Obsah obrázku text

Popis byl vytvořen automaticky8

**ALFAGEN - EQUIPMENT FOR CASTING STRIPS FROM ALUMINIUM AND ITS ALLOYS**

Annex 3 of Tender Documentation – Technical Specification

AL INVEST Břidličná, a.s.

Bruntálská 167

793 51 Břidličná

An open above-threshold public contract for the supply in compliance with S. 56 of Act No. 134/2016 Coll., „Public Procurement Act“, as amended, (hereinafter also as the "**Act**" or "**ZZVZ**"

Procurement procedure

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1. General Information
   1. List of Abbreviations

ALINVEST ALINVEST Břidličná, a.s.

Customer AL INVEST Břidličná, a.s.

AIB AL INVEST Břidličná, a.s.

MCC Motor Control Center

IPPC Integrated Pollution Prevention and Control

EU ETS EU Emissions Trading System

TiB Titanium Boron

CS, CZ Czech language

UST Ultrasonic testing

PLC Programmable Logic Controller

HMI Human-Machine Interface, e.g. a touch screen

PC Personal Computer

Remote IO Remote input/output

MES Manufacturing Execution System

ERP Enterprise Resource Planning

OT Operational Technology

VPN Virtual Private Network

ICMP Internet Control Message Protocol

UAC User Account Control

LOTO Lock-out & Tag-out

MPCB Motor Protection Circuit Breaker

Y/D Y/D Starter

IGBT Insulated Gate Bipolar Transistor

LPBS Local push button stations

CPU Central Processing Unit

SAFETY PLC Safety Programmable Logic Controller

GSM Global System for Mobile Communications

LTE Long-Term Evolution

SSL Secure Sockets Layer

HW Hardware

SW Software

SNMP Simple Network Management Protocol

ICMP Internet Control Message Protocol

UAC User Account Control

SIEM Security Information and Event Management

TEFC Totally Enclosed Fan-Cooled

DCS Distributed Control System

CPU Central Processing Unit

OPC Open Platform Communications

OPC UA Open Platform Communications Unified Architecture

DHCP Dynamic Host Configuration Protocol

TOP Take over point

OEM Original equipment manufacturer

GHG Green house gas

SPI Serial Peripheral Interface (SPI), a common term used in in process control and automation systems.

TRC Twin Roll Cast

* 1. Introduction

The company, ALINVEST Břidličná, a.s. (“ALINVEST”), with its 800 local employees is a leading European producer of packaging materials and rolled semi-finished aluminium products. Its origins date back to the year 1852, when the construction of the flax processing company was launched. ALINVEST is a member of the European Aluminium Foil Association (EAFA), Packaging Institute SYBA, Southern Bohemian Chamber of Commerce and Czech Testing Laboratories Association.

ALINVEST’s state-of-the-art research and development unit and certificates, ISO 9001:2008, ISO/TS 16 949:209, BRC/IOP, AD 2000 WO, and EN 15088, guarantee the quality and reliability of its products. The company also holds various packaging and automotive certificates, which are relevant for the present project.

ALINVEST belongs to the MTX Group a.s.—an industrial-business holding company based in Prague which mainly focuses on management, financing and coordination of manufacturing and trading member companies. In the Central European area, the company has its agencies in the Czech Republic, Germany, Austria and Poland. It primarily trades in metallurgical semi-finished products, production and the sale of fuel coke, aluminium and copper products.

MTX Group a.s. is a joint-stock company incorporated in the register of companies kept by the Municipal Court in Prague, Czech Republic, Section B, File 10649, as of the 31st March 2006. The company has its registered office at Štěpánská 621/34, 110 00 Prague 1.

MTX Group a.s. was founded by Petr Otava Sr. In 2015, he was succeeded by his son, Petr Otava Jr. The MTX Group has expanded remarkably abroad with manufacturing activities that affect a number of industrial branches such as parts for the automotive industry as well as metallurgy and food processing.

* 1. Place of business, Project site

The project will be implemented at Bruntálská 167, 793 51 Břidličná, which is the registered office of ALINVEST. The whole affected area is a property of ALINVEST Břidličná a.s. This will be the site of the project, which consists primarily of the construction of new manufacturing facilities and the installation of new equipment, as well as the site for the project’s coordination and management.

The project is planned to take place in the regions defined by the Czech government resolution No. 321/2021. The city of Břidličná lies in the Moravian-Silesian Region which is treated as an economically problematic region in the resolution. The Moravian-Silesian Region is one of three coal-mining regions in the Czech Republic, as registered in the so-called “EU Coal Platform”.

* 1. Company’s approach to the environment

ALINVEST is committed to assume a part of responsibility for the conservation and protection of the environment within the region. In 2018, a voluntary agreement was signed with the Moravian-Silesian Regional Authority which governs the obligations of individual parties. The obligations deal with the reduction of dust nuisance, compilation of a power management study and a comprehensive power management conception, which would reduce the power demand of production and service operations. The agreement also covers the replacement of diesel forklift trucks with electric ones.

To guarantee the continuous quality of the final products and to achieve a sustainable production growth, the most important strategic investments include not only the technology upgrades but also those of an environmental nature, which address environmental protection and air pollution control. These upgrades will put the company in compliance with the environmental management requirements as per ISO 14000, which will qualify it to acquire this certificate.

Considerable financial resources are expended every year for comprehensive solutions to improve the environment.

ALINVEST Břidličná a.s. is also a member of the EKO-KOM collective compliance system.

The company is a holder of the Integrated Pollution Prevention and Control (IPPC) permit, for which the compliance parameters are always verified on an annual basis.

Machinery used in the manufacturing plant is registered in the EU ETS system. Emission assessment is compiled annually.

* 1. Project purpose and objective

ALINVEST is considering building an Aluminum Production Plant for Continuous Casting Strip-Sheet.

The project concerns the replacement of all existing melting and casting equipment at the Břidličná site. Removal and replacement of the existing assets at Alinvest assumes a significant amount of risk. Risk to the business involves not only the aspect of asset removal and replacement but also involves risk to our loyal customers who have been with us many years and we intend to keep these customers as we adopt the new assets assocaited with this project. The equipment anticipated includes both the melting and the casting furnaces as well as the in-line purification equipment for continuous casting strip-sheet technology.

It should be understood by all parties that today’s sheet producers have limitations which ensure a minimum percent prime metal input as prime is perceived a clean input. Economics and the race for recycling is compressing this minimum over time to a reasonable level in the single digits. Some traditional clean scrap melting equipment may fit well within the scope of the materials processed today and the ALINVEST project team has been actively communicating on this regard with some of the various furnace supply companies. The materiál ALINVEST intends to consume in the years forward are considerably different from the traditional clean manufacturing scrap, which offers no attractive recycle discount when compared to prime remelt ingot.

Sheet products are extremely strong, and the bend sensitivity is determined by coarse intermetallic and internal inclusions as well as rolling surface defects. Some of the coarse intermetallic and internal inclusion sensitivity originates with the incoming scrap; this is normally overcome by traditional settling, degassing and filtration processes and procedures.

In order to meet the customer’s strength expectations, the molten delivered from the furnace must go through a series of purification steps prior to solidification. First, Hydrogen, alkalis and a portion of the coarse inclusions are removed in a first order reactor where argon and sometimes minute amounts of chlorine are distributed via a stirring impeller in a heated box with molten aluminum flowing counterflow the bubbles. Finally, inclusions are separated from the molten stream via a unique tortuous path filter commonly referred to in the industry as a Ceramic Foam Filter (CFF). Our Vision, which is brought to focus in the filter section is an enhanced or high performance CFF, capable of increasing the tortuous path length, or capable of increasing the filtration efficiency via a 70 Pores Per Inch (PPI) device. Immediately after this filtration step, the molten enters the Twin Roll Casting (TRC) machine via the tundish or metal distributor prior to entering the horizontally oriented roll bite.

One of the key products for our customers is the medium Magnesium sheet alloys which are currently produced on the Vertical Direct Chill (VDC) machines and after scalping, rolled on the rolling mill. Our investigations into the progress in producing these products with the TRC route has focused our study to the work in the mid 1980’s at Mohka Japan and SK  
OA Bulgaria where a significant volume of these products were produced. The common thread, associated with these alloys, setting aside the production challenges and metallurgical aspects involves a considerably larger diameter pair of casting rolls at the TRC machine. Our casting trials and investigations have set a firm foundation in our beliefs that we need to focus our new equipment to larger diameter rolls, e.g., 980+ mm diameters and technologies which are friendly to an open tip design. As you review this specification, the molten cleanlyness, the control levels we are asking for with trough metal level and operating temperature tolerances please do not fall into the saddle of what you currently provide or what your customers currently produce but to an elevated level of how you can enable Alinvest for the future. Now, as you understand our vision, you will be able to realize that the normal TRC business goals looking forward are noted, without any tangible experience with TRC casting of the mid Magnesium alloys, we believe that these products can be cast at head box temperatures below 665 °C, at a 5.0 mm gauge at 0.93–0.95 m/min.

After casting, the sheet is coiled onto cylindrical mandrels with the possibility to attach a spool for coiling forming large coils that are cut or separated from the live casting machine into 1000–1350 mm wide coils, which are, subsequentially, cold rolled, annealed and otherwise prepared for shipment.

Please understand parameters indicated as **BOLD** specified within chapter 2.2 and 2.3 as mandatory shall be fullfilled by the Contractor. All other values are to be understand as indicative based on our understanding of the state of the art today, but shall be not mandatory within 10 % indicated value understood as agreed – but in case of deviation higher than 10 % vendor shall communicated to Alinvest the deviation before sending the final bid. Contractor has to transmit within his final offer the technical parameters in **BOLD**. Values, parameters in the remaining chapters (2.3+) shall be understand as mandatory.

Contractor has to ensure full independent casting line = casting equipment from TOP up to coiler including hydraulic, cooling circuits, lubrication circuits, miller swarf suction system, electric, instrumentation and automation design and supply has to be for each casting line fully independent. In case of a single caster stoppage the other operating casting lines have to be not influenced. Means in practical all 4 casting lines have to have the same equipment starting from mechanic, hydraulic, cooling, electric Level 0 equipment (low voltage distribution, sensors, motors etc.), Level 1 equipment (PLC/HMI, network etc.) up to UPS. This base is absolutely mandatory – no common equipment over several lines is allowed.

* 1. Other general requirements
     1. Standards

All equipment supplied, and related work (layout, installation, and operation) shall comply with all CE and EU-local applicable laws and regulations, including, but not limited to, those relating to environment, health and safety of workers.

The CCONTRACTOR shall be ISO 14001, ISO 9001 certified.

All equipment designed for fabrication in the European Union (EU) shall be designed to use commonly available metric standard commodities, e.g. mm thickness steel sheet, plate etc.

Design must comply with standards. Documentation of compliance must be provided to ALINVEST. Any OEM components supplied, which are not a part of the overall assembly, must be CE or UL marked. The following list of directives shall be reviewed for applicability to the equipment being produced. This is not a comprehensive list of all directives; the Contractor is responsible to determine whether appropriate Indian standards exist and seek approval prior to engineering and manufacturing to commence. In the event that the Contractors‘ standards are not present, the following EU directives need to be applied for their products.

* 2001/95/EC – Product Safety Directive
* 2004/108/EC – EMC Directive
* 2006/42/EC – Machinery Directive
* 2006/95/EC – Low Voltage Directive
* 2009/105/EC – Simple Pressure Vessel Directive
* 2009/125/EC – Eco-design requirements for energy related products
* 2037/2000/EC – Ozone depleting substances
* 842/2006/EC – Fluorinated Greenhouse Gases
* Guidelines for Handling Molten Aluminum (Availible Online)
* 94/9/EC – ATEX directive
* 97/23/EC – Pressure Equipment Directive
* 92/58/EEC – Safety and/or Health Signs

The use of parts which are discontinued by manufactures is not allowed. Exceptions must be approved by ALINVEST.

* + 1. Accessibility and replaceability

All working parts must be designed so as to ensure the easiness of maintenance, control, inspection, monitoring, lubrication and replacement during minimum down times, with the highest possible safety and ergonomics.

* + 1. Safety

All the equipment and machines must be designed with and incorporate safety devices wherever there is potential risk for the operators, and with adequate measures for safe access to the staff and the vicinity of the machines for operation and maintenance. These items must not only include the conventional elements of the machinery but also additional covers, guards, barriers, steps, ladders, railings, coupling guards, belt covers, transmission and chain covers, etc. that are necessary for safe and ergonomic operation of the equipment. All the details of the structures that are necessary for correct operation and maintenance must be specified by the Contractor. The Contractor shall specify the safety needs which may produce compulsory blocking between functions and consequences for the operation.

* 1. Scope of the Works – Major projected parts

The purpose of this document is to present an engineering, manufacturing and operation specification for the aluminium and aluminium alloy continuous casting strip-sheet casting line. The defined technical parameters are binding for the deliveries within this public procurement. The submitted bids must meet these technical parameters.

The anticipated project includes the supply of a molten metal purification portion, a aluminium continuous casting strip-sheet casting portion, which includes the supervision, the installation and completion of the testing sections. The delivery includes the following envisaged parts and components:

* Metal distribution system
* Grain refining system
* Degassing
* High performance filter
* Head box
* Tip with accessories
* Casting system (caster stand, roll change equipment, roll spray system)
* Exit equipment (entry assembly, pinch rolls, edge miller, X ray gauge, shear, air knife, breaker, guide table)
* Winder/coiler up to coil weighing scale (coil pick up by overhead crane)
* Cooling water systems (roll cooling, auxiliary cooling)
* Hydraulic system(s)
* Lubrication system(s)
* Electric, instrumentation and automation equipment
* Ethernet communication with the ALINVEST MES system
* Mechanical, electric, instrumentation, automation general standards
* Securing the working sites according to applicable standards
* Compliance with hygienic limits upon occurrence of all hygienic factors which may affect the employees’ health and their risk level for the personal health during particular shift (Act No. 258/2000 Coll., as amended, namely Section 37 on the Protection of Public Health and implementing provisions).
* CE declaration of conformity
* Documents, certificates, labeling of control switches, selectors, tables, tags etc. in Czech

The Customer hereby points out that the present list is not exhaustive and may not necessarily establish a complete scope of the Works for the Contrator.

The major work of scope includes the following: Design, purchase of materials, manufacturing, assembling, inspection, painting, packaging, transportation, erection and commissioning supervision (erection performed by the Customer including interconnecting piping and interconnecting cabling including required erection material – machine attached onboard piping and cabling within Contractors scope), performance tests, performance guarantee, training, and manuals.

The Contractor should carry out this project from design to the performance tests based on this purchase specification. As to possible modifications that may occur in the process of conducting the project, the contractor shall discuss with and get a written approval from customer.

The Contractor is encouraged to suggest, through a technical proposal, more advanced technologies, and design contents than those described in this purchase specification.

* 1. Technical offer contents

The following documents shall be provided with transmittal of the offer:

* Detailed technical description of the entire line (including description of individual sub-devices / equipment),
* Estimated layout indicating the overall arrangement (top and side view) and configuration, including sub-devices.
* Product mix calculation for casting thickness 4,5 and 6 mm need to be filled out and transmitted with the bid as per Annex 13 (file: Annex\_13\_TD\_Product mix calculation\_need to be filled).
* Estimated places with elevated noise level (above acoustic pressure level L82 dB, measured at a height of 1.2 m above the floor or 1.0 meter from the source).
* Estimated consumption at take over point (TOP) of cooling water, process media (compressed air, argon, oxygen ... as required for the scope) and their quality requirements (data shall be understood as basic information – but fitting 90 % to final values confirmed during basic engineering) - minimum content:
  + Temperature (°C): Supply line and delta (between supply - / return line)
  + Pressure (MPa): Supply line and delta (between supply - / return line)
  + Flow rate (m3/h): Constant and peak
  + Quality
  + All other key requirements as per corresponding media
* Estimated HVAC requirements (electric equipment, fans, hydraulic equipment etc.).
* Electrical consumers with installed power [kW] versus real active power [kW] during production as to be transmitted with the technical offer.
* Estimated installed electrical installed power and calculation of electrical energy consumption per metric ton production (kWh/t), for all components consuming more than 3 kWh/t.
* Single line diagram.
* Flow diagrams for each media with TOPs
* Other important information (accessories or production method) not specified above which the Contractor considers to be worth mentioning to the Customer in the technical offer to ensure safe and reliable functioning of the line.
* Filled prefered equipment vendor list.
* OPEX costs per produced MT – split into:  
  - Energy costs  
  - Consumable costs  
  - Maintenance costs
* Capital spares (part of commerical offer)
* Wear parts, consumables required for the first 6 months of production
* Man power requirement per shift.

1. Technical specification
   1. Current state – description

The operator is preparing the charge using the handling devices. The charge consists of three input raw materials: primary pure aluminium, internal aluminium scrap and external aluminium scrap. Using the forklift truck with a charging bucket, the operator drive the charge into the melting furnace (18 t). Two gas burners with adjustable power melt the input material. The melting furnace is connected to the parent control system which controls the movement of the ceramic partition for the correct melt level. With the metal melted, the operator draws the skims off its surface. A liquid metal with a temperature of 720 °C comes off the furnace. The liquid metal is then processed in the refining unit where the melt is being refined (using the injected refining salts). The melting furnace is also filled with alloying elements and pre-alloys (as per the required formula). As soon as the proper chemical composition of the melt is achieved (based on the sample taken), the liquid metal is poured from the melting furnace to the casting furnace. A plugging bar is manually drawn out of the casting furnace. A liquid metal with a temperature of 720 °C comes off the casting furnace. The melt continues through meral distribution system to deggasing unit and filtration unit where it get rid of impurities. After filtration the melt ends in casting line, where coils are produced with thickness of 8,5 mm. The coils are then processed according to the particular customer’s requirements.

The production of coils is currently controlled by the SIEMENS control system. The line is connected to the parent system MES (SYBAS).

* 1. Base requirements

Apart from the delivery of the items specified above, the Contractor is also expected to provide supervision over the entire installation process. The supervisor must be present at the installation site (from 8 am to 6 pm on weekdays and from 8 am to 12 noon on Saturdays). Whenever the supervisor is absent from the installation site, he/she must be available on his/her phone for consultation (24/7). Supervision forms a part of the price quotation, at maximum possible amount. Furthermore, the Contractor is responsible for commissioning the entire working site, so that the whole line is fully functional. The contractor is present during Cold Commissioning, Start-up and Hot Commissioning, Initial Operation Tests and Performance Tests as well.

Take over points, including conversions, will be prepared by the Customer as per the project documents provided by the Contractor. Within the delivery, the Contractor will submit the technical specification for the practical completion of the Works so that the Customer is able to prepare and arrange for the necessary conversions before the delivery itself which would enable the operation and compliance with all the standards applicable to the operation. The technical specification must define all the requirements for the line, such as: take over points, layout, building foundations (loads, pits etc.), climatic conditions and requirements set out by the relevant occupational health and safety standards, so that the line is allowed to be put into operation.

The line must comply with the noise and hygienic limits (with technological load). The limit of the acoustic pressure level LA must not. exceed 82 dB in the place where the operator will move (measured at a height of 1.2 m above the floor).

The line must comply with all statutory requirements and provisions concerning the protection of the environment.

Each line must be fully independent from the other lines = common used equipment over several lines is not allowed (for example: hydraulic power unit, roller cooling circuit, lubrication, UPS, electric/automation system or any similar equipment). Contractor must consider this in his design and scope to ensure any kind of stoppage of a single line not influencing other lines.

* + 1. Introduction of melting process
* It should be understood by all parties that, today’s foil producers have limitations which ensure a minimum percent prime metal input as prime is perceived as a clean input. Economics and the race for recycling will compress this minimum over time to a reasonable level in the single digits. Some traditional clean scrap melting equipment may fit well within the scope of the materials processed today and the Customer’s project team has been active communicating on this regard with some of the various furnace supply companies. The input materials that Customer intends to consume in the years forward are considerably different from the traditional clean manufacturing scrap which offers no attractive recycle discount when compared to prime remelt ingot. We will be most interested in companies who are willing to work with our plan of adding an average of 2-3 % Volatile Organic Contents (VOC), from third party or post consumer sources with what we consider to be clean internal scrap containing less than 1 % VOC, to a charge containing a small amount of prime.
* It is to be understood by all parties that, today’s Twin Roll Cast product producers have limitations which ensure a minimum percent prime metal input as prime is perceived as a clean input. Economics and the race for recycling will compress this minimum over time to a reasonable level in the single digits. We want your assistance, by helping us move our thoughts forward as we purchase furnaces today, anticipating the moderately clean material in the future.
* Strips products are extremely fatigue sensitive to coarse intermetallic and internal inclusions and foil surface defects. The coarse intermetallic and internal inclusion sensitivity originates with the incoming scrap, and this is normally overcome by traditional settling, degassing and filtration processes and procedures at the connected downstream process.
* The focus of this request is to solicit your feedback in an offer format, for a series of melting and holding furnaces for our new facility. The success of our project is based on four key points, for ‘s project team, listed in priority, are as follows:
  + - Minimize the amount of GHG’s which are generated in our process. This is measured by kWh/t of natural gas and electricity consumed during the scrap hearth drying, melting, and holding-casting portions of our process. The total target is 650 kWh/t, over the entire year’s production when considering the three steps we just mentioned.
    - This project’s focus and thus funding is based on substantial reduction in green house gasses, consequentially we have chosen Roof Mounted Electrical Resistance Heaters at the holding furnaces as our heating means. In doing so, insulation at the walls, hearth and roof becomes paramount in that every kW of energy lost thru the walls or structure must be replaced with additional energy to replace the heat which is lost. As a Contrator on this project, we encourage you to choose well respected high alumina materials in contact with the molten aluminium and hyper insulative layers near the steel walls. Eventually, we will be asking for very specific Product Acceptance Tests and Gurantee’s and thus, we ask you to keep this in mind because every kW you keep from escaping to atmosphere will help you meet or exceed our expectations.
    - Minimize the amount of GHG’s carried with the prime and scrap inputs. Scrap inputs vary considerably in the marketplace, most clean materials containing less than 1 % volatiles which is in high demand making the cost of these inputs close to or at par with prime in cost. The direction, on the short term will be to bring in relatively clean materials but with volatiles up to 3 % in total charge and in one charge up to 5-7 % in total, Volatile Organic Contents (VOC)\* which will open the door to consume a greater percentage of third-party manufacturing scrap.
    - To minimize the concentraton of inclusions which are trapped in the liquid after melting, by reducing the moisture and VOC’s which are submerged during melting, including the steps in the melting furnace of Rotary Flux Injection followed by settling prior to transfer to the holding/casting furnace. We estimate that, based on industry experiences the Rotary Flux Injector plus 45 minute settling can reduce the total inclusion content, as measured by PoDFA by 25-30 %, meaning that if our average inclusion count prior to Rotary Flux Injection is 0.4 mm2/kg then at transfer we should experience an inclusion concentration of 0.3 mm2/kg.
    - Minimize the Capital Costs (CAPEX) and Operating Expense (OPEX), which is the normal game however, in this case the importance or priority of this item is less than the first two.
    1. Volatile incineration and scrap melting – Background

The following scrap preperation and melting outline is presented so that you understand exactly how we intend to adopt an increase in scrap consumption at the furnace. After melting, the molten is transferred to a holding furnace for casting. The pouring spout or specifically one meter past the furnace joint will be your take off point. We anticipate with this increase in scrap an increase in the inclusion loading and with this in mind have the melt treatment equipment contained in this Specification.

* ALINVEST believes that an oxygen lance or incinerator engaged during the dry and de-oil or de-coat portions of the cycle will incinerate the volatiles preparing them to be send to the Air Pollution Control (APC) equipment.
* A melt cycle which resembles the following:
* Starting with a “Hot Wall-Roof” i.e. the roof thermocouple indicates a temperature greater than 1100 °C.
* With the door open, charging via a charging machine, (7.0 Tons) (5 minutes)
* Prime set on the sill, via a fork truck, (4 stacks), (2 minutes)
* Closing the door, allowing radiation to dry and de-oil or de-coat lightly painted scrap, (20 minutes)
* Hi Fire, to allow the roof refractory thermocouple to return to the normal operating or hot range (15 minutes).
* With the door open, charging via a charging machine, after advancing the prime, (7.0 more Tons) (10 minutes)
* Closing the door, allowing radiation to dry and de-oil or de-coat lightly painted scrap, (20 minutes)
* Hi Fire, to allow the roof refractory thermocouple to return to the normal operating or hot range (15 minutes).
* With the door open, charging via a charging machine, (7.0 more Tons) (5 minutes)
* Closing the door, allowing radiation to dry and de-oil or de-coat lightly painted scrap, (20 minutes).
* For your information: a 25 ton charge, 50 % of the charge containing 3 % volatiles equales to approximately 350-375 kg VOC per charge.
* Hi Fire, to convert the pre-heated but not totally melted scrap to molten to 750 °C. 5.58 hours (335 minutes) rough calculation, 5.30 hours (318 minutes) with PMS/EMS Stirrer.
* Stirring with the PMS/EMS Stirrer during the last 3 hours of the high fire portion, intermittently with CCW-CW rotation. Periodically the PMS/EMS Stirrer will be shifted to the right and the left 0.4 m each to assist in gathering the dross, which has collected on the molten surface and against the furnace wall.
* Skimming, 1st sample (10 minutes)
* Alloying, “First”, with Rotaty Impeller Melt Processing (45 minutes)
* Quantometer (2nd sample) (15 minutes)
* Alloying, “Final” with PMS/EMS Stirring, (10 minutes)
* Skimming / Settling (45 minutes)
* Transfer to Holding Furnace (15 minutes)
* Roughly a 9,95 hour cycle (597 minutes) without a stirring device,
* Less than 9.67 hour cycle (580 minutes) with stirring.
* The transfer from melter to holder resembling the following:
* With the Electric/Radiant Holding Furnace at 80-85 % tilt, the Natural Gas fired Melting Furnace is pre tilted with a dam in the transfer trough, at the Melting Furnace exit trough, to a level which matches the Holding Furnace metal level in the trough at the exit of the holding furnace.
* After a level equilibrium is met, the dam is released, allowing molten to flow from the melter to the dam at the entrance spout of the Holding/Casting furnace.
* Once the metal levels stabalize at the same level, the entry spout is slowly opened releasing the molten into the holder.
* After another equilibrating moment, the transfer sequence is initiated, using the trough metal level sensor at the exit of the Holding Furnace to control the the Holding Furnace lowering while the Melting Furnace is raised.
* We will be casting, from the same holding furnace while transferring molten from the melting furnace.
  + 1. Basic Technical Parameters
* Line Data
* Product: Twin Roll Cast (TRC) Sheet
* Estimated capacity: **min.** **45 000** tons/year – on total 4 lines \*
* Range of the molten metal process temperatures, at the casting machine:

680–730 °C

* Material: All common aluminium foil alloys, **EN3105/3004, with chemistries up to 3.5 % Magnesium See chapter 2.2.4.**
* Strip Width Untrimmed Maximum **1 450** mm
* Strip Width Trimmed Maximum **1 400** mm
* Strip Width Trimmed Minimum **1 000** mm
* Strip Thickness (Casting):  
  - Maximum: **8.0** mm  
  - Nominal: **6.0** mm  
  - Minimum: **4.0** mm
* Minimum 3000, 5000 and 8000 series alloys: **5.0** mm
* Minimum 1000 series alloys: **4.0** mm
* Alloys with Mg. > 1.5 % **5.0** mm
* Caster Orientation Horizontal OR 15 degree tilt
* Tip Type: Open/Closed
* Edge Dams: Yes
* Gauge Control: **Hydraulic Gauge Control**

(Pressure or position control)

* Coil Outside Diameter Maximum: **2 400** mm
* Coil Inside Diameter: 500 mm (without spool usage)

**600** mm (with spool usage)

* Coil Build-up Ratio: 4.6 : 1
* Coil Weight Maximum: 16 370 kg
* Outboard Bearing: Provided
* \* Expected min. capacity on 4 lines based on 6804 net available productive time on each line (= 365 days – 15 days of year stoppage = 350 available days x 0,9 x 0,9 = 6804 hours) – below table as per Alinvest expectation based on product mix of alloy and width at 6 mm casting thickness with net productive available hours of 6804:



4,5 mm casting thickness:  


Contractor has to fill out product mix calculation table for thickness 6 and 4,5 mm as per Annex 13 (file: Annex\_13\_TD\_Product mix calculation\_need to be filled) = productivity [kg/hr/mm] with related speed [m/min]. Rest of table shall be calculated automatically. Productivity values must be warrantied by the Contractor together with qualities specified in Annex 3.1 (file: Annex\_3.1\_TS\_Guaranteed\_parameters\_ of\_ strips).

