Grupa LOTOS S.A.	**TECHNICAL SPECIFICIATION**	Spec. N^{o}
	Analysers	3510

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1 Subject of specification

This specification used in conjunction with other technical specifications of LOTOS Group S.A., establishes minimal requirements regarding designing and execution of on-line analysers. The requirements must be met in particular on technical design stage, as well during selecting measuring method of analyser.

2 Scope of validity

This specification shall be used when preparing both quotations and Purchase Orders concerning planned LOTOS Group S.A. new investments and modernizations.

It shall also be a base for preparation of other detailed specifications and quotations relevant for package units or other equipment deliveries.

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 SA. 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 SA or non-compliance with the referred documents / standards and obtain a written explanation from Grupa Lotos SA.

2.2 Exclusions

Gas detectors – covered in specification GLSA 3520

Auxiliary systems of analytics– covered in specification GLSA 3530

3 Hierarchy of documents

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 with GLSA
- Data Sheets approved by GLSA
- This specification
- Other Specifications
- Drawings and other documents
- Standards

4 Definitions and designations

GLSA – Grupa Lotos S. A.

On-line analysers - instruments operating in automatic mode, performing measurements of physical and chemical properties in technological processes.

Portable analysers – instruments able to operate in manual or automatic mode of operation, not being permanently built-in on process plant. They have its own system of sample preparation, as well as internal recording of measurements results and instrument condition. They can be supplied from internal or external power supply source.

Analysers shelter – the object constituting place of process analysers operation and preparation of sample, slop systems for analysed samples, coolers and heating systems, as well as air-conditioning system in order to provide proper operating conditions for analysers. For analysers' shelter foundation purposes (four liquid analysers mounted), together with its whole external infrastructure, it is necessary to provide area of dimension 10 m by 8 m, and 5 m in height. Analysers shelter must be "step in shelter" that ensure space necessary for two people maintenance crew working inside shelter with door closed.

5 Description

5.1.1 General principles valid for all analysers

- Analysers used on production plants have flame-proof or reinforced enclosure. It is allowed to use analysers in ventilated (pressurised) and intrinsically safe enclosure, after obtaining LOTOS Group S.A. approval.
- Deviation in regard of flame-proof or reinforced design is allowed for water and power engineering plants, if explosion hazard zones do not exist in places foreseen for analysers' installation. Using suitable for zone 2, Ex n type protection is allowed only in special cases and only with written approval from Grupa LOTOS S.A.
- In general, analysers are being repaired on-site. Therefore necessary working conditions and working space must be foreseen for two people maintenance crew.
- All analysers powered by 230V must be equipped with local turn-off switch located in area not farther then 1,5m from analyser. Switch shall be marked with analyser tag-name and information "Analyser emergency turn off".
- Analysers shall be mounted in analyser shelters in general.
- Deviation from mounting analysers in shelter is allowed only then, if they are analysers installed on ducts of furnaces, pipelines, in halls or if process engineering requirements do not allow for transportation of sample. In such cases analysers can be located in protective cabinets. Such deviation has to be accepted by LOTOS Group S.A. Acceptance is not required for the cases that are allowed in paragraphs 4.1.2 to 4.1.3.
- Analysers must be equipped with sampling system described in GLSA 3530. Vendor shall foresee local indication of pressure, flow, temperature and vales necessary to cut analyser from sample/return line. Sampling system shall contain drain and calibration gases regulation.
- Analysers shall be provided with auto diagnostics system, enabling assessment of their technical condition locally and through network operating with TCP/IP protocol or other, in conformance to GLSA specifications.
- Application of communicators enabling operation of analyser's program without need to Ex enclosure opening is allowed.
- Basic output signal is 4 ÷ 20 mA signal and dry contact for alarm (closed circuit mean no alarm). In case of multi-channel analysers, or such that are measuring several components, each channel or component must have separate output. Deviation applies to chromatographs, for which digital communication with Modbus protocol or others, conforming to GLSA specifications, can be used.

