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Definitions

**Quality Certificate** – document prepared by the Operator, certifying quality of LNG, which is unloaded from LNG Carrier to Terminal or reloaded from Terminal to LNG Carrier.

**Quality and Quantity Report** – document prepared and signed by the Expert in accordance with Quantity and Quality Certificates.

1. **Cargo Measurement Procedure**

   The quantity and quality of LNG unloaded to Terminal/reloaded from Terminal shall be determined in accordance with international ISO standards at reference conditions, stipulated by Lithuanian legal acts: combustion/measurement temperature accordingly 25/0 °C, pressure – 1.01325 bar. All readings and computations shall be verified by Expert with participation of the Operator, LNG seller and the Terminal User or their representatives. However, the absence of LNG seller, Operator, Terminal User or their representatives shall not prevent the performance of Cargo measurement procedure, except for the cases when all parties concerned agreed otherwise, and data confirmed by the Expert shall be final for all parties.

   The Terminal User will supply, operate and maintain, or cause to be supplied, operated and maintained, suitable gauging devices for the LNG tanks of the LNG Carrier and the custody transfer measurement system, as well as pressure and temperature measuring devices and all other measurement or testing devices that are incorporated in the structure of such LNG Carrier or customarily maintained on board such LNG Carrier.

   The Operator will supply, operate and maintain, or cause to be supplied, operated and maintained, devices required for collecting samples and for determining quality of the delivered LNG and all other measurement or testing devices that are necessary to perform the measurement and testing in FSRU.

   Independent Expert shall witness and verify all devices’ certification of accuracy levels measurements, gauging and analysis, calibration/validation of equipment referred to in this document. The Expert shall prepare and sign Quantity and Quality Report on the basis of Cargo quantity data, provided by LNG Carrier’s Master or his representative and Cargo quality data provided by the Operator (provided that the sampling system is installed in the Terminal). Provisional Quantity and Quality Report shall be issued within 48 (forty eight) hours after LNG loading or LNG reloading operation, and final Quantity and Quality Report shall be prepared within 72 (seventy two) hours after LNG loading or LNG reloading operation. Before sampling system is installed, LNG quality shall be determined in accordance with section 7 of Cargo Measurement Procedure.

   In all cases the Terminal User is responsible for submitting of Loading Certificate issued at load port to the Operator. If quantity and quality of LNG are not determined in accordance with international ISO standards, the Terminal User must ensure that the quantity and quality shall be recalculated in accordance with international ISO standards and approved by Expert prior to commencement of LNG unloading to the Terminal. Together with Loading Certificate and quantity certificate the Terminal User must also provide Cargo quality recalculation made by applying theoretical calculation method for gas aging, indicating the quality of the LNG when LNG Carrier arrives to the Terminal.

2. **Natural Gas Quality Requirements**

   There is no LNG quality treatment facility in the Terminal.

   LNG supplied to the Terminal must comply with natural gas quality requirements as set forth in Lithuanian legal acts at reference conditions defined by Lithuanian legal acts, and the Terminal User must prove it by providing document, issued by Expert recognized in the LNG industry.

   In case of discrepancies, the Terminal Users shall bear responsibility as it is specified in the Regulations.

3. **Measurement Equipment Maintenance, Calibration and Testing**

   The Terminal User shall ensure the tests for the accuracy of the equipment described in section 5 of Cargo Measurement Procedure prior to the LNG Carrier being brought into service in order to ensure that the equipment and devices comply with these measurement requirements.
Thereafter, the Terminal User shall carry out or cause to be carried out tests to ensure the accuracy of the equipment excluding the volumetric calibration of the Cargo tanks in the LNG Carrier. Such tests will be carried out as follows:

1) when the LNG Carrier is out of operation for scheduled inspection and/ or repairs;
2) when the Operator, acting as a reasonable and prudent Operator, requests such verification in writing due to the changes in accuracy of custody transfer measurements related to the specific LNG Carrier in question;
3) at the time of each scheduled dry-docking or maintenance period, scheduled calibration tests shall be carried out in accordance with the vendor equipment recommendations, as part of the regular scheduled maintenance and servicing.

The tests referred to the above shall be witnessed and verified, by a mutually agreed industry recognised authority.

The Terminal User shall ensure the equipment for which it is responsible to be maintained according to:

1) a maintenance procedure;
2) a schedule of maintenance;
3) a log of the maintenance carried out, which is verified by the LNG Carrier’s master, or its designate, which shall be retained for inspection and audit, as requested by the Operator or Expert; and
4) calibration, testing and defect correction procedures.

All gauging devices and systems shall be installed, operated and maintained according to the manufacturers’ specification and standards used in the LNG industry.

As a minimum requirement, the LNG Carrier shall meet the conditions as described in ISO10976 standard and requirements set in Regulations. Measurement equipment of LNG Carrier shall be approved in the Republic of Lithuania by authorised company pursuant to legal acts. The authorised company is going to be hired by the Operator following the procedure set in the legal acts. In the case, when the authorised company issues negative decision after evaluation of verification documents of LNG Carrier’s measurement equipment, the Operator informs the Terminal User and the Terminal User puts the efforts to correct the deficiencies defined during evaluation of verification documents of LNG Carrier’s measurement equipment by the authorised company. If deficiencies are not corrected, LNG quantity during LNG loading or LNG reloading operation shall be determined pursuant to clause 6.6 of Cargo Measurement Procedure.

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 or agreed by the Operator and Terminal User. If there is no possibility to adjust the device exceeding the permissible tolerances, LNG quantity during LNG loading or LNG reloading operation shall be determined pursuant to clause 6.6 of Cargo Measurement Procedure.

4. LNG Carrier Tank Gauge Tables

4.1 Calibration of LNG Tanks

During or immediately following the completion of construction of a vessel the Terminal User intends to use as an LNG Carrier, or immediately prior to entry into service hereunder of any LNG Carrier that the Terminal User intends to use as an LNG Carrier, the Terminal User shall ensure that each LNG tank of such LNG Carrier has been calibrated for volume against level by an industry recognised authority. The Terminal User shall provide to the Operator the evidence of any calibration conducted by competent inspector according to the requirements of section 4 of Cargo Measurement Procedure.

