ANNEX I

GAS MEASUREMENTS AND TESTING AT THE DELIVERY POINT

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1. Purpose

This document has the following purposes:

- To set up the guidelines to be used in the right measurement of natural Gas flow at the Delivery Point;

- To maintain, regulate and calibrate the Delivery Point measurement facilities, and to manage measurement information, ensuring compliance with the applicable regulations on Gas measurement.

2. Scope

The Gas measurement and transfer facility to which this protocol refers is located at the Delivery Point. GNLM will deliver the regasified Gas from the regasification Terminal to gas pipelines and Clients.

This document communicates the rules which back up the activities described herein. It also covers the activities dealing with natural gas volumetric flow and energy calculation under the operating temperature (T) and pressure (P) conditions at the measurement points; the determination of the lower calorific value (LCV) and upper calorific value (UCV); the calculation of the compressibility factor for the gas mixture under reference conditions ($Z_{referencia}$; 15 °C and 101,325 kPa) and the compressibility factor (Z) under T and P conditions measured at the measurement point. Additionally, it covers tasks related to the chromatographic analysis of the gas (composition of the Gas sent out to a Downstream Gas Pipeline) and to obtaining a corrected volumetric flow (q_{vc}) under standard T and P conditions.

With regards to maintenance, it covers the checking, inspection and calibration of the instruments involved in gas volumetric flow measurement, such as transmitters, field indicators and analytical instruments (online chromatograph, standard samples for analysis, etc.) and in general, the primary, secondary and tertiary instruments involved in Gas volumetric flow measurement at the measurement points.

It also describes the methods used in gas volumetric flow determination when abnormalities or errors in the measurement system occur as a result of maintenance procedures or instrument and equipment failures, and sets the acceptance or rejection criteria for measurements due to said abnormalities or errors in the case of scheduled events and/or eventual failures.

Finally, it describes the necessary requirements for ensuring that the measurement system(s) remain unaltered.

3. Definitions, Symbols and Abbreviations

Self-calibration (chromatograph): A self-assisted procedure of gas chromatography equipment whereby the actual composition of natural gas is compared, at certain defined time intervals, with the results obtained in previous time periods and/or against parameters pre-entered into the equipment and/or with known values of gas-standard samples.

Bar or bar: Unit of pressure equivalent to 100 kPa.

Btu: A British thermal unit which is equivalent to the amount of energy of 251.995761 calories.

Molar composition: Moles of the component of interest ("i") over the total moles in the mixture, expressed on a percentage basis as mol/mol (n_i/n_{total}).

C_9+: Hypothetical set defined in chromatographic analyses of natural gas to quantify the composition of hydrocarbons with a number greater than or equal to nine carbons (C_9 to C_{12}).

Relative density: The relationship between the density of a substance of interest (e.g., natural gas) and that of another used as a reference ($\rho_i/\rho_{referencia}$) under the same temperature and pressure conditions. For gases, the estimation of relative density uses air as a reference substance under temperature and pressure conditions equal to 288.15 K (15 ºC) and 101,325 kPa, respectively.

Accuracy: The extent to which a measured variable deviates from its actual value.

Compressibility factor: The relationship between the actual molar volume of the fluid and the volume it would have if it were calculated using the ideal gas model under identical temperature and pressure conditions. It may be understood as a correction factor that measures the deviation of the actual behavior of a substance from the behavior it would exhibit in an ideal state (molecules of negligible volume without energy interactions).

NA: Gasoducto Nor Andino (Nor Andino Gas Pipeline)

GA: Gasoducto Gas Atacama (Gas Atacama Gas Pipeline)

Wobbe index: A measure of the interchangeability of a gas of a given composition by another with a different composition in relation to combustion characteristics. It is defined as the relationship between the upper calorific value (UCV) and the square root of the relative density of the gas.

Modified Wobbe index: An index designated as MWI, which provides for measuring the degree of substitution of various types of natural gas and which is determined by the following expression:

MWI = (LCV/35.314667)/√((MWgas/28.9625)*Tgas)

$\mathbf{n_i}$: Moles of the “i” component, in % mol/mol.

