Final report

ET6 - LNG advanced training requirements and vocational programme

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More Information

Public CORE LNGas HIVE reports and additional information related with the project execution and results are available through CORE LNGas Hive public website at www.corelngashive.eu

Contents

1. Introduction

Natural gas is a mixture of light gases, with a variable composition, having a great percentage of methane in such composition (between 80 and 95%). Liquefied natural gas (LNG), as its name states, is the result of the liquefaction of natural gas, that meaning the cooling of gas down to -162ºC at atmospheric pressure. Its density on those conditions is 0.45 t/m3 and its volume is 1/600 of natural gas in gaseous state. During the liquefaction process many polluting components present in natural gas in its gaseous state along with methane (particularly CO2 and sulphur) are eliminated.

The use of LNG as fuel in the transport sector, being a cryogenic product, requires specific knowledge on its treatment, with singular nuances depending on the means of transport (maritime or terrestrial), and with different requirements according to the level of responsibility of the tasks to be carried out in order to complete the operations successfully.

The COSTA Project (2011-EU-21007-S) detected, as one of the main difficulties of the use of LNG as fuel in the transport sector, the social acceptance of the fuel, involving the necessity of looking after the safety aspects even more than using conventional fuels, as well as an appropriate training and competence of the human element, which results into the benefit of the development of operations involving LNG in the transport sector with adequate safety levels.

In relation to training and competence, Recommendation #11 from the report published by the Senate of Spain on the use of LNG as marine fuel, states that it is recommended to put specific training programmes under way for human resources to carry out operations involving LNG so that an efficient and safe service is guaranteed, both for terminal staff and crew on-board a ship, defining professional levels, study plan and corresponding degrees.

Subactivity ET6 from the Core LNGas Hive Project, in which the present document is framed, intends to establish the basis to fulfil the requirement stated by the Senate of Spain regarding the use of LNG as marine fuel, particularly in Recommendation #11 above mentioned, so that personnel in charge of carry out the different operations included in LNG bunkering, as well as loading and unloading LNG tanks, have the appropriate training and, consequently, the necessary competence to accomplish the tasks required in an efficient and safe way.

The present document aims to give response to training necessities associated to LNG bunkering operations, including storage and transport, related to the use of LNG as marine fuel. The process of definition of training and accreditation is accomplished according to the following steps.

Firstly, and after the presentation of the reasons that have led to the necessity to elaborate the present document, a description of training necessities is made, including vocational education and related university modules. The training defined should cover the whole professional capacities, from the most basic to the most complex management of activities, associated to the supply and use of LNG as fuel.

Secondly, the document defines a proposal of contents made for the different activities included in the training necessities defined, based on the goal of matching the training already defined for on-board personnel for LNG bunkering activities.

Finally, this present document includes a proposal of accreditation path, proposing a response to the necessity of creating a regulated training framework for LNG bunkering activities not carried out on-board a ship.

The aim of this document, in summary, is to fulfil the Grant Agreement with reference INEA/CEF/TRAN/M2014/1026196, in what concerns subactivity ET6 described therein, and produce a document to be used as basis for the establishment of professional categories and accreditation process for professionals, trainers and training centres to assure the maximum quality of the capacitation of the human element to accomplish LNG bunkering operations.

2. Background

2.1. Rise of the use of LNG as fuel in the transport sector

The White Paper for Transport 2011 is the document in which the objectives of European Transport for the near future are described. The document includes all the transport modes in order to have an optimised transport system by 2050, and it outlines a list of initiatives to fulfil the objectives to achieve the goal of having a competitive and efficient transport system in Europe. Among the initiatives, the White Paper 2011 includes the establishment of a strategy for the implementation of the use of alternative fuels, that strategy including the appropriate infrastructure adequately used.

In October 2014, following the list of initiatives outlined by the White Paper 2011, Directive 2014/94/EU on the deployment of alternative fuels infrastructure was published. This Directive states that LNG is a very interesting fuel as it helps to reduce the content of sulphur in global emissions, according to what was established in Directive 2012/33/EU of the European Parliament and of the Council amending Council Directive 1999/32/EC as regards the sulphur content of marine fuels. Additionally, the use of LNG also helps to reduce the emissions of NOx, very much in line with the policy of emission reduction outlined for the European Union in the abovementioned White Paper 2011.

Directive 2014/94/EU sets up a list of minimum conditions for the establishment of an LNG supply network in the European Union, urging the Member States to elaborate national policy frameworks "outlining their national targets and objectives, and supporting actions for the development of the market as regards alternative fuels, including the deployment of the necessary infrastructure to be put into place, in close cooperation with regional and local authorities and with the industry concerned, while taking into account the needs of small and medium-sized enterprises".

Considering that shipping accounts for 90% of world trade, and given the fact that LNG has been considered adequate as marine fuel as it is efficient and environmentally friendly, a remarkable rise in the use of LNG as fuel in the transport sector should be expected in the following years.

This rise should be accompanied by the adequate measures for the effective implementation of LNG as fuel in the transport sector, establishing, not only the necessary infrastructures, but also a regulation for its safe and efficient use, that obviously involves a regulation at international level of the training and competency programmes for the human resources that will be responsible for making the new infrastructures work.

As a conclusion, it is a clear necessity that the human element can make the new infrastructures work in an efficient and safe way.

2.2. Necessity of training activities

The use of a new fuel, along with the fact that LNG is a cryogenic product, has itself particularities from the physical and chemical point of view, and causes that infrastructures related to the use of LNG have also particularities in the way they are used, especially regarding safety issues, thus it is highly convenient to have specific training and capacitation so that human resources are capable of operate them in a safe and efficient manner.

The supply of LNG implies a particular operational sequence and a safety protocol system for LNG bunkering operations, and not only training and capacitating actions are required, but also a standardization of the minimum requisites of capacitation that human resources should fulfil in order to accomplish the tasks associated to the operations carried out with this cryogenic fuel.

The fact that the use of LNG as fuel in the transport sector is still at an implementing phase produces certain lack of awareness regarding the particular execution of supply operations, especially concerning the safety protocol, which is strictly necessary to understand and follow step by step to avoid any setback in the implementation process of the use of LNG as fuel in the transport sector.

Parallel to the necessity of specific training for the operations associated to the use of LNG in the transport sector, there is a specific aim to achieve the social acceptance of a relatively unknown substance to be used as fuel, avoiding a rejection from the society that could condemn to failure the global objective of implementing the use of a fuel that allows, maintaining efficiency standards, the necessary reduction of emissions to the atmosphere.

Consciousness raising is an objective that can be carried out through different ways depending on the target of the actions to be taken.

On one side, it is necessary to raise awareness in workers carrying out operations that will change considerably with the implementation of LNG as fuel in the transport sector. It is extremely difficult to have the adequate capacitation without the motivation and conviction of what should be done.

On the other side, consciousness raising should get into the whole society, and publicity has a big say in reaching the general public. It is of huge importance to transmit the appropriate messages to the public in order to eliminate existing prejudices and so achieve the convincement of the society, even though most of the public will not be directly implicated in the use of LNG in the transport sector but will be implicated in an indirect way as final consumers in the supply chain.

Also, and looking into the future, consciousness raising can be carried out through training modules adapted to the youth during their compulsory education. Consciousness raising is not the main aim of subactivity ET6, in which this present document is framed, but it should not be forgotten that the use of a new fuel has a social component, and that the messages transmitted to society, though in an indirect way, should always be positive in order to maintain the rise of the use of LNG, and obviously avoiding any kind of incident when operating with LNG appears as a clear necessity.

2.3. Description of previous related projects

Prior to the training action carried out in subactivity ET6 of the Core LNGas Hive Project, and in the frame of the Trans-European Transport Network, other training actions have been accomplished in the past among several European Universities in order to create synergies to boost training activities related to the main issues arisen in the new European transport policies.

Related to subactivity ET6 of the Core LNGas Hive Project, the most prominent related training actions are TrainMoS and TrainMoS II.

Pilot Project TrainMoS, in 2011, proposed to support the extension of knowledge on issues related to Motorways of the Sea (MoS) in order to contribute, through the human element, to the development and the extension of the multimodal transport system in the EU, making possible to have a smart, sustainable and inclusive connection among the regions in Europe and neighbouring countries.

The TrainMoS Action consisted of a study taking the form of a pilot action, contributing to:

a) support the concept of Motorways of the Sea (MoS) in the EU Multimodal Transport Networking, by developing an initial MoS knowledge platform, and to
b) introduce the human element in the Motorways of the Sea by defining the basis for a future EU virtual open MoS University Master Programme and by pulling together local MoS related competences and knowledge of different EU universities.

TrainMoS developed a MoS knowledge base at EU university level by testing a MoS knowledge platform (within an information and communications technology infrastructure) through the preparation of eight EU wide pilot actions in seven EU countries (Spain, Portugal, Sweden, Germany, United Kingdom, Italy, and Greece).

The participation of seven universities and their corresponding students succeeded to create a critical mass that allowed for the development and testing of a European academic training in all MoS related subjects in order to meet the needs of the transport industry.

Following the abovementioned action, during 2014 and 2015 a complementary training action took place to continue with the TrainMoS global project. It was called TrainMoS II, and it developed a second phase that tackled new emerging training necessities related to transport and sustainability, taking into consideration the different challenges identified for maritime transport, based in the knowledge and the instruments generated during the TrainMoS Action, introducing new contents and improving the existing information and communications technology (ICT).

The main priorities, concerning both maritime transport and logistics, were covered by pilot training modules that tackled the following aspects:

- Alternative fuels and technologies.
- Logistic issues and single windows directive
- Damage control
- Evacuation/crisis management

The main outputs obtained from this second action of the TrainMoS Global project were:

- to deliver a specific tool to match the demand and offer related with training and job on the maritime logistic sector
- to design and provide training modules according to stakeholder needs
- to design a master science MSc based on the created training modules
- to draft an agreement among the universities to provide the MSc based on the TMS training modules and experiences
- to provide a system of recognition of the credits obtained by each single participant.

In terms of training and competence, it is noteworthy a publication from the Society for Gas as a Marine Fuel (SGMF) on recommendations related to training and competence, which is a guide to determine the necessary competences for each of the participating actors involved in bunkering operations, so that those operations are carried out safely and efficiently and in an environmentally friendly mode. To accomplish that, the SGMF proposes a modular training for each actor identified in bunkering operations, gathering the various modules in the following aspects:

- Operating and regulatory framework
- Ensuring a safe environment
- Checking equipment as fit for purpose
- Connection and testing
- Transferring LNG
- Draining, disconnection and storage
- Responding to Emergencies
- Quantity & Quality
- Port & Ship Specific.

The distribution proposed by the SGMF aims at assuring the competence of each of the elements of the operative chain, establishing a map of responsibilities and roles, though not defining specific training programmes associated to them.

3. Identification of training necessities based on operations

3.1. Description of LNG bunkering operations

Covering the definition of training contents implies a previous identification of training and capacitation necessities in order to accomplish the tasks needed to carry out LNG bunkering operations.

Such identification suggests the necessity of having a thorough knowledge of the main tasks associated to LNG bunkering operations for each of its modes of development.

This section intends to give a brief description of such tasks, as well as of the main elements that are part of the LNG supply chain and so compose a complete radiograph of the situation to which this document aims at giving a proposal of response.

There are four main bunkering modes:

- Truck to Ship (TTS).
- Terminal to Ship via Pipeline (TPS). Also known as Pipeline to Ship (PTS).
- Ship to Ship (STS).
- Container to Ship (CTS). Also known as cassette bunkering.

Each of those bunkering modes is succinctly described in this section of the document.

3.1.1. Regulatory framework, standards and guidance documents

The regulatory framework is defined in or derived from legislative instruments relevant to LNG bunkering operations, such as:

- International conventions.
- International/European directives.
- Legislation at national or regional level.
- Terms and conditions of licences and permits.

The following documents are used as reference documents regarding the use of LNG as marine fuel:

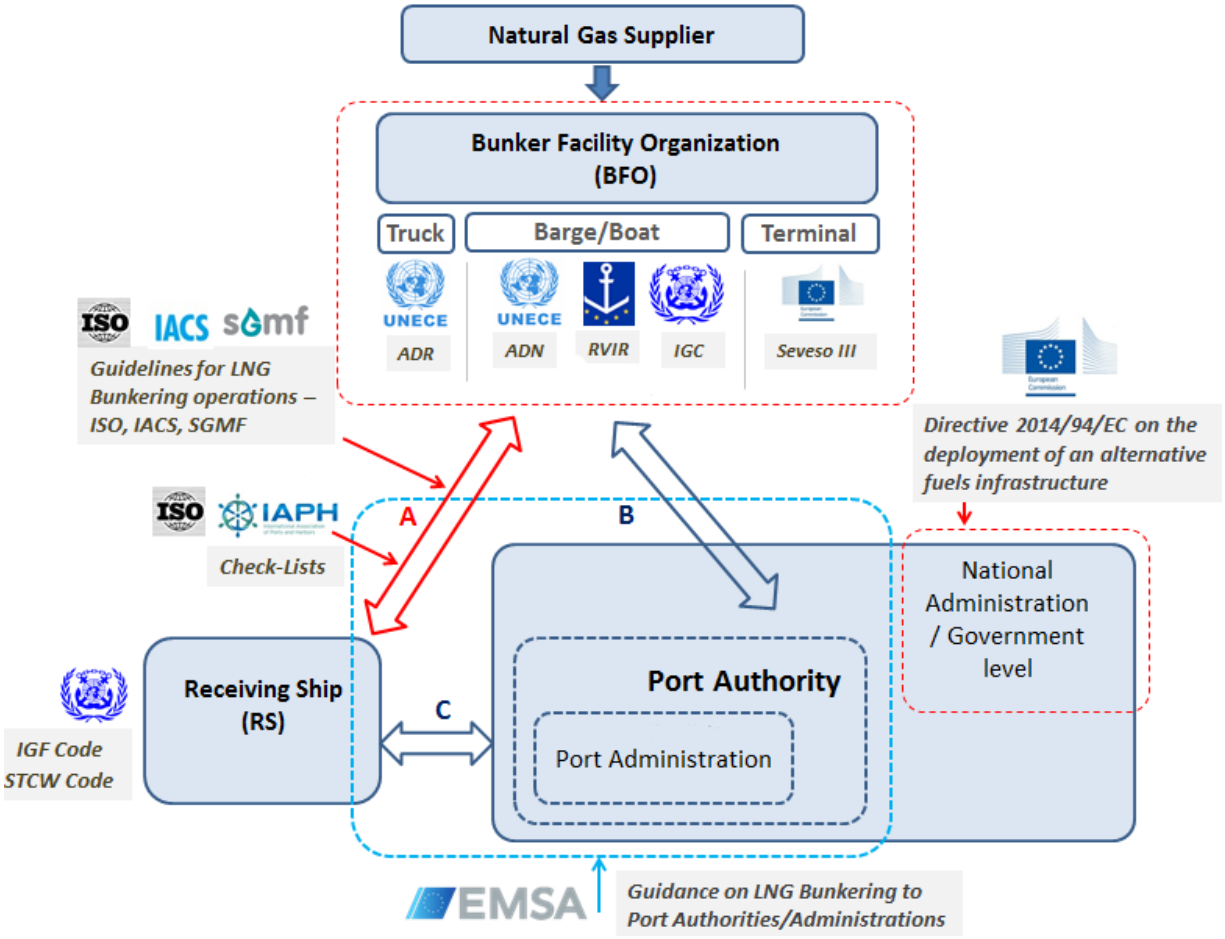
- IMO. IGF International Code of Safety for Ships using Gases or other low flashpoint Fuels.
- IMO. Interim Guidelines on Safety for Natural-Gas Fuelled engine installations in ships, adopted in 2009 through Resolution MSC.285(86).

- IMO. IGC International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk, adopted in 1983 and completely reviewed in 2014, entering into force 1st of January 2016.
- ISO/TS 18683, Guidelines for systems and installations for supply of LNG as fuel to ships.
- ISO 20519:2017, Ships and marine technology — Specification for bunkering of liquefied natural gas fuelled vessels, already approved and published.
- ISO 28460:2010. Petroleum and natural gas industries -- Installation and equipment for liquefied natural gas -- Ship-to-shore interface and port operations.
- EN 1474 Part 1 “Installation and equipment for liquefied natural gas – Design and testing of marine transfer systems – Design and testing of transfer arms”.
- EN 1474 Part 2 “Installation and equipment for liquefied natural gas – Design and testing of marine transfer systems - Design and testing of transfer hoses”.
- EN 1474 Part 3 “Installation and equipment for liquefied natural gas – Design and testing of marine transfer systems – Offshore transfer systems”.
- IEC 60079 Explosive atmospheres.
- Guidance on LNG bunkering to Port Authorities. EMSA.

Particularly regarding risk assessment and management, the following reference documents are remarkable:

- ISO - IEC 31010:2009 – Risk management – Risk assessment techniques.
- ISO/TS 16901, Guidance on performing risk assessments in the design of onshore LNG installations including the ship/shore interface.
- IMO Revised Guidelines for formal safety assessment (approved by MSC-MEPC.2/Circ.12, appendix 3).

The full framework is represented in the following figure:



LNG bunkering frame/stakeholders. Source: EMSA.

3.1.2. LNG bunkering modes. General description.

The following sub-sections intend to give a succinct description of the bunkering modes considered relevant to date.

3.1.2.1. Truck to Ship (TTS)

LNG bunkering through Truck to Ship (TTS) consists of the transfer of LNG from truck to ship, with this ship using the LNG as fuel. TTS bunkering is a flexible method, efficient from an economic point of view, adequate when the frequency of supply is not very high and the volumes to be supplied are small (50 to 200 m3). Furthermore, transfer rates are low in this bunkering method (40-60 m3/h).

Regarding the procedure, the supply of LNG to ships carried out using trucks is similar to the procedure of unloading LNG from trucks in terminals and supply stations. The operation, in general terms, is done with a velocity of supply of around 40 to 60 m3/h using a 3" flexible hose.

Regarding the tanks used for the operations, there are basically two types depending on the isolation used: vacuum filled with isolating material and with insulating materials. The thermal transfer in this type of tanks is about 10 times higher than in vacuum units.

- Vacuum isolated tank: This type of tank is formed by a double hull. An inside hull made of stainless steel (low temperature) and an outside hull made of carbon steel at ambient temperature. The thermal isolation is achieved by using an isolating material and vacuum between both hulls. Isolation can be done by using perlite and a multi-layer isolation.
- Polyurethane isolated tank: It is formed by a single hull made of stainless steel (low temperature). Around that hull a polyurethane foam layer and a final aluminium lacquered layer are added.
- Isolated tanks using other materials and/or isolating procedures.

The LNG transfer is carried out through one of the following methods:

- Pressure gradient.
- Cryogenic pumping.

The inevitable warming of LNG produces an increase in the volatility of LNG, and the gaseous phase increases the pressure in the tank. In order to prevent that, tanks have safety valves installed for when pressure is higher than desirable, as well as emergency shutdown systems in case of overfilling of tank.

The maximum load is determined by the most restrictive between its maximum weight and the maximum degree of filling.

The maximum permissible weight for LNG tanks is 40 tons.

The capacity of storage tanks has evolved as summarized in the following references:

- Initial tanks (1970 and after): With a gross capacity of around 40 m3, and a net loading capacity of 34 m3, equivalent to around 20000 Nm3 of natural gas as a reference level.
- Current tanks: With a gross capacity of up to 56.5 m3 and a net loading capacity of 48 m3 of LNG, equivalent to around 28000 Nm3 of natural gas.
- Tanks are constructed specially for transport of cryogenic liquids and are duly certified for LNG transport.
- According to the Agreement on Dangerous Goods by Road (ADR), the maximum filling for an LNG tank is 95% of its geometric capacity.
- LNG tanks are the bulkiest that are permitted to travel by road since the liquid transported has a density around 0.45 t/m3.

- Considering all maximum dimensions established by regulation, the resulting gross volume is 56.5 m3.

The investment needed to implement Truck to Ship LNG bunkering is much lower than other bunkering modes, making it easier to supply the bunkering service for almost any supplier in the market scene. As previously mentioned, it is a very flexible method thanks to its availability for almost any dock, but only feasible in case of low volumes.

Trucks have a tank capacity of 40 to 80 m3, depending on the design of the tank and regulations to travel by road.

Considering volumes of up to 200 m3, TTS is an adequate bunkering method. For higher volumes a study of the truck traffic should dictate the adaptation of the supply to this method, considering that the traffic of trucks may reduce safety levels and thus make this bunkering mode inappropriate.

Trucks may also supply the industry near the port facilities, or even vessels in nearby ports, always considering a short distance and low volumes.

In order to reduce the total time of supply there are various solutions that make possible to give service using several trucks at the same time using adapted units for TTS LNG bunkering.

An example of TTS LNG bunkering that took place in Spain is represented in the following images:

Truck to ship LNG bunkering operation. Source: Puertos del Estado.

Truck to ship LNG bunkering operation. Source: Puertos del Estado.

Truck to ship LNG bunkering operation. Source: Puertos del Estado.

Truck to ship LNG bunkering operation. Source: Puertos del Estado.

The operation can be summarised in the following steps:

a. Previous operations:

   1. Truck arrival and placement.
   2. Earth connection.
   3. Verification of procedure checklist. Check all manual valves.
   4. Connection of loading hose.
   5. Leak test, inerting and purging.
   6. Start cooling of pumping equipment.
   7. Start pumping stabilising pressure to 5-6 bar.

b. LNG transfer: full operation is monitored by personnel.

c. Transfer completed:

   1. Stop pump and close valves.
   2. Purging process.

3. Relieve pressure from the hose. Inerting.
4. Disconnect earth connection.
5. Equipment and storage checking.
6. Removal of ice on pipelines.
7. Removal of hoses and truck leaves.

Truck to ship LNG bunkering operation. Source: Puertos del Estado.

3.1.2.2. Pipeline to Ship (PTS)

The supply through pipeline has the capacity to transfer large flows and volumes, meaning that fuelling times can be shortened.

This bunkering mode is adequate for any volume, particularly for specialised services, e.g. regular lines with high frequencies and niche-ports like, for example, tug vessels, port service vessels or fishing boats.

The maritime access to the jetty and the distance between storage tanks and vessels are key factors for the success of this bunkering solution.

Storage tanks should generally be placed near the supply berth due to difficulties from different points of view (technical, logistic and economic) to maintain the adequate temperature of LNG in the pipeline, as well as the boil-off gas that may be produced and the thermal shrinkage of pipelines. It is recommended to have a distance under 250 metres for vacuum isolated pipelines, though there may be longer distances if the adequate equipment is used.

This bunkering method is very rigid due to the fact that the location of the bunkering berth should be near the storage tanks.

Moreover, there may be conflicts with other activities carried out in the dock (loading and unloading of vessels). This method is adequate for market niches with high frequency of supply and low volumes (supply to service vessels or programmed ferries).

Also, if the demand of LNG as marine fuel is expected to have peak periods, it is recommended to have enough facilities for bunkering operations within the port, even though the initial demand is not as high.

LNG bunkering using pipelines is carried out the same way as the LNG loading operations of vessels in import or bunker terminals. Facilities and procedures are the same than when loading vessels with LNG, though regulation is not the same for both cases.

In order to accomplish a bunkering operation, it is necessary to have a specialised jetty available, as well as loading arms or cryogenic flexible hoses with a facility for elevation and manoeuvring of the hoses.

Regarding the bunkering methodology, the vessel receiving the bunker should dock in the supply berth considering the operating radius of the loading arms and the position of the vessel connections.

Optionally, instead of loading arms, connections may be installed at ground level and use a cryogenic flexible hose with an adapted crane and an inerting system, though the recommended system, when feasible technically and economically, includes loading arms, more expensive, but faster and safer. The choice mainly depends on the demand.

Loading arms. Source: Reganosa.

PTS bunkering is carried out from LNG storage tanks, with mainly two kinds of tanks: those at atmospheric pressure and pressurized (pressures between 5 and 23 bar).

The first type (atmospheric pressure) are usually tanks from 10000 to 150000 m3, designed for large LNG storage and regasification terminals, with internal hulls made of steel and external walls made of prestressed concrete.

The second type (pressurized), which is the most adequate for an LNG supply plant, are tanks admitting pressurization, with commercial capacities of up to 300 m3, even 1000 m3 in special orders. Maximum design pressure is usually 5-9 bar, but also may be 14 or even 23 bar. When this pressure is exceeded, the safety valves start venting the tank, and so preventing it from higher pressures.

These LNG storage tanks are usually designed to withstand temperatures down to -196ºC with double hull made of treated steel, vacuum isolation and/or perlite filling. The maximum filling level before the safety valves start taking action for venting is up to 95%.

The usual equipment for these tanks is the following:

- Valves: cryogenic.
- Instrumentation: gauge and level.
- Communication systems.
- Pressurizing vaporizer
- Safety valves
- Maximum filling level system up to 95%.
- Venting circuit.

Tanks are cylindrical or spherical and may be horizontal or vertical. Generally, the largest are positioned horizontally. In the following image two tanks (120 m3 each) are placed horizontally:

Horizontal LNG storage tanks. Source: HAM

The operation is summarised in the following steps:

a. Previous operations:

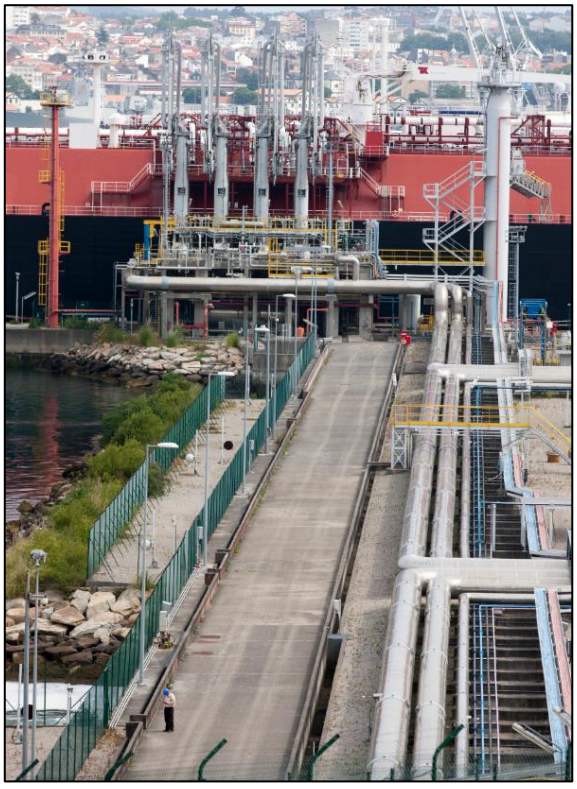
   1. Inerting.
   2. Checking of tanks and equipment.

3. Request.
4. Checklist for the receiving vessel.
5. Fuel hose and boil-off return connection.
6. Checklist completed.
7. Start signal.
8. Opening of valves.

b. Pumping sequence: start, pumping and stop.

c. Disconnection:

1. Purging of pipelines.
2. Closing of manual and automatic valves
3. Disconnection of hoses.
4. Inerting of pipelines of receiving vessel.
5. Supply document.
6. Unmooring.
7. Receiving vessel leaves.
8. Inerting of supply pipelines.



Infrastructure for PTS bunkering at jetty. Source: Reganosa.

3.1.2.3. Ship to Ship (STS)

This bunkering mode is used to supply volumes of up to 20,000 m3 with high supply frequency. In this method, a barge is loaded with LNG in a large LNG import terminal or a medium sized terminal. The bunkering operation may be carried out in the dock, with the receiving vessel moored and the barge brought alongside the vessel to supply the bunker, or it may also take place with the receiving vessel anchored inside or outside the port, again with the supply barge brought alongside. The capacity of the barge and the supply time should be adapted to the bunker necessities of the receiving vessel.

STS is a flexible bunkering method with high supply speed, the most remarkable inconveniences are the high early costs (initial investment and maintenance) and a potential interference with port traffic.

Supply barges are floating tanks, generally self-propelled, that are prepared to give bunker to vessels. There exist storage barges that are not self-propelled, and that are moved with the assistance of a tug, but it is not the most recommendable option given the fact that it carries a potentially dangerous substance.

Types of vessels that can transport methane depending on the capacity:

1. Large methane tankers: these vessels are used to transport LNG at large scale to import terminals. These tankers have capacities of up to 250,000 m3.
2. Feeder vessels: these vessels carry out LNG distribution at medium scale and small scale, with capacities of 5,000 to 50,000 m3.
3. Barges: used for the supply of LNG to vessels. Capacity of up to 5,000 m3.

There is another relevant difference among these groups, which is referred to the connection points for the hoses in loading and unloading operations. While in the case of large methane tankers the connection points are about 12-15 metres above the floating line, and in the case of small barges, these connection points are located 5-8 metres above the floating line. This difference represents a relevant incompatibility when sharing loading and unloading facilities.

In the case of feeder vessels, these should be adapted to both heights, usually by a double equipment for loading/unloading.

LNG ship to ship bunkering. Source: DNV.

Both self-propelled and non-self-propelled supply barges should comply with the IGC code from IMO and with all the national and regional applicable regulation.

The vessels have one or more cryogenic tanks in their hold that make them possible to maintain the load at -162ºC.

The ship to ship bunkering operations may be carried out, as previously mentioned in the dock, with the receiving vessel moored and the barge brought alongside the vessel to supply the bunker, or it may also take place with the receiving vessel anchored inside or outside the port, again with the supply barge brought alongside. The latter depends on weather conditions (waves, wind, fog, currents, etc.).

Additionally, the bunker may be supplied to neighbouring ports that lack LNG bunkering facilities.

In such case, vessels should be equipped with fenders, mooring systems and fuel transfer equipment that makes possible to have a safe relative movement with each other.

The available time to moor should not have a great impact in the global supply time, which implies that this operation should be made as dynamic as possible considering the technology available.

This method is the most suitable for volumes of more than 100 m3 given the flexibility offered that the fact that the bunkering operation can be carried out while moored at the dock and also outside of the port, and also given the large volumes that may be supplied in a short period of time.

The bunkering service has to be conveniently planned both for the bunker barge and for the receiving vessel, thus it is recommendable to take the following phases:

- **Phase 1. Pre-planning for ship arrival**

It should be accomplished before the STS operation starts. STS operation planning may be carried out by ship operators and person in charge (PIC) in case a terminal is involved.

- **Phase 2. Arrival**

During this phase the aim is to establish a communication line between the ships that are involved in the STS operation. It may be through radio or telephone, and both have to agree with the operational procedures, that should **be** evaluated and accepted.

- **Phase 3. Berthing**

This phase consists of the docking of the receiving vessel, with the supply barge being brought alongside.

For manoeuvring operations, there should exist a contingency plan to face any emergency situation.

