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Hydrogen Demo Valley Pre-Feasibility Study

Duty Specification for Industrial Boiler Package

50-PK-07



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1. INTRODUCTION

ENEA, the Italian National Agency for New Technologies, Energy and Sustainable Economic Development, has planned the realization of a Hydrogen Demo Valley (HdV) inside the research facility located at “La Casaccia”, in the municipality of Rome (Italy). Such infrastructure will act as an incubator of technologies and services related to the entire hydrogen value chain, and is expected to be completed in May 2024.

T.EN Italy Solutions SpA has been awarded the preparation of a pre-feasibility study aimed at defining the scope and the execution model for the subsequent design phase and construction activity.

2. PROCESS DESCRIPTION



Inside the main context illustrated in the previous paragraph, ENEA is interested in testing the NG-H2 blend in an existing heating system of great potential (multi-MW), such as the district heating plant present in La Casaccia Research Center.

This duty specification concerns the installation of a new industrial boiler package, to be installed in parallel to the existing ones.

3. PACKAGE SPECIFICATIONS

Main process data:

a) Nominal heat output:	2000 kW
b) Combustion efficiency (ref. LHV)	> 90%
c) Service Factor	< 1000 h/y (expected 480 h/y)
d) Fuel type – gas	NG-H2
e) Hydrogen concentration	5 ÷ 20% mol.
f) Fluid type:	hot Oil
g) Fluid flow:	350 m3/h
h) Outlet temperature:	170 ÷ 225 °C
i) Inlet temperature:	158 ÷ 215 °C
j) Design pressure	4 barg (shall be the same as existing boilers, to be confirmed by ENEA)

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- k) Natural gas composition (see table below). Natural gas composition is compliant with Italian decree of May 18 2018 and subsequent amendments and additions.

Component	Average (mol. %)
CH ₄ – Methane	90.224
C ₂ H ₆ – Ethane	6.065
C ₃ H ₈ – Propane	1.050
C ₄ H ₁₀ – i-Butane	0.111
C ₄ H ₁₀ – n-Butane	0.154
C ₅ H ₁₂ – i-Pentane	0.035
C ₅ H ₁₂ – n-Pentane	0.027
Hexane +	0.018
CO ₂ – Carbon Dioxide	1,021
N ₂ – Nitrogen	1.263
He – Helium	0.034
H ₂ – Hydrogen	0.000
O ₂ – Oxygen	0.000
Co – Carbon Monoxide	0.000
H ₂ S - Hydrogen Sulfide	≤ 5 mg/Sm3
S as Mercaptans (*)	≤ 5 mg/Sm3
Total Sulfur (*)	≤ 20 mg/Sm3

4. UTILITIES SPECIFICATION

Electric power

- a) Medium voltage 8,4 kV

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- b) Low voltage 400 V, 50 Hz, 3 Ph
 230 V, 50 Hz, 1 Ph
- c) UPS will follow

Potable Water

- a) Source Tap water
- b) Pressure 2,5 barg (TBC)
- c) Quality see table below

pH	—	6,80
Conductivity a 20°C	μS/cm2	262
Kubel oxidation number (as O ₂)	mg/l	<1,0
Arsenic - As	μg/l	6,4
Disinfectant (residue)	mg/l	0,08
Iron – Fe	μg/l	21,2
Nitrites (as NO ₂)	mg/l	< 0,1
Sulfates	mg/l	24,7
Ammonium (as NH ₄ ⁺)	mg/l	< 0,1
Total hardness	F°	9,2
Dry residue at 180°C	mg/l	292,6



Nitrogen

will be supplied by ENEA.

Instrument air

will be supplied by ENEA.

5. SITE AND CLIMATIC DATA (MONTHLY AVERAGE)

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- Ambient temperature (min/max) 4°C / 29°C
- Max humidity (at min/max temp.) 77% / 65%
- Wind speed (max) 16 km/h
- Rain (max) 132 mm
- Altitude above sea level 150 m

6. APPLICABLE CODES AND STANDARD

Supplier shall design and fabricate the heater in accordance with the following documents:

- National State and Local Laws and Codes
- EN 12828 Heating Systems in Buildings - Design of water based heating systems
- EN 13384/1 Chimneys – Thermal and fluid dynamic calculation methods Part 1:

Chimneys serving one appliance



- EN 1443 Chimneys – General Requirements
- EN 1859 Chimneys – Metal Chimneys- Test methods
- EN 676 Automatic forced draught burners for gaseous fuels
- EN 1886 Ventilation for buildings - Air handling units - Mechanical performance
- EN 12391 Chimneys - Execution standard for metal chimneys - Part 1:

Chimneys for non-room sealed heating appliances

- EN 12831 Heating systems in buildings - Method for calculation of the design heat load
- ISO 1016 DIN IEC 64/1016/CD, Electrical installations of buildings – Part 4:

