MEASUREMENT, SAMPLING AND TESTING PROCEDURES
FOR THE LNG QUANTITIES RECEIVED AT THE POINT OF DELIVERY

1. The procedures and guidelines specified below shall apply for determination of the LNG quantity delivered.

2. Tank Gauge Tables

   Prior to the utilization of any LNG Ship, the Terminal Users shall (a) in the case of an LNG Ship the tanks of which have never been calibrated, arrange for such tanks to be calibrated for volume against level by an industry recognized authority or (b) in the case of an LNG Ship the tanks of which have previously been calibrated, provide evidence of such calibration by an industry recognized authority.

   Calibration of the tanks shall be prepared in accordance with methods described in the LNG Custody Transfer published by the GIIGNL, latest edition.

   Calibration certificates shall state that the tank tables are determined with an uncertainty less than +/- 0,2% at ambient temperature.

   The gauge tables are completed with correction tables according to:

   - The condition of the LNG Ship (Trim/List).
   - The average LNG temperature in the tank that influences contraction or expansion of the tank.
   - The temperature in the gaseous phase, and/or the density of the LNG influencing the level measuring devices.

   Tank gauge tables may also provide an example of how to conduct the volume calculation using the measurements provided.

3. Selection of Gauging Devices

   3.1 Liquid Level Gauging Devices

   Each LNG tank of each LNG Ship shall be equipped with a main and an auxiliary liquid level gauging device.

   The measurement accuracy of the main and auxiliary liquid level gauging devices shall be for:

   - Electrical capacitance type level gauge: +/- 5 mm or better.
   - Float type level gauge: is in the range of +/- 4 mm to +/- 8 mm.
   - Radar (microwave) type level gauge: +/- 5 mm or better.
   - Laser type level gauge: +/- 7.5 mm or better.

3.2 Temperature Gauging Devices

Each LNG tank of each LNG Ship shall be equipped with a minimum of four (4) temperature gauging devices located on or near the vertical axis of such LNG tank. These temperature sensors shall have 100% back up redundancy in the form of spare sensors, for emergency use mounted adjacent to such temperature sensors.

The measurement uncertainty of the temperature gauging devices shall be, under normal operations:

- Overall uncertainty for temperature ranging between -145 and -165 ºC (including sensor, cable, signal converter, display): +/- 0.5 °C or better.
- Typically, an accuracy in the range -145 to +40 °C is required: +/- 1.0 °C or better.

3.3 Pressure Gauging Devices

Each LNG tank of each LNG Ship shall have one absolute pressure gauging device.

Typically, the required pressure measurement accuracy is specified between +/- 0.1 and 1% FS (1% of Full-scale instrument range.)

3.4 Verification of Accuracy of Gauging Devices

Gauging devices shall be verified for accuracy, and any inaccuracy of a device exceeding the permissible tolerance shall require correction of recordings and computation. Where the inaccuracy of a device is found to exceed the permissible tolerances, the device, if possible, shall be adjusted accordingly and recordings and computations made on the basis of those recordings shall be corrected with respect to any period of error that is definitely known.

4. Measurement Procedures

The quantity in cubic metres and the temperature and the pressure of the delivered LNG shall be measured with the LNG Ship instrumentation in accordance with the methods described in the LNG Custody Transfer published by the GIIGNL, latest edition.

5. Determination of LNG Composition

The mean composition of the delivered LNG is determined utilizing Terminal's facilities' instrumentation, or in the absence of such instrumentation, with an ageing method advised by the independent surveyor appointed by the Terminal, in either case in accordance with the methods described in the LNG Custody Transfer published by the GIIGNL, latest edition.

The vapor return during the delivery operations shall be taken into account in the energy balance. The mean composition of the vapor phase return to the LNG Ship shall assumed to be pure methane in accordance with the methods described in the LNG Custody Transfer published by the GIIGNL, latest edition.

6. Determination of BTU Quantity of LNG Delivered

6.1 LNG Density

The LNG density shall be calculated by use of the method of Klosek McKinley from NBS Technical Note 1030, December 1980.

The molar mass shall be determined by use of the method ISO 6976-1995, units of density shall be in kg/m³ and calculation results shall be given with 0.01 significant figures.

