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STÁTNÍ FOND
ŽIVOTNÍHO PROSTŘEDÍ
ČESKÉ REPUBLIKY

AL INVEST Břidličná, a.s.

Bruntálská 167

793 51 Břidličná



Annex 3 of Tender Documentation – Technical
Specification

ALFAGEN – MOLTEN ALUMINUM MELT QUALITY ANALYZER

Procurement procedure

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")

OBSAH

1	MOLTEN ALUMINUM MELT QUALITY ANALYZER.....	3
2	SYSTEM DESCRIPTION	5
2.1	Ultrasonic Counter System.....	5
2.2	Electrical Resistive Pulse Counter System (Coulter Counter)	5
3	CONTRACTOR SCOPE OF SUPPLY	6
4	TECHNICAL DATASHEET REQUIREMENTS	6
5	MEASUREMENT PERFORMANCE REQUIREMENTS	7
5.1	Minimum required performance (unless otherwise agreed) Ultrasonic Counter System:.....	7
5.2	Minimum required performance (unless otherwise agreed) Coulter Counter System: .	7
6	ENVIRONMENTAL CONDITIONS	7
7	ELECTRICAL REQUIREMENTS	8
8	COMPRESSED AIR REQUIREMENTS	8
9	MECHANICAL REQUIREMENTS	8
10	EQUIPMENT DESCRIPTION	8
10.1	Measuring Head	8
10.2	Measuring Unit.....	9
10.3	Control Station	9
10.4	Main Electrical Cabinet.....	9
11	APPLICABLE STANDARDS.....	9
11.1	Machine Safety & Design Standards	9
11.2	Electrical, Control, & Documentation Standards	9
11.3	Materials, Finishing & Structural Standards.....	10
11.4	Relevant CE and local regulatory requirements.....	10
12	DESIGN REQUIREMENTS.....	10
13	REFRACTORY AND WETTED COMPONENTS.....	10
14	COATINGS AND FINISHES	10
15	FACTORY ACCEPTANCE TESTING (FAT)	10

1 MOLTEN ALUMINUM MELT QUALITY ANALYZER

INTENT

- This specification defines the minimum requirements for engineering, design, manufacturing, testing, performance, and documentation for molten aluminum quality analyzers intended for use across multiple production lines, allowing their relocation between individual workstations.
- This document serves as a basis to receive an offer for the equipment with a one-year service contract designed to assist the plant personnel as the equipment ramps up to its designed-anticipated capacity.
- The same basis shall be used to present a consumable cost, using normal frequency testing of two (2) of the five (5) lines per day for a one-hour period each.
- Any annual or semiannual service costs and periods where the equipment is out of service, sent back to The Supplier, should also be included as a separate line item in the consumable cost break out portion of the offer.
- Two measurement principles are covered under a common format:
 - an ultrasonic-based inclusion counter and
 - an electrical resistive pulse inclusion counter (Coulter counter).
- The Contractor shall design, furnish, and deliver complete, fully operational systems—including all mechanical, electrical, pneumatic, sensing, automation, software, and protection subsystems—capable of continuously or semi-continuously measuring non-metallic inclusions in molten aluminum.
- All equipment shall comply with this specification and applicable standards, be suitable for long-term, reliable operation in industrial aluminum melting and casting environments, and safely integrate into foundry processes.
- The intent of this specification is to define the functional, mechanical, electrical, environmental, and performance requirements for real-time inclusion measurement, with systems providing traceable, reproducible, and industry-accepted inclusion cleanliness data suitable for process control, quality assurance, and customer reporting in aluminum cast houses.
- In addition to the hardware and software provided The Contractor shall provide a one-year service plan to help assist the technical staff during process ramp up.
- The Twin Roll Caster, (TRC Line) analyzer location as suggested in Figure 1., after the Ceramic Foam Filter, able to analyze a significant portion of the molten metal delivered to the Twin Roll Caster.
- The Horizontal Direct Chill (HDC Line) analyzer, as suggested in Figure 2, is able to analyze the molten metal stream after it is divided at the launder.