- **Phase 4. LNG transfer**

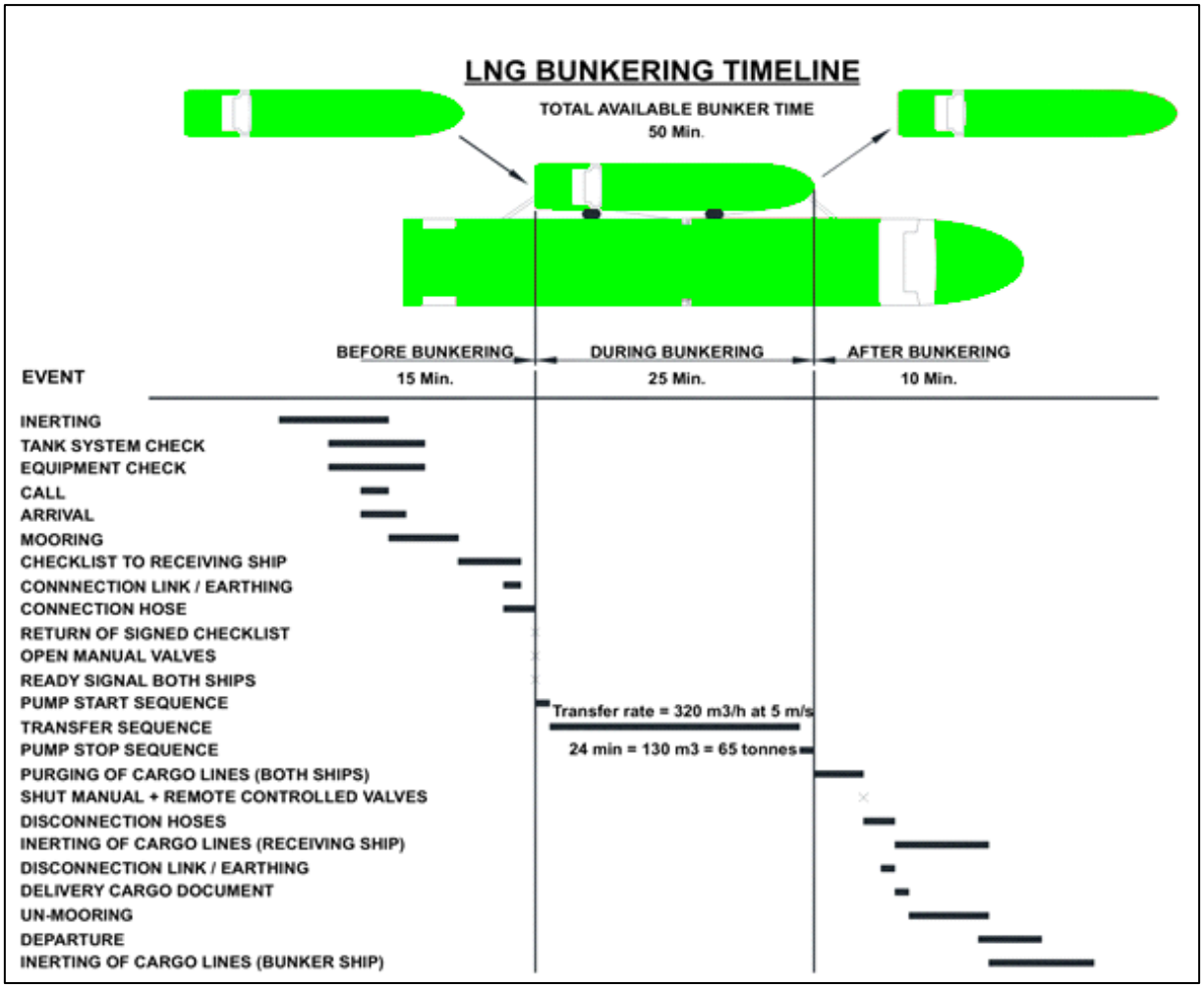
The LNG transfer should only start once both ships are docked and brought alongside, respectively, and the procedures to follow are verified by both parts.

The Master Mariner/Captain mariner or his representative should make sure that all the safety procedures are being followed. There should exist a contingency plan to face any emergency during the transfer phase.

- **Phase 5. Departure**

The departure is the last phase in an STS bunkering operation, and it obviously takes place once the LNG transfer phase is completed.

A summary of the LNG STS bunkering operation is described in the following figure, which also adds indicative times for each of the main phases of the operation.



LNG bunkering timeline. Source: LNG Ship to Ship Bunkering Procedure. Swedish Maritime Technology Forum.

The operations represented in the previous figure (some of them could be simultaneous), are the following:

a. Previous operations:

1. Inerting.
2. Tank and equipment check.
3. Call.
4. Arrival and mooring of receiving ship, with the supply barge brought alongside.
5. Checklist to receiving ship.
6. Earth connection of ship and supply barge.
7. Connection of hoses (LNG supply and boil-off return if needed).
8. Checklist completed.
9. Opening of valves.

10. Mutual ready signal from both ships.

b. Transfer sequence: start pumping, transfer and stop pumping.

c. Disconnection:

1. Manual and automatic valves are closed.
2. Purging of cargo line, both for receiving ship and supply barge.
3. Purging and disconnection of hoses.
4. Inerting of cargo lines for the receiving ship.
5. Earth disconnection (both ships).
6. Delivery cargo document.
7. Un-mooring.
8. Departure.
9. Inerting of cargo lines for the supply barge.

The connection between the supply barge and the receiving ship may be carried out using loading arms or flexible hoses. In the following image, a sequence of the STS bunkering operation between the Viking Grace (receiving ship) and the Fjalir barge (supply barge), using a flexible hose and an elevator device, is represented.

Connection process. Source: Fjalir project

3.1.2.4. Container to Ship (CTS)

Container to Ship (CTS) bunkering, also known as Cassette bunkering, is a bunkering mode in which an LNG container (ISO standard) is used to supply LNG to the receiving ship.

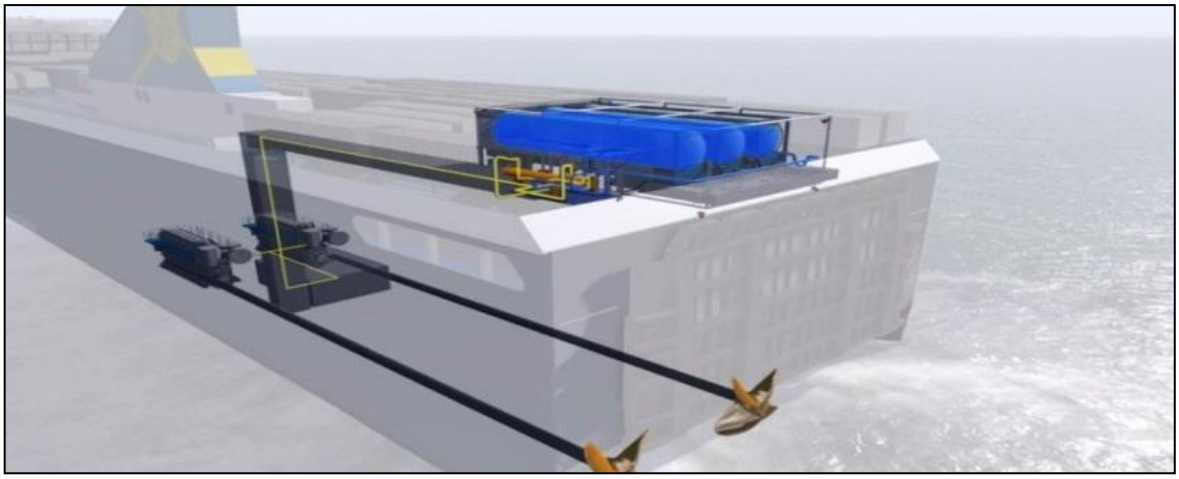
This method is still in a development phase, not being regularly used yet. The containers used are also used for transporting LNG as general cargo.

The main features of the containers are those of a standard TEU, with a total weight of about 31 tons, and a capacity of 31 m3 of LNG.

Container to ship example

The main advantage of this bunkering method is that LNG can be manipulated as the rest of containers, and currently there are enough port infrastructures to manage containers.

Considering those infrastructures and their efficiency, there could be possible to obtain great LNG transfer rates for receiving ships.



Container placement simulation

The main disadvantage of this method is the complex adaptation of the receiving ship to this method, and the short period of storage available with it, making it impossible to be used for long trips.

3.1.3. Description of the LNG supply chain

The LNG supply chain consists of a series of events that are carried out to make possible to transfer LNG from its production to the final consumer.

The scope of this document does not include the liquefaction process or its transport to an LNG import terminal, focusing on LNG distribution from storage tanks of the import terminal to the final consumer.

The diverse actors involved the supply chain considered in the scope of this document are those associated to storage and transport of LNG, as well as the human resources necessary to make this supply chain work in an efficient and safe way from the storage plant to the final consumer.

The most relevant options for storing LNG are:

- Storage and regasification plant
- Satellite plant
- LNG station

On the other hand, LNG transport may be carried out using one of the following modes:

- Truck

- Ship
- Railway
- Pipeline

3.1.3.1. Liquefaction process

Even though the liquefaction process is not included in the scope of this document, it is a very important link in the LNG supply chain.

The technology used for the liquefaction processes is based on successive processes of compression, condensation, expansion and evaporation, all together reducing the temperature of the natural gas until it is liquefied.

The liquefaction process may be carried out in large scale plants and small-scale plants, with the scale factor being a point to consider in the economy of production.

3.1.3.2. Storage and regasification plant

A storage and regasification plant is a facility in which LNG is received from methane tankers. Due to the nature of LNG transport, storage and regasification plants are located in coastal sheltered zones, so that it is possible to easily transfer LNG from the methane tankers.

The main operations usually carried out are:

- Unload of methane tankers, using pumps from the ships and cryogenic loading/unloading arms. Prior to the first transfer of a methane tanker, a compatibility study between the ship and the plant is carried out. Current unloading flows are about 12,000 m3/h.
- LNG storage in tanks specially designed for cryogenic conditions. LNG is stored at a temperature of less than -160ºC with a pressure slightly higher than the atmospheric pressure. LNG can be stored during several days. Pressure inside the storage tanks is controlled with the management of the vapours produced in the evaporation of natural gas (boil-off gas or simply BOG). These vapours are restored due to the compression of BOG that makes possible to introduce it in the tank again once it is liquefied. When for any reason it is not possible to restore the BOG, they are moved to the torch and burnt in a controlled way.
- Pumping operations. These operations are carried out using pumps submerged in the tank (primary pumps) and then the pressure is increased in the liquid phase with a secondary pumping to the vaporizers.
- Regasification, which is an operation that consists of vaporizing LNG to introduce it in the transport network in a gaseous state.

- Measurement. The gas is measured when getting out of the plant using turbine or ultrasound counters.
- Odorization. An odorizer is injected in order to detect leaks in the transport and distribution network.
- BOG treatment (vaporizations). BOG generated in the tanks is used in the unloading process to restore gas to the methane tanker. During a normal process, it is recovered using compressors and injecting it into a re-liquefier for its later vaporization.

Methane tanker. Port of Cartagena. Source: Enagás.

3.1.3.3. LNG satellite plant

An LNG satellite plant is a storing, regasification and regulation facility used for the supply of gas for small scale gas use in zones where there is no gas supply through pipelines.

The operation carried out in LNG satellite plants consists of unloading LNG tanks previously transported to the satellite plant by road from a much larger plant.

Operations carried out in satellite plants that may require personnel are, apart from the typical maintenance (preventive and corrective) of components, those associated to the unload of LNG from the trucks.

Regarding the rest of operations of a satellite plant, it functions in an autonomous way.

3.1.3.4. LNG station

The supply of LNG to trucks requires LNG stations. Currently, LNG stations work in a very automatic way, but it is necessary to consider that certain rules should be followed, and the presence of some personnel is needed in order to assure that the LNG fuelling operations are carried out according to regulation in terms of safety.

3.1.3.5. Transport

As previously mentioned, the transport of LNG may be carried out in tanks of different typology through trucks, ships or railway, as well as through pipelines. For each means of transport, it is necessary to consider certain particular considerations depending on the different nature of the means of transport.

Gas stations in Spain (updated to mid-2019). Source: Gasnam

3.2. Human resources needed for bunkering operations

Safe and efficient bunkering operations are carried out thanks to properly trained and capacitated personnel. The human resources estimated for the defined operations are identified in the following sub-sections, considering:

- Truck to Ship bunkering
- Pipeline to Ship bunkering
- Ship to Ship bunkering (human resources and training and capacitation already defined for on-board personnel).
- Container to Ship bunkering (considered as loading and unloading operation).

3.2.1. Human resources linked to Truck to Ship Bunkering

This preliminary description of the human resources linked to Truck to Ship bunkering operations include the identification of profiles and a classification of those profiles in two main groups: operating and management.

The human resources considered are both for the supply terminal operations carried out using pipelines and the on-board operations (receiving ship).

3.2.1.1. Identification of profiles

The human resources linked to accomplishing the TTS operations described in this document may be slightly different, especially regarding supervising tasks, depending on the terminal where the operations are carried out and the operator of such terminal.

Generally, and since TTS bunkering necessarily involves trucks and ships, now the resources for each of the parts are described for this bunkering method.

Firstly, the human resources associated to the operations carried out in the terminal (truck) are the following:

- **ADR driver:** the ADR driver, as mentioned by the acronym (European Agreement concerning the International Carriage of Dangerous Goods by Road), is responsible for carrying the LNG to the terminal by road (truck).

- **Ground operator:** this operator is responsible for all the technical operations related to the supply truck. He may have an assistant to help him with certain operations. The main operations carried out by the ground operator are the following:

    - Firstly regarding the previous operations, the ground operator is responsible for the truck arrival and parking, earth connection of the truck, verify the checklist (supervised by the terminal supervisor), check the manual valves, connect the loading hose, open the valves, pressurize the hose, check that there are no leaks, start the cooling process of the pumping equipment and start the pumping operation stabilizing the pressure to 5-6 bar.
    - Secondly, once the LNG transfer has been completed, the ground operator stops the pump and closes the valves, and he is also responsible for the vaporization of the LNG from the hose into the storage tank. The ground operator also depressurizes the hose, disconnects the earth connection and will make a final visual supervision of the equipment and store of the equipment in perfect conditions.

- **Assistant to ground operator:** this operator is responsible for the assistance to the ground operator in all the operations related to the transfer of LNG and broken down above.

- **Chief of ground operation:** this operator is responsible for supervising all the operations carried out in the terminal during LNG TTS bunkering, linking the operational and managerial processes.

Secondly, the human resources associated to the operations carried out in the receiving ship (on-board operations) are the following:

- **Donkey man/Bosun/Boatswain:** the donkey man, bosun or boatswain is responsible for the technical operations needed in this bunkering mode, assisted by an able seaman or oiler. The operations are the following:

    - Inerting, tanks and equipment checking, check-list verification (supervised by the Deck/Engine Officer), connections and opening of valves.
    - During the LNG transfer, the donkey man, bosun or boatswain constantly supervises the operation.
    - Once the LNG transfer is finished, the donkey man, bosun or boatswain closes the valves, purges pipelines, disconnects hoses and inerts the ship pipelines.

- **Able seaman/oiler:** the able seaman/oiler is responsible for assisting the donkey man, bosun or boatswain in all the operations to be carried out.

- **Deck/Engine Officer:** the Deck/Engine Officer is responsible for supervising the tasks carried out, taking special attention to safety elements related to the ship in this bunkering mode.

- **Chief Engineer:** Person in charge and responsible for the supervision of the bunkering operation on board helped by another engine officer, rendering account to the Master of the vessel.

- **Master Mariner/Captain:** the Master Mariner/Captain is responsible for authorizing the operation and for a potential cancelation, as well as being the main responsible for fulfilling all the safety conditions established for the operations in the ship linked to this bunkering mode.

According to various recommendations, the following figures may also be part of the operation:

- **Responsible for supply operation:** this is the person designated by the LNG supply company responsible for planning and executing the supply.

- **Coordinator of the supply operation:** this is the person designated by the LNG supply company responsible for supervising the planning of the LNG supply, as well as for establishing the coordination among all the parts involved in the bunkering operations, especially in case of emergency.

3.2.1.2. Classification of profiles

According to the main tasks initially assigned to each of the human resources identified for TTS bunkering operations, it is also necessary to identify a training profile for those human resources.

In the particular case of TTS bunkering operations, it is necessary to identify the human resources associated to the terminal (supply truck) and the receiving ship. In the case of the receiving ship, the IMO establishes training and competence for the on-board personnel, though a description is included in this document as reference.

For the terminal (supply truck):

For the terminal two different levels are identified: operation level and management level.

Operation level: Training defined at vocational education level. Profiles identified to require operation training, regardless of other capacitation that may be required by the provider of the bunkering operation services, are the following:

- Ground operator
- Assistant to ground operator
- Chief of ground operation

In addition, the following profile must be included in the operation level:

- ADR driver: Capacitation of the ADR driver is associated to the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR). No specific training for LNG carriage is defined, though this profile must be included as this bunkering mode is defined by LNG truck carriage.

Management level: Training defined at university level. Profiles identified to require management training, regardless of other capacitation that may be required by the provider of the bunkering operation services, are the following:

- Responsible for supply operation (person in charge, PIC)
- Coordinator of the supply operation

Other equivalent profiles may be defined to carry out management tasks, although training defined is also proposed for those potential equivalent profiles.

For the receiving ship (training already defined and regulated):

Operation level (defined as basic training):

- Donkey man/Bosun/Boatswain
- Able seaman or oiler

Management level (defined as advanced training):

- Deck/Engine Officer
- Chief Engineer
- Master Mariner/Captain

3.2.2. Human resources linked to Pipeline to Ship bunkering

This preliminary description of the human resources linked to Pipeline to Ship bunkering operations include the identification of profiles and a classification of those profiles in two main groups: operating and management.

The human resources considered are both for the supply terminal operations carried out using pipelines and the on-board operations (receiving ship).

3.2.2.1. Identification of profiles

Generally, PTS bunkering involves a fixed supply facility in a terminal (jetty) and a receiving ship. The following description contains the human resources identified as necessary and the tasks carried out by them.

Firstly, for the supply terminal the following human resources have been identified:

- **Ground operator:** this operator is responsible for all the technical operations related to the supply terminal. He may have an assistant to help him with certain operations. The main operations carried out by the terminal operator are the following:
    - Firstly, regarding the previous operations, the ground operator is responsible for inerting the pipelines, checking tanks and equipment, verifying the checklist (supervised by the chief of operation), check the manual valves, connect the loading hose, open the valves, pressurize the hose, check that there are no leaks, start the cooling process of the pumping equipment and start the pumping operation.
    - Secondly, once the LNG transfer has been completed, the ground operator stops the pump and closes the valves, and he is also responsible for the vaporization of the LNG from the hose into the storage tank. The ground operator also depressurizes the hose, disconnects the earth connection and will make a final visual supervision of the equipment and store of the equipment in perfect conditions.

- **Assistant to ground operator:** this operator is responsible for the assistance to the ground operator in all the operations related to the transfer of LNG and broken down above.

- **Panel operator:** responsible for technical checking for the supply operation by using the terminal control panel. Also responsible for giving indications to ground operator on the tasks to be carried out during the operations in this bunkering mode.

- **Chief of operation:** responsible for the supervision of the tasks to be carried out by ground and panel operators, as well as responsible for the fulfilling of all the safety rules associated to the terminal in this bunkering mode.

- **Head of operations:** responsible for authorizing the operation and for a potential cancelation if deemed necessary. Global responsible for the bunkering operation from the side of the terminal.

- **Design engineer:** Responsible for designing the bunkering operation for the specific facility. Also participates in later stages of the operation to check the proper work of the operation design.

- **Head of plant:** Not an active part in bunkering operations. Responsible for all issues and operations carried out in the plant/terminal.

Secondly, the human resources associated to the operations carried out in the receiving ship are the following:

- **Donkey man/Bosun/Boatswain:** the donkey man, bosun or boatswain is responsible for the technical operations needed in this bunkering mode, assisted by an able seaman or oiler. The operations are the following:
    - Inerting, tanks and equipment checking, check-list verification (supervised by the Deck/Engine Officer), connections and opening of valves.
    - During the LNG transfer, the donkey man, bosun or boatswain constantly supervises the operation.
    - Once the LNG transfer is finished, the donkey man, bosun or boatswain closes the valves, purges pipelines, disconnects hoses and inerts the ship pipelines.

- **Able seaman/oiler:** the able seaman/oiler is responsible for assisting the donkey man, bosun or boatswain in all the operations to be carried out.

- **Deck/Engine Officer:** the Deck/Engine Officer is responsible for supervising the tasks carried out, taking especially regarding safety elements related to the ship in this bunkering mode.

- **Chief Engineer:** Person in charge and responsible for the supervision of the bunkering operation on board helped by another engine officer, rendering account to the Master of the vessel.

- **Master Mariner/Captain:** the Master Mariner/Captain is responsible for authorizing the operation and for a potential cancelation, as well as being the main responsible for fulfilling all the safety conditions established for the operations in the ship linked to this bunkering mode.

3.2.2.2. Classification of profiles

According to the main tasks initially assigned to each of the human resources identified for carrying out PTS bunkering operations, it is also necessary to classify each of them.

For the case of PTS bunkering it is necessary to identify and describe profiles for human resources associated to the terminal/plant and the receiving ship. In the case of the receiving ship, the IMO establishes training and competence for the on-board personnel, though a description is included in this document as reference.

For the terminal:

For the terminal two different levels are identified: operation level and management level.

Operation level: Training defined at vocational education level. Profiles identified to require operation training, regardless of other capacitation that may be required by the provider of the bunkering operation services, are the following:

- Ground operator
- Assistant to ground operator
- Panel operator
- Chief of operation

Management level: Training defined at university level. Profiles identified to require management training, regardless of other capacitation that may be required by the provider of the bunkering operation services, are the following:

- Head of operations
- Design engineer
- Head of plant

Other equivalent profiles may be defined to carry out management tasks, although training defined is also proposed for those potential equivalent profiles.

For the receiving ship (training already defined and regulated):

Operation level (defined as basic training):

- Donkey man/Bosun/Boatswain
- Able seaman or oiler

Management level (defined as advanced training):

- Deck/Engine Officer
- Chief Engineer
- Master Mariner/Captain

3.2.3. Human resources linked to Ship to Ship bunkering

Once the STS operation has been described in previous sections, in the present section there is a description of the human resources needed for STS bunkering, both from the supply barge and from the receiving ship.

It is also necessary to classify the profile for each of the human resources previously identified in operation and management profiles.

3.2.3.1. Identification of profiles

Firstly, from the supply barge, the human resources identified are:

- **Bosun/Boatswain:** the bosun or boatswain is responsible for the technical operations needed in the supply barge in this bunkering mode, assisted by an able seaman or oiler. The operations are the following:
    - Inerting, tanks and equipment checking, check-list verification (supervised by the Deck/Engine Officer), connections and opening of valves.
    - During the LNG transfer, the bosun or boatswain constantly supervises the bunker station and hoses.
    - Once the LNG transfer is finished, the bosun or boatswain closes the valves, purges pipelines, disconnects hoses and inerts the barge pipelines.

- **Able seaman/oiler:** the able seaman/oiler is responsible for assisting the donkey man, bosun or boatswain in all the operations to be carried out.

- **Deck/Engine Officer:** the Deck/Engine Officer is responsible for supervising the tasks carried out, taking especially regarding safety elements related to the ship in this bunkering mode.

- **Master Mariner/Captain:** the Master Mariner/Captain is responsible for authorising the operation and for a potential cancelation, as well as being the main responsible for fulfilling all the safety conditions established for the operations in the barge linked to this bunkering mode.

Secondly, from the receiving ship, the human resources identified are:

- **Donkey man/Bosun/Boatswain:** the donkey man, bosun or boatswain is responsible for the technical operations needed in the receiving ship in this bunkering mode, assisted by an able seaman or oiler. The operations are the following:

    - Inerting, tanks and equipment checking, check-list verification (supervised by the Deck/Engine Officer), connections and opening of valves.
    - Once the LNG transfer is finished, the donkey man, bosun or boatswain closes the valves, purges pipelines, disconnects hoses and inerts the ship pipelines.

- **Able seaman/oiler:** the able seaman/oiler is responsible for assisting the donkey man, bosun or boatswain in all the operations to be carried out.

- **Deck/Engine Officer:** the Deck/Engine Officer is responsible for supervising the tasks carried out, taking especially regarding safety elements related to the ship in this bunkering mode.

- **Chief Engineer:** Person in charge and responsible for the supervision of the bunkering operation on board helped by another engine officer, rendering account to the Master of the vessel.

- **Master Mariner/Captain:** the Master Mariner/Captain is responsible for authorising the operation and for a potential cancelation, as well as being the main responsible for fulfilling all the safety conditions established for the operations in the ship linked to this bunkering mode.

3.2.3.2. Classification of profiles

For the supply barge, IMO establishes training and competence for the on-board personnel according to IGC Code and STCW IMO Convention V/1.

For the receiving ship, IMO establishes training and competence for the on-board personnel according to IGF Code and STCW IMO Convention V/3-1 or V/3-2, basic or advanced training and competence.

In both cases, though it is already under proper regulation, according to criteria used in the present document, training would be defined as follows.

For the supply barge:

Operation level (defined as basic training):

- Bosun/Boatswain
- Able seaman or oiler

Management level (defined as advanced training):

- Deck/Engine Officer
- Master Mariner/Captain

For the receiving ship:

Operation level (defined as basic training):

- Donkey man/Bosun/Boatswain
- Able seaman or oiler

Management level (defined as advanced training):

- Deck/Engine Officer
- Chief Engineer
- Master Mariner/Captain

Additionally, there should be a consideration on the bunkering preparation phase and the previous manoeuvring, for which the following personnel have been identified:

- **For the supply barge:** Master Mariner/Captain at control bridge, and the Deck/Engine Officer and able seaman at the deck.
- **For the receiving ship:** Master Mariner/Captain at control bridge, with at least one deck officer and an able seaman with him. At the deck, another officer at bow with no less than two able seamen and a boatswain and one more able seaman at stern.

Usually ships are moored using lines and the manoeuvring is carried out at the port, but considering new bunkering barge design, a dynamic positioning system is being implemented in order to carry out the manoeuvring without lines outside of the port.

3.2.4. Human resources linked to Container to Ship bunkering

Once a brief description of the CTS bunkering operation was made in previous sections of this document, this present section aims at describing the human resources needed for the operation previously described, as well as making a description of the profiles for the human resources identified.

This description is carried out considering that the procedure followed in CTS bunkering is still in development process, so the conclusions set up in this document are approximate and up to future considerations, and it is in any case a loading/loading and unloading process.

3.2.4.1. Identification of profiles

As one of the main advantages of this bunkering method is that port infrastructures can be used for the logistics associated to containers, this fact reduces the specific training and competence necessary at the terminal, reducing the specific personnel to a responsible person for the operation, though taking into consideration that the operation is carried out at a port terminal with the infrastructure (including human resources) necessary for managing the logistics associated to container transport:

- **Responsible for supply operation:** this is the person designated by the LNG supply company responsible for planning and executing the supply.

The resources identified from the part of the receiving ship are:

- **Donkey man/Bosun/Boatswain:** the donkey man, bosun or boatswain is the person responsible for the technical operations associated to the receiving ship, supervised by the Deck/Engine Officer and that has an able seaman or oiler as assistant.

- **Able seaman/oiler:** the able seaman/oiler is responsible for assisting the donkey man, bosun or boatswain in all the operations to be carried out in CTS bunkering operations.

- **Deck/Engine Officer:** the Deck/Engine Officer is responsible for supervising the tasks carried out, taking especially regarding safety elements related to the ship in CTS bunkering.

- **Chief Engineer:** Person in charge and responsible for the supervision of the bunkering operation on board helped by another engine officer, rendering account to the Master of the vessel.

- **Master Mariner/Captain:** the Master Mariner/Captain is responsible for authorising the operation and for a potential cancelation, as well as being the main responsible for fulfilling all the safety conditions established for the operations in the barge linked to this bunkering mode.

3.2.4.2. Classification of profiles

According to the main tasks initially assigned to each of the human resources identified for carrying out CTS bunkering operations, it is also necessary to classify each of them.

For the particular case of CTS bunkering it is necessary to identify and describe profiles for human resources associated to the terminal and the receiving ship. In the case of the receiving ship, the IMO establishes training and competence for the on-board personnel, profiles are included in the present document.

For the terminal:

Management level: Training defined at university level. The profile identified to require management training, regardless of other capacitation that may be required by the provider of the bunkering operation services, is the following:

- Responsible for supply operation

For the receiving ship:

Operation level (defined as basic training):

- Donkey man/Bosun/Boatswain
- Able seaman or oiler

Management level (defined as advanced training):

- Deck/Engine Officer
- Chief Engineer
- Master Mariner/Captain

3.3. Human resources needed in the LNG supply chain

Regasification plants usually have the function of unloading LNG from methane tankers. One of the main tasks in this type of plant consists of loading and unloading storage tanks.

The aim of this section is to describe the tasks carried out by the human resources identified, as well as describe the profiles corresponding to the human resources identified for loading and unloading storage tanks.

3.3.1. Human resources linked to storage and regasification plants

Storage and regasification plants are nodes of huge relevance in the LNG supply chain, with the human element being essential for the development of the operations carried out in storage and regasification plants.

In the following paragraphs profiles are identified and succinctly described, as well as classified according to training levels.

3.3.1.1. Identification of profiles

The profiles identified for operations carried out in storage and regasification plants are described in this section along with the tasks assigned for each profile.

- **Ground operator:** this operator is responsible for all the technical operations related to loading and unloading LNG storage tanks, those including previous inspection of tanks and equipment, inerting, opening and closing valves, verifying the checklist (supervised by chief of operation), connection and disconnection of hoses and transfer checking. He may have an assistant to help him with certain operations.

- **Assistant to ground operator:** responsible for assisting the ground operator in all the operations to be carried out regarding loading and unloading LNG storage tanks.

- **Panel operator:** responsible for technical checking for the supply operation by using the terminal control panel. Also responsible for giving indications to ground operator on the tasks to be carried out during the operations in loading and unloading LNG storage tanks.

- **Chief of operation:** responsible for the supervision of the tasks to be carried out by ground and panel operators, as well as responsible for the fulfilling of all the safety rules associated to the terminal in loading and unloading LNG storage tanks.

- **Head of operations:** responsible for authorizing and managing operations in the plant.

- **Design engineer:** Responsible for designing operations for the specific facility. Also participates in later stages of plant operations to check the proper work of the operation design.

- **Head of plant:** Not an active part in operations. Responsible for all issues and operations carried out in the plant/terminal.

3.3.1.2. Classification of profiles

The classification of the profiles previously identified for activities related to loading and unloading LNG storage tanks is the following:

Operation level: Training defined at vocational education level. Profiles identified to require operation training, regardless of other capacitation that may be required by the provider of the operation services, are the following:

- Ground operator
- Assistant to ground operator
- Panel operator
- Chief of operation

Management level: Training defined at university level. Profiles identified to require management training, regardless of other capacitation that may be required by the provider of the bunkering operation services, are the following:

- Head of operations
- Design engineer
- Head of plant

Other equivalent profiles may be defined to carry out management tasks, although training defined is also proposed for those potential equivalent profiles.