* Alinvest currently uses slotted spools (outer diameter 600 mm – see file: Annex\_14\_TD\_Spool drawing). The new casters will need to be able to use the same system. We will need to verify that the Alinvest cold mill has stub mandrels and not keyed mandrels. If stubs are used, the mill will be able to accommodate open eyed as cast rolls which were wound on a continuous caster mandrel. This may limit the amount of payoff tension on the first pass, but we will need to investigate this further.
* Line Speed
* Caster (at full torque): Maximum: 2.9 m/min
* Rewind: Maximum: 3.5 m/min
* Hand of Line
* To be determined, as we are purchasing four (4) machines. We anticipate Two (2) Left Hand (LH) and Two (2) Right Hand (RH).
* Strip Crown 0.5 % to 1.0 % typical, any value between 0.0 % and 1.5 % is obtainable according to the roll crown.
* Loads
* Load Cylinder Diameter: 860 mm
* Preload Force: Maximum: 2042 tonnes
* Caster Housing Post: Housing thickness to be sufficient

to provide adequate support for 2 row bearing chocks or a rocker plate with 4 row bearing chocks and stability to the roll stack for roll change on a tilt caster.

* Post tensile stress: Maximum: 2.0 kg/mm2
* Minimum Post Area (per post) 255, 250 mm2
* Caster Roll Drive
* Motors: **2 x 110** kW
* Roll Torque (Continuous) Each Roll: 461 x 103 Nm
* Roll Torque (Peak) Each Roll: 576 x 103 Nm
* Gear Reducer Efficiency 92 %
* Gearbox Minimum Rated Continuous Torque Capacity (each): 520 x 103 Nm
* Gearbox Minimum Peak Torque (each): 780 x 103 Nm
* Rewind Drive **1 x 11** kW
* Line Tensions (Based on Cross Section Areas as Shown):

|  |  |  |
| --- | --- | --- |
| Equipment / Selection | Tension  (kN) | Stress  (kg / mm2) |
| Casting: 8.0 x 1 450 mm cross section  Caster Nip / Rewind (Maximum) | 128 | **1.18** |

* Roll Schedule for 1450 mm Twin Roll Caster:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Roll Type | DIAMETER | BARREL | MATERIAL THICKNESS | |
| **mm** | **mm** |  | **mm** |
| **Caster** | |  |  |  |
| Shell | **Min. 980 +** | **1600** | Alloy steel | Min. 50 |
| Core | 903 (finally need to fit to selected shell thickness) | 1603 | Alloy steel |  |
| Stainless Steel  overlay | 16 |
| **Guide Out Roll1,2** | | | | |
|  | 230 | 1615 | Stainless steel |  |
| **Primary Pinch Roll** | | | | |
| Upper | 203 | 1725 | Stainless Steel |  |
| Lower | 203 | 1725 | Stainless Steel |  |
| **Secondary Pinch Roll** | | | | |
| Upper | 203 | 1725 | Stainless Steel |  |
| Lower | 203 | 1725 | Stainless Steel |  |
| **Breakover Roll1** | | | | |
|  | 230 | 1725 | Stainless Steel |  |
| **Plunge Roll** | | | | |
|  | 230 | 1725 | Stainless Steel |  |

*1Guide-out, Breakover and Plunge roll bearings and cooling water joints shall be designed to minimize friction.*

*2Guide-out roll only necessary for tilt caster.*

* + 1. Anticipated Chemical Composition

Today‘ alloys:

A table of periodic table

Description automatically generated

Additional future alloys:  


* + 1. Anticipated Utility Consumption 1450 mm Twin Roll Caster

Electrical consumers with installed power [kW] versus real active power [kW] during production as to be transmitted with the technical offer.

* + 1. Line Layout

This is the projected floor plan of the hall section, indicating the area intended for the process.

**Line Layout**

Bidder shall specify within the bid required space from furnace TOP up to coil pick up.

Obsah obrázku diagram, text, snímek obrazovky, Plán

Popis byl vytvořen automaticky

* 1. TWIN ROLL CAST EQUIPMENT
     1. Metal distribution system
* Intent
* The Metal Distribution System is key to a well managed and operated recycle and remelt facility. Only the highest quality (High Silica and moderate Alumina) pre-fired materials shall be used while maintaining a healthy balance with thermal conductivity as material choices will earmark the type of inclusions generated in the metal distribution system and thermal losses in the system.

We prefer hot air high velocity trough pre-heating for our system as the typical heated trough cover systems are an extra maintenance item, and the energy consumed during heating distracts us from our goal of reduced electrical needs. We prefer smaller CX troughs, with hot air blowing as a pre-heat system when needed.

* Description
* The launder system shall join the furnace launder system (approximately 1 m from holding furnace – exact location to be defined during engineering phase) to the degassing unit and then to the dual bowl ceramic foam filter unit and from the filter unit to the headbox launder.
* Qty n – Straight Sections
* Qty n – Corner (90 degree) Sections (where applicable)
* Qty n – Transitions (angled sections)
* Qty n – Heavy Duty Stands (Under Corners and Transitions)
* Qty n – Conventional Stands (Under Straight Sections)

n: to be specified with final layout configuration during engineering phase.

* Design
* The launder system shall be non-wetting, abrasion resistant precast and fully cured refractory liner with minimum of 75 mm micro porous insulation between the working liner and the outer steel shell and covers. Launder system shall be supported by a steel shell mounted on steel stands resting on the Customer-supplied, level concrete floor. Cross section of the launder shall be designed for optimal thermal efficiency while maintaining sufficient metal velocity to prevent fading of the grain refiner.
* Equipment
* (1) Length of approximately 4 m \* to join the furnace launder system to the entry of the degassing unit.
* (1) Length of approximately 3 m \* to join the degassing unit to the entry of the dual bowl ceramic foam filter unit.
* (1) Length of approximately 1.0 m \* to join the dual-bowl ceramic foam filter unit to the headbox launder.
* (2) Laser level sensors, one before filtration system, and one after, to monitor head level across filter.
* Laser sensors shall be coordinated with the furnace Contractor so that like devices are selected and utilized.

\* Lengths shall be adjusted to match furnace, layout and building constraints.

* Reference Drawings, Standards & SPI’s
* The following is a list of Drawings, Standards and SPI’s having pertinent information and details for this portion of the project. The latest editions of specific codes and standards shall apply.
* Burner and Flames EN 746, EN 1539 (available online).
* Guidelines for Handling Molten Metal (available online and see Annex\_10\_TD\_Guidelines\_for\_handling\_molten\_aluminium).
* Design Requirements
* Flow Requirements:
* Metal Flow velocity in launder between holding furnaces and casting unit shall be greater than 6 but less than 9.8 m/min maximum at steady state flow conditions.
* Nominal metal level in trough shall be 50 mm from top of refractory between the holding furnace and the casting unit. Nominal metal level shall be 200 mm at casting unit.
* Cross section of the refractory shall be designed for easy cleaning.
* Minimum corner radius (in center line) of any refractory section shall be 300 mm.
* Modules From Furnace to Casting Unit
* Trough system shall be designed in modules. Module lengths shall be a maximum of 2 meters.
* Each module shall be designed to maintain a 3-dimensional compressive force on the refractory lining.
* Each module shall have integrated covers or covers that can be removed and stored on the module.
* Trough Sections shall be easily removable from overall assembly for maintenance.
* Transition Sections shall be minimal in length to prevent heat loss.
* Covers are not required on transition sections.
* Refractory joints between trough modules and between modules and transition sections shall be under compression.
* The Contractor is to minimize the use of silica fiber blanket materials in the metal distribution system.
* Any change of trough profile shall use an angle of no more than 30 degrees.
* Joints between refractory shall use 9.5 to 12.5 mm Inconel woven rope for sealing.
* The troughing system Take Off Point (TOP) shall be within one meter length of the furnace knuckle or joint. The system shall interface with the degasser and the filter prior to connecting to the casting system.
* The system shall include min. 4 pneumatic or hydraulic metal control dams at the following locations:
* Exit of the furnace joint shall be within 2 meters of the joint.
* Entrance to the CFF
* Exit of the CFF to allow a bleed for initial temperature normalization.
* Entrance to the tip from the head box.
* Trough Invert Slope Angle (mm/m) of trough between respective equipment:
* Furnace to degasser: + **2** mm/meter
* Degasser to filter entry: + **2** mm/meter
* Filter exit to head box: - **1.0** mm/meter
* Metal shall flow back to furnace from the filter entry trough invert in the event of a controlled end of cast.
* Total trough volume shall be presented with the offer to enable ALINVEST to interface with the furnace suppler to manage the metal flow in the event of an upset condition.
* The Contractor shall provide Hot Air Blower (Pre Heat) for Straight modules and Joining Points: Hot air blowers heat difficult areas in the metal distribution system without exposing the refractory to a direct flame.
* The Contractor shall provide Metal Level Sensors: Steady State metal level sensors are highly accurate and generate a reliable signal, which is needed to control the furnace and the processing and metal treatment equipment.
* One sensor at the exit of the furnace before the degasser (May be by furnace contractor)
* One sensor at the entrance of the CFF
* One sensor at the exit of the CFF
* Low/High Level Sensors at the furnace: This special type of probe sensor, offers redundancy at the start of the cast to ensure enough metal static pressure is available to properly fill the trough to the CFF.
* Low/High Level Sensor at the CFF exit Invert Trough Dam: This special type of probe sensor, offers redundancy at the start of the cast to ensure enough metal static pressure is available to properly fill the head box.
* Temperature Sensors: Steady State temperature sensors are highly accurate and generate a reliable signal which is needed to control the furnace and the processing and metal treatment equipment. The Contractor shall install at least 3 temperature sensors as follows:
* One at furnace TOP
* One after degasser
* One at head box
* For each section type minimum 2 operational spares (common for all 4 lines together) shall be delivered by the Contractor within base scope.
* Refractory
* Refractory shall be chosen for low thermal conductivity, durability, and non-wetting characteristics.
* Refractory shall be pre-cast standard shapes.
* Refractory materials shall contain Al2O3 greater than 30 % with SiO2 greater than 65 %.
* Refractory material shall have an as fired Thermal Conductivity, less than **1.6 W/M K.**
* Refractory material shall be pre-fired at a temperature greater than 650 °C.
* Refractory material shall have a Modulus of Rupture (MOR) value greater than **3 100 kPa**.
* Trough outside shell temperature shall not exceed 150 °C with a 45 °C ambient temperature.
* Trough Stands:
* Trough Stands shall be designed to support trough modules during use and any maintenance activities.
* Trough stands shall have provisions for fixing to concrete.
* Trough stands shall be strategically placed in overall assembly for support. Each trough module does not require 2 stands.
* Maximum distance between stands shall be 2 m.
* Coating
* Trough steelwork shall be coated with high-heat powder coat or equivalent. Stainless steel components need not be coated.
* System Performance and Acceptance Specifications  
  The Contractor shall guarantee the performance of the system. Acceptance by ALINVEST shall be based on tests upon completion of the commissioning of the system.
* General standards:
* The system shall be leak free at all joints based on proper maintenance.
* Trough outside shell temperature shall not exceed 150 °C with a 45 °C ambient temperature. Temperature shall be taken at the end of the cast, just prior to end of cast sequence.
* Freeboard measurements shall be taken after standard casting practice is adopted. Freeboard in all areas of the trough shall not be less then 50 mm.
* Melt differential temperature measured at furnace TOP and at head box shall not exceed > 20 °C. Range of 12–15 °C shall be understood as normal condition.
  + 1. Grain refining system
* Intent
* This specification shall define the minimum requirements for design, fabrication and supply of One (1) (1 x 2) Rod Feeder Systems.
* Description of System
* Rod feeder system shall consist of:
* Qty 2 – Dual Variable Speed Rod Feeders
* Qty 1 – Rod Feed Drive Stands
* Qty 2 – De-Coiling Spools
* Qty 1 – Coil Racks
* The grain refiner or alloying rod shall be placed onto the de-Coiling Spool via crane or lift truck with the rotary axis of the reel in the vertical orientation. The de-Coiling Spool with the rod coil shall then be positioned onto a coil rack with the rotary axis in either the vertical or horizontal orientation via crane or lift truck. The feeders shall be mounted as close as feasible to the metal delivery troughs to minimize the length and friction of the downstream guide tube. The de-coiling spool shall be positioned to minimize length of pull between it and the feeder, while allowing suitable access to load and unload the reel.
* The feeders shall receive a proportional command signal for speed control as well as digital pulse command to start and stop the feeder. These signals shall come from the casting system automation PLC.
* Supports and rod guides to be designed and supplied by others; vendor shall provide mounting patterns and loading diagrams.
* General
* Possible Alloys:
* TiBOR = 3/1; 5/1; or 5/0.2 percentage Ti/B
* TiCAR = 3/0.15 percentage Ti/C
* 3/8” (0.375” or 9 mm) dia. rod material to be fed – aluminum-based alloys (adjustment for drive force on rod required).
* Dual Variable Speed Rod Feeder
* Rod Feed Speed range required = 15 - 300 cm/minute, +/- 1 cm/min precision over complete range.
* Electrical/Controls:
* Digital input: start command
* Digital output: drive fault/status
* Analog input: command (speed) à 4-20 mA
* Analog output: rod speed feedback à 4-20 mA Drive Feed Roller shall not be used.

OR (preferred):

* Bus communication with respective drive with full data exchange to PLC.
* Feeder drives capable of pulling rod from the reel up to 6 meters away and pushing the rod through a 1” stainless steel pipe 5 meters long with one (1) 45-degree x minimum 300 mm radius bend and one (1) 90-degree x minimum 300 mm radius bend.
* Adjustable feed force.
* Interconnecting Electrical Cabling for Power and Control between variable speed drive and drive motor (30 meters maximum distance).
* Connection plugs for all supplied devices.
* De-coiling Spools
* Reel with low friction bearings for holding and dispensing up to 450 kg coil of 9 mm rod.
* Bearing friction not to exceed 1 kg at coil O.D. throughout life of the coil.
  + 1. Degassing
* Intent
* The degassing process is designed and operated to separate soluble Hydrogen from the melt and then encourage those separated Hydrogen bubbles to raise to atmosphere, at the oxide layer, contained in the degasser. While Hydrogen is separating, Alkali Elements, (Li, Na and to some extent Ca) are also removed from the molten stream.
* Raising bubbles, collect or scavenge additional inclusions on the surface of the bubbles and provide a minor, but important, role in further inclusion removal of our entire process.
* Description of System
* The proposed system shall consist of:
* Qty One (1) – Aluminum Degassing Systems
* Degasser shall consist of, but is not limited to, the following components:
* Fume Exhaust system (to be connected to furnace stack) including blower and a nominal length of duct of 8 m.
* Duct Velocity shall be not less than **21 m/min**.
* Gas panel & associated controls for mixing argon / chlorine
* PLC & associated I/O connections – preferred bus communication in case usage of drive (regulation of rotor speed) with full data exchange to PLC.
* Panel to house HMI and required field wiring.
* Rotor Maintenance Stand
* Operator Maintenance and operation platform, giving access to the degasser and the cover
* Reference Drawings, Standards & SPI’s
* The following is a list of Drawings, Standards and SPI’s having pertinent information and details for this portion of the project. The latest editions of specific codes and standards shall apply.
* Burner and Flames EN 746, EN 1539 (available online).
* Noise DIN 45635 (85 db) and DIN 45641 (8 hr 82 db) (available online).
* Effluents TA Luft 2002 (available online and see Annex\_12\_TD\_TA Luft).
* ALINVEST Powder and Dust Explosion Hazard Specification (see Annex\_11\_TD\_ALINVEST\_Combustible\_ Dust\_ Standard).
* Guidelines for Handling Molten Metal (available online and see Annex\_10\_TD\_Guidelines\_for\_handling\_molten\_aluminium).
* Design Requirements
* Metal flow rate range for degassing varies per cast line. The degasser shall be sized accordingly.
* Peak Transient Metal Flow Rate (Start of the cast, during trough and filter filling) 2 200 kg/hr.
* Process temperatures: between 600 °C minimum – 720 °C maximum, depending on alloy family processed (+ 30 °C above liquidus).
* Process gases available at site: argon, chlorine, nitrogen, and compressed air.
* Degasser must be capable of shutting off chlorine and argon to a broken rotor.
* Fume Exhaust System – Fans
* Exhaust fans shall be direct drive. Fan blades shall be single stage. Fan housings shall be split for wheel removal and shall have a drain connection (plugged) as well as an approx. 200 mm x 200 mm removable panel to allow access for blade cleaning and fan balancing, suitable shaft seals and approved guards. The fans shall be mounted on a vibration eliminator base.
* The fan speeds shall be limited to 1 500 RPM (50 Hz) maximum.
* Fans shall be sized to permit increases in pressure and capacity, which may be required to balance system operation at start-up.
* System should withstand HCl and Cl2
* Gas Consumption & Environmental
* The system shall comply with current ISO 14000 requirements, while operating with Stochiometric input of Chlorine for alkali metal removal, as follows:
* 0.003 to 0.020 kg of HCL per ton of Al processed.
* Maximum of 0.004 kg dust (particles emissions) per ton of Al processed.
* Specific Argon input shall be 0.3 – 0.4 liters per kg of aluminum treated.  
  The Contractor can provide an option for utilization of Salt vs. Chlorine if documentation can be provided of previous trials and results with regards to qty and type of salt used.
* At chlorine input above .25 %, the chlorine shall be distributed equally across all rotors except the last (downstream) rotor which maintains 0.25 % Cl2 or optionally no chlorine.
* If chlorine is used, a suitable external storage containment building shall be provided with an appropriate gas scrubber to process any inadvertent chlorine leaks during cylinder change out and operation.
* Chlorine in use shall be located on a scale or series of load cells to help alarm and notify the operator if a leak is detected.
* Temperature Control
* System shall have the ability to raise the static metal temperature at a rate of **20 °C/hr**.
* System shall be able to maintain metal temperature with ± **3 °C**.
* Draining
* Alloy changes will be frequent, potentially one per day. An economical solution shall be presented to completely drain metal to a drain pan located near unit. Minimal foundation work shall be required. Degasser must be capable of draining the metal after each cast.
* Lids
* There shall be a sealed reactor area within the degassing trough under operating conditions. Oxygen (O2) level, within the enclosed rotor/reactor area of the degasser, when operating, shall be less than 0.2%. A flooding/diluting cover gas shall not be used to obtain the requirements.
* The lids shall have the ability to be automatically removed from the system. Quotations shall be submitted listing two options (when applicable).
* Lid movement shall be directly above the unit for cleaning.
* Lid movement shall be up and then rotating away from the unit for cleaning and maintenance.
* There must be a safety lock to protect the operator from the Lid.
* Gas Mixing Panel
* Panel must have the ability to be ventilated to location away from work environment.
* Cl2 leak detection system.
* Argon purge system.
* Gas Mass Flow Controllers
* Glass mass flow controller.
* Chlorine Sensors
* If the Contractor proposes a mixed Chlorine sensor, this may be done only after approval by ALINVEST.
* System Performance and Acceptance Specifications.

The Contractor shall guarantee the performance of the system. Acceptance by ALINVEST shall be based on tests upon completion of the commissioning of the system. The following performance guarantee conditions shall be met for ALINVEST to accept the system:

* Metallurgical Performance and Acceptance Specifications.
* Efficiency of Hydrogen removal shall be minimum of **75 %.** The unit shall have the ability to obtain a hydrogen level of **0.13 cc Hydrogen/100 g A**L for alloy contain less or equal 1 % Mg.
* Unit shall demonstrate an inclusion removal rate of **30 - 35 %** based on Alcan PoDFA measurements of the incoming and outgoing metal stream at steady state flow.
* Unit shall demonstrate removal of **50 – 70 %** of Na & Ca at stoichiometric chlorine input based on OES measurements of incoming vs. outgoing metal stream at steady state flow. Li removal to be determined & agreed to by Contractor and customer.
* Similar requirements for Na & Ca are required if Salt is utilized instead of Chlorine.
  + 1. High Performance Filter
* Intent
* The filter shall be designed to remove non-metallic inclusions. Our goal or vision with this device is to demonstrate an inclusion reduction, furnace spout to filter exit of:
* **98 % reduction in 20 m** inclusions AND
* **85 % reduction in 10 m** inclusions with (based on **15”** CFF)
* It shall be understood that we intend to produce extremely high-quality finished products with chemically compatible recycle inputs.
* It shall be understood that this unit is envisioned as filter modules with a straight thru trough dividing two (2) adjacent filter bowls, known as either the right or the left-hand bowls. See Figure 2.



