APPENDIX 2

MEASURING, COUNTING AND QUALITY PROCEDURES FOR THE LOADING OF SMALL-SCALE LNG CARRIERS

English translation for information.

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1 MEASUREMENTS TAKEN ON THE CARGO AT THE TERMINAL

1.1 Cargo inspection operations

Two Cargo inspection operations are carried out on board the Small-Scale LNG Carrier, respectively before and after the Loading:

- Cargo inspection before Loading takes place after preparing the Checklist and before the gas and liquid cross-feed valves are opened;
- Cargo inspection after Loading takes place after the liquid manifold and cross-feed valves are drained and the gas and liquid cross-feed valves are closed.

If the piping filling state is different before and after Loading, the corresponding variation in Cargo volume must be taken into account when calculating the Quantity Loaded. For this purpose, the Shipper shall provide the Operator with a calculation of the manifold volumes that it intends to use and the procedure for cooling and draining these manifolds.

If the Shipper operates the Small-Scale LNG Carrier's machinery using gas when it is connected to the gas arm, the energy consumed is then either determined by the gas meter of the Small-Scale LNG Carrier's machinery if applicable, or by a set quantity of 0.10% of gas taken off the Quantity Loaded non corrected of the energy quantity returned on a gaseous form (return gas) :

$Q_{mach} = 0.001 * V * d * H_m$

This set quantity of gas taken off is also applied in event of a failure or a dysfunction of the existing meter, or in the absence of statement of indexes of the gas meter during the Cargo measurement.

1.2 Gauging and calculation of the volume of LNG transferred

The gauging procedures must comply with the recommendations of the current version of the LNG Custody Transfer Handbook of the International Group of Liquefied Natural Gas Importers (GIIGNL). The primary and secondary measuring systems are of capacity, float and/or microwave type and/or laser type (LIDAR); they must comply with standard ISO 18132.

The LNG volume transferred, expressed in cubic metres, is determined by the difference between the volumes of LNG contained in the Small-Scale LNG Carrier's tanks before and after the Loading. Each of the Small-Scale LNG Carrier's tanks must be equipped with two gauging systems, a main system dedicated to Cargo inspection operations and an emergency system. The maximum permissible error in the primary and secondary gauging systems must not exceed plus or minus 5 mm. The primary and secondary gauging systems must be identified during the Cargo inspection before the Loading without modification during the operation. In the event of failure of the main gauging system, the emergency system is used; if its maximum permissible error exceeds plus or minus 5 mm, particularly on an old Small-Scale LNG Carrier, the Shipper and the Operator shall mutually agree on a maximum permissible error greater than +/- 5 mm.

The total uncertainty in measuring the LNG volume transferred as a result of the gauging system measurement uncertainty, gauge tables and correction tables associated with each of the Small-Scale LNG Carrier tanks must be less than 0.3%, in accordance with European Union Directive n°2011/17/UE, transposed into French law by the Order dated 07/11/2011 ("*Arrêté*") and the Decree n°2016-769 of 09/06/2016.

In case the Small-Scale LNG Carrier's cargo lines used for the Loading have not the same filling state during gauging before and after Loading:

- if the Small-Scale LNG Carrier's cargo lines are full before Loading and empty after Loading, the volume of LNG measured before Loading is increased by the volume of the cargo lines;
- if the Small-Scale LNG Carrier's cargo lines are empty before Loading and full after Loading, the volume of LNG measured after Loading is increased by the volume of the cargo lines.

The volume of the cargo lines is usually provided by the Small-Scale LNG Carrier's tables: this value is used to increase the volume measured in the tanks. If the volume of the cargo lines is unknown or if the Small-Scale LNG Carrier is not able to provide the relevant tables, a fixed increase of 5 m^3 of LNG is applied.

1.3 Determining the LNG temperature and the gas phase temperature

Each of the Small-Scale LNG Carrier's tanks must be equipped with temperature sensors placed in such a way that at all times at least one sensor is located in the liquid and one in the gas phase, with the other sensors distributed at regular intervals from the top to the bottom of the tank. Only the measurements in the tanks concerned by the Loading are taken into account. The temperature of the LNG before Loading is determined by calculating the arithmetic mean of all the measurements from the temperature sensors immersed in the liquid. The temperature of the gas phase after the Loading operations is determined by calculating the arithmetic mean of all the measurements from the temperature sensors located above the liquid phase. The overall temperature measurement error, including the temperature measurement system element errors, must not exceed the values in the following table in accordance with standard ISO 8310.

	overall error of the measuring system
LNG (Liquid phase < -145°C)	± 0.2 °C
Natural Gas (gaseous phase > -145°C)	± 1.5 °C

1.4 Determining the pressure in the Small-Scale LNG Carrier's tanks

The measuring procedures must comply with the recommendations of the current version of the GIIGNL *LNG Custody Transfer Handbook*.