$\mathbf{n_{total}}$: Total moles of the mixture (n_{total}: $\sum_{i=1}^{N} n_i$) , in % mol/mol

m^3Std: **m^3 standard:** The volume of one cubic meter of dry gas measured under Standard Conditions, i.e., at a Temperature of 15 °C and an Absolute Pressure of 1.01325 bar.

m^3Std@9300Kcal: m^3Std with an energy content of 9300 Kcal/m^3Std

Precision: A measure of the dispersion of a set of values obtained through repeated measurements of a magnitude.

Lower calorific value (lcv or LCV): The energy released in the (full) isothermal and isobaric combustion of natural gas, in which the products of the reaction –i.e., carbon dioxide and water– are obtained as gas and saturated vapor, respectively. The temperature and pressure conditions under which the reaction takes place depend on the reference state selected (e.g., 298 K (25°C) and 101.3 kPa).

Upper calorific value (upv or UCV): The energy released in the (full) isothermal and isobaric combustion of natural gas in which the products of the reaction –i.e., carbon dioxide and water– are obtained as gas and saturated liquid, respectively. The temperature and pressure conditions under which the reaction takes place depend on the reference state selected (normally 298 K (25°C) and 101.3 kPa). The upper calorific value is the maximum energy that can be obtained in the combustion reaction of natural gas, as it considers energy recovery by condensation of the water vapor generated in the combustion reaction.

Atmospheric pressure: The force per unit area exerted by the weight of the atmosphere on a given surface. For the purpose of this Protocol, the value of atmospheric pressure to be used will be the value resulting from the arithmetic mean of the monthly averages reported by the *Dirección Meteorológica de Chile* (Chilean Bureau of Meteorology) at its Cerro Moreno-Antofagasta station or whichever replaces it, in the event there is a station that delivers better information about atmospheric pressure at the Mejillones terminal.

Hydrocarbon dew point: The temperature, pressure and composition conditions of a hydrocarbon mixture under which the first "dew drop" of the liquid phase is observed to appear/disappear, in equilibrium with the vapor phase.

Repeatability: This term indicates the degree of agreement of test results between mutually independent assays, obtained by using the same method, with identical materials, at the same laboratory, by the same operator, using the same equipment, and within a short time interval.

Reproducibility: This term indicates the degree of agreement between mutually independent results of an assay obtained by the same method, with identical materials, at different laboratories, with different operators, and using different equipment.

List of Symbols and Abbreviations

$D_{interno}$	Internal diameter of the ultrasonic flow meter
P	Pressure
$P_{referencia}$	Reference pressure (101.3 kPa)
q_{vc}	Corrected volumetric flow rate
T	Temperature
$T_{referencia}$	(15 °C)
Z	Compressibility factor of the mixture
$Z_{referencia}$	Compressibility factor under reference conditions

Acronyms

AGA	American Gas Association
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing Materials
GA [	Gasoducto Gas Atacama (Gas Atacama Gas Pipeline)
Gas	Natural gas
GNLM	Sociedad GNL Mejillones S.A
ISO	International Standard Organization
LNG	Liquefied natural gas
MMBtu	Million British Thermal Units (British energy unit)
NA	Gasoducto Norandino (Norandino Gas Pipeline)
UCV	Upper Calorific Value

LCV	Lower Calorific Value
S.A.	Sociedad Anónima [i.e., a corporation]

4 General

4.1 Natural Gas Measurement

The measurement systems provided for in this Annex will be applied to the measurement of the Gas volume and energy quantities delivered by GNLM to the Client at the Delivery Point.

All the Gas delivered at the Delivery Point shall be measured in MMBtu. As a reference, one (1) MMBtu is equivalent to 27.09634387 m^3Std@9300Kcal.

4.2 Presence of the Parties

Whenever GNLM performs an activity that may affect the result of the measurements made at the Delivery Point, including, but not limited to, equipment checks, calibrations, maintenance and repairs, it shall give notice to and invite the Client to participate as a witness of said activity, so that the Client may express its approval or rejection of the results thereof.

The abovementioned notice and invitation shall be communicated at least 96 hours beforehand, unless an extraordinary emergency intervention is required, so as to prevent measurement errors and/or loss of data, in which case GNLM shall inform the Client at the time the emergency is detected.

GNLM may not carry out any activity in the measurement system, such as calibrations, adjustments, or any other task that may mean a change of configuration, the alteration or loss of data, without the Client having been advised and invited beforehand to participate in the performance thereof.

