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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 testing the Flare.

2 Scope of validity

This specification applies to the preparation of tender documents, inquiries and contracts for newly planned investment or modernization projects of 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 S.A.

2.2 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

2.3 Exclusions

This specification does not include any civil works for foundation.

3 Elevated flare

3.1 General remarks

3.1.1 Reference Documents

Where reference is made to a code, specification or standard the reference shall taken to mean the latest edition of the code, specification or standard, including addenda, supplement and revision thereto.

3.1.2 Regulations

In addition to the requirements of this specification, the mechanical design, fabrication, inspection and erection of the Flare System shall be in accordance with all mandatory requirements of the applicable national, Polish laws and regulations.

3.2 General requirements

3.2.1 The Flare System shall be delivered to the site as prefabricated elements, assembled to to the most possible extent allowed by transport conditions.

3.2.2 Site welding shall be avoided or limited to a minimum.

3.2.3 All valves, instrumentation and equipment shall be located and available for testing, repair and replacement without production shutdown, except instrumentation at flare tip. Ladders and platforms allowing for access to aircraft warning lights (if required), instrumentation and equipment shall be provided. Rest platform shall be provided with spacing between 15 and 20 meters. The platforms shall meet requirements of Grupa LOTOS S.A. specification 5120.

3.2.4 For normal operation (up to 20% maximum flare capacity) smokeless burning shall be provided. Steam is recommended for smokeless burning.

3.2.5 The piping slope shall be towards knock-out drums. No pockets are allowed.

3.2.6 Considering topographical and meteorological conditions, the height of the flare stack shall be such determined so that the thermal radiation shall not exceed the level of 6.3 kW/m^2 at the ground level (excluding solar radiation) in established sterile zone radius of 60 m..

3.2.7 At the boundary in any case thermal radiation shall not exceed 4.73 kW/m^2. The recommended design thermal radiation for personnel shall be in accordance with Table 9 of API STD 521.

3.2.8 In case the sterile zone of radius of 60 m is not possible to be established due to the local conditions, the flare stack height shall be elevated so that the permissible thermal radiation level at the Flare ground will not be exceeded. .
In this case the thermal radiation level shall be selected in accordancewith API STD 521 and shall be subject to approve by Grupa LOTOS S.A.

3.2.9 For normal operation noise level at the safety zone boundary shall not exceed 85 dB (A) (at flow rate 20%).

3.2.10 Design pressure for the flare system equipment shall not be less than 6 bar g.

3.2.11 Following factors influencing flare system shall be included in the design as a minimum:

- Flow rate

- Gas composition
- Gas temperature
- Gas pressure available
- Ambient conditions
- Site conditions
- Utility cost and availability
- Corrosive nature of the flared stream
- Safety requirements
- Environmental requirements

3.3 Flare tip

3.3.1 A flare tip should be selected to achieve the following aims:

- Ensure combustion to reduce the proportion of unburned gases realised to atmosphere
- Reducing radiation level
- The flame shall be stable in a whole operating range.
- The maintenance of the flare tip shall be reduced to a minimum over its operating life.

3.3.2 High speed (sonic speed) of the gas exit shall be used wherever possible.

3.3.3 Flame stabilizers and wind deflectors shall be provided to avoid the flame impingement on the flare tip.

3.3.4 The material of the flare tip shall be sufficiently heat and corrosion resistance (AISI 310S, Incoloy 800H or equivalent). Service piping connected to the flare tip shall be of the same material.

3.3.5 The flange of the flare tip may be made of carbon steel.

3.3.6 The Flare tip stack connection and the tip service piping connection to the feeding piping shall be flange type for possible future tip replacement.

3.4 Flare pilot and ignition

3.4.1 The flare tips shall be provided with continuous pilot burners to ignite gas as it leaves the tip.

3.4.2 Each pilot burner shall be equipped with an ignition system in case it is extinguished.

3.4.3 Flame front ignition generator type is recommended, designs to ignite the pilot burners at the design wind conditions..

