

VULCO®

Wear Resistant Linings

Mill Lining Systems

Excellent
Minerals
Solutions

WEAR
MINERALS



Weir Minerals designers and engineers work to create Vulco® products that are continuously improving the state-of-the-art in mill lining systems.

Mill liner experience and expertise

Weir Minerals has considerable experience in the design and manufacture of linings for autogenous (AG) and semi-autogenous (SAG) mills, primary, secondary, and re-grind ball and rod mills.

Using a holistic approach, our experienced staff of engineers, designers, and chemists custom design Vulco® mill liners for exceptional life and reliability in the most arduous grinding applications. Our in-house facilities enable total control of the entire process, from design to manufacture, so that our customers' needs and requirements for best quality mill liners are satisfied.

Before an optimal design and material can be recommended, a complete analysis is conducted for each milling duty. Factors such as mill dimensions, mill speed, mill power, ore type, feed top size, feed size distribution, throughput, charge volume and make-up, density and product size are considered.



Above: Model mill for optimizing design of grate discharge assembly

Combining design and research tools

Design and research techniques used include scaled laboratory models, CFX fluid dynamics and Discrete Element Method (DEM) charge analysis. Combined with Unigraphics CAD systems, these tools ensure optimum system design and excellent liner fit. 3-D visualization with CAM is a necessity 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.

Continuous improvement and new development in technology

Weir Minerals global expertise in slurry hydraulics and wear resistant materials has partnered well with mineral processing research facilities of a number of prestigious universities to drive continuous improvement and new developments in mill lining technology. Our focus is on innovation and improved products for ball and SAG mill applications, specifically in areas such as grates and shell and head protection where our intimate understanding of discharge flow dynamics is beneficial.



Above top: Typical grate discharge assembly

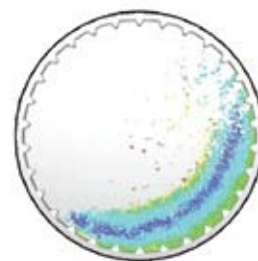
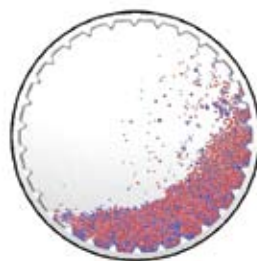
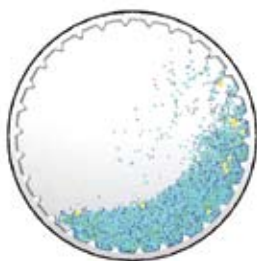


Above bottom: New composite SFL plates for SAG mill application



Above: Vulco's patented heavy duty metal cap shell plate for extended service life in large diameter AG, SAG and ball mills

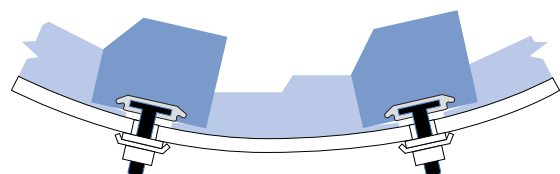
Right: DEM simulations showing energy levels, size distribution and ball/mineral particles



Vulco mill liners help reduce costs per ton of material processed for plant owners and operators.

Increasing importance of liner design

The emphasis on liner design to ensure efficient mill operation has grown, particularly as mills have increased in size. The extent to which a liner effectively protects the mill, imparts energy *and* controls the mill charge, impacts on the total ownership costs for plant owners and operators. In general, the harder the material fed to a grinding mill, the greater economy achieved using rubber liners.



Above: Typical Vulco mill liner with SIC/A lifters and SSL plates with liner bolt attachment system



Right: Typical large SAG mill

Below: Large SAG mill in the copper industry with some of the local Vulco mill liner team



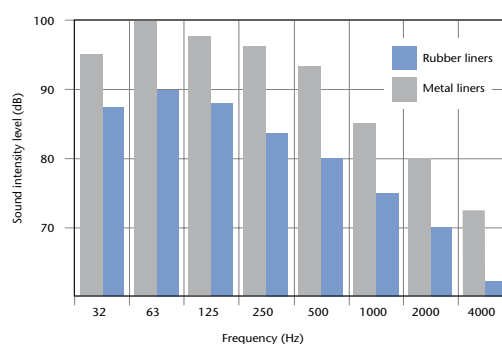
Versatile, economical, and efficient Vulco wear resistant rubber and metal cap mill liners provide:

