
moulds™
we give shape to steel

WHO WE ARE

Innovation with a long standing history

EM MOULDS is an Italian company with more than 50 years of experience in the design and manufacturing of copper moulds for continuous casting of steel.
Our team of more than 100 employees including engineers, specialized technicians and researchers strives to assist our customers in improving the quality of the semifinished product and optimising the casting process.

WHERE WE ARE

From Italy to the world

EM MOULDS has its registered office in Florence, while the production plant and sales offices are located in Fornaci di Barga, near Lucca.
Our sales network covers the entire world market and is supported by more than 25 experienced local agencies.

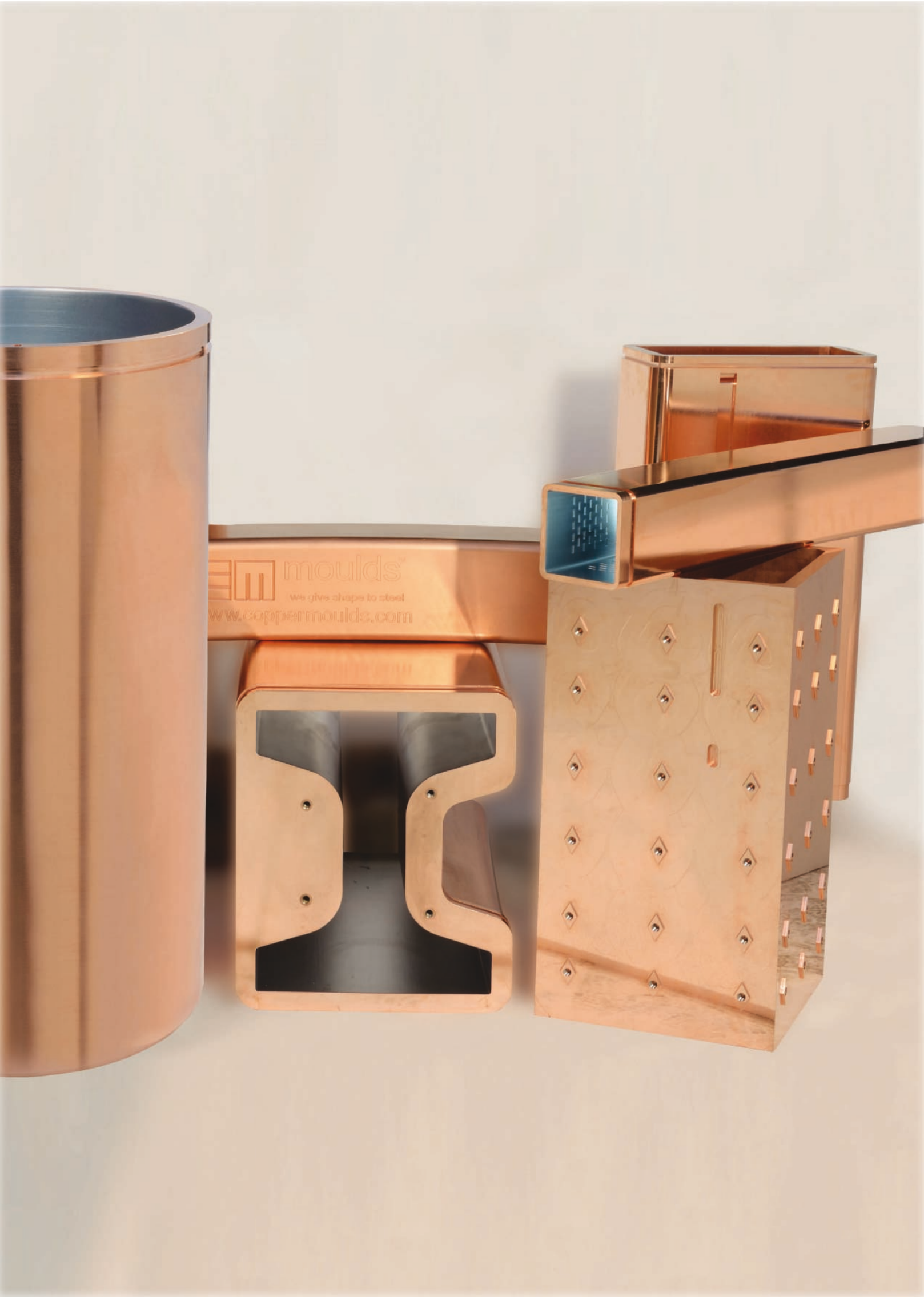
WHY CHOOSE US

Not just a supplier but a reliable partner

The key points that make EM MOULDS the world's leader in copper moulds are:

- extensive experience and knowhow
- customer focused approach, from engineering to delivery
- tailor-made design according to each Customer's requirements
- high product quality and optimal performances
- worldwide presence
- pre and post sales support with a team of experts in metallurgy and steel plant operations

To ensure optimal performances, moulds must keep their original specifications at the operating temperatures as long as possible, and preserve the adequate heat transfer capacity.
Thermal stress - which arises mainly on the hot faces at the meniscus area – may result in a permanent deformation of the mould, thus cutting short its life. This phenomenon is related to both the temperature level inside the mould and the temperature differences respectively between the hot faces and the cold faces and between the meniscus area and the area immediately below it.
In order to optimize the mould performance according to the casting conditions we can choose from a wide range of materials as follows.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www.coppermoulds.com

METAL MOULD 1 - CuDHP

Phosphorus Deoxidized Copper

DHP copper is still used to manufacture moulds for the continuous casting where the thermal flow is usually moderate and the thickness of the moulds is not excessive.

METAL MOULD 2 - CuAg

Silver Bearing Copper

Adding 0.10% silver to the copper increases the re-crystallization temperature by approximately 100°C, so that the temperature in the mould can reach 300°C even for long exposures without compromising its stability. The thermal conductivity of this alloy is in the region of 10% higher compared to MM1 material.

METAL MOULD 3 - CuCrZr

Copper Chromium Zirconium

In order to improve the mechanical properties at high temperatures of copper alloys, metallurgical experts have turned to structurally hardened alloys. There are numerous alloys which can be obtained in saturated solution of several elements, but results are not always compatible with industrial realities, such as coping with pollution problems, high costs and excessive loss of thermal conductivity.
The MM3 alloy represents an excellent solution as this satisfies all the requirements for the application. In fact, although with a comparable thermal conductivity to MM1, this alloy is sensibly harder and keeps its stability at temperatures exceeding 500°C.

