Minutes of Meeting
75th Meeting of the Technical Study Group
Groningen (The Netherlands) - May 29th - 30th, 2024

PRESENT

P.E. Decroës	ENGIE – TSG Chairman
H. Malvos	ENGIE / CRIGEN – TSG Secretary
R. Ellis	BP
V. Chaudhary	Centrica Energy / British Gas
E. Partos	Distrigas/Constellation
S. Planteline	Dunkerque LNG
R. Jimenez	Enagas
R. Vara	Freeport LNG
J. Yang	Equinor ASA
K. Stevens	Fluxys LNG
R. Witteman	Gate Terminal
A. J. Bahman	KIPIC
A. A. Mulji	MOL LNG Transport
P. Cervera	Naturgy
C. Patricio	N.V. Nederlandse Gasunie
M. Hirabayasi	Osaka gas
T. Matulionis	Royal Vopak
A. Scaraggi	Sempra Infrastructure
R. Alikhanbagi	Shell Global Solutions International B.V.
P.P. Ang	Singapore LNG Corporation
S. Shimizu	Tokyo Gas
O. Pasteau	TotalEnergies
S. Dubbeldam	Vitol

INVITED

J. R. Ammireddy	Centrica
J. J. Soler	Enagas
B. Aldaihani	KIPIC
J. Hooker	National Grid (Grain LNG)
M. Theelen	N.V. Nederlandse Gasunie
M. Hömmen	N.V. Nederlandse Gasunie
P. V. Perez	Shell Global Solutions International B.V.

APOLOGIES RECEIVED

Ü. Gürses	Ege Gaz
G. Caudron de Coquereaumont	Elengy
O. Phillips	National Grid (Grain LNG)
A. Amorin Torres	GNL Quintero
K. Hurley	South Hook LNG

Agenda Item 1: INTRODUCTION

TSG Chairman opened the session, thanking N.V. Nederlandse Gasunie for kindly hosting the meeting and making the excellent arrangements for this 75th meeting, in particular for the technical visit of the EemsEnergyTerminal (FSRU and barge).

He noted the attendance of 30 participants from 23 companies at the TSG meeting, with a good representation of each region and each segment of the LNG chain (liquefaction, shipping and Regas).

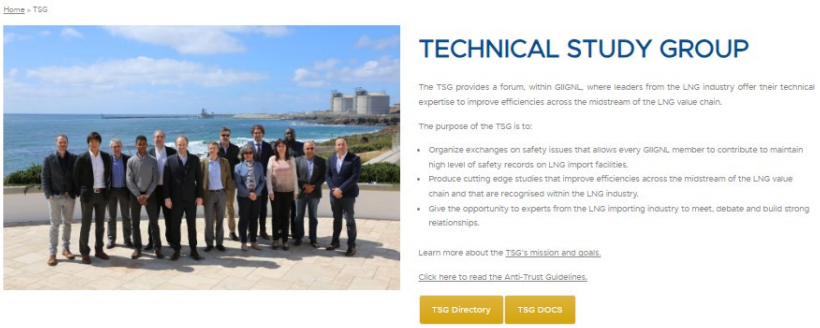
Ege Gaz, Elengy, National grid (Grain LNG), GNL Quintero and South Hook LNG sent apologies for absence.

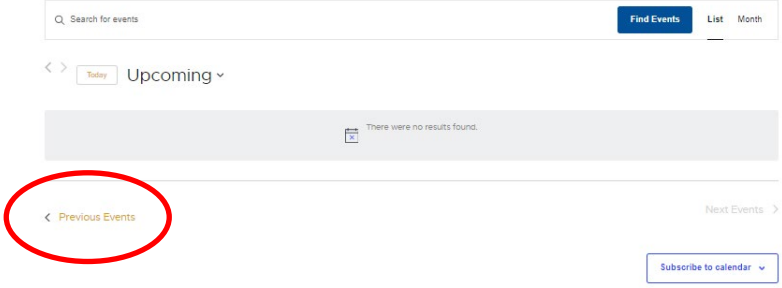
TSG Chairman welcomed new TSG representatives from existing members Sempra, Total, Vopak as well as the new TSG representatives from new members (KIPIC, Vitol).

This meeting covered the TSG ongoing and planned new works as specified in the Meeting Agenda. Due to lack of time the last items of the agenda couldn't be addressed. The content of these items is therefore reminded in the present minutes as a summary of the minutes of last TSG minutes.

TSG Secretary reminded the main rules attached to anti-trust / competition law. He presented as well the principles of the Chatham House Rule for the verbal reports. He also circulated an attendance sheet. Both Anti-Trust Guidelines and Chatham House Rule are posted, as reminder, on the private area of GIIGNL website, with the present minutes and the signed attendance sheet.

It was also reminded that the minutes of TSG meetings and the related presentations are posted on the following page of GIIGNL website: https://giignl.org/tsg/





By clicking on "Previous Events", one can access the documents specific to each TSG meeting.

Agenda Item 2: GIIGNL INFORMATION

GIIGNL General Delegate (Mr. Laurent DAVID) and GIIGNL LNG Analyst & Communications Officer (Mrs. Marianne Renard) attended this TSG meeting.

TSG Chairman reminded that GIIGNL has currently 94 company members and that TSG keeps count of 45 members (about 50% from Europe, 35% from Asia and 15% from Americas).

Since some new members were attending a TSG meeting for the first time, going around the table allowed participants to briefly introduce themselves.

With a pace of 2 meetings a year, holding this 75th TSG implies that it will be soon 40 years that TSG has been meeting, exchanging on safety and technology.

74th TSG meeting (held in Tokyo in September 26-27, 2023)

The minutes of the 74th TSG meeting had been issued to all members in advance and were posted on GIIGNL website. No remark were received prior to this 75th TSG meeting, neither made by the participants. TSG Chairman therefore declared approved the minutes of the 74th TSG meeting.

