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1 Subject of specification

This specification used in conjunction with other technical specifications of Grupa LOTOS S.A. establishes the minimum requirements for the design, fabrication, inspection and testing of general purpose steam turbines intended for work in Grupa LOTOS S.A. plants.

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.

This specification shall be read in conjunction with the applicable ISO/API standard and Grupa LOTOS S.A. specification no. 2400 – General Requirements for Machines and Drives.

Reference to other industrial standards for compliance shall be interpreted as an integral part of this specification.

2.1 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

2.2 Local regulations

The steam turbines shall be designed, constructed and installed in compliance with all applicable national and local laws and regulations, Grupa LOTOS S.A. specifications and current technical standards referred to in purchase order documents.

2.3 Standards/norms

Turbines shall be designed and delivered in accordance with API standard 611 4th ed. or newer including requirements stated herein. Other standards may be used if agreed with Grupa LOTOS S.A.

Applicable standard shall be stated in data sheets.

2.4 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 S.A.

3 Guarantees

All materials, design and construction shall be subject to the conditions and guarantees required by the purchase order.

The checking of drawings, the intermediate and final inspections of the compressor by Grupa LOTOS S.A. as well as the release for shipping shall not relieve the Supplier from his responsibility for the compliance of the compressor with the terms and conditions of the purchase order.

4 Design Criteria

4.1 General

4.1.1 General purpose steam turbines and auxiliaries shall be designed for outdoor unsheltered installation in applicable explosion zone, unless otherwise specified in the data sheet.

4.1.2 The overall mechanical and thermodynamic performance of the general purpose steam turbine unit shall be the turbine Supplier's responsibility.

4.1.3 General purpose steam turbine design and construction recommended by the Supplier shall be mutually agreed to and in compliance with applicable laws and standards. Supplier shall indicate where specifications require excessive measures that result in non-standard material supply. The Supplier is obligated to identify such deviations.

4.2 Basic Design

4.2.1 General purpose steam turbines and auxiliaries shall be designed to meet Grupa LOTOS S.A. requirements, as specified on the data sheet.

4.2.2 When winterizing protection is required, Supplier shall indicate in his proposal what winterizing provisions are included by Supplier and what must be provided by Grupa LOTOS S.A.

4.2.3 When immediate starting is required for multipressure stage design, the data sheet will so indicate and Supplier's proposal shall state precautions required.

4.2.4 Water side design pressure shall be specified higher than cooling water inlet pressure shown on the turbine data sheet, and shall be mutually agreed to.

4.2.5 Durability and ease of maintenance shall be given equal importance as initial efficiency in turbine selection.

4.2.6 The Supplier shall review and comment on Grupa LOTOS S.A. piping and foundation drawings.

4.2.7 Casing shall be designed for pressure and temperature encountered when running uncoupled with design inlet steam conditions.

4.2.8 General purpose steam turbine casing shall be equipped with a sentinel warning valve if specified on data sheet. The relationship between the exhaust casing pressure and the sentinel warning valve setting shall be as prescribed in the applicable codes and standards.

4.2.9 The casing design for general purpose horizontal steam turbines shall permit inspection of subassemblies and removal of the rotor and wearing parts without removal of casing from its foundation or disconnecting inlet or exhaust steam piping. The exception is for ratings up to 35 kW because then vertically split designs are acceptable. Above this size, casings shall be horizontally split unless the Supplier has reference proven radial split design. Axially split multistage turbine casings may be additionally split vertically at a section between the high and low pressure portion to facilitate material change. Cast exhaust sections are preferred to fabricated sections.

4.2.10 Through-bolts or studs shall be used. Machine bolts may be used only with Grupa LOTOS S.A. written permission.

4.2.11 Clearance shall be provided at bolting locations to permit the use of socket or box-type wrenches and impact driver. The Supplier shall provide any required special tools and fixtures.

4.3 Piping and Connections

4.3.1 Casing openings for lubricating oil service or steam of 5 bar or higher pressure service shall be arranged for flanged connections. Flanged connections shall be readily accessible with turbine mounted on baseplate. Screwed and back-welded connections are not acceptable. Where flanged connections are impractical, Supplier shall quote extra cost for furnishing socket welding nipples of Schedule 80 minimum seamless steel not over 150 mm long, 15 mm (1/2 inch) IPS minimum, terminating with weld neck flanges.

