

PAUL WURTH

SMS group



BLAST FURNACE TECHNOLOGY







Hot metal and pig iron produced by Blast Furnaces stand for 60 % of all steel products which the world's population consumes. Blast Furnace ironmaking is a traditional technology which has been steadily innovating towards the most universal and flexible way for winning the primary metal for steel: for construction and machinery, tools and healthcare, vehicles and household appliances.

Paul Wurth and its ironmaking specialists are proud to supply their state-of-the-art technologies to blast furnaces around the globe! Almost every medium to large-size blast furnace operating in the world today incorporates Paul Wurth technology. Many smaller-size blast furnaces benefit from these technologies, too!

Welcome to

THE STATE-OF-THE-ART OF BLAST FURNACE IRONMAKING!



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TECHNOLOG LEADERSHIP IN IRONMAKING – AVAILABLE HERE!



Blast furnace No. 1, Hyundai Steel, South Korea.

A FULL LINE OF TECHNOLOGY AND SERVICES

Our products and services cover the full range of blast furnace projects ranging from complete new ironmaking plants, furnace modernisations and relines, new or upgraded equipment and systems, plant automation and process control systems, engineering design services through to equipment maintenance and spare parts. We provide operational and system design advice and on-site services for blast furnace operation and maintenance activities.

The benefits for the client can include:

- increased plant capacity, availability and reliability,
- higher unit productivity,
- improved hot metal quality and stability,
- lower energy consumption,
- reduced operational costs,
- improved plant hygiene, plant safety and environmental performance,
- longer campaign life,
- access to Paul Wurth's continuous innovation and developments.





BLAST FURNACE CONSTRUCTION & MODERNISATION

**PROVEN SOLUTIONS COUPLED WITH THE
NEWEST TECHNOLOGIES.**

Paul Wurth has the reputation as the leader in Blast Furnace engineering – for developing new plants as well as upgrading existing ones. 220 reference projects worldwide are witness of a unique and all-plant covering competence.



Blast furnaces No. 1 & 2, ThyssenKrupp CSA Siderúrgica do Atlântico, Brazil.

The modern Paul Wurth blast furnace combines proven solutions with new and latest developments to provide the best gain from the project – capital cost, project implementation, operation ramp-up, availability, safety, environmental compliance, long campaign life, total cost of ownership, etc.

We work closely with our clients to develop the optimum solution – whether for a new furnace or for relining or rebuilding an existing unit. We work closely with sub-contractors and construction companies to minimise the impact of major work on on-going operations, the out-of-operation or construction time and to optimise the costs for the client.

Our philosophy of continuous improvement assures our clients of receiving the most up-to-date proven technologies and solutions for the project's technical and commercial success.





STOCKHOUSE & CHARGING SYSTEMS

Top charging a blast furnace starts on the ground. Relying on our sound expertise in blast furnace top charging and knowing about the interaction of hot metal quality, blast furnace operation and burden material supply, Paul Wurth can provide state-of-the-art solutions for the stockhouse and the related charging system, including all equipment and facilities for storing, weighing, screening, batching and conveying.



The stockhouse designed by Paul Wurth is characterised by:

- a high operating flexibility in handling batch composition and charging sequence options,
- sufficient spare charging capacity,
- a high screening efficiency and
- minimum burden size degradation through a limited number of transfer points.

For all charging system designs, process and operational simulation is performed. The incorporation of efficient dedusting systems is considered in all cases in order to meet environmental regulations.





BLAST FURNACE TOP CHARGING TECHNOLOGY – THE ORIGINAL

Since the first successful industrial application of the BLT® in 1972, Paul Wurth has developed a large family of Bell Less Top® Charging Systems for any blast furnace size, satisfying the customers' requests for flexible burden distribution and segregation control, while matching their budgets.

Our knowledge gained from more than 500 installations, combined with the operational experience of our clients and our process-focused product development, all bundled into a unique charging technology – that's what creates the standard in today's blast furnace ironmaking.



The Paul Wurth Bell Less Top family includes Series Hopper and Parallel Hopper Tops, the "Mini", "Midi" and "Compact" types and combinations of these configurations.