Each of the Small-Scale LNG Carrier's tanks must be equipped with at least one pressure sensor in contact with the gas phase. Only the measurements in the tanks concerned by the Loading are taken into account. The average pressure in the tanks is determined before and after the Loading as the arithmetic mean of the measurements read in each tank. The maximum permissible error of the absolute pressure measuring system must not exceed ± 10 mbar or ± 1% of the measurement scale ranging at least from 800 mbar to 1,400 mbar over the entire pressure range over which the tanks of the Small-Scale LNG Carriers can e operated.

2 MEASUREMENTS TAKEN AT THE TERMINAL

2.1 LNG sampling and return gas offtake

LNG in-line sampling: The Operator uses a so-called "in line" discontinuous sampling method, as defined in the LNG European standard EN 12838 and standard ISO 8943 of 2007, that involves:

- continuously collecting and vaporising the LNG during nominal Cargo Transfer conditions (i.e. not including the start and end of the Loading operation); collection is performed by means of an isolated Pitot tube (by maintaining it under vacuum conditions or by re-circulating LNG) located in the centre of the transfer pipe, after the transfer arms; the transfer line, which complies with standard ISO 8943, maintains the LNG sub-cooled until it is vaporised in an electric vaporiser, by Joule effect, at regulated temperature;
- transferring the vaporised gas at stabilised pressure and flow rate to a chromatograph via suitable and identified piping;
- and carrying out chromatographical analyses at regular intervals (at least three (3) times an hour).

LNG cylinder sampling: In parallel with in-line sampling, LNG in the gaseous state is sampled periodically using sampling cylinders. The systems for collecting and transferring the evaporated gas to the sampling cylinders are the same as for in-line sampling. For each Loading, three samples (one for the Shipper, one for the Operator and one for an independent laboratory) are sampled simultaneously and in parallel in cylinders when half of Cargo has been transferred, and kept sealed by the Operator for two weeks after the Cargo Transfer ; at the end of this period, the sampling cylinders are purged and inerted. At the express request of the Shipper, and on an exceptional basis, the Operator shall make reasonable efforts to keep the sample cylinders for a longer period. The cylinder samples are only analysed at the Shipper's explicit request and expense, and this only applies to the measurement of the main components.

If the Loading is a Specific Service (gassing up, cooling down) or consists in a specific operation such as the Loading of a heel of a limited quantity of LNG, there is no LNG cylinder sampling except in case of express request from the Shipper.

Return gas offtake: The return gas sent back by the Terminal to the Small-Scale LNG Carrier or by the Small-Scale LNG Carrier to the Terminal is collected directly in the return gas pipe with a so-called "in-line" discontinuous sampling method, under nominal Loading rate (i.e. not including the start and end of Loading); it is transferred to a chromatograph for analysis at regular intervals (at least three (3) times an hour).

If the LNG sampling line (vaporiser and sampling rod) is out of service, making the analysis impossible, the Shipper and the Operator shall mutually agree on an alternative method to estimate the LNG transferred, e.g.: the weighted average quality of unloaded LNG used for the Loading.

In the event of a failure of the return gas sampling line or the chromatograph dedicated to the analysis results of this gas return, the Shipper and the Operator jointly agree to use the empirical method recommended by the current version of the *LNG Custody Transfer Handbook* from GIIGNL in order to determine the average molar composition of the return gas.

2.2 Analysis of the components, fitting and checking of the chromatographs

2.2.1 Analysis of the main components of the LNG and the return gas

The main components of the LNG and the return gas are analysed by gas chromatography in accordance with standard ISO 6974 (part 5). An analysis is performed at least three times (3) an hour and the analysis results are validated and

standardised. The composition of the LNG and the return gas is determined, for each component, as the arithmetic mean of the analysis results obtained under nominal Loading rate (i.e. not including the start and end of Loading).

