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1 Subject of specification

This specification and other documents referenced herein establish the minimum requirements for the design, fabrication, erection, inspection and tests for different types of equipment, machines, and piping.

2 Scope of validity

This specification applies to the preparation of tender documents, inquiries and contracts concerning new investments and modernization projects planned by Grupa LOTOS S.A.

It shall also be a basis for preparing both detailed specifications and inquiries for individual or package unit supplies.

2.1 Deviations

Any deviation from this specification and the relevant specifications, standards and related documents including proposals, which the bidder claims to be economically and / or technically superior solutions must be submitted in writing for review and approval by Grupa LOTOS S.A. Non-approved exceptions are not acceptable by Grupa LOTOS S.A.

The supplier must report in writing any ambiguity in this or any other specifications of Grupa LOTOS S.A. or non-compliance with the referred documents / standards and obtain a written explanation from Grupa LOTOS SA.

3 General requirements

3.1 Order of Precedence

In case of conflicts existing between this specification and other documents, the following order of precedence shall govern:

- The current Polish legislation
- Terms of purchase order / contract and other requirements agreed in writing Grupa LOTOS S.A.
- Data Sheets approved by Grupa LOTOS S.A.
- This specification
- Other Specifications
- Drawings and other documents
- Standards

3.2 Design Parameters

3.2.1 Design pressure

Design pressure for pressure vessels, reactors, heat exchangers, columns and pipelines shall be greater of the following:

- Maximum operating pressure + 1.5 bar or
- Maximum operating pressure x 1.14

For o pressures above 60 bar g and equipment or piping protected with pressure safety relief valves, design pressure shall be equal to maximum operating pressure x 1.1.

Minimum design pressure for pressure equipment and piping subject to steam-out, due to process reasons, shall be 6 bar g at 210 °C and F.V. (full vacuum) at 120 °C.

Minimum design pressure for piping shall be 3.5 bar g. The minimum hydrostatic test pressure for the piping that is subject to UDT, ZDT shall be 15.0 g.

The test pressure shall be determined in accordance with the design code used for construction and Pressure European Directive.

3.2.2 Design temperature

- The minimum design temperature shall be equal to maximum working temperature increased by 15°C and shall be in no case lower than plus (+) 55°C
- For insulated equipment and insulated piping operating below0°C, design temperature shall be + (plus) 35°C
- Minimum design metal temperature (MDMT) is the lowest metal temperature, which can occur during operating conditions, taking into account minimum ambient temperature -25°C (minus 25°C). To set MDMT the minimum startup, test or upset temperature while at normal, operating pressure shall be taken into account .
- Minimum design temperature for pressure equipment (including piping) subject to steam-out due to process reasons, shall be 210°C at 6 bar g and 120 °C at F,V.(full vaacum)..
- Maximum temperature for steam-heated objects (equipment, pipelines) for stress analysis is 240°C, and for wall thickness calculation is 200°C.

3.3 Guidelines for the selection of materials for the process conditions

3.3.1 Hydrogen embrittlement.

Selection of materials for work in conditions, which cause the possibility of occurrence of high-temperature hydrogen embrittlement, should be based on the hydrogen action resistance curves, provided in API 941 standard 941 „Steels for hydrogen service at elevated temperatures and pressures in petroleum refineries and petrochemical plants". As a rule, assume the limitation of the maximum working conditions to 3.5 bar of hydrogen partial pressure and 28 ºC below the applicable material curve of API 941.

3.3.2 High-temperature hydrogen sulphide corrosion in the presence of hydrogen (H_2/H_2S corrosion)

When sulfidation corrosion in the presence of hydrogen (referred to H_2/H_2S corrosion) can occur recommendation of API RP-939-C „Guidelines for avoiding sulfidation corrosion failures in oil refineries" shall be considered.

The Couper-Gorman curves should be used to predict the corrosion rate in this environment and to select construction material and appropriate corrosion allowance for the desired lifetime expectancy of the equipment.

Solid 18-8 stainless steel or cladding (for vessels with thick wall thickness) should be used when the anticipated corrosion rate for carbon and/or low alloys steels is greater than 0.25 mm/year.