Paul Wurth's latest developments in this field focus on the challenges arising from demanding burden material quality specifications. Thus, further significant top charging flexibility improvements for our customers keep The Original at the top of top charging!

The application of the Bell Less Top charging system provides the following benefits:

- improved furnace operational stability & efficiency leading to better hot metal chemistry control,
- increased furnace productivity,
- lower operating costs due to reduced coke consumption and higher attainable PCI rates,
- longer campaign life thanks to controllable blast furnace wall heat loads,
- higher furnace availability, limited equipment maintenance, easy and quick maintainability.





Blast furnace No. 3, Rashtriya Ispat Nigam Ltd, India.

BLAST FURNACE DESIGN: THE BLAST FURNACE PROPER, LINING & COOLING

The correct design of the furnace proper is fundamental to reliable operation, metallurgical performance, sustained high productivity and long campaign life.

For new turnkey installations of any capacity as well as for plant rebuilds, the modern blast furnace designs produced by Paul Wurth are based on the concept of a free-standing vessel with a surrounding tower structure, providing access to the furnace.

Making use of powerful simulation tools for the optimisation of the burden and gas flow, Paul Wurth designs the furnace proper considering the potential raw material and operating conditions for the furnace throughout its campaign. Serious consideration is given in the design stage to ensure rapid and accurate constructability.

Integrating the properties of the shell, the cooling elements and refractory lining, the global solution engineered by Paul Wurth ensures the well-balanced overall operation of the plant.



With many years of experience in furnace lining and proven know-how in furnace profile definition and cooling concepts, Paul Wurth offers complete solutions from the bottom and hearth to the top of the blast furnace. Based on extensive expertise materialised in 250 blast furnace projects, Paul Wurth offers refractory design, material supply and construction supervision of entire blast furnace linings.

Efficient cooling is required to balance the thermal load and associated wear of the inner lining of the furnace. Offered in combination with our copper, steel and cast iron stave coolers for any zone of the blast furnace, our optimised primary and secondary

cooling systems ensure a high availability, long campaign life and reduced operating costs.

Paul Wurth uses closed loop cooling circuits with forced recirculation. These provide for advantages such as:

- low water consumption,
- low electrical power consumption,
- low maintenance costs,
- no corrosion or clogging of the pipes and cooling elements,
- sensitive leak detection and rapid location.





HOT BLAST GENERATION & SUPPLY

Having integrated many decades of experience in world leading Hot Blast System design, the Paul Wurth proposes the best available technology for construction of Hot Blast Stove Systems with internal and external combustion chamber as well as for repairs of all kind.

The benefits of our solutions are:

- uninterrupted furnace operation for many years,
- highly energy efficient,
- maintenance free systems,
- low emissions,
- optimal use of available space,
- long-time proven concepts against stress corrosion cracking.



Hot Blast Stoves at BF1, Hyundai Steel, South Korea.

We are specialised in the design and supply of waste gas heat recovery and pre-heating systems for stove combustion air and gas. This is one of Paul Wurth's engineered solutions addressing energy efficiency and operating cost already when designing a plant for a customer.

Paul Wurth designs Hot Blast Mains and Bustle Pipes to address system movements and residual expansions to give trouble-free operation. A single main mixer or individual branch mixers can be incorporated.

Our portfolio also includes the entire set of valves used for the hot blast system applications.

The Paul Wurth Tuyere Stocks, applied on more than 150 blast furnaces, are designed for long service life, easy handling, low maintenance and zero noise pollution. The blow pipes designed by Paul Wurth are readily adaptable to accept auxiliary fuel injection.





Pulverised coal grinding, drying and injection plant, ThyssenKrupp CSA Siderúrgica do Atlântico, Brazil.