**Figure #2. Straight Thru High Performance Filter**

* The straight thru trough, has adjoining entry molten metal passageways, connecting the trough to either the right or the left-hand bowl. Each entry passageway underpours molten into the respective filter bowl. Each right- and left-hand bowl shall be equipped with a filter tile, which is intended to collect inclusions as molten metal passes from the positive pressure or over the filter side to the negative pressure or under the filter side. Molten flows after the filter tile into a collecting basin, which flows past the trough invert to fill the trough, underpouring molten back into the trough, which communicates with the headbox launder and eventually, a headbox assembly.
* Description of the System
* This specification establishes minimum requirements for a High-Performance (HP) Ceramic Foam Filter (CFF) filtration system for molten aluminum. The filtration system’s hall mark capability being an ability to prime reticulated ceramic foam materials more than 70 pores per inch (ppi), consisting of, but is not limited to, the following principal components:
* Steel structure for casting-remelt floor mounting.
* All insulation and refractory.
* Automatic dams with manual override possibility.
* Metal level lasers monitoring both entrance and exit metal levels (as an option).
* Priming means (Electromagnetic, Permanent Magnet, Vacuum, Vibration, or even a Hydrostatic means).
* Insulating covers and lifting devices/hinges as necessary.
* Natural Gas/Hydrogen Hot Air heating system with complete combustion controls to preheat the filter bowl and filter tile. Likewise, the positive side of the filter shall be equipped with two (2) immersion heaters to help maintanin the incoming molten temperature.
* It is perceived that this filter unit shall be serviceable at mid height on a person, so steps, handrails and operating platforms shall not be needed. However, if you believe these may improve the serviceability or operability of the filter unit, these shall be discussed, and the design shall be supplied in accordance with industry and local standards.
* Sketches or drawings: alternate purchase points on all necessary drain pans, lifting hooks, scrap pans. Information shall include all necessary capacity/design of drain pans and scrap pans.
* Reference Drawings, Standards & SPI’s
* The following is a list of Drawings, Standards and SP’s having pertinent information and details for this portion of the project. The latest editions of specific codes and standards shall apply.
* Burner and Flames EN 746, EN 1539 (available online).
* Noise DIN 45635 (85 db) and DIN 45641 (8 hr 82 db) (available online).
* Effluents TA Luft 2002 (available online and see Annex\_12\_TD\_TA Luft).
* Guidelines for Handling Molten Metal (available online and see Annex\_10\_TD\_Guidelines\_for\_handling\_molten\_aluminium).
* Design and Construction
* General
* The CFF inlet/outlet and elevation shall be designed to gravity feed metal from the filter at the end of the cast to the furnace while feeding the metal after the filter into the tap hole drain (plug and cone) at the collection basin, to a covered low profile sow mold.
* Quick disconnects shall be provided for all power/control/fuel supplies.
* CFF system shall be capable of utilizing up to a 70 PPI filter media.
* Contractor must provide the approximate metal level priming mechanism with an appropriate margin of safety for trough design.
* CFF system shall be designed to utilize one filter in each of two (2) adjacent filter bowls.
* The filter tile shall be sized to 381 mm (15 inch) filter tiles.
* Bins shall be large enough to contain at least 4 unbroken filters.
* Gas: Hot air burner heating system shall include separate burners and separate control thermocouples for each filter bowl.
* Optional Automatic dam shall be located prior to the two-filter bowls for control of initial metal flow onto the filter to ensure that it is primed completely.
* If used, the automatic dam shall be primarily automatic from the casting PLC, with automatic opening when metal level is sensed at the dam and at an elevation dictated by the Contractor.
* Provision shall be made for manual override by an operator. The manual actuator for this dam shall be easily accessible by the operator without standing on top of the CFF. It shall be physically different from any other actuator on the CFF, clearly marked and guarded to prevent inadvertent actuation.
* Heat shields shall be supplied as necessary to maintain surface temperature below 35 °C at any location an operator must contact to operate the ceramic foam filter (kneeling or leaning points required replace filters, raise lids, etc.).
* At the end of the cast, the CFF system shall be capable of purging a portion of the liquid metal remaining in the CFF into the bowl as the liquid drains into the sow.
* Refractory
* Trough and filter bowl refractory material: Metal contact refractory shall rate 1 or 2 in CIREP immersion tests. Phosphate bonded materials can be used, subject to approval, but are discouraged.
* The system shall be designed such that the filter bowls and inlet/outlet sections are identical to each other, a right-hand bowl and a left-hand bowl.
* The CFF refractory shall be heated and capable of maintaining metal temperature of 730 °C at zero flow with a trough level equivalent to that of steady state casting.
* Direct heating of metal in the refractory is not acceptable.
* Cold face steel temperatures shall not exceed 150 °C with a 45 °C ambient temperature at steady state molten metal flow.
* The working lining of the trough or filter bowl shall be designed for ease of replacement. The expected operating life of the lining shall be 2 calendar years minimum; but changed as the maintenance cycle allows and as operator damage scores the hot face of the bowl, this shall be incorporated into the design criteria of the CFF. Utilization of silicon carbide is acceptable and preferred only for the filter seat.
* Non soluble RCF shall not be any part of the CFF system lining or backup insulation.
* Corners exposed to molten metal and atmosphere shall be fully radiused to eliminate vortex shedding at the exit of the filter and preferably at the entrance to minimize transient oxide introduction to the melt stream.
* The system shall be designed such that refractory lining is continuously subject to 3 axis compressive force wherever possible.
* The steel cover structure shall be designed for ease of installation with common hand tools and the jib crane. It shall include covers or shields where necessary to minimize pockets where dust and debris can accumulate.
* Lids shall be provided to cover bowl and inlet/outlet trough such that metal temperature loss and operator exposure to heat from molten metal are minimized. Lids over 20 kg must have powered lift mechanism. Lift mechanism must always orient hot side of lid away from operator.
* Controls requirements
* The Contractor shall provide a complete combustion control system for the CFF burners. Controlling unit shall be capable of interfacing with caster control system for I/O status and interface (Temperature, fault, e-stop, sequence start, stop, etc.). The controlling unit shall be capable of accepting a temperature set point from caster control system. It is requested that all control components shall be provided into one control cabinet.
* Preferred bus communication to PLC for full data exchange.
* All required safety features and devices shall be provided with the combustion control system.
* Control for all drain plugs and machine-assisted cover opening shall be through manual values. The manual value for drains and covers shall be physically different and clearly marked to prevent inadvertent actuation by an operator.
* Pre-Assembly, Shop Testing and Inspection
* General
* The Contractor shall guarantee the performance of the system. Acceptance by ALINVEST shall be based on tests upon completion of the commissioning of the system. The following performance guarantee conditions shall be met for ALINVEST to accept the system:
* Unit(s) shall be capable of filtering molten aluminum within the stated metal flow ranges and casting duration times, utilizing 70 PPI filters with molten metal head differential but not exceeding **25 mm**. Failure to maintain this head differential as a result of the pre-heat or priming mechanism in any one of five (5) consecutive casts during the first three (3) days of commissioning shall result in a re-start of the system acceptance scheme. Failure to meet this will trigger a reset of this acceptance scheme and the Contractor commissioning costs shall not be billed to ALINVEST.
* Unit shall demonstrate temperature control
* Controlled heat up rate with a temperature difference of not greater than 25 °C between any two points of the metal side of the CFF bowl as measured with an IR thermometer.
* Heat up rate shall be less than 60 minutes.
* Controlled heat up shall maintain temperature set point of +/- 15 °C measured at the control thermocouple up to a set point of 750 °C when CFF is empty.
* Controlled heat up shall deliver a pre-heated CFF tile greater than 700 °C but less than 800 °C.
* When measured by PoDFA, unit shall demonstrate:
* **98 %** or better inclusion removal, on **85 %** of the samples taken during steady state casting measurements of the incoming and outgoing metal stream.
* During steady state casting, a post filter metal level oscillation not more than 5 mm over a 5-minute period. Incoming metal level variances from the tilting furnace hydraulics shall be removed / filtered.
* An average PoDFA post filter during steady state casting to the casting center with a PoDFA count of less than **0.002 mm2/kg**—Titanium Borides excluded. This means that given the data on the table from the various incumbents, we need to:
* Use oversized filter tiles which lower the Superficial Velocity to capture a greater percentage of inclusions less than 10 microns.
* **The partner in this project shall present their proposal with a common aim in this endeavor, facing forward in contrast to a proposal from the rear view of what has been supplied in the past. Doing so, releases us from the capabilities of the customary supply, "That which has been used in the past" to “What we want to deliver in the future”.**
  + 1. Headbox Launder
* Intent
* The headbox launder shall connect the stationary launder exiting the filter bowl to the caster. This special launder is typically extremely light weight, which aids in removal and replacement between casts.
* Reference Drawings, Standards & SPI’s
* The following is a list of Drawings, Standards and SP’s having pertinent information and details for this portion of the project. The latest editions of specific codes and standards shall apply.
* Burner and Flames EN 746, EN 1539 (available online).
* Noise DIN 45635 (85 db) and DIN 45641 (8 hr 82 db) (available online).
* Effluents TA Luft 2002 (available online and see Annex\_12\_TD\_TA Luft).
* Guidelines for Handling Molten Metal (available online and see Annex\_10\_TD\_Guidelines\_for\_handling\_molten\_aluminium).
* Design and Construction
* General
* A lightweight sheet steel brace shall support a replaceable vacuum formed, single piece launder. The formed trough launder has pre-formed slots for positive locating any sock filters, which may be used, and an overflow notch that shall allow easy, remote-automated overflow protection.
  + 1. Headbox Assembly
* Intent
* The headbox assembly is the final preparatory step which the molten metal passes prior to entering the caster tip. For the caster tip to properly regulate and distribute evenly over the entire width of the tip, the molten metal must be at the target temperature and metal level, within very specific molten metal level targets.
* Three (3) head boxes shall be delivered = One (1) as online installed + Two (2) as operation spare per line shall be delivered.
* Reference Drawings, Standards & SPI’s (Filter Specific).
* The following is a list of Drawings, Standards and SP’s having pertinent information and details for this portion of the project. The latest editions of specific codes and standards shall apply.
* Burner and Flames EN 746, EN 1539 (available online), if a pre-heating flame is used.
* Noise DIN 45635 (85 db) and DIN 45641 (8 hr 82 db) (available online).
* Effluents TA Luft 2002 (available online and see Annex\_12\_TD\_TA Luft).
* Guidelines for Handling Molten Metal (available online and see Annex\_10\_TD\_Guidelines\_for\_handling\_molten\_aluminium).
* Design and Construction
* Components typically shall be employed, without limitation include:
* Metal frame for housing the headbox and locating the molten metal control monitoring and control pieces.
* One (1) frame or fixture for supporting the metal level sensor, control and thermocouple.
* One (1) vacuum formed ceramic headbox chamber.
* One (1) support for a non-wetting and coated thermocouple.
* One (1) spare holder for an extra thermocouple
* One (1) “steady eddy” float-type level control device with float and lever actuated metering plug.
* One (1) laser level measurement sensor for mounting on the frame or support mentioned above.
* Run-off gate assembly
* Headbox drain stopper rod and drain trough assembly.
* One (1) feed tube.
  + 1. Ceramic Fiber Tip Assembly
* Intent
* The Tip assembly shall be a disposable ceramic fiber planar nozzle which introduces the molten aluminum between the rolls of the casting machine.
* Reference Drawings, Standards & SPI’s
* The following is a list of Drawings, Standards and SP’s having pertinent information and details for this portion of the project. The latest editions of specific codes and standards shall apply.
* Burner and Flames EN 746, EN 1539 (available online), if a pre-heating flame is used.
* Guidelines for Handling Molten Metal (available online and see Annex\_10\_TD\_Guidelines\_for\_handling\_molten\_aluminium).
* Design and Construction
* The nozzle, though slightly different from Contractor to Contractor shall be constructed from top and bottom molded ceramic fiber plates separated by spacers. The top and bottom molded ceramic fiber plates shall be clamped together in compression by the tip holder.
* The edges of the tip shall be sealed by end dams that shall be clamped against the end of the ceramic fiber tip plates with jack screws, which shall be mounted in the end of the tip holder.
* The spacing between these dams shall determine the width of the as cast strip.
* The tip shall be joined to the headbox by a rectangular refractory feed tube, which shall be clamped against the back of the tip by the headbox to form a rigid, leak proof assembly.
* The heater shall be used, for prolonged caster tip downtime if the tip is removed from the pre-heater oven.
* The heater incorporates a blower and electric heating element, which shall be electronically set to regulate the discharge temperature.
* Maximum Heating Power: 11 kW
* Maximum Air Volume: 33 m3/hr
* Maximum Discharge Temperature: 630 °C
* Maximum heat up time: 35 min.
* Minimum lifetime of tip in continuous casting operation is expected by **14 days** = must be warrantied by the Contractor.
  + 1. Adjustable Tip Table
* Intent
* The Tip Table is a fabricated steel carriage, mounted on a machined steel slide assembly. The table is located by a hydraulic cylinder operating against AC inverter motor driven jacks, which provide fine individual horizontal adjustment of each side of the tip as needed during installation and operation. The hydraulic cylinder also allows for rapid retraction of the tip table for quick removal and replacement of the tip base complete with the headbox and tip assembly. The cylinder stroke is sufficient to allow overhead crane loading of the tip without crane chain/cable interference with the caster housing spreader. Quick release clamps shall lock the tip base to the table. The slide assembly is mounted to the caster frame by geared AC servomotor positioned gibs which provide vertical tip adjustment.
* Reference Drawings, Standards & SPI’s
* The following is a list of Drawings, Standards and SP’s having pertinent information and details for this portion of the project. The latest editions of specific codes and standards shall apply.
* Burner and Flames EN 746, EN 1539 (available online), if a pre-heating flame is used.
* Guidelines for Handling Molten Metal (available online and see Annex\_10\_TD\_Guidelines\_for\_handling\_molten\_aluminium).
* Design and Construction
* Horizontal and vertical adjustment and positioning is achieved by AC servomotors.
* Horizontal speed by AC inverter controlled electrical motors maximum speed 30 mm/min.
* Vertical speed by AC inverter controlled electrical motors Maximum Speed 58 mm/minThe nozzle, though slightly different from Contractor to Contractor shall be constructed from top and bottom molded ceramic fiber plates separated by spacers. The top and bottom molded ceramic fiber plates shall be clamped together in compression by the tip holder.
* Position accuracy: **+/- 0.005 mm**
  + 1. Quick change stationary Tip Table with Tip Support and pre-heating system
* Intent
* The head box including tip is pre-assembled within the offline tip workshop. In case of necessary change of the tip (after stop casting), the head box including tip is removed, transported to the workshop via overhead crane.
* Exchange of head box including tip must be performed in less than 20 minutes = from start of removal „old“ head box up to finishing placing / aligining of „new“ head box.
* The Stationary Tip Table is a fabricated steel carriage, typically used in the mold/tip shop to provide a stable workplace for final assembly, pre-heating and mounted on a machined steel slide assembly.
* This Tip Table is configured with two connectors, which are connected to the customer’s stand-alone heating system with control and thermocouple.
* Reference Drawings, Standards & SPI’s
* The following is a list of Drawings, Standards and SP’s having pertinent information and details for this portion of the project. The latest editions of specific codes and standards shall apply.
* Burner and Flames EN 746, EN 1539 (available online), if a pre-heating flame is used.
* Guidelines for Handling Molten Metal (available online and see Annex\_10\_TD\_Guidelines\_for\_handling\_molten\_aluminium).
* Design and Construction
* G25 cast iron support to reduce thermal distortion during pre-heating.
  + 1. Casting system
       1. Caster Stand
* Design
* 2 – Hi, 15° tilt-back or horizontal, with one-piece housings.
* Caster Rolls
* (1) set of caster rolls = full assemblies (Upper/lower roll) = core with shells, seals, bearing chocks, end caps, rotary joints and all other required not listed accessories per line.
* (1) set of caster rolls full assemblies (upper/lower roll) as operational exchange per line.
* Additional two (2) sets of caster rolls full assembly (upper/lower roll) to be delivered common for all 4 lines.
* Bearing Chocks (attached to the caster rolls as part of the full assembly)
* (4) with straight neck bearings
* (4) for additional as operational spares (per line).
* Guide Out Roll (tilt caster only)
* (1) water-cooled, stainless steel roll shall be mounted in a hydraulically actuated carriage on the exit side of the stand.
* Load Cylinders
* (2) double acting
* Balance Cylinders
* (4) frame mounted balance blocks with (4) hydraulic pistons
* Frame Assembly
* The caster frame shall consist of two (2) heavy steel housings cross-tied for rigidity. The frame assembly shall be designed to operate in a tilt-back position during casting.
* Frame Tilt (tilt caster only)
* Hydraulic cylinders shall be used to pivot the frame assembly to the vertical position for roll change. Pivot pins shall be flash chrome plated and lubricated via an easily accessible grease point.
* Tilt Cylinders and Lock Pins shall include:

- (2) hydraulically actuated tilt cylinders and (2) hydraulically actuated lock pins to raise and fix the stand into the working position.

* Keeper Plates shall include:
* (4) hydraulically actuated keeper plates to secure the operator side chocks.
* Caster Rolls
* The rolls shall consist of forged steel cores with stainless steel overlay and forged alloy steel shells.
* The caster roll shell shall internally chromed and cooled by contact with water flowing in machined circumferential grooves in the surface of the core.
* The water flow inside the rolls shall be distributed to minimize any temperature variations on the surface of the shell. In a typical configuration the water flow reverses every 60° in this pattern, and the flow direction shall reverse every two (2) grooves along the length of the roll – final design as per Contractor’s technology.
* The operator side roll core necks shall be machined for cooling water inlet and outlet.
* The longitudinal water distribution bores shall have rounded bottoms to prevent the initiation of fatigue cracks in the drive side roll necks.
* The roll shells shall be shrink-fit mounted on the cores and sealed with special lip seals and end caps.
* The caster rolls each shall be driven by an independent planetary gear reducer and A.C. electric motor combination; the motors shall be synchronized by a sophisticated digital control system.
* Hot Water Roll Pre-Heater (see chapter 2.3.16.).
* Roll Assemblies shall include
* One (1) complete roll set (upper/lower roll) with rotating water joints
* Bearing Chocks
* The Contractor shall provide four steel machined bearing chocks with bearings, seals and covers.
* The bottom roll bearing chocks shall be fitted with wheels for travel on the steel rails of the roll changing system.
* During caster operation, the chocks shall be held in place by hydraulically actuated keeper plates on the operator side.
* To maintain a constant elevation of the roll nip, it is necessary to add shims to the upper roll when the roll diameter is reduced during grinding.
* A shim set shall be supplied which allows the rolls to be shimmed within 1 mm.
* Sufficient shims shall be provided to cover a roll diameter grind down.
* The shims shall fit under the top chock rocker plates and shall be installed in the roll grinding shop before the rolls are brought to the caster
* Rotating Water Joint
* The operator side caster rolls necks each shall have provision for a rotating joint with anti-rotation bracket mounted to the roll chock.
* Rotary Joints shall be part of the roll set:
* Attached at the upper roll AND
* Attached at the lower roll.
* Stainless steel braided flexible hoses shall connect the rotating joints to the cooling water header.
* Clean, treated and temperature-controlled cooling water from the closed loop cooling water system shall be circulated through the roll cores to extract heat.
* Two. (2) rotating water joints as operational exchange per line.
* Load Cylinders
* Two double acting, hydraulically controlled, low friction load cylinders shall supply the casting force.
* This force shall balance the casting separating force to maintain a constant, preset roll gap.
* A position transducer shall be located at the center of the cylinder for position feedback.
* The position of the cylinders shall be regulated by proportional valves located on a valve stand mounted near the caster housing.
* The pressure transducers for each cylinder also shall be in this valve stand.
* Gap Control
* The roll gap is controlled by two (2) 860 mm diameter roll load cylinders with integral position transducers which allow the casting gauge to be easily changed and maintained after the caster is started and is approaching steady state.
* Each caster roll is driven by a separate variable frequency **110 kW** AC motor and epicyclic gear box. These independent drives are synchronized by the Contractor digital drive system which matches the peripheral speed for the top and bottom roll to allow mis matched roll diameters to be used, thereby extending shell life, and minimizing roll inventory and sensing the torque applied. Each drive produces a 461 kN-m of torque with a gear box peak torque capability of at least 780 kN-m to provide a good service factor and long life.
* The Hydraulic Gap Control system controls the hydraulic preload cylinders. In Pressure Control, the separating forces are balanced, and the pressure is maintained at the desired value by closed loop control, using pressure transducers as the feedback signal to the proportional valves controlling the preload cylinder pressure.
* In Gap Control, the cylinder position is controlled using the feedback signal from a linear position transducer centrally located in each cylinder. In both Pressure Control and Gap Control modes, the required demand set-point can be set manually by means of Increase / Decrease switches or automatically by means of inputting a desired value into the HMI.
* The schematic below shows a typical hydraulic schematic for implementing gap control. High-pressure oil is introduced into each load cylinder via a proportional valve. A pressure transducer built into the valve provides a feedback signal for use when the constant pressure mode is selected. The caster rolls are initially "zeroed" by means of an automatic zeroing function in which the rolls are brought together, and a preset pressure threshold applied. Data from the position transducers is then stored and used to achieve accurate gap control. In gap control, the desired roll gap is set by the operator and the electro-hydraulic system ramps the cylinders to the desired position and maintains the position constant.

A computer screen shot of a diagram

Description automatically generated

**Hydraulic Schematic for Gap Control**

* When the “Start zero gap” pushbutton is pressed, the following condition are met:
* Rolls rotating
* Winder tension off
* Hydraulic power unit is working and pressure OK
* Not in roll change
* This automatic sequence is carried out by the following steps:
* Cylinders are synchronously raised in position control
* Control is automatically switched to pressure mode when the rolls make contact.
* Average position of the two cylinders is monitored for one roll revolution.
* Switch control to position mode with a target set to a predefined value
* A mill stretch compensation package is used to provide accurate modification of the cylinder position signal in order to reflect the actual roll gap and cast gauge.
* All the software for the Hydraulic Gap Control system control is developed in the Main PLC. Functional module for axis control and required isolated digital and analog I/Os are added in the basic configuration of the PLC.
* All necessary controls (pushbutton, selector switches. etc.) on main control desk and in the Caster information system are included in the system.
* The caster load cylinder has a linear position transducer which is mounted inside the cylinder on centerline in such a manner as to provide accurate displacement of the moving piston relative to the fixed body.
* The position signal from each of the (2) transducers is used to provide accurate cylinder position control.
* While the caster is operating under Hydraulic Gap Control, the roll gap is set on the main operator station. Casters equipped with Hydraulic Gap Control, have the system and controls seamlessly integrated into the Caster control system, Human Machine Interface (HMI) and data logger.
* The caster control system main operator station provides the HMI to the hydraulic gap control system and an alphanumeric keypad which allows the entering of relevant data into the system. Pushbuttons and switches provide additional functions as follows:
* Gap Mode: An illuminated push button to select gap control mode.
* Pressure Mode: An illuminated push button to select pressure control mode Start Zero Gap: An illuminated push button to start gap zeroing procedure.
* Increase/Decrease: A 2-position, spring return selector switch to manually increase or decrease the active set point in either Gap Control or Pressure Control.
* Op Side/Both/Drive Side: A 3-position latched selector switch to select on which side to apply the manual set point changes.

Transducers and Control Valves

|  |  |  |  |
| --- | --- | --- | --- |
| **ITEM** | **DEVICE** | **QTY** | **NOTES** |
| 1. | Linear Position Transducer | 2 | MTS (or equivalent) digital position transducer with 2-micron resolution providing accurate measurement of cylinder stroke for each load cylinder used by the gap control system |
| 2. | Pressure Transducers | 2 | Provide accurate measurement of pressure in each load cylinder used by the gap control system |
| 3. | Proportional Valve | 2 | Provide accurate control of hydraulic fluid being introduced into each load cylinder |

* The pressure transducers and proportional control valves are mounted on a valve stand, which incorporates all necessary manifolds and test ports. Two (2) valve stands are provided, each comprising one (1) single group of valves for each preload cylinder. The valve stand is designed for field installation at a suitable location as close to the preload cylinder as possible in order to optimize system response time, reduce hydraulic time lags in the system and ensure identical response characteristics from both preload cylinder circuits.
* The system is designed to make corrections based on feedback from a profile and thickness measurement system.
* The gap shall be automatically controlled by an electro-hydraulic system that shall establish the spacing between upper and lower rolls.
* The initial gap between the rolls shall be set by the operator as required.
* During caster start-up the system shall maintain a constant gap in open-loop mode by monitoring the output from the load cylinder position transducers with a compensation for housing stretch in accordance with the rolling load as measured by the pressure transducers.
* Once the caster is running and stabilized, and a reliable signal is available from the in-line X-ray gauge, the system shall switch to closed loop mode.
* The system shall provide a zeroing function, a position mode, and a pressure mode.
* Guide Out Roll (tilt caster only)
* A water-cooled, stainless-steel roll shall be used to support and guide the strip as it exits the caster.
* The roll shall be bearing mounted in a machined steel carriage that hydraulically travels up rails mounted on the exit side of the caster housings.
* The roll shall lower below a retractable floor plate to allow access to the caster rolls at start up and when the caster is not operating.
* The roll carriage assembly shall include a telescoping guide table to support the strip as it exits the roll nip on start-up.
* Retractable Floor Plate
* A hydraulic actuated retractable floor plate shall be located at the exit of the caster.
* The plate shall retract to allow passage of the guide out roll and shall provide access to a lower floor level that allows comfortable approach to the lower roll for maintenance functions.
* Platform (pit covers)
* For safety reason and in order to prevent any possible accident to the operators working to the casting line, a proper steel platform is forseen.
* The platform is a structure of steel beams, plates, stairs and fences, and it shall be properly designed to match the pit size, which locates the caster stand.
* Purge Gas System
* A steel gas header with a series of nozzles shall be mounted to the top side of the tip assembly.
* The header shall direct nitrogen, piped through a heater / dryer, into the roll nip to prevent condensation and corresponding damage to the caster tip and associated quality problems.
* The gas control valves, and heater shall be mounted in cabinets that are located on the drive side of the caster stand.
* Typical Caster Rolls Design and Construction 1 450 mm Wide Caster
* Total Weight of Roll Assembly (approximate):
* Upper: 18 659 kg
* Lower: 18 985 kg
* Includes:(1) complete roll, (2) chocks, (2) bearings and (1) water joint.
* Roll Lifting Beam: 600 Kg
* Roll Core and Shell
* Overall length roll: 3 142 mm
* Barrel length: 1 603 m
* Shell length: **1 600 mm**
* Shell diameter (new): **980 + mm**
* Roll + shell weight (new) 12 147 kg
* Shell Thickness
* New: Min. 50 mm
* Used minimum: 25 mm
* Nominal Shell Service Life: minimum **10 000 hours operation hours** (active casting) OR minimum **15 000 tons of production**. These figures must be warrantied by the Contractor.
* Shell Surface Finish
* External: 1.6 Ra (60-80 RMS)
* Internal: Chromed
* Hardness
* Shell: Brinell 420 to 440 depending on Contractor.
* Core Surface: HRC 52 – 54 modified AISI 420 stainless steel
* overlay 16 mm thick.
* Core Body: HRC 35 – 38 through hardened modified AISI

4 340 with added nickel and vanadium.

* Roll Bearings
* To be defined by the Contractor, TDI for two row or TQO type, for four rows.
* Size
* To be defined by the Contractor.
* Service life
* Average bearing life shall be more than 5 years.
* Caster Roll Drive System
* Design
* Each caster roll shall be driven by independent electric motor frequency converter controlled.
* Gear Reducers
* (2) Epicyclic type, 4 - Stage, with right angle input.
* Water or air cooled.
* Thrust Isolation:
* (2) stub shafts each shall be mounted in (2) opposed taper roller type bearings, at output of each reducer to isolate gearbox output stage from spindle thrust.
* Spindle Couplings
* (2) flexible gear type with spade type roll engagement or (2) cardan type.
* Spindle Support
* (2) floor mounted manually adjustable screw jacks with spherical roller platens shall support the coupling ends during roll change.
* The drive spindles shall remain attached to the drives during the roll change operation.
* Drive Base
* Fabricated steel, with motor foundation shall be mounted on a concrete base.
* Each caster roll shall be driven by an electric motor through an individual epicyclic gear reducer.
* An independent lubricant circulating pump, filter, desiccant breather and oil cooler shall be provided for each reducer.
* The output shafts of the gear reducers shall be isolated from axial spindle forces by thrust bearing assemblies with stub shafts that engage with the gearbox on the input side and the spindle couplings on the output side.
* The drive reducers and spindles shall remain fixed during roll change.
* Gearbox Torque Rating
* Continuous: 520 x 103 Nm
* Intermittent: 780 x 103 Nm
* Roll Load Cylinders
* Description
* The roll pre-load cylinders, with waterproof central position transducers, located on the bottom or the top of the caster stand, shall provide the rolling force for the casting operation.
* Design:
* Type: Double acting
* Number: 2
* Diameter: 860 mm
* Stroke: ≈ 120 mm
* Working pressure: 220 bar
* Total preload force: 2 042 tons
* Piston seal surface: Chromed
* Transducer resolution 1µm
* Position accuracy: 2µm
* Roll Diameter Compensation Shims
* Pass line Shims
* To maintain a constant elevation of the roll nip, shims shall be added to the upper roll when the roll diameter is reduced during grinding.
* The Contractor shall supply a shim set that allows the rolls to be shimmed within 1 mm.
* Sufficient shims shall be provided to cover a roll diameter grind-down from maximum to minimum shell thickness.
* The shims fit on the top chock and shall be installed in the roll grinding shop before the rolls shall be brought to the caster.
* Roller Scraper Blades
* Description
* During caster start-up, small pieces of aluminum can adhere to the surface of the rolls, and if they are not removed, they can damage the tip.
* The machine shall be equipped with scraper blades to intercept and remove these aluminum adherences.
* Design
* A pneumatically actuated, adjustable brass/bronze scraper/buff shall be furnished for each caster roll and shall be mounted on the roll chocks.
* During start-up, the blades shall run directly on the roll.
* After start-up, they shall be either lifted off the roll surface, or covered with a customer-supplied, absorbent, wear resistant cotton cloth material to smooth and homogenize the roll surface condition.
* Upon customer request, brackets and a buff pressure bar with manually adjustable pressure screws shall be provided for supplementary roll surface conditioning.
* Construction Type
* Pneumatically actuated scraper blade (pressure adjustable)
* Material Specification
* Phosphor-bronze, aluminum-bronze or brass
* Dimension of Cleaner Blade
* Covers full roll face.
  + - 1. Roll Change Equipment
* Tilting type
* Description
* Prior to a roll change, a new roll stack shall be completely prepared and positioned on the outer end of the floor mounted roll change rails. Once the caster is stopped, spacer blocks shall be inserted between the top and bottom roll chocks, the preload pressure shall be released and the roll stack in the caster shall be lowered such that wheels on the lower chocks rest on fixed rails that shall be mounted between the caster housings. The spindle jacks shall be raised manually to support the spindle hubs in position.
* Two short stroke hydraulic cylinders shall be mounted on the drive base that act against the drive side lower chock and push the roll stack until the caster rolls shall be clear of the spindle couplings. The housings shall be sufficiently thick that the rolls remain supported even after the couplings are fully disengaged.
* The caster housing then shall be tilted to the vertical position. In this position the frame rails shall align with the floor roll change rails and the drive side lower chock shall engage with the pre-positioned roll change carriage. The rolls then shall be extracted from the caster and moved along the floor rails until they can safely be lifted by the customer- supplied overhead crane. Then the roll change carriage shall traverse out to the pre-positioned new rolls and shall latch with the operator side chock and shall push the new roll stack into the caster.
* The caster stand then shall tilt back into the working position, re-engage the drive side of the roll stack with the short stroke cylinders and these cylinders shall pull the roll stack into engagement with the spindle couplings.
* Design
* Sled type carriage of welded and machined steel construction with locking lever.
* The carriage shall be actuated by chain and sprocket and shall be driven by a gear reducer and variable frequency AC motor.
* Maximum speed 2.54 m/min
* Carriage travel to be determined
* AC motor 5.5 kW
* Hydraulic Pre-extraction
* Bore 1 x 150 mm
* Stroke 380 mm
* Equipment Components
* (1) Sled carriage with floor mounted rails
* (1) Drive system consisting of AC motor, gear reducer, sprockets, and chain
* (2) Short stroke hydraulic pre-extraction cylinders
* (2) Spacer blocks
* Vertical type
* Description
* Two sections of rails compose the roll changer: a fixed section outside the housing and a hydraulically actuated section mounted on a steel frame inside the housing. During roll change the steel frame lifts the roll stack so that the rails inside the housing align with the fixed mounted rails outside the housing. The bottom chocks have wheels so that, with rails in upper position, the roll stack can be extracted by using an electric motor drive. A set of limit switches controls the travel of the roll stack. The operator directly activates the movement using a dedicated local control console.
* Design
* Sled type carriage of welded and machined steel construction with locking lever.
* Assembly Weight 2 800 kg
* Extraction type Hydraulic cylinder
* Stroke 4 000 mm
* Roll exit travel speed 2 m/min
* Roll exchange time

Exchange of complete caster roll set (upper/lower rolls) must not take longer than **120 minutes**. This value must be warrantied by the Contractor.