- **Lower installed cost** – Since rubber and metal cap mill liners weigh up to 80% less than steel alone, they are faster, easier and safer to install.
- **Operating efficiency** – Vulco rubber compounds, specially formulated for maximum tear resistance and resilience, increase wear life and reduce downtime. Liner profiles are custom engineered to fit specific geometry and operating conditions. Reducing the mass of lining systems commits greater charge weight to be utilized, increasing throughput.
- **Reduced maintenance** – The low profile T-track system eliminates the need for frequent inspections, repair, and bolt tightening. Rubber conforms to the mill's internal surface creating a seal that prevents leakage and slurry erosion of the mill shell. Faster change outs and longer wear life with fewer maintenance interruptions mean greater mill availability and performance.
- **Health and safety** – Rubber liners significantly reduce the generated and transmitted sound level associated with grinding. The risk of strain injuries during installation is reduced because of the lighter weight of the liners. Converting to rubber linings from metal can reduce the number of components to be handled.



Above: Rubber retention ring

Sound level comparison



Compared to metal liners, rubber liners can reduce sound levels associated with grinding by up to 10dB, equal to a 50% reduction registered by the ear

- **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 rubber liners effectively reduce this expense.

Special developments in rubber liners evolved as the result of the rigorous demands of large primary grinding mills.

Correct material and design extend mill availability

Mill lining design and wear materials that last longer and are easier and faster to change out are the solution to the requirement for increased mill availability. Rubber and metal cap meet both needs. Since impact forces in large primary autogenous and semi-autogenous mills may cause very high wear rates, downtime with high capital and maintenance costs is a major financial consideration.

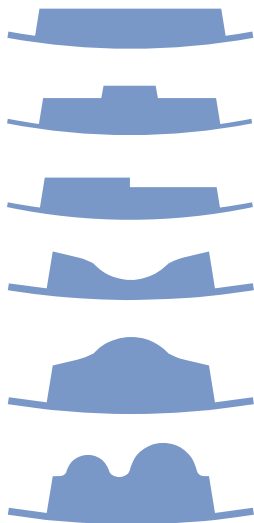
Rubber mill liners outlast steel on abrasive service

The inherent characteristics of Vulco rubber compounds—elasticity, high tensile strength, and corrosion resistance—make rubber the preferred mill lining material over steel. Rubber’s elasticity permits restoration of its original profile after impact, and its high tensile strength prevents tearing.

Shell plate and lifter bar profiles are custom designed

Vulco linings are custom designed for each grinding application with consideration given to factors such as plate thickness, width and height of lifter bars, distance between bars, shape of bars, mill capacity and power draw.

Various types of feed head liner, discharge head liner, shell plate, and lifter bar geometry options are available to ensure optimum grinding and lowest ownership costs.

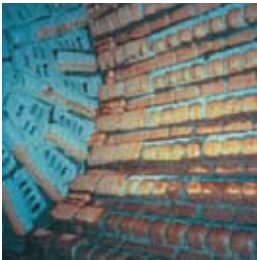


Various shell plate configurations, top to bottom: SFL, SCL, SSL, SSW, SDW and STW

High-low installation pattern reduces downtime

For primary grinding, unique sloped sided lifter bars up to 400mm (15.75”) wide and up to 500mm (19.7”) high are installed in an alternating high-low pattern. When high bars are worn down to the original height of low bars, new high bars replace the low bars. Therefore at every change of bars, only half are changed out.

Lifter bar lengths are easily adapted to the wear pattern in the mill. Shell plates last through several sets of bars. Replacing a minimal number of parts during shutdown periods ensures that a more cost efficient maintenance program can be adopted to deliver the maximum possible mill availability.



Above top: Metal cap shell plates and lifters plus metal cap lifters on the grate discharge mill end
Above bottom: Typical SAG/ ball mill circuit

