

V – Commissioning and Testing

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COMMISSIONING AND TESTING

5.1. Tests on Completion of Design-Build

(FIDIC Gold Book, Clause 11.1)

The Contractor's quality assurance system shall include procedures for carrying out inspection and testing of the works both on and off site during the design-build phase. The Contractor's project plan shall include a programme for completing such inspections and tests in a coordinated manner and in accordance with the requirements of the Contract.

The Contractor shall provide all labour, plant, materials and services required for testing and inspecting the works.

The Contractor shall submit to the Employer's Representative full details of inspections and tests to be carried out at least 21 days in advance. Attendance at and acceptance of tests and inspections of the works shall not prejudice the right of the Employer's Representative to reject any part of the works if it subsequently fails to comply with the requirements of the Contract.

The Contractor shall keep a record of all tests and inspections, irrespective of whether or not they show compliance with the Contract and shall issue this record to the Employer's Representative on completion of each test and inspection.

When the Works of Design-build of the facility is completed, the Contractor shall carry out the Tests on Completion of Design-build in accordance with the Sub-Clause 11.1 "Testing of the Works" and Sub-Clause 7.4 "Testing" of GCC, after providing the documents in accordance with Sub-Clause 5.5 "As-Built Documents" and Sub-Clause 5.6 "Operation and Maintenance Manuals" of GCC. The Tests on Completion of Design-build shall be carried out in the following sequence:

- Pre-Commissioning Period during the Design-Build phase
 - Off-site Inspection and Testing (Factory Acceptance Tests)
 - On-site Inspection and Testing (Inspection and Functional Tests)
- Commissioning Period at least 3 months before the completion of Design-Build phase
 - Commissioning Tests
 - Trial Operation Period and Performance Tests
- Issuance of Commissioning Certificate

5.1.1. Pre-Commissioning Period

5.1.1.1. Off-site Inspection and Testing (Factory Acceptance Tests)

All major items of facility and equipment (e.g. heat exchangers, filters, boilers, air blowers/fans, pumps, transformers, and generators) shall satisfactorily pass a factory acceptance test (FAT) to design working conditions prior to dispatch. The Contractor shall complete routine and functional works tests to ensure the item is in compliance with the specifications. The Contractor shall give the Employer's Representative the opportunity to attend and witness such tests by giving notice in due time.

No material or item of plant and equipment shall be delivered to site without prior inspection, testing and certification, where applicable, unless written confirmation of the Employer's Representative such inspection, testing and/or certification is not required.

The Contractor's responsibility is to ensure that the works and services performed by itself, and material suppliers are of high quality, properly executed, and in compliance with the requirements of the contract.

The Contractor shall prove that the supplied materials and equipment comply with the specifications, which shall be evidenced by the successful completion of relevant tests and inspections.

The expenses incurred during the supervision of factory inspections and/or factory tests conducted by the Employer's Representative shall be covered by the Contractor.

During any repeated tests (factory tests or site tests) caused by the Contractor's default, the Employer's Representative's supervision costs shall be covered by the Contractor.

If the Employer's Representative deems it necessary and requests specific tests, the costs for these tests shall also be covered by the Contractor.

All materials, equipment, and installations provided under the contract, as well as all related inspection and testing activities, may be subject to independent witnessing and testing by the Employer's Representative during manufacturing, assembly, as deemed necessary.

5.1.1.2. On-Site Inspection and Testing (Inspection and Functional Tests)

The Inspections and Functional Tests shall cover all necessary activities and tests before commissioning period to demonstrate that the works have been designed and built (construction and installation) in accordance with requirements of the contract, to make the facility ready to commissioning period, to operate safely under the control of the operator and the automation control system.

The Inspections and Functional Test Programme shall include a Completion Checklist for Design-build Works detailing each of the activities and tests ("dry" and "cold") required for the successful pre-commissioning of the facility during in any time at the design-build phase. The Inspections and Functional Test results shall be mutually signed by the Contractor, the Employer's Representative and the Employer if necessary manufacturer when each activity is concluded.

Inspections and Functional Tests shall include, but not be limited to:

Test of structures and pipes

- Pipe tests such as pressure, leakage tests of piping, sealing tests, etc.,
- Construction materials testing (refractors, isolation, steel materials, etc.),

Tests of mechanical equipment

- Pressure tests of heat transfer equipment, boilers and furnaces,
- Axial rotation tests, vibration and balance tests of pumps and fans,
- Tests of hydraulic and pneumatic systems and valve movements,

- Tests of conveying systems,
- Testing of instruments and electro-mechanical equipment.

Tests of electrical equipment and automation system

- Electrical continuity and insulation tests,
- Pressure tests of primary circuits,
- Settings of electrical protection devices,
- Static tests on generators and transformers,
- Testing the control system inputs, outputs and closed circuits by sending a signal at the source throughout the entire SCADA & Automation system,
- Examination of interlocks and hard-wired shutdown circuits,
- Grounding tests,
- Testing of fire detection and protection systems,
- Examination of control modes (both automatic and manual) sequencing,
- Testing of CCTV (closed circuit tv) systems.

Inspections and Functional Tests shall cover all necessary pieces of equipment/instruments and automation control systems (including alarm and shutdown systems), after completion of pressure tests and conformity inspection of the structure.

The test documents shall be prepared in accordance with the recommendations of the Contractor or the Employer's Representative and shall include, without limitation, the following:

- For each test, a number (not to be duplicated) shall be assigned in relation to that part of the works for which the test(s) are to be performed,
- the order in which the tests are performed,
- The purpose, type, duration, and input-output parameters of each test, together with the approval criteria for each item of structure and equipment,
- Method statement for each test,
- Test specification parameters,
- Tests shall be carried out by experienced staff who are assigned,
- Each test result shall be recorded and signed in a format approved by the Employer's Representative.
- Health and safety procedures shall be executed during the tests to ensure safety.

All tests shall be executed in a manner that does not cause any hazards or damage to equipment or property.

Upon completion of the tests, the relevant documents shall be completed promptly and signed by the Contractor, the Employer's Representative.

Test Forms shall be issued for each test performed.

Each test document shall be signed by the Employer's Representative after the following conditions have been met:

- Successfully completion of the relevant Inspections and Functional Tests by the Contractor,
- The Contractor has fully complied with the contractual obligations.