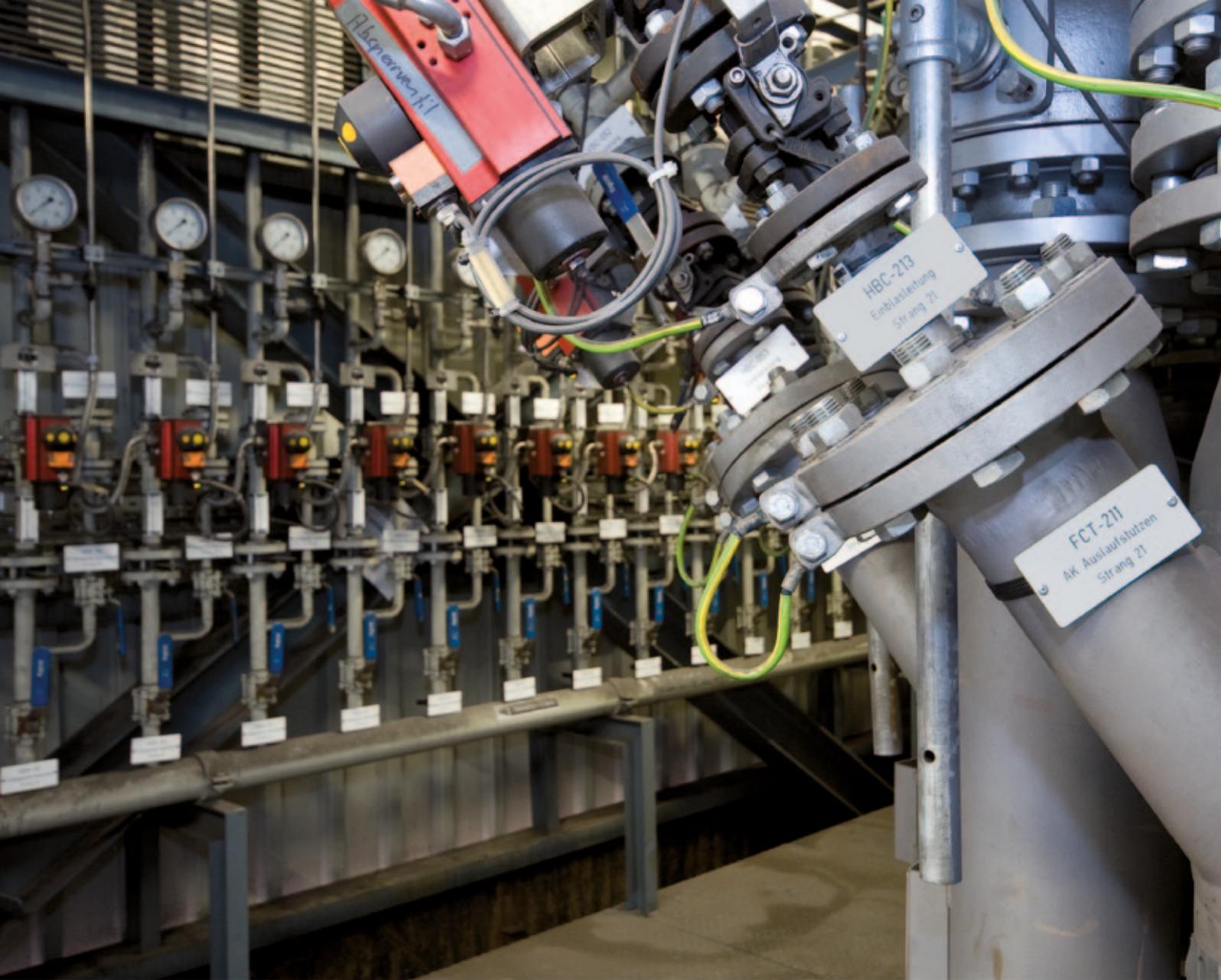
PULVERISED COAL INJECTION

Reliable, efficient and accurate injection of auxiliary reducing agents is vital for cost effective blast furnace operation. Paul Wurth is involved in the application of all forms of gaseous, liquid and solid fuel and reducing agents injection via the hot blast tuyeres.

Paul Wurth has been a driver of the pioneering development of Pulverised Coal Injection (PCI) technologies since the early 1980s; today, close to 60 large size Blast Furnaces worldwide are operating with our PCI systems.

