HIGH PRESSURE (HP) TRANSMISSION SYSTEMS

GAS CHROMATOGRAPHS (FOR NATURAL GAS ANALYSIS AT BORDER STATIONS)

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REFERENCES DOCUMENTS

Job Specification DSF-SPC-INS-004

[Technical Requirements for Instrument Erection]

Job Specification DSF-SPC-QAC-005

[Shop Inspection of Equipment and Materials for NGT Project]

Directive 2014/34/EU

[Equipment Explosive Atmospheres Directive]

Directive 2014/68/EU

[Pressure Equipment Directive]

Directive 2014/30/EU

[Electromagnetic Compatibility Directive]

MINISTERIAL DECISION No. Δ1/1227

Governmental Gazette 135B/05.02.2007

ELOT EN 60529

[Degrees of protection provided by enclosures (IP code)]

EN 60801

[Electromagnetic compatibility for industrial-process measurement and control equipment]

ELOT EN ISO 6974

[Natural Gas - Determination of Hydrogen Inert Gases and Hydrocarbon up to C8- Gas Chromatographic Method]

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[Natural gas - Extended Analysis - Gas Chromatographic Method]

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[Natural Gas - Calculation of Calorific Values, Density, Relative Density and Wobbe Index from Composition]

ELOT EN ISO 10715

[Natural Gas - Sampling Guidelines]

ELOT EN ISO 10723

[Natural Gas - Performance Evaluation for On-line Analytical Systems]

ELOT EN ISO/IEC 17025

[General requirements for the competence of testing and calibration laboratories]

EN ISO 6142

[Gas analysis - Preparation of calibration gas mixtures - Gravimetric method]

EN ISO 6143

[Gas analysis - Comparison methods for determining and checking the composition of calibration gas mixtures]

1. SCOPE

This specification specifies the minimum technical requirements of a Gas Chromatograph (GC) system for analyzing Natural Gas samples at the Border Stations of the Transmission System, calculating and recording their physical characteristics.

The system shall be suitable to work in pairs that will comprise at least two GCs working in parallel and analyzing the same stream for redundancy and mutual checking purposes.

2. GUIDELINES AND STANDARDS

The following standards and guidelines (latest editions) form an integral part of this specification.

- **Directive 2014/30/EU**
- **Directive 2014/34/EU**
- **Directive 2014/68/EU**
- **MINISTERIAL DECISION No. Δ1/1227 Governmental Gazette 135B/05.02.2007**
- **ELOT EN ISO 6974**
- **ELOT EN ISO 6975**
- **ELOT EN ISO 6976**
- **ELOT EN ISO 10715**
- **ELOT EN ISO 10723**
- **EN 60801**
- **EN ISO 6142**
- **EN ISO 6143**

3. GENERAL

The GC system shall meet the requirements set forth in the Appendices of this specification.

3.1 GENERAL DESCRIPTIONS

Each GC unit shall have its own related computing facilities with a high level or functional language programming facility, plus the necessary means for the retrieval of stored data and installation of new software versions.

The system shall have the ability to communicate with the central control station through a Supervisory Control and Data Acquisition (SCADA) system.

Each unit shall be designed for analyzing natural gas with an indicative composition corresponding to that specified in the Appendices E, F and G.

Based on the determined gas sample composition the values shall be calculated as per Appendix A.

The unit shall also be connectable to Supervisory Computer or any other computer in order to print.

The printer may be an integral part of the gas chromatograph processing unit.

Furthermore long-term memory shall be provided to enable trend-recording for all components and calculated values.

Since the calculated data will be used by the Owner for accounting purposes, the GC system must be high reliable and accurate according to the state of the art.

4. UNIT SPECIFICATION

Each GC unit shall be equipped with a gas stream selection valve (GSSV) for the selection of the gas sample, including a calibration gas. In the automatically operated stream selection sampling system, the gas sample shall not contain any liquids. Manufacturer/Vendor shall give a full description of its sampling system.

The GC Manufacturer shall be responsible for the selection of a suitable carrier gas and a

suitable detector.

The GC shall have suitable columns to ensure high separation ability and high repeatability for all measured components. The processing unit shall be of the microprocessor-based type, and shall be equipped with a non-volatile memory (EEPROM) or a long duration battery back-up, thus avoiding the need for frequent maintenance.

The system shall be suitable to detect methanol ranging 0% to 0.036% mole.

The Manufacturer/Vendor shall specify the total time required for one cycle of safe and accurate analysis. In any case the total time shall be less than 15 minutes.

