

**WEAR**



# Enduron<sup>®</sup> High Pressure Grinding Rolls

Efficient comminution without compromise

# Contents

Introduction	<b>2</b>	Compare capacity	<b>22</b>
— Proven for over 30 years	2	— A summary of the range of Enduron® HPGR	23
— HPGR benefits at a glance	3	The savings you can expect	<b>24</b>
— Exclusive to Enduron® HPGR	3	— HPGR Technology Overview	24
HPGR in operation	<b>4</b>	Applications and feed materials	<b>25</b>
— HPGR working principle	4	Validating grinding performance	<b>28</b>
— Grinding between rotating rollers	5	— HPGR pilot test work	29
— Two distinct stages	5	Enduron® HPGR components	<b>31</b>
Compared to other crushers	<b>6</b>	— Enduron® rolls	32
— Bond work index reduction	8	— Enduron® press frame and roller exchange	34
— Greater percentage of fines	8	— Enduron® bearing system	36
— Improved mineral recovery	10	— Enduron® hydraulic pressing device	38
Not all HPGRs are created equal	<b>14</b>	— Enduron® self-adjusting lateral walls	40
— Roller skewing is mandatory	14	— Enduron® HPGR dynamic control philosophy	42
— Enduron® HPGR	17	Digital condition monitoring and remote support	<b>47</b>
— Other HPGRs	17	— Synertrex® Technology	47
Compare product particle size	<b>18</b>	— Venlo Digital Tower	47
— Enduron® HPGR compared to other brands	18	— Weir Minerals' services	48
Compare tyre wear	<b>20</b>		
— Enduron® HPGR compared to other brands	20		

# Proven for over 30 years

How can you reduce your plant's overall operating costs while processing large volumes of material? The answer is Enduron® High Pressure Grinding Rolls (HPGR).

Partnering with our customers, Weir Minerals has extensive real-world experience gathered since the 1990s.

## Enduron®

**Engineered to order**

**Efficient**

**Innovative**

**Reliability**

Underpinning the design and manufacture of all of our Enduron® products is a commitment to innovation and quality.

By combining our latest technologies and advanced wear-resistant materials, we deliver custom-made solutions precisely designed to fit your unique requirements.

And all of our products are fully supported by our Weir Minerals service network offering unrivalled service, support and local expertise right across the globe.

Enduron® HPGR innovative solutions, engineered specifically for your particular needs.

### HPGR technology cuts direct energy consumption by up to 40%

Even with the improvements in the design of SAG (Semi-Autogenous Grinding) mills, adoption of HPGR takes energy savings to a completely different level, not to mention huge reductions in water consumption.

### Lower grinding media consumption

This cuts operating expenditure and improves stability of the floatation/leaching circuit. It's also a huge step forward in supporting the decarbonisation of mines.

### Saves up to tens of thousands of tonnes of CO<sup>2</sup> annually

Direct energy savings of up to 40% are the tip of the iceberg. The high embodied energy required to produce the grinding media consumption means that the adoption of HPGR brings even bigger energy savings per tonne of ore processed.

As a result, most greenfield projects processing hard (competent) rock include HPGR as part of their standard comminution flow sheet. Downstream capacity uplifts of up to 40% make Enduron® HPGR a great solution for brownfield optimisation.

## HPGR benefits at a glance

Enduron® HPGR is increasingly being used in the minerals industry and for good reason.

- Low energy consumption (0.8–2.2kWh/t)
- High machine availability >95% with low maintenance requirements, comparing very favourably to traditional crushers typically providing only circa 80% availability
- Flexible comminution solution with the operational bandwidth to process changing ore bodies throughout the life of mine
- Enhanced downstream mineral recovery
- Improved downstream grindability
- Substantial savings from reduced grinding media consumption
  - lower costs
  - significantly reduced carbon footprint
  - less contamination and downtime in the recovery process
- Improved productivity and recovery
- Enduron® HPGR compact frame design for lowest civil cost
- Optimal product quality via controlled roll skewing and self-adjusting lateral walls
- Enduron® HPGR market leading tyre wear life, backed up with proven performance and guarantees
- Unique Enduron® bearing arrangement delivers market leading bearing life with proven performance guarantees >100,000hrs

## Exclusive to Enduron® HPGR

For high availability and operational stability, there's no better choice than the internationally renowned Enduron® HPGRs.

### Enhanced Roller Surface Technology

This unique feature of Weir Minerals' Enduron® HPGR, combined with spring loaded lateral walls, delivers optimal product quality with minimal wear and power consumption.

### Protective Bearing Arrangement

Another unique feature of the Enduron® HPGR, this arrangement has been designed to protect against premature failure and reduce the number of peak loads which can be transferred to the bearings.

### Controlled Roller Skewing

Skewing ensures that pressure is distributed across the full width of the tyre, minimising recirculation. This is particularly applicable in segregated feed conditions which are typical in mineral processing applications. Enduron® HPGR can dynamically accommodate these changing feed conditions through skewing.

### Unique Roll Length:Diameter Ratio

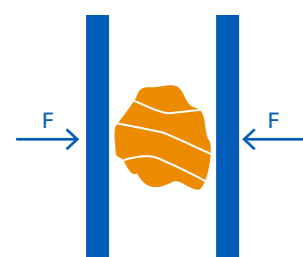
This feature delivers the highest product quality, minimising recirculation and reducing operational costs. Enduron® HPGR L:D ratio enables smaller tyre diameters for a given tonnage relative to all competitors. This optimises the operating gap, ensuring full pressure across the full tyre length, exceeding the ore's compressive strength. Our superior L:D ratio and compact cylindrical bearing arrangement means that Enduron® HPGR users enjoy significantly reduced infrastructure costs as the required civil structural height is kept to a minimum.

# HPGR in operation

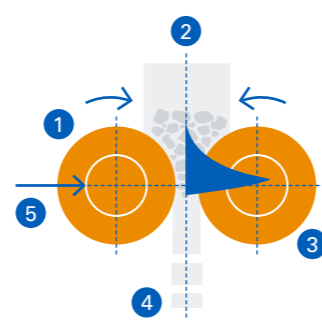
## HPGR working principle

- HPGR is pressure controlled, not gap controlled
- Product size is changed by controlling the pressure
- Size reduction by inter-particle grinding
- Inter-particle grinding increases grinding efficiency as pressure is transferred to the particle via multiple directions
- Breaking and fracturing of particles only happens when the material compressive strength is exceeded. Pressure controlled HPGR assures that the right pressure is applied for the specific material
- HPGR streamlines transition between crushing and grinding by accepting larger feed size than ball mills and producing finer size particles than cone crushers

Traditional Crushing



HPGR Grinding



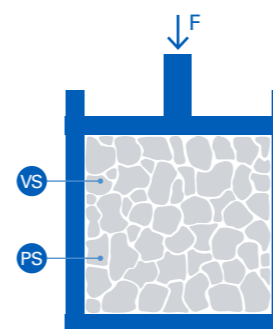
- 1 Floating roller
- 2 Feed material
- 3 Fixed roller
- 4 Compacted cakes
- 5 Grinding pressure

Comminution principles: high pressure comminution and breakage process between rollers

## Grinding between rotating rollers

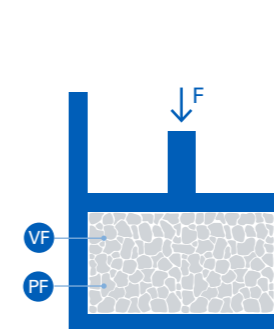
An Enduron® HPGR reduces particles by compressing and grinding the feed between two counter rotating, parallel rollers. This forces the rocks against each other and compresses the feed's density to 85% of its solid volume. This compression is achieved by applying high pressure of up to nearly 300Mpa, exceeding the compressive strength of the feed material. During this process, the material is ground to a wide particle size distribution with a large proportion of fines, compacted into flakes.