6.2 Gross Heating Value

(i) Gross Heating Value (Mass)

The Gross Heating Value (Mass) shall be calculated by use of the method ISO 6976-1995 with combustion reference conditions of fifteen degrees Celsius (15 °C) and units of MJ/kg and 0.01 significant figures or with combustion reference conditions of sixty degrees Fahrenheit (60 °F), stated in units of BTU/kg and given with one (1) significant figures or as specified in the relevant Terminal Rules.

(ii) Gross Heating Value (Volumetric)

The Gross Heating Value (Volumetric) shall be calculated by use of the method ISO 6976-1995 with combustion reference conditions of fifteen degrees Celsius (15/15 °C), stated in units of MJ/Sm³ and 0.01 significant figures or with combustion reference conditions of sixty degrees Fahrenheit (60 °F) and units of BTU/SCF and given with 0.1 significant figures or as specified in the relevant Terminal Rules.

6.3 Energy delivered

The net quantity of the energy delivered shall be calculated in accordance with the formula given in the LNG Custody Transfer published by the GIIGNL, fourth edition 2015, Clause 2.1.

For the purpose of this calculation the quantity of energy is expressed in MMBtus, rounded to zero (0) decimal places.

Energy of gas consumed as fuel in the LNG Ship:

The LNG Ship, subject to agreement of buyer and seller, may use gas as fuel in its engine room during the unloading operation (CIF or DES cargo), between the opening and closing CTS.

This amount of energy can be determined either:

- by the measurement of the total volume of gas consumed (V_g) (by the gas flow meter on board the LNG Ship) and the evaluation of the GCV of gas as described in section 12.1 of GIIGNL 4th edition 2015 for vessels using boil-off gas as fuel.

$$E_{fuelgas} = V_g * GCV_{gas}$$

or for LNG vessels using forced vaporization of LNG cargo, the quality of the LNG unloaded can be taken.

- BOG consumed is assumed to be 100% Methane.

7. Decimal Places for Parameters

D	is the density to 0.01 significant figures of the LNG unloaded, stated in Kilogram per Cubic Meter at temperature T_L
T_L	is the temperature of the liquid LNG in the tanks of the LNG Ship. Temperature Reading: the nearest two (2) decimal places Arithmatic average of the temperature of the individual tank and whole tanks: rounded to 0.01 °C
T_G	is the temperature of the gaseous LNG in the tanks of the LNG Ship. Temperature Reading : the nearest two (2) decimal places Arithmatic average of the temperature of the individual tank and whole tanks: rounded to 0.01 °C
P_{vap}	Vapour pressure (mbar), to the nearest mbar.
X_i	is the mol fraction, to the nearest five (5) decimal places, of compenent (i) from the composition obtained. The mol fraction of methane shall be adjusted so as to make the total mol fraction equal to 1.00000
M_i	is the molecular weight of the compenent (i), stated in kg/kmol or g/mol, the nearest three (3) decimal places in accordance with ISO 6976-1995
V_i	is the molecular volume, to the nearest six (6) decimal places from the table of KMK method, of compenent (i), stated in Kg/kmol or l/mol at the temperature T_L and obtained by lineer interpolation of the data set in NBS Technical note 1030
K1	shall be calculated to the nearest six (6) decimal places.
K2	shall be calculated to the nearest six (6) decimal places
$X_i * M_i$	shall be calculated to the nearest six (6) decimal places.
$\Sigma(X_i * M_i)$	shall be calculated to the nearest six (6) decimal places by summing all "$X_i * M_i$" obtained as above.
$X_i * V_i$	shall be calculated to the nearest six (6) decimal places.
$\Sigma(X_i * V_i)$	shall be calculated to the nearest six (6) decimal places by summing all "$X_i * V_i$" obtained as above.
$GHV_{(mass)}$	Gross Heating Value MJ/kg and 0.01 significant figure.
$GHV_{(vol.)}$	Gross Heating Value MJ/m^3 and 0.01 significant figure.
MMBTU	rounded to zero (0) decimal place.
MJ	rounded to two (2) decimal places.

8. Refecence & Standard

- The reference document of this procedure is based on the GIIGNL, fourth (4th) edition, 2015.
- The reference standards of this procedure are as specified in the GIIGNL, fourth (4th) edition, 2015.

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