Minerals

VULCO®
Mill Lining Systems


VULCO®
Wear Resistant Linings

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Vulco® mill lining systems: revolutionary rubber liners that provide exceptional wear life and reliability

Weir Minerals is committed to delivering market-leading mill liners combining state-of-the-art technology and innovative design with unparalleled service to all our customers across the world.

The grinding circuit is the most abrasive application that process equipment endures. At Weir Minerals, we've invested in formulating our abrasion- and corrosion-resistant materials to be the best there is – with technologically advanced elastomer compounds that include impact-resistant properties.

Mill liner experience and expertise

Weir Minerals has over 40 years of experience in the design, manufacture and supply of mill linings. Our innovative designs are tailored specifically for every customer and are manufactured to the highest industry standards for autogenous (AG) and semi-autogenous (SAG) mills, primary, secondary, and re-grind ball and rod mills.

With an integrated approach, our skilled teams of engineers, designers and chemists consider your entire circuit and custom design a Vulco® mill lining system for exceptional wear life and reliability. Our in-house research and development facilities enable management of the entire process, from initial design through to manufacture, so that our customers' expectations for superior quality mill liners are not only satisfied but exceeded.

Our team of experienced engineers complete a comprehensive analysis for each milling duty. Factors such as service life, grind and power efficiency, ore characteristics, along with customer circuit constraints both up and down stream of the mill are considered to ensure we deliver the most optimised solution.

Our global capability and experience in all aspects of grinding mill circuits throughout the world have positioned us as a leading developer of abrasion-resistant materials for all applications.

World-leading elastomers

Weir Minerals has extensive experience and has invested decades of laboratory and practical research to develop best-in-class elastomer compounds for mill grinding duty.

Vulco® R series

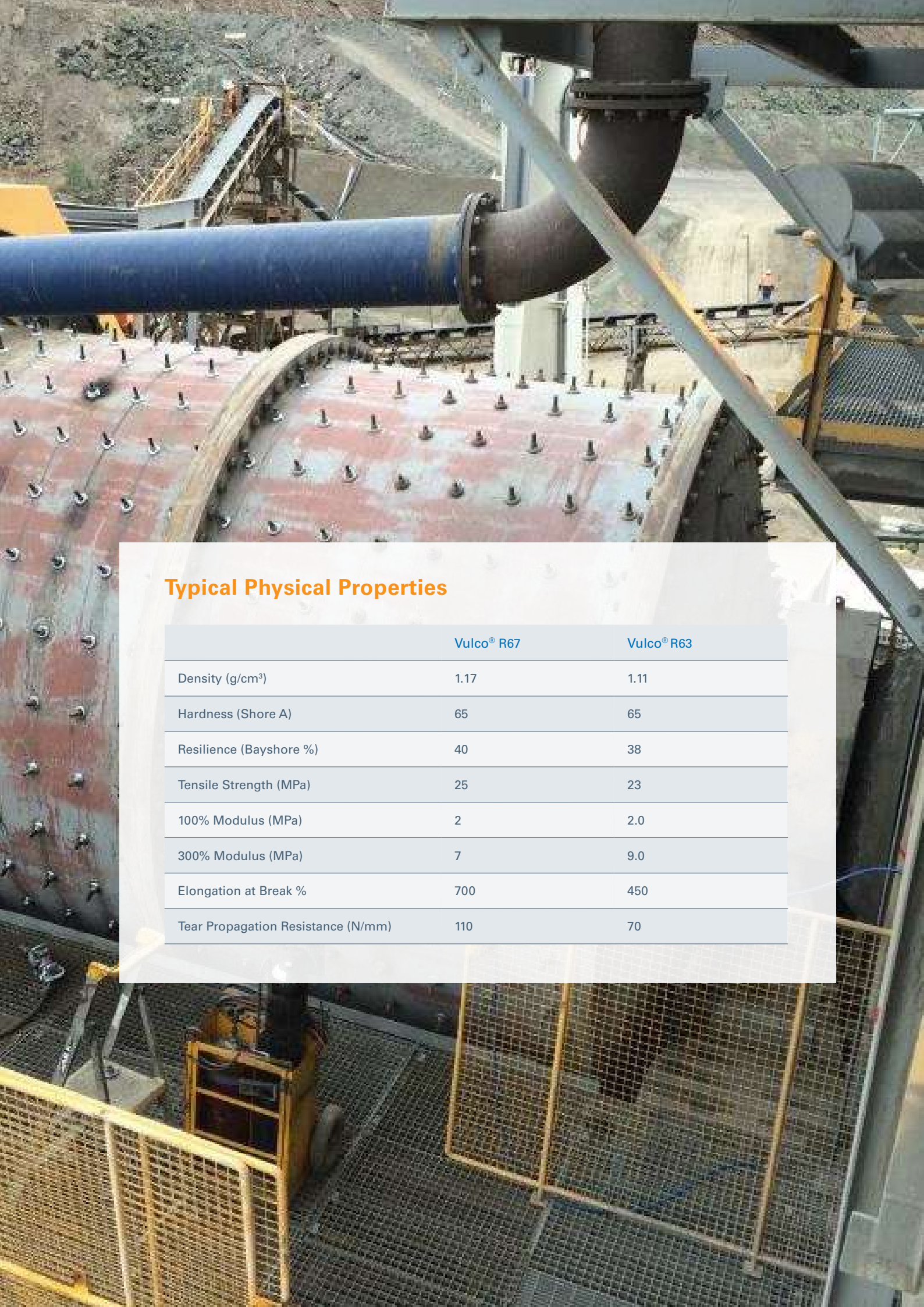
Our team of highly experienced in-house elastomer scientists have created rubber formulations, which are ideally suited for use in mill linings under the Vulco® R series of rubber formulations.