4.3.2 Copper tubing and fittings shall not be allowed. For instrumentation signal lines, 8 mm (1/4 inch) stainless steel tubing and fittings shall be supplied.

4.3.3 All turbine casings shall be provided with drains in the lowest parts of the casing. These connections shall not be less than 15 mm (1/2 inch) iron pipe size. For steel cases, connections for drains, vents, pressure gauges, etc., shall be made with accessible boss flanges or welding neck flanges and threaded extra heavy pipe nipples, backwelded to the turbine case. (Supplier shall quote alternate for providing socket welded connections to case). Flanged connections shall be readily accessible when turbine and driven equipment are assembled on base.

4.4 Bearings and Bearing Housings

4.4.1 Antifriction bearings for horizontal turbines are acceptable for turbines rated 35 kW or less. Oil lubrication of all horizontal turbine bearings is required.

4.4.2 Multistage turbines shall have Kingsbury type double-acting thrust bearings. Tapered land thrust bearings (normally loaded and normally unloaded) shall not be allowed for multiwheel application.

4.4.3 Vertical turbines shall be supplied with oil lubricated ball or roller type radial and thrust bearings. Vertical turbine drives for vertical pumps shall be designed to carry the maximum thrust (up and down), which the pump may develop during starting and stopping, while operating at any capacity.

4.4.4 Mutually agreed constant level oilers shall be provided for each bearing housing containing oil lubricating bearings with no pressure. Transparent containers shall remain clear when exposed to specified lubricating oil, outdoors, etc.

4.4.5 Supplier shall state in quotation the amount of cooling water required.

4.4.6 Cored cooling jackets are preferred to cooling coils. Each bearing housing (top and bottom halves) shall be separately jacketed, separately fed and shall have no interconnecting passages linking one bearing housing cooling jacket with another.

4.5 Shaft Seals

4.5.1 Arrangements of labyrinth in series with carbon rings are acceptable for single stage turbines provided that design calculations are submitted for Grupa LOTOS S.A. written approval. Clearances shall be determined accordingly.

4.5.2 When full labyrinth (as opposed to labyrinth with ring) shaft gland packing is specified, interstage seals shall be by labyrinth.

4.5.3 On multistage condensing turbines, the low pressure seal shall be supplied with steam from the high pressure gland leak off. In addition, Grupa LOTOS S.A. sealing steam supply shall be provided with a self-contained pressure regulator for makeup. Means shall be provided to bleed off excessive pressure from high pressure gland.

4.5.4 All segments of shaft gland packing, carbon or labyrinth, shall be replaceable without disturbing upper casing half.

4.6 Couplings

4.6.1 Coupling guards shall be of metal plate rather than expanded mesh design and shall be supplied per ISO requirements.

4.6.2 Couplings shall have drilled and tapped puller holes of sufficient diameter and length to facilitate pulling coupling without breaking puller studs or be of such design as to facilitate standard coupling puller equipment.

4.7 Baseplates

4.7.1 Turbine baseplates, when required, shall be provided by the turbine Supplier.

4.7.2 Oil reservoirs integrated in the baseplates shall be provided only if specified on the data sheet.

4.8 Thermal insulation

4.8.1 The steam turbines shall be provided with thermal insulation and metallic protective hoods. The surface temperature on the atmospheric side shall not exceed 60 °C.

4.8.2 Insulation shall permit access to flange bolting. When removable shaft packing glands are supplied, insulation shall be arranged to permit gland removal without disturbing insulation.

4.9 Gearing

4.9.1 Integral (built-in type) general purpose turbine units are only acceptable if specified on the data sheet.

4.9.2 Maximum allowable pinion displacement in the axial direction loaded or unloaded, as well as peak to peak displacement values at any frequency shall be mutually agreed to. The maximum radial vibration shall be as described in applicable codes and standards.

4.10 Materials

4.10.1 Materials not in accordance with applicable codes and standards shall be approved by Grupa LOTOS S.A. before the Supplier can proceed with fabrication.

4.10.2 For ambient temperatures below 0°C, carbon steels shall have impact strength at the lowest temperature sufficient to qualify under the minimum impact energy requirements of the applicable ASME Code and PED requirements.