- Manual calibration mode of analysers is considered as basic method, while automatic calibration mode as optional. In case if analysers preferred by Supplier do not feature manual calibration mode, their application is allowed after obtaining GLSA. approval for such solution.
- Component elements of analysers (e.g. pressure transducers) must conform to list of qualified suppliers. In case when instruments originating from other vendors are to be used, then manufacturer of specific analyser must obtain GLSA approval.
- Preferred solution is using of pressure difference between sample point and return line. In case of sample pump application electric engine type is recommended.
- In case when specific analyser needs consumable materials, such as chemical reagents, then basic delivery shall include provision of such reagents for first year of operation. Composition of the reagents and method of their preparation shall be presented to GLSA on running stage of tender action, in order to verify possibility of their preparation by GLSA, as well as introduction into documents of environment protection (dangerous substances management). In case when substances dangerous to environment are used analyser (e.g. mercury compounds), then GLSA approval shall be obtained for their application.
- In case when analysers require application of carrier and calibration gases, it is necessary to foreseen that gas cylinders delivered along with analyser shall originate from supplier having current contract on delivery of special gases to LOTOS Group S.A., or after approved proposed supplier with GLSA. Gas cylinders shall be equipped with pressure reductor to allow direct connection to calibration console pipeline.
- Gas cylinders with calibration or other gases must be located on zero level and fasten to cylinder holder (minimum for 3 cylinders). Each cylinder must have its own pressure reducer or two cylinders can be connected to one switch-over pressure reducing station. Pipelines from cylinder to sampling system and analyser shall be made of one piece of 6mm pipe. In case of using connection manufacturer must perform pressure test that include increasing gas pressure to working level, cutting off whole pipeline and leave it under pressure for 30minutes. No pressure drop is allowed to give positive result.
- Analysers intended for boiler plant or other hot places shall have air-conditioned or cooled cabinets.
- All parts of analysers and especially elements in contact with corrosive sample or atmosphere must be corrosive resistant type. However space for analyzer disconnection shall be foreseen.

5.2 SO_2 and H_2S analyser

- This is the analyser used on sulphur recovery plants, or hydro-desulphurization plants of refinery products.
- The analyser shall operate basing on measuring cell, performing measurement in ultraviolet band.
- The analyser has to be mounted directly on a pipeline.
- The probe enabling sample taking and blowing down, is inserted to pipeline through ball valve and lock, making possible probe slipping in and out of the pipeline without interrupting of technological process.
- The distance between sample point and analysers shall be done as short as possible and constantly heated to at least 160°C. Separate steam line must be provided to this purpose with individual valve marked with analyser tag-name.

- The analyser shall be mounted in protective cabinet equipped according to directions established in specification GLSA 3530.