Before Compression



- VS Bulk volume
- PS Bulk density

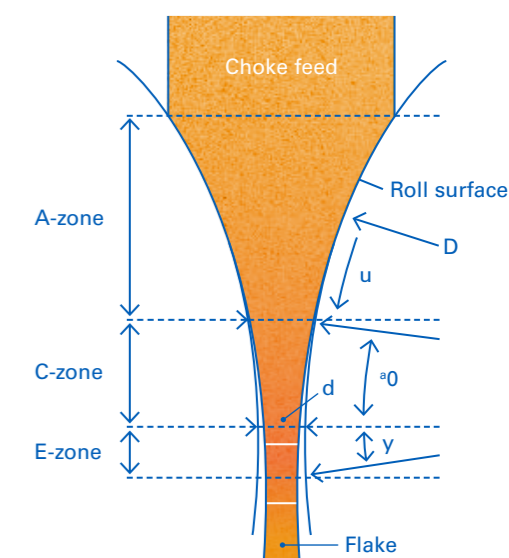
After Compression



- VF Slab volume
- PF Slab density

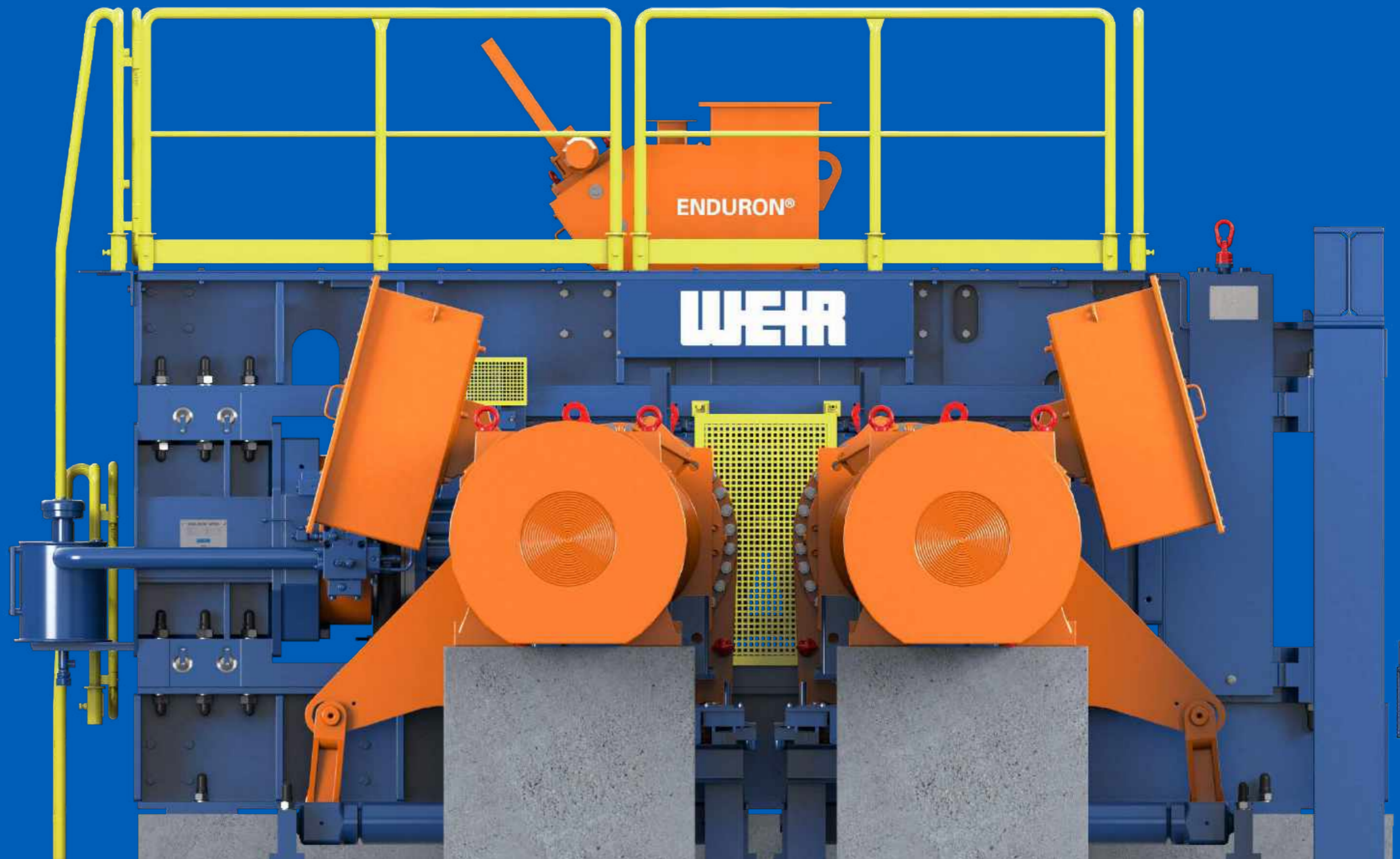
## Two distinct stages

1. The choke-fed material entering the Enduron® HPGR is accelerated to meet the peripheral roll speed. As a consequence of the narrowing gap between the rolls, the material is gradually compacted, and the larger pieces and particles are pre-crushed.
2. Maximum force is applied to all particles in the compression bed as they are squeezed together between the rolls. This results in the disintegration of most particles.



- A-zone = Acceleration zone
- C-zone = Compaction zone
- E-zone = Expansion zone
- D = Diameter of rolls
- d = Flake thickness
- $\alpha_0$  = Angle of compaction zone
- y = Angle of expansion zone
- u = Circumferential speed

# Compared to other crushers



## Bond work index reduction

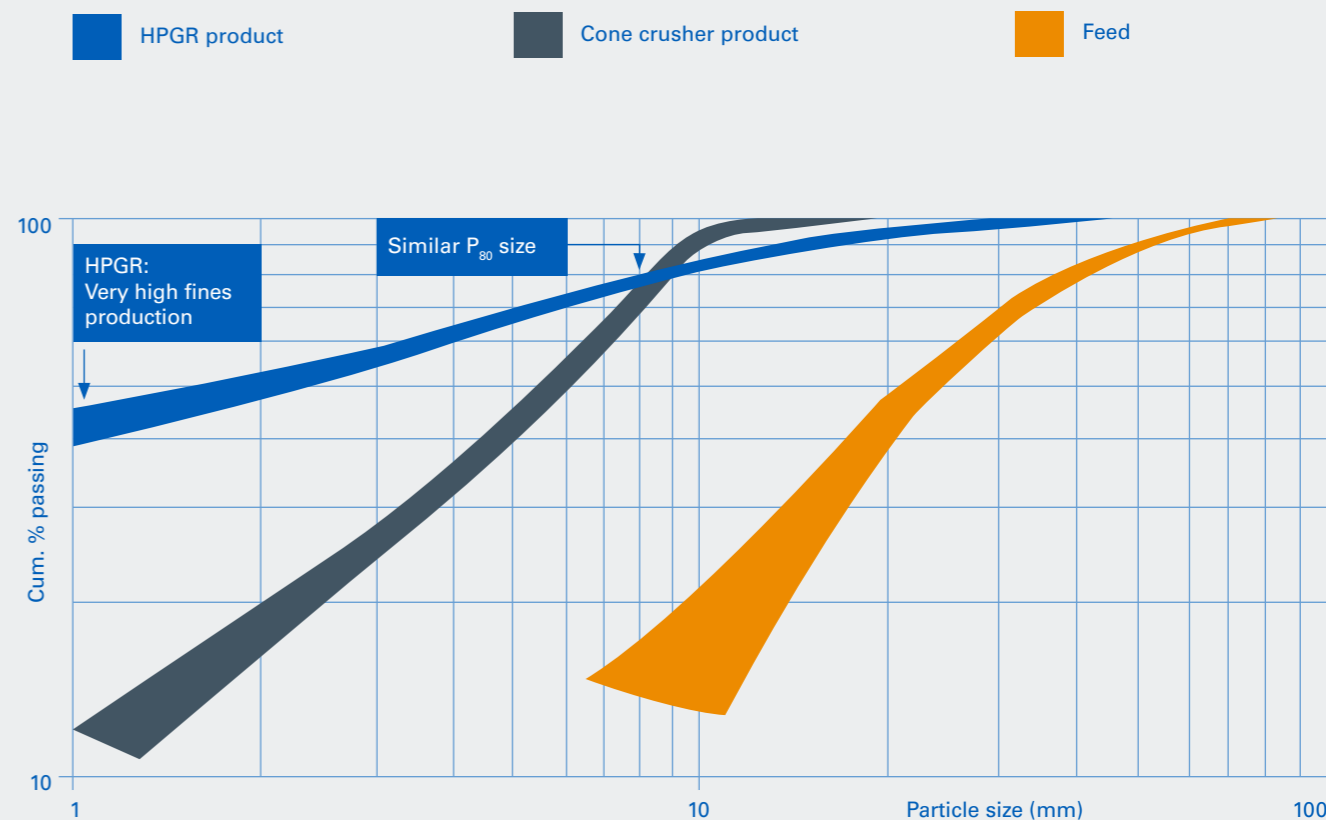
In applications where HPGR is followed by tumbling mills, the induced micro cracks generally result in a reduction of the Bond Work Index. For most ores this reduction is in the range of 10–25%.

This directly translates to either an increased throughput of the grinding circuit or a reduced power consumption at similar throughput rates, which will reduce the required number of mills. Bond Work Index reduction by Enduron® HPGR can be demonstrated on a variety of ores, both in laboratory and pilot plant scale testing. We have a proven track-record of optimising existing, traditional grinding circuits and can demonstrate impressive recovery improvements.

The improved grindability of Enduron® HPGR means that optimum product size is achieved with significant cost savings in energy together with reduced labour and maintenance.

## Greater percentage of fines

The spring-loaded lateral wall system of the Enduron® HPGR provides an optimal seal, reducing wear in all feed conditions and lowering energy consumption. It also produces a wider particle size distribution (PSD) with a higher percentage of fines compared to a traditional tertiary crusher and other HPGRs with static, non-adjustable lateral walls.