Protection for safety chapter 41: Protection against electric shock

- EN 12593 Shell Boilers
- EN 13480-1/2/3/4/5 Industrial Piping
- ASME B31.1 Power Piping
- ASME B1.1 Unified Inch Screw Threads
- ASME B16.5 Steel Pipe Flanges and Flanged Fittings
- ASME B16.11 Forged Steel Fittings, Socket Welding and Threaded
- ASME B16.21 Non-metallic Gaskets for Pipe Flanges

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- ASME B16.25 Butt Welding Ends
- ASME B46.1 Surface Texture
- ABMA American Boiler Manufacturers Association
- AISC Specification for Design, Fabrication and Erection of Structural Steel Buildings

- ANSI/AWS D1.1 Structural Welding Code
- ASTM American Society for Testing and Materials
- NFPA 85 Boiler and Combustion System Hazard Code
- European Norm EN 746-2
- European directive ATEX 94/9 EC
- IEC Standards
- European Machinery Directive 89/392 EEC, 91/44/EEC and further amendments
- API, ANSI, DIN, ISO, BS and other international codes for machinery design, fabrication and testing.
- ATEX and PED Directives.

7. SCOPE OF SUPPLY



The boiler will be firetube type with multiple passes, forced circulation type, flue gas condensing type, and will be provided with a forced draught burner and associated fan.

Supply shall be integrated with all those elements that are necessary for the operability and safety of the boiler package even if these are not expressly mentioned in the specification.

The supply of the boiler package shall include, but not limited to, the following:

Gas Fired boiler, fully skid mounted including:

- A cylindrical shell
- Two tube sheets on both ends, attached to the shell by welding
- A Fire tube
- Return flue gas tubes
- Economizer

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- Self-supported stack located on top of boiler module or at grade level. If stack is not internally lined, but external insulated, casing material will be selected considering the maximum flue gas temperature at any operating/emergency conditions

Burner section, including:



- Forced Draft Burner, Low NOx type, with removable burner guns.
- Burner pilot with ignition system (local box with ignition transformer, interconnecting cable, etc.). Pilot will be provided with its own ionization rod for flame verification.
- UV flame scanner completed with amplifier and interconnecting cables. Scanner amplifiers will be mounted on a common rack with shelter.
- Fuel Gas skid with all instrumentation for firing control and safety according to local norms and international EN norms.
- Electrical/Instrument Junction Boxes and cable glands (metallic type) at skid edge
- Grounding system inside skids, up to the common grounding lugs at skid battery limit
- All interconnecting piping (so called off-skid piping) between each fuel gas skid and boiler module skid

Forced Draft Fan system including:

- Air filter, silencer, flow measurement device, rain hood at inlet
- Inlet guide vane with pneumatic actuator and positioner
- All ducting in flanged sections with relevant accessories (supports, expansion joints, guillotine and any required devices, if foreseen for boiler design).
- Electric motor and direct flexible coupling

Burner Management System (BMS PLC)

- The boiler shall be provided with its specific BMS.
- BMS and other ESD functions will be performed by the PLC supplied by Boiler vendor. Vendor is requested to provide all complete (basic and detailed) PLC engineering, at least the minimum.
 - BMS narrative description
 - BMS basic logic diagrams (I/O diagrams)
 - BMS detailed logic diagram (ladder diagrams)

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- I/O List of signals from BMS to Plant ESD and vice versa
- I/O List of signals from BMS to DCS and vice versa.

- Vendor shall be completely responsible for the good operation of the ESD and BMS interlock system. Vendor will attend to the Factory Acceptance Test.

- Burning Management System shall perform the following basic operations:

- Automatic start-up
- Main fuel trip
- Boiler shutdown
- Burning Management System signals will be duplicated to the local panel

- The Boiler Equipment Package shall be provided by with a dedicated Emergency Stop Push button.

Control System

- The Boiler package will be provided by Supplier with a dedicated PLC based stand-alone control panel to be installed in a safe area, and independent from the plant ESD.

- The Equipment Packages shall be provided with their own Human Machine Interface (HMI) inside cabinet, to ensure a safe operation in case of failure of the communication with PLANT ESD and DCS.

- All the instruments necessary for a good operation and safety of the Equipment Package are part of Supplier's scope of design and supply.
Supplier shall provide its shutdown logic documents following the same principles as those specified for the PLANT main shutdown logic.
The Safety Integrity Level for these systems shall be (HOLD).



- As a minimum, the following signals shall be connected from the Boiler Equipment Package to the PLANT DCS, either through a hardwired link for shut-down purpose:

- Boiler unit summarized malfunction alarm;
- Boiler unit summarized shut down alarm;
- Boiler unit running status.

In addition, a Shut-Down signal from the PLANT ESD shall be connected to the Boiler Equipment Package.



The Equipment Package Supplier design shall ensure that sufficient space and access for inspection, cleaning, removal and maintenance of such parts as headers, retractable burner parts, valves, pumps, fans, and electric motor is provided. The shell boiler shall mandatory be cylindrically shaped and shall have all the openings necessary for inspection purposes and for easy access to all parts and internal portions.