Paul Wurth's PCI plants can support blast furnace operation with injection levels above the 200 kg/thm target. Simultaneously, development is focused on improving the combustion of the coal in the tuyeres/raceway area which further enhances the customers' gains in coke replacement.

Paul Wurth's injection technology is based on our advanced 'Dense Phase' know-how resulting in minimum nitrogen consumption (reduced operating costs) and low coal conveying speed – resulting in low pipeline and component abrasion, very stable coal flow rates and reduced capital costs.



The injection process calls for best control accuracy at high coal conveying flow rates – Paul Wurth's GRITZKO® flow control valve, combined with modern plant design, is a reliable high-tech tool for reaching stable operation via fine-tuned coal distribution. We have developed technologies to upgrade existing PCI systems to meet higher throughput or delivery accuracy requirements.

Paul Wurth can offer individual solutions based on different conveying and distribution techniques which ensure the desired coal delivery accuracy parameters, from high to excellent, thus matching customers' budgets. Generally, PCI is considered a Best Available Technology with extremely short return on investment; and it can improve the overall CO₂ balance of an integrated steel plant.

Paul Wurth designs and supplies coal grinding and drying plants which transform the raw coal into injectable pulverised coal. The choice of energy-saving hot gas generators, vertical roller mills and efficient filtering technique, all provided by reputed system suppliers, makes the Paul Wurth grinding and drying plant an ideal technological preparation unit for PCI operations.





GAS CLEANING AND ENERGY RECOVERY

High-efficiency Gas Cleaning Systems are vital for the reliable operation and long campaign life of high temperature hot blast systems and steam generation facilities, and allow the operators to meet the relevant pollution control standards.

We design and supply the full range of gas cleaning systems, gas distribution equipment and processes designed to the highest levels of cleaning efficiency, safety and reliability and providing the best possible environmental protection. With more than 120 references worldwide, Paul Wurth offers turnkey plants and core components for blast furnace gas cleaning.

The **Axial Cyclone** for high-efficiency dry dust separation with its compact design can be ideally integrated into an existing plant configuration. A wear-resistant lining provides for optimum system lifetime, whilst the dust removal degree (typically more than 85%) of this dry technology can be adjusted individually to suit the overall requirements.



The **Annular Gap Scrubber** with its movable Venturi elements provides high dust capture efficiency at minimum pressure loss and is the state-of-the-art in controlling blast furnace top pressure.

The efficiency and accuracy of dust separation provides higher recycling rates of ferrous ironmaking by-products thus reducing the environmental impact and improving the Fe-yield of the entire steel plant. Sludge from the scrubber, for instance, can effectively be recycled by the Paul Wurth RedIron/RedSmelt™ technology.

Prior to the use of the top gas' calorific value in combustion processes, the use of the **Top Gas Energy Recovery Turbine (TRT)**, an expansion turbine installed downstream of the gas cleaning equipment, can transform the potential energy contained in the pressure of the blast furnace gases into electricity.

For a large blast furnace with high top pressure, the gas recovery results in substantial electric energy savings and contributes, in a sizeable way, to the reduction of CO₂ emissions.





TAPPING HOT METAL IN A MODERN CASTHOUSE ENVIRONMENT

Stable and reproducible tapping operations are essential for both the hot metal quality and the establishment of a smooth, efficient blast furnace ironmaking process.

Paul Wurth has extensive experience in the design of modern, highly functional casthouses – whether for new furnaces or for existing plant modernisation.



Castfloor, Blast furnace 'H', Tata Steel, India.

Today's flat casthouse floor layout, runner design and reliable equipment ensure flexible operation, easy maintenance access and best safety conditions. The use of Paul Wurth's state-of-the-art casthouse dedusting systems and implementing modern filtering technologies makes your blast furnace operation comply with the strictest environmental regulations.

Paul Wurth recommends and uses world-class casthouse machinery from its affiliated company TMT – Tapping Measuring Technology, a joint company of Dango & Dienenthal and Paul Wurth. TMT's full range of proprietary casthouse equipment includes fully hydraulic taphole openers, clay guns and runner cover manipulators as well as tilting runner drives, sampling and measuring devices and auxiliary equipment.

