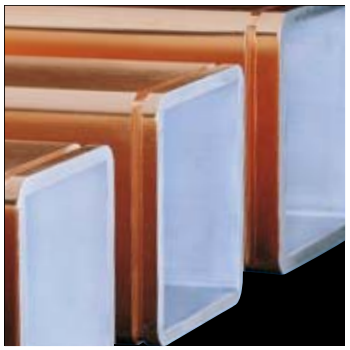
EM moulds™

we give shape to steel

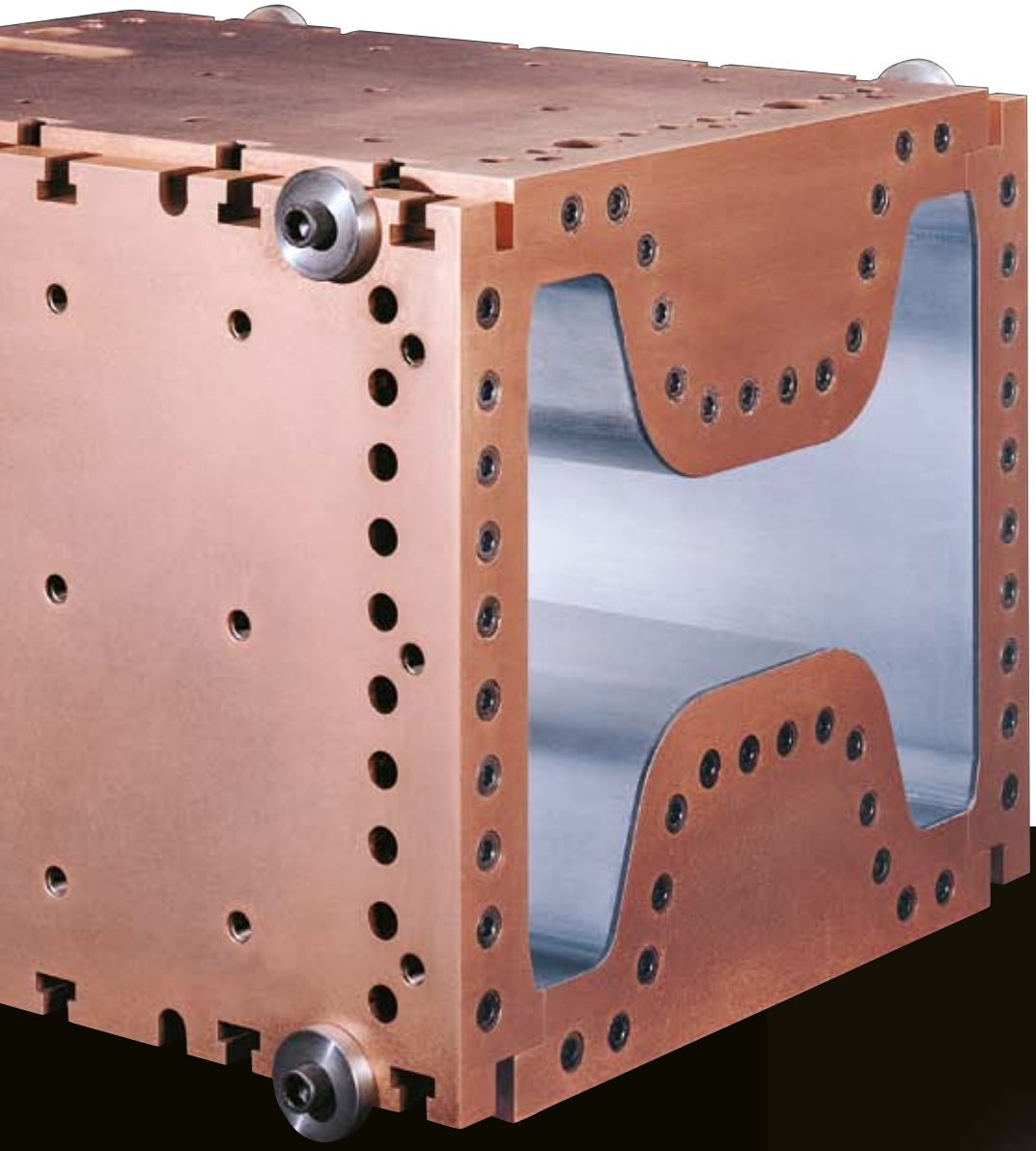


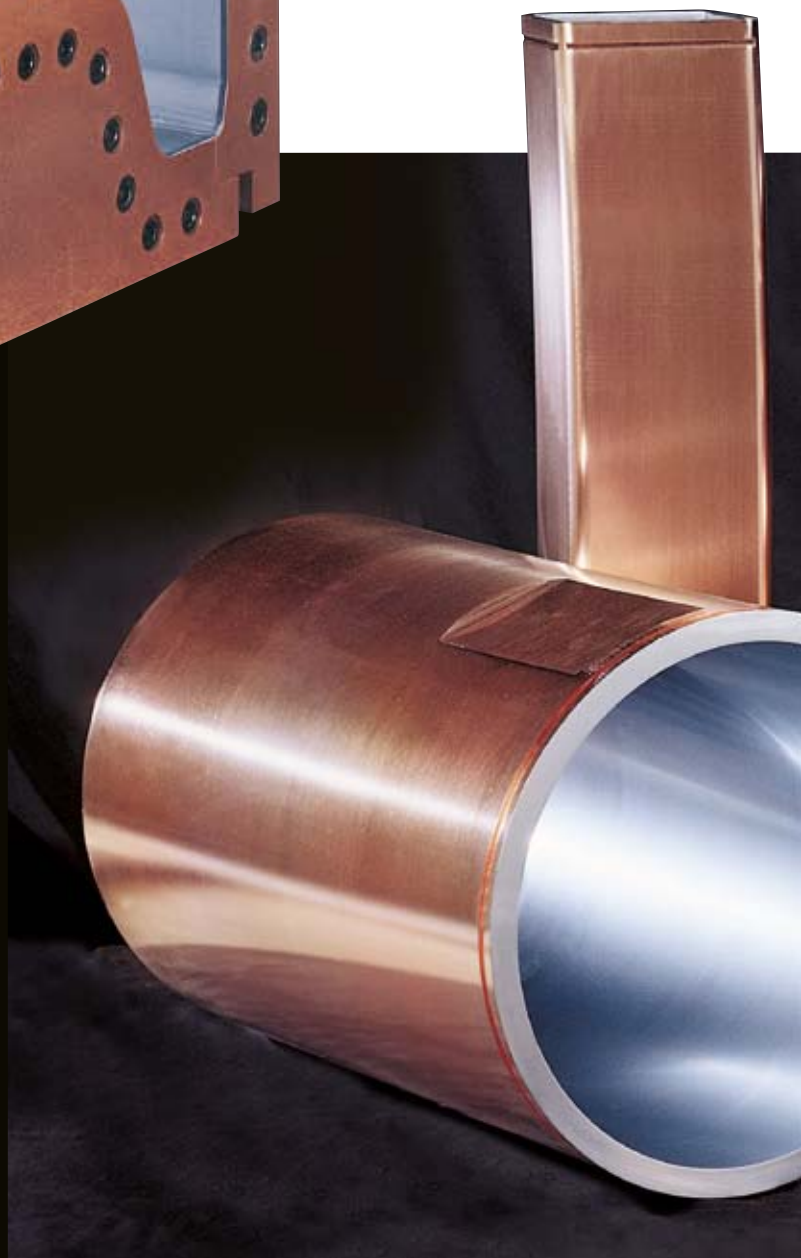


EM MOULDS

mould tubes and plates for continuous casting

EM moulds™
we give shape to steel





Contents

EM MOULDS is an Italian company specialized in the field of copper moulds for continuous casting of steel. It can look back to more than 100 years of experience in the field of copper and copper alloys.