Agenda Item 3: SAFETY ON LNG FACILITIES

A3.1. Incident Identification database (Leader Elengy)

Reminder:
There is a real necessity to maintain a regular update of the database; Lessons learnt from the past are helpful for all members (designers, operators, maintenance staff, …) to improve the daily operation and when discussing with the authorities, the local communities…
Confidentiality attached to the data collection is ensured through a specific process involving regional coordinators and secure web access (https address).
Each GIIGNL member shall make sure to bring all available data into the database. All users were regularly reminded by the regional coordinators to use the database.

General information about the database

The administration of the database is carried out by Mr. Caudron de Coquereaumont (Elengy) with the support of Central Office.

The database is accessible by PC, laptop, touch pad or smartphone with the following link: https://incidents-giignl.org

The recommended navigators are Chrome and Firefox. Login and password generation is carried out by the administrators.

The scope of the Data Base covers all LNG facilities, including FSRUs and small-scale facilities. Large public incidents but also near misses are considered (HiPo events). It is NOT an exhaustive list of all the incidents, since it doesn't represent all terminals in the world, but it is representative of what could happen in a typical LNG Terminal. The database provides a description of the accident, its consequences and the measures taken to prevent such accident to happen again. For recent incidents, sketches/pictures are attached. The information is recorded anonymously and is validated by a regional coordinator.

The regional coordinators are:

- Mr. Olagoke Phillips (National Grid) for Europe (30 originators authorized so far),
- Mr. Masayuki Hirabayashi (Osaka Gas) for Asia (36 originators authorized so far),
- Mr. Anthony Scaraggi (Sempra Infrastructure) for Americas (16 originators authorized so far).

The role of the coordinators is to liaise with the originators to ensure the completeness of the incident description, and to track the incidents published in the LNG news in their respective region.

TSG Secretary insisted on the need to keep an active participation of the GIIGNL members and the HSE managers, pointing out the role of TSG members for contacting HSE&Operation&Maintenance managers and inciting them to record the incidents of interest.

A video, accessible through the website menu, explains how to create and search an incident and presents as well guidelines / flowchart.

Status of the Data Base:

TSG Chairman presented on behalf of Mr. Caudron de Coquereaumont (who sent apologies for not attending this meeting) the current status of the GIIGNL Incident Identification Data Base web platform. He also reminded some general background information.

- So far, 481 incidents are registered in the data base.
- Two new incidents were reported in 2024:
  - A temporary diesel generator installed closed to the suction of a air conditioning system, leading to CO accumulated inside the container (incident N°1930)
  - A LNG leak on a high pressure flange of an expansion bellow, due to a 50°C temperature difference between top and bottom pipes (incident N°1931). 'Warm' HP LNG coming from a BOG precooler was injected on the top of the HP pump discharge header in low sendout conditions, creating a bad mixing and a stratification in the line. The temperature difference degraded the flange bolt torque, leading to loosening of the flange connection and a 15' drop leak. Leak stopped after stop of the BOG cooler. Take away : ensure enough cold LNG mixing flow before starting the BOG precooler and pay attention to the temperature differential indications (they are installed for cooldown but they are also useful in normal operation).

It was reminded that the information in SIGTTO database related to accidents on ships at berth, should be available as well in GIIGNL database. Consistency of both databases on this part was checked in the past and such a comparison could be made again.

As a reminder, at 73rd TSG meeting in Barcelona Mr. Lauck (Distrigas/Constellation) suggested to work on a new report analyzing the database anonymized information. The last TSG report on the LNG Incident Identification Study was issued by TSG in 2017. It is available on GIIGNL website, as well as the paper published in 2018 and the presentation at WGC 2018. It was decided that a new report will be prepared when enough new data are entered in the database.

End of 2023, the developer of the database (Kernix) proceeded with the following modifications requested in former TSG meetings:

- Implementation of automatic launching of bi-annual campaigns for collecting the incidents. The receivers should be the TSG members and the originators of the data base (with a link to the tutorial video and guidelines).
- In case of update of an incident by the administrators, recording and display of the date of the update in addition to the date of the incident creation,
- Automatic notification by email to the "sleeping" originators, after 3 years without entering any incidents with copy to the TSG company representative.

Mr Vara (Freeport LNG) commented that the automatic alert which is received by TSG members when a new accident is reported in the database is a good reminder for filling in the database. He also gave feed-back on the use of the database, mentioning that there are many fields to fill in, which could be simplified. Several members have difficulties to connect (No password, reminder sent in the spam..). Mr. Mulji added export files could be simplified as well.

TSG Chairman noted that European terminals are the most active in reporting incidents in the database. As regional coordinator for Asia, Mr. Hirabayasi (Osaka gas) sent recently a reminder to Asian members for filling in the database.

Decisions were as follows:

- Mr. Caudron de Coquereaumont will ensure that the following requested implementations were fully addressed by Kernix:
  - recording and display of the date of the update in addition to the date of the incident creation.
  - reminder message is sometimes directly going to the trash bin
- Efforts are required from the data base originators to include also incidents related to FSRUs, small scale terminals and truck loading.
- TSG Chairman and Secretary will check consistency of GIIGNL and SIGTTO data bases on incident which occurred on ships at berth.
- GIIGNL central office will review the list of originators to make sure that it is still up to date.

A3.2. lessons from incidents

To extend safety information sharing and as a mean to promote the use of the database, information on representative incidents which occurred in the last period is included in the Agenda (Lessons from incidents). Such discussions enrich members knowledge on the type of incident which are recorded in the data base.

- Mrs. Ang (SLNG) pointed out that Singapore LNG was aiming for zero leak and that for the last 11 years, the main sources of leak have been the jetty line flanges (improved by Belleville washers), LP LNG flanges (improved by reducing the pressure swings and temperature differentials).