MAIN PARAMETERS

		MM1 CuDHP	MM2 CuAg		MM3 CuCrZr		MM8 CuNiP	
Chemical Properties	Chemical composition (%)	P 0.015 0.040	Ag 0.08-0.12 P 0.004-0.012		Cr 0.30-1.20 Zr 0.03-0.30		Ni 0.47-0.53 P 0.09-0.115	
Physical Properties	Thermal conductivity at 20°C [W/mK]	340	377		325		284	
	Electrical Conductivity (%IACS) – minimum value	83	93		80		70	
Mechanical Properties		Tubular	Tubular	Plate	Tubular	Plate	Tubular	Plate
	Hardness at 20°C [HB]	93	95	90	125	120	115	110

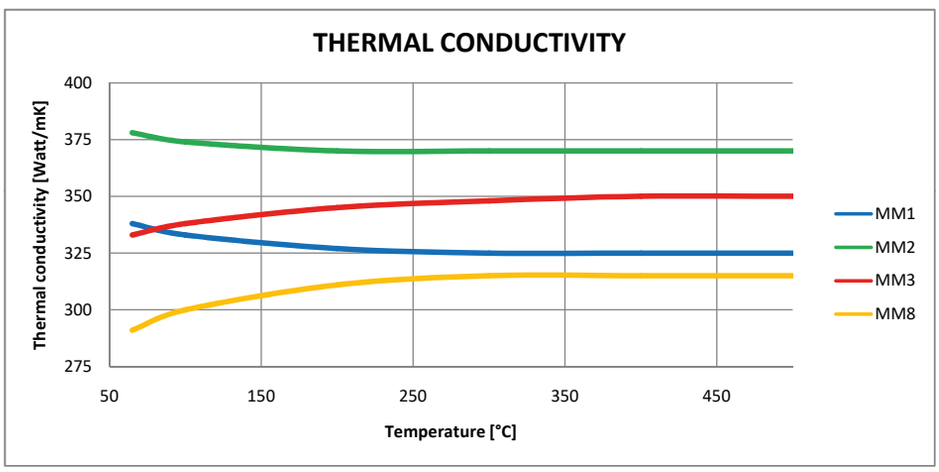
FURTHER PARAMETERS

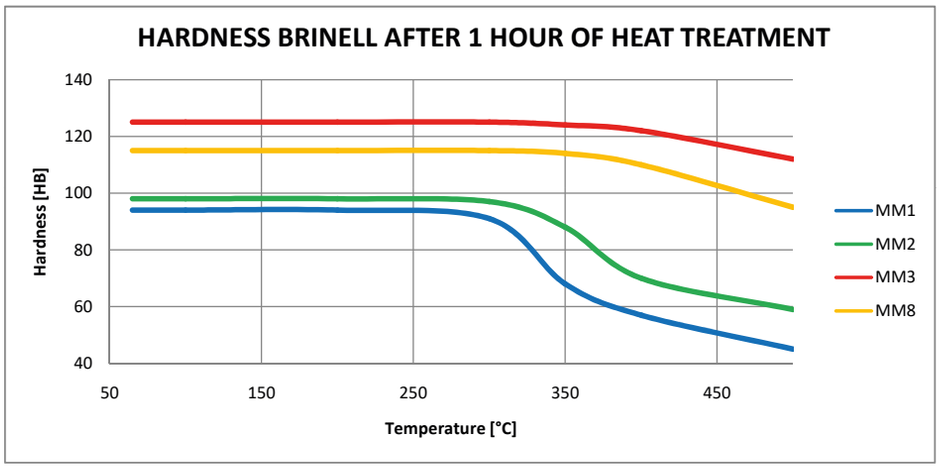
		MM1 CuDHP	MM2 CuAg		MM3 CuCrZr		MM8 CuNiP	
Mechanical Properties	Thermal expansion at 20°C [K-1]	$1{,}68 \cdot 10^{-5}$	$1{,}68 \cdot 10^{-5}$		$1{,}70 \cdot 10^{-5}$		$1{,}68 \cdot 10^{-5}$	
	Recristallization Temperature [°C]	330	370		700		600	
	Softening Temperature [°C]	-	-		500		400	
	Young Modulus [MPa]	$1{,}20 \cdot 10^{5}$	$1{,}20 \cdot 10^{5}$		$1{,}30 \cdot 10^{5}$		$1{,}20 \cdot 10^{5}$	
Physical Properties		Tubular	Tubular	Plate	Tubular	Plate	Tubular	Plate
	Ultimate Tensile Strenght at 20°C [MPa]	295	300	275	415	400	335	320
	Ultimate Tensile Strenght at 200°C [MPa]	-	245	230	385	370	310	300
	0,2% proof Stress at 20°C [MPa]	270	275	260	340	310	320	300
	0,2% proof Stress at 200°C [MPa]	-	230	210	320	280	280	265
	Elongation at 20°C (%)	20	18	18	20	20	18	20