4.2 Preparation of Tank Gauge Tables

The Terminal User shall have an industry recognised authority prepare tank gauge tables for each LNG tank of a vessel that the Terminal User intends to use as an LNG Carrier. Such tank gauge tables shall include sounding tables, correction tables for list and trim, volume corrections to tank service temperature, and other corrections if necessary. The Terminal User shall provide to the Operator a copy of such certified tank gauge tables as well as all correction charts for each tank of the LNG Carrier and present inspection certificates evidencing last LNG Carrier inspection.
4.3 Precision of Tank Gauge Tables

LNG Carrier’s tank gauge tables prepared pursuant to clause 4.2 of Cargo Measurement Procedure shall, in the relevant loading and reloading range of the LNG Carrier’s tanks, indicate volumes in cubic metres expressed to the nearest thousandth (1/1000), with LNG tank depths expressed in metres to the nearest thousandth (1/1000). Terminal User shall enable the Operator or its representative to audit the LNG Carrier’s tables upon notice at commercially reasonable time.

5. Selection of Gauging Devices

5.1 General

All LNG Carrier’s gauging devices and systems shall be installed, operated and maintained according to the manufacturers’ specification and a standard used in the LNG industry, the priority is given to ISO standards. Terminal User shall provide to the Operator a copy of the calibration certificates of the respective gauging devices.

5.2 Liquid Level Gauging Devices

Each LNG tank of an LNG Carrier shall be equipped with independent main and auxiliary liquid level gauging devices that preferably utilize different technologies. For each LNG Carrier, the Terminal User shall identify the main and auxiliary liquid level gauging devices.

The measurement accuracy of the main and auxiliary liquid level gauging devices shall be equal to or better than ±5 mm (plus or minus five millimetres). Indications from the 2 (two) systems shall be routinely compared to ensure they are performing normally. In case one of the liquid level gauging devices would not be able to meet this verification tolerance, a verification tolerance of ±7.5 mm (plus or minus seven decimal five millimetres) may be applied after mutual agreement between the Terminal User and the Operator.

The liquid level from the main and auxiliary gauging devices in each LNG tank shall be logged and printed.

5.3 Temperature Gauging Devices

Each LNG tank of any LNG Carrier shall be equipped with a minimum 5 (five) pairs of temperature gauging devices located on or near the vertical axis of such LNG tank, in such a way as not to be affected by the spray of LNG when the spray pumps are in operation.

Primary and redundant temperature gauges are required, and indications from the two systems shall be routinely compared to ensure they are performing normally. Such temperature gauging devices shall be installed at various locations from the top to bottom of each LNG Carrier’s tank to provide temperature measurements at various levels in the tank. The topmost temperature device shall be located in the vapour space at all times, and the bottom temperature device shall be located near the tank bottom for heel measurement.

In the temperature range of -165°C (minus one hundred sixty-five degree Celsius) to -145°C (minus one hundred forty-five degree Celsius), the accuracy shall be ±0.2°C (plus or minus zero decimal two degree Celsius). In the temperature range of -145°C (minus one hundred forty-five degree Celsius) to +40°C (plus forty degree Celsius), the accuracy shall be ±1.5°C (plus or minus one decimal five degree Celsius).

The temperature in each LNG tank shall be logged and printed.

5.4 Pressure Gauging Devices

Each LNG tank of each LNG Carrier shall have 1 (one) absolute vapour pressure gauging device.

The measurement accuracy of each pressure gauging device shall not exceed ±3 mbar (plus or minus three millibar) or its equivalent in alternate units.

The pressure in each LNG tank shall be logged and printed.
5.5  List and Trim Gauging Devices

A list gauging device and a trim gauging device shall be installed on each LNG Carrier. These shall be interfaced with the custody transfer system.

List and trim corrections shall be made using devices which accuracy is better than ±0.05° (plus or minus zero decimal zero five degrees) for list and ±0.05 m (plus or minus zero decimal zero five metres) for trim.

The list and trim in each LNG tank shall be logged and printed.

Summary LNG Carrier accuracies:

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary and Secondary Level Gauge</td>
<td>±5 mm; a verification tolerance of ±7.5 mm may be applied after mutual agreement between the Terminal User and the Operator</td>
</tr>
<tr>
<td>Pressure gauge</td>
<td>±3 mbar</td>
</tr>
<tr>
<td>Temperature Gauge:</td>
<td></td>
</tr>
<tr>
<td>Range: -145 °C to +40 °C</td>
<td>±1.5 °C</td>
</tr>
<tr>
<td>Range: -165 °C to -145 °C</td>
<td>±0.2 °C</td>
</tr>
<tr>
<td>List (inclinometer)</td>
<td>±0.05 °</td>
</tr>
<tr>
<td>Automatic Trim Gauge</td>
<td>±0.05 m</td>
</tr>
</tbody>
</table>

6. Measurement Procedures

6.1  Condition LNG Carrier and timing measurements

The condition of the LNG Carrier at the time of custody transfer shall be as described in ISO10976 standard.

The measurements referred to in clauses 6.2 - 6.5 of Cargo Measurement Procedure shall be made at the same time. During this period in which the readings are taken, no LNG Load/ LNG Reload, ballast, boil off gas, fuelling or other activity will be carried out on the LNG Carrier.

Measurements shall first be made immediately before LNG Load LNG Reload) commences.

Accordingly, after connection of the flexible Cargo hoses, but prior to their cool down, and immediately before opening the cargo manifold Emergency Shutdown System (ESD) valves of the LNG Carrier, the initial gauging shall be conducted upon the confirmation of stoppage of all spray pumps and compressors and shut-off of the gas master valve to the LNG Carrier’s boilers or to any other gas consuming unit. The gas master valve to the LNG Carrier’s boilers or to any other gas consuming unit shall remain closed until after the second gauging, unless mutually agreed differently between the Operator and Terminal User. If vapour consuming for LNG Carrier technological needs during LNG Load/ LNG Reload operations is mutually agreed between the Operator and the Terminal User and if LNG Carrier is equipped with gas flow meters for measuring vapour consumption for technological needs, the readings of such flow meters shall be recorded at the same time as other meters reading is performed, i.e. immediately before the LNG Load/ LNG Reload commences, and right after LNG Load/ LNG Reload is completed. If LNG Carrier is not equipped with gas flow meters for measuring vapour consumption for technological needs, the Operator and the Terminal User shall mutually agree on the method to calculate the vapour consumption for LNG Carrier technological needs.

As far as practicable, the period between the time of measurement and LNG Load/ LNG Reload commencement should be narrowed to the minimum achievable. The same should be applied r to Cargo level measurement after LNG Load/ LNG Reload is completed, once time is allowed to correctly drain Cargo lines.

A second gauging shall be made immediately after LNG Load/ LNG Reload is completed. Accordingly, the second gauging shall be conducted upon the confirmation of shut-off of the manifold ESD valves and gas master valve, with transfer pumps off and allowing sufficient time for the liquid level to stabilize.