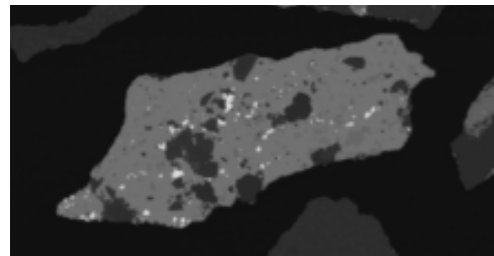


**Comparison of particle size distribution:  
High Pressure Grinding Roll v. Cone Crusher**

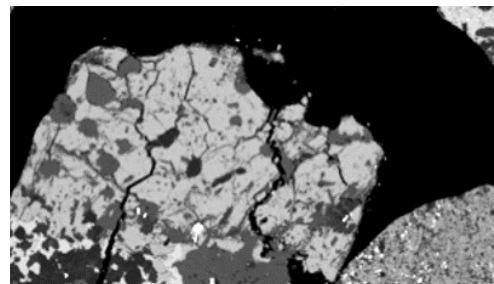
## Improved mineral recovery

### Advantages of micro-cracks

Quartzite samples after comminution:



From a laboratory jaw crusher



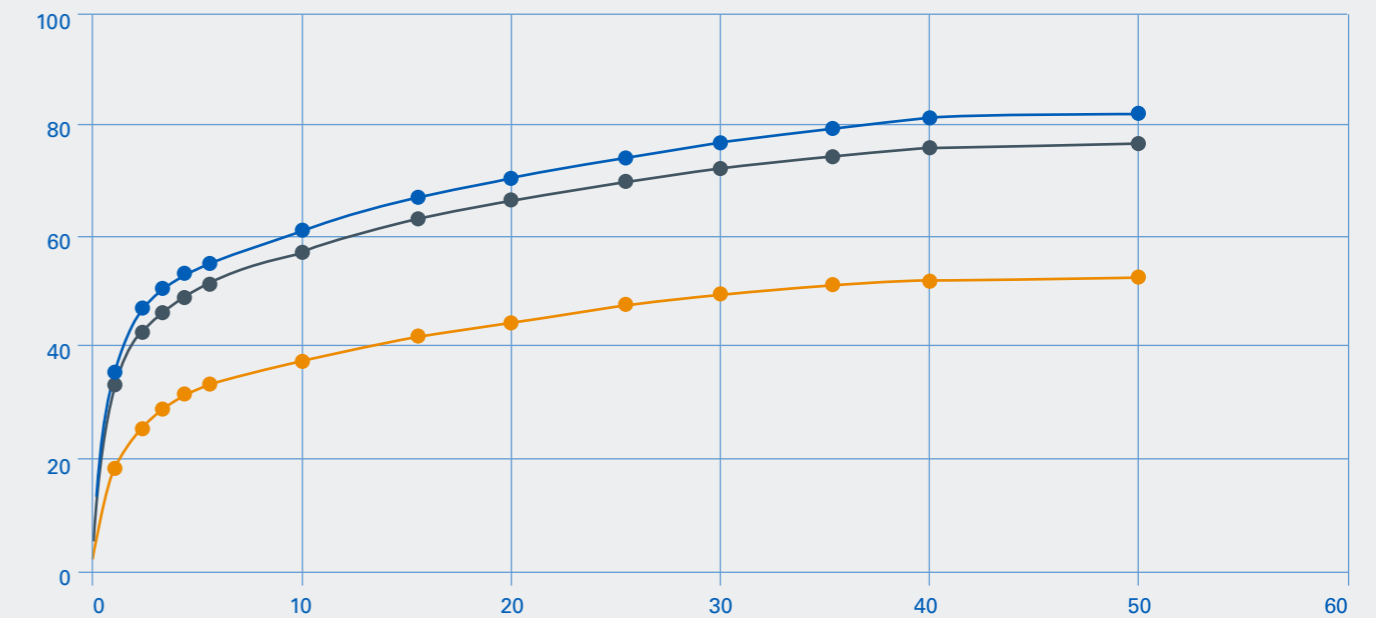
From a HPGR, showing myriad micro-cracks

The high pressure force in the material bed promotes differential stresses locally within the ore grains and between the ore minerals and the surrounding waste rock. The ability of the individual minerals to accommodate this stress determines whether they break, deform, or remain unaffected. Our unique design introduces the press force in the most efficient way, maximising the quantity of particles that break.

Optical comparison between jaw crusher sample (top) and HPGR processed sample (bottom)



Leach Recovery, %



Leach Time, days

Benefits of HPGR—Heap Leach Recovery, HPGR Design Features—Performance





# Not all HPGRs are created equal

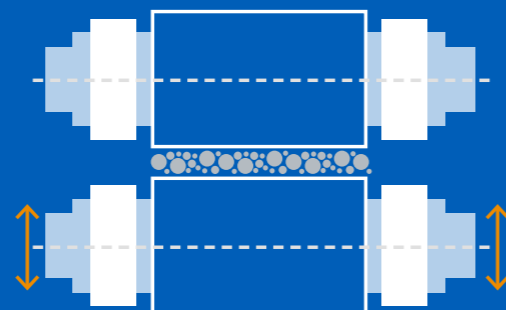
## Roller skewing is mandatory

Every mine operator understands the complexity associated with processing a wide variety of ore bodies. It's almost impossible to eliminate feed segregation, meaning that the HPGR requires to effectively adapt to unbalanced and changing feed conditions.

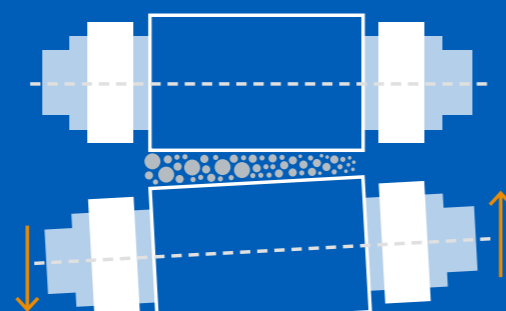
Firstly, segregated feeds can result in markedly uneven particle sizes across the width of the feed. An uneven feed means high pressure on one end of the roll and not enough on the other, creating high pressure on one side of the roll and insufficient pressure on the other. This would also result in a coarser product, requiring more work downstream.

Secondly, mine operators know that in real world settings, tramp material, such as SAG mill balls, will occasionally make its way into the HPGR feed.

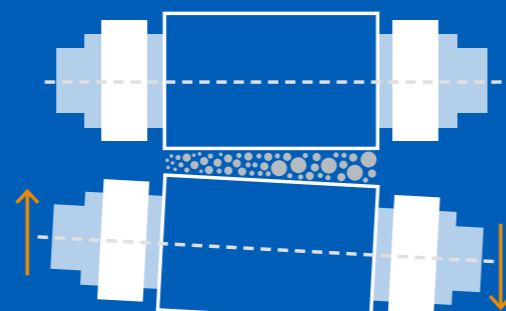
Enabling one roller to skew maintains an even pressure distribution across the rollers. This facilitates larger or potentially damaging material at one end of the roll, while ensuring the smaller particles at the other end receive enough pressure to be ground down. The even pressure distribution means better product and lower recirculation, saving energy and reducing wear.



**Feed:** Even  
**Response:** Parallel Gap



**Feed:** Coarse Particles Left Side  
**Response:** Gap Increased on Left Side



**Feed:** Coarse Particles Right Side  
**Response:** Gap Increased on Right Side

## What do we mean by skewing?

The ability of the HPGR to react to changing feed conditions where different particle sizes and ore hardness are being presented to the rolls. Skewing ensures that the materials' compressive strength is exceeded across the full width of the tyre. Enduron® HPGRs are unique, the only machines with the capability to reliably deliver efficient roller skewing, necessary in real world applications with changing feed conditions.





Enduron® HPGR studded rolls with spring-loaded, self adjusting lateral walls

## Enduron® HPGR

### Utilises a spring-loaded lateral wall

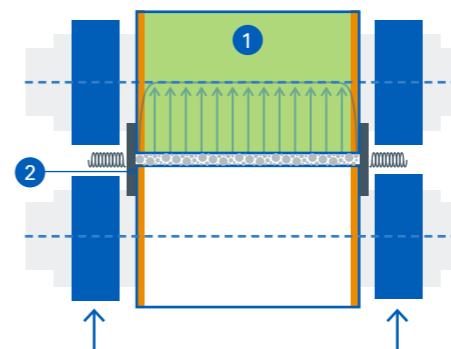
This not only reduces the edge effect (maintaining a gap of as little as 1mm), but is specifically designed to facilitate roll skew. The spring-loaded lateral wall system provides optimal seal, reducing wear at all feed conditions (see diagram below).

### Compact diameter and longer roll design

Our superior L:D ratio reduces the edge effect area (coarser product), further increasing the effective grinding surface compared to traditional HPGRs (see diagram below). The higher the pressure across the length of the tyre, the more product is generated at the required grind size with a single pass. This reduces the recirculating load, allowing for a leaner classification plant design and reducing energy consumption.

#### Enduron® HPGR

- 1 Large effective roller surface (green) transferring the energy (pressure) into the ore effectively
- 2 Self-adjusting cheek plates keep the pressure in the operating gap and assures a tight seal at all times



## Other HPGRs

### Use large lateral walls or static cheek plates

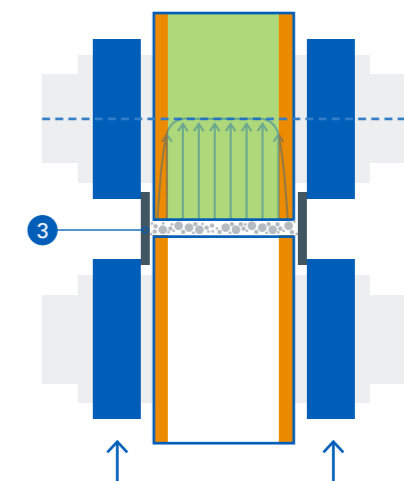
The aim is to reduce the materials exiting the high pressure area horizontally without being properly crushed. However, these static cheek plates make it impossible for them to warrant a tight operating gap seal between the tyre, resulting in reduced grinding efficiency and increased wear (see diagram below).