If GNML has reliably confirmed the date and time of performing a given task, and the Client fails to put in an appearance, GNML will be entitled to perform exclusively the tasks scheduled for that date, and whatever action is performed shall be deemed to be fully valid. If this should happen, GNML shall give prompt and reliable notice to the Client of every action performed, and send the Client all the documentation related to the activity, including, but not limited to, measurements made on the equipment before and after performing the activity, a detailed description of the tasks, identification and serial number of the equipment involved, electronic records, changes in programming parameters of flow computers or chromatographs, etc.

GNML undertakes to communicate, as early as possible, any force majeure circumstance that forces it to interrupt any agreed activity, in order to prevent the unproductive deployment of personnel and equipment. If this situation should come about, a new date and time to perform said activity shall be agreed to in the short term, showing consideration for the Client's possibility of attending.

Whenever an intervention takes place, whether it is a revision, calibration or change, etc., in the measurement facilities, a certificate shall be issued stating the status of the facility prior to and after the intervention has taken place, including all the parameters required to fully trace the performance of the measurement. Such a certificate shall be signed by all participants in the procedure.

<u>4.3 Safety Strapping</u>

GNLM will implement a system of safety strapping and/or seals to ensure the inviolability of the measurement systems (valves, transmitters, primary measurement equipment, flow computers, chromatographs, and so on). A numbered safety strapping shall be placed at each point to be safe strapped.

The placement and breaking of safety strapping shall be communicated and entered in the Safety Strapping Certificate.

Strapping and/or seals shall be used in such a way as to render it impossible for the measurement system to be violated without breaking one of them.

4.4 Flow Computer Configuration Parameters

Flow computer configuration parameters shall be in strict accordance with the physical characteristics of the measurement system and the variables associated to the site where the measurement system is installed, e.g., atmospheric pressure, and so on.

At the same time, each flow computer shall register any changes in flow computer configuration parameters in an encrypted database –i.e. not modifiable by any system user, including users with maximum administrator privileges– indicating for each individual change at least the following information: date, time, user name, modified parameter, previous value, new value. This database will always be kept at the disposal of any user who requires it, along with the software that enables it to be properly read, registered and stored.

4.5 Party Access to Data Reading and Collection

In accordance with section 4.2 above, GNLM shall allow Client access to the facilities to witness data reading and collection, as well as to check the measurement system flow computer configuration concerned.

Whenever such access takes place, an overall visual inspection of the measurement facilities may be made, including check-ups on the areas with safety strapping, positioning of shut-off valves, instrument power supply, and so on.

5. Natural Gas Volumetric Flow Measurement

5.1 Description of the Natural Gas measurement system

The Gas flow measurement system installed at each of the Delivery Points consists of two measurement skids: the first is meant to measure the Gas flow transferred to the GNA gas pipeline; the second is meant to measure the Gas flow transferred to the GGA gas pipeline. Each skid (per each Delivery Point) features two measuring arms, each fitted with two multiple-path ultrasonic flow meters (with mechanical installation and associated instrumentation in conformity with AGA-9 recommendations), which have been installed in series to provide for redundant Gas flow measurement.

The measurement system described also features temperature and pressure transmitters plus a gas chromatograph which is shared by both measurement arms, all of which allow the meters to read the corrected volumetric flow.

The gas chromatograph allows to obtain the composition of the Gas and is shared by both measuring skids. A gas composition analysis can be performed for mixtures formed by saturated hydrocarbons with nine or more carbon atoms (nonane and higher; C_9+). The chromatograph is connected to the flow computer and transmits the Gas composition in real time (according to the sampling time set up in section 6 of this Annex), allowing, along with the T and P variables, for the subsequent determination of the corrected volumetric flow in each regulating skid arms as per the procedure described in section 5.10.

5.2 Admissible tolerances for measurement variables

The admissible tolerance for the components of the measurement system is the lesser value between: i) the error limits established in the applicable regulations; ii) the maximum error reported by the manufacturer.

5.3 Costs associated to calibrations

The cost of testing and calibration involving the equipment units that make up the measurement system and envisaged in GNLM's maintenance plan shall be borne by GNLM. The aforementioned GNLM maintenance plan shall be at least the one recommended by the manufacturer of the equipment concerned.

