



**TMT  
COMBINED CLAY GUN AND  
TAPHOLE DRILL**

**PORTOVESME S.R.L.  
LEAD SMELTER REVAMPING PROJECT**

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**Technical Specification**

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Project Reference: T0-01040



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## 1. DESCRIPTION

### 1.1 ADVANTAGES

TMT compact tapping machines have the following advantages:

- Simple robust design with an optimized balance of industry standard and customised components.
- Reduced space requirement in the retracted position.
- Good accessibility of the clay gun and the taphole drill in the retracted position for refilling of the clay and changing the drill rod.
- Good accessibility for maintenance
- Hoses are covered by pyrojacket and most of them are guided by cable tracks

### 1.2 INTRODUCTION

We transmit herewith our technical specification for 1 (one) combined clay gun and taphole drill unit to service the Portovesme Lead Smelter in Sardinia - Italy. The furnace has four tapholes at the same elevation, which will be served by the machine.

The machine consists of a combined unit of a clay gun and a taphole drill with a common support carriage. The support carriage is suspended from overhead support rails.

The machine will be powered by a hydraulic power unit including bladder accumulator to cover flow peaks and to ensure the emergency plugging in case of a power failure. The hydraulic power unit will be located in the furnace building in an enclosed room.

Controlled functions of the units, with the associated electric components and instrumentation are included. The machine will be operated from a remotely located control desk. In addition, the drilling functions can be operated from an onboard control desk, mounted on one side of the equipment.



### 1.3 COMBINED CLAYGUN AND TAP HOLE DRILL UNIT

The tapping machine unit comprises a wheeled support carriage on which the clay gun and taphole drill are suspended. The clay gun is mounted in an inclined position above the taphole drill, in order to meet the local space requirements.

The overhead support rails are fixed to the furnace building steel structure. The rails allow the unit to move parallel to the furnace and are independent from the furnace itself. The machine can service all four tap holes of the furnace situated at the same elevation. The park-position is away from the taphole area, to provide good maintenance and service access.

The support carriage runs on the support rails with guide rolls to accommodate transverse forces and to allow smooth travel.

A power track will be installed to supply the unit with electric power, control signals, hydraulic fluid and compressed air.

In operation, the support carriage travels parallel to the furnace to the working position at the chosen taphole.

The carriage is moved by two hydraulic motors. There are two travelling speeds available. The high speed enables the positioning of the machine next to the selected taphole, the crawling speed is used to align the unit in front of the taphole.

The taphole approach will be controlled by an encoder. Once approached, the base frame will be mechanically centred and locked by the locking cylinder.

To start the plugging or drilling operation, the working unit has to be selected. The clay gun or taphole drill selector switch interlocks one unit against the other.



For the plugging operation, the clay gun is lowered in front of the taphole by the shifting cylinder. The whole unit is then moved towards the taphole by means of a travel carriage. When plugging, the clay gun nozzle covers the taphole and is held in place with sufficient force, provided by the carriage travel cylinder, to allow the clay to be extruded against the molten material flow. During this ramming operation the hydraulic pressure is maintained in the travel and shifting cylinders to prevent the clay gun from moving away from the taphole, as this could result in clay loss and inefficient taphole plugging. The hydraulic pressure can be regulated in order to adjust the ramming force.

When drilling, the clay gun stays in its retracted position over the taphole drill. First, the whole unit is moved forward close to the taphole by the travel carriage, driven by a cylinder. The hammer roller carriage is then moved forward by a hydraulic motor to drill the taphole. The operator will determine the exact moment to withdraw the drill. The taphole drill has a hydraulic rotation with an independent hydraulic forward hammer action. The drilling operation can either be done from the remotely located control desk, or from the onboard controls.

Once the taphole is open, the drill and its suspension frame are retracted from the tapping stream. The entire tapping unit is moved back to the park position from the remotely located control desk. The park position is on one side of the overhead rails with access for maintenance.

In order to stop an eventual flow out of the taphole when the inner copper block is removed, a tool, allowing the insertion of a specially shaped refractory insert into the external copper block, will be designed. The tool will consist of an adapter, allowing the fixation of the refractory insert to the drilling unit, which can be inserted in the taphole in emergency situations. The feed force of the roller carriage will keep the refractory plug well in position. Only the design of this tool will be supplied by TMT.