The possible installation of compact blast furnace slag granulation devices at the end of the slag runner system is an integral part of the Paul Wurth casthouse layout concept.





SLAG GRANULATION & PIG CASTING

SLAG GRANULATION

Handling of blast furnace slag is an important aspect of modern blast furnace operation. Granulated blast furnace slag is a vitrified sand and today a marketable product (popular mainly with the cement industry) rather than a difficult and costly waste material.

Paul Wurth developed the INBA® slag granulation process, incorporating our proprietary dynamic INBA dewatering drum. With about 220 references, it is today the world's most popular and effective means of processing blast furnace slag. The process is highly flexible and the compact sub-plant can be applied to any furnace configuration. Granulation, dewatering and storage of the slag can be done adjacent to the furnace or can be separated to suit available plant space or logistics.

On top, modern granulation and condensation concepts as well as closed loop water circuits make the INBA process the best available slag processing technology for environmental compliance.



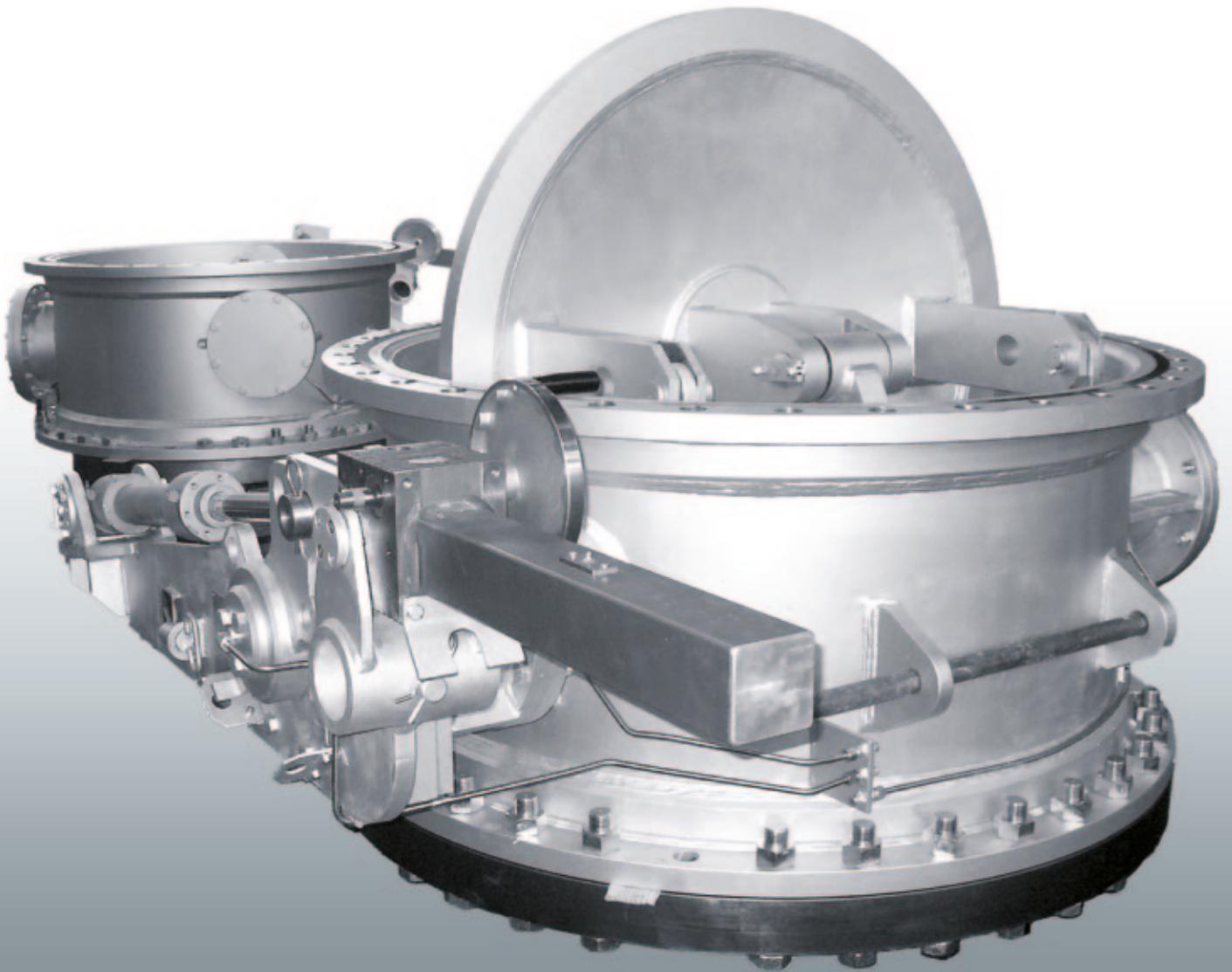
PIG CASTING MACHINES

Paul Wurth offers modern Pig Casting Machines incorporating the latest knowledge of casting, process control and monitoring. Our technology aims at decreasing maintenance and installation time as well as increasing production capacity and control.

All of our machines are built based on a modular construction design. They can be either a single strand or double strand machine with different design arrangements depending on the pouring method. Paul Wurth can accommodate many different design considerations into the standard design along with a fully automatic control package and including several optional features.

As with all Paul Wurth technologies, our pig casters are subject to a continuous improvement process aimed at optimising the users' total cost of ownership and at ensuring environmental compatibility.





BLAST FURNACE VALVE TECHNOLOGY

For decades Paul Wurth has been designing and supplying specialised valves for various applications in the blast furnace process. Our valves are designed to meet and exceed the most severe operating conditions to be expected in blast furnace operation. Long service lifetime, high reliability and ease of maintenance are further design criteria.

Also this product range is under continuous improvement, so that new features and components suit the most recent application, quality and service demands.

