

tenova<sup>®</sup>



# SECONDARY METALLURGY

Complete Solutions for Quality Steel

TENOVA. INNOVATIVE SOLUTIONS FOR METALS AND MINING





Tenova is a worldwide partner for innovative, reliable and sustainable solutions in the metals and mining industries.

Building upon decades of experience, Tenova develops solutions that help mining and metals companies reduce costs, save energy, limit environmental impact and improve working conditions for their employees.

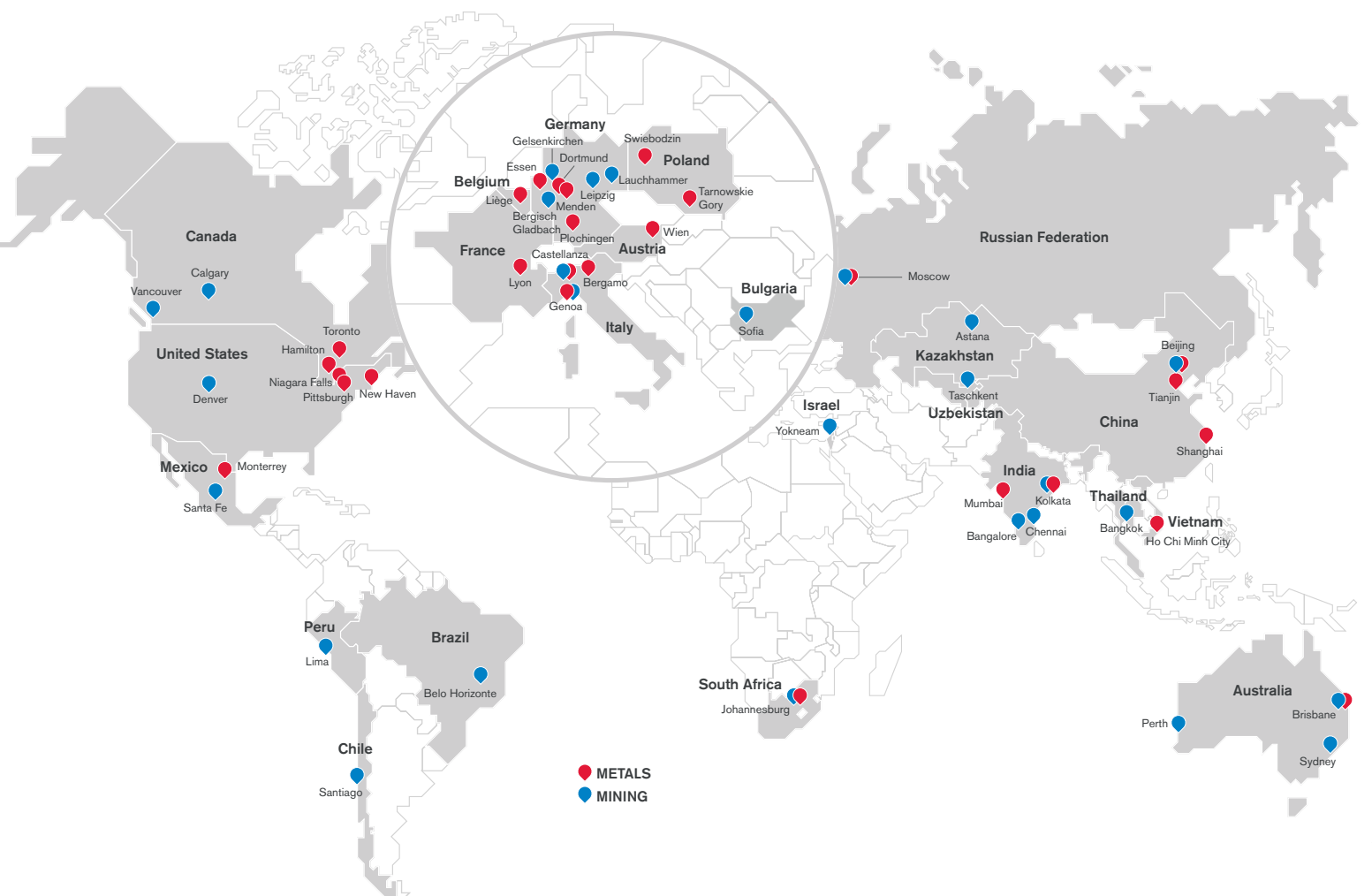
Tenova believes in on-the-job passion, and actively seek out professionals who truly love what they do. Their contributions to the business have helped make Tenova the industry-leading company it is today, and their passion is the driver behind the company business approach.

This approach can be summed up in four key pillars: Innovation, Reliability, Sustainability and Safety.

# Global Presence

Tenova Melt Shops Business Line is a global benchmark supplier of steelmaking equipment. With engineering offices for the development of its technologies in Germany, Italy and the USA, an R&D center of excellence for process technologies in Canada, and operations offices in China, Russia, India and Vietnam it is a one-stop shop for the requirements of the steel industry and upstream suppliers.

Tenova Melt Shops Business Line is supported by the synergies and worldwide presence of Tenova's global network of operating companies with solid local roots, who provide unique solutions through an integrated, multi-business organization. This global approach enables Tenova companies to keep in close contact with customers, to provide engineering capabilities aligned with local standards and to guarantee real-time responsiveness.



## Heritage

The Tenova Melt Shops Business Line heritage embraces well-known brands like Tagliaferri, associated with steelmaking equipment since the earliest days of electrometallurgy and EMCI, Core, Goodfellow and Technometal focused on process, R&D and secondary metallurgy. A combination of leading trademarks sharing tradition, know-how and expertise supported by a solid steelmaking background which qualifies Tenova Melt Shops Business Line to offer some of the most advanced technologies in the sector.