The inherent characteristics of elasticity, high tensile strength and corrosion resistance found in the Vulco® elastomer compounds position them as the preferred mill lining material over steel in many applications. Not only do the elastomer compounds perform better, but they do not wear as quickly as steel.

The elasticity of the Vulco® elastomer compounds enables our mill lining material to restore back to its original form after impact, while its high tensile strength prevents premature tearing or cracking. This resistance to deformation also results in linings that are easier and faster to remove when it is time for replacement.

Vulco® mill linings are custom-designed for each grinding application with consideration given to available mill power, trunnion bearing loads, mill weight restrictions, grinding media charge volume and service life.

At Weir Minerals, we have a wide range of flexible manufacturing techniques that enable combinations of rubber shell plates and lifter bars to be produced to different specifications. In arduous applications with high wear zones, our engineers can select the appropriate R series of Vulco® rubber compounds that can be combined with cast or rolled metal inserts to form composite linings with maximised service life.



Typical Physical Properties

	Vulco® R67	Vulco® R63
Density (g/cm³)	1.17	1.11
Hardness (Shore A)	65	65
Resilience (Bayshore %)	40	38
Tensile Strength (MPa)	25	23
100% Modulus (MPa)	2	2.0
300% Modulus (MPa)	7	9.0
Elongation at Break %	700	450
Tear Propagation Resistance (N/mm)	110	70

Components

Vulco® mill lining components incorporate features that have been engineered for severe ore and milling characteristics.

Composite rubber shell plates

Most mills can be converted from metal liners to composite rubber liners. These liners combine the best characteristics of metal alloys and rubber to obtain a superior design for use in AG/SAG, grate discharge, overflow ball mills and grinding ball mills.

By using special alloy steel segments moulded into rubber, composite plates greatly reduce the liner breakage risk, present in the grinding process where balls of over 100mm are used.

In addition, composite linings are up to 35-50% lighter than their metal equivalents. This translates into an increase in grinding capacity.