Without limitation to the tests indicated in this section, the related tests indicated in the latest version of the regulations and standards and other sections of the contract document shall be executed by the Contractor. If no standard for the relevant equipment/unit/instrument/material is specified, the tests shall be carried out in accordance with the applicable Turkish and/or international standard with the prior approval by the Employer's Representative.

Methodology of Functional Test for Inspection of Materials and Equipment

Not limited to this section, the materials and equipment shall be manufactured and tested in compliance with Employer's Requirements II – Design – Build Requirements Part 2 – Material and Equipment, as well as all other relevant sections.

The Contractor shall provide test samples of the materials/equipment required by the relevant Regulations and Standards to ensure that the quality of the materials/equipment supplied in accordance with the requirements of the Contract is determined. Expenses of preparation and measurement of such materials/equipment samples are covered by the Contractor and submitted to the Employer's Representative. If any materials/equipment sample does not comply with the requirements of the Specification for such materials/equipment, the Employer's Representative may reject all the related materials/equipment.

The Contractor shall regularly calibrate all measuring instruments, and calibration records shall be submitted to the Employer's Representative.

Test methodology specified in the related acceptable regulations shall be used to measure the temperature, residence time of the furnaces, and emissions. If required by the Employer's Representative, Computational Fluid Dynamics (CFD) modelling shall be performed to demonstrate design adequacy. In such cases, the Contractor shall perform the CFD modelling of their furnaces and cover all related costs.

The general required tests are stated but are not limited to the mentioned below. If requested by the Employer's Representative, additional tests according to the relevant Turkish and/or International standards shall be applied for each unit and equipment.

Mechanical Equipment

The tests related to mechanical works shall be performed in accordance with the procedures specified in Section 2.4 Mechanical Works of Employer's Requirements without being limited to the matters specified below.

Pressurized Parts and Equipment

All relevant facility equipment shall be tested in accordance with Turkish and/or International regulations.

Pressure Test

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All products and equipment operating under pressure or vacuum shall be tested on-site, unless otherwise agreed (even if tested at the manufacturer's facilities). This test shall be performed before any internal or external coating/covering processes. Unless otherwise agreed, hydrostatic pressure tests shall be carried out, and all pressure tests shall comply with the relevant regulations specified in the contract document.

Hydrostatic Test

Unless otherwise agreed, water shall be used for this test. The measured test pressures shall comply with the relevant specifications. If any pressure value is not specified, the test pressure shall be 1.5 times the design pressure.

After the completion of the hydrostatic test, drying, cleaning, and preservation procedures shall be applied to prevent damage to the equipment and parts.

Pneumatic Test

The Contractor may propose a pneumatic testing method for equipment and parts unsuitable for hydrostatic testing procedures. In this case, the safety measures, test pressures/durations, and non-destructive testing levels for the relevant equipment and part shall be submitted to the Employer's Representative.

Pneumatic or gas leakage tests shall comply with the conditions specified in the applicable regulations of the relevant structure.

Rotating Equipment

Each item shall be balanced both statically and dynamically. This shall be performed for impellers both before and after the rotor shaft assembly. Components subjected to overspeed tests shall be rechecked for balance.

The Contractor shall determine and submit the dynamic balancing standards to the Employer's Representative.

Overspeed tests for turbine rotors shall be conducted in accordance with IEC 60045.

The vibration characteristics of rotating units shall be measured during the performance test. Measurement locations and applicable standards shall be agreed upon with the Employer's Representative.

Pumps

Unless otherwise agreed by the Employer's Representative, all feedwater pumps, condensate pumps, boiler circulation pumps, and fire water pumps shall be subjected to operational function tests. Operational function tests shall be conducted under closed-valve conditions across the entire operating range of the pump. Graphs showing Flow/Power Consumption, Flow/Pressure, Flow/NPSH, and Flow/Efficiency values for each pump shall be submitted to the Employer's Representative.

Steam Turbine and Generator

The turbine shall be fully assembled at the manufacturer's facility, including control, adjustment, and shut-off valves. It shall be carefully inspected for manufacturing and assembly tolerances, and the necessary measurements shall be conducted. The turbine casings, along with control, adjustment, and shut-off valves, shall be subjected to pressure tests. Functional tests shall also be performed on the safety equipment.

Auxiliary Burner Equipment

The Contractor shall provide the manufacturer's test certificates for burners. The equipment shall be tested on a fully assembled burner test platform and/or on-site to verify its burning

performance. In the scope of this testing, the equipment shall be tested for injection pattern, flame shape, stability, and turndown ratio.

Heat Exchangers

Leakage, power, and strength tests for heat exchangers shall be conducted at the manufacturer's facilities.

Refractory

Strength, thickness, and durability tests for refractory materials shall be conducted at the manufacturer's facilities.

Coating and Insulation Materials

Temperature resistance tests for coating and insulation materials shall be conducted at the manufacturer's facilities.

Forced Draft Fans

Leakage, motor, power, and strength tests for forced draft fans shall be conducted at the manufacturer's facilities.

Waste Heat Boilers

Pressure and leakage tests for waste heat boilers shall be conducted at the manufacturer's facilities.

Condenser

Pressure and leakage tests for the condenser shall be conducted at the manufacturer's facilities.

Air Blowers/Fans

Graphs and characteristic curves showing Flow/Power Consumption, Flow/Pressure, Flow/Efficiency, and Flow/NPSH values for each air fan shall be submitted to the Employer's Representative. Power, motor, pressure, and leakage tests shall be conducted at the manufacturer's facilities.

Units of Emission Control System

Pressure, temperature resistance, and leakage tests for materials used in units of emission control systems shall be conducted at the manufacturer's facilities.

Electrical Equipment

The tests related to electrical works shall be performed in accordance with the procedures specified in section 2.6 Electrical Works of Employer's Requirements without being limited to the matters specified below.

All electrical equipment shall be subject to routine tests specified by the current IEC standards at the manufacturer's facilities, including the applicable items listed below. The manufacturer's test certificates issued by an independent testing authority shall be submitted and/or according to the directive of the Employer's Representative.