## 1.4 HYDRAULICS

The tapping equipment will be powered by a hydraulic power station. The hydraulic power station is foreseen to be located in a separate room in the furnace building.

The hydraulic power station comprises a hydraulic fluid reservoir made out of mild carbon steel, three pumps and one circulation pump including filter, an oil/water heat exchanger unit and return line filter and bladder type accumulators. All the field instruments of the hydraulic power station are cabled to the local terminal box.

The bladder type accumulators are designed to cover flow peaks during normal operation and to ensure the pressure and flow for the emergency plugging operation in case of a power failure. The capacity of the accumulators is sufficient to guarantee the following movements:

- move the carriage from the park position to the furthest taphole
- lock the carriage
- inclined shifting of the clay gun towards the tap hole centreline
- move the carriage towards the furnace
- perform one complete plugging operation

The hydraulic power station will be delivered in three parts: pump unit, tank with oil conditioning unit, accumulators. The unit is supplied with all valves, filters and instrumentation. Manual and remote controlled isolation valves will be provided.

The hydraulic distribution blocks for both the clay gun and the taphole drill with the electrically operated valves, will be positioned on the supporting carriage. On the carriage, the hydraulic fluid supply to the corresponding cylinders is done by flexible hoses and rigid piping. A power track system feeds the electric and hydraulic power as well as the compressed air to the carriage.



(Typical hydraulic power unit during shop tests)



## 1.5 PNEUMATICS

The pneumatic control valves for the drill bit flushing air, together with the air filter and lubrication for the hammer, will be mounted in a panel, fixed to the building structure.



(Typical pneumatic panel layout)



## 1.6 ELECTRICAL COMPONENTS AND INSTRUMENTATION

### 1.6.1 Functions

All field devices are cabled to an onboard terminal box, from which the signals are transmitted to the PLC panel.

### 1.6.2 Control desk

A stainless steel panel will be foreseen to operate the machine. The control panel will be equipped with the necessary control devices of the hydraulic unit (push-buttons and signalisation lamps). The control desk will be located on the taphole floor. The operator will have visual sight to the taphole area while operating the machine.

Additionally, onboard controls for the drilling operation are foreseen.



(Typical column mounted control desk layout)



### **1.6.3 Electric and control panel**

The PLC-System will be installed in a panel for installation inside the hydraulic room.

The PLC panel will include the following components:

- One main incomer feeded by the customer
- 24VDC regulated power supply
- All necessary relays
- Circuit breakers

The PLC equipment consists of a Siemens S7/300 PLC including:

- PLC rack
- 24VDC power supply
- CPU315
- Digital input modules
- Digital output modules
- Analog input modules
- Analog output modules
- TCP/IP Link
- Each type of card supplied with 10% spares and wired up to terminal blocks.



## **2. MAIN CHARACTERISTICS**

### **2.1 CLAYGUN**

Clay barrel capacity	: 16 l total
Pressure on clay	: 65 bar max. (adjustable)
Force applied on the furnace	: 49 kN max. (adjustable)
Nozzle inner diameter	: 85 mm
Nozzle outer diameter	: 145 mm
Height adjustment	: +/- 50 mm (by shim plates)
Clay barrel inner diameter	: 190 mm
Tap hole approach	: by shifting cylinder and travel cylinder
Operation mode	: electrically operated hydraulic valves

### **2.2 TAPHOLE DRILL**

Total drill stroke	: 1400 mm
Height adjustment	: +/- 50 mm achieved by shim plates
Drill rod diameter	: 25 mm (32 mm)
Drill bit diameter	: 32 – 50 mm (55 – 90 mm)
Drill feed	: hydraulic motor
Hammer/drill	: hydraulic hammer with separate hydraulic rotation HHD420
– Impact frequency	: approx. 3.400 1/min (at 62 l/min oil flow)
– Impact energy	: 114 Nm at 160 bar
– Rotation speed	: approx. 250 1/min (at 40 l/min oil flow)
– Rotation torque	: 380 Nm at 160 bar
Tap hole approach	: by travel cylinder
Operation mode	: electrically operated hydraulic valves
Retracting speed of drill bit	: 500 mm/s