Rubber composite lifter bars

In aggressive SAG/AG applications where a higher impact wear protection is required than that offered by the Vulco® R series rubber compounds, rubber composite lifter bars can be used.

Weir Minerals has designed a series of composite inserts for lifter bars ranging from 100mm up to 500mm wide and high.

All composite designs are pressure-moulded to provide outstanding surface impact resistance with considerable weight savings over traditional steel lining systems.

Vulco® composite lifter bars utilise a variety of materials including chromiummolybdenum and white iron castings to high abrasive steel plate, all of which are vulcanised within an elastomer to form a composite component.

Discharge grates

Vulco® rubber and composite grates have many advantages over traditional cast steel. The Vulco® range includes grate designs resistant to pegging, with relief angles on apertures, positive sealing and fitment between adjoining components, safety and ease of installation.

Vulco® discharge grates have flexibility in size, shape and location of apertures. Options range from small multiple apertures per grate to large AG/SAG mill applications, with integrated reinforcement for structural integrity and open pebble ports for maximum open area.

Pulp discharge designs

Pulp discharge segments, designed by Weir Minerals' engineers, maintain a high throat discharge capacity and flow to reduce slurry carry-over and back flow circulation.

These designs incorporate outer or upper, intermediate discharge segments with a centre cone – allowing for steel, composite or rubber grates to be installed with or without apertures.

By preventing recirculation between segments, the overall service life is extended and reline times reduced.

At Weir Minerals, we design and manufacture complementary products to the mill lining systems, including trommel screens, moulded trunnion liners and high-impact chute components.

Fastening system (product)

Weir Minerals' fastening systems are designed and tested through numerical Finite Element Analysis (FEA) modelling and are destruction load tested to suit the application. These systems employ a track system using either aluminium, rolled steel or (in specific conditions) stainless steel.

Vulco® moulded lifter bars incorporate the robust security of mechanical and chemical rubber bonding to the "T" track to prevent disbanding in operation and are designed to attach securely for the safety of the reline personnel.

This system design produces a low-profile fastening system giving maximum use of wear material.

Quality assurance tested

Vulco® mill lining products are quality checked at every step, from the original design, engineering, manufacturing and curing stage to installation, to provide high quality, correct fitment and low installation time.

