

IV – Performance Requirements

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4. PERFORMANCE REQUIREMENTS

4.1. PERFORMANCE GUARANTEES

- a) The Contractor is obliged to comply with the performance guarantees declared in the technical proposal.
- b) The Contractor's performance guarantee obligations in this section shall be evaluated according to the limit values in the Annex 2 of Section VII of Employer's Requirements and Schedules of Performance Guarantees Table of Section IV of Bidding Documents that shall be submitted in the technical proposal.
- c) The purpose of the Hurma WTE Facility is to incinerate the existing dried sludge (25 tons/day with % 90 DS) with inlet sludge (500 tons/day with %18 DS) after passing it through the pre-dryer under autothermal conditions and to provide the highest possible energy production.
- d) The entire sections of Hurma WTE Facility shall be operated 24 hours a day, 7 days a week, in accordance with the criteria specified in Section VII Employer's Requirements.
- e) The performance guarantees specified in this section shall be displayed simultaneously with the facility under continuous operation and automatic control by performance guarantee tests, unless otherwise specified.
- f) The Tests on Completion of Design-Build and Tests prior to Contract Completion of the facility shall be carried out with the approved operation team of the Contractor and comply with draft/updated operation-maintenance manuals.
- g) The Employer's Representative shall compare (if required, can be interpolated) the actual test results with the guaranteed limits specified in Schedules of Performance Guarantees by the Contractor. In case of any unconformity, identified performance damages shall be compensated by the Contractor in accordance with Section X - Contract Forms Appendix 3 Performance Damages, Item 3 - Failure to pass Tests Prior to Contract Completion in Appendix 3 –Performance damages of the Bidding Documents. In addition, during the operation services period carried out by the Contractor, output parameters will be monitored by the Employer's Representative, actual operation outputs will be compared with the limits specified in the Annex-2 of Employer's Requirements. In case of any unconformity, identified performance damages shall be compensated by the Contractor in accordance with Appendix 3 Performance Damages, Item 2 - Failure to meet Performance Guarantees during the Operation Service Period in Appendix 3 –Performance damages of the Bidding Documents
- h) The Contractor shall provide all performance requirements under steady-state operation conditions defined in Employer's Requirements II - Design - Build Requirement Part 1 – Design Basis & Process Description & Phasing.

The results of the tests and measurements carried out to check whether the values in the performance guarantees are met shall be evaluated with the methods given in Annex 2 of Section VII- Employer's Requirements. If a test method is not specified in the Input and Output KPI tables given in Annex 2 of Section VII – Employer's Requirements, the Employer's Representative shall determine the testing methodology based on the recommendations of an accredited organization or laboratory, in accordance with the latest version of applicable Turkish and International standards. Even if test

methods are specified in the Input and Output KPI tables given in Annex 2 of Section VII – Employer's Requirements, they shall still be submitted to the Employer's Representative for approval.

4.1.1. Thermodynamic Performance

The Contractor shall provide detailed calculations regarding the heat and mass balance, the combustion efficiency and energy supply diagram, and the commitment regarding the amount of natural gas/electrical/chemical, etc., to be consumed by the proposed design in the technical proposal as stated in Section IV Bidding Forms – Schedule of the Performance Guarantees. These data shall form the basis of the thermodynamic performance guarantee indicated in Annex 2 of Section VII Employer's Requirements.

Each line shall operate either independently or in an integrated manner, as required, while ensuring compliance with the guaranteed combustion conditions and emission limits.

During the operation services period, performance measurements, tests (e.g. temperature, mass and volumetric flow rates, humidity), and short and elemental analyses of the sludge shall be carried out by the Contractor under the conditions of operating the fluidized bed incineration units at full load, and the combustion efficiency shall be determined by the "Thermodynamic Calculation Method" using the below-mentioned data.

The tests regarding the sludge and ash analyses, output parameters of the emission control system, chemicals (if required), natural gas (if required), and process water (if required) shall be analysed both by the online system and an independent accredited institutions.

In addition, the "Thermodynamic Calculation Method" specified below shall also be calculated and submitted in the technical bid of the Contractor by using the sludge characterisation data defined in Clause 2.1.4. Characterization of the Sludge of Design Basis & Process Description & Phasing part of Employer's Requirements. This calculation will also assist Employer's Representative to cross-check of fulfilment of the Contractor's KPIs values of performance guarantees in Annex 2 of Employer's Requirements.

