

# **STEEL** **INDUSTRY** **BOF CONVERTERS**

# CALDERYS PERFORMANCE YOU CAN TRUST

For all industries with extreme temperatures and working conditions, Caldersys is there for you. Combining a global network with local expertise, we offer customised solutions wherever you are: from monolithic refractory to bricks and precast shapes to a full range of engineering and installation services.

## KEY POINTS

Over 100 years of refractory experience

Over 2 300 employees across 33 countries

19 plants in 16 countries totaling 600 000 tons capacity

Annual revenue of over € 500 million

1 Global Technology Centre and 15 Customisation Labs

150 major projects implemented every year

Wholly-owned subsidiary of Imerys Group



# CALDERYS - YOUR TRUSTED PARTNER IN THE STEEL INDUSTRY

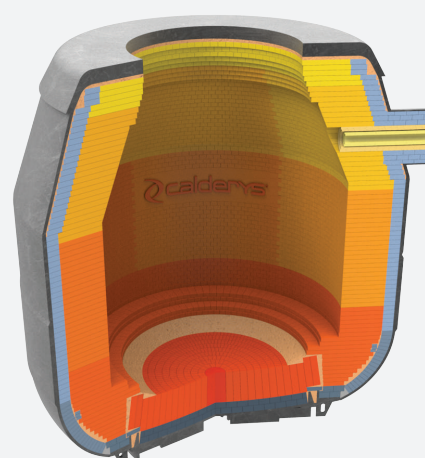
As a world leader in refractory solutions, Calderys has a complete product portfolio to satisfy all your refractory requirements. With our monolithic products and a full range of bricks, we are ideally positioned to offer individual as well as full package solutions including:

- Bricks for full relines, partial relines and patching
- Gunning Maintenance materials and castables
- A full range of remotely operated application equipment
- On site labour and supervision for efficient material installation



Calderys is considered a reference supplier in the steel industry, offering value-added solutions based on tailor-made designs and engineering to provide refractory linings for optimal performance.

Our comprehensive technology and services are a result of a world-class R&D network, local expertise from over 30 locations around the globe, and over 100 years of experience in the refractory business.



In addition to our product offerings, Calderys provides a complete range of services:

- Design
- Product selection
- Thermal calculations
- CFD analysis
- Installation
- Labour & machinery
- Supervision
- Repair service support
- Full refractory project management

# OUR VALUE TO THE STEELMAKING INDUSTRY

The world leader in monolithic refractory solutions, Calderys has a full product and service portfolio to adapt to the refractory needs of steelmakers. We ensure that we propose products most suitable for your process requirements and deliver to you superior refractory performance and reliable services. We are able to do so by combining our innovative product range and modern installation techniques with end-to-end project management.

## Value Optimisation



Offering tailor-made solutions that meet the commercial and technical requirements for optimal performance.

## Complete Refractory Solutions



We offer a full range of refractory products to meet the process needs of modern Steelmaking.

## Technology Expertise



Ensuring the best possible equipment availability and productivity at the lowest total refractory cost per ton of steel produced, whilst adhering to strict environmental and safety regulations in operations.





# CALDE® BRAND

## The Complete Refractory Solution For BOF Converters

Calderys holds two basic principles as the highest priorities when designing tailor-made solutions for converters:

### Reduced refractory consumption

Selecting the correct refractory products for each zone is the key to reducing the cost per ton of steel produced.

### High Grade, Long Life gunning maintenance materials

Reduced gunning maintenance time means increased Converter productivity and efficiency. This results in higher production rates, more efficient production planning and increased production stability.

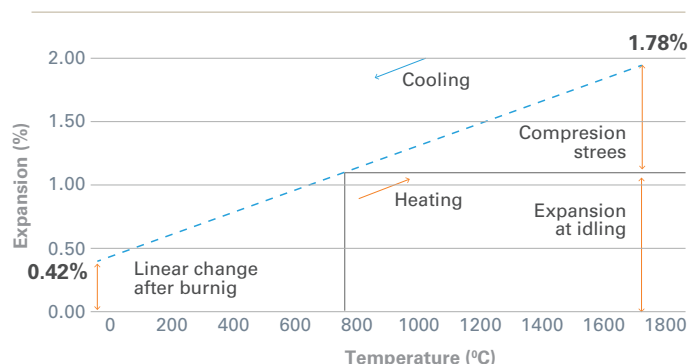
## Calderys Lining Design In-depth: Principle Of Expansion Allowance

Calderys design expertise ensures that the magnesia bricks that make up the core of any converter refractory lining solution are installed in such a way that normal expansion stresses are taken into account.