4.11 Lube Oil System

4.11.1 Pressure lubricated general purpose turbines shall have auxiliary pump or other Grupa LOTOS S.A. approved arrangements to provide lubrication for bearings on start up. Hand operated pumps are not acceptable.

4.11.2 Unless otherwise specified, dual cartridge filters with steel casings shall be provided. Filter cartridge shall have a nominal filtration of 10 microns.

4.11.3 Turbine oil piping shall be furnished by turbine Supplier.

4.11.4 Oil reservoir immersion heaters shall be sized to prevent carbonization of the lube oil. Controls shall be arranged to permit heating only when oil is circulating.

4.12 Controls and Protective Devices

4.12.1 All controls and instruments shall be suitable for outdoor installation in specified hazardous area.

4.12.2 Unless otherwise specified, turbine Supplier shall provide accommodation for mounting non-contacting probes for simultaneous measurement in the lateral horizontal and vertical planes at both radial bearing housing. Turbine rotors must be machined to provide reference marks for key phasor.

4.12.3 Where not covered by any specific job requirements, instrumentation and installation shall conform to Grupa LOTOS S.A. specifications and reference standards.

4.12.4 All instruments must be identified in accordance with P&I diagram or the instrument specification. The P&I diagram is also binding for the scope of supply.

4.12.5 Supplier of driven machine will coordinate instrumentation and control for driven machine and turbine.

4.12.6 Instrumentation for installation in a control room shall be according to the purchase order scope of supply.

5 Inspection and testing

5.1 General

For general requirements refer to Grupa LOTOS S.A. specification no. 2400 – "General requirements for machines and drivers."

5.2 Testing

5.2.1 If Grupa LOTOS S.A. waives witnessing the shop test, certified test report shall be submitted in lieu and shipment shall not be made until the unit is released by Grupa LOTOS S.A.

5.2.2 Spare rotors purchased currently with the turbine shall be given a mechanical running test.

5.2.3 High exhaust temperatures shall not be used to limit inlet steam conditions.

5.3 Inspections

5.3.1 Turbines shall be tested, completely assembled, and painted (if required) prior to surface inspection. The turbines shall not be skidded (or boxed) prior to inspection; however, the skids and/or boxes shall be available for inspection. Surface inspection shall include a check of dimensions, nameplates, preparation for shipment, markings and auxiliary equipment.

5.3.2 Grupa LOTOS S.A. will make an inspection for cleanliness of the equipment and all piping and appurtenances furnished by or thru the Supplier prior to the installation of nozzles blocks and steam-chest covers, the closure of openings in vessels or exchangers or the assembly of piping.

5.4 Painting

Painting shall be in accordance with specification no. 2400.

6 Nameplate

6.1.1 Original Supplier's name shall be stamped on the nameplate made of stainless steel. The nameplate shall be extended to be visible over the insulation.

6.1.2 Grupa LOTOS S.A. purchase order number and equipment tag number shall be added.

6.1.3 Rotating arrow shall be of stainless steel.

7 Documentation

Supplier shall ensure that the following data/documents are included in the final documentation.

Dimensional outline drawing

- total weight and the weight of the heaviest elements for repair purposes, rotor/impeller weight for rotating machines
- position of the centre of gravity for machines of a weight exceeding 1500 kG
- location of flanges and the dimensions of flanges, venting, draining openings, and of other threaded connections
- location of the lubricating points
- the values of the maximum allowable forces and torques on flanges and the maximum differences in their position during cold and hot working condition
- direction of rotation
- static and dynamic foundation loads
- tolerances for levelling the foundation plate on the foundation
- dimensions of the foundation plate (base frame) and location of the foundation bolts
- type and technical data of the mechanical (gas) seal
- type, dimensions and number of the foundation bolts
- type and the technical data of the drive
- type of the coupling, the distance between shaft faces, the length of the spacer
- type and the technical data for gear.

Pipeline documentation

Pipeline documentation within the scope of supply of the machine shall be in accordance to the requirements of specification no. 6100.

Instrumentation and electric documentation

Documentation of the instrumentation and electrical discipline shall include the following:

- list of control and measuring instruments
- technical characteristics of the instruments and their set points
- wiring diagrams and control logic diagrams
- drawing of the control panel
- assembly drawings and list of materials
- installation, operation and maintenance manuals for individual equipment.