* Definition of 120 minutes.
* Start: “Old” casting roll set in working position = water circuit active with all connected hoses, cardan etc. With first activity for roll set exchange the 120 minutes are starting.
* Manipulation of rolls shall be considered as one by one = upper / lower roll with separate crane movement.
* Stop is defined after “new” roll set is in working position with all hoses, cardan connected and start of water circuit is possible.
* Air venting of the “new” roll set (if required) is not included within the 120 minutes.
  + - 1. Roll Spray System
* Description:
* The spray system consists of two air atomizing nozzles that shall be mounted on reciprocating ball screw linear actuators, each powered by a variable frequency AC motor. A PLC controlled valve system shall regulate the flow from each nozzle as well as the nozzle self-cleaning cycle, the traverse speed of the nozzle and the nozzle stroke. Compressed air has the function of needle positioning and nozzle opening. The nozzles shall be designed for automatic cleaning by periodically stroking the needle in the metering orifice.
* The system shall be configured to minimize colloid flocculation and sedimentation of graphite in the tanks and nozzle supply lines.
* The graphite solution shall be supplied to the nozzles either by using peristaltic pumps or by continuously circulating filtered graphite solution past each nozzle.
* Each spray bar shall be fitted with LED lighting to help monitor the spray pattern and density.
* The spray bars shall be fitted with failsafe limit switches to control over-stroke. Liquid and atomizing air pressures for each spray bar shall have the capacity to be individually adjusted to ensure the optimum spray pattern and application rate for any casting condition.
* Solution
* 0.1 % - 2 % colloidal graphite in water or a synthetic oil emulsion-based product
* Spray Nozzle Arrangement
* The upper spray bar shall be fix mounted on the caster housings for the upper caster roll with one reciprocating nozzle.
* On a horizontal caster the bar shall be fix mounted on the caster housings for the lower caster roll with one reciprocating nozzle.
* On a tilt caster the lower spray bar shall be mounted on the guide roll carriage for the lower caster roll with one reciprocating nozzle. The spray bar can be retracted with the guide out roll below floor level to allow access to the lower roll.
* Spray Control Panel
* (2) round stainless-steel tanks with conical bottoms and drains:
* (1) One pre-mixing tank with a capacity of 200 l. An inlet filter shall be provided for water entering the tank. The tank shall be equipped with an electric motor driven pump. Depending on the position of a three-way valve, the pump shall either mix the solution by recirculation or transfer the solution to the supply tank via an outlet filter.
* (1) One supply tank with a capacity of 200 l shall be provided with electric motor driven mixer and a thermostatically controlled immersion heater. Two variable speed pumps shall supply the solution from this tank to the spray bars via duplex filters that can be changed while the spray system is in operation. A stainless-steel catch pan shall be provided under the filter to channel any spillage back into the supply tank.
* For good housekeeping, the entire spray system shall be mounted over a stainless-steel drip pan to catch any graphite spillage.
  + 1. Exit Equipment

The exit group shall include the following components:

* Entry Assembly with Cooling Blower
* Primary Pinch Roll
* Edge Miller Assembly
* Secondary Pinch Roll
* Scanning X-ray Thickness Gauge
* Shear Assembly
* Air Knife
* Passline (Breaker) Roll
* Plunge Roll
* Guide Table
  + - 1. Entry Assembly with Cooling Blower
* Description
* The entry assembly shall consist of a floor mounted stand that supports the entry table, the strip cooling ducts, the strip guides and the pinch roll.
* Entry Table
* A hydraulically actuated telescoping table shall be provided at the entry to the assembly to partially bridge the gap between the caster and the pinch roll assembly. The table shall be of fabricated steel construction and hydraulically actuated for lift and telescoping movements. Table shall have a chrome-plated steel roll on the leading edge to facilitate strip threading. During normal caster operation, the table shall swing down inside the pinch roll frame.
* Strip Guides
* Steel lower guide table and robust steel upper guide plate shall be mounted on large tubular spreader guide the strip into the exit equipment.
* Opening: 200 mm
* Cooling Ducts
* The entry assembly shall incorporate a cooling system to cool the strip before it enters the edge miller. Air ducts shall be located in the lower guide table to direct air from a blower assembly that shall be located on the floor on the drive side of the casting line.
* Blower: 7.5 kW
  + - 1. Primary Pinch Roll
* Pinch Roll
* The primary pinch roll shall be used for strip threading during start-up. The rolls shall not be used during steady state operation. The bottom roll shall be fixed mounted, and the top roll shall be raised and lowered by hydraulic cylinders.
* Design
* The pinch rolls shall be housed in a fabricated steel frame that also supports the entry threading table.
* The pinch rolls shall be stainless steel.
* Top Roll Pressure:
* The clamping pressure of the top roll shall be adjustable.
* Roll Drive:
* The top and bottom rolls shall be driven by individual variable frequency AC gearmotors synchronized to strip speed.
* 2 x 5.5 kW
* Roll Opening:
* 200 mm
* Edge Guide:
* Vertical edge guide rollers shall be provided on the exit of the primary pinch roll. The position of the rollers shall have the capacity to be adjusted by means of manual jack screws.
  + - 1. Edge Miller Assembly
* Application
* The edge miller shall be located between the entry assembly and the secondary pinch roll. The edge miller removes any minor cracks and imperfections in the cast strip edge that can cause deep edge cracks during cold rolling.
* General Design
* The edge miller shall consist of two independent milling heads that shall be mounted on a common fabricated steel support structure. Each head shall consist of a variable frequency AC motor drive with a cutter head that shall be mounted on the output shaft. The heads shall travel on slide bars attached to the support structure.
* The position of each head shall be independently adjustable by means of an individual variable frequency AC motor driven geared with low backlash jackscrews with encoder and brake. A desk mounted digital display shall provide the readout of the trimmed width.
* The cutter heads shall be housed in sound insulated enclosures and shall be accessible for maintenance via hinged covers. The cutters shall have a quick-change feature, so the tungsten carbide cutting elements can be replaced off-line. Small jets of compressed air carrying droplets of lubricant shall be used inside the cutter enclosure to lubricate the cutters and prevent swarf accumulation.
* Miller Chip (Swarf) System discharges swarf; each milling head shall have a telescopic pipe for connection to the Suction System (Contractor provided). The telescopic pipe shall be attached to the cutter enclosures to remove the swarf from the miller assembly and collect it in a cyclone located on the drive side of the casting line. The cyclone shall discharge the swarf via a rotating vane type value into a customer-supplied scrap tub. A separate suction system and cyclone shall be provided for each line, even when the lines are installed in a “mirror image” configuration.
* Miller Type
* Dual rotary millers
* Material
* Aluminum and common aluminum wrought alloys up to 4 % magnesium.
* Strip thickness
* Maximum: 10 mm
* Minimum: 3.2 mm
* Maximum Cutting Depth
* 2 x 50 mm at rated maximum casting speed of machine on 5000 series alloys.
* Trimmed Width
* Maximum: 1 450 mm
* Minimum: 1 000 mm
* Miller Heads (2)
* Diameter: 250 mm
* Cutting elements: 16, each replaceable element with two cutting edges.
* 3 sets of miller heads (in total 6) should be delivered within base scope for fast exchange during production = operational exchange part.
* Exchange time: not longer than **5 minutes** for one miller head. Need to be demonstrated and warrantied by Contractor.
* Expected lifetime of the knives: Minimum 5000 tons
* Contractor must specify minimum set of wear parts (knives) to be purchased by the Customer during engineering phase to ensure availability at site at start of hot commissioning. Minimum 2 sets shall be supplied by the Contractor with the base equipment.
* Miller Drive
* (2) variable speed (frequency converter controlled) 15 kW AC motors
* Head Traverse
* (2) variable speed (frequency converter controlled) 2.2 kW AC jackscrews
* Miller Chip (Swarf) Suction System
* Suction fan: 7.5 kW
* Rotary valve: 0.75 kW
* Lubrication
* A dedicated station shall provide cooling and lubrication to the cutting heads. The system shall include the following components:
* (1) oil tank, with electrical level indicator
* (1) compressed air station, including filter, regulator, and solenoid valve (1) frequency controller
* (2) volumetric oil pumps (operated by compressed air)
* (2) air/oil coaxial distribution pipes and
* (2) nozzles (1 for each cutting head). The nozzles shall be designed with a quick-change capability.
* The system shall provide a continuous flow of compressed air to the cutting tool, while the volumetric pumps inject oil drops into the airflow at regular intervals; both the size of the oil drops and the injection frequency shall have the capacity to be be adjusted.
* Oil consumption: ~ 2 l/day
* Oil type To be defined during engineering
  + - 1. Secondary Pinch Roll
* Pinch Roll
* The secondary pinch roll shall be used for strip threading and during coil change to not only provide strip tension during coil change, but also to firmly maintain the cast strip position between the cutter heads. The rolls shall not be used during steady state operation. The bottom roll shall be fixed mounted, and the top roll shall be raised and lowered by hydraulic cylinders.
* Design
* The pinch rolls shall be housed in a fabricated steel frame that also supports the exit threading table.
* Material: Stainless steel.
* Water cooled.
* Assembly with bearings and vertical guides.
* Actuation via hydraulic cylinders.
* Top Roll Pressure
* The clamping pressure of the top roll shall be adjustable.
* Roll Drive
* The top and bottom rolls shall be driven by individual variable frequency AC gearmotors synchronized to strip speed.
* Roll Drive: 2 x 5.5 kW
* Roll Opening: 300 mm
  + - 1. X-ray Gauge / thickness measurement
* Description
* One single spot traversing X-ray thickness gauge shall be mounted on a traversing C-frame that travels across the strip width on rails. A full specification for this gauge shall be available on request.
* The gauge shall monitor and log the thickness and profile of the cast strip and shall display the readings on a monitor as a moving representation of the cast strip with color coded representation of the gauge deviations.
* The gauge shall have the capacity to be withdrawn offline for strip threading. During threading, a hydraulically actuated threading table shall span the gap between the entry assembly and the miller.
* Traversing Drive
* Electric with position feedback
* Gauge Opening: 800 mm
* Throat Depth: 1 690 mm
* Maximum Reciprocation: 1 500 mm
* X-ray Source: 50 kV DC
* Maximum Strip Temperature: 400 ºC
* HMI Software:
* Dependent on gauge CONTRACTOR.
  + - 1. Shear
* Description
* The shear shall be used to separate coils in process and to cut strip samples during coil change operations. The shear shall have the capacity to also crop damaged/off-gauge material.
* The shear shall be able to operate in either single cut or multiple cut modes to provide full width samples of a desired length for quality or other process control inspection.
* Design
* Hydraulic, up-cut, double rake, traveling type shear, with spring loaded stripper plate with mechanical links to the lower shear block for positive return at the end of each cut.
* The shear shall be synchronized with speed rolls to hydraulically shift position during shearing.
* The movement of the shear is controlled by a proportional valve, synchronized with the speed of the rolls of the stand.
* The feedback for the speed control and its position is given by a linear transducer installed in the hydraulic piston.
* Two Hydraulic cylinders operate the upper cutting blade. A system composed of reel and rack ensures the correct alignment or parallelism during the shearing operation.
* Maximum blade angle 4 degrees.
* Shear shall be configured to complete **5 shears** per minute.
* Construction
* The shear shall be of fabricated and machined steel construction designed to cut strip on a horizontal pass line. The unit shall consist of upper and lower die blocks.
* Hydraulic cylinders shall be mounted on a spreader and shall be connected to the lower die block, providing force for the up-cut action. A compensation gear and rack system shall prevent possible binding of the lower die block while in motion.
* Shear shall provide a system to alert the operator should a hydraulic hose rupture and position sensors.
* The shear frame shall be roller mounted on a track to allow shear travel with the strip during a cutting cycle. The shear traverse shall be unassisted in the forward direction with hydraulic return in the reverse direction.
* Capacity: 10 % over maximum strip thickness
* Maximum Speed: Approximately 10 cuts per minute.
* Expected lifetime of the knives: Minimum 1 year operation
* Blade Length: 1.780 mm
* Blade Opening: 127 mm
* Blade Type: Reversible tool steel
* Scrap Diverting Table
* An inclined table on exit side of shear shall divert scrap and cut samples into a tub located at floor level on the exit side of the shear.
* The tub shall be equipped with wheels that run on in-floor rails on the operator side of the machine (drive side on customer request). Tub shall be traversed by a long stroke hydraulic cylinder. Tub sides shall have slots to allow samples and scrap to be removed either individually by hand or multiple cuts with a fork truck.
* Contractor has to specify minimum set of wear parts (knives) to be purchased by the Customer during engineering phase to ensure availability at site at start of hot commissioning. Minimum 2 sets shall be supplied by the Contractor with the base equipment.
  + - 1. Air Knife
* Description
* Blower and nozzle assembly: The strip blower shall be located on the drive side of the line near the breaker roll. The blower shall direct a jet of air, via a chevron shaped header, transversely across the strip surface to remove any debris that may have settled on the strip between the caster and the winder. The header shall have the capacity to be pivoted by means of pneumatic cylinder to an idle position, which allows a greater clearance for strip threading. Once a production coil has been started, the header then shall be repositioned into the operating position.
* Blower: 7.5 kW
  + - 1. Breaker (Passline) Roll, sometimes called deflector roll
* Internally water-cooled steel roll, mounted in low-friction bearings to maintain constant pressure as the coil builds up on the winder.
* Deflector roll shall be stainless steel.
* The roll is located after the shear and air knife assemblies and is fitted with a rotating water joint to provide the cooling water feed and return.
* A resolver is coupled to the breaker roll to provide accurate feedback of the sheet speed.
  + - 1. Guide Table
* Description
* A hydraulically actuated pivoting and (if required by the configuration of the winder) telescoping table the full width of the cast strip to bridge the gap between the breaker roll and the rewind shall be provided. This table shall be used to support and guide the strip into the pre-positioned gripper slot of the winder at the start of a coil. Once a coil has been started, the table shall be retracted to provide sufficient clearance for the coil to build to its maximum diameter.
  + 1. Winder/coiler
* Design
* Overhung mandrel type with gripper slot. Capable to wind with or without spool. First period due to cold rolling mill stand spool must be used. In future it might happen, that spool will be not used after an upgrade of the cold rolling mill stand.
* Contractor must consider respective design to ensure spool handling (including storage rack for min. 2 spools with automatic centering) = fully automatic spool pick up (Contractor to decide how), spool insertation to mandrel up to fully automatic start of winding.
* Coil removal after coil is finished must be fully; automatic with or without spool up to coil placed on saddle position.
* Coil removal cycle (starting with strip cut at shear) up to ready for start winding new coil shall take less than:  
  **- 260 seconds in case of spool usage OR  
  - 120 seconds in case of no spool usage**These values must be warranteed by the Contractor.
* Duty
* Underwinding
* Mandrel Face Width: 1 650 mm
* Mandrel Expansion Range: 495 – 525 mm (fitting for spool use)
* Mandrel Full Circle Diameter: 520 mm
* Winder Drive: AC motor frequency converter controlled
* Service Factor: AGMA 1.5
* The winder shall be designed to rewind the metal into a coil on an expanding mandrel and to provide tension as the strip winds. The unit shall be of fabricated and machined steel construction.
* The mandrel shall be designed to grip the leading edge of the sheet and shall consist of steel segments operated by wedges with self-lubricating bronze wear pads actuated by a rotary hydraulic cylinder. The mandrel shall be anti-friction bearing mounted as the output shaft of a single speed integral helical gear reducer. The main winder gear reducer shall be driven by an electric motor through an intermediate reducer.
* The main gear reducer shall be forcing feed lubricated. The gearbox shall be equipped with a desiccant breather. Gear reducer shall be water or air cooled.
  + 1. Coil Stripper
* Coil Stripper
* A hydraulically actuated pusher plate shall be installed on the winder gearbox to assist in stripping the coil from the rewind mandrel. The pusher plate shall be guided by two rods sliding in bushings mounted on the top of the main winder reducer casing. The stripper force shall have the capacity to be regulated by adjusting the hydraulic pressure of the hydraulic actuating cylinder.
* Stripper plate travel: 1 700 mm
  + 1. Coiler support arm
* Design
* A hydraulically actuated arm supporting / stabilizating the coiler mandrel during coiling process. The arm needs to move into release position before starting coil car taking over the coil from the coiler.
* Fabricated machined steel struction.
  + 1. Coil Car and Weigh Scale
* Description
* The coil car shall be used to remove coils (with or without spool) from the winder mandrel. The car shall be of heavy duty machined and welded steel construction and supported on four (4) steel wheels that run on rails set into a shallow pit in the concrete foundation.
* The coil car shall traverse by means of hydraulic motor and that drives the car via the wheels. The car shall support a hydraulic cylinder actuated box construction lift platen. The hydraulic controls shall include a high/low pressure lift circuit for coil snubbing during the coil change sequence. At no point should any portion of the outer wrap interfere with the coil car function or the platform or any other equipment near to the coil car – platform. A power track shall carry the cables. The coil shall be unloaded at saddles at the end of the rails.
* Coil car functions shall be solenoid valve actuated; bearings and slideways shall be manually grease lubricated. The unit shall be designed with leading and trailing floor plates.
* The coil car shall have a roller lock, which is a necessary safety feature.
* Design: Pit type
* Traverse Speed: Max. 15 m/min
* Lift Speed: Max. 2 m/min
* Lift Actuation: Hydraulic cylinder
* Traverse Actuation: Hydraulic motor
* Platform
* (4) steel rollers shall be arranged around a central banding guide.
* Roller brake
* To prevent high magnesium alloy coil “clock-springing,” a platen roller brake shall be provided.
* Pit Covers: Leading and trailing floor plates.
* Rails: Standard locally available
* Coil Size: Max. OD: 2 400 mm

Min. OD: 600 mm (Spool outer diameter)

* Weigh Scale
* Separate rail section in coil car rails shall be mounted on load cells to measure the weight of the coil car and coil. The scale shall feature a tare function for the weight of the coil car and shall display the weight of the coil. The coil net weight shall be final measured at coil car at saddle position before start lowering with a stabilization time of min. 3 seconds (= no active travel or lowering movement - should be adjustable) to avoid dynmic impact on the scale system.
* Design
* Fabricated steel assembly shall be installed at the extreme outward travel of the coil car. The unit shall have digital display on the winder station and an electronic interface with the data collection system.
* Accuracy: 0,15 % on 20 tons scale
  + 1. Cooling water systems

Each casting line shall have two cooling water systems: a thermostatically controlled closed loop system to keep the casting rolls (upper/lower roll) at uniform operating temperature, and a separate auxiliary system to cool the hydraulic unit(s), pinch rolls, gear boxes (if applicable), pass line rolls and any other miscellaneous equipment associated with the casting line.