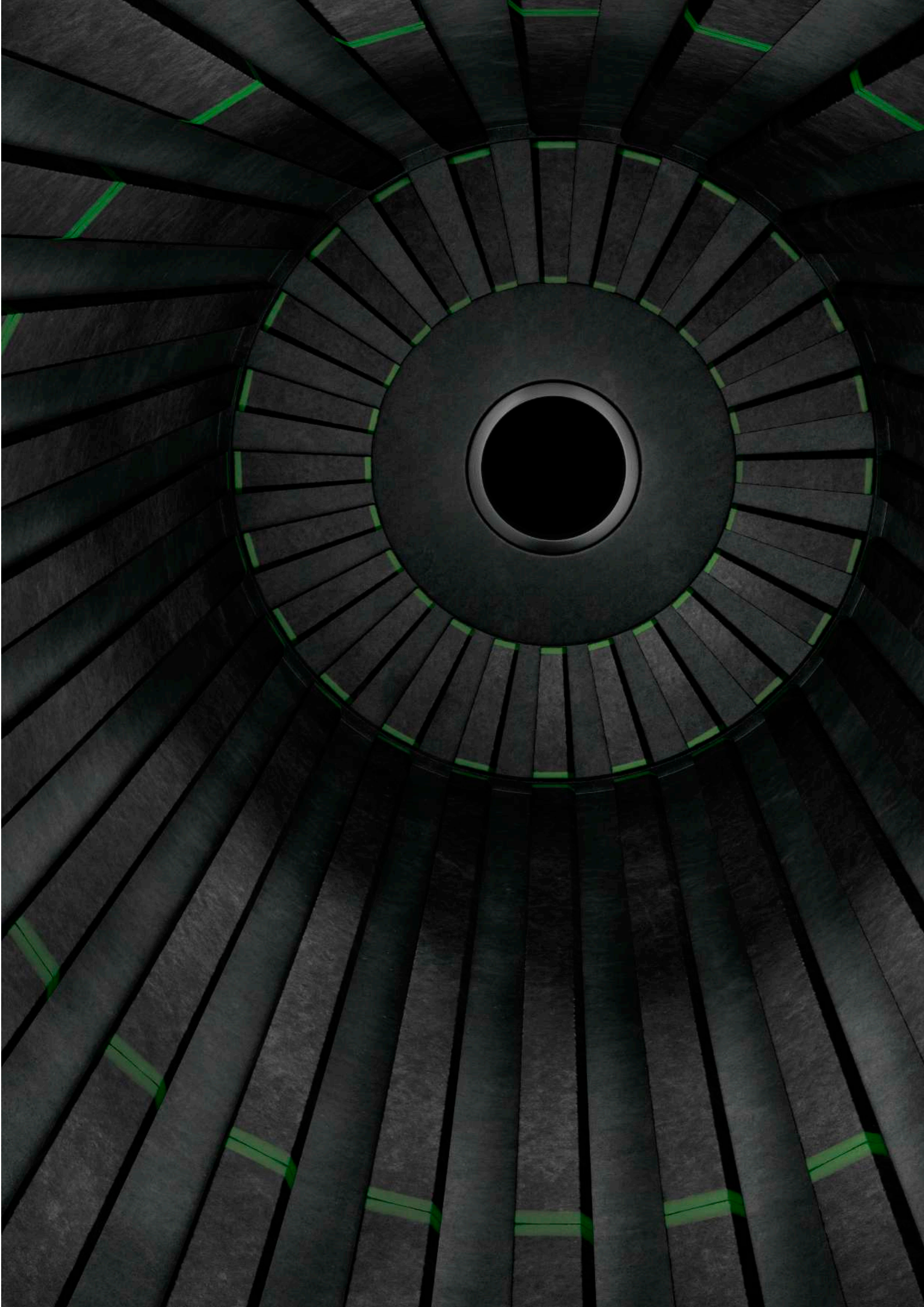
The Weir Minerals' global production facilities are registered to quality assurance standards to guarantee that Vulco® mill lining products are manufactured to the highest quality standard.

In addition, Weir Minerals' internal quality control procedures, which include comprehensive raw material checks, visual, electronic, chemical and physical testing procedures, ensure that Vulco® products meet strict design and quality expectations.

Circuit optimisation

Weir Minerals' mill lining design engineers consider the mill the heart of your comminution circuit and will design a lining system that interacts optimally with the cyclones, screens, and pebble crushers.

The key to circuit optimisation is the value that Weir Minerals' ongoing mill inspection reports deliver. Allowing for trend analysis of lining system wear patterns, visual inspections can identify changes occurring in the mill lining patterns, which can subsequently be linked to site performance. The Weir Minerals engineers utilise their experience to support our customers and maximise their circuit returns whilst optimising the lining systems' service life.



Our innovative Vulco® mill lining systems are designed and manufactured to suit our customers' specific milling needs

Coupled with our unique service offering, personalised and tailored to our customers' specific site and goals, we provide market-leading mill liners which instill our customers with confidence, reliability and assurance.

When high performance and durability are priorities, Weir Minerals is the only choice for innovative and trusted mill lining solutions.

Combining research and technology

We utilise the most up-to-date technologies and design tools, including Finite Element Analysis (FEA), Discrete Element Modeling (DEM), Fluid Dynamic Modeling (FDM), scaled laboratory models, and Single Particle Hydrodynamics (SPH), combined with Unigraphics CAD systems, to ensure an optimum system design and accurate liner fit.

In most regions we can apply 3D visualisation with computer-aided modelling, as this is necessary for the complicated geometries of grate and pulp discharge systems and new-generation liner profiles.

