

## **II – Design – Build Requirements**

## **Part 1 – Design Basis & Process Description & Phasing**

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## **2. DESIGN-BUILD REQUIREMENTS**

### **2.1. DESIGN BASIS**

The new Hurma WTE Facility shall consist within the frame of below-mentioned sections:

- (a) Sludge acceptance/storage Unit,
- (b) Sludge pre-drying Unit,
- (c) Odour Control Unit,
- (d) Fluidized Bed Incinerator (FBI) Unit with Heat Recovery System,
- (e) Energy Recovery Unit with Steam Turbine,
- (f) Flue gas Emission Control Unit,
- (g) Ash Collection and Storage Unit.

The Hurma WTE Facility shall consist of at least two parallel lines and each line with the capacity 10,417 kg/hour shall have at least two pre-drier units and one incineration unit. The feeding capacity of wet sludge containing 18% DS to the thermal pre-dryer unit in each line is 5,208 kg/hour. In each line, sludge dried to a minimum of 36% DS in the pre-dryer shall be fed to the fluidized bed incineration furnace.

In addition, sludge transfer lines need to be established so that the 1,042 kg/h at 90% DS coming out of the existing drying facility can be directly fed to each fluidized bed incineration unit. In the fluidized bed incineration units, incineration shall be carried out without requiring additional fuel, i.e. under autothermal conditions and above 850°C. The temperature of the incineration air to be given to the fluidized bed combustion unit shall be at least 180°C. It is recommended that the system ensures internal heat recovery by utilizing waste heat within the process, thereby enabling the inlet air temperature to reach higher levels in accordance with the maximum recoverable thermal energy. 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 the incineration air can be higher or lower. The retention time of the combustion gases in the system should not be less than 5 seconds.

Incineration efficiency shall be at least 98%. The Contractor must demonstrate compliance with this requirement through calculations, following the template provided in the “Thermodynamic Calculation Method for Fluidized Bed Incinerator” part in Section IV Performance Requirements of the Employer’s Requirements and related output indicators in annex 2 of Employer’s Requirements.

The maximum excess air coefficient to be used in the fluidized bed shall be 1,5 (150%). In case of providing duly justified and demonstrated through detailed energy and mass balance calculations submitted together with an integrated process flow diagram, the coefficient value can be higher or lower. FBI flue gas temperature shall be a maximum of 900°C.

Hurma WTE Facility should be designed as an integrated facility. It is expected that this integrated facility shall benefit from the waste heat generated as a result of incineration to the maximum extent. The waste heat to be produced should meet the energy of the thermal pre-dryer units to be installed on both lines, the heating energy of the hot air to be fed to the fluidized bed incinerators and, if possible, it is expected to allow a certain amount of electricity production.

There shall be a sludge input of 500 tons/day with 18% solid matter brought to the autothermal point in the new pre-dryer section of the fluidized incinerator and sludge inputs with 90% dry matter coming out of the existing drying facility (25 tons/day). Apart from these, sawdust, coal, and similar additives shall not be added.

During the Design Services Period, the new incineration unit shall be designed and constituted of two parallel lines. The project's priority is the operation of the Hurma WTE Facility without additional fuel except for the initial start-up phase.

The biogas and natural gas can be used for the initial start-up phase as an external fuel in the current situation, 10000 m<sup>3</sup>/day of biogas is being produced in the Hurma WWTP.

Within the scope of the Design-Build Works, the natural gas and biogas supply system and piping in the facility shall be constructed according to the values defined in the "Network Services Values" part of Section I –on of the Employer's Requirements. It is foreseen that this natural gas and biogas shall be used only for the start-up period. The fluidized bed incineration furnace shall be fed at the auto-thermal point. The Contractor may use external fuel (natural gas) only to ensure the temperature balance inside the furnace during the operation period. Biogas supply system will be only used during trial-operation term to demonstrate the operation conditions and/or whether the system is operable with biogas. However, biogas shall not be used during operational services by the Contractor as an external fuel. In this respect, any guaranteed consumption value related to biogas is not expected from the Contractor within the scope of the Contract.

Furthermore, in order to observe operational conditions in integration with biogas, the Contractor shall execute the trial operation by using biogas (if required mixed natural gas and biogas) during one month of the trial operation period.

The Hurma WTE Facility shall have;

Flue gas removal section that shall ensure that all pollutants (NO<sub>x</sub>, SO<sub>2</sub>, Acidic gases, PM) in the combustion gases to be formed remain below the limit values specified in the European Union Directive;

Units of ash controlling section for the collection of bottom ashes formed as a result of incineration, particulate matter (PM), Dust emissions should be collected and safely removed from the system and stored at the area determined by the Employer within the boundary of the Hurma WWTP and other equipment and auxiliary units required for the proposed process. Execution of the final disposal and transfer of the storage ash will be under the Employer's responsibility.

If additional equipment/unit is required for the Hurma WTE facility to be fully compliant with legislation, regulations and European Union Directive Provisions, these issues shall be specified by the Contractor during the design phase and shall be made within the scope of the contract. All designs specified in the specification shall also be 3D-designed and submitted to the Employer's Representative for approval.

### **2.1.1. General Requirements**

The general obligations of the contractor are as follows:

- To ensure that fuel and raw materials are delivered and waste is removed without impeding the movement of other vehicles around the facility,

- To design the facility in such a way as to facilitate the supervision of the operators and to ensure ease of maintenance and control,
- To provide the spare parts of the equipment for important installations; to design and organize each part of the facility in such a way that it does not require major dismantling of other parts during inspection, cleaning, maintenance assembly and disassembly,
- Design all components of the facility taking into consideration health, safety and environmental requirements in all operating conditions,
- Provide permanent access to all parts of the facility that require access for inspection, operation or maintenance.

The Contractor shall design the facility to maximize its performance over its economic life. To ensure this, the following points need to be taken into consideration:

- Optimization of flue gas treatment systems and furnace supply water to minimize natural gas consumption and waste generation,
- Minimizing electricity consumption of facility by designing more efficient electrical systems and selecting more efficient equipment,
- Design of the facility to ensure safe, reliable, and efficient operation with a minimum number of personnel,
- The facility is built to operate under varying weather conditions with ambient temperature between -5 C° and +45 C°, atmospheric pressure of 100 kPa, and relative humidity between 30% and 100% (average 60%).
- The average ambient temperature of Antalya province shall be accepted as 20°C.
- The design of the fluidized bed sludge incinerator and all related equipment (pumps, heat exchangers, blowers, emission control system, etc.) shall be in accordance with the relevant criteria, and the Contractor shall be responsible for the design, coordination and correct operation of the entire system.
- The works shall be designed in accordance with known and accepted engineering practices. All facility, equipment, and systems and their auxiliaries provided for the works shall be designed using proven methods and shall be supplied by manufacturers offering the latest technology and the best available technical solutions.
- At least one of the relevant Turkish, European, or International standards regarding the Design, Manufacturing, and Installation of Structural Steel shall be complied with.
- At least one of the relevant Turkish, European, or International Standards for Arc and Gas Welding shall be complied with.
- Problems in any part of the equipment should only affect that line, and the other line should continue to operate without problems.
- Contractor shall submit to the following documents;
  - Details of erosion and corrosion allowances in the piping, channels, and tanks including construction materials, minimum thickness required for structural strength, and expected corrosion rate

- Measures to be implemented by the Contractor to minimize shocks and stresses caused by factors such as thermal shock, temperature changes, changes in seasonal environmental conditions, vibration, and differences in fuel flow, etc.
- Details of the system or installation for monitoring the current status of the facility and its parts.
- Details of permanent access bridges/platforms to be included in the design for equipment to be worked on at fixed locations
- Details of planned preventive maintenance and inspection activities, including technical specifications of appropriate equipment and methods to be used
- Details of the replacement of important facility parts and the anticipated replacement frequency, and details of the equipment and methods to be used for each item that shall require replacement
- Operation / Maintenance: When designing the facility, it should be ensured that there is no need to stop both lines at the same time for any reason (maintenance, inspection, renovation, etc.)

#### **2.1.2. Key Features of Incineration System**

The FBI furnace system shall be installed in a closed steel construction structure which shall be built by the Contractor. The foundation of the facility shall be reinforced concrete and shall be covered with a non-slip/flammable material for industrial facilities. Other auxiliary units and facilities shall be positioned as shown in the layout plan. In cases of necessity, changes may be made in agreement with the Employer's Representative during the design phase. This integrated facility to be constructed using a steel structure is recommended by the Employer. The sludge reception unit, pre-drying and incineration furnaces, heat recovery boilers, heat-energy recovery sections, electrical power generation, emission control unit, ash collection, workshop, laboratory, automation, and technical offices shall be designed as interconnected units, ensuring a unified architectural layout within a single structural framework.

The equipment shall be transported and stored by the Contractor to the warehouses to be shown by the Employer's Representative at Hurma WWTP. The Contractor shall be responsible for the safety of the stored equipment.

The Hurma WTE Facility shall operate for 8,000 hours per year, excluding planned unit shutdown time for normal maintenance. Heating and cooling of the fluidized bed furnace shall not be included in this period.

The entire WTE facility (thermal pre-dryer, incineration furnace, supply pumps, air blowers (fans, blowers, etc.), etc.) shall be designed and built 10% additional capacity. Concordantly, capacity of all electromechanical equipment shall be supplied according the 10% additional capacity except the solid transfer system (transfer system, conveyors, etc.) shall be designed with the %20 additional load capacity.

#### **2.1.3. Spare Parts of the Equipment**

The Contractor shall provide spare parts of the equipment it deems necessary, except for the equipment which is required in the bidding documents, in order to ensure that the guarantees for the operation of the facility. The Contractor shall install the spare parts of the equipment in the system

and keep it ready for operation. The equipment kept in reserve shall be automatically activated in case the relevant equipment in operation malfunctions or stops in order to ensure uninterrupted, continuous operation of the facility. In cases where it is not technically possible for any equipment to be automatically activated in this way, the design shall be made to minimize operator intervention for the efficient operation of the facility or to shutdown it safely.

Where installed spare parts of the equipment or installations are not possible, the facility design shall enable the replacement of the failed equipment with a spare within a minimum period of time.