IEC 60034: Rotating Electrical Machines

IEC 60076 / IEC 214: Power Transformers

IEC 60044: Instrument Transformers

IEC 60255: Electrical Relays

IEC 60214: Tap Changers

IEC 60271: High-Voltage Switchgear and Controlgear

IEC 60439: Low-Voltage Switchgear and Controlgear Assemblies

IEC 60896: Batteries and Battery Chargers

IEC 60099: Surge Arresters

IEC 60502: Cables

UPS: Uninterruptible Power Supply System

Main Generator of the Hurma WTE Facility

The minimum required tests for the main generator and exciter are as follows:

Generator:

After the installation of the generator, the following tests shall be conducted:

- Three-phase short-circuit characteristic set and current balance check
- Overspeed test
- Efficiency calculation
- Dielectric test
- Open-circuit characteristic test, voltage balance, and phase sequence check
- Measurement of insulation resistance
- Measurement of winding resistance
- Separation of mechanical losses and generator winding losses
- Separation of stray load losses
- Measurement of shaft voltage
- Unbalanced load test for negative phase sequence reactance
- Oscillographs and harmonic analysis of specified voltage waveforms
- Measurement of vibration

Exciter:

- Routine tests on the exciter
- Overspeed test
- High voltage tests
- Winding resistance
- Insulation resistance

- No-load characteristic
- Square-wave voltage test
- Short-circuit characteristic

Electrical, Control, and Supervision Systems of the Buildings

- Inspection records shall demonstrate the proper installation of electrical and fiber optic cables between the main grid connection terminal point and the site.
- Ground resistance measurements shall be conducted at the main grounding connection point of each electrical connection to determine the resistance of each grounding grid installation to the earth. This test shall be performed initially, immediately after the installation of each grounding grid, including its braces, T-connections, and other related components.
- The Contractor shall terminate all fiber strands in the fiber optic cabling and perform end-to-end testing on all strands using a calibrated optical power meter and a calibrated light source. A bidirectional Optical Time Domain Reflectometer (OTDR) test shall also be conducted on all fiber optic strands to ensure the absence of faults. Losses in the cables and connectors shall comply with the limits defined in ISO 11801.
- Low-voltage power cables shall be tested in accordance with local and/or international standards/instructions. Necessary inspections shall be conducted before the phase terminal connections are made.
- All control equipment, including instrumentation, shall be properly installed in accordance with the manufacturer's instructions, wiring diagrams, and overall design specifications.
- All control signal cables shall be tested along their entire length, from the connection terminals of field data devices/sensors to their final destination equipment, such as pressure switches, junction boxes, maneuvering boxes, and control system input terminals.
- Pull-out tests shall be conducted, and test samples shall be appropriately presented for crimped cable terminal connections. Unless otherwise agreed, the number of these tests shall not be less than one per 50 connections for small cable terminations (7/0.67 mm and below).
- Transformer auxiliary power supplies, lighting installations, and small power supply systems shall be tested in accordance with local and/or international standards/instructions. Inspections shall be conducted before the phase terminal connections are made. All necessary closed-circuit checks and functional tests shall be performed.

Control and Monitoring Equipment

The tests related to SCADA and Automation works shall be performed in accordance with the procedures specified in Section 2.6 Electrical Works of Employer's Requirements without being limited to the matters specified below.

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All hardware, software, and control and monitoring equipment shall be tested at the manufacturer's facilities before shipment to the site.

The Contractor shall prepare and submit a detailed document for each proposed test. This document, including the types and classes of all test equipment, shall be submitted. Tests shall demonstrate that the equipment operates smoothly at specified temperature or humidity values.

Construction and Building Works

The tests related to construction works shall be performed in accordance with the procedures specified in section 2.5 Building Works of Employer's Requirements without being limited to the matters specified below.

Infrastructure Works

- Inspection records verifying the formation and construction of suitable roads, spreading areas, and hard-surfaced parking areas.
- Inspection records before piling and/or backfilling to confirm the suitability of the excavated area for the intended hard-surfaced areas.
- Load test records to confirm that finished levels can withstand maximum loads for all hard-surfaced and spreading areas.

Foundations

- Site investigation results for each specific foundation location (where applicable).
- Inspection records verifying the accuracy of the foundation formation.
- Test records to verify the acceptability of the bearing capacity for the foundations.
- Inspection records verifying that foundations are constructed to the required dimensions, at the specified elevations and contains the necessary amount of steel reinforcement.
- Inspection records and dimensional checks verifying the proper placement of cable trenches, ducts, grounding lines, etc.
- Cube test records for concrete strength.
- Records of steel reinforcement assembly.

Building Works

Fire safety inspection certificates and other relevant documents/certificates/permissions shall be provided by the appropriate regulatory authority and/or Department of Fire Brigade. Related documents and certificates should be provided until the issuance of the Commissioning Certificate.

- Application records for earthworks.
- Testing records for steel works.
- Testing of all electrical installations.
- Ensuring all buildings/structures are windproof and waterproof.
- Record related to the successful completion of all building works, including finishing works, building services, and drainage.
- Test certificates that comply with Turkish and/or international standards for all lifting beams and lifting equipment must be provided.

- Testing records for building instalments and drainage systems, including exhaust fans, grounding systems, gas detection, lightning protection, HVAC equipment, and fire and security alarm systems.

5.1.2. Commissioning Period

5.1.2.1. Commissioning Tests

The Commissioning Tests procedure shall be submitted to the Employer's Representative at least 3 months before the time for completion of the design-build. This procedure shall include a detailed test program, including the type of tests.

The Contractor shall complete the entire design-build works at least three months before time for completion of the design-build period. The Contractor shall carry out commissioning period. During the first stage of the Commissioning Period, the Contractor shall carry out the Commissioning Tests.

Commissioning and testing plan shall be prepared. A commissioning checklist shall be prepared to ensure the facility is successfully commissioned. This checklist shall include details for each required activities and tests. The commissioning schedule shall be signed by both the Employer's Representative and the Contractor upon completion of each activity.

The Contractor shall operate and maintain the facility in accordance with the draft operation and maintenance manuals for the commissioning period which is commenced at least three months before the time for completion of whole Design-Build Works. During the Commissioning Period the Employer's Representative shall have the opportunity to witness all operation and maintenance activities, regarding the objectives of which are to optimize the function and operation of the entire facility.