Measurements prior to LNG Load/ LNG Reload and after LNG Load/ LNG Reload will be carried out based on the condition of the LNG Carrier’s lines upon its arrival at the berth. Since significant volumes of LNG may remain in the LNG Carrier’s Cargo manifold and crossover, gauging will be performed with
these lines in the same condition prior to LNG Load/ LNG Reload and after LNG Load/ LNG Reload. If the LNG Carrier’s Cargo manifold and crossover lines are empty when measurement is taken before LNG Load/ LNG Reload, they will be emptied prior to measurement following the completion of LNG Load/ LNG Reload. If the crossover lines are liquid filled when measurement is taken before LNG Load/ LNG Reload commences, they will remain full until measurement is taken following the completion of LNG Load/ LNG Reload.

In case the LNG Carrier is fitted with a re-liquefaction plant, if the re-liquefaction plant is running at the time of taking tank level measurements, for custody transfer purposes, then it can continue to do so during the tank level measurement process, as necessary to control tank pressures. The volume of condensate returned to the LNG tanks during the measurement process by the re-liquefaction plant, and the quantity of condensate contained in the re-liquefaction system are immeasurable and will be regarded as zero for Custody Transfer Measurement System (CTMS purposes).

6.2 Liquid level

Liquid levels in each LNG tank of an LNG Carrier shall be determined in accordance with ISO10976 standard. Measurement of the liquid level in each LNG tank of an LNG Carrier shall be made in metres, accurate to the nearest millimetre by using the main liquid level gauging devices referred to in clause 5.2 of Cargo Measurement Procedure.

The same liquid level gauging device must be used for both the initial and final measurements of loaded (reloaded) Cargo. If the main level gauging device is inoperative at the time of commencement of LNG Load/ LNG Reload, it’s necessary to use of the auxiliary level gauging device. The auxiliary level gauging device shall be used at the time of cessation of LNG Load/ LNG Reload, even if the main level gauging device has subsequently become operative. Trim and list of the LNG Carrier shall be kept unchanged while the referenced measurements are performed.

At least 5 (five) readings shall be made following manufacturer’s recommendations on reading interval. The arithmetic average of the readings shall be deemed the liquid level. Such arithmetic average shall be rounded to the nearest millimetre.

Any necessary corrections for trim, list, temperature or other adjustment as defined in the tank gauge tables as called for in clause 4.2 of Cargo Measurement Procedure must be applied to the arithmetic reading to get the true level reading.

The liquid level shall be logged and printed.

6.3 Temperature

The average temperature of the LNG in each LNG Carrier’s LNG tank shall be determined immediately i) before LNG loading commences (in case of unloading to Terminal operation) or ii) after LNG reloading completion (in case of reloading to LNG Carrier operation) by means of the temperature measuring instruments which are fully immersed in the liquid. This determination shall be made by taking the temperature readings of the LNG to the nearest 0.01°C (zero decimal zero one degree Celsius). If more than one of the instruments in the individual Cargo tank is immersed in the liquid, the arithmetic average of these readings will be used. Such calculated arithmetic average shall be rounded to the nearest 0.1°C (zero decimal one degree Celsius). The LNG Carrier average Liquid temperature will be calculated by taking the average of the average liquid temperature in the different Cargo tanks and rounding to the nearest 0.1°C (zero decimal one degree Celsius).

The average temperature of the vapour in each LNG Carrier's Cargo tank shall be determined immediately i) after LNG loading completion (in case of unloading to Terminal operation) or ii) before LNG reloading commencement (in case of reloading to LNG Carrier operation) by means of such temperature measuring instruments which are fully surrounded by vapour. This determination shall be made by taking the temperature readings of the vapour to the nearest 0.01°C (zero decimal zero one degree Celsius), and if more than one are fully surrounded by the vapour in the individual Cargo tank, the arithmetic average of these readings will be used. Such calculated arithmetic average shall be rounded to the nearest 0.1°C (zero decimal one degree Celsius). The LNG Carrier average Vapour temperature will be calculated by taking the average of the average vapour temperature in the different Cargo tanks and rounding to the nearest 0.1°C (zero decimal one degree Celsius).

The temperature in each LNG tank shall be logged and printed.
6.4 Pressure
At the same time the liquid level is measured, the absolute pressure in each LNG Carrier’s LNG tank shall be measured to the nearest 1 mbar (one millibar) by using the pressure gauging device referred to in clause 5.4 of Cargo Measurement Procedure.

The determination of the absolute pressure in the LNG tanks of each LNG Carrier shall be made immediately i) after LNG loading completion (in case of unloading to Terminal operation) or ii) before LNG reloading commencement (in case of reloading to LNG Carrier operation) by taking 1 (one) reading of the pressure gauging device in each LNG tank, and then by taking an arithmetic average of all such readings.

Such arithmetic average shall be rounded to the nearest 1 mbar (one millibar).

If the LNG tank pressure cannot be obtained by the absolute vapour pressure gauging device, the tank pressure may be read from a normal pressure gauge, provided a barometric pressure reading, accurate to 0.1 mbar (zero decimal one millibar) must also be taken and recorded to correct such reading to absolute pressure.

The pressure in each LNG tank shall be logged and printed.

6.5 List and Trim
The list and trim of the LNG Carrier shall be measured at the same time as the liquid level and temperature of LNG in each LNG tank are measured by using the list gauging device and trim gauging device referred to in clause 5.5 of Cargo Measurement Procedure.

The measurement of the list and of the trim shall be conducted to the nearest 0.01° (zero decimal zero one degree) for list and the nearest 0.01 m (zero decimal zero one metres) for trim.

The determination of the list and of the trim of the LNG Carrier shall be made by taking 1 (one) reading of the list and trim gauging devices. In case draft marks of the LNG Carrier can be read physically, trim determination based on these readings will prevail over automatic reading.

The list and trim of the LNG Carrier shall be logged and printed.

6.6 Procedure in case of Gauging Device Failure or Non-compliance with Requirements
Should the measurements referred to in clauses 6.2 - 6.5 of Cargo Measurement Procedure become impossible to perform due to a failure of gauging devices or non-compliance with conditions and requirements set in ISO 10976 standard and the Regulations, FSRU CTMS shall be determined.

6.7 Determination of Volume of LNG loaded/ LNG reloaded
The volume of LNG, stated in cubic metres to the nearest 0.001 m³ (zero decimal zero zero one cubic metre), shall be determined by using the tank gauge tables referred to in section 4 of Cargo Measurement Procedure and by applying the volume corrections set forth therein.