Detailed information concerning the measurement points and the surrounding area is provided in the attached documents:

Annex_3.1_TD_Technical specifications_Billets_measuring

Annex_3.2_TD_Technical specifications_Strip casting metal level

Annex_3.3_TD_Technical specifications_Strip casting measuring area

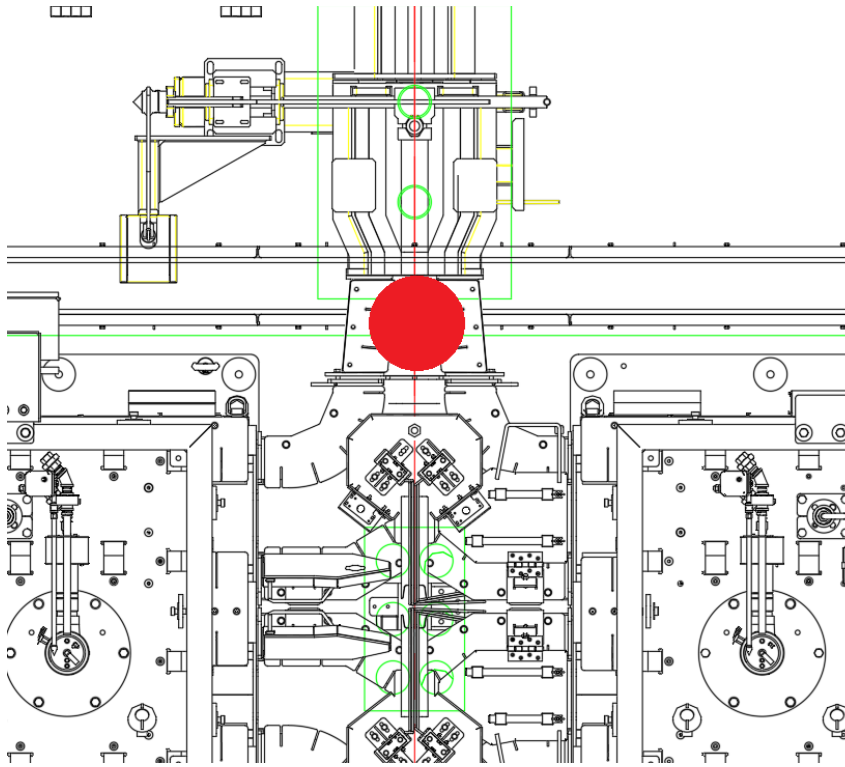


Figure 1 Twin Roll Casting (TRC Line) Metal Inclusion Analyzer , measuring point

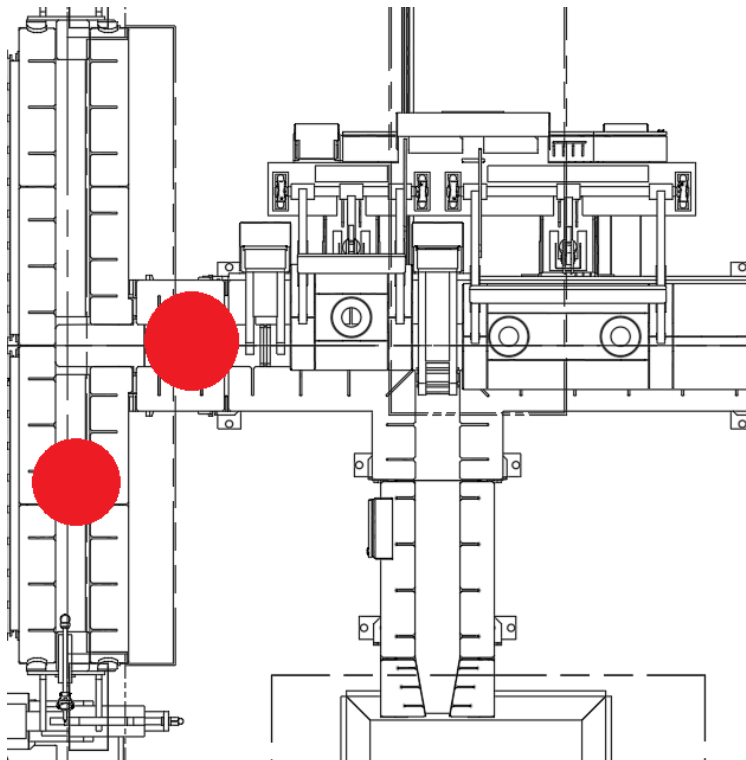


Figure 2 Horizontal Direct Chill (HDC Line) Metal Inclusion Analyzer , two possible measurement points