### Flanged tyres

These have also been reintroduced by some OEMs to compensate for throughput losses compared to the Enduron® HPGR. Flanges do provide a tight sealing system, similar to the Enduron spring loaded cheek plates, but they prevent skew, necessary in every application, and makes maintenance more complex and costly.

#### Conventional HPGR

- 3 Static cheek plates require a bigger gap between the tyre sides, which results in pressure drop and increased particle bypass



# Compare product particle size

For ideal inter-particle compression, the feed particle sizes should be smaller than the operating gap between the rolls. In real world applications, the top size of a feed distribution can contain particles that are up to 70% greater than the operating gap.

## Enduron® HPGR compared to other brands

The Enduron® HPGR has a unique roll length:diameter ratio, which consistently delivers a high-quality end-product while minimising recirculation and reducing operational costs. The smaller roll diameter optimises the operating gap, fully penetrating pressure through it and exceeding the ore's compressive strength.

### Why Enduron®? – L/D ratio

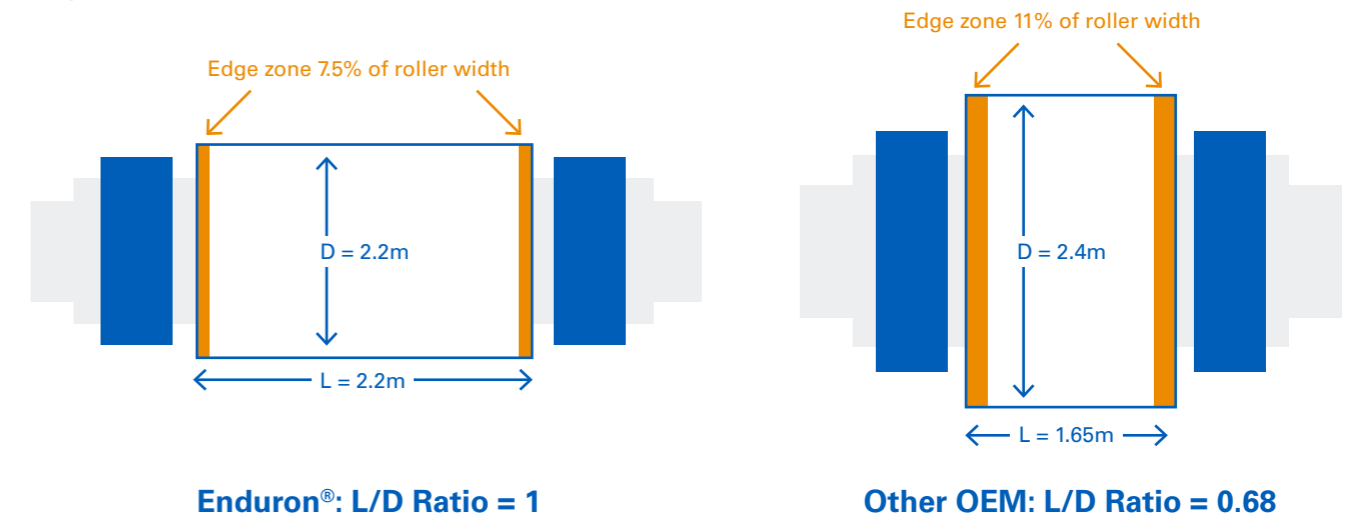
Enduron System Design allows a superior L/D ratio

- L/D ratio of 1 possible
- Minimal edge effect
- Increased throughput and better product
- Leads to lower machine and lower hopper
  - Reduced building height
  - Reduced conveyor length
  - Reduced plant foot print
  - Substantial reduction in structural engineering costs



Enduron® HPGR with unique L:D ratio for hard-rock grinding

### Edge zone



# Compare tyre wear

The longevity of an HPGR's tyre life is critical to the performance of a processing plant, both in terms of availability and grind quality. Our ability to optimise and align tyre wear life with scheduled stoppages in production allows for efficient tungsten carbide use, and also mitigates production loss associated with unplanned downtime.

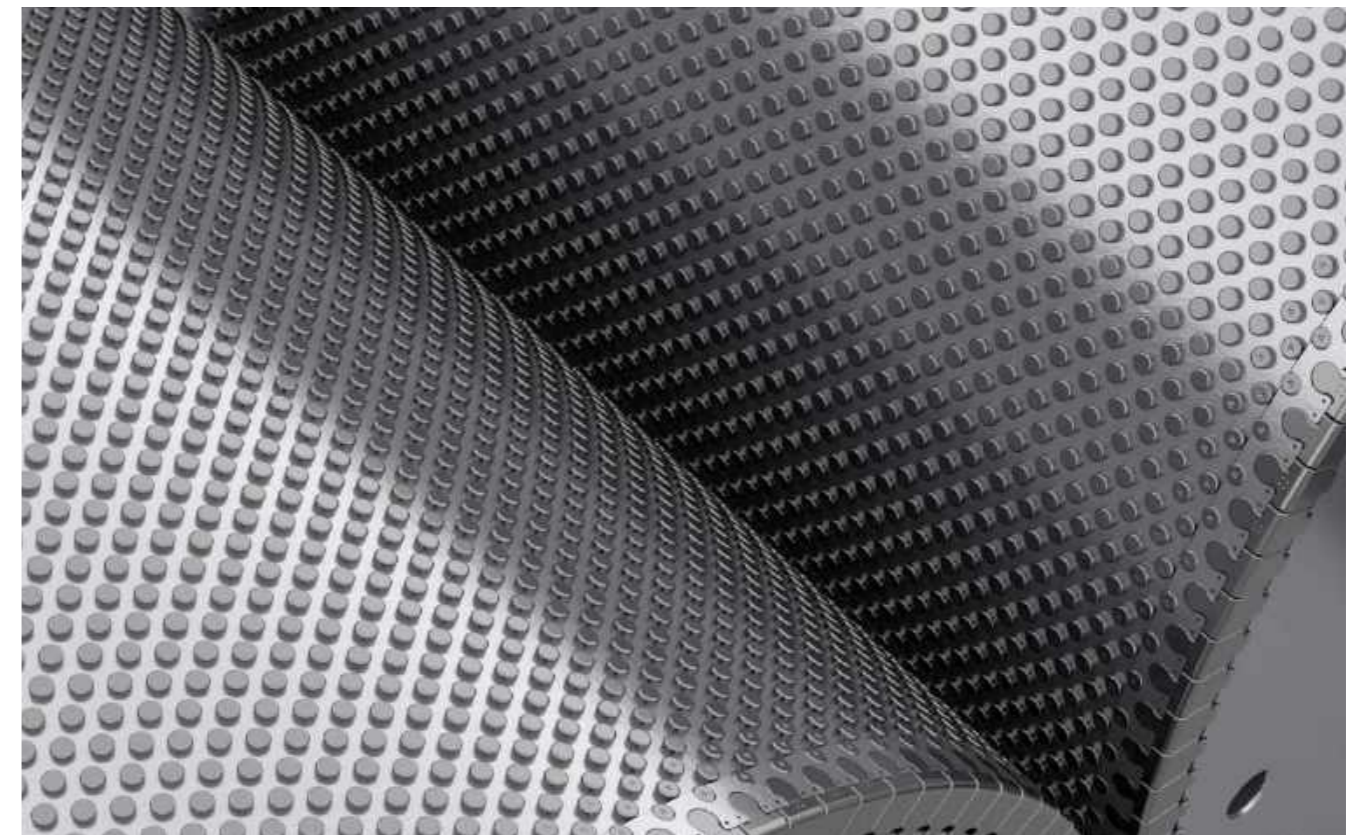
## Enduron® HPGR compared to other brands

We use premium tungsten carbide studs, ensuring that Enduron® HPGR tyres outlast the competition. Optimised for load bearing and promoting an autogenous layer to absorb wear, our superior tyres are supplied with a robust lifetime guarantee. Combined with our unique bearing assembly that reduces the risk of failure and the wear reduction associated with skewing, each Enduron® HPGR is engineered to last longer. The large surface area afforded by our unique L:D ratio, further reduces the peripheral roll speed, which significantly benefits roller wear life.