The power of the operation and spare parts of the equipment of the facility shall be supplied from independent switchboards, where possible, to avoid a complete shutdown of the relevant function due to a single electrical fault.

The Contractor shall carry out Reliability and Maintainability checks with the participation of the Employer's Representative to ensure that appropriate spare parts of the equipment are included in the facility design.

#### **2.1.4. Characterization of the Sludge**

The amount of inlet sludge varies seasonally depending on the change in the number of people in the province. Currently, the mass of the sludge varies between 454 and 500 tons/day, with the lowest in winter and the highest in summer.

The characterization of the sludge; calorific values and solid matter content degrees of the sludges also vary depending on the source and season. However, the design shall be made by taking into account the annual average values of the sludge to be disposed of. Since the change in sludge properties shall also affect the design, this should be taken into account.

The new WTE Facility to be established for waste sludge disposal shall ensure the processing of 500 tons/day (18% DS) and 25 tons/day (%90 DS) [total capacity is 525 tons/day inlet sludge]. The total amount of 500 tons/day of sludge includes 250 tons/days of digested sludge generated from Hurma WWTP and the remaining is biological sludge generated from Lara WWTP and districts WWTPs. The average calorific value of digested sludge and biological sludge from districts to be taken into consideration during the design phase is 3,500 kcal/kg (on dry basis).

The characteristics and general condition of the waste sludges given in **Table 1, Table 2, Table 3, Table 4, Table 5 and Table 6.**

It can be assumed that Hurma WTE Facility with 500 tons/day will be constitute;

- Average 250 tons/day Hurma WWTP digested sludge characterization (please see table 2)
- Average 25 tons/day (%90 DS) is the same sludge characterization with district's WWTPs sludge characterization (please see table 1)
- Average 150 tons/day Lara WWTP biological sludge characterization (please see table 4)
- Average 100 tons/day district's WWTPs sludge characterization (please see table 1).

**Table 1: Characteristics of Sludge in Districts**

| DISTRICTS       |               |               |               |
|-----------------|---------------|---------------|---------------|
| Parameter       | Maximum Value | Minimum Value | Average Value |
| Lead (Pb mg/kg) | 21.64         | 5.056         | 13.18         |

|                                                    |                         |         |          |           |
|----------------------------------------------------|-------------------------|---------|----------|-----------|
| <b>Cadmium (Cd mg/kg)</b>                          |                         | 0.87    | 0.247    | 0.53      |
| <b>Chrome (Cr mg/kg)</b>                           |                         | 72.8    | 19.795   | 42.14     |
| <b>Arsenic (mg/kg)</b>                             |                         | 5.41    | 0.848    | 3.21      |
| <b>Nickel (Ni mg/kg)</b>                           |                         | 69.2    | 18.6     | 38.91     |
| <b>Beryllium (mg/kg)</b>                           |                         | 0.5     | 0.16     | 0.36      |
| <b>Thallium (Tl mg/kg)</b>                         |                         | 0.73    | 0.11     | 0.94      |
| <b>Copper (Cu mg/kg)</b>                           |                         | 253.8   | 104.6    | 176.47    |
| <b>Cobalt (Co mg/kg)</b>                           |                         | 6.642   | 1.734    | 3.87      |
| <b>Manganese (Mn mg/kg)</b>                        |                         | 627.492 | 96.8     | 278.30    |
| <b>Antimony (Sb mg/kg)</b>                         |                         | 1.429   | 0.33     | 1.02      |
| <b>Tin (Sn mg/kg)</b>                              |                         | 14.36   | 2.5      | 9.24      |
| <b>Vanadium (V mg/kg)</b>                          |                         | 29.816  | 7.938    | 17.40     |
| <b>Mercury (Hg mg/kg)</b>                          |                         | 0.49    | 0.05     | 0.202     |
| <b>Chloride (Cl mg/kg)</b>                         |                         | 1314    | 205.5    | 639.226   |
| <b>Sulfate (SO<sub>4</sub><sup>2-</sup> mg/kg)</b> |                         | 481.9   | 28.8     | 150.186   |
| <b>Fluoride (F- mg/kg)</b>                         |                         | 2.97    | 0.2      | 1.62      |
| <b>Total Organic Carbon (TOK %)</b>                |                         | 45.1855 | 36.4759  | 41.36     |
| <b>Total Organic Carbon (TOK mg/kg)</b>            |                         | 424136  | 121040   | 326238.97 |
| <b>Total Carbon (%)</b>                            |                         | 33.769  | 18.50551 | 26.73     |
| <b>Total Nitrogen (N mg/kg)</b>                    |                         | 98756   | 70812    | 90052.58  |
| <b>Ash (at 900 °C %)</b>                           |                         | 39.35   | 15.77    | 25.52     |
| <b>Humidity (%)</b>                                |                         | 90.22   | 74.55    | 82.71     |
| <b>Dry Matter (%)</b>                              |                         | 25.45   | 9.78     | 17.29     |
| <b>Ash (%)</b>                                     | <b>Dry Value in Air</b> | 38.09   | 14.95    | 23.82     |
|                                                    | <b>Dry Value</b>        | 39.6    | 16.58    | 25.14     |
|                                                    | <b>Original Value</b>   | 7.27    | 2.37     | 4.16      |
| <b>Volatile Suspended Matter (%)</b>               | <b>Dry Value in Air</b> | 70.61   | 54.59    | 63.08     |
|                                                    | <b>Dry Value</b>        | 73.49   | 57.7     | 65.92     |
|                                                    | <b>Original Value</b>   | 15.85   | 7.54     | 10.95     |
| <b>Upper Calorific Value (kcal/kg)</b>             | <b>Dry Value in Air</b> | 4900    | 2962     | 3799.86   |
|                                                    | <b>Dry Value</b>        | 5199    | 3079     | 4025.71   |
| <b>Lower Calorific Value (kcal/kg)</b>             | <b>Dry Value in Air</b> | 4608    | 2743     | 3552.74   |
|                                                    | <b>Dry Value</b>        | 4889    | 2874     | 3780.86   |

|                                             |                                        |         |        |       |
|---------------------------------------------|----------------------------------------|---------|--------|-------|
| <b>Total Sulphur (S %)</b>                  | <b>Dry Value in Air</b>                | 1.14    | 0.28   | 0.45  |
|                                             | <b>Dry Value</b>                       | 1.21    | 0.29   | 0.47  |
|                                             | <b>Original Value</b>                  | 0.29    | 0.04   | 0.08  |
| <b>H seyler (%)</b>                         | <b>Dry Value</b>                       | 6.29    | 5.18   | 5.63  |
| <b>Fixed Carbon (%)</b>                     | <b>Dry Value in Air</b>                | 9.51    | 9.44   | 9.48  |
|                                             | <b>Dry Value</b>                       | 10.29   | 10.04  | 10.14 |
|                                             | <b>Original Value</b>                  | 2.62    | 2.26   | 2.43  |
| <b>Temporary Relative Density (gr/cm³)</b>  | <b>Dry Value in Air</b>                | 1.62    | 1.26   | 1.49  |
|                                             | <b>Dry Value</b>                       | 1.78    | 1.5    | 1.62  |
|                                             | <b>Original Value</b>                  | 0.42    | 0.2    | 0.27  |
| <b>Humidity (%)</b>                         | <b>Dry Value in Air</b>                | 35.69   | 2.29   | 8.45  |
|                                             | <b>Dry Value</b>                       | 37.81   | 17.76  | 22.17 |
|                                             | <b>Original Value</b>                  | 90.6    | 2.39   | 58.35 |
| <b>Dry based C (%)</b>                      |                                        | 48.14   | 30.14  | 38.33 |
| <b>Dry Base H (%)</b>                       |                                        | 5.93    | 3.96   | 4.82  |
| <b>Dry Base N (%)</b>                       |                                        | 6.08    | 0.96   | 4.56  |
| <b>Ammonia (NH<sup>3</sup> - mg/kg)</b>     |                                        | 111.872 | 35.264 | 73.57 |
| <b>Phosphorus (P- mg/kg)</b>                |                                        | 111.473 | 22.54  | 67.01 |
| <b>Sodium Oxide (Na<sub>2</sub>O - %)</b>   |                                        | 0.12    | 0.08   | 0.10  |
| <b>Potassium Oxide (K<sub>2</sub>O - %)</b> |                                        | 0.24    | 0.1    | 0.17  |
| <b>Ash Melting Degree (°C)</b>              | <b>Initial Deformation Temperature</b> | 1215    | 1191   | 1203  |
|                                             | <b>Softening Temperature</b>           | 1221    | 1220   | 1221  |
|                                             | <b>Melting Temperature</b>             | 1259    | 1245   | 1252  |
|                                             | <b>Flow Temperature</b>                | 1325    | 1319   | 1322  |