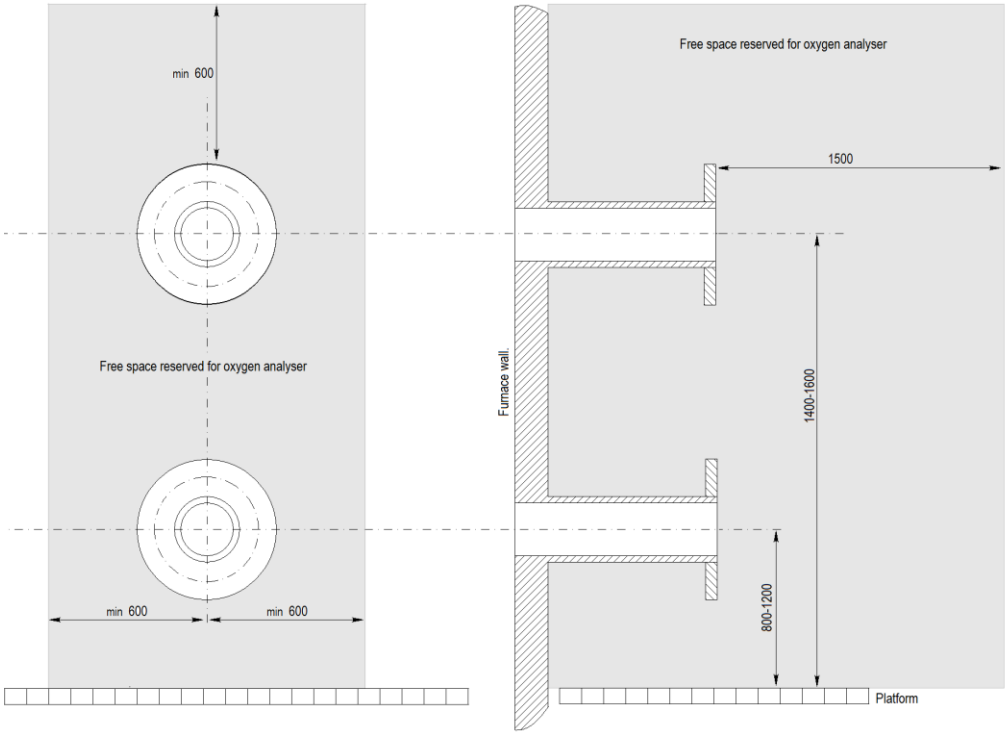
5.3 Hydrogen analyser

- Hydrogen analyser is used for determination of hydrogen concentration in refinery gases.
- The analyser shall operate on the basis of katharometer (thermal conductivity cell) sensor, or flame – ionization gauge.
- Application of analysers with electrochemical sensors is not allowed.

5.4 Analyser of oxygen content and carbon monoxide content in flue gases for furnaces

- This is the analyser monitoring oxygen concentration in flue gases downstream process furnaces and power boilers.
- The basic detector, accepted in GLSA and operated in oxygen analysers, is zirconium detector. Laser beam analysers are allowed if analyser can be calibrated onsite with gas from cylinder. Application of paramagnetic detectors is allowed for emission systems. For other applications, GLSA approval for deviation is required. If temperature of flue gases does not exceed 700ºC, then location of measuring probe in flue gases stream is preferred. For applications where flue gases temperature exceeds 700°C, it is preferred to mount measuring probe on furnace shell, with sample being sucked into cell with use of lifting injector or convection method.

  Carbon monoxide can be measured only if infrared detector IR is applied. In cases where zirconium analyser is equipped with COe cell all documents and information must contain information that combustibles will be measured and not CO. COe detector cannot be implemented to replace IR carbon monoxide analyser where CO measurement is foreseen.
- Each analyser must have its own nozzle located on furnace. It is preferred to provide two nozzles located at two heights that will allow to choose best location for analyser and will provide place for verification analyser. Nozzle location must be approved by instrumentation engineer, Grupa LOTOS representative.
- No other devices can be located around the analyser within a radius of 1m.
- Space for analyzer disconnection shall be foreseen.
- Analysers mounted within explosion hazard zones must be produced in flame-proof version.
- Zirconium oxygen analyser doesn't require analyser shelter but protection from strong wind, rain and snow shall be foreseen. Analyser vendor usually can provide optional isolation protection.
- For analysers of flame-proof design, mounted on furnaces where burners are fired with fuel oil, the sample shall be taken with use of convection method. Application of ventilated/pressurised Ex p enclosure is allowed.
- For analysers mounted on furnaces, where burners are fired with fuel gas, and the analysers are of flame-proof design, the sample shall be taken with use of injector method.
- Nozzle with flange for oxygen analyser must be located at height that allows on-site operation and maintenance activities. Two possibilities are preferred (or both):
  - Nozzle located at 0,8 – 1,2m from platform that allow access from top and both sides.
  - Nozzle located at 1,4 – 1,6m from platform that allow access from any side.



- Oxygen analyser must be equipped with local oxygen indication (display) that will allow to perform two point calibration (located 1 – 1,6m from platform) and calibration console located next to display for one man calibration. Two calibration cylinders (with O2 at different levels) must be provided at the ground and connected to calibration console and then to analyser with one piece of pipe. Vendor shall minimise number of connections and must test finished pipe line for leaks as specified in 4.1.1.
- Two configurations are acceptable:
  - Analyzer with measurement unit located directly on furnace, while transmitter, calibration console and gas cylinders located at the ground level.
  - Analyzer, measurement unit and transmitter located directly on furnace, while calibration console and gas cylinders located at the ground level.
- Calibration console shall be able to fully calibrate analyzer and shall be equipped with:
  - Rotameter for flow measurement of each gas
  - Pressure reductor for carrier gas
  - Needle valve for precision adjustment of flow
- All devices: probe, electronic unit, and calibration cosole shall be accessible from one platform.

