

RAUCH Furnace Technology GmbH

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## Technical availability of RAUCH equipment

Agreement of technical availability as defined in standard VDI 3423:

### Preamble:

It is the intended purpose of RAUCH equipment to provide metal melt from a melting furnace. (see quotation: process description)

Troubles during operation of equipment deriving from external equipment or from technical alterations performed by the customer / third party having impact on RAUCH equipment shall have no effect on the evaluation of the operation behavior of RAUCH equipment.

### Trouble-free operation:

Only circumstances that are unquestionably causal for the prevention of the intended purpose (provision of metal melt form furnace) shall be considered as trouble.

Trouble-free operation of RAUCH equipment strongly depends on several prerequisites from the customer concerning operational media and basic resources e.g.

- Ingots – sizes, tolerances in dimensions, accuracy of stack formation, oxide-content, surface quality, accuracy of metallurgical composition, ...
- Constant and sufficient supply with operational media, electricity, fuel gas, pressurized air, ...
- Auxiliary media e.g. protection gas quantity and quality, ...
- And more meaningful

Troubles caused by insufficient supply with these media or non-conforming resources shall not be considered as interruption of trouble-free operation.

RAUCH provides detailed manuals for continuous maintenance, repair works, operation and safety together with its equipment. All contained information, provisions and recommendations have to be observed by the operator. Troubles or interruption in equipment operation deriving from violations of the contained information, provisions or recommendations by the customer shall not be considered as interruption of trouble-free operation.

Messages indicated on operation terminals / screens shall not be considered as trouble in general.

Messages indicated on operation terminals / screens indicating just deviations of normal operation status and not causing immediate interruption of normal operation by the control system of the equipment shall not be considered as trouble, if the operator is able to restore normal operation mode by performing the correct troubleshooting actions described in operation manual.



## Technical Availability (hereinafter referred to as “availability”)

Availability = (total time – downtime) / total time

Total time: time period for performance verification that was agreed in written between customer and RAUCH (e.g. 7 x 24 h = 168 h)

### Downtime:

Time period of an unplanned interruption in normal operation (equipment is unable to perform the intended purpose); E.g. blockage of siphon, malfunction of necessary heating device, malfunction of feeding device, ...

Downtime shall be calculated as the sole time for the exchange of the affected device by a spare part of the equivalent functionality including time to start-up and establish the normal operation mode. The duration of subsequent repair for the affected device shall not be considered as downtime. All OEM spare parts (RAUCH) have to be available immediately on customer's stock and have to be kept ready for installation (e.g. prewarmed) by the customer. Prolongations of downtime due to missing or inappropriate (e.g. insufficiently prewarmed) spare parts shall not be considered as parts of calculated downtime.

Equipment stops due to the performance of regular and plannable work routines described in operation manual (e.g. preventive cleaning, preventive exchange of spare parts, dross or slag removal, ...) shall not be considered as part of calculated downtime. Operation manuals describe in detail all necessary preventive and regular work routines together with a time schedule and average duration to perform the activities (provided that all necessary spare parts and tools are available on customer's stock and ready for use).

Crucibles or other components of RAUCH equipment exposed to high thermal stress can cause troubles, downtime or early failure if not operated or maintained properly by the customer's personnel (e.g. insufficient melt cleaning, false melt level, elevated operation temperature, elevated temperature gradients or any changes in operation parameters / limit values not prior agreed with RAUCH). Downtime due to these reasons shall not be considered as part of calculated downtime.

A part of complex equipment performing a defined functional purpose for itself is regarded as “single equipment”, it is often marked with separate name plate e.g.

- Ingot de-palletizing
- Ingot pre-warming unit
- Melting furnace
- Siphon
- Dosing furnace (without dosing pump)
- Protective gas mixing unit
- Casting platform
- ...

Downtime and availability is calculated for every single equipment separately.

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**General conditions for the agreement of “technical availability and trouble-free operation” of RAUCH equipment** are the following customer's obligations:

- Operation, maintenance and repair works on RAUCH equipment is performed by qualified and trained personnel only
- Availability of sufficient OEM spare parts (see recommendations RAUCH) on customer's stock
- Continuous provision of qualified and trained-on-equipment maintenance personnel in case of shift operation
- Provision of network access for RAUCH, connected via router to company network of customer. Establishment and provision of a VPN tunnel by customer to enable permanent remote access to control systems of RAUCH equipment. VPN server running preferably on CISCO software.
- Basis of downtime calculation is the instant of time, when the customer reports trouble to RAUCH personnel during core working time. Core working time for RAUCH is
- Mon –Thu 07:00-16:00 CET; Fri 07:00-13:00 CET.
- Customer commits to keep a trouble log book (acc. to VDI 3423 standard) and to submit the relevant contents to RAUCH weekly or upon request.
- Minor troubles that can be easily fixed by a customer's employee after training as well as troubles caused by insufficient operation, lacking knowledge or carelessness shall not be considered as part of calculated downtime.
- Troubles or downtime periods caused by circumstances RAUCH cannot be blamed for or RAUCH cannot control shall not be considered as part of calculated downtime.
- Ulterior claims for damages exceeding the regulations in the purchase contract are excluded.