After careful review of all data, the most appropriate design and materials are selected in order to deliver the optimal grinding performance and the lowest ownership cost.

ROI and TOC

To ensure efficient milling operations, liners should maintain the original design profiles for longer periods throughout their service life.

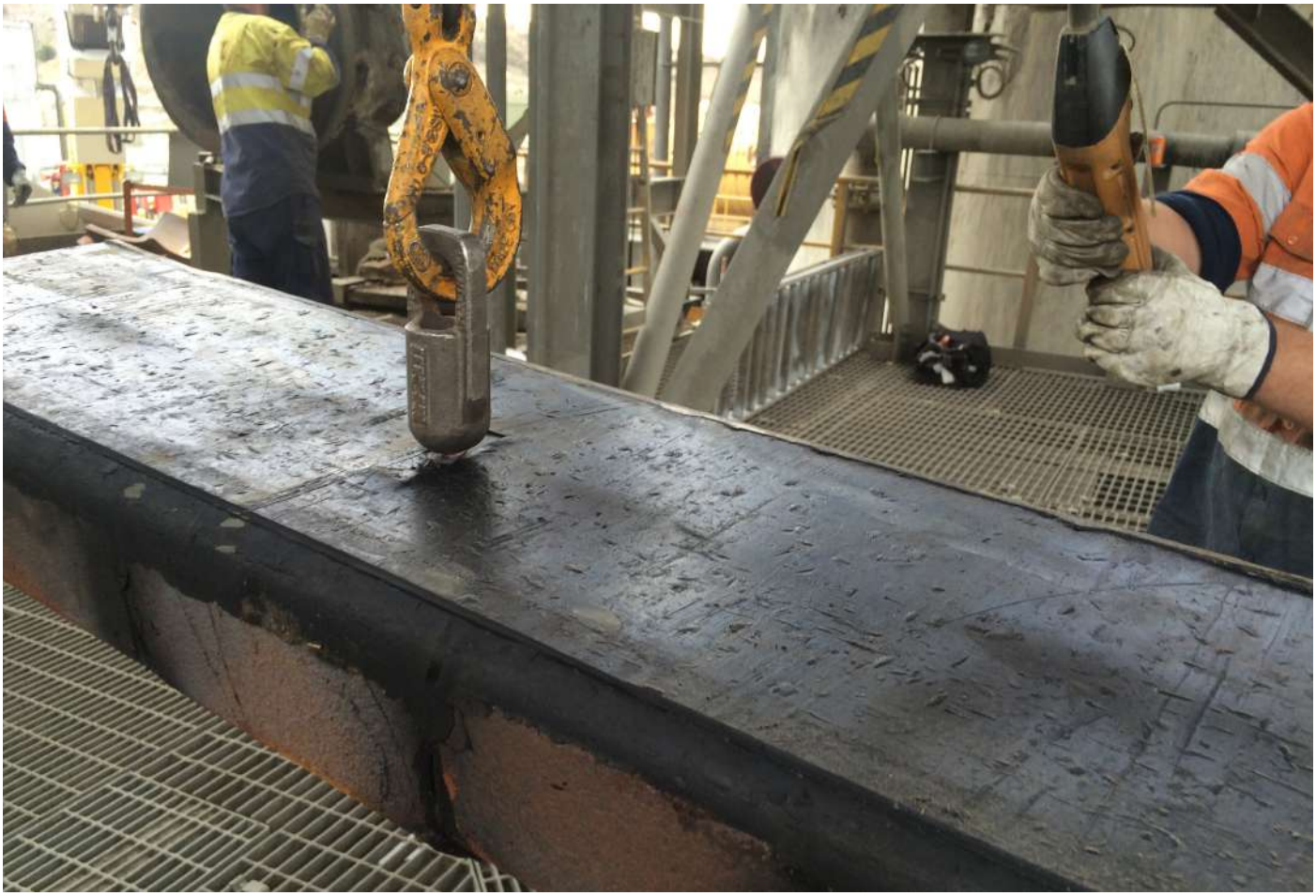
By employing designs unique to your specific application, mill volumes can be increased and variable-speed mills can potentially maintain a longer period of effective grind recovery and optimisation.