The volume of LNG reloaded shall be determined by deducting the total volume of LNG in all LNG Carrier’s LNG tanks, involved in the operation, before reloading from the total volume of LNG in all LNG Carrier’s LNG tanks, involved in the operation, after reloading has been completed. This volume of LNG reloaded is then rounded to the nearest one cubic metre.

The volume of LNG loaded to the Terminal shall be determined by deducting the total volume of LNG in all LNG Carrier’s LNG tanks, involved in the operation, after loading has been completed from the total volume of LNG in all LNG Carrier’s LNG tanks, involved in the operation, before loading has been commenced. This volume of LNG loaded is then rounded to the nearest one cubic metre.

6.8 LNG Consumption for LNG Carrier’s Technological needs During LNG Load/ LNG Reload Operation
The consumption of LNG for LNG Carrier technological needs during the LNG Load/ LNG Reload operation and the accounting procedures for this consumption will be mutually agreed upon and confirmed between the Terminal User and the Operator before each individual LNG Load/ LNG Reload operation.
6.9 Partial LNG Carrier’s Unloading/Reloading

In case of a partial unloading/ reloading of the LNG Carrier, the measurements shall be performed as taken above: volume, temperature and pressure will be taken for all LNG Carrier’s LNG tanks. However, the volume, liquid temperature, vapour temperature and vapour pressure as used in energy calculations will only be based upon the values from the LNG tanks involved in the LNG Load/ LNG Reload operation.

6.10 Gassing up & Cool Down Operation

In case the Terminal User wants to perform gassing up and cool down before reloading LNG from FSRU, the Terminal User needs to contact the Operator who will consider the request (without guarantee) and will provide specific procedures in case request is approved.

7. Determination of Quality of LNG and Vapour until LNG Sampling System is Installed at the Terminal

In case LNG sampling system is not yet installed at the Terminal the below procedures for determination of LNG quality will apply.

The Terminal User shall ensure that Cargo quality during LNG loading shall be determined in consultation with the Expert based on the Loading Certificate issued at the load port and the actual voyage conditions assuming that the LNG quality determined at the load port is correct. This determination will be based upon historical data from the same loading port (and similar quality) using only voyages with a similar boil-off. In case not enough historical data is available for LNG quality determination, then theoretical ageing model shall be applied.

When performing LNG reloading from FSRU to LNG Carrier, quality determination shall be carried out in consultation with the Expert based upon the following principles:

- The latest available quality of the regasified LNG will be taken as a basis for LNG quality determination after LNG reloading completion;
- If required an LNG quality shall be determined by applying theoretical ageing.

In case the quality of the regasified LNG cannot be determined in the Terminal, quality of the LNG unloaded to the FSRU during the last operation will be used as a basis for the theoretical ageing.

If both the Terminal User and the Operator agree that the at least one of the above results does not give a fair representation of the quality of the LNG, the Operator and the Terminal User shall meet and decide in good faith in consultation with the Expert the acceptable for both parties method to determine the quality of LNG.

8. Determination of Quality of LNG and Vapour

8.1 Sampling Procedure

8.1.1. General

The quality of the loaded LNG/ reloaded LNG is determined as follows: the Operator shall identify one primary and one back-up sampling system(s) as described in clause 8.1.2 of Cargo Measurement Procedure.

Unless confirmed differently by the Operator, the online Gas Chromatograph will be considered as the primary system; the intermittent sampling using the Constant Pressure/ Floating Piston (CP/ FP) sample container will be the backup system.

8.1.2. Intermittent sampling system

The Operator shall obtain representative samples according to the method described in ISO8943 standard and issue Quality Certificate.

The sampling period for LNG movements shall be only that period of LNG Load/ LNG Reload in which the flow rate is sufficiently stable, which excludes the initial start-up upsurge in the flow rate and the decreased flow rate before stopping. If a sudden change in the LNG flow rate or in the pressure occurs in the transfer line during the LNG sampling period (e.g. due to a Cargo pump being tripped, an
emergency shut-off device being activated) sampling shall be temporarily suspended until the flow rate of LNG is normalized.

Samples shall be analysed by online gas chromatograph as described in clause 8.1.2 sub-clause 1) of Cargo Measurement System and simultaneously collected in CP/ FP sample containers on a continuous basis.

1) Online gas chromatograph analysis:
   A sample shall be taken and analysed by an on-line chromatograph according to the method described in ISO8943 standard.
   Flow rate of LNG (re)loading shall be set up as to ensure that a representative sample is provided to the online gas chromatograph during the (re)loading operation.

2) CP/ FP sample container:
   The Operator shall charge samples into 3 (three) CP/ FP sample containers during the LNG (re)loading operation. Such sample bottles shall be sealed by the Expert who witnessed the sampling.

CP/ FP sample container with samples shall be distributed as follows:

1) 1 (one) CP/ FP sample container shall be used for analysis in line with clause 8.2 of Cargo Measurement Procedure;
2) 1 (one) CP/ FP container shall be made available for the Terminal User. In case Terminal User exercises the right of using this sample container, it should be returned within 5 (five) working days after CP/ FP container receipt.
3) 1 (one) CP/ FP sample container(s) containing sample shall be retained by the Operator for at least 30 (thirty) days. In case of any dispute as to the accuracy of any analysis which is advised by the Terminal User to the Operator within such 30 (thirty) days period, the sample container(s) shall be further retained until the Terminal User’s advice, but in any case for not longer than 90 (ninety) days.

8.1.3. Failure in Collecting Samples and in Determining the Quality of LNG

8.1.3.1. Loading FSRU from LNG Carrier

If the Expert determines, in consultation with the Terminal User and the Operator, that, as a result of the failure of primary sampling procedure or analysis, accurate results as to the quality of the loaded LNG are not able to be determined as prescribed in clause 8.1.1 of Cargo Measurement Procedure, then the results of the back-up sampling system shall be deemed to be the quality of the LNG.

If the Expert determines, in consultation with the Terminal User and the Operator, the failure of both the primary and back-up sampling procedure and/ or analysis, then LNG quality shall be determined in consultation with the Expert on the basis of the actual Cargo load port quality, assuming that the load port quality is correct, and the actual voyage conditions. Quality determination will be based on historical data from the same loading port (and similar quality) using only voyages with a similar boil-off. In case not enough historical data is available for an LNG quality determination, then a theoretical ageing model will be applied.

If both the Terminal User and the Operator agree that at least one of the above results does not give a fair representation of the quality of the LNG loaded to the Terminal, the Operator and the Terminal User shall meet and decide in good faith in consultation with the Expert the appropriate method to determine the LNG quality.