4.1.2. Thermodynamic Calculation Method for Fluidized Bed Incinerator

- The formulations related to thermodynamic calculations are provided in this section, and the Contractor shall prepare the calculations accordingly and submit them with its technical proposal. However, the Contractor may propose an alternative calculation method in its proposal, depending on its know-how. This alternative calculation method shall cover at least all the parameters included in the calculations provided in this section. In case of any additions or modifications to the calculations, the source of the alternative method and the coefficients used shall be clearly indicated and justified within the submitted calculations. The calculations to be submitted in the technical proposal shall be presented in Excel format and must include the full formulation structure.
- Measurements shall be made during the performance testing process for the variables included in the equation.
- If a test method is not specified for the measurement of these variables in the relevant section, measurements shall be made by the Employer according to Turkish and International standards.
- Measurements regarding the sludge and ash analyses, output parameters of the emission control system, chemicals (if required), natural gas (if required), and process water (if required) shall be performed by an independent accredited institution.

- The Contractor is obliged to provide the necessary measuring equipment and instruments for all these measurements or to cover the costs of the accredited institution that shall carry out the measurement.

The optimum temperature for the conditions required for steady-state combustion and emission in a fluidized bed incinerator (FBI) is around 850 °C with a minimum 5 seconds retention time. The change in the amount and properties of waste sludge over time causes a change in working conditions. It is necessary to balance these situations. In case of such circumstances, the maximum combustion temperature may be changed. The acceptable range for maximum combustion temperature shall be kept between 850-900 °C. However, the optimal value is 850 °C. Environmental weather conditions, heated air temperature, temperatures of the fed sludge and most importantly the degree of dryness of the sludge affect the combustion temperature. Taking this into account, the degree of dryness at the end of drying should be at appropriate values, a minimum of 36% DS.

Dewatered sludge with an average calorific value of 3,500 kcal/kg and 18% dry solids content shall be pre-dried in the pre-drying units to a minimum dry solids content of 36%, and that all performance evaluations, process design calculations, and testing shall be carried out accordingly. However, in the event that the actual calorific value of the sludge during operation changing the expected value of 3,500 kcal/kg, the pre-drying unit shall be capable of being operated within a flexible dry solids range of 30% to 45% throughout the operational period, taking into account the energy efficiency of the pre-drying and incineration system as well as the plasticity zone of sludge considerations of the process.

It is necessary to supply an air temperature minimum of 180 °C and a coefficient maximum of 150% to meet the steady-state combustion conditions. In case of providing duly justified and demonstrated through detailed energy and mass balance calculations submitted together with an integrated process flow diagram, the temperature of incineration air and the coefficient value can be higher or lower.

In the fluidized bed boiler, the combustion loss must be less than 2%, and the thermal losses must be less than 2% of the capacity. Considering all these situations, the FBI outlet temperature was defined as a performance indicator depending on easily measurable parameters as stated in Annex 2 of Section VII Employer's Requirements.

The parameters used in the correlation shall be as follows:

Ambient air temperature (°C)	: Ta
Ambient air specific humidity (kg water/kg air)	: W
Undried inlet sludge degree of dryness	: x
Degree of dryness of dried inlet sludge	:X
degree of dryness of dried ready-made sludge	:X
Amount of undried inlet sludge (kg/h)	: myc1
Amount of dry matter in undried inlet sludge (kg/h)	: MC1
Amount of water in dried inlet sludge (kg/h)	: MCS1
Amount of dry matter in dried ready-made sludge (kg/h)	: MC2
Amount of water in dried ready sludge (kg/h)	: MCS2
Amount of dried ready sludge (kg/h)	: myc2