Through balancing the high- and low-wear zones within the mill, similar service life can be achieved for all zones, achieving a lower Total Ownership Cost (TOC) for your circuit.

Installation and reline periods

With advanced materials and state-of-the-art design and technology, Vulco® wear-resistant rubber and metal cap mill liners are versatile, economical and efficient products that provide:

- **Lower installed cost** – Since rubber and metal cap mill liners weigh 35-40% less than steel alone, they are faster, easier and safer to install. Lower costs are achieved through correct dimensional components, on-time and fully labelled packaging, certified lifting points along with providing trained personnel from Weir Minerals to assist with risk and hazard management strategies.
- **Operating efficiency** – Vulco® rubber compounds are specially formulated for maximum tear resistance and resilience, increased wear life and reduced downtime between relines. All liner profiles are custom-engineered to fit specific geometry and operating conditions.



Reducing the mass of lining systems results in an increased mill chamber capacity, enabling more materials to be processed. This additional material can then be added without overloading the mill support bearing and shell structural design.

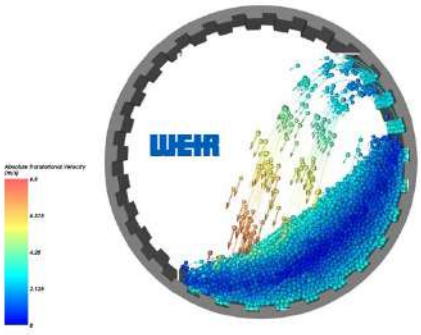
- **Reduced maintenance** – The low-profile T-track system eliminates the need for frequent inspections, repair and bolt tightening. Vulco® rubber conforms to the mill's internal surface, creating a seal that prevents leakage, slurry erosion of the mill shell and precious metal lockup under the liners. Longer wear life, faster change-outs and fewer maintenance interruptions lead to greater mill availability, performance and production.
- **Health and safety** – Rubber liners will significantly reduce the generated and transmitted sound level associated with grinding, while the risk of strain injuries during installation is reduced due to the lighter weight of the liners. Converting to Vulco® rubber linings from metal can also reduce the number of components to be handled, thereby decreasing the potential for injuries to fingers, hands and limbs.
- **Lower operating cost** – Next to the ongoing cost of electrical power and grinding media, mill liners are the highest recurring expense for a mineral grinding operation. Compared to traditional metal liners, the benefits of Vulco® rubber liners will effectively reduce this expense as the longer wear life leads to fewer replacements, shorter downtime and longer periods of productivity.

Optimum lifter bar geometry

Weir Minerals employs numerical analysis using Rocky DEM software to ensure the correct lifter bar face angle design.

Delivering you exceptional support and performance, regular onsite mill inspections and monitoring by our mill lining engineers will link in-field results to Rocky DEM or mill charge trajectory analysis.

Vulco® mill lining system combinations of height to width shell/lifter bars with an optimal leading-edge face angle will ensure the available power is converted to particle size reduction in the most efficient manner.



An example of Discrete Element Modeling (DEM) of mill charge dynamics in a SAG mill.

Weir Minerals provides dedicated engineering, installation and ongoing after-sales service.