8.1.3.2. Reloading LNG Carrier from FSRU

If the Expert determines, in consultation with the Terminal User and the Operator, that, as a result of the failure of primary sampling procedure or analysis, accurate results as to the quality of the reloaded LNG are not able to be determined as prescribed in clause 8.1.1 of Cargo Measurement Procedure, then the results of the back-up sampling system shall be deemed to be the quality of the LNG.

If the Expert determines, in consultation with the Terminal User and the Operator, the failure of both the primary and back-up sampling procedure and/ or analysis, then LNG quality shall be determined in consultation with the Expert based on the following principles:

- The latest available quality of the regasified LNG will be taken as a basis for the quality determination of reloaded LNG;
- If required an LNG quality shall be determined by applying theoretical ageing.
In case the quality of the regasified LNG cannot be determined in the Terminal, LNG quality of the LNG unloaded to the FSRU during the last operation will be used as a basis for the theoretical ageing.

If both the Terminal User and the Operator agree that the at least one of the above results does not give a fair representation of the quality of the reloaded LNG, the Operator and the Terminal User shall meet and decide in good faith in consultation with the Expert the acceptable for both parties method to determine the quality of LNG.

8.2 Analysis Procedure - Hydrocarbons

The Operator shall analyse the LNG loaded/ LNG reloaded to determine, by gas chromatograph, the molar fractions of Hydrocarbons, Carbon Dioxide, Nitrogen in the sample.

Hydrocarbons heavier than hexane shall be included in normal hexane fraction.

1) Online gas chromatograph analysis:
   The results of each analysis, excluding those results deemed to be erroneous shall be averaged to determine the final LNG quality. The Operator shall establish the statistical method to identify the outliers. In case the Terminal User does not agree with the statistical method used, the Operator and the Terminal User shall meet and agree to discuss an acceptable method.

2) Offline gas chromatograph analysis:
   The method used shall be the method described in ISO6974 standard. Duplicate runs shall be made on each sample to determine that the repeatability is within acceptable limits. The calculated results of such duplicate runs shall be averaged.

8.3 Calibration and validation gas chromatograph

The gas chromatograph used for custody transfer shall be validated and/or calibrated by the Operator (witnessed by the Expert and/or the Terminal User or its representative) prior to the start of each LNG Load/ LNG Reload operation. After completion of LNG Load/ LNG Reload operation, a validation of the gas chromatograph will be performed repeatedly.

Calibration and validation shall be performed using a standard gas supplied by a reliable and reputable manufacturer, with known accuracy and traceability.

The quality of the standard gas shall be certified and traceable to international standards. The quality of the standard gas shall be similar to the sample quality of the LNG.

Validation of the gas chromatograph analysers shall be carried out by the Operator in accordance with an international and industry acceptable standard.

9. Quantity Determination of LNG Unloaded to FSRU

9.1 Gross Heating Value/ Wobbe Index

Reference conditions are the following:

<table>
<thead>
<tr>
<th></th>
<th>Before 2015</th>
<th>After 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference Temperature of Combustion</td>
<td>25 °C</td>
<td>25 °C</td>
</tr>
<tr>
<td>Reference Temperature of Metering</td>
<td>20 °C</td>
<td>0 °C</td>
</tr>
<tr>
<td>Reference Pressure</td>
<td>1.01325 bar</td>
<td>1.01325 bar</td>
</tr>
<tr>
<td>Ideal/ Real Gas</td>
<td>Ideal gas</td>
<td>Ideal gas</td>
</tr>
</tbody>
</table>

All calculations are done in line with ISO6976 standard.

9.1.1. Gross Heating Value mass

Gross Heating value mass of the LNG is calculated using the below formula:

\[
H_m = \frac{\sum (H_m \cdot X_i \cdot M_i)}{\sum (X_i \cdot M_i)} \tag{1}
\]

Where:
\( H_m = \) Gross Heating Value Mass based on the LNG loaded to the Terminal, in MJ/kg, rounded to 2 (two) decimal places.

\( H_{mi} = \) Gross Heating Value (Mass Based) of component "i", in MJ/kg, as specified in Table 3.

\( M_i = \) Molecular mass of component "i", in kg/kmol, as specified in Table 3.

\( X_i = \) Molar fraction of component "i" of the LNG, determined as described in clause 8.2 of Cargo Measurement Procedure. The mol fraction of methane shall be adjusted as to make the total fraction equal to 1.0000.

9.1.2. Gross Heating value Volume

Gross Heating value volume of the LNG is calculated using the below formula:

\[
H_v = \sum X_i \cdot H_{vi}
\]  

(2)

Where:

\( H_v = \) Gross Heating Value volume of the LNG loaded to the Terminal, in MJ/m³, rounded to 2 (two) decimal places.

\( H_{vi} = \) Gross Heating Value (volume based) of component "i", in MJ/m³, as specified in Table 3.

\( X_i = \) Molar fraction of component "i" of the LNG, determined as described in clause 8.2 of Cargo Measurement Procedure. The mol fraction of methane shall be adjusted as to make the total fraction equal to 1.0000.

9.1.3. Wobbe Index

Wobbe Index of the LNG is calculated using the below formula:

\[
W_i = \frac{H_v}{\sqrt{\sum X_i \cdot M_i \times 28.9626}}
\]

(3)

Where:

\( W_i = \) Wobbe Index of the LNG loaded to the Terminal, in MJ/m³, rounded to 2 (two) decimal places.

\( H_v = \) Gross Heating Value volume of the LNG loaded to the Terminal, in MJ/m³, rounded to 2 (two) decimal places.

\( X_i = \) Molar fraction of component "i" of the LNG, determined as described in clause 8.2 of Cargo Measurement Procedure. The mol fraction of methane shall be adjusted as to make the total fraction equal to 1.0000.

\( M_i = \) Molecular mass of component "i", in kg/kmol, as specified in Table 3.


9.2 LNG Density

Density is calculated using the formulas as described in ISO6578 standard. Density is calculated using the liquid temperature \( T_{liq} \):

\[
d = \frac{\sum (X_i \times M_i)}{\sum (X_i \times V_i) - \left( K_2 + \frac{(K_2 - K_1) \times X_n}{0.0425} \right) \times X_m}
\]

(4)

Where:

\( d = \) density of the LNG loaded to the Terminal, calculated using the quality of the LNG and the liquid temperature \( T_{liq} \), in kg/m³, rounded to 2 (two) decimal places.
\( T_{\text{avg}} \) = average temperature of the LNG in the LNG Carrier immediately before loading, in degrees Celsius, rounded to 1 (one) decimal place, in accordance with clause 6.3 of Cargo Measurement Procedure.