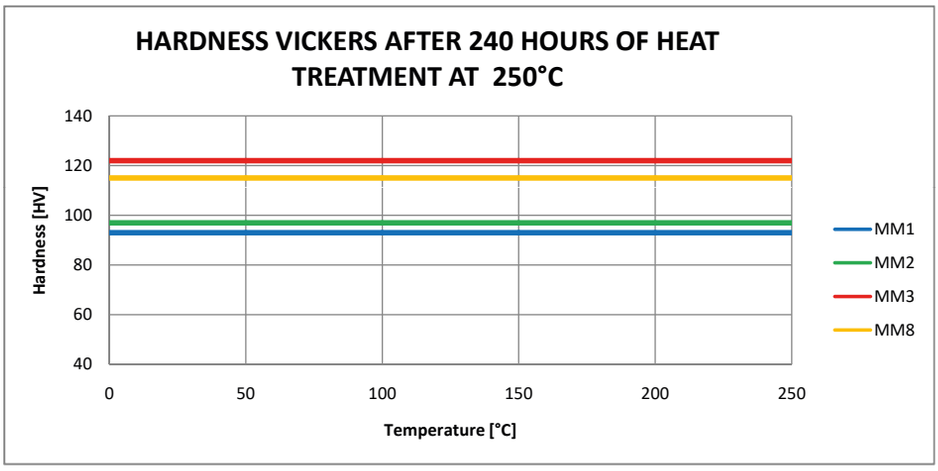
METAL MOULD 8 - CuNiP

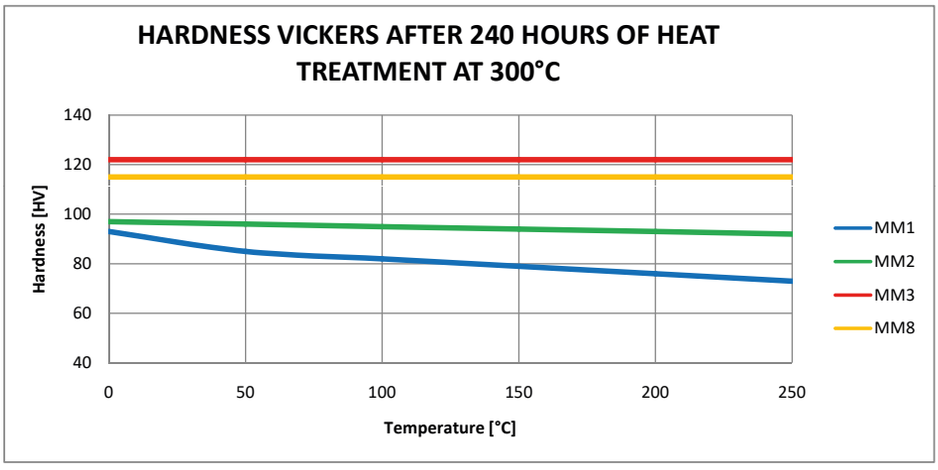
Copper Nickel Phosphorus

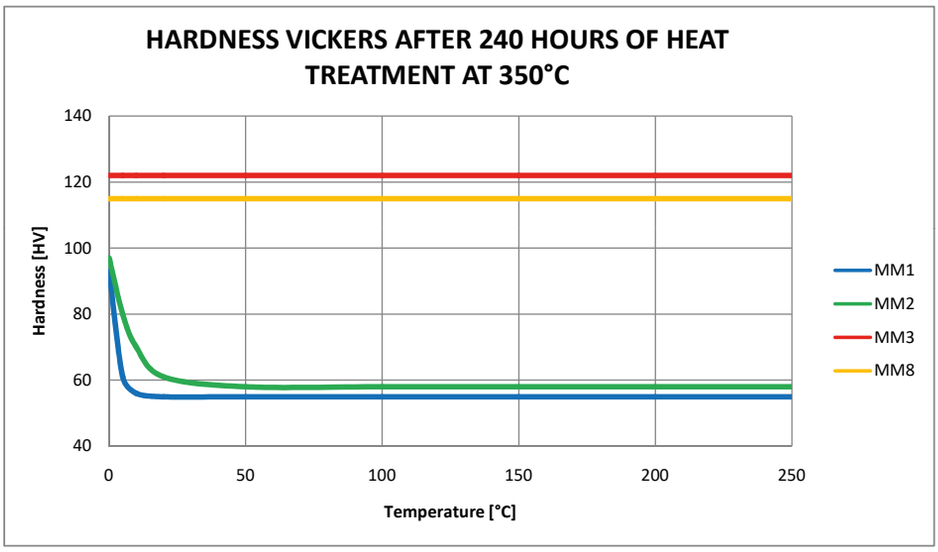
In an effort to minimize the problem of temperature variations within the mould, EM MOULDS developed the MM8 alloy.
This has obvious advantages for solidification conditions without excessive thermal stress in the solidified skin, as well as in the mould itself.
The controlled thermal conductivity of this new alloy considerably diminishes the critical state of the cooling conditions, which are linked to three variables: thickness of the lubricating film, thermal flow and shrinkage of the solid skin. As a result, excessive thermal stress is avoided and problems of cracking are reduced.



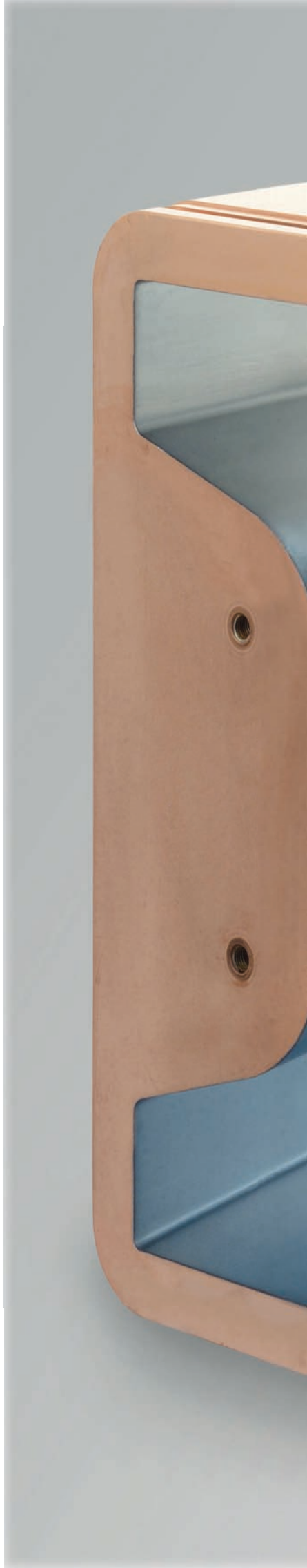

HARDNESS BRINELL AFTER 1 HOUR OF HEAT TREATMENT
Hardness [HB]
140
120
100
80
60
40
50
150
250
350
450
Temperature [°C]
MM1
MM2
MM3
MM8


HARDNESS VICKERS AFTER 240 HOURS OF HEAT TREATMENT AT 250°C
Hardness [HV]
140
120
100
80
60
40
0
50
100
150
200
250
Temperature [°C]
MM1
MM2
MM3
MM8


