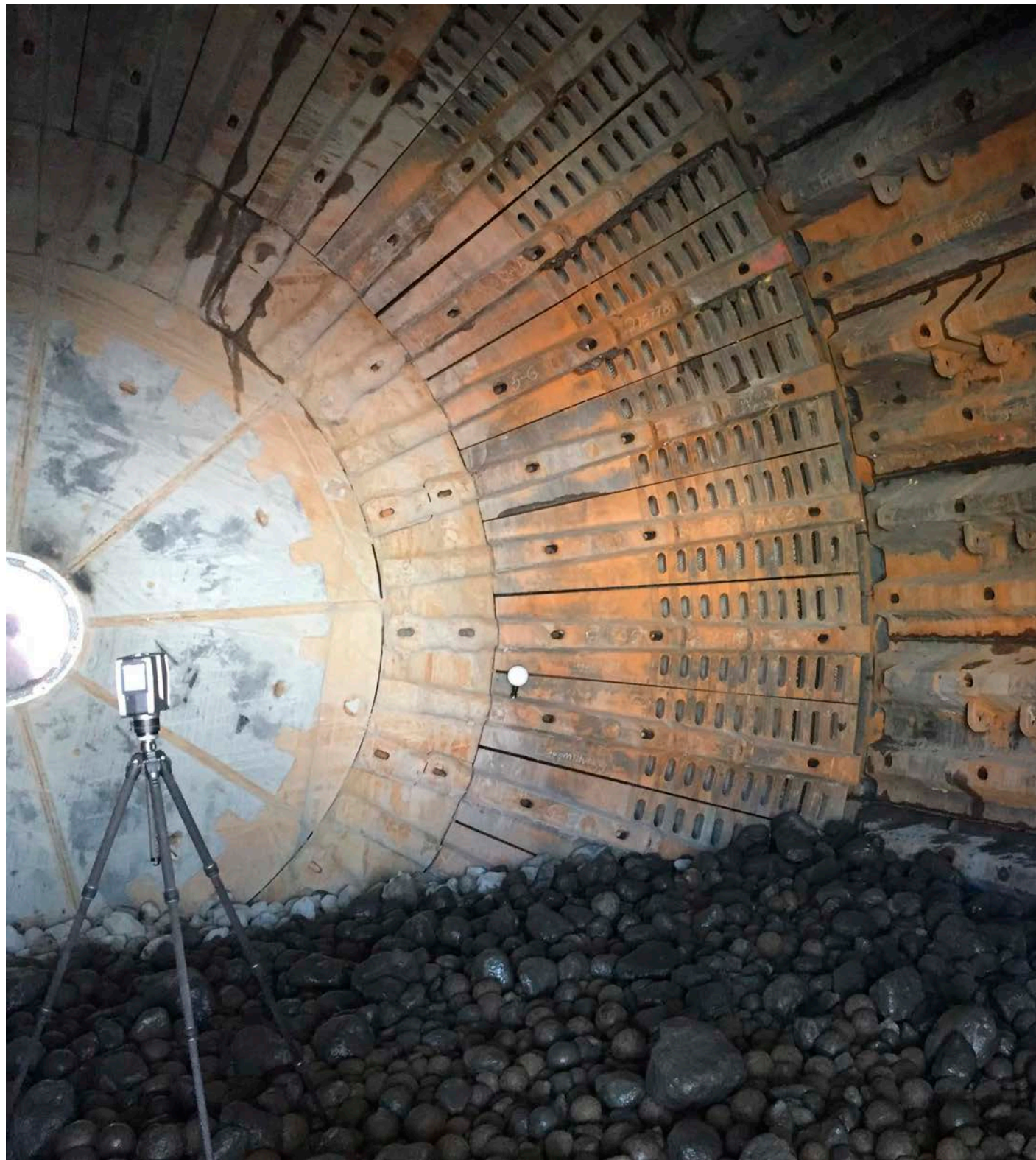
#### ECS/Plant Data Management

Transform process and quality data into real-time operations and get the most out of your plant and equipment.

## 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



### Optimise your milling operation

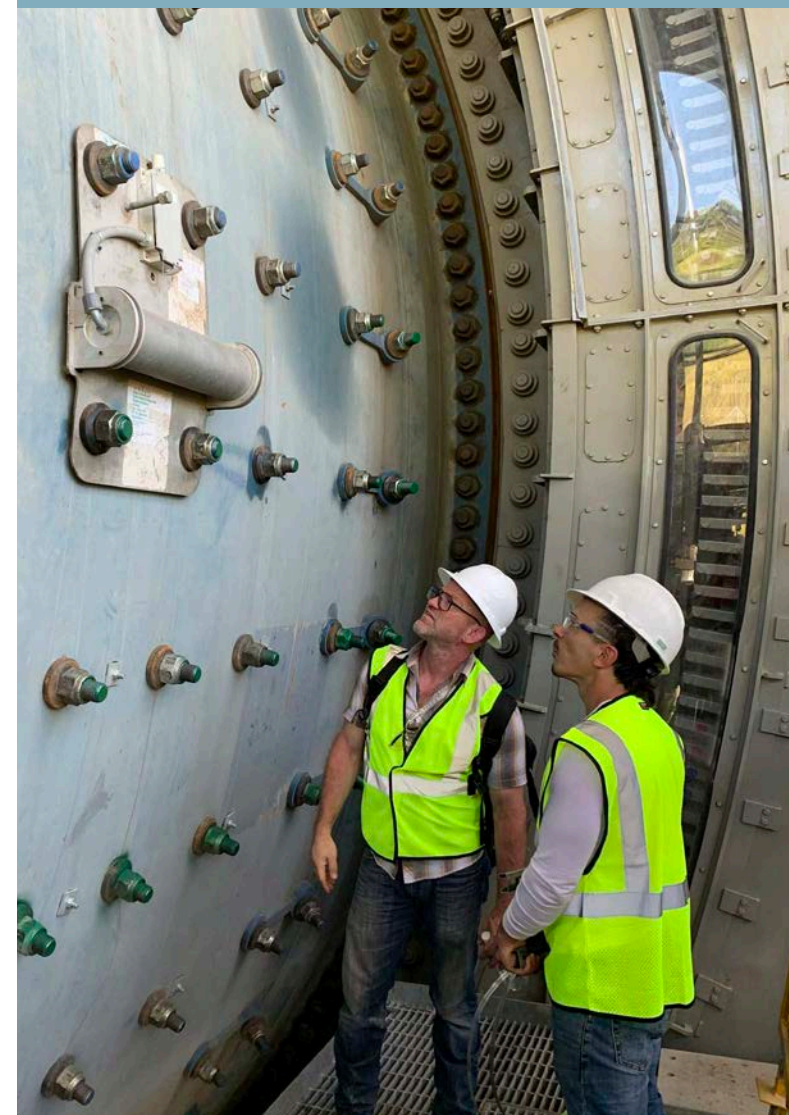
Our experts are ready to help.  
Contact them at:

✉ [grinding@flsmidth.com](mailto:grinding@flsmidth.com)



### Discover how our digital optimisation technologies enhance productivity and increase mill availability

🌐 [www.flsmidth.com/products/process-control-and-optimisation](http://www.flsmidth.com/products/process-control-and-optimisation)



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FLSMIDTH

# Mission Zero



TOWARDS ZERO EMISSIONS IN MINING



Zero water  
waste



Zero  
emissions



Zero energy  
waste

in

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