3.3.2. Human resources linked to LNG satellite plants

In general terms, LNG satellite plants operate independently from a regasification plant, and receive LNG in trucks coming (by road) from regasification terminals/plants. The aim of this section is to carry out a description of the human resources needed for loading and unloading operations in LNG satellite plants. It is also necessary to classify the profiles identified.

3.3.2.1. Identification of profiles

The resources identified for loading and unloading operations in satellite plants are the following:

- **Satellite plant operator:** this operator is responsible for all the technical operations related to loading and unloading LNG storage tanks in the satellite plant, those including previous inspection of tanks and equipment, inerting, opening and closing valves, connection and disconnection of hoses and transfer checking. He may have an assistant to help him with certain operations depending on the magnitude of the operations carried out in the plant and the degree of automation.

- **Assistant to satellite plant operator:** responsible for assisting the ground operator in all the operations to be carried out regarding loading and unloading LNG storage tanks in the satellite plant.

- **Chief of satellite plant:** responsible for the supervision of the tasks to be carried out by the satellite plant operator, as well as responsible for the fulfilling of all the safety rules associated to the satellite plant in loading and unloading LNG storage tanks.

As LNG tanks arrive to the satellite plant, it is necessary to consider some specific personnel for the trucks transporting the LNG. The personnel considered are the following:

- **ADR driver:** responsible for driving the truck.

- **Ground operator:** responsible for all the technical operations linked to the truck, including previous inspection of tanks and equipment, inerting, opening and closing valves, connection and disconnection of hoses and transfer checking. He may have an assistant to help him depending on the magnitude of operations.

- **Assistant to ground operator:** responsible for assisting the ground operator in all the operations to be carried out.

- **Chief of ground operation:** responsible for the supervision of the tasks to be carried out by ground operator, as well as responsible for the fulfilling of all the safety rules associated to the satellite plant in loading and unloading LNG storage tanks.

3.3.2.2. Classification of profiles

For the satellite plant:

Operation level: Training defined at vocational education level. Profiles identified to require operation training, regardless of other capacitation that may be required by the provider of the operation services, are the following:

- Satellite plant operator
- Assistant to satellite plant operator
- Chief of satellite plant

For the truck:

- ADR driver
- Ground operator
- Assistant to ground operator
- Chief of ground operation

Satellite plant. Source: Molgás.

3.3.3. Human resources linked to LNG stations

Nowadays, practice is showing that LNG stations are operating autonomously, without the personnel that should be desirable in order to carry out the LNG refuelling operations in a safe and efficient way. It is recommended to have certain supervision in LNG stations, and so there should be specific training and competence for truck drivers, though not as extensive as ADR, but at least at a basic level that make possible to accomplish LNG refuelling operations in a safe and efficient way.

The aim of this section is to identify the human resources recommended for LNG stations and the corresponding tasks to be carried out by each of the profiles identified.

3.3.3.1. Identification of profiles

The resources initially identified for the truck are the following:

- **Specialized driver:** responsible for making a revision of the vehicle before refuelling, checking valves and levels, and, after the revision, will connect the hoses and open the valves in the truck. During the refuelling operation, the specialized driver will supervise the transfer in the truck panels. After the refuelling operation, the specialized driver will close the valves and disconnect the equipment.

The resources identified for the LNG station are:

- **LNG station operator:** responsible for making a revision of the equipment before and after each refuelling operation, checking valves and levels, and, after the revision, the LNG station operator will connect the hoses and open the valves. During the refuelling operation, the LNG station operator will check the transfer panels of the LNG station. After the refuelling operation, the LNG station operator will close the valves and disconnect the equipment.

- **Chief of LNG station:** responsible for supervising the LNG station operator/s, especially regarding the safety procedures.

3.3.3.2. Classification of profiles

Once the human resources have been identified, the following step is to describe the corresponding profiles.

For the truck:

- Specialized driver

For the LNG station:

Operation level

- LNG station operator
- Chief of LNG station

LNG station. Source: Molgás.

3.3.4. Human resources linked to railway operations with LNG

Nowadays this type of operations is not carried out, but the present document aims to be a first reference to establish the criteria for the training and competence required to carry out operations related to the transport of LNG by railway, particularly regarding loading and unloading operations for tanks transported by railway.

There should also be considerations on LNG-fuelled railway.

3.3.4.1. Identification of profiles

For the various tasks related to loading and unloading of LNG tanks transported by railway, the human resources initially considered are the following:

- **Railway operator:** responsible for carrying out the tasks related to loading and unloading tanks transported by railway, including previous inspection of equipment and tanks, inerting, opening and closing valves, connecting and disconnecting equipment and transfer checking.
- **Assistant to railway operator:** responsible for assisting the railway operator in the tasks related to loading and unloading tanks transported by railway.
- **Chief of railway operations:** responsible for supervising the tasks carried out by the railway operator, especially concerning the safety and efficiency aspects.

3.3.4.2. Classification of profiles

Once the human resources have initially been identified, the aim now is to describe the profiles associated to the human resources previously identified.

Operation level:

- Railway operator
- Assistant to railway operator
- Chief of railway operations

4. Training proposal at operational level

The profiles identified in the previous section and classified into the operational level have to acquire a series of common competences in order to develop the tasks assigned.

The training proposal at operational level made in this section includes mainly bunkering operations, while the rest of the supply chain is also considered as a reference. For the case of railway operations, as are not yet carried out, the training proposal is just a first reference to be considered as a basis for future adaptations according to actual operation processes.

4.1. Truck to Ship bunkering operations

The training proposal for TTS bunkering operations is composed of two different parts:

- Definition of competences and description of contents proposed for the development of each competence.
- Proposal of evaluation of competences.

4.1.1. Competences and contents

Competence 1: Basic knowledge on LNG

Truck to Ship operations require that participating operators have certain level of knowledge on the main product used in the operations to be used as a basis of a better understanding of the efficiency and safety processes associated to Truck to Ship bunkering operations.

Contents for this competence shall include a brief description of the physical and chemical characteristics of LNG and an introduction of the impact of LNG in its different states (liquid and vapour) for a better understanding of the emissions to the atmosphere derived from the use of LNG as marine fuel. The basic knowledge on LNG shall also include a succinct description of LNG main hazards and behaviour of liquid leakages. Other relevant LNG basics include a brief introduction to the LNG effects on equipment and construction materials, a briefing on potential generation of sparks and ignition due to electric equipment and static loads and a summary of the properties of inert gases (including nitrogen).

A breakdown of the contents for competence 1 is included below.

- Physical and chemical characteristics of LNG

- Definition of LNG and BOG and their role in Truck to Ship bunkering operations
- Comparison between LNG and other fuels
- Gas laws and application to LNG Truck to Ship operations
- Physics related to changes of state in the liquid and how they are related to Truck to Ship bunkering operations:
  - Latent heat
  - Transference of heat and energy
  - Refrigeration and liquefaction of gases
  - Critical temperature
  - Dewpoint definition and temperature
  - Bubble point
  - Gas mixture
  - Cold gas cloud behaviour
  - Rollover causes and effects

- Environmental impact of LNG: liquid and vapour

  - Performance of engines and machines powered by natural gas versus those powered by other fuels related to emissions of:
    - CO2
    - NOx
    - SOx
    - PM (particulate matters)
  - Behaviour of methane as GHG (Greenhouse Gas)

- LNG main hazards linked to Truck to Ship bunkering operations

  - Cryogenic nature of LNG
    - Hypothermia
    - Frostbite
    - Cold burn
  - Flammability
    - Lower Explosion Limit (LEL)
    - Flammability level (LFL)
    - Ignition point
    - Self-ignition temperature
    - Jet fires
    - Pool fires
    - Flash fires
    - Vapour cloud explosion
    - Boiling liquid expanding vapour explosion (BLEVE)

- Lack of oxygen
- Material Safety Datasheet (MSDS)

- Behaviour of fluid leakages, especially for the case of Truck to Ship bunkering operations

  - Behaviour of natural gas and LNG in case of fluid leakages
    - Liquid pools
    - Dense gas clouds, heavier than air until later warming
    - Wind direction
    - Causes and effects of "Rapid Phase Transition"

- LNG effects on equipment and construction materials used for Truck to Ship bunkering operations

  - Selection of appropriate materials for cryogenic conditions and types of failure for such materials
  - Definition of coefficients of expansion and contraction
  - Coefficients of expansion and contraction of the different materials according to temperature gradient
  - Types of materials according to use
  - Repairing methods, including the importance of the use of the adequate spare parts
  - Effect of cryogenic temperatures on the equipment and materials used
  - Interaction between water and LNG
  - LNG transfer system blocking caused by the presence of water/moisture inside lines/equipment

- Potential generation of sparks and ignition due to electric equipment and static loads, particularly for the case of Truck to Ship bunkering operations

  - How electric equipment can cause sparks
  - Causes of static loads
  - Definition of classified areas

- Properties of inert gases (including nitrogen) and applications to Truck to Ship bunkering operations

  - Definition of inert gas
  - Content of oxygen
  - Nature of gas
  - Amount of moisture

Competence 2: Corporate and system management

Operators participating in Truck to Ship bunkering operations shall have certain knowledge of corporate and system management, particularly regarding those issues affecting Truck to Ship bunkering operations. Corporate and system management for Truck to Ship bunkering operations include international regulation, recommendations and relevant guidelines on Truck to Ship bunkering operations, risk analysis for Truck to Ship bunkering operations, responsibilities assumable to the equipment owner or tenant in Truck to Ship bunkering operations, management of safety systems used in Truck to Ship bunkering operations and operating procedures in Truck to Ship bunkering.

A breakdown of the contents for competence 2 is included below.

- International regulation, recommendations and relevant guidelines on Truck to Ship bunkering operations
    - Use of LNG as fuel – MARPOL Annex VI, IGF Code, others.
    - LNG transfer according to IGS Code and port regulation
    - LNG transfer – tanks, containers, barges and LNG terminals
    - Standards and guidelines on LNG operations provided by shipyards, classification societies and equipment suppliers
    - Recommendations from industrial organisations – SGMF, ISO, OCIMF and SIGTTO
- Risk analysis for Truck to Ship bunkering operations
    - Relevant parameters for the risk analysis at operational level
    - How to identify hazards
    - How to determine risks
    - How to establish probability of occurrence and severity
    - How to decide whether a risk is tolerable
    - How to prepare an action plan for risk control
- Responsibilities assumable to the equipment owner or tenant in Truck to Ship bunkering operations
    - Knowledge of the responsibilities resulting from the “duty of care” legal principle regarding the safeguard of damage to third parties
    - Knowledge of applicable regulation to acquisition process for leased or owned equipment
    - Knowledge of operating manuals for main equipment
    - Analysis of the principles of adequate use of hoses and hazards associated to fixing and movement of the hoses without the help of a crane

- Knowledge of how the LNG transfer system should be held to avoid excessive tension/shear efforts for hoses, emergency release systems, connections and collectors
- Knowledge of how to give the adequate response in case of any defect in the facility or documentation
- Knowledge of how safety devices and natural gas detectors work and are calibrated

- Management of safety systems used in Truck to Ship bunkering operations

  - Description of corporate safety management systems and how the safety policy is transferred to the documentation for vessel operation
  - Methodology and techniques to assure an efficient risk management
  - Necessity to manage changes in order to continuously assure that the safety requisites are fulfilled satisfactorily and that changes are implemented in a controlled fashion
  - Importance of compiling information on safety incidents and accidents to promote understanding, learning and potential improvements for future actions
  - Definition of safety levels for the tasks carried out

- Operating procedures for Truck to Ship bunkering operations

  - Object, scope and legal framework of the procedures
  - Contents for the operating procedures and adequate location
  - Necessity to follow operating procedures
  - Necessity to manage any change in the operating procedures in a controlled fashion

Competence 3: Organisation and management

Truck to Ship operators shall have knowledge, at operational level, of how organisation and management works in Truck to Ship bunkering operations. Contents related to organisation and management shall include a description of how communication and working teams are carried out in practice in Truck to Ship bunkering operations, complemented with knowledge of the roles and responsibilities during Truck to Ship bunkering operations.

A breakdown of the contents for competence 3 is included below.

- Communication and working teams in Truck to Ship bunkering operations

  - Chain of command
  - Importance of communication protocols, good practices and methods for obtaining feedback to guarantee effective communication

- Previous meetings to loading operations:
  - Object of meetings
  - Contents
- Checklists and how to use them – Safety checklists ship-shore (or similar)

- Roles and responsibilities during Truck to Ship bunkering operations

  - LNG supplier
  - Company responsible for loading operation
  - LNG receiver
  - Port Authority
  - Independent inspections

Competence 4: Operation, calibration and maintenance of equipment and instrumentation

Truck to Ship bunkering operators shall have knowledge on operation, calibration and maintenance of equipment and instrumentation to the extent necessary for carrying out the tasks associated to Truck to Ship bunkering operations. The contents associated to the competence shall include mechanical manipulation of equipment, devices and instrumentation typically used in Truck to Ship bunkering operations, as well as transfer systems associated to the particular mode of bunkering, LNG storage tanks used in Truck to Ship bunkering operations and different operational requirements and restrictions of the particular mode of bunkering.

A breakdown of the contents for competence 4 is included below.

- Mechanical manipulation in Truck to Ship bunkering operations

  - Knowledge on types of devices to manipulate hoses and equipment used in LNG bunkering operations
  - Knowledge of the principles of mechanical manipulation and hazards associated to operation without the proper holding and transportation systems

- Transfer systems in Truck to Ship bunkering operations

  - Knowledge of the components and principles of operation that form the LNG transfer system:
    - Flexible hoses
    - Articulated arms
    - Fixed pipe on board the ship or on shore and pipe of BOG return and existing elements in those lines
    - Emergency disconnections and safety coupling

        - On shore and on-board connections
        - Manifold layout
        - Multi-truck to Ship connections
    - Understanding of failure types that may result in equipment malfunction

- LNG storage tanks, especially those typically used in Truck to Ship bunkering operations

    - Typology of LNG storage tanks for Truck to Ship bunkering operations:
        - Construction and installation for each type
    - Tank classification
        - Type A details and examples
        - Type B details and examples
        - Type C details and examples
        - Integral or membrane tanks – details and examples
    - Operational requirements for each type
    - Operational restrictions for each type

- LNG pumps typically used in Truck to Ship bunkering operations

    - Pump operation
        - Pressure versus flow
        - Required NPSH versus available NPSH
        - Specific questions related to pumping of boiling liquids such as LNG: cavitation, starting, waiting time until next start, etc.
    - Types of pumps
        - Construction and installation of each type
        - Operational requirements for each type
        - Operational restrictions for each type

- Valves typically used in Truck to Ship bunkering operations

    - Types of valves used in LNG and natural gas installations for:
        - Isolation
        - Control
    - Design features
    - Operational requirements
        - Prevention of over-pressure
    - Maintenance requirements
    - Potential problems – leakages

- Over-pressure protection devices typically used in Truck to Ship bunkering operations

  - Valves and pressure relief systems
    - Types
    - Design features
    - Operational requirements
    - Design and operation
    - Limitations
    - Potential problems

- Electric equipment in classified areas used for Truck to Ship bunkering operations

  - Classification of areas (zoning)
    - Different categories of safety types for electric equipment
    - Role of regulation standards for a safe use of electric equipment
    - How to identify safe electric equipment for its use in classified areas

- Management of safety systems (leakages/spillages) in Truck to Ship bunkering operations

  - Water curtains
  - Spill plates:
    - Recommendations
    - Draining processes
  - CCTV/Monitoring equipment
  - Over-filling protection methods
  - Elements for the detection of gas, flames, etc.
  - Firefighting equipment

- Personal Protective Equipment (PPE) for Truck to Ship bunkering operations

  - Equipment
  - Dressing

- Operation manuals for main equipment in Truck to Ship bunkering operations

  - Relevant content of operation and maintenance manuals for main equipment
    - Specific equipment issues

Competence 5: LNG Truck to Ship bunkering operations

Truck to Ship bunkering operators shall have deep knowledge of how LNG Truck to Ship bunkering operations are carried out in practice, starting with the previous activities to the loading operation,

which include checking compatibility of equipment and devices and a deep knowledge of the checklist for previous operations; purging, which includes a deep knowledge of how to carry out the task as well as the relevance of doing and not doing it; pressurization and depressurization, draining and isolation, focusing on how to carry out the different processes and highlighting the object and necessity of each task of the process so that the trainee is fully aware of the importance of each of them in terms of safety and efficiency.

A breakdown of the contents for competence 5 is included below.

- Previous activities to TTS loading operation
    - Compatibility between manifold of receiving vessel and the LNG transfer system (hoses) of the truck, including connectivity to Multi-truck to Ship systems when necessary
    - Compatibility between earth installation and the LNG transfer system (hoses) of the truck.
    - Fulfilling of previous checklist for Truck to Ship bunkering operations
    - Meeting prior to loading operation
    - Necessity of obtaining checklist validation by supplier and receiver

- TTS operation management – purging
    - Object and importance of purging operations before and after LNG transfers
    - Potential consequences of incorrect of inefficient purging process related to:
        - Safety
        - Operational issues
        - Fiscal issues

- Pressurization and depressurization
    - Pressurization process
        - Necessity of controlling pressurization ratio
        - Pressurization processes and associated tests
        - High-pressure safety process
    - Depressurization processes:
        - Joule-Thompson cooling effect and how equipment temperature is reduced considerably
    - Vacuuming
    - Fatigue cycles

- TTS Operation management – draining

- Draining method for lines prior to disconnecting
  - Methods and precautions related to vacuuming of liquid lines and their connections
  - Methods and precautions related to vacuuming of gas lines and their connections
  - Safety issues due to potential inefficient draining

- TTS Operation management – isolation

  - Methods for a safe line and equipment division into sectors in relation to:
    - Preventing liquid retention between isolating valves
    - Assuring a safe emergency disconnection
    - Assuring safety conditions during the execution of the LNG transfer operation

Competence 6: Control and monitoring for LNG Truck to Ship bunkering operations

Truck to Ship bunkering operators shall have knowledge on control and monitoring of operations, particularly regarding Truck to Ship bunkering operations at operation level.

In order to acquire this competence the trainees shall have knowledge of fire and gas detection systems (including the detectors typically used for Truck to Ship bunkering operations, such as O2 analyser, LEL % detector, gas volume % detector, dewpoint meter, CO2 meter, cooling meter, infrared and ultraviolet), emergency stop systems, control system of the truck and devices for the instrumentation and monitoring of the truck (including temperature meters, pressure meters, level meters, floats and radars), typically used in Truck to Ship bunkering operations. The trainees shall have both the knowledge and the awareness of the necessity of each of the control and monitoring tasks carried out in Truck to Ship bunkering operations.

A breakdown of the contents for competence 6 is included below.

- Fire and gas detection systems typically used in Truck to Ship bunkering operations

  - Operation principles
    - Adequacy of different types of gas detector for different environmental conditions
  - Object, operating procedures, limitations and calibration requirements for each type of detector:
    - O2 analyser
    - LEL % detector
    - Gas volume % detector

        - Dewpoint meter
        - CO2 meter
        - Cooling meter
        - Infrared
        - Ultraviolet

- Emergency stop system typically used in Truck to Ship bunkering operations

    - Object
    - Operation principles
    - System configuration
    - Operating considerations related to connected or independent systems
    - Actions unleashed once the shot takes place

- Control system of the truck

    - Description of how the control system works for bunkering operations
    - Description of the interaction between different control systems
    - Functions of the control system
    - Elements of the control system
    - Alarms and activators

- Devices for the instrumentation and monitoring of the truck

    - Temperature meters
        - Types
        - Limitations
        - Alarm configuration
    - Pressure meters
        - Types
        - Limitations
        - Alarm configuration
    - Level meters
        - Operation principles for each type
    - Floats
    - Radars
        - Operational requirements for each type
        - Limitations for each type
        - Maintenance requirements for each type
        - Alarm configuration and actions

Competence 7: Emergency situations and operations in Truck to Ship bunkering

Truck to Ship operator shall have deep knowledge on how to identify emergency situations and the operations associated to such situations. It is important to associate procedures to the nature of the product; therefore, basic knowledge on the behaviour of LNG is linked to this competence for the operator to understand procedures and take the proper decisions in emergency situations.

In order to acquire this competence, trainees shall have knowledge on emergency procedures, firefighting techniques and specific equipment to be used against LNG, contingency plans and first aid in case of potential contact with LNG, as well as awareness on the relevance of emergency situations and operations in Truck to Ship bunkering.

A breakdown of the contents for competence 7 is included below.

- Emergency procedures defined for Truck to Ship bunkering operations
    - Effective use of contingency plans
    - Importance of emergency drills and conclusions obtained from them
- Firefighting techniques and specific equipment to be used against LNG, especially the equipment typically used and/or recommended for Truck to Ship bunkering operations
    - Use of high expansion foam
    - Use of dry chemical powder
    - Risk of re-ignition
    - Heating intensity of a fire
    - Risks while trying to extinguish a fire before stopping the leakage
    - Water spray systems
    - Use of water curtains for division into sectors and prevent dispersion of gas clouds to sensitive areas
- Contingency plans defined for Truck to Ship bunkering operations
    - Role of contingency plans in usual operations, unusual operations end emergency situations
- First aid in case of contact with LNG
    - Skin contact
    - Inhalation
    - Ingestion

Competence 8: Commercial basics associated to LNG Truck to Ship bunkering operations

Truck to Ship bunkering operators shall have a basic commercial knowledge in order to carry out the tasks associated to operators related to commercial issues, such as transfer registers, measurement of quantity and quality of the product and composition of LNG.

In order to acquire this competence, trainees shall have knowledge on the LNG transfer procedure, including LNG transfer registers; LNG quality management, that including knowledge on the relevance of custody transfer and how the custody transfer systems work; LNG composition and the impact in engine and machine performance; and LNG transaction documents.

A breakdown of the contents for competence 8 is included below.

- LNG transfer process
    - LNG transfer procedure including transfer registers
- LNG quality management
    - Relevance of custody transfer and how the custody transfer systems work
        - How quantity and quality meters work
        - Precision levels to be reached and how to maintain them through calibration and tests
    - LNG composition (Methane number)
    - Impact of LNG composition in engine and machine performance
    - LNG quality certificate, contractual documents and estimations

4.1.2. Evaluation of competences

The evaluation of competences of the operational level for Truck to Ship bunkering operations shall be based on the training proposed and supported by evidence provided by examination and assessment.

For each competence proposed the corresponding methods for demonstrating such competence are proposed in this section, while criteria for evaluating each competence proposed are also suggested. Evidence of competence shall be provided through theoretical and practical exercises designed for the contents associated to each competence.

Evaluation of Competence 1: Basic knowledge on LNG

The methods proposed for demonstrating competence related to basic knowledge of LNG are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be Truck to Ship bunkering operators shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding basic knowledge on LNG:

    - Physical and chemical characteristics of LNG
    - Environmental impact of LNG in terms of emissions to the atmosphere
    - LNG main hazards linked to Truck to Ship bunkering operations
    - Behaviour of fluid leakages focusing on Truck to Ship bunkering operations
    - LNG effects on equipment and materials focusing on those used for Truck to Ship bunkering operations
    - Potential generation of sparks and ignition due to electric equipment and static loads, focusing on the case of Truck to Ship bunkering operations
    - Properties of inert gases and applications to Truck to Ship bunkering operations

- Practical exercise: candidates to be Truck to Ship bunkering operators shall obtain the minimum standard of a practical case involving the necessity of having knowledge on the LNG basics defined in competence 1 in an example of Truck to Ship bunkering operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to Truck to Ship bunkering operations, complying with the minimum standards established for the practical case.

Evaluation of Competence 2: Corporate and system management

The methods proposed for demonstrating competence related to corporate and system management are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be Truck to Ship bunkering operators shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding corporate and system management:

    - Internal regulation, recommendations and relevant guidelines on Truck to Ship bunkering operations

- Risk analysis for Truck to Ship bunkering operations
- Responsibilities assumable to the equipment owner or tenant in Truck to Ship bunkering operations
- Management of safety systems used in Truck to Ship bunkering operations
- Operating procedures for Truck to Ship bunkering operations

- Practical exercise: candidates to be Truck to Ship bunkering operators shall obtain the minimum standard of a practical case involving the necessity of having knowledge on corporate and system management as defined in competence 2 in an example of Truck to Ship bunkering operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to Truck to Ship bunkering operations, complying with the minimum standards established for the practical case.

Evaluation of Competence 3: Organisation and management

The methods proposed for demonstrating competence related to organisation and management are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be Truck to Ship bunkering operators shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding organisation and management:

  - Communication and working teams in Truck to Ship bunkering operations
  - Roles and responsibilities during Truck to Ship bunkering operations

- Practical exercise: candidates to be Truck to Ship bunkering operators shall obtain the minimum standard of a practical case involving the necessity of having knowledge on organisation and management as defined in competence 3 in an example of Truck to Ship bunkering operation.

The proposed criteria for evaluating competence 3 are:

- The candidate complies with the minimum standard established in the theoretical examination.

- The candidate is able to use the knowledge acquired in a practical case related to Truck to Ship bunkering operations, complying with the minimum standards established for the practical case.

Evaluation of Competence 4: Operation, calibration and maintenance of equipment and instrumentation

The methods proposed for demonstrating competence related to operation, calibration and maintenance of equipment and instrumentation are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be Truck to Ship bunkering operators shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding operation, calibration and maintenance of equipment and instrumentation:
    - Mechanical manipulation in Truck to Ship bunkering operations
    - Transfer systems in Truck to Ship bunkering
    - LNG storage tanks, especially those typically used in Truck to Ship bunkering operations
    - LNG pumps typically used in Truck to Ship bunkering operations
    - Valves typically used in Truck to Ship bunkering operations
    - Over-pressure protection devices typically used in Truck to Ship bunkering operations
    - Electric equipment in classified areas used for Truck to Ship bunkering operations
    - Management of safety systems (leakages/spillages) in Truck to Ship bunkering operations
    - Personal protection equipment for Truck to Ship bunkering operations
    - Operation manuals for main equipment used in Truck to Ship bunkering operations
- Practical exercise: candidates to be Truck to Ship bunkering operators shall obtain the minimum standard of a practical case involving the necessity of having knowledge on operation, calibration and maintenance of equipment and instrumentation as defined in competence 4 in an example of Truck to Ship bunkering operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.

- The candidate is able to use the knowledge acquired in a practical case related to Truck to Ship bunkering operations, complying with the minimum standards established for the practical case.

Evaluation of Competence 5: LNG Truck to Ship bunkering operations

The methods proposed for demonstrating competence related to LNG Truck to Ship bunkering operations are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be Truck to Ship bunkering operators shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding LNG Truck to Ship bunkering operations:
    - Previous activities to TTS loading operation
    - TTS operation management – purging
    - Pressurization and depressurization
    - TTS operation management – draining
    - TTS operation management – isolation
- Practical exercise: candidates to be Truck to Ship bunkering operators shall obtain the minimum standard of a practical case involving the necessity of having knowledge on LNG Truck to Ship bunkering operations as defined in competence 5 in an example of Truck to Ship bunkering operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to Truck to Ship bunkering operations, complying with the minimum standards established for the practical case.

Evaluation of Competence 6: Control and monitoring for LNG Truck to Ship bunkering operations

The methods proposed for demonstrating competence related to control and monitoring for LNG Truck to Ship bunkering operations are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be Truck to Ship bunkering operators shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding control and monitoring for LNG Truck to Ship bunkering operations:

    - Fire and gas detection systems typically used in Truck to Ship bunkering operations
    - Emergency stop system typically used in Truck to Ship bunkering operations
    - Control system of the truck
    - Devices for the instrumentation and monitoring of the truck

- Practical exercise: candidates to be Truck to Ship bunkering operators shall obtain the minimum standard of a practical case involving the necessity of having knowledge on control and monitoring for LNG Truck to Ship bunkering operations as defined in competence 6 in an example of Truck to Ship bunkering operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to Truck to Ship bunkering operations, complying with the minimum standards established for the practical case.

Evaluation of Competence 7: Emergency situations and operations in Truck to Ship bunkering

The methods proposed for demonstrating competence related to emergency situations and operations in Truck to Ship bunkering are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be Truck to Ship bunkering operators shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding emergency situations and operations in Truck to Ship bunkering:

    - Emergency procedures defined for Truck to Ship bunkering operations
    - Firefighting techniques and specific equipment to be used against LNG, especially the equipment typically used and/or recommended for Truck to Ship bunkering operations
    - Contingency plans defined for Truck to Ship bunkering operations
    - First aid in case of contact with LNG

- Practical exercise: candidates to be Truck to Ship bunkering operators shall obtain the minimum standard of a practical case involving the necessity of having knowledge on emergency situations and operations in Truck to Ship bunkering as defined in competence 7 in an example of Truck to Ship bunkering operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to Truck to Ship bunkering operations, complying with the minimum standards established for the practical case.

Evaluation of Competence 8: Commercial basics associated to LNG Truck to Ship bunkering operations

The methods proposed for demonstrating competence related to commercial basics associated to LNG Truck to Ship bunkering operations are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be Truck to Ship bunkering operators shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding commercial basics associated to LNG Truck to Ship bunkering operations:
    - LNG transfer process
    - LNG quality management
- Practical exercise: candidates to be Truck to Ship bunkering operators shall obtain the minimum standard of a practical case involving the necessity of having knowledge on emergency situations and operations in Truck to Ship bunkering as defined in competence 8 in an example of Truck to Ship bunkering operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to Truck to Ship bunkering operations, complying with the minimum standards established for the practical case.

Truck to ship LNG bunkering operation. Source: HAM.

Truck to ship LNG bunkering operation. Source: HAM.

4.2. Pipeline to Ship bunkering operations

The training proposal for PTS bunkering operations is composed of two different parts:

- Definition of competences and description of contents proposed for the development of each competence.
- Proposal of evaluation of competences.

4.2.1. Competences and contents

Competence 1: Basic knowledge on LNG

Pipeline to Ship operations require that participating operators have certain level of knowledge on the main product used in the operations to be used as a basis of a better understanding of the efficiency and safety processes associated to Pipeline to Ship bunkering operations.

Contents for this competence shall include a brief description of the physical and chemical characteristics of LNG and an introduction of the impact of LNG in its different states (liquid and vapour) for a better understanding of the emissions to the atmosphere derived from the use of LNG as marine fuel. The basic knowledge on LNG shall also include a succinct description of LNG main hazards and behaviour of liquid leakages. Other relevant LNG basics include a brief introduction to the LNG effects on equipment and construction materials, a briefing on potential generation of sparks and ignition due to electric equipment and static loads and a summary of the properties of inert gases (including nitrogen).

A breakdown of the contents for competence 1 is included below.

