Employer
**SAKO BRNO A.S.**

Project
**High-efficient combined heat and power facility utilizing renewable sources (OHB II - line K1)**

Date
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# PART III, APPENDIX A13
# PROCESS AND DESIGN DATA

SAKO

RAMBØLL

# PART III, APPENDIX A13
# PROCESS AND DESIGN DATA

| | |
|---|---|
| Project name | **High-efficient combined heat and power facility utilizing renewable sources (OHB II - line K1)** |
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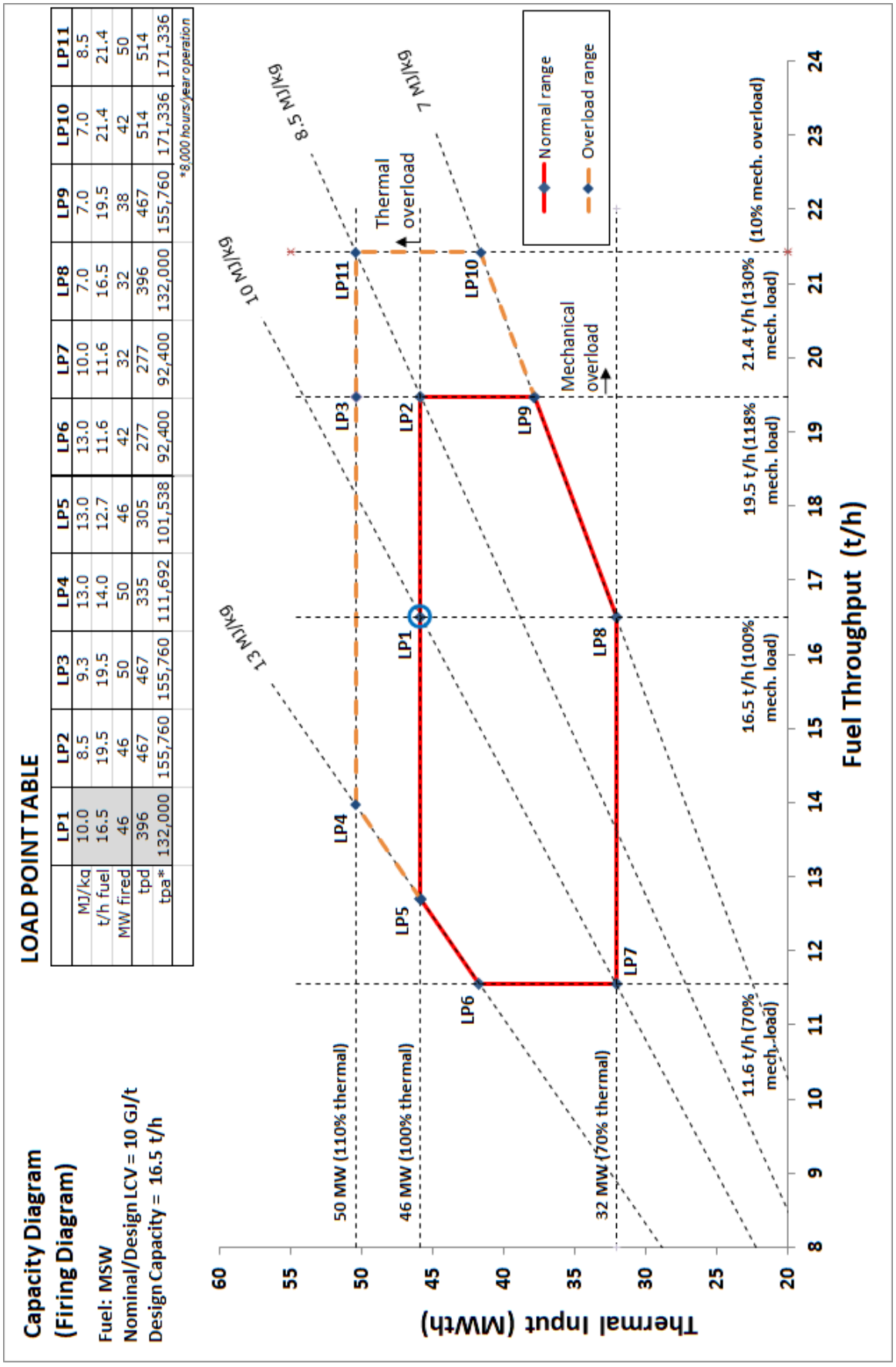
# CONTENTS

# 1. CAPACITY DIAGRAM




| | LP1 | LP2 | LP3 | LP4 | LP5 | LP6 | LP7 | LP8 | LP9 | LP10 | LP11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MJ/kg | 10.0 | 8.5 | 9.3 | 13.0 | 13.0 | 13.0 | 10.0 | 7.0 | 7.0 | 7.0 | 8.5 |
| t/h fuel | 16.5 | 19.5 | 19.5 | 14.0 | 12.7 | 11.6 | 11.6 | 16.5 | 19.5 | 21.4 | 21.4 |
| MW fired | 46 | 46 | 50 | 50 | 46 | 42 | 32 | 32 | 38 | 42 | 50 |
| tpd | 396 | 467 | 467 | 335 | 305 | 277 | 277 | 396 | 467 | 514 | 514 |
| tpa* | 132,000 | 155,760 | 155,760 | 111,692 | 101,538 | 92,400 | 92,400 | 132,000 | 155,760 | 171,336 | 171,336 |