**Table 2: Characteristics of Digested Sludge in Hurma WWTP**

| <b>HURMA WWTP (Digested Sludge)</b> |                      |                      |                      |
|-------------------------------------|----------------------|----------------------|----------------------|
| <b>Parameter</b>                    | <b>Maximum Value</b> | <b>Minimum Value</b> | <b>Average Value</b> |
| <b>Lead (Pb mg/kg)</b>              | 37.56                | 2.22                 | 21.19                |
| <b>Cadmium (Cd mg/kg)</b>           | 1.00                 | 0.07                 | 0.54                 |
| <b>Chrome (Cr mg/kg)</b>            | 74.80                | 7.62                 | 42.38                |
| <b>Arsenic (mg/kg)</b>              | 13.15                | 0.50                 | 5.90                 |
| <b>Nickel (Ni mg/kg)</b>            | 43.30                | 4.49                 | 24.70                |
| <b>Beryllium (mg/kg)</b>            | 0.50                 | 0.25                 | 0.42                 |

|                                                       |                         |           |           |           |
|-------------------------------------------------------|-------------------------|-----------|-----------|-----------|
| <b>Thallium (Tl mg/kg)</b>                            |                         | 2.50      | 0.13      | 1.71      |
| <b>Copper (Cu mg/kg)</b>                              |                         | 195.60    | 18.96     | 130.90    |
| <b>Cobalt (Co mg/kg)</b>                              |                         | 8.03      | 0.50      | 4.36      |
| <b>Manganese (Mn mg/kg)</b>                           |                         | 174.20    | 35.49     | 115.75    |
| <b>Antimony (Sb mg/kg)</b>                            |                         | 2.31      | 0.25      | 1.49      |
| <b>Tin (Sn mg/kg)</b>                                 |                         | 19.80     | 2.50      | 11.51     |
| <b>Vanadium (V mg/kg)</b>                             |                         | 26.60     | 2.31      | 12.94     |
| <b>Mercury (Hg mg/kg)</b>                             |                         | 0.21      | 0.05      | 0.11      |
| <b>Chloride (Cl mg/kg)</b>                            |                         | 2074.30   | 241.70    | 947.94    |
| <b>Sulfate (SO<sub>4</sub><sup>2-</sup> mg/kg)</b>    |                         | 602.60    | 67.70     | 321.17    |
| <b>Fluoride (F- mg/kg)</b>                            |                         | 2.00      | 0.20      | 1.22      |
| <b>Total Organic Carbon (TOK %)</b>                   |                         | 38.66     | 38.66     | 38.66     |
| <b>Total Organic Carbon (TOK mg/kg)</b>               |                         | 386647.00 | 153583.00 | 299420.00 |
| <b>Total Carbon (%)</b>                               |                         | 25.91     | 25.91     | 25.91     |
| <b>Total Nitrogen (N mg/kg)</b>                       |                         | 24036.00  | 8.48      | 12022.24  |
| <b>Ash (900 °C %'de)</b>                              |                         | 31.24     | 31.24     | 31.24     |
| <b>Humidity (%)</b>                                   |                         | 82.47     | 79.60     | 80.69     |
| <b>Dry Matter (%)</b>                                 |                         | 20.40     | 17.53     | 19.31     |
| <b>Total Humidity (%)</b>                             | <b>Original Value</b>   | 79.71     | 79.71     | 79.71     |
| <b>Composition Moisture (%)</b>                       | <b>Dry Value in Air</b> | 6.26      | 6.26      | 6.26      |
| <b>Ash (%)</b>                                        | <b>Dry Value in Air</b> | 28.17     | 19.46     | 24.87     |
|                                                       | <b>Dry Value</b>        | 30.05     | 21.79     | 26.45     |
|                                                       | <b>Original Value</b>   | 6.10      | 3.76      | 4.86      |
| <b>Volatile Suspended Matter (%)</b>                  | <b>Dry Value in Air</b> | 63.18     | 56.25     | 59.72     |
|                                                       | <b>Dry Value</b>        | 64.41     | 60.01     | 62.21     |
|                                                       | <b>Original Value</b>   | 12.18     | 11.07     | 11.63     |
| <b>Upper Calorific Value (cal/g)</b>                  | <b>Dry Value in Air</b> | 3959      | 3592      | 3812      |
|                                                       | <b>Dry Value</b>        | 4434      | 3832      | 4076      |
|                                                       | <b>Original Value</b>   | 778       | 681       | 742       |
| <b>Lower Calorific Value (cal/g)</b>                  | <b>Dry Value in Air</b> | 3714      | 3368      | 3579      |
|                                                       | <b>Dry Value</b>        | 4160      | 3593      | 3830      |
|                                                       | <b>Original Value</b>   | 290.00    | 186.00    | 246,33    |
| <b>Total Sulphur (S %)</b>                            | <b>Dry Value in Air</b> | 0.92      | 0.37      | 0.65      |
|                                                       | <b>Dry Value</b>        | 0.98      | 0.38      | 0.68      |
|                                                       | <b>Original Value</b>   | 0.20      | 0.06      | 0.13      |
| <b>H seyler (%)</b>                                   | <b>Dry Value</b>        | 4.85      | 4.85      | 4.85      |
| <b>Fixed Carbon (%)</b>                               | <b>Dry Value in Air</b> | 9.32      | 9.32      | 9.32      |
|                                                       | <b>Dry Value</b>        | 9.94      | 9.94      | 9.94      |
|                                                       | <b>Original Value</b>   | 2.02      | 2.02      | 2.02      |
| <b>Temporary Relative Density (gr/cm<sup>3</sup>)</b> | <b>Dry Value in Air</b> | 1.57      | 1.44      | 1.51      |
|                                                       | <b>Dry Value</b>        | 1.67      | 1.61      | 1.64      |

|                                             |                                        |        |        |        |
|---------------------------------------------|----------------------------------------|--------|--------|--------|
|                                             | <b>Original Value</b>                  | 0.34   | 0.28   | 0.31   |
| <b>Humidity (%)</b>                         | <b>Dry Value in Air</b>                | 28.17  | 1.91   | 16.51  |
|                                             | <b>Dry Value</b>                       | 30.05  | 21.79  | 25.92  |
|                                             | <b>Original Value</b>                  | 82.80  | 3.76   | 30.89  |
| <b>Dry based C (%)</b>                      |                                        | 39.15  | 39.15  | 39.15  |
| <b>Dry Base H (%)</b>                       |                                        | 4.59   | 4.59   | 4.59   |
| <b>Dry Base N (%)</b>                       |                                        | 4.11   | 4.11   | 4.11   |
| <b>Ammonia (NH<sup>3</sup> - mg/kg)</b>     |                                        | 48.64  | 48.64  | 48.64  |
| <b>Phosphorus (P- mg/kg)</b>                |                                        | 397.92 | 397.92 | 397.92 |
| <b>Sodium Oxide (Na<sub>2</sub>O - %)</b>   |                                        | 0.13   | 0.13   | 0.13   |
| <b>Potassium Oxide (K<sub>2</sub>O - %)</b> |                                        | 0.66   | 0.66   | 0.66   |
| <b>Ash Melting Degree (°C)</b>              | <b>Initial Deformation Temperature</b> | 1301   | 1301   | 1301   |
|                                             | <b>Softening Temperature</b>           | 1317   | 1317   | 1317   |
|                                             | <b>Melting Temperature</b>             | 1327   | 1327   | 1327   |
|                                             | <b>Flow Temperature</b>                | 1370   | 1370   | 1370   |

**Table 3: Characteristics of Biological Sludge in Hurma WWTP**

| <b>HURMA WWTP<br/>(Biological Sludge)</b>          |                      |                      |                      |
|----------------------------------------------------|----------------------|----------------------|----------------------|
| <b>Parameter</b>                                   | <b>Maximum Value</b> | <b>Minimum Value</b> | <b>Average Value</b> |
| <b>Lead (Pb mg/kg)</b>                             | 22.20                | 1.96                 | 13.59                |
| <b>Cadmium (Cd mg/kg)</b>                          | 0.64                 | 0.15                 | 0.39                 |
| <b>Chrome (Cr mg/kg)</b>                           | 42.47                | 7.61                 | 28.07                |
| <b>Arsenic (mg/kg)</b>                             | 7.40                 | 0.50                 | 3.71                 |
| <b>Nickel (Ni mg/kg)</b>                           | 28.30                | 4.22                 | 17.55                |
| <b>Beryllium (mg/kg)</b>                           | 0.50                 | 0.18                 | 0.39                 |
| <b>Thallium (Tl mg/kg)</b>                         | 2.50                 | 0.10                 | 1.70                 |
| <b>Copper (Cu mg/kg)</b>                           | 139.20               | 28.94                | 99.78                |
| <b>Cobalt (Co mg/kg)</b>                           | 5.01                 | 0.50                 | 3.00                 |
| <b>Manganese (Mn mg/kg)</b>                        | 88.80                | 24.89                | 66.04                |
| <b>Antimony (Sb mg/kg)</b>                         | 1.47                 | 0.25                 | 1.02                 |
| <b>Tin (Sn mg/kg)</b>                              | 13.60                | 2.50                 | 8.70                 |
| <b>Vanadium (V mg/kg)</b>                          | 16.02                | 2.22                 | 8.58                 |
| <b>Mercury (Hg mg/kg)</b>                          | 0.17                 | 0.05                 | 0.13                 |
| <b>Chloride (Cl mg/kg)</b>                         | 510.00               | 191.20               | 388.34               |
| <b>Sulfate (SO<sub>4</sub><sup>2-</sup> mg/kg)</b> | 125.75               | 1.00                 | 72.25                |
| <b>Fluoride (F- mg/kg)</b>                         | 123.40               | 0.20                 | 41.87                |
| <b>Total Organic Carbon (TOK %)</b>                | 40.14                | 40.14                | 40.14                |
| <b>Total Organic Carbon (TOK mg/kg)</b>            | 413391.00            | 199402.00            | 338062.33            |
| <b>Total Carbon (%)</b>                            | 23.92                | 23.92                | 23.92                |
| <b>Total Nitrogen (N mg/kg)</b>                    | 17781.00             | 9.24                 | 8895.12              |
| <b>Ash (900 °C %'de)</b>                           | 18.81                | 18.81                | 18.81                |
| <b>Humidity (%)</b>                                | 80.85                | 77.38                | 79.03                |