- Physical and chemical characteristics of LNG
    - Definition of LNG and BOG and their role in Pipeline to Ship bunkering operations
    - Comparison between LNG and other fuels
    - Gas laws and application to LNG Pipeline to Ship operations
    - Physics related to changes of state in the liquid and how they are related to Pipeline to Ship bunkering operations
        - Latent heat
        - Transference of heat and energy
        - Refrigeration and liquefaction of gases
        - Critical temperature
        - Dewpoint definition and temperature
        - Bubble point

        - Gas mixture
        - Cold gas cloud behaviour
        - Rollover causes and effects

- Environmental impact of LNG: liquid and vapour

    - Performance of engines and machines powered by natural gas versus those powered by other fuels related to emissions of
        - CO2
        - NOx
        - SOx
        - PM (particulate matters)
    - Behaviour of methane as GHG (Greenhouse Gas)

- LNG main hazards linked to Pipeline to Ship bunkering operations

    - Cryogenic nature of LNG
        - Hypothermia
        - Frostbite
        - Cold burn
    - Flammability
        - Lower Explosion Limit (LEL)
        - Flammability level (LFL)
        - Ignition point
        - Self-ignition temperature
        - Jet fires
        - Pool fires
        - Flash fires
        - Vapour cloud explosion
        - Boiling liquid expanding vapour explosion (BLEVE)
    - Lack of oxygen
    - Material Safety Datasheet (MSDS)

- Behaviour of fluid leakages, especially for the case of Pipeline to Ship bunkering operations

    - Behaviour of natural gas and LNG in case of fluid leakages
        - Liquid pools
        - Dense gas clouds, heavier than air until later warming
        - Wind direction
        - Causes and effects of “Rapid Phase Transition”

- LNG effects on equipment and construction materials used for Pipeline to Ship bunkering operations

    - Selection of appropriate materials for cryogenic conditions and types of failure for such materials, particularly for the infrastructures and devices typically used in Pipeline to Ship bunkering operations
    - Definition of coefficients of expansion and contraction
    - Coefficients of expansion and contraction of the different materials according to temperature gradient
    - Types of materials according to use
    - Repairing methods, including the importance of the use of the adequate spare parts
    - Effect of cryogenic temperatures on the equipment and materials used
    - Interaction between water and LNG
    - LNG transfer system blocking caused by the presence of water/moisture inside lines/equipment

- Potential generation of sparks and ignition due to electric equipment and static loads, particularly for the case of Pipeline to Ship bunkering operations (particularly non-intrinsically safe equipment – no ATEX equipment)

    - How electric equipment can cause sparks
    - Causes of static loads
    - Definition of classified areas

- Properties of inert gases (including nitrogen) and applications to Pipeline to Ship bunkering operations

    - Definition of inert gas
    - Content of oxygen
    - Nature of gas
    - Amount of moisture

Competence 2: Corporate and system management

Operators participating in Pipeline to Ship bunkering operations shall have certain knowledge of corporate and system management, particularly regarding those issues affecting Pipeline to Ship bunkering operations and the infrastructures and devices used in such operations.

Corporate and system management for Pipeline to Ship bunkering operations include international regulation, recommendations and relevant guidelines on Pipeline to Ship bunkering operations, risk analysis for Pipeline to Ship bunkering operations, responsibilities assumable to the equipment

owner or tenant in Pipeline to Ship bunkering operations, management of safety systems used in Pipeline to Ship bunkering operations and operating procedures in Pipeline to Ship bunkering.

A breakdown of the contents for competence 2 is included below.

- International regulation, recommendations and relevant guidelines on Pipeline to Ship bunkering operations
    - Use of LNG as fuel – MARPOL Annex VI, IGF Code, others.
    - LNG transfer according to IGS Code and port regulation
    - LNG transfer – tanks, containers, barges and LNG terminals
    - Standards and guidelines on LNG operations provided by shipyards, classification societies and equipment suppliers, particularly those referred to Pipeline to Ship bunkering operations
    - Recommendations from industrial organisations – SGMF, ISO, OCIMF and SIGTTO
- Risk analysis for Pipeline to Ship bunkering operations
    - Relevant parameters for the risk analysis
    - How to identify hazards
    - How to determine risks
    - How to establish probability of occurrence and severity
    - How to decide whether a risk is tolerable
    - How to prepare an action plan for risk control
- Responsibilities assumable to the equipment owner or tenant in Pipeline to Ship bunkering operations
    - Knowledge of the responsibilities resulting from the “duty of care” legal principle regarding the safeguard of damage to third parties
    - Knowledge of applicable regulation to acquisition process for leased or owned equipment
    - Knowledge of operating manuals for main equipment
    - Analysis of the principles of adequate use of hoses and hazards associated to fixing and movement of the hoses without the help of a crane
    - Knowledge of how the LNG transfer system should be held to avoid excessive tension/shear efforts for hoses, emergency release systems, connections and collectors
    - Knowledge of how to give the adequate response in case of any defect in the facility or documentation
    - Knowledge of how safety devices and natural gas detectors work and are calibrated

- Management of safety systems used in Pipeline to Ship bunkering operations

    - Description of corporate safety management systems and how the safety policy is transferred to the documentation for vessel operation
    - Methodology and techniques to assure an efficient risk management
    - Necessity to manage changes in order to continuously assure that the safety requisites are fulfilled satisfactorily and that changes are implemented in a controlled fashion
    - Importance of compiling information on safety incidents and accidents to promote understanding, learning and potential improvements for future actions
    - Definition of safety levels for the tasks carried out

- Operating procedures for Pipeline to Ship bunkering operations

    - Object, scope and legal framework of the procedures
    - Contents for the operating procedures and adequate location
    - Necessity to follow operating procedures
    - Necessity to manage any change in the operating procedures in a controlled fashion

Competence 3: Organisation and management

Pipeline to Ship operators shall have knowledge, at operational level, of how organisation and management works in Pipeline to Ship bunkering operations.

Contents related to organisation and management shall include a description of how communication and working teams are carried out in practice in Pipeline to Ship bunkering operations, complemented with knowledge of the roles and responsibilities during Pipeline to Ship bunkering operations.

A breakdown of the contents for competence 3 is included below.

- Communication and working teams in Pipeline to Ship bunkering operations

    - Chain of command
    - Importance of communication protocols, good practices and methods for obtaining feedback to guarantee effective communication
    - Previous meetings to loading operations:
        - Object of meetings
        - Contents
    - Checklists and how to use them – Safety checklists ship-shore (or similar)

- Roles and responsibilities during Pipeline to Ship bunkering operations

    - LNG supplier
    - Company responsible for loading operation
    - LNG receiver
    - Port Authority
    - Independent inspections

Competence 4: Operation, calibration and maintenance of equipment and instrumentation

Pipeline to Ship bunkering operators shall have knowledge on operation, calibration and maintenance of equipment and instrumentation to the extent necessary for carrying out the tasks associated to Pipeline to Ship bunkering operations.

The contents associated to the competence shall include mechanical manipulation of equipment, devices and instrumentation typically used in Pipeline to Ship bunkering operations, as well as transfer systems associated to the particular mode of bunkering, LNG storage tanks used in Pipeline to Ship bunkering operations and different operational requirements and restrictions of the particular mode of bunkering.

A breakdown of the contents for competence 4 is included below.

- Mechanical manipulation in Pipeline to Ship bunkering operations

    - Knowledge on types of devices to manipulate hoses and equipment used in LNG bunkering operations
    - Knowledge of the principles of mechanical manipulation and hazards associated to operation without the proper holding and transportation systems

- Transfer systems in Pipeline to Ship bunkering operations

    - Knowledge of the components and principles of operation that form the LNG transfer system:
        - Flexible hoses
        - Articulated arms
        - Fixed pipe on board the ship or on shore and pipe of BOG return and existing elements in those lines
        - Emergency disconnections and safety coupling
        - On shore and on-board connections
        - Manifold layout
    - Understanding of failure types that may result in equipment malfunction

- LNG storage tanks, especially those typically used in Pipeline to Ship bunkering operations
    - Typology of LNG storage tanks used in facilities where Pipeline to Ship bunkering operations take place:
        - Construction and installation for each type
    - Tank classification
        - Type A details and examples
        - Type B details and examples
        - Type C details and examples
        - Integral or membrane tanks – details and examples
    - Operational requirements for each type
    - Operational restrictions for each type

- LNG pumps typically used in Pipeline to Ship bunkering operations
    - Pump operation
        - Pressure versus flow
        - Required NPSH versus available NPSH
        - Specific questions related to pumping of boiling liquids such as LNG: cavitation, starting, waiting time until next start, etc.
    - Types of pumps
        - Construction and installation of each type
        - Operational requirements for each type
        - Operational restrictions for each type

- Valves typically used in Pipeline to Ship bunkering operations
    - Types of valves used in LNG and natural gas installations for:
        - Isolation
        - Control
    - Design features
    - Operational requirements
        - Prevention of over-pressure
    - Maintenance requirements
    - Potential problems – leakages

- Over-pressure protection devices typically used in Pipeline to Ship bunkering operations
    - Valves and pressure relief systems
        - Types

        - Design features
        - Operational requirements
        - Design and operation
        - Limitations
        - Potential problems

- Electric equipment in classified areas of facilities where Pipeline to Ship operations take place

    - Classification of areas (zoning)
        - Different categories of safety types for electric equipment
        - Role of regulation standards for a safe use of electric equipment
        - How to identify safe electric equipment for its use in classified areas

- Management of safety systems (leakages/spillages) in Pipeline to Ship bunkering operations

    - Water curtains
    - Spill plates:
        - Recommendations
        - Draining processes
    - CCTV/Monitoring equipment
    - Over-filling protection methods
    - Elements for the detection of gas, flames, etc.
    - Firefighting equipment

- Personal Protective Equipment (PPE) for Pipeline to Ship bunkering operations

    - Equipment
    - Dressing

- Operation manuals for main equipment in Pipeline to Ship bunkering operations

    - Relevant content of operation and maintenance manuals for main equipment
        - Specific equipment issues

Competence 5: LNG Pipeline to Ship bunkering operations

Pipeline to Ship bunkering operators shall have deep knowledge of how LNG Pipeline to Ship bunkering operations are carried out in practice, starting with the previous activities to the loading operation, which include checking compatibility of equipment and devices and a deep knowledge of the checklist for previous operations; purging, which includes a deep knowledge of how to carry out

the task as well as the relevance of doing and not doing it; pressurization and depressurization, draining and isolation, focusing on how to carry out the different processes and highlighting the object and necessity of each task of the process so that the trainee is fully aware of the importance of each of them in terms of safety and efficiency.

A breakdown of the contents for competence 5 is included below.

- Previous activities to loading operation for Pipeline to Ship bunkering operations
    - Compatibility between manifold of receiving vessel and the LNG transfer system (hoses) of the pipeline.
    - Compatibility between earth installation and the LNG transfer system (hoses) of the pipeline.
    - Fulfilling of previous checklist for Pipeline to Ship bunkering operations
    - Meeting prior to loading operation
    - Necessity of obtaining checklist validation by supplier and receiver
- Pipeline to Ship bunkering operation management – purging
    - Object and importance of purging operations before and after LNG transfers
    - Potential consequences of incorrect of inefficient purging process related to:
        - Safety
        - Operational issues
        - Fiscal issues
- Pressurization and depressurization
    - Pressurization process
        - Necessity of controlling pressurization ratio
        - Pressurization processes and associated tests
        - High-pressure safety process
    - Depressurization processes:
        - Joule-Thompson cooling effect and how equipment temperature is reduced considerably
    - Vacuuming
    - Fatigue cycles
- Pipeline to Ship bunkering operation management – draining
    - Draining method for lines prior to disconnecting
        - Methods and precautions related to vacuuming of liquid lines and their connections

        - Methods and precautions related to vacuuming of gas lines and their connections
        - Safety issues due to potential inefficient draining

- Pipeline to Ship bunkering operation management – isolation

    - Methods for a safe line and equipment division into sectors in relation to:
        - Preventing liquid retention between isolating valves
        - Assuring a safe emergency disconnection
        - Assuring safety conditions during the execution of the LNG transfer operation

Competence 6: Control and monitoring for LNG Pipeline to Ship bunkering operations

Pipeline to Ship bunkering operators shall have knowledge on control and monitoring of operations, particularly regarding Pipeline to Ship bunkering operations at operation level.

In order to acquire this competence the trainees shall have knowledge of fire and gas detection systems (including the detectors typically used for Pipeline to Ship bunkering operations, such as O2 analyser, LEL % detector, gas volume % detector, dew point meter, CO2 meter, cooling meter, infrared and ultraviolet), emergency stop systems, control system of the pipeline and devices for the instrumentation and monitoring of the pipeline (including temperature meters, pressure meters, level meters, floats and radars), typically used in Pipeline to Ship bunkering operations. The trainees shall have both the knowledge and the awareness of the necessity of each of the control and monitoring tasks carried out in Pipeline to Ship bunkering operations.

A breakdown of the contents for competence 6 is included below.

- Fire and gas detection systems typically used in Pipeline to Ship bunkering operations

    - Operation principles
        - Adequacy of different types of gas detector for different environmental conditions
    - Object, operating procedures, limitations and calibration requirements for each type of detector:
        - O2 analyser
        - LEL % detector
        - Gas volume % detector
        - Dewpoint meter
        - CO2 meter
        - Cooling meter

        - Infrared
        - Ultraviolet

- Emergency Shut-down system (ESD) typically used in Pipeline to Ship bunkering operations

    - Object
    - Operation principles
    - System configuration
    - Operating considerations related to connected or independent systems
    - Actions unleashed once the shot takes place

- Control system of the facility

    - Description of how the control system works for bunkering operations
    - Description of the interaction between different control systems
    - Functions of the control system
    - Elements of the control system
    - Alarms and activators

- Devices for the instrumentation and monitoring of the facility

    - Temperature meters
        - Types
        - Limitations
        - Alarm configuration
    - Pressure meters
        - Types
        - Limitations
        - Alarm configuration
    - Level meters
        - Operation principles for each type
    - Floats
    - Radars
        - Operational requirements for each type
        - Limitations for each type
        - Maintenance requirements for each type
        - Alarm configuration and actions

Competence 7: Emergency situations and operations in Pipeline to Ship bunkering

Pipeline to Ship operator shall have deep knowledge on how to identify emergency situations and the operations associated to such situations. It is important to associate procedures to the nature of the product; therefore, basic knowledge on the behaviour of LNG is linked to this competence for the operator to understand procedures and take the proper decisions in emergency situations.

In order to acquire this competence, trainees shall have knowledge on emergency procedures, firefighting techniques and specific equipment to be used against LNG, contingency plans and first aid in case of potential contact with LNG, as well as awareness on the relevance of emergency situations and operations in Pipeline to Ship bunkering.

A breakdown of the contents for competence 7 is included below.

- Emergency procedures defined for Pipeline to Ship bunkering operations
    - Effective use of contingency plans
    - Importance of emergency drills and conclusions obtained from them
- Firefighting techniques and specific equipment to be used against LNG, especially the equipment typically used and/or recommended for Pipeline to Ship bunkering operations
    - Use of high expansion foam
    - Use of dry chemical powder
    - Risk of re-ignition
    - Heating intensity of a fire
    - Risks while trying to extinguish a fire before stopping the leakage
    - Water spray systems
    - Use of water curtains for division into sectors and prevent dispersion of gas clouds to sensitive areas
- Contingency plans defined for Pipeline to Ship bunkering operations
    - Role of contingency plans in usual operations, unusual operations end emergency situations
- First aid in case of contact with LNG
    - Skin contact
    - Inhalation
    - Ingestion

Competence 8: Commercial basics associated to LNG Pipeline to Ship bunkering operations

Pipeline to Ship bunkering operators shall have a basic commercial knowledge in order to carry out the tasks associated to operators related to commercial issues, such as transfer registers, measurement of quantity and quality of the product and composition of LNG.

In order to acquire this competence, trainees shall have knowledge on the LNG transfer procedure, including LNG transfer registers; LNG quality management, that including knowledge on the relevance of custody transfer and how the custody transfer systems work; LNG composition and the impact in engine and machine performance; and LNG transaction documents.

A breakdown of the contents for competence 8 is included below.

- LNG transfer process
    - LNG transfer procedure including transfer registers
- LNG quality management
    - Relevance of custody transfer and how the custody transfer systems work:
        - How quantity and quality meters work
        - Precision levels to be reached and how to maintain them through calibration and tests
    - LNG composition (Methane number)
    - Impact of LNG composition in engine and machine performance
    - LNG quality certificate, contractual documents and estimations

4.2.2. Evaluation of competence

The evaluation of competences of the operational level for Pipeline to Ship bunkering operations shall be based on the training proposed and supported by evidence provided by examination and assessment.

For each competence proposed the corresponding methods for demonstrating such competence are proposed in this section, while criteria for evaluating each competence proposed are also suggested. Evidence of competence shall be provided through theoretical and practical exercises designed for the contents associated to each competence.

Evaluation of Competence 1: Basic knowledge on LNG

The methods proposed for demonstrating competence related to basic knowledge of LNG are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be Pipeline to Ship bunkering operators shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding basic knowledge on LNG:

    - Physical and chemical characteristics of LNG
    - Environmental impact of LNG in terms of emissions to the atmosphere
    - LNG main hazards linked to Pipeline to Ship bunkering operations
    - Behaviour of fluid leakages focusing on Pipeline to Ship bunkering operations
    - LNG effects on equipment and materials focusing on those used for Pipeline to Ship bunkering operations
    - Potential generation of sparks and ignition due to electric equipment and static loads, focusing on the case of Pipeline to Ship bunkering operations
    - Properties of inert gases and applications to Pipeline to Ship bunkering operations

- Practical exercise: candidates to be Pipeline to Ship bunkering operators shall obtain the minimum standard of a practical case involving the necessity of having knowledge on the LNG basics defined in competence 1 in an example of Pipeline to Ship bunkering operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to Pipeline to Ship bunkering operations, complying with the minimum standards established for the practical case.

Evaluation of Competence 2: Corporate and system management

The methods proposed for demonstrating competence related to corporate and system management are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be Pipeline to Ship bunkering operators shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding corporate and system management:

    - Internal regulation, recommendations and relevant guidelines on Pipeline to Ship bunkering operations

- Risk analysis for Pipeline to Ship bunkering operations
- Responsibilities assumable to the equipment owner or tenant in Pipeline to Ship bunkering operations
- Management of safety systems used in Pipeline to Ship bunkering operations
- Operating procedures for Pipeline to Ship bunkering operations

- Practical exercise: candidates to be Pipeline to Ship bunkering operators shall obtain the minimum standard of a practical case involving the necessity of having knowledge on corporate and system management as defined in competence 2 in an example of Pipeline to Ship bunkering operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to Pipeline to Ship bunkering operations, complying with the minimum standards established for the practical case.

Evaluation of Competence 3: Organisation and management

The methods proposed for demonstrating competence related to organisation and management are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be Pipeline to Ship bunkering operators shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding organisation and management:

  - Communication and working teams in Pipeline to Ship bunkering operations
  - Roles and responsibilities during Pipeline to Ship bunkering operations

- Practical exercise: candidates to be Pipeline to Ship bunkering operators shall obtain the minimum standard of a practical case involving the necessity of having knowledge on organisation and management as defined in competence 3 in an example of Pipeline to Ship bunkering operation.

The proposed criteria for evaluating competence 3 are:

- The candidate complies with the minimum standard established in the theoretical examination.

- The candidate is able to use the knowledge acquired in a practical case related to Pipeline to Ship bunkering operations, complying with the minimum standards established for the practical case.

Evaluation of Competence 4: Operation, calibration and maintenance of equipment and instrumentation

The methods proposed for demonstrating competence related to operation, calibration and maintenance of equipment and instrumentation are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be Pipeline to Ship bunkering operators shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding operation, calibration and maintenance of equipment and instrumentation:
    - Mechanical manipulation in Pipeline to Ship bunkering operations
    - Transfer systems in Pipeline to Ship bunkering
    - LNG storage tanks, especially those typically used in Pipeline to Ship bunkering operations
    - LNG pumps typically used in Pipeline to Ship bunkering operations
    - Valves typically used in Pipeline to Ship bunkering operations
    - Over-pressure protection devices typically used in Pipeline to Ship bunkering operations
    - Electric equipment in classified areas used for Pipeline to Ship bunkering operations
    - Management of safety systems (leakages/spillages) in Pipeline to Ship bunkering operations
    - Personal protection equipment for Pipeline to Ship bunkering operations
    - Operation manuals for main equipment used in Pipeline to Ship bunkering operations

- Practical exercise: candidates to be Pipeline to Ship bunkering operators shall obtain the minimum standard of a practical case involving the necessity of having knowledge on operation, calibration and maintenance of equipment and instrumentation as defined in competence 4 in an example of Pipeline to Ship bunkering operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.

- The candidate is able to use the knowledge acquired in a practical case related to Pipeline to Ship bunkering operations, complying with the minimum standards established for the practical case.

Evaluation of Competence 5: LNG Pipeline to Ship bunkering operations

The methods proposed for demonstrating competence related to LNG Pipeline to Ship bunkering operations are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be Pipeline to Ship bunkering operators shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding LNG Pipeline to Ship bunkering operations:
    - Previous activities to PTS loading operation
    - PTS operation management – purging
    - Pressurization and depressurization
    - PTS operation management – draining
    - PTS operation management – isolation
- Practical exercise: candidates to be Pipeline to Ship bunkering operators shall obtain the minimum standard of a practical case involving the necessity of having knowledge on LNG Pipeline to Ship bunkering operations as defined in competence 5 in an example of Pipeline to Ship bunkering operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to Pipeline to Ship bunkering operations, complying with the minimum standards established for the practical case.

Evaluation of Competence 6: Control and monitoring for LNG Pipeline to Ship bunkering operations

The methods proposed for demonstrating competence related to control and monitoring for LNG Pipeline to Ship bunkering operations are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be Pipeline to Ship bunkering operators shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding control and monitoring for LNG Pipeline to Ship bunkering operations:

    - Fire and gas detection systems typically used in Pipeline to Ship bunkering operations
    - Emergency stop system typically used in Pipeline to Ship bunkering operations
    - Control system of the facility
    - Devices for the instrumentation and monitoring of the facility

- Practical exercise: candidates to be Pipeline to Ship bunkering operators shall obtain the minimum standard of a practical case involving the necessity of having knowledge on control and monitoring for LNG Pipeline to Ship bunkering operations as defined in competence 6 in an example of Pipeline to Ship bunkering operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to Pipeline to Ship bunkering operations, complying with the minimum standards established for the practical case.

Evaluation of Competence 7: Emergency situations and operations in Truck to Ship bunkering

The methods proposed for demonstrating competence related to emergency situations and operations in Pipeline to Ship bunkering are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be Pipeline to Ship bunkering operators shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding emergency situations and operations in Pipeline to Ship bunkering:

    - Emergency procedures defined for Pipeline to Ship bunkering operations
    - Firefighting techniques and specific equipment to be used against LNG, especially the equipment typically used and/or recommended for Truck to Ship bunkering operations
    - Contingency plans defined for Pipeline to Ship bunkering operations
    - First aid in case of contact with LNG

- Practical exercise: candidates to be Pipeline to Ship bunkering operators shall obtain the minimum standard of a practical case involving the necessity of having knowledge on emergency situations and operations in Pipeline to Ship bunkering as defined in competence 7 in an example of Pipeline to Ship bunkering operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to Pipeline to Ship bunkering operations, complying with the minimum standards established for the practical case.

Evaluation of Competence 8: Commercial basics associated to LNG Pipeline to Ship bunkering operations

The methods proposed for demonstrating competence related to commercial basics associated to LNG Pipeline to Ship bunkering operations are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be Pipeline to Ship bunkering operators shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding commercial basics associated to LNG Pipeline to Ship bunkering operations:

    - LNG transfer process
    - LNG quality management

- Practical exercise: candidates to be Pipeline to Ship bunkering operators shall obtain the minimum standard of a practical case involving the necessity of having knowledge on emergency situations and operations in Pipeline to Ship bunkering as defined in competence 8 in an example of Pipeline to Ship bunkering operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to Pipeline to Ship bunkering operations, complying with the minimum standards established for the practical case.

Pipeline supply operation. Source: Enagás.

Preparation of operation. Source: Reganosa.

4.3. Ship to Ship bunkering operations

Ship to Ship bunkering operations are carried out by on-board personnel. Training and certification for on-board personnel for LNG Ship to Ship operations is defined by the Seafarers' Training, Certification and Watchkeeping (STCW) Code.

In order to maintain homogeneity in this document, the definition and requirements defined by the Seafarers' Training, Certification and Watchkeeping (STCW) Code are transcript into the same format as the proposal made in the present document for onshore personnel.

4.3.1. Competences and contents

Table A-V/1-2-1 refers to the *specification of minimum standard of competence in basic training for liquefied gas tanker cargo operations.*

Competence 1: *Contribute to the safe operation of a liquefied gas tanker*

Design and operational characteristics of liquefied gas tankers

Basic knowledge of liquefied gas tankers

.1 types of liquefied gas tankers

.2 general arrangement and construction

Basic knowledge of cargo operations:

.1 piping systems and valves

.2 cargo handling equipment

.3 loading, unloading and care in transit

.4 emergency shutdown (ESD) system

.5 tank cleaning, purging, gas-freeing and inerting

Basic knowledge of the physical properties of liquefied gases, including:

.1 properties and characteristics

.2 pressure and temperature, including vapour pressure/temperature relationship

.3 types of electrostatic charge generation

.4 chemical symbols Knowledge and understanding of tanker safety culture and safety management

Competence 2: *Take precautions to prevent hazards*

Basic knowledge of the hazards associated with tanker operations, including:

.1 health hazards

.2 environmental hazards

.3 reactivity hazards

.4 corrosion hazards

.5 explosion and flammability hazards

.6 sources of ignition

.7 electrostatic hazards

.8 toxicity hazards

.9 vapour leaks and clouds

.10 extremely low temperatures

.11 pressure hazards

Basic knowledge of hazard controls:

.1 inerting, drying and monitoring techniques

.2 anti-static measures

.3 ventilation

.4 segregation

.5 cargo inhibition

.6 importance of cargo compatibility

.7 atmospheric control

.8 gas testing

Understanding of information on a Material Safety Data Sheet (MSDS)

Competence 3: *Apply occupational health and safety precautions and measures*

Function and proper use of gas-measuring instruments and similar equipment

Proper use of safety equipment and protective devices, including:

.1 breathing apparatus and tank evacuating equipment

.2 protective clothing and equipment

.3 resuscitators

.4 rescue and escape equipment

Basic knowledge of safe working practices and procedures in accordance with legislation and industry guidelines and personal shipboard safety relevant to liquefied gas tankers, including:

.1 precautions to be taken when entering enclosed spaces

.2 precautions to be taken before and during repair and maintenance work

.3 safety measures for hot and cold work

.4 electrical safety

.5 ship/shore safety checklist

Basic knowledge of first aid with reference to a Material Safety Data Sheet (MSDS)

Competence 4: *Carry out fire-fighting operations*

Tanker fire organization and action to be taken.

Special hazards associated with cargo handling and transportation of liquefied gases in bulk.

Fire-fighting agents used to extinguish gas fires.

Fixed fire-fighting foam system operations.

Portable fire-fighting foam operations.

Fixed dry chemical system operations.

Basic knowledge of spill containment in relation to fire-fighting operations.

Competence 5: *Respond to emergencies*

Basic knowledge of emergency procedures, including emergency shutdown.

Competence 6: *Take precautions to prevent pollution of the environment from the release of liquefied gases*

Basic knowledge of the effects of pollution on human and marine life.

Basic knowledge of shipboard procedures to prevent pollution

Basic knowledge of measures to be taken in the event of spillage, including the need to:

.1 report relevant information to the responsible persons

.2 assist in implementing shipboard spill-containment procedures

.3 prevent brittle fracture

4.3.2. Evaluation of competence

For each of the competences defined, the methods for demonstrating competence are transcript in this section from Table A-V/1-2-1 referred to the *specification of minimum standard of competence in basic training for liquefied gas tanker cargo operations*.

Also, in this section, transcriptions for criteria for evaluating competence from the table before mentioned are included.

Evaluation of Competence 1: *Contribute to the safe operation of a liquefied gas tanker*

Methods for demonstrating competence:

Examination and assessment of evidence obtained from one or more of the following:

.1 approved in-service experience

.2 approved training ship experience

.3 approved simulator training

.4 approved training programme

Criteria for evaluating competence:

Communications within the area of responsibility are clear and effective.

Cargo operations are carried out in accordance with accepted principles and procedures to ensure safety of operations.

Evaluation of Competence 2: *Take precautions to prevent hazards*

Methods for demonstrating competence:

Examination and assessment of evidence obtained from one or more of the following:

.1 approved in-service experience

.2 approved training ship experience

.3 approved simulator training

.4 approved training programme

Criteria for evaluating competence:

Correctly identifies, on an MSDS, relevant cargo-related hazards to the vessel and to personnel, and takes the appropriate actions in accordance with established procedures.

Identification and actions on becoming aware of a hazardous situation conform to established procedures in line with best practice.

Evaluation of Competence 3: *Apply occupational health and safety precautions and measures*

Methods for demonstrating competence:

Examination and assessment of evidence obtained from one or more of the following:

.1 approved in-service experience

.2 approved training ship experience

.3 approved simulator training

.4 approved training programme

Criteria for evaluating competence:

Procedures for entry into enclosed spaces are observed.

Procedures and safe working practices designed to safeguard personnel and the ship are observed at all times.

Appropriate safety and protective equipment is correctly used.

Evaluation of Competence 4: *Carry out fire-fighting operations*

Methods for demonstrating competence:

Practical exercises and instruction conducted under approved and truly realistic training conditions (e.g. simulated shipboard conditions) and, whenever possible and practicable, in darkness.

Criteria for evaluating competence:

Initial actions and follow-up actions on becoming aware of an emergency conform with established practices and procedures.

Action taken on identifying muster signals is appropriate to the indicated emergency and complies with established procedures.

Clothing and equipment are appropriate to the nature of the fire-fighting operations.

The timing and sequence of individual actions are appropriate to the prevailing circumstances and conditions.

Extinguishment of fire is achieved using appropriate procedures, techniques and fire-fighting agents.

Evaluation of Competence 5: *Respond to emergencies*

Methods for demonstrating competence:

Examination and assessment of evidence obtained from one or more of the following:

.1 approved in-service experience

.2 approved training ship experience

.3 approved simulator training

.4 approved training programme

Criteria for evaluating competence:

The type and impact of the emergency is promptly identified and the response actions conform to the emergency procedures and contingency plans.

Evaluation of Competence 6: *Take precautions to prevent pollution of the environment from the release of liquefied gases*

Methods for demonstrating competence:

Examination and assessment of evidence obtained from one or more of the following:

.1 approved in-service experience

.2 approved training ship experience

.3 approved simulator training

.4 approved training programme

Criteria for evaluating competence:

Procedures designed to safeguard the environment are observed at all times.

Bunkering barge in service. Source: Core LNGas Hive: EPA 3

4.4. Container to Ship bunkering operations

No specific operational level profile has been identified for container to ship bunkering operations, as it is considered as a loading operation of dangerous goods.

If the container were to be used as a tank to supply fuel to the ship, profiles identified, and training defined for Truck to Ship bunkering operations would be applicable.