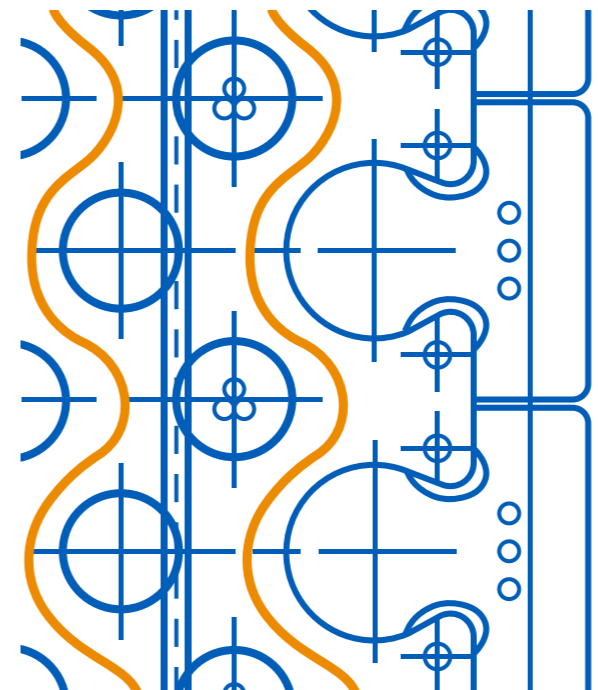
### The unique body and lateral studs design consist of:

- The latest innovations on stud design and material improvements
- Variable hardness permissible over roller surface to avoid bathtub effect and guaranteeing constant operation conditions
- Rounded stud base to reduce stress points in tyre reducing operational disruption

Based on a large database with actual field feedback we can select the best stud length and hardness to optimize OPEX.



Enduron® HPGR tyres with premium tungsten carbide studs



### Wear-life performance achieved with Enduron® tyres

	Operating hours
Iron ore (pellet feed)	15,000 – 36,000
Iron ore (coarse)	8,000 – 15,000
Gold / Copper ore (coarse)	8,000 – 12,500
Lead / Zinc (coarse)	10,000 – 12,000
Limestone	35,000 – 40,000

# Compare capacity

As every ore body is different and operating conditions vary by application type, meaning ores respond differently to pressure at these conditions.

At Weir Minerals, the specific throughput for an Enduron® HPGR is initially determined by laboratory or pilot plant testing. This allows for a scale-up with correction factors for roll geometry, peripheral speed, press force, gap and moisture content to be present in the industrial sized installation. The dedicated scale-up procedures are validated by more than 30 years of actual field performance and form the basis of our wide ranging performance guarantees. Furthermore, the specific energy, measured in kWh/t is captured during the tests at different pressures. This allows a HGPR to achieve the best operating conditions for maximum mineral recovery at the least energy consumption.

We are specialised in high tonnage, hard rock HPGRs to satisfy the need in mining to process higher volumes of ore. Our Enduron® HPGR portfolio ranges from pilot machines to large format production machines including the world's largest operational roller surface capable of processing over 118,000 tons of ore per day.



Enduron® HPGR's larger rollers reduce the number of lines per concentrator

## A summary of the range of Enduron® HPGR

Model	Typical Capacity (TPH)	Max Top Size (mm)	Typical Installed Power (kW)
RPP 2	25 – 45	35	2 x 50
RPP 3.6	140 – 230	35	2 x 230
RPP 5	180 – 400	38	2 x 365
RPM 10	490 – 835	42	2 x 840
RPM 13	710 – 1025	48	2 x 1200
RPM 16	950 – 1670	54	2 x 2415
RPM 20	1520 – 2075	60	2 x 3430
RPM 24	1950 – 4100	66	2 x 4050
RPM 32	3680 – 5940	80	2 x 6800

# The savings you can expect

Weir is committed to help the minerals industry move to a more sustainable future. This goal is at the very core of what we do. Through innovations and advanced materials technologies, we aim to create long-term value for our customers, positively impacting their operations and the planet.

Enduron® HPGR technology can save up to 40% in power consumption, when compared to traditional grinding circuits. When combined with air classification, the use of grinding media for fine grinding can be diminished, which will significantly reduce the embodied energy.

## HPGR Technology Overview

**Up to 40% less energy consumption than traditional tumbling mills**

>200,000t CO<sub>2</sub> saved\*

**No additional water needed for fine grinding**

**Lower total cost of ownership**

€0,09 – €0,20 cost per ton of ore processed (labour and wear parts)

**No grinding media needed**

>700,000t CO<sub>2</sub> saved\*

**High availability (>95%) + prolonged wear life**

\*annual saving from our 2021 installed base

# Applications and feed materials

An Enduron® HPGR can deal with any material—in fact, it never knows what ore it's grinding. Specific ore type is not detected by an Enduron® HPGR. All that matters is ore hardness, size and bed compressibility.

### Iron ore beneficiation

HPGRs are used for coarse-grained to ultra-fine-grained ores. Circuits vary from single pass processing combined with edge or partial product recycle, closed circuit classification with screens or air classifiers to multistage HPGR configurations. Common beneficiation technologies are magnetic separation and floatation. Flowsheets for strongly magnetic minerals like magnetite are often optimized towards dry magnetic separation to minimize water consumption and generate dry tailings. When combining the HPGR with air classifiers, the system can deliver a dry fine product (< 100 µm) suitable for subsequent vertical stirred mill grinding, making tumbling mills superfluous.

### Precious metal beneficiation

Enduron® HPGR has a proven track record in the processing of gold and copper ore, substantially increasing the plant recovery.

Unlike the flattening which occurs in ball mills, the native gold particles processed by Enduron® HPGRs are left untouched. As a consequence, separation processes like spiral or centrifugal concentration, are more efficient with an improved gold recovery.

### Base metal liberation

In sulphide ore beneficiation, HPGR grinding can selectively increase liberation. The generation of micro-cracks in or along the mineral grain surfaces assists in liberating the locked minerals ahead of gravity concentration, classification or floatation.

### Pellet feed preparation

In iron ore pellet feed preparation, a HPGR, in either a stand-alone grinding device or in combination with ball mills, has been proven to increase the throughput and pellet quality at a low level of energy input. In this specific type of application, HPGR technology also offers advantages to processing beneficiated concentrates, avoiding the need for either excessive drying or difficult filtration and sedimentation processes.

### Battery metal liberation

HPGR offers several benefits in spodumene grinding. The flexibility to operate at a low pressure maximises a Lithium yield without producing an undesirable number of fines, which influences the downstream beneficiation. The formation of a competent, autogenous mineral layer in between the studs protects the tyres and promotes wear life, even despite the abrasive nature of the mineral's high silica content. In addition to lithium, HPGRs bring benefits in Palladium and Nickel applications.

### Diamond liberation

In diamond treatment, the most important consideration is the efficient crushing of the ore. In tumbling mills (ball mills, SAG mills) or crushers, coarse size reduction occurs through impact, which destroys the larger diamonds, causing a loss of extremely high value, gemstone quality product. By adopting HPGR, diamonds can withstand the applied operating pressure and are not shattered, as they have no direct contact with the grinding surface. We achieve this by ensuring that the operating gap never falls below a fixed set point (e.g. 25mm).



# Validating grinding performance

Weir Minerals has seven pilot HPGRs strategically located across the globe. One is installed at the Weir Venlo Technology Hub in the Netherlands, home to the Enduron Research and Development department and process team. All our laboratories are well equipped, and some also specialise in downstream mineral liberation tests. Upon request, we can facilitate a complete pilot validation plant to be installed at your mine site. This comprehensive suite of capabilities allows Weir to tailor and optimise a bespoke solution for every individual operation.



Example of an on-site validation plant that can be installed at your plant

## HPGR pilot test work

The Enduron® pilot HPGRs are the smallest industrial scale machines. This means that the test results are representative of full scale production results, and that realistic and secure scale up calculations can be applied to determine the actual process and operating data.

### Primary objectives of pilot test work:

- Determination of process parameters for the design of industrial scale HPGRs
- Estimation of wear behaviour
- Production of test material for downstream processes
- Determination of mechanical design parameters for the industrial scale HPGRs

### The process and operating data captured:

- Total and specific throughput
- Total and specific power consumption
- Total and specific press forces
- Gap and flake thickness
- Circumferential roll speed
- Test duration

### Post HPGR treatment analyses:

- Particle size distribution by wet or dry screening
- Specific gravity, bulk and flake density
- Bond Work Index
- Moisture content
- Investigations of mineralogy
- Wear rate determination
- Chemical analysis
- X-ray analysis