|                                            |                         |        |        |        |
|--------------------------------------------|-------------------------|--------|--------|--------|
| <b>Dry Matter (%)</b>                      |                         | 22.62  | 19.16  | 20.97  |
| <b>Total Humidity (%)</b>                  | <b>Original Value</b>   | 85.36  | 85.36  | 85.36  |
| <b>Composition Moisture (%)</b>            | <b>Dry Value in Air</b> | 7.05   | 7.05   | 7.05   |
| <b>Ash (%)</b>                             | <b>Dry Value in Air</b> | 27.93  | 15.04  | 20.53  |
|                                            | <b>Dry Value</b>        | 30.05  | 17.58  | 22.31  |
|                                            | <b>Original Value</b>   | 4.40   | 3.25   | 3.74   |
| <b>Volatile Suspended Matter (%)</b>       | <b>Dry Value in Air</b> | 66.54  | 54.65  | 60.60  |
|                                            | <b>Dry Value</b>        | 68.96  | 58.80  | 63.88  |
|                                            | <b>Original Value</b>   | 12.74  | 8.61   | 10.68  |
| <b>Upper Calorific Value (cal/g)</b>       | <b>Dry Value in Air</b> | 4259   | 3453   | 3895   |
|                                            | <b>Dry Value</b>        | 4646   | 3715   | 4258   |
|                                            | <b>Original Value</b>   | 859    | 544    | 740    |
| <b>Lower Calorific Value (cal/g)</b>       | <b>Dry Value in Air</b> | 4001   | 3238   | 3655   |
|                                            | <b>Dry Value</b>        | 4357   | 3484   | 4003   |
|                                            | <b>Original Value</b>   | 357.00 | 40.00  | 239.33 |
| <b>Total Sulphur (S %)</b>                 | <b>Dry Value in Air</b> | 1.21   | 0.35   | 0.78   |
|                                            | <b>Dry Value</b>        | 1.30   | 0.36   | 0.83   |
|                                            | <b>Original Value</b>   | 0.19   | 0.07   | 0.13   |
| <b>H seyley (%)</b>                        | <b>Dry Value</b>        | 4.69   | 4.69   | 4.69   |
| <b>Fixed Carbon (%)</b>                    | <b>Dry Value in Air</b> | 10.36  | 10.36  | 10.36  |
|                                            | <b>Dry Value</b>        | 11.15  | 11.15  | 11.15  |
|                                            | <b>Original Value</b>   | 1.63   | 1.63   | 1.63   |
| <b>Temporary Relative Density (gr/cm³)</b> | <b>Dry Value in Air</b> | 1.65   | 1.34   | 1.50   |
|                                            | <b>Dry Value</b>        | 1.77   | 1.57   | 1.67   |
|                                            | <b>Original Value</b>   | 0.29   | 0.26   | 0.28   |
| <b>Humidity (%)</b>                        | <b>Dry Value in Air</b> | 3.51   | 3.51   | 3.51   |
|                                            | <b>Original Value</b>   | 81.52  | 81.52  | 81.52  |
| <b>Dry based C (%)</b>                     |                         | 43.20  | 43.20  | 43.20  |
| <b>Dry Base H (%)</b>                      |                         | 5.02   | 5.02   | 5.02   |
| <b>Dry Base N (%)</b>                      |                         | 5.92   | 5.92   | 5.92   |
| <b>Ammonia (NH³ - mg/kg)</b>               |                         | 92.42  | 92.42  | 92.42  |
| <b>Phosphorus (P- mg/kg)</b>               |                         | 380.46 | 380.46 | 380.46 |
| <b>Sodium Oxide (Na₂O - %)</b>             |                         | 0.15   | 0.15   | 0.15   |

|                                             |                                        |      |      |      |
|---------------------------------------------|----------------------------------------|------|------|------|
| <b>Potassium Oxide (K<sub>2</sub>O - %)</b> |                                        | 0.21 | 0.21 | 0.21 |
| <b>Ash Melting Degree (°C)</b>              | <b>Initial Deformation Temperature</b> | 1296 | 1296 | 1296 |
|                                             | <b>Softening Temperature</b>           | 1324 | 1324 | 1324 |
|                                             | <b>Melting Temperature</b>             | 1345 | 1345 | 1345 |
|                                             | <b>Flow Temperature</b>                | 1389 | 1389 | 1389 |

**Table 4:** Characteristics of Biological Sludge in Lara WWTP

| <b>LARA WWTP<br/>(Biological Sludge)</b>           |                         |                      |                      |                      |
|----------------------------------------------------|-------------------------|----------------------|----------------------|----------------------|
| <b>Parameter</b>                                   |                         | <b>Maximum Value</b> | <b>Minimum Value</b> | <b>Average Value</b> |
| <b>Lead (Pb mg/kg)</b>                             |                         | 13.40                | 1.97                 | 9.04                 |
| <b>Cadmium (Cd mg/kg)</b>                          |                         | 0.60                 | 0.07                 | 0.40                 |
| <b>Chrome (Cr mg/kg)</b>                           |                         | 32.40                | 11.95                | 22.15                |
| <b>Arsenic (mg/kg)</b>                             |                         | 9.30                 | 0.50                 | 4.45                 |
| <b>Nickel (Ni mg/kg)</b>                           |                         | 27.80                | 10.87                | 19.12                |
| <b>Beryllium (mg/kg)</b>                           |                         | 0.50                 | 0.15                 | 0.38                 |
| <b>Thallium (Tl mg/kg)</b>                         |                         | 2.50                 | 1.50                 | 2.17                 |
| <b>Copper (Cu mg/kg)</b>                           |                         | 146.95               | 21.84                | 98.20                |
| <b>Cobalt (Co mg/kg)</b>                           |                         | 2.40                 | 0.50                 | 1.72                 |
| <b>Manganese (Mn mg/kg)</b>                        |                         | 205.95               | 42.35                | 123.20               |
| <b>Antimony (Sb mg/kg)</b>                         |                         | 1.68                 | 0.25                 | 1.07                 |
| <b>Tin (Sn mg/kg)</b>                              |                         | 19.45                | 2.50                 | 9.43                 |
| <b>Vanadium (V mg/kg)</b>                          |                         | 17.80                | 2.35                 | 10.47                |
| <b>Mercury (Hg mg/kg)</b>                          |                         | 0.15                 | 0.05                 | 0.10                 |
| <b>Chloride (Cl mg/kg)</b>                         |                         | 592.00               | 149.40               | 374.10               |
| <b>Sulfate (SO<sub>4</sub><sup>2-</sup> mg/kg)</b> |                         | 524.44               | 1.00                 | 236.48               |
| <b>Fluoride (F- mg/kg)</b>                         |                         | 98.10                | 0.20                 | 33.43                |
| <b>Total Organic Carbon (TOK %)</b>                |                         | 41.44                | 41.44                | 41.44                |
| <b>Total Organic Carbon (TOK mg/kg)</b>            |                         | 454144.00            | 336095.00            | 401555.00            |
| <b>Total Carbon (%)</b>                            |                         | 33.82                | 33.82                | 33.82                |
| <b>Total Nitrogen (N mg/kg)</b>                    |                         | 26540.00             | 9.76                 | 13274.88             |
| <b>Ash (900 °C %'de)</b>                           |                         | 20.15                | 20.15                | 20.15                |
| <b>Humidity (%)</b>                                |                         | 81.24                | 76.19                | 78.76                |
| <b>Dry Matter (%)</b>                              |                         | 23.81                | 18.76                | 21.24                |
| <b>Total Humidity (%)</b>                          | <b>Original Value</b>   | 72.34                | 72.34                | 72.34                |
| <b>Composition Moisture (%)</b>                    | <b>Dry Value in Air</b> | 6.46                 | 6.46                 | 6.46                 |
| <b>Ash (%)</b>                                     | <b>Dry Value in Air</b> | 23.27                | 19.44                | 20.92                |
|                                                    | <b>Dry Value</b>        | 22.74                | 20.66                | 21.66                |
|                                                    | <b>Original Value</b>   | 6.29                 | 3.65                 | 4.59                 |

|                                             |                                        |        |        |        |
|---------------------------------------------|----------------------------------------|--------|--------|--------|
| <b>Volatile Suspended Matter (%)</b>        | <b>Dry Value in Air</b>                | 74.62  | 62.34  | 68.48  |
|                                             | <b>Dry Value</b>                       | 79.33  | 66.65  | 72.99  |
|                                             | <b>Original Value</b>                  | 18.44  | 14.00  | 16.22  |
| <b>Upper Calorific Value (cal/g)</b>        | <b>Dry Value in Air</b>                | 4082   | 3938   | 4008   |
|                                             | <b>Dry Value</b>                       | 4340   | 4238   | 4287   |
|                                             | <b>Original Value</b>                  | 1184   | 753    | 901    |
| <b>Lower Calorific Value (cal/g)</b>        | <b>Dry Value in Air</b>                | 3785   | 3690   | 3744   |
|                                             | <b>Dry Value</b>                       | 4059   | 3971   | 4015   |
|                                             | <b>Original Value</b>                  | 712    | 253    | 409    |
| <b>Total Sulphur (S %)</b>                  | <b>Dry Value in Air</b>                | 0.91   | 0.41   | 0.66   |
|                                             | <b>Dry Value</b>                       | 0.97   | 0.44   | 0.71   |
|                                             | <b>Original Value</b>                  | 0.27   | 0.08   | 0.18   |
| <b>H seylar (%)</b>                         | <b>Dry Value</b>                       | 5.42   | 5.42   | 5.42   |
| <b>Fixed Carbon (%)</b>                     | <b>Dry Value in Air</b>                | 9.92   | 9.92   | 9.92   |
|                                             | <b>Dry Value</b>                       | 10.61  | 10.61  | 10.61  |
|                                             | <b>Original Value</b>                  | 2.93   | 2.93   | 2.93   |
| <b>Temporary Relative Density (gr/cm³)</b>  | <b>Dry Value in Air</b>                | 1.54   | 1.48   | 1.51   |
|                                             | <b>Dry Value</b>                       | 1.65   | 1.59   | 1.62   |
| <b>Humidity (%)</b>                         | <b>Dry Value in Air</b>                | 5.94   | 5.94   | 5.94   |
|                                             | <b>Original Value</b>                  | 82.35  | 82.35  | 82.35  |
| <b>Dry based C (%)</b>                      |                                        | 42.76  | 42.76  | 42.76  |
| <b>Dry Base H (%)</b>                       |                                        | 5.71   | 5.71   | 5.71   |
| <b>Dry Base N (%)</b>                       |                                        | 1.10   | 1.10   | 1.10   |
| <b>Ammonia (NH<sup>3</sup> - mg/kg)</b>     |                                        | 114.30 | 114.30 | 114.30 |
| <b>Phosphorus (P- mg/kg)</b>                |                                        | 538.76 | 538.76 | 538.76 |
| <b>Sodium Oxide (Na<sub>2</sub>O - %)</b>   |                                        | 0.17   | 0.17   | 0.17   |
| <b>Potassium Oxide (K<sub>2</sub>O - %)</b> |                                        | 0.53   | 0.53   | 0.53   |
| <b>Ash Melting Degree (°C)</b>              | <b>Initial Deformation Temperature</b> | 1307   | 1307   | 1307   |
|                                             | <b>Softening Temperature</b>           | 1318   | 1318   | 1318   |
|                                             | <b>Melting Temperature</b>             | 1329   | 1329   | 1329   |
|                                             | <b>Flow Temperature</b>                | 1355   | 1355   | 1355   |