*8,000 hours/year operation

# 2. PROCESS AND DESIGN DATA, GENERAL

| Table for Process and Design Data, General<br>Appendix A13 | | |
|---|---|---|
| **Reference** | **Line Component / Parameter** | **Value / Description** |
| **Appendix A1** | **Design Basis** | |
| **A1: sec. 2/3/4** | **Basic Process** | |
| | Incinerator/Boiler | Furnace with grate and boiler cooled combustion chamber, SNCR and auxiliary burners.<br><br>Steam boiler with two radiation passes and a horizontal convection pass. |
| | Flue gas treatment | Semi-dry concept consisting of a reactor system with $Ca(OH)_2$/CaO and AC injection and a baghouse filter followed by an ID-fan, emission monitoring system, duct and installations in existing stack. |
| | Turbine/Generator | Recovery of the energy content of the steam produced in a back-pressure turbine with a generator for power production and at least one bleed for MP steam. The exhaust shall be condensed in a condenser for district heat production.<br><br>Under normal operations the generator will generate electrical power. Power generated will meet Employers site requirements for Complete Plant and the balance of the electrical power generated will be exported to grid.<br><br>The Line shall be able to operate in power island mode to support waste processing i.e. where no power exports to the grid are possible due to failures etc. |
| | Cooling | Summer coolers (dry coolers) shall be installed with sufficient capacity to off-take DH production in periods with minimal DH demand from the grid. |

| Table for Process and Design Data, General<br>Appendix A13 | | |
|---|---|---|
| **Reference** | **Line Component / Parameter** | **Value / Description** |
| **A1: sec. 10** | **Design Data for the Line** | |
| **A1: sec. 10.1** | **Estimate of the waste** | |
| | • Municipal solid waste (0-100%)<br>• Commercial and industrial waste (0-100%)<br>• Other waste fractions (as defined in Appendix E8 *Approved Waste Types for Employer's Existing Plant*) in excess of mixed municipal solid waste and mixed commercial and industrial waste (0-30%)<br><br>Mixed municipal solid waste composition<br>- Water content:<br>- Ash content:<br>- Combustibles: | <br><br><br><br><br><br><br>10-40%<br>10-30%<br>40-70% |
| | Range of calorific value of fuel mixture (lower calorific value) | 7-13 MJ/kg |
| **A1: sec. 10.2** | **Operating Conditions** | |
| | Operating range | According to the Capacity Diagram |
| | Nominal mechanical MSW flow<br>Nominal calorific value (lower calorific value) | 16.5 tonnes/h<br>10 MJ/kg, LP1 |
| | Superheating in boiler | Full superheating in the entire operating range of the capacity diagram approx. 1,000 hours after manual cleaning of the boiler / clean boiler.<br><br>0-1000 hours after manual cleaning: a slightly lower superheating temperature can be accepted.<br><br>Turbine must be in safe operation after 100 hours after manual cleaning, without problems with erosion due to low steam temperature. |
| | Load variation for incinerator/boiler | 70-110% |
| | Operational range turbine/generator | Max. 110% |
| | Number of planned annual outages | 1 |
| | Number of annual cold starts | 1-4 |

| Table for Process and Design Data, General<br>Appendix A13 | | |
|---|---|---|
| **Reference** | **Line Component / Parameter** | **Value / Description** |
| | **Minimum hours of operation annually (availability)** | |
| | Minimum hours of annually Line operation availability<br>(Definition of operational availability according to part II.c Contractual penalties for non-compliance with values) | 8,000 h/year |
| | Planned stop | 560 h/year |
| | Unplanned stop | 200 h/year |
| | Minimum continuous operation period | 8,000 h |
| **A1 sec. 10.2.2 + 10.3** | **Thermal efficiency & Ambient Air Conditions** | |
| | Bottom ash temperature | 500 °C |
| | Bottom ash quantity | 22 %<br>wet weight of waste load |
| | Feed water temperature | 130 °C |
| | Temperature of primary intake air | 25 °C |
| | Temperature, outdoor | Local climate<br>However, as a minimum<br>-10 ºC to 35 ºC |
| | Temperature, indoor<br>(General minimum requirement) | 0 ºC to + 40 ºC |
| | Radiation and convection losses indoor (boiler hall) | 1.5 % of nominal thermal load i.e. thermal input into the furnace from waste fired. |
| | **Thermal insulation** | |
| | Process equipment surface temperature requirements | Refer to appendix A14.4 *Insulation and Cladding* |
| **A1: sec. 10.4.5** | **District heating** | |
| | Design pressure DH network | 25 bara |
| | Operational pressure DH network downstream DH pumps<br>*(refer to DH supply limit to Plant stated in Appendix A18 Limits of Supply)* | Nominal: 16 bara<br>min.: 8 bara<br>max.: 23.5 bara |
| | Design temperature DH network | 130°C |
| | Maximum supply temperature | 105°C |
| | District heating return temperature range | 60-70°C<br>Nominal 67°C |
| | District heating supply temperature range (possible operation) | 80-105°C<br>Nominal 90°C |
| | Typical Winter operation | 67 return → 95°C supply |