If the chromatograph is out of service or drifts after the first third of the Loading under steady-state operating conditions, the chromatographic analysis carried out during this first third shall be used for the Cargo inspection.

If the chromatograph is out of service during the first third of the Loading under steady-state operating conditions, three (3) samples in cylinders with a double ogive shall be taken in parallel at regular intervals; a cylinder of each of the samples shall then be chromatographically analysed as soon as the chromatograph is operational again and fit in accordance with the procedures in force.

2.2.2 Calibration and fitting of the chromatographs for analysing the main components

Outside the Loading phases, the chromatographs are permanently swept with vector gas. The gas chromatograph is calibrated by carrying out at least five consecutive analyses with a reference gas that complies with the current standard ISO 6141, the last three analyses being kept to determine the area of the peaks of each component of this gas. This calibration is performed every year, or following a check that revealed a non-conformity, or after a maintenance action that required the instrument to be stopped. The chromatographs are checked with a working gas produced from the gas regularly received at the Terminal, at least once a quarter.

2.2.3 Analysis of trace elements

Sulphur-based compounds are analysed according to standard ISO 19739. The methods described in this standard may be adapted according to the measuring instruments available and the recommendations of the suppliers of such instruments.

When equipment checking for trace elements contained in the LNG is faulty after the first third of the Loading under steady-state operating conditions, the analyses carried out during this first third will be the ones used for the Cargo inspection.

If the equipment checking for trace elements is out of service during the first third of the Loading under steady-state operating conditions, the values retained are the weighted average of the values of the unloaded LNG used for the Loading

2.3 *Determination of the Gross Calorific Value (GCV), Wobbe Index and density*

The GCV and Wobbe Index on a volumetric basis are established for a real gas according to the method recommended by the current standard ISO 6976, the reference conditions of which are as follows:

- volumetric measuring conditions: 0 °C and 1.01325 bar absolute (so-called "normal" conditions);
- combustion conditions: 0 °C and 1.01325 bar absolute.

The GCV calculations on a mass basis are established according to the same method and under the same reference combustion conditions.

The LNG density is calculated according to the revised Klosek McKinley method (published in December 1980 in Technical note 1030 – National Bureau of Standards and described in the GIIGNL LNG Custody Transfer Handbook), taking into account:

- the mean temperature of the transferred LNG,
- the LNG mean composition determined during the Loading operations,
- the molar mass of each component as defined in the current standard ISO 6976,
- the molar volume of each component and the correction factors K1 and K2 as described in Technical note 1030 – National Bureau of Standards, published in December 1980.

3 Units and ROUND-OFFS

3.1 *Units and round-offs*

The calculations and associated round offs are performed in International Units as defined in the standard ISO 8000-1. The calculation methods for the transferred energy and the round-off rules are described in a technical note published on the Operator's website.

The following table shows the round-offs to be applied to the calculation results that are displayed in the certificates (see Paragraph 4.3):

Variable	Unit	Round-off
Volume (except for gross and net LNG)	m^3 (cubic metre)	0.001
Gross and net LNG volume	m^3 (cubic metre)	0.1

LNG and gas return temperature	°C (degree Celsius)	0.1
Pressure in the Vessel's tanks	mbar (millibar)	1
LNG and gas return composition	mole %	0.001
Mass of LNG	Kg (kilogram)	0.1
Mass GCV	MJ/kg (Megajoule per kilogram) or kWh/kg (kilowatt-hour per kilogram)	0.01
Volumetric GCV	MJ/m³ (Megajoule per cubic metre) or kWh/m³ (kilowatt-hour per cubic metre)	0.01
Wobbe Index	MJ/m³ (Megajoule per cubic metre) or kWh/m³ (kilowatt-hour per cubic metre)	0.01
Density	kg/m³ (kilogram per cubic metre)	0.1
Quantity of energy returned to the Vessel or to the Terminal Qr	MJ (Megajoule) or kWh (kilowatt-hour)	1
Quantity of energy	MJ (Megajoule) or kWh (kilowatt-hour)	1
Methane Index	Number without unit	1

Any quantity of energy expressed in MWh (Megawatt-hour) is rounded off to three (3) significant decimals according to the rules described below.

Any quantity of energy expressed in kWh (kilowatt-hour) is rounded off to zero (0) significant decimals according to the following rules:

- an insignificant decimal equal to zero (0), one (1), two (2), three (3) or four (4) does not increment the significant decimal;
- an insignificant decimal equal to five (5), six (6), seven (7), eight (8) or nine (9) increments the significant decimal.