### Basic data of the pilot HPGR

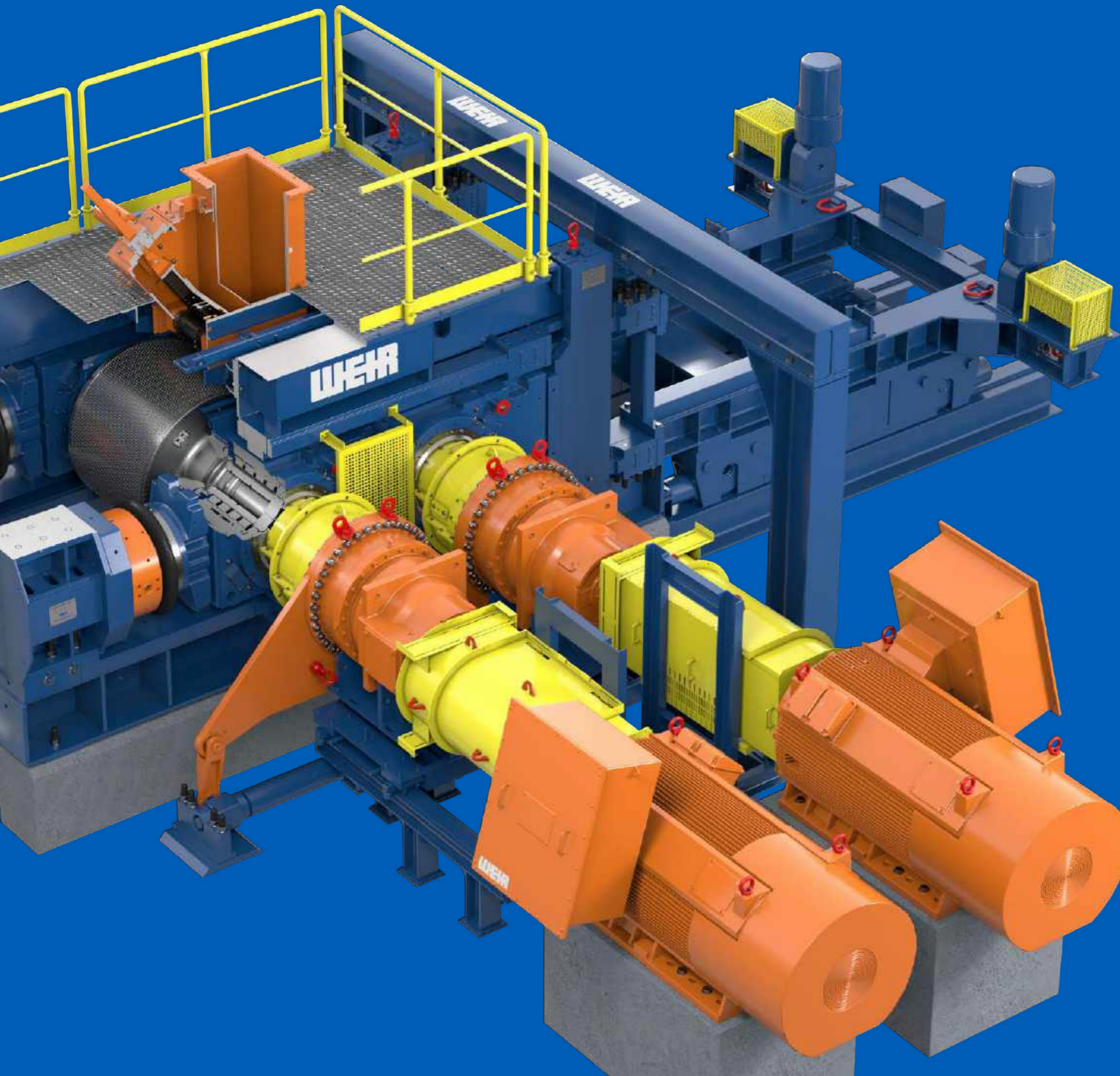
The basic data of the pilot HPGR at the Weir Venlo Technology Hub test facility, the Netherlands:

Roll diameter	800mm
Roll width	250mm
Max. spec press force	Up to ~ 10 N/mm <sup>2</sup> **
Capacity	~ 30–80 t/h (1)
Motor size	2 x 250 kW
HPGR weight	~ 21t
Required amount of test material	~ 100kg (each test)

(1) depending on the properties of the feed material

\*\* normal max specific press force for minerals~ 5N/mm<sup>2</sup>





# Enduron® HPGR components

## Advanced roller process

The surface of the rolls is lined with hard metal studs to ensure autogenous wear protection. Centralised automatic oil or grease lubrication systems supply the cylindrical or self-aligning roller bearings. One roll is fixed to the frame, the other roll is movable and free to slide within certain limits during roll skew. The press rolls are driven individually, and the power is transmitted via a cardan shaft, a safety or optional fluid clutch, and standard planetary gears. Various drive arrangements are available.

## Feed and optimal size reduction

The material is gravity-fed vertically into the roll gap over the feeding device which may be equipped with a regulating gate if necessary. The forces required for optimal size reduction are transmitted by means of a hydraulic system to the sliding roll and thus, in a controlled manner, to the material bed between the press rolls.

## Control system

This comes as standard and automatically monitors and controls all relevant operating and machine parameters, and has dynamic controlled skew control that prioritises pressure, not the gap.

# Enduron® rolls

The rolls, or tyres, are the grinding tools of the HPGR and Weir Minerals has made wear protection a top priority in our Enduron® tyres.

## Wear resistance

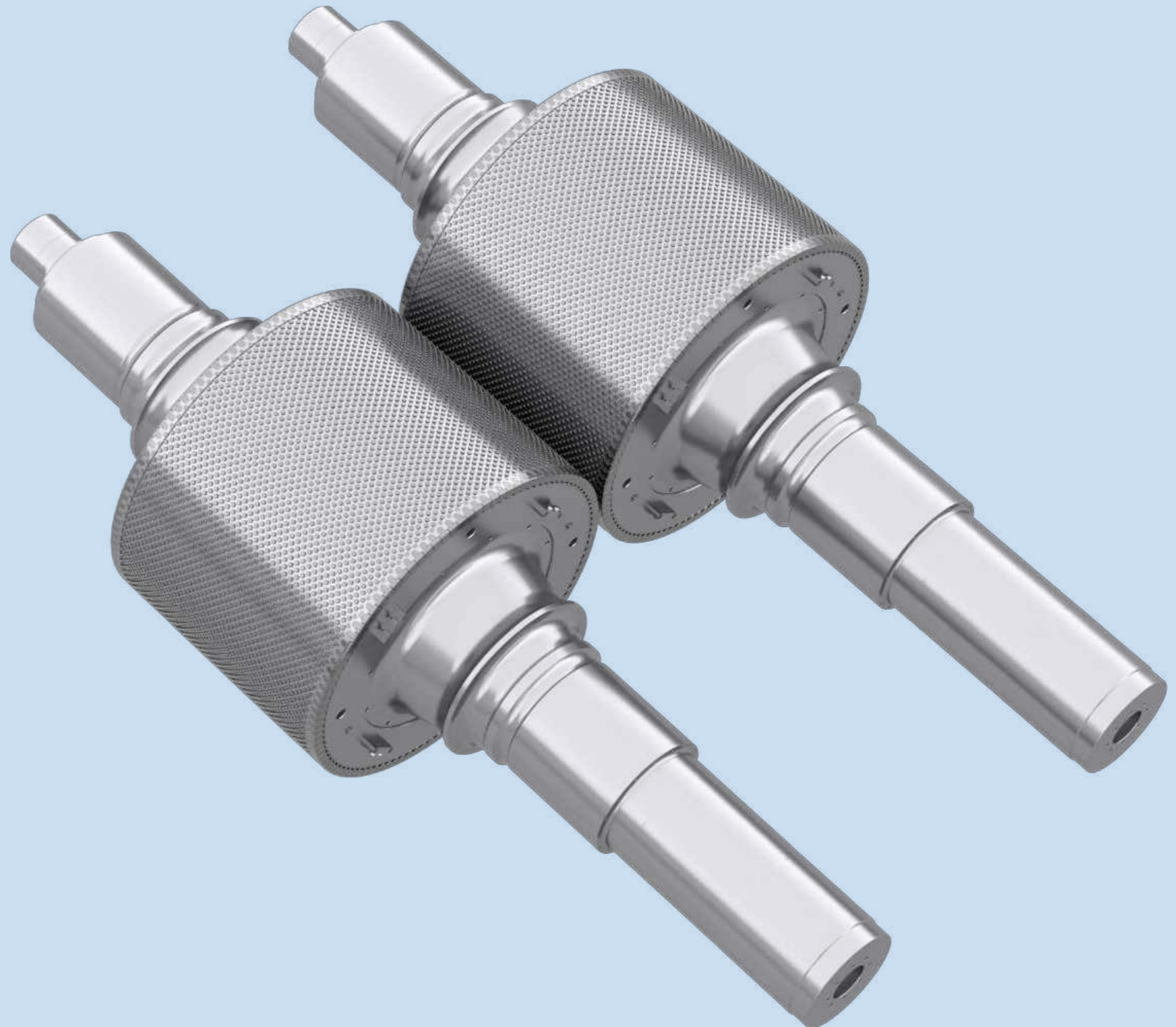
Our combination of hard-metal studs and the material embedded between these studs has gained wide recognition, enabling a superior autogenous wear layer protecting the roll surface. As a further benefit of the studded roll, the nipping properties are significantly improved. Our patented roll surface system has been further developed to the stud-lined surface and is state-of-the-art technology. It is highlighted by excellent service cycles.

## Long tyre life

The Weir automated stud installation process guarantees repeatable quality and tyre performance. Enduron® tyres guarantee long wear life. Enduron® edge blocks are built to last and remain in place at all times. The tyres are removed from the shafts and replaced at the end of their service lifetime.

## High product quality at lower operational costs

Enduron® HPGR's unique roll Length-Diameter ratio delivers highest product quality, minimising recirculation, and reducing operational costs. Our smaller roll diameter optimises the operating gap, fully penetrating pressure through it to exceeding the ore's compressive strength. The spring-loaded lateral wall system provides optimal seal, reducing wear at all feed conditions.