2 SYSTEM DESCRIPTION

2.1 Ultrasonic Counter System

- The ultrasonic counter shall measure non-metallic inclusions by analyzing acoustic impedance variations within molten aluminum using ultrasound. A converging-waveguide pitch-and-catch configuration shall create a defined 10 cm² focal zone through which a controlled fraction of molten metal is monitored.
- The system shall utilize:
 - Control (NDT)I ultrasound for continuous inclusion detection and measurement with,
 - Power ultrasound pulses to maintain wetting of ceramic waveguides and prevent buildup of oxides, carbides, grain refiner particles, or gas bubbles
- The system shall be capable of:
 - Continuous or semi-continuous sampling
 - Quantitative measurement of inclusion concentration and size distribution
 - Stable operation with defined probe immersion depth and controlled metal flow
 - Real-time visualization, data logging, and traceable results
- System functions shall include automatic probe preheating, immersion control, signal generation, regeneration, data acquisition.
- As a general reference, the metal cross-section at the measurement location (Strip Casting) is 79.87 cm² at a metal level of 100 mm. Under these conditions, the fraction of metal analyzed is 10 cm² / 79.87 cm² or 12.5% of the flow which is 0.275 ton/hour analyzed.

The following calculation is provided for reference only and does not constitute a mandatory design requirement.

2.2 Electrical Resistive Pulse Counter System (Coulter Counter)

- The electrical resistive pulse counter shall operate on the resistive pulse principle. Non-metallic inclusions shall be detected as transient electrical resistance changes as they pass through a calibrated orifice immersed in molten aluminum.
- The system shall be capable of:
 - Continuous or semi-continuous sampling
 - Quantitative measurement of inclusion concentration and size distribution
 - Stable operation with defined probe immersion depth and controlled metal flow
 - Real-time visualization, data logging, and traceable results
- The system functions shall include automatic probe preheating, immersion control, signal generation, regeneration, data acquisition.
- Sampling is done every 80 seconds, once the equipment is ready for sampling. Over an hour, this would represent 45 measurements, which would equate to a sample weight analyzed of approx. 1 kg per hour.
- Draw molten aluminum through the orifice using controlled vacuum or pressure
- Generate and measure electrical pulses corresponding to inclusions
- Convert pulses into size-classified counts
- Normalize counts to sampled metal mass
- Report standardized metrics (e.g., N20, N40, N60)

Values are indicative and shall be confirmed by the Contractor

3 CONTRACTOR SCOPE OF SUPPLY

The Contractor shall supply all equipment, assemblies, hardware, software, documentation, and services necessary for a complete operational system, including but not limited to:

- Measuring head(s)
- Measuring unit assembly with mechanical structure and positioning system
- Control station with HMI and local controls
- Main electrical cabinet with PLC, or industrial controller
- Signal processing hardware (ultrasonic or electrical as applicable)
- Sensors, probes, metal-level laser, limit switch, position sensors, waveguides or orifices, and consumables
- Control software, firmware, PLC logic, and HMI screens
- Web-based software and embedded server
- Interconnecting cables, conduits, tubing, and fittings
- Lifting, mounting, alignment, and installation interfaces
- Education and industrial unit visit to a facility using the analyzer, similar generation recognizing the most recent version or updated software may not be employed at this facility.
- Factory Acceptance Tests
- Performance and Acceptance Testing Protocol
- Site commissioning and support
- Operator and maintenance training
- Complete documentation package
- Any item not explicitly excluded shall be deemed included.

4 TECHNICAL DATASHEET REQUIREMENTS

The Contractor shall submit a completed technical datasheet covering:

- Measurement principle
- Detectable inclusion size range
- Measurement repeatability and resolution
- Sampling rate and duration
- Sampled melt volume or mass
- Data outputs and communication protocols
- Electrical load summary
- Compressed air consumption
- Environmental operating limits
- Mechanical dimensions and weights
- Consumables and expected service life

The Contractor shall clearly list all consumables required for the operation of the offered system, including but not limited to probes, waveguides, orifices, electrodes, filters, gases, protective components, or any other parts subject to regular wear or replacement due to normal operation.