The base material for cladding or weld-overlay should be low alloy steels selected for hydrogen service.

3.3.3 High-temperature hydrogen sulphide corrosion in H_2-free streams (hydrogen free sulfidation)

When sulfidation corrosion in the hydrogen free (referred to H_2 free corrosion) environment can occur recommendation of API RP-939-C „Guidelines for avoiding sulfidation corrosion failures in oil refineries" shall be considered.

The modified McConomy curves should be used to predict the corrosion rate in this environment and to select construction material and appropriate corrosion allowance for the desired lifetime expectancy of the equipment.

3.3.4 Solid 18-8 stainless steel or cladding (for vessels with thick wall thickness) should be used when the anticipated corrosion rate for carbon and/or low alloys steels is greater than 0.25 mm/year. Chloride stress corrosion

Material selection, including stainless steels, for chloride service should be carefully considered, taking into account the following: chloride contraction, dry or wet service, pitting, possibility of deterioration or damage of passivated layer.

3.3.5 Wet Hydrogen Sulphide corrosion

There are several types of material damages that can occur as a result of aqueous hydrogen charging in wet hydrogen sulphide (H_2S) environments such as: sulphide stress corrosion (SSC) cracking of hard weldments and microstructures, hydrogen blistering, hydrogen induced cracking (HIC) and stress-oriented hydrogen induced cracking (SOHIC).

The partial pressure of H_2S, total H_2S concentration in liquid phase and / or values of other factors contributing to SCC above that approaches shall be used to prevent SSC are included in standard NACE MR0103.

When selecting of construction material for mechanical equipment that is exposed to listed different cracking mechanism such as: SSC, hydrogen blistering, HIC, SOHIC requirements of the following standards: NACE MR0103, NACE SP0472 and NACE 8X19 shall be considered.

3.3.6 Caustic Stress Corrosion

When selecting of construction material for mechanical equipment that is exposed to caustic environments requirements of the following standard NACE SP0403 „Avoiding Caustic stress corrosion cracking of carbon steel refinery equipment and piping" shall be considered.

3.4 Other Requirements

Selection and designing of equipment and plant elements must consider the plant's continuous operation over the period of 5 years (the period between overhauls).

3.4.1 Equipment/piping operating in a creep zone

- Piping qualification creep calculation criteria:
  - Carbon steel piping ND ≥ 4", operation temp. above 400°C.
  - Stainless steel piping ND ≥4", operation temp. above 475°C.
- Design time

Pressure vessels/piping operating in a creep zone should be designed for minimum 100 000 hours of operation.

- Materials

Materials used for construction of hot elements shall be fully creep resistant minimum during that period of time. Materials after final heat treatment shall be of uniform and fine grain microstructure.

- Test elements (for testing during operation)

Together with vessel/piping should be delivered following test elements:

- Duly marked test plates 250mm x 250mm representing the corresponding shell material and head material (one plate for each item)
- One (1) piece 200mm long of pipe as used for the vessel's nozzles
- For each piping: one (1) piece of 0.5m long of pipe and test ring coupon for elbow 250mm wide or complete elbow

The supplied test materials shall be heat treated identically as their corresponding elements of vessels or pipes and elbows. Test pieces will be used for testing of material microstructure and properties, to collect initial data necessary to check status of the plant during further operation.

3.4.2 Corrosion allowances and anticorrosion protection

If the Basic Engineering, relevant codes and standards do not specify special requirements, the following corrosion allowances shall be applied:

- 3 mm for carbon and low-alloy steel,
- 0 ÷ 1.6 mm for high-alloy and acid-resistant steel and non-ferrous alloys.

For internal equipment of vessels:

- 1 mm per side for carbon and low-alloy steel,
- 0.5 mm per side for high-alloy and acid-resistant steel and non-ferrous alloys.

Corrosion allowance should not be applied for outside surfaces of vessels and for supports.

During designing and manufacturing requirements of PN-EN-ISO-12944-3 "Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 3: Design considerations" shall be taken into account.

The arrangement (location) of machinery, equipment and piping must ensure adequate access for operation, maintenance and repair work.

All equipment should be protected against the effects of atmospheric discharge (earthed) and electrostatic discharge in compliance with the requirements of Specification No. 4500.

