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Hellenic Gas Transmission System Operator

HELLENIC GAS TRANSMISSION SYSTEM OPERATOR

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TECHNICAL JOB SPECIFICATION

610/6

REVISION 0

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LNG PLANT

TESTING, CALIBRATION & ALIGNMENT OF INSTRUMENTATION

QUALITY ASSURANCE PAGE

CHANGES LOG

REVISIONS LOG

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REFERENCE DOCUMENTS

Job Specification 610/1
[General Instrumentation]

Job Specification 610/5
[Instrument Erection]

ELOT EN 60079-11
[Explosive atmospheres - Part 11: Equipment protection by intrinsic safety "i"]

1.0 GENERAL

Scope of this specification is to provide the general rules to be followed by the Contractor for testing, calibration, check and alignment of instruments and instrumentation systems.

The testing must be considered inclusive of all the operations necessary to have the instrumentation perfectly operating, in accordance with all Owner and/or package Manufacturer/Vendor documentation and with the best workmanship practice. Therefore, all the operations are included in order to assure:

- Every instrument perfect integrity and operability.
- Instruments accuracy in agreement with the values guaranteed by the Manufacturer/Vendor.
- The correct connections.
- Everything else is needed to ensure the perfect instrumentation systems operation.

It is Instrumentation Erection Contractor's (called hereafter only Contractor) responsibility to check the supply correspondence to Owner specifications and any other pertinent documents: in case of any discrepancies Contractor must immediately give written notice to Owner construction management, who will take the proper actions.

2.0 CONTRACTOR'S COSTS

Instrumentation testing has to be performed in accordance with the general rules outlined in this specification and with the Manufacturer/Vendor's instructions and recommendations.

The following shall be considered at Contractor's costs:

a) Expendable materials.

b) Testing instruments.

c) Tools.

d) Calibration benches.

e) Suitable premises for instruments testing, calibration and storage. Such premises must be weather resistant, their climatic internal conditions shall be ideal for accurate testing performance and they shall ensure that no damage will occur to the instruments stored therein.

f) Everything else needed to perform the works in the best workmanship practice.

g) Qualified staff (instrument engineers).

At quotation stage Contractor must submit to Owner approval:

a) Equipment list (bench, tools, etc.).

b) List of testing instruments, complete with their type and accuracy.

c) Layout of the premises where tests and calibration will take place.

d) Everything else could be suggested by Contractor's experience.

e) A short professional curriculum of the instrument engineers leader, responsible

for testing and calibration. It is Contractor's responsibility to replace immediately those people who will be considered by Owner Supervisors unqualified for the specified job.

Testing instruments must be of high accuracy.

Each instrument accuracy shall be certified by a qualified institute. Owner Supervisors have the right to ask for a check of testing instruments accuracy and the Contractor has the duty to provide it. Should the accuracy not meet the certified value, the check cost will be at Contractor's expenses.

Each test shall be resumed in a report signed by the Contractor:

Contractor shall submit a form with the title "Instrument testing and calibration" which has to be approved by Owner.

All the costs related to the delivery of instruments from Owner warehouse to the calibration site, as well as all costs outlined on the Owner specification relevant to the installation work must be considered at Contractor's expense.

Therefore possible dismantling and reassembling operations, if necessary for calibrations and tests shall be at Contractor's expenses.

3.0 INSTRUMENTATION TESTING AND CALIBRATION

Instruments testing and calibration include the following activities:

a) Inspection.

b) Bench calibration.

c) Verifications (installations check).

d) Pressure test, electrical insulation and continuity check.

e) Loop checking/field calibration (check of operation alignment).

f) Tuning (*).

(*) **NOTE :** This activity normally is not required unless otherwise specified.

For general inspection, installations check, pressure test, electrical insulation and continuity check refer to **Job Specification 610/5.**

4.0 BENCH CALIBRATION

The planning of bench calibration works shall be elaborated by the Erection Contractor and approved/modified by Owner Instrument Supervisors.

Owner Supervisors shall check, prior to activity starting, Contractor's premises and to verify that instrumentation workshop is as specified in this document and all the required personnel equipment / tools are available and in accordance with the previous articles of this Specification. Additionally the following documentation shall be provided by Contractor and shall remain available, in instrumentation workshop, during bench calibration activities:

- Certifications by a qualified institute for each one of the prototypes instruments that are available inside the instrumentation workshop, with tractability maintained via instruments serial number. In this certifications shall be indicated, as a minimum, the certified accuracy, the calibration's date and the validity limits of the certifications.

- The data sheets of all instruments that shall be bench calibrated, together with the

relevant Manufacturer's Certifications, as specified in **Job Specification 610/1,** to be segregated in files per instrument type.