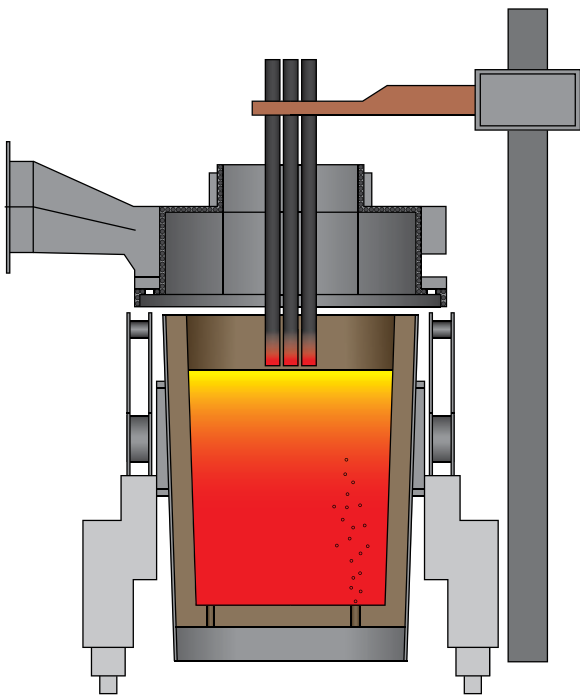


## Secondary Metallurgy

Tenova Melt Shops Business Line offers the complete range of secondary metallurgy technologies and services. Its state-of-the-art plants are custom designed to assure high operational availability, maintenance friendly design and efficient and economical processes. Tenova Melt Shops Business Line solutions suit the particular needs and product ranges of the customers, its integrated approach has contributed over the years to build long term customer relationships throughout the complete plant life cycle. Tenova Melt Shops Business Line' dependable equipment is designed to minimize energy consumption and environmental impact, key issues for the sustainable development of the industry.

APPLICATIONS	STEEL CLASSIFICATION	TYPE OF SECONDARY METALLURGY
Automotive	Spring, Gear, Shaft steel, SBQ	LTS, LF, CHS, VD
	Car sheets and panels	LTS, CHS, LF, RH
Construction and fabrication	Rebar	LTS, CHS, LF
Machinery and Plants	Bearing steel	LF, VD, RH
Railway	Rails and wheels	LF, VD, RH
Steel Cord	Tire cord	LF, VD
Gas Industry	Pipe steel	LF, VD
Oil Industry	Tube steel	LF, VD, VOD
Household and Chemical	Stainless steel	VOD, LF, AOD
Offshore	Stainless steel	VOD, LF, AOD
Power plants, offshore, steel plants	Special and stainless steel	LF, VD, VOD, VSD

## LF



The Ladle Furnace (LF) is the fundamental secondary metallurgy solution for improved productivity, flexibility and quality.

Tenova Ladle Furnaces are usually designed to increase the melt temperature up to 5°C/min. They are equipped with either a direct-or an indirect-suction water-cooled roof (controlled atmosphere), as well as other related facilities such as wire-feeding machines and powder-injection systems.

To maximize productivity without sacrificing process quality, the Tenova Ladle Furnaces can be designed as a twin unit, using a single transformer with swinging electrode arms.

Metallurgical and operational features:

- Temperature adjustment
- Composition adjustment with alloy additions and/or wire feeding
- Thermo-chemical homogenization with inert gas injection through ladle bottom and/or a vertical stirring lance and electromagnetic stirring
- Improved deoxidation and desulfurization with proper additions
- Buffer operation prior to casting

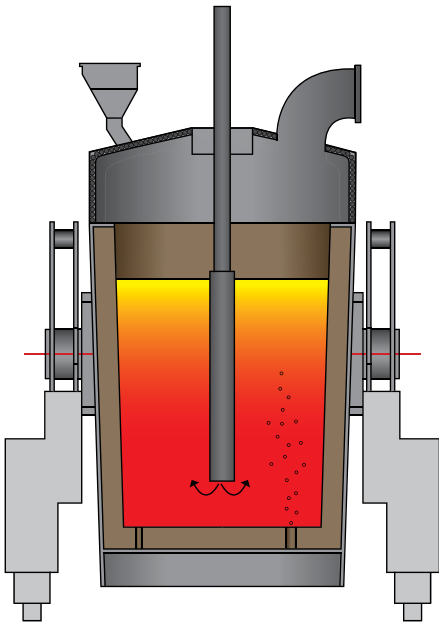


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The Ladle Treatment Station (LTS), positioned between the melting and the continuous casting plants, delivers important metallurgy benefits for a lower investment outlay.

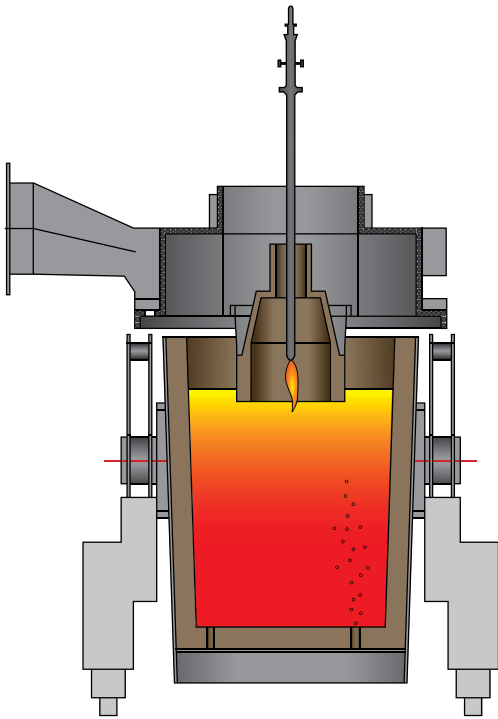
Metallurgical and operational features:

- Composition adjustment with alloy additions and/or wire feeding
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# CHS



The Chemical Heating Station (CHS) allows temperature and composition to be adjusted without using electrical energy: heat is provided by the combustion of aluminum with oxygen, in a refractory-lined snorkel immersed in the melt.