The computer software shall be designed for automatic reactivation of the system after power cut-off.

The high level or the functional language program shall incorporate a manual input feature for naming fixed parameters, such as pipeline number, sample stream e.t.c. Further means for remote restoring of the real time clock, date and time should also be incorporated.

Each unit shall store its daily analysis results and calculations on a hard disk.

Data shall be stored chronologically into separate text and graphic files. The file formats shall be suitable to be processed using standard programs. These data shall also be available for transmission.

Communication via keyboard facilities between the analysing system and the local control room or the central control station shall also be available.

Each unit shall be designed for manual or automatic calibration. Automatic calibration shall incorporate a calibration autotest on a daily basis and at a given time.

Gas mixtures to be used as calibration gases shall be selected according to **ELOT EN ISO 6974** and shall have a concentration nearly the same as of the sample gases to be analyzed.

The calibration gas shall be prepared as per EN iso 6142 analysed and checked as per **EN ISO 6143** and shall have a laboratory analysis certificate with concentration as specified by Owner. the specification of the gas concentration shall be required by the Contractor from Owner three

months prior to the commissioning. the laboratory shall be accredited as per **ELOT EN ISO/IEC 17025.**

During the daily autocalibration check, the calibration gas shall be injected through the GSSV into the separation columns and shall be analyzed and reported by detailed chromatographic report. Selectable limits for response factors deviation of a given component shall be included in the program. If a deviation exceeds the allowable limits, then alarm occurs and the software shall give the operator the ability to choose the working status of the device.

The unit shall indicate this alarm condition visually on its display and record it on the printer. The alarm signals shall also be available for transmission as stated in the Appendix B.

If the determined concentration of the chosen component is within the allowable limits, automatic analysis shall continue.

The GC unit shall have self-diagnostic capabilities. Faults detected shall be shown locally and sent to the central control station.

If the GC dedicated hardware / software cannot accommodate the extent of the requirements, then an additional computer unit, dedicated to the GC use, may be provided by the Manufacturer/Vendor. The latter shall be housed in the local control room and shall communicate with the GC analyser unit via a serial link.

5. SYSTEM CONFIGURATION

The standard system configuration shall have the following features as a minimum but shall not be limited to:

5.1 OPERATING STREAMS

Manufacturer/Vendor shall state the maximum operating streams the GC unit can support.

5.2 INVOICING SYSTEM

The GC system shall be capable to perform as a stand-alone analyzer. Furthermore, it shall be capable to interface with multiple GCs and supervisory computers, which together with the flow computers compose an overall invoicing system.

5.3 PERFORMANCE REQUIREMENTS

The analysis shall be done according to **ELOT EN ISO 6974 / ELOT EN ISO 6975,** and the computation in accordance with **ELOT EN ISO 6976.**

In general, the performance of the analyser system shall be characterized by the following:

- Analytical accuracy : Better than 0.15%.
- Repeatability for gross calorific value : Better than or equal to 0.05% repeatability of the measurement of individual components over their specified ranges shall be according to **ELOT EN ISO 6974.**
- Repeatability for physical properties : Better than or equal to 0.1%.
- Component separation: The ability of the system to measure the components specified in the analytical method (system efficiency).
- Linearity of response : The relationship between response and concentration of individual components over their specified ranges.

5.4 COMMUNICATION

The communication with an external apparatus (e.g. supervisory computer system) shall be mainly done via an Ethernet (Modbus TCP) Interface. The unit shall be additionally equipped with two serial RS-232 or RS-485 interfaces (depending on whether the ports have been configured for point to point or bus network / multi-drop communication), utilizing a Modbus (ASCII/RTU) protocol, as well as spare slots available for the installation of any combination of analogue (4 - 20 mA) and digital (24 VDC) software assignable I/O boards. Eight (8) analogue and four (4) digital outputs are required as a minimum.

One of the serial links might be used for the communication between the analyser itself and its computer unit.

5.5 SAMPLING SYSTEM

The sampling system shall follow the guidelines of **ELOT EN ISO 10715.**

6. QUALITY CONTROL

6.1 APPROVAL TEST

The system shall be subject to an approval test by an Accredited Inspection Body nominated by Owner.

6.2 FACTORY TEST

All parts and materials processed, manufactured or assembled within the factory shall be carefully inspected and pre-tested. The complete system shall undergo a full scale test against the specifications in accordance with **ELOT EN ISO 10723.** The outcome is to be stated in a factory test report. Prior to testing, Owner shall be informed in writing.