- Manufacturer's operation manuals and calibration procedure for all special type instruments requiring bench calibration. The necessity of these documents shall be defined on site by Owner Instrument Supervisor.

Any further documentation required by Owner Instrument Supervisors for smoothly performance of bench calibration activities.

4.1 INSPECTION

The following verifications shall be carried out to ensure the instruments correspondence to the required characteristics:

a) Verification that all instruments are in accordance with Owner requisitions and any other pertinent documentation.

b) Verification that instruments are suitable for the installation shown on Owner hook up sketches, drawings etc., as well as Manufacturer/Vendor's instructions and recommendations.

c) Check of both primary (process side) and secondary connections.

d) Visual examination to determine the "good state" of instruments.

e) Shipping stop removal.

4.2 CALIBRATION TEST

a) Generally instrument calibration means the operations necessary to ensure the correct working of the instruments (correspondence between input and output signals, range and span adjustment, etc.) and to verify that the instruments will measure indicate and record within the tolerances guaranteed by the Manufacturer and that in any case fulfill the specific project's requirements. Specifically, for the controllers, alignment of the controlling unit is included.

b) The instrument 'bench calibration' includes the above mentioned operations for all the instruments for which the calibration is to be performed in the Contractor's workshop at site prior to their installing.

c) In **para. 5.1** and **5.2** instruments are listed which normally are bench or field calibrated, respectively. These lists are to be considered indicative and not restrictive.

d) The calibration of indicating, recording and/or transmitting instruments, in general shall be made at five points (0, 25, 50, 75, 100 %) of the range, on both rising and falling of the input signal.

Linearity adjustment shall be made at 25, 50 and 75 %.

e) When pressure test is foreseen, test medium shall preferably be nitrogen. Nitrogen bottles, when required, shall be supplied by Contractor.

5.0 INSTRUMENTS REQUIRING SITE CALIBRATION

5.1 INSTRUMENTS TO BE BENCH CALIBRATED

a) Pressure gauges

b) Pressure switches (see **note** 1)

c) Pressure transmitters and/or direct meter controllers

d) Differential pressure transmitters and/or meters, controllers

e) Rota meters: indicators, transmitters, controllers (see **note** 2)

f) Orifice plates (bore check)

g) Level switches

h) Temperature dial indicator (see **note 3)**

i) Temperature transmitters and/or direct meters, controllers (bulb type)

j) Electronic instruments and relevant accessories

k) Electronic transducers / converters

l) Electronic trips, and devices (see **note 1)**

m) Board mounted receivers, electronic and/or pneumatic

n) Safety relief valves (see **note 8)**

5.2 INSTRUMENTS TO BE FIELD CALIBRATED

a) Control valves and relevant positioners (see **note 4)**

b) Level transmitters and/or controllers (displacement and floating type)

c) Tank level indicators and transmitters (telemetric type or similar) (see **note 5)**

d) Emergency shut-down systems. Interlock systems. Sequences (see **note 7)**

e) Sample analyzers (pH, flue gas, O_2, conductivity, etc.)

f) Positive displacement flow meters and similar (see **note 6)**

g) Densitometer for gas metering

Notes relevant to paragraphs 5.1 and 5.2

Note 1 The calibration will be made in correspondence of the set point, decreasing or increasing the variable, respectively for minimum or maximum trips. Both set point and differential gap shall be recorded.

Note 2 As far as the metering is concerned, check the free movement of the float within the entire range. In case of transmitting and/or controlling devices, check the output signal according to the general rules.

Note 3 Check one point between 30 and 70 %.

Note 4 Check in correspondence of the 3 positions : completely closed, 50% and fully opened.
This check shall be made by-passing the positioner (if possible) and must be repeated through the positioner.

Note 5 Calibration could be made during the plant start-up, unless otherwise prescribed by Owner.

Note 6 Calibration by Manufacturer/Vendor but a function test has to be performed in connection with the tightness test after erection on site has been completed. After tightness test of the header upstream of the turbine meter, test gas (NITROGEN) is led to the meter run by opening the shut-off valve. When the test gas flows into the meter both the mechanical counter and the counter in the flow computer, i.e. both actual and corrected flow, is checked to ensure that there is a flow. While the meter run is pressurized the flow computer is checked to ensure that a reasonable gas

density is shown.

Note 7 Check shall be made as specified under **para 7.2.**

Note 8 Check of set pressure. Check of tightness, (see **Job Specification 610/5).**

5.3 SPECIAL INSTRUMENTS

Generally, special instruments will be equipment such as:

- Distributed control system microprocessor based.
- Data logger systems.
- Digital temperature systems (Digital TI).
- Special emergency shut-down systems.
- High density electronic sequence systems.
- Complex analyzers (chromatographs).
- Other special instrument systems.