EM MOULDS has its registered office in Florence. Moulds production plant and EM MOULDS sales offices are located at Fornaci di Barga, near Lucca. A commercial network of agencies covers the entire world market.

Tubular moulds

The development and increasing use of continuous casting have transformed ingot moulds from pure and simple containers for the molten metal into the principal component required by the producer to attain his goals in terms of quality and production. The choice of ever more sophisticated materials which increase the products life and improve its heat-exchange features, coupled with studies on optimal taper, have successfully turned the ingot mould into an object which is at the cutting edge of modern technology. Its features are specific to each production unit, and thus increasingly developed and designed in close consultation with the end user. Like in the past, EM MOULDS continues to be a key promoter in this ongoing process of technological improvement.

While EM MOULDS is clearly not the only supplier of ingot moulds with top-quality geometrical, mechanical and physical features, it is without a doubt the only one which has the necessary know-how to appreciate your specific requirements. Indeed, EM MOULDS brings you a product of its own design which in every way meets the aims of all steel producers, and can even supply the mould-cooling jacket where this is required.

Having said this, which in itself is reason enough to justify the use of EM MOULDS ingot moulds, let us add that we are unrivalled for:

- speedy delivery
- high quality at competitive prices
- personalized after-sales technical service
- high quality of the steel produced with our moulds
- benefits to production costs

Working with EM MOULDS means you will get exactly what you desire:

- reduction of production costs
- improvement in the quality of your steel
- trouble-free existence

Products range

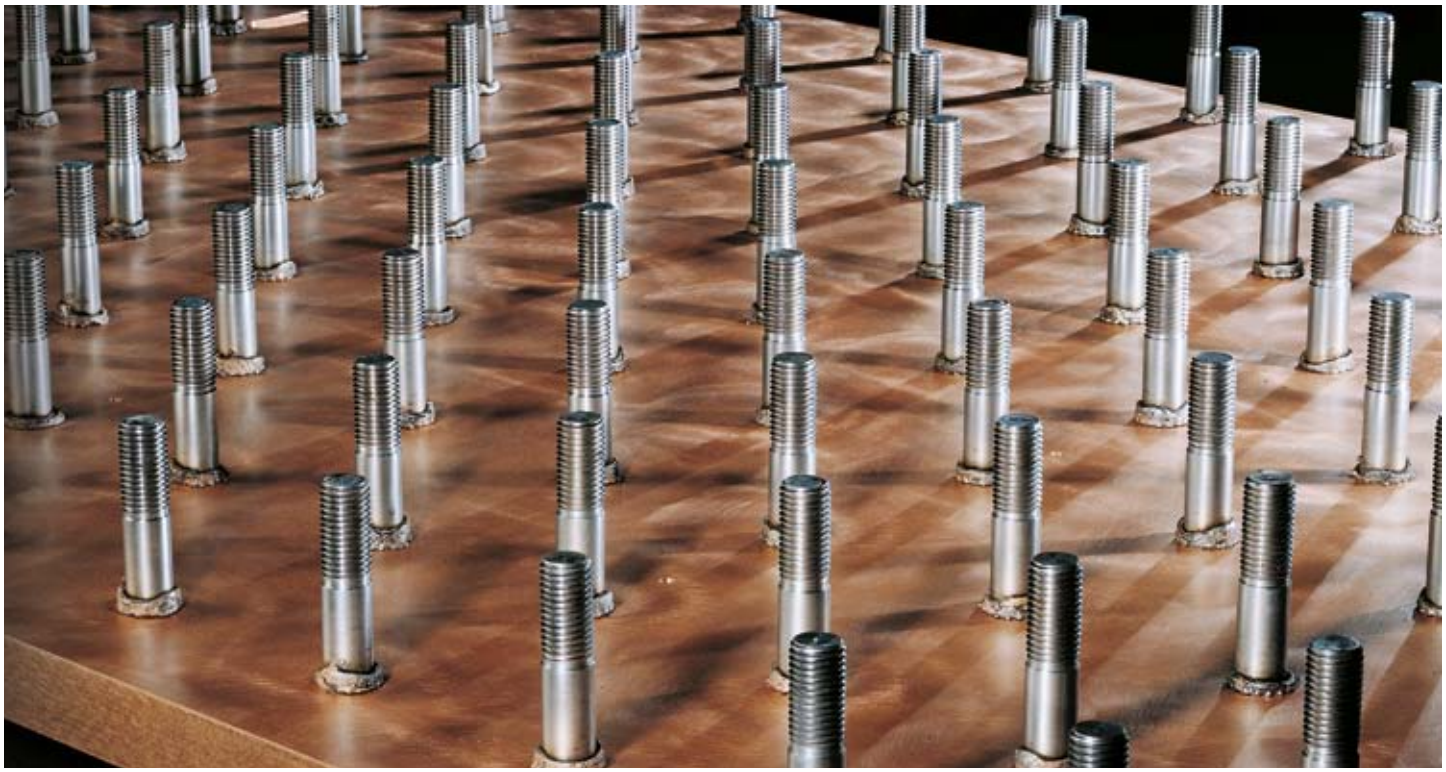
Materials	MM1, MM2, MM3, MM8
Shape	Square, rectangular, round, polygonal, beam blank
Size	Up to 750 mm of diagonal, larger sizes on special inquiry
Internal profile	Parallel, single taper, multi taper, parabolic, EM parabolic
Curvature	Straight, curved
Corner radius	> 1 mm
Length	No limitation
Wall thickness	No limitation
Coating	Chrome max 0.2 mm thickness; Ni+Cr; ECC.

Special moulds for Luna ECR® Plant

Plate moulds

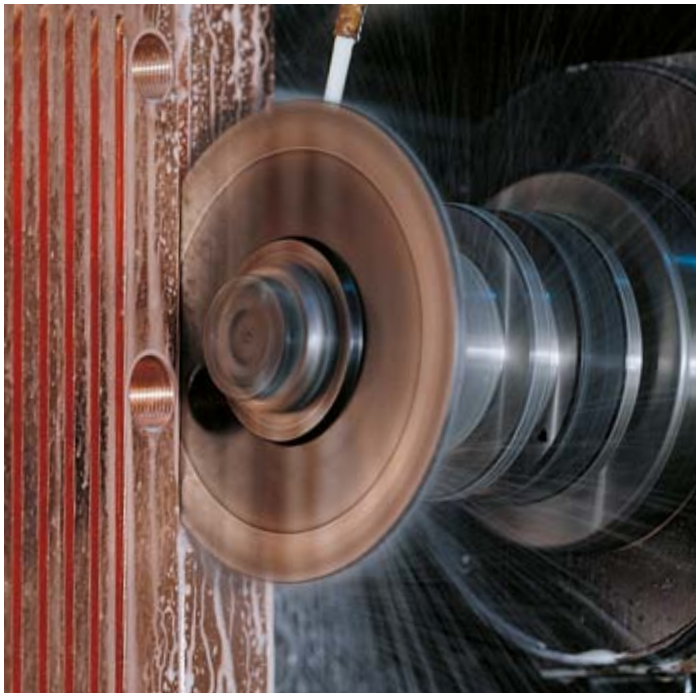
EM MOULDS is one of the world's leading suppliers of plate moulds for continuous casting, with a 100-plus years' experience in metallurgy of copper and copper alloys and in-depth knowledge of its products' applications.
Products' range includes all the types of plate moulds currently in use - CuAg, CuCrZr or CuNiP, with or without Nickel and Chromium coating.