**Table 5: Adhesion Properties of Sewage Sludge Test from Districts**

**Adhesion Properties of Sewage Sludge Test**

| Sample Name              | Dry Weight (m1(gr)) | Damp Weight (m0(gr)) | First Height (h0(mm)) | Height In Deformed Form (h1(mm)) | h0/h1 | % H <sub>2</sub> O |
|--------------------------|---------------------|----------------------|-----------------------|----------------------------------|-------|--------------------|
| Average of the Districts | 40                  | 60                   | 39.4                  | 26.6                             | 1.5   | 33                 |
|                          | 40                  | 70                   | 39.2                  | 21.5                             | 1.8   | 43                 |
|                          | 40                  | 80                   | 39.85                 | 18.25                            | 2.2   | 50                 |
|                          | 40                  | 100                  | 41                    | 13.85                            | 2.95  | 60                 |
|                          | 40                  | 135                  | 40.25                 | 11.8                             | 3.4   | 70                 |

**Table 6:** Adhesion Properties of Sewage Sludge Test from Centre WWTPs (Lara WWTP and Hurma WWTP)

| Adhesion Properties of Sewage Sludge Test |                     |                      |                       |                                  |       |                    |
|-------------------------------------------|---------------------|----------------------|-----------------------|----------------------------------|-------|--------------------|
| Sample Name                               | Dry Weight (m1(gr)) | Damp Weight (m0(gr)) | First Height (h0(mm)) | Height In Deformed Form (h1(mm)) | h0/h1 | % H <sub>2</sub> O |
| Hurma WWTP (Digested Sludge)              | 40                  | 60                   | 40.2                  | 24.8                             | 1.6   | 33                 |
|                                           | 40                  | 70                   | 39.6                  | 21.2                             | 1.9   | 43                 |
|                                           | 40                  | 80                   | 38.4                  | 17.0                             | 2.3   | 50                 |
|                                           | 40                  | 100                  | 41                    | 14.3                             | 2.9   | 60                 |
|                                           | 40                  | 135                  | 40.3                  | 11.3                             | 3.6   | 70                 |
| Hurma WWTP (Biological Sludge)            | 40                  | 60                   | 40.2                  | 30.1                             | 1.3   | 33                 |
|                                           | 40                  | 70                   | 39.5                  | 22.3                             | 1.8   | 43                 |
|                                           | 40                  | 80                   | 39.6                  | 18.2                             | 2.2   | 50                 |
|                                           | 40                  | 100                  | 39.7                  | 16.2                             | 2.5   | 60                 |
|                                           | 40                  | 135                  | 39.8                  | 12.1                             | 3.3   | 70                 |
| Lara WWTP (Biological Sludge)             | 40                  | 60                   | 39.4                  | 25.6                             | 1.5   | 33                 |
|                                           | 40                  | 70                   | 41                    | 21.0                             | 2     | 43                 |
|                                           | 40                  | 80                   | 40.7                  | 17.4                             | 2.3   | 50                 |
|                                           | 40                  | 100                  | 41.2                  | 15.2                             | 2.7   | 60                 |
|                                           | 40                  | 135                  | 39.7                  | 11.4                             | 3.5   | 70                 |

## 2.2. PROCESS DESCRIPTION

The section of the new Hurma WTE Facility is summarized below and a detailed description of each section has been presented as follows;

1. Sludge Acceptance/Storage Unit
2. Sludge Pre-drying Unit
3. Odour Control Unit
4. Fluidized Bed Incinerator (FBI) Unit with Heat Recovery System
5. Energy Recovery Unit with Steam Turbine
6. Flue Gas Emission Control System Unit

## 7. Ash Collection and Storage Unit

The entire system (thermal pre-dryer, incinerator, air blowers (fans, blowers, etc.) shall be designed to carry this 10% additional load, except the solids transfer system. The solids transfer system (feed pumps, conveyors, etc.) shall be designed to carry this 20% additional load.

### 2.2.1. Sludge Acceptance/Storage Unit

Determination of Inlet Sludge Capacity:

There shall be 2 different lines for sludge to enter and be accepted to the new Hurma WTE facility. The sludge intake to the Hurma WTE facility should be designed to allow it to be taken both from the weighbridge and by trucks.

#### 1. Input-Waste Sludge Coming from Districts:

A weighbridge shall be placed in front of the facility for the waste sludge coming from the districts and the amount of sludge coming from the districts shall be determined.

**Weighing Scale:** It shall be placed at a location according to the contractor's design at the entrance of the facility and shall be fully electronic with sufficient capacity. The relevant components of the weighing scale with ISO 9001 quality assurance system must also meet the requirements of ISO, CE and EC Conformity Certificates.

The weighing scale must have at least the following components:

- steel type weighing bridge (Platform)
- load cell
- Weighing room
- Weighing terminal
- Connection box
- Computer and its equipment

#### 2- Waste Sludge Coming from the Hurma Wastewater Treatment Plant Dewatering Unit:

The Contractor shall provide the construction of a connection line and the installation of a flow meter from the existing dewatering unit of the Hurma Wastewater Treatment Plant and the amount of sludge coming to the new Hurma WTE Facility shall be determined.

**Waste Sludge Acceptance Bunker:** The bunker/s, each compartment of which shall be designed by the contractor, shall be constructed for sludge acceptance after the weighbridge at the entrance of the facility. The connection of the existing dewatered sludge of Hurma Wastewater Treatment Plant, which is under the responsibility of the Contractor, shall be made to the bunker.

The capacity of the bunkers to be constructed for the sludge to be received from the districts, the Hurma Wastewater Treatment Plant and the Lara Wastewater Treatment Plant shall be designed so as to ensure sludge storage for a minimum period of ten (10) consecutive days (240 hours). Accordingly, the bunkers shall be constructed as a minimum of three (3) and a maximum of five (5) units, with a minimum total storage capacity of 5,000 m<sup>3</sup>.

The bunker shall be constructed of reinforced concrete in accordance with the TSE and Earthquake regulations or of non-corrosive material in accordance with the approval of the Employer's representative. Epoxy coating shall be applied to the bunker base and curtain inner walls.

The bunker shall be closed on top, but there shall be sufficient spaces on top for trucks to discharge sludge. There shall be an automatic hydraulic opening-closing cover made of stainless steel on this space.

A warning system shall be installed for hazardous and explosive gases accumulated in the bunker and the system shall be designed by the contractor for the treatment of gases. An odour control system shall be designed in which biological + chemical odour removal methods are applied together for odour removal in the bunkers.

Level measurement, H<sub>2</sub>S, CO and CH<sub>4</sub> and other hazardous/explosive gas measurements shall be made in the bunker and appropriate equipment shall be placed in the bunker. Measurements of these gases shall be made continuously and a system shall be established to prevent danger. These measurements shall be monitored in the facility's general automation/SCADA center. The Contractor shall provide audible and visual alarms from the automation system and in the bunker. All equipment of the bunker (including preventive systems) shall be manufactured in a way that can be activated in the automation system.

A push-flow mechanism shall be used at the bunker base to ensure the movement of sludge within the bunker. The sludge in the bunker or bunkers shall be transferred from the sludge bunker to the silos by means of pumps and/or screw systems/and or additional systems according to the contractor's design and necessary precautions shall be taken to prevent the sludge from clogging during this transfer.

**Waste Sludge Storage Silos:** Silos with a volume and number sufficient for the daily capacity of the facility shall be manufactured for the pre-storage of sludge to be transferred from the main sludge bunker to the thermal pre-drying unit.

Silos shall be manufactured in ST37 (S235JR) material and shall be coated with a coating system that prevents rust, chemical and physical wear. Statical calculation and designs shall be done according to the static load capacities of all silo(s) and bunker(s). The stainless steel grade shall be minimum 304. The wall thickness of the silo shall be at **least 12 mm**. A sliding base mechanism and/or mixers shall be used at the silo base to ensure the movement of sludge within the silo, and pumps/screw conveyors/closed belt systems shall be used to feed the pre-drying unit from the silos. Apart from these, if necessary, additional equipment shall be used in the silos to prevent the pre-drying connection line from clogging and to ensure the healthy operation of the system.

A system shall be established to treat the gases formed in the silos. The system to be established shall control the emission in cases where the new Hurma WTE facility is not operating. This system shall be established as a backup for hazardous and explosive gases in case of danger. Each storage silo shall be equipped with the necessary ventilation and filters to ensure safe operation. Continuous level indicators, high/low level detectors and alarms shall be used to prevent excessive filling and emptying of the silos. Sufficient capacity shall be provided above the high alarm to be able to receive the full load. The Contractor shall provide audible and visual alarms in the automation system to monitor the level status in the storage silos. Fine particles that shall ensure that the system complies with the standards shall be captured by ventilation filters.

When sizing the ventilation filters, care shall be taken to ensure that they provide air flow resulting from any discharge process. Each filter with automatic cleaning shall be waterproof, resistant to weather conditions and easily replaceable (within its minimum life). Each silo shall have a pressure relief system to prevent excessive pressure in case of blockage of the filters. Stairs, ladders and inspection platforms shall be constructed to provide safe access to the top of the silos and the parts requiring maintenance on them. Silos shall be connected to each other via a walkway at the roof level. Manholes shall be provided for inspection and maintenance inside the silo. Stairs shall be angled to the vertical and shall not be perpendicular to the horizontal plane. The transmission of sludge from the silos to the pre-drying unit shall be provided by a pump or screw conveyor or a different closed transmission system. Level measurement, hazardous/explosive gas measurements such as H<sub>2</sub>S, CO and CH<sub>4</sub> shall be made in the silos and appropriate equipment shall be placed in the silos. Measurements of these gases shall be made at all times and a system shall be established to prevent any danger. These measurements shall be monitored from the automation/SCADA center. The Contractor shall provide audible and visual alarms in the automation system and silos for hazardous gases. All equipment of the silos, including preventive systems, shall be manufactured in a way that can be activated in the automation system.