**Period of performance evaluation:**

The period of performance evaluation is agreed in the purchase contract, it is necessary that a certain period is agreed wherein customer operation is accompanied by qualified RAUCH personnel. Duration of performance evaluation must not exceed 1 month.



## **Start-up operation, start-up time, melting time, melt output (acceptance test)**

### **Limits for melting time:**

The maximum temperature gradient during heating-up of the furnaces must not exceed 50 K/hr. Otherwise thermally-stressed parts of the equipment can be damaged or cause early failures.

### **Start-up time:**

After pre-warming the whole equipment up to 700°C all melting furnaces need some 20 – 30 minutes to reach nominal melting rate, to heat up all thermal relevant parts up to operation temperature (e.g. crucible, furnace insulation, sensors, pumps, ...)

### **Start-up requirements:**

All material intended to enter the furnace or melt (ingots, recycling material, tools, pumps, ...) have to be absolutely free of humidity and heated up to min. 120°C core temperature.

Start-up procedures differ between continuously operated melting furnaces and furnaces designed for intermitting operation (batch operation).

### **Continuous melting furnaces:**

Nominal temperature of all thermal relevant parts cannot be reached unless by melt flow, otherwise melt in furnace would be overheated. Hence start-up procedure of the furnace has to be split in 2 phases as described below.

- 1) Initial situation: melt temperature in furnace is on nominal value 700°C.
- 2) Melt flow rate setting: 50%- 70% of nominal flow rate for 20-30 min. and production with reduced output. During this period heating must not be interrupted (no shut down of burners or electric heating) and all thermal relevant parts can be pre-warmed sufficiently by melt flow.
- 3) Raising melt flow rate setting up to 100% of nominal flow rate.

### **Acceptance test:**

Customer and RAUCH agree on the following test procedure:

Customer allows that melt-flow is varied during the test period upon request of RAUCH, e.g. by variation of process cycle-time.

- a) Initial situation: melt temperature in furnace is on nominal value (e.g. 700°C).
- b) Melt flow rate setting: 50%- 70% of nominal flow rate by extension of process cycle-time.
- c) Operation of equipment at set values with reduced output for 30 min. with steady charging
- d) Melt flow rate setting: 100% of nominal flow rate
- e) Operation of equipment with nominal (maximum) flow rate, duration as agreed in contract (standard duration 60 min.); steady charging
- f) Proof of performance is given if melt temperature in dosing area of furnace does not come below initial nominal temperature (e.g. 700°C) at the end of test period.
- g) Minor deviations in temperature due to inaccuracy of measurement or control system shall not be considered.



Further constraints for acceptance test:

- All charging material (ingots, recycling material) have to be absolutely free of humidity and heated up to min. 120°C core temperature
- Continuous charging with portions of 8 or 12 kg according to melt output in order to keep melt level constant
- Initial melt level at nominal level
- Proper maintenance and cleanliness condition of equipment

### Batch operated melting furnaces:

Prior to starting the acceptance test at least one batch has to be molten in order to reach the operation temperature of all thermal relevant components, the crucible has to be emptied, cleaned and refilled immediately with charging material (ingots, recycling material). Crucible temperature must be above 550°C, furnace chamber temperature must be above 850°C before start of test time. Crucible has to be charged continuously during melting process in order to keep the melt level close to maximum, a permanent melt motion has to be ensured to facilitate fast melting.

### Acceptance test:

Customer and RAUCH agree on the following test procedure:

Initial situation: All thermal relevant components (crucible, furnace insulation, heating, ...) were heated up to nominal temperature by a prior batch; crucible filled with specified charging material, closely stacked or chopped in small pieces to minimize hollows.

- a) Melt temperature setting according to agreed nominal temperature
- b) Steady charging of crucible with specified material during melting process in order to keep the melt level close to maximum level
- c) Ensure permanent melt motion in crucible by using suitable tools, stirring or nitrogen injector.
- d) Proof of performance is given if set melt temperature in crucible is reached within the agreed time (temperature deviation  $\pm 10$  K is acceptable)
- e) Minor deviations in temperature due to inaccuracy of measurement or control system shall not be considered.

Further constraints for acceptance test:

- All charging material (ingots, recycling material) have to be absolutely free of humidity and heated up to min. 120°C core temperature before charging into liquid melt
- Continuous charging with portions of 8 or 12 kg (ingots or chopped recycling material) in order to keep melt level constant
- Proper maintenance and cleanliness condition of equipment