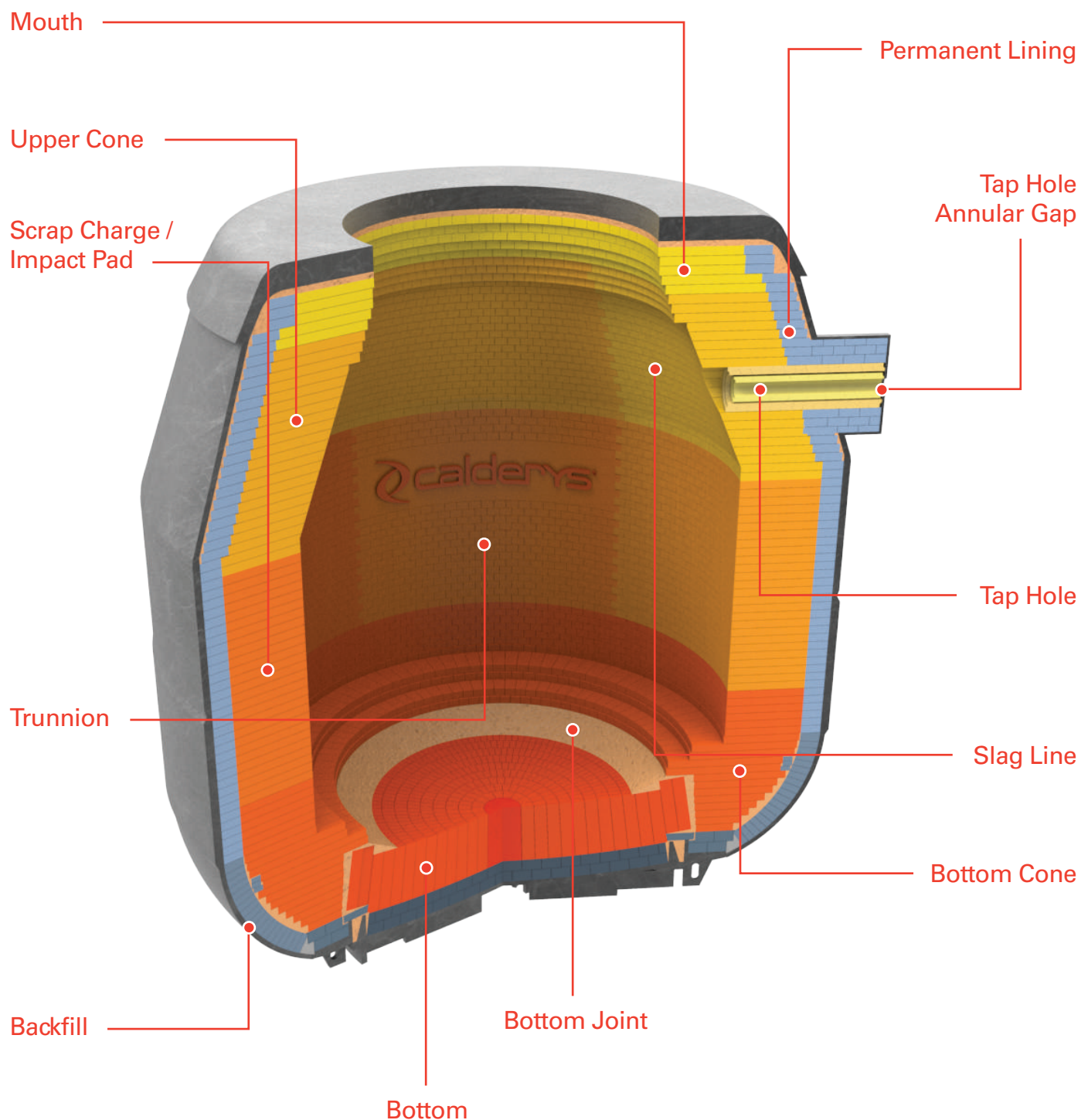
The reversible thermal expansion of magnesia bricks at steelmaking temperatures is ~1.5 - 2.0%, which in bigger vessels can add more than 200 mm expansion per ring in the lining.