HARDNESS VICKERS AFTER 240 HOURS OF HEAT TREATMENT AT 300°C
Hardness [HV]
140
120
100
80
60
40
0
50
100
150
200
250
Temperature [°C]
MM1
MM2
MM3
MM8

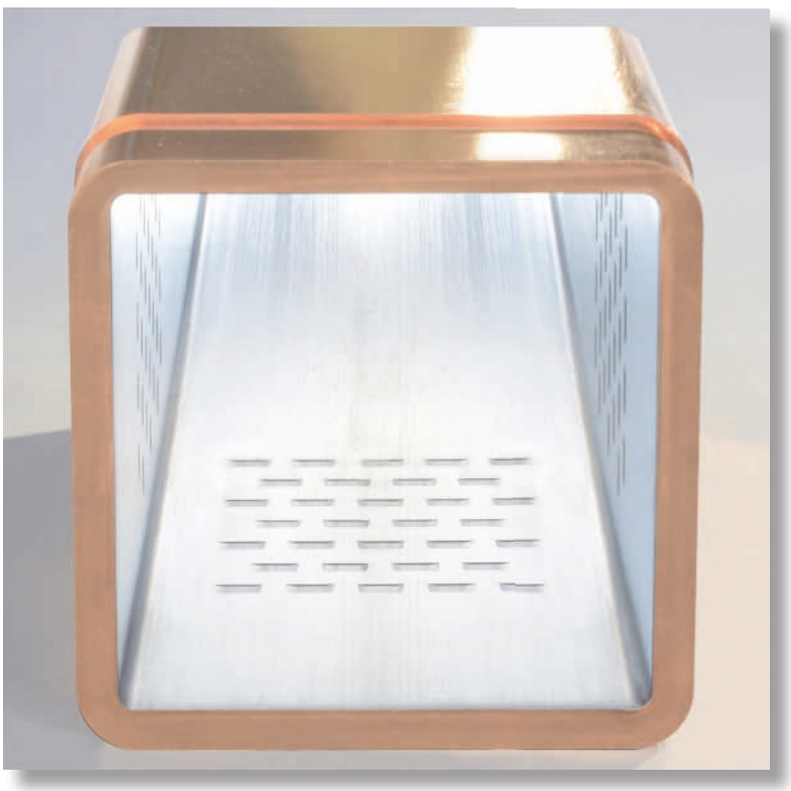

HARDNESS VICKERS AFTER 240 HOURS OF HEAT TREATMENT AT 350°C
Hardness [HV]
140
120
100
80
60
40
0
50
100
150
200
250
Temperature [°C]
MM1
MM2
MM3
MM8

The development of continuous casting has turned copper moulds into one of the main components required by the producer to attain his goals in terms of quality and productivity.
The evolution of ever more sophisticated materials which contribute to increase the products'life and improve its performances, together with the most recent studies to determine the optimal taper, has brought the copper mould to the cutting edge of modern technology.
Its features are specific to each production unit and designed in close consultation with the end user.
EM MOULDS can provide any size and shape of copper mould tube aiming to reduce production costs, improve the steel quality and guarantee hassle free operations.



GROOVED MOULD TUBE

This new solution developed by EM MOULDS has demonstrated to improve the steel surface quality and reduce the shape defects especially in open stream casting. The grooves in the upper part of the mould tube internal wall optimize the cooling and the heat extraction from the steel around the meniscus area. As a consequence a reduction of shape defects such as rhomboidity can be achieved, in some cases with an extended mould life. Moreover this solution helps to reduce the breakout rate and allows a more uniform shell growth.



SPECIAL APPLICATIONS

In order to meet any Customer's requirements, EM MOULDS is available to supply any mould tube geometry with any tailor made technical requirement.

CHROMIUM COATING

EM MOULDS offers the guarantee of a knowhow which has been fully tested and improved during the past 50 years. The chromium coating technology has advanced considerably in recent past, as EM MOULDS has developed and installed the new coating facility which ensures a constant chromium deposition in every area of the mould (including corners) thanks to a controlled chromium flow.
The development of ever more performing tooling design has also contributed to improve the uniformity of the deposition.

MATERIAL PROPERTIES

	CHROMIUM	NICKEL	NICKEL COBALT
Thermal Expansion	$0.84\text{-}10^{-5}$	$1.28\text{-}10^{-5}$	$1.00\text{-}10^{-5}$
Hardness [HV]	980	220	410
Thermal conductivity at 20°C [W/mK]	70	88	80

EM NICKEL CHROMIUM COATING

The Nickel Chrome coating consists of a double layer coating of nickel and chrome. The component in contact with the copper hot face is a nickel alloy, which is then overlaid with a layer of hard chrome.
The idea to apply an intermediate layer of nickel has the focus to increase mould life avoiding the formation of cracks in the chrome layer, especially at the meniscus. The nickel alloy, in fact, has a coefficient of thermal expansion that is almost half way between thermal expansion coefficients of copper and chrome.
Therefore, the nickel alloy coating is better able to tolerate the greater expansion of the copper that takes place in the meniscus area during the casting process.
The presence of the nickel layer prevents the contamination of the copper substrate with components from the molten steel and/or casting lubricants such as sulphur or zinc, hence avoiding for example brass formation.
Comparative field tests in a number of steel plants have confirmed a significant increase in the average life of mould tubes plated with the EM MOULDS NC coating.