\( X_i \) = Molar fraction of component "i" of the LNG, determined as described in clause 8.2 of Cargo Measurement Procedure. The mol fraction of methane shall be adjusted as to make the total fraction equal to 1.0000.

\( X_n \) = the value of \( X_i \) for methane.

\( X_n \) = the value of \( X_i \) for nitrogen.

\( M_i \) = molecular mass of component "i", in kg/kmol, as specified in Table 3.

\( V_i \) = molar volume of component "i" in m\(^3\)/kmol at \( T_{\text{avg}} \) obtained by linear interpolation of the relevant data as specified in Table 4.

\( K_1 \) = volume correction in m\(^3\)/kmol at temperature \( T_{\text{avg}} \) obtained by linear interpolation of the relevant data as specified in Table 5.

\( K_2 \) = volume correction in m\(^3\)/kmol at temperature \( T_{\text{avg}} \) obtained by linear interpolation of the relevant data as specified in Table 6.

### 9.3 Energy

#### 9.3.1 Gross Energy

Loaded to the Terminal gross energy is calculated using the following formula:

\[
Q_{\text{gross}} = \frac{V \cdot d \cdot H_m}{3.6}
\]

Where:

\( Q_{\text{gross}} \) = gross energy loaded to the Terminal (kWh).

\( V \) = volume of the LNG loaded to the Terminal as calculated in accordance with clause 6.7 of Cargo Measurement Procedure (m\(^3\)).

\( d \) = density of the LNG as calculated according to clause 9.2 of Cargo Measurement Procedure (kg/m\(^3\)).

\( H_m \) = Gross Heating Value mass based as calculated according to clause 9.1 of Cargo Measurement Procedure (MJ/kg).

3.6 = conversion factor: 1 kWh = 3.6 MJ.

#### 9.3.2 Vapour Return

\[
Q_v = V \cdot \frac{T_{\text{ref}}}{273.15 + T_{\text{vap}}} \cdot \frac{P_{\text{vap}}}{1013.25} \cdot \frac{\text{GHV}_{\text{vap}}}{3.6}
\]

Where:

\( Q_v \) = vapour return quantity (kWh).

\( V \) = volume of the LNG loaded to the Terminal, as calculated in accordance with clause 6.7 of Cargo Measurement Procedure (m\(^3\)).

\( T_{\text{ref}} \) = metering reference temperature, applicable at the time of LNG loading (K).

\( T_{\text{vap}} \) = average temperature of the vapour in the LNG Carrier immediately after LNG loading to the Terminal, calculated in accordance with clause 6.3 of Cargo Measurement Procedure, rounded to 0.1 °C (zero decimal one Celsius).

\( P_{\text{vap}} \) = average pressure in mbar of the vapour in the LNG Carrier immediately after LNG loading to the Terminal., calculated in accordance with clause 6.4 of Cargo Measurement Procedure, rounded to 1 mbar (one milibar).
1.01325 = reference pressure (mbar).

\[ \text{GHV}_{\text{vap}} = \text{GHV volume based on the vapour return at the time of LNG loading to the Terminal, assuming that its composition is 100% of methane at reference conditions applicable at the time of LNG loading to the Terminal, (MJ/m}^3\).] \]

3.6 = conversion factor: 1 kWh = 3.6 MJ.

9.3.3. Vapour consumption

In case it is agreed in writing between the Operator and the Terminal User that vapour consumption for LNG Carrier technological needs will take place during LNG loading operation and if LNG Carrier is equipped with gas flow meters for measuring vapour consumption for LNG Carrier technological needs, the quantity of vapour shall be calculated according to the formula below. If LNG Carrier is not equipped with gas flow meters for measuring vapour consumption for technological needs, the Operator and the Terminal User shall mutually agree on the method to calculate the vapour consumption for LNG Carrier technological needs:

\[ Q_f = (GTE_{CCT} - GTE_{OCT}) \cdot GHV_{BOG} \]  

(7)

Where:

\[ Q_f \] = vapour quantity, consumed during LNG loading for LNG Carrier technological needs, (kWh).

\[ GTE_{CCT} \] = Sum of flow meters readings measuring vapour consumption for LNG Carrier technological needs before LNG loading commencement, (nm\(^3\)).

\[ GTE_{OCT} \] = Sum of flow meters readings measuring vapour consumption for LNG Carrier technological needs after LNG loading completion, (nm\(^3\)).

\[ GHV_{BOG} \] = Gross Heating value of vapour consumed for LNG Carrier technological needs, assuming that its composition is 100% of methane at reference conditions applicable in accordance with Description of the Procedure for Natural Gas Accounting, (kWh/m\(^3\)).

9.3.4. Net Energy

Net energy is calculated using the following formula:

\[ Q_{net} = Q_{gross} - Q_r - Q_f \]  

(8)

Where:

\[ Q_{net} \] = Net Energy of the LNG loaded to the Terminal, (kWh).

\[ Q_{gross} \] = Gross Energy of the LNG loaded to the Terminal, (kWh).

\[ Q_r \] = Vapour Return energy, (kWh).

\[ Q_f \] = vapour consumption for LNG Carrier technological needs during LNG loading to the Terminal, calculated in accordance with clause 9.3.3. of Cargo Measurement Procedure, (kWh).

10. Quantity Determination of LNG Reloaded into LNG Carrier

10.1 Gross Heating Value/ Wobbe Index

Reference conditions are the following:

<table>
<thead>
<tr>
<th></th>
<th>Before 2015</th>
<th>After 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference Temperature of Combustion</td>
<td>25 °C</td>
<td>25 °C</td>
</tr>
<tr>
<td>Reference Temperature of Metering</td>
<td>20 °C</td>
<td>0 °C</td>
</tr>
<tr>
<td>Reference Pressure</td>
<td>1.01325 bar</td>
<td>1.01325 bar</td>
</tr>
<tr>
<td>Ideal/Real Gas</td>
<td>Ideal gas</td>
<td>Ideal gas</td>
</tr>
</tbody>
</table>

All calculations are done in line with ISO6976 standard.
10.1.1. Gross Heating Value mass

Gross Heating value mass of the LNG is calculated using the below formula:

\[ H_m = \sum \left( H_{mi} \cdot X_i \cdot M_i \right) \sum \left( X_i \cdot M_i \right) \]  \hspace{1cm} (9)

Where:

\( H_m \) = Gross Heating Value Mass of reloaded LNG, in MJ/kg, rounded to 2 (two) decimal places.

\( H_{mi} \) = Gross Heating Value (Mass Based) of component "i", in MJ/kg, as specified in Table 3.

\( M_i \) = Molecular mass of component "i", in kg/kmol, as specified in Table 3.