This can be partially compensated by inserting expansion allowance, typically in the form of cardboard sheets, in the ring. On site experience must be considered and our design personnel will make a recommendation taking all aspects into account.

Expansion example: CALDE® BRICK MC R 706-G



# CALDERYS SOLUTIONS FOR BOF CONVERTER



# CALDERYS SOLUTIONS FOR BOF CONVERTER

## Wear Lining - Bricks

Zone	Product Recommendations	Chemical Analysis (Averages)				Residual Carbon %	Bulk Density g/cm <sup>3</sup>	Apparent Porosity %	CCS MPa	Anti Oxidants
		MgO %	CaO %	Fe <sub>2</sub> O <sub>3</sub> %	SiO <sub>2</sub> %					
Mouth	CALDE® MAG BRICK FM 97 PI	96	2.0	1.5	1.5	3	3.08	8	50	No
	CALDE® BRICK MC R 212-B	97	0.9	0.7	0.9	6	3.03	6	60	Yes
	CALDE® BRICK MC R 502-B	96.5	-	0.8	0.8	6	3.08	5	60	Yes
Upper Cone	CALDE® BRICK MC R 604-G	97	1.1	0.65	0.55	12	3.04	3.6	45	Yes
Scrap charge / Impact pad	CALDE® BRICK MC R 804-G	97.5	1.0	0.5	0.5	12	3.02	3.4	45	Yes
	CALDE® BRICK MC R 704-G	97.5	1.0	0.6	0.5	12	3.03	2.5	45	Yes
Slag line, Trunnion, Bottom	CALDE® BRICK MC R 806-G	97.5	1.0	0.5	0.5	15	2.95	3	35	Yes
	CALDE® BRICK MC R 706-G	97.5	1.0	0.6	0.5	15	3.00	3.1	35	Yes
Trunnion	CALDE® BRICK MC R 806-H	97.5	1.0	0.5	0.5	15	2.95	3.4	35	Yes
	CALDE® BRICK MC R 706-H	97.5	1.0	0.6	0.5	15	2.95	3.7	35	Yes
Bottom / Bottom Cone	CALDE® BRICK MC R 606-G	97	1.1	0.65	0.55	15	2.98	3.1	35	Yes
	CALDE® BRICK MC R 502-N	96.5	-	0.8	0.8	6	3.10	4.7	60	No
	CALDE® BRICK MC R 212-N	97	0.9	0.7	0.9	6	2.99	6	60	No

## Permanent Lining - Bricks

Zone	Product Recommendations	Chemical Analysis (Averages)				Residual Carbon %	Bulk Density g/cm <sup>3</sup>	Apparent Porosity %	CCS MPa	Anti Oxidants
		MgO %	CaO %	Fe <sub>2</sub> O <sub>3</sub> %	SiO <sub>2</sub> %					
All Zones	CALDE® MAG BRICK FM 95	95.0	2.0	1.5	2.5	-	2.95	18	50	No
	CALDE® BRICK MC R 112-N	94.5	2.3	0.8	2.3	6	2.94	8.3	60	No

## Bricks For Special Zones And Components

Zone	Product Recommendations	Chemical Analysis (Averages)				Residual Carbon %	Bulk Density g/cm <sup>3</sup>	Apparent Porosity %	CCS MPa	Anti Oxidants
		MgO %	CaO %	Fe <sub>2</sub> O <sub>3</sub> %	SiO <sub>2</sub> %					
Tap Hole	CALDE® BRICK MC R 806-E	97.5	1.0	0.5	0.5	15	2.95	3.2	35	Yes
Tap Hole, Tap Hole surround	CALDE® BRICK MC R 706-E	97.5	1.0	0.6	0.5	15	2.98	2.3	35	Yes
Purging Plugs	CALDE® BRICK MC R 806-G	97.5	1.0	0.5	0.5	15	2.95	3.0	35	Yes