**Transferring and storage of 90% Dried Sludge:** The existing sludge drying facility is feeding by sludge of Lara WWTP. It is already transferring with trucks to the existing inlet bunker of sludge drying facility of Hurma WWTP. After the drying process, the sludge of the Lara WWTP will be sent to the 90% dried sludge silos within the scope of the contract by the Contractor.

Silos shall be manufactured for the 90% dry sludge coming out of the existing drying facility before transferring it to each fluidized bed furnace. The transfer of the 90% dry sludge from the existing drying facility to the silos and the transmission lines from the silos to the fluidized bed furnaces shall be carried out under the responsibility of the contractor. The safety measures specified in the above silos shall also be applied in these silos.

#### **2.2.2. Sludge Pre-Drying Unit**

The indirectly heated thermal-drying system shall be supplied and installed in accordance with the specifications specified in this section. Thermal drying unit shall have energy recovery system and high energy efficiency.

All construction, mechanical, electrical, etc. works required for the full operation of the drying unit shall be completed completely, whether or not specified in the specifications. The waste sludge shall be dried in the sludge pre-drying unit to the minimum autothermal dryness point (min. 36% DM).

- Indirectly Heated (Thermal) Sludge Dryer with high energy recovery system
- Heating, steam and gas condensation, piping, etc. systems required for obtaining dry product
- Emission/Odour Control Unit

#### **Instrumentation and Control Equipment and Systems**

Transportation System of pre-dried sludge and, if necessary, silo.

Any emission/odour shall not be allowed to be discharged from the pre-dryer system to the outside environment.

For pre-drying units, “heat-mass calculations and required drying area” shall be submitted by the Contractor together with their proposal.

The dimensioning of the sludge pre-drying system shall be based on a total capacity amount of 500 tons/day of wet sludge with an average dry matter content of 18% and consisting of at least four lines.

The Contractor shall supply, install and test all equipment required to provide a complete sludge pre-drying system with a minimum of four lines including all auxiliary equipment as defined below in its designs. A pre-drying unit shall be designed to incinerate the dewatered sludge containing an average of 18% DS in a fluidized bed sludge incineration furnace under appropriate conditions (min. 36% DS) in autothermal conditions.

The elements to be included in the system shall include, but are not limited to, the following:

**A. Feeding of dewatered sludge with %18 DS from waste sludge storage silos to pre-drying units**

Systems with necessary equipment that shall transport dewatered sludge from silos to the pre-dryer shall be supplied and installed.

A suitable with spare lines sludge feeding system for each pre-dryer units shall feed the dewatered sludge to the sludge feeding area of the dryer. The sludge to be dried shall be fed with suitable carriers according to Contractor's design.

**B. Drying Unit**

At least 4 indirect steam heated dryers shall be provided. In this context, steam supply system shall be designed. Thermal oil systems and hot air shall not be accepted. All equipment, accessories and all necessary installations, piping, etc. that shall produce the steam required for drying are included in the scope),

Heat Production: The heat energy required by the dryer shall be produced as follows:

- Under suitable conditions, intermediate steam drawn from the turbine in the new Hurma WTE facility shall be used.
- There shall be steam circuit (piping, valves, installation, insulation, etc.) and insulation where necessary (Insulation-related locations, insulation materials and information shall be specified in detail in the Contractor's technical bid)
- There shall be water and wastewater connection circuit (installation, valves, tanks, etc. equipment) with their insulation. (Insulation locations, insulation materials and details about the equipment shall be specified in the technical bid)
- The dryer outlet gas shall be passed through a condenser and non-volatile organics shall be kept in the water and then given to the beginning of the facility. The volatile part shall be transmitted to the odour control unit in gaseous form.

**C. Outlet of the Pre-drying**

The sludge coming out of the dryers can be fed to the silo or silos for each line with appropriate equipment. The sludge coming out of these silos shall be sent to the incineration section with appropriate conveying methods. The sludge brought to the dryness rate at the autothermal point (min. 36% DS) at the dryer outlet shall be transported to the fluidized bed incineration furnace with appropriate conveying systems. This conveying system shall be

supplied with all its accessories. The contractor shall provide detailed information in their technical bid.

#### **D. Condenser**

The wastewater vapor from the sludge dryers shall go to the condensation towers. The condenser should be designed to remove a minimum of 90% of the water vapor. Volatile organic substances that cannot be captured in the condenser shall be transmitted to the odor control unit. Necessary precautions and insulation should be made to prevent any sealing problems in this line.

#### **2.2.3. Fluidized Bed Incineration (FBI) Unit with Heat Recovery System:**

The Fluidized Bed Incineration (FBI) shall be designed as two lines consisting of two incinerators. Material of the FBI should be P295GH or equivalent and its thickness should be minimum 14 mm. Each line shall be connected to the two lines of the pre-drying unit located before the fluidized incinerator. The sludge that is subject to pre-drying (min 36 DS) and 90% dryness coming out of the existing drying facility shall be burned in the fluidized incinerators. The furnace, which has an internal refractory lining and is manufactured with an external steel body, shall include a fluidized bed with a hot air chamber and a self-supporting refractory belt.

The Contractor shall fully comply with the provisions of the Law, Regulation, and European Union Directives indicated in the Employer's Requirements I – General Information Clause 1.4. Technical Standards and Applicable Regulations. The design and build works of the fluidized bed incineration section shall be executed according to prepared calculations and project documents depending on the design criteria. The heat loss of the FBI furnace shall be less than 2% and the total energy loss of the new WTE Facility shall be less than 3%. The external contact surface temperature of the FBI furnace, waste heat boiler, and all pipes shall be insulated in such a way as not to exceed the external contact surface temperature up to 60°C. The heat losses will be measured based on the temperature difference between the inside of the furnace and/or other thermal systems (e.g. pipes, heat exchangers, waste heat boiler, etc.) and the surface temperatures recorded on the outer side of the insulation material of these units.

The FBI furnace shall have a high-pressure upper air spray water spray system including water spray sprays for controlling flue gas temperatures.

The FBI furnace shall be equipped with a chemical (urea or ammonia water or another chemical to be proposed by the contractor in the design) feeding system to be used when necessary, thus ensuring control of nitrogen oxides.

The temperature of the FBI shall be kept under control by a bed temperature control system that includes the use of bed water injectors (or a different system to be proposed by the contractor).

FBI furnaces shall be provided with suitable openings for the addition and removal of sludge and bed material and for the supply of suppression water.

FBI furnaces shall be equipped with sufficient sampling and observation ports in horizontal positions to enable multiple points to be sampled for flue gas temperature, velocity, composition, retention time, etc. A horizontal plane shall be located adjacent to the boundary of the fluidized bed furnace. This horizontal plane shall be positioned in accordance with CFD (Computational Fluid Dynamics) modeling or other approved calculations to achieve the specified residence time and temperature. In autothermal combustion conditions, the determination of ash melting and plastic zone limit values

shall also be carried out by the Contractor. If requested by the Employer's Representative, tests shall be carried out at these points to confirm the results.

FBI furnaces shall be fully compliant with the relevant Law, Regulation, and European Union Directive provisions given in General Information part of section VII of Employer's Requirements.

The Contractor shall demonstrate, if necessary, by performing simulation applications, that the most appropriate positioning angles and nozzle locations have been determined during the design of FBI furnaces and that appropriate temperatures, residence times and speed profiles have been provided. Furnace CFD analyses shall be conducted to support this demonstration. If requested by the Employer's Representative, the Contractor shall submit to the Employer's Representative all models and calculations for simulation purposes for the due diligence trials to be conducted.

Fludized bed Incineration Section shall include, but not limited to, the following components:

#### **2.2.3.1. FBI Furnace**

FBI furnaces shall be designed in a cylindrical shape, each FBI furnace shall include, but are not limited to, the following components:

##### **a) Hot air chamber**

The hot air chamber refractory shall be designed according to the specifications for acceptable refractory materials/standards defined in Section VII – Employer's Requirements II – Design – Build Requirements Part 2 – Material and Equipment – I Mechanical Works..

##### **a.i.) Burner**

For the FBI furnace, a preheating burner capable of operating with natural gas/biogas should be provided. This burner shall able to both;

raise the temperature of the inert (non-chemically reacting) FBI bed to a level high enough to allow the sludge to ignite within 36 hours with biogas/natural gas

and heat the excess air going to the FBI furnace.

The preheating burner shall include all necessary accessories and control elements to form a complete and automatic system in accordance with one of the Turkish, European or US fire protection regulations.

The ignition of the preheating burner should be fully automatic.

##### **a.ii ) Preheat burner connection**

##### **a.iii ) Sufficient number of biogas/natural gas injectors (Inlet Start-up)**

##### **a.iv) Preheat air inlet**

##### **b) Sludge feed nozzles**

##### **c) Sand Bed**

##### **c.i) Bed material loading nozzle**

##### **c.ii) Bed material discharge nozzle**

c.iii) Sand should be dry (less than 1% moisture) and its density should be bigger than 1450 kg/m<sup>3</sup>.

**d) Combustion chamber (Freeboard)**

- d.i) Sufficient number of bed-top air injectors
- d.ii) Sufficient number of top air chamber water sprayers
- d.iii) Sufficient number of top air chamber urea (or ammonia water) sprayers

**e) Flue gas outlet: There shall be flanges on the furnace flue gas outlet, exhaust duct, hot air inlet port and air duct.**

- Sufficient number of pressure taps (for hot air chamber, sand bed and combustion chamber)
- Sufficient number of thermocouples (for hot air chamber, sand bed and combustion chamber)
- Refractory steam vents with covers (for hot air chamber, sand bed and combustion chamber)
- Personnel access door to access the suitable places (such as flue gas channel, hot air chamber, etc)
- Nozzle Manufacturing: Each nozzle gas-tight nozzle ring shall be placed inside the furnace.
- Sight Glasses: The sight glass shall be designed to allow the glass to be removed for cleaning or replacement while the system is operating.