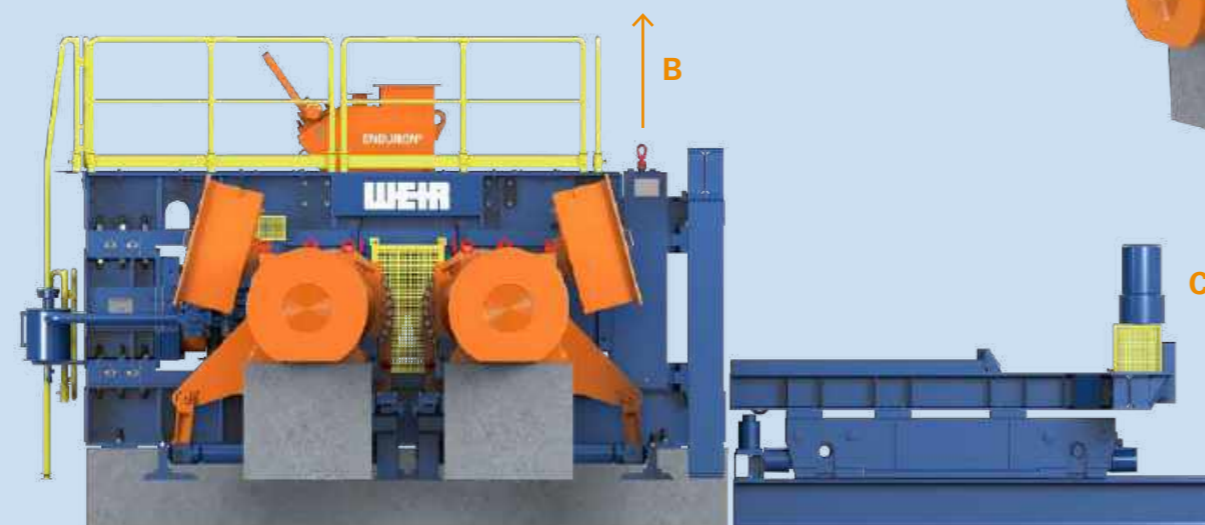
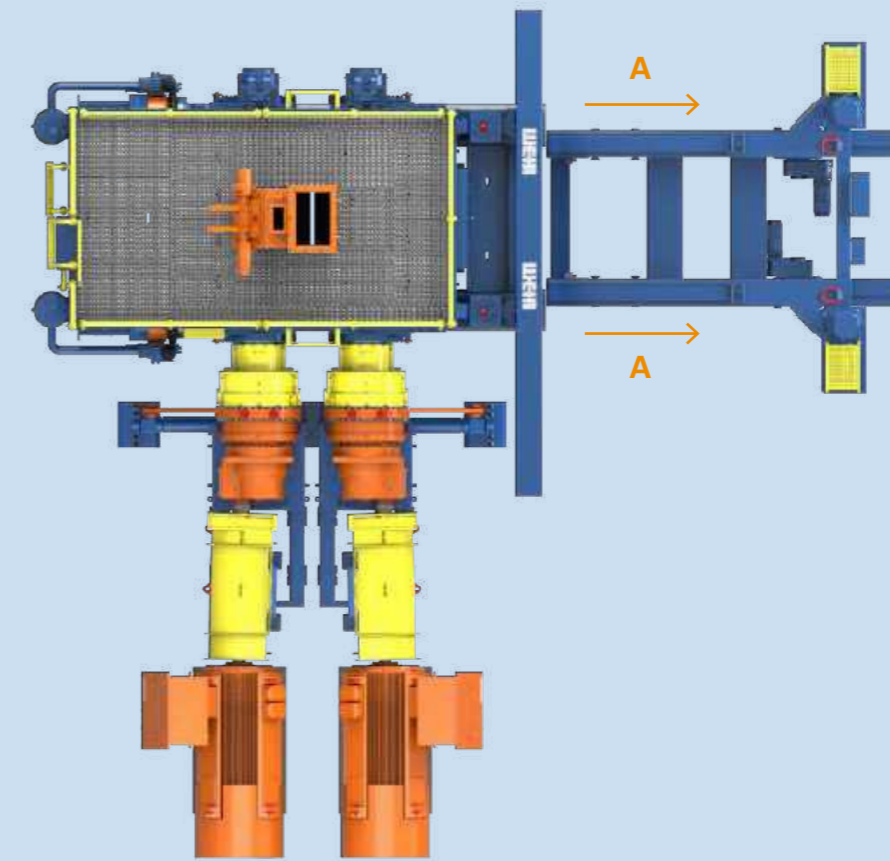
# Enduron® press frame and roller exchange

Weir Minerals engineers perfected a low vertical height design with reduced conveyor angles resulting in a compact final system. This means less steel, less concrete and conveyors and a substantial cost down in overall capital costs.

## Safe maintenance with minimal downtime

Side roller exchange can be carried out without dismantling the HPGR frame. There is no need to remove the HPGR feed bin, feeding device or fixed hydraulic lines. The upper structural parts of the HPGR frame can remain in place.

Access to the roller assembly is easily accommodated by opening the pluggable end-pieces (B). The complete roller assembly can be removed laterally after disconnecting the quick-release hydraulic lines, lubrication lines and planetary gearbox (A). Combined with the Teflon and Stainless-Steel sliding plates, the powered hinged twin cable system (C) allows controlled and safe removal of the complete roller assembly.



# Enduron® bearing system

Enduron® HPGRs are supplied with a multi-row cylindrical roller bearing system and a tailored rubber thrust pad which is arranged directly in front of the bearing housings. The rubber thrust pad combined with the bearing arrangement ensures that the bearings are always parallel with the shaft, mitigating the peak pressures and bearing contamination. This unique design also allows for oil lubrication to the main bearings.

## Highly engineered cylindrical roller bearing arrangement

### Even load bearing and roller skew

The Enduron® HPGR has a bespoke tailored rubber thrust pad to absorb and distribute the bearing loads evenly and also accommodate roller skew.

### Savings on plant construction costs

That's thanks to a small bearing diameter lowering machine height. These compact bearing housings are also cost effective to transport as well as easy to handle in transit.

### Guaranteed long bearing life (>100,000hrs)

To date, none of the Enduron® HPGRs installed across the globe have experienced pre-mature bearing failures.

## Oil-lubricated system for optimum temperature and to filter contamination

### Long life and high availability

This oil-lubricated system secures the longevity of the bearing arrangement and warrants high machine availability.

### Enduron® HPGRs can be completely air-cooled

Depending on the ambient temperature, no water cooling is required on either shafts, nor on the bearing housings.



# Enduron® hydraulic pressing device

A HPGR's main objective is to attain a satisfactory product at a minimum pressing power. This is consistently achieved in our Enduron® HPGRs thanks to the highly engineered hydraulic pressing device in combination with the press control system.

## Optimal operating parameters

Having pre-determined these in material tests, the optimal operating parameters are automatically monitored and kept within specified tolerances by the hydraulic control system. Constant product quality is achieved even in case of normal fluctuations of the feed characteristics. The operator will be in a position to manually control the HPGR for short periods if required.

## Controlled roller skewing

This maximises size reduction at all times.

## Ore pressure distributed across the full width

Skewing allows the ore to effectively distribute pressure across the full width of the tyre, minimising recirculation.

## Particularly applicable in segregated feed conditions typical in mineral processing

By contrast competitor HPGRs that do not allow for skewing have a larger gap resulting in larger product and a higher recirculation load.



# Enduron® self-adjusting lateral walls

The Weir Minerals method of material feeding is a contributing factor to its steady and vibration-free HPGR operation.



## Optional regulating gate

Depending on the specific material to be processed, the feeding device can be equipped with a regulating gate and given the most appropriate wear-protection lining.

## Adjustable cheek plates to accommodate skewing

The cheek plates mounted on both sides are vertically and horizontally adjustable and are an integral part of the feeding device. They ensure that only a minimum of unpressed feed will flow past the sides of the roll faces. The plates are mounted in a manner which enables them to give way upon skewing of the movable roll. In such a case, the cheek plate is pressed back to its original position by means of a pre-loaded spring assembly after the parallel position of the movable roll relative to the fixed roll has been restored.

## Lower the cost of wear

Of a split design, you can just change the bottom part of the cheek plate, which is subject to maximum wear. By only replacing the worn section of the cheek plate, you are helping to lower the cost of wear.

# Enduron® HPGR dynamic control philosophy

At the heart of the Enduron® HPGR, its control philosophy responds to changing feeding conditions and adapts the machine to maximise the grinding efficiency. This dedicated local control system seamlessly integrates with a plant's DCS (Distributed Control System) and provides the operator with transparent feedback on the performance of the equipment.



