

Technical Specification for Fabrication Requirements of Waste Heat Exchangers

1. Quality control plan

The SUPPLIER shall present with its proposal a quality control plan, which shall contain in the inspection and test section the following minimum items:

- 1.1 Planned inspection points and its localization, during the material production schedule, including sub-vendors inspection, meanwhile production inspection and final inspection;
- 1.2 Characteristics to be inspected in each point;
- 1.3 Types of exams, essays, tests or verifications to be done in each point;
- 1.4 Procedures and/or Standards that will be followed;
- 1.5 Acceptance criteria;
- 1.6 Obligatory hold points and witness points, if utilized;
- 1.7 Sample points, if utilized;
- 1.8 Indication of the inspection points on which will be emitted reports of the results, informing the type of inspection, certificate, graphic or register to be utilized.

The inspection plan, the procedures, standards and other documents, necessary to the inspection execution and interpretation of its results shall be open to any consult by the PURCHASER.

The PURCHASER will define, based on the quality control plan, the extend of its participation or its legal representative, in the attendance of inspection and tests on factory.

1.9 The vendor shall submit the following documents for comments:

- a) The welding and inspection plan;
- b) WPSs and respective PQRs;
- c) Heat treatments;
- d) Leak tests;
- e) Hydrostatic Test;
- f) NDEs (RT, UT, MT, PT and HT).
RT: radiographic examination
UT: ultrasonic examination
MT: magnetic particles examination
PT: dye penetrant examination
HT: hardness measurements

2. Manufacture Inspection and Tests

2.1. Applicable NDE during manufacturing:

- a) Steam and Water Drums:
 - 100% RT butt welds;
 - 100% PT all welds including in the non pressure parts;
 - Nozzle welds shall be 100% UT;
 - All root pass shall be done with TIG welding process and controlled with 100% PT;
 - All bevels shall be 100% PT prior to the welding;
 - All inspection should be done before PWHT;
 - After the hydrostatic test all welds should be 100% PT.
- b) Headers, Tube Bundles:
 - 100% RT butt welds;
 - 100% PT all welds including in the non pressure parts;
 - Nozzle and branch welds shall be 100% UT.
- c) External Piping
Temperature > 400°C and NPS > 51mm
 - 100% RT butt welds;
 - 100% PT all welds including in the non pressure parts;
 - Branch connection welds: 100% UT.

2.2. Applicable Fabrication Tests

All equipment and piping shall be hydrostatic pressure tested, according to ASME Sec VII Div 1. Tube bundles shall be leak tested according to ASME Sec V.

3. Material Quality Certification

The SUPPLIER shall keep for verification, during the manufacturing, the following documents:

- a. Material Quality Certification of all the pressure parts:
 - Drums: plates, spherical segments, heads, flanges and internals;
 - Economizer, Bank, Superheater: tubes, panels, coils, headers, flanges and caps;
 - Silencers;
 - Expansion joints, dampers, ducts and stack;
 - Bolts, screws, nuts and gaskets;
 - Liners, refractories and consumables for welding;
 - Fans;
 - Continuous and intermittent blowdown drum and liquid in gas detection drum.
- b. Heat treatment certificates and records.
- c. Certificate of: hardness measurement of cast zones, heat affected zones and all welds that had been stress relieved in factory.
- d. Welding reports, including welding procedures, welders, and welding operators qualifying, emitted by inspectors qualified by a recognized organization inside their original countries.
- e. Repairs procedures, when applicable.
- f. Non Destructive Examination (NDE) Certificates, emitted by inspectors qualified by a recognized organization inside their original countries, for all materials and goods, as below:
 - Steam and water drums;
 - Return curves castings and forged materials;
 - Tube and coil casting supports;
 - Tubes, coils, panels, headers, flanges and caps;
 - Ducts, dampers, guillotines and expansion joints;
 - Metallic structures and plates;
 - Stack.
- g. Dimensional inspection reports, specified as follows:
 - Drums
 - Circularity, curvature and thickness of wall in all regions of high level of conformation of spherical segments and cylindrical parts.
 - Perpendicularity of seats of inspection holes;
 - Dimensions and position of internal supports;
 - Broaching holes: diameter, positioning, deepness, width and roughness.
 - Flanges
 - Standardization of the grooves of the faces, according to gasket type and MSS-SP6.
 - Tubes to grooved expanded connections
 - Roughness, dimensions and hardness of extremities.
 - Sootblower Tubes
 - Length;
 - Position and internal diameter of orifices;
 - Longitudinal flexibility.
 - Panels and Coils (Economizer, Bank, Superheaters and Feedwater Preheater)
 - Transversal and longitudinal flexibility;
 - Centerline clearance of the extreme tubes;
 - Maximum difference between the panel diagonals $\leq 4\text{mm}$.