The general requirements applicable to this phase are described below:

- a) The Contractor shall provide a detailed "Commissioning and Testing Programme". The Commissioning and Test Programme shall be submitted to the Employer's Representative for approval at least 21 days before the date shown for the commencement of commissioning period in the Contractor's Work Program. Any changes in the Commissioning and Test Programme shall be submitted to the Employer's Representative for review and approval.
- b) The Contractor shall be obliged to attend all necessary meetings in relation to the performance and/or evaluation of each of the Tests.
- c) All resources required for the tests, including test equipment, tools, materials, consumables, personnel, workers, spare parts, additives and other resources, shall be provided by the Contractor during the Commissioning Period and their expenses shall be covered by the Contractor.
- d) The Contractor shall be responsible for providing all necessary measurement points for operation and testing. The instruments shall have sufficient accuracy. They shall be calibrated by the Contractor before and after each test or test series as required by the Employer's Representative.
- e) The tests shall be carried out according to internationally accepted standards where applicable.

- f) The Contractor shall ensure that its Quality Engineer actively participates in the performance and recording of all Tests and certifies to the Employer's Representative in writing that the Contractor's reports on all Tests are accurate and complete.

The Commissioning Tests shall be carried out in accordance with Clause 11. Testing of the Works of GCC.

Commissioning refers to testing the interfaces between the facility, its systems, and subsystems under site conditions similar to normal operating conditions, ensuring proper performance. Commissioning shall include all other “dry” or “cold” tests required to prepare for the starting of operational period.

Commissioning tests, which shall include the specified operational tests to demonstrate that the Works can be operated safely and as specified, under all available operating conditions and it shall be conducted for each commissioning procedure. These tests shall provide evidence that functional requirements.

Methodology of Test Procedures for Commissioning

The commissioning procedure shall be developed for each system, specifying the critical stages in the commissioning process and the tests and supervision required to demonstrate the successful completion of each stage.

The program of commissioning test of the facility shall include:

- Major inspections or tests,
- Training of the Employer's personnel,
- Requirements for materials/auxiliary services to be provided by the Employer,
- Requirements for labour to be provided by the Employer,
- Requirements for external services to be provided by the Employer to the facility.

A commissioning test program approved by the Employer's Representative shall be prepared, and the Employer's Representative shall be regularly updated on daily on-site activities. Details of the training activities required under the contract shall be provided by the Contractor in compliance with Operation Management Requirements Clause 3.7. Training of Employer's Personnel of Employer's Requirements.

The Contractor shall prepare a procedure for system cleaning, which shall include all piping, filters, valves, vessels, and conveyors. Each procedure for commissioning shall include a series of tests that demonstrate all elements of the process meet all the requirements of the specification. Alternatively, these procedures shall include a series of tests proving compliance with any other data provided by the Contractor. The procedures shall specify the acceptance criteria for each task item.

This commissioning test shall ensure the facility is prepared, operated, and adjusted to achieve the trial operation and required performance guarantees. The Contractor shall provide all labor, materials, consumables, chemicals, instruments, and equipment, including tools necessary to commission the facility. All expenses for tests shall be covered by the Contractor. This shall ensure the successful completion of each test to the satisfaction of the Employer's Representative.

All expenses for test repetitions requested by the Employer's Representative shall be covered by the Contractor.

Test Documents

After the completion of the processes listed below, each commissioning test document shall be signed by the Employer/Employer's Representative:

- The Contractor shall successfully complete the relevant tests,
- The Contractor shall submit the relevant safety inspection report to the Employer's Representative,
- The Contractor shall fully comply with the relevant requirements of the contract.

The test documentation shall be revised to reflect any changes deemed necessary by the Contractor or the Employer's Representative and shall include, but not be limited to, the following:

- Each commissioning test to be conducted, identified individually with a test number, along with the sequence of the tests for the related works,
- The purpose, type, duration of each test, the approval criteria for each facility/equipment item to be tested, and input-output parameters,
- Test specification parameters,
- Method statements for each test,
- The format in which test results and records shall be recorded in the "sign-off" sheets during each inspection,
- Pre-inspection health and safety procedures to confirm the test can be conducted safely,
- On-site communication procedures during the tests.

All tests shall continue to be conducted unless they cause damage to equipment or property or create any hazard. After the completion of the tests, the relevant documents shall be completed and signed promptly by the Contractor, the Employer's Representative and the Employer.

For each commissioning test document, the Contractor must fulfil the requirements of the contract.

Tests for process of the entire Hurma WTE Facility

The commissioning tests shall include, but are not limited to, the following activities and their evidence:

- Startup, shutdown, emergency shutdown, power shutdown, etc., for each line and the entire Hurma WTE Facility units (Sludge Acceptance/Storage Unit, Sludge Pre-drying Unit, Fluidized Bed Incinerator (FBI) Unit with Heat Recovery System, Energy Recovery Unit with Steam Turbine and Flue Gas Emission Control Unit, Ash Collection and Storage Unit, Odour Control Unit)

- Stable operation of the entire Hurma WTE Facility under site conditions and automation control system,
- Stable operation of Pre-drying Unit under site conditions and automation control system,
- Transferring of acceptable purity steam to the turbine,
- Stable operation of steam turbine protection systems,
- Stable operation of the usage/recovery heat system,
- Stable operation of Fluidized Bed Incinerator (FBI) Unit with Heat Recovery System under site conditions and automation control system,
- Stable operation of the Energy Recovery Unit with Steam Turbine under site conditions and automation control system,
- Stable operation of the Flue Gas Emission Control Unit under site conditions and automation control system,
- Calibration of continuous emission monitoring equipment and verification of compliance with regulations.
- Stable operation of turbine on load rejection, bypass and islanding modes,
- Stable operation of transferring line(s) of the natural gas/sludge feeding,
- Stable operation of all auxiliary equipment and systems (e.g. calibration, loading, functionality of weighbridge, transferring line, silos of sludge acceptance unit, pre-dryer unit, auxiliary burner, access air supply systems, ash collecting systems),
- Stable operation of all Emergency Response Systems.

5.1.2.2. Trial Operation Period and Performance Tests

5.1.2.2.1. Trial Operation

Once the pre-commissioning and commissioning tests have been completed to the satisfaction of the Employer's Representative and all certificates related to these tests have been handed over to the Employer's Representative, the Trial Operation with the minimum 3 months duration shall be carried out according to the start-up programme.