Operation and maintenance manuals

Operation and maintenance manuals shall include the following:

- the data sheet
- the report on the factory tests of the machine with the characteristic curves from these tests
- technical description of the machine
- technical description of the auxiliary equipment
- assembly and disassembly instructions
- operation manual (start-up, adjustment/regulation, shutdown)
- the maintenance and repair manual
- cross-section drawings of the machine, its subassemblies and auxiliary equipment with a list of parts including their construction materials and the manufacturer's code numbers
- the minimum and maximum clearance for mated parts
- the torques and the sequence of bolts tightening
- list of antifriction bearings, stating their symbols, the name of the manufacturer, the place of installation and their number (i.e. quantity) in a single machine. This applies also to elements used for mounting the bearing, such as bearing housings, bearing sleeves etc.
- the maximum allowable bearing temperature
- the allowable vibration level
- lubrication and cooling diagrams
- operating parameters for oil systems (pressure and temperature)
- list of oils and greases with recommendation (identification and the name of the manufacturer) and their substitutes, if any, as well as their physical and chemical characteristics, quantities required for the first filling (the capacity of the oil system or the greasing chamber), life time till the first replacement and the replacement frequency, expected annual consumption.

Manufacturer Data Book

MDB documentation shall include the following:

- Ex certificates

- material certificates
- heat treatment reports
- NDT reports
- reports on the dynamic balancing of impellers (if applicable)
- pressure test reports
- functional test reports
- information on already applied lubricants

8 Relevant documents

8.1 Grupa LOTOS S.A. specifications

Any "Technical Specification" issued by GRUPA LOTOS S.A. listed in Contract Files.

8.2 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:

- API 611 – Petroleum, Petrochemical and Natural Gas Industries – General Purpose Steam Turbines
- API 614 – Lubrication, Shaft-Sealing and Control-Oil Systems for Special-Purpose Applications
- API 670 – Machinery Protection Systems
- API 671 – Special-Purpose Couplings for Refinery Service
- API 684 – Tutorial on the API Standard Paragraphs Covering Rotor Dynamics and Balancing: An Introduction to Lateral Critical and Train Torsional Analysis and Rotor Balancing
- API 686 – Recommended Practices for Machinery Installation and Installation Design
- ASME PTC 6 – Performance Test Code for Steam Turbines
- TEMA Cl. C – Mechanical Standards, Heat Exchanger
- ASME Code Sect.VIII, Div.1 – Pressure Vessels and Heat Exchanger
- H.E.I. – Standards for Steam Surface Condensers
- EN ISO 12100 Safety of Machinery – General principles for design – Risk assessment and risk reduction
- EN ISO 3744 - Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Engineering methods for an essentially free field over a reflecting plane
- ISO 1940-1 - Mechanical Vibration; Balance Quality Requirements for Rotors in a constant (rigid) state. Specification and verification of balance tolerances.

- ISO 21940-14 - Mechanical Vibration. Rotor balancing. Part 14: Procedures for assessing balance errors
- ISO 11342 - Mechanical vibration-Methods and criteria for the mechanical balancing of flexible rotors
- ISO 10816 (applicable part) - Mechanical Vibration-Evaluation of Machine Vibration by Measurement on non-rotating parts
- ISO 21940-32 - Mechanical Vibration - Rotor Balancing; Shaft and Fitment Key Convention
- EN 10204 - Metallic Products-Type of Inspection Documents
- ISO 10474 - Steel and steel product – Inspection documents
- ASTM A435/A435M-90 - Standard Specification for Straight-Beam Ultrasonic Examination of Steel Plates
- ASTM A578/A578M-07 - Standard Specification for Straight-Beam Ultrasonic Examination of Rolled Steel Plates for Special Applications
- MSS Standards - MSS-SP-6-2012 Standard Finishes for Contact Faces of Pipe Flanges and Connecting-end Flanges of Valves and Fittings
- EN ISO 3651-2 Determination of resistance to intergranular corrosion of stainless steels — Part 2: Ferritic, austenitic and ferritic-austenitic (duplex) stainless steels — Corrosion test in media containing sulfuric acid

9 Record of changes

No.	Date	Description	Introduced by
0		This specification entirely replaces the former Grupa LOTOS S.A. standard No. PR 07 247 with the same title.	T. Wójcik
1	30.11.2013 (rev.1)	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 contents changes.	T. Wróbel