# HIGH PERFORMANCE BOF CONVERTER MONOLITHICS

## Monolithics For Maintenance, Repair And Special Zones

### Gunning

**G** CALDE® MAG GUN G 65

### Gunning

High grade

**G** CALDE® MAG GUN BRG

**G** CALDE® MAG GUN HD

**G** CALDE® MAG GUN P 83

Standard grade

**G** CALDE® MAG GUN G 89

**G** CALDE® MAG GUN S 89

### Hot Repair

**SF** CALDE® MAG DRY S 75

**SF** CALDE® MAG FLOW K 94 HOT

**SF** CALDE® MAG BDTF 7001

### Backfill

**V R** CALDE® MAG DRY K 78 G2

### Deskulling Gunning Aids

CALDE® MAG GUN PSC 60 C2 **G**

CALDE® MAG GUN S 80 **G**

### Tap Hole Repair

CALDE® MAG FLOW K 94 **SF**

### Tap Hole Repair, Annular gap

CALDE® MAG CAST G 95 **V R**

CALDE® MAG GUN P 83T **G**

Gunned **G**

Hot Installation **Hot**

Rammed **R**

Ready Shaped / Vibrated **RsV**

Spraycast **SC**

Self-Flow **SF**

Vibrated **V**

### Bottom Joint

CALDE® MAG DRY K 95 **V R**

CALDE® MAG RAM R 96 G **V**

## Extending BOF Life In a Cost-Efficient Manner

Based on our global experience, we think that one particular gunning method cannot suit the needs of all steel plants.

The Calderys gunning and repair philosophy is dictated to a large extent by the balance between **converter availability** requirements and **refractory life** requirements.

Our converter refractory maintenance aim is to increase overall **furnace availability**, extend **vessel life** and reduce the total refractory cost per ton of steel produced.

### Focus: Composition Of BOF Maintenance Products

Our family of BOF maintenance products optimise the use of MgO and CaO bearing aggregates and use specialised and sophisticated phosphate bonding systems which interact with the converter slag to increase sticking, durability and reduce material consumption and maintenance time.



# MAINTENANCE EQUIPMENT



## CALDE® MACHINE DRY GUN

A full range of Automated Remote controlled Pressure vessel gunning machines operated with compressed air. **Available in 2 models: permanent or mobile.**