Air Excess Coefficient (1.5 to 50%)	: L
Combustion efficiency (%)	: Y1
heat efficiency (%)	: Y1
Energy efficiency (%)	: Y
Dry Matter Elemental Analysis Values for Inlet sludge (%)	: c1 , h1 , s1 , n1 , o1 , a1
Dry Ready Mixed Sludge Dry Matter Elemental Analysis Values (5) : C ₂ , H ₂ , S ₂ , N ₂ , O ₂ , A ₂	
(Here, the substances show the values of carbon, hydrogen, sulphur, nitrogen, oxygen and ash, respectively. If the values are 40% as an example, they shall be taken as 40.)	
The amount of oxygen required for the combustion of 1 kg/s sludge (kg/s)	: y _{o2min}
For undried inlet sludge:	
$y_{o2minc1} = c1 / 12 + h1 / 4 + s1 / 32 - o1 / 32$	
For dry ready-made sludge:	
$y_{o2minc2} = c2 / 12 + h2 / 4 + s2 / 32 - o2 / 32$	
Amount of water formed by the combustion of sludge (kg/s)	: m _{Ywater}
$m_{Ywater} = 0,09 (mc1 h1 + mc2 h2)$	
total amount of dry air required for combustion (kg/h)	: m _{Hk}
$m_{Hk} = 1,38 \lambda (mc1 y2minc1 + mc2 y2minc2)$	
Amount of water coming with air humidity (kg/h)	: m _{no}
$m_{nem} = w m_{Hk}$	
Total amount of sludge water entering AYYF (kg/s)	: m _{cs}
$m_{cs} = m_{cs1} + m_{cs2}$	
Total amount of ash (kg/h)	: m _{ash}
$m_{Ash} = 0,01 (mc1 a1 + mc2 a2)$	
Total amount of water vapor in flue gas (kg/s)	: m _{sb}
$m_{sb} = m_{cs} + m_{nem} + m_{ysu}$	
dry flue gas amount (kg/h)	: m _{Kd}
$m_{kd} = mc1 + mc2 + m_{Hk} - m_{ysu} - m_{kil}$	
Upper calorific value for inlet sludge (KJ/kg)	: Hc1
Upper calorific value for ready-made dry sludge (kJ/kg)	: Hc2
the FBI inlet temperature of the heated air (°C)	: TS
The average temperature of the sludge entering the boiler (°C)	: T _c
FBI Flue Gas Temperature	: TK
With the general correlation created based on the parameters and relations defined here, the FBI temperature, TK:	

$$TK = A / B$$

It is calculated as follows. In this relation, parameter A is

$$A = y_{m_{c1}} H_{c1} + y_{m_{c2}} H_{c2} + 1,047 y_{m_{Hk}} TH + 2500 y_w m_{Hk} + 1.8 w y_{m_{Hk}} Ta + 4.2 y_{m_{cs}} Tc - 2400 m_{sb}$$

Parameter B,

$$B = 1,095 m_{kd} + 2,21 m_{sb} + m$$

Here, combustion loss and thermal losses are taken into account for energy efficiency. It has a minimum limitation of 98% for combustion and 99% for heat loss. Total energy efficiency should not be below 97%. In other words, $y >$ should be 0,97.

The combustion performance, under the specified sludge properties, drying degree, and environmental conditions, shall be deemed satisfactory if the calculated combustion temperature is determined within the range of 850–900°C.

CORRECTION FOR THE TESTS

Correction for Chemical, Agent, and Fuel Consumables

Before comparing the guaranteed consumption rates with the measured consumption rates of consumables, the correction shall be made as follows:

$$\text{Corrected Consumable Consumption Guarantee Amount} = A * B / C$$

- A = Guaranteed Consumable Amount
- B = Measured Pollutant Parameter of the Inlet Concentration at the Emission Control Unit and any other Systems (During the test period)
- C = Inlet concentration of the pollutant Parameter based on the Proposed Calculations for the Emission Control Unit and any other Systems Inlet in the Contractor's Technical Proposal.

Correction for Other Consumables

The correction shall be made for electricity generation using the Turbine Load Curve provided by the Contractor with its technical proposal.

Regarding the electricity consumption, the total electricity consumption for the entire electromechanical equipment list shall be submitted in the Contractor's technical proposal. The maximum guaranteed value for electricity consumption shall be taken into account as stated in Annex 2 of Employer's Requirements and Appendix 2 – Schedule of Performance Guarantees of Section X – Bidding Forms.

4.1.2.1. Incineration Conditions

Hurma WTE Facility should comply with Employer's Requirements II - Design - Build Requirement Part 1 – Design Basis & Process Description & Phasing section regarding incineration conditions and the requirements of the Regulation on Waste Incineration and the Waste Incineration Directives stated in Employer's Requirements I – General Information Clause 1.4. Technical Standards and Applicable Regulations.

Incineration conditions should meet requirements for the Tests on Completion for Design-Build procedures (according to GCC 11.1) and Tests prior to Contract Completion procedures (according

to GCC 11.9).

4.1.2.2. Waste Heat Boiler

The waste heat boiler shall be designed in such a way that it can be operated safely and reliably at all loads up to the maximum steam generation capacity, as well as providing the energy required to raise the combustion air to the desired temperature. The load change rate and throttling ratio of the waste heat steam boiler shall be compatible with the fluidized bed furnaces.

Heat transfer surfaces, pipes, boilers, collector pipes, instruments, Superheated steam generating coils and other equipment of Waste Heat Boiler shall be designed to operate safely without damage, taking into account the ranges of heat flow, and temperature defined in Annex 2 of Employer's Requirements output parameters.