Ingot moulds must be capable of rapidly conveying the heat of the molten steel to the cooling water. The materials used – i.e., both the copper substrate and the nickel or chromium lining – are thus expected to meet high-level specifications to ensure long life, even in critical conditions, and avoid deformation, which could mar the quality of the cast steel.
In recent years special impetus has been given to studies exploring different types of lining for plate moulds, and a good number of different configurations have been put to the test. Each type of solution is carefully researched and then verified in close association with the technical experts of the steel mill.



Consult our steel-casting experts as to the best solution for your plant!

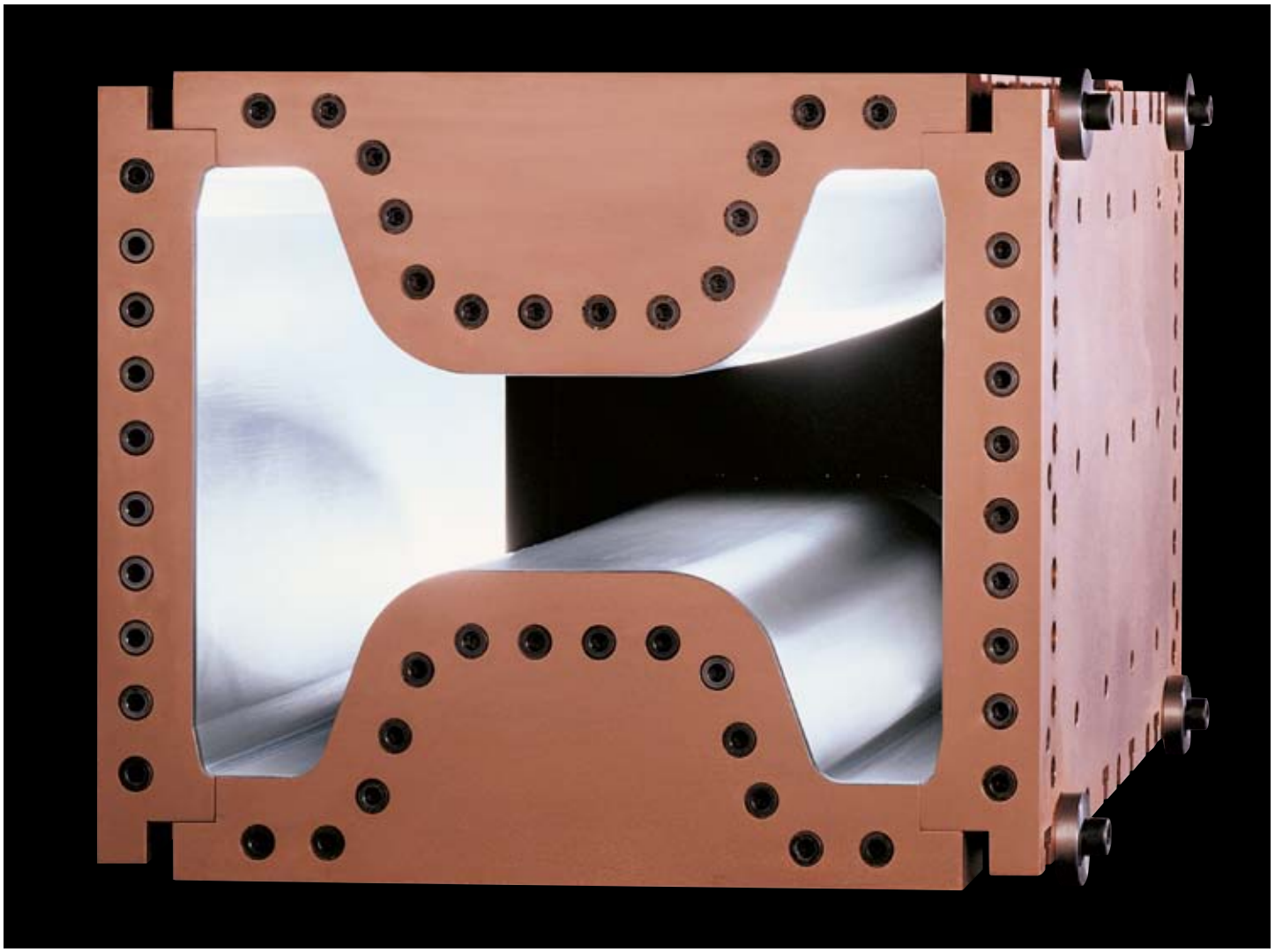
We will be happy to give you all the help and expertise you require.



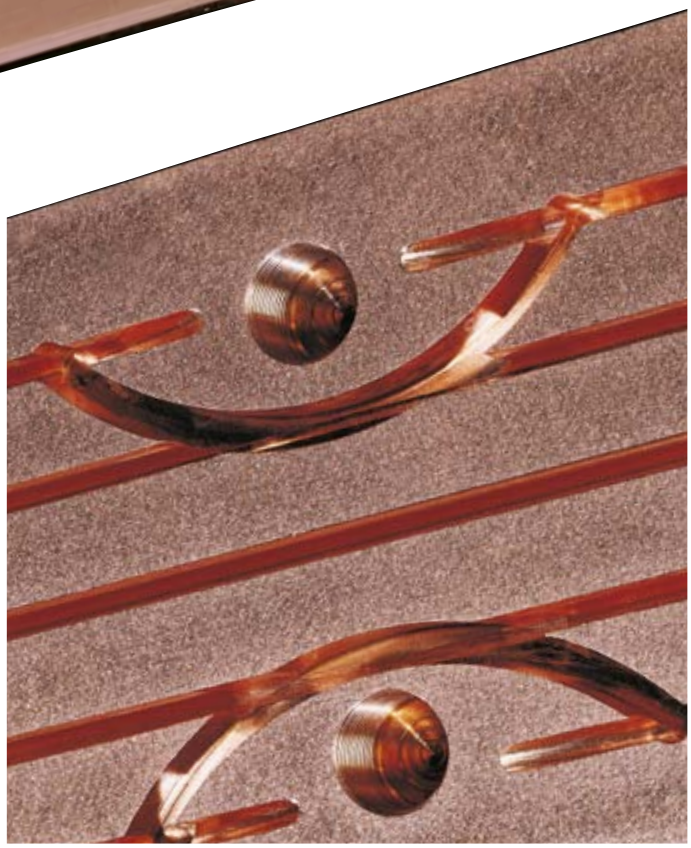
Products range

Materials	MM2, MM3, MM8
Designs	With cooling slots, with drilled cooling channels, with welded studs, beam blank, funnel type for thin slab
Size	No limitation
Coating	Nickel, Nickel and Chrome, Chrome, Nickel alloys

Special moulds for Luna ECR® Plant



Mould materials



To ensure optimal performance, moulds must keep their original specifications at mean operating temperatures as long as possible, and must, above all, have adequate heat transfer capacity. Thermal stresses which arise mainly on the hot faces in the area of the meniscus result in more or less rapid and permanent deformation of the mould, thus cutting short its life.
The seriousness of this phenomenon is related to the temperature level inside the mould, and to temperature differences between the hot faces and the cold faces, and between the area of the meniscus and the area immediately below it.
The appropriate solution for each of the various operating conditions depends on correctly choosing one of the following materials:

MetalMould1 - CuDHP
Phosphorus Deoxidized Copper

The properties of this material are widely known. DHP copper is still today the most widely used material to manufacture moulds for the continuous casting of billets, where the thermal flow is usually moderate and the thickness of the moulds not excessive.