Heating rates of more than  $7^{\circ}\text{C}/\text{min}$  are possible with this unit.

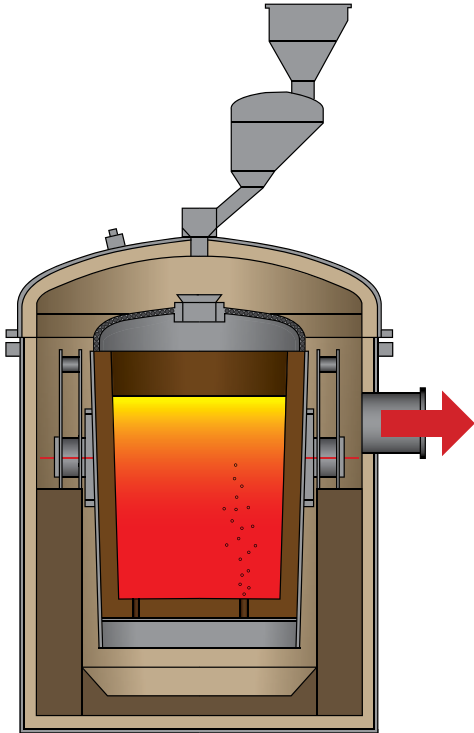
Excellent alloy yields are achieved through addition under inert gas conditions covered by the refractory-lined snorkel.

Metallurgical and operational features:

- Chemical heating by aluminum addition and oxygen blowing
- Composition adjustment with alloy additions and/or wire feeding
- Thermo-chemical homogenization with inert gas injection through ladle bottom and/or a vertical stirring lance
- Improved deoxidation and desulfurization with proper additions
- Buffer operation prior to casting



## vd and VD-OB



The Vacuum Degasser unit (VD) is used to degas and decarburize the melt, in addition to creating optimal conditions for desulfurization and removal of inclusions.

During VD treatment, the liquid steel ladle is placed in a stationary or movable vacuum tank, depending on specific layout needs.

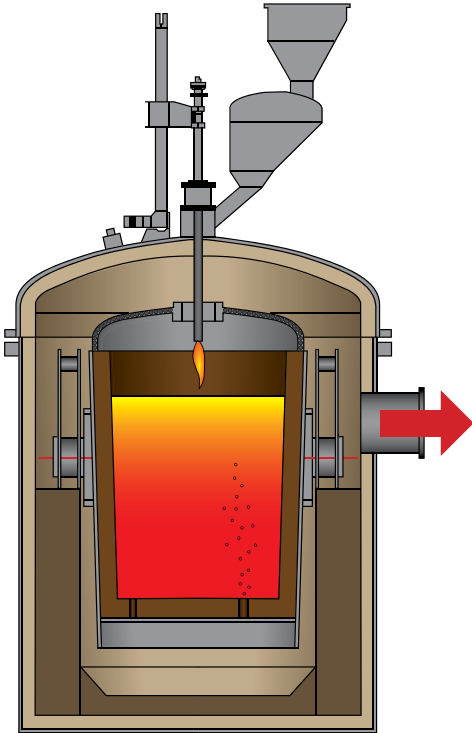
A vacuum is achieved with a vacuum pump system, consisting of mechanical pumps or steam jet pumps. To assist stirring, inert gas is injected through porous plugs. The VD unit can be equipped with an additional oxygen lance (VD-OB process) to obtain further benefits, such as forced decarburization or chemical heating. To maximize productivity without sacrificing process quality, the Vacuum Degassing System can be designed as a twin unit using a single vacuum pump system.

Metallurgical and operational features:

- Hydrogen and nitrogen removal
- Natural and forced decarburization
- Improved conditions for desulfurization with proper slag management
- Improved conditions for inclusion flotation
- Adjustment of temperature and composition



## VOD



Extensive decarburization is achievable with a Vacuum Oxygen Decarburization (VOD) unit. The unit is basically a tank degasser equipped with an oxygen lance, but specifically configured to withstand the heat load from an intense CO emission.

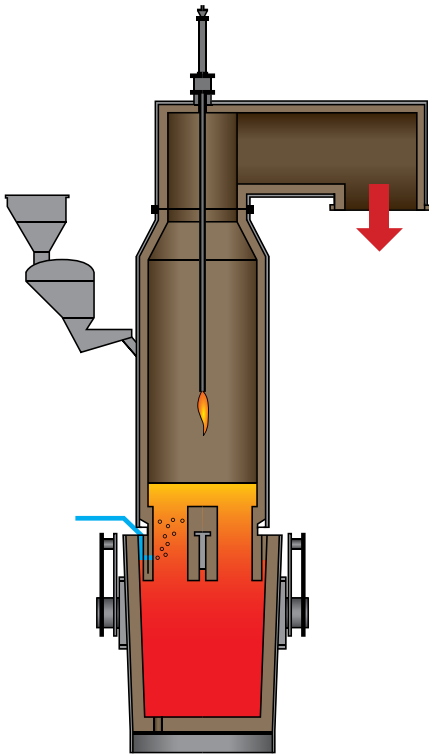
It is normally used for deep decarburization of high-alloy steel grades, usually to remove carbon without affecting chromium content in the production of stainless steel grades. The VOD unit can be operated as the sole decarburization unit after the furnace (DUPLEX process) or as a refining stage after rough decarburization with an AOD unit (TRIPLEX process).