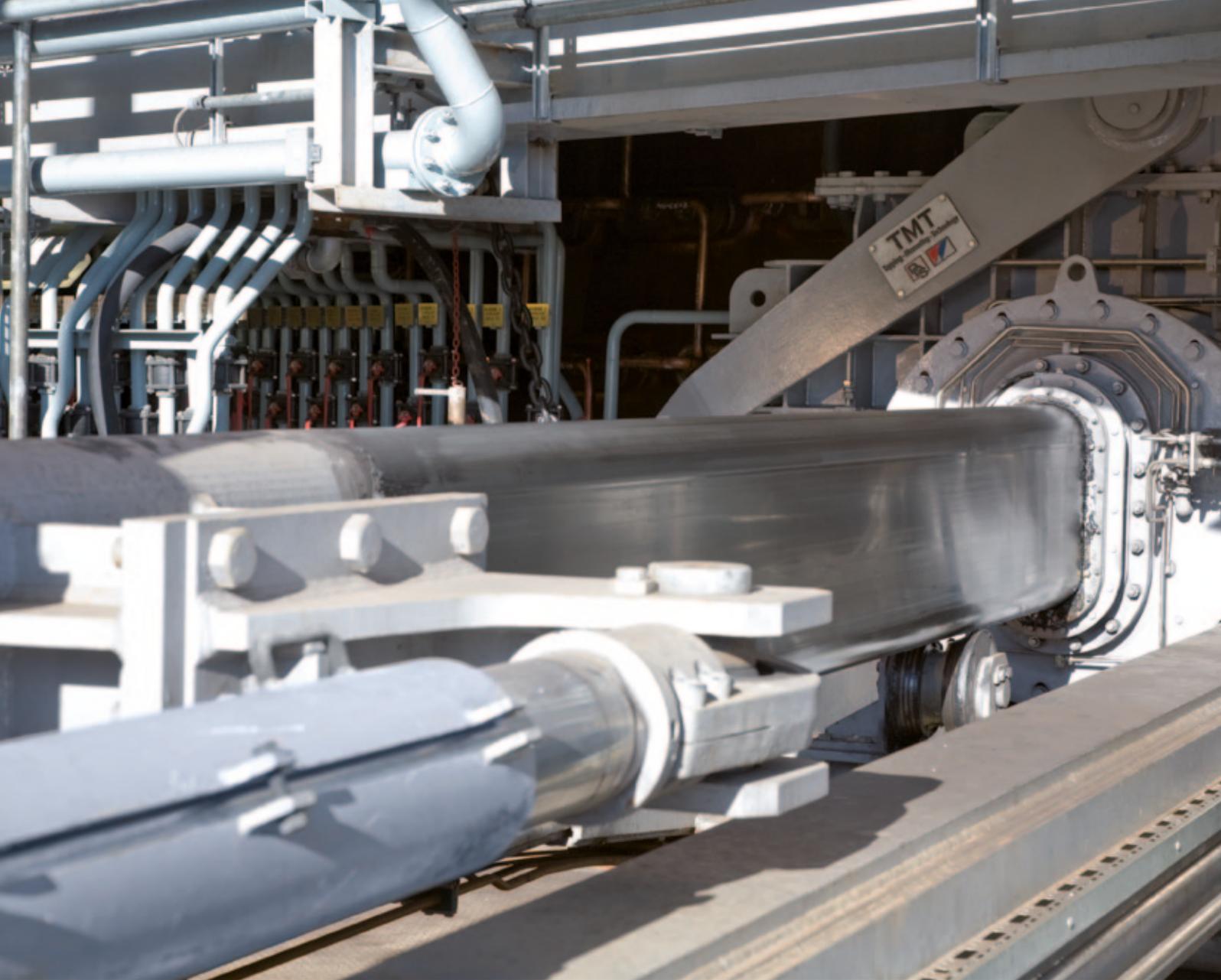


Blast furnace operators rely on products from the Paul Wurth valve family when it comes to:

- blast furnace top and top gas operations as pressure equalization, pressure relief “bleeding”, back draft,
- isolating the BF top gas main upstream or downstream of the gas cleaning plant,
- dust discharging (GRITZKO® metering valves) from cyclones or dust catchers,
- all control, isolation and safety operations related to the generation of the blast: gate valves, butterfly valves, double eccentric and three-lever valves, be it for the cold or the hot blast, be it for fuel gas, combustion air, waste gas, etc.

Paul Wurth’s propriety GRITZKO valve is also well-known for its flow control accuracy and reliability as a metering device in dense phase pneumatic conveying of pulverised coal, copper matte and other materials.