Kosan Crisplant LNG bunkering unit

4.5. LNG storage and regasification plants

The training proposal for the different tasks carried out at LNG storage and regasification plants is composed of two different parts:

- Definition of competences and description of contents proposed for the development of each competence.
- Proposal of evaluation of competences.

4.5.1. Competences and contents

Competence 1: Basic knowledge on LNG storage and regasification plants

LNG storage and regasification plants require operators to have basic knowledge on the operations carried out in such facilities, as well as on the nature of the products used.

Contents for this competence shall include a definition of LNG storage and regasification plants (roles, elements and regulation), as well as a brief description of the physical and chemical characteristics of LNG. The basic knowledge on LNG shall also include a succinct description of LNG main hazards and behaviour of liquid leakages. Other relevant LNG basics include a brief introduction to the LNG effects on equipment and construction materials, a briefing on potential generation of sparks and ignition due to electric equipment and static loads and a summary of the properties of inert gases (including nitrogen).

A breakdown of the contents proposed for competence 1 is included below.

- Definition of LNG storage and regasification plant
    - Role of LNG storage and regasification plants in the supply chain
    - Description of elements
    - International regulation, recommendations and relevant guidelines on LNG storage and regasification plants
- Physical and chemical characteristics of LNG
    - Definition of LNG and BOG and their role in LNG storage and regasification plants
    - Comparison between LNG and other fuels
    - Gas laws and application to LNG storage and regasification plant operations
    - Physics related to changes of state in the liquid and how they are related to LNG storage and regasification plants

        - Latent heat
        - Transference of heat and energy
        - Refrigeration and liquefaction of gases
        - Critical temperature
        - Dew point definition and temperature
        - Point of bubble
        - Gas mixture
        - Cold gas cloud behaviour
        - Rollover causes and effects

- LNG main hazards linked to LNG storage and regasification plants

    - Cryogenic nature of LNG
        - Hypothermia
        - Frostbite
    - Flammability
        - Lower Explosion Limit (LEL)
        - Flammability level (LFL)
        - Ignition point
        - Self-ignition temperature
        - Jet fires
        - Pool fires
        - Flash fires
        - Vapour cloud explosion
        - Boiling liquid expanding vapour explosion (BLEVE)
    - Lack of oxygen
    - Material Safety Datasheet (MSDS)

- Behaviour of fluid leakages, especially for the case of LNG storage and regasification plants

    - Behaviour of natural gas and LNG in case of fluid leakages
        - Liquid pools
        - Dense gas clouds, heavier than air until later warming
        - Wind direction
        - Causes and effects of “Rapid Phase Transition”

- LNG effects on equipment and construction materials used for LNG storage and regasification plants

    - Selection of appropriate materials for cryogenic conditions and types of failure for such materials

- Definition of coefficients of expansion and contraction
- Coefficients of expansion and contraction of the different materials according to temperature gradient
- Types of materials according to use
- Repairing methods, including the importance of the use of the adequate spare parts
- Effect of cryogenic temperatures on the equipment and materials used
- Interaction between water and LNG
- LNG transfer system blocking caused by the presence of water/moisture inside lines/equipment

- Potential generation of sparks and ignition due to electric equipment and static loads, particularly for the case of LNG storage and regasification plants

  - How electric equipment can cause sparks
  - Causes of static loads
  - Definition of classified areas

- Properties of inert gases (including nitrogen) and applications to LNG storage and regasification plant operations

  - Definition of inert gas
  - Content of oxygen
  - Nature of gas
  - Amount of moisture

Competence 2: Corporate and system management

LNG storage and regasification plant operators shall have knowledge on corporate and system management at operation level.

Contents to acquire the necessary competence shall include risk analysis for operations in LNG storage and regasification plants and management of safety systems used in LNG storage and regasification plants.

A breakdown of the contents proposed for competence 2 is included below.

- Risk analysis for operations in storage and regasification plants

  - Relevant parameters for the risk analysis
  - How to identify hazards
  - How to determine risks

- How to establish probability of occurrence and severity
- How to decide whether a risk is tolerable
- How to prepare an action plan for risk control

- Management of safety systems used in storage and regasification plants

  - Description of corporate safety management systems and how the safety policy is transferred to the documentation for vessel operation
  - Methodology and techniques to assure an efficient risk management
  - Necessity to manage changes in order to continuously assure that the safety requisites are fulfilled satisfactorily and that changes are implemented in a controlled fashion
  - Importance of compiling information on safety incidents and accidents to promote understanding, learning and potential improvements for future actions
  - Definition of safety levels for the tasks carried out

Competence 3: LNG storage and regasification plant operations

LNG storage and regasification plan operators shall have deep knowledge on the operations carried out in the facilities, with an integrated vision of the whole operations and the role of each of them.

Therefore, contents for competence 3 shall include a full vision of plant processes, interpretation of diagrams and main equipment, as well as of the ancillary services, pipelines and safety and control systems.

A breakdown of the contents proposed for competence 3 is included below.

- Plant processes, interpretation of diagrams and main equipment

  - Tanks
    - Typology of LNG storage tanks for LNG storage and regasification plants
    - Tank classification (types and examples)
  - Pumps
    - Pump operation
    - Types of pumps
  - Valves
    - Types
    - Design characteristics for each type
    - Operational requirements
    - Design and operation
    - Limitations – MARVS – Maximum Allowable Relief Valve Setting

        - Potential problems
    - Re-liquefier
        - Main characteristics
        - Operation description
    - Compressors
        - Compressors used in LNG storage and regasification plants
        - Role in operation cycle
    - Combustor
        - Main characteristics
        - Role in operations
    - Jetty
    - Loading and unloading arms
        - Loading arms main characteristics
        - Operation of loading and unloading arms
    - Measurement station
        - Main characteristics
        - Role in operations
    - Tank loader
        - Main characteristics
        - Role in operations
    - Other equipment

- Ancillary services

    - Use of nitrogen in plant operations
    - Use of air in plant operations
    - Use of gas-fuel in plan operations
    - Odorization systems
    - Electro-chlorination system
    - Neutralization system
    - Other ancillary services

- Integration and global revision of main and ancillary services

    - Global plan revision: productive process and ancillary services
    - Inter-relation of systems
    - Interlocks and emergency stop systems
    - Work permits
    - Safety conditions

- Pipelines

- Characteristics and main equipment associated
- Operation and manipulation of valves
- Operation and manipulation of other elements used un pipelines

- Safety system

  - Basic safety concepts for storage and regasification plants
  - Detection equipment
  - Extinction equipment

- Control systems

  - Description of control systems used in storage and regasification plants
  - Integration of safety systems and devices
  - CCTV system

- Integration of procedures in regasification plant operation

Competence 4: LNG storage and regasification plant maintenance

LNG storage and regasification plan operators shall have deep knowledge on the maintenance of the facilities that integrate the plant.

Therefore, contents for competence 4 shall include a full vision of the maintenance operations of the plant, that containing the electrical installation, instrumentation maintenance, main equipment maintenance, safety and control system maintenance and predictive maintenance.

A breakdown of the contents proposed for competence 4 is included below.

- Electrical installation maintenance

  - Electrical lines
  - Safety electrical systems
  - Electrical devices
  - Lighting system

- Instrumentation maintenance

  - Measurement
  - Primary elements

  - Valves
  - Control systems
  - Transmission
  - Other instrumentation

- Main equipment maintenance

  - Tanks
  - Pumps
  - Valves
  - Re-liquefier
  - Compressors
  - Combustor
  - Jetty
  - Loading and unloading arms
  - Measurement station
  - Tank loader
  - Other equipment

- Safety system maintenance

- Control system maintenance

- Predictive maintenance

Competence 5: Control and monitoring for LNG storage and regasification plant operations

LNG storage and regasification plant operators shall have knowledge on control and monitoring of operations at operational level.

In order to acquire this competence the trainees shall have knowledge of fire and gas detection systems (including the detectors typically used in plant operations, such as O2 analyser, LEL % detector, gas volume % detector, dewpoint meter, CO2 meter, cooling meter, infrared and ultraviolet), emergency stop systems, control system of the plant and devices for the instrumentation and monitoring of the plant (including temperature meters, pressure meters, level meters, floats and radars), typically used in LNG storage and regasification plant operations. The trainees shall have both the knowledge and the awareness of the necessity of each of the control and monitoring tasks carried out in plant operations.

A breakdown of the contents for competence 5 is included below.

- Fire and gas detection systems typically used in LNG storage and regasification plant operations
    - Operation principles
        - Adequacy of different types of gas detector for different environmental conditions
    - Object, operating procedures, limitations and calibration requirements for each type of detector:
        - O2 analyser
        - LEL % detector
        - Gas volume % detector
        - Dew point meter
        - CO2 meter
        - Cooling meter
        - Infrared
        - Ultraviolet

- Emergency stop system typically used in LNG storage and regasification plant operations
    - Object
    - Operation principles
    - System configuration
    - Operating considerations related to connected or independent systems
    - Actions unleashed once the shot takes place

- Control system of the facility
    - Description of how the control system works for plant operations
    - Description of the interaction between different control systems
    - Functions of the control system
    - Elements of the control system
    - Alarms and activators

- Devices for the instrumentation and monitoring of the facility
    - Temperature meters
        - Types
        - Limitations
        - Alarm configuration
    - Pressure meters
        - Types

    - Limitations
    - Alarm configuration
  - Level meters
    - Operation principles for each type
  - Floats
  - Radars
    - Operational requirements for each type
    - Limitations for each type
    - Maintenance requirements for each type
    - Alarm configuration and actions

Competence 6: Emergency situations and operations in LNG storage and regasification plants

LNG storage and regasification plant operators shall have deep knowledge on how to identify emergency situations and the operations associated to such situations. It is important to associate procedures to the nature of the product; therefore, basic knowledge on the behaviour of LNG is linked to this competence for the operator to understand procedures and take the proper decisions in emergency situations.

In order to acquire this competence, trainees shall have knowledge on emergency procedures, firefighting techniques and specific equipment to be used against LNG, contingency plans and first aid in case of potential contact with LNG, as well as awareness on the relevance of emergency situations and operations in LNG storage and regasification plants.

A breakdown of the contents for competence 6 is included below.

- Emergency procedures defined for LNG storage and regasification plant operations
  - Effective use of contingency plans
  - Importance of emergency drills and conclusions obtained from them
- Firefighting techniques and specific equipment to be used against LNG, especially the equipment typically used and/or recommended for LNG storage and regasification plant operations
  - Use of high expansion foam
  - Use of dry chemical powder
  - Risk of re-ignition
  - Heating intensity of a fire
  - Risks while trying to extinguish a fire before stopping the leakage
  - Water spray systems

  - Use of water curtains for division into sectors and prevent dispersion of gas clouds to sensitive areas

- Contingency plans defined for LNG storage and regasification plant operations
  - Role of contingency plans in usual operations, unusual operations end emergency situations

- First aid in case of contact with LNG
  - Skin contact
  - Inhalation
  - Ingestion

Competence 7: Environmental considerations related to LNG storage and regasification plants

LNG storage and regasification plant operators shall have knowledge at operational level of environmental issues related to the plant.

In order to acquire this competence, trainees shall have knowledge at operational level on LNG storage and regasification plant general environmental consideration, gaseous and liquid effluents, noise level and environmental considerations on soil pollution.

A breakdown of the contents for competence 7 is included below.

- LNG storage and regasification plant general environmental considerations
  - LNG emissions to the atmosphere
  - Emissions by operations

- Gaseous effluents
  - Description
  - Potential consequences

- Liquid effluents
  - Description
  - Potential consequences

- Noise level

- Environmental considerations on soil pollution

Competence 8: Commercial basics associated to LNG storage and regasification plant operations

LNG storage and regasification plant operators shall have a basic commercial knowledge at operational level in order to carry out the tasks associated to operators related to commercial issues, such as transfer registers, measurement of quantity and quality of the product and composition of LNG.

In order to acquire this competence, trainees shall have knowledge on the LNG transfer procedure, including LNG transfer registers; LNG quality management, that including knowledge on the relevance of custody transfer and how the custody transfer systems work; LNG composition and the impact in engine and machine performance; and LNG transaction documents.

A breakdown of the contents for competence 8 is included below.

- LNG transfer process
    - LNG transfer procedure including transfer registers
- LNG quality management

4.5.2. Evaluation of competence

The evaluation of competences of the operational level for Pipeline to Ship bunkering operations shall be based on the training proposed and supported by evidence provided by examination and assessment.

For each competence proposed the corresponding methods for demonstrating such competence are proposed in this section, while criteria for evaluating each competence proposed are also suggested. Evidence of competence shall be provided through theoretical and practical exercises designed for the contents associated to each competence.

Evaluation of competence 1: Basic knowledge on LNG storage and regasification plants

The methods proposed for demonstrating competence related to basic knowledge of LNG are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be LNG storage and regasification plant operator shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding basic knowledge on LNG:

- Definition of LNG storage and regasification plant
- Physical and chemical characteristics of LNG
- LNG main hazards linked to LNG storage and regasification plants
- Behaviour of fluid leakages, especially for the case of LNG storage and regasification plants
- LNG effects on equipment and construction materials used for LNG storage and regasification plants
- Potential generation of sparks and ignition due to electric equipment and static loads, particularly for the case of LNG storage and regasification plants
- Properties of inert gases (including nitrogen) and applications to LNG storage and regasification plant operations

- Practical exercise: candidates to be LNG storage and regasification plant operator shall obtain the minimum standard of a practical case involving the necessity of having knowledge on the LNG basics defined in competence 1 in an example of LNG storage and regasification plant operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to LNG storage and regasification plant operations, complying with the minimum standards established for the practical case.

Evaluation of competence 2: Corporate and system management

The methods proposed for demonstrating competence related to corporate and system management are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be LNG storage and regasification plant operator shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding corporate and system management:

  - Risk analysis for operations in storage and regasification plants
  - Management of safety systems used storage and regasification plants

- Practical exercise: candidates to be LNG storage and regasification plant operator shall obtain the minimum standard of a practical case involving the necessity of having knowledge on

corporate and system management as defined in competence 2 in an example of LNG storage and regasification plant operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to LNG storage and regasification plant operations, complying with the minimum standards established for the practical case.

Evaluation of competence 3: LNG storage and regasification plant operations

The methods proposed for demonstrating competence related to LNG storage and regasification plant operations are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be LNG storage and regasification plant operator shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding LNG storage and regasification plant operations:
    - Plant processes, interpretation of diagrams and main equipment
    - Ancillary services
    - Integration and global revision of main and ancillary services
    - Pipelines
    - Safety system
    - Control systems
    - Integration of procedures in regasification plant operation

- Practical exercise: candidates to be LNG storage and regasification plant operator shall obtain the minimum standard of a practical case involving the necessity of having knowledge on LNG storage and regasification plant operations as defined in competence 3 in an example of LNG storage and regasification plant operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to LNG storage and regasification plant operations, complying with the minimum standards established for the practical case.

Evaluation of competence 4: LNG storage and regasification plant maintenance

The methods proposed for demonstrating competence related to LNG storage and regasification plant maintenance are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be LNG storage and regasification plant operator shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding LNG storage and regasification plant maintenance:

    - Electrical installation maintenance
    - Instrumentation maintenance
    - Main equipment maintenance
    - Safety system maintenance
    - Control system maintenance
    - Predictive maintenance

- Practical exercise: candidates to be LNG storage and regasification plant operator shall obtain the minimum standard of a practical case involving the necessity of having knowledge on LNG storage and regasification plant maintenance as defined in competence 4 in an example of LNG storage and regasification plant operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to LNG storage and regasification plant operations, complying with the minimum standards established for the practical case.

Evaluation of competence 5: Control and monitoring for LNG storage and regasification plant operations

The methods proposed for demonstrating competence related to control and monitoring for LNG storage and regasification plant operations are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be LNG storage and regasification plant operator shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding control and monitoring for LNG storage and regasification plant operations:

- Fire and gas detection systems typically used in LNG storage and regasification plant operations
- Emergency stop system typically used in LNG storage and regasification plant operations
- Control system of the facility
- Devices for the instrumentation and monitoring of the facility

- Practical exercise: candidates to be LNG storage and regasification plant operator shall obtain the minimum standard of a practical case involving the necessity of having knowledge on control and monitoring for LNG storage and regasification plant operations as defined in competence 5 in an example of LNG storage and regasification plant operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to LNG storage and regasification plant operations, complying with the minimum standards established for the practical case.

Evaluation of competence 6: Emergency situations and operations in LNG storage and regasification plants

The methods proposed for demonstrating competence related to emergency situations and operations in LNG storage and regasification plants are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be LNG storage and regasification plant operator shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding emergency situations and operations in LNG storage and regasification plants:

  - Emergency procedures defined for LNG storage and regasification plant operations
  - Fire-fighting techniques and specific equipment to be used against LNG, especially the equipment typically used and/or recommended for LNG storage and regasification plant operations
  - Contingency plans defined for LNG storage and regasification plant operations
  - First aid in case of contact with LNG

- Practical exercise: candidates to be LNG storage and regasification plant operator shall obtain the minimum standard of a practical case involving the necessity of having knowledge on

emergency situations and operations in LNG storage and regasification plants as defined in competence 6 in an example of LNG storage and regasification plant operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to LNG storage and regasification plant operations, complying with the minimum standards established for the practical case.

Evaluation of competence 7: Environmental considerations related to LNG storage and regasification plants

The methods proposed for demonstrating competence related to environmental considerations related to LNG storage and regasification plants are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be LNG storage and regasification plant operator shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding environmental considerations related to LNG storage and regasification plants:

    - LNG storage and regasification plant general environmental considerations
    - Gaseous effluents
    - Liquid effluents
    - Noise level
    - Environmental considerations

- Practical exercise: candidates to be LNG storage and regasification plant operator shall obtain the minimum standard of a practical case involving the necessity of having knowledge on environmental considerations related to LNG storage and regasification plants as defined in competence 7 in an example of LNG storage and regasification plant operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to LNG storage and regasification plant operations, complying with the minimum standards established for the practical case.

Evaluation of competence 8: Commercial basics associated to LNG storage and regasification plant operations

The methods proposed for demonstrating competence related to commercial basics associated to LNG storage and regasification plant operations are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be LNG storage and regasification plant operator shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding commercial basics associated to LNG storage and regasification plant operations:
  -
- Practical exercise: candidates to be LNG storage and regasification plant operator shall obtain the minimum standard of a practical case involving the necessity of having knowledge on commercial basics associated to LNG storage and regasification plant operations as defined in competence 8 in an example of LNG storage and regasification plant operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to LNG storage and regasification plant operations, complying with the minimum standards established for the practical case.

4.6. Satellite plants

4.6.1. Competences and contents

Competence 1: Basic knowledge on LNG satellite plants

LNG satellite plants require operators to have basic knowledge on the operations carried out in such facilities, as well as on the nature of the products used.

Contents for this competence shall include a definition of LNG satellite plants (roles, elements and regulation), as well as a brief description of the physical and chemical characteristics of LNG. The basic knowledge on LNG shall also include a succinct description of LNG main hazards and behavior of liquid leakages. Other relevant LNG basics include a brief introduction to the LNG effects on equipment and construction materials, a briefing on potential generation of sparks and ignition due to electric equipment and static loads and a summary of the properties of inert gases (including nitrogen).

A breakdown of the contents proposed for competence 1 is included below.

- Definition of LNG satellite plants
    - Role of LNG satellite plants in the supply chain
    - Description of elements
    - Classification of LNG satellite plants
    - International regulation, recommendations and relevant guidelines on LNG satellite plants
    - LNG satellite plant definitions:
        - General definitions
        - Tank loading
        - Transport to LNG satellite plant
        - LNG unloading facility at the LNG satellite plant
        - Storage facility
        - Regasification facility
        - Electrical installation
        - Civil infrastructure
        - Operation and maintenance
        - Measurement and contractual issues
        - Safety
- Physical and chemical characteristics of LNG
    - Definition of LNG and BOG and their role in LNG satellite plant operations

- Comparison between LNG and other fuels
- Gas laws and application to LNG satellite plant operations
- Physics related to changes of state in the liquid and how they are related to LNG satellite plant operations:
  - Latent heat
  - Transference of heat and energy
  - Refrigeration and liquefaction of gases
  - Critical temperature
  - Dew point definition and temperature
  - Point of bubble
  - Gas mixture
  - Cold gas cloud behaviour
  - Rollover causes and effects

- LNG main hazards linked to LNG satellite plant operations
  - Cryogenic nature of LNG
    - Hypothermia
    - Frostbite
  - Flammability
    - Lower Explosion Limit (LEL)
    - Flammability level (LFL)
    - Ignition point
    - Self-ignition temperature
    - Jet fires
    - Pool fires
    - Flash fires
    - Vapour cloud explosion
    - Boiling liquid expanding vapour explosion (BLEVE)
  - Lack of oxygen
  - Material Safety Datasheet (MSDS)

- Behaviour of fluid leakages, especially for the case of LNG satellite plant operations
  - Behaviour of natural gas and LNG in case of fluid leakages
    - Liquid pools
    - Dense gas clouds, heavier than air until later warming
    - Wind direction
    - Causes and effects of “Rapid Phase Transition”

- LNG effects on equipment and construction materials used for LNG satellite plant operations

- Selection of appropriate materials for cryogenic conditions and types of failure for such materials
- Definition of coefficients of expansion and contraction
- Coefficients of expansion and contraction of the different materials according to temperature gradient
- Types of materials according to use
- Repairing methods, including the importance of the use of the adequate spare parts
- Effect of cryogenic temperatures on the equipment and materials used
- Interaction between water and LNG
- LNG transfer system blocking caused by the presence of water/moisture inside lines/equipment

- Potential generation of sparks and ignition due to electric equipment and static loads, particularly for the case of LNG satellite plant operations (particularly non-intrinsically safe equipment – no ATEX equipment)

  - How electric equipment can cause sparks
  - Causes of static loads
  - Definition of classified areas

- Properties of inert gases (including nitrogen) and applications to LNG satellite plant operations

  - Definition of inert gas
  - Content of oxygen
  - Nature of gas
  - Amount of moisture

Competence 2: Corporate and system management

LNG satellite plant operators shall have knowledge on corporate and system management at operation level.

Contents to acquire the necessary competence shall include risk analysis for operations in LNG satellite plants and management of safety systems used in LNG satellite plants.

A breakdown of the contents proposed for competence 2 is included below.

- Risk analysis for operations in LNG satellite plants

- Relevant parameters for the risk analysis
- How to identify hazards
- How to determine risks
- How to establish probability of occurrence and severity
- How to decide whether a risk is tolerable
- How to prepare an action plan for risk control

- Management of safety systems used in LNG satellite plants

  - Description of corporate safety management systems and how the safety policy is transferred to the documentation for vessel operation
  - Methodology and techniques to assure an efficient risk management
  - Necessity to manage changes in order to continuously assure that the safety requisites are fulfilled satisfactorily and that changes are implemented in a controlled fashion
  - Importance of compiling information on safety incidents and accidents to promote understanding, learning and potential improvements for future actions
  - Definition of safety levels for the tasks carried out

Competence 3: Elements and processes of LNG satellite plants

LNG satellite plant operators shall have knowledge on elements and processes of LNG satellite plants at operational level.

Contents to acquire the necessary competence shall include LNG tank unloading, LNG storage facility, regasification facility, cooling facilities, control and register facilities, fire-fighting facilities, electrical facilities, safety facilities and civil infrastructures.

A breakdown of the contents proposed for competence 3 is included below.

- LNG tank unloading

  - Description of unloading process
  - Elements used in unloading process

- LNG storage facility

  - Description of storage processes
  - Description of storage elements

- Regasification facility

- Description of regasification process
- Description of regasification elements

- Cooling facilities
  - Description of processes
  - Description of elements

- Control and register facilities

- Fire-fighting facilities
  - Description of elements
  - Descriptions of operations

- Electrical facilities
- Safety facilities
- Civil infrastructures

Competence 4: LNG satellite plant operation

LNG satellite plant operators shall have knowledge on LNG satellite plant operation at operational level.

Contents to acquire the necessary competence shall include generalities on LNG satellite plant operation, plant supervision, operation main facts, cooling operations, storage tank operations, regasification operations and other minor operations carried out in LNG satellite plants.

A breakdown of the contents proposed for competence 4 is included below.

- Generalities on LNG satellite plant operation
  - Definition of operation phases
  - Integration of operation phases

- Plant supervision
  - Operations associated to supervision
  - Documents produced on plant supervision

- Operation main facts
    - Manual
    - Personnel
    - Necessary material resources
- Cooling operations
    - Definition of elements used
    - Operation dynamics
- Storage tank operations
    - Definition of storage tank typology used in LNG satellite plants
    - Operations associated to storage tanks
- Regasification operations
    - Definition of elements
    - Description of full regasification operation
- Other minor operations carried out in LNG satellite plants

Competence 5: LNG satellite plant maintenance

LNG satellite plant operators shall have knowledge on LNG satellite plant maintenance at operational level.

Contents to acquire the necessary competence shall include regulation on LNG satellite plant maintenance, periodical maintenance operations, role of personnel and equipment and devices.

A breakdown of the contents proposed for competence 5 is included below.

- Regulation on LNG satellite plant maintenance
    - Legislation
    - Guidelines and recommendations
- Periodical maintenance operations
    - Manual

- Control and registering

- Role of personnel
- Equipment and devices

Competence 6: Safety and emergencies in LNG satellite plants

LNG satellite plant operators shall have knowledge on safety and emergencies in LNG satellite plants at operational level.

Contents to acquire the necessary competence shall include safety levels, emergencies and accidents, emergency plans, procedures in case of leakages and spillages, safety procedures during the operation phase, safety procedures during tank unloading operations, individual safety equipment and first aid in case of contact with LNG.

A breakdown of the contents proposed for competence 6 is included below.

- Safety levels
- Emergencies and accidents
- Emergency plans
    - Definition and object
    - Emergency plan contents
    - Implementation of emergency plans
    - Applicable legislation
    - Emergency plan activation
- Procedures in case of leakages and spillages
    - Without fire
    - With fire
- Safety procedures during the operation phase
- Safety procedures during tank unloading operations
- Individual protective equipment
- First aid in case of contact with LNG
    - Skin contact
    - Inhalation
    - Ingestion

Competence 7: Environmental considerations related to LNG satellite plants

LNG satellite plant operators shall have knowledge on environmental considerations related to LNG satellite plants at operational level.

Contents to acquire the necessary competence shall include LNG satellite plant general environmental considerations and environmental good practices in LNG satellite plants.

A breakdown of the contents proposed for competence 7 is included below.

- LNG satellite plant general environmental considerations
    - Overview of environmental aspects
    - Legislation, guidelines and recommendations on environmental aspects
    - Gaseous effluents
    - Liquid effluents
    - Noise level
    - Soil pollution
- Environmental good practices in LNG satellite plants

Competence 8: Commercial basics associated to LNG satellite plant operations

LNG satellite plant operators shall have knowledge on commercial basics associated to LNG satellite plant operations at operational level.

Contents to acquire the necessary competence shall include commercial considerations for the LNG transfer process and LNG quality management.

A breakdown of the contents proposed for competence 8 is included below.

- LNG transfer process
    - LNG transfer procedure including transfer registers
- LNG quality management
    - Relevance of custody transfer and how the custody transfer systems work:
        - How quantity and quality meters work
        - Precision levels to be reached and how to maintain them through calibration and tests
    - LNG composition (Methane number)
    - Impact of LNG composition in engine and machine performance

- LNG quality certificate, contractual documents and estimations

4.6.2. Evaluation of competence

Evaluation of competence 1: Basic knowledge on LNG satellite plants

The methods proposed for demonstrating competence related to basic knowledge on LNG satellite plants are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be LNG satellite plant operator shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding basic knowledge on LNG:

  - Definition of LNG satellite plants
  - Physical and chemical characteristics of LNG
  - LNG main hazards linked to LNG satellite plant operations
  - Behaviour of fluid leakages, especially for the case of LNG satellite plant operations
  - LNG effects on equipment and construction materials used for LNG satellite plant operations
  - Potential generation of sparks and ignition due to electric equipment and static loads, particularly for the case of LNG satellite plant operations
  - Properties of inert gases (including nitrogen) and applications to LNG satellite plant operations

- Practical exercise: candidates to be LNG satellite plant operator shall obtain the minimum standard of a practical case involving the necessity of having knowledge on the LNG basics defined in competence 1 in an example of LNG satellite plant operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to LNG satellite plant operations, complying with the minimum standards established for the practical case.

Evaluation of competence 2: Corporate and system management

The methods proposed for demonstrating competence related to corporate and system management are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be LNG satellite plant operator shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding corporate and system management:

    - Risk analysis for operations in LNG satellite plants
    - Management of safety systems used in LNG satellite plants

- Practical exercise: candidates to be LNG satellite plant operator shall obtain the minimum standard of a practical case involving the necessity of having knowledge on corporate and system management as defined in competence 2 in an example of LNG satellite plant operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to LNG satellite plant operations, complying with the minimum standards established for the practical case.

Evaluation of competence 3: Elements and processes of LNG satellite plants

The methods proposed for demonstrating competence related to elements and processes of LNG satellite plants are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be LNG satellite plant operator shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding elements and processes of LNG satellite plants:

    - LNG tank unloading
    - LNG storage facility
    - Regasification facility
    - Cooling facilities
    - Control and register facilities
    - Fire-fighting facilities
    - Electrical facilities
    - Safety facilities
    - Civil infrastructures

- Practical exercise: candidates to be LNG satellite plant operator shall obtain the minimum standard of a practical case involving the necessity of having knowledge on elements and

processes of LNG satellite plants as defined in competence 3 in an example of LNG satellite plant operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to LNG satellite plant operations, complying with the minimum standards established for the practical case.

Evaluation of competence 4: LNG satellite plant operation

The methods proposed for demonstrating competence related to LNG satellite plant operation are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be LNG satellite plant operator shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding LNG satellite plant operation:

    - Generalities on LNG satellite plant operation
    - Plant supervision
    - Operation main facts
    - Cooling operations
    - Storage tank operations
    - Regasification operations
    - Other minor operations carried out in LNG satellite plants

- Practical exercise: candidates to be LNG satellite plant operator shall obtain the minimum standard of a practical case involving the necessity of having knowledge on LNG satellite plant operation as defined in competence 4 in an example of LNG satellite plant operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to LNG satellite plant operations, complying with the minimum standards established for the practical case.

Evaluation of competence 5: LNG satellite plant maintenance

The methods proposed for demonstrating competence related to LNG satellite plant maintenance are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be LNG satellite plant operator shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding LNG satellite plant maintenance:
    - Regulation on LNG satellite plant maintenance
    - Periodical maintenance operations
    - Role of personnel
    - Equipment and devices
- Practical exercise: candidates to be LNG satellite plant operator shall obtain the minimum standard of a practical case involving the necessity of having knowledge on LNG satellite plant maintenance as defined in competence 5 in an example of LNG satellite plant operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to LNG satellite plant operations, complying with the minimum standards established for the practical case.