In case the Client requests the performance of any testing and/or calibration which is not included in the aforementioned GNLM maintenance plan and the results of said Client-requested testing demonstrate that the measurement equipment is within the calibration required by the applicable regulations or within the precision stated by the manufacturer, the cost of said testing and/or calibration shall be borne by the Client. Otherwise, the costs shall be borne by GNLM.

5.4 Alternative and backup measurements

Based on the configuration described in section 5.2, a designation has been set up for each of the meters installed in series (applicable to each skid); the meter installed immediately downstream of the pressure regulation skid has been designated as the Primary meter, and the one installed immediately upstream of the contractual delivery point has been designated as the Secondary meter. The main difference between the two meters lies in the fact that the measurement read by the Primary ultrasonic meter will be considered for invoicing purposes, while the measurement read by the Secondary ultrasonic flow meter will only serve for comparison with the Primary meter, as well as for the cases mentioned below:

In case the differences between the corrected measurements by both ultrasonic flow meters are less than the specification in the AGA-9 standard but a failure occurs in the Primary ultrasonic flow meter, the measurement of the Secondary ultrasonic meter shall be deemed to be valid for invoicing purposes. In case the differences in measurement are less than the specification in the AGA-9 standard and a failure occurs in the Secondary meter, the measurement by the Primary ultrasonic meter will continue to be valid for invoicing purposes. However, stakeholders shall be advised of the time and reason why the flow measurement was carried out without a comparison, or why invoicing was made on the basis of the Secondary ultrasonic meter reading.

In case any differences are found to exist which are greater than the specification in the AGA-9 standard (absolute and relative to the Primary meter) between the corrected measurement read by the two ultrasonic flow meters in series (placed in either of the skids), the Primary ultrasonic flow meter and associated instrumentation shall be initially subjected to checking, and the measurement yielded by the Secondary ultrasonic meter will be deemed to be valid for invoicing purposes. If as a consequence of the checking it is found that the Secondary ultrasonic flow meter exhibited the defects that led to the differences, invoicing will be made as from the date when such failure was detected, as mentioned in the paragraphs below.

In case no defect whatsoever is found in the Primary meter, the Secondary flow meter and associated instrumentation will be subjected to checking, and again the measurement yielded by the Primary ultrasonic flow meter will be deemed to be valid for invoicing purposes. Nevertheless, the reading time interval used for invoicing based on the Secondary meter shall be corrected according to any one of the procedures described in the following paragraphs.

If for any of the reasons discussed in the preceding paragraphs of this section the Gas flow measurement is found to be in error, one of the following criteria will be used:

(i) For a time period less than or equal to one (1) hour ($t \leq 1$ h): Transfer will be considered to occur at a constant flow during the period under consideration. The flow value will be set at the arithmetic mean of the measurements made during one hour before and during one hour after the failure has occurred.

(ii) For a time period between one (1) and twelve (12) hours ($1 \text{ h} < t < 12$ h): The volume transferred will be estimated on the basis of the arithmetic mean of the following components:

a) The volume transferred during a time period equal to the interruption, read 12 hours before the interruption and at the same time as the onset of the interruption.

b) The volume transferred during a time period equal to the interruption, read 12 hours after the interruption and at the same time as the onset of the interruption.

Note: The 12-hour limit may be changed to a multiple of 12 hours so that the control periods selected are representative.

(iii) For a time period greater than or equal to twelve (12) hours ($t \leq 12$ h): The volume transferred will be estimated on the basis of the arithmetic mean of the following components:

a) The volume transferred during a time period equal to the interruption, read one (1) natural day before the interruption and starting at the same time as the interruption.

b) The volume transferred during a time period equal to the interruption, read one (1) natural day after the interruption and starting at the same time as the interruption.

Note: The one-(1) day period may be changed to a multiple of one (1) day so that the control days selected are representative, as well as in extreme cases of interruptions longer than one (1) day.

The parties may, by mutual agreement, opt for a different estimation method that fits more precisely the system's operating conditions at the time of the interruption, as agreed by both parties in a document that will subsequently be considered in the event of any commercial problem.