Metallurgical and operational features:

- Extensive decarburization with low chromium losses
- Use of less expensive high-carbon alloys
- High rate of chromium recovery with proper additions
- Chemical heating of liquid steel
- Hydrogen and nitrogen removal
- Improved conditions for desulfurization with proper additions
- Improved conditions for inclusion flotation



## RH



In the Ruhrstahl Hereaus (RH) unit, vacuum treatment of the melt is carried out in a refractory-lined vessel equipped with two snorkels immersed in the steel bath. As system pressure is reduced, the melt rises into the vessel and circulation is induced by the injection of inert gas into the up-leg snorkel. The RH unit is usually employed for vacuum treatment and decarburization of long sequences of low-carbon steel grades.

Metallurgical and operational features:

- Fast decarburization down to 15 ppm
- Hydrogen and nitrogen removal
- Use of less expensive high-carbon alloys
- Chemical heating of killed and un-killed heats
- Improved steel cleanliness in terms of non-metallic inclusions
- Good composition control



## Top Lance System

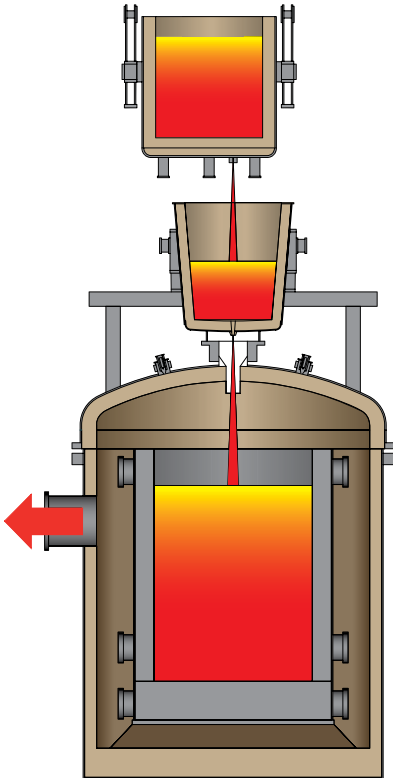
The Top Blowing Lance System is installed above the RH vessel and combines several functions. Oxygen blowing rates of 2000 – 4000 Nm<sup>3</sup>/h and installed burner capacities of 2 – 4 MW are typical design features. For process supervision the lance can be equipped with a TV camera. In addition the TOP lance can be equipped with a powder blowing function in order to conduct a deep desulfurization of the steel.

Process functions:

- Oxygen blowing for forced decarburization and chemical heating
- Heating of RH vessel refractory material by gas / oxygen combustion
- Powder blowing for desulfurization
- Fast skull removal by usage of the oxygen jet
- Advanced ignition by external ignition facility



## VSD



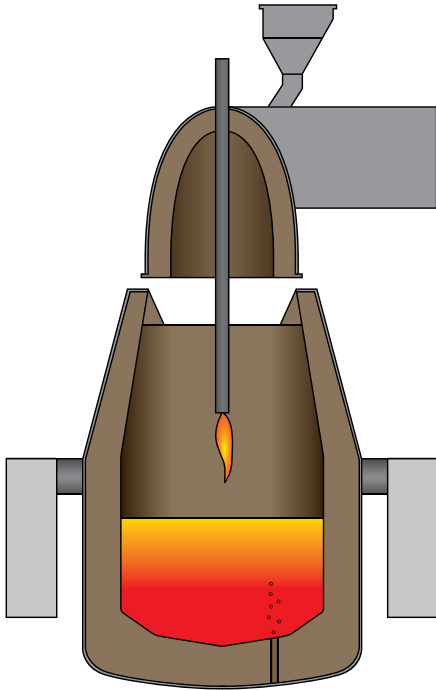
The Vacuum Stream Degassing (VSD) can be used for the production of extremely low hydrogen content steel grades. The possible VSD configurations include ladle to mold, ladle to ladle and tap degassing. Ladle to mold stream degassing allows for the production of very large ingots from multiple heats. This is achieved by tapping ladles into a tundish or pony ladle which then feeds the liquid steel into the vacuum chamber where the ingot is being cast. The vacuum is achieved with a vacuum pump system consisting of mechanical pumps or steam ejectors.

Metallurgical and operational features:

- Double degassing for the production of ultra-low hydrogen content
- Production of large ingots from multiple heats
- Natural decarburization
- Adjustment of chemical composition



## AOD



The Argon Oxygen Decarburization (AOD) unit is used for extensive decarburization of the melt. The process injects oxygen and inert gas (argon or nitrogen) through submerged tuyeres and additional oxygen is blown through a top lance.

The AOD process is suitable for production of stainless steel and other high-grade alloys because dilution with argon/nitrogen minimizes unwanted chromium oxidation.

Metallurgical and operational features:

- Efficient operation even with high initial carbon levels
- Use of less expensive high-carbon alloys
- Low chromium oxidation losses
- High rate of chromium recovery with proper additions
- Chemical heating of liquid steel
- Low final dissolved gas content
- Improved steel cleanliness
- Good composition control



## Vacuum Pump Systems

Tenova Melt Shops Business Line can provide dry mechanical pump systems as well as design and supply of steam jet pump systems for heat sizes ranging from 3 t/s to more than 300 t/s.

## Dry Pump Systems

Dry Pump Systems are set up in a 3-stage or 4-stage design, containing a combination of rotary lobe and screw pumps. Depending on the required suction capacity several modules can be installed.