- Mr. Vara (Freeport LNG) reported leaks in expansion bellows, because of differential temperatures between top and bottom.

- Mr. Chaudhary (Centrica) reported regular leaks on ship manifold during rapid cooling because difference of temperature as well. Solution : stop the flow and wait for temperature equalization.

- As a reminder, TSG Chairman mentioned the 2 incidents which were reported in 2023 in the database:

  - Incident which occurred on June 8, 2022 at Freeport facility, resulting from thermal expansion of trapped LNG within a LNG line (incident N°1929):

    This incident was presented by Mr Vara (Freeport LNG) at last TSG meeting (see minutes of 74th TSG meeting for more information) but it is rediscussed because of the attendance of Mr Vara. Nobody was injured because it was the lunch time. The source of ignition (after a few seconds) is unknown but it was probably a cable damaged. Fire fighting hydrans were also blown by the explosion, creating a problem on the fire water system.

    As a consequence of this incident, NFPA is now reinforcing the regulations on MOC, log out/Tag out, administrative controls, additional layers of protections (procedures, 3rd party control..etc) in order to reduce single human errors.

- Leak + fire at a truck loading facility (incident N°1929):

  LNG leak from a blind flange at the end of truck loading rack due to frequent & sharp pressure increases in the low pressure 'zero sendout' system. Gas cloud ignited 50 seconds later, maybe due to static electricity.

- Mr. Soler (Enagas) reported a fire due to static electricity when removing a LP pumps 5 years ago. This incident was then reported in the database (incident N°1890):

  - On the 5th of June 2018, During in-tank pump extraction operation, prior to preventive maintenance, and after placing the pump on a support, a small flame was produced. Ignition source was not identified (static electricity ?) but Enagas is now always immediately grounding the pumps

- Several incidents were reported with LNG cryogenic hoses used during LNG unloading (for Ship to ship transfer) or during LP sendout (transfer of LP LNG from one ship to the other) :

  - *Mr. Patricio (N.V. Nederlandse Gasunie) reported some damages (deformations with small gas leak) in the 8'' LNG composite flexible cryogenic hoses connecting the FSRU with the LNG barge. They have to maintain a minimum flow of 50 m3/h per flexible to avoid LNG pockets getting vapor through rapid expansion and causing damage to corrugated parts of the hose (deforming the internal). Gasunie added flow transmitters on the ship manifold, implemented a procedure to increase from min flow to max flow and proceed now with a daily visual inspection.*
  - *Gasunie also reported some deformation (damage) on the 10'' cryogenic composite flexible cryogenic hoses used during the STS LNGC to FSRU transfer. The hoses collapsed at the end of inerting procedure after STS is completed.*
  - Mr. Mulji (MOL LNG Transport) mentioned that the STS LNG cryogenic hoses can stand relatively high pressures during STS (+/- 5 times the design pressure) but they are weak in case of vacuum/LNG flashing. As a consequence, MOL maintains always a positive pressure on both ends during the operation of the flexible and use a small valve for slow draining.
  - Cpt Chaudhary (Centrica) mentioned several cases reported during STS with 10'' cryogenic hoses. Since 2006, Centrica never experienced any problem with 8'' cryogenic hoses which are also easier to handle. By gaining experience, Gutteling progressively extended the number of cycles before maintenance from 50 cycles to 150 cycles.
  - Cpt Chaudhary mentioned an issue with too long cryogenic flexibles during STS and 'omega' shape forming with using extra 6m length that could cause additional heat transfer from ships water curtains causing higher temperature and pressure in course of transfer.

-LNG bunkering hoses :

  - Mr. Mulji (MOL LNG Transport) mentioned some leaks during bunkering on the QCDC, because of the O-ring on the receiving vessel.
  - SGMF published interesting guidelines on cryogenic hoses, used for STS, truck (un)loading and bunkering. MOL shared them after the meeting (see documents posted online with the minutes).

-Truck (un) loading hoses :

- No problems are reported on the cryogenic flexibles used for truck(un)loading, probably because they are metallic, although a problem was mentioned by Klaipeda Naphta during the TSG visit of the small scale LNG facility.
- Freeport had to modify the truck loading design to avoid sharp edges.

-HP gas flexibles :

No bad experiences with HP gas flexibles. Gasunie operates the HP gas flexibles at 70 barg (design 100 barg) and they have to be pressure tested every 5 years

- LNG Trucks : Mr. Ellis reported an LNG Truck explosion which occurred in Mongolia in January 2024. 6 persons died. After an accident between a car and a LNG truck in the Mongolian capital of Mongolia, Ulaanbaatar, the fuel tanker exploded and set fire to buildings. 3 firefighters were among those killed after the truck carrying liquefied natural gas exploded. Fire engulfed several nearby buildings, including a residential block. BBC reported the accident, as well as the Guardian:

https://www.bbc.co.uk/news/world-asia-68079262

https://www.theguardian.com/world/video/2024/jan/24/fuel-tanker-explosion-mongolia-people-dead-video

Mr. Hirabayasi (Osaka Gas), as safety database coordinator for Asia, offered to try to get more information. He provided the following link:

https://www.asahi.com/articles/ASS1S6J68S1SUHBI02T.html

More information can be found as well through the following link, as reported by RFI: https://www.rfi.fr/en/international-news/20240124-six-killed-in-mongolia-gas-explosion

Decisions were as follows:

- Mr. Caudron de Coquereaumont (Elengy) will report at next TSG meeting if GIIGNL Truck Loading Safety Guidelines should be updated at the light of (1) the incident at the LNG truck loading bay of Fluxys LNG facility (see Tokyo TSG), (2) the incident in Mongolia as well as (3) SGMF recommendations on flexibles

Agenda Item 4: OPERATION & MAINTENANCE

A4.1. COVID experiences and lessons learned (Leader Sempra Infrastructure)

TSG Chairman reminded that results from the study were presented at LNG 2023 Conference in Vancouver (10-13 July 2023) and that the final report is posted on GIIGNL website:

http://giignl.org/wp-content/uploads/2024/04/GIIGNL-Lessons-Learned-in-the-LNG-Terminals-during-Covid-19-Pandemic.pdf

He closed the related Task Force as there are no further remarks/comments on the document

Decision was as follows:

- Task Force on COVID experiences and lessons learned is officially closed.

