Gas LNG Europe

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THEORETICAL TECHNICAL CAPACITY METHODOLOGY

Rue Ducale 83
B 1000 Brussels
Tel +32 2 209 0500
Fax +32 2 209 0501
gie@gie.eu.com
www.gie.eu.com

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Introduction

This document defines a new methodological approach for assessing the Theoretical Technical Capacity of an LNG Terminal within the new context created in the European gas market. The main features of this new environment for the Terminal Operators are :

- Multi-users Terminals,
- Terminaling activity unbundled from gas trade and network operation,
- Transparency requirements of the Regulatory Authority.

The Theoretical Technical Capacity is defined as the maximum physical throughput of the LNG Terminal. It can be expressed either in (or a combination of): energy per unit of time, volume per unit of time, weight per unit of time, slot per unit of time. The unit of measure and the basic time for this assessment will be chosen by each Terminal Operator individually. For the purpose of this document, the energy per unit of time measurement is used.

This Theoretical Technical Capacity is here called “Technical Capacity” as it is based on the performance of the equipments on line and on the critical bottleneck of the LNG Terminal. It only takes into account the Terminal operation, excluding limitations due to upstream (which are under the responsibility of shippers) or downstream constraints (which are under grid Operator responsibility).

An approach for assessing the “Commercial Capacity” should take into account the various constraints (such as, amongst others, the maximum storage volume) and bottlenecks that limit the possibility to reach the optimal use of the Technical Capacity of the Terminal. Such an approach will be defined later on.

The Technical Capacity will be reviewed every 12 months or in a case of a “major” change of the Technical Capacity within the 12 months period.

Description of an Import Terminal (regasification plant)

To assess the Technical Capacity, the Import Terminal can be divided in three main sections, each of them can be evaluated as part of the plant. This split allows a better understanding of the various bottlenecks and enhances transparency. In some cases, a bottleneck may occur in a common part of the plant (e.g. transfer lines, flare system, metering or ballasting infrastructure), which is not exclusively part of one of the main sections. In such case, a fourth section (common section) may be added. The three main sections are :

1. Unloading Section

This section includes both harbour and Terminal facilities:

- ⇨ Buoy, channel, tugs, dock
- ⇨ Jetty, ship shore interfaces, unloading arms, unloading lines to the tanks,...

2. Storage Section

This section includes only the LNG tanks, excluding the Low Pressure LNG pumps. Nota : This section will not be considered relevant for assessing the Technical Capacity.

3. Send Out Section

This section is the part of the plant dedicated to the Send Out of LNG, including :

- ⇨ LP LNG pumps;
- ⇨ HP LNG pumps;
- ⇨ Boil off compressors;
- ⇨ Recondensor;
- ⇨ Vaporisers;
- ⇨ Truck Loading Station.

Appendix 1 illustrates the different sections of an LNG Import Terminal.

Assumptions

To calculate the Technical Capacity some assumptions concerning non technical aspects are necessary. Important items are, amongst others, gas quality and Send Out pattern.

LNG quality

When the Capacity is expressed in terms of energy per unit time, it is necessary to introduce some data characterizing the LNG, such as Wobbe index or Superior Calorific Value (CV_S). In a multi-users Terminal, receiving long term and short term contracts from different exporting Terminals across the world, LNG can have a wide range of qualities. Depending on the source of LNG and the

ship transit time, this may result in a difference of up to 10% in the assessment of the Technical Capacity.

On the other hand, LNG pump Capacity is proportional with the density of LNG, so that the result depends directly on this parameter.

For calculation purposes, one LNG quality reference is used per import Terminal. This LNG quality reference may be the mean value of LNG unloaded at the Terminal during the past years, or a forecast of possible LNG in the future. Every publication regarding the Technical Capacity must include this associated information.

Storage

Assuming there is always sufficient LNG available in the storage tanks, the maximum storage volume will not limit the Technical Capacity of the Terminal. However, the maximum storage volume will be very important when assessing the Commercial Capacity as it will impact on the one hand the Terminal Unloading Capacity and the maximum ship size and on the other hand the Terminal Send Out Capacity.

Unloading section Capacity

The Technical Unloading Capacity (TUC) is defined in terms of a Certain Number of Slots (CNS), and then in terms of energy, as a quantity of energy unloaded. These two values are corrected through the standardized values for LNG quality and LNG volume unloaded by ships.

We can define the following parameters:

- **Theoretical Slot (TS)** : minimum theoretical period of time inside which a ship (mean volume considered) can be unloaded. The unloading is to be considered as performing without any interruption or loss of time. This period includes : times to moor and unmoor, initial and final cargo measurements, arms connection and disconnection, safety checks, unloading duration and eventual pre-discharge meetings and is function of ship dimension and unloading capacity.
- **Available Slot (AS)** : available period of time inside which a ship (mean volume considered) is unloaded. This parameter is greater than TS and depends on : TS, scheduled maintenance period of unloading equipment, tides, night restrictions and other ship activities while the ship is moored.
- **Certain Slot (CS)** : certain period of time inside which a ship (mean volume considered) is unloaded. This parameter is greater than the AS and depends on : AS, unforeseeable unavailability of unloading equipment, restriction in unloading flow, or of the jetty (failure, bad weather, …).
- **Available Time (AT)** : period of time during which the jetty is open for the unloading operations. This parameter is evaluated considering all activities requesting the closure of jetty or port.