Generally, the calibration and check of operation will be at Manufacturer responsibility. Therefore procedure and prescriptions agreed with manufacturer will be followed. However Contractor is requested to supply the needed assistance to the Manufacturer for the field testing and calibration for these special items.

5.4 PACKAGE'S INSTRUMENTATION

It is preferable for al package's instrumentation to be supplied pre-installed on packages skid and to be checked by Manufacturer as integral part of the package. In that case no additional checking is required on site. For package's instrumentation that is supplied "loose" the requirements of this specification shall be applied per instrument type. Safety valves on packages are excluded and shall be handled same as the other safety valves of the project.

6.0 FIELD CALIBRATION

Time and schedule for filed calibrations activities shall be elaborated by the Erection Contractor and approved/modified by Owner Instrument Supervisors. Similar requirements to those described for bench calibration concerning personnel tools/equipment and documentation availability and handling are also applicable in field calibration. Moreover, Contractor shall provide for all additional requirement that may be risen by Owner Supervisor, such us temporary accessibility facilities, safety precautions, cranes etc. Field Calibration is required for instruments as listed in article 5.2 of this Specification where general rules are also indicated. In particular the below articles shall be adhered to:

a) Flow Instruments

In line flow instruments, mass flow meters, ultrasonic flow transmitter etc., normally are installed by other (e.g. Mechanical Erection Contractor). It is anyhow Instrumentation Erection Contractor's responsibility to check their installation is according to project, Owner and Manufacturer/Vendor's requirements and with respect to flow direction of the line. Field calibration checking shall be performed according to Manufacturer/Vendor's procedure.

b) Level Instruments

Float and displacer type instruments shall be checked at minimum, midpoint and maximum levels at the same time the vessel they associated with, is liquid filled.

If vessels are not field hydrostatically tested or if it is not feasible to check the instruments with the vessels, external cages shall be filled with fluid and internal instruments shall be mechanically actuated to check output.

Gauge glasses and gauge board - Check when vessels are liquid filled for hydrostatic test.

Differential type - Either check when vessels are liquid filled or check against a portable manometer for correct reading and/or output at 0, 25, 50, 75, and 100% differential.

Tank gauging - Position of float either with vessel fluid or mechanically and check reading and/or output signal at minimum, midpoint and maximum levels.

7.0 LOOP CHECKING

Loop checking shall be carried out taking into consideration the requirements of **ELOT EN 60079-11** by Contractor upon final installation of instrument has been completed after piping testing/commissioning activities. These activities shall be performed by others but it is Contractor's responsibility to ensure the following:

During pressure tests of the equipment to which the instruments are connected, it is mandatory for the Contractor to provide the following:

- All instrument primary block valves (process side) must be closed.

- All instruments shall be in a safe position by opening drainages or vents or by disconnecting their process connections.

- Any precaution needed to avoid instruments damage.

Furthermore Contractor is requested to check that:

- In-line mounted instruments (normally installed by others) are in a safe position in accordance with the prescriptions given by Owner construction management (block valves closed or instruments dismounted from the lines, control vales either dismounted from the lines or in open position).

- Be sure that all orifice plates are not installed in lines.

7.1 INSPECTION

After completion of above described Mechanical Erection Contractor activities, Contractor shall inspect the site to verify the correct instruments re-instatement.

Special care shall be taken for correct re-instatement of in-line instruments, control valves and primary elements according to instrumentation drawings, details and requirements and with respect to flow direction of the lines. In that stage shall be checked also the completion of instruments protection foreseen by Owner documentation:

- Direct sun exposure.

- Flush, purge, seal etc.

- Fire proofing (cable trays, special devices, etc.) (*).

- Insulation (*).
- Tracing (steam/electrical) (*).
- Any other protection required by **ELOT EN 60079-11** and Owner documentation.

Note:

Activities marked with asterisk (*) can be completed after loop checking (subject to Owner's Engineer approval) but in any case before start-up.

Check in control room of the correct installation of all the instruments and accessories installed on the control panels and within the control room area.

The Contractor shall perform the necessary inspections and provide sufficient manpower and equipment (on his own account) for completing the station as described in this specification.

The Contractor's time schedule shall show sufficient time between testing and handing-over to allow correction of failures as well as supervision.

Normally, the Contractor will not be allowed to proceed with the next step before the preceding step is finished and approved.

7.2 LOOP OPERATION CHECKING

The operation check includes all the verifications to ensure the correct response of each loop, automatism, sequence, etc.

As a rule, in this phase, no calibrations are required, since each loop components has already been calibrated.

In general, the loop checking shall be performed by simulating in a suitable and reliable way the process variables which are inputs to field transmitters, switches, converters, etc.