Liner product codes

Lifter bar code	Lifter bar description	Width (mm)	Width (inches)
RIC/A	round top w/aluminum T-track	100 to 400	4 to 15.75
RIC/S	round top w/steel T-track	100 to 400	4 to 15.75
QIC/A	square top w/aluminum T-track	100 to 400	4 to 15.75
QIC/S	square top w/steel T-track	100 to 400	4 to 15.75
SIC/A	sloped edge w/aluminum T-track	100 to 400	4 to 15.75
SIC/S	sloped edge w/steel T-track	100 to 400	4 to 15.75
Head plate code	Head plate description	Thickness (mm)	Thickness (inches)
HFL	flat top	40 to 150	1.6 to 6
HCL	raised centerline (hump) top	40 to 150	1.6 to 6
HSL	step top	40 to 150	1.6 to 6
Shell plate code	Shell plate description	Thickness (mm)	Thickness (inches)
SFL	flat top	40 to 200	1.6 to 7.8
SCL	raised centerline (hump) top	40 to 200	1.6 to 7.8
SSL	step top	40 to 200	1.6 to 7.8
SSW	single wave top	40 to 200	1.6 to 7.8
SDW	double wave top	40 to 200	1.6 to 7.8
STW	triple wave top	40 to 200	1.6 to 7.8
Grate plate code	Grate plate description	Thickness (mm)	Thickness (inches)
GFL	flat top	40 to 200	1.6 to 7.8
GCL	raised centerline (hump) top	40 to 200	1.6 to 7.8
GSL	step top	40 to 200	1.6 to 7.8

Notes
1. Standard bars and plates are rubber; also available with metal caps in hardened steel plate and chrome-moly steel or iron
2. Inserts can be aluminum, carbon steel or stainless steel
3. Special width lifter bars up to 500 mm are available

Weir Minerals specializes in SAG and AG applications.

SFL composite shell plate reduces risk of breakage

SFL is a composite product that combines the best characteristics of metal alloys and rubber to obtain a superior element for use as a shell plate in AG or SAG grinding mills. By using special alloy steel segments molded into rubber, SFL plates greatly reduce breakage risk always present in the grinding process where balls of over 100mm (4") are used.

In addition, SFL linings are up to 60% lighter than equivalent metal liners. This can be translated into an increase in grinding capacity.

Metal cap liners provide best possible service life

In aggressive SAG and AG applications, impact situations that exceed allowable stresses on rubber linings may dictate the use of a metal cap liner. A metal cap, pressure molded to the rubber, provides surface impact resistance with considerable weight savings.

Vulco SIC/S design lifter bar reduces cataracting during the initial stages of the lifter bar life. This reduces energy and media and lining material losses that would otherwise arise from unproductive cataracting of the grinding charge.

Vulco metal cap lifter bars utilize chromium-molybdenum steel or white iron castings vulcanized within a natural/synthetic elastomer matrix. The rubber compound is specifically designed for maximum abrasion resistance in the most aggressive grinding environments commonly found in primary milling applications. Metal cap lifter bars are designed to achieve the best possible service life by placing the more costly alloy where it will be most efficiently used.

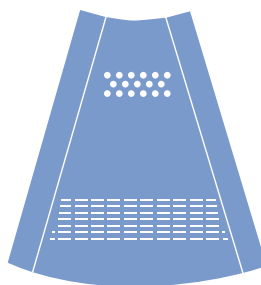
Grate discharge head liners

Non-plugging grate openings, positive seals between manufactured parts, safety and ease of installation, and long wearing rubberized components are major benefits of Vulco grate discharge head liners. Large mill grate discharge heads offer improved flow and reduce recirculation to increase mill efficiency. Optimized design and material selection matches the wear life of linings.

Both autoclave vulcanizing and molded parts are available as alternate manufacturing methods.

Flexible reinforced grate plates have positive tapered holes

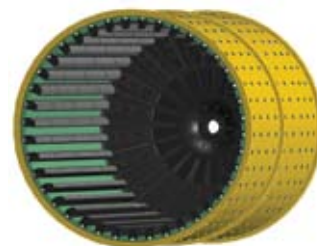
Vulco flexible, reinforced grate plates have positive tapered apertures which permit self-cleaning and minimize plugging. As a result, the grates have a very effective open area for good pulp extraction.



Left: Grate plate with an arrangement of different apertures

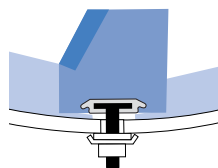


Above top: Head lining with a curved design

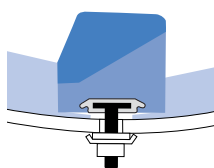


Above bottom: Shell lining with radial head liner design

Metal cap liners



medium duty service



heavy duty service



Above: Metal cap lining used near the grate end of a mill

Left: Metal cap lifter for medium duty service

Vulco mill lining systems offer a range of user benefits.