- Common inclusions:

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- Reinforcing plates, where necessary.
- Bolts, nuts and gaskets.
- All steel structures including (but not limited) the support steelwork frame, supports, platforms, landings, stairs, ladders, cages, handrails, grating, safety bars, bolting, etc.
- Any additional structural steel required for bracing of modules, ducting & stacks during transport, shipping and erection.
- All ducting within the battery limits.
- Expansion joints.
- Access openings and Observation openings.
- All internal insulation and relevant anchoring system.
- External insulation for stacks and ducts if not internally lined.
- Protective SS metallic liner in case ceramic fibre lining is installed
- Anti-acid coating on casing behind the ceramic fibers.
- Process and utility interconnecting piping up to the supply battery limits, complete with valves, fittings, flanges, bolting, supports.
- All piping, including the instrument air, within the battery limits.
- Safety valves
- Drains, as required
- Flanged connections at battery limits, including gasket and bolting.
- Instrument connections
- All local instrumentation within the battery limits
- Junction boxes
- Local panels
- PLC panels and boiler control systems
- All wiring from local instrument to junction boxes/local panel, as well as the cables, trays and all accessories.
- Acoustic insulation and cladding, as necessary, to obtain the overall guaranteed noise level
- External protection.
- Name plates (SS material)

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- Lifting lugs.
- Earthing lugs
- All lifting beams necessary for correct lifting and handling operation.
- Special tools for installation and maintenance (separately listed and quoted) shall be included in Vendor scope of supply (if any)
- All special foundation devices (such as SS sliding and Teflon plates, shear keys, etc.)
- Spare Parts for Erection, Pre-Commissioning, Commissioning and Start-Up
- List of Spare parts for two years' operation (separately listed and quoted)
- Shop painting and protective coating (from surface preparation SA 2 ½ minimum, primer, intermediate and final painting) according to Project Specifications for all complete package, including structural beams, vessels, burners, fans, electrical and instruments.
- Hot dip galvanizing where required (grating, stair steps, etc.)
- Packing and marking (Seaworthy packing suitable for outdoor storage for 6 months in high humidity environment).
- Burner Performance Test
- Refractory dry-out for castable (if required) on separate quotation
- External insulation on all skid mounted equipment (boiler modules and skids). Insulation for heat conservation and/or for personnel protection shall be considered out of the scope only for interconnecting piping between boiler module skids.; Vendor must specify the insulation thickness and provide the relevant support clips (Insulation will be supplied by Others).

7.1 Services

The supply shall provide the following services:

- Performance guarantee, utilities consumption guarantee
- Complete engineering and design of all boiler package, including general design information for the maintenance platform, ladder/stairs, hoist, civil works design. Operation & Maintenance Manuals in Italian language

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- Compliance with local regulations and codes
- Transportation to site
- Supplier supervision to erection, commissioning, start-up and test run activities, on daily rate

7.2 Exclusions

The following items are not included in Supplier scope of supply:



- Field erection
- Fireproofing
- External insulation materials, except bolts/nuts and supporting clips
- Power cables from sub-station to electric devices junction boxes.
- Local motor start/stop push button stations.
- Instrument cables from local junction boxes to technical room.
- Underground earthing loops.
- Fire and gas detection system.
- Lighting.
- Utility supply (instrument air not available at site, electricity).
- Foundation and civil works
- Foundation anchor bolts
- Piping outside battery limits

7.3 Battery limits

Supplier shall provide a battery limits summary.

7.4 Health and Environment

- Hazardous area classification

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The complete Unit, associated equipment and components shall be suitable for the following IEC area classification:

Zone 2, grade IIA, Temp T1



- Acoustic requirements

The maximum noise emission for each equipment shall not exceed 85 DbA@1mt.

8. GUARANTEES

As a minimum requirement, Vendor shall guarantee the following:

- Hot Oil production as per paragraph 3.
- Vendor shall state and guarantee fuel efficiency at maximum continuous rate (MCR) (LHV basis), with reference to specified fired fuel and ambient temperature of 15°C.
- Vendor shall state and guarantee utility consumption, fuel gas and electrical consumption, at MCR condition.
- For natural gas only fuel, Vendor shall guarantee the following emission pollutant levels referred to 3% vol. oxygen content, dry condition:
 - NOx 100 mg/Nm3;
 - PM 5 mg/Nm3
- For H2-NG mix fuel, Vendor shall guarantee the following emission pollutant levels referred to 3% vol. oxygen content, dry condition:
 - NOx 200 mg/Nm3;
 - PM 5 mg/Nm3
- Vendor shall guarantee noise level of 85 dBA at 1m from the whole package skid edge.

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9. REQUESTED INFORMATION

Supplier shall submit a technical and commercial proposal to include:

- Process Flow Diagram
- Electric power, utilities and chemicals consumptions
- Effluents and emissions
- List of signals to be sent from the PLC to monitor the operation
- Dimensions and weight
- Reference list
- Expected lifetime
- Maintenance requirements with expected Opex
- Schedule for design, construction and delivery of the unit
- Budgetary offer for purchase, lease or right to use.
- Typical performance guarantees.
- Commissioning times and costs.