For each consumable, the Contractor shall specify the expected lifetime, replacement interval, and unit cost.

Consumables shall be explicitly distinguished from spare parts and corrective maintenance activities. Unless explicitly stated otherwise in the offer, consumables shall not be considered part of standard service or maintenance activities.

5 MEASUREMENT PERFORMANCE REQUIREMENTS

5.1 Minimum required performance (unless otherwise agreed) Ultrasonic Counter System:

- Minimum detectable inclusion size: $\geq 20 \mu\text{m}$
- Maximum detectable inclusion size: – Ultrasonic counter: $\geq 2000 \mu\text{m}$
- Measurement repeatability: $\pm 10\%$ or better
- Data sampling interval: – Ultrasonic counter: approx. 0.1 s
- Output units: Number of events per unit of time for different threshold levels (US index).
- Size classification: user-configurable bins
- Data storage: local and exportable

5.2 Minimum required performance (unless otherwise agreed) Coulter Counter System:

- Minimum detectable inclusion size: $\geq 20 \mu\text{m}$
 - Maximum detectable inclusion size: – Coulter Counter: $\geq 300 \mu\text{m}$
 - Particle size measurement Approx. $\geq 20 - 155 \mu\text{m}$
 - Inclusion concentration 0.05 – 1000 k/kg
 - Typical sample interval ~80 seconds
 - Typical sample volume ~7.5 ml
 - Typical sample mass ~17.5 g
 - Reproducibility (high counts) $\pm 10\%$
 - Output metrics Size distribution, cumulative counts
- Performance values reflect typical capabilities of the respective technologies and shall be met by any offered solution using the given measurement principle.

6 ENVIRONMENTAL CONDITIONS

The system shall be designed for continuous operation under the following conditions:

- Ambient temperature: 0–45 °C
- Relative humidity: up to 85%, non-condensing
- Molten aluminum temperature: up to 750 °C
- Industrial foundry atmosphere with dust and oxides
- Normal plant vibration levels
- Storage temperature –20–60 °C
- Internal Operating temperature 25–35 °C

7 ELECTRICAL REQUIREMENTS

- Supply voltage: – Ultrasonic counter: 115/230 VAC, 50/60 Hz, single or two phase
Coulter counter: 100/240 VAC $\pm 10\%$, 47/63 Hz, single phase
- Control voltage: 24 VDC
- Grounding: dedicated protective earth
- Power consumption: 12.5–25 A
- Main supply cable sizing shall be defined by the Contractor based on actual load.
- Electrical design: IEC compliant
- EMC: industrial immunity and emissions compliance
- All wiring shall be identified and documented.

8 COMPRESSED AIR REQUIREMENTS

- Air quality: clean, dry, oil-free
- Air temperature: 5–25 °C
- Flow: ≥ 1000 L/min during cast, ≥ 100 L/min between casts
- Filtration: 10 μm , 99% purity
- Dew point: –40 °C
- Hose nominal diameter: 19 mm
- Supply pressure: 5–6 bar(g) or
- Supply Argon: 4, 14 - 8,0 bar (g) for LiMCA
- Usage: probe protection, purging, cooling, and ultrasonic regeneration (where applicable)
- Loss of air supply shall not result in unsafe conditions

9 MECHANICAL REQUIREMENTS

The Contractor shall provide:

- Overall system dimensions and weights
- Probe or waveguide immersion envelope
- Required installation clearances
- Clearly marked lifting points
- Structures designed for rigidity, thermal exposure, and vibration resistance

10 EQUIPMENT DESCRIPTION

10.1 Measuring Head

- Ultrasonic counter: dual ceramic waveguides with ultrasonic transducers and cooling interfaces
- Coulter counter: refractory/glass-protected probe with precision calibrated orifice
- Replaceable wear components
- Electrical and thermal insulation suitable for molten aluminum exposure
- Provides cooling, electrical interface, and temperature regulation

10.2 Measuring Unit

- Structural frame with positioning system
- Immersion control and level sensing
- Signal conditioning and noise filtering
- Self-diagnostic functions

10.3 Control Station

- Industrial HMI or PC-based interface
- Real-time trends, alarms, and status indicators
- Data logging, export, and recipe management
- Pneumatic cabinet with temperature regulation valves
- Support frame and local operator interface

10.4 Main Electrical Cabinet

- Industrial enclosure, minimum IP54
- Power distribution and protection
- Network switch
- PLC or industrial controller
- Proper ventilation or active cooling

11 APPLICABLE STANDARDS

In case of conflict, EU directives shall prevail.