3.4.4 The pilots provided at the flare tip shall be capable of sustaining stable combustion under all burning and meteorological conditions.

3.4.5 For the flare tips up to 400 mm diameter, at least two pilot burners shall be provided.

3.4.6 For the flare tips larger then 400 mm at least three pilot burners shall be provided.

3.4.7 Each burner shall be fed and ignited by means of individual fuel gas supply and ignition line.

3.4.8 The location of the pilot burners should be such that they are not engulfed by the main flare flame even in strong wind, whilst ignition of the main flare is guaranteed under these conditions.

3.4.9 The materials and design of the pilots and their type of support should be such that they require minimum maintenance and are suitable for at least a five years of operation.

3.4.10 The ignition lines and fuel gas supply lines to the pilot burners shall be made of stainless steel.

3.4.11 The provision for thermal expansion between the flare stack and the pilot lines shall be considered and provided, if required..

3.4.12 The pilot system equipped with a Venturi device in the pilot nozzle is recommended.

3.4.13 The pilot flame shall be additionally stabilized by the installation of wind shields around the pilot nozzles.

3.4.14 The fuel gas and air used to supply the pilot lights and ignition system shall be dried and filtered.

3.4.15 Fuel gas pipelines used to fed pilots and ignition lines shall be heat traced.

3.4.16 The hydrocarbons and water dew point of the fuel gas and the water dew point of the air shall be such that condensation shall not be possible whatever the mode of operation.

3.4.17 The filter shall be installed between fuel gas lines to the pilot burners made of carbon steel and stainless steel. This refers to the pilot ignition lines as well.

3.4.18 The fuel gas to the pilot burner and to the ignition lines shall be of a constant composition.

3.4.19 The pilot gas supply lines shall be arranged without pockets and any built-up condensation shall be alarmed at the control room before blockage can occur.

3.4.20 One double "K" type thermocouple shall be provided for each pilot burner.

3.4.21 Failure of a pilot shall be indicated in the control room by an alarm.

3.5 Knock out drum

3.5.1 Sizing of the flare knock-out drum shall be determined considering of such emergency relief case that based on the maximum gas relief as well as the release case at which a maximum amount of liquid can be released.

3.5.2 If significant amount of liquid is expected to be released the load factor λ shall be equal to max 0.1 m/s and shall be calculated from the following equation:

$$\lambda = \frac{Q}{A_g}\sqrt{\frac{S_g}{S_l - S_g}}$$

λ = Gas load factor (m/s)

Q = Gas flow rate (m^3/s) at operating conditions

Ag = Area available for gas flow (m^2)

Sg = Gas density (kg/m^3) at operating conditions

Sl = Liquid density (kg/m^3) at operating conditions

If relief gas is dry gas a λ value of λ = max 0.25 m/s can be applied.

3.5.3 The capacity above LSHH (maximum liquid level for normal operation) shall be designed to provide sufficient volume for a 15 (fifteen) minutes emergency release. The period of 15 (fifteen minutes) has been selected on the basis that emergency relief will be stopped within this time. Longer hold-up times might be required if it takes longer to stop the flow.

3.5.4 Maximum liquid level after the emergency relief shall remain:

- one inlet pipe diameter or 0.3 m whichever is greater below the bottom edge of the inlet pipe for vertical knock-out drums
- below the horizontal centre line for horizontal knock-out drums.

3.5.5 If necessary the knock out drum may be furnished with a steam coil at the bottom to vaporize of light hydrocarbons separated in the drum.

3.5.6 For refinery service the knock-out drum shall be equipped with electrically driven pumps (one operating, one stand by) capable of emptying the drum in two hours.