* Base design standards (to be considered at each closed cooling circuit):
* Pump units (1 working and 1 hot stand by) with drainage valve, isolution valve (hand valve) and automatic shut off valve (to ensure hot stand by start if required). Pump motor shall be frequency controlled.
* Signals from instrumentations (flow meter, pressure, temperature) connected to control system (PLC) must be continuous (4-20 mA) = no digital status (0 / 1) signals to be used. Local display of respective instruments (flow, pressure) to be considered. Mechanical gauge indicators (for pressure, temperature) to be installed in addition as well (for local maintenance).
* Flow meter as electro-magnetic flow meter – no mass flow meter.
* Automatic shut off valves (pneumatic operated) with manual override possibility
* Hand valves to be monitored (open/close condition to control system).
* Summery common measurement = flow meter, pressure transmitter and temperature transmitter (after pump unit).
* At each return line a separate flow meter, temperature transmitter and pressure transmitter.
* Automatic backwash filter with isolation valves (at filter inlet/outlet) with differential pressure transmitter and bypass valve (to ensure maintenance on the filter in case of running cooling circuit).
* Air venting points at respective high points to be considered.
* Heat exchange stainless steel plate design. Heat exchanger cold side is TOP to Customer scope. Flow regulation at cold side via control valve (Contractor scope) must be considered = control valve has to be connected to Contractor’s control system. Manual bypass via hand valve must be as well considered.  
  - Contractor’s scope shall start at heat exchanger cold side hand valve (Contractor’s scope) in the incoming line. After hand valve an automatic filter (with differential pressure measurement) with isolation valves (at filter inlet/outlet) and bypass valve (to ensure maintenance on the filter in case of running cooling circuit).
* Pipe material (machine attached – onboard piping within Contractor’s scope / intermediate piping within Customers scope): Stainless steel
* Expansion tank (if required) including level measurement to be considered.
* Drainage points to be considered.
* Stainless steel hoses to respective consumers.
  + - 1. Caster roll cooling closed loop
* Description
* The system shall be completely sealed and there shall be no water losses apart from minor spillage that may occur during roll changing and evaporation at the surge tank.
* The closed loop caster roll cooling water shall be isolated from the overall Customer plant cooling water (heat exchanger cold side is TOP to Customer cooling water). The closed system shall be charged with softened water and a sophisticated organo-phosphate (or equivalent) corrosion inhibitor during the first fill and only shall require occasional top-up and checking of the inhibitor concentration. The initial charge and periodic maintenance of the corrosion inhibitor shall be the Customer’s responsibility.
* Softened water shall be used for any make-up water.
* The closed loop system also includes a caster roll by-pass circuit for roll pre-heating (preheating the rolls before each start of cast to 55 - 58 °C) or a temperature hotter than the drewpoint when the machine will be started. This “roll preheating” circuit shall include a small pump including a heater and a small integrated water tank with separate piping to the water header at the rolls. Switch over from “roll preheating” circuit” to closed loop caster roll cooling circuit shall be performed automatically (shut off valves - manually via HMI operation can be done any time) at start of cast = at start of roll turning the “roll preheating circuit” shall be stopped and automatic shut off valve closed. After start of liquid flow to the caster roll from the header AND the rolls have performed a certain rotation the closed loop for the caster roll should get active = automatic open of respective automatic shut off valves at = water flow through the caster rolls. Once the caster is started, the thermostatically controlled valve at the cold side of the heat exchanger shall direct a portion of the plant cooling water to the heat exchanger, thereby maintaining a uniform caster roll cooling water temperature. With these designs, we anticipate using a variable speed pump to deliver an appropriate volume of water so that when the heating water circuit is switched to the caster water circuit, the temperature of the rolls do not drop below the drewpoint.
* Automatic filter with bypass shall be considered in the closed loop.
* Compressed air connection at caster rolls water header connection to be considered for water blow off in case of required roll change.
* Water hoses shall be designed in such form to connect IN-OUT hoses to bypass caster roll in case of caster roll exchange or a longer stoppage without caster roll installed ensuring water circulation (special in cold sesson time).
* Technical Data / design
* System Data for caster roll cooling closed loop (to be understood as indicate – finally as per Contractor’s design):
* Flow rate: 3 700 l/min
* Inlet pressure (at caster rolls): 2.5 bar
* Delta pressure (pressure drop at caster rolls): 0.8 bar
* Inlet temperature range (at caster rolls): 30 – 35 °C
* Delta temperature (temperature pick up at caster rolls): max. 2 °C
* Expansion tank: 300 liters
* Heat exchanger (rated): 850 kW
* Pump motor (1 + 1 hot stand by) 30 kW
* Plant flow rate (cold side of heat exchange) 4 300 l/min
* “Roll preheating” circuit:
* Flow rate 250 l/min
* Water temperature at rolls: 55 – 58 °C
* Heating time (after roll exchange or before start of cast = rolls are “ready for hot” operation): Max. 120 min.
* Pump motor (only one (1)) 3 kW
  + - 1. Auxiliary closed loop
* Description
* The auxiliary closed loop shall cool all consumpers requiring cooling water – except caster rolls as having its own water circuit. Consumers are caster hydraulic heat exchanger(s), pinch rolls, deflector roll, gear boxes (if applicable) etc.
* Contractor shall consider also additional 10 m3/h for the furnace hydraulic pump station heat exchanger (Customer scope).
* The system shall be completely sealed and there shall be no water losses apart from minor spillage that may occur during disconnection of any hose in case of inspection or equipment exchange (for example pinch roll exchange).
* The closed loop caster roll cooling water shall be isolated from the overall Customer plant cooling water (heat exchanger cold side is TOP to Customer cooling water). The closed system shall be charged with softened water and a sophisticated organo-phosphate (or equivalent) corrosion inhibitor during the first fill and only shall require occasional top-up and checking of the inhibitor concentration. The initial charge and periodic maintenance of the corrosion inhibitor shall be the Customer’s responsibility.
* Softened water shall be used for any make-up water.
* Automatic filter with bypass shall be considered in the closed loop.
* Technical Data / design
* System Data for caster roll cooling closed loop (to be understood as indicate – finally as per Contractor’s design):
* Flow rate: 400 l /min
* Inlet pressure: 4 bar
* Delta pressure: 0.8 bar
* Inlet temperature: 30 – 35 °C
* Delta temperature: max. 2 °C
* Expansion tank: 100 liters
  1. Required documentation
     1. General
* The Contractor shall provide all revised or new drawings and documentation required for installation and maintaining the equipment in editable format. Where applicable, these shall include, but are not limited to, the following: Functional Description, Assembly and Disassembly Procedure Description, Process & Instrumentation Diagrams (P&I), General Arrangement & Equipment Layout Drawings, Assembly Drawings, Foundation Drawings, Structural Drawings, Piping Drawings, Plan, Section & Detail Drawings, Conduit and Cable Schedules, Single Line Drawings, Equipment Grounding Drawings, Exposed Raceway Drawings, Transition Drawings, Junction Box / Termination Panel Details, Interconnection Drawings, Control Drawings, Elementary Drawings, Communication & Interface Drawings, Level I & Level II Logic Documents, Operation & Maintenance Manuals, and Training Manuals & Visual Aids.
* Safety instructions,
* Risk analysis,
* Technical protocol (specifying name of equipment, type of equipment, serial nr., weight, main dimensions),
* Guidlines for a inspectionand checks (on daily, weekly, monthly, yearly basis),
* List of spare parts for mechanics, hydraulics, pneumatics and electrical systems with a cataloque nr., for min 2 years,
* Basic list of alarms with a help instruction,
* Initional revision, tests protocol, certificatrs for electro cabinets ets.,
* For Automation, the Contractor shall provide PLC Configuration, Hardware and Software Specifications, and technical & schematic wiring diagram. (including existing panel) PLC control software in editable and open form
* The Contractor shall provide, in one master document, a listing of all parameter settings for electrical, mechanical, and hydraulic equipment.
* The Contractor is required to notify the Customer’s Purchasing representative of any impact on cost or schedule resulting from Customer’s requested changes, whether the request was made verbally, written or in review comments on drawings. The said changes shall only be executed upon authorization by Customer’s purchasing.
* The Contractor shall provide the “As Built / As Commissioned” editable, electronic drawings and documentation, with one hard copy, no later than 3 weeks after completion of the project. The Contractor shall provide detailed fabrication drawings of all non-commercial parts utilized in the fabrication and installation of equipment within the Contractor’s scope of supply. All standard commercial parts are to be specified on respective assembly drawings, and in O & M manuals in sufficient detail to permit direct purchase from third party contractors.
* Any components currently covered by patents must be identified and appropriate patent # must be listed.
* The Contractor shall provide one editable copy of all computer-generated documents on CD or USB disk or external hard drive.
* All documentation provided to Customer shall be in Czech and English
* On the operational panel will be possible to choice a language Czech or English.
* The Contractor shall provide Customer with a limited use Right to Copy said documentation for the explicit use by Customer in maintaining, training and operating the equipment.
* The Contractor shall provide Customer with the Material Safety Data Sheets (MSDS) for any used chemical.
* Instead of CD use external hard drive.
* Technical documentation of the machine (layout of the system, sets of machining drawing, hydraulic schema, pneumatic schema, lubrication instruction),
* All documentation is delivered in 3 copies in paper format and 1 copy on CD, USB disk (pdf format). The documentation documentation must be prepared in Czech form and English.
  + 1. Drawings
* All design drawings must be done in Metric Form in the latest AutoCad version and provided in addition in \*.dwg and \*.pdf format. Other preferred formats are \*.step, \*.igs, \*.mi, \*.pkg, \*.dxf.
* The design and installation drawings shall be submitted for Customer’s review. To expedite Customer’s review, drawings shall be transmitted electronically.
* Comments on drawings by Customer do not relieve the Contractor of his responsibility for the system design, operation and safety. Drawings returned by Customer with comments, shall be resubmitted for record purposes.
* EPLAN is the preferred software for electrical documentation.
* Manuals
* Contractor shall provide a full and complete Bill of Material (BoM) for all delivered parts. Documentation in SAP Materials Management Module is preferred.
* Operation and maintenance manuals shall be submitted in editable, electronic format.
  + 1. Dokuments for construction readiness
* Machine layout and basic data output data
* Side views
* Basic information for compressed air system, cooling water, hydraulic system, other required media
* Final of load data
* Conduits/channels for media/electric dimensions - connected to civil works as needed for general designer for building engineering
* Emissions arising from the technology (if relevant) - characteristics, amount, location of the chimney (exhaust), height and diameter of the chimney (exhaust), amount of air, operating hours
* Noise - sources, amount of emissions (technical data), proposal of a possible method of limitation
  + 1. Documents for Basic engineering
* Machine layout with connection points and all utility output data
* Side views with connection points
* Foundation plan with load data (static and dynamic) including the Machine ground connection
* Anchor plans of the equipment
* Drawings and requirements for compressed air system – power, flow, pressure, connection dimensions, piping plans etc.
* Drawings and requirements for cooling water – power, flow, pressure, connection dimensions, piping plans etc.
* Drawings and requirements for hydraulic system – power, flow, pressure, piping plans etc.
* Drawings and requirements for air extraction (if you consider) -power, flow, connection dimensions, piping plans etc.
* Emissions arising from the technology (if relevant) - characteristics, amount, removal method - cleaning, location of the chimney (exhaust), height and diameter of the chimney (exhaust), amount of air, operating hours
* Documents for Electrical Equipment containing
* Electric switchboard dimensions
* Electric design drawings
* The required cable routes
* Drawings and requirements for other required media – power, flow, pressure, connection dimensions, piping plans, etc.
* Noise - sources, amount of emissions (technical data), proposal of a possible method of limitation
* 3D model of the device for the possibility of creating an overall model in the hall and thereby eliminating the crossing of distribution lines
* Technology requirements for other professions - lifting equipment, platforms, camera systems, special lighting, etc...
  + 1. Documents for installation of the Equipment
* engineering and design documentation containing the Detail Design documentation elaborated in details necessary for performance of the subject matter of the Contract;
* all documentation needed for proper construction, installation, erection, commissioning, operation, maintenance and repairs of the Equipment;
* detailed assembly, installation, erection, commissioning, operation and maintenance manuals for each appropriate unit of the Equipment; and
* implementation documentation to the extent necessary for the needs of the tender procedure under the Subsidy Program (including measuring technology, preparations for assembly, requirements for measurement accuracy, etc.) and assembly.
  + 1. Final Documentation
* mechanical drawing documents for parts, sub-assemblies and assemblies, in PDF and DWG format,
* electronic drawing documents in E-Plan format, version 2.9 or later and in PDF format
* pneumatic line diagram in PDF and DWG format,
* hydraulic line diagram in PDF and DWG format
* operation and maintenance manual, hard copy (3x) and digital form, in Czech and English,
* BOM for spare parts in PDF and XLS format (indicating the type identification, ordering number, manufacturer, standard, dimension, lead time etc.),
* BOM for wear parts in PDF and XLS format (indicating the name, ordering number, manufacturer, standard, dimension, lead time etc.),
* maintenance, inspection and revision plan in Czech – based on the government resolution No. 378/2001 Coll. Section 2
* calibration sheets and recommended calibration intervals
* leak test reports for compressed air, gas and industrial water
* safety circuit function verification report
* electrical equipment verification test report pursuant to Czech national standard ČSN EN 60204-1 ED.3 (initial inspection of electrical parts)
* certificates, CE declaration of conformity
* risk analysis according to ČSN EN ISO 12100
* data sheets and certificates for the materials used
* installation logbook
* SW backup (source codes must be supplied for the PLC control system, visualisation e.g. WinCC, control of frequency converters, hydraulics etc.), source codes must be in English
* other documents necessary for the operation of the line
* list of necessary workshop equipment for mold preparation and cleaning
* Version of AutoCAD (DWG) and EPLAN must be confirmed by Customer at start of project.
  + 1. Others
* 3D model documents of the line, in STEP format – due date as per the Contractor’s suggestion, however not later than 8 months since the order date
* preliminary operation and maintenance manual, hard copy (3x) and digital form, in Czech – due date before the operation and maintenance operator training
* all units, dimensions and weights must be given in SI (metric) units.
  1. Mechanical
     1. General
* The equipment shall be configured for maximum availability, reliability and maintainability. Maintainability shall include, but not be limited to, the following:
* Ease of maintenance and reduction of time required to change components and parts:  
  - Duplication of components and connected spare devices where practical  
  - All valves and all components requiring lubrication or adjustment shall be serviceable from accessible positions, without endangering operating or maintenance personnel.
* All rotating equipment shall be statically balanced.
* All pipe threads (coupling nut) to be Metric ISO standard. No alternative is allowed. (Usage: Assembly of plant or equipment piping, and connections or direction changes between rigid pipe. It is not the same as port fittings into cylinders.)
* All threaded fasteners to be Metric ISO standard. No alternative is allowed. (Usage: Bolts, screws, nuts, machine assembly)
* Bearing shall be precision ball or roller type.
* Guards shall be provided for all power movable parts and rotating drive components for personnel and equipment protection. Access to moving parts may be restricted by handrail and/or mesh guards to prevent operators or maintenance technicians from accidentally reaching the moving part. Refer to ISO 13857:2008 for Safety distances to prevent hazard zones being reached by upper and lower limbs.
* Locking mechanism, manually actuated, shall be furnished to lock moving parts during maintenance. Locking mechanisms shall follow LoTo requirements.
* Lifting facilities shall be provided on all major items of equipment to allow movement by crane.
* Leveling screws shall be provided on all main bases to facilitate installation.
* Vibrating system parts shall be equipped with effective damping to avoid transmission of vibrations to buildings, steel structures, other machinery parts, and piping.
* Structural supports, platforms, stairways, handrails, floor plate etc. required for operation and on-line maintenance shall be provided by the Contractor. Dimple plate shall be provided on other than concrete walking surfaces.
* Design shall minimize the need for foundation pits and trenches.
  + 1. Lubrication
* Customer is responsible for the first fill as par Contractror detail engeneering specification
* A means to lubricate all bearings shall be provided. All rolling contact bearings shall meet or exceed 44,000 hrs. of equipment operation.
* As far as technically possible, maintenance/lubrication free equipment shall be used, based upon a minimum design life of 44,000 hr. of operation.
* The state of lubrication upon delivery shall be documented and identified. (i.e. is it a basic lubrication or lubrication ready for operation)
* If possible, facility for lubrication while the equipment is running shall be installed, i.e. lubrication nipples, oil level gauges and fill points shall be moved outside the machine guarding for easy access and reasonably centralized and labeled.
* At all rotating grease based lubrication points where centralized automated grease lubrication (see below) is not possible manual greasing has to be considered with clear interval (time based on running motor hours or equipment movement intervals) with specified amount of grease per grease point.
* Monitoring manual grease interval based on running motor hours / equipment movement of respective manual grease point has to be visible on automation system with reset pushbutton after manual greasing was performed.
  + - 1. Centralized automated grease lubrication:
* A central automated grease lubrication system shall be considered ver application = at none-rotating grease points such as bearings, sliding ways, pivot pins and equipment requiring grease fittings for automatic lubrication. Inaccessible fittings shall be individually piped to an accessible lubrication point on the unit. Where possible, auxiliary equipment shall be fitted with pre-packed and sealed anti-friction bearings.
* The lubrication system shall be dualine type. The centralized dual line method consists of in dispesing of grease under pressure to a group of lubrication points from the central lubrication.
* To lubricate the mechanical parts on the machines, pressure is developed by the pump mounted on central unit. Under pump pressure, each metering (dosing) valve in the system delivers a measured amount of lubricant to the greasing points.
* Main components are:
* Tank with level measurement (4-20 mA signal to automation system). Low low level used for pump interlock. Alarming of high / low level for refilling of grease into the tank.
* Pump unit including safety relief valve (over pressure protection) with pressure transmitter (4-20 mA signal to automation system) – pressure transmitter used as system pressure.
* Switch over valve between 2 main supply (dual system) line with end of line pressure transmitter used for greasing control including local manometer.
* Distributors located on respective equipment/machine (onboard) close to grease points.
* Distributors:
* Grease quantity is individually adjustable according to lubrication point requirement.
* Control
* Automation system shall control the grease cycle with adjustable time setting (via HMI).
* Automatic greasing shall be initiated with start of casting/operation and automatically stopped with stop of casting/operation to avoid over-greasing.
* Alarming for over-pressure or leakage (end of line pressure not reached at adjustable active time of greasing) has to be considered on the HMI to inform operation / maintenance.
  + - 1. Twin roll caster drives (oil based)
* The caster planetary gear reducers shall be lubricated by a re-circulating system.
* A lubrication pump, double-filter (with 4-20 mA signal to automation system), desiccant breather, water/oil heat exchange with automatic thermostatic control, shall be provided for each gear reducer.
* Tank monitoring with oil level monitoring (4-20 mA signal to automation system).
* The system shall be complete with piping and fittings.
  + - 1. Winder drive (oil based)
* The winder main gear reducer shall be lubricated by a re-circulating system.
* A lubrication pump, double-filter (with 4-20 mA signal to automation system), desiccant breather, water/oil heat exchange with automatic thermostatic control, shall be provided for each gear reducer.
* Tank monitoring with oil level monitoring (4-20 mA signal to automation system).
* The system shall be complete with piping and fittings.
  + 1. Pneumatics and Hydraulics
       1. General
* Customer is responsible for the first fill as par Contractor detail engeneering specification
* The Hydraulic system offered with all equipment include small hydraulic power packs and are being procured along with the individual equipment as a package and the same will conform to the standard / good engineering practice adopted for Hydraulic power packages. These packages will include all necessary electrics, pipework, instrumentation and controls.
* The hydraulic systems in general will include tank units, pump motor units, filtration unit, plate type heat exchanger cooling unit, valve stands, piping, hoses, instrumentation, controls, accumulator stands as required for a complete functional system.
* The system shall be designed such that the components are not allowed to be over-pressurized by the maximum discharge pressure of the pumps (i.e. the design pressure of every component in the system is higher than the maximum discharge pressure of the system pumps). This includes all cylinders, hoses, fittings, piping, gauges etc. Pressure relief valves may be allowed to protect the hydraulic components, provided they are discharged directly back to the reservoir.
* Relief pressure plus any relieving backpressure to the reservoir shall not exceed the design pressure of the protected component(s). Use of pressure relief valves to protect components will only be allowed with written approval from Customer on a case-by-case basis
* Complete skid mounted hydraulic power packs shall be provided to meet any equipment hydraulic power requirements. Equipment shall be designed for use with “Water based and fireproof hydraulic fluid“. Exact type of hydraulic fluid has to be coordinated with Customer during engineering phase = approval by Customer is mandatory. The skid shall have a containment or drip pan with a capacity to hold the entire volume of oil in the system.
* Hydraulic tank(s) and piping (onboard as well intermediate piping up to end position) shall be of stainless steel. Pump-tank level interlocks shall have safety switches and analog for measuring/monitoring temperature shall be provided.
* Each hydraulic system shall be provided with electrical control panel. Audible and visible alarms shall be provided in the control panel as well as in HMI for indicating malfunctioning of any component.
* Supply of one test kit for proportional and servo valves will be provided as per the relevant system (one unit for all 4 lines is sufficient).
* Supply of one portable pressure recorder with minimum 4 measuring ports / 4-20 mA with measuring range up to 600 bar.
* Supply of one (1) no. mobile filling pump-motor-filter unit (one unit for all hydraulic packs within Contractors scope) complete with 15 m long suction and delivery hoses, electrical control cabinet, 15 m long cable and power plug. The filter will be of adequate capacity and 5 micron fineness for hydraulic systems for unloading fresh hydraulic oil from barrels/tanker to the tank of each hydraulic system.
* Supply of one (1) no. mobile nitrogen booster complete (one unit for all hydraulic packs within Contractors scope) with electric motor, control cabinet, 15 m long each suction and delivery hoses, 15 m long cable and power plug for initial charging of accumulators with nitrogen.
* Supply of one (1) no. contamination gauge.
* Supply of one (1) no. accumulator charging & testing unit.
* Hydraulic filter in any respective line (circulation, feed, pressure, return line) need to be double type (switch over between working and standby filter during operation without system stoppage is ensured) with differential pressure transmitter (4-20 mA signal to automation system with local mechanical inspection display) monitoring.
* For each type of pump (circulation, feeding, pressure pump) min. one (1) hot stand by pump has to be considered.
* The pumps shall be mounted relatively close to the reservoir to ensure pump suction is always flooded.
* At tank temperature and level measurement has to be continuous type = 4-20 mA signal to automation system. Pump interlock signal (low low level in tank) has to be separate considered as a safety signal (0 / 1 status).
* Heater at tank has to be considered.
* Re-cooling (water to oil heat exchanger) within circulation as part of circulation circuit has to be considered. Control of the heat exchanger shall be controlled via automation system using oil temperature from the tank.
* Mechanical gauges / indicators for temperature and level to be considered on tank.
* Mechanical gauges for pressure to be considered at all pumps, valve stands and tables. Gauges to be liquid filled.
* Sufficient number of test points (minimess) at hydraulic power unit (tank, pumps) as well on valve stand(s) / table(s) to be considered.
* Manual, lockable isolation valves with electrical monitoring signal to control system shall be provided on pump suction and discharge sides of each pump to allow isolation for maintenance or repair without disruption of the system. In addition, pressure gauges with isolation valves shall be provided in between pump discharge and the discharge isolation valve.
* Selection or change of operating pump during operation has to be possible via control system HMI without stoppage of the hydraulic system. Monitoring of running motor hours with possible reset in case change of motor or pump has to be considered via control system HMI.
* Pumps shall be pressure compensated variable displacement type and shall be sized to handle the maximum flow for the system. Pumps shall be arranged in parallel using common suction and discharge headers. Pumps shall be identical.
* At each pump a pressure transducer measurement (4-20 mA signal to automation system) with local mechanical inspection display shall be provided.
* At each pressure pump a double type filter with differential pressure transducer measurement (4-20 mA signal to automation system) with local mechanical inspection display shall be provided.
* All pressure transducer measurements with isolation valves need to be analog type with 4-20 mA signal to control system with local display.
* All critical located (hot area) or for the machine function major important hydraulic cylinders need to be equipped with 2 pressure transducer measurements with isolution valves for measuring A and B side of respective cylinder. Analog type with 4-20 mA signal to automation system with local display. In addition, fittings located at each cylinder A and B side shall be provided for temporary installation of pressure gauges for maintenance and diagnostic directly at site. Final decision if pressure transducers to be considered on respective cylinder shall be done during engineering phase.
* Any kind of servo / proportional valve need to be onboad electronic type (no external hardware card) and directly controlled by automation system with position feedback signal to automation system (preferred 4-20 mA).
* Pneumatic equipment shall be specified for 10.5 bar maximum pressure. Actual pressure shall not exceed 6 bar (5-6 bar is the air pressure in the plant air pipelines). Contractor shall provide lockable shutoff supply valve, regulator and filter/lubricator for pneumatic devices. Contractor shall specify and supply, specify air-receiving tanks for large air volume using equipment or safety – critical equipment.
* Hydraulic piping connections on cylinders, power units and valves shall be 4-bolt SAE flanges.
* Each hydraulic / pneumatic circuit / cylinder shall be provided with lockable isolation valves on supply and return piping. In addition, each circuit / cylinder shall have a lockable drain valve to relieve circuit pressure prior to maintenance.
* Cylinders shall be designed to withstand twice the operating pressure according to the relation of the cross sections. Cylinder tubing to be seamless grade 55 steel tubing, piston rod plated with minimum 0.038 mm C45 hard chromium. Guide Bushings to be RG7 Red Brass, or equivalent. Connections to be SAE O-ring Flanges.
* Hydraulic equipment shall be mill duty type. In the melting and casting area, the hydraulic fluid shall be a suitable water based Polyol Ester.
* Hydraulic tubing, fittings and ports.
* All hydraulic tubing to be Metric ISO standard. No alternative is allowed. (Usage: Tubing which may be bent or formed with hand tools or automatic tubing bender. Used for connections between valves, cylinders etc that are within a machine, panel, HPU. Typically heavy gauge stainless steel.).
* All hydraulic tube fittings must be approved by Customer Engineers. (Usage: Fittings used to connect SS tubing to other tubing or devices, these fittings rely on compression to form a seal between the tube and the fitting).
* All hydraulic valve & cylinder ports to be BSPP standard. Exceptions must be approved by Customer Engineers (Usage: Connection ports between pipe, tubing, or hoses and a valve, cylinder, or other hydraulic device).
* All hydraulic hose fittings to be Metric ISO 24°. Exceptions must be approved by Customer Engineers (Usage: Connection between tubing, pipe, or hydraulic device and a flexible hose).
* On valves stands, tables function block diagram has to be mounted by using stainless steel plate - engraved. In addition, fittings located at each function served from the valve stand/table shall be provided for temporary installation of pressure gauges for maintenance and diagnostic directly at site.
* At all components (pumps, valves, instruments etc.) stainless steel plate (engraved) has to be mounted displaying reference code on respective installed steel frames, table, stands etc.
* Electrical signal (LED or diode) at soleniod valve connectors or any other kind of electric powered devices indicating power or switching status.
* Standard pneumatic tie rod cylinders shall be rated for min. 17 bar.
  + - 1. Twin roll caster specific
* Each Twin roll casting line to include two (2 = separate units for low and for high pressure) or one (1) common hydraulic power unit (HPU) for high pressure (mainly for caster stand load cylinders) and for low pressure (for all other hydraulic cylinders / motors of the line). Decision is with the Contractor.
* The hydraulic power unit (HPU) including pressure pumps and all other related accessories AND valve stands/tables shall be located in sub-basement or at shop floor level (in this case HPU need to be housed) next to each casting line.   
  - In case of sub-basement: Sufficient access has to be ensured with necessary shop floor opening to ensure equipment exchange if required. Only pipes shall reach / be visible on the shop floor reaching final consumers.
* Onboard piping is within Contractors scope. Intermediate piping / erection material within Customers scope.
  + 1. Pneumatic tubing, hoses, fittings and ports.
* All pneumatic tubing and hoses to be Metric ISO standard. No alternative is allowed. (Usage: Tubing, hoses which may be bent or formed with hand tools or automatic tubing bender. Used for connections between valves, cylinders, etc., that are within a machine, panel, HPU. Tubing typically lighter gauge stainless steel.)
* All pneumatic tube fittings must be approved by Customer Engineers. (Usage: Fittings used to connect SS tubing to other tubing or devices, these fittings rely on compression to form a seal between the tube and the fitting)
* All pneumatic valve & cylinder ports to be BSPP standard. Exceptions must be approved by Customer’s Engineers (Usage: Connection ports between pipe, tubing, or hoses and a valve, cylinder, or other pneumatic device.
* All pneumatic hose fittings to be approved by Customer’s Engineers (Usage: Connection between tubing, pipe, or pneumatic device and a flexible hose) Hydraulic directional control valves shall be 3 - position valves; center position shall vent ports A & B to T with a pilot operated check valve. Pneumatic directional control valves shall be 3 - position with blocked center. Loss of power will cause the valve to center in order to prevent movement when power is restored. Solenoid actuated valves shall have indicator lights and manual overrides.
  + 1. Piping
* All utilities serving the furnace shall have lockable shutoff valves upstream of all operating valves and/or components to provide “zero energy state” immediately downstream.
* All machine assemblies shall be pre-piped to the machine boundary with single point connections.
* Contractor drawings shall clearly show tie-in points, connection size and type for all connections to plant piping systems (i.e. utility connections). Drawings shall also indicate tie-in points for interconnecting piping between Contractor provided components.
* All Hydraulic lines or pipes shall be stainless.
* Absolutely no hydraulic or electrical lines may be located below metal level on the furnace shell in the proximity of the walled in molten receiving window, RFI door or pouring spout.
* There shall be no services fastened to or attached to the concrete flooring or inside furnace basement wall in the proximity of the walled in molten receiving window, RFI door or pouring spout.
* Pipes should be sized to minimize pressure drops.
* Flow velocity shall be determined based upon an analysis between capital and operating costs. The connection of the equipment with the supply, production and waste lines should be as short as possible. If direction changes or branch offs are required, they shall be designed to allow optimal flow rates and minimize pressure drops. With limited space available optimization between routing and flow rates must be found.
* All piping shall be clearly arranged to facilitate inspection for damage/leakage. All piping shall be color-coded and labelled in compliance with ANSI 13.1.
* Pipe routing and location of valves, sensors etc. shall respect ergonomic ease for servicing and replacement.
* Hoses shall be resistant to ambient heat, commercial lubricants, hydraulic fluids and cleaning detergents. Metallic hoses shall be used in areas where molten aluminum spill hazard exists.
* Hoses shall be installed in such a way that they can neither be pinched nor worn through.
* All machine assemblies shall be pre-piped to the machine boundary with single point connections.
  + 1. Walkways, Platforms and Ladders
* Platforms shall be installed in all locations where inspection and maintenance are required.
* Stairs shall be installed for all elevated areas that require access. Ship ladders are acceptable.
* All handrails shall be 1.2 meters high and have 100 mm high toe guards installed.
* All walkways, platforms and stairs shall be made using checkered plates, or grating as necessary for fire prevention.
  1. Electric and Instrumentation
     1. General

This chapter specifies the documentation of electrical and instrumentation systems that is necessary to meet the requirements of a new industrial facility.

The documentation level requirements for each part are set out in the scope of work.

The intention is to design modern equipment in accordance with the needs of the entire project, including electrical and instrumentation systems.

When selecting the size and type of electrical cabinets, transformers, motors, drives etc., standardized types and ratings must be preferred to maximize interchangeability and minimize maintenance needs.

TOP (Take over point):  
- 400 V power supply for low voltage equipment – TOP is input terminal at incoming section of Contractors electrical cabinet.  
- Contractor shall provide the preliminary SLD and automation configuration diagram with his offer document.

* + 1. Ambient conditions

The proposed instrumentation will be suitable for operation in the following ambient conditions:

* Outdoor temperature max. 40 °C

min. - 30 °C

* Indoor temperature max. 50 °C (close to hot working area)

else max. 40 °C

min. 10 °C

* level above sea to 1 000 m

The Contractor acknowledges that the above information is a guide to the general design. However, the maximum temperatures to be considered will depend on the location of the equipment, which is the responsibility of the Contractor.

* MCC / distribution room 15 - 35 °C

Relative humidity 70 % (air-conditioned)

* Control room / PLC room 15 - 25 °C

Relative humidity 55 ± 5 % (air- conditioned)

* Cable tunnel / cable cellar Ventilated

Relative humidity 95 %

* + 1. Voltage and power supply conditions
* Voltage system

Medium voltage: nn kV (will be defined during engineering)

Low voltage: 0.4 kV TN-C 3+PEN, TN-C 3+PE+N

* Frequency 50 Hz
* Voltage fluctuations ± 10 %
* Frequency fluctuations ± 0.5 %
* Operation of air circuit breakers, AC contactor coils

auxiliary relays etc. 230 VAC, 1 phase, 50 Hz

* Digital input and output card,

Auxiliary relays, control voltage, solenoid / control (magnetic) valves

LED indication lights 24 V DC

* Analogue input and output card 4-20 mA (prefered) or 0 - 10 V
  + 1. Other conditions

The casting line shall be designed in accordance with the latest technological developments. It shall also be designed to allow easy interconnection with other systems. It must ensure that all parts of the process are equipped with all necessary safety features such as emergency stop buttons, limit switches etc.

The motors and controls must conform with the main mechanical equipment and process control requirements. Drives requiring speed control, positioning and coordinated operation shall be equipped with AC motors powered by a variable speed drive system. In the case of AC motor control by a frequency converter, insulated bearings shall be used. All other drives not requiring speed control, such as pumps, blowers etc., shall be equipped with constant speed AC motors and controlled from motor control centres. The control features shall be designed for easy interfacing with other control systems that are separately supplied by other contractors.

All LEDs must be the clustered LED type indicator lights.

Identification numbers shall be provided for all devices in the circuit breaker panels, control panel, motor control center, drive panel, control panel/column etc., and all terminals on the various control devices shall be interlocked terminals with engraved numbers.

A non-magnetic gland shall be provided in the electrical cabinet for termination of single core power cables.

Power for all Level 1 and Level 2 automation equipment, process AC drives and all communication/electronic/microprocessor equipment and field devices (instruments, sensors etc.) for whole Contractor and its Sub-Contractor scope (= it is not allowed to install several UPS as per Contractors scope split) shall be provided from an uninterruptible power supply (UPS) system with a minimum 30 minute battery backup provided by the Contractor.

The basic level automation system (Level 1) required for interlocking, sequencing, switching, safety etc., shall be designed using programmable logic controllers (PLCs) and PCs as specified in the section for the Level 1 automation system.

The degree of protection by the enclosure for equipment located internally and externally shall be as follows:

* Electrical cabinet/MCC IP4X (indicative, according to the required standard)
* Control panel/pulpit IP3X (indicative, according to the required standard)
* Motors (internal) IP54 (indicative, according to the required standard)
* Motors (external and pump motor) IP55 (indicative, according to the required standard)
* Local push-button station IP65 (indicative, according to the required standard)
* Junction box etc. IP65 (indicative, according to the required standard)

The design of mechanical equipment shall take into account and provide features to facilitate the maintenance of electrical equipment including motors, brakes, circuit breakers, switches, junction boxes, etc.