**f) Natural gas /biogas distribution system and piping**

In this system, biogas shall be used as the main fuel as a general operating principle. Besides, when there is not enough biogas, natural gas can be used as an additional fuel. However, within the scope of this Design – Build – Operation contract, the Contractor shall only use natural gas, and the biogas shall be used when the Employer handover the operating of new Hurma WTE Facility after the completion of the operating section of this Design – Build – Operation contract (after project completion). In order to provide the desired amount of fuel to the burners, a natural/biogas gases supply system shall be established, including measuring systems, piping, valves, controls and safety connections. The designs of the system shall be prepared in accordance with the approval of the local gas supplier company (ENERYA) and the Employer's representative. natural gas and biogas distribution system shall be established. With the distribution system, natural gas/biogas shall be fed to the preheating burner located in the hot air room and

Biogas/natural gas shall be fed to the FBI biogas/natural gas injectors. The system shall consist of gas injectors, piping for system connection, control valves and other control elements.

**2.2.3.2. Air Feeding system /Fludifier Air blower**

For each fluidized bed line, a fluidizing air blower shall be provided along with the required amount of main and 1 spare according to the design calculations to provide fluidizing air to the hot air chamber of the furnace, to cool the furnace ports and expansion elements, and to provide air to the preheating burner. The blowers required for complete combustion of the sludge feed stream should be sized based on a 10% increase in the required air and discharge air flow and pressure for the contractor's autogenous combustion calculations.

#### **2.2.3.3. Heat exchangers**

Heat exchangers should be used to ensure the heat balance of the hot gas exiting the FBI, to preheat the supply air and to use the appropriate waste heat within the system in the contractor's design.

#### **2.2.3.4. Sludge feeding system**

At the exit of the pre-drying unit, the dewatered sludge brought to the dryness point (min. 36%), which is the autogenous combustion point, should be fed to each FBI incinerator with sludge stainless steel nozzles from different points to ensure homogeneous combustion. In addition, the 90% dry sludge coming out of the existing drying should be fed to each FBI incinerator separately.

#### **2.2.3.5. Sand/Chemicals feeding system**

A sand screw cooling conveyor shall be engineered and fabricated as part of the sand addition/removal system. One (1) unit shall be provided for each fluidized bed incineration furnace line.

The sand addition system shall constitute a complete and self-contained assembly, comprising all components and sub-systems up to and including the flange connection of the sand feeding nozzles.

The sand removal system shall comprise, as a minimum, a sand discharge valve, a screw-type sand cooling conveyor, and a rotary discharge valve. The cooling screw shall transfer and discharge the waste sand through a rotary valve into a screw conveyor, which shall subsequently convey the cooled sand to the downstream conveyor and the sand removal system. All equipment shall be designed and supplied in accordance with the applicable standards and the specified process requirements.

In the FBI incinerator, the necessary nozzle and system designs must be made for dosing chemicals such as urea to control combustion gases.

#### **2.2.3.6. Gas, air and sludge piping /channells with compensating coupling**

Gas, sludge, air, flue gas piping system with their isolation (if required) and gas and air channels (if necessary compensating coupling) to be required for connection of entire units of incineration section and connection of incineration section with other section of Hurma WTE Facility shall be designed, supply, installed and tested.

#### **2.2.3.7. Flue Gas Outlet:**

In order to ensure the discharge of gases formed in the FBI furnace and to regulate the pressure, the contractor must supply and install a number of forced exhaust fans (with spares) and flue gas outlets in accordance with the design.

Each of the two (2) fluidized bed incineration furnaces shall be provided with one (1) induced draft (ID) fan, resulting in a total of two (2) ID fans. In addition, one (1) spare ID fan shall be supplied for the two (2) furnaces. All fans shall be sized to ensure adequate capacity to handle the required exhaust gas flow and to achieve the necessary pressure rise. A Warehouse spare motor shall be provided for each fan to ensure operational continuity.

#### **2.2.3.8. Flue Gas Emission Control Unit :**

The flue gases coming out of the waste heat boiler shall be fed to the waste gas treatment system for the removal of particulate matter (PM, dust), sulfur dioxide, nitrogen oxides, acidic gases and other hazardous components. It is expected that the waste gas treatment system shall have treatment units using the latest technology in order to provide the removal of fly ash, sulfur dioxide, nitrogen oxides,

acidic gases and other hazardous components within the limit values specified in the European Union Directives.

Dry type emission removal methods shall be used primarily for the treatment of combustion gases and fly ash coming out of the waste heat boiler. If necessary, wet type treatment technologies can also be used for the flue gas output values to meet the limit values of the European Union Directives.

The emission control, treatment and disposal of the auxiliary products to be formed during the operation of Hurma Waste to Energy Facility shall satisfy the requirements of the relevant EU directives – especially 2010/75/EU (available for instance at the following website: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32010L0075>) - and the legislations of the Republic of Turkey. Therefore, the Contractor shall carry out the most suitable and safe solution for the purpose of the control and treatment of emissions of Hurma Waste to Energy. Emission treatment units shall be designed in consideration of sustainable operation management. The flue gas system in which the emission to be formed after incineration is released to the atmosphere after treatment shall be included in Hurma Waste to Energy Facility. Emission treatment units shall be designed to operate in series as dry type and if necessary wet type. (i.e. multicyclone, chemical dosing units and reactors, electrostatic filter, bag filter unit (mandatory)) If a wet type treatment system is proposed in addition to the dry type treatment, the impact of the wet treatment system on the overall thermal efficiency and the adequacy of the dry type treatment system shall be assessed during the technical evaluation. In case of wet type treatment systems being found inefficient or not acceptable in terms of performance, they may be rejected based on the evaluation results, and only the dry type treatment system shall be considered in the assessment of compliance with the Employer's Requirements.

There shall be an ash collection tank (with separation plates) at the bottom for the dust captured in the cyclone, sampling nozzles at the inlet and outlet, pressure and temperature indicators, and ventilation plates. Since the exhaust air temperature passing through the cyclone is high, appropriate insulation shall be manufactured. Before the bag filter, lime or bicarbonate dosages or chemical dosages recommended by the Contractor in the design shall be made for the removal of acidic gases such as SO<sub>2</sub>, H<sub>2</sub>S, HF and HCl. However, if measured in the flue gas, active carbon or a chemical recommended by the Contractor shall be used for the removal of organic matter (PAH, dioxin-furans etc.) or possible heavy metals. Sufficient retention/contact times of these chemicals must be achieved before the bag filter, and reactors can also be designed. Bag filters shall have sampling nozzles at the inlet and outlet, pressure and temperature indicators, and ventilation plates.

Additionally, when the FBI combustion furnace operates at high temperatures, urea/ammonia can be injected into the FBI furnace to remove NO<sub>x</sub>. However, if the NO<sub>x</sub> level is still above the standard even with this injection, a separate DeNO<sub>x</sub> system should be installed..

Since the exhaust air temperature passing through the filters is high, appropriate insulation shall be manufactured. If the previous dry type systems could not meet the flue gas discharge regulations, wet type flue gas treatment units (chemical washing through the packed bed, for example lime or NaOH or a different chemical recommended by the contractor) can be included in the system. The contractor should specify the methods to be applied to condense the water vapor in the flue gas outlet so that it does not create a bad visual.

The emission treatment system shall be designed to be connected to a single flue (stack) in two lines. For each of the chemicals to be used in the emission treatment system, at least 2-day dosing units with all necessary equipment shall be supplied and installed.

A continuous measurement and monitoring system shall be established for the emission and pollutant parameters emitted to the air from the stack outlet as a result of the incineration of sludge. This system shall be in compliance with the European Directive 2010/75/EU and the “Regulation on the Incineration of Wastes” (Official Gazette dated 06/10/2010; No 27721; available for instance at the following website: <https://www.resmigazete.gov.tr/eskiler/2017/04/20170407-1.htm>).

The treated combustion gases drawn from the waste gas treatment system with air blowers shall be released to the atmosphere through the stack in a way that they shall not fall below 140°C. The stack height shall be designed at least 40 m and in accordance with the conditions specified in the regulations. A suitable process shall be added for the condensation of treated flue gas under normal operating conditions. In addition, the heat of the flue gas shall be recovered to the WTE Facility by establishing energy recycling.

#### **2.2.3.9. Odour Control Units:**

- i. Waste odour formed in sludge bunkers, silos, pre-dryers and various sources shall be removed by biological + chemical odour control system.
- ii. Odour control units shall be a complete system that includes main odour control structures pipelines, equipment, auxiliary components, materials (media, chemicals etc.) and connection channels between relevant units and odour control structure.
- iii. The material in the odour control units shall be resistant to heat, humidity and corrosion. In addition, precautions shall be taken to prevent possible ammonia etc. gases against corrosion of the materials in the odour control unit.
- iv. The necessary flue gas flow rate, retention time, area, pressure drop, bed depth, bed material shall be presented by the Contractor.
- v. The odour control unit shall provide at least 95% H<sub>2</sub>S, 95% ammonia removal and there shouldn't be any odour problem at the outlet of the odour control unit.
- vi. Under all conditions, the outlet parameters of the odour control unit shall be comply with the limit values given in the emission and odour regulations and the limit values shall not be exceeded.
- vii. The odour control unit design calculations and details shall be submitted to the Employer's Representative.

#### **2.2.4. Energy Recovery Unit with Steam Turbine**

The electricity generation system shall consist of 1 (one) waste heat boiler for each line (2 in total), 1 (one) multi-stage steam turbine and generator common for both lines and 1 (one) condenser (if applicable).

The use of a condenser within the electricity generation system is foreseen by the Employer. Nevertheless, depending on the requirements of the proposed technology, Bidders may include or omit a condenser in their turbine system, provided that such configuration shall not adversely affect the overall operational performance or electricity generation efficiency, shall not lead to any additional clean water consumption, and that the Bidder shall duly demonstrate that the proposed system is technically and economically more efficient.

##### **a) Waste Heat Steam Boiler**

The materials and equipment required for the proper operation of the waste heat steam boilers for the fluidized bed sludge incineration furnace exhaust gas shall be provided by the Contractor.

- i. There shall be a total of two (2) waste heat steam boilers, one (1) for each fluidized bed incineration boiler. Steam shall be produced at a minimum temperature of 400°C in the waste heat steam boilers. Electricity shall be generated by using steam in the steam turbine.
- ii. All pressurized parts of the boiler shall be designed in accordance with EN 12952 or equivalent standards.
- iii. The design pressure and temperature of the boiler parts shall be set based on the limits stipulated in EN 12952 and shall include the effects of pressure on the boiler wall.
- iv. Remotely operated shut-off valves with suitable bypasses shall be provided on the steam final outlet lines.
- v. A thermal insulation system shall be used to prevent corrosion that may arise from condensation at the dew point on the boiler surface.
- vi. Soot blower should be designed and added.
- vii. Demineralize water treatment system should be installed based on the steam turbine supplier request.