3.5.7 Knock-out drums shall be equipped with winterization protection such as steam coil or electrical heat tracing.

3.5.8 Knock-out drum shall be provided with suitable manholes.

3.5.9 The Knock-out Drum shall be provided with a nameplate in Polish or Polish and English language in accordance with PED 97/23/EC. Nameplates shall be of corrosion resistant material installed on a nameplate bracket by solid stainless steel rivets. Inscriptions on the nameplate shall be engraved. The nameplate on vertical vessels shall be located on the shell above the lowest manhole, and on horizontal vessels it shall be located above the fixed support saddle.

3.6 Water seal

3.6.1 The water seal shall prevent:

- any flashback from the flare tip and propagated further upstream of the water seal vessel.
- air ingress due to a sudden temperature change of the flare and relief system
- to maintain a slight overpressure in the flare system up stream of the seal.

3.6.2 The design of the water seal vessel shall be based on the maximum vapor relief case.

3.6.3 Water seal vessel shall be equipped with a skimmer for intermittent operation. Recommendation of API STD 521 paragraph 7.3.2.4 k shall be taken into account.

3.6.4 Water Seal and all water feeding and drain piping shall be equipped with winterization protection such as steam coil or electrical heat tracing.

3.6.5 Water Seal vessel shall be provided with suitable manholes.

3.6.6 Water Seal shall be constructed in the way to avoid “pulsating flow”.

3.7 Flare purging and reduction seals

3.7.1 To mitigate an ingress of air into flare system a purging shall be considered, taking into account the following:

- the formation of flammable air/fuel mixtures in the stack
- the formation of deposits causing flare blockage
- back burning or a licking flame reducing the service life of the tip
- impact on the surroundings and the environment if fuel gas is used as a purge gas
- flare gas composition

3.7.2 The minimum purge gas rate shall be calculated based on flare stack diameter and molecular weight of the purge gas.

3.7.3 Due to possibility of plugging labyrinth type (molecular seals) and flame arresters are not recommended, except as stated in 3.7.5

3.7.4 Velocity seals located close to the flare tip shall be used to prevent air infiltration into the flare burner exit..

3.7.5 Flame arresters should only be used when the use of purge gas is not feasible and the discharged gas is non-corrosive, dry and clean (i.e. free of any liquid that can congeal and free from any substances that can cause obstruction).

3.8 Flare stack (riser)

3.8.1 The diameter of the flare stack shall be at least equal to the diameter of the tip.

3.8.2 The flare stack construction type (self supported, derrick-supported or guyed) shall be determine basing on available space, height of the flare, number of the flare risers.

3.8.3 The flare stack height is determined based on relief case with the maximum radiant heat intensity so that the thermal radiation shall not exceed the level of 6.3 kW/m^2 at the ground (excluding solar radiation).

3.8.4 The steel structure of the flare stack shall meet the requirements of Polish building regulations and standards.

3.8.5 A dynamic vibration analysis shall be made for the full range of local wind velocities.

3.8.6 If necessary, provision shall be made to avoid periodical Karman's vortex separation.

3.8.7 Static and dynamic calculation of the flare stack shall be checked and approved by Polish state authorized civil engineer. Refer to Grupa LOTOS S.A. specification no. 5120.

3.8.8 Minimum wall thickness shall be 8 mm including 3 mm corrosion allowance.

4 Ground flare

If ground flare is required, only a proven design with references for comparable capacity and service shall be considered.

Ground flare shall be designed for smokeless and invisible combustion of gas.

If the ground flare is provided further to the elevated flare, gas line to the elevated flare shall be sealed by a water seal of a height equivalent to the maximum allowable gas pressure of the ground flare.

The combustion air intake to the ground flare shall be equipped with silencers to meet required noise level.