A4.2. Recent O&M Surveys

TSG Chairman reminded the possibility given to members to raise a question to Central Office. If the interest is confirmed, Central Office may circulate it, as a survey, to all members. After gathering the answers, Central Office analyses the results and produces an anonymous synthesis.

-TSG Chairman reminded the last surveys on tank relief valves (PSV), as well as recent issues with LNG compositions (N2, C6+), which are published on the GIIGNL web site.

-The questionnaire on ways to reduce CO2 footprint of LNG terminals was sent by central office on May 13, 2024 in the frame of the task force related to CO2 emissions

-It is planned to launch a survey about the flare pilot (Is the pilot always on/off ? what kind of fuel is used (CH4/propane/H2) ? How to ignite the pilot)…etc.

- On the flare pilot topic, Mr. Vara (Freeport LNG) mentioned that one have to keep positive pressure in the flare and that different gases can be used for that purpose (natural gas but also nitrogen, …). He added that Freeport LNG has a project for using nitrogen for maintaining such positive pressure.
- For maintaining a positive pressure, Enagas switched from natural gas to nitrogen 3 years ago. For the pilot, Enagas has now a project to replace the natural gas by Hydrogen in Cartagena (H2 from grid) and in Huelva (solar panels+sea water electrolysis+buffer tank)
- Gate LNG has a flare pilot on demand (which is switch on only when necessary, as well as once a month for testing). In normal circumstances, the flare is not used (Tank design pressure is 255 mbarg). This was a request from Authorities. In fact, it is a vent which can be used occasionally as a flare but in case of incident it functions as a vent as it is not easy to ignite cold gas remotely.
- Total upstream is sometimes using ground flares but there is a serious safety issue if the emergency release is not ignited at ground elevation.

- A debate took place about the CO2/O2 concentration limit to accept a vapor return flaring during a LNG carrier gassing-up (normal inert gas concentration is 14% CO2, max 2%O2 and the rest is N2 at the beginning of gassing-up). Equinor accepts to flare the vapour return with 200 ppm CO2. Freeport requires 800 BTU/m3 to ensure a proper combustion and considers that a CO2 could freeze if the CO2 concentration is above 100 ppm. Zeebrugge has the same limit of 100 ppm. Gate has additional limits on O2 (< 5 ppm). When possible, N2 is now preferred as inert gas instead of on-board inert gas generation.

A4.3. Recent issues with LNG composition (N2, C6+..)

- **Heavy Hydrocarbons (C6+)**

Reminder : A survey was circulated in Feb 2023 about potential issues with C6+ in LNG and it was discussed during the last TSG's in Barcelona and Tokyo. A lot of issues were reported on :

- *US LNG liquefaction terminals ;*
- *LNG ships in ballast condition or equipped with subcoolers/reliquefaction when they are transporting US LNG cargoes ;*
- *LNG regas terminals (Issues with the BOG reliquefaction, suction filters of BOG compressors and HP pump), with potential HSE and safety concerns*

As reminder, the following elements were reported :

Upstream of US liquefaction plants:

Today, C6+ (C6 to C12) are reported upstream the liquefaction plants but the gas producers/transporters are OK as the gas quality is within the specification and there is no issue at ambient temperature. C6+ could come from :

- Lube oil from the gas compressors used for gas transport ;
- the field itself (in this case the problem could be more and more severe as the gas/oil ratio is changing)
- The shale gas
- the fracking process

Liquefaction terminals

Heavy hydrocarbons are not soluble at low temperature (although solubility depends on LNG temperature, C3-C4 content) and should be catched by the NGL recovery at -50/-60°C. However, some traces can pass through the NGL recovery and block the downstream plate fin exchangers and filters.

The first remedy was to install two equipment in parallel to allow inline cleaning.

The US LNG industry is now testing other solutions to remove/reduce the C6+ entering in their facility :

- Several plants are installing carbon filters (charcoal) to collect C10+
  Measures at the loading showed a saturation in C6 to C9 (C6 solubility in LNG is around 50 ppm)
- Golden pass tried to replace the adsorbant by something different, but it needs regeneration

➔ After denying the problem, US liquefiers are now trying to remove/reduce the bulk of C10+ at the inlet of their plant.

It was also reported by Freeport that the presence C6+ in the LNG loaded is linked to the liquefaction process :

- Air product process is a kind of filter. C6+ (mainly C10/C12 in Freeport) slowly accumulates, generate a high DP in the process, indicating that a flush is required. Freeport does one flush per year. No C6+ problem reported from freeport in the loaded LNG
- Philips cascade process allows the C6+ to pass through the process and be present in the end product

LNG ships

Serious problems were reported by shippers mainly with ships in ballast conditions during long voyages (US-China for instance). Main issues related to :

-BOG subcoolers / subcooler downstream filters / Reliquefaction unit blocked (C6 solubility is decreasing when temperature is dropping)

-LNG sprayers blocked during ship tank cooldown before loading, in case of low tank heel (so high C6+ concentration)

-BOG compressor suction filters clogged and requiring regular flushing to GCU

These issues forced the LNG shippers to adjust their operating modes such as

-Smaller filter mesh at the suction of the BOG compressors

-Reduce the ship speed

-Ask the liquefaction terminal to do the tank cooldown

-Get a bigger heel (500 m3 min in 4 tanks instead of 200 m3 in two tanks) (no tank warming anymore)
-Change the logistic to avoid that the same ship is always loading at the same terminal
These elements are of course affecting the ship reliability

Serious problems were reported with a C6+ concentration higher than 50 ppm (C6 solubility in LNG) but concentration of 800 ppm where sometimes measured and some ship manifold filters were blocked by solid C6+.