| Table for Process and Design Data, General<br><br>Appendix A13 | | |
|---|---|---|
| **Reference** | **Line Component / Parameter** | **Value / Description** |
| | Typical Summer operation | 67 return → 85°C supply |
| | Design Flow Velocity for DH pipes | 3.5 m/s<br>(@ maximum heat output, bypass operation, with winter DH temperatures) |
| | Maximum total pressure loss (@ maximum heat output, bypass operation, with winter DH temperatures):<br><br>- DH pipe outlet to DH pipe inlet through outer walls of existing DH building (including condensers, exterior and interior pipework, valves, etc., refer to DH supply limits in Appendix A18 *Limits of Supply*) | 1.5 bar |
| | Maximum pressure difference between cold and hot connection to summer cooler at main DH pipe (connection located between existing DH building and Line). | 2 bar |
| **A1: sec. 10.4.1** | **Water Supply** | |
| | Velocity in water pipes | Max. 1 m/s |
| | Fresh water<br>- Water pressure<br>- Water temperature, winter<br>- Water temperature, summer | <br>4-5 bara<br>5-15°C<br>16-21°C |
| **A1: sec. 10.8.8** | **Electrical Supply** | |
| | Medium voltage power supply | 22/6,3 kV AC |
| | Low voltage power supply | 400/230 V AC |
| | Safe Supply (UPS) | 2 UPS units for safe power 400/230 V AC |
| | Emergency power supply | 400/230 V AC |
| | Control Voltage | 230V AC /220 V DC/24V DC |
| | CMS Control Voltage | 24 DC |

# 3. PROCESS AND DESIGN DATA, INCINERATOR/BOILER

| Table for Process and Design Data, Incinerator/boiler<br>Appendix A13 | | |
|---|---|---|
| **Reference** | **Line Component / Parameter** | **Value / Description** |
| **Appendix A2** | **Incinerator / Boiler** | |
| **A2: sec. 2.1** | **Feed Hopper** | |
| | Hopper opening area | The length of the slant opening of the hopper shall minimum be equivalent to the width of the waste grab in open position. The grab may thus not drop waste directly into the chute but shall drop all waste onto the slanted part without spillage.<br><br>Minimum three sides of the hopper shall have angled sides.<br><br>The width of the hopper shall be minimum 2 meter wider than the width of the grate.<br><br>The front of the hopper shall have an angle of approximately 60 degrees. |
| | Volume | Min. 1 hour capacity |
| | Material thickness, steel plates | Min. 12 mm, depending on the structural reinforcement |
| | Blockage detection | Min. 2 radar sensors |
| **A2: sec. 2.2/2.3** | **Waste Chute** | |
| | Height of chute | Min. 4-5 m |
| | Minimum depth of refuse chute | 1.5 m |
| | Cut-off gate drive | Hydraulic |
| | Material thickness, steel plates | > 8 mm |
| | Level measuring equipment | Micro-wave or gamma ray |
| **A2: sec. 2.4** | **Waste Feeder** | |
| | Pusher drive | Hydraulic |
| **A2: sec. 3** | **Grate** | |
| | Grate drive | Hydraulic |
| | Min. number of access doors to grate | 2 |
| | Access door to grate, minimum dimension (W x H) | 1.50 m x 1.80 m |
| **A2: sec. 4.2** | **Primary Air** | |
| | Ducts for combustion air: | |
| | Material thickness | Min. 4 mm |
| | Air velocity | Max. 15 m/sec |

| Table for Process and Design Data, Incinerator/boiler<br>Appendix A13 | | |
|---|---|---|
| **Reference** | **Line Component / Parameter** | **Value / Description** |
| **A2: sec. 4.3** | **Secondary Air** | |
| | Ducts for combustion air: | |
| | Material thickness | min. 4 mm |
| | Air velocity | Max. 15 m/sec |
| **A2: sec. 4.4** | **Primary and Secondary Air Fan** | |
| | Design specifications for Primary and Secondary Air Fans | Fan and motor shall be designed for 15 % excess capacity relative to the nominal load point (LP1) with $\lambda$ = 1.8.<br><br>Pressure head shall be increased with respect to the 15 % excess capacity. |
| | **Primary Air Fan:** | |
| | Primary air fan speed at nominal load point with $\lambda$ = 1.8 | Max. 1500 rpm |
| | Minimum wall thickness of the housing | Min. 6 mm |
| | **Secondary Air Fan:** | |
| | Secondary air fan speed at nominal load point with $\lambda$ = 1.8 | Max. 1500 rpm |
| **A2: sec. 4.5** | **Air Pre-heater** | |
| | Air temperature increase at nominal load point with $\lambda$ = 1.8 | -10 °C to design temperature |
| | Driving steam condensate return temperature | 60-110°C |
| | Construction | Bare tube structure / unfinned |
| | Free distance between tubes | min. 15 mm |
| | Cleaning system | Water spray |
| | Drains | Yes |
| **A2: sec. 6-7** | **Primary and Secondary Combustion Chambers** | |
| | Excess air ratio<br>To be calculated as 21/(21-O2), where O2 specifies the oxygen content in flue gas on dry basis (% vol.) for the purposes of calculating chamber dimensions | $\lambda$=1.8 |
| | Variation of CO-content at outlet of secondary combustion chamber | Max. factor 2 across a cross section |
| **A2: sec. 8** | **Refractory/Ceramic lining/Inconel Cladding** | |
| | Minimum SiC (Silicon Carbide) - content in areas with t ≥ 900 °C | ≥ 90% |
| | Minimum $Al_2O_3$ (Aluminium Oxide) - content in areas with t < 900 °C | ≥ 60% |
| | Inconel cladding until temperature level in flue gas | ≤850 °C |