5.5 Viscosity analyser

- Analyser of viscosity is used for dynamical viscosity determination purposes in refinery products' streams.
- Measurement of viscosity is performed on basis of differential pressure measurement on capillary tube, through which the measured medium is flowing. It is allowed for some applications to use cell, operating on principle of measuring vibration frequency of piston, placed in liquid being measured.

- Analyser of viscosity cannot be in-situ analyser with exception of measuring products that freezing point temperature is higher than 90°C.
- Preferred are analysers that make viscosity measurement at stable, predefined temperature. Using analysers that measures viscosity at sample temperature and later calculates viscosity at defined temperature requires Grupa LOTOS written approval.
- All algorithms, enabling realization of basic calibration and change of analyser operation range, have to be delivered along with the analyser.
- In particular cases application of analyser, which design allows for installation in pipeline, is allowed. Its mounting shall enable access to measuring part of the analyser, without need to limit production of process plant. Such application requires GLSA approval.
- Pipe lines from sample point to analyser and return line must have independent heating lines (steam or electrical) that ensure keeping sample as fluid regardless its flow speed.
- Pipe with in-situ analyser must have two valves to cut analyser from sample and drain to remove sample form system. Local indication of pressure, temperature and flow shall be foreseen.

5.6 Flash point analyser

- Flash point analyser is used for determination of flash point value in refinery products' streams.
- Detector of the analyser shall operate on temperature monitoring principle of hydrocarbons burnt on platinum sensor in catalytic combustion process.

5.7 Freezing point analyser

The analyser operates basing on measuring cell, which is directly or indirectly cooled and heated with Peltier elements.

Measuring cell operates on principle of measuring elements' setting angle change detection, in the moment when freezing point of liquid is reached.

5.8 Vapour pressure analyser

- Detection shall be based on measurement of partial absolute pressure, measured on nozzle expanding product which vapour pressure is to be measured. Measuring system shall be placed in enclosure ensuring thermal stabilization of product being measured.
- Thermostat of the analyser shall ensure full stabilization of sample prior to introducing it to measuring capillary tube.
- Analyser construction without pump forcing sample through the analyser is preferred. In case when pressure in process pipeline is to low, then circulation pump shall be used that simultaneously shall provide proper pressure on analyser input.

5.9 Specific gravity and density analyser

- Analyser of specific gravity and density for gases shall be based on detector built of vibrating ring, mounted in enclosure compensating sample pressure and ambient pressure influence.
- Analyser of density for liquids shall be based on detector built of miniature U-tube with coils wound on both its arms, where change of wound coils vibration frequency constitutes

measured value. Enclosure of measuring cell must ensure full thermal stabilization of measuring sensor.

- Analyser of liquid density have to be provided with resolvers, enabling readouts of density expressed in various units, API for example.

5.10 Water content analysers

- Analyser of water content in hydrogen gases
  The analyser operates on basis of measuring cells, in which quartz-crystal resonator with hygroscopic material sprinkled on it is detecting element, and detection itself is based on change of quartz-crystal resonator operation frequency change. Alternatively laser beam technology can be used. In both cases analyser must have possibility to check it with internal and external humidity source.
- Analyser of water content in liquid hydrocarbon products
- Analyser of water content in gaseous hydrocarbon products and measuring range up to 1 ppm
- Analyser of water content in instrument air and inert gases

5.11 pH analysers and conductivity analysers

- For pH analysers operating on low conductivity water, reference electrodes shall have large active surface, or analysers with semiconductor electrode shall be used.
  Semiconductor electrode shall be used for measurements in water containing ammonia compounds, or in water coming from separators isolating hydrocarbons from water.
- Measuring cells shall be located outside process pipelines, on by-passes. In case of necessity for application of specific cell in process pipeline, GLSA approval shall be obtained.
- Using of in-situ type analysers is allowed if probe is equipped with retractable assembly that will allow to insert and remove probe under working pressure or if probe is located on by-pass that can be cut off without process interruption. In both cases LOTOS approval is necessary.
- Measuring cells of conductivity analysers shall be located in process pipelines, as far as possible. Measuring probe shall be inserted into pipeline through lock, enabling assembling and disassembling of the probe without need to technological process interruption.
- pH and conductivity analyser generally doesn't require analysers shelter.