\( X_i \) = Molar fraction of component "i" of the LNG, determined as described clause 8.2 of Cargo Measurement Procedure. The mol fraction of methane shall be adjusted as to make the total fraction equal to 1.0000.

10.1.2. Gross Heating Value Volume

Gross Heating value volume of the LNG is calculated using the below formula:

\[ H_v = \sum X_i \cdot H_{vi} \] \hspace{1cm} (10)

Where:

\( H_v \) = Gross Heating Value volume of the LNG reloaded, in MJ/m³, rounded to 2 (two) decimal places.

\( H_{vi} \) = Gross Heating Value (volume based) of component "i" in MJ/m³, as specified in Table 3.

\( X_i \) = Molar fraction of component "i" of the LNG, determined as described clause 8.2 of Cargo Measurement Conditions. The mol fraction of methane shall be adjusted as to make the total fraction equal to 1.0000.

10.1.3. Wobbe Index

Wobbe Index of the LNG reloaded is calculated using the below formula:

\[ W_i = \frac{H_v}{\sqrt{\sum X_i \cdot M_i \cdot 28.9626}} \] \hspace{1cm} (11)

Where:

\( W_i \) = Wobbe Index of the LNG reloaded, in MJ/m³, rounded to 2 (two) decimal places.

\( H_v \) = Gross Heating Value volume of the LNG reloaded, in MJ/m³, rounded to 2 (two) decimal places.

\( X_i \) = Molar fraction of component "i" of the LNG, determined as described clause 8.2 of Cargo Measurement Conditions. The mol fraction of methane shall be adjusted as to make the total fraction equal to 1.0000.

\( M_i \) = Molecular mass of component "i", in kg/kmol, as specified in Table 3.


10.2 LNG Density

Density is calculated using the formulas as described in ISO6578 standard. Density is calculated using the liquid temperature \( T_{liq} \):

\[ d = \frac{\sum (X_i \times M_i)}{\sum (X_i \times V_i) - \left( K_1 + \frac{(K_2 - K_1) \times X_m}{0.0425} \right) \times X_m} \] \hspace{1cm} (12)

Where:
d = density of LNG reloaded, calculated using the quality of LNG and the liquid temperature $T_{liq}$, in kg/m³, rounded to 2 (two) decimal places.

$T_{liq}$ = average temperature of the LNG in the LNG Carrier immediately after reloading, in degrees Celsius, rounded to 1 (one) decimal place, in accordance with clause 6.3 of Cargo Measurement Procedure.

$X_i$ = Molar fraction of component "i" of the LNG, determined as described in clause 8.2 of Cargo Measurement Procedure. The mol fraction of methane shall be adjusted as to make the total fraction equal to 1.0000.

$X_m$ = the value of $X_i$ for methane.

$X_n$ = the value of $X_i$ for nitrogen.

$M_i$ = molecular mass of component "i", in kg/kmol, as specified in Table 3.

$V_i$ = molar volume of component "i", in m³/kmol, at $T_{liq}$ obtained by linear interpolation of the relevant data as specified in Table 4.

$K_1$ = volume correction, in m³/kmol, at temperature $T_{liq}$ obtained by linear interpolation of the relevant data as specified in Table 5.

$K_2$ = volume correction, in m³/kmol, at temperature $T_{liq}$ obtained by linear interpolation of the relevant data as specified in Table 6.

### 10.3 Energy

#### 10.3.1. Gross Energy

Gross Energy reloaded is calculated using the following formula:

$$Q_{gross} = \frac{V \cdot d \cdot H_m}{3.6}$$  \hspace{1cm} (13)

Where:

$Q_{gross}$ = Gross energy reloaded (kWh).

$V$ = volume of the reloaded LNG, as calculated in accordance with clause 6.7 of Cargo Measurement Procedure (m³).

$d$ = density of the LNG as calculated in accordance to clause 9.2 of Cargo Measurement Procedure (kg/m³).

$H_m$ = Gross Heating Value mass as calculated according to clause 9.1 of Cargo Measurement Procedure (MJ/kg).

3.6: conversion factor: 1 kWh = 3.6 MJ.

#### 10.3.2. Vapour Return

$$Q_r = V \cdot \frac{T_{ref}}{273.15 + T_{vap}} \cdot \frac{P_{sup}}{1013.25} \cdot \frac{GHV_{vap}}{3.6}$$  \hspace{1cm} (14)

Where:

$Q_r$ = Vapour Return quantity, (kWh).

$V$ = volume of the reloaded LNG, as calculated in accordance with clause 6.7 of Cargo Measurement Procedure, (m³).

$T_{ref}$ = metering reference temperature, applicable at the time of reloading (K).

$T_{vap}$ = average temperature of the vapour in the LNG Carrier immediately before LNG reloading, calculated in accordance with clause 6.3 of Cargo Measurement Procedure, rounded to 0.1 °C (zero decimal one Celsius).
\[ P_{\text{vap}} = \text{average pressure in mbar of the vapour in the LNG Carrier immediately before LNG reloading, calculated in accordance with clause 6.4 of Cargo Measurement Procedure, rounded to 1 mbar (one milibar), (mbar)}. \]

\[ 1013.25 = \text{reference pressure, (mbar)}. \]

\[ \text{GHV}_{\text{vap}} = \text{Gross Heating Value volume based on the vapour return at the time of LNG reloading, assuming that its composition is 100\% of methane at reference conditions applicable in accordance with Description of the Procedure for Natural Gas Accounting, (MJ/m}^3)\].

\[ 3.6 = \text{conversion factor: } 1 \text{ kWh} = 3.6 \text{ MJ} \]

10.3.3. Vapour consumption

In case it is agreed writing between the Operator and the Terminal User and if LNG Carrier is equipped with gas flow meters for measuring vapour consumption for LNG Carrier technological needs, the quantity of vapour shall be calculated according to the formula below. If LNG Carrier is not equipped with gas flow meters for measuring vapour consumption for technological needs, the Operator and the Terminal User shall mutually agree on the method to calculate the vapour consumption for LNG Carrier technological needs:

\[ Q_f = (GTE_{\text{CCT}} - GTE_{\text{OCT}}) \cdot \text{GHV}_{\text{BOG}} \quad (15) \]

Where:

\[ Q_f = \text{vapour quantity, consumed during LNG reloading for LNG Carrier technological needs, (kWh)}. \]

\[ GTE_{\text{CCT}} = \text{sum of flow meters readings measuring vapour consumption for LNG Carrier technological needs before LNG reloading commencement, (nm}^3\)].

\[ GTE_{\text{OCT}} = \text{sum of flow meters readings measuring vapour consumption for LNG Carrier technological needs after LNG reloading completion, (nm}^3\)].

\[ \text{GHV}_{\text{BOG}} = \text{Gross Heating value of vapour consumed for LNG Carrier technological needs, assuming that its composition is 100\% of methane at reference conditions applicable in accordance with Description of the Procedure for Natural Gas Accounting, (kWh/m}^3)\].