Evaluation of competence 6: Safety and emergencies in LNG satellite plants

The methods proposed for demonstrating competence related to safety and emergencies in LNG satellite plants are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be LNG satellite plant operator shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding safety and emergencies in LNG satellite plants:
    - Safety levels
    - Emergencies and accidents
    - Emergency plans
    - Procedures in case of leakages and spillages

- Safety procedures during the operation phase
- Safety procedures during tank unloading operations
- Individual safety equipment
- First aid in case of contact with LNG

- Practical exercise: candidates to be LNG satellite plant operator shall obtain the minimum standard of a practical case involving the necessity of having knowledge on safety and emergencies in LNG satellite plants as defined in competence 6 in an example of LNG satellite plant operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to LNG satellite plant operations, complying with the minimum standards established for the practical case.

Evaluation of competence 7: Environmental considerations related to LNG satellite plants

The methods proposed for demonstrating competence related to environmental considerations related to LNG satellite plants are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be LNG satellite plant operator shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding environmental considerations related to LNG satellite plants:

  - LNG satellite plant general environmental considerations
  - Environmental good practices in LNG satellite plants

- Practical exercise: candidates to be LNG satellite plant operator shall obtain the minimum standard of a practical case involving the necessity of having knowledge on environmental considerations related to LNG satellite plants as defined in competence 7 in an example of LNG satellite plant operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.

- The candidate is able to use the knowledge acquired in a practical case related to LNG satellite plant operations, complying with the minimum standards established for the practical case.

Evaluation of competence 8: Commercial basics associated to LNG satellite plant operations

The methods proposed for demonstrating competence related to commercial basics associated to LNG satellite plant operations are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be LNG satellite plant operator shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding commercial basics associated to LNG satellite plant operations:
    - LNG transfer process
    - LNG quality management
- Practical exercise: candidates to be LNG satellite plant operator shall obtain the minimum standard of a practical case involving the necessity of having knowledge on commercial basics associated to LNG satellite plant operations as defined in competence 8 in an example of LNG satellite plant operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to LNG satellite plant operations, complying with the minimum standards established for the practical case.

4.7. Operations in LNG stations

The training proposal for the different tasks carried out at LNG stations is composed of two different parts:

- Definition of competences and description of contents proposed for the development of each competence.
- Proposal of evaluation of competences.

4.7.1. Competences and contents

Competence 1: Basic knowledge on LNG stations

LNG stations require operators to have basic knowledge on the operations carried out in such facilities, as well as on the nature of the products used.

Contents proposed for this competence are listed below.

- Definition of LNG stations
- Physical and chemical characteristics of LNG
- LNG main hazards linked to LNG stations
- Behaviour of fluid leakages, especially for the case of LNG stations
- LNG effects on equipment and construction materials used for LNG stations
- Potential generation of sparks and ignition due to electric equipment and static loads, particularly for the case of LNG stations
- Properties of inert gases (including nitrogen) and applications to LNG stations

Competence 2: Corporate and system management

LNG station operators shall have knowledge on corporate and system management at operation level.

The contents proposed for competence 2 are listed below.

- Risk analysis for operations in LNG stations
- Management of safety systems used in LNG stations

Competence 3: Elements and processes of LNG stations

LNG satellite plant operators shall have knowledge on elements and processes of LNG stations at operational level.

Contents proposed for competence 3 are listed below.

- LNG storage facility
- LNG supply facility
- Control and register facilities
- Fire-fighting facilities
- Electrical facilities
- Safety facilities
- Civil infrastructures

Competence 4: LNG station operation

LNG station operators shall have knowledge on LNG station operation at operational level.

Contents proposed for competence 4 are listed below.

- Generalities on LNG station operation
- LNG station supervision
- LNG loading and unloading operations
- LNG supply
- Operation main facts
- Other minor operations carried out in LNG stations

Competence 5: LNG station maintenance

LNG station operators shall have knowledge on LNG station maintenance at operational level.

Contents proposed for competence 5 are listed below.

- Regulation on LNG station maintenance
- Periodical maintenance operations
- Role of personnel
- Equipment and devices

Competence 6: Safety and emergencies in LNG stations

LNG station operators shall have knowledge on safety and emergencies in LNG stations at operational level.

Contents proposed for competence 6 are listed below.

- Safety levels
- Emergencies and accidents
- Emergency plans
- Procedures in case of leakages and spillages
- Safety procedures during the operation phase
- Safety procedures during loading and unloading operations
- Individual safety equipment
- First aid in case of contact with LNG

Competence 7: Environmental considerations related to LNG stations

LNG station operators shall have knowledge on environmental considerations related to LNG stations at operational level.

Contents proposed for competence 7 are listed below.

- LNG station general environmental considerations
    - Overview of environmental aspects
    - Legislation, guidelines and recommendations on environmental aspects
    - Gaseous effluents
    - Liquid effluents
    - Noise level
    - Soil pollution
- Environmental good practices in LNG stations

Competence 8: Commercial basics associated to LNG station operations

LNG station operators shall have knowledge on commercial basics associated to LNG station operations at operational level.

Contents proposed for competence 8 are listed below.

- LNG transfer procedure including transfer registers

- LNG quality management

4.7.2. Evaluation of competence

Evaluation of competence 1: Basic knowledge on LNG stations

The methods proposed for demonstrating competence related to basic knowledge on LNG stations are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be LNG station operator shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding basic knowledge on LNG:

    - Definition of LNG stations
    - Physical and chemical characteristics of LNG
    - LNG main hazards linked to LNG stations
    - Behaviour of fluid leakages, especially for the case of LNG stations
    - LNG effects on equipment and construction materials used for LNG stations
    - Potential generation of sparks and ignition due to electric equipment and static loads, particularly for the case of LNG stations
    - Properties of inert gases (including nitrogen) and applications to LNG stations

- Practical exercise: candidates to be LNG station operator shall obtain the minimum standard of a practical case involving the necessity of having knowledge on the LNG basics defined in competence 1 in an example of LNG station operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to LNG station operations, complying with the minimum standards established for the practical case.

Evaluation of competence 2: Corporate and system management

The methods proposed for demonstrating competence related to corporate and system management are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be LNG station operator shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding corporate and system management:

    - Risk analysis for operations in LNG stations
    - Management of safety systems used in LNG stations

- Practical exercise: candidates to be LNG station operator shall obtain the minimum standard of a practical case involving the necessity of having knowledge on corporate and system management as defined in competence 2 in an example of LNG station operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to LNG station operations, complying with the minimum standards established for the practical case.

Evaluation of competence 3: Elements and processes of LNG stations

The methods proposed for demonstrating competence related to elements and processes of LNG stations are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be LNG station operator shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding elements and processes of LNG stations:

    - LNG storage facility
    - LNG supply facility
    - Control and register facilities
    - Fire-fighting facilities
    - Electrical facilities
    - Safety facilities
    - Civil infrastructures

- Practical exercise: candidates to be LNG station operator shall obtain the minimum standard of a practical case involving the necessity of having knowledge on elements and processes of LNG stations as defined in competence 3 in an example of LNG station operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to LNG station operations, complying with the minimum standards established for the practical case.

Evaluation of competence 4: LNG station operation

The methods proposed for demonstrating competence related to LNG station operation are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be LNG station operator shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding LNG station operation:

    - Generalities on LNG station operation
    - LNG station supervision
    - LNG loading and unloading operations
    - LNG supply
    - Operation main facts
    - Other minor operations carried out in LNG stations

- Practical exercise: candidates to be LNG station operator shall obtain the minimum standard of a practical case involving the necessity of having knowledge on LNG station operation as defined in competence 4 in an example of LNG station operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to LNG station operations, complying with the minimum standards established for the practical case.

Evaluation of competence 5: LNG station maintenance

The methods proposed for demonstrating competence related to LNG station maintenance are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be LNG station operator shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding LNG station maintenance:

- Regulation on LNG station maintenance
- Periodical maintenance operations
- Role of personnel
- Equipment and devices

- Practical exercise: candidates to be LNG station operator shall obtain the minimum standard of a practical case involving the necessity of having knowledge on LNG station maintenance as defined in competence 5 in an example of LNG station operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to LNG station operations, complying with the minimum standards established for the practical case.

Evaluation of competence 6: Safety and emergencies in LNG stations

The methods proposed for demonstrating competence related to safety and emergencies in LNG stations are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be LNG station operator shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding safety and emergencies in LNG stations:

  - Safety levels
  - Emergencies and accidents
  - Emergency plans
  - Procedures in case of leakages and spillages
  - Safety procedures during the operation phase
  - Safety procedures during loading and unloading operations
  - Individual safety equipment
  - First aid in case of contact with LNG

- Practical exercise: candidates to be LNG station operator shall obtain the minimum standard of a practical case involving the necessity of having knowledge on safety and emergencies in LNG stations as defined in competence 6 in an example of LNG station operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.

- The candidate is able to use the knowledge acquired in a practical case related to LNG station operations, complying with the minimum standards established for the practical case.

Evaluation of competence 7: Environmental considerations related to LNG stations

The methods proposed for demonstrating competence related to environmental considerations related to LNG stations are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be LNG station operator shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding environmental considerations related to LNG stations:
    - LNG station general environmental considerations
    - Environmental good practices in LNG stations
- Practical exercise: candidates to be LNG station operator shall obtain the minimum standard of a practical case involving the necessity of having knowledge on environmental considerations related to LNG stations as defined in competence 7 in an example of LNG station operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to LNG station operations, complying with the minimum standards established for the practical case.

Evaluation of competence 8: Commercial basics associated to LNG station operations

The methods proposed for demonstrating competence related to commercial basics associated to LNG station operations are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be LNG station operator shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding commercial basics associated to LNG station operations:
    - LNG transfer procedure including transfer registers
    - LNG quality management

- Practical exercise: candidates to be LNG station operator shall obtain the minimum standard of a practical case involving the necessity of having knowledge on commercial basics associated to LNG station operations as defined in competence 8 in an example of LNG station operation.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to LNG station operations, complying with the minimum standards established for the practical case.

LNG station. Source: HAM.

4.8. Railway operations with LNG

The training proposal for the different tasks carried out in railway operations with LNG is composed of two different parts:

- Definition of competences and description of contents proposed for the development of each competence.
- Proposal of evaluation of competences.

4.8.1. Competences and contents

Competence 1: Basic knowledge on LNG

Railway operations with require that participating operators have certain level of knowledge on the main product used in the operations to be used as a basis of a better understanding of the efficiency and safety processes associated to the supply and use of LNG in railway operations.

Contents for this competence shall include a brief description of the physical and chemical characteristics of LNG and an introduction of the impact of LNG in its different states (liquid and vapour) for a better understanding of the emissions to the atmosphere derived from the use of LNG as fuel. The basic knowledge on LNG shall also include a succinct description of LNG main hazards and behaviour of liquid leakages. Other relevant LNG basics include a brief introduction to the LNG effects on equipment and construction materials, a briefing on potential generation of sparks and ignition due to electric equipment and static loads and a summary of the properties of inert gases (including nitrogen).

A breakdown of the contents for competence 1 is included below.

- Physical and chemical characteristics of LNG
    - Definition of LNG and BOG and their role in railway operations with LNG
    - Comparison between LNG and other fuels
    - Gas laws and application to railway operations with LNG
    - Physics related to changes of state in the liquid and how they are related to railway operations with LNG:
        - Latent heat
        - Transference of heat and energy
        - Refrigeration and liquefaction of gases
        - Critical temperature
        - Dew point definition and temperature

        - Point of bubble
        - Gas mixture
        - Cold gas cloud behaviour
        - Rollover causes and effects

- Environmental impact of LNG: liquid and vapour

    - Performance of engines and machines powered by natural gas versus those powered by other fuels related to emissions of:
        - CO2
        - NOx
        - SOx
        - PM (particulate matters)
    - Behaviour of methane as GHG (Greenhouse Gas)

- LNG main hazards linked to railway operations with LNG

    - Cryogenic nature of LNG
        - Hypothermia
        - Frostbite
        - Cold burn
    - Flammability
        - Lower Explosion Limit (LEL)
        - Flammability level (LFL)
        - Ignition point
        - Self-ignition temperature
        - Jet fires
        - Pool fires
        - Flash fires
        - Vapour cloud explosion
        - Boiling liquid expanding vapour explosion (BLEVE)
    - Lack of oxygen
    - Material Safety Datasheet (MSDS)

- Behaviour of fluid leakages and the particular case of railway operations with LNG

    - Behaviour of natural gas and LNG in case of fluid leakages
        - Liquid pools
        - Dense gas clouds, heavier than air until later warming
        - Wind direction
        - Causes and effects of “Rapid Phase Transition”

- LNG effects on equipment and construction materials applicable for railway operations with LNG

    - Selection of appropriate materials for cryogenic conditions and types of failure for such materials, particularly for the infrastructures and devices to be used in railway operations with LNG
    - Definition of coefficients of expansion and contraction
    - Coefficients of expansion and contraction of the different materials according to temperature gradient
    - Types of materials according to use
    - Repairing methods, including the importance of the use of the adequate spare parts
    - Effect of cryogenic temperatures on the equipment and materials to be used
    - Interaction between water and LNG
    - LNG transfer system blocking caused by the presence of water/moisture inside lines/equipment

- Potential generation of sparks and ignition due to electric equipment and static loads, particularly for the case of railway operations with LNG (particularly non-intrinsically safe equipment – no ATEX equipment)

    - How electric equipment can cause sparks
    - Causes of static loads
    - Definition of classified areas

- Properties of inert gases (including nitrogen) and applications to railway operations with LNG

    - Definition of inert gas
    - Content of oxygen
    - Nature of gas
    - Amount of moisture

Competence 2: Corporate and system management

Operators participating in railway operations with LNG shall have certain knowledge of corporate and system management, particularly regarding those issues affecting railway operations with LNG and the infrastructures and devices used in such operations.

Corporate and system management for railway operations with LNG include international regulation, recommendations and relevant guidelines on railway operations and their relation to the use of LNG as fuel, risk analysis for railway operations with LNG, responsibilities assumable to the equipment

owner or tenant in railway operations with LNG, management of safety systems to be used in railway operations with LNG and operating procedures to be defined in railway operations with LNG.

A breakdown of the contents for competence 2 is included below.

- International regulation, recommendations and relevant guidelines on the use of LNG as fuel and their relation to railway operations
    - Use of LNG as fuel
    - LNG transfer in railway
    - LNG transport in railway
- Risk analysis for railway operations with LNG
    - Relevant parameters for the risk analysis
    - How to identify hazards
    - How to determine risks
    - How to establish probability of occurrence and severity
    - How to decide whether a risk is tolerable
    - How to prepare an action plan for risk control
- Responsibilities assumable to the equipment owner or tenant in railway operations with LNG
    - Knowledge of the responsibilities resulting from the “duty of care” legal principle regarding the safeguard of damage to third parties
    - Knowledge of applicable regulation to acquisition process for leased or owned equipment
    - Knowledge of operating manuals for main equipment
    - Analysis of the principles of adequate use of hoses and hazards associated to fixing and movement of the hoses without the help of a crane
    - Knowledge of how the LNG transfer system should be held to avoid excessive tension/shear efforts for hoses, emergency release systems, connections and collectors
    - Knowledge of how to give the adequate response in case of any defect in the facility or documentation
    - Knowledge of how safety devices and natural gas detectors work and are calibrated
- Management of safety systems to be used in railway operations with LNG
    - Description of corporate safety management systems and how the safety policy is transferred to the documentation for vessel operation
    - Methodology and techniques to assure an efficient risk management

- Necessity to manage changes in order to continuously assure that the safety requisites are fulfilled satisfactorily and that changes are implemented in a controlled fashion
- Importance of compiling information on safety incidents and accidents to promote understanding, learning and potential improvements for future actions
- Definition of safety levels for the tasks carried out

- Operating procedures for railway operations with LNG

  - Object, scope and legal framework of the procedures
  - Contents for the operating procedures and adequate location
  - Necessity to follow operating procedures
  - Necessity to manage any change in the operating procedures in a controlled fashion

Competence 3: Organisation and management

Operators involved in railway operations with LNG shall have knowledge, at operational level, of how organisation and management work in railway operations with LNG.

Contents related to organisation and management shall include a description of how communication and working teams are carried out in practice in railway operations with LNG, complemented with knowledge of the roles and responsibilities in railway operations with LNG.

A breakdown of the contents for competence 3 is included below.

- Communication and working teams in railway operations with LNG

  - Chain of command
  - Importance of communication protocols, good practices and methods for obtaining feedback to guarantee effective communication
  - Previous meetings to loading operations:
    - Object of meetings
    - Contents
  - Checklists and how to use them – Safety checklists ship-shore (or similar)

- Roles and responsibilities in railway operations with LNG

  - LNG supplier
  - Company responsible for loading operation
  - LNG receiver
  - Port Authority

- Independent inspections

Competence 4: Operation, calibration and maintenance of equipment and instrumentation

Operators involved in railway operations with LNG shall have knowledge on operation, calibration and maintenance of equipment and instrumentation to the extent necessary for carrying out the tasks associated to the defined railway operations with LNG.

The contents associated to the competence shall include mechanical manipulation of equipment, devices and instrumentation to be used in railway operations with LNG, as well as transfer systems associated to the particular transfer operation carried out in railway, LNG storage tanks used in railway operations with LNG and different operational requirements and restrictions of the particular transfer operation carried out in railway.

A breakdown of the contents for competence 4 is included below.

- Mechanical manipulation in railway operations with LNG
  - Knowledge on types of devices to manipulate hoses and equipment to be used in railway operations with LNG
  - Knowledge of the principles of mechanical manipulation and hazards associated to the operation without the proper holding and transportation systems

- Transfer systems railway operations with LNG
  - Knowledge of the components and principles of operation that form the LNG transfer system:
    - Flexible hoses
    - Articulated arms
    - Lines both on train and on supply equipment or facility
    - Emergency disconnections and safety coupling
    - Connections both on train and on supply equipment or facility
    - Manifold layout
  - Understanding of failure types that may result in equipment malfunction
  - LNG storage tanks, especially those to be used in railway operations with LNG
  - Typology of LNG storage tanks to be used in facilities where railway operations with LNG take place:
    - Construction and installation for each type
  - Tank classification
    - Type A details and examples
    - Type B details and examples

        - Type C details and examples
        - Integral or membrane tanks – details and examples
    - Operational requirements for each type
    - Operational restrictions for each type

- LNG pumps to be used in railway operations with LNG

    - Pump operation
        - Pressure versus flow
        - Required NPSH versus available NPSH
        - Specific questions related to pumping of boiling liquids such as LNG: cavitation, starting, waiting time until next start, etc.
    - Types of pumps
        - Construction and installation of each type
        - Operational requirements for each type
        - Operational restrictions for each type

- Valves to be used in railway operations with LNG

    - Types of valves used in LNG and natural gas installations for:
        - Isolation
        - Control
    - Design features
    - Operational requirements
        - Prevention of over-pressure
    - Maintenance requirements
    - Potential problems – leakages

- Over-pressure protection devices to be used in railway operations with LNG

    - Valves and pressure relief systems
        - Types
        - Design features
        - Operational requirements
        - Design and operation
        - Limitations
        - Potential problems

- Electric equipment in classified areas of facilities where railway operations with LNG take place

- Classification of areas (zoning)
  - Different categories of safety types for electric equipment
  - Role of regulation standards for a safe use of electric equipment
  - How to identify safe electric equipment for its use in classified areas

- Management of safety systems (leakages/spillages) in railway operations with LNG
  - Water curtains
  - Spill plates:
    - Recommendations
    - Draining processes
  - CCTV/Monitoring equipment
  - Over-filling protection methods
  - Elements for the detection of gas, flames, etc.
  - Fire-fighting equipment

- Personal protection equipment for railway operations with LNG
  - Equipment
  - Protective clothing

- Operation manuals for main equipment in railway operations with LNG
  - Relevant content of operation and maintenance manuals for main equipment
    - Specific equipment issues

Competence 5: Railway operations with LNG

Operators involved in railway operations with LNG shall have deep knowledge of how railway operations with LNG are carried out in practice, starting with the previous activities to the loading operation, which include checking compatibility of equipment and devices and a deep knowledge of the checklist for previous operations; purging, which includes a deep knowledge of how to carry out the task as well as the relevance of doing and not doing it; pressurization and depressurization, draining and isolation, focusing on how to carry out the different processes and highlighting the object and necessity of each task of the process so that the trainee is fully aware of the importance of each of them in terms of safety and efficiency.

A breakdown of the contents for competence 5 is included below.

- Previous activities to loading operation for railway operations with LNG

  - Compatibility between manifold of receiving vessel and the LNG transfer system (hoses) of the supply equipment
  - Compatibility between earth installation and the LNG transfer system (hoses) of the supply equipment.
  - Fulfilling of previous checklist for railway operations with LNG
  - Meeting prior to loading operation
  - Necessity of obtaining checklist validation by supplier and receiver

- Management of railway operations with LNG – purging

  - Object and importance of purging operations before and after LNG transfers
  - Potential consequences of incorrect of inefficient purging process related to:
    - Safety
    - Operational issues
    - Fiscal issues

- Pressurization and depressurization

  - Pressurization process
    - Necessity of controlling pressurization ratio
    - Pressurization processes and associated tests
    - High-pressure safety process
  - Depressurization processes:
    - Joule-Thompson cooling effect and how equipment temperature is reduced considerably
  - Vacuuming
  - Fatigue cycles

- Management of railway operations with LNG – draining

  - Draining method for lines prior to disconnecting
    - Methods and precautions related to vacuuming of liquid lines and their connections
    - Methods and precautions related to vacuuming of gas lines and their connections
    - Safety issues due to potential inefficient draining

- Management of railway operations with LNG – isolation

  - Methods for a safe line and equipment division into sectors in relation to:
    - Preventing liquid retention between isolating valves

- Assuring a safe emergency disconnection
- Assuring safety conditions during the execution of the LNG transfer operation

Competence 6: Control and monitoring for railway operations with LNG

Operators involved in railway operations with LNG shall have knowledge on control and monitoring of operations, particularly regarding railway operations with LNG at operational level.

In order to acquire this competence the trainees shall have knowledge of fire and gas detection systems (including the detectors to be used for railway operations with LNG, such as O2 analyser, LEL % detector, gas volume % detector, dewpoint meter, CO2 meter, cooling meter, infrared and ultraviolet), emergency stop systems, control system of the supply equipment/facility and devices for the instrumentation and monitoring of the supply equipment/facility (including temperature meters, pressure meters, level meters, floats and radars), to be used in railway operations with LNG. The trainees shall have both the knowledge and the awareness of the necessity of each of the control and monitoring tasks carried out in railway operations with LNG.

A breakdown of the contents for competence 6 is included below.

- Fire and gas detection systems to be used in railway operations with LNG
    - Operation principles
        - Adequacy of different types of gas detector for different environmental conditions
    - Object, operating procedures, limitations and calibration requirements for each type of detector:
        - O2 analyser
        - LEL % detector
        - Gas volume % detector
        - Dewpoint meter
        - CO2 meter
        - Cooling meter
        - Infrared
        - Ultraviolet
- Emergency stop system to be used in railway operations with LNG
    - Object
    - Operation principles
    - System configuration

- Operating considerations related to connected or independent systems
- Actions unleashed once the shot takes place

- Control system of the facility

  - Description of how the control system works for bunkering operations
  - Description of the interaction between different control systems
  - Functions of the control system
  - Elements of the control system
  - Alarms and activators

- Devices for the instrumentation and monitoring of the supply equipment/facility

  - Temperature meters
    - Types
    - Limitations
    - Alarm configuration
  - Pressure gauges
    - Types
    - Limitations
    - Alarm configuration
  - Level meters
    - Operation principles for each type
  - Floats
  - Radars
    - Operational requirements for each type
    - Limitations for each type
    - Maintenance requirements for each type
    - Alarm configuration and actions

Competence 7: Emergency situations and operations in railway operations with LNG

Operators involved in railway operations with LNG shall have deep knowledge on how to identify emergency situations and the operations associated to such situations. It is important to associate procedures to the nature of the product; therefore, basic knowledge on the behaviour of LNG is linked to this competence for the operator to understand procedures and take the proper decisions in emergency situations.

In order to acquire this competence, trainees shall have knowledge on emergency procedures, firefighting techniques and specific equipment to be used against LNG, contingency plans and first

aid in case of potential contact with LNG, as well as awareness on the relevance of emergency situations and operations associated to such situations in railway operations with LNG.

A breakdown of the contents for competence 7 is included below.

- Emergency procedures defined for railway operations with LNG
    - Effective use of contingency plans
    - Importance of emergency drills and conclusions obtained from them
- Firefighting techniques and specific equipment to be used against LNG, especially the equipment to be used and/or recommended for railway operations with LNG
    - Use of high expansion foam
    - Use of dry chemical powder
    - Risk of re-ignition
    - Heating intensity of a fire
    - Risks while trying to extinguish a fire before stopping the leakage
    - Water spray systems
    - Use of water curtains for division into sectors and prevent dispersion of gas clouds to sensitive areas
- Contingency plans defined for railway operations with LNG
    - Role of contingency plans in usual operations, unusual operations end emergency situations
- First aid in case of contact with LNG
    - Skin contact
    - Inhalation
    - Ingestion

Competence 8: Commercial basics associated to railway operations with LNG

Operators involved in railway operations with LNG shall have a basic commercial knowledge in order to carry out the tasks associated to operators related to commercial issues, such as transfer registers, measurement of quantity and quality of the product and composition of LNG.

In order to acquire this competence, trainees shall have knowledge on the LNG transfer procedure, including LNG transfer registers; LNG quality management, that including knowledge on the

relevance of custody transfer and how the custody transfer systems work; LNG composition and the impact in engine and machine performance; and LNG transaction documents.

A breakdown of the contents for competence 8 is included below.

- LNG transfer process
    - LNG transfer procedure including transfer registers
- LNG quality management
    - Relevance of custody transfer and how the custody transfer systems work:
        - How quantity and quality meters work
        - Precision levels to be reached and how to maintain them through calibration and tests
    - LNG composition (Methane number)
    - Impact of LNG composition in engine and machine performance
    - LNG quality certificate, contractual documents and estimations

4.8.2. Evaluation of competence

Evaluation of Competence 1: Basic knowledge on LNG

The methods proposed for demonstrating competence related to basic knowledge of LNG are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be operators for railway operations with LNG shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding basic knowledge on LNG:
    - Physical and chemical characteristics of LNG
    - Environmental impact of LNG: liquid and vapour
    - LNG main hazards linked to railway operations with LNG
    - Behaviour of fluid leakages and the particular case of railway operations with LNG
    - LNG effects on equipment and construction materials applicable for railway operations with LNG
    - Potential generation of sparks and ignition due to electric equipment and static loads, particularly for the case of railway operations with LNG
    - Properties of inert gases (including nitrogen) and applications to railway operations with LNG

- Practical exercise: candidates to be operators for railway operations with LNG shall obtain the minimum standard of a practical case involving the necessity of having knowledge on the LNG basics defined in competence 1 in an example of railway operation with LNG.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to railway operations with LNG, complying with the minimum standards established for the practical case.

Evaluation of competence 2: Corporate and system management

The methods proposed for demonstrating competence related to corporate and system management are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be operators for railway operations with LNG shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding corporate and system management:

    - International regulation, recommendations and relevant guidelines on the use of LNG as fuel and their relation to railway operations
    - Risk analysis for railway operations with LNG
    - Responsibilities assumable to the equipment owner or tenant in railway operations with LNG
    - Management of safety systems to be used in railway operations with LNG
    - Operating procedures for railway operations with LNG

- Practical exercise: candidates to be operators for railway operations with LNG shall obtain the minimum standard of a practical case involving the necessity of having knowledge on corporate and system management as defined in competence 2 in an example of railway operation with LNG.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to railway operations with LNG, complying with the minimum standards established for the practical case.

Evaluation of competence 3: Organisation and management

The methods proposed for demonstrating competence related to organisation and management are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be operators for railway operations with LNG shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding organisation and management:
    - Communication and working teams in railway operations with LNG
    - Roles and responsibilities in railway operations with LNG
- Practical exercise: candidates to be operators for railway operations with LNG shall obtain the minimum standard of a practical case involving the necessity of having knowledge on organisation and management as defined in competence 3 in an example of railway operation with LNG.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to railway operations with LNG, complying with the minimum standards established for the practical case.

Evaluation of competence 4: Operation, calibration and maintenance of equipment and instrumentation

The methods proposed for demonstrating competence related to operation, calibration and maintenance of equipment and instrumentation are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be operators for railway operations with LNG shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding operation, calibration and maintenance of equipment and instrumentation:
    - Mechanical manipulation in railway operations with LNG
    - Transfer systems railway operations with LNG
    - LNG pumps to be used in railway operations with LNG
    - Valves to be used in railway operations with LNG
    - Over-pressure protection devices to be used in railway operations with LNG

- Electric equipment in classified areas of facilities where railway operations with LNG take place
- Management of safety systems (leakages/spillages) in railway operations with LNG
- Personal protection equipment for railway operations with LNG
- Operation manuals for main equipment in railway operations with LNG

- Practical exercise: candidates to be operators for railway operations with LNG shall obtain the minimum standard of a practical case involving the necessity of having knowledge on operation, calibration and maintenance of equipment and instrumentation as defined in competence 4 in an example of railway operation with LNG.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to railway operations with LNG, complying with the minimum standards established for the practical case.

Evaluation of competence 5: Railway operations with LNG

The methods proposed for demonstrating competence related to railway operations with LNG are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be operators for railway operations with LNG shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding railway operations with LNG:

  - Previous activities to loading operation for railway operations with LNG
  - Management of railway operations with LNG – purging
  - Pressurization and depressurization
  - Management of railway operations with LNG – draining
  - Management of railway operations with LNG – isolation

- Practical exercise: candidates to be operators for railway operations with LNG shall obtain the minimum standard of a practical case involving the necessity of having knowledge on operation, calibration and maintenance of equipment and instrumentation as defined in competence 5 in an example of railway operation with LNG.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to railway operations with LNG, complying with the minimum standards established for the practical case.

Evaluation of competence 6: Control and monitoring for railway operations with LNG

The methods proposed for demonstrating competence related to control and monitoring for railway operations with LNG are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be operators for railway operations with LNG shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding control and monitoring for railway operations with LNG:
    - Fire and gas detection systems to be used in railway operations with LNG
    - Emergency stop system to be used in railway operations with LNG
    - Control system of the facility
    - Devices for the instrumentation and monitoring of the supply equipment/facility
- Practical exercise: candidates to be operators for railway operations with LNG shall obtain the minimum standard of a practical case involving the necessity of having knowledge on control and monitoring for railway operations with LNG as defined in competence 6 in an example of railway operation with LNG.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to railway operations with LNG, complying with the minimum standards established for the practical case.