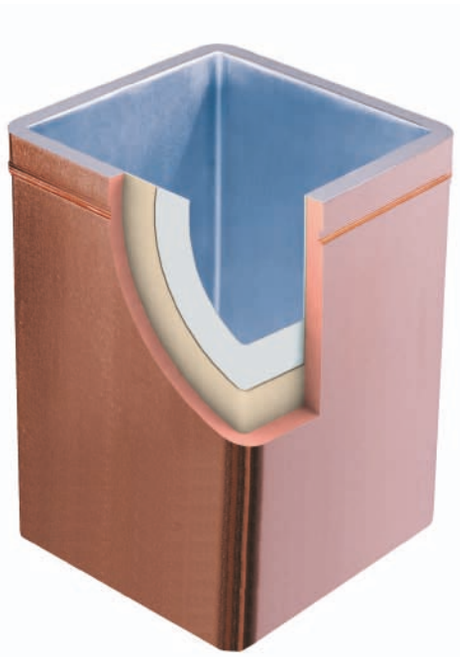
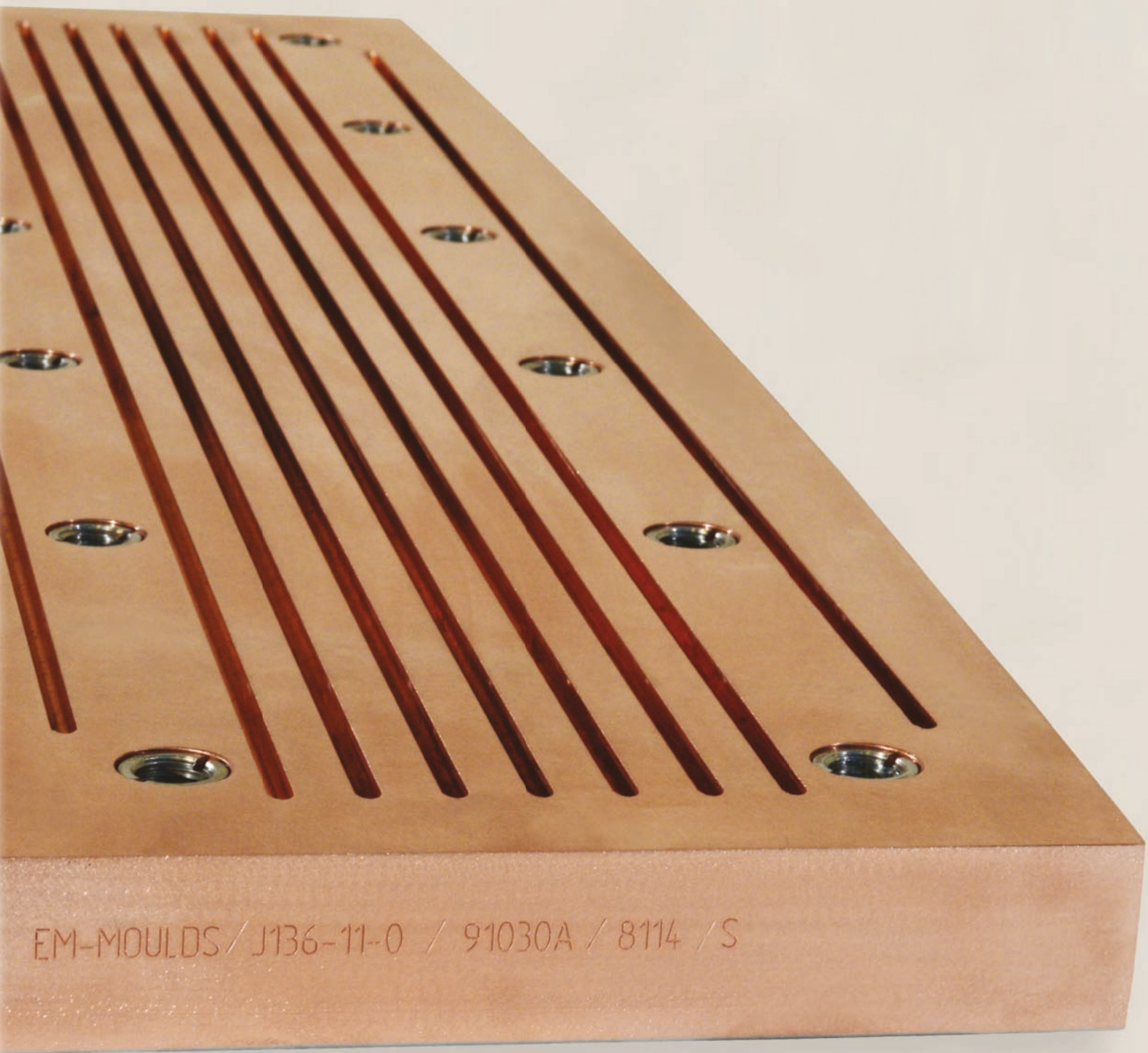


PLATE MOULDS

EM MOULDS products range includes plates for blooms, beam blanks and slabs in any alloy.
Special machining such as cooling slots, drilled cooling channels, welded studs, funnel type for thin slab, machining of slots for thermocouple installations can be designed and made.
Plates can be coated with Nickel, Nickel Chromium technology and Nickel Cobalt.

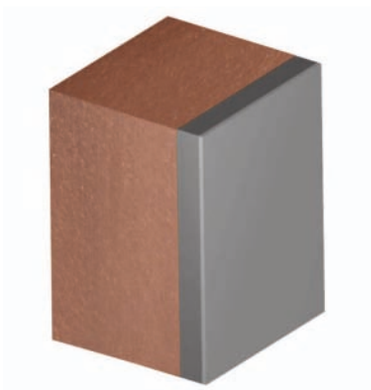

EM-MOULDS / J136-11-0 / 91030A / 8114 / S

COATINGS FOR PLATE MOULDS

In recent years great importance has been given to studies exploring different types of coatings for plate moulds, and numerous different configurations have been tested; however chromium coating is still widely used for plate moulds for blooms and beam blanks casting , while plate moulds for slabs can be manufactured with different materials, thicknesses and configurations according to customers' needs.