MetalMould2 - CuAg
Silver Bearing Copper

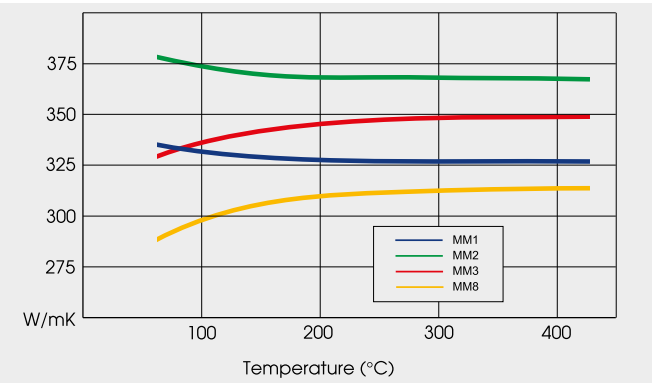
Adding 0.10% silver to the copper increases the recrystallization temperature by approx. 100°C. Thanks to its special properties, this alloy is used to manufacture moulds for the casting of blooms and slabs, where the temperature at the meniscus reaches and exceeds 300°C. Such high temperatures are due to the considerable thickness of the walls and to the high thermal flow inside the mould.
The fact that this material maintains its initial hardness, HB>80, for long periods of exposure at 300°C, also makes it possible to re-process plates that have been subjected to repeated wear before reaching the minimum prescribed thickness.
Silver-bearing copper is also widely used for moulds producing billets in special conditions, such as weekly sequential casting, high casting speeds, cooling conditions which are not optimal, high temperature delta of the cooling water, and others.

Material	*MM1 (CuDHP)*	*MM2 (CuAg)*		*MM3 (CuCrZr)*		*MM8 (CuNiP)*	
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							
Coefficient of thermal expansion at 20°C (K^{-1})	$1.68\ 10^{-5}$	$1.68\ 10^{-5}$		$1.70\ 10^{-5}$		$1.68\ 10^{-5}$	
Thermal Conductivity at 20°C (W/(m·K))	340	377		325		284	
Electric Conductivity (%IACS) - minimum values	83	93		80		70	
Recristallization Temperature (°C)	330	370		700		600	
Softening Temperature (°C)	-	-		500		400	
Young Modulus (MPa)	$1.2\ 10^{5}$	$1.2\ 10^{5}$		$1.3\ 10^{5}$		$1.2\ 10^{5}$	
Mechanical Properties		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
Hardness at 20°C (HB)	93	95	90	125	120	115	110
Application	Tubular moulds	Tubular & plate Moulds		Tubular & plate Moulds		Tubular & plate Moulds	

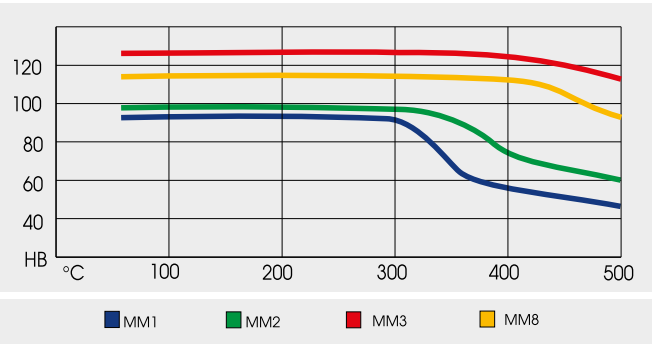
MetalMould 3 - CuCrZr
Copper Chromium Zirconium

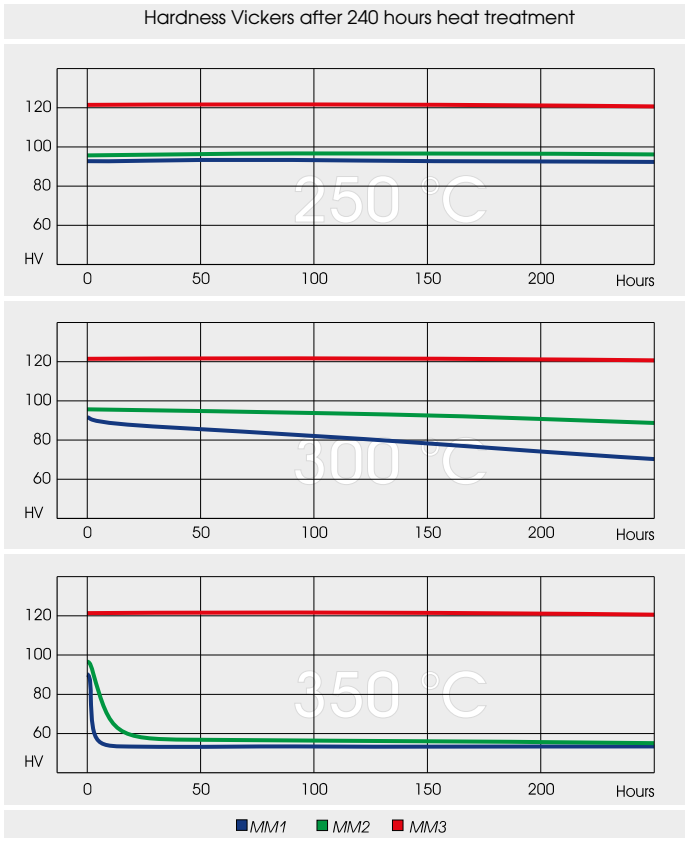
To improve the mechanical properties at high temperatures of copper alloys with high thermal conductivity, metallurgical experts have turned to structurally hardened alloys.
The main elements used for these copper alloys, whose solubility generally varies according to temperature variations, are the following: Be - Cr - Co - Cd - Fe - Mg - Mn - Ni - Nb - P - Si - Sn - Ti - Zr.
There are numerous alloys which can be obtained in saturated solution of these elements, but results are not always compatible with industrial realities, such as coping with pollution problems, high costs, and excessive loss of thermal conductivity. Thus the number of alloys which can be used in practice is considerably reduced.
The percentage of addition of elements is further restricted by the need to harmonise a high level of hardness with a high degree of thermal conductivity. The Copper-Chromium-Zirconium alloy satisfies all the above-mentioned requirements, and is used also because its excellent properties allow it to maintain its hardness for long exposure periods at high temperatures.

THERMAL CONDUCTIVITY



Hardness Brinnell after 1 hour heat treatment





MetalMould 8 - CuNiP
Copper Nickel Phosphorus

The remarkable success in further developing the continuous casting process has greatly increased the need to carry out adjustments to the mould which will enable the new technology of continuous casting to fulfil the expectations of the players in this field.
Rising to the challenge, EM MOULDS has broadened the range of traditional materials with a new alloy, whose chemical composition can be altered in accordance with single applications – thus personalizing each type of mould to meet the specific requirements of each customer. The alloy in question allows us to correctly combine thermal conductivity and mechanical resistance at high temperatures, in an effort to minimize the problem of temperature variations across the mould's entire perimeter.
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, as we know, are linked to three variables: thickness of the lubricating film, thermal flow and shrinkage of the solid skin. As a result, excessive thermal stress and problems of cracking are both eliminated.