The following must be ensured:

* Sufficient space around each machine
* Easy access (maintenance) to each machine

Layout of electrical equipment

* Location of Low voltage panels, MCC(s), frequency converters, PLC panels, UPS for steel shop shall be as per Contractor disposition of the equipment. Locations for the above need to be indicated in the layout.
* As mentioned earlier, one central control room for centralized operation is envisaged in the shop control room building.

During engineering Risk assessment study shall be elaborated according to requirements of norm ČSN EN ISO 12100. Study shall define requirements to ‘Safety Integrity Level’ (ČSN EN ISO 13849-1) and ‘Performance Levels’ (ČSN EN 62061).

Salient technical features of equipment and system

* Contractor in his design shall include the technical features of equipment and system as mentioned in the following section.
  + 1. Main technical features

In their proposal the Contractor must include the following technical features (whereever applicable) as they are listed below.

* Medium voltage electrical cabinets

1. Medium voltage electrical cabinets are within the scope of the Customer. Monitoring and remote control of this electrical cabinet to the indoor substation will be the responsibility of the Customer.
2. The Contractor will only be responsible for monitoring (status of disconnector, circuit breaker, consumption etc.) of this electrical cabinet for local maintenance purposes. The Customer shall provide the Contractor with the bus interface. Monitoring will be designed using a simple schematic in a level 1 system accessible on the control panel (HMI)

* Medium/low voltage transformers (or, potentially, another transformer – Customer scope)

1. Transformers must be the dry-type tranformers
2. Transformers will be naturally ventilated
3. IP rating IP2X

* Low voltage electrical cabinet

The scope of engineering work under this tender will include basic data for the low voltage electrical cabinet, but detailed engineering is required for integration into the control system.

Below are the technical properties of the 400 V electrical cabinets (or, potentially, other low voltage cabinets):

1. The preferred type is the standard fixed cabinet type.
2. Each transformer MV/0,42kV (Customer scope) or shall be connected to the independent power distribution switchboards.
3. For back up purpose will be incoming section of power distribution switchboards interlocked with another power distribution switchboard (with automatic coupling section). The switchboard shall be provided with automatic incoming feeder transfer in case of breakout of main feeder from transformer.
4. Each medium/low voltage transformer (Customer scope) must be connected to independent electrical cabinets.
5. The short circuit current level is 50 kA for 1 second.
6. IP rating to be IP4X (indicative, must comply with the required standard). The design must take into account the external influence assessment.
7. Electrical cabinets shall include one spare section for future needs.
8. The input and output status of all power supplies must be monitored. It is necessary to provide a Remote IO connection to the PLC (using auxiliary contacts for the power supplies) and to indicate it on level 1 of the HMI.
9. A device measuring voltage, current, power consumption etc. is installed on the input part - connected via a bus system to the PLC and indicated on level 1 of the HMI.
10. All feeders will be equipped with a pull-out circuit breaker and motor charging and will also have remote control (PLC) capability from a Level 1 HMI.
11. Busbar material shall be made of copper.
12. The internal wiring of the electrical cabinet will be marked and all electrical cabinet equipment will be tagged.
13. The Contractor must bear in mind that it is not possible to connect several auxiliary contacts for power supplies, contactors and similar items in series to the respective PLC/Remote IO digital inputs. Each auxiliary contact must have a separate PLC/Remote IO digital input.
14. Number of outgoing feeders shall be as per requirement.
15. All feeders shall ensure safety and galvanic outage with possibilities lock in outage status for example by fuse disconnector or lock on circuit breaker. Equipment has to meet safety norm of Customer.

* AC motors and control units

1. The asynchronous motor with cage shall be designed, manufactured and tested according to IEC 60034.
2. A motor with an output of less than 350 kW must be supplied from a low-voltage grid and a motor with an output of 350 kW or more must be supplied from a medium-voltage grid. The motors shall be continuous duty, totally enclosed, fan cooled (TEFC), IP54 rated (IP55 for a pump motor), Class F insulated with temperature rise limited to Class B at 100 % load.
3. If necessary, an electro-hydraulic brake with low-voltage three-phase motors and a limit switch to release the brake to be used, e.g. for tilting furnace drives etc.
4. All accessories, such as digital tacho/pulse encoder, brakes etc., as required, shall be supplied. Adequate motor ventilation with air-to-air heat exchanger shall be provided along with the required monitoring equipment. Motor cooling at low speed and rated power shall be provided. Motor cooling in the IC number shall be clearly indicated. The number of motor frame sizes shall be standardised and kept to a minimum as far as possible.
5. Built-in Pt100 temperature sensors are considered for all motors with an output of 20 kW and above that require speed control, and the signals shall be interfaced to the automation system for central parameter monitoring in addition to the standard alarm and shutdown functions implemented in the drive system.
6. Motor shall be energy efficient type. The motors must comply with EU Regulation 640/2009 as amended by EU Regulation 4/2014, EU Directive 2009/125/EC and EN (IEC) 60034 or later applicable standards. All motors shall comply with IE4 efficiency, but at least IE3 according to EN60034-30.
7. Anti-condensation heaters shall be provided for motors located outdoor.
8. Medium voltage motors and other motors where applicable shall be equipped with a bearing temperature and vibration monitoring system at the end of the drive and beyond, anti-condensation heaters, in addition to duplicate resistive temperature detectors (PTC) for each phase winding. This also applies to all fan IDs (primary/secondary) regardless of voltage level.
9. Also phase segregated power terminal box and separate control terminal box with brass cable glands for termination of anti-condensation heaters and winding RTDs.
10. For variable speed applications the motors must be inverter type.
11. Any additional motor mounted equipment required for the process must be available.

* Motor Control Centers (MCC)

The MCCs shall be equipped for the control of low voltage motors as well as for the supply and control of feeders for downstream equipment with all necessary arrangements for interfacing via Remote IO with PLCs and Level 1 controllers. Technical properties of the low voltage MCCs are specified below:

1. A standard fixed (preferred smart type with bus communication to PLC to ensure full diagnostic and data exchange) MCC type is preferred.
2. The short circuit current level is 50 kA for 1 second.
3. IP rating: IP4X (indicative, must comply with the required standard). The design must take into account the external influence assessment.
4. A contactor and electronic overload relay must be provided for motors rated 7.5 kW and above, and a motor protection circuit breaker (MPCB) must be provided for motors rated less than 7.5 kW. For motors rated 90 kW and above up to 350 kW, a YD (star-delta) starter shall be provided.
5. One section shall remain free as a spare for future needs.
6. All feeders shall provide safety and galvanic failure with the possibility of interlocking in a fault condition, for example by a fuse disconnector or circuit breaker interlock.
7. The status of all input and output feeders must be monitored. The necessary connection to the Remote IO with the PLC (auxiliary contacts for the power supplies) must be provided and indicated on level 1 - HMI.
8. A device measuring voltage, current, power consumption etc. shall be installed on the input part - connected via a bus system to the PLC and indicated on the HMI level 1.
9. All feeders will be equipped with a pull-out circuit breaker and motor charging and will also have remote control (PLC) capability from a Level 1 HMI.
10. Motor output feeders of 15 kW and above must have an ammeter – except motors are controlled by frequency converter or smart MCC = integrated ammeter with communication to automation systsem.
11. Output feeders with directly controlled switching elements/contacts must be controlled and connected via the bus system to the PLC and indicated on the level 1 HMI.
12. Busbar material shall be made of copper.
13. The internal wiring of the electrical cabinet will be marked (tagged) and all electrical cabinet equipment will be tagged.
14. The Contractor must bear in mind that it is not possible to connect several auxiliary contacts for power supplies, contactors and similar items in series to the respective PLC/Remote IO digital inputs. Each auxiliary contact must have a separate PLC/Remote IO digital input.

* Variable speed drive

1. For a variable speed drive, the AC induction motor must be powered by an IGBT (insulated gate bipolar transistor) type inverter with a fully digital microprocessor based control system. Individual variable speed drives shall be provided for individual motors requiring speed and torque control.
2. The enclosure of the drive must have a minimum IP31 rating.
3. If necessary, the active front end must be mains regenerative (no braking resistance).
4. The VVVF drives shall generally be sensor less vector controlled and shall have provision for hardwired as well as bus interface with PLC of level-1 automation system.
5. Cast resin insulated converter transformer shall be provided for VVVF drive where is necessary.
6. VVVF will have necessary input and output filters or reactor for prevention against influence to the electric net.

* Control station

1. The main control console in the control room must accommodate HMI terminals. The control console to be equipped with all necessary control switches, buttons, signal lamps, joysticks etc. As required for control of the entire line, it must be of the fully enclosed floor mounted type, dust and pest proof, with vertical sides and sloped tops. The top of the control console shall be stainless steel plate.
2. The controls and instruments to be located on the various control consoles shall be grouped for convenient operation and shall include those items necessary to meet the ultimately established control and operating philosophy.
3. Local control pulpits shall be provided for convenient operation and maintenance, in addition to remote control from the control room.
4. Wherever more than one control console is provided to control a common machine, the necessary control switches will be provided, along with indicator lamps for switching control from one console to another, with a confirmation function.
5. For all drives, a local control/pushbutton station (LPBS) shall be provided and shall be located in the vicinity of the relevant equipment. LPBSs for non-reversible drives that are controlled via a Level 1 automation system shall be equipped with 'Start', 'Stop' and 'Emergency Stop' buttons along with an indicator light showing 'Locally Selected', while LPBSs for reversible drives shall additionally be equipped with 'Forward/Open/Up' and Backward/Close/Down' buttons and a 'Start' button is not required. However, for drives not controlled by a Level 1 automation system, a "Local/Remote" switch shall be provided on the appropriate LPBS instead of the "Locally Selected" indicator. The 'Emergency Stop' buttons shall have a mushroom-shaped head and be of the 'press to lock and key to release' type.
6. The IP rating of the control console shall be IP4X and the local control pulpits IP65 (indicative, must comply with the required standard). The enclosure for the local control pulpits must be sheet steel. The top of the control console shall also be made of stainless steel. The design must take into account the external influence assessment.

* Junction box

The required number of local junction boxes shall be provided. The junction box rating will be IP65. The enclosure for the local junction box to be made of sheet steel. The design must take into account the external influence assessment.

* Uninterruptable power supply (UPS)

Power for all Level 1 and Level 2 automation equipment, process AC drives and all communication/electronic/microprocessor equipment and field devices (instruments, sensors etc.) for whole Contractor and its Sub-Contractor scope (= it is not allowed to install several UPS as per Contractors scope split) shall be provided from an uninterruptible power supply (UPS) system with a minimum 30 minute battery backup provided by the Contractor.

* UPS shall be fed from 400 V switch board
* The UPS unit shall comprise but not be limited to the following,
  + - * + Incoming circuit breaker
        + Isolation transformer
        + UPS modules considering parallel redundant load sharing arrangement
        + Ni-cd battery for 30 min.
        + 230 V distribution for power distribution to various loads
* Technical parameters

|  |  |  |
| --- | --- | --- |
| Rating | **:** | To suit requirement and + 30 % spare capacity for future loads (to be supported with calculation) |
| Input voltage | **:** | 400 VAC ± 10 %, 3phase, TN-C 3+PEN, TN-C 3+PE+N |
| Output voltage | **:** | 230 VAC± 1 %, single phase |
| Output frequency | **:** | 50 Hz ± 0.1 % |

* Each UPS distribution circuit breaker need to be monitored (auxiliary contact as PLC input / Remote IO). Contractor to note that no serial connection of several auxiliary contacts for feeders, contactors and similar items to respective PLC / Remote IO digital inputs are to be considered. Each auxiliary contact needs to have separate PLC / Remote IO digital input.
* UPS unit shall be connected via bus communication for monitoring to respective PLC.
* Power and control cables and installation material

#### All electrical devices must be designed to withstand the environment in which they are to be used. Temperature is of particular concern, especially for those devices which are mounted above or near molten metal or near furnaces.

Cable sizes shall be designed and standardized during the design phase, taking into account the following properties:

1. Single or multi-core armoured cables with PVC insulation, dimensions 500, 400, 300, 240, 150 and 95 mm2.
2. Class 1.1 kV, single or multi-core, PVC insulated and PVC sheathed copper cables with dimensions ranging from 1.5 to 500 mm2 and to be standardised during the design phase.
3. Class 1.1 kV, multi-core, PVC insulated and PVC sheathed copper control cables with the following dimensions and core numbers:

Core number Dimensions, mm2

2, 4, 7, 10, 16, 24, 48 1.5 (for control, indication

PLC input/output)

1. When there are three or four cores in a cable, one core must be spare and when more than four cores are used, there must be 20 % of spare cores.
2. Special signal cables including shielded twisted pairs and shielded control cables required for signal transmission shall be provided. A fibre optic cable shall be provided for data transmission.
3. The hot zone (for example around furnace(s), launders, casting area) must have heat resistant power and control cables according to the ambient conditions at the workplace.
4. Different cable trays/ducts must be used for different voltage levels.
5. Mixing voltage levels on the cable is not allowed.
6. Any cables used for data transmission (regardless of the system) must be installed in isolation from other cable types.
7. All bus and network cables are to be measured and an inspection protocol is to be provided.
8. Exposed conduit shall be rigid zinc conduit.
9. All conduit, grounding and piping shall be routed to avoid likely molten metal spill and heat release areas such as around doors, throughs etc.
10. Floor penetrations and pits shall be curbed to prevent metal spills from damaging conduit and piping systems or from entering pits.
11. Where trenched utility chases are required, the trench is to be filled with sand or other protective material if in close proximity to potential molten metal spills.
12. Common equipment ground to be provided for all electrical components via conduit or separate conductor.
13. Low level signal instrumentation wiring shall be Teflon insulated (150 °C to 200 °C).
14. Thermocouple extension wire shall be type PLTC, PVC / PVC with overall shield, type KX.
15. Thermocouple extension wire for high temperature areas shall be type FEP / TEP insulated cable.
16. Fiber Optics Cable:  
    - Multimode fiber optic cable (50/125) for general short haul application internal to any single infrastructure – cable color: Orange.  
    - Single-mode fiber optic cable (9/125) for long haul fiber optic runs, typically by carriers that have implementations over several miles providing connectivity between two facilities – cable color: Yellow.
17. All communication or networking cable, if utilized near or around high temperatures shall be plenum rated.
18. If Contractor is responsible for equipment installation, then the Contractor shall be responsible for purchasing and installing all equipment grounds and ensuring that all equipment is properly grounded. Contractor shall be responsible for tying in equipment grounds to the existing plant ground grid. Connection to grid shall be via Exothermic Weld using 4/0 copper cable (or equivalent), green & yellow colored jacket required were exposed.
19. Identification:
    * + All cables shall be identified by cable tagging at both ends, identifying the cable and the individual wires by color and wire number. The tagging shall indicate the purpose, source and destination of the cable.
      + Each wire shall be identified by wire number on both ends. Wire labels shall be pre-labeled tubular type.
      + Devices located in electrical panels, terminal boxes, or mounted on stands, shall be labeled with a device tag identifying the device. The tag shall be permanently attached to the component. If the component is mounted on a mounting plate, the plate shall also include the identity of the device.

* Grounding

1. Complete earthing system design shall be provided for the total earth resistance value for the new buildings must be within respective norm (Information for BD purpose)
2. The dimensions of the grounding conductors and their installation must be in accordance with the applicable standards.
3. A separate electronic grounding system shall be provided for the various units covered by this specification for AC drives, PLC, Level 1 and Level 2 automation system, instrumentation system etc. The total electronic grounding resistance values per device shall not exceed 0.5 to 1 Ohm
4. All non-current-carrying metal parts of various electrical equipment as well as cable fittings, trays etc. must be properly grounded.

* Protection against lightning (section for BD purpose)

Lightning protection must be provided wherever necessary. The separate grounding system for lightning protection shall be complete with grounding electrodes, grounding conductors and accessories as required by the standard.

* Illumination system (section for BD purpose)

Illumination system shall be in Contractor scope for all building which in scope of turnkey. It means especially:  
- Indoor lighting  
- Outdoor lighting   
- Emergency lighting

Number of lamp and intensity of lighting shall be according norm for concrete space. LED type of lamp will be preferably used.

* Maintenance socket distribution (section for BD purpose)

For new buildings and equipment will be installed socket box 400 VAC with one socket 63 A, one socked 32 A and four socked 16 A.

Number of sockets will such that it can be without problem make maintenance and repair of all installed equipment, piping, building, infrastructure etc.

* Fire signalization (section for BD purpose)

To the new building with dispatch center will be installed new central exchange. Number and location of fire signalization sensors will be implemented according norm and fire brigade.

* Telecommunication and data distribution (section for BD purpose)

For new buildings and equipment will be installed new IP telecommunications and data distribution systems, especially to the pulpits, dispatch centers, maintenance rooms, operation rooms, electrics rooms, social building, and offices.

* Intercommunication System (section for BD purpose)

An intercommunication system will be provided for the whole plant with a sufficient number of communication units in the production areas, electric rooms, hydraulic stations, civil rooms/buildings, at each gate, at local control boxes etc.

* Painting of Equipment

For all electrical, instrumentation and automation equipment necessary steps shall be taken in treating all enclosures, plates, frames, fixtures etc. to prevent any rusting, corrosion or any other physical damage to the equipment or the components thereof.

Shade agreed during finalization of tender for finish coat to be applied for equipment installed indoor. All equipment to be installed in the control room shall generally have paint shade RAL 7032.

* Electrical cabinet base requirements

1. Self-Standing floor mounted type, Front/Rear access door (  
   rear door if required).
2. Protections: IP 20 without doors by standing in separate PLC room / IP54 or better as standalone by standing in production hall or other non-electrical rooms.
3. Dimensions
4. Height: 2000 mm
5. Width: 800 mm (minimuim, as per final design)
6. Depth: 600 mm
7. Socket: 200 mm (no socket required in rooms with raised floor)
8. Cooling units if necessary
9. Color: RAL7032
10. Cable entry: Bottom
11. Cabinet lighting
12. Power outlet for computer etc.
13. Power supply for low-voltage main distribution board
14. 400 VAC 3 Phase UPS power supply.
15. Separate 230 VAC for socket, lightning without UPS power supply.
16. Over voltage protection

* Electrical cabinet door locks

All supplied electrical cabinets, control pulpits, junction boxes etc. shall have the same door lock design.

Door lock type for "2bit 5 mm key" - Select which one

Obsah obrázku skica, diagram, kresba, Technický výkres

Popis byl vytvořen automaticky Obsah obrázku kovové předměty, Železářské zboží pro domácnosti, klíč

Popis byl vytvořen automaticky

Door lock type for "8 mm triangle key" - Select which one

* Type of electric devices (frequency converter, MCC, PLC / Remote IO, circuit breakers etc.) to be standardized – including sub-contractor packages / package units!
* Drawings to be handed over in editable form (DWG for layout drawings, EPLAN for circuit diagram drawings) and as PDF.
* Emergency power back up

As mentioned in one of the earlier emergency power back up shall be provided for ‘black out’ type of situation. Contractor is requested to include this into respective Contractor’s low voltage distribution and automatic switching elements.

* 1. Automation Instrumentation Equipment
* For general, standards, battery limit, scope of work, installation, testing and commissioning, design basis, voltage and power supply conditions, layout of equipment, painting shall follow the guidelines mentioned in the electrical part.
  + 1. General equipment specification
* The design of the instrumentation system must be based on the latest technology and spare parts and service support must be available. Contractor provided instrumentation shall be calibrated prior to shipment to meet contractor’s published accuracy.
* All transmitter output signals shall be minimum isolated 4-20 mA DC or in case applicable signal output via bus communication. Transmitters shall be suitable for the environment in which they are to be located and shall meet all applicable codes.
* Flow measurement elements shall be differential pressure devices (orifice plate, pilot tube, etc.) or integrated mass flow control.
* Water flow measurements shall be based on electro-magnetic principe.
* Gas and Electric energy metering shall be accurate to 0.5 % unless otherwise specified in the specific equipment specification.
* For any fan (above 15 kW), continuous vibration measurement at minimum four points using acceleration type sensors with locally mounted transmitters for 4-20 mA DC signal outputs for PLC based system.
* Signals having different voltage levels shall not be mixed-up in same cable or same tray.
* Fan speed measurement shall use encoders.
* Noncontact type proximity switches shall be considered to suit the process requirement.
* Control valves shall generally be of the electric or pneumatic type, but for the gas handling area the control valve shall be of the pneumatic type with smart positioner.
* All Contractors provided instrumentation shall be calibrated prior to shipment to meet Contractors published accuracy.
* Flow measurement elements shall be differential pressure devices (orifice plate, pilot tube etc.).
* Water flow measurements shall be based on electro-magnetic principe.
* All valves, dampers, flow actuators or other final control elements shall be suitable for the installation environment and designed for a 4-20 ma DC input control signal.
* The body of the control and shut-off valves shall be stainless steel.
* An electro-pneumatic actuator shall be used to open and close the valves. Open and close limit switches shall be included to monitor valve position.
* Field mounted gauges shall be phenolic or stainless steel construction and have 100 mm diameter dial. Remote seal gauges shall include stainless steel diaphragm and suitable fill fluid for the application. Fluorocarbons or flammable fill fluids will not be permitted.
* All impulse lines, instrument air lines and fittings and accessories shall be of stainless steel. Impulse lines/instrument air lines shall have 2 mm thickness
* All control valves (pneumatic, hydraulic, …) need to send back actual position for movement / position monitoring.
* Local gauges like those for temperature, pressure, differential pressure etc. shall be provided.
* All local temperature gauges shall be bi-metallic type.
* All transmitters must have an integrated type divider.
* The leakage class of all safety shut-off valves shall be Class VI.
* All control and shut-off valves shall have a handwheel for emergency operation.
* All impulse lines and fittings and accessories shall be of stainless steel. Impulse lines/instrument air lines shall have 2 mm thickness.
* Hydraulic tank level interlocks shall have safety switches as per norm needed and analog level / temperature measurement (4-20 mA) for monitoring and respective alarm level adjustment via L1-HMI.
* Hydraulic pressure measurement shall be analogue (4-20 mA) with local display.
* Hydraulic filter (differential pressure) monitoring shall be analogue (4-20 mA) with local display.
* Water temperature measurement shall be analogue (4-20 mA) with local display (in case not possible in parallel installation of mechanical gauge measurement for local temperature verification).
* Water flow measurement shall be analogue (4-20 mA) with local display – electro-magnetic type.
* Lubrication tanks shall be equipped with minimum following level switches and option shall be provided for analog type (4-20 mA) level monitoring:  
  - Max  
  - Min  
  - Min min (shall be mandatorily safety switch)
* Lubrication line pressure switches and pressure switches for other systems shall be analogue (4-20 mA) with local display.
* Water or any kind of media (compressed air etc.) filter (differential pressure) monitoring shall be analogue (4-20 mA) with local display.
* Control, proportional, servo valves (for any kind of media and) to have 4-20 mA position feedback signal
* Control, proportional, servo valves (for any kind of media and) to have 4-20 mA position command signal – Except special type valve with different command signal (bus communication).
* Mounting hardware for measurement and control devices, actuators etc. must be designed to minimize vibration. Necessary modifications to mounting hardware due to vibration are at the expense of the Contractor.
* All powered throttling valves shall have integrally mounted feedback positioners.
* Any on/off control elements shall be mounted with necessary solenoids or pilots.
* All on/off control elements shall be equipped with the position sensing limit switches to signal both fully open and fully closed.
* All actuators shall be capable of local manual override operation.
* Totalizers shall be calibrated in liters, Nm3 or kilograms of consumption and shall be installed so they can be reset (to 0) by remote contact closure.
* Natural gas/totalizing meters shall be equipped with a contact closure for each 10 or 100 normal cubic meters (Nm3) of gas.
* Contractor shall provide a CE approved flame detection devices to provide safe operation of equipment. Flame protection relays shall be provided to match the detection devices. The flame protection system shall be capable of independent operation separate from the control system. However, all events/alarms to be monitored by the PLC system.
  + 1. Casting line specific

Below points should be understood as a minimum – final as per Contractors engineering and needs.

* Temperature sensors for metal:  
  - At launder before degasser  
  - At degasser unit  
  - At head box
* Temperature sensors at water cooling circuit:  
  - Common water inlet temperature  
  - Temperature of each return line (Upper / lower casting roll, pinch rolls, whereever applicable).  
  - Temperature at hydraulic tank unit.
* Metal level (non-contact based – laser based):  
  - Before filtration unit  
  - After filtration unit (delta level shall indicate clogging status of filter)  
  - At head box (used for metal level control in head box)
* Metal level actuator:  
  - Electric linear actuator (used for metal level control in head box)
* Pressure sensors:  
  - Casting roll hydraulic pressure – on both sides = drive side and opposite side, on piston and rod side (used for force calculation and for hydraulic pressure control)  
  - Pinch rolls hydraulic pressure on both sides = drive side and opposite side, on piston and rod side (used for force calculation)  
  - Shear hydraulic pressure on both sides = on piston and rod side (used for force calculation)  
  - Hydraulic pressure at each pump  
  - Common water inlet pressure  
  - Water pressure of each return line (Upper / lower casting roll, pinch rolls, whereever applicable).  
  - Spray (graphite) air pressure at upper casting roll  
  - Spary (graphite) air pressure at lower casting roll
* Flow sensors:  
  - Common water inlet flow  
  - Water flow of each return line (Upper / lower casting roll, pinch rolls, whereever applicable).  
  - Degassing unit process gas flow
* Level sensors:  
  - Level at hydraulic tank  
  - Level at expansion tank at water cooling circuit
* Speed:  
  - Degassing unit rotor speed  
  - Grain refining unit feed speed  
  - Upper casting roll speed  
  - Lower casting roll speed  
  - Upper casting roll spray (graphite) drive speed  
  - Lower casting roll spray (graphite) drive speed  
  - Miller speed  
  - Pinch roll speed  
  - Coiler/winder speed
  1. Control System and Automation
     1. General

This chapter specifies the documentation of control and automation systems that is necessary to meet the requirements of a new industrial facility.

The documentation level requirements for each part are set out in the scope of work.

The intention is to design modern equipment in accordance with the needs of the entire project, including control and automation systems.

The control system used to manage the individual processes will be designed to ensure that all processes operate and communicate reliably. The system will control and monitor all processes and measured variables. The status of the process units and the measured quantities will be displayed on the control console and on the PC monitor in the control room. Inputs and permissions to the individual program levels will be accessible according to the rights defined by Customer.

The caster control system need to communicate (full data exchange via suitable bus communication system) with upstream connected holding/melting furnace, all process required systems like fume exhaust system, electrical distribution system, Water treatment plant and other auxiliary plant overall plant systems. Implementation of general overview information (status, main data, alarm/warning) at Contractors HMI systém. has to be considered and implemented by the Contractor. Details to be defined during engineering phase.

Interface to other Customer systems like:  
- Connected upstream holding/melting furnace  
- Laboratory  
- MES  
- Others if applicable  
have to be considered by the Contractor. Details to be defined during engineering phase.