10.3.4. Net Energy

Net energy is calculated using the following formula:

\[ Q_{\text{net}} = Q_{\text{gross}} - Q_r + Q_f \quad (16) \]

Where:

\[ Q_{\text{net}} = \text{Net Energy of the reloaded LNG, (kWh)}. \]

\[ Q_{\text{gross}} = \text{Gross Energy of the reloaded LNG, (kWh)}. \]

\[ Q_r = \text{vapour return energy, (kWh)}. \]

\[ Q_f = \text{vapour consumption for LNG Carrier technological needs during LNG reloading, calculated in accordance with clause 10.3.3. of Cargo Measurement Procedure, (kWh)}. \]

11. Conversion and Rounding

11.1 Energy Conversion

Following conversion factors will be used for converting Energy:

\[ Q \text{ (MJ)} = Q \text{ (kWh)} \times 3.6 \text{ (at the same reference temperature)}. \]

\[ Q \text{ (MMBTU)} = Q \text{ (MJ)} / 1055.056 \text{ (at the same reference temperature)}. \]

\[ Q \text{ (MWh)} = Q \text{ (kWh)} / 1000. \]

Note:

1 MMBTU = 1055.56 MJ (GPA 2145-09 standard).
1 kWh = 3.6 MJ (by definition).
1 MWh = 1000 kWh (by definition).

11.2 Rounding
If the first of the figures to be discarded is 5 (five) or more, the last of the figures to be retained is increased by 1 (one).
If the first of the figures to be discarded is 4 (four) or less, the last of the figures to be retained is unaltered.
The following examples are given to illustrate how a number shall be established in accordance with the above:

<table>
<thead>
<tr>
<th>Number to be rounded</th>
<th>Number after being rounded to first decimal place</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.24</td>
<td>2.2</td>
</tr>
<tr>
<td>2.249</td>
<td>2.2</td>
</tr>
<tr>
<td>2.25</td>
<td>2.3</td>
</tr>
<tr>
<td>2.35</td>
<td>2.4</td>
</tr>
<tr>
<td>2.97</td>
<td>3.0</td>
</tr>
</tbody>
</table>

12. Tables

Table 3: This table is for reference only; values to be used are values as given in ISO6976 standard, reference conditions: 25°C combustion, 0°C measurement.

<table>
<thead>
<tr>
<th></th>
<th>Molar Mass (kg/kmol)</th>
<th>Hmi (MJ/kg)</th>
<th>Hvi (MJ/m³)</th>
<th>Hvi (MJ/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ideal/Real gas</td>
<td>---</td>
<td>---</td>
<td>Ideal</td>
<td>Ideal</td>
</tr>
<tr>
<td>Reference pressure (bar)</td>
<td>---</td>
<td>---</td>
<td>1.01325</td>
<td>1.01325</td>
</tr>
<tr>
<td>Tref metering (°C)</td>
<td>---</td>
<td>---</td>
<td>0 °C</td>
<td>20 °C</td>
</tr>
<tr>
<td>Tref combustion (°C)</td>
<td>---</td>
<td>25 °C</td>
<td>25 °C</td>
<td>25 °C</td>
</tr>
<tr>
<td>Methane</td>
<td>16.043</td>
<td>55.516</td>
<td>39.735</td>
<td>37.024</td>
</tr>
<tr>
<td>Ethane</td>
<td>30.070</td>
<td>51.90</td>
<td>69.63</td>
<td>64.88</td>
</tr>
<tr>
<td>Propane</td>
<td>44.097</td>
<td>50.33</td>
<td>99.01</td>
<td>92.25</td>
</tr>
<tr>
<td>Iso-Butane</td>
<td>58.123</td>
<td>49.35</td>
<td>127.96</td>
<td>119.23</td>
</tr>
<tr>
<td>N-Butane</td>
<td>58.123</td>
<td>49.51</td>
<td>128.37</td>
<td>119.62</td>
</tr>
<tr>
<td>Iso-Pentane</td>
<td>72.150</td>
<td>48.91</td>
<td>157.44</td>
<td>146.70</td>
</tr>
<tr>
<td>N-Pentane</td>
<td>72.150</td>
<td>49.01</td>
<td>157.75</td>
<td>146.99</td>
</tr>
<tr>
<td>N-Hexane</td>
<td>86.177</td>
<td>48.68</td>
<td>187.16</td>
<td>174.39</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>28.0135</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Oxygen</td>
<td>31.9988</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td>44.010</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>
**Table 4:** This table is for reference only; values to be used are molar volumes as given in ISO6578 standard.

<table>
<thead>
<tr>
<th></th>
<th>-165</th>
<th>-160</th>
<th>-155</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane</td>
<td>0.037500</td>
<td>0.038149</td>
<td>0.038839</td>
</tr>
<tr>
<td>Ethane</td>
<td>0.047524</td>
<td>0.047942</td>
<td>0.048369</td>
</tr>
<tr>
<td>Propane</td>
<td>0.062046</td>
<td>0.062497</td>
<td>0.062953</td>
</tr>
<tr>
<td>Iso-Butane</td>
<td>0.077851</td>
<td>0.078352</td>
<td>0.078859</td>
</tr>
<tr>
<td>N-Butane</td>
<td>0.076398</td>
<td>0.076875</td>
<td>0.077359</td>
</tr>
<tr>
<td>Iso-Pentane</td>
<td>0.091179</td>
<td>0.091721</td>
<td>0.092267</td>
</tr>
<tr>
<td>N-Pentane</td>
<td>0.091058</td>
<td>0.091583</td>
<td>0.092111</td>
</tr>
<tr>
<td>N-Hexane</td>
<td>0.104340</td>
<td>0.104890</td>
<td>0.105450</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>0.044043</td>
<td>0.047019</td>
<td>0.051022</td>
</tr>
<tr>
<td>Oxygen</td>
<td>0.030610</td>
<td>0.031510</td>
<td>0.032520</td>
</tr>
</tbody>
</table>

**Table 5:** This table is for reference only, values to be used are $k_1$ factor as given in ISO6578 standard.

<table>
<thead>
<tr>
<th>Temp</th>
<th>-165</th>
<th>-160</th>
<th>-155</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
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**Table 6:** This table is for reference only; values to be used are $k_2$ factor as given in ISO6578 standard.

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