**b) Steam Turbine Generator**

The Contractor is responsible for the supply of all materials, equipment and accessories required to supply and install one (1) condensing type Steam Turbine Generator (STG) package to be operated jointly for both lines as described herein. The water supplied from the cooling towers shall be used in the condensers.

All equipment shall be supplied from a STG supplier with similar references in this regard.

The basic components that the STG package must contain at least are as follows:

- i. Condensing type intermediate steam turbine and multi-stage steam turbine
- ii. Control panels, controllers, relays and necessary devices
- iii. Generator
- iv. Other auxiliary equipment and devices required for a complete and operational system

The Contractor shall be fully responsible for the design, supply, assembly coordination, initial commissioning, testing and function of the STG package.

The Contractor shall be responsible for ensuring that all equipment constituting the energy recovery system are compatible with each other by ensuring general coordination with the supplier.

The Contractor shall be responsible for the provision of operating and maintenance manuals, testing, training, and start-up services with the supplier.

The Contractor shall be responsible for the installation of the STG equipment.

All installation procedures shall be reviewed and the installation of the STG package and the items to be installed shall be coordinated.

The Contractor shall coordinate all work with other areas of the facility.

The steam produced in the steam boilers shall be used both in the steam turbine generators within the facility and shall be supplied to the local distribution network to generate electricity. The intermediate steam from the turbine shall be used in the pre-drying of the sludge. The turbine design shall be optimized together with the efficiency of the boiler and the water/steam cycle to maximize the net cycle efficiency of the facility.

The steam turbine shall be constructed in accordance with good engineering practice and shall meet at least the requirements of IEC 60045 and IEC 60034 standards, including testing procedures.

The steam turbine shall control the pressure of the steam system, and hence the pressure of the boiler, under normal conditions. Any deviations in the normal steam flow rate (caused by fluctuations in calorific value and fuel flow rate) shall be eliminated by the inlet pressure control in the turbine. The maximum load capability of the steam turbine shall be provided by the Contractor in such a way that fluctuations in the steam flow rate above and below the nominal maximum thermal capacity of the facility shall not result in failure.

#### **c) Condenser**

The steam coming out of the turbine shall go to the condenser.

A water-cooled type condenser shall be used.

The condenser cooling water shall be provided from the closed circuit cooling towers to be built within the FBI system.

#### *Feedwater tank and deaerator*

The feedwater tank shall be sized to allow the waste steam boiler to operate safely at low load in the event of a sudden cut-off of water and to prevent any damage to the waste steam boiler due to the level in the drum dropping.

The feedwater tank shall be equipped with a low-level alarm and a cut-out system, which shall automatically deactivate the facility.

The deaerator shall be integrated with the feedwater tank and shall eliminate the gases in the boiler feedwater.

#### **2.2.5. Ash Collection and Storage Unit**

In the fluidized bed incineration system, the bottom ashes formed as a result of incineration shall be withdrawn from the system at certain intervals and taken to the ash silo. The ash transfer system and consumable storages shall also be made in accordance with the waste gas treatment system proposed by the Contractor. The fly ashes kept in the waste gas treatment system shall be stored in separate ash silo in a similar manner. Ash collection and transfer systems shall be designed in a way that shall prevent ash and dust distribution to the environment.

Ash storage silos shall be manufactured separately for each line.

Bottom ash formed in the sludge combustion facility (FBI Furnace) from materials such as sand and slag and bottom ash generated from waste heat boiler shall be collected and stored in one main + one stand-by bunker and/or ash pit and/or hopper type storage from two FBI furnaces. The capacity of bunker and/or ash pit and/or hopper type storage shall be calculated as 3 days retention time.

Fly ash shall be transferred with the necessary pneumatic transfer system should be installed separately for the units (multi-cyclones, bag filters, etc.) in the flue gas emission system and stored in silos as two lines. Each line shall have individual one main silo with the capacity equal to 3 days retention time.

In addition to one main silo, one stand-by silo with the capacity equal to main silo for each line.

The total amount of ash to be stored in silos should not exceed 70% of the silo capacity.

Intermediate storage units shall be designed as silo-bus for fly ash. Fly ash shall be transferred by means of silo-bus directly to the truck for carry to Employer's final disposal and/or stored in big-bags and stored in the temporary storage area for ready to Employer's final disposal. Bottom ash stored in bunker and/or ash pit and/or hopper-type storage shall be directly transferred to trucks and/or collected in big bag(s). The temporary storage area shall be designed taking into consideration the space required to accommodate a sufficient number of big-bags to store the quantity of bottom ash and fly ash generated over a 3-day period.

The ash management system shall consist of two main components: Ash transfer system and Ash storage silos.

**Ash transfer system:**

The necessary pneumatic transfer system should be installed to separate and collect the ash to be formed in the sludge combustion facility from materials such as sand and slag in the units (multi-cyclones, bag filters, etc.) in the flue gas emission system and to store it.

The ash collection and transfer system shall be designed in a way that shall prevent ash and dust distribution to the environment.

In addition, an ash cooling system should be installed.

Ash collection and separation of ashes should be provided at the entrance of ash chambers and waste heat steam boiler in the duct system.

**Ash Storage Silos:**

Ash storage silos should be provided for each line for the storage of ash to be released from the units (multi-cyclones, chemical dosing units and reactors, electrostatic filter, bag filters, etc.) in the flue gas emission system, depending on the amount of ash to be calculated by the Contractor.

Minimum capacity of Each storage silo should correspond to the quantity of ash produced in 3 days. Each storage silo shall be equipped with the necessary ventilation, filters and separation plates to ensure the safe operation of the system during unloading and operation. There shall be no dust escape to the outside environment in any way.

Bottom ash shall be collected and stored in one main + one stand-by bunker and/or ash pit and/or hopper type storage from two FBI furnaces.

Systems to prevent dew formation should be provided in the ash storage under the units (multi-cyclones, chemical dosing units and reactors, electrostatic filter, bag filters, etc.) in the flue gas emission system. Since the waste gas coming from these units shall be at high temperatures, appropriate insulation should be made in order to protect the personnel, prevent heat loss and prevent condensation of moisture.

Measures should be taken in ash storages to prevent condensation in the filter.

Silos shall be equipped with continuous level indicators, High and Low level detectors and alarms to prevent overfilling and over-discharging. Sufficient capacity shall be provided above the High alarm to enable the full load to be received. The Contractor shall provide audible and visual alarms in the storage silo and automation / SCADA system. Silo Level indicators shall be provided in the automation / SCADA system. Silos shall be designed and manufactured in a way that they can be discharged into silo bus tankers and suitable for bagging systems for use in emergency situations.

## **2.3. PHASING**

Hurma Waste Sludge Incineration and Energy Recovery Facility Project has 24 months (730 days) Design-Build (design and construction) Period and 24 months (730 days) Operation Service Period.

The duration of the Contract has been described as follows (The following periods may vary depending on the Work Programme to be submitted by the Contractor in accordance with Section VII Employer's Requirements Clause 1.6.1 – General Methodology and First Work Program for Design-Build) and according to the sub-clause 8.3 Programme of GCC.

### **Design-Build Period: 24 months (730 days)**

The Design-Build period shall be started according to the Notice of the Commencement Date, and the related period shall be completed after the issuance of the Commissioning Certificate.

- Commencement of Design-Build Works
- Completion of Design Services (max. 8 months)
- Completion of entire Works related to construction and supply and installation of equipment/units/instruments for the entire Hurma WTE Facility – 24 months (including design works, remediation works and repairing)
- Commissioning period – (Commissioning period shall cover Commissioning tests, Trial Operation and Performance Tests, the contractor shall complete the entire design-build works at least three months before the completion of the design-build period)
- Commissioning Certificate

### **Operation Service Period: 24 months (730 days)**

The Operation Service shall be started after the issuance of the Commissioning Certificate, and the related period shall be completed by the issuance of Contract Completion Certificate.

- Commencement of the Operation Service
- Operation service of the Hurma WTE Facility (in proper and steady-state conditions, maintenance services, remediations of operational failures, remediation works and repairing, best practices improved by suggestion studies and training services) – 24 months
- Joint Inspection Prior to Contract Completion (at least six months before the Contract Completion)
- Tests Prior to Contract Completion (at least three months before the Contract Completion)
- Issuance of the Contract Completion Certificate

The Contractor shall carry out the above-mentioned main processes in accordance with the Work program approved by the Employer's Representative.

In addition, the following details should be submitted along with the work program:

- For the Design period (maximum 8 months), the submission and finalization dates of each design report, calculation, and drawings considering the approval process of the Employer's Representative, and relevant documents, as well as necessary permits for the Preliminary and Final Design Deliverables of the entire Facility.
- For the Design-Build period (24 months including the design and commissioning period);
  - Pre-construction, construction stages (soil improvement, bored piles, etc.),
  - Supply and installation processes for each equipment/unit/instrument/material for the entire Facility,
  - Pre-commissioning tests to be performed and its' start and completion dates
  - Dates of the reports to be delivered to the Employer's Representative,
  - Dates of the training to be performed during the Design-Build period,
  - Date of Completion of Design-Build (Construction) Works excluding the Commissioning period.
- Commissioning period (at least 3 months before the Completion of Design-Build period);
  - Commissioning tests to be performed and its' start and completion dates,
  - Trial operation and performance tests to be performed and its' start and completion dates,
  - Date for receipt of the Commissioning Certificate.
- Operation Service period after the issuance of the Commissioning Certificate (24 months);
  - Commencement date of Operation Service
  - Dates of the reports to be delivered to the Employer's Representative,
  - Dates of the trainings to be performed during the Operation Service period,
  - Joint Inspection Prior to Contract Completion to be performed and its' start and completion dates,
  - Tests prior to Contract Completion to be performed and its' start and completion dates,
  - Date(s) for receipt of the Contract Completion Certificate and Handover (Handback) of the Facility to Employer.