### 2.3 HYDRAULIC POWER STATION

Hydraulic operation pressure	: 160 bar for normal operation and plugging
Fluid	: Quintolubric 888-46 (Fire retardant fluid)
Tank volume	: 800 l
Pump capacity	: 3 x 50 l/min (2 in operation, 1 stand-by)
Circulation pump	: 1 x 50 l/min
Accumulators	: 3 x 50 l
Oil/water heat exchanger unit	: max. inlet water temperature = 42 °C

### 2.4 COMPRESSED AIR CONSUMPTION

Operation pressure	: 4 - 5 bar
Drill bit flushing	: 1,5 Nm <sup>3</sup> / min
Drill hammer lubrication	: 0,4 Nm <sup>3</sup> / min

### 2.5 ELECTRICS

Power supply available	: 400 VAC 50 Hz and 230 VAC - 50 Hz
Installed power	: 3 x 18.5 kW (hydraulic pump motors)
	: 1 x 0.55 kW (circulation pump motor)
	: 1 kW (tank heater)

### 2.6 WEIGHT LIST (ESTIMATIONS)

One clay gun and taphole drill unit	: ~ 4,0 t
One support carriage for clay gun and tap hole drill	: ~ 2,0 t
One hydraulic power unit (delivered in 3 parts)	: ~ 2,0 t
One set of overhead rails	: ~ 7,0 t



## 2.7 SHIPPING WEIGHTS AND DIMENSIONS (ESTIMATIONS)

Item	Qty.	Weight [t]	Dimensions (l x w x h) [m]
Clay gun + taphole drill	1	~ 6,0	4.0 x 1.6 x 2.3
Electric control desk	1	~ 0,2	0.8 x 1.2 x 1.5
Accessories	1	~ 0,6	1.0 x 1.5 x 1.5
Hydraulic power station	1	~ 2,0	2.0 x 2.5 x 2.3
Set of overhead rails	1	~ 7,0	10.0 x 2.5 x 1.0

Total shipping weight without spare parts: ~ 14,8 t



### 3. **SCOPE OF SUPPLY**

The scope and distribution of supplies and services is mentioned below.

#### Definitions

TMT : TMT

C : Customer

- : not applicable

BE : Basic engineering:

The basic engineering comprises layout and assembly drawings, layout calculations, a technical description of the tapping equipment, preliminary loads on foundation or structures, flow sheets, component and motor lists.

DE : Detail engineering:

The detail engineering comprises all drawings, specifications, a material list with the estimated weights, a spare part list, data sheets of the purchased items and other information that are required to do the shop drawings. (Shop drawings are not included)

SU : Equipment supply according to the technical description



ITEM	DESIGNATION	QTY	DESCRIPTION	BE	DE	SU	REMARKS
1.	<b><u>Mechanical equipment</u></b>						
	Tapping equipment	1	Combined unit of clay gun and taphole drill, consisting of Items 1.1-1.3	TMT	TMT	TMT	
1.1	<u>Support carriage</u>						
1.1.1	Base frame	1	Welded steel construction including : <ul style="list-style-type: none"> <li>- Base frame</li> <li>- Guide and drive wheels with hydraulic motors and gearboxes for translation movement</li> <li>- Encoder for taphole and park position control</li> <li>- Onboard piping in mild carbon steel</li> <li>- Flexible hoses with pyrojacket protection to connect all moveable hydraulic consumers</li> <li>- Support and protection shield for onboard control panel for drill / hammer operation</li> </ul>	TMT	TMT	TMT	Common for clay gun and taphole drill
1.1.2	Carriage centring	1	Hydraulic centring/locking cylinder (fixes and centres the support carriage at each taphole working position)	TMT	TMT	TMT	
1.1.3	Horizontal Travel unit	1	Hydraulic travel cylinder, allowing the motion of the taphole machines towards the taphole	TMT	TMT	TMT	