Due to the need to perform daily and monthly operating closeouts and certified monthly closeouts, the deadlines for submitting and agreeing to a manual correction of the measurement may not exceed the three (3) business days following the closeout of the previous month. However, if no agreement is reached within the set deadline, the Client may request a new recalculation and, if the latter is accepted, adjustments and changes shall be made to the information provided and subsequently to the invoicing.

<u>5.5 Error correction in the measurement records</u>

If upon checking any instrument which is a constitutive part of the measurement system, an error is found whose magnitude is greater than the maximum admissible limit for the instrument, in conformity with the provisions in this Annex, the variable will be adjusted to values within the admissible tolerance.

The earlier values recorded in the measurement system shall be recalculated considering the values and signs of all the errors observed in the variables checked. The correction shall be made starting on the date on which the error occurred or is estimated to have occurred. If that date is not reliably known, or if there is no agreement about it, a period equal to half of the time elapsed between the current and the previous calibration will be used, with a maximum limit of fifteen (15) days.

Any and all changes should be duly recorded, with particulars about the reasons for them as well as the time when they were made and who made them.

5.6 Inspection of ultrasonic meters

The accepted value of the internal diameter ($D_{interno}$) of ultrasonic meters shall be that stated by the equipment manufacturer, which is found in the equipment dossier and was reported by GNLM.

In case a calibration of the equipment $D_{interno}$ is required, or requested by either GNLM or the Client in order to have its certified value checked, this task shall be performed fully in accordance with the provisions in the AGA-9 report.

In the event a difference is found (as a consequence of a meter maintenance inspection) with respect to the certified $D_{interno}$ of the ultrasonic meter, the degree of incidence of such difference in determining the volumetric flow shall be evaluated and, if necessary, the measurements and associated invoices shall be remade as provided in this Annex. Along with the foregoing, GNLM will consider making an eventual new calibration of the meter under in-service conditions; otherwise, it shall justify its decision in writing to the Client.

When any ultrasonic meter malfunctions are detected that should be solved by performing work that involves invasive actions on the meter's internal surface, a new measurement of the meter's $D_{interno}$ shall be made immediately after such work has been completed.

In situ inspections ultrasonic flow meters are made at monthly, quarterly and annual intervals. In addition, every five years an inspection will be made of the inner part of the tubes in the measurement spans, internal meter tubes and ultrasound sensors, and any liquids and impurities shall be removed, if any.

5.7 Transmitter comparison against standards and checking of flow computers

On a monthly basis, GNLM will have the temperature and pressure transmitters used in Gas volumetric flow measurement compared against standards. The precision of the measuring instrument shall be as stated by the instrument manufacturer and, if a measuring instrument should be replaced, it will be upgraded to the maximum admissible precision as per the manufacturer's recommendation.

The comparison points for static-pressure measuring instruments will be the average pressure of the gas circulating in the line, obtained as the arithmetic mean of the daily pressure records of the respective instrument in the immediately preceding month, at 0, 25, 50, 75 and 100% of the instrument scale going upwards, and at 100, 80, 50, 20 and 0% of the instrument scale going downwards.

In the case of temperature measuring instruments, the comparison points will be the average temperature of the gas circulating in the line, obtained as the arithmetic mean of the daily temperature records of the respective instrument in the immediately preceding month, at 0, 25, 50, 75 and 100% of the instrument scale going upwards, and at 100, 80, 50, 20 and 0% of the instrument scale going downwards.
Flow computer inspections will be carried out on a monthly basis.

<u>5.9 Standard instruments</u>

The standard instruments used for calibrating instruments that measure the different variables used in controlling and monitoring gas custody transfer should have a precision of at least three times the quality of the instruments to be checked. In addition, they should have current calibration certificates traceable to the instrument manufacturer or to a competent entity whose laboratories have certified traceability accepted by the Client.
Standard instruments shall be checked in due time and manner by an accredited metrological laboratory so as to maintain the traceability chain. The traceability of the reference instruments used should be documented in relation to the primary standards existing in competent agencies.

<u>5.10 Calculation procedure for corrected gas volumetric flow</u>

The flow computer, configured with typical ultrasonic flow meter values, receives both the volumetric flow and the T and P measurements of the gas in the line from the ultrasonic flow meter and T and P transmitters, respectively. In addition to the above, the flow computer receives the results of the online chromatographic analysis –i.e., the values of all the variables received are in real time– and makes the respective calculations and creates records at intervals not longer than one hour.