During this period the Employer's Representative shall have the opportunity to witness all operation and maintenance activities, the objectives of which are to optimize the function and operation of the entire facility.

Before starting the trial operation, the Contractor shall, at his own cost, ensure that all tanks are filled with consumables to start-up the process.

The facility shall be operated under automatic and manual control as described in the operation manuals with directions of the Employer's Representative to prove the functionality and reliability of the control systems.

The Contractor shall run the facility and monitor the performance during the trial operation under the supervision of the Employer's Representative.

The Contractor shall prepare a written procedure and method statement(s) for the execution and sequencing of the tests, along with a test program. These shall be submitted to the Employer's Representative.

The Trial Operation period and performance tests shall not commence until the following conditions are met:

- The Contractor shall submit draft Operation and Maintenance Manuals to the Employer's Representative, where applicable,
- The Contractor shall submit draft As-built drawings to the Employer's Representative,
- The Contractor shall complete the related trainings for Employer personnel,
- The Contractor shall submit a copy of the updated health and safety plan for the trial operation period including performance tests to the Employer's Representative,
- Draft Test Documentation shall be submitted related to the parts to be tested.

Methodology of Test Procedures during the Trial Operation Period

The trial operation period shall be executed during the commissioning period and is designed to demonstrate that the facility meets the acceptable levels of the contract requirements as a prerequisite for the commissioning certificate. During the trial operation tests, the following shall be provided:

- The Contractor should carry out the trial operation of the facility within the conditions of the performance guarantees (input/output KPIs) specified in Annex 2 of Employer's Requirements and Schedule of Performance Guarantees part of Section IV – Bidding Forms of Bidding Documents.
- Continuous operation of the facility within the limits specified in the burning and feeding diagrams.
- The Employer's operating staff are sufficiently trained and capable of safely and efficiently operating the facility.
- The facility can meet performance guarantees during operation without causing excessive corrosion or wear to any components/units.

A detailed program and procedures for the trial operation period shall be included in the commissioning and testing plan.

The Contractor shall be responsible for conducting the trial operation tests and shall utilize the personnel of the Employer and the Employer's Representative to ensure continuous supervision during the tests.

During the trial operation tests, the facility shall be operated under full automatic control and in accordance with the instructions in the operation and maintenance manuals, using the personnel specified in the Contractor's Proposal.

Trial Operation Period includes:

- Demonstration Trials

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- Continuous Full-Load Trial Operation
- Mechanical Inspection

Demonstration Trials

The demonstration trials shall confirm that each part of the facility (or all groups functioning as a system) can operate safely and continuously at full load in compliance with the contract. This requires the facility to function correctly under the control of the control system during cold and hot startups, normal and emergency shutdowns, and with varying setpoints and fuel mixtures. Additionally, the facility shall be stopped, restarted in island mode, and reconnected to the main grid.

During the 3-month Trial Operation, within two separate uninterrupted periods of 6 weeks each:

- A maximum of two shutdowns/interruptions that disrupt electricity generation or sludge feed for less than 4 hours shall be permitted, and
- A maximum of two shutdowns that disrupt electricity generation or sludge feed for more than 4 hours but not exceeding 24 hours shall be permitted.

The timing of each shutdown shall include the period from the suspension of sludge input or production loss until operations resume. Maintenance may be carried out during these shutdown periods, except for repairs to the facility or equipment item causing the shutdown. In such cases, the test shall resume after the shutdown, including the time elapsed before the shutdown.

If the following faults occur during the demonstration trials, the monitoring program shall restart entirely, excluding any time accounted for:

- Any fault causing interruptions to electricity generation or sludge supply for more than 4 hours, or
- Any fault causing interruptions to electricity generation or sludge supply for more than 24 hours, or
- More than three interruptions caused by the same fault, or
- Any emission violation or any condition specified by regulatory authorities.

Continuous Full-Load Trial Operation

The facility must operate continuously for a minimum of 720 hours under nominal full-load conditions in automatic control without significant failures. If a significant failure occurs, the monitoring program shall restart.

Failures are considered significant in the following cases:

- A fault causing interruptions to fuel supply or electricity generation for more than 6 hours, or
- More than two interruptions caused by the same fault, or
- A total interruption duration exceeding 24 hours within the 720-hour period, or
- Violation of any emission value or any condition set by regulatory authorities.

During the trial operation period of the facility, the required permit and licence applications to be made according to the Ministry of Environment, Urbanisation and Climate Change Regulation on Waste Incineration and tests shall be completed. During this period, the tests and inspections specified in the document and required by the regulation must be carried out simultaneously by the Contractor and their costs must be covered. No additional payment shall be made by the Employer for this.

5.1.2.2.2. Performance Tests

The Contractor shall give Notice to the Employer's Representative not less than 21 days prior to the date after which the Contractor shall be ready to carry out each of the Performance Guarantee Tests for Tests on Completion of Design-Build. The Performance Tests shall be carried out within 14 days three times after this date, on such day or days as the Employer's Representative. These tests should consist of Performance Tests to demonstrate compliance with the performance guarantees detailed in Annex 2 of the Employer's Requirements and Schedule of Performance Guarantees indicated in Section IV – Bidding Forms of Bidding Documents.

When the Contractor is ready to carry out the Performance Tests during the trial operation period provided that conducting the Continuous Full-Load Trial Operation, the Contractor shall give notice with a test programme and method to the Employer's Representative not less than 21 days before. Performance tests shall be conducted in accordance with detailed test procedures approved by the Employer's Representative.

The test documentation shall include, but not be limited to:

- Each test, identified with an individual number corresponding to the part of the work being tested,
- The sequence in which the tests shall be conducted,
- Method statements for each test,
- The type, purpose, and duration of each test, along with the input-output parameters and acceptance criteria for each facility and equipment item to be tested,
- Test specification parameters,
- Health and safety procedures to confirm the safe execution of the tests,
- The format for recording and signing off test results and records during each inspection,
- A list of personnel assigned by the Employer's Representative and the Contractor to conduct and supervise the tests, with Employer personnel assigned for each test to be notified in writing to the Contractor,
- On-site communication procedures during the tests.