At any time during which work on the order is being carried out, the Owner or Owner Representative shall have free access to the Manufacturer's premises where the manufacturing and testing of the items ordered take place. The Manufacturer shall without charge, provide Owner or Owner Representative with all reasonable facilities necessary to satisfy them that the product is being produced in compliance with the specifications.

6.3 INSTALLATION

6.3.1 GENERAL

The Manufacturer/Vendor of the system is responsible for the correct installation of the complete system. The GC should be suitable for an outdoor installation, if required.

6.3.2 PIPING

Piping for sample, carrier and calibration gases shall be carried out and tested as specified in **Job Specification DSF-SPC-INS-004.** Test pressure of piping for sample and calibration gases shall be minimum 10 bar. Test medium may be air or nitrogen.

6.3.3 ELECTRICAL

The GC equipment shall be suitable for use in a hazardous area and in accordance with its classification study according to the requirements of **Directive 2014/34/EU.** Enclosures and connections shall have a minimum IP 65 protection class **(ELOT EN 60529),** as far as outdoor installations are concerned. For indoor installations, IP 54 protection class can be accepted.

6.4 STATION COMMISSIONING

Commissioning shall be carried out by the manufacturer after installation of the system. The Manufacturer shall supply all necessary instruments, equipment, means of transportation and personnel necessary to perform the commissioning.

The commissioning carried out by the Manufacturer shall at least comply with the procedures stated in **Appendix C.**

The commissioning shall be supervised by a specialist nominated by Owner.

Owner reserves the right to reject the system if the result of the commissioning proves that the requirements of the specifications have not been fulfilled.

7. TRAINING OF PERSONNEL

Manufacturer shall provide training to Owner personnel in the operation and maintenance of the system at Owner premises.

8. DELIVERY

The delivery is not considered fulfilled until all the items and the associated documentation and certificates have been received.

The system shall be delivered as completely assembled as practically possible. If it is not delivered as a complete unit, each part shall be marked with item number and listed on an item list. The system shall be suitably packed for safe transportation.

9. INSPECTION AND CERTIFICATION

Inspection will be performed by an Accredited Inspection Body appointed by Owner.

Inspection requirements are defined in the following documents:

a. Material Requisition.

b. Job Specification DSF-SPC-QAC-005.

c. Relevant Project Specifications.

d. Inspection Clauses of Applicable Standards.

10. COMPLIANCE WITH THE EU DIRECTIVES

Instrumentation that complies with the "New Approach" directives shall be provided with:

a. A physical CE marking and other information as required by the relevant directives.

b. A declaration of conformity which lists all the directives with which the product complies.

c. Any other information specified by the directive, e.g. user instructions.

11. ATTACHED DOCUMENTS

1. Appendix A

[Calculated Values to be provided by the GC]

2. Appendix B

[Alarms]

3. Appendix C

[Commissioning]

4. Appendix D (Normative)

[The Gas Composition as per National Legislation: Ministerial Decision No. Δ1/1227 Governmental Gazette 135B/05.02.2007]

5. Appendix E (Informative)

[Typical Composition, Range and Standard Deviation Required (Russian Natural Gas)]

6. Appendix F (Informative)

[Typical Gas Composition, Range and Standard Deviation Required (Regassified Algerian LNG)]

7. Appendix G (Informative)

[Typical Gas Composition for Turkish Natural Gas]

APPENDIX A

CALCULATED VALUES TO BE PROVIDED BY THE GC

(See process data)

ALGORITHMS FOR THE ABOVE CALCULATIONS

To be defined during detail engineering and shall include such details as how the basis for the quality figure is to be calculated (mol-fraction, vol-fraction, mass basis, volume basis etc.), as well as whether normalization of the composition to 100% shall be done, or if a check of an upper and lower limit of the expected nitrogen peak area is required, etc.

GC Manufacturer/Vendor shall specify with his quotation all calculation and calibration algorithms available in the quoted software together with the special calculation options he has.

APPENDIX B

ALARMS

Apart from the special alarm requirements which are stated in the process data and the P&ID's, GC Manufacturer shall give a detailed list of all alarm reporting for the system status monitoring.

These shall include:

1. Operation status alarms.
2. Hardware status alarms.
3. Component validity status alarms.
4. System diagnostics both internal and external for system software and hardware.

APPENDIX C

COMMISSIONING

The commissioning shall be supervised by a specialist nominated by Owner.