Dry mechanical pump features:

- Lower operational costs compared to steam jet pumps
- No contact cooling water needed
- Compact and modular installations
- Vacuum control by gas dilution
- Redundant systems can be installed upon customer's request





# Steam Jet Pumps

Steam Jet Pumps are designed in 4 or 5 - ejector stages. The motive steam is condensed by contact cooling water condensers. The steam jet pumps are designed as full steam pumps or as Hybrid pumps in combination with liquid ring pumps.

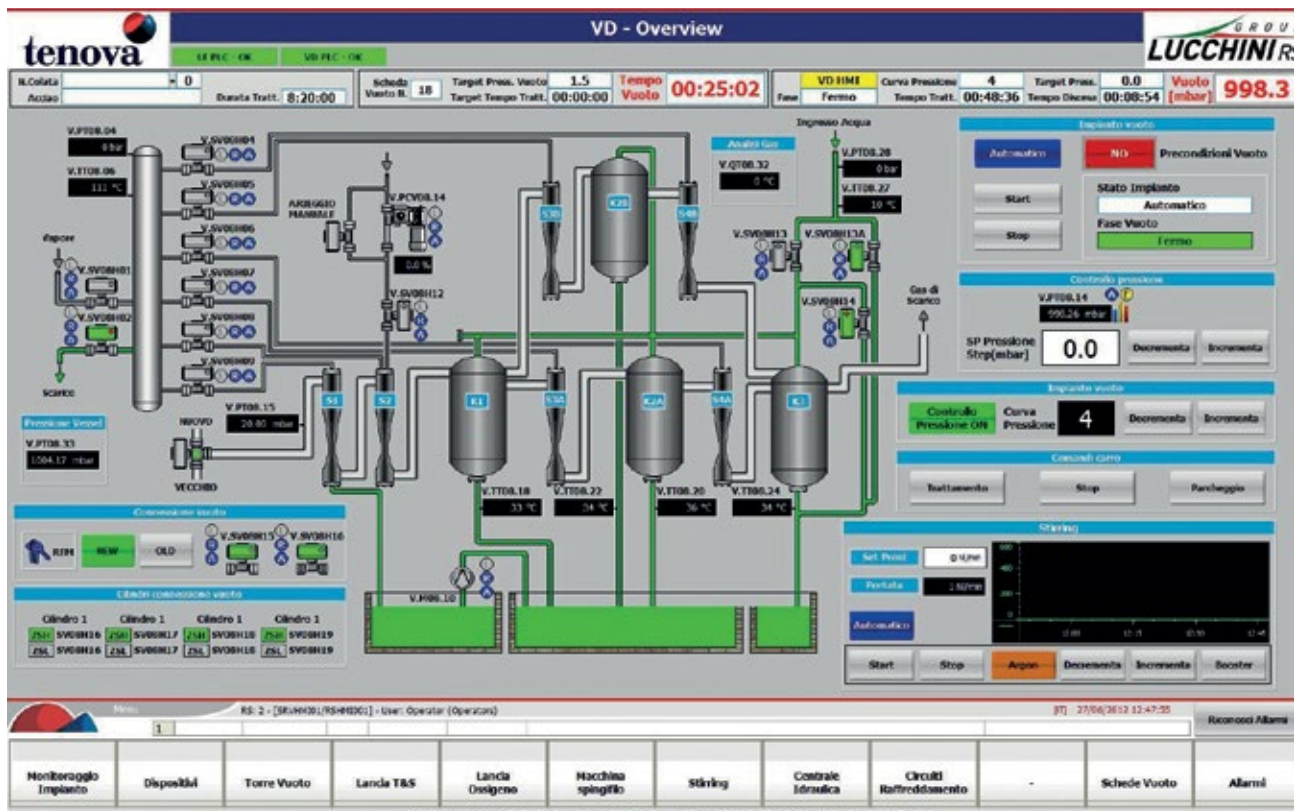
Steam jet pump features:

- Reliably high suction capacity at deep vacuum condition as well as in the mid-range for heavy process gas loads
- Robust long-life design matching steel plant demands
- Simple maintenance required
- Low wear and tear
- Vacuum control by needle valves

# In-line Vacuum Filter Systems

Tenova Melt Shops Business Line provides an in-house technology for In-line Vacuum Filter Systems to help plants achieve environmental process requirements keeping the vacuum pump system free of heavy dust loads. This equipment is operated under vacuum conditions and is mandatory when using mechanical vacuum pumps and keeps the water treatment plant for steam jet pumps largely free of dust contamination.

Depending upon gas cooling requirements, an efficient gas cooler serves to protect the bags from excessive thermal load.