Optimum pulp discharge assembly design

Pulp discharge assemblies, incorporating upper discharge or center cone design, preassemble to insure fit and avoid extended mill downtime. Each system is designed to prevent recirculation, extending overall assembly life.



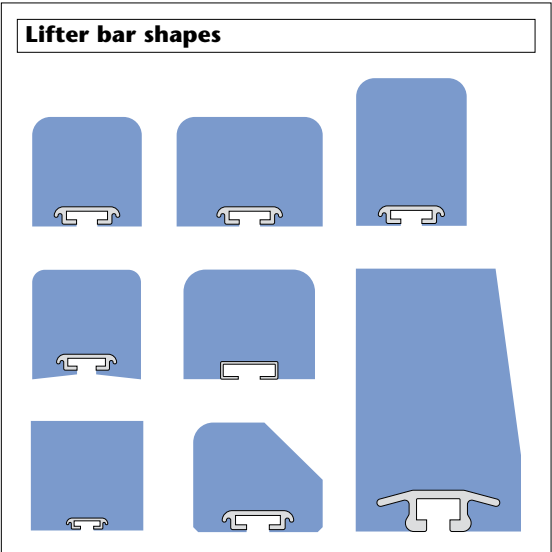
T-track fastening system provides safety and quick adjustment

An aluminum or steel T-track, molded into rubber under high pressure, provides both longer liner life and a safe secure attachment. This system takes advantage of both mechanical and chemical bonding to produce a low profile, metal insert lifter bar which affords maximum utilization of rubber, and can also be used with metal cap liners.

The T-track system allows worn or damaged parts to be quickly and easily replaced. Lifter bars can be replaced without removing the shell plates. Special molded corner segments fill the gap between shell and head liner, allowing the change of shell and head parts independent of each other.

Above: Fit testing of pulp dischargers for large AG/SAG mill

Below: Various lifter bar shapes include round top, square top, and sloped edge



Secure seals prevent leakage

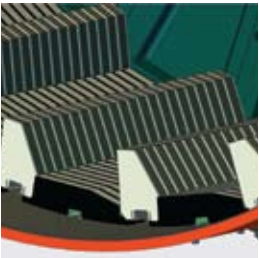
Liner installations are securely sealed to prevent any leakage by use of a rubber washer held in place by a steel cup washer. A special bushing, utilized when changing from steel to rubber linings, centers the bolt and prevents pulp from penetrating into the bolt hole and enlarging it by wear.

Optimum lifter bar geometry

Discrete element method (DEM) charge trajectory analysis is conducted to guarantee the correct lifter bar face angle to ensure the available power is converted to ore size reduction in the most efficient manner.

Lighter weight components mean increased cost savings

Pulp dischargers, cone liners, trunnions and trommel screens can be made as steel fabrications covered with thick, abrasive resistant sheet rubber and ceramic inserts when required. Lower operating costs through power savings are achieved via significant reduction in the overall system weight.



Above: Composite metal cap SFL shell lining

Left: Typical molded SFL lining section

Weir Minerals' Total Care provides dedicated after sales service.



Above: Taking a wear reading for predicting wear life

Global network ensures Weir Minerals is close to customers' operations

Weir Minerals has a global network of offices and service facilities worldwide to provide Total Care for Vulco products, including:

- design analysis
- condition monitoring services
- responsive manufacturing
- lining system installation supervision
- inventory management

Quality through testing

Vulco wear resistant products are quality checked at the design and engineering stage to ensure correct fit and lowest installation time. All Weir Minerals worldwide 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 and visual, electronic, chemical and physical testing procedures, ensure that Vulco products are to design, to quality, and to expectations.

Below top: Inspecting a rubber head lining for wear

Below bottom: SAG mill with hooded trommel screen attached



Left: Block type steps and overhead wire for safety during maintenance

Above: Inspecting a rubber head lining for wear

Right: Ball mill undergoing maintenance



WARMAN® Centrifugal Slurry Pumps
GEHO® Positive Displacement Slurry Pumps
VULCO® Wear Resistant Linings
CAVEX® Hydrocyclones
FLOWAY® PUMPS Vertical Turbine Pumps
ISOGATE® Slurry Valves
MULTIFLO® Mine Dewatering Pumps
HAZLETON® Specialty Slurry Pumps
LEWIS PUMPS™ Vertical Chemical Pumps
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For further information on Weir Minerals products or services, contact the nearest sales office or visit www.weirminerals.com

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