In the event of dispute, the quantity of energy expressed in MWh (Megawatt-hour) prevails.

3.2 *Unit conversion*

A quantity of energy expressed in kWh (kilowatt-hour) at 25 °C (GCV) is converted into a quantity of energy expressed in MWh (Megawatt-hour) at 0 °C GCV by multiplying this quantity of energy by one point zero zero two six (1.0026), in accordance with the recommendations of standard NF ISO 13443, and by dividing the product of this multiplication by one thousand (1,000).

A quantity of energy expressed in MWh (Megawatt-hour) at 0 °C GCV is converted into a quantity of energy expressed in kWh (kilowatt-hour) at 25 °C GCV by multiplying this quantity of energy by one thousand (1,000) and by dividing the product of this multiplication by one point zero zero two six (1.0026), in accordance with the recommendations of standard NF ISO 13443.

A quantity of energy expressed in Wh (Watt-hour) is converted into a quantity of energy expressed in J (joule) by multiplying this quantity of energy by 3,600.

A quantity of energy expressed in Btu (British Thermal Unit) is converted into a quantity of energy expressed in J (joule) by multiplying this quantity of energy by 1,055.056.

3.3 *Cargo report and certificates*

3.3.1 Cargo Report

After a Loading, a Cargo Report shall be drawn up by the Operator and sent to the Shipper. The Cargo Report consists of a certificate of quality and a certificate of quantity, with the energy quantities expressed at the reference temperature of 0°C.

One single original copy of the Cargo Report is issued by the Operator.

The Cargo Report for the Service shows the methane index, calculated according to the PKI method as described in the normative annex A of standard NF EN ISO 23306 in force.

Terminal Méthanier
Fos Cavaou
Route des plages
13270 FOS SUR MER

RAPPORT DE CARGAISON: Certificat de Qualité
CARGO REPORT: Certificate of Quality

Date de l'opération / *Transfer date* : **jj/mm/aaaa**
Type d'opération / *Transfer operation* : **RECHARGEMENT** / *Reloading*
Nom du navire / *Vessel Name* : **LNG carrier name**

Références ELENGY		**Références Company**	
N° d'escale *Ship Call Number*	xxxxx	**N° de cargaison** *Cargo Number*	yyyyy

Tous les calculs sont effectués conformément au contrat d'accès aux terminaux exploités par Elengy, dans les conditions de référence suivantes : [PCS à 0°C ; V(0°C ; 101325 Pa)]. *All calculations are made according to Elengy-operated LNG terminals access contract, with the following reference conditions: [GHV at 0°C ; V(0°C ; 101325 Pa)].*

Analyse / *Analysis*	**GNL** / *LNG*	**Gaz retour** / *Return gas*	
Azote / *Nitrogen* (N_2)	x.xxx	x.xxx	%mol
Méthane / *Methane* (CH_4)	xx.xxx	xx.xxx	%mol
Ethane / *Ethane* (C_2H_6)	x.xxx	x.xxx	%mol
Propane / *Propane* (C_3H_8)	x.xxx	x.xxx	%mol
Iso Butane / *Iso-butane* (iC_4H_{10})	x.xxx	x.xxx	%mol
Normal butane / *n-butane* (nC_4H_{10})	x.xxx	x.xxx	%mol
Neo-pentane / *Neo-pentane* ($neoC_5H_{12}$)	x.xxx	x.xxx	%mol
Iso-pentane / *Iso-pentane* (iC_5H_{12})	x.xxx	x.xxx	%mol
Normal pentane / *n-pentane* (nC_5H_{12})	x.xxx	x.xxx	%mol
Hexanes plus / *Hexanes plus* (C_{6+})	x.xxx	x.xxx	%mol
Dioxyde de carbone / *Carbon dioxyde* (CO_2)	x.xxx	x.xxx	%mol

Impuretés / *Trace elements*	**GNL** / *LNG*	
Sulfure d'hydrogène / *Hydrogen sulfide* (H_2S)	x.x	mg(S)/m³(n)
Mercaptans / *Mercaptans* (RSH)	x.x	mg(S)/m³(n)
Oxy sulfure de carbone + Sulfure d'hydrogène (COS + H_2S) *Carbonyl sulfide + Hydrogen sulfide*	x.x	mg(S)/m³(n)
Soufre total (S) / *Total sulfur*	x.x	mg(S)/m³(n)