Global manufacturing facilities

Weir Minerals' global network of offices, service facilities and manufacturing teams across more than 60 countries provides a truly worldwide total care package for Vulco® products, including:

- Design analysis
- Condition monitoring services
- Responsive manufacturing
- Installation supervision
- Inventory management
- Research and development
- Technical reporting
- Safety and risk monitoring
- Innovative solutions
- Access to a worldwide network
- In-house engineering

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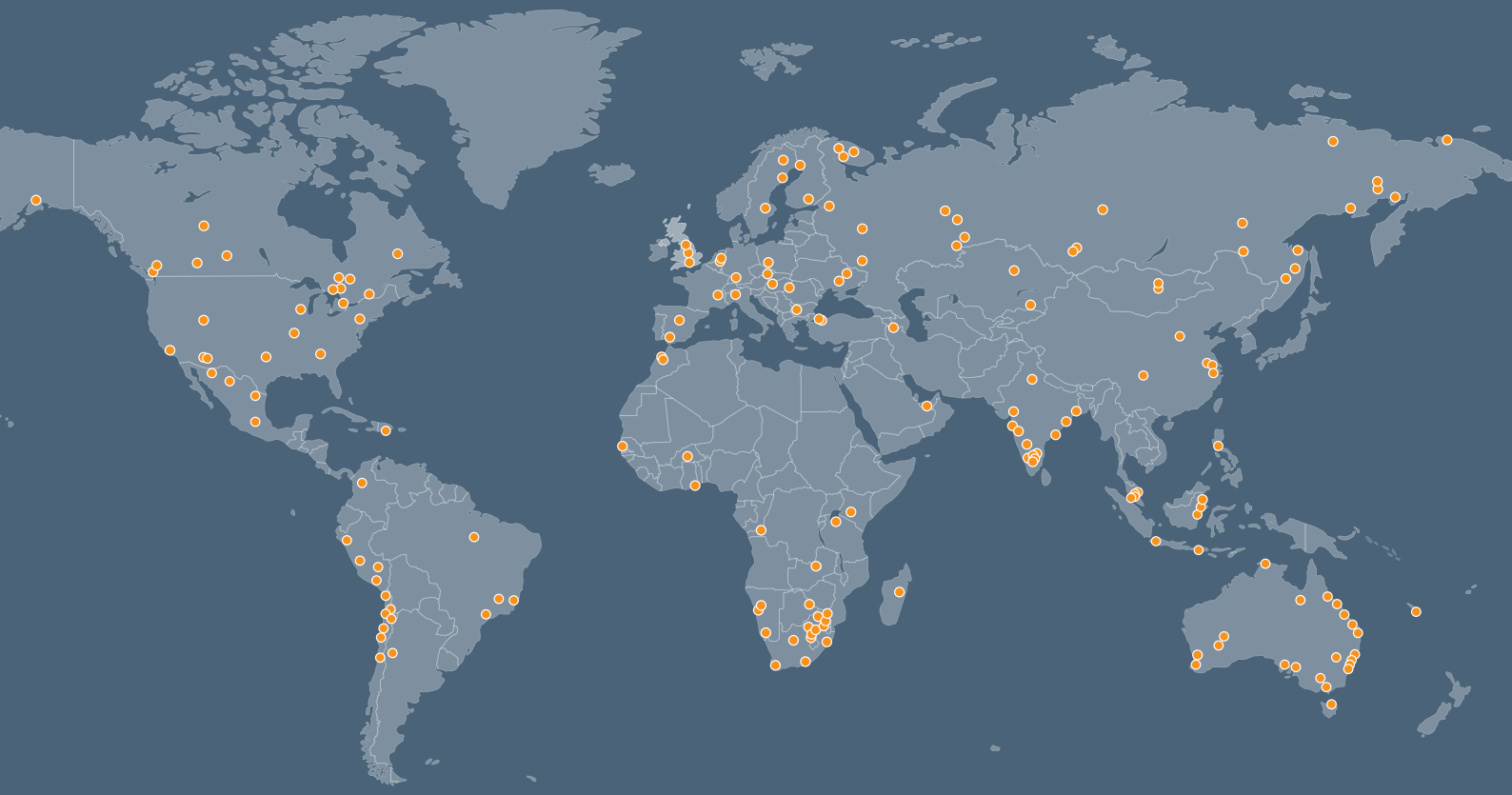

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