ITEM	DESIGNATION	QTY	DESCRIPTION	BE	DE	SU	REMARKS
1.2	<u>Taphole drill</u>						
1.2.1	Drill feed	1	Hydraulic motor	TMT	TMT	TMT	
1.2.2	Drill hammer	1	Hydraulic forward hammer with separate hydraulic rotation, including : <ul style="list-style-type: none"> <li>- Flexible hoses with cable track for hammer unit energy feeding</li> </ul>	TMT	TMT	TMT	
1.2.3	Drill bar adapter	1	Adapter for drilling bar connection (drill rod to drill unit)	TMT	TMT	TMT	
1.2.4	Drilling tools	10	Drill bars	TMT	-	TMT	consumables
		20	Drill bits	TMT	-	TMT	consumables
1.2.5	Tool for emergency closing of the taphole	1	Tool allowing to insert a specially shaped refractory plug by the use of the forward movement of the taphole drill carriage  Refractory plug for emergency closing	TMT  C	TMT  C	C  C	To be discussed
1.3	<u>Clay gun</u>						
1.3.1	Shifting cylinder	1	Hydraulic shifting cylinder, allowing the axial downwards movement of the clay gun	TMT	TMT	TMT	



ITEM	DESIGNATION	QTY	DESCRIPTION	BE	DE	SU	REMARKS
1.3.2	Ramming gun	1	Comprising : <ul style="list-style-type: none"> <li>- clay barrel with the intermediate cone and nozzle end</li> <li>- hydraulic ramming cylinder</li> </ul>	TMT	TMT	TMT	TMT will supply loads at connecting points
1.4	<u>Steel structures</u>	1 set	Supporting steel structure to which are attached the overhead rails	TMT	C	C	
1.5	<u>Overhead support rails</u>	1 set	2 reinforced beams with shim plates and fixation bolts	TMT	TMT	TMT	
<b>2.</b>	<b><u>Hydraulic/Pneumatic equipment</u></b>			TMT	TMT	TMT	
2.1	<u>Hydraulic power unit</u>	1	Hydraulic unit, comprising 3 pumps with electric motors, fluid tank made out mild carbon steel, oil conditioning unit with circulation pump, filter, oil/water cooler and accumulator station (nitrogen bladder type 3 x 50 l). The power unit will be supplied in thee parts	TMT	TMT	TMT	
		1	Electric junction box for the hydraulic power unit.	TMT	TMT	TMT	



ITEM	DESIGNATION	QTY	DESCRIPTION	BE	DE	SU	REMARKS
2.2	<u>Valve block unit</u>	1 set	It includes the electrically operated hydraulic control valves for the clay gun and the drill movements.	TMT	TMT	TMT	Mounted on the machine
		1 set	Electrically operated pneumatic control valve for the hammer lubrication and drill bit flushing.	TMT	TMT	TMT	Mounted in cast house
2.3	<u>Hydraulic piping (external)</u>	1 set	Fittings for hydraulic and pneumatic pipes	TMT	C	C	Basic data by TMT
		1 set	Pipes according to DIN standards.	TMT	C	C	
		1 set	Pipe clamps and supports.	--	C	C	
		1	Pickling and flushing.	--	--	C	
2.4	<u>Hydraulic fluid</u>	1	First filling	--	--	C	(dangerous good deliveries)
2.5	<u>Enclosure for hydraulic equipment</u>	1	Dust protection for hydraulic power unit	TMT	C	C	
<b>3.</b>	<b><u>Electrics</u></b>						
3.1	<u>Motors</u>	3	For hydraulic power unit –18.5 kW – 400 VAC/50 Hz	TMT	TMT	TMT	
		1	For circulation circuit – 0.55 kW – 400 VAC/50 Hz	TMT	TMT	TMT	



ITEM	DESIGNATION	QTY	DESCRIPTION	BE	DE	SU	REMARKS	
3.2	<u>Control unit</u>	1	Remotely located control desk for clay gun and taphole drill with the necessary push-buttons, selector switches is foreseen on the tapping platform.	TMT	TMT	TMT		
		1	Protection shield for remotely located control desk	TMT	C	C		
		1	Onboard control panel for the drilling operation (including following functions: hammering, rotation, drill feed, drill bit flushing, carriage travel)	TMT	TMT	TMT		
	<u>Electrical panel</u>	1	Electrical panel including PLC Siemens S7 – all necessary relays – circuit breakers	TMT	TMT	TMT		
3.3	<u>MCC</u>	1	Power feeders for 4 hydraulic pump motors	TMT	C	C		Feeder details by TMT
3.4	<u>Instrumentation</u>	1 set	Pressure switch hydraulic + pneumatic	TMT	TMT	TMT		
		1 set	Level and temperature switch for hydraulic power unit	TMT	TMT	TMT		
		1 set	Limit switches for the suction valves	TMT	TMT	TMT		
		1 set	Encoder for main carriage drive position	TMT	TMT	TMT		
3.5	<u>Warning and safety device</u>	1	One (1) siren and one (1) red flashing light will be installed on the tapping machine	TMT	TMT	TMT		