The LNG shipper position is not easy contractually as the C6+ analysis is not accurate (< 0,01%). If a specific C6+ measure is asked and the results shows a C6+ concentration higher than 50 ppm, the cargo is still within the contractual limits. Some contracts are mentioning limits in C6+, others have very high limits such as 3500 ppm.

Regas terminals :
Serious problems were also reported by LNG Regas terminals

- One C6+ deposit was founded during the maintenance of a nikkiso pump on a FSRU
- A regas terminal experienced problems with their BOG reliquefaction unit
- At least three terminals experienced C6+ problems on HP pumps, damaging material :
  In general, the pumps are running, without excessive vibrations and without bad performances, but when they are inspected after 16000-20000 running hours, damages on the impeller and the TEM (balancing system of the pump) are discovered. Gate founded C34 traces which is solid at cryogenic temperature and can block the pump equalizing system

HSE/ Reliability consequences
This C6+ issue is also generating in the LNG industry some :
-HSE concerns (as Benzene is carcinogenic)
-The presence of C6+ was modifying the results of the storage tank LTD (Level/Temperature/Density) measure (used to select the top/bottom filling mode to prevent stratification and potential roll-over)
-As the C6+ are accumulating on the low points, problems were also reported with LNG external pumps on LNG fueled vessels (which might cause a safety issue if the vessel is not dual fuel)

- **N2**

Reminder : Several regas terminals reported that some US liquefaction operators asked to increase the N2 content at LNG loading above 1%. Contractually it is OK as the usual limits are for all inerts (CO2+N2), but the question was raised on the potential operational consequences.

Mr. Vara (Freeport LNG) pointed out it that such increase could be an issue in the coming months and years as the content of N2 in some gas fields is increasing and could be more than 1.5% (some spec are now at 1% N2 max, others at 1,5% N2 max). To tackle this issue, Freeport LNG is considering to

- get the gas from different places ;
- limit the use of electric compressors to allow the plant to burn more fuel gas (concentrated in N2)
- analyse the consequences of having more than 1% N2 content in the ships.

Mr. Chaudhary (Centrica) pointed out that if N2 content reaches 1.3%, temperature reaches -163°C, which might be an issues for the ship (notably membrane vessels and especially NO96). In addition, more nitrogen in the boil-off gas could be an issue for the ship engines (normal N2 limit in LNG is 0,6/0,65%, corresponding to 25%/28% N2 in BOG with a switch to MDO at 0,7% N2 in LNG). Modern ships are less sensitive (Equinor is revamping their vessels)

- **O2**

-MOL reported a high O2 content in the vapour return from Chinese and Thailand terminals during ship unloading ;

-Gate/Eemshaven have a very strict O2 limit (max 5 ppm) in the LNG at arrival because of the Dutch pipeline specification (gas might be injected into underground gas storages and might create corrosion problems with O2 concentration higher than 5 ppm). This was an issue recently as a cargo was rejected and needed to be unloaded elsewhere + nitrogen inerting before further loading. The normal O2 concentration in LNG at loading is around 10 ppm but there is no on-line O2 measurement. A special request must be done to the surveyor. Zeebrugge, Gate and Japanese terminals have dedicated O2 analysis in the LNG unloaded.

-In case of excessive O2 in the cargo of a bunkering ship, vessel must use the on-board vaporiser and send the vaporized gas to the GCU.

Decision was as follows:

The C6+ issue will be relayed to the US LNG suppliers by GIIGNL central office, with the assistance of both TSG and CSG because of the potential HSE, safety and reliability consequences

Pending

- As a follow-up of last TSG meetings, TSG Chairman and Secretary will ask SIGTTO if they have information to share about the NORMs issue.

Agenda Item 5: GHG EMISSIONS

A5.1. Ways to reduce the CO_2 footprint of the LNG terminals (Leader Dunkerque LNG)

TSG Chairman reminded that a first study linked to this topic was led by Mr. Witteman (Gate LNG) on Methane Emissions. Other GIIGNL sources are also available, listing more or less directly CO_2 reduction examples, but none with a direct focus on CO2 reductions. To avoid repeats, the study focuses on new recent solutions.

Mr. Planteline (Dunkerque LNG) gave an update of the work carried out by his Task Force (see PwPt presentation).

The Task Force members are: Dunkerque LNG (Task Force Leader), Enagas, Engie, Sempra Infrastructure, Shell and TotalEnergies.

The study focuses on the CO_2 impact of each main equipment of a terminal (a global benchmark would be difficult because the operating conditions of each terminal are too different).

A questionnaire was circulated on May 13th, 2024, to feed the reflections of the Task Force on CO2 emissions reduction. **12 replies were received** : Asia (6), Europe (4), America (2). **7 members shared their full emissions results**, which showed a great gap reflecting the differences between installations and their use. **For 8 members, CO2 represents more than 50% of total scope 1 emissions, and** for 2 members, CH4 is responsible for the majority of scope 1 emissions.
Regarding scope 1 CO2 emissions, a ratio of 280 is observed between highest and lowest declarations. 1st emitter is SCV (4) ; 2nd emitter relates to fugitives emissions (3) and flare (3).

8 members indicated that have already implemented CO2 reductions actions and all members indicated that they are studying reduction actions. 7 members are ready to share their experience in a dedicated report.