Mould coatings

Tubular moulds conventional coating

The technology of chromium coating has advanced considerably. Now the deposit, with the thickness appropriate to the various needs, guarantees completely satisfactory results at all levels. As regards the chromium coating, EM MOULDS offers the guarantee of a know-how which has been fully tested in 40 years of experience.

Tubular moulds special coatings

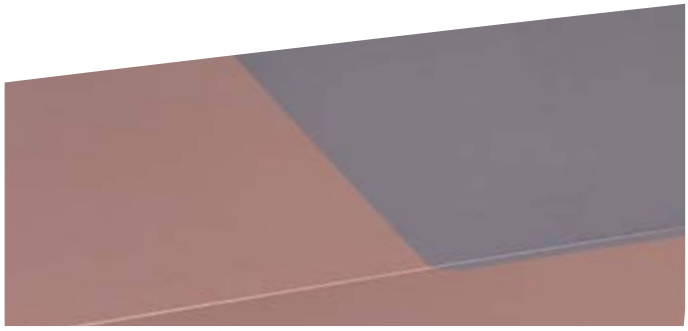
EM NC (EM Nickel Chrome)

EM Mould's EM NC coating for extruded copper mould tubes consists of a double layer coating of nickel and chrome. The component in contact with the extruded copper hot face is a nickel alloy, which is then overlaid with a layer of hard chrome.
This approach is derived from EM Moulds's experience in producing four piece plate moulds. Accordingly, the fundamental process of applying a layer of nickel between the chrome and copper to achieve a much higher service life for the mould is backed by several years of operational experience.
This new coating is particularly useful for avoiding the formation of cracks in the chrome coating, especially in the meniscus zone of the mould. The nickel alloy, in fact, has a coefficient of thermal expansion that is almost double that of the chrome. Therefore, the nickel alloy coating is better able to tolerate the greater expansion of the copper that takes place in the meniscus zone during the casting process.
Up to now, nickel plating the inner surface of a single piece extruded mould tube has proven to be particularly difficult, with the technical issues focusing on the regularity and surface quality of the nickel coating.
With the advent of the EM NC coating process developed by EM Moulds, it is now possible to achieve a smooth and consistent nickel plated surface in both the corners and flat surfaces of the mould tube hot face.
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 NC coating, versus moulds tubes plated with the conventional chrome coating.

EM ECC (EM Enhanced Corner Coating)

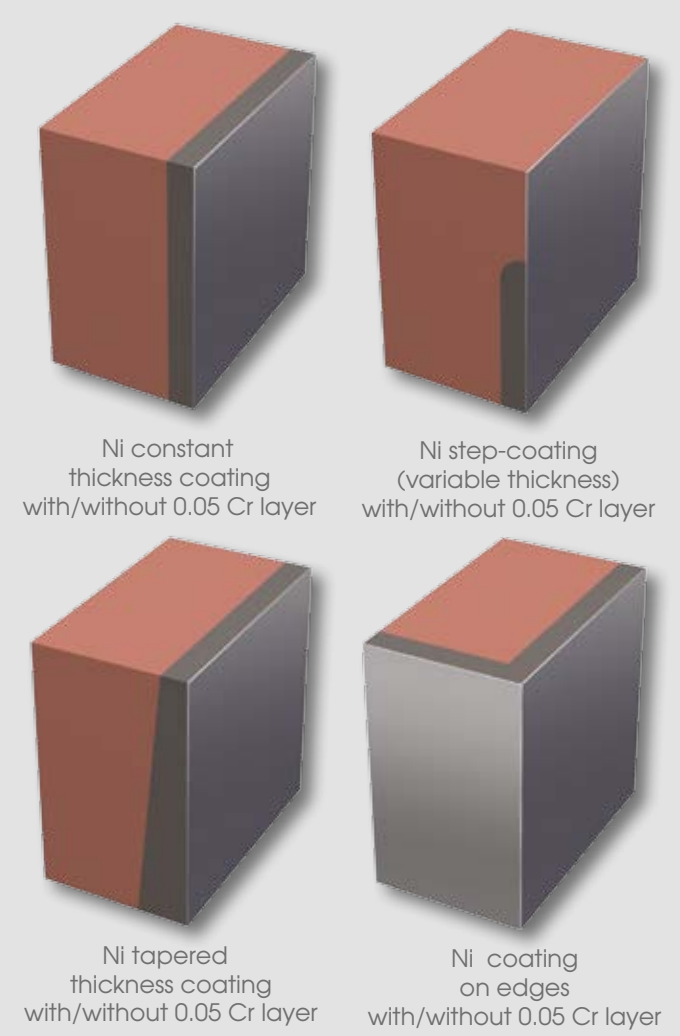
It is a well known operational fact that the removal of an extruded single piece mould tube from service is determined by the wear conditions of its inner dimensions. If not addressed, these wear conditions can lead to solidification problems, and/or defects in the final cast product.
It is also a well known operational fact that the corners of the mould tube tend to wear faster than other areas within the mould tube - a function of the rapid solidification that takes place in the corners.
To address this problem, EM Moulds has developed a method of applying the chrome coating with specific geometric characteristics, wherein the chrome thickness in the corners is thicker.
This unique plating geometry provides a coating that will better withstand corner wear, while at the same time preserving the heat transfer properties that are necessary for the proper solidification of the flat faces.
Comparative laboratory and field tests have confirmed that this new and unique coating geometry significantly addresses the corner wear problem.

Plate moulds



Chromium coating is still widely used for plate moulds for blooms and beam blanks, and the technology is well known.
Plate moulds for slab casting are generally nickel coated, and have varying degrees of thickness and diverse configurations. A thin chromium layer is sometimes applied to increase the durability of the nickel coating.

As well as Nickel, which is available in two different hardness configurations, new Nickel and Cobalt alloys have recently been tried, and these afford better wear resistance.
Choosing one of the standard solutions described above will depend entirely on the specific operating conditions each user adopts, and to his moulds' maintenance and re-machining requirements.
Through comparative tests, the user has to establish the best coating thickness to increase availability and cost-effectiveness, which in turn ensures longer mould life.



Material Properties	*MM1 (CuDHP)*	*Nickel*	*Hardened Nickel*	*Chromium*	*Nickel Cobalt*
Hardness (HV)	93	220	400	980	410
Coefficent of thermal expansion	1,68 10^{-5}	1,28 10^{-5}	1,25 10^{-5}	0,84 10^{-5}	1,00 10^{-5}
Thermal conductivity at 20°C (W/(m·K))	340	88	78	70	80

Technical Service and Design

Mould Cooling Jacket

A stainless steel mould-cooling jacket is available at last!
A single piece with big wall thickness, very small size tolerances and non-deformable over time. Years of work have demonstrated that this part has to meet the highest quality standards to enable you to make full use of all the excellent characteristics of the last generation of moulds.

Now a single supplier brings you both the mould and the mould jackets.

We take care to get every detail right. The two pieces will be delivered to you ready for use, and all you have to do is assemble them in the water jacket, without any adjustment or control. The rivets used to center the moulds inside the cooling jacket are set and fixed taking into consideration the exact outer dimensions of the mould, as well as the copper's expansion during casting. Thanks to this new solution we have eliminated one of the main problems that make steel casting so difficult. We have automated mould assembly with results guaranteed and constant over time, greatly reducing the time needed to take out the used mould and install the new one.