ITEM	DESIGNATION	QTY	DESCRIPTION	BE	DE	SU	REMARKS
3.6	<u>Power and signal connections to carriage</u>	1	A power track system with necessary flexible hoses and cables feeds and returns pneumatic/hydraulic and electric power to the tapping equipment.	TMT	TMT	TMT	
3.7	<u>Cabling</u>	1	Control cables between PLC panel and hydraulic power unit.	TMT	C	C	
		1	Power cables between existing LV distribution (of customer) and electrical panel resp. hydraulic power pack	--	--	C	
		1	Cable trays and conduits	--	C	C	
		1	Power track cabling	TMT	TMT	TMT	includes 3 m of free length beyond power track
		1	Power and control cables between electrical panels and take-over point on tapping equipment junction box (fix point of main cable track)	TMT	C	C	
<b>4.</b>	<b><u>Services</u></b>						
4.1	<u>Shop tests</u>		Tests as described in paragraph 4.2 are included.	--	--	TMT	
4.2	<u>Erection and Start-up</u>		Erection and start-up as described in paragraph 4.3	--	--	--	
4.3	<u>Supervision for erection start-up</u>		On daily rate basis (see paragraph 4.4).			TMT	



ITEM	DESIGNATION	QTY	DESCRIPTION	BE	DE	SU	REMARKS
4.4	<u>Training</u>		Operational and maintenance/calibration training on site during commissioning on daily rate basis (see paragraph 4.4).			TMT	
5.	<u>Spare parts</u>	1 set	As per table under paragraph 7	--	--	--	To be discussed



#### **4. SPECIFICATION OF SERVICES**

The clay gun and taphole drill are designed and manufactured according to the following standards:

- DIN : Deutsches Institut für Normung
- ISO : International Organisation for Standardisation
- UVV : Unfallverhütungsvorschriften (Safety)
- IEC : International Electro technical Commission
- ISA : Instrument Society of America.

Note: The customer's standards will be considered as far as applicable in case they do not influence function of the equipment

#### **4.1 DOCUMENTS**

Drawings and documents of TMT standard equipment are executed wherever possible to the customer's standard.

Detail drawings for maintenance purposes are part of TMT supply, if the information is not mentioned in the maintenance manual.

Documentation of serial fabricated buy-out items, like motors, pumps, etc. are supplied according to the availability of manufacturer's standards.

Following technical documents will be established:

- a) General
  - Project planning and quality plan, time schedule
  - Layout of the machines in front of the furnace
  - Assembly drawings of the machines
  - Operation, maintenance and erection manual
  - Spare parts list



- b) Electric
- Functional description
  - Electrical specification
  - Motor and component list
  - Single line diagram
  - Wiring terminal diagrams
  - PLC software
  - Documentation of the supply
- c) Piping/Hydraulics
- Hydraulic diagram and pneumatic flow sheet
  - Assembly drawings of hydraulic power pack
  - Equipment list
  - Hydraulic Equipment detailed parameters and name of supplier.
  - Documentation of the supply.

Language: Documentation will be provided in English language. Some drawings for TMT standard components may be trilingual (English / French / German).

## 4.2 SHOP TESTS BEFORE SHIPMENT

The following tests are foreseen:

- Test of the control desk and electrical panel in the electrical subcontractor's workshop.
- Test of the hydraulic power pack in the hydraulic subcontractor's workshop.
- Test of all mechanical functions and movements with nominal working pressure in the mechanical subcontractor's workshop.



#### 4.3 ERECTION

Erection of the equipment and the external piping and cabling will be done by the customer. The customer will provide all materials, tools, rigging and apparatus required for safe off-loading and erection of the equipment.