| Table for Process and Design Data, Incinerator/boiler<br>Appendix A13 | | |
|---|---|---|
| **Reference** | **Line Component / Parameter** | **Value / Description** |
| | Inconel requirements must meet VGB standard | VGB-S-013-00-2017-04-EN |
| | Degree of dilution | The iron content in the surface must not exceed 5% |
| **A2: sec. 9** | **Boiler** | |
| | Access doors | Min. 800x800 mm |
| | Boiler drum, no. of doors | 2 (one at each end of drum) |
| | **Superheater and evaporators in convection pass** | |
| | First section:<br>Transverse tube pitching | Min. 160 mm |
| | Subsequent sections:<br>Transverse tube pitching | Min. 120 mm |
| | All sections:<br>Longitudinal tube pitching | Min. 120 mm |
| | **Economizer** | |
| | Transverse tube pitching | Min. 100 mm |
| | Longitudinal tube pitching | Min. 100 mm |
| | Minimum distance between evaporator-, superheater- and economizer sections: | Min. 800 mm |
| | **Pressure in furnace chamber** | |
| | Lowest permissible pressure in furnace chamber | Max. -5,000 Pa |
| | **Membrane tube walls** | |
| | Tube Pitching | Max. 80 mm |
| **A2: sec. 10.1** | **Blow down and drainage system** | |
| | Maximum temperature to IBA wastewater pit | 65 °C |
| **A2: sec. 10.5** | **Water and Steam data** | |
| | Steam quality | In accordance with VGB guideline no. 450 L ("Normalstufe") |
| | Steam pressure at inlet to turbine stop valve<br>- Nominal | 40 bara |

| Table for Process and Design Data, Incinerator/boiler<br>Appendix A13 | | |
|---|---|---|
| **Reference** | **Line Component / Parameter** | **Value / Description** |
| | - Variation | Acc. to IEC[1] 60045-1 |
| | Steam temperature<br>- Nominal<br>- Variation | <br>400 °C<br>Acc. to IEC 60045-1 |
| | Steam flow<br>Max. steam flow variation | <br>At least 90 % of all 1 minute mean values from a 14 days period within ±5 % relative to set point |
| **A2: sec. 10.6** | **Flue gas Temperature Conditions*** | |
| | Flue gas temperature downstream first pass at the end of the guaranteed minimum continuous operation period | Max. 900°C |
| | Flue gas temperature upstream the surface of a possible evaporator "cooling trap" at the end of the guaranteed minimum continuous operation period | Max. 650°C |
| | Flue gas temperature upstream the first superheater surface at the end of the guaranteed minimum continuous operation period | Max. 625°C |
| | Flue gas temperature at boiler outlet | Min. 170°C<br>Nominal 170°C<br>Maximum 190°C |
| | *(Maximum temperature limits shall be valid also after 8,760 hours operation, without manual boiler cleaning. Online cleaning frequency during Guarantee period:<br>a) Water spray cleaning max one cleaning sequence per 24 h<br>b) Mechanical rapping max one cycle per shift (8 h) | |
| **A2: sec. 10.7** | **Flue Gas Velocity Conditions** | |
| | First pass, secondary combustion chamber | Max. 3.5 m/s |
| | Second pass | Max. 6 m/s |
| | Third pass | Max. 4 m/s |
| | Horizontal convection part | Max. 6 m/s |
| | Velocity in the flue gas ducts | Max. 15 m/s |
| **A2: sec. 10.8** | **Auxiliary and Start-up Burners** | |
| | Fuel | Natural gas |
| | Capacity, percentage of rated thermal boiler input | 60% |
| | Number of burners | Min. 2 |
| | Burner modulation, each burner | Min. 1:10 |

[1] The International Electrotechnical Commission (IEC) prepares and publishes International Standards for all electrical, electronic and related technologies.

| Table for Process and Design Data, Incinerator/boiler<br>Appendix A13 | | |
|---|---|---|
| **Reference** | **Line Component / Parameter** | **Value / Description** |
| **A2: sec. 10.9** | **Make-up Water System** | |
| | Make-up water quality | Boiler make-up water<br>Acc. to industry standard EN 12952-12 |
| | Capacity of make-up water plant | Complete filling of the boiler within 24 hours |
| | Volume of make-up water tank | min. 120% of ordinary water content of boiler |
| **A2: sec. 11** | **Feed water system** | |
| | Net volume of de-aerator/feed water tank | Minimum 30 min. x nominal steam production |
| | Temperature in feed water tank | 130 ± 3 ºC |
| **A2: sec. 12** | **Feed Pump System** | |
| | Electrically driven pumps | Two pumps, each with 100% capacity, frequency-controlled and emergency power supplied by emergency generator(s). |
| | Diesel driven pump | One additional direct diesel engine driven pump with 100% capacity |
| | Maximum rate of pressure rise during boiler start-up (inlet of boiler economizer) | 2 bar/minute |
| | **Flow Velocity** | |
| | Maximum values at maximum flow (at 100 % load) | |
| | Saturated steam | 25 m/s |
| | Superheated steam | 50 m/s |
| | Feed water and condensate (pressure pipe) | 5 m/s |
| | Feed water and condensate (suction pipe) | 2 m/s |
| **A2: sec. 13** | **Component cooling system** | |
| | Content of propylene glycol (in water/glycol mixture) | 41 % |
| | Cooling glycol supply temperature | max. 35 °C |
| | Cooling glycol return temperature | min. 39 °C |
| | Design pressure of cooling glycol circuit | 6 barg |
| | Operating pressure at interfaces to existing cooling glycol supply | 1.8 barg |
| | **Employer's Existing Component cooling system** | |
| | Content of propylene glycol (in water/glycol mixture) | 41 % |