The system will be equipped with acoustic and light fault signalling. The system will store all technical-technological data and this data can be recalled, printed and further processed at any time. The control system will allow:

* ongoing monitoring of blocking conditions
* monitoring and control of the whole process
* monitoring and automatic testing of the control automaton, including sensors and actuators
* signalling of deviation of operating parameters from the set values
* back check of set limits
* continuous monitoring of instantaneous power consumption
* controlled process visualization
* the control system will allow and be equipped for remote connection
* the caster control system will be ready for connection to the data collection system

The delivery includes the supply of cables and cable routes to individual machine units.

* + 1. Level 1 automation system
       1. General

The Level 1 automation system shall monitor and control all significant variables in accordance with process requirements, providing all operational requirements and necessary sequencing, interlocking and safety functions including alarms for abnormal conditions. The Level 1 automation system shall be designed as an integrated system for drives, controllers and automation of the entire line.

* The caster software specifications for the Level 1 automation system include, but are not limited to, the following:

1. All PLC systems shall be of the same make and the same series.
2. Each PLC must have a power supply module and a CPU communication module.
3. Safety circuits shall be designed using the SAFETY PLC.
4. Each bus system must be designed as "circular" (circular closed topology). A bus system within a single electrical box does not need to have a closed topology.
5. Active online bus diagnostics must be maintained. Each station/device connected to the relevant bus system must be visible with the maximum possible online diagnostic information (status/fault message or warning code).
6. At frequency converters full bus communication data (commands, set points, actual values, status/fault or warning code) has to be visible on HMI.
7. Remote input/output units connecting inputs/outputs in different areas of the casting line.
8. Input/output modules must have active online diagnostics.
9. For signals from field devices (sensors, instruments etc.) online hardware diagnostic (wire breakage detection etc.) has to be installed (usage of respektive DI/DO/AI/AO card).
10. Data bus connecting the PLC and HMI units and remote I/O units to the PLC.
11. Two (2) Nos. portable laptop type programming terminal for the PLCs mentioned above, with all required system software packages and accessories (cables etc.).
12. Monitor for servers and HMI/SCADA operator stations (located in pulpit etc.), etc. must have a 27" widescreen (state-of-the-art); minimum screen resolution of 1920 x 1200. In case of touchscreen monitors for local operator stations/panels size should be selected by the Contractor, but Contractor shall inform Customer before ordering regarding size and location. Target shall be max. possible size to ensure information required for process are displayed in sufficient size and quality.
13. The Web Remote HMI client system will be accessible from the "Customer's" network. The Customer will hand over the user access list to the Contractor during the project processing.
14. Production views, diagnostic views, maintenance views, trend views and historical data must be accessible on Web Remote clients.
15. The operating system for PC-based HMI units must be Windows-based. The system shall be equipped with standard software packages such as multi-program executive routines, protocol formats, compilers, assemblers, editors and utility packages. The required application software licences shall be included.
16. Additional software, e.g. antivirus, communication, MS office etc., necessary for the implementation of the functions and completeness of the system must be included.
17. The HMI/SCADA screens must be in Czech and English.
18. The programming language must be in English.
19. Separate grounding of electronic devices and grounding of the electrical cabinet.
20. Online diagnostics of field devices (measurement, valves etc.), where is applicable (bus communication etc.).
21. The Ethernet switch must be of the manageable type and the required number of optical ports must be taken into account. Type to be agreed with Customer during basic engineering.
22. Each network component must have a fixed IP address (without DHCP).
23. Establishment of links / communications and required integration into L1 automation system as well as necessary hardware and software amongst the following systems (where applicable):

- BUYER’s automation system like dedusting system, water treatment plant, substation, building related automation equipment.

1. There must be 3 independent Ethernet levels.

* PLC network (communication between PLC and Level 1 + 2 "warm backup" servers)
* Level 1 network (communication between level 1 server and level 1 clients = workstations)
* Level 2 network (communication between level 2 server and level 2 clients = workstations)

1. All computers, servers, client stations must be equipped with the maximum state-of-the-art RAM and hard drives available at the time of project implementation/delivery.
2. All monitors must be of the same type/manufacturer to ensure interchangeability between different clients and different levels (level 1 or 2).
3. All software licenses shall have unlimited validity. In special cases where unlimited validity is not possible, the maximum validity by mutual agreement will be taken into account.
4. Sub contractor packages need to be connected via respective bus communication system (= stand alone system with just status OK / Not OK communication is allowed). Sub contractor package(s) can have its own HMI system, but full integration to overall Contractors caster HMI / SCADA system has to be considered = full communication and integration of status / alarm / values to overall PLC / HMI / SCADA to ensure central monitoring.
5. Level 1 automation shall have features to enable and predict proactive preventive maintenance requirements. Such as the view of operating hours of engines, pumps, fatigue cycles (e.g. for cylinder movement, valve operation, ...) etc., coupled with warning messages (e.g. for preventive inspection, seal replacement, lubrication, oil check, ...).
6. The Contractor must bear in mind that it is unacceptable to connect several auxiliary contacts for power supplies, contactors and similar items in series to the respective PLC/Remote IO digital inputs. Each auxiliary contact must have a separate PLC/Remote IO digital input.
7. There must be full access to the source code. The know-how protection area must be clear specified and listed up with transmittal of the bid.
8. Ethernet switches must be supplied by a reputable manufacturer (e.g. CISCO, HP etc.).
9. Ethernet network panels for Servers / client stations with related required equipment like network switch / FO patch panels / other required network accessories / UPS circuit breakers with front and back side doors to be placed in respective rooms. Connection from network panels to respective working place / desk shall be done with respective cable connection (for example KVM or similar). Inside of each network panel has to be space reserve for minimum 2 additional computers for Customer purpose. At control room one complete empty network panel shall be available with respective power sockets and network accessories.
10. Working place / desk shall be “cable-free”.
11. Each individual control desk shall be equipped with CCTV, Intercom, telephone.
12. Keyboard in Czech and English layout for all computers (level 1 / 2 and maintenance).
13. IP address and password/user access definition to be fixed in cooperation with Customer's IT-department during basic engineering stage.

* The Level 1 automation system shall provide both process control and drive control/interlock functions for the complete casting line (from furnace TOP up to packing equipment), including operation and status monitoring of all drives, pumps, fans, valves etc.
* PLC programming: Instruction List (IL) programming shall be avoided. Ladder programming is the preferred language, but programming may be done in CFC (Continuous Function Chart) or in FBD (Function Block Diagram). If Instruction List programming is necessary due to system requirements, then it shall be commented in detail (each line). The IL code shall be separated into networks according to functionality and the networks shall be commented in detail.
* The configuration of the automation system must be designed to achieve the following operating modes:

1. Computer control mode
2. Automatic control mode
3. Remote-manual mode
4. Local mode

* Failure/unavailability of the Level 2 system shall not impede the operation of the Level 1 system or affect normal production.
* For critical parameters, an audio-visual message with "CONFIRMATION" and "RESET" function should be considered.
* Various alarm levels on Level 1 - HMI

1. Critical (= process stopping alarm)
2. Alarm (= immediate operator's intervention required)
3. Warning (= advance warning for an impending alarm situation)
4. Event, information (= any kind of motion monitoring, process run/stop status, any kind of operator intervention from local panel or remote screen or level 1 HMI screen).

Everything must be recorded in the level 1 historical archive – HMI / SCADA.

* A Level 1 HMI / SCADA system shall provide the following functions and features (In detail for the Contractors scope = from furnace TOP up finished coil at coil car including weighing unit AND overall information of the upstream furnace equipment as well as connected Customer equipment (such as substation, water treatment plant etc.):

1. Caster operation and monitoring of the whole process displaying all installed sensors, measurements, signals from sub-units, drives etc.
2. List up of all preconditions/interlocks for any kind of control (automatic, semi-automatic sequence etc.) or operation etc. to ensure easy and fast (without necessary checking of PLC program) respective condition.
3. Recipe management (read only by operation team, write/read by technology engineers). – As per alloy with all parameter required for the process within Contractors scope
4. System configuration and PLC programming.
5. Dynamic interactive graphic displays group displays loop (PI) displays.
6. PI drawing of all related medias (water, compressed air, argon, hydraulic etc.) as per project scope with all PLC connected devices.
7. Real-time trends and historical trends.
8. Process alarm and event monitoring.
9. Diagnostic alarms and event monitoring.
10. Real-time alarms / events and historical alarm archive.
11. Ability to filter alarms by device / alarm level / area.
12. Data logging and online configurable report generation.
13. Multilevel password.
14. Real-time server database.
15. Possibility of remote Internet access for troubleshooting, software upgrade, data analysis.

* Diagnostic screens for maintenance diagnostics - The HMI/SCADA must display, among other things:

1. Frequency converter / MCC (status/control expression/required values/actual values according to bus communication with online mode).
2. Safety logic (E-Stop, E-Limit switches etc. - blocking a particular function/process etc.).
3. Single line diagram with status of all available signals from circuit breakers etc.
4. UPS diagnostic
5. Hardware configuration with complete network diagnostics (Ethernet/any installed bus system).
6. Active online bus diagnostics must be maintained. Each station/device connected to the relevant bus system must be visible with the maximum possible online diagnostic information (status/fault message or warning code). Respective alarming information to be available as alarm message in alarm system / archive.
7. IOs (Digital / Analogue / Counters / etc. modules) arranged as per PLC / remote IO configuration (arranged as per PLC Hardware configuration; status of respective DI / DO (0 or 1) or AI / AO (analogue rough value) or Counter module (counter value) to be available on respective IO point.
8. Analog measurement with alarm level setting (HH-very high, H-high, L-low, LL-very low), gross value display, simulation option (for testing software functions), alarm enable function, different colors for different alarm levels.
9. Alarm level setting.
10. All feeders to the control cabinets are monitored (analogue voltage value), all 24 VDC power supplies are monitored (analogue voltage value).
11. Operating hour counters for motors, pumps etc. (with counter reset function).
12. Preventive maintenance information system (equipment status, preventive inspection information, ...).
13. Full data model scope for realizing full access of HMI / SCADA system for process control, process and system diagnosis, parameter settings, regulator / quality analysis.

* Various password levels for:

1. Administrator
2. Maintenance
3. Process Engineer
4. Operator

* All metering and control of utilities, gases and energy systems must be implemented in the PLC system of the respective area.
* Large displays (if required) for displaying temperature etc. shall be seven-segment LED type, 100 mm in size for each area, with suitable IP rating (IP54).
* All digital displays on the control panels must be suitably connected to the PLC via a bus connection.
* Automation system acceptance criteria:

|  |  |  |
| --- | --- | --- |
| a) | Level 1 automation system availability | ≥ 99.9 % |
| b) | HMI screen refresh time | ≤ 1 s |
| c) | I/O scanning time, data update time | ≤ 20 ms for analogue signals  ≤ 20 ms for digital signals  *Data requiring higher scanning speeds are processed as a priority.* |
| d) | Network bandwidth usage (average 5 minutes)  *Measured continuously for 8 hours* | < 10 % |
| e) | Available free memory capacity  (for system, server and PC, DCS/PLC controller) | ≥ 50 % (after commissioning) |
| f) | Spare I/O capacity of each type at each location, spare base bus modules | ≥ 20 % (after commissioning) |
| g) | CPU load (average) | ≤ 50 % (after commissioning) |
| h) | CPU cycle time | Max. up to 50 ms for a normal cycle  Average 30 ms for a normal cycle |
| i) | Data backup | i. Historical data shall be available at the HMI operator station for at least 180 working days  ii. Availability of historical data for a minimum of 2 years on an external storage device |
| j) | Maximum response time for full screen update (background and foreground) | ≤ 2 s. (the 2 s refer to the time from the function request to the end of the display) |
| k) | Ethernet switch | Minimum of 40 % free (unused) ports per Ethernet switch (after commissioning) |
| l. | L1-HMI tag licenses | Minimum 50 % free available tag license (after commissioning). |
| m. | L1-HMI historical data base tag licenses | Minimum 50 % free available tag license (after commissioning). |
| n. | IBA for fast data recording with | £ 5 ms scanning rate |

* + 1. IBA for data collection / diagnostic

Contractor to supply one common IBA system for all 4 lines collecting process data directly from the PLC CPU in fast cycle (cycle time to be defined during engineering as per need to process). Tag license (with future possible upgrade) shall cover min. 100 tags per line. A separate IBA server to be supplied by the Contractor ensuring data storage of minimum 1 year. The system shall be modular with possibility to upgrade (enlarge) to ensure capable to connect other Customer systems (for example furnace data) in future. Possible upgrade shall be understood as Customer scope (if capable).

* + 1. Caster specific

Below points should be understood as a minimum – final as per Contractors engineering and needs.

* + - 1. Control
* Caster Process count down process simulator and operator clock, to help monitor overall process connections with the caster.
* Display, setting the targeted process time.
* Operation shall be from a touch screen-based Human-Machine Interface (HMI) system will be located near the equipment for each caster to be fully independent from the other casters – this should be used as a back-up and for maintenance purpose. Main operation has to be considered from a central pulpit: one pulpit for used for 2 casting lines - placed in such way to fast reach each of the casting lines, but with full independent desks and HMI system for each casting line. Pulpit civil and construction is in Customers scope, but operator desk, panel, equipment (monitor, network equipment etc.) is in Contractors scope. Contractor to specify required space for its equipment not later than 2 months from contract in force.
* HMI system control development shall be included. It shall be the caster Contractors responsibility to provide the necessary means to ensure input and output data is easily transferred from the furnace PLC to the HMI system control.
* The caster control system shall include all programming of the PLC to control all caster functions.
* The PLC program shall also provide monitoring and alarm functions for all direct connected furnace control equipment.
* The Contractor shall provide hardwired local control pushbuttons, indicating lights etc. The devices shall function as redundant to the touch screen-based HMIs.
* There shall be appropriate hardwired components to permit safe and orderly shutdown following completion of process cycle in the event of touch screen failure.
  + - 1. Specific application software
* Recipes (for all important set parameters – for example for: Grain refining, degassing, mold level height, twin roll stand, miller etc.) for all alloys with base setting installed by Contractor. Customer shall be able to update / tune and add alloys as per future needs - as per Contractors definition if part of Level 1 or Level 2 (in case of Level 2 it has to be covered by Contractor). Recipes has to be down-loaded at each start of cast / alloy change to ensure correct parameter setting. Operator override during casting process has to be possible in case of need.
* Launder temperature and level control
* Grain refining wire control (speed and type of wire)
* Degassing unit control (argon, stirring/rotor speed, temperature etc.)
* Filter unit control (filter clogging status, temperature etc.)
* Dam(s) control up to head box
* Automatic start of cast = whole automatic procedure (without required access of operators – operators should only monitor and access if required) from start of filling launders (start tilting of holding furnace) up to start of casting at twin roll stand with ramp up of speed.
* Mold level control (PID loop) in the head box:  
    
  Obsah obrázku text, snímek obrazovky, diagram, Plán

  Popis byl vytvořen automaticky  
  By using metal level measurement in the head box controlling a electric linear actuator. Accuracity of the mold level control must be warranted by the Contractor. Acceptable level of deviation is +/- 0.2 mm over a time of 10 minute.
* Twin roll stand control (gap or position control, casting speed etc.) and with following additional functions:
* Hydraulic gap control / position control:
* Hydraulic gap (pressure) control shall control the hydraulic preload cylinders. In Pressure Control, the separating forces shall be balanced, and the pressure shall be maintained at the desired value by closed loop control, using pressure transducers as the feedback signal to the proportional valves controlling the preload cylinder pressure.
* Hydraulic gap (position) control the cylinder position shall be controlled using the feedback signal from a linear position transducer centrally located in each cylinder.
* In both Pressure Control and Gap Control modes, the required demand set-point shall have the capacity to be set manually by means of Increase / Decrease switches or automatically by means of inputting a desired value into the HMI.
* The system shall be designed to make corrections based on feedback from the X-Ray thickness measurement. Corrections have to be released by the operator and tracked on the HMI (time and value of correction).
* Speed / Current (Torque) ratio control:
* Speed Mode: the master speed reference shall be derived from speed increase / decrease pushbuttons and shall be applied to the top (upper) caster roll drive. The bottom (lower) caster roll speed reference shall be adjustable relative to the top master speed reference with an offset of +/- 10 %.
* Minimum Mode: When the caster shall be requested to start, both main drives shall rotate at a minimum peripheral speed of around 300 mm/min (adjustable within the system). The relative offset shall, under these conditions, be reset to zero.
* Load sharing: When in speed mode control, the torque shall be split between the caster rolls (the percentage can be selectable).

The operator shall be able to switch from speed mode to load mode without instability of the control.

During normal run, the caster shall be speed controlled.

* Microstick Detection
* Should metal intermittently stick to the rolls when speed mode has been selected, the differential main drive current shall become oscillatory. Under such conditions, the microstick-detected lamp shall be illuminated, and an alarm shall briefly sound. When sticking control set to on, the system shall reduce speed by a predetermined microstick amount. Typically, the differential current shall be in the range 3 - 10 amperes and at a frequency of between 0.5 - 10 Hz. An indicating lamp on the operator's desk shall confirm that a speed decrease due to micro sticking has been taken into effect. No further corrections shall be made until the operator either depresses the auto slowdown button or makes a manual speed change.
* Severe Stick Detection
* Should metal stick to one of the caster rolls, this will cause the un-stuck roll drive motor to sustain an excess load condition, resulting in a sustained differential between the motor current. When this differential exceeds a preset limit (10-20 amperes), the system shall illuminate the severe sticking lamp and sound an alarm. When sticking control is set to on, speed shall be reduced by a predetermined severe stick amount. When auto-torque mode is selected, the system shall switch to the current (torque) mode.
* Void Detection
* Should voids appear in the cast strip, both main caster drive currents shall drop. This type of condition shall be automatically detected, and the void detected lamp shall be illuminated and an alarm shall sound. When sticking control is set to on, the system shall reduce speed by a predetermined void amount.
* The control strategies described above shall be designed to function in either the manual or automatic mode. In the manual mode, the occurrence of micro-sticking, severe sticking or voids shall be displayed to the operator only with no corrective speed changes being implemented.
* Spray (graphite) at upper / lower roll at twin roll stand (flow rate, speed etc.)
* Pinch roll control (speed etc.)
* Miller control (miller width, speed etc.)
* X-Ray gauge system
* Shear control  
  - Manual and automatic functions (connected to automatic coil unloading / new coil winding sequence) shall be provided.  
  - Shear shall be capable of making a single cut or sample cuts. A timer function shall be available to make multiple cuts at a fixed interval or to synchronize the cutting cycle with the strip speed. The synchronization function shall allow a predetermined number of samples to be taken in one caster roll circumference (with allowance for extrusion) and shall limit the length, so the samples fit in the scrap tub.
* Winder/coiler tension/speed control:  
  - The winder drive shall provide constant tension control for the strip during normal operation. A selectable wrap-up mode shall allow the drive to function as a speed regulator with a suitable pre-selectable, tail-end wrap-up speed. When the shear is operated, the line tension shall automatically reduce to a predetermined amount. After the cut, the operator shall initiate set tension control.
* Coil unloading:  
  - Manual and automatic functions shall be provided.  
  - The necessary pushbutton controls shall allow the operator to manually remove the finished coil after it has been sheared from the line and completely wound up onto the winder mandrel.  
  - Automatic coil unloading / new coil winding sequence is overall from cutting of strip at shear via fast winding of cut strip at winder/coiler via coil car pick of coil from mandrel up to unloading of coil at coil parking position with connected weighing and striping sequence. The shear is performing several automatic cuts (strip scrap cut length to be defined – but cca. 30 cm). Scrap cuts are completed after the spool has been picked up by the coil car (optimalization has to be done during start up to ensure as less as possible scrap loss during coil change). After coil is set on parking position coil car is moving to spool pick up position to take over the spool with further movement to insert spool at mandrel. With automatic inserting of strip at spool opening the winder/coiler is restarting winding. Re-start of winder/coiler can be initiated as well via manual pushbutton. In case of any stop within the automatic sequence re-start has to be considered in the automation program to ensure fast completion of the automatic sequence.
* Coil car:  
  - Manual and automatic functions shall be provided.  
  - The operator shall control the coil car using manual pushbutton control for both traverse and lift motions. The snub and lift controls of the coil car shall be interlocked with the winder to prevent full lift pressure being applied while the coil is winding.
* Spool handling:  
  - Manual and automatic functions shall be provided.
* Finished coil scale weighing (data transfer to Customer system with all coil data).
* Coil data monitoring (summary of all key information for one coil – such as (to be final defined during engineering):  
  - Time / date of start / finish coil.  
  - Shift number (start / finish coil)  
  - Coil number  
  - Customer identification  
  - Order identification  
  - Alloy number  
  - Coil data (size (length, diameter), strip width (casted and after miller) and thickness (from X-Ray gauge measurement), weight)  
  - X-Ray data  
  - All process data during casting (from holding furnace metal temperature and tilting angle, metal temperature from launder (at TOP) up to winder tension important for the evaluation process) – logging interval has to be defined during engineering.  
  Communication to Customers MES.
* Auxiliary functions – such as:  
  - Hydraulic unit (manual / automatic sequence). Attention: Change of main / stand-by pump during running hydraulic unit must be possible. As well as change from manual to automatic or vice versa (in case the status of the pump (running or stopped) must to remain unchanged to ensure no wrong stoppage of hydraulic with connected stoppage of caster).  
  - Water system (manual / automatic sequence). Attention: Change of main / stand-by pump during running cooling unit must be possible. As well as change from manual to automatic or vice versa (in case the status of the pump (running or stopped) must to remain unchanged to ensure no wrong stoppage of cooling circuit with connected stoppage of caster).  
  - Roll exchange  
  - Tip table positioning  
  - Pinch roll entry table control  
  - Strip blower control  
  - Winder threading table control  
  - Gear reducer lubrication control  
  - Coil stripper  
  - Mandrel expansion control  
  have to be ensured.
  + 1. Level 2 automation system

The complete Level 2 automation system is the responsibility of the Customer. Customer will hand over the system parameters - SW/HW configuration to the Contractor during the project.

The Contractor must equip the level 1 control system with an OPC interface to enable communication with the OPC server and the "Customer's" MES system.

The standard is the OPC UA variant, which must be used by the Contractor.

* + 1. Others
* Requirement for the network address range

Before implementing the industrial systems, it is necessary to compile and approve the draft network address range and its individual features which will be used by the Contractor for communication with the control system, MES, ERP and other communication layers. The approval of the draft network address range must be made by the Customer before the implementation of the industrial systems.

* Requirement for the network isolation

To ensure safe and continuous operation, it is necessary to strictly isolate parts of the production network from the administrative network and from other networks of individual processes. This isolation is aimed at restricting the risk of attack or malfunction propagation to one individual part of the network while keeping the other parts safe and maintaining the continuity of the operation.

In the event that the production network needs to be interconnected with other surrounding networks, the individual destinations, including the IPv4 source, IPv4 target and ports, must be clearly defined in accordance with the safety standards and the Customer’s requirements.

The network interconnection with other networks must be approved by the Customer and secured so as not to endanger the production network safety.

* Remote access

For the purpose of remote administration and service interventions the remote connection is subject to the prior approval and discretion of the Customer via the pre-arranged HW and SW features.

If the Contractor uses his own HW devices for remote connection, the Customer’s approval must be sought. The final technical design of this access must be properly documented, including the identification of the network connection point.

The Contractor is required to arrange for the following:

1. Update and maximum possible securing of all the devices within the Customer’s network that are used for remote access.
2. Default passwords preset by the device manufacturers must not be used. Passwords must have at least 12 characters.
3. Adherence to the current safety standards, including regular update of the operation system, functional and updated antivirus software and/or use of two-factor authentication.
4. Ensuring that the users connected to the Customer’s network have no administrative rights in their local computers.
5. Every use of the remote access must be properly documented and must comply with the pre-arranged conditions and safety requirements.

* OT (Operational technology) documentation

Detailed documentation for the OT area will be developed during the project implementation. This documentation should include:

1. Control system communication diagrams
2. Allocated addresses of features
3. Methods of communication among individual features
4. Feature configuration back up method, including a description of their creation and restoring
5. Inventory of HW/SW computer equipment, such as servers and stations
6. Authorisation information for each purpose of the system

* Change management

Change management must be maintained during implementation and operation. Any change in the configuration or topology of the system must be recorded at least to the extent of:

1. The person who made the change
2. Time of the change
3. Extent of the change
4. Reason for the change
5. Responsible person

* Support and service

The level of support and service, including response time and availability of technical support, must be specified for each feature. It shall be determined how system updates and repairs will be provided. It should be clear in advance how long the company wants to support the systems and to what extent = taking into account costs and consequences.

* Monitoring a logging

If the Contractor does not implement his own monitoring and logging system, it is necessary to ensure that all the active elements are monitored at least by ICMP to secure the elementary availability from a particular address within the OT network supplied by the Customer. The Contractor should make available the diagnostics information through the SNMP protocol if present on the particular device, feature or system.

If the system cannot arrange for logging itself, it is necessary that the systems where authentication/verification of users take place are able to send the SYSLOG messages to the address designated by the operator, with the following information:

1. Person performing the action.
2. Time of the action.
3. System where the action takes place.
4. Description of the change or event.

* Disaster recovery a continuity plan

As part of the implementation, plans will be developed to restore the operation of the given device in the event of an attack/damage to the system. This plan should include the following:

1. Definition of the individual recovery steps, including:
2. Identification of critical processes and systems for recovery
3. Procedures for data and application recovery
4. Procedures for hardware and software feature recovery
5. Plans for communication with the internal and external stakeholders during the recovery
6. Matrix of responsibilities, including:
7. Identification of persons responsible for individual recovery steps.
8. Clearly defined roles and responsibilities within the disaster recovery

The Contractor is required to ensure that the disaster recovery plan complies with the latest procedures and best practices in the field of disaster planning and recovery.

* Requirement for endpoint and server security

As part of the protection against the introduction of malicious code, security of end stations and servers must be secured by the following means:

1. Periodic update of the system, at least in the area of critical vulnerabilities
2. Physical security of active features and network distribution
3. Operation of basic antivirus protection
4. UAC activation
5. Not using administrator accounts for regular user operation.
6. Adherence to generally applicable rules for the security of operation systems and accounts with a view to Mitre ATT&CK, SIEM Security Configuration Assessment.
7. Disabled use of USB flash disks, cameras and other portable media.

All essential control and operation systems for the operation of the production facility / set shall have an available backup in accordance with 3-2-1 Rule, which means a backup on at least three different media, with at least two locations and one backup outside the operation site. This conception must be designed and implemented in cooperation with the Customer.

The Contractor should ensure that all the safety measures are implemented and observed in accordance with the latest safety standards and the Customer’s requirements.

* Disaster recovery plan

As part of the implementation, plans will be developed to restore the operation of the given process in the event of an attack/damage to the system. This should include the definition of the individual recovery steps, the matrix of responsibilities and their contacts, the location of backups, the recovery process (method and procedure) of the system.

* 1. Standardization

Components of all the devices must be designed, assembled and tested in accordance with the applicable Czech and EU standards, as appropriate, to reflect all the specific aspects in the environment of the Czech Republic.

All the items of the equipment must comply with the regulations and provisions of the relevant statutory bodies of the Czech government as long as applicable. If required by the regulations, the Contractor must obtain the necessary permits from the statutory bodies and other relevant authorities.

All products delivered from the non-EU countries must be furnished with the CE certificate (Conformité Européenne) / Conformance to European Norms).

Electrical equipment must also correspond to the latest Czech electro-technical regulations in terms of safety, grounding and other basic provisions set out for the installation and operation of electrical devices and facilities.