This solution's key points are:

- A single piece without mechanical connection
- Very small size tolerances
- Big thickness stainless steel, non-deformable
- Mould jacket produced for automatic mould-centering control
- One producer for both mould and mould jacket
- Eliminating risk of human errors during assembly

Targets

- Improving product quality
- Reducing risk of breakout
- Increasing mould life
- Reducing maintenance costs

Are you sure that your continuous casting machine is performing to the full extent allowed for by its features?

With 4 decades of experience as leading suppliers of moulds for continuous casting and with its after-sales technical service, Europa Metalli can tell you if this is indeed the case, and can help you in running your equipment more easily and effectively.
Your job is to produce steel. Ours is to help you do this better. Together we can grow and keep abreast of new developments.
Our technical service is based on the experience gained in working in close conjunction with our customers to develop the continuous casting process, and is supported by the very latest calculus and designing systems to engineer the ingot mould which will be most perfectly suited to your specific requirements.
We are aware that nowhere in the world will you find two casting plants which are quite the same. Both your experts and ours have to work together in order to create your ideal ingot mould.

To achieve this aim, we have developed a special approach of collecting information, theoretical processing and practical trials, which greatly reduces the time needed to solve any problems arising in the steel mill. Where necessary, we suggest adoption of the full ingot mould/cooling jacket unit.

Nobody better than Europa Metalli can help you in seeking out the solution that best fits your specific requirements:

- Increasing your casting speed
- Reducing break-outs
- Reducing the defects on blooms and billets
- Increasing the life of your ingot moulds
- Finding the ideal wear-resistant coating for your plate moulds

For further information visit www.coppermoulds.com

Mould manufacturing

EM MOULDS tubular and plate ingot moulds are produced at the Fornaci di Barga plant.
This fully integrated plant comprises copper melting and casting units, extrusion and hot-rolling, drawing and cold-rolling, machine working, electrolytic coating and quality controls.

The fact of having the entire production process under its direct control gives EM MOULDS the necessary agility with which to meet customers' demands in terms of delivery and product quality. Its modern production units also ensure process repetitiveness, making for seamless quality over time.

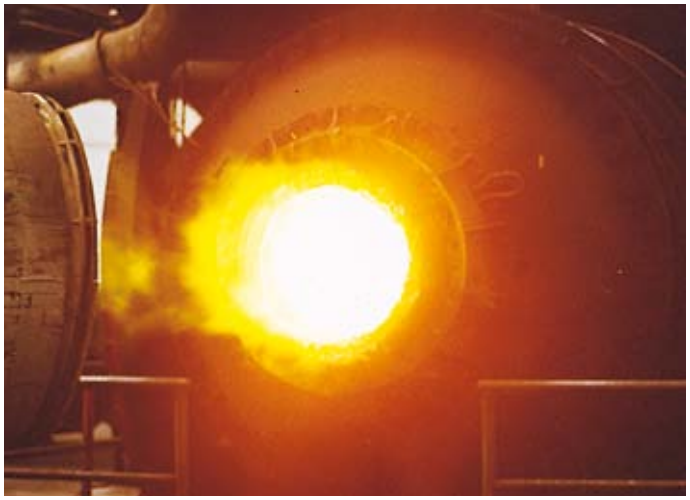


Plate moulds

MELTING & CASTING

HOT ROLLING OR FORGING

COLD ROLLING

ULTRASONIC INSPECTION

MACHINING

COATING

FINAL INSPECTION

Our alloys are always produced with high-purity copper cathodes. For an optimal control of the elements added into the alloy, a chemical analysis of the molten metal is always carried out before casting.

The production of **tubular moulds** kicks off with the casting of bars with a circular cross-section. 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. For the latter step - by far the most crucial one in the production cycle - is used the latest, most powerful and best equipped press to be found in the sector today. Forming is accomplished with special steel equipment, which is specific to each ingot mould and is produced with CNC machines. Finally, the tube undergoes machining and is then chromium-plated internally, before being inspected and measured. The foregoing process is recorded on quality certificates which are packed together with the ingot mould in the shipping box.

Production of **plate moulds** involves the casting of a slab which is subsequently hot rolled (or forged) and then cold rolled. The entire plate is then ultrasonically inspected. Only plates which have passed the test 100% are then worked with high precision CNC machines, to achieve compliance with the strictest tolerances set down in the technical specifications. This phase also includes welding of the steel studs when the plate moulds are designed for this type of configuration. Finally, galvanic wear-resistant coating is applied if called for, after which the plate mould goes for final inspection.
The quality certificate is packed together with the mould in the shipping box.