5.12 TOC analysers

- TOC analysers shall be equipped with furnace, that enables carrying out of full mineralisation of all compounds contained in water. The furnace shall carry out mineralisation process at temperature of 1200°C.
- CO_2 analyser shall be equipped with thermostat ensuring thermal stability of measuring detector and humidity protection.
- TOC analysers must be located in measuring containers. Additional space must be provided to enables opening analysers enclosure.
- TOC analysers must have sampling systems that will contain filtration, pressure reduction, flow and pressure gauge.

5.13 Chromatographs

- All types of detectors are allowed for chromatographs, depending on intended use of specific chromatograph. Application of selective detectors is preferred.
- Acceptance of LOTOS Group S.A. is not required for chromatographs, if their enclosure is made in „p" version.
- Chromatograph must be located in air-conditioned, step-in analyser shelters. Micro-chromatograph located without analyser shelter can be used only with written approval of Grupa LOTOS.
- Using compact type chromatographs must have approval for their application, and it would be issued only then, when manufacturer of specific chromatograph has adequate service group established in Poland.
- Two-module chromatographs are preferred, where first of the modules contains thermostat with columns and detector, and the second contains electronic system, serving the chromatograph programme.
- The chromatograph shall communicate with plant control system (e.g. DCS) via Modbus, TCP/IP or other communication protocols used in GLSA. Measurement data can be also transmitted by means of 4-20 mA signal.
- The supplier of chromatograph shall agree communication protocols with supplier of plant control system, so that values of individual components, statuses and alarms coming from the chromatograph, would be presented on screen of operator station. The data must be available in form of tables and chart.
- Input module of distributed control system constitutes boundary of delivery for chromatograph.
- Chromatograph scope of delivery must include necessary gases, service applications for computer and on-site start-up.

5.14 Spectrophotometers (NIR analysers)

Spectrophotometers shall be used in such situations, where possibility exists for construction of mathematical model, which basing on measured parameters would be able to substitute several analysers of classical type.

Classical application of such analyser, are product blending systems.

Application of NIR analyser is connected with necessity to collect a few dozen of laboratory samples, required for construction of mathematical model. In connection with this requirement, the supplier must quote, in adequate advance, methodology of sampling and required number of samples. Adequate amount of time shall be reserved in buying process of such analyser type, for preparation of such model.

Time necessary for such analyser start-up shall be foreseen in investment processes.

In connection with mathematical model maintenance necessity, it is required to have adequately trained staff, or to sign suitable agreement with the analyser supplier.

It is preferred to ensure LOTOS representative presence at all activities connected with purchasing of NIR analyser. Contract shall include operation and maintenance training.

5.15 Analysers operated in Emission and Immision Measurement Systems

Analysers operating in both these systems are based on the same measuring methods, and difference between them is connected with measuring ranges and law requirements.

Analysers operating in extraction system and based on standard reference method are preferred within LOTOS Group S.A. Dust analyser shall operate basing on reference method or be individually approved by Grupa LOTOS.

It is important that probes (also in non-typical cases) shall not be located in flame and in combustion zone.

Emission systems must be built in accordance to EN 14181 and Polish regulations and being subjected to quality assurance procedures QAL-1, QAL-2 and equipped with all documentation according to EN 14181. Whole system must be certified by accredited laboratory according to PN-EN ISO/IEC-17025 and validated by independent audit.

For purposes of data collection from analysers one shall use programs, which can be easily adapted to Polish regulations that comply with European regulation. Data collection system must feature possibility of remote backup, and safety copies preparation. Vendor must provide licence for program used for backup.