Performance tests shall be conducted three times during the trial operation. The duration of each performance test shall be two weeks, with a total testing duration of six weeks. The results of the performance tests shall be determined according to the average results of these three tests. During the two weeks test period, test procedures shall be carried out continuously for 8 hours each day.

If a major failure occurs during the test, the test program shall restart entirely, without considering any elapsed time.

Performance tests shall be conducted under stable operating conditions of the facility. The Contractor shall not replace or adjust any essential components of the facility for the performance tests without written permission from the Employer.

Before each performance test, a minimum of 6-8 hours shall be allocated to ensure stability, and the test durations shall be sufficient. At least 24 hours shall be allowed for the facility to stabilize.

During the performance tests, a maximum of two shutdowns affecting electricity generation or sludge supply for up to 4 hours, and a maximum of two shutdowns lasting between 4 and 24 hours, shall be permitted. Each shutdown period shall include the time from the suspension of sludge input or electricity generation to the restart of operations. During these shutdowns, maintenance can also be performed alongside the repair of the relevant component causing the shutdown. In such cases, the test shall restart after the shutdown, considering the time elapsed before the shutdown.

During the performance tests, the quantity of inlet sludge shall be measured daily by the Contractor using the weighing systems located inside the silos/bunkers and/or the flowmeters and flow measuring devices installed on the sludge conveying lines.

All test equipment and expert personnel shall be provided by the Contractor. Additional sampling points shall be designated by the Contractor, and the Employer shall ensure the provision of sufficient inlet sludge to conduct the tests.

In order to determine the sludge characterisation on a daily basis and twice a day, sludge samples shall be taken from the sludge received from the districts, Lara WWTP, and Hurma WWTP. These samples shall be homogenously mixed and accumulated throughout each performance test period (14 days). The homogenised composite sample shall be sent by the Contractor to an accredited laboratory for determination of calorific value, proximate and ultimate analyses, and dry solids content. The Contractor shall be responsible for the planning and costs of the accredited laboratory analyses required to ensure the timely execution of the performance tests.

The Contractor shall also carry out daily on-site measurements of parameters such as moisture content and other sludge properties that shall be analysed within the laboratory of Hurma WTE Facility.

Performance tests shall be evaluated based on data obtained from accredited laboratories, daily measurements at the Laboratory Unit of the Hurma WTE Facility, and online measurement results. During online measurements, calibrated instruments installed under the Contract shall be used.

The Contractor shall provide descriptive data for the instruments to be used during performance tests, ensuring compliance with relevant standards. All instruments used shall be calibrated for accuracy before each test and, if applicable, upon reasonable request by the Employer's Representative.

In order to be considered successful, all test values shall be within the agreed tolerance range indicated in Annex 2 of Employer's Requirements and Schedule of Performance Guarantees part of Section IV – Bidding Forms of Bidding Documents.

All instruments used for online measurement of performance tests shall have valid calibration certificates issued by an independent authority. The calibration of test instruments shall be checked before and after the performance test to validate increasing and decreasing reading values.

The measurement methods shall comply with minimum acceptable standards as per VDI/VDE (e.g., VDI/VDE 3511 - Temperature Measurement standard). The accuracy limits of instruments used for analog readings shall be specified in the performance test report. For automatically recorded results, repeatability of test equipment shall be verified when necessary.

Pressure measurements shall be conducted using suitable equipment for differential pressure, such as transducers or manometers.

Temperature measurement results shall be recorded using thermocouples with automatic data recording.

Volumetric flow measurements shall be conducted using special volumetric meters.

Flow measurements shall use orifices and nozzles compliant with EN ISO 5167-1, where capacity permits. If the standard's limits are exceeded, the Contractor shall determine a suitable alternative.

Dust flow measurements shall comply with VDI 2066.

International standards approved by the Employer's Representative shall be applied for testing of boiler efficiency and process performance via appropriate heat and mass balance.

The electricity meters meeting the standards set in IEC 953-2 shall be used for electricity production and consumption testing. The electricity production and consumption test shall be conducted under stable conditions at the load defined in the guarantee for a minimum of 8 hours. The average production/consumption during this 8-hour period shall be recorded. Electricity production shall also be measured at least once during the 8-hour test using the methods specified in IEC 953-2.

The steam turbine generator and the steam circuit shall be measured in accordance with IEC 953-2. Using the obtained data, the overall performance measurement of the facility shall be completed. If a separate measurement process is required, both general and turbine measurement processes shall be conducted.

To determine electricity consumption, directly measurement via electricity meters will be applied. The measured total electricity consumption shall be corrected by considering consumption that is not related to the normal operation of the Contractor's supply scope under guaranteed inlet sludge conditions by the Employer. This correction shall comply with the calculations indicated in Section 4 - Performance Requirements – Clause 4.1.2. Thermodynamic Calculation Method for Fluidized Bed Incinerator of Employer's Requirements.

Stack emissions measurements shall be conducted by independent testing organizations approved by the Employer's Representative.

Total organic carbon and biodegradable matter in ash shall be tested using appropriate standards.

Natural gas consumption values will be measured via flowmeters. The variables, parameters and content of the natural gas shall be measured by an accredited organization. If no accredited

organization is available, a testing method compliant with Turkish and/or International standards, as agreed upon by the Employer, the Employer's Representative and the Contractor, shall be determined. The Contractor shall cover all testing costs and required instruments and equipment.

The average quantities of consumables defined in Annex 2 – Input and output parameters of Employer's Requirements shall be determined as a result of at least continuously for 8 hours each day during the two weeks test period.

Natural gas consumption shall also be calculated using the thermodynamic calculation method indicated in Section 4 - Performance Requirements – Clause 4.1.2. Thermodynamic Calculation Method for Fluidized Bed Incinerator of Employer's Requirements.

Based on the results obtained from the accredited laboratory and the daily on-site measurements, online measured consumables against to determined sludge characterisation and sludge quantity shall be compared with the performance guarantees values stated in the Annex 2 of the Employer's Requirements and Schedule of Performance Guarantees part of Section IV – Bidding Forms of Bidding Documents to verify consumption levels and Inputs and Outputs.