# Automation Systems

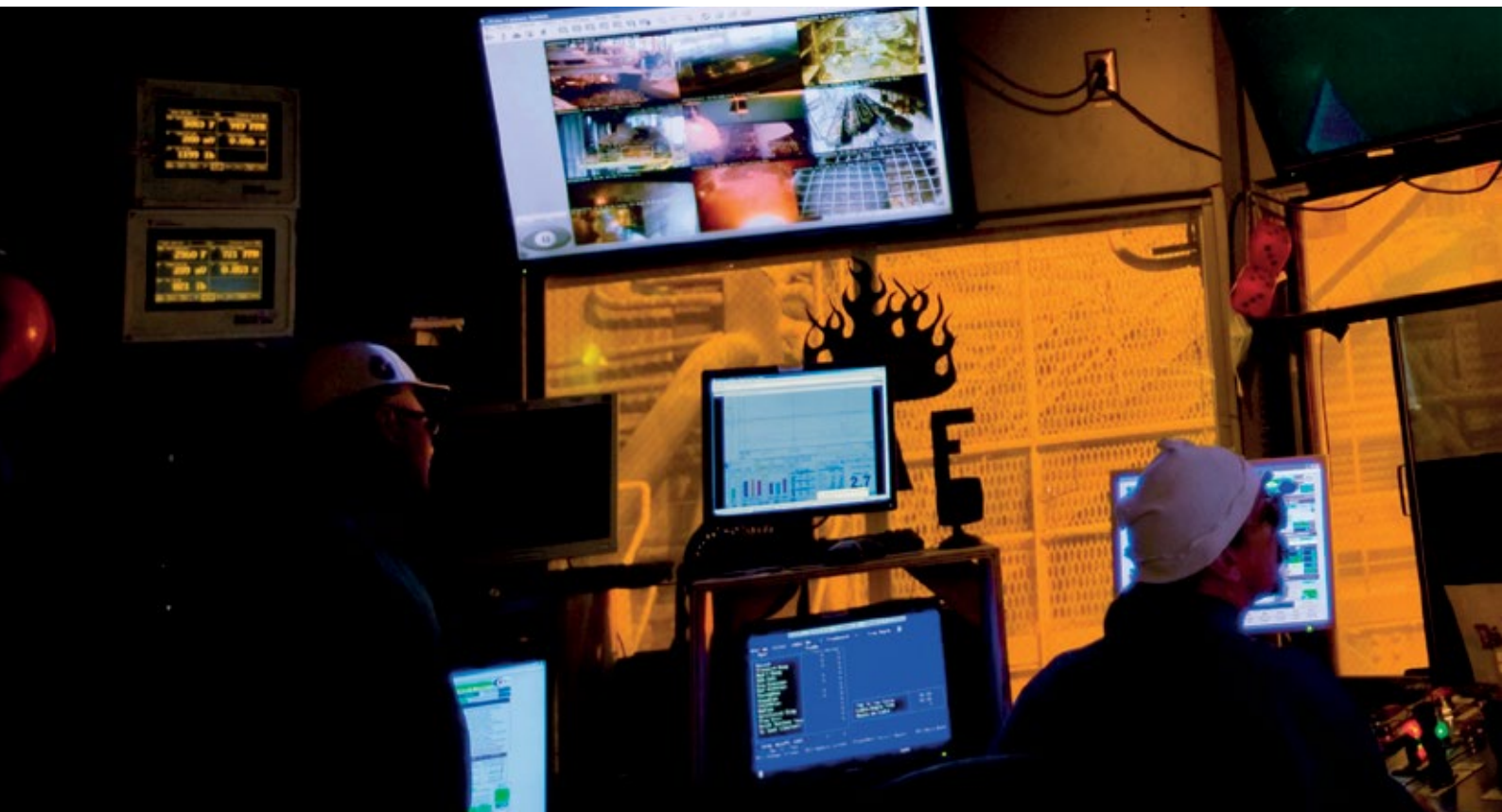
Tenova Melt Shops Business Line secondary metallurgy equipment expertise and in-depth understanding of melt shop process applications has been applied to the in-house development of advanced control and automation systems. All Tenova Melt Shop systems are designed and supplied using state-of-the-art technology and the modular structure of our systems allows for easy integration into existing plant systems.

Tenova Melt Shops Business Line systems cover every level of the plant melt shop including:

- Level 1 basic automation plant control
- Level 2 metallurgical process modeling incl. heat tracking, production planning and operator guidance
- Level 3 production tracking
- Level 4 management of in-progress product production orders

Tenova Melt Shops Business Line metallurgical models provide:

- Degassing (Hydrogen and Nitrogen)
- Decarburization of carbon and stainless steel
- Desulfurization
- Oxygen blowing for carbon and stainless steel
- Thermal models
- Reduction
- Alloy and flux additions
- Inclusion shape control
- Analysis control
- Physical ladle tracking (PLT)