The flow computer is able to make mathematical calculations using the appropriate algorithms (equation of state, mixing rule). The calculation of volumetric flow under standard conditions (288.15 K, 101,325 kPa) shall be in accordance with the equation expressed in AGA 9 and shall also comply with the API-21 standard. Based on this, the flow computer gives the result of the volumetric flow under standard conditions according to the following expression:

$$q\left(288K,\ 101.3\ kPa,\ \bar{y}\right)=q_v\left(T,P,\bar{y}\right)\left[\frac{P}{P_{referencia}}\frac{T_{referencia}}{T}\frac{Z_{referencia}}{Z\left(T,P,\bar{y}\right)}\right] \quad 1)$$

Where:

$q_v\left(288K,\ 101.3\ kPa,\ \bar{y}\right)$: Is the gas volumetric flow rate under standard conditions (288.15 K, 101,325 kPa) [Sm^3/h].

$q_v\left(T,P,\bar{y}\right)$: Is the gas volumetric flow rate under the temperature, pressure and composition conditions of the gas in the line [m^3/h].

P: Is the pressure of the gas flowing by the duct or line [Pa].

$P_{referencia}$: Is the pressure under standard conditions (101300 Pa).

$T_{referencia}$: Is the temperature under standard conditions (288.15 K).

T : Is the temperature of the gas flowing by the duct or line [K].

Z: Is the compressibility factor calculated according to an equation of state and mixing rule as a function of the composition, temperature and pressure of the gas in the line.

$Z_{\text{referencia}}$: Is the compressibility factor under standard conditions (288.15 K, 101,325 kPa) for the composition of the gas in the line.

Both compressibility factors are obtained by the flow computer by means of the calculation algorithm described in the AGA-8 standard, Detailed Method.

6. Gas Quality

6.1 Online chromatograph

The quality of the Gas measured at the measuring station is quantified with a gas chromatograph that will operate online. The main function of the chromatograph is the qualitative and quantitative identification of each component of the Gas. In addition, the equipment is able to provide important parameters typical of the Gas, such as upper and lower calorific value, Wobbe index, relative density and compressibility factor under the reference conditions.

In case of failures in the chromatographic system, the default values to be entered in the flow computer configuration shall be those proposed in section 6.7 of this Annex.

6.2 Obtaining the chromatographic composition of the transferred gas

The procedure carried out to obtain the chemical composition of the Gas transferred to the Client shall be carried out in accordance with the ASTM-1945/03 standard. The repeatability and reproducibility assays shall meet the tolerance levels set out by said standard.

6.3 Quantitative determination of natural Gas components, calorific value and Wobbe Index.

The gas chromatography equipment will provide for at least the quantitative identification of the following Gas components, their calorific value and Wobbe index:

Nitrogen (N_2)

Carbon dioxide (CO_2),

Methane (CH_4),

Ethane (C_2H_6)

Propane (C_3H_8)

Isobutane (i-C_4H_{10})

Normal butane (n-C_4H_{10})

Isopentane (i-C_5H_{12})

Normal pentane (n-C_5H_{12})

Normal hexane (n-C_6H_{14})

Normal heptane (n-C_7H_{16})

Normal octane (n-C_8H_{18})

Heavy hydrocarbons grouped under the C_9+ designation.

UCV

Wobbe Index

Oxygen

6.4 Gas-chromatographic analysis cycle

The analysis shall be carried out with a frequency that may vary between 5 and 10 minutes. The data reported in the daily report shall be a weighted average, by volume, of the hourly average of the composition measurements made during the day. Consequently, the corrected volumetric flow shall be the result of an instantaneous integration of the volumetric flow and the quality of the gas available based on the sampling rate used.