Nickel constant thickness coating
with or without chromium layer

Nickel step-coating (variablethickness)
with or without chromium layer



Nickel tapered thickness coating
with or without chromium layer

Nickel coating on edges
with or without chromium layer

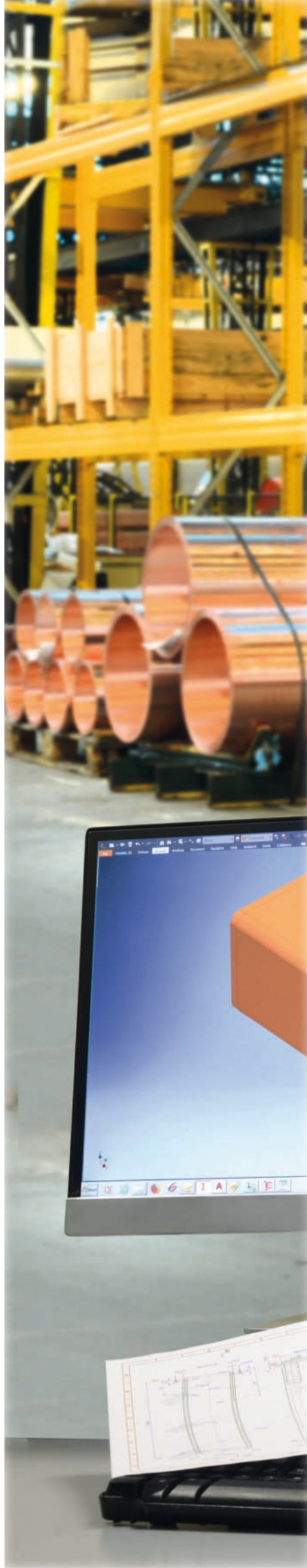
MATERIAL PROPERTIES

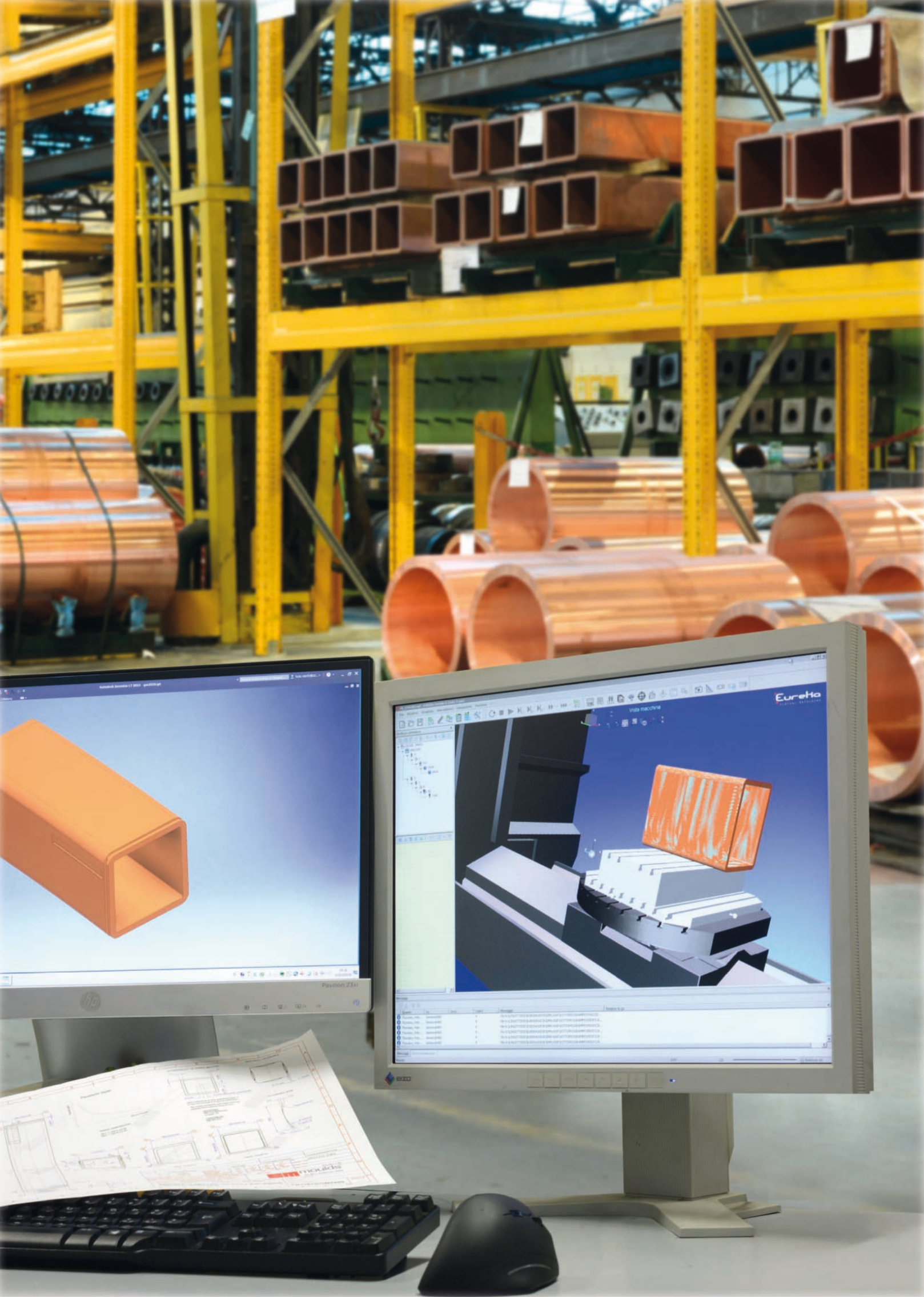
	CHROMIUM	NICKEL	NICKEL COBALT
Thermal Expansion	$0.84\text{-}10^{-5}$	$1.28\text{-}10^{-5}$	$1.00\text{-}10^{-5}$
Hardness [HV]	980	220	410
Thermal conductivity at 20°C [W/mK]	70	88	80