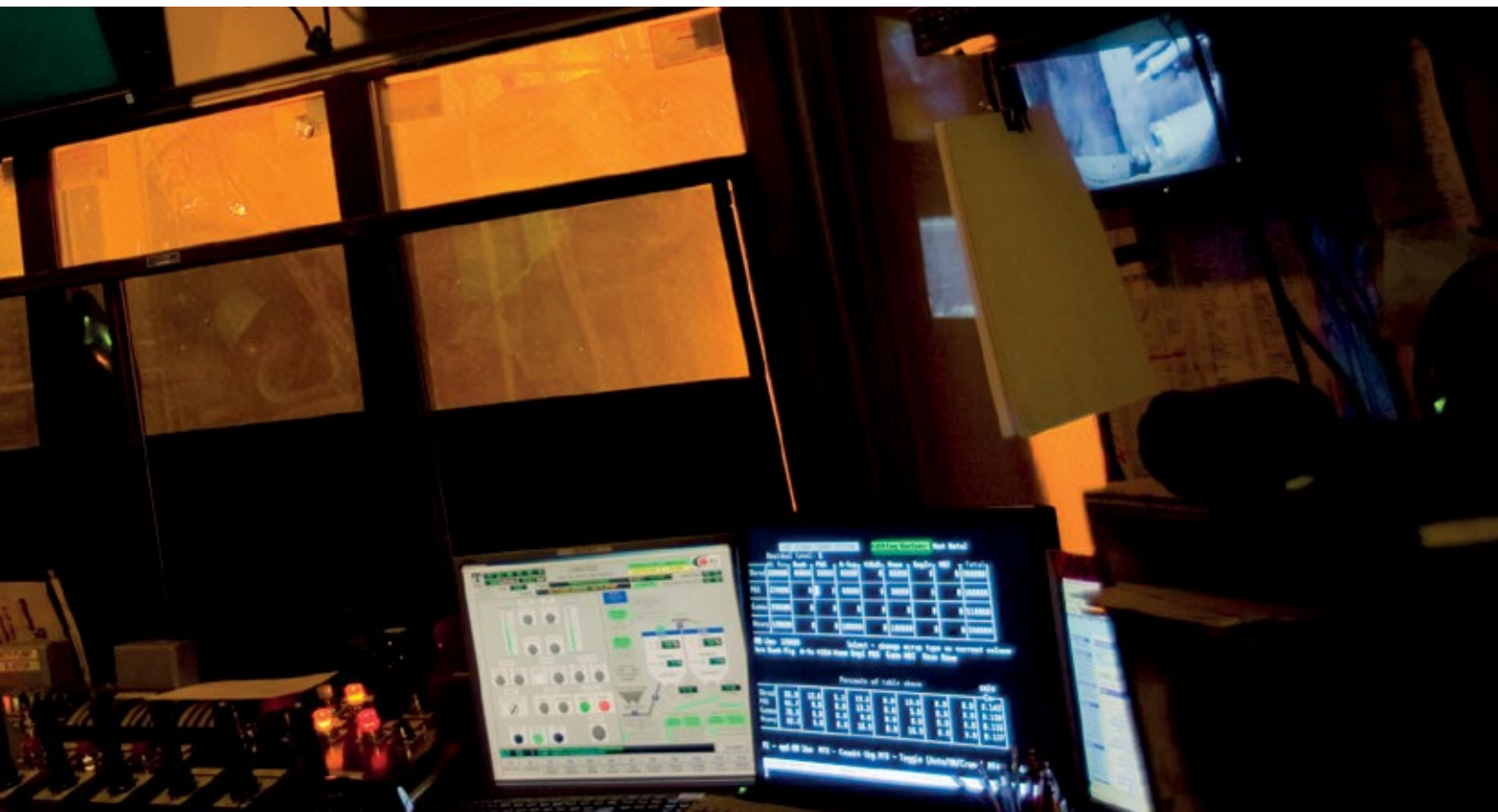


# Safety

Safety is a core value of Tenova Melt Shops Business Line projects.

Tenova Melt Shops Business Line integrated systems and equipment create a safe and reliable working area, implementing cutting-edge technologies to reduce manual operations in the areas most at risk:

- Automatic sampling and temperature measurement equipment
- Automatic material addition
- Movement interlocks supervision
- Limit-switch monitoring and supervision
- Oxygen monitoring



## Customer Service

Tenova Melt Shops Business Line provides training programs for personnel in charge of operations and equipment maintenance. Courses include practical and theoretical sessions on technologies, equipment functions, maintenance and operational procedures.

Rapid commissioning and a fast learning curve are provided by Tenova Melt Shops Business Line expertise and assistance.

After-sales assistance includes a comprehensive spare parts service.