| Table for Process and Design Data, Incinerator/boiler<br>Appendix A13 | | |
|---|---|---|
| **Reference** | **Line Component / Parameter** | **Value / Description** |
| | Design outdoor temperature (@ glycol temperature 35/41,2 °C) | 30.6 °C |
| | Cooling glycol supply temperature | nom. 33 °C |
| | Cooling glycol return temperature | nom. 39 °C |
| | Maximum permissible glycol temperature | 45 °C |
| | Design pressure of cooling glycol circuit | 10 barg |
| | Static operating pressure | 1.8 barg |
| | Volume of existing glycol tank | 16 $m^3$ |
| | Maximum permissible pressure of existing glycol tank | 6 barg |
| | Cooling capacity of existing component cooling system available for the Line | 500 kW |
| **A2: sec. 14** | **Boiler ash transport system** | |
| | Collection boiler | Mechanical |
| | Transport from boiler to end product silo 1 and 2 | Mechanical or pneumatic |
| | Sampling (pneumatic part) | Automatic sampling |
| **A2: sec. 15** | **IBA Handling System** | |
| | Ash content in waste | Max. 30% |
| | Water content in bottom ash downstream extractor | Max. 20% wt. basis |
| **A2: sec 16.1** | **Technical water tank** | |
| | Quantity | 1 |
| | Net capacity of pit/tank | 25 $m^3$ |
| **A2: sec 16.2** | **Wastewater pit** | |
| | Quantity | 1 |
| | Net capacity of pit | 50 $m^3$ |
| **A2: sec 18.4** | **Hydraulic System** | |
| | Capacity of hydraulic system | 110% |

# 4. PROCESS AND DESIGN DATA, FLUE GAS TREATMENT

| Table for Process and Design Data, Flue gas treatment<br>Appendix A13 | | |
|---|---|---|
| **Reference** | **Line Component / Parameter** | **Value / Description** |
| **Appendix A3** | **Flue gas treatment** | |
| **A3** | **Raw Flue Gas** | |
| | Referring to flue gas downstream boiler | |
| | **Nominal load data (100%) [1)]** | |
| | Flue gas flow rate, wet, actual $O_2$ [2)] | 85,800 $Nm^3/h$ |
| | Flue gas flow rate, dry at 11% $O_2$ | 91,400 $Nm^3/h$ |
| | Temperature | 170 °C |
| | Pressure | – 1,000 Pa |
| | H2O | 14.9 % vol. |
| | O2 | 8.5 % vol., dry |
| | Dust | 2,200 $mg/Nm^3$, 11 % $O_2$, dry |
| | Σ Cd + Tl | 1 $mg/Nm^3$, 11 % $O_2$, dry |
| | Σ Sb+As+Pb+Cr+Co+Cu+Mn+Ni+V | 50 $mg/Nm^3$, 11 % $O_2$, dry |
| | HCl | 840 $mg/Nm^3$, 11% $O_2$, dry |
| | $SO_2$ and $SO_3$ (as $SO_2$) | 360 $mg/Nm^3$, 11 % $O_2$, dry |
| | HF | 20 $mg/Nm^3$, 11 % $O_2$, dry |
| | $NO_x$ as $NO_2$ [3)] | 120 $mg/Nm^3$, 11 % $O_2$, dry |
| | $NH_3$ [3)] | 10 $mg/Nm^3$, 11 % $O_2$, dry |
| | Hg | 0.2 $mg/Nm^3$, 11 % $O_2$, dry |
| | Dioxins and furans (tox. equivalent 2,3,7,8 TCDD) | 2 $ng/Nm^3$, 11 % $O_2$, dry |
| | [1)] Nominal values to be used as reference for guarantee values (at nominal) of consumables, residues, and energy production and consumption etc. Values apply at boiler exit<br>[2)] Wet flue gas at actual $O_2$ content<br>[3)] after SNCR-deNOx | |
| | **Dimensioning data, process [1)]** | |
| | Min. Flue gas flow rate, wet flue gas at actual $O_2$-content | No higher than 60,100 $Nm^3/h$ |
| | Max. flue gas flow rate, wet flue gas at actual $O_2$-content | No less than 101,100 $Nm^3/h$ |
| | Flue gas flow rate, dry at 11% $O_2$, dry | 63,900-100,500 $Nm^3/h$ |
| | Temperature [2)] | 160 – 200 °C |
| | Pressure [2)] | – 2,500 Pa |
| | $H_2O$ | 10 – 24 % vol. |
| | $O_2$ [2)] | 6 – 10 % vol., dry |
| | Dust [2)] | 500-5,000 $mg/Nm^3$, 11% $O_2$, dry |
| | Σ Cd + Tl [2)] | Max. 5 $mg/Nm^3$, 11% $O_2$, dry |
| | Σ Sb+As+Pb+Cr+Co+Cu+Mn+Ni+V [2)] | Max. 200 $mg/Nm^3$, 11% $O_2$, dry |
| | HCl | 50 - 2,500 $mg/Nm^3$, 11% $O_2$, dry |