Each Terminal Operator shall define its own method to evaluate the above slots including the unit of time.

Technical Unloading Capacity

As result, the Certain Number of Slots can be calculated using the following formula:

$$\mathbf{CNS = AT/CS}$$

Where:

CNS : Certain Number of Slots

AT : Available time

CS : Certain Slot.

If we consider the Unloading Capacity in terms of energy:

$$\mathbf{TUC = CV_S * Exp * \sum_{i=1}^{CNS} (Vi)}$$

Where:

TUC : Technical Unloading Capacity , expressed in Energy (kWh)

CV_S : High Calorific Value(kWh/m3(n))(ISO 6976)

Exp : Gas / liquid ratio, $m^3_{(n)}/m^3_{LNG}$. Usually between 560 to 600 $m^3_{(n)}/m^3_{LNG}$

CNS : Certain Number of Slots

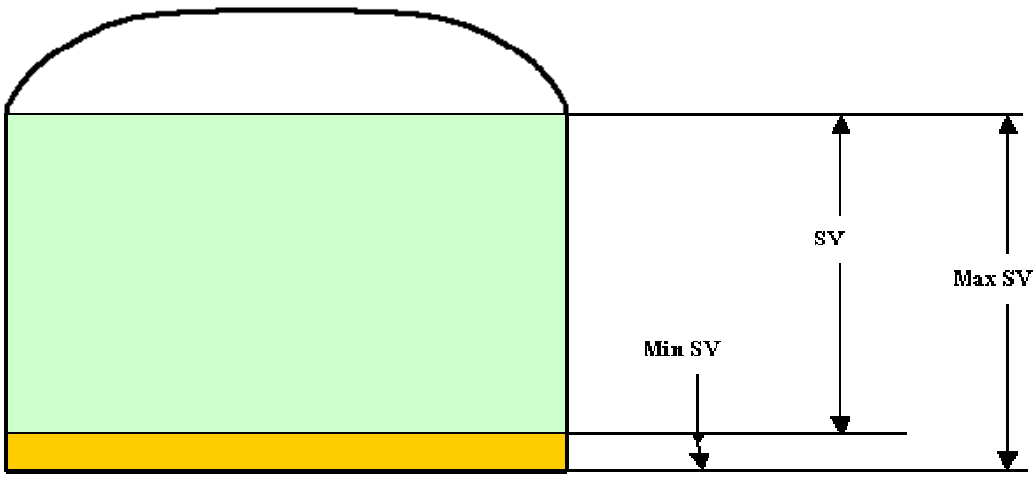
V_i : Mean Net Unloaded Volume (m^3_{LNG})

Storage section Capacity

In this case, for each storage tank, we can define three different storage volumes (m^3_{LNG}) :

1. **Maximum Storage Volume (MaxSV) :** maximum quantity of LNG accepted in the management of the storage tank (above this quantity there is overfilling);
2. **Minimum Storage Volume (MinSV) :** minimum quantity of LNG accepted in the management of the storage tank;
3. **Storage Volume (SV) :** the difference between the Maximum Storage Volume and the Minimum Storage Volume.

The Total Storage Volume (TSV) is the sum of the Operating Storage Volumes of all tanks.



Based on the assumptions hereabove, this section is not relevant for assessing the Technical Capacity.

Send Out section Capacity

The Send Out Capacity depends, amongst others, on the maintenance policy, the spare policy, the availability of each equipment and the availability of the import Terminal as whole.

Some Send Out rates shall be defined first to be able to calculate the Send Out Capacity. The technical Send Out Capacity is then calculated by choosing one of the Send Out rates and integrating the gas quality.

Maximum Send Out

The purpose of the Technical Capacity is to determine the maximum export flow from the Terminal, whatever the business rules are. For an existing Terminal, the Terminal Operator shall determine during which period of time the Terminal should be able to demonstrate such a flow. For new Terminals, this flow is assumed to be the maximum design flow, subject to confirmation during the commissioning of the Terminal.