Delivered equipment should be adequately protected for the time of transport and, if needed, outdoor storage during a period of up to 1 year, should be provided with adequate fixtures for hoisting equipment for transport and erection.

3.4.3. Non-electrical equipment for potentially explosive atmospheres.

All non-electrical equipment destined for operation in potentially explosive atmosphere should fulfil standard PN-EN 13463 and Directive 94/9/EC (ATEX) requirements.

3.4.4. Spare parts

The equipment supplier is obliged to deliver a set of spare parts necessary for start-up and first start together with the equipment, and to submit an offer for spare parts for three years' operation based on the supplier's experience.

Equipment delivered with complete equipment, as its accessories must comply with the Vendors/Suppliers List approved by Grupa LOTOS S.A.

3.4.5. In-service diagnostic guidelines

For the following equipment and piping, such as:

- reactors and columns
- coil pipes of furnaces
- heat exchangers
- piping,

operating in critical conditions (such as, e.g. in creep conditions or hydrogen corrosion conditions mentioned in par. 3.3. of this Specification) the Contractor, that carried out of the project should specify the type, scope and frequency of in-service diagnostic tests to avoid damage caused by creep or corrosion .

3.4.6. Scope of supply

The mechanical equipment shall be supplied to the site completely fabricated to the most possible extent and tested. Unless otherwise specified, column trays, and ladders and platforms are exceptions.

In case of a delivery in elements, all parts must have adequate marking to avoid errors during assembly.

Unless otherwise specified in Purchase Order, ladders and platforms, anchor bolts, and all special tools required for equipment proper installation such as anchor bolts templates, special shims for positioning and aligning, etc shall be supplied together with mechanical equipment.

4 Relevant documents

Any “Technical Specification” issued by Grupa LOTOS S.A. listed in Contract Files.

5 Codes and standards

Codes and standards listed below form part of this specification. Each publication shall be the latest revision and addendum in effect at the Contract award, unless otherwise specified:

- PN-EN-ISO 12944-3 Paints and varnishes. Corrosion protection of steel structures by protective paint systems. Design considerations.
- PN-EN 13463 Non-electrical equipment intended for use in potentially explosive atmospheres
- NACE MR0103 Materials Resistant to Sulfide Stress Cracking in Corrosive Petroleum Refining Environments - Item No. 21305.
- NACE SP0472 Methods and Controls to Prevent In-Service Environmental Cracking of Carbon Steel Weldments in Corrosive Petroleum Refining Environments - Item No. 21006.
- NACE 8X194 Materials and Fabrication Practices for New Pressure Vessels Used in Wet H2S service in Refinery.
- NACE SP0296 Detection, Repair, and Mitigation of Cracking in Refinery Equipment in Wet H_2S Environments - Item No. 21078.
- NACE MR0175/ISO 15156 Petroleum and natural gas industries Materials for use in H_2S-containing Environments in oil and gas.
- NACE SP0403 Avoiding Caustic Stress Corrosion Cracking of Carbon Steel Refinery Equipment and Piping - Item No. 21102.
- API RP 941 Steels for Hydrogen Service at Elevated Temperatures and Pressures in Petroleum Refineries and Petrochemical Plants.
- API RP 945 Avoiding Environmental Cracking in Amine Units
- API RP 939-C Guidelines for avoiding sulfidation corrosion failures in oil refineries.

6 Record of changes

No.	Date	Description	Introduced by
1	22.03.2006.	This specification entirely replaces the specification rev.0 Changed points 3.4.1 and 5.9. Added point 3.4.3.	B. Kowalewski
2	20.06.2006.	Added point 3.4.6.	B. Kowalewski
3	29.08.2006	Added API Std 685 in point 5.4.	B. Kowalewski
4	09-05-2011	Changed points: 3.2.1, 3.2.2, 3.3.5, 5.9.	S. Zajączkowski
5	30-11-2013 (rev.5)	Review, update, standardize and changes to the Standard within scope of order No. OK/990/2012	Editorial board coordinated by T.Wróbel
-	31-08-2015	Page layout corrections, no content changes.	T. Wróbel