| Table for Process and Design Data, Flue gas treatment<br><br>Appendix A13 | | |
|---|---|---|
| **Reference** | **Line Component / Parameter** | **Value / Description** |
| | $SO_2$ and $SO_3$ | 0 - 1,500 mg/Nm$^3$, 11% $O_2$, dry |
| | HF | 0 - 50 mg/Nm$^3$, 11% $O_2$, dry |
| | $NH_3$ 2) | 0 - 20 mg/Nm$^3$, 11% O2, dry |
| | Hg | Max. 0.5 mg/Nm$^3$, 11% $O_2$, dry |
| | Dioxins and furans (tox. equivalent 2,3,7,8 TCDD) 2) | Max. 10 ng/Nm$^3$, 11% $O_2$, dry |
| | 1) Minimum and maximum dimensioning values refer to continuous load based on half hour average. i.e. there may be short term peaks exceeding stated values. Values in general apply at boiler exit. When raw gas values are outside range, environmental guarantees and guarantees of consumption do not apply, but no damage or corrosion may be ascribed to exceeding raw gas values.<br>2) preliminary values, subject to Contractor responsibility. | |

| Table for Process and Design Data, Flue gas treatment<br>Appendix A13 | | |
|---|---|---|
| **Reference** | **Line Component / Parameter** | **Value / Description** |
| **A3: sec. 2** | **Reactor** | |
| | Gas outlet temperature | min. 135°C |
| **A3: sec. 2** | **Baghouse Filter** | |
| | Dust content downstream filter (dry flue gas at 11% $O_2$)<br>- 12 hours average | Max. 5 mg/Nm³ |
| | Specific filter area load<br>at maximum flue gas flow<br>all n chambers in operation | <0.8 am³/min/m² |
| | Specific filter area load<br>at maximum flue gas flow<br>with n-1 chambers in operation | <1.0 am³/min/m² |
| | Maximal preheating time from cold conditions | 8 hours |
| | Flue gas temperature in bag house filter in any given point. | Min 120 °C |
| | Minimum design temperature | 220 °C |
| | Gas velocity through filter bags at nominal load (LP1) | max. 0.8 m/min |
| **A3: sec. 3** | **Low-Temperature Economizer and Flue Gas Condensation (Option 1)** | |
| | **Low temperature Economizer (LT-ECO)** | |
| | Flue gas temperature out, nominal | 90°C |
| | District heating temperature in / out nominal | Refer to nominal DH temperatures. |
| | District heating max outlet | 105°C |
| | Corrosion protection, tubes | Enamel+PFA or similar |
| | **Flue Gas Condenser** | |
| | Net heat recovery from flue gas condensation at LP1 and with nominal DH temperatures | min. 6 MW |
| | **Heat pump system** | |
| | MP steam available from Existing facility as driving heat source at interface<br>- Nominal temperature<br>- Maximum temperature<br>- Nominal pressure<br>- Pressure variation | <br>215 °C<br>250 °C<br>11.0 bara<br>8-11.5 bara |
| | Condensate return from heat pump to condensate tank for Existing facility<br>- Temperature<br>- Pressure | <br>Max 95°C<br>Atmospheric pressure |
| | **Flue Gas Condensate System** | |
| | Minimum condensate tank capacity<br>ref. max. flow of produced condensate | 15 min |
| | **Reheater** | |
| | Minimum temperature increase capability Flue gas reheater | 10 °C |

| Table for Process and Design Data, Flue gas treatment<br><br>Appendix A13 | | |
|---|---|---|
| **Reference** | **Line Component / Parameter** | **Value / Description** |
| **A3 sec. 4** | **Induced Draught Fan** | |
| | Revolutions | Max. 1,100 rpm. at nominal flow rate. |
| | Fan capacity<br>(pressure increase corresponding to the inclusion of option LT ECO and Flue Gas Condensation.) | The fan(s) shall be selected for a flow rate of 1.3 times the nominal flow rate and the corresponding pressure increase, as a minimum. |
| | Number of motors | 1 or 2 |
| | Motor power | The motor(s) shall have a total operational capacity of 110% of the power needed at the dimensioning capacity. |
| | Maximum ramping down time<br>from max power load<br>to 20% of speed in situ | 60 sec |
| **A3: sec. 6.1** | **Ducts** | |
| | Max. flue gas velocity | 15 m/s, actual conditions |
| | Construction materials | Min. 6 mm steel plates<br><br>or<br><br>where the conditions so require, glass fibre re-enforced plastic materials. Choice of materials shall reflect operational condensation temperatures and acid dew points. |
| **A3: sec. 6.2** | **Stack** | |
| | Height above ground level to be defined as a part of the EIA | 125 m |
| | Existing stack pipe cavity, diameter | 1.6 m |
| | Flue gas exit velocity at nominal load | Max. 22 m/s, actual condition |
| | Materials, flue gas pipe and inner liner | Choice of materials shall reflect temperatures at normal and abnormal operation. |