1. Scope of work

The Contractor’s activities include: design, engineering, delivery and supervision over the installation, testing, commissioning within the limits and tolerances defined herein. The scope of the Contractor’s work must generally comply with the following:

* 1. Structures – mechanical, electrical, instrumentation and automation
* Engineering includes designing the devices, technological structures, electrical installation, instrumentation and automation, water supply system, utility lines, hydraulic, lubrication and pneumatic systems, auxiliary and ancillary equipment. Drawings and documents must include the general arrangement, assembly, arrangement drawings, pipeline arrangement drawings with supporting details, technological diagrams, pipeline and instrumentation diagrams, one-line power-management diagram, block diagrams, list of motors with calculated power, management philosophy, functional description, test certificates, technical and installation drawings etc. Designs of all the devices/systems/items, as mentioned in this specification and set out for proper functioning/operation of the system.
* The Contractor shall be responsible for supplying the necessary data relating to the scope of work which will be used by the Customer as a background material for acquiring all statutory permits such as the zoning plan, building permit etc., on request by the Customer by an agreed date.
* Providing the basic data / technical data for all the units/items not stated in this document however necessary for the completeness of the system is the basic responsibility of the Contractor.
* In the course of designing the machinery within the competence of the Contractor, it is necessary to take account of the interface with the devices of other Contractors (such as furnace systems, power supply etc.) which are not within the scope of this specification.
* Designing the pipeline/lines, fittings, valves and other accessories for the utility lines and water supply system within the faucets, including the pipe supports.
  1. Designing – constructional and structural
* Load data for all the machines and accessories designed by the Contractor for the necessary construction project of the Customer. This includes the data concerning the load of the necessary foundations, supports, structures, buildings, rooms, local stations which are required by the Contractor’s machines/system.
* Format and parts of the load data must be agreed on between the Customer and the Contractor at the designing stage, based on the applicable European regulations and standards.
* Structural design of the entire line/system supplied by the winning Contractor, as stated in various parts of this specification. This includes the structural design, necessary supports and anchors for the line/system as required by the line/system of the Contractor.
  1. Delivery

The scope of the delivery includes: engineering, delivery of the equipment, technological structures, electrical, instrumentation and automation, water supply system, utility lines, hydraulic, lubrication and pneumatic systems, auxiliary and ancillary equipment within the premises of the Contractor. Supervision of mechanical, piping and electric equipment installation (erection within Customer's scope). Supervision of cold/hot commissioning. Refractory material as well installation is within Contractors scope.

* 1. Spare parts

Contractor to submit a list of Preliminary Recommended Spare Parts based on historical Mean Time Between Failures (MTBF) data along with ABC ranking and criticality ranking. The quote proposal shall include:  
- List of individual normal Wear items for two years of operation;  
- List of Capital Spare Parts (Longer durability items)  
Both lists shall be understood as recommended with included normal expected life time, recommended quantity at Customer stock level, standard delivery time and most favorable pricing.

Final lists as per detail engineering with exact type and specification has to be transmitted with detail engineering to ensure sufficient time for ordering by Customer.

* The list shall include (minimum and as per Contractor additions):
* Metal distribution items (heating elements, temperature/level sensors, shutters etc.)
* Degasser unit rotor / drive / heating elements
* Filter unit heating elements
* Tip table adjustment drives / motors
* Mold level actuator unit, sensor
* Twin roll stand gear reducer
* Twin roll stand motor
* Twin roll stand load cylinder
* Casting roll chock / bearing
* Casting roll rotary joint
* Casting roll cooling hoses
* Spray (graphite) nozzle and drive system
* Miller drive system
* Pinch roll gear reducer
* Pinch roll motor
* Shear hydraulic cylinder
* Shear knive
* X-Ray thickness measurement drive, motor, sensor head, electronic items (evaluation unit, computer etc.)
* Air knive fan / motor
* Winder/coiler gear reducer
* Winder/coiler motor
* Winder/coiler mandrel
* Load cell
* Cooling circuit items (pump, motor, instrumentation, valve etc.)
* Bearing (2 of each type / size)
* Hoses (6 of each type / size)
* Min. 2 pieces of each sensor / transmitter installed.
* Solenoid valves, motorized valves, regulating valves, filters.
* Control motors, actuators.
* Hydraulic components (pump, motor, valves, sensors, instrumentations)
* Hydraulic cylinders (2 of each type / size)
* Pressure switches & gauges, thermometers, thermocouples.
* Transmitters (temperature, flow, pressure, differential pressure), flow meters
* HMI stations (computers, monitor etc.)
* Control system components (of each PLC / Remote IO type / component at least one piece, power units etc.)
* Frequency converter (2 of each type / size)
* Network equipment (router, switch, couplers etc.)
* UPS equipment
* Limit switches & sensors.
* If – during the commissioning – the Contractor uses the spare parts delivered under the delivery contract, the Contractor will be obliged to replenish these spare parts / to deliver them to Customer free of charge.
* The Contractor will provide technical specification of the spare parts for their purchase in the future. Where applicable, detailed and production drawings must be prepared so that Customer may produce/order from several sources/markets as needed.
* The Contractor will clearly specify the list of spare parts where detailed technical drawings / production drawings cannot be shared. The main idea is to be informed beforehand about the spare parts where Customer is “dependent on” the Contractor.
  1. Supervision over installation, testing and commissioning
* The Contractor’s area of competence includes: supervision and necessary technical assistance during installation, testing, commissioning of the line and putting into operation, including performance tests of all the devices, machines and equipment, i.e. cables, pipes etc., which the Contractor has delivered, as well as those acquired/produced by any other parties based on the Contractor’s drawings and specifications.
* The Contractor’s area of competence includes but is not limited to:
* Supervision over the assembly staff, assistance and instructions given to the same for proper interpretation and use of project specifications, drawings, specific technical documents for the installation company within the competences of the Contractor.
* Preparation of project specifications, procedures and supervision of the performance of dimensional checks, adjustment checks, welding procedures, non-destructive tests, pressure tests, leakage tests, corrosion-proof treatment etc.
* Planning, supervision and technical assistance for cold and hot tests, commissioning and testing of guaranteed power parameters.
* Within its bid, the Contractor is obliged to mention the following information concerning the equipment delivered.
* Size of roofed area necessary for storage (in m2)
* Size of free area necessary for storage (in m2)
* Size of free area necessary for installation/production, outside the area intended for the machinery itself (in m2).
  1. Work progress report

The Contractor is responsible for preparation of weekly and monthly work progress reports during the engineering activity.

* 1. Drawings and documents – General
* The Contractor is responsible for providing and submitting the drawings and documents, including BOM’s and technical catalogues, standard operation and maintenance procedures, calculations of productivity and dimensioning.
* The Contractor is responsible for providing a detailed time schedule for the engineering stage, indicating the deadlines for drawings and documents to be submitted.
* Delivery of detailed technical drawings/documents for spare parts and wear parts is included in the scope of the Contractor’s delivery.
* 3D model documents must be submitted for the line, depicting the as-built status in which it was handed over to the Customer. In its bid, the Contractor should state which kind of 3D software is planned to be used for this project. This information is important for the Contracting Authority so that it is able to obtain compatible software which it will use for loading the 3D models submitted by the Contractor.
* Isometric drawings of pipelines, with indicated dimensions, must be submitted.
* The Contractor’s scope of activities must include preparation and submission of drawings of the line depicting the as-built status in which it was handed over to the Contracting Authority.
* Contractor to submit recommended spares list based on mean time between failure information from Contractor’s database.
* All spare parts to be quoted individually at system design prices, stating delivery time and quantity in use.
* Spares will be ordered separately at Customer’s discretion, after receipt of complete recommended spare parts list. Recommended spare parts lists, with prices, shall be submitted no later than 6 weeks after the completion of engineering. All parts shall be identified by original manufacturer’s part number and full description.
* Contractor shall be responsible for providing and staging all spare parts required for system start-up and commissioning. These parts are to be provided at no expense to Customer.
  1. Specification of public procurement for installation work

The Contractor’s scope of activities includes preparation of tender documentation concerning the installation of the line as designed by the Contractor.

The specification applies to all mechanical, electrical, instrumentation and automation equipment. The specification must reasonably describe the use of special tools and instruments, preventive measures, binding and fixing equipment for transfer and positioning of the line sub-assemblies.

* 1. Governing language
* All drawings and documents must be submitted in the Czech and English language.
* All HMI’s must be submitted in the Czech and English language.
* During engineering, the Contractor must have at least one member of the team who is able to speak and write in English or Czech.
  1. Others

The Contractor’s activities include provision of training for various operation and maintenance works.

Design of special tools and instruments that are necessary for effective operation and maintenance of the line/system projected by the Contractor falls in the competence of the Contractor.

1. Specific provisions
   1. Assembly and testing at the Contractor’s site

The Customer will be authorized to check the quality and quantity of mechanical and electrical parts of the specified line at the Contractor’s site or at the sites of the latter’s subcontractors.

Prior to sending the line and machines to the Customer’s site, they must be completely assembled to the maximum extent and tested by the Contractor at its site. The Customer’s representatives must be given access to the assembly and testing. None of the machines delivered by the Contractor according to this specification may be sent to the Customer’s site until the tests are fully approved by the Customer’s representatives. The Customer requests the tests be announced at least fourteen (14) days in advance.

* 1. Preparation for transport

The line may only be disassembled to the minimum necessary extent for the transport, all parts must be carefully packed and labelled. All conductors should be left in their channels, bare wires should be wound and packed so as to be protected during the transport. All conductors and cables must be properly labelled for the ease of identification.

* 1. Lock-out & Tag-out (LOTO)

The Contractor must compile a Lock-out & Tag-out procedure for its line.

The system must ensure that all dangerous parts of the machine are properly switched off and cannot be switched on before the maintenance or service is finished.

The Contractor will prepare the task lists for four (4) points of Lock-out and Tag-out. These points are as follows: identification of power source, disconnection of power source, securing and identifying the power source and proof of the disconnection effectiveness.

The procedure for disconnection and identification (lock-out and tag-out) must be discussed with and approved by Customer.

* 1. Delivery to the Customer’s site

The Contractor will take into account the width and height of the production hall gate. Gate dimensions are as follows: 5.0 x 5.0 m.

The delivery of the line, machines and other related consumables to the Customer’s site must be coordinated with and approved by the Customer in advance.

* 1. Technical media interface

The Customer will arrange for and provide the following technical media in the place of installation.

* + 1. Natural gas
* Pressure in supply line: 25 or 100 kPa
* Temperature: Ambient temperature
* Heating value 30,4 – 38,4 MJ/m3
  + 1. Cooling water (plant wide open circuit with cooling towers)
* Temperature in supply line: 10 - 25 °C
* Delta temperature (between supply and return line): 5 – 8 °C
* Pressure in supply line: 0,59 – 0,70 MPa
* Flow rate: 250 m3/h (at 0,6 MPa)
* Chemical composition will be communicated during engineering
* pH value 7,6 – 8,0
  + 1. Compressed air
* Pressure in supply line: 0,5 - 0,6 MPa
* Temperature: 15 - 25 °C
* Quality class: 1 according to ISO 8573-1
* Relative humidity: 0 %
  + 1. Argon
* Pressure in supply line: 1,1 MPa, max. 1.6 MPa
* Temperature: Ambient temperature
* Quality class: 5.0 / 99,999

Contractor to define with transmittal of offer all required media (water, technical gases) with base definition (temperature, pressure, flow rate etc. and acceptable range).

1. Safety requirements
   1. General

The Contractor is obliged to address and/or implement the criteria for the safety device design.

The Contractor is obliged to reasonably reduce the risks, propose the necessary protective measures for those who may be exposed to risks due to dangerous situations.

Dangerous situations may be caused by the following:

* Failures or failure statuses in electrical devices which may result in electric shock or fire of electric origin.
* Failures or failure statuses in control circuits (or components and devices connected to these circuits) which result in malfunctioning of the line/machine.
* Failures or power outages as well as failures and failure statuses in power circuits which result in malfunctioning of the line/machine.
* Loss of integrity in circuits dependent on the sliding or rolling contacts, which results in impaired safety function.
* Electrical interference, e.g. electromagnetic, electrostatic generated either outside or inside the electrical devices, which results in malfunctioning of the line/machine as a whole.
* Release of accumulated power (electric or mechanic) which results in electric shock or unexpected motion which may cause injury.
* Surface temperatures which may cause injury.

Safety measures must combine the measures introduced at the design stage (this is the Contractor’s responsibility; whereas the measures which are to be introduced by the user are the responsibility of the Customer).

Safety shall be a primary consideration in the design of this equipment. Guards, protective devices and Lockout and Tag-out and Zero Energy procedures shall conform to applicable Customers standards and shall minimize potential hazards to operating and maintenance personnel. Contractor shall obtain all approvals of equipment and components prior to delivery and commissioning.

As part of the CE certification the Contractor shall collaborate with Customers Personnel in executing a risk analysis. The machinery and equipment must be designed and built by taking into account the results of the risk analysis. Risks from hazardous substances, biological hazards, fire and explosion hazards, thermal, physical, physical risks are incorporated into the risk analysis.

The Contractor shall design and furnish all necessary machine guarding and fall protection incorporated within machine assemblies.

All elevated platforms > 1.0 m (with regard to an adjacent floor, ground or other working/walking surface) shall be equipped with a hand rail and a mid rail (local regulations that require railings be installed at a lower height shall be met). A toe board is required when there is the potential for tools and/or materials to be kicked off the elevated work platform and onto personnel below.

The Contractor shall provide a zoned LOTO (Lock Out Tag Out) according to maintenance requirements on the equipment.

The Contractor shall design equipment such that cleaning, adjustments, threading and/or maintenance of such equipment shall minimize “Confined Space” entry by operating or maintenance personnel. If entry is unavoidable, design of the confined space shall permit rescue and provide means of extraction of an unconscious individual, weighing up to 130 kg.

The equipment shall be designed with a noise level having an upper exposure action value equal to 85 dB and a lower exposure action value equal to 80 dB.

The Contractor shall provide periodic safety reviews with Customer’s representatives during equipment design, installation, commissioning and start-up.

The Contractor shall calculate the distributed load of platforms etc. (kg/m²) and show the sufficiency of the support.

Equipment shall be designed such as minimizing / controlling the risk of spills and emissions in compliance with local regulations.

Special attention should be placed on the inherent explosion hazards associated with molten aluminium, the best reference being the “Guidelines for Handling Molten Aluminum.

* 1. Requirements for mechanical safety

Mechanical safety covers the protection of users against risks related to moving parts, mechanical forces, falling objects or any other mechanical risks.

* + 1. Protective covers and guards

The line must be equipped with fixed protective covers which protect the users against access to moving parts of the line or any other risks. The covers must be designed so that they are difficult to circumvent or removed without tools.

* + 1. Protective fencing

Protective fencing is another form of protection which prevents access to dangerous parts of the line and the line must be fitted with the same. This fencing should be reasonably rigid and resistant to withstand external influences and to enable clear view of the machine interior for the purpose of inspection and maintenance.

* + 1. Safety switches and sensors

The use of safety switches and sensors may prevent the operation of the line if the protective elements have been removed or in case of a dangerous situation. These elements may include: emergency switches which stop the line in case of touching or vicinity switches.

* + 1. Protective brakes and emergency stop

The machines should be equipped with safety brakes or emergency stop systems which can quickly stop the movement of the machine in case of danger or whenever instant stop is required.

* + 1. Distance from dangerous parts

The design of the line must minimize the risk of injury by keeping the safe distance between the user and dangerous parts of the machine, such as rotating or moving parts.

* + 1. Protection against falling objects

The machinery should be designed so as to minimize the risk of fall of dangerous objects from the working platform which could lead to personal injury of the user.

* + 1. Rigidity and stabilization

The machinery must be stable and firmly fixed on the floor in order to minimize the risk of tilting or any other accidents related to the machinery instability.

* + 1. Appropriate marking and indication

Dangerous parts of machines should be marked in accordance with the applicable standards so that the users are informed of potential risks.

* 1. Requirements for electrical safety
     1. Electric shock protection

The machinery must be designed so as to minimize the risk of electric shock. This includes the use of insulation materials, grounding, protective elements such as fuses, circuit breakers and protective switches.

* + 1. Protection against electric discharge

Electrical components of the machinery must be placed and insulated so as to minimize the risk of occurrence of electric discharge which would endanger the user or damage the line/machine.

* + 1. Safety insulation

The machinery must be fitted with sufficient insulation to protect the user against touching or approaching dangerous electrical parts.

* + 1. Ensuring safe voltage

The voltage used in the machinery must comply with the applicable standards and must be designed to minimize the risk of injury.

* + 1. Protection against overload and short-circuit

The machinery must be fitted with protective elements, such as fuses, circuit breakers etc. which protect against overload and short-circuit that may lead to fire or injuries.

* + 1. Safety grounding

Electrical devices must be grounded in order to minimize the risk of electric discharge and to ensure safe excess current drainage.

* + 1. Protection against humidity and dust

The line must be designed so that it is resistant against ingress of moisture and dust which could lead to damage of electrical components and increased risk of injury.

* + 1. Protection against electromagnetic interference

Electrical devices must be designed so that they minimize the interference from electromagnetic fields which may influence the functioning of the machine or any other machinery in its vicinity.

* + 1. Safety marking and indication

Dangerous electrical parts of the machinery must be marked in accordance with the applicable standards so that the users are informed of potential risks.

* + 1. Regular inspection and maintenance

Electrical devices must be regularly checked and maintained in order to detect potential problems which may endanger safety.

1. Service and maintenance

The bid will include a draft service level agreement covering the machinery. The Customer wishes the agreement to include annual service checks. If a higher frequency of these checks is necessary, the agreement should set out their interval.

**Troubleshooting**

* Failure condition addressed via remote connection: response time within 4 hours of the announcement.
* Failure condition addressed personally by a technician: response time within 24 hours of the announcement.

The draft service level agreement should also incorporate a price quotation for regular service and urgent service, with price validity of 5 years. Price for regular service means 1 on-site service check.

* 1. Reliability

Customer’sprefers items that would lead to reliable physical assets and reliable processes to be implemented as early as in the design phase. Some of these items are listed below:

* An asset care / maintenance program shall be provided. The preferable asset care strategy shall be condition based maintenance rather than time based maintenance.
* The Contractor shall consider maintainability in the design (e.g. lifting devices, quick releases) operability, (i.e. layout and location of control pulpits, analysis of operator movements, visual management for inspection and recognition of equipment condition), testability, (e.g. sample points for oil), accessibility, (e.g. room for maintenance workers and tools, platforms etc.), time saving methods, standardization, and mistake proofing in the design.
* The Contractor shall base equipment selection decisions on Life Cycle Cost, incl. energy cost, maintenance costs, operating costs, buying cost, material cost.
* The Contractor shall deliver standard procedures for installation, start-up, commissioning, (incl. detailed plans, required times & resources, tolerances, alignment, start-up sequencing, check of performance indicators).
* Where practical and cost effective, the Contractor shall implement redundancy of critical components, for instance so that maintenance work can be performed without causing downtime.
* The Contractor shall be willing to participate with at least one representative in a risk analysis event if asked to. They shall also provide a limited amount of reliability reviews with Customer’s representatives during equipment design, installation, commissioning and start-up.
* Contractor shall provide all preventive maintenace (PM) procedures necessary to properly maintain the equipment. Each PM shall include the recommended frequency and work / motor hours required to complete maintenance item. Frequency and work / motor hours shall be monitored as much as possible / applicable on control system.
  1. Special tools

The Contractor must specify any special tools (for example casting roll assembly lifting beam or special wrenches for roll bearing assembly etc.) required for removal, assembly and maintenance of any system or component as soon as possible AND must be handed over to Customer not later than 3 months = within basic engineering to the Customer to ensure sufficient time for purchasing by the Customer and availability at site.

1. Energy
   1. General

* The equipment and components shall be selected to ensure the lowest life cycle cost and meet all energy efficiency requirements in the Břidličná facility.
* The Contractor will provide means to meter and to monitor each energy source (common incoming measurement for electricity, gas) and fluids (compressed air, nitrogen, argon, etc.) at each casting lines and also for each significant single user (est. yearly cost > $100 K) with an accuracy of 0.5 %.
* The following data shall be provided for the equipment: Power installed (all in kW), energy efficiency class /standard, and power used for nominal output and 50 % nominal output, specific energy consumption (in kWh - using upper calorific value) per output unit (e.g. Tons) and energy consumption for the key process steps (e.g. consumption during holding time).
* The electrical equipment and components shall follow the state of art energy efficiency rules.
* All AC motors shall meet the “IE3 “ or “NEMA Premium ” efficiency standards. IE2 motors are only acceptable if the yearly use is less than 2000 h.
* Direct coupling with “state of the art” alignment. If a belt must be used, the selection of the belt will target the highest friction.
* The selection of distribution transformers will target the lowest life cycle cost (class I efficiency transformers or NEMA premium, efficiency > 98 %).
* All electrical appliances shall meet the A or B or “EU Eco Label” (Directive 2009/125/EC) or “Energy Star” efficiency ratings.
* The lighting provided with the equipment should be of high energy efficiency and a good color rendering (> 70) (fluorescent T5 with electronic ballast are preferred).
* The selection of compressed air energy source for driving / moving / cleaning / cooling is only allowed only if no alternative with a lower life cycle cost is available or it is required for specific safety, regulation, or process reasons. The compressed air equipment design and working pressure set point should target the minimum life cycle cost.
* Energy conservation will be fully integrated in the design and control of the equipment by providing systems which automatically switch off the energy consumers or reduce their energy consumption in a controlled and safe way according to the standards and regulations during idle time or downtimes. The MMI systems will allow an easy manual switch off of the equipment.
* Adapt the energy use to the real demand: The equipment shall be designed and sized to optimize the real energy use according to the real demand. In the case of a fixed demand, the equipment should be designed to target the optimal equipment efficiency. In case of a variable demand, the equipment should be equipped with variable output systems. (number of motors running by a cascade control, variable speed drives, variable flow pumps, heating control, level control etc.).
  1. Heat management:
* State of art high efficiency burners shall be selected based on a life cycle cost analysis. The combustion air temperature and furnace door opening time shall be monitored. The oxygen content in flue gas and furnace pressure control will be optimized to ensure the highest energy efficiency.
* The insulation (piping, tanks, furnaces, boilers etc.) will be designed to minimize the energy losses and will target the lowest life cycle cost.
* Natural convective cooling is preferred, where applicable.
* Simultaneous cooling and heating shall be avoided.
* The heat recovery solutions are preferred over solutions that require any additional energy use.
  1. Hydraulics:
* The use of variable flow pumps with an integrated proportional valve for pressure control combined with a variable speed drive on the motor (main pump and filtration pump) is recommended. The pressure set point will be adjusted to the purpose for each cycle step. The use of low friction oil is also recommended.

1. Training

Staff training will be provided by the Contractor FREE OF CHARGE within the delivery of the line.

The training will be divided into three levels, based on the proficiency and complexity of the line/machine:

* Operators
* Maintenance
* Technologist

The training will take place in a minimum of four blocks, at the Customer’s site, in English. The blocks are necessary due to various working shifts of the operators and expert staff.

Theoretical training will take place in the Contractor’s classroom, duration: 3 (three) days. The purpose of the theoretical training is to give general information of the line technology.

On site training (duration: 5 (five) days) as per during cold and hot commissioning.

All training documents to be provided in PDF format and hand over in electronic form (USB or CD).

Detailed training schedule will be agreed on at the appropriate time during the project implementation.

To this end, the Customer will arrange for an adequate number of interpreters at the appropriate time.

Each training will be documented; an attendance list will be made according to the Customer’s internal regulations.

* 1. Operators

The Contractor will compile the training documents (in Czech and English) for the operators, and will train the staff in safety measures and simple maintenance interventions.

The training will cover the following topics:

* Process and procedure
* Tools and changeover
* Maintenance (daily maintenance within the operators’ competence)
  1. Maintenance

This training applies to expert staff, such as electricians, mechanics, tool makers, PLC programmers, process engineers, metallurgists and management.

The Contractor will provide general and specialized expertise of the operation as well as experience through this training which will also include recommendations concerning the process technology, working procedures with special oral/written operation and testing specifications, as well as information about specific performance data based on the practice.

The Contractor will prepare the training documents (in Czech and English) for the expert staff.

The training will cover at least the following topics:

* Safety systems at the machinery
* Functional description of electric, pneumatic, hydraulic control (flow chart)
* Maintenance planning and performance
* Troubleshooting, breakdowns. Basic structure of the programmed management process To this end, practical hardware and software training must be provided.
* Setting the technological parameters and effect of their changes.
* Review of available documentation including drawings, instruction manuals, bill of material and spare parts.
* Review of system operation, control, interlocks, sequencing, maintenance and safety via operation and maintenance manuals and drawings.
* Provide suggestions of other pertinent topics related to operating and maintaining the new equipment.

1. Painting
   1. General

* The Contractor shall comply with the Customer Plant Appearance Standards, which shall be final confirmed and agreed during engineering.
* The Contractor shall comply with DIN 2403 (Identification of pipelines according to fluid conveyed) and DIN 12792 (Ventilation for buildings – symbols, terminology and graphical symbols) in regard to the identification of pipelines according to the fluid conveyed. The below table is a quick reference for the information within DIN 2403 and is specific to the Customer facility.

|  |  |  |
| --- | --- | --- |
| **Pipe/Media/**  **Machine parts** | **Color Code** | **Color** |
| Stacionary machine parts | RAL 5022 night blue | Blue |
| Movable machine parts | RAL 1021 | Yellow |
| Machine parts above 80 °C | RAL 9007 | Grey |
| Natural Gas | RAL 1003 | Yellow |
| Hydraulic | RAL 8023 | Orange Brown |
| Cooling Water | RAL 6032 with shield / insulation | Yellow Green |
| Fresh Water | RAL 6032 with shield / insulation | Yellow Green |
| De-ionized Water | Stainless steel Grade 1.4571 [316Ti] with shield |  |
| Hot Water | RAL 6032 with shield / insulation |  |
| Compressed Air | RAL 5015 | Blue |
| Acid | RAL 2003 with shield | Pastel Orange |
| Thermal Oil | RAL 8023 with shield / insulation | Orange Brown |
| Argon | Stainless steel Grade 1.4571 [316Ti] with shield / insulation |  |
| Chlorine | Stainless steel Grade 1.4571 [316Ti] with shield / insulation |  |

* Primer and finish coats of a suitable aluminum explosion prevention coating (2 layers)shall be applied to all equipment near the furnace including duct system exposed to molten metal, heat per manufactures instructions.
* Area’s not to be painted include:  
  - Machined surfaces  
  - Electrical connection points  
  - Bearings, liners, gears, wheel contact surfaces
* All chemical solvents and paints shall be used in accordance with manufacturer’s instructions and Customer standard practices.
* All chemicals and paints shall be approved by submission of a Material Safety Data Sheet as well as any manufacturers supplied information and or instructions to the Customer project manager prior to delivery onto Customer site.
* A Material Safety Data Sheet shall be in the immediate vicinity of all chemical and paints when located on Customers site.
* At end of installation, the Contractor shall touch-up / paint to cover unpainted, field-welded or scratched / damaged surfaces. Any paint waste products shall be removed and disposed of properly and legally by the Contractor at no additional cost to Customer.