The performance tests shall include the evaluation of input parameters such as electricity consumption, natural gas consumption, and consumables consumption, and achievement of required output indicators in accordance with the guaranteed Inputs and Outputs stated in Annex 2 of the Employer's Requirements and Schedule of Performance Guarantees part of Section IV – Bidding Forms of Bidding Documents.

Although the performance tests include the evaluation of input parameters such as electricity consumption, natural gas consumption, and consumables consumption, if the guaranteed consumption values are met but the required output indicators are not achieved, the performance tests shall be deemed as Failure to Pass Tests on Completion of Design-Build.

If it is determined during the performance test that any consumption/guaranteed value has not been achieved, the Contractor shall have the right to make the necessary adjustments, and the tests shall be repeated under the same terms and conditions indicated in the Employer's Requirements according to Sub-clause 11.3 and 11.4 of GCC. The test results will be evaluated as a failure after the application of correction methods according to the conditions of Section 4 - Performance Requirements – Clause 4.1.2. Thermodynamic Calculation Method for Fluidized Bed Incinerator of Employer's Requirements.

The Contractor shall carry out the necessary corrective actions and notify the Employer's Representative when the facility is ready for retesting. Performance tests shall be repeated within 7 days after the Employer's Representative confirms the test can be repeated.

All expenses incurred by the Employer's Representative for participation in these repeated tests shall be borne by the Contractor.

If there is a significant delay in starting the tests, the Employer's Representative may arrange for an independent and suitable organization to conduct the performance tests at the Contractor's expense.

The Contractor has satisfactorily completed the necessary tests, to demonstrate compliance with the Employer's Requirements and performance guarantees, he shall submit a Performance Test

Report to the Employer's Representative summarizing the test results. This report shall be accompanied by:

- A statement from the Contractor that, in his opinion, the works have passed the tests on completion; and
- An application for a Commissioning Certificate.

The Performance Test Report and all related documentation shall be signed by the Employer, Employer's Representative and Contractor.

The Contractor shall be responsible for collecting and compiling all data related to Tests on Completion of Design-Build, documentation of tests performed at the manufacturer's facilities, documentation of commissioning on Site, and results.

After the trial operation period and performance tests, the facility shall be shut down for a mechanical inspection. During this inspection, if evidence of significant damage, contamination, clogging in conveyors or Stack, damage to refractory linings, corrosion or wear, deformation of equipment, or any significant leakage or lumping is identified, the Contractor shall take corrective action and address the defect with a test program approved by the Employer's Representative.

5.1.3. Issuance of the Commissioning Certificate

(FIDIC Gold Book, sub-clause 11.7)

After the completion of all such obligations for Design-Build phase in accordance with the Contract, the Employer's Representative shall issue the Commissioning Certificate to the Contractor within 28 days after the application by the Contractor in line with Sub-clause 11.7 of the GCC.

The Commissioning Certificate shall not be signed and issued to the Contractor until the following conditions are met:

- The Contractor shall submit the final version As-built drawings to the Employer's Representative (sub-clause 5.5 of GCC),
- The Contractor shall submit the final version of the Operation and Maintenance Manuals for Design-Build Period to the Employer's Representative (sub-clause 5.6 of GCC),
- Final Test Documentation and Commissioning Test Book shall be submitted in relevant sections of the Operation and Maintenance Manuals.
- The Contractor shall submit records and training materials of the completed training for Employer personnel,
- The Contractor has successfully completed all tests and trial operation,
- Completion of mechanical inspection, if any remediation actions after the trial operation period and performance tests.
- Acceptance of Trial Operation Procedures according to Ministry of Environment, Urbanization and Climate Change for the Regulation on Waste Incineration

- Department of Fire Brigade approval has been obtained,

Completion of all related permission procedures shall be taken according to Turkish legislation (e.g. permission from the Ministry of Environment, Urbanization and Climate Change for the Regulation on Waste Incineration, and if required, other relevant regulations and permission from the Fire Brigade Department for Regulation on Fire protection and emergency response and other permissions from the relevant authorities).

The Contractor shall prepare and ensure the submission of all documents for the commissioning tests as a “Commissioning Test Book” to the Employer’s Representative as part of the Final Operation and Maintenance Manual. The Commissioning and Test Book shall contain information about all kinds of operational disruptions affecting the facility during each of the tests. Such disruptions shall include unexpected events, unusual temperatures, unusual or excessive emissions, abnormal measurements, equipment/ancillary parts defaults, any change of installed values, etc. The Contractor shall submit a summary of the Commissioning and Test Book at the meetings to be held in relation to each of the Tests. The Commissioning and Test Book shall be kept in the facility and updated by the Contractor.

The result of the commissioning tests shall be the part of the operation and maintenance manuals and shall be submitted to the Employer’s Representative upon successful completion of the tests. Commissioning test records shall guide during the operation service period if required re-startup term after repair or renewal.

Satisfactory completion of Design-build Works and Tests on Completion of Design-build shall be confirmed by the Employer’s Representative by issuing Commissioning Certificate (in accordance with Sub-Clause 9.12 “Completion of Design-Build” and Sub-Clause 11.7 “Commissioning Certificate” of GCC). The issuance of the Commissioning Certificate shall be considered as the Commencement of Operation Service.

5.2. Tests Prior to Contract Completion

(FIDIC Gold Book, sub-clause 11.9)

5.2.1. Operation Duration Tests

Compliance with the availability guarantee shall be demonstrated through the availability test. The duration of the availability test shall be **4000**. During this one-year period, the Hurma WTE Facility shall be available for operation not less than **8000 hours**. 4000 hours uninterrupted + 4000 hours uninterrupted operation duration shall be reached on the scope of the necessary records. The result of this test shall be used in the evaluation of the downtime parameter within the output indicators defined in Annex 2 of Employer’s Requirements.

The Contractor and the Employer’s Representative shall hold regular meetings to reach a mutual agreement on any mandatory shutdowns, reductions in process efficiency or electricity generation, as well as any necessary adjustments regarding records and their results.

During the operation duration tests period, the Hurma WTE Facility shall be operated with a sufficient number of personnel, under full automatic control, and in accordance with the instructions outlined in the operation and maintenance manuals.