# 5. PROCESS AND DESIGN DATA, TURBINE/GENERATOR

| Table for Process and Design Data, Turbine/generator<br>Appendix A13 | | |
|---|---|---|
| **Reference** | **Line Component / Parameter** | **Value / Description** |
| **Appendix A4** | **Turbine/generator set** | |
| **A4: sec. 1** | **Preliminary steam data** | |
| | Nominal load (100%) Steam flow | Maximum continuous flowrate (MCR) set point (LP2) in boiler capacity diagram |
| | Expected MCR steam flow | 15.5 kg/s |
| | 110% load steam flow | 17.1 kg/s |
| | 70% load steam flow | 10.9 kg/s |
| | Steam flow rates possible | Low: Island mode<br>High: 110% of boiler MCR |
| | Steam pressure<br>(inlet of Emergency shut-off valve, controlled by turbine inlet nozzle group) | 40 bara |
| | Steam temperature during start-up (maximum up to 500 hrs after boiler cleaning) | 320°C |
| | Steam temperature nominal at turbine inlet | 400 °C |
| | Max. steam temperature variation | ACC. to IEC 60045-1 |
| | Swallowing capacity for turbine | Corresponding to live steam flow at 110% MCR |
| | Swallowing capacity for bypass system | Corresponding to live steam flow at 110% MCR with no auxiliary steam reduction |
| | Max. steam flow variation | At least 90% of all 1 minute mean values from a 14 days period within +/-5% relative to set point |
| | Steam Pressure variation normal operation (continuous waste fired boiler operation) | +/- 0.2 bara |
| | Steam quality (chemical) | VGB-S-010-T-00;2011-12.EN |
| | Steam quality (mechanical) | VGB R 513-00-2014-07-EN |
| | Maximum temperature of condensate to feed water tank/deaerator | 110 °C |
| | **Island mode** | |
| | Electricity demand, Island Mode | Contractor to determine during detailed engineering |

| Table for Process and Design Data, Turbine/generator<br>Appendix A13 | | |
|---|---|---|
| **Reference** | **Line Component / Parameter** | **Value / Description** |
| **A4: sec. 3** | **Turbine bleeds (design)** | |
| | | Approx. 5 bara to supply steam to:<br>- air preheater<br>- de-aerator |
| **A4: sec. 11** | **Turbine bypass station** | |
| | Steam downstream turbine bypass station Temperature | Lower limit:<br>Saturation + 5-10 °C |
| | Steam capacity | 10-110% nominal steam from boiler. Zero auxiliary steam use to be assumed. |
| **A4: sec. 13** | **District Heating condensers** | |
| | Hydraulic capacity of district heating condensers / DH system | -Live steam flow of 110% of MCR<br>-Bypass operation (no turbine)<br>-DH temperature difference of 11°C over DH condenser. |
| | Maximum capacity at DH export connection interface | -Live steam flow of 110% of MCR<br>-Bypass operation (no turbine)<br>-LT-ECO in operation<br>-Flue gas condensation in operation<br>-DH temperature difference of 17°C over the Line producers. |
| | Tolerance on DH forward temperature | ±2 ºC from set point |
| | District heating water quality | Refer to Appendix E2, *Quality of Water Flows*. |
| | Pressure vessel design code in general | EN 13345 |
| | Type | Shell and U-tube heat exchangers with district heat water in the tubes |
| | Materials:<br>• Shell and water boxes<br>• Tubes<br>• Tube sheets | Mild steel<br>Stainless steel<br>Solid stainless or stainless steel plated |
| **A19: sec. 2.9** | **Summer coolers** | |
| | Capacity of summer coolers @<br>- 100/70ºC forward/return DH temp.<br>- 30ºC ambient air temperature & 25% relative humidity | 30 MW |

## Table for Process and Design Data, Turbine/generator

## Appendix A13

| Reference | Line Component / Parameter | Value / Description |
|---|---|---|
| | Nominal DH temperature, in | 82°C |
| | Nominal DH temperature, out | Max. 67°C |
| | Hydraulic capacity: | To match the cooling capacity at the Contractor's design DH temperature out |

**Load points**

The Tenderer shall supply energy and mass balances the following load points both with and without Option 1 included and in operation:

| Load point | Name | Live Steam turbine (% MCR) | Live steam bypass (% MCR) | DH return/supply* |
|---|---|---|---|---|
| **1** | Nominal | 100% | 0% | 69/83°C |
| **2** | High forward | 100% | 0% | 69/90°C |
| **3** | Very high forward | 100% | 0% | 69/95°C |
| **4** | Low dT | 100% | 0% | 69/80°C |
| **5** | 70% load | 70% | 0% | 69/83°C |
| **6** | Max forward | 100% | 0% | 69/105°C |
| **7** | Low DH return T | 100% | 0% | 60/83°C |
| **8** | 110% steam load | 110% | 0% | 69/90°C |
| **9** | 110% turbine bypass + high DH flow | 0% | 110%** | 69/83°C |
| **10** | 70 % turbine load + low DH flow | 70% | 0% | 69/105°C |
| **11** | Power island mode | To sustain estimated 1 MWe generated power | Supplier design | 0 MJ/s |

* DH temperatures are at DH supply limits of the Line, refer to Appendix A18 *Limits of Supply*. I.e the connection points for the Line to the Employer's existing DH system.
** Based on 110% live steam supply to be split between de-aeration steam (reduction station outside scope) and the live steam bypass.