Tubular moulds

MELTING & CASTING

HOT EXTRUSION OR FORGING

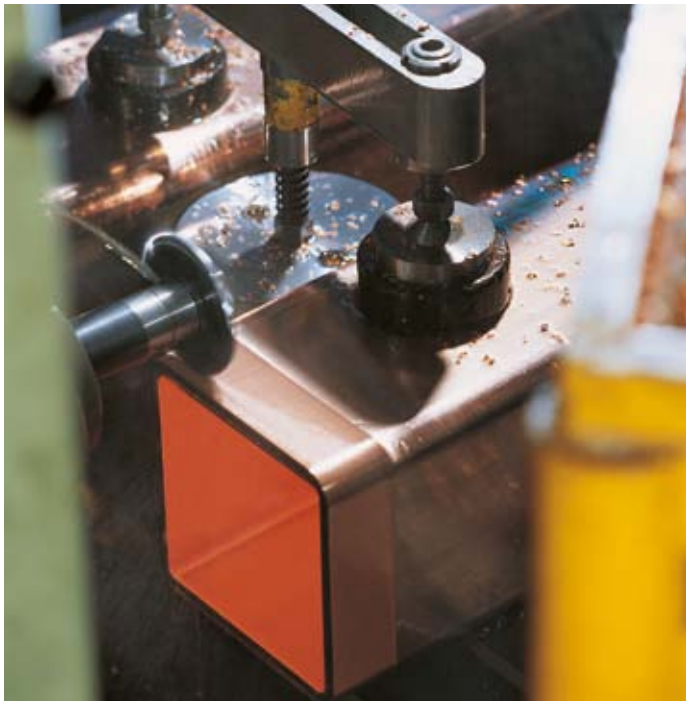
COLD DRAWING

TAPERING

MACHINING

COATING

FINAL INSPECTION

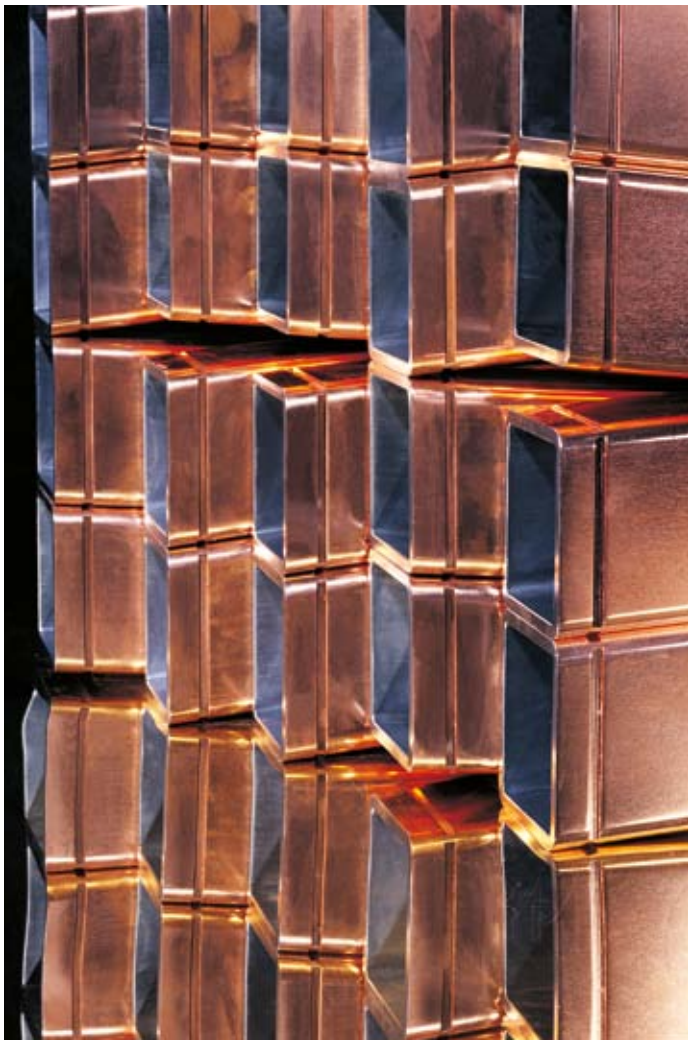


Research & Development

Some things have to change to stay the same.
In today's world, companies need to meet the challenges posed by toughening competition, more exacting demand and new markets. Even their most well-established products and the materials they have successfully worked with for decades need to pass the ongoing test of efficiency and market acceptance in the face of new technological developments and dynamic shifts in market trend and competition.

One of Italy's most advanced institutions of this kind, and specialized in the study of metallurgy and the development of new materials.

EM MOULDS has the opportunity to use Research Center at Fornaci di Barga, that is one of the most important research centers in the world, with full competence in this sector.



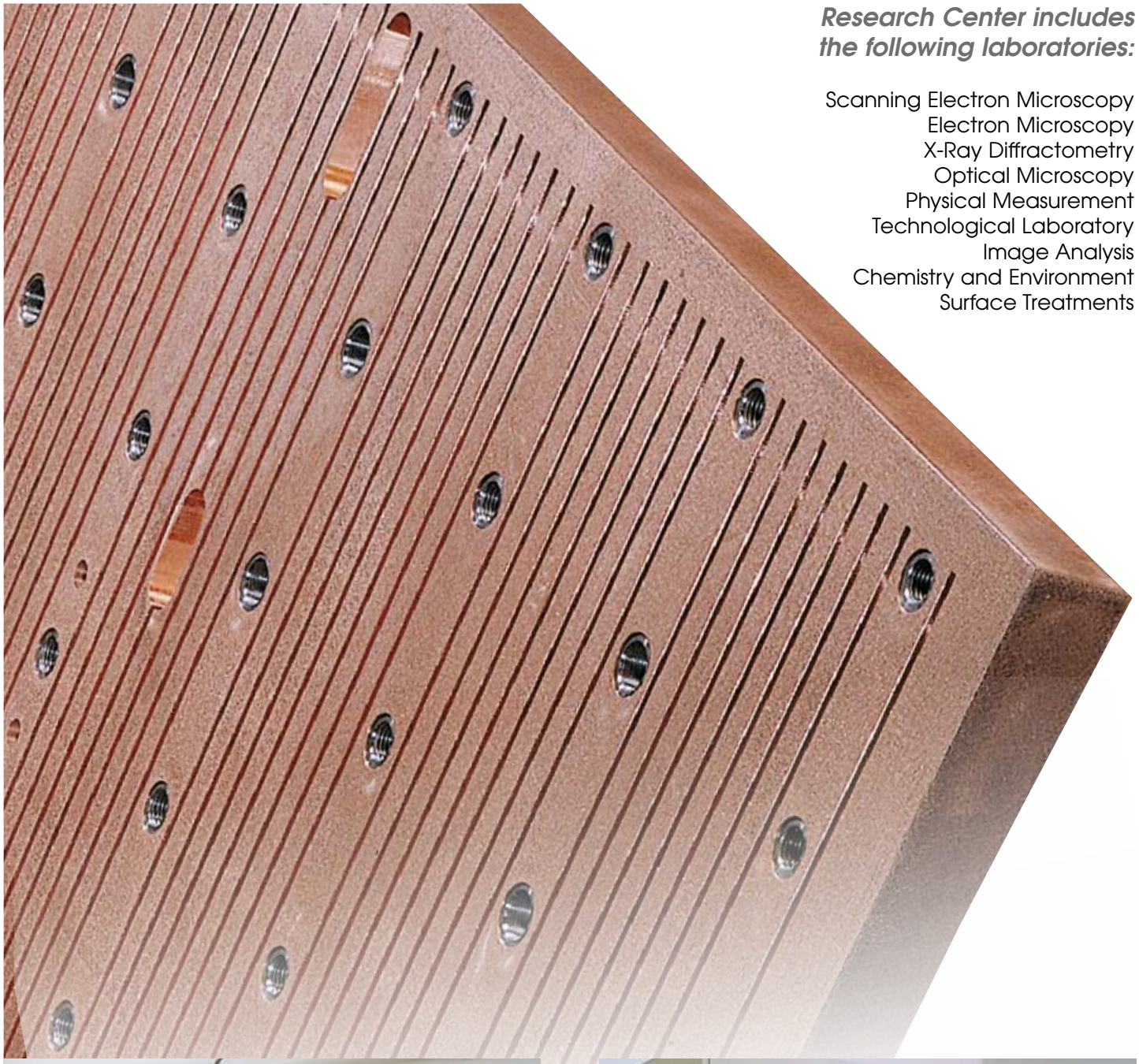
Its high-tech equipment and the experience and competence of its researchers are our customers' disposal to find solutions to problems related to the use of moulds in casting machines. The Research Centre has a library of over 5,000 specialized works, and is connected to important European and U.S. data banks (CDC - USA). It also has a range of cutting-edge instruments, including:

- Electron scanner Microscope

- Electron transmission Microscope

- X-ray diffractometer

Our specialized staff and the instruments they operate at the Fornaci di Barga Research Centre, as well as our technical servicing unit, are always ready to work together with and help EM MOULDS customers to study projects aiming at new objectives, and to solve any problems which may arise in the course of the continuous casting process.