Integrated Enduron® HPGR control system

## Automatic adaptation to changing conditions

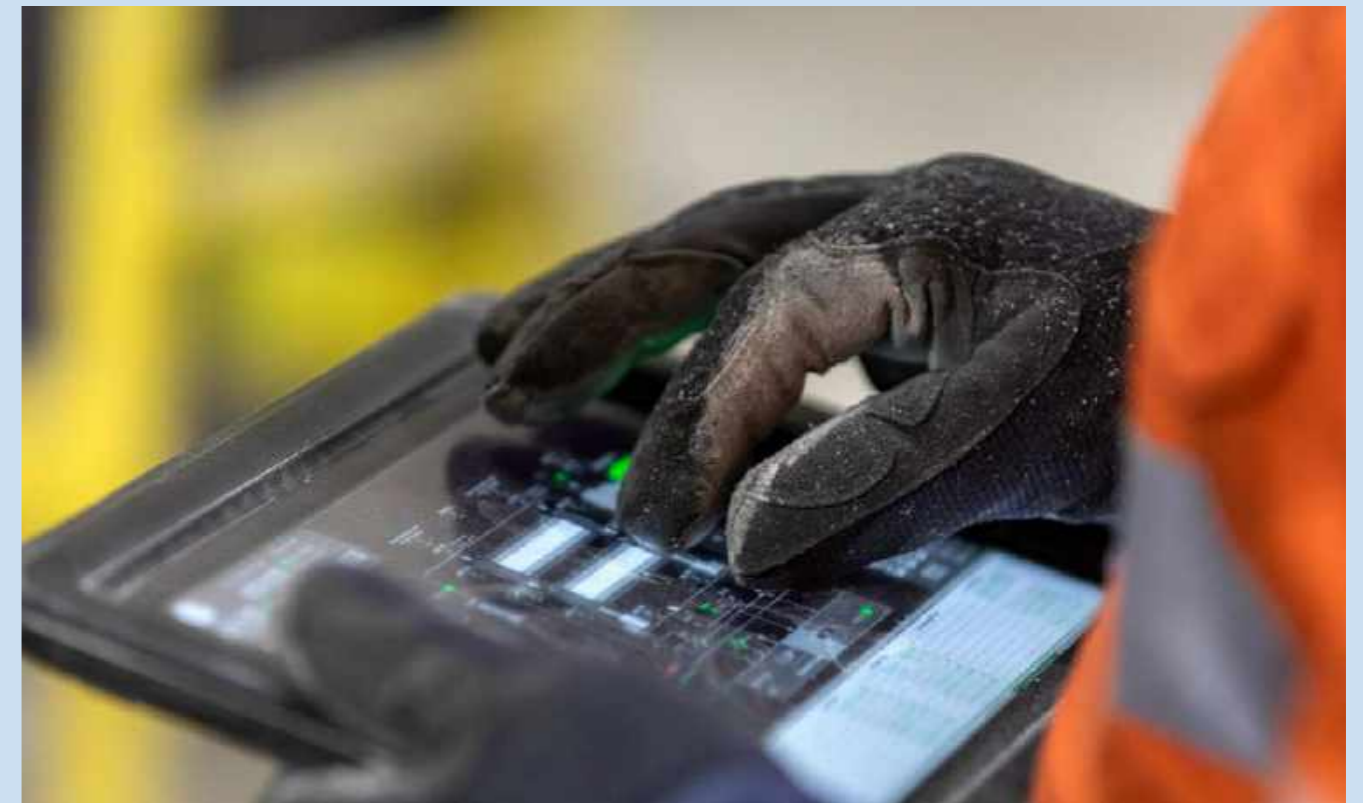
Increasing the grinding circuit's productivity and efficiency demands for a comminution solution which performs at changing feed conditions. The Enduron® HPGR with dynamic skew control has the ability to stabilise the product output despite changing feeding conditions. Having less fluctuations downstream will enhance process control and increase mineral recovery.

## Simple, safe and flexible control

Operators have full access to heart of the HPGR via the DCS system or local HMI (Human Machine Interface).

The Enduron® mobile HMI provides operators with greater flexibility on site and Synertrex® smart analytics platform enables remote conditioning monitoring and expert support.

The set points can be changed online, of which the dedicated HPGR control system will automatically operate within the predefined bandwidth.



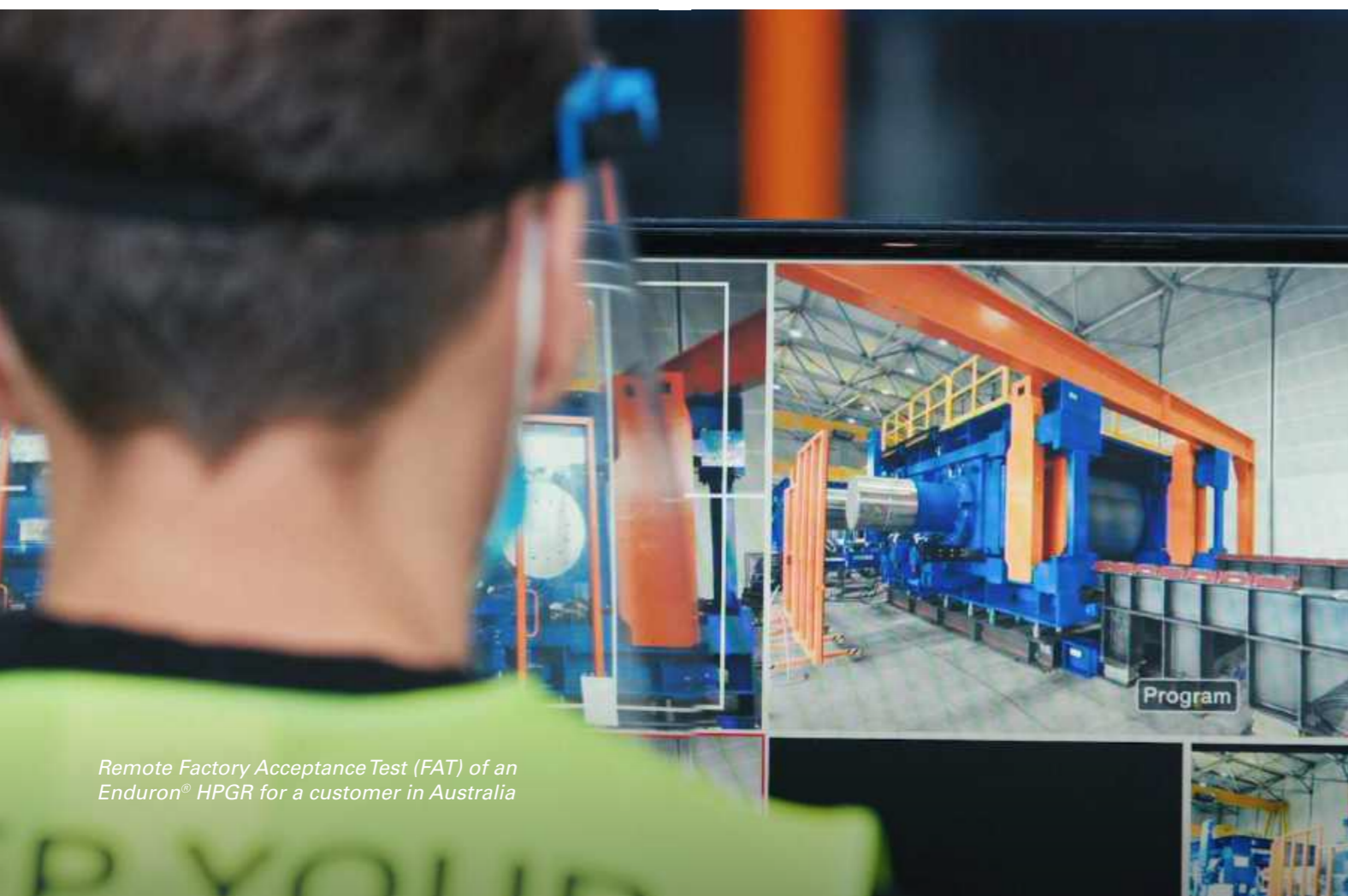
Mobile and accurate HPGR control.







*Weir Minerals expert team remotely supporting a customer using smart glasses*



*Remote Factory Acceptance Test (FAT) of an Enduron® HPGR for a customer in Australia*

# Digital conditioning monitoring and remote support

Weir Minerals is leading the way in data capture and analytics to maximise equipment availability, mitigate unscheduled downtime, all the while ensuring wear components are fully utilised to reduce operating costs.

## Synertrex® Technology

Synertrex® sensors can be applied to Enduron® HPGR. Then, through advanced cloud or edge computing, data is continually captured and analysed in real time, with alarms activated for troubleshooting to avoid unnecessary failures. The data can be analysed on site or remotely by Weir Minerals experts to maximise wear life and equipment availability.

## Venlo Digital Tower

Imagine a futuristic control room transmitting data around the clock. A digital realm where our world-leading team of experts can virtually visit customer sites, assess the operability of the equipment and provide support with the use of new technologies. Weir Minerals dedicated team supports our customers from all over the world, 24/7, through the Venlo Control Tower in the Netherlands.

# Weir Minerals' services

With on the ground staff and service facilities already operating in more than 70 countries, Weir Minerals' unmatched regional support network allows our product experts to be in close proximity to our customers.

## 24/7 support

With dedicated HPGR service and process engineers in all regions supporting our customers every step of the way.

## Service centres

In close proximity to help maintain our extensive, global HPGR-installed base.

## Regional HPGR service technicians

On the ground and experienced.

## Specialist HPGR project and site management

For full system installations.

## Sustainability experts

Ready to assist at any time, understanding both upstream and downstream conditions to deliver the greatest energy, water and ownership cost savings.

## In-house support

From machining, manufacturing and assembly to factory acceptance testing. All adhering to the strictest global quality standards at our bespoke facility in the Netherlands.