5 Flare control and monitoring

- As a minimum following control and monitoring have to be included in the Flare System:

Function	P	T	L	F	A	Remarks
Knock-Out Drum	M	M[1)]	C[1)]		X[1)]	[1)] Low or high temperature and liquid level
Flare Meter				X		
Flare Tip Pilots					X[2)]	[2)] Pilots extinguished

P = Pressure, T = Temperature, L = Level, F = low, A = Alarm, M = Monitoring, C = Control, X = Alarm available as required

6 Quality assurance and testing

- The Inspection and Test Plan (ITP) shall be completed and submitted to Grupa LOTOS S.A. for fixing the notification, review, witness and hold points.
- Design drawings and the design calculations of the flare required in the preceding paragraphs of this specification, the selection of the materials for all components shall be provided for review approval.
- The conformity of pressure parts components shall be certified by mill certificates.
- Mill certificates shall be supplied for all flare system construction material.
- Welding procedures, welding qualification, production test welds (if required), welding and other non-destructive testing and inspection, heat treatment etc shall be performed and certified in full accordance with the applicable code and Grupa LOTOS S.A. standards for welding.
- Prior the start of fabrication prefabrication meeting shall be organize at the place of fabrication.
- 100% radiographic examination is mandatory for all bimetallic welds (for instance: carbon steel with stainless steel or heat resisting steel) and for all alloy steel welds and for each weld that is not accessible for inspection and repair after assembly of the flare.10% spot radiographic test (including all junction welds) for any other welds shall be performed.

7 Inspection

Final inspection and certification shall comprise as a minimum following activities:

- Pressure test
- Dimensional check
- Check of the material certificates

- Heat treatment reports
- Check of the NTD reports

Irrespective to the inspection and testing required above LOTOS Group S.A. reserves the right to witness all steps of fabrication, inspection and testing by its own representatives.

8 Battery limit

Knock-out drum inlet nozzle flange, inlet nozzles of the service piping (steam, natural gas, water, compressed air) located the one point at the flare bottom, discharge nozzle of the pump and top surface of the flare foundation shall be battery limit for the mechanical equipment, piping and stack.

The limit of supply of the electrical and instruments cables shall be terminal blocks (included) in the local panels and/or junction boxes located, at one point at battery limit of the flare package.

Inside the flare package all necessary local panels with glands, junction boxes with glands, cable trays for cable running shall be provided with their supports.

9 Technical documentation

- Data sheet of the Flare:
- Tip
- Pilots
- Stack
- Knock –out Drum
- Water Seal
- Pump and electric motor
- General arrangement drawing
- Plot plan with, foundation drawing with anchoring loads
- Heat radiation calculation
- Static and dynamic calculation of the stack structure
- Equipment list
- P&I Diagram
- Utility balance
- Instrument list with cable list
- Electrical cable list
- Motor list and motor data sheets
- Data sheets for each type of instrument and electrical equipment
- Junction boxes, local panels and cabinet wiring diagram and terminal drawings
- Instrument hook-up
- Loop description and list of alarms

- Arrangement drawings of cable routs
- Welding Procedure Specification (WPS)
- Welding Procedure Qualification record (PQR)
- Material mill certificates
- Acceptance certificates
- Shop inspection and test reports
- Pressure test report
- Sub vendor list
- Suppliers inspection procedure applicable for all components and equipment
- Recommendation for protection during transportation and storage at site
- Instruction for handling on site including lifting procedure
- List of spare parts for commissioning and start –up
- List of special tools for erection and maintenance
- Packing list
- Erection manual
- Commissioning manual
- Flare system manual

10 Relevant documents

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

11 Norms 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:

- API 521 Pressure-relieving and depressuring system
- ASME BPVC ASME Boiler & Pressure Vessels Code – Sections I through X
- ASME B31.3 Process piping
- PN-EN 1993-3-2 Eurokod 3 - Design of steel structures. Towers, masts and chimneys. Chimneys
- PN-EN 1991-1-4 Eurokod 1 Actions on structures. General – Wind actions
- PN-EN 13084 Free standing chimneys
- ICAO International Civil Aviation Organization – wymagania dotyczące oznakowania

12 Record of changes

No.	Date	Description	Introduced by
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