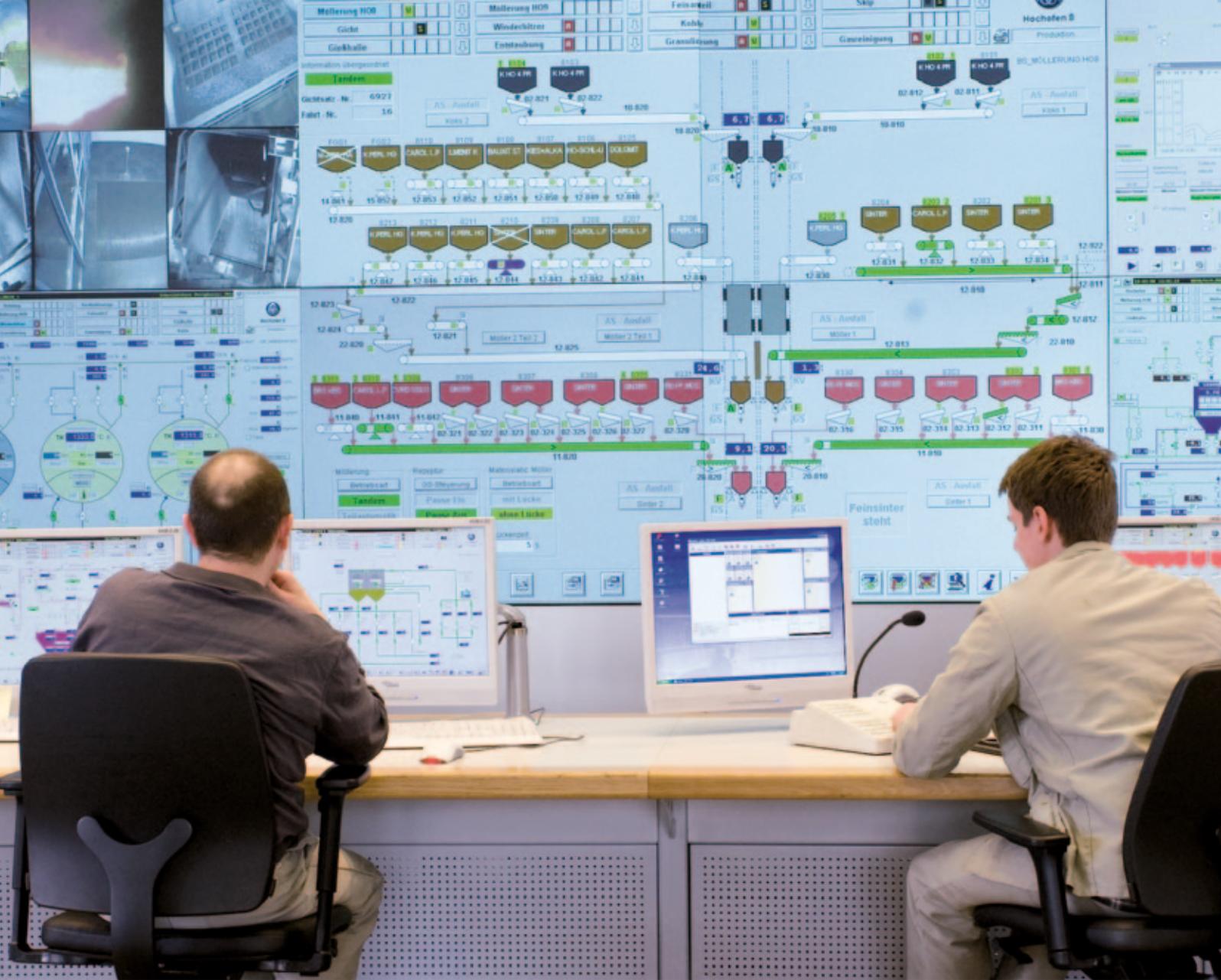
THE TRANSPARENT, HIGH-TECH BLAST FURNACE

FURNACE PROBES (TMT*)

After many years of experience in development and the supply of essential Blast Furnace process data recorders (Probes), Paul Wurth has combined its design know-how with that of Dango & Dienenthal by creating the joint, affiliated company TMT – Tapping Measuring Technology. Paul Wurth works with its colleagues at TMT and with their clients to implement the best combination of probes and measuring equipment to properly monitor and control the blast furnace process.

Reliable probe operation is important to support, on a regular basis, data processing, furnace process models and furnace operation supervisory systems. TMT's probes help the blast furnace operator to establish:

- top gas temperature profile and top gas chemistry,
- material falling trajectories, stockline level and profile,
- burden layer build-up, mixing and descent behaviour,
- gas and temperature profiles in the burden column,
- raceway and coke bed conditions,
- hot metal quality and tapping operations.



FURNACE AUTOMATION & SUPERVISORY SYSTEMS

The efficient operation of the modern blast furnace requires a high degree of automation in conjunction with computerised monitoring and control systems.

For each Paul Wurth technology, we offer Level-1 Automation (PLC and HMI systems). A dedicated team of specialists has developed advanced process control for all critical processes. These control means are completed by Level-2 solutions (process models, expert systems and program tools), covering either the overall BF operation or specific parts of the ironmaking process (Cokemaking, Hot Stoves, BF charging, etc.).

Paul Wurth's integrated Level-2 solution for the Blast Furnace is known as the **BFXpert™**. This advanced process assistance system includes BF control and real time data analysis & process optimisation as well as deferred BF data analysis. It allows operators to optimise hot metal production, to be assisted by a knowledge based system and to report performance indicators and production figures.

The **SACHEM®** Expert Operating Guidance System is a key element of a blast furnace automation package. It analyses the raw data to determine relevance and to advise the operator of remedial action. Based on operational know-how, this Intelligent Supervisory System will guide the operators in making the best decisions to keep all of the ironmaking process stable, efficient and in control.



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