Documentation of the system must contain full specification of delivered computer system, description of operation algorithms and algorithms of computations performed by the system. The system must be provided with simple mechanism of data transfer to Excel application.

In Imission and Emission Systems one shall use analyser determining concentration of pollutions that are required by Polish Law, for example such as:

- SO_2
- NO_x
- CO
- CO_2
- O_2
- Benzene
- Hydrocarbons required by norm
- Dust
- Humidity – measurement of metrological parameters
- Other compounds, according to tender query.

All stages of contracting and building of Emission and Imission system require GLSA opinion.

5.16 Computers operating in process analytics systems

Computers operating in process analytical systems shall meet requirements given in specification GLSA 3520. The supplier shall take care of:

- verification of hardware and software configuration, from system reliability point of view
- accurate specification of all components
- in case of computers equipped with software stored on arbitrary data carrier (e.g. hard disk or non-volatile memory, from which the computer is booted), the supplier is obliged to prepare and deliver verified data backup copy along with the computer, in the form enabling booting

of the computer without need to reinstall and configure it once again. Data backup procedure, performed by LOTOS Group S.A. employees after commissioning of the computer, shall be simultaneously foreseen and submitted.

- in case the computer is to be connected to factory LAN network, it is necessary to provide automatic method of data backup on another computer (backup server).
- licences for operating system, backup-up application and other application must be part of delivery.

6 Relevant documents

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

7 Norms and standards

Design, fabrication and erection shall comply with the latest editions standards: ASTM, TUF, EPA, and PN-EN

8 Enclosures

- Enclosure No 1, Requirements regarding documentation
- Enclosure No 2 Instrument data sheets

9 Record of changes

No.	Date	Description	Introduced by
1		This specification entirely replaces the former LOTOS Group S.A. standard No. PR 07 360 with the same title.	M. Domaniewski
2	05.05.2011	This specification entirely replaces the former LOTOS Group S.A. standard No. PR 50 018 with the same title.	P. Skoneczny M. Domaniewski
3	30-11-2013 (rev. 2)	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

Grupa LOTOS S.A.	**ENCLOSURE No. 1**	Spec. N^{o}
	Requirements regarding documentation	3510

	WITH OFFER	ON DELIVERY	NOTES
TECHNICAL SPECIFICATION OF MANUFACTURER	Yes	Yes	
LIST OF DEVIATIONS TO TENDER QUERY SPECIFICATION	Yes		
LIST OF SPARE PARTS ALONG WITH PRICES, RECOMMENDED FOR 2-YEAR OPERATION	Yes		
LIST OF SPARE PARTS FOR PRE-COMMISSIONING AND COMMISSIONING PERIOD	Yes		
CERTIFICATES OF TESTS		Yes	if specified
MATERIAL CERTIFICATES ACCORDING TO PN-EN 10204 3.1		Yes	if specified
CERTIFICATES OF CONFORMITY FOR EQUIPMENT INTENDED FOR OPERATION IN EXPLOSION HAZARD ZONE	Yes	Yes	if applies
CERTIFICATES ISSUED BY APPROPRIATE BODY FOR EQUIPMENT SERVING SETTLEMENT MEASUREMENTS		Yes	if applies
DIMENSIONAL DRAWINGS	Yes	Yes	
ELECTRICAL WIRING DIAGRAMS		Yes	
ASSEMBLY, OPERATION AND MAINTENANCE INSTRUCTIONS		Yes	
ELECTRONIC VERSION ON CD CARRIER		Yes	
INSPECTION BOOK	Yes	Yes	if specified
PRODUCTION QUALITY PLAN		Yes	if specified
DECLARATION OF CONFORMITY TO EUROPEAN UNION DIRECTIVE (CE MARK) ISSUED BY MANUFACTURER	Yes	Yes	
CERTIFICATES OF MANUFACTURER		Yes	if specified
CALIBRATION SHEETS		Yes	if specified
HYDROSTATIC TEST REPORT		Yes	if applies