The following reduction actions on scope 1 were mentioned in reply to the questionnaire:

- On SCV:
  - Use of solar panels to reduce consumption
  - Burner efficiency / Study: H2 green as burner fuel
  - Review testing frequency : since these terminals don't use SCVs any longer and keep them as back-up, testing is performed less often (every 2 or 3 months instead of every month)
- On Flare:
  - Switch of sweep gas and flare header blanketing from gas to nitrogen
  - Green H2 as pilot
  - Study : switch to low consumption pilot or on a pilot on demand system
- On fugitive emissions :
  - LDAR campaign
- Others : site electrical vehicles, solar PV on roofs for electrical production

Less replies were received for scope 2. They showed a greater variability on ratio vs scope: from 0% (green electricity supply) to 291% (low emission terminal). 7 members indicated that they have implemented or are studying scope 2 reduction actions. 3 members only are ready to share experience, notably because their new procedures are not mature yet.

The following reduction actions on scope 2 were mentioned in reply to the questionnaire:

- Installations of VFD on LPP, HPP, SWP
- Turboexpander
- LED lighting on site
- Green electricity supply contract

Mr. Planteline (Dunkerque LNG) presented the proposed table of content of the report to be issued.

This report will be divided in three main parts:

- Introduction (General content, Source of main CO2 emissions inside a regasification terminal, Extent of CO2 emissions per main equipment and scope)
- Ways to reduce CO2 emissions
- LNG terminal concrete examples (Case studies)

For the last part of the report (case studies), he suggested to follow the same template as in TSG report on 'Worldwide experience of LNG import terminal & power plant integrations' (2015): https://giignl.org/wp-content/uploads/_pda/2021/08/worldwide_experience_of_lng_import_terminal_and_power_plant_integrations.pdf

A discussion was initiated by Task Force Leader and TSG Chairman on whether the study should focus on scope 1 only. TSG Chairman and Mr. Pasteau (TotalEnergies) supported to keep scope 1 and scope 2 in the study. Mr. Witteman (Gate terminal) pointed out that scope 2 is highly dependent on each terminal (linked for instance to source of power).

Mr. Planteline (Dunkerque LNG) proposed to exclude scope 3 from the study. It was agreed that scope 3 is definitely out of the scope of work of this Task Force.

Decisions were as follows:

- The report will focus on scope 1 and 2, even if less information can be provided on scope 2.
- The questionnaire phase will be pursued for one more month.
- Mr. Planteline (Task force Leader) will circulate the anonymized results to Task Force Members first, asking them if they agree to circulate these results to all GIIGNL Members.
- Mr. Planteline (Task force Leader) will prepare a template for the case studies presented in the last part of the report and submit it to volunteers.

A5.2. Methane emissions

No particular feedback from the use of the GIIGNL guideline to reduce the methane emissions (GIIGNL recommended practice : 'Methane emission management and mitigation in LNG terminals'). GNL Quintero (Alejandro Amorin) has been contacted to get their return of experience as pilot terminal for the use of the GIIGNL frame work. The frame work forced them to establish methodologies to identify and calculate/measure all sources of emissions (including the emissions which are less evident such as fugitives, maintenances, chromatographs, flare, SCV's..). The verification process by an external consultant helped them to structure their reporting.

Mr. Planteline (Dunkerque LNG) mentioned a new European regulation coming into force next year, requiring a leak detection every 4 months and repair within one year if any. A debate took then place about the threshold / frequency for methane detection & repair :

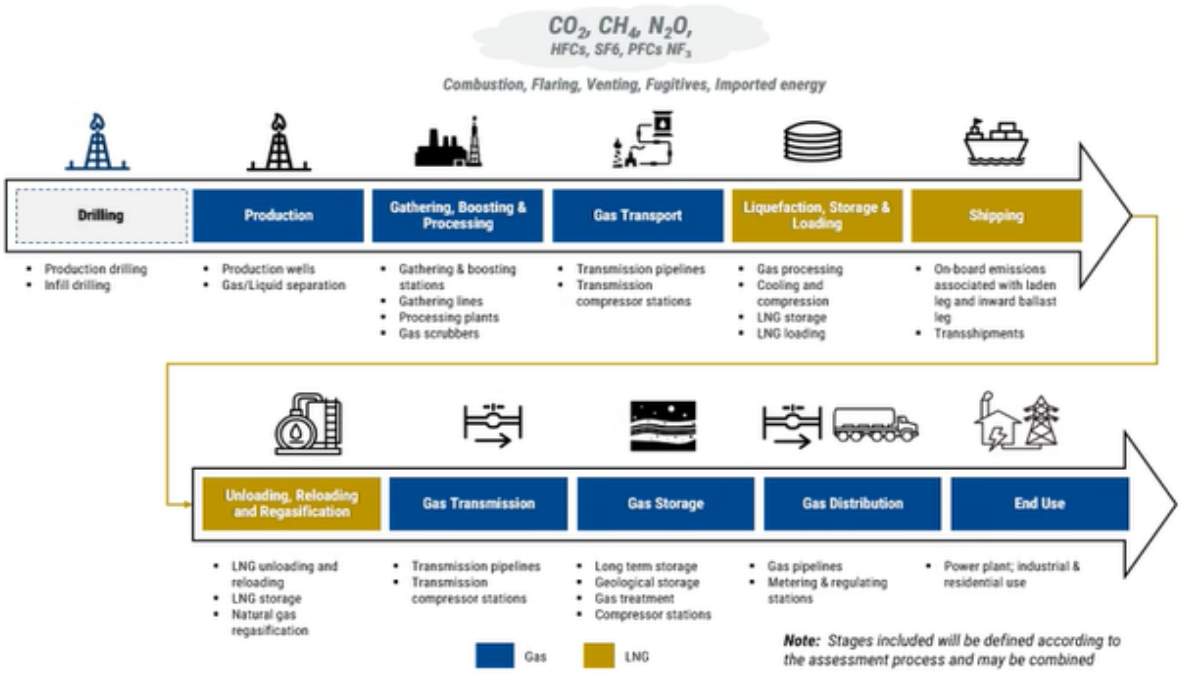
- In Europe, in 2025-26, Companies will have to report the methane emissions, in 2028 the report will be extended to any GHG and in 2030, an emission limit will be imposed ;
- In Spain, checking new European regulation methane emissions must be informed if the detection exceeds 500 ppm;
- In Gate, camera's are used to detect gas leaks (detection limit is lower) + portable gas detectors on flange sniffing tubes ;
- In USA, each source of methane emissions must be (sniffing) tested every month. If OK, the test frequency can be extended. A repair must be programmed above 500 ppm. OGE camera's are also used. On the jetty, the regulation is different as a shutdown is required when gas is detected by a sensor ;
- On ships, gas detectors are not really reliable. How to measure accurately the emissions? Today, emissions are based on fuel consumption but there is also a methane slip from gas engine.