# 6. PROCESS AND DESIGN DATA, AUXILIARY EQUIPMENT

| Table for Process and Design Data, Auxiliary Equipment<br><br>Appendix A13 | | |
|---|---|---|
| **Reference** | **Line Component / Parameter** | **Value / Description** |
| **A5: sec. 4** | **Waste cranes** | |
| | Number of cranes | 2 fully automated cranes for the new Line and Existing facility. |
| | Grab size | Min. 8 $m^3$ |
| | Crane lifting capacity | Min. 12 t |
| | Precision of weighing system | +/- 2% of actual weight in the complete scale range |
| | Crane rail | DIN 536 |
| | Crane rails, clamps and base material | VDI 3576 |
| | Tolerances for crane rails | VDI 3576 Tolerance Class 1 |
| | **Crane capacity (pr. crane in automatic mode)** | |
| | Charging hopper (nominal) | 45 t/h |
| | Mixing | 75 t/h |
| | Maximum hourly supply of delivered waste to be removed from the unloading bays and redistributed | 200 t/h |
| **A5: sec. 4** | **Hoppers of existing Lines K2 and K3** | |
| | Dimensions | Refer to Appendix E7 *Waste hopper drawings for Existing Plant* |
| **A5: sec. 4** | **Waste crane availability** | |
| | Operational availability of crane system (common system for Line K1, Line K2 and Line K3) | 8760 hours/year |
| | Operational availability of each of the two individual crane systems<br>(cranes are not considered available while performing service and maintenance) | 8700 hours/year |
| | Availability of crane system in unmanned full automatic mode (common system for Line K1, Line K2 and Line K3) | 8700 hours/year |
| | Maximum number of required interventions in evening, night and weekends, due to malfunctions of unmanned full automatic operation system. | Within any period of 2 months the crane system shall operate for at least 30 evenings/nights of 16 consecutive hours and 5 whole weekends (weekend of 48 consecutive hours) without it is required that the operating staff intervenes. |
| | Maximum number of required interventions in working days due to malfunctions of unmanned full automatic operation system<br><br>Interventions due to unnormal operation due | Within any period of 5 consecutive working days the crane system shall be able to operate with a maximum of: |

| Table for Process and Design Data, Auxiliary Equipment<br>Appendix A13 | | |
|---|---|---|
| **Reference** | **Line Component / Parameter** | **Value / Description** |
| | to nonconforming waste shall not be taken into account. | a) 4 required interventions per day in connection with change of tasks.<br><br>b) 1 required intervention not due to change of tasks. |
| **A5: sec. 4** | **Waste composition** | |
| | Waste density in grab to be used for calculation of waste crane capacity. | 600 kg/m$^3$ |
| | Waste density in grab to be used for calculation of design load. | min. 850 kg/m$^3$ |
| **A5: sec. 4** | **Construction for Waste cranes** | |
| | Load- carrying structure safety factor | Normal |
| | FEM Crane 1.001 class | A8 |
| | FEM Mechanisms classification as per ISO norm: | |
| | - Hoist | M8 |
| | - Crane travelling drive | M7 |
| | - Trolley traversing drive | M7 |
| | DIN Crane classes | H4, B6 |
| | DIN Mechanism Groups | |
| | - Hoist | 5m |
| | - Crane travelling drive | 4m |
| | - Trolley traversing drive | 4m |
| | Lifting speed, lifting gear with full grab | 70 m/min |
| | Driving speed, trolley | 80 m/min |
| | Driving speed, bridge | 80-100 m/min |
| | Safety class | Normal |
| | Design lifetime | 25 years |
| | Length of runways (approx.) | To be designed to achieve full coverage of new and existing bunkers and crane maintenance decks with both cranes. |
| | Span of crane bridge | To be designed according to building dimensions. |
| | Lifting height | To be designed according to building dimensions. |

| Table for Process and Design Data, Auxiliary Equipment<br>Appendix A13 | | |
|---|---|---|
| **Reference** | **Line Component / Parameter** | **Value / Description** |
| **A5: sec. 2.3.1** | **Firefighting equipment in waste bunker (existing and new bunker)** | |
| | Number of water spraying cannons | Minimum 3 large water cannons to cover the entire bunker.<br>3 smaller water cannons or powerful sprinklers to cover hoppers |
| **A5: sec. 5.2** | **Turbine hall service crane** | |
| | Number of cranes | 1 overhead crane |
| | Length of runways | To be designed according to building dimensions. |
| | Span of crane bridge | To be designed according to building dimensions. |
| | Hoisting height | To be designed according to building dimensions. |
| | Lifting capacity for maintenance works (not installation). | Heaviest item for maintenance, however min. 20 t.<br>Supplier to guarantee lifting capacity is sufficient for all maintenance works on turbine, including lifting upper turbine casing parts, control valve bodies, turbine rotor, generator parts etc. Excepted are parts as bottom of casing and generator stator which normally are not removed for maintenance. Parts shall be removable out of the turbine hall without removing façade elements (i.e. shall be moved from turbine hall through suitable service opening in the turbine hall floor or doors) |
| **A5: sec. 7** | **Compressed Air (Available from existing compressed air station)** | |
| | **General** | Compressed air quality according to ISO 8573-1:2010. |
| | **Process air** | |
| | ISO 8573-1 Quality class | [1:-:1]<br>No drying is applied. |
| | Supply pressure at connection points | 8 bara |
| | **Instrument air** | |
| | ISO 8573-1 Quality class | [1:2:1] |
| | Supply pressure at connection points | 8 bara |

| Table for Process and Design Data, Auxiliary Equipment<br>Appendix A13 | | |
|---|---|---|
| **Reference** | **Line Component / Parameter** | **Value / Description** |
| **A7: sec. 7** | **Camera monitoring system (CCTV)** | |
| | Total number of new cameras to be included in the process and building surveillance of the Line (positioning of cameras shall be coordinated with the Employer) | 20 |

# 7. CIVIL WORKS

*The Contractors filled-in Room Data Sheet (see part 0.h Room Data Sheet) are to be completed and handed over before Contract signing.*