- Circular Section Ducts
 - Circularity of any transversal section;
 - Maximum clearance between the generating line and a straight template;
 - Angular deformation.
- Rectangular Section Ducts
 - Difference between diagonals in any transversal section;
 - Maximum clearance of any duct face related to a straight template;
 - Angular deformation.
- Ducts and Stack
- Pins and wire clothes for refractory and lining support.
 - h. Hydrostatic test, broaching, painting and commissioning procedures.
 - i. Hydrostatic test certificates.
 - j. Electric components, motors and panels tests certificates.
 - k. Performance tests certificates of other equipment.
 - l. Certification of calibration of instruments.
 - m. Executed inspection report.
 - n. Painting Inspection Certificate.
 - o. Electric equipment protection designed for explosive environment.

4. Manufacturing requirements

- a. The manufacturing hold points or witness points shall be accompanied by an inspector defined by the PURCHASER or by a defined representative.
- b. The SUPPLIER shall present the execution and inspection procedures, qualified and certified as follows:
- c. For Non Destructive Examination (NDEs)

Level III Inspector of Brazilian National System for Personal Qualification and Certificated in NDE by ABENDE (Brazilian Organization) or another recognized Organization.

- d. For Welding

Level II Welding Inspector of Brazilian National System for Personnel Qualification and Certificated in Welding by FBTS (Brazilian Organization) or another recognized Organization that attends the Standards EN-45013 requirements.

- e. For Welders and Weld Operators

- ASME Sec IX for equipment, and oil and gas pipelines;
- ANSI / AWS D1.1 for metallic structures.

- f. The weld between the header and tubes shall be of total penetration type to avoid the groove where normally begins the cracks and the disbanding of the welds.

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5. Assembly requirements

- a. Assembly Field: Installations, materials and assembly equipment:

The SUPPLIER shall be responsible for all items necessary for the assembly.

After 30 days after the issue of Material Supply Authorization (MAS), the SUPPLIER shall present the Assembly Field Lay-out for analysis and approval by the PURCHASER.

The PURCHASER will furnish the area for the assembly, including potable water and electricity.

- b. Electric Energy

The PURCHASER will supply electric energy at ----- V, 3 phases and 60hz for the assembly field and services. The SUPPLIER shall be responsible for the tension reduction and supply and installation of the capacitors to correct the power factor.

All the lighting and distribution system shall be furnished and installed by the SUPPLIER, in accordance with the instructions of the refinery.

- c. The SUPPLIER shall be responsible for the supply of the necessary service air.

- d. The SUPPLIER shall be responsible for all Material Rigging and Transportation, including equipment, personnel and rigging studies.
- e. The SUPPLIER shall design, supply and install all the scaffolds necessary to the services.
- f. The SUPPLIER shall be responsible for the area cleaning and maintenance; the residues shall be segregated and immediately transported to places defined by the refinery.
- g. The SUPPLIER shall be responsible for all the tools and assembling equipments necessary to the services, including materials for tests, essays, heat treatment, including fuels.
- h. The SUPPLIER shall present to the PURCHASER for comments and approval, the following procedures:
 - Assembly;
 - Broaching;
 - Painting;
 - Refractory Installation and Dry-out;
 - Hydrostatic Test;
 - Water Tight Test;
 - Performance Test;
 - Welding and NDE Execution;
 - Instrumentation Test;
 - Electrical Items Tests;
 - PWHT;
 - Hardness Tests;
 - Leak Test.