Caractéristiques sous forme gaz / *Characteristics in gas state [0°C ; 101325 Pa]*	**GNL** / *LNG*	**Gaz retour** / *Return gas*	
PCS massique / *GHV (mass)*	xx.xx	xx.xx	kWh/kg
PCS volumique / *GHV (volumetric)*	xx.xx	xx.xx	kWh/m³(n)
PCI volumique / *LHV (volumetric)*	xx.xx	xx.xx	kWh/m³(n)
Indice de Wobbe / *Wobbe index*	xx.xx	xx.xx	kWh/m³(n)
Masse volumique / *Density*	x.xxx	xx.xx	kg/m³(n)
Densité / *Relative density*	x.xxx	x.xxx	-
Indice de méthane / *Methane number (PKI)*	xx.x		

Caractéristiques sous forme liquide / *Characteristics in liquid state*	**GNL** / *LNG*	**Gaz retour** / *Return gas*	
Température du GNL réel / *Real LNG temperature*	-xxx.x	-160.0	°C
PCS volumique / *GHV (volumetric)*	x xxx.xx	x xxx.xx	kWh/m^3_{LNG}
Masse volumique / *Density*	xxx.x	xxx.x	kg/m^3_{LNG}
Facteur d'expansion / *Expansion factor*	xxx.x	xxx.x	-

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Terminal Méthanier
Fos Cavaou
Route des plages
13270 FOS SUR MER

RAPPORT DE CARGAISON: Certificat de Quantité
CARGO REPORT: Certificate of Quantity

Date de l'opération / *Transfer date* : **jj/mm/aaaa**
Type d'opération / *Transfer operation* : **RECHARGEMENT** / *Reloading*
Nom du navire / *Vessel Name* : **LNG carrier name**

Références ELENGY		Références Company	
N° d'escale *Ship Call Number*	xxxxx	**N° de cargaison** *Cargo Number*	yyyyy

Tous les calculs sont effectués conformément au contrat d'accès aux terminaux exploités par Elengy, dans les conditions de référence suivantes : [PCS à 0°C ; V(0°C ; 101325 Pa)]. *All calculations are made according to Elengy-operated LNG terminals access contract, with the following reference conditions: [GHV at 0°C ; V(0°C ; 101325 Pa)].*

Reconnaissance de cargaison / *Custody Transfer Measurement*

[Données retenues pour l'établissement du bilan net / *Data used for calculating the net transferred quantities*]

	Avant transfert *Before transfer*	**Après transfert** *After transfer*	
Date et heure / *Date and time*	jj/mm/aaaa hh:mm	jj/mm/aaaa hh:mm	
Volume GNL / *LNG volume*	xxx xxx.xxx	xxx xxx.xxx	m^3_{LNG}
Température moyenne GNL / *LNG average temperature*		-xxx.x	°C
Température moyenne phase gaz / *Vapour phase average temperature*	-xxx.x		°C
Pression moyenne phase gaz / *Vapour phase average pressure*	xxx.x		mbar(abs)

Gaz consommé aux machines du navire *Gas consumed by vessel's engines*	xx xxx.x	kg (mesuré / *measured*)
		m^3(n) (mesuré / *measured*)
		kWh (0,10% de la quantité brute de GNL transféré / *0.10% of gross transferred LNG quantity*)

Bilan net des quantités transférées / *Net transferred quantities*

		Volume /*Volume* (m^3_{LNG})	**Energie /** *Energy* **(kWh @ 0°C)**	Masse / *Mass* (kg)
	GNL transféré brut / *Gross transferred LNG*	xxx xxx.xxx	**x xxx xxx xxx**	xxx xxx xxx.x
-	Gaz retour / *Return gas*	xxx.xxx	**x xxx xxx**	xxx xxx.x
+	Gaz consommé aux machines du navire *Gas consumed by vessel's engines*	xxx.xxx	**x xxx xxx**	xxx xxx.x
	GNL transféré net / *Net transferred LNG*	xxx xxx.x	**x xxx xxx xxx**	xxx xxx xxx.x

ELENGY:
Date / *Date* :
Nom / *Name* :
Tampon et signature / *Stamp and signature* :

Company:
Date / *Date* :
Nom / *Name* :
Tampon et signature / *Stamp and signature* :

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