It is assumed that the customer's personnel will be available for the commissioning phase.

#### 4.4 SUPERVISION OF ERECTION AND COMMISSIONING, TRAINING

TMT estimates 20 man days of site supervision for hot/cold commissioning and training. It is recommended that the customer's personnel are trained during cold commissioning. Training documentation will be delivered by TMT.

#### 4.5 PAINTING

The painting specification is only applicable for mechanical parts. TMT painting shall be applied for steel structure.

High Heat-Resistant Painting up to 450° C

- Base coat: 1 layer of 80 µm  
ZS Zinc Dust Priming, grey moisture curing
- Top coat: 1 layer of 20 µm  
SI aluminium paint, light silver

The total thickness of the layers will be at least 100 µm

Commercial parts will be painted according the manufacturer's standard.



## 5. **EXCLUSIONS OF SUPPLIES AND SERVICES**

Excluded from TMT scope of supply are:

- Modification of existing installations platforms and structures required for the overhead rail fixation, installation of the hydraulic power station, installation of the control desk with cabin and all civil work.
- Clearance of the site if necessary for the erection of the machine
- Supply of compressed air
- Supply of electric power (230 V & 400V)
- All receiving, unloading and storage of equipment on site
- Pickling and flushing of pipes
- Supply of N<sub>2</sub>
- Supply of Oil
- Protection shield for remotely located control desk
- Enclosure for hydraulic power unit
- All not mentioned parts and services
- Erection works
- Spare and wear parts
- Site Services
- External piping and cabling
- Clay mass
- MCC's
- UPS



## 6. TECHNICAL GUARANTEE AND PERFORMANCES

### 6.1 TECHNICAL GUARANTEE

The Supplier guarantees that the equipment supplied will be of adequate design, material and workmanship.

The guarantee is based on a correct operation and maintenance of the equipment in accordance with the supplier's instructions.

Following pre-conditions have to be met:

- Used clay mass has to be fluid under 50 bar clay pressure
- The 4 tapholes have to be on the same elevation (+/- 3 mm)

### 6.2 PERFORMANCES

The equipment will meet the performance characteristics as described in this specification



## 7. RECOMMENDED WEAR AND SPARE PARTS

### Parts for commissioning service

Remark: Lifetime of these parts depends on the number of taps per day and operational parameters.

These parts shall be available at the first day of the commissioning / start-up to ensure a smooth operation. If TMT makes use of part of these items, they will be substituted at completion of the commissioning period.

### Wear parts (WP), spare parts (SP) and two-year spare parts (2Y)

		<u>Quantity</u>
1.1	<u>Clay gun</u>	
	• Ram Piston ring (WP)	1
	• Extension piece for nozzle (WP)	2
	• Intermediate cone (SP)	1
	• Clay barrel (2Y)	1
1.2	<u>Tap hole drill</u>	
	• Drill bar adapter (WP) (if applicable)	2
	• Drill bar centring device (SP)	1
	• Drill boom (2Y)	1
	• Spare drill hammer (2Y)	1
	• Set of spare parts for drill hammer (SP) (seals, bushings)	1 set



1.3 Hydraulic/Pneumatic and electric equipment

- Flexible hoses for hydraulics (SP) 1 set
- Flexible hoses for pneumatics (SP) 1 set
- Hydraulic cylinders (2Y) 1 set
- Set of seals for hydraulic cylinders (SP) 1 set
- Spares for hydraulic valve bank (to be detailed at a later date) (SP) 1 set
- Spares for pneumatic valve bank (to be detailed at a later date) (SP) 1 set
- Electric spares (to be detailed at a later date) (SP) 1 set

1.4 Consumables

TMT offers a complete range of different types of drill bits and drill bars. The size and the quality of the drill bits must be detailed on a later stage, and requests adaptation on each furnace/process Depending on process

- typical • Drill rod D32 x l-2100, both sides R32 left rope thread
- typical • High alloy drill bit A-SX 50 mm type
- typical • High alloy drill bit A-SX 55 mm type
- typical • Tungsten Carbide dill bit HT-S-052 type

**8. DRAWINGS**

Layout Proposal      T1-01040-1013119 1/1 0