Rather, an overall verification is required to ensure both the correct insertion of each component and the correct operation of each loop. The following list of operation to be performed is meant to be a guide and is not restrictive:

Check of the power supply systems (electrical and/or pneumatic).

Check of the correspondence between each electrical breaker/pneumatic valves and the relevant loop.

Check of the right action of all the components of the loop so that generating signals of various levels will operate the final elements in the proper sense.

Check of the proper operation of every primary device of safety, alarm, etc. systems.

Adjustment of controllers action in safe position: wide proportional band, derivative and reset action excluded.

Check the proper operation of all special sequences.

Any other verification to have the instrumentation working properly.

As a guide, some particular cases are indicated here below:

7.2.1 CONTROL VALVES

Each remote operated valve shall be stroked from its remote station.

By applying the proper signal to the valve operators, the valve stroke shall be checked for each end and midpoint of its travel.

Travel indicators, positioners and transducers shall be checked for proper stroke position of valve at both ends of travel.

Hand operated valves shall be stroked and travel indicators checked. These apply also to motor operated valves provided with hand wheel.

A visual inspection shall be made to insure valves are installed in accordance with the specified or recommended direction of flow.

Where positive tight shut-off is required, the valve shall be checked for seats leakage.

7.2.2 PRESSURE GAUGES WITH SWITCHES FOR ALARM

The alarm limits shall be adjusted according to the alarm limits indicated in the set point list.

The test medium is nitrogen.

The normal pressure to be supplied.

The pressure of the nitrogen shall be raised to the high alarm limit and afterwards reduced to the low alarm limit.

It shall be checked that the alarm is received in the SCP and in the GCC. The pressure of the nitrogen shall be regulated to operating pressure.

Now, it shall be verified that the alarm indication in the annunciator panel, will not disappear until reset of the alarm on the panel.

It shall be checked that the alarm in the GCC disappears.

7.2.3 SLAM-SHUTS POSITION SWITCHES

It shall be verified that closed valve activates the position switch for closed valve equal to alarm.

The alarm shall be checked in the SCP and in the GCC.

By reopening the slam-shut valve it shall be verified that the alarm indication in the annunciator panel will not disappear until reset of the alarm on the panel.

It shall be checked that the alarm in the GCC disappears.

7.2.4 ELECTRIC ACTUATORS POSITION SWITCHES

For the motorized valves as a minimum the position switches for open and closed valve indication shall be tested.

It shall be checked that the limit switch for open valve stops the actuator, when the valve is open. It shall be checked that the limit switch for closed valve stops the actuator, when the valve is closed. It shall be checked that the remote signal close from the GCC closes the actuator.

8.0 ALIGNMENT

After the check of operation the alignment will follow.

Alignment means the operations required to have the synchronization of all the loop components.

Normally, unless otherwise specified, the alignment is made keeping the measured variable at zero (process side) and with the signal at minimum level (3 psig, 4 mA, etc), then synchronizing the loop on these values.

9.0 TUNING

This is an operation to be performed when the plant is in operation. It consists of making minor corrections to receivers settings to have the instrumentation as it is required in the way of control.

a) At this stage the proper actions of control mode will be defined as well as the settings check of every trip devices and special systems.

- Proportional band value on each controller.
- Derivative action value on each controller.
- Reset action value on each controller.
- Set point value.
- Check of every time delay relays connected with alarms, shut-off and sequence systems.
- Any other operation required to have the instrumentation working in the best of the ways.

b) Unless otherwise specified by Owner the tuning will be performed when the plant is in operation (start-up).

The tuning normally is out of the scope of Contractor's work unless specifically requested. However, Contractor is requested to supply 24 hours per day qualified and skilled personnel, perfectly aware of the plant instrumentation. These personnel will report to Owner and will be employed as assistant as required by the circumstances.

Furthermore, Contractor has the duty to supply the necessary labor which could be required due to plant modification during the start up phase.

10.0 ACCEPTANCE

The preliminary acceptance of the instrumentation will typically consist of a spot check (10 % maximum) of the instruments already tested by the Contractor, unless differently specified with Contractual Documents.

This check will be at Contractor's expenses and will be carried out with the cooperation (supervision) of Owner instrument Supervisors.

After this check a report will be prepared and signed by the Contractor and Owner Supervisor.

a. Contractor's signature will confirm that all instrumentation has been duly tested and calibrated.

b. Owner instrument Supervisor's signature will mean that a spot check has been done and that the methods followed by the Contractor performing the testing and calibration of all the instrumentation are in accordance with the specifications and prescriptions given by Owner. In any case it is to be noted that the signature of Owner instrument Supervisor in the above mentioned report does not affect any clauses and any guarantees given by the Contractor and that the final acceptance will be released to the Contractor only after the plant start-up and in accordance with the clauses outlined in the Contract.