## BOF SHOOTER

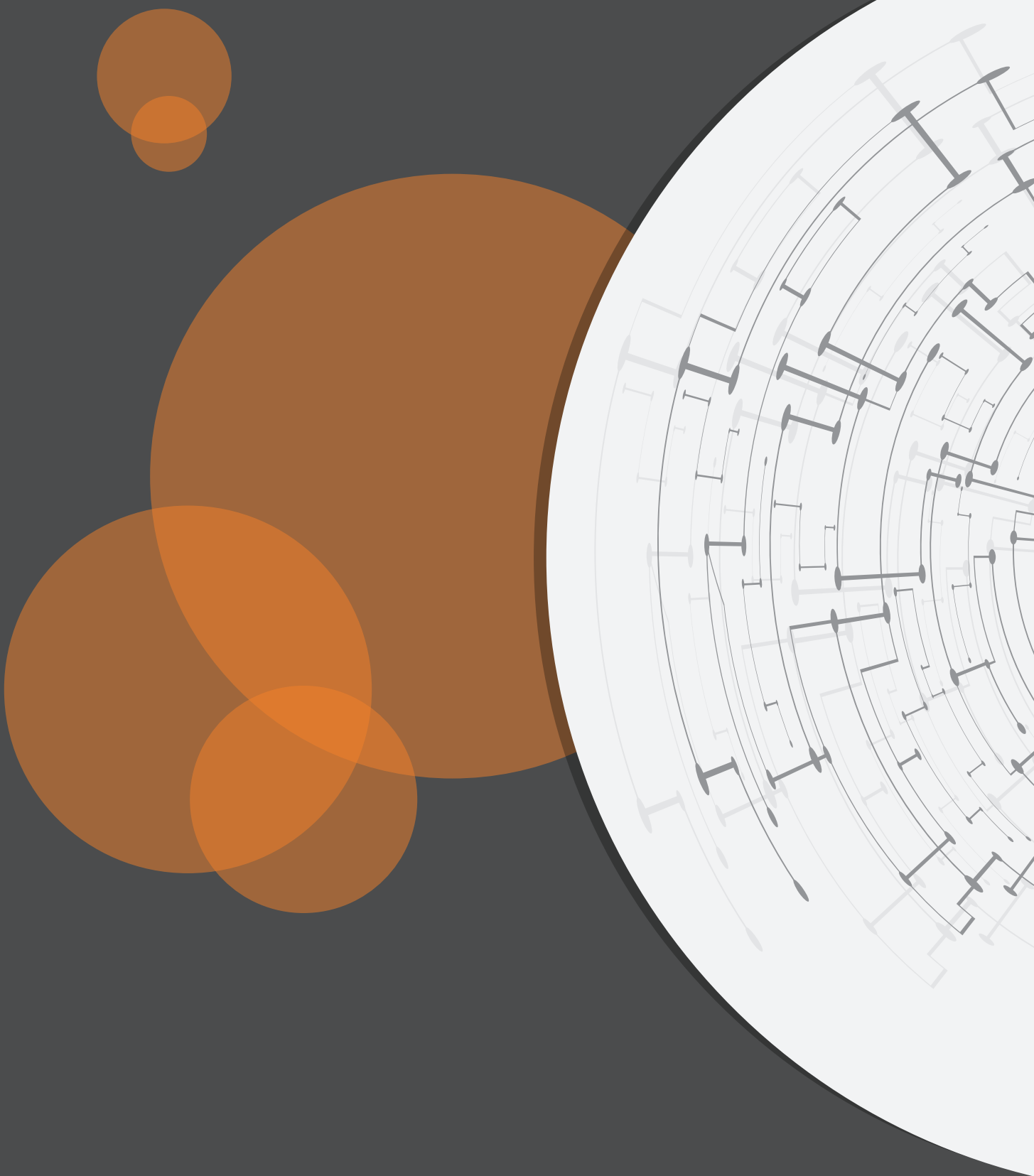
A Remote controlled gunning robot or 'Shooter' is available to ensure operator safety and fast, efficient, and accurate placement of material.



## Monolithic Refractory for BOF Converters

Product Name	Main Component	Binding System	Max. Recomm. Temp (°C)	Max. Grain Size (mm)	Chemical Analysis (Averages %)		
					MgO	CaO	SiO <sub>2</sub>
CALDE® MAG BDTF 7001	Magnesia	Carbon bonded	1700	8	76.5	2.5	-
CALDE® MAG CAST G 95	Magnesia	Chemical	1750	3.15	94.4	2.2	2.2
CALDE® MAG DRY K 78 G2	Magnesia	Ceramic	1750	2	78	12.5	1.2
CALDE® MAG DRY K 95	Magnesia	Ceramic	1700	5	94.5	2.0	1.5
CALDE® MAG DRY S 75	Magnesia	Chemical	1700	3	79	-	10.5
CALDE® MAG FLOW K 94 HOT	Magnesia	Mineral Reaction	1850	6	94	-	4.6
CALDE® MAG GUN BRG	Magnesia	Chemical	1700	4	76	17	0.5
CALDE® MAG GUN G 89	Magnesia	Chemical	1750	3.5	86	3.1	9.3
CALDE® MAG GUN HD	Magnesia	Chemical	1700	4	73.5	17.5	2.2
CALDE® MAG GUN P 83	Magnesia	Chemical	1750	3.5	83	3.9	8.8
CALDE® MAG GUN PSC 60 C2	Magnesia, Olivine	Chemical	1650	3.5	60.5	2.4	28
CALDE® MAG GUN S 65	Magnesia	Chemical	1700	3.15	65	20.0	12
CALDE® MAG GUN S 89	Magnesia	Chemical	1750	3.5	87.1	2.5	6.9
CALDE® MAG RAM R 96 G	Magnesia, Carbon	Chemical	1700	5	96	2.5	1.5

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