6.5 Chromatograph out of service

In order to provide for the continuity of gas volumetric flow measurement process, any of the following prioritized alternatives shall be used in case the online chromatograph goes out of service:

a) Using a fixed table which will be introduced into the flow computer configuration so that the computer considers it as the composition of the transfer gas in case the chromatograph fails. The entries in the fixed table (composition values for each component and calorific value resulting from said composition) shall be defined based on a representative average of the transferred gas composition, whose values shall be updated at least each time a new Vessel is received, with data being collected as from the fifth day from the time in which said Vessel finished unloading. If these values by the fifth day are not representative, GNLM can increase or decrease the number of days in order to improve the accuracy of the test. Nevertheless, the previous values can be adjusted according to the measurement conciliation procedure, based on the average of the values measured during the lesser period i) the following month; or ii) the time elapsed until the arrival of a new Vessel.

b) Using the last value recorded in the daily closeout report of the previous day.

c) Using the average composition of the day before the chromatograph failure.

d) Using the result of the chromatographic analysis of representative samples of the natural gas to be transferred. This analysis may be carried out either in GNLM's laboratory gas chromatograph or at a competent and certified laboratory. The sample shall be preserved for at least twenty (20) days.

6.6 Availability of the measuring instrument signals

GNLM will make available to users the following information at no cost[1]:

- Instantaneous upper and lower calorific value (per unit) (latest chromatographic analysis on the chromatograph), weighted hourly average, weighted average accumulated during the operating day, weighted average of the previous operating day, cumulative monthly weighted average.

- Instantaneous modified Wobbe index (per unit) (latest chromatographic analysis on the chromatograph), weighted hourly average, weighted average

[1]The Client should pay for the cost of installing and commissioning the equipment required to send the signals.

accumulated during the operating day, weighted average of the previous operating day, cumulative monthly weighted average.

- Instantaneous physical (m^3) and corrected (m^3Std) gas volume delivered, hourly average, average accumulated during the operating day, previous operating day, cumulative monthly average.
- Instantaneous amount of energy delivered, hourly average, average accumulated during the operating day, previous operating day, cumulative monthly average.

6.7 <u>Results of the analysis</u>

Daily reports shall include at least the following information on an hourly basis:

a) Molar composition of the gas (mol/mol)

b) Upper and lower calorific value (kJ/m^3Std)

c) Modified Wobbe index (kJ/m^3Std)

d) Physical (m^3) and corrected (m^3Std) gas volume

e) Amount of energy delivered (MMBtu) UCV and LCV

<u>6.8 Procedures applicable to parameter determination</u>

Parameter	**Quantification procedure**
Calorific Value	ISO-6976
Relative Density	ISO-6976
Hydrocarbon Dew Point	Peng-Robinson EoS*
Nitrogen Composition	Chromatographic method as per ASTM-1945
Carbon Dioxide Composition	Chromatographic method as per ASTM-1945
Water Vapor Content	ASTM D-1142**
Sulfhydric Acid Content	ASTM D-4084 / GPA 2377 / ISO 6326***

Table 2: Procedures applicable to parameter determination.

*: Obtained at 5500 kPa from the chromatographic analysis of the gas and less than 269 K (-4 °C). Extended chromatographic analyses shall be performed on the C6+ group to obtain the composition of C_6 to C_8 hydrocarbons.

**: With a maximum concentration of 65 mg/m^3

***: With a maximum concentration of 3 mg/m^3 (Chilean Standard 2264/03)

7. References

TA1949C-0000-I001: P&I latest revision.

AGA 8: Compressibility factors of natural gas and other related hydrocarbons.

AGA 9: Gas measurement by multiple-path ultrasonic meters.

AGA 10: Sound speed in natural gas and other related hydrocarbons.

ASTM D1945: Determination of the composition of natural gas by gas chromatography.

ASTM D1142: Standard method for determining the water vapor content in gaseous fuels by measuring the dew point.

ASTM D4084: Standard testing method for detecting sulfur compounds in natural gas and gaseous fuels by gas chromatography and flame photometric detector.

GPA 2145: Tables of physical constants of paraffinic hydrocarbons and other components of natural gas.

GPA 2172: Calculation of upper calorific value, specific gravity and compressibility factor of multicomponent mixtures in natural gas.

GPA 2377: Tests for sulfhydric acid (H_2S) in natural gas using the length-of-stain detector tube method.

GPA 2286: Tentative method of extended analysis of natural gas and similar gaseous mixtures by gas chromatography with temperature programming.

ISO 6976: Natural gas – Calculation of calorific value, density, relative density and Wobbe index based on the composition of the gas.

NCh 2380: Natural gas – Calculation of calorific value, density, relative density and Wobbe number based on the composition of the gas.