Evaluation of competence 7: Emergency situations and operations in railway operations with LNG

The methods proposed for demonstrating competence related to emergency situations and operations in railway operations with LNG are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be operators for railway operations with LNG shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding control and monitoring for railway operations with LNG:

    - Emergency procedures defined for railway operations with LNG
    - Firefighting techniques and specific equipment to be used against LNG, especially the equipment to be used and/or recommended for railway operations with LNG
    - Contingency plans defined for railway operations with LNG
    - First aid in case of contact with LNG

- Practical exercise: candidates to be operators for railway operations with LNG shall obtain the minimum standard of a practical case involving the necessity of having knowledge on emergency situations and operations in railway operations with LNG as defined in competence 7 in an example of railway operation with LNG.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to railway operations with LNG, complying with the minimum standards established for the practical case.

Evaluation of competence 8: Commercial basics associated to railway operations with LNG

The methods proposed for demonstrating competence related to emergency situations and operations in railway operations with LNG are based on examination and assessment obtained from the following exercises:

- Theoretical examination: candidates to be operators for railway operations with LNG shall obtain the minimum standard of a theoretical examination showing knowledge on the following main areas regarding control and monitoring for railway operations with LNG:

    - LNG transfer process
    - LNG quality management

- Practical exercise: candidates to be operators for railway operations with LNG shall obtain the minimum standard of a practical case involving the necessity of having knowledge on emergency situations and operations in railway operations with LNG as defined in competence 8 in an example of railway operation with LNG.

The proposed criteria for evaluating competence are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case related to railway operations with LNG, complying with the minimum standards established for the practical case.

LNG transport by railway. Source: Core LNGas Hive

5. Training proposal at management level

Training at management level has been identified both on shore and on board a ship. Training at management level for onshore operations are defied through a university module, while training and certification for on-board personnel is defined by the Seafarers' Training, Certification and Watchkeeping (STCW) Code.

5.1. Proposal of university module

5.1.1. Competences and contents

Competence 1: LNG as fuel

Students shall have a comprehensive knowledge on the use of LNG as fuel, focusing on the managerial tasks. Particularly, this competence shall include the following main elements:

- LNG general review: students shall have a historical review of the used of natural gas in the different sectors, as well as an overview of the state of the art for the uses of natural gas in its different states.
- LNG characteristics: students shall use their previous knowledge in physics and chemistry to apply them to natural gas in its liquefied state.
- Materials: students shall acquire knowledge on the characteristics of the materials used fin operations involving LNG according to the cryogenic nature of LNG.
- Storage, pumping and piping elements: students shall acquire knowledge on the main elements linked to operations with LNG, mainly including:
    - Storage tanks
    - Pumps
    - Valves
    - Connectors
    - Pipelines
    - Hoses
    - Cranes
    - Safety and emergency systems
- Management of LNG as fuel: students shall acquire knowledge on how to manage LNG as fuel considering the perishable nature of the product. Students shall be aware of the best uses of LNG as fuel according to how it can be managed.

Competence 2: The LNG supply chain

- Overview of the LNG supply chain: students shall have an overview of the full supply chain, including the following elements:
    - Extraction
    - Liquefaction
    - LNG Maritime transport
    - Loading/unloading operations
    - LNG storage and regasification plants
    - Bunkering operations
    - Pipeline transport
    - Truck transport
    - Railway transport
    - Satellite plants
    - LNG stations
- Extraction: students shall acquire knowledge on the following aspects related to the extraction of natural gas:
    - Legislation, guidelines and recommendations
    - Overview of extraction operations
- Liquefaction: students shall acquire knowledge on the following aspects regarding the liquefaction process of natural gas:
    - Legislation, guidelines and recommendations
    - Overview of liquefaction operations
- LNG maritime transport: students shall acquire knowledge on the following aspects regarding the maritime transport of LNG:
    - Legislation, guidelines and recommendations
    - Tanker vessels
    - Overview of main issues related to transport operations
- Loading/unloading operations: students shall acquire knowledge on the following aspects related to LNG loading/unloading operations:
    - Legislation, guidelines and recommendations

- Facilities, equipment, devices and instrumentation used in operations
- Human resources needed for operations
- Operation organisation and dynamics
- Main safety issues related to loading/unloading operations
- Best practices

- LNG storage and regasification: students shall acquire knowledge on the following aspects concerning LNG storage:

  - Legislation, guidelines and recommendations
  - Plant diagrams
  - Elements of storage and regasification plants
  - Types of tank used
  - Overview of regasification processes
  - Main safety issues related to LNG storage and regasification
  - Best practices

- Bunkering operations: students shall acquire knowledge on the following aspects related to LNG bunkering operations:

  - Legislation, guidelines and recommendations
  - Bunkering modes
  - Pros and cons for each bunkering mode
  - Main safety issues for bunkering operations
  - Best practices for bunkering operations

- Pipeline transport: students shall acquire knowledge on the following aspects related to pipeline transport:

  - Legislation, guidelines and recommendations
  - Elements of pipeline transport
  - Uses of pipeline transport

- Truck transport: students shall acquire knowledge on the following aspects regarding truck transport in the LNG supply chain:

  - Legislation, guidelines and recommendations
  - Tanks used for truck transport
  - Overview of operations linked to truck transport

- Railway transport: students shall acquire knowledge on the following aspects regarding railway transport in the LNG supply chain:

    - Legislation, guidelines and recommendations
    - Tanks used for railway transport
    - Overview of operations linked to railway transport

- LNG satellite plants: students shall acquire knowledge on the following aspects regarding satellite plants in the LNG supply chain:

    - Role of satellite plants in the supply chain
    - Legislation, guidelines and recommendations
    - Satellite plant diagrams
    - Elements of satellite plants
    - Overview of operations carried out in satellite plants
    - Main safety issues for satellite plants
    - Best practices in satellite plants

- LNG stations: students shall acquire knowledge on the following aspects regarding LNG stations:

    - Elements of an LNG station
    - Overview of operations carried out in LNG stations

Competence 3: LNG bunkering operations

Students shall have deep knowledge on how to manage LNG bunkering operations, broken down by bunkering mode.

- Truck to Ship bunkering operations

    - Legislation, guidelines and recommendations
    - Uses and limitations of this bunkering mode
    - Operation phases
    - Elements involved in operation
    - Human resources involved in operation
    - Management and control of operation:
        - Operation permitting
        - Procedures
        - Registers
        - Checklists

- Safety issues

- Pipeline to Ship bunkering operations
  - Legislation, guidelines and recommendations
  - Uses and limitations of this bunkering mode
  - Operation phases
  - Elements involved in operation
  - Human resources involved in operation
  - Management and control of operation:
    - Operation permitting
    - Procedures
    - Registers
    - Checklists
  - Safety issues

- Ship to Ship bunkering operations
  - Legislation, guidelines and recommendations
  - Uses and limitations of this bunkering mode
  - Operation phases
  - Elements involved in operation
  - Human resources involved in operation
  - Management and control of operation:
    - Operation permitting
    - Procedures
    - Registers
    - Checklists
  - Safety issues

- Container to Ship bunkering operations
  - Legislation, guidelines and recommendations
  - Uses and limitations of this bunkering mode
  - Operation phases
  - Elements involved in operation
  - Human resources involved in operation
  - Management and control of operation:
    - Operation permitting
    - Procedures
    - Registers

        - Checklists
    - Safety issues

Competence 4: Risk assessment

Students shall acquire the necessary knowledge to carry out the full risk assessment needed in operations involving LNG. The knowledge to be acquired shall include, at least, the minimums listed below.

- Overview of risk analysis
- Hazard identification
    - Identification
    - Potential affections of hazards
    - Corrective actions to be taken
- Estimation of risks
    - Boundaries of tolerant risks
    - Budgeting considerations
- Prevention planning
- Registering
- Application of risk assessment to each of the elements of the supply chain
    - Extraction
    - Liquefaction
    - LNG maritime transport
    - Loading/unloading operations
    - LNG storage and regasification plants
    - Bunkering operations
    - Pipeline transport
    - Truck transport
    - Railway transport
    - Satellite plants
    - LNG stations

Competence 5: LNG safety assessment

Students shall acquire knowledge on how to manage the safety issues associated to the operations described in the LNG supply chain. The knowledge to be acquired shall include, at least, the minimum contents listed below.

- General safety considerations for operations with LNG: legislation, regulation, guidelines and recommendations
- Safety of personnel
    - Personal protective equipment (PPE)
    - Collective protective equipment
    - Safety training for personnel
- Safety considerations for each element of the supply chain
    - Extraction
    - Liquefaction
    - LNG maritime transport
    - Loading/unloading operations
    - LNG storage and regasification plants
    - Bunkering operations
    - Pipeline transport
    - Truck transport
    - Railway transport
    - Satellite plants
    - LNG stations
- Safety planning

Competence 6: Environmental assessment

Students shall acquire knowledge on how to manage the environmental issues associated to the operations described in the LNG supply chain. The knowledge to be acquired shall include, at least, the minimum contents listed below.

- General environmental considerations for operations with LNG: legislation, regulation, guidelines and recommendations
- Environmental aspects to be considered for each of the elements of the supply chain
    - Extraction

- Liquefaction
- LNG maritime transport
- Loading/unloading operations
- LNG storage and regasification plants
- Bunkering operations
- Pipeline transport
- Truck transport
- Railway transport
- Satellite plants
- LNG stations

- Impact assessment related to operations with LNG

  - Identification of potential impacts
  - Corrective actions
  - Preventive actions

- Best environmental practices

Competence 7: Quality control management

Students shall have knowledge on quality control of operations, detecting non-conformities and taking the corresponding corrective action and preventive planning for the future. Students shall acquire, at least, the minimum contents listed below.

- Quality regulation
- Quality references and certification
- Quality procedures

  - Product quality control
  - Process quality control
  - Equipment quality control
  - Instrumentation used for quality control

- Quality registering

  - Registering procedures and documents
  - Non-conformities
  - Corrective actions
  - Preventive actions

- Quality planning

Competence 8: LNG commercial assessment

Students shall have knowledge on commercial aspects related to natural gas, including, at least, the following minimum contents listed below.

- Overview of commercial aspects
    - Offer and demand
    - Main commercial aspects driven by offer and demand
- Natural gas pricing
    - Key drivers
    - Evolution
    - Prediction methods
- Custody transfer
    - Regulation
    - Elements for measurement
    - Processes
- General aspects on the natural gas market

5.1.2. Evaluation of competence

Evaluation of competence 1: LNG as fuel

The methods proposed for demonstrating competence related to LNG as fuel are based on a theoretical examination plus a practical project case.

Contents for the theoretical examination will be based on the contents proposed for competence 1:

- LNG general review
- LNG characteristics
- Materials
- Storage, pumping and piping elements
- Management of LNG as fuel

The project case will be elaborated by the student based on the contents proposed for competence 1 and will revolve around the use of LNG as fuel.

The proposed criteria for evaluating competence 1 are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case, showing that evidence in a project case.

Evaluation of competence 2: The LNG supply chain

The methods proposed for demonstrating competence related to the LNG supply chain are based on a theoretical examination plus a practical project case.

Contents for the theoretical examination will be based on the contents proposed for competence 2:

- Overview of the LNG supply chain
- Extraction
- Liquefaction
- LNG maritime transport
- Loading/unloading operations
- LNG storage and regasification plants
- Bunkering operations
- Pipeline transport
- Truck transport
- Railway transport
- Satellite plants
- LNG stations

The project case will be elaborated by the student based on the contents proposed for competence 2 and will revolve around the LNG supply chain.

The proposed criteria for evaluating competence 2 are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case, showing that evidence in a project case.

Evaluation of competence 3: LNG bunkering operations

The methods proposed for demonstrating competence related to LNG bunkering operations are based on a theoretical examination plus a practical project case.

Contents for the theoretical examination will be based on the contents proposed for competence 3:

- Truck to Ship bunkering operations
- Pipeline to Ship bunkering operations
- Ship to Ship bunkering operations
- Container to Ship bunkering operations
- LNG stations

The project case will be elaborated by the student based on the contents proposed for competence 3 and will revolve around LNG bunkering operations.

The proposed criteria for evaluating competence 3 are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case, showing that evidence in a project case.

Evaluation of competence 4: Risk assessment

The methods proposed for demonstrating competence related to risk assessment are based on a theoretical examination plus a practical project case.

Contents for the theoretical examination will be based on the contents proposed for competence 4:

- Overview of risk analysis
- Hazard identification
- Estimation of risks
- Prevention planning
- Registering
- Application of risk assessment to each of the elements of the supply chain

The project case will be elaborated by the student based on the contents proposed for competence 4 and will revolve around risk assessment.

The proposed criteria for evaluating competence 4 are:

- The candidate complies with the minimum standard established in the theoretical examination.

- The candidate is able to use the knowledge acquired in a practical case, showing that evidence in a project case.

Evaluation of competence 5: LNG safety assessment

The methods proposed for demonstrating competence related to LNG safety assessment are based on a theoretical examination plus a practical project case.

Contents for the theoretical examination will be based on the contents proposed for competence 5:

- General safety considerations for operations with LNG: legislation, regulation, guidelines and recommendations
- Safety of personnel
- Safety considerations for each element of the supply chain
- Safety planning

The project case will be elaborated by the student based on the contents proposed for competence 5 and will revolve around LNG safety assessment.

The proposed criteria for evaluating competence 5 are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case, showing that evidence in a project case.

Evaluation of competence 6: Environmental assessment

The methods proposed for demonstrating competence related to environmental assessment are based on a theoretical examination plus a practical project case.

Contents for the theoretical examination will be based on the contents proposed for competence 6:

- General environmental considerations for operations with LNG: legislation, regulation, guidelines and recommendations
- Environmental aspects to be considered for each of the elements of the supply chain
- Impact assessment related to operations with LNG
- Best environmental practices

The project case will be elaborated by the student based on the contents proposed for competence 6 and will revolve around environmental assessment.

The proposed criteria for evaluating competence 6 are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case, showing that evidence in a project case.

Evaluation of competence 7: Quality control management

The methods proposed for demonstrating competence related to quality control management are based on a theoretical examination plus a practical project case.

Contents for the theoretical examination will be based on the contents proposed for competence 7:

- Quality regulation
- Quality references and certification
- Quality procedures
- Quality registering
- Quality planning

The project case will be elaborated by the student based on the contents proposed for competence 7 and will revolve around quality control management.

The proposed criteria for evaluating competence 7 are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case, showing that evidence in a project case.

Evaluation of competence 8: LNG commercial assessment

The methods proposed for demonstrating competence related to LNG commercial assessment are based on a theoretical examination plus a practical project case.

Contents for the theoretical examination will be based on the contents proposed for competence 8:

- Overview of commercial aspects
- Natural gas pricing
- Custody transfer
- General aspects on the natural gas market

The project case will be elaborated by the student based on the contents proposed for competence 8 and will revolve around LNG commercial assessment.

The proposed criteria for evaluating competence 8 are:

- The candidate complies with the minimum standard established in the theoretical examination.
- The candidate is able to use the knowledge acquired in a practical case, showing that evidence in a project case.

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5.2. Contents for on-board personnel at management level

In order to maintain homogeneity in this document, the definition and requirements defined by the Seafarers' Training, Certification and Watchkeeping (STCW) Code for the advanced level (assuming its equivalency to management level) are transcript into the same format as the proposal made in the present document for on-shore personnel.

5.2.1. Competences and contents

Table A-V/1-2-2 of the SCTW code mentioned before refers to the *Specification of minimum standard of competence in advanced training for liquefied gas tanker cargo operations.*

Competence 1: *Ability to safely perform and monitor all cargo operations*

Design and characteristics of a liquefied gas tanker Knowledge of liquefied gas tanker design, systems, and equipment, including:

.1 types of liquefied gas tankers and cargo tanks construction

.2 general arrangement and construction

.3 cargo containment systems, including materials of construction and insulation

.4 cargo-handling equipment and instrumentation, including:

- *.1 cargo pumps and pumping arrangements*
- *.2 cargo pipelines and valves*
- *.3 expansion devices*
- *.4 flame screens*
- *.5 temperature monitoring systems*
- *.6 cargo tank level-gauging systems*
- *.7 tank pressure monitoring and control systems*

.5 cargo temperature maintenance system

.6 tank atmosphere control systems (inert gas, nitrogen), including storage, generation and distribution systems

.7 cofferdam heating systems

.8 gas-detecting systems

.9 ballast system

.10 boil-off systems

.11 reliquefaction systems

.12 cargo Emergency Shut Down system (ESD)

.13 custody transfer system

Knowledge of pump theory and characteristics, including types of cargo pumps and their safe operation.

Loading, unloading, care and handling of cargo.

Knowledge of the effect of bulk liquid cargoes on trim and stability and structural integrity.

Proficiency in tanker safety culture and implementation of safety management requirements.

Proficiency to apply safe preparations, procedures and checklists for all cargo operations, including:

.1 post docking and loading:

- *.1 tank inspection*
- *.2 inerting (Oxygen reduction, dewpoint reduction)*
- *.3 gassing-up*
- *.4 cooling down*
- *.5 loading*
- *.6 deballasting*
- *.7 sampling, including closed-loop sampling*

.2 sea passage:

- *.1 cooling down*
- *.2 pressure maintenance*

.3 boil-off

.4 inhibiting

.3 unloading:

.1 unloading

.2 ballasting

.3 stripping and cleaning systems

.4 systems to make the tank liquid-free

.4 pre-docking preparation:

.1 warm-up

.2 inerting

.3 gas-freeing

.5 ship-to-ship transfer

Proficiency to perform cargo measurements and calculations, including:

.1 liquid phase

.2 gas phase

.3 On Board Quantity (OBQ)

.4 Remain On Board (ROB)

.5 boil-off cargo calculations

Proficiency to manage and supervise personnel with cargo related responsibilities.

Competence 2: *Familiarity with physical and chemical properties of liquefied gas cargoes*

Knowledge and understanding of basic chemistry and physics and the relevant definitions related to the safe carriage of liquefied gases in bulk in ships, including:

.1 the chemical structure of gases

.2 the properties and characteristics of liquefied gases (including CO2) and their vapours, including:

.1 simple gas laws

.2 states of matter

.3 liquid and vapour densities

.4 diffusion and mixing of gases

.5 compression of gases

.6 reliquefaction and refrigeration of gases

.7 critical temperature of gases and pressure

.8 flashpoint, upper and lower explosive limits, auto-ignition temperature

.9 compatibility, reactivity and positive segregation of gases

.10 polymerization

.11 saturated vapour pressure/reference temperature

.12 dewpoint and bubble point

.13 lubrication of compressors

.14 hydrate formation

.3 the properties of single liquids

.4 the nature and properties of solutions

.5 thermodynamic units

.6 basic thermodynamic laws and diagrams

.7 properties of materials

.8 effect of low temperature – brittle fracture

Understanding the information contained in a Material Safety Data Sheet (MSDS).

Competence 3: *Take precautions to prevent hazards*

Knowledge and understanding of the hazards and control measures associated with liquefied gas tanker cargo operations, including:

.1 flammability

.2 explosion

.3 toxicity

.4 reactivity

.5 corrosivity

.6 health hazards

.7 inert gas composition

.8 electrostatic hazards

.9 polymerizing cargoes

Proficiency to calibrate and use monitoring and gas-detection systems, instruments and equipment.

Knowledge and understanding of dangers of non-compliance with relevant rules/regulations.

Competence 4: *Apply occupational health and safety precautions*

Knowledge and understanding of safe working practices, including risk assessment and personal shipboard safety relevant to liquefied gas tankers, including:

.1 precautions to be taken when entering enclosed spaces (such as compressor rooms), including the correct use of different types of breathing apparatus

.2 precautions to be taken before and during repair and maintenance work, including work affecting pumping, piping, electrical and control systems

.3 precautions for hot and cold work

.4 precautions for electrical safety

.5 use of appropriate Personal Protective Equipment (PPE)

.6 precautions for cold burn and frostbite

.7 proper use of personal toxicity monitoring equipment

Competence 5: *Respond to emergencies*

Knowledge and understanding of liquefied gas tanker emergency procedures, including:

.1 ship emergency response plans

.2 cargo operations emergency shutdown procedure

.3 emergency cargo valve operations

.4 actions to be taken in the event of failure of systems or services essential to cargo operations

.5 fire-fighting on liquefied gas tankers

.6 jettisoning of cargo

.7 enclosed space rescue

Actions to be taken following collision, grounding or spillage and envelopment of the ship in toxic or flammable vapour.

Knowledge of medical first-aid procedures and antidotes on board liquefied gas tankers, with reference to the Medical First Aid Guide for Use in Accidents involving Dangerous Goods (MFAG).

Competence 6: *Take precautions to prevent pollution of the environment*

Understanding of procedures to prevent pollution of the environment.

Competence 7: *Monitor and control compliance with legislative requirements*

Knowledge and understanding of relevant provisions of the International Convention for the Prevention of Pollution from Ships (MARPOL) and other relevant IMO instruments, industry guidelines and port regulations as commonly applied.

Proficiency in the use of the IBC and IGC Codes and related documents.

5.2.2. Evaluation of competence

Evaluation of competence 1: *Ability to safely perform and monitor all cargo operations*

Methods for demonstrating competence:

Examination and assessment of evidence obtained from one or more of the following:

.1 approved in-service experience

.2 approved training ship experience

.3 approved simulator training

.4 approved training programme

Criteria for evaluating competence:

Communications are clear, understood and successful

Cargo operations are carried out in a safe manner, taking into account liquefied gas tanker designs, systems and equipment.

Pumping operations are carried out in accordance with accepted principles and procedures and are relevant to the type of cargo.

Cargo operations are planned, risk is managed and carried out in accordance with accepted principles and procedures to ensure safety of operations and avoid pollution of the marine environment.

Proper loading, stowage and unloading of liquefied gas cargoes ensures that stability and stress conditions remain within safe limits at all times.

Potential non-compliance with cargo-related procedures is promptly identified and rectified.

Actions taken and procedures followed correctly identify and make full use of appropriate shipboard equipment.

Calibration and use of monitoring and gas-detection equipment is consistent with safe operational practices and procedures.

Procedures for monitoring and safety systems ensure that all alarms are detected promptly and acted upon in accordance with established procedures.

Personnel are allocated duties and informed of procedures and standards of work to be followed, in a manner appropriate to the individuals concerned and in accordance with safe operational practices.

Evaluation of competence 2: *Familiarity with physical and chemical properties of liquefied gas cargoes*

Methods for demonstrating competence:

Examination and assessment of evidence obtained from one or more of the following:

.1 approved in-service experience

.2 approved training ship experience

.3 approved simulator training

.4 approved training programme

Criteria for evaluating competence:

Effective use is made of information resources for identification of properties and characteristics of liquefied gases and their impact on safety, environmental protection and vessel operation.

Evaluation of competence 3: *Take precautions to prevent hazards*

Methods for demonstrating competence:

Examination and assessment of evidence obtained from one or more of the following:

.1 approved in-service experience

.2 approved training ship experience

.3 approved simulator training

.4 approved training programme

Criteria for evaluating competence:

Relevant cargo-related hazards to the vessel and to personnel associated with liquefied gas tanker cargo operations are correctly identified, and proper control measures are taken.

Use of gas-detection devices is in accordance with manuals and good practice.

Evaluation of competence 4: *Apply occupational health and safety precautions*

Methods for demonstrating competence:

Assessment of evidence obtained from one or more of the following:

.1 approved in-service experience

.2 approved training ship experience

.3 approved simulator training

.4 approved training programme

Criteria for evaluating competence:

Procedures designed to safeguard personnel and the ship are observed at all times.

Safe working practices are observed and appropriate safety and protective equipment is correctly used.

Working practices are in accordance with legislative requirements, codes of practice, permits to work and environmental concerns.

Correct use of breathing apparatus.

Evaluation of competence 5: *Respond to emergencies*

Methods for demonstrating competence:

Assessment of evidence obtained from one or more of the following:

.1 approved in-service experience

.2 approved training ship experience

.3 approved simulator training

.4 approved training programme

Criteria for evaluating competence:

The type and impact of emergency is promptly identified, and the response actions conform with established emergency procedures and contingency plans.

The order of priority and the levels and timescales of making reports and informing personnel on board are relevant to the nature of the emergency and reflect the urgency of the problem.

Evacuation, emergency shutdown and isolation are appropriate to the nature of the emergency and implemented promptly.

The identification of and actions taken in a medical emergency conform to current recognized first aid practice and international guidelines.

Evaluation of competence 6: *Take precautions to prevent pollution of the environment*

Methods for demonstrating competence:

Assessment of evidence obtained from one or more of the following:

.1 approved in-service experience

.2 approved training ship experience

.3 approved simulator training

.4 approved training programme

Criteria for evaluating competence:

Operations are conducted in accordance with accepted principles and procedures to prevent pollution of the environment.

Evaluation of competence 7: *Monitor and control compliance with legislative requirements*

Methods for demonstrating competence:

Assessment of evidence obtained from one or more of the following:

.1 approved in-service experience

.2 approved training ship experience

.3 approved simulator training

.4 approved training programme

Criteria for evaluating competence:

The handling of liquefied gas cargoes complies with relevant IMO instruments and established industrial standards and codes of safe working practices.

6. Synthesis of training contents proposed

The aim of this synthesis of results is to summarize the contents proposed in the present document into a matrix to serve as a quick reference for the profiles defined.

6.1. Synthesis of training at operational level

The main contents proposed for training at operational level of LNG Truck to Ship bunkering operations are synthesised in the following tables:

Competence	Main contents - knowledge	Methods for demonstrating competence	Criteria for evaluating competence
1. Basic knowledge on LNG	Physical and chemical characteristics of LNG	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Environmental impact of LNG: liquid and vapour		
	LNG main hazards linked to Truck to Ship bunkering operations		
	Behaviour of fluid leakages, especially for the case of Truck to Ship bunkering operations		
	LNG effects on equipment and construction materials used for Truck to Ship bunkering operations		
	Potential generation of sparks and ignition due to electric equipment and static loads, particularly for the case of Truck to Ship bunkering operations		
	Properties of inert gases (including nitrogen) and applications to Truck to Ship bunkering operations		
2. Corporate and system management	International regulation, recommendations and relevant guidelines on Truck to Ship bunkering operations	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Risk analysis for Truck to Ship bunkering operations		
	Responsibilities assumable to the equipment owner or tenant in Truck to Ship bunkering operations		
	Management of safety systems used in Truck to Ship bunkering operations		
	Operating procedures for Truck to Ship bunkering operations		
3. Organisation and management	Communication and working teams in Truck to Ship bunkering operations	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Roles and responsibilities during Truck to Ship bunkering operations		

Competence	Main contents - knowledge	Methods for demonstrating competence	Criteria for evaluating competence
4. Operation, calibration and maintenance of equipment and instrumentation	Mechanical manipulation in Truck to Ship bunkering operations	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Transfer systems in Truck to Ship bunkering operations		
	LNG storage tanks, especially those typically used in Truck to Ship bunkering operations		
	LNG pumps typically used in Truck to Ship bunkering operations		
	Valves typically used in Truck to Ship bunkering operations		
	Over-pressure protection devices typically used in Truck to Ship bunkering operations		
	Electric equipment in classified areas used for Truck to Ship bunkering operations		
	Management of safety systems (leakages/spillages) in Truck to Ship bunkering operations		
	Personal protective equipment for Truck to Ship bunkering operations		
	Operation manuals for main equipment in Truck to Ship bunkering operations		
5. LNG Truck to Ship bunkering operations	Previous activities to TTS loading operation	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	TTS operation management – purging		
	Pressurization and depressurization		
	TTS Operation management – draining		
	TTS Operation management – isolation		
6. Control and monitoring for LNG Truck to Ship bunkering operations	Fire and gas detection systems typically used in Truck to Ship bunkering operations	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Emergency stop system typically used in Truck to Ship bunkering operations		
	Devices for the instrumentation and monitoring of the truck		
7. Emergency situations and operations in Truck to Ship bunkering	Emergency procedures defined for Truck to Ship bunkering operations	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Fire fighting techniques and specific equipment to be used against LNG, especially the equipment typically used and/or recommended for Truck to Ship bunkering operations		
	Contingency plans defined for Truck to Ship bunkering operations		
	First aid in case of contact with LNG		
8. Commercial basics associated to LNG Truck to Ship bunkering operations	LNG transfer process	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	LNG quality management		

The main contents proposed for training at operational level of LNG Pipeline to Ship bunkering operations are synthesised in the following tables:

Competence	Main contents - knowledge	Methods for demonstrating competence	Criteria for evaluating competence
1. Basic knowledge on LNG	Physical and chemical characteristics of LNG	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Environmental impact of LNG: liquid and vapour		
	LNG main hazards linked to Pipeline to Ship bunkering operations		
	Behaviour of fluid leakages, especially for the case of Pipeline to Ship bunkering operations		
	LNG effects on equipment and construction materials used for Pipeline to Ship bunkering operations		
	Potential generation of sparks and ignition due to electric equipment and static loads, particularly for the case of Pipeline to Ship bunkering operations		
	Properties of inert gases (including nitrogen) and applications to Pipeline to Ship bunkering operations		
2. Corporate and system management	International regulation, recommendations and relevant guidelines on Pipeline to Ship bunkering operations	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Risk analysis for Pipeline to Ship bunkering operations		
	Responsibilities assumable to the equipment owner or tenant in Pipeline to Ship bunkering operations		
	Management of safety systems used in Pipeline to Ship bunkering operations		
	Operating procedures for Pipeline to Ship bunkering operations		
3. Organisation and management	Communication and working teams in Pipeline to Ship bunkering operations	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Roles and responsibilities during Pipeline to Ship bunkering operations		
4. Operation, calibration and maintenance of equipment and instrumentation	Mechanical manipulation in Pipeline to Ship bunkering operations	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Transfer systems in Pipeline to Ship bunkering operations		
	LNG storage tanks, especially those typically used in Pipeline to Ship bunkering operations		
	LNG pumps typically used in Pipeline to Ship bunkering operations		
	Valves typically used in Pipeline to Ship bunkering operations		
	Over-pressure protection devices typically used in Pipeline to Ship bunkering operations		
	Electric equipment in classified areas of facilities where Pipeline to Ship operations take place		
	Management of safety systems (leakages/spillages) in Pipeline to Ship bunkering operations		
	Personal protective equipment for Pipeline to Ship bunkering operations		
	Operation manuals for main equipment in Pipeline to Ship bunkering operations		

Competence	Main contents - knowledge	Methods for demonstrating competence	Criteria for evaluating competence
5. LNG Pipeline to Ship bunkering operations	Previous activities to loading operation for Pipeline to Ship bunkering operations	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Pipeline to Ship bunkering operation management – purging		
	Pressurization and depressurization		
	Pipeline to Ship bunkering operation management – draining		
	Pipeline to Ship bunkering operation management – isolation		
6. Control and monitoring for LNG Pipeline to Ship bunkering operations	Fire and gas detection systems typically used in Pipeline to Ship bunkering operations	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Emergency stop system typically used in Pipeline to Ship bunkering operations		
	Control system of the facility		
7. Emergency situations and operations in Pipeline to Ship bunkering	Emergency procedures defined for Pipeline to Ship bunkering operations	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Fire fighting techniques and specific equipment to be used against LNG, especially the equipment typically used and/or recommended for Pipeline to Ship bunkering operations		
	Contingency plans defined for Pipeline to Ship bunkering operations		
	First aid in case of contact with LNG		
8. Commercial basics associated to LNG Pipeline to Ship bunkering operations	LNG transfer process	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	LNG quality management		

Training for Ship to Ship bunkering operations is already defined and regulated by IMO, therefore no proposal is needed for those operations.