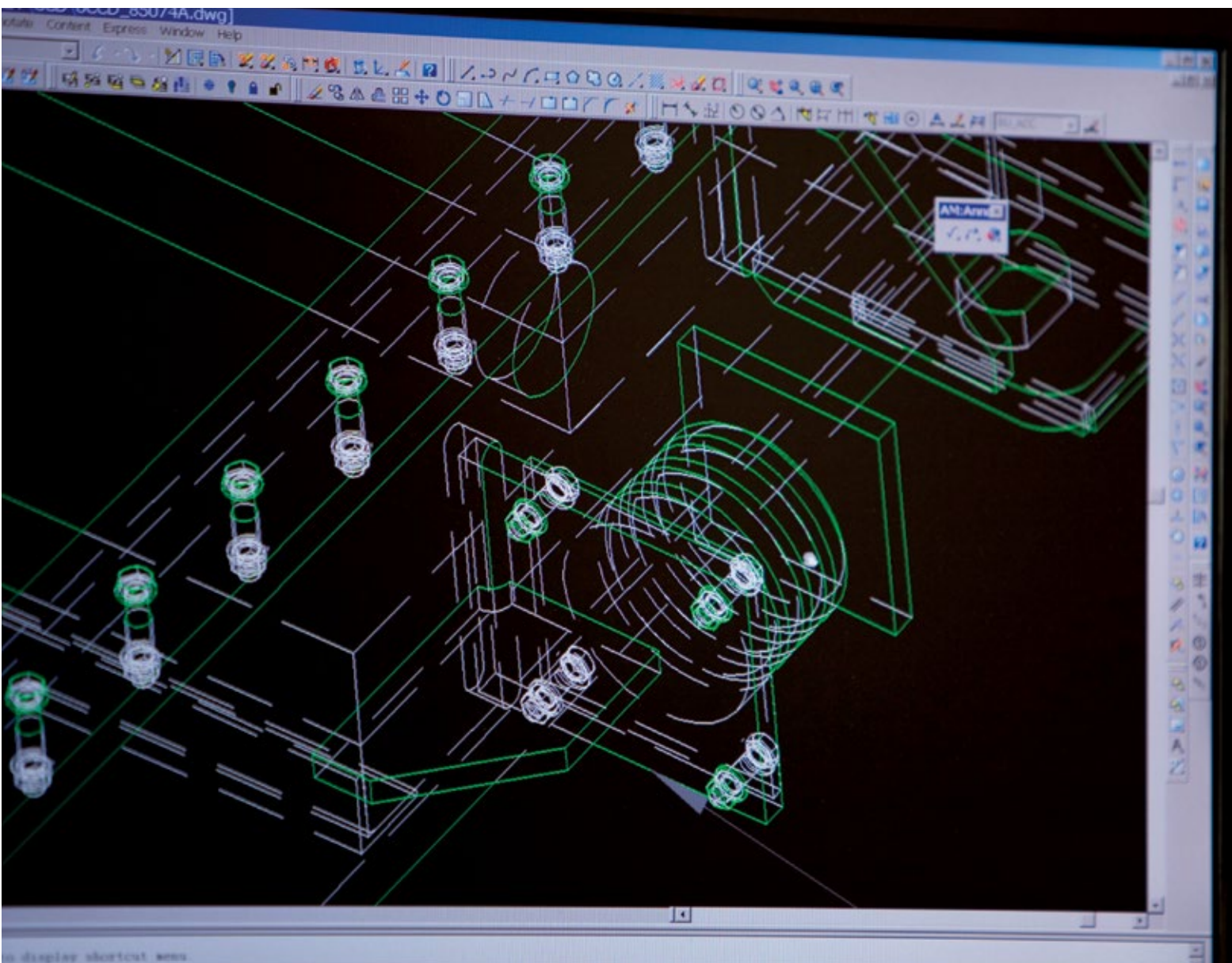


## R&D

Technological innovation is the main pillar of Tenova Melt Shops competitiveness. Its successful R&D work is based on effective co-operation with:

- Customers, through joint research projects combining Tenova's engineering capabilities with the customer's production expertise
- Production specialists from the steelmaking companies of the Techint Group
- A network of research centers offering dedicated facilities to test R&D project results
- Universities and other research institutes

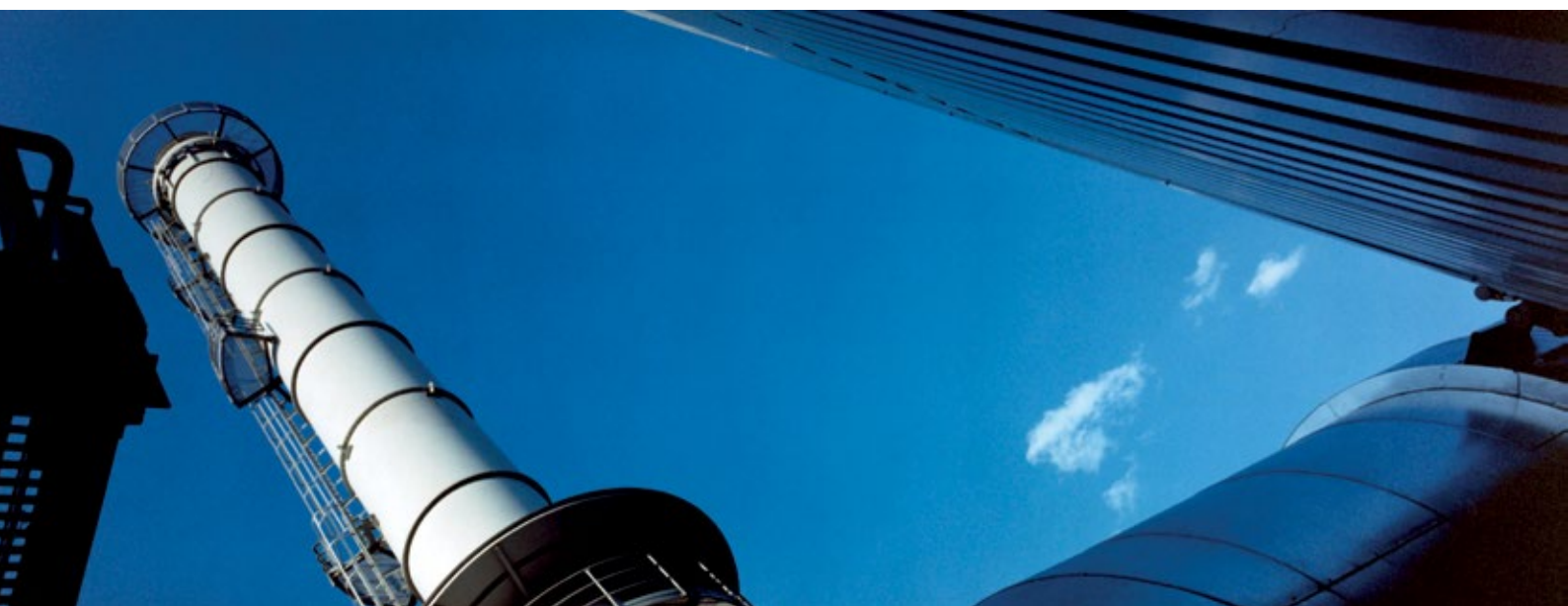
The Tenova Melt Shops Business Line R&D Team is an international network of specialists and engineers from the companies and business units around the world.



## Environmental Responsibility

Tenova Melt Shops Business Line provides the most advanced technologies for environmental impact control. Its technology is designed to improve the steel plant environment by:

- Reducing dust
- Reducing fumes and gaseous emissions
- Reducing GHG (Greenhouse gases) emissions
- Reducing noise levels
- Reducing electric network disturbances



## Focus on People

People are vital to success and growth at Tenova Melt Shops Business Line. Qualified engineers and technicians are the lifeblood of the network. Outstanding technical and management expertise in every area of activity, a strong focus on the customer, a passion for innovation and continuous flexibility: these are the features that distinguish Tenova Melt Shops Business Line professionals.

With their varied nationalities, Tenova Melt Shops Business Line specialists execute projects all over the world. Their multicultural backgrounds equip them to take on new challenges in any location.

Tenova Melt Shops Business Line enhances and optimizes the talents of the individual for the good of the team and to the benefit of the customer.

By supervising every stage of professional growth and providing on-going knowledge and skills training, Tenova Melt Shops Business Line guarantees the expertise of its people.



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