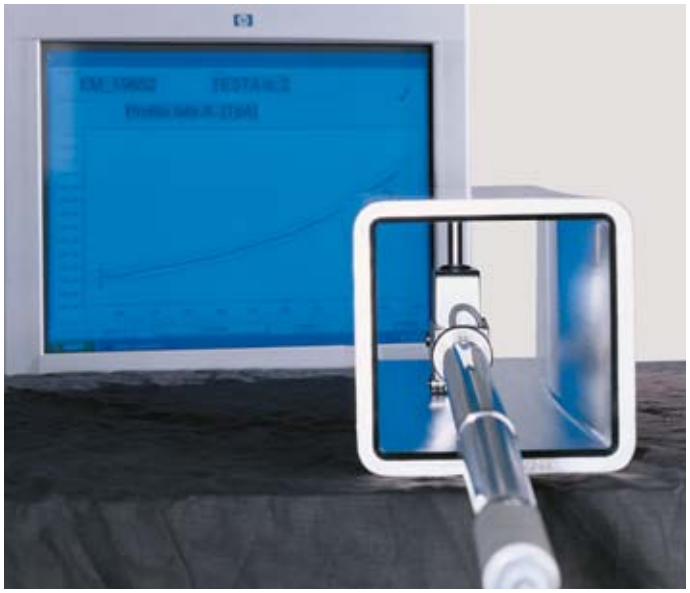


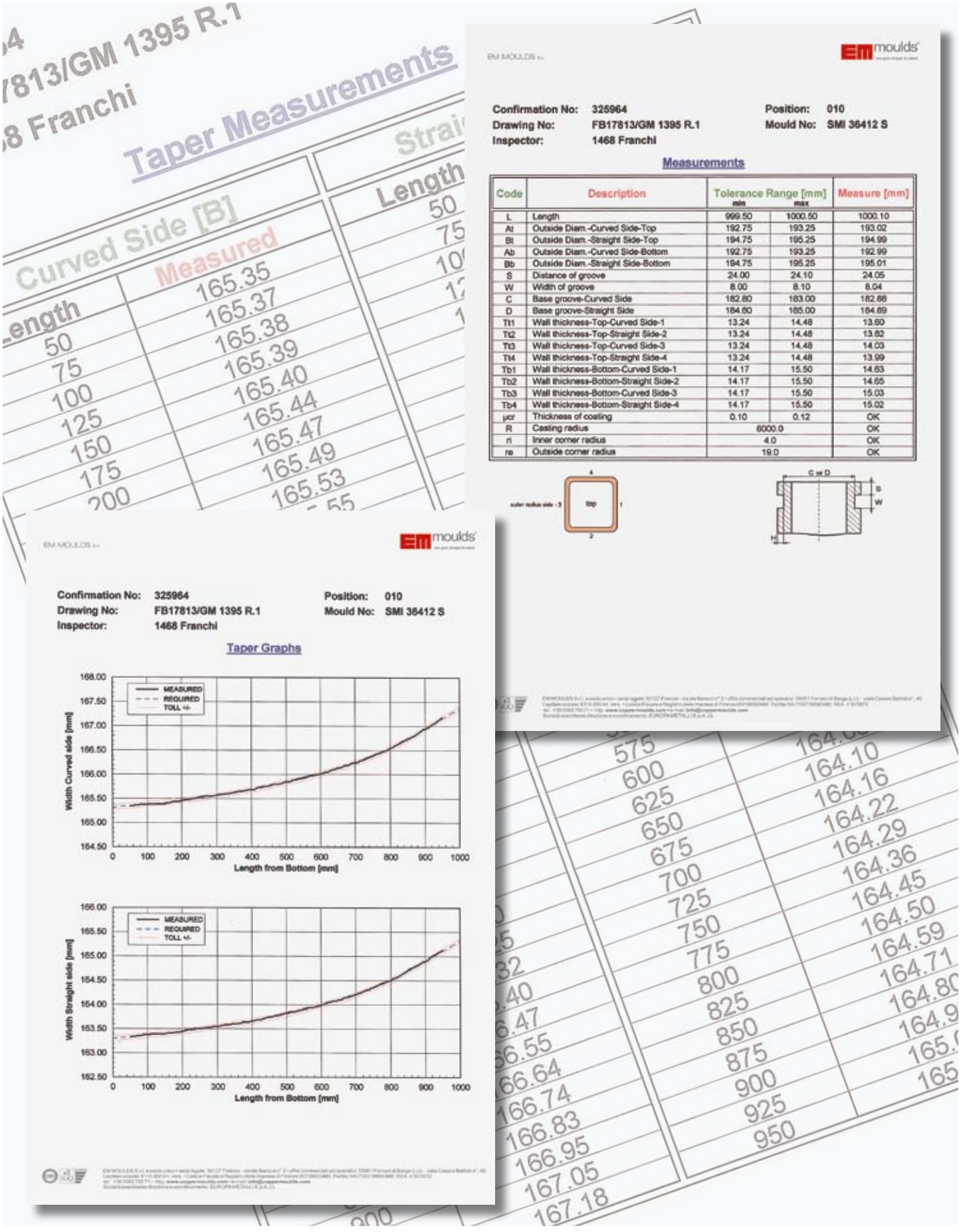
Research Center includes the following laboratories:

Scanning Electron Microscopy
Electron Microscopy
X-Ray Diffractometry
Optical Microscopy
Physical Measurement
Technological Laboratory
Image Analysis
Chemistry and Environment
Surface Treatments

Quality assurance

EM MOULDS is fully committed to improving the quality standards of both its products and processes. This quest, which was already underway in 1984, when Europa Metalli spa launched a Total Quality Program involving its whole work force, generated further schemes in the following years. The company's commitment to supply products which comply exactly with its customers' specifications and are competitive in terms of delivery, prices and service, finally led the company in 1992 to create - through the full involvement of its employees - a documented Quality Management System in accordance with ISO 9001:2000 standards.
The Quality Management Systems put into effect in all of EUROPA METALLI's plants, warehouses and in the sales offices, is now applied to EM MOULDS and certified according to the ISO 9001:2000 standard by Istituto Italiano Garanzia Quality (IGQ).
We are convinced that customer satisfaction is the most eloquent statement on the quality of our performance.

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Measured
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165.37
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165.40
165.44
165.47
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164.10
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164.71
167.05
167.18
EM MOULDS S.r.l.
moulds
Confirmation No: 325964
Drawing No: FB17813/GM 1395 R.1
Inspector: 1468 Franchi
Position: 010
Mould No: SMI 36412 S
Measurements
Code
Description
Tolerance Range [mm]
min
max
Measure [mm]
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At Outside Diam.-Curved Side-Top 192.75 193.25 193.02
Bt Outside Diam.-Straight Side-Top 194.75 195.25 194.99
Ab Outside Diam.-Curved Side-Bottom 192.75 193.25 192.99
Bb Outside Diam.-Straight Side-Bottom 194.75 195.25 195.01
S Distance of groove 24.00 24.10 24.05
W Width of groove 8.00 8.10 8.04
C Base groove-Curved Side 182.80 183.00 182.88
D Base groove-Straight Side 184.80 185.00 184.89
Tt1 Wall thickness-Top-Curved Side-1 13.24 14.48 13.60
Tt2 Wall thickness-Top-Straight Side-2 13.24 14.48 13.82
Tt3 Wall thickness-Top-Curved Side-3 13.24 14.48 14.03
Tt4 Wall thickness-Top-Straight Side-4 13.24 14.48 13.99
Tb1 Wall thickness-Bottom-Curved Side-1 14.17 15.50 14.63
Tb2 Wall thickness-Bottom-Straight Side-2 14.17 15.50 14.65
Tb3 Wall thickness-Bottom-Curved Side-3 14.17 15.50 15.03
Tb4 Wall thickness-Bottom-Straight Side-4 14.17 15.50 15.02
μcr Thickness of coating 0.10 0.12 OK
R Casting radius 6000.0 OK
ri Inner corner radius 4.0 OK
re Outside corner radius 19.0 OK
top
C or D
B
W
Confirmation No: 325964
Drawing No: FB17813/GM 1395 R.1
Inspector: 1468 Franchi
Position: 010
Mould No: SMI 36412 S
Taper Graphs
MEASURED
REQUIRED
TOLL +/-
Width Curved side [mm]
Length from Bottom [mm]
Width Straight side [mm]
Length from Bottom [mm]

1915

nowadays...

Contacts

Operative Office
Via della Repubblica, 257
55051 Fornaci di Barga (LU) – Italy
Tel: +39 0583 700 71
Fax: +39 0583 700 791
e-mail: info@coppermoulds.com
website: www.coppermoulds.com

Registred Office
Via dei Barucci n° 2
50127 Firenze - ITALY

EM MOULDS Srl
55051 Fornaci di Barga (Lu) ITALY