The main training contents proposed for LNG storage and regasification plants at operational level are synthesised in the following tables.

Competence	Main contents - knowledge	Methods for demonstrating competence	Criteria for evaluating competence
1. Basic knowledge on LNG storage and regasification plants	Definition of LNG storage and regasification plant	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Physical and chemical characteristics of LNG		
	LNG main hazards linked to LNG storage and regasification plants		
	Behaviour of fluid leakages, especially for the case of LNG storage and regasification plants		
	LNG effects on equipment and construction materials used for LNG storage and regasification plants		
	Potential generation of sparks and ignition due to electric equipment and static loads, particularly for the case of LNG storage and regasification plants		
	Properties of inert gases (including nitrogen) and applications to LNG storage and regasification plant operations		
2. Corporate and system management	Risk analysis for operations in storage and regasification plants	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Management of safety systems used in storage and regasification plants		
3. LNG storage and regasification plant operations	Plant processes, interpretation of diagrams and main equipment	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Ancillary services		
	Integration and global revision of main and ancillary services		
	Pipelines		
	Safety system		
	Control systems		
	Integration of procedures in regasification plant operation		
4. LNG storage and regasification plant maintenance	Electrical installation maintenance	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Instrumentation maintenance		
	Main equipment maintenance		
	Safety system maintenance		
	Control system maintenance		
	Predictive maintenance		
5. Control and monitoring for LNG storage and regasification plant operations	Fire and gas detection systems typically used in LNG storage and regasification pla	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Emergency stop system typically used in LNG storage and regasification plant ope		
	Control system of the facility		
	Devices for the instrumentation and monitoring of the facility		

Competence	Main contents - knowledge	Methods for demonstrating competence	Criteria for evaluating competence
6. Emergency situations and operations in LNG storage and regasification plants	Emergency procedures defined for LNG storage and regasification plant operations	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Fire fighting techniques and specific equipment to be used against LNG, especially the equipment typically used and/or recommended for LNG storage and regasification plant operations		
	Contingency plans defined for LNG storage and regasification plant operations		
	First aid in case of contact with LNG		
7. Environmental considerations related to LNG storage and regasification plants	LNG storage and regasification plant general environmental considerations	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Gaseous effluents		
	Liquid effluents		
	Noise level		
	Environmental considerations on soil pollution		
8. Commercial basics associated to LNG storage and regasification plant operations	LNG transfer process	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	LNG quality management		

The main training contents proposed for LNG satellite plants at operational level are synthesised in the following tables.

Competence	Main contents - knowledge	Methods for demonstrating competence	Criteria for evaluating competence
1. Basic knowledge on LNG satellite plants	Definition of LNG satellite plants	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Physical and chemical characteristics of LNG		
	LNG main hazards linked to LNG satellite plant operations		
	Behaviour of fluid leakages, especially for the case of LNG satellite plant operations		
	LNG effects on equipment and construction materials used for LNG satellite plant operations		
	Potential generation of sparks and ignition due to electric equipment and static loads, particularly for the case of LNG satellite plant operations		
	Properties of inert gases (including nitrogen) and applications to LNG satellite plant operations		

Competence	Main contents - knowledge	Methods for demonstrating competence	Criteria for evaluating competence
2. Corporate and system management	Risk analysis for operations in LNG satellite plants	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Management of safety systems used in LNG satellite plants		
3. Elements and processes of LNG satellite plants	LNG tank unloading	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	LNG storage facility		
	Regasification facility		
	Cooling facilities		
	Control and register facilities		
	Fire-fighting facilities		
	Electrical facilities		
	Safety facilities		
	Civil infrastructures		
4. LNG satellite plant operation	Generalities on LNG satellite plant operation	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Plant supervision		
	Operation main facts		
	Cooling operations		
	Storage tank operations		
	Regasification operations		
	Other minor operations carried out in LNG satellite plants		
5. LNG satellite plant maintenance	Regulation on LNG satellite plant maintenance	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Periodical maintenance operations		
	Role of personnel		
	Equipment and devices		
6. Safety and emergencies in LNG satellite plants	Safety levels	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Emergencies and accidents		
	Emergency plans		
	Procedures in case of leakages and spillages		
	Safety procedures during the operation phase		
	Safety procedures during tank unloading operations		
	Individual protective equipment		
	First aid in case of contact with LNG		
7. Environmental considerations related to LNG satellite plants	LNG satellite plant general environmental considerations	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Environmental good practices in LNG satellite plants		
8. Commercial basics associated to LNG satellite plant operations	LNG transfer process	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	LNG quality management		

The main training contents proposed for LNG stations at operational level are synthesised in the following tables.

Competence	Main contents - knowledge	Methods for demonstrating competence	Criteria for evaluating competence
1. Basic knowledge on LNG stations	Definition of LNG stations	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Physical and chemical characteristics of LNG		
	LNG main hazards linked to LNG stations		
	Behaviour of fluid leakages, especially for the case of LNG stations		
	LNG effects on equipment and construction materials used for LNG stations		
	Potential generation of sparks and ignition due to electric equipment and static loads, particularly for the case of LNG stations		
	Properties of inert gases (including nitrogen) and applications to LNG stations		
2. Corporate and system management	Risk analysis for operations in LNG stations	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Management of safety systems used in LNG stations		
3. Elements and processes of LNG stations	LNG storage facility	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	LNG supply facility		
	Control and register facilities		
	Fire-fighting facilities		
	Electrical facilities		
	Safety facilities		
	Civil infrastructures		
4. LNG station operation	Generalities on LNG station operation	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	LNG station supervision		
	LNG loading and unloading operations		
	LNG supply		
	Operation main facts		
	Other minor operations carried out in LNG stations		
5. LNG station maintenance	Regulation on LNG station maintenance	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Periodical maintenance operations		
	Role of personnel		
	Equipment and devices		
6. Safety and emergencies in LNG stations	Safety levels	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Emergencies and accidents		
	Emergency plans		
	Procedures in case of leakages and spillages		
	Safety procedures during the operation phase		
	Safety procedures during loading and unloading operations		
	Individual safety equipment		
	First aid in case of contact with LNG		

Competence	Main contents - knowledge	Methods for demonstrating competence	Criteria for evaluating competence
7. Environmental considerations related to LNG stations	LNG station general environmental considerations	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Environmental good practices in LNG stations		
8. Commercial basics associated to LNG station operations	LNG transfer procedure including transfer registers	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	LNG quality management		

The main training contents proposed for railway operations with LNG at operational level are synthesised in the following tables.

Competence	Main contents - knowledge	Methods for demonstrating competence	Criteria for evaluating competence
1. Basic knowledge on LNG	Physical and chemical characteristics of LNG	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Environmental impact of LNG: liquid and vapour		
	LNG main hazards linked to railway operations with LNG		
	Behaviour of fluid leakages and the particular case of railway operations with LNG		
	LNG effects on equipment and construction materials applicable for railway operations with LNG		
	Potential generation of sparks and ignition due to electric equipment and static loads, particularly for the case of railway operations with LNG		
	Properties of inert gases (including nitrogen) and applications to railway operations with LNG		
2. Corporate and system management	International regulation, recommendations and relevant guidelines on the use of LNG as fuel and their relation to railway operations	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Risk analysis for railway operations with LNG		
	Responsibilities assumable to the equipment owner or tenant in railway operations with LNG		
	Management of safety systems to be used in railway operations with LNG		
	Operating procedures for railway operations with LNG		
3. Organisation and management	Communication and working teams in railway operations with LNG	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Roles and responsibilities in railway operations with LNG		

Competence	Main contents - knowledge	Methods for demonstrating competence	Criteria for evaluating competence
4. Operation, calibration and maintenance of equipment and instrumentation	Mechanical manipulation in railway operations with LNG	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Transfer systems railway operations with LNG		
	LNG pumps to be used in railway operations with LNG		
	Valves to be used in railway operations with LNG		
	Over-pressure protection devices to be used in railway operations with LNG		
	Electric equipment in classified areas of facilities where railway operations with LNG take place		
	Management of safety systems (leakages/spillages) in railway operations with LNG		
	Personal protection equipment for railway operations with LNG		
	Operation manuals for main equipment in railway operations with LNG		
5. Railway operations with LNG	Previous activities to loading operation for railway operations with LNG	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Management of railway operations with LNG – purging		
	Pressurization and depressurization		
	Management of railway operations with LNG – draining		
	Management of railway operations with LNG – isolation		
6. Control and monitoring for railway operations with LNG	Fire and gas detection systems to be used in railway operations with LNG	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Emergency stop system to be used in railway operations with LNG		
	Control system of the facility		
	Devices for the instrumentation and monitoring of the supply equipment/facility		
7. Emergency situations and operations in railway operations with LNG	Emergency procedures defined for railway operations with LNG	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	Fire fighting techniques and specific equipment to be used against LNG, especially the equipment to be used and/or recommended for railway operations with LNG		
	Contingency plans defined for railway operations with LNG		
	First aid in case of contact with LNG		
8. Commercial basics associated to railway operations with LNG	LNG transfer process	Theoretical examination and practical exercise	The candidate complies with the minimum standard established in the theoretical examination and practical exercise
	LNG quality management		

6.2. Synthesis of training at management level

The main contents proposed for training at management level are synthesised in the following tables:

Competence	Main contents - knowledge	Methods for demonstrating competence	Criteria for evaluating competence
1. LNG as fuel	LNG general review	Theoretical examination plus a practical project case	The candidate complies with the minimum standard established in the theoretical examination and the practical project case
	LNG characteristics		
	Materials		
	Storage, pumping and piping elements		
	Management of LNG as fuel		
2. The LNG supply chain	Overview of the LNG supply chain	Theoretical examination plus a practical project case	The candidate complies with the minimum standard established in the theoretical examination and the practical project case
	Extraction		
	Liquefaction		
	LNG maritime transport		
	Loading/unloading operations		
	LNG storage and regasification		
	Bunkering operations		
	Pipeline transport		
	Truck transport		
	Railway transport with LNG		
	LNG Satellite plants		
	LNG stations		
3. LNG bunkering operations	Truck to Ship bunkering operations	Theoretical examination plus a practical project case	The candidate complies with the minimum standard established in the theoretical examination and the practical project case
	Pipeline to Ship bunkering operations		
	Ship to Ship bunkering operations		
	Container to Ship bunkering operations		
4. Risk assessment	Overview of risk analysis	Theoretical examination plus a practical project case	The candidate complies with the minimum standard established in the theoretical examination and the practical project case
	Hazard identification		
	Estimation of risks		
	Prevention planning		
	Registering		
	Application of risk assessment to each of the elements of the supply chain		
5. LNG safety assessment	General safety considerations for operations with LNG: legislation, regulation, guidelines and recommendations	Theoretical examination plus a practical project case	The candidate complies with the minimum standard established in the theoretical examination and the practical project case
	Safety of personnel		
	Safety considerations for each element of the supply chain		
	Safety planning		

Competence	Main contents - knowledge	Methods for demonstrating competence	Criteria for evaluating competence
6. Environmental assessment	General environmental considerations for operations with LNG: legislation, regulation, guidelines and recommendations	Theoretical examination plus a practical project case	The candidate complies with the minimum standard established in the theoretical examination and the practical project case
	Environmental aspects to be considered for each of the elements of the supply chain		
	Impact assessment related to operations with LNG		
	Best environmental practices		
7. Quality control management	Quality regulation	Theoretical examination plus a practical project case	The candidate complies with the minimum standard established in the theoretical examination and the practical project case
	Quality references and certification		
	Quality procedures		
	Quality registering		
	Quality planning		
8. LNG commercial assessment	Overview of commercial aspects	Theoretical examination plus a practical project case	The candidate complies with the minimum standard established in the theoretical examination and the practical project case
	Natural gas pricing		
	Custody transfer		
	General aspects on the natural gas market		

7. Training staff

On-board training staff is already regulated by IMO, but onshore training staff selection is yet to be regulated. It is that training staff shall be selected according to the type of training (at operational and management level) and depending on the competences that they train.

Training at operational level is defined as vocational education, while training at management level is defined as a university module.

7.1. Vocational education staff

Staff for vocational education training shall be selected according to the competences to be trained. Therefore, trainers for vocational education shall have experience directly related to the competence to be trained in the terms defined in the qualification created for the vocational education training, and shall also obtain a certificate of trainer as defined in the previously mentioned qualification created for the vocational education training.

For competences in which no candidates to be training personnel could accredit the necessary previous experience for on-shore training as defined in the qualification, on-board trainers may give support to train the competence (e.g.: competences related to LNG bunkering operations, currently at innovation level), as regulation for on-shore trainers is more mature.

7.2. University module staff

Staff for the university module defined shall be selected according to university rules for selection of personnel, being desirable that personnel selected had working experience on the competences to be trained.

The qualification that defines vocational education does not apply for training at university level, but it is desirable that the experience required for training staff at university level is equivalent to the experience required for trainers at vocational education level in order to assure homogeneity in the requirements and guarantees training staff prepared for the tasks assigned.

8. Definition of training centres

The relevance of providing the proper training implies offering such training in the most adequate centres. Conditions for those centres vary depending on the type of training to be provided, setting apart centres for vocational education training and centres offering the university module.

8.1. Training centres for vocational education

Vocational education centres shall fulfil the specifications defined in the qualification created for the LNG operations defined.

In general terms, training centres should be able to provide training both at theoretical and practical level, guaranteeing that trainees acquire the necessary minimum knowledge to properly give response to professional tasks assigned.

8.2. Training centres for university module

Training centres to provide the university module shall be universities with capacity to provide the technical and managerial knowledge defined for the profiles at management levels defined in the present document.

In order to provide full training, not only at theoretical level but also at practical level, it would be desirable that universities have any form collaboration with enterprises or centres accredit to provide practice on the competences defined in the proposal made in the present document.

9. Accreditation of training and capacitation

Training and capacitation should be regulated to guarantee that professionals have been provided with the necessary minimum knowledge defined to give an adequate response to the professional tasks assigned in LNG operations.

Accreditation of training distinguishes between vocational education for training at operational level and the university training module for training at management level.

9.1. Accreditation of vocational education

The accreditation of vocational education is linked to the establishment of a reference for training and capacitation. The references used at vocational education level are qualifications.

9.1.1. European qualification state-of-the-art

European qualifications are subject to the COUNCIL RECOMMENDATION of 22 May 2017 on the European Qualifications Framework for lifelong learning and repealing the recommendation of the European Parliament and of the Council of 23 April 2008 on the establishment of the European Qualifications Framework for lifelong learning. Such recommendation establishes criteria to adequately make the necessary equivalences between the European Qualification Framework (EQF) and national qualification frameworks.

Using the recommendation makes possible to define qualifications at national level and establish adequate correspondences with the EQF, and so it is possible to establish training and capacitation correspondences.

The following paragraphs mention the recognition of professional qualifications for UE Member States through different directives adopted.

The suppression of obstacles to the circulation of persons and services in the EU Member States is one of the main objectives of the EU, that implying the faculty of carrying out a profession in an EU Member State different from the one where the professional obtained the professional qualification. In that sense, Directives have been adopted in order to guarantee such faculty.

Regulated training was first considered in Directive 2001/19/EC, and Directive 2005/36/EC made a proposal intending to combine all the previous European legislation related to mutual recognition of

professional qualifications plus incorporating new elements and principles, making possible to develop, in a single text, the regulation of the recognition of professional qualifications in the EU.

Directive 2006/123/EC establishes a general legal framework which benefits a wide variety of services while taking into account the distinctive features of each type of activity or profession and its system of regulation.

Directive 2013/55/EU has as main objectives the rationalisation, simplification and improvement of the rules for the recognition of professional qualifications establishing rules concerning partial access to a regulated profession and recognition of professional traineeships pursued in another Member State. It includes the concept of 'European Professional Card' as *"an electronic certificate proving either that the professional has met all the necessary conditions to provide services in a host Member State on a temporary and occasional basis or the recognition of professional qualifications for establishment in a host Member State".*

9.1.2. Creation of qualification

The creation of a qualification in order to regulate a profession is clearly understood from the definition of "regulated profession" made by Directive 2005/36/EC, considering it *"a professional activity or group of professional activities, access to which, the pursuit of which, or one of the modes of pursuit of which is subject, directly or indirectly, by virtue of legislative, regulatory or administrative provisions to the possession of specific professional qualifications; in particular, the use of a professional title limited by legislative, regulatory or administrative provisions to holders of a given professional qualification shall constitute a mode of pursuit"*.

Such definition implies that a regulated profession is linked to a qualification, which has yet to be created for LNG operators.

The creation of a qualification may be carried out by national institutions belonging to EU Member States and/or coordinated by the European Centre for the Development of Vocational Training (CEDEFOP). National institutions are already active in certain Member States, such as:

- Spain – Instituto Nacional de Cualificaciones Profesionales (INCUAL)
- Germany – Bundesinstitut für Berufsbildung (BIBB)
- Italy – Istituto per lo Sviluppo della Formazione Professionale dei Lavoratori (ISFOL)
- Ireland – National Qualifications Authority of Ireland (NQAI)
- Portugal – Agência Nacional para a Qualificação, (ANQ)
- Denmark – Danish Agency for International Education (DEK)
- The Netherlands - Centre of Expertise on Vocational Education and Training (CINOP)

9.1.3. European Professional Card

As defined in Directive 2013/55/EU, the European Professional Card is an electronic certificate for the recognition of qualifications, and it is available since January 2016. The EPC does not replace other recognition procedures previously used.

On 24 June 2015, the European Commission adopted the Commission Implementing Regulation (EU) 2015/983 on the procedure for issuance of the European Professional Card and the application of the alert mechanism pursuant to the Professional Qualifications Directive. The EPC is available for nurses responsible for general care, pharmacists, physiotherapists, mountain guides and real estate agents.

This system may be a very suitable solution for the accreditation of qualification for LNG operators, as the card aims to ease the free movement of these mobile professionals by simplifying the procedure for getting their professional qualifications recognised in another EU country.

9.1.4. Accreditation of experience

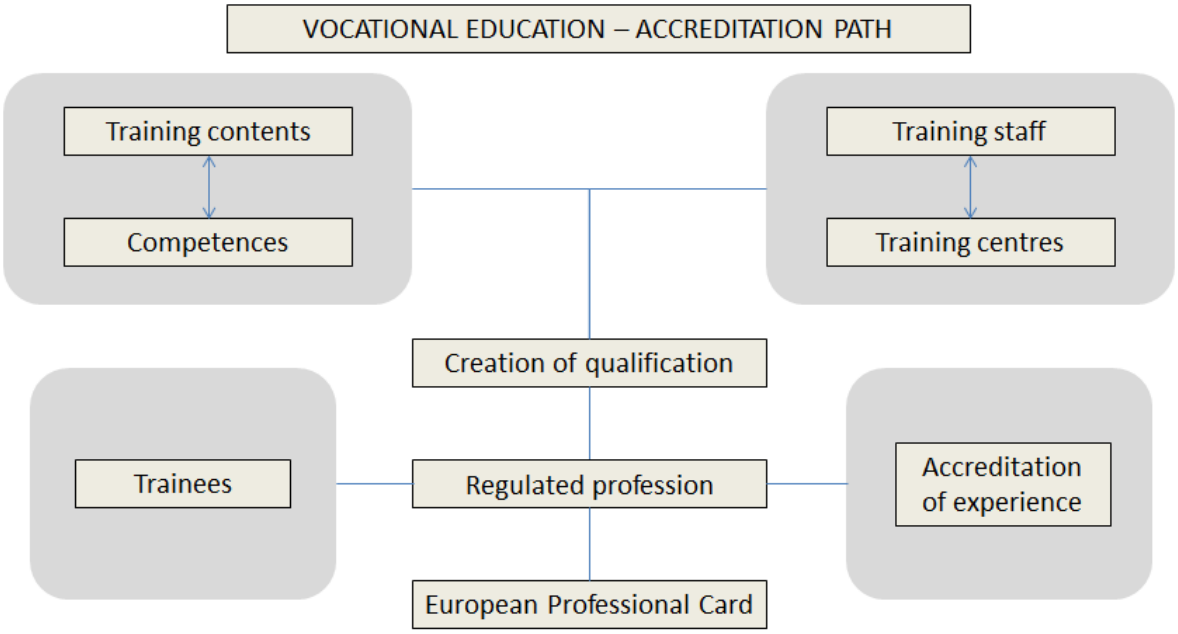
The accreditation of experience is considered in Directive 2005/36/EC and in the amendment to that Directive (Directive 2013/55/EU previously mentioned). The accreditation of competences of the regulated profession to be created as defined by the corresponding qualification shall be carried out in accordance to the current directive regarding vocational education.

9.1.5. Accreditation path proposed for vocational education

The accreditation path proposed for vocational education starts with the definition of a qualification. The definition of a qualification includes contents and requisites for training staff and training centres.

After a qualification is created, the profession can be regulated, and candidates can obtain a European Professional Card.

Accreditation of experience can be carried out according to Directives 2005/36/EC on the recognition of professional qualifications and Directive 2013/55/EU amending Directive 2005/36/EC on the recognition of professional qualifications and Regulation (EU) No 1024/2012 on administrative cooperation through the Internal Market Information System (‘the IMI Regulation’).



9.2. Accreditation of university training module

9.2.1. The Bologna Declaration

The Bologna Declaration (1999) is the result of the agreement between representatives from 29 countries that were willing to set a series of measures to harmonise the European Higher Education Area, establishing the following objectives:

"Adoption of a system of easily readable and comparable degrees, also through the implementation of the Diploma Supplement, in order to promote European citizens employability and the international competitiveness of the European higher education system

Adoption of a system essentially based on two main cycles, undergraduate and graduate. Access to the second cycle shall require successful completion of first cycle studies, lasting a minimum of three years. The degree awarded after the first cycle shall also be relevant to the European labour market as an appropriate level of qualification. The second cycle should lead to the master and/or doctorate degree as in many European countries.

Establishment of a system of credits - such as in the ECTS system – as a proper means of promoting the most widespread student mobility.

Credits could also be acquired in non-higher education contexts, including lifelong learning, provided they are recognised by receiving Universities concerned.

Promotion of mobility by overcoming obstacles to the effective exercise of free movement with particular attention to:

• for students, access to study and training opportunities and to related services

• for teachers, researchers and administrative staff, recognition and valorisation of periods spent in a European context researching, teaching and training, without prejudicing their statutory rights.

Promotion of European co-operation in quality assurance with a view to developing comparable criteria and methodologies.

Promotion of the necessary European dimensions in higher education, particularly with regards to curricular development, interinstitutional co-operation, mobility schemes and integrated programmes of study, training and research".

9.2.2. The ECTS system

In order to promote mobility, a system of credits denominated the European Credit Transfer and Accumulation System (ECTS system) was established after the Bologna Declaration.

ECTS credits are translated into workload for students. Considering that an academic year consists of a range of 1500 to 1800 working hours, and that academic year corresponds to 60 ECTS, it is assumed that an ECTS corresponds to 25 to 30 study hours for students, with that being only a reference, as time to achieve the same learning outcomes will vary depending on the student and on the familiarity of contents. Some examples of different considerations are the following:

- Austria, Italy, and Spain - 1 ECTS = 25 study hours;
- Finland - 1 ECTS = 27 study hours;
- The Netherlands, Portugal - 1 ECTS = 28 study hours;
- Germany, Belgium, Romania, and Hungary - 1 ECTS = 30 study hours

Students accumulate credits to obtain degrees from academic institutions.

Credits can be transferred from one institution to another, as the ECTS is established as the reference system for academic institutions.

9.2.3. Accreditation path for university module

The existence of a recognized credit transfer system makes possible to have an automatic accreditation path among European academic institutions for the university module proposed.

10. Conclusions

The development of the use of LNG as fuel in the transport sector has as a consequence that human resources in charge of the operations linked to the abovementioned use of LNG have to be properly trained and capacitated so that operations are carried out in a safe and efficient way.

The identification of the training necessity is associated to the definition of such training, as well as the regulation of the professions directly connected with LNG bunkering operations and other services provided within the LNG supply chain.

As defined in the present document, though many different training profiles have been identified, in practical terms only two levels have been considered for the definition of training and capacitation: operational and management levels.

For each of the operations considered in the LNG supply chain, eight different competences have been defined at operational level, and a generic evaluation proposal has been carried out for each competence.

At management level, contents for a university module has been proposed, with eight competences defined for the operations considered in the LNG supply chain.

Accreditation of training and previous experience at European level is regulated through Directive 2005/36/EC on the recognition of professional qualifications and Directive 2013/55/EU amending Directive 2005/36/EC on the recognition of professional qualifications and Regulation (EU) No 1024/2012 on administrative cooperation through the Internal Market Information System ('the IMI Regulation').

Appendix I: Reference Documents

The following reference documents have been used or considered in the making of this document:

- COSTA Action (2011-EU-21007-S).
- Council Recommendation of 22 May 2017 on the European Qualifications Framework for lifelong learning and repealing the recommendation of the European Parliament and of the Council of 23 April 2008 on the establishment of the European Qualifications Framework for lifelong learning.
- Decision 85/368/EEC: Council Decision of 16 July 1985 on the comparability of vocational training qualifications between the Member States of the European Community.
- Directive 2005/36/EC of the European Parliament and of the Council of 7 September 2005 on the recognition of professional qualifications.
- Directive 2006/123/EC of the European Parliament and of the Council of 12 December 2006 on services in the internal market.
- Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure
- Directive 2001/19/EC of the European Parliament and of the Council of 14 May 2001 amending Council Directives 89/48/EEC and 92/51/EEC on the general system for the recognition of professional qualifications and Council Directives 77/452/EEC, 77/453/EEC, 78/686/EEC, 78/687/EEC, 78/1026/EEC, 78/1027/EEC, 80/154/EEC, 80/155/EEC, 85/384/EEC, 85/432/EEC, 85/433/EEC and 93/16/EEC concerning the professions of nurse responsible for general care, dental practitioner, veterinary surgeon, midwife, architect, pharmacist and doctor.
- Directive 2013/55/EU of the European Parliament and of the Council of 20 November 2013 amending Directive 2005/36/EC on the recognition of professional qualifications and Regulation (EU) No 1024/2012 on administrative cooperation through the Internal Market Information System ('the IMI Regulation').
- Directive (EU) 2019/1159 of the European Parliament and of the Council of 20 June 2019 amending Directive 2008/106/EC on the minimum level of training of seafarers and repealing Directive 2005/45/EC on the mutual recognition of seafarers' certificates issued by the Member States.
- DNVGL-ST-0026:2014-04. Competence related to the on board use of LNG as fuel.
- DNVGL-RP-G105. Development and operation of liquefied natural gas bunkering facilities.
- EN 1474 Part 1 "Installation and equipment for liquefied natural gas – Design and testing of marine transfer systems – Design and testing of transfer arms".

- EN 1474 Part 2 “Installation and equipment for liquefied natural gas – Design and testing of marine transfer systems - Design and testing of transfer hoses”.
- EN 1474 Part 3 “Installation and equipment for liquefied natural gas – Design and testing of marine transfer systems – Offshore transfer systems”.
- “Estudio sobre el suministro de GNL a buques mediante camión”. Puertos del Estado.
- Guidance related to vessels and waterfront facilities conducting liquefied natural gas (LNG) marine fuel transfer (bunkering) operations. US Department of Homeland Security.
- Guidelines for Liquefied Natural Gas Transfer Operations and Training of Personnel on Vessels using Natural Gas as Fuel. US Department of Homeland Security.
- Guidelines on LNG Bunkering. Bureau Veritas.
- IEC 60079 Explosive atmospheres.
- IMO. IGF International Code of Safety for Ships using Gases or other low flashpoint Fuels.
- IMO. Interim Guidelines on Safety for Natural-Gas Fuelled engine installations in ships, adopted in 2009 through Resolution MSC.285(86).
- IMO. IGC International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk, adopted in 1983 and completely reviewed in 2014, entering in force 1st of January 2016.
- IMO Revised Guidelines for formal safety assessment (approved by MSC-MEPC.2/Circ.12, appendix 3).
- International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW).
- ISO - IEC 31010:2009 – Risk management – Risk assessment techniques.
- ISO/TS 16901, Guidance on performing risk assessments in the design of onshore LNG installations including the ship/shore interface.
- ISO/TS 18683. Guidelines for systems and installations for supply of LNG as fuel to ships.
- ISO 20519:2017, Ships and marine technology — Specification for bunkering of liquefied natural gas fuelled vessels, already approved and published.
- ISO 28460:2010. Petroleum and natural gas industries — Installation and equipment for liquefied natural gas — Ship-to-shore interface and port operations.
- IAPH Checklist. LNG Bunker Checklist Bunker Station to Ship.
- LNG Ship to Ship Bunkering Procedure. Swedish Maritime Technology Forum.
- Resolution MSC.396(95)
- Resolution MSC.397(95)

- "Recomendación técnica suministro de gas natural licuado como combustible marino". GASNAM.
- Society for Gas as a Marine Fuel (SGMF) on recommendations related to training and competence.
- Study of Standards and Rules for Bunkering of Gas-fuelled Ships. European Maritime Safety Agency (EMSA).
- TrainMoS Action (2011-EU-21004-S).
- TrainMoS II Action (2013-EU-21012-S).
- White Paper for Transport 2011.
- Workshop on LNG Bunkering to Port Authorities & Administrations. European Maritime Safety Agency (EMSA).

Appendix II: List of abbreviations

The following abbreviations have been used in the document:

ADR: European Agreement concerning the International Carriage of Dangerous Goods by Road

BLEVE: Boiling Liquid Vapour Explosion

CCTV: Close Circuit TV

COSTA: CO2 & Ship Transport emissions Abatement by LNG

CTS: Container to Ship

ECTS: European Credit Transfer and Accumulation System

EMSA: European Maritime Safety Agency

ERS: Emergency Release System

ESD: Emergency Shutdown System

EU: European Union

ICT: Information and Communications Technology

IGC Code: International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk

IGF Code: International Code of Safety for Ships using gases or other low flash-point fuels

IMO: International Maritime Organization

ISO: International Organization for Standardization

LNG: Liquefied Natural Gas

MoS: Motorways of the Sea

PhD: Doctor of Philosophy

PIC: Person in charge

PTS: Pipeline to Ship, also known as TPS (Terminal to Ship via Pipeline)

RPT: Rapid Phase Transition

SCTW: International Convention on Standards of Training, Certification and Watchkeeping for Seafarers

SGMF: Society for Gas as a Marine Fuel

SIGTTO: Society of International Gas Tanker and Terminal Operators

STS: Ship to Ship

TrainMoS: Training Motorways of the Sea

TEU: Twenty-Foot Equivalent Unit

TTS: Truck to Ship