Mr. Vara (Freeport LNG) and Mr. Patricio (N.V. Nederlandse Gasunie) initiated a discussion on the decommissioning of perlite insulated tanks. They pointed out the precautions to be taken for detecting and removing gas from perlite insulation. Vopak recently had to remove the ammonia from perlite before removing the perlite. It took 3 months and required a lot of scaffoldings.

A5.3. GIIGNL MRV and CHG Neutral Framework

At last TSG meeting, Shell insisted on the need for the LNG industry to continue to collect primary data as it allows to have a better picture of the real carbon footprint of the industry. Ms. Alikhanbagi (Shell) suggested to launch a Task Force for creating a database on primary data to be used with GIIGNL MRV and CHG Neutral Framework.

Mrs. Raha Alikhanbagi (Shell) and Mr. James Beddoe (Shell, through visio-conference) presented a framing and proposed an input sheet for such a database (see Excel file). The following LNG Life Cycles Stages and emission sources are considered by the frame work :



Emission Sources

Within the physical boundary chosen for reporting, all sources of GHG emissions must be included in the assessment for each stage. Specific sources will be identified and assessed for each relevant stage and sources will include, as relevant:

- Stationary combustion and flaring, including unburnt methane emissions from flares and methane slip from ships
- Mobile combustion, including product transport (LNG, BOG and liquid fuels) and applicable support services(land/marine/air)
- Venting
- Fugitive losses
- Emissions due to imported energy (electricity, steam, heat, cooling)

A debate then took place about the proposition :

- Emissions not directly related to gas activity are not easy to report and are not always representative of a typical year. For instance, a terminal reported that a leak on the air conditioning system was the major source of GHG in a particular year.
- The TSG members questioned the need to collect these data in a specific data base (confidentiality issue, need a database manager..). It will obviously help GIIGNL to define benchmarks and assist to produce a 'carbon neutral certificate' but we could also start by

defining the template (as proposed by Shell) and ask each member to fill the form on a yearly basis and decide themselves on how/who to share the data.

The proposed time granularity is the calendar year and the scope is limited first to unloading & reagzeification of a cargo (no truck loading or marine LBV loading).

Stage Included	Estimate % emissions based on primary data	Overview of calculation methodology(ies) applied, including use of primary and/or secondary data *(attach separate methodology description(s) as appropriate)*	Date range of the emissions calculation	GWP Applied (e.g. AR5/AR6)

Mrs. Alikhanbagi (Shell) asked for volunteers for continuing the work with Gate and Hazira, providing sites to do the testing. TSG Chairman proposed that Engie joins the Task Force with Mejillones LNG terminal (Chile).

Decisions were as follows:

- A Task Force is launched for creating a structure to report primary data to be used with GIIGNL MRV and CHG Neutral Framework. A database for primary data is not decided.
- The Task Force members are Shell (Task Force Leader) and Hazira, Gate terminal, Engie (with Mejillones Terminal.
- Mrs. Alikhanbagi (Task force leader) will specify what the framework requires in term of data.

A5.3. LCO2 terminalling

This Task Force has been on stand-by since last TSG meeting, after TotalEnergies informed central office that it couldn't keep the position of Task Force Leader.
Elengy, with support of Engie Lab Crigen, took over as task Force Leader beginning of May. Task force Members were informed on May 7th, 2024, that the new Task Force leader was Mrs. Clémence Detournay (Engie Lab Crigen) in support of Elengy: Ghislain Caudron de Coquereaumont (new Elengy representative at TSG), Benjamin Poirson and Yann Le Goc.
TSG Secretary reminded the main elements presented by TotalEnergies at last TSG Meeting (see PwPt presentation on LCO2-LNG synergies at 74th TSG Meeting in Tokyo). Notably, he reminded the initial objectives of the study:

- to evaluate the challenges and synergies brought by combining onshore LNG receiving and CO2 liquefaction terminals,
- to define design principles considering the overall CO2 chain from capture to re-injection,
- to focus on Onshore LNG Terminals (FSRU specificities will be studied in a second phase if interest is confirmed).

A kick-off meeting of the Task Force has been scheduled on June 3rd, 2024, aiming to:

- Validate and complete scope of work
- Get comments regarding report summary
- Call for volunteers for report part redaction
- Call for volunteers for cases study

The proposed deliverables are a survey about CCUS chain and LCO2 terminal sent to GIIGNL members, on one hand, and a report including LCO2 terminal export case studies, on the other hand.

After TSG Secretary invited more TSG Members to join the Task Force and attend the kick-off meeting, Tokyo Gas volunteered as Tast Force member.