The system shall comply with applicable standards, including:

11.1 Machine Safety & Design Standards

- 2006/42/CE Machinery Directive
- EN 953 – Machinery Guarding Requirements
- EN 1247 – Safety Requirements for Foundry Machinery
- ISO 12100 – Machinery Safety: Principles for Design
- ISO 13849 – Safety-Related Parts of Control Systems
- IEC 60204 – Electrical Equipment of Machines
- IEC 62061 – Functional Safety of Machinery
- Guidelines for Handling Molten Aluminum

11.2 Electrical, Control, & Documentation Standards

- IEC 61000 – EMC Requirements
- IEC 61131 – Industrial Automation Programming
- IEC 61439 – Low-Voltage Switchgear Assemblies
- IEC 61082 – Documentation for Electrotechnology
- IEC 60617 – Electrical Symbols
- CSA C22.2 No.14 – Industrial Control Equipment (Canada)
- NFPA 79 – Electrical Standard for Industrial Machinery (USA)
- IEC/EN 60947-2 (Circuit protection)
- IEC Laser Class 2 / FDA Class II
- ISO 9001 (Calibration and quality systems)
- Applicable CE and industrial safety directives

11.3 Materials, Finishing & Structural Standards

- ISO 12944 – Corrosion Protection by Paint
- RAL 840-HR – Industrial Color Specifications
- CSA-G40.20/.21 – Structural Steel Requirements
- CSA W59 – Welded Steel Construction

11.4 Relevant CE and local regulatory requirements

12 DESIGN REQUIREMENTS

- Ensure safe operation under molten aluminum casting conditions
- Maintain structural rigidity and vibration resistance
- Provide precise positioning of waveguides
- Maintain cooling airflow and stable thermal environment for electronics
- Ensure EMC compliance and immunity to induction furnaces and magnetic fields
- Support maintainability, accessibility, and safe replacement of Module 0
- Protect hardware from heat, dust, humidity, and splashing metal
- Drawings shall be provided in .DWG and .PDF
- Deliver continuous, high-quality acoustic measurements with automatic regeneration

13 REFRACTORY AND WETTED COMPONENTS

- Coulter counter systems shall utilize refractory materials compatible with molten aluminum, with defined service life and replacement procedures
- Ultrasonic counter systems shall utilize ceramic or metallic wetted components designed for long-term operation without refractory linings

14 COATINGS AND FINISHES

- Measuring head housing: Yellow RAL-1003, TGIC polyester powder coat, 2.5–4 mil DFT
- Column: Blue RAL-5017, TGIC polyester powder coat, 2.5–4 mil DFT
- Electrical/pneumatic cabinets: Black RAL-9004, zinc-phosphate epoxy, 4–6 mil DFT
- Control/pneumatic cabinets: Light gray RAL-7035 OEM textured powder coat, 3.2–4.8 mil DFT
- Fasteners: Stainless steel ISO-metric hardware

15 FACTORY ACCEPTANCE TESTING (FAT)

FAT shall include:

- Mechanical alignment, motion, and stroke limits
- Correct assembly and wiring of electrical, pneumatic, and UT subsystems
- PLC and HMI functionality, alarms, and interlocks
- Communication with UT hardware and verification of data acquisition

- Verification of metal-level sensor operation
- Verification of cooling airflow and temperature regulation
- Documentation completeness: drawings, manuals, wiring diagrams
- Three (3) day operating and maintenance training session, during FAT with training outline (pdf) to assist Customer's development of module for inclusion into the Learning Management System.
- The FAT shall be witnessed by the Client or their representative upon two weeks prior notification to the event/request.