MOULD WATER JACKET

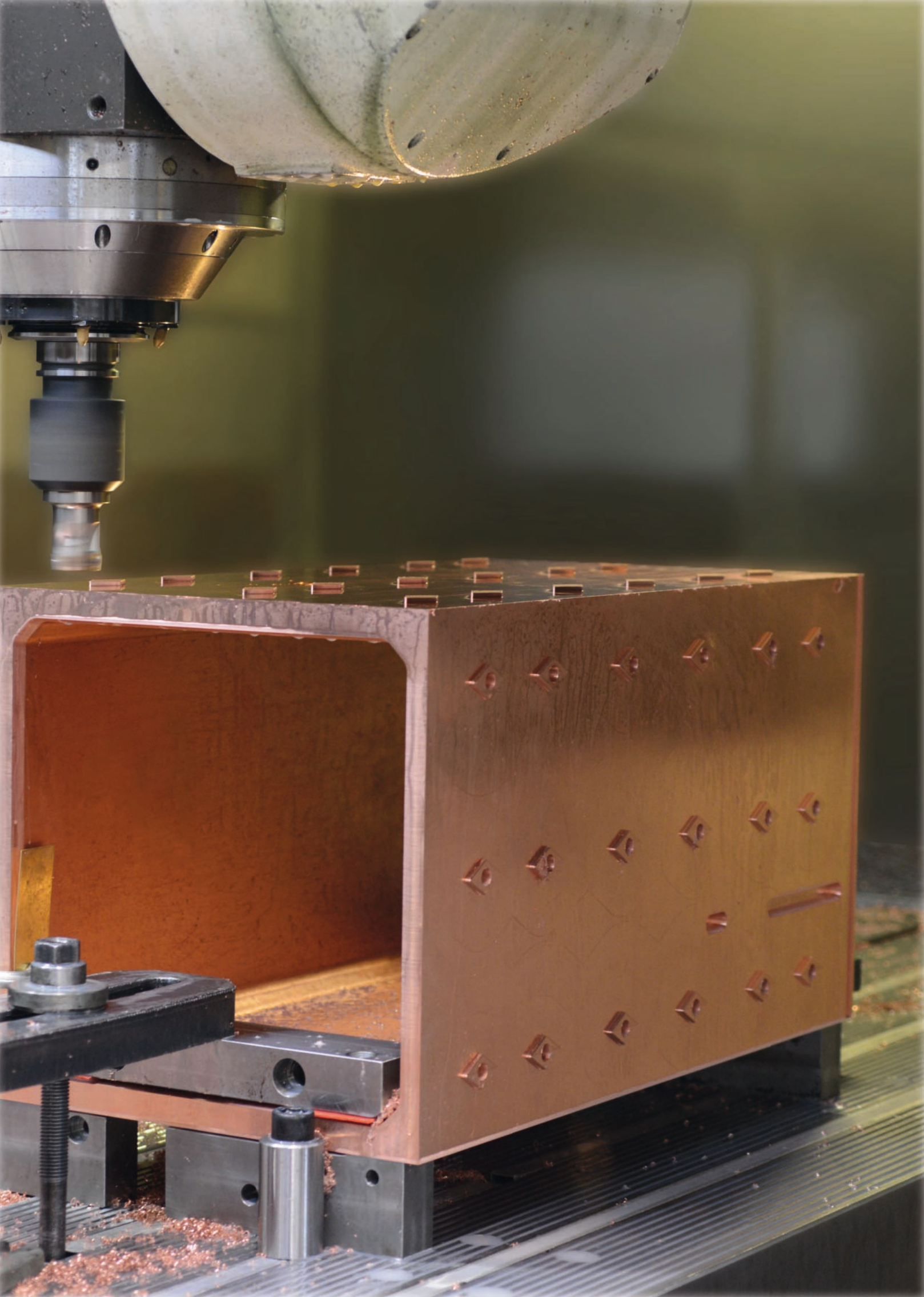
EM MOULDS technical know-how and experience in the field has led to the realization that the design and reliability of the water jacket is essential for the cast steel products quality.
That is why EM MOULDS can also provide a single piece stainless steel mould water jacket with tight tolerances and the necessary thickness to avoid deformation. The highest quality standards ensure optimal moulds tube performances and an easier mould installation and removal.
The water jacket and the copper moulds will be delivered to you ready to use, without any need for adjustment or setup before installation.
The centering pins are set taking into consideration the exact outer dimensions of the mould tube, as well as thermal expansion during casting, in order to allow a hassle-free tube maintenance.

The copper mould is one of the most important components of a continuous casting machine.
Whilst giving the desired shape to the steel in production it should ensure the optimal skin growth in order to contain the liquid steel during the solidification process, therefore avoiding internal or superficial defects. It is extremely important to design the mould considering all variables and casting practices that may affect the steel production and quality.
With more than 50 years of experience in the field, EM MOULDS is able to design the most suitable solution for each plant. Every mould design is based on computer aided analyses and simulations – which enable the study of the thermal heat exchange and the steel solidification along the mould - as well as on site trials results.This tailor made approach to suit the required productivity and steel quality is key to EM MOULDS success worldwide.




Eureka
Vista macchina

EM MOULDS tubular and plate moulds are produced at the Fornaci di Barga plant.
This fully integrated plant includes copper melting and casting, extruding, hot and cold rolling, drawing, machining, heat treating and electrolytic coating.
The complete production process control allows EM MOULDS to guarantee the full product traceability and high flexibility to meet every Customer's demand both in terms of quality and delivery time.
The production process for tubular moulds begins with the casting of round bars.
These are subsequently hot extruded or forged.
The extruded tube is then cold-drawn and formed to attain the geometrical and mechanical features required by the technical specifications, which of course also includes taper.
Tapering is achieved through special steel tools, which are specific to each mould tube and are also manufactured internally through CAD/CAM technology.
Finally, the tube undergoes machining and is then chromium-plated internally, before being inspected and measured.
Production of plate moulds starts with the casting of a copper slab which is then hot rolled (or forged) and subsequently cold rolled.
The next phase is a fully ultrasonic inspection, after which the plate can be machined to achieve the final design. During this phase slots for thermocouples and plate fastening are also manufactured in the required configuration.
The last production phase consists of mould plate coating.