Operation Duration Calculation

Operation duration shall be calculated using the following formula:

Operation duration = 8,760 – A – B – C hours

Where:

- A = Duration of scheduled shutdowns (time covered between termination of sludge feeding to the restart of operation).
- B = Malfunction duration for periods of facility operates below full capacity caused by the Contractor. (e.g., 1 hour × 2/3 capacity = 1/3 hour of failure time).
- C = Total duration of unscheduled or accidental shutdowns caused by reasons under the Contractor's responsibility (time covered between termination of sludge feeding to the restart of operation)

The failure reports shall include the list of defects that occurred during the operation duration period. These reports shall be prepared by the Employer's Representative. The failure report shall clearly state the characteristics of the defect, the result of the operational duration loss, and the necessary measures.

The Contractor shall review the report and determine the necessary measures to be taken during the operation duration period.

The reports shall be reviewed and evaluated in regular meetings attended by the Employer, the Employer's Representative, and the Contractor for quality control and shall revise mutually agreed actual records of the facility's operation duration.

Scheduled maintenance shutdowns during the operation duration period shall not be shorter than the duration specified in the values of performance guarantees. If the planned shutdown is extended due to reasons of the Employer/Employer's Representative, the operation duration period shall be extended accordingly. However, if the shutdown is extended due to maintenance or repair works and such work cannot be completed in a shorter period, any extension shall not be applied.

Because of the planned and/or unforeseen shutdown conditions, within the 4000 hours of operation period maximum of five short shutdowns that have a maximum of 24 hours shall be accepted.

If this requirement is not met, the test shall be extended for an additional **4,000 hours** following the first planned maintenance shutdown. During the operation duration test, the facility shall achieve two **4,000-hours** periods. During the extended operation duration period, the performance damages will be applied. Besides, any additional 4,000 hours period will be executed within the two years Operation Service Period. If the additional 4,000 hours period exceeds the two years operation service period, the procedures of Sub-clause 10.7(b).(ii) Failure to Reach Production Outputs of GCC will be applied.

During the operation duration period, all units of the facility shall be examined for potential issues related to wear, abrasion, corrosion, and condensation.

5.2.2. Joint Inspection Prior to Contract Completion

(FIDIC Gold Book, sub-clause 11.8)

Not less than six months before the expiry date of the Operation Service Period, the Employer, the Employer's Representative and the Contractor shall jointly inspect the Works.

The facility shall be shut down for inspection. Any significant or unusual damage shall be covered under the Contractor's liability. Additionally, maintenance of the entire facility shall be executed. The wear and corrosion conditions of key facility components (e.g., fuel-carrying pipes, flue ducts, channels, boiler, and superheater tubes) shall be inspected and compared with the guaranteed service life. If the thickness loss is greater than the value of wear or corrosion rates indicated in the related technical specification, the Contractor shall replace the defective component.

Within 28 days following the completion of this joint inspection, the Contractor shall submit a report detailing the condition of the Works. This report shall identify any maintenance works (excluding routine maintenance and defect correction), replacements, or other required works necessary to meet the requirements of the Operation and Maintenance Plan beyond the Contract Completion Date.

The Contractor shall be responsible for performing any remediation works, repairing and making good any damage or defect occurring during the Operation Service Period, whether such defect or damage is notified by the Employer or the Employer's Representative, or observed by the Contractor himself. All costs associated with remediation works, repairing and making good any damage or defect occurring during the Operation Service Period shall be covered by the Contractor.

5.2.3. Completion of Operation Service and Performance Tests

(FIDIC Gold Book, sub-clause 10.8)

Before the Contract Completion, the same procedures described in Performance Tests for Commissioning Certificate under item 5.1.2.2.2. Performance Tests of Commissioning and Testing of Employer's Requirements shall be applied for the Tests prior to Contract Completion.

In case of Retesting of Performance Tests for Contract Completion, procedures will be applied in accordance with the item 5.1.2.2.2. Performance Tests of Commissioning and Testing of Employer's Requirements and Subclause 11.12 of GCC.

If the Contractor fails to pass the Tests Prior to Contract Completion, the procedure will be applied in accordance with Sub-Clause 11.11 of GCC.

5.2.4. Issuance of Contract Completion Certificate

(FIDIC Gold Book, sub-clause 8.6)

Satisfactorily execution of the Operation Service, Procedures regarding to the Tests prior to Contract Completion, Updating of the Operation and Maintenance Manuals and Remedying defects of the entire Hurma WTE Facility shall be a prerequisite for Contract Completion Certificate.

The Contract Completion Certificate shall not be signed and issued to the Contractor until the following conditions are met:

- Inspection in accordance with Sub-Clause 11.8 [Joint Inspection Prior to Contract Completion];
- Testing in accordance with Sub-Clause 11.9 [Procedure for Tests Prior to Contract Completion];

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- Updating Operation and Maintenance manuals providing performance records and data in accordance with Sub-Clause 5.6 [Operation and Maintenance Manuals]; and
- Remedying defects found during inspection in accordance with Sub-Clause 11.8 [Joint Inspection Prior to Contract Completion]

The Contractor shall ensure that all storage containers/silos for consumables and additives are fully stocked and shall demonstrate that the Facility operates under steady-state conditions before the issuance of the Contract Completion Certificate and hand-over (handback) progress of the Facility.

The Contract Completion of the facility shall be carried out with the approval of the Employer's Representative after the completion of Tests Prior to Contract Completion, the remediation of all identified deficiencies and defects, and the fulfillment of all Contract Requirements and Handback Requirements. Handback Requirements are as follows:

- The Facility shall be operated under steady-state conditions,
- All storage containers/silos for consumables and additives shall be fully stocked by the Contractor for the uninterrupted and continuously operation of the Facility,
- The obligations of Contractor Completion Certificate shall be completed,
- Updated Operation and Maintenance Manuals providing performance records and data shall be submitted,
- Updated Records and Materials of the completed training for Employer personnel shall be submitted,
- Updated Emergency Response Plan (including firefighting methodology, hazardous gas detection and control) shall be submitted,
- Revised Permission Procedure Documents regarding to local legislations for operational requirements shall be submitted (if required by the Employer).

Upon the successful execution and fulfillment of all relevant requirements carried out by the Contractor, the Employer/Employer's Representative shall issue the Contract Completion Certificate. Subject to issuing the Contract Completion Certificate, the Contractor shall handover (handback) the Hurma WTE Facility to the Employer.