Send Out rates

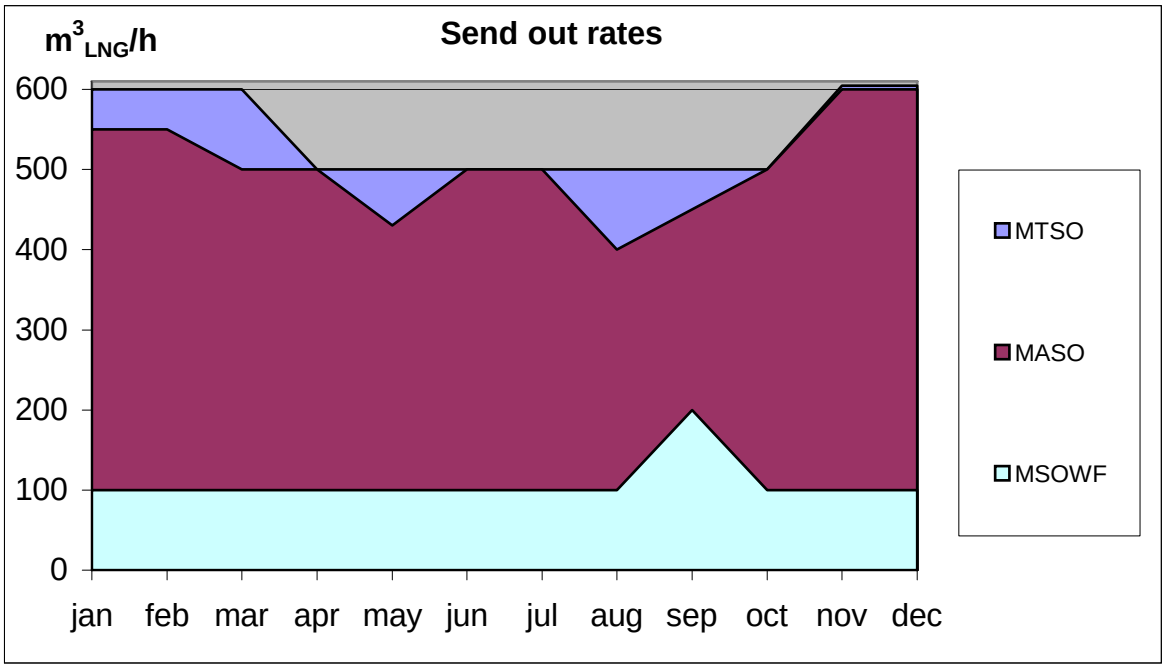
The following Send Out rates are defined below :

1. **Maximum Theoretical Send Out (MTSO)** : it is the maximum value when all the installed pumps (LP&HP) and all vaporisers are on stream at the maximum flow. A method to calculate this Send Out rate is to evaluate the maximum Send Out of : all LP pumps, all HP pumps and all vaporisers. The minimum of these three maximum values is the resulting value for the MTSO. The same calculation has to be done if one of the three values depends on weather or external parameter.

2. **Maximum Available Send Out (MASO)** : it is the maximum available Send Out when scheduled maintenance periods are taken into account. If part of an equipment is not available due to maintenance or lack of spare according to company's policy, the Send Out is reduced. The calculation is the same as for the MTSO, but some equipments, in maintenance or considered as spare, have to be deducted.

3. **Minimum Send Out Without Flaring or Venting (MSOWF)** : it is the minimum technical acceptable Send Out where LNG is still being evaporated without any flaring or venting, hence only considering the Boil Off Compressors Capacity. This value isn't used for the Technical Send Out Capacity calculation but may be used for the business rules. In some cases, this Send Out may be the minimum commercial calorific exchange with another Terminal.

These Send Out rates are reflecting instant availability of the Terminal. According to the maintenance program, it may be based on an hourly, daily, weekly or monthly period or any other period above a month. The representation of these different Send Out rates on a graph may be helpful.



Availability Factor

The Availability Factor «**K_m**» is representative of unscheduled events. This parameter is less than one and is evaluated considering unplanned events such as : failure of equipment, re-gasification plant shut-down (total or partial) either due to electric power interruption, to liquid or vapour LNG leakage, etc. The best way to evaluate this availability is the historical events analysis. The "K_m" is generally between 0,85 and 0,95.

Fuel Consumption Coefficient

Fuel consumption coefficient «**K'**» is a coefficient, less than one taking into account the total fuel consumption and losses.

Truck Loading Capacity (TLC)

If applicable, each Terminal Operator shall define its own method to evaluate the Truck Loading Capacity (TLC).

Technical Send Out Capacity calculation

Considering the above definitions, the Technical Send Out Capacity is calculated as followed :

$$\mathbf{TSOC = K' * K_m * MASO * H_m * Exp_m * CV_S + TLC}$$

Where:

TSOC	*: Technical Send Out Capacity (kWh)*
K'	*: Coefficient less than 1 to cover the fuel consumption and LNG losses*
K_m	*: Availability Send Out factor*
MASO	*: Maximum Available Send Out when scheduled maintenance periods are taken into account (m^3_{LNG}/h)*
H_m	*: Number of hours per unit of time*
Exp_m	*: Mean gas to liquid ratio ($m^3_{(n)}/m^3_{LNG,}$ usually between 560 to 600 $m^3_{(n)}/m^3_{LNG}$)*
CV_s	*: Superior Calorific Value ($kWh/m^3_{(n)}$)*
TLC	*: Truck Loading Capacity (kWh)*

Technical Bottleneck Capacity

If there is a bottleneck on the common part of the Import Terminal, it must appear as a "Bottleneck Capacity". In this case, each Operator has to explain the calculation of this Capacity according to its specific configuration.

The technical Bottleneck Capacity is **TBC** and is expressed in energy (kWh).

Technical Capacity of the plant

The "Technical Capacity" of the Import Terminal is then the minimum value of :

- *TUC*
- *TSOC*
- *TBC*

Appendix 1

Green : Send Out section;
Yellow: Storage section;
Orange: Unloading section