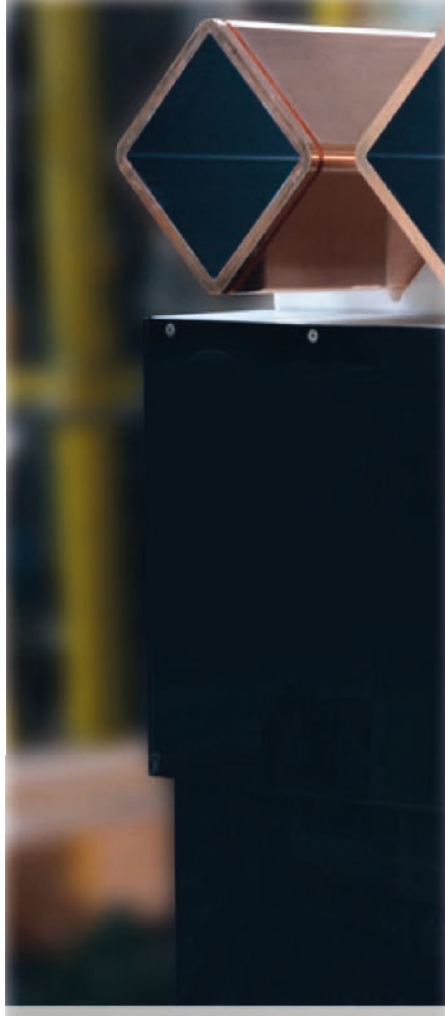


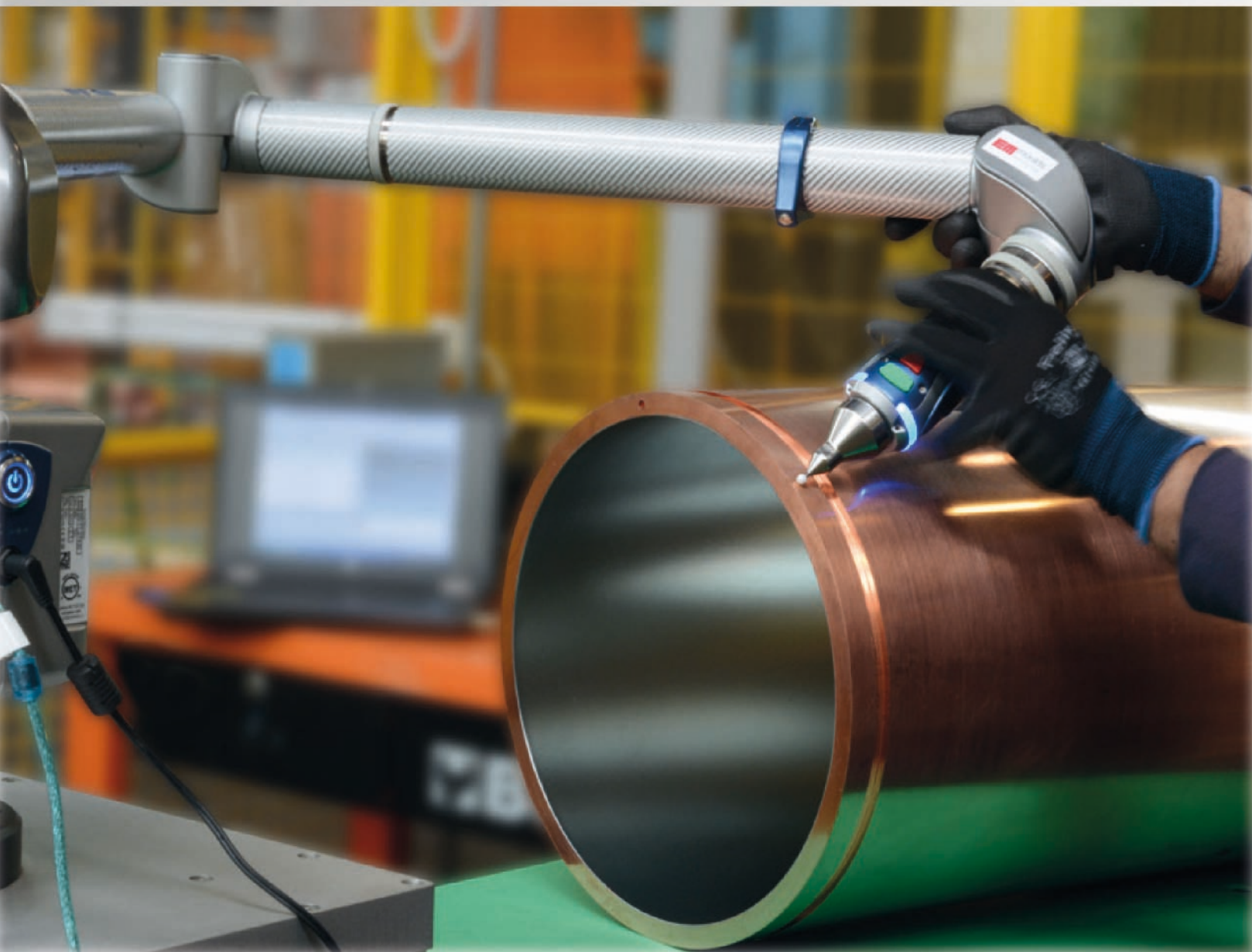
QUALITY ASSURANCE

EM MOULDS is fully committed to guaranteeing the quality standards of its products and processes.
After every production step the products are inspected and measured. All data is reported in the certificates forwarded to the Customers together with the moulds.
The quality tests and measurements that EM MOULDS performs on each mould before the delivery include:

- taper inspection through 3D laser station
- geometrical tolerances check through 3D anthropomorphic arm
- chemical, physical and mechanical analyses
- coating thickness through ultrasonic device

The quality control process dates back to 1984, when Europa Metalli spa (the old name of EM MOULDS) launched a project named “Total Quality Program” until in 1992 - through the full involvement of its employees – the company obtained the certification of Quality Management System in accordance with ISO 9001:2000 standards.
The Quality Management Systems is now applied not only in production areas but also in warehouses and in the technical and sales departments in accordance with the new ISO 9001:2015 standard certified by “Istituto Italiano di Garanzia della Qualità” (IGQ).
In recent years EM MOULDS has also received the certification ISO 14001:2004
Environmental Management System
and OHSAS 18001:2007
Occupational Health and Safety Management System.





Nowadays companies need to meet the challenges imposed by toughening competition, more stringent demand and new markets.
EM MOULDS constant investments in its Research Center aim to improve existing products developing new materials and technologies. The state of the art equipment include:

- scanning Electron Microscope (SEM)
- energy Dispersive Spectrometer (EDS)
- high temperature tensile strength measurement equipment
- X-ray scan

EM MOULDS Research Centre owns a library of over 5.000 specialized works, also connected with the European and U.S. data banks (CDC - USA).

SERVICES

As well as the engineering and manufacturing of copper mould tubes and plates EM MOULDS provides to its customers a complete range of services aimed to improve the quality of the cast steel and increase the productivity.
The technical after sales and consultancy – thanks to the wide experience in the field - distinguishes EM MOULDS from all other competitors.
Our team of metallurgical experts and technical assistants are always available to visit the Customers' plants in order to promote continuous improvements and process efficiency.
Not only a copper mould supplier but a reliable partner in steel production

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