The commissioning shall, as a minimum, include the below listed activities in this order:

- Determination of response factors for each individual component with a calibration gas according to the Manufacturer's procedures.

- Twenty analysis cycles of a gas sample with a composition similar to the actual expected composition. The standard deviation of the concentration of each individual component shall be calculated. The standard deviations may not exceed the limits stated in **Appendices e & f.**

- Three more analysis cycles on the same gas. For these three analysis cycles of each individual component, the difference Δ_{xi}, equal to the average concentration by the 20 previous cycles, minus the actual found concentrations shall be calculated. Δ_{xi} for each component may in 2 out of the 3 cycles not exceed twice the previously determined standard deviation.

- Repeatability test comparison of response factors for individual components over their specified ranges shall be executed in seven sequential cycles as per **ELOT EN iso 6974.**

- Owner reserves the right to reject a system if the result of the commissioning proves that the requirements of this specification have not been fulfilled.

APPENDIX D (NORMATIVE)

THE GAS COMPOSITION AS PER NATIONAL LEGISLATION: Ministerial Decision No. Δ1/1227 Governmental Gazette 135B/05.02.2007]

		CONCENTRATION
Methane CH_4	CH_4	≥ 75 mole %
Carbon dioxide	CO_2	≤ 3 mole %
Nitrogen	N_2	≤ 6 mole %
Oxygen	O_2	≤ 0,2 mole %
Hydrogen Sulphide	H_2S	≤ 5,4 mg/Nm^3
Total Sulphur content	S	≤ 80 mg/Nm^3

APPENDIX E

(FOR REFERENCE ONLY) (*)

TYPICAL GAS COMPOSITION, RANGE AND STANDARD DEVIATION REQUIRED (RUSSIAN NATURAL GAS)

	TYPICAL GAS CONCENTRATION (MOLE%)	RANGE OF TYPICAL GAS CONCENTRATION (MOLE%)	STANDARD DEVIATION REQUIRED (% OF MEAN)
Carbon dioxide CO_2	0.12	----	0.3
Oxygen O_2	----	----	1.5
Nitrogen N_2	0.82	0.2-1.4	0.2
Methane CH_4	(*)	86.65-96.6	0.03
Ethane C_2H_6	(*)	3.2-8.5	0.2
Propane C_3H_8	0.21	0.00-3.00	0.15
i-Butane i-C_4H_{10}	0.04	0.00-0.52	0.5
n-Butane n-C_4H_{10}	0.04	0.00-0.7	0.5
i-Pentane i-C_5H_{12}	0.02	0.00-0.23	1.0
n-Pentane n-C_5H_{12}	0.02	0.00-0.23	1.0
Hexane + C_6+	0.03	----	1.5
Methanol	----	0.00-0.036	----

(*) To be defined during detail engineering.

APPENDIX F

(FOR REFERENCE ONLY)(*)

TYPICAL GAS COMPOSITION, RANGE AND STANDARD DEVIATION REQUIRED (REGASSIFIED ALGERIAN LNG)

	TYPICAL GAS CONCENTRATION (MOLE%)	RANGE OF TYPICAL GAS CONCENTRATION (MOLE%)	STANDARD DEVIATION REQUIRED (% OF MEAN)
Carbon dioxide CO_2	----	----	----
Oxygen O_2	----	----	----
Nitrogen N_2	0.86	0.18-1.24	0.2
Methane CH_4	92.09	85.76 -96.61	0.03
Ethane C_2H_6	6.23	3.21 -8.54	0.2
Propane C_3H_8	0.71	3.01-3.01	0.15
i-Butane i-C_4Hi_0	0.05	0.52-0.52	0.5
n-Butane n-C_4Hi_0	0.06	0.70-0.70	1.0
i-Pentane i-C_5Hi_2	----	0.23-0.23	1.0
n-Pentane n-C_5Hi_2	----		
Hexane + C_6+	----		

(*) To be defined during detail engineering.

APPENDIX G

(FOR REFERENCE ONLY) (*)

TYPICAL GAS COMPOSITION FOR TURKISH NATURAL GAS

Methane	(C_1)	82% min.
Ethane	(C_2)	12% max.
Propane	(C_3)	4.0% max.
Butane	(C_4)	2.5% max.
Pentane and higher hydrocarbons	(C_{5+})	1 .0% max.
Nitrogen	(N_2)	5.5% max.
Carbon Dioxide	($C0_2$)	3.0% max.
Oxygen	(O_2)	0.5% max.

(*) To be defined during detail engineering.