The manufacturer designs and equipment supplies of the waste heat boiler shall comply with the sections of NFPA 70 and NFPA 497 or any of the relevant BS, EN, DIN, ISO, and TSE standards related to installation in an area classified as hazardous.

The waste heat boiler shall be designed to operate continuously at all loads from start-up to steady-state conditions.

4.1.2.3. Consumption and Production of Electricity

The Contractor shall provide the min. value for electricity production and maximum value for electricity consumption for the Hurma WTE Facility, KPIs related to electricity consumption and production shall be presented in its technical proposal with Schedule of Performance Guarantee.

When determining guarantee values of the electricity, the design temperature of 20 °C shall be taken as a basis.

The output guarantee values of electricity production and consumption shall be provided when the waste heat boiler is operated (i.e. after 8,000 hours of operation) and under the design conditions proposed and guaranteed by the Contractor in accordance with feed water temperature, steam temperature, and pressure values at boiler discharge. Enhancing the electricity production by increasing the feed water temperature and/or steam temperature and/or pressure and quantity above the specified design values shall not be acceptable.

4.1.2.4. Emissions

The maximum amount of emissions discharged from the Hurma WTE Facility into the atmosphere shall not exceed the emission values given or referred to in the current Turkish Regulations, and the related International Directives and Standards under any operating conditions (except for the starting and closing moments)

During the start-up and shutdown of the operation, the emissions discharged into the atmosphere shall not exceed the emission values given in the relevant regulations.

4.1.2.5. Waste Water Discharge

The pollution values in the wastewater from the facility shall not exceed the discharge limit values in the relevant regulations and/or if the wastewater is transferred to the inlet section of the Hurma WWTP, the pollution load shall not exceed the limit values of the Hurma WWTP inlet parameters. In case of the requirement, the necessary treatment procedures should be applied before the discharge to the inlet section of the Hurma WWTP.

Acceptable concentration inlet parameters of Hurma WWTP are as follows;

BOD : 600 mg/l
COD : 1000 mg/l

SS	: 750 mg/l
TN	: 60 mg/l
TP	: 12 mg/l

4.1.2.6. Other Solid and Liquid Discharges

The Contractor shall propose limit values for other solid and liquid discharges from the facility.

4.1.2.7. Consumables

The consumables commitment prepared and given by the Contractor together with the technical offer shall be taken as a basis.

Guaranteed maximum consumption values of the consumables shall be provided in line with the Input Parameters of KPI as stated in Annex 2 of the Employer's Requirements.

The consumables mentioned below and mentioned in the input KPIs are only examples, the type of the consumables can be changed according to the Contractor's know-how and proposed design. If the Contractor wants to change any type of below-mentioned consumables, it can be defined as N/A and the Contractor can add a new type of consumables. These kinds of changes shall be reflected in the same manner as the KPIs Tables in Annex 2 of Employer's Requirements and the Schedules of the Performance Guarantee Table in Section IV of the Bidding Forms.

- Lime
- Bicarbonate
- Sodium hydroxide
- Activated carbon
- Ammonia
- Other chemicals/consumables proposed by the Contractor
- Natural gas consumption related to start-up the operation
- Electricity consumption

4.1.2.8. Noise and Vibration

Even when the facility is operating in the most adverse conditions, compliance with the following noise parameters must be ensured. With performance guarantee tests, measurements shall be made under the most adverse conditions and it shall be proven that compliance with noise parameters is ensured.

The noise contribution at any of the facility's permitted receptors must not result in an increase in the collective noise level shall comply with the Turkish Environmental Law and Regulations on Management of Assessment for Environmental Noise (published in the Official Gazette dated 04.06.2010 and numbered 27601 and/or latest current version) and shall not exceed 80 dB(A)¹.

The turbine shall be isolated with a proper cabinet and the maximum sound pressure level shall not exceed 80 dB(A)¹.

Technical specs of the equipment (fans, pumps, hydraulic equipment, etc.) regarding the noise level shall be complied with the permitted noise level indicated in Turkish Regulation and Standards.

The maximum sound pressure level of any unit/equipment of the stationary facility, measured at a distance of 1 m, shall in no way exceed the limit in the Turkish regulations and/or 80 dB(A)¹, whichever is higher.

Vibration occurred during the operation of related equipment shall not be transmitted from a

¹ Sound pressure level shall be defined as the daily sound exposure level (L EX, 8 hours) (dB(A) re. 20 μ Pa): sound exposure levels in eight hours of normal daily operation according to the international standard ISO 1999 refer to time-weighted average sound exposure levels

room/unit to others or into any steel structure.