Therefore, Task Force Members are now:

- BP (Mr. Richard Ellis)
- Dunkerque LNG (Mr. Sylvain Planteline)
- Elengy (Mr. Philippe Bouchy, Mr. Benjamin Poirson)
- Engie (Mrs. Clémence Detournay: Task Force Leader, Mr. Paul-Emmanuel Decroes, Mr. Hugues Malvos)
- Equinor (Ms. Jingshhi Yang)
- Fluxys LNG (Mr. Kim Stevens, Mr. Siegfried Spanhove)
- National Grid (Mr. Olagoke Phillips)
- Osaka Gas (Mr. Masayuki Hirabayash
- Sempra Infrastructure (Mr. Yovannis Mierez)
- Shell (Ms. Raha Alikhanbagi, Mr. Pablo Vega Perez)
- Singapore LNG (Ms. Pei Pei Ang)
- Tokyo Gas (Mr. Shogo Shimizu)
- TotalEnergies (Mr. Ginès Petit , Mr. Olivier Pasteau / Mr. Stéphane Dubois du Bellay)

Decisions were as follows:

- Task Force members are: Elengy / Engie (Task Force Leader), BP, Dunkerque LNG, Equinor, Fluxys LNG, National Grid, Osaka Gas, Sempra Infrastructure, Shell and Singapore LNG, Tokyo Gas, TotalEnergies.
- After the kick-off meeting (which is scheduled on June 3rd, 2024), Mrs. Detournay (Task Force Leader) will organize other work sessions at the soonest for validating the table of content of the report and for specifying the survey content.
- The work carried out will be presented at next TSG meeting.

A5.4. Cold recovery

As proposed by Mr. Jiménez (Enagas) at a former TSG meeting, in relation with case studies on ways to reduce CO2 emissions of LNG terminals, Mr. Juan José Soler (Enagas) presented the way cold recovery is performed with an Organic Rankine Cycle (ORC) at Huelva LNG terminal (see PwPt presentation).

The objective is electric power generation making use of LNG physical exergy, based on an Organic Rankine Cycle (ORC), which uses LNG as a cold source, propane at 99% purity as thermofluid and sea water as a hot one. The pilot production electric power plant with Ormat Energy Converter (OEC) was connected to Electrical Net in Jun 2012. In 2018, a cycle modification was implemented.

The early stage phases of the project are:

- 2009 - 2010: permits and authorization
- January 2009 – March 2010: EPC engineering

- March 2010 – March 2011: construction
- March 2011 – June 2011: interconnection
- March 2012: commissioning

The main technical data summarizes as follows:

- ✓ GROSS POWER : 5.140 kW/h
- ✓ NET POWER: 4.500 kW/h
- ✓ GENERATED NET ENERGY: 29.565 MWh/y
- ✓ ANUAL TIME WORKING : 7.000 hour
- ✓ PILOT PLANT DIMENSIONS : 25 m x 25 m
- ✓ AUTO-CONSUMPTION : 4.200 MWh/y
- ✓ LNG FLOW : 600 m3/h
- ✓ SEAWATER FLOW : 8.000 m3/h
- ✓ TURBINE SPEED : 1.500/1.800 rpm

Mr. Soler (Enagas) pointed out the following operational problems:

- Unstable performance:
  - The low pressure and high pressure cycles do not operate smoothly together.
  - Causing numerous trips during the operation.
  - Once the trip is generated , the propane gets cold very fast and It is difficult to
  - avoid it. Long time until restart.
- Low pressure condenser and turbine designed:
  - The outlet of the LP Turbine goes into the LP Condenser in the mid point.
  - Level control is critical: liquid to the turbine causing trip and failure (difficult to
  - remove)
- Seawater inside tubes: H deltaP problems, fouling.
  - Seawater filter was installed
- Reduced life expectancy of the Propane LP an HP pumps

The suggested plant modifications which were taken into account for redesign in 2018 are:

- LP turbine isolation.
- LP condenser isolation.
- VRU system changes.
- Propane storage tank changes.
- Fill & Drain system changes.
- HP condenser area changes.

As to real efficiency of the process, Mr. Soler (Enagas) pointed out that the electrical generation versus LNG flow follows an exponential behavior. If an LNG flow is decreased a little below the Nominal, this considerably affects the electrical performance. Going down from 580 m3/h of LNG to 480 m3/h implies generating 1 MWh less.

As a conclusion, Mr. Soler (Enagas) presented the historical data related to the generated energy (energy saving) from 2019 (after redesigned), with a zoom in 2022.
He mentioned that in 2023 the terminal proceeded to low send-out and Propane pump replacement.

ORMAT Energy Saving :
2019 → 19.599,28 MWh
2020 → 25.359,93 MWh

2021 → 17.493,07 MWh
2022 → 21.047,68 MWh
2023 → 11.208,63 MWh
Total from 2019 to 2023: 94.763,60 MWh

In 2022, the ORMAT energy saving was 21.047 MWh, for an electric consumption of the terminal of 64.760 MWh, which represents a 32,50% saving (3.907,89 Tn CO2 Equivalent).

Due to a tight schedule, the item 6, 7, 8 and 9 of this 75th TSG meeting couldn't be covered. Therefore, the following part of the present minutes is a simple summary of last TSG meeting which stands as a reminder; For more detailed information, please revert to the minutes of 74th TSG meeting in Tokyo.

Agenda Item 6: GIIGNL PUBLICATIONS

A6.1. Update of the Custody Transfer Handbook (Leader Fluxys LNG)

As a reminder, the purpose of the custody handbook is to serve as a reference manual to assist readers in understanding the procedures and equipment available to be used by GIIGNL members. It helps to determine the energy quantity of LNG transferred between LNG ships and LNG terminals (ship to shore or shore to ship).

It is neither a standard nor a specification, but it sets out the practical issues and requirements to work out a suitable procedure for a specific LNG custody transfer application.

Last Update of GIIGNL Custody Transfer Handbook was finalized at the end of 2021 (6th edition).

Future subjects under consideration for a next update of GIIGNL Custody Transfer handbook include:

- *some small-scale LNG transfer operations (such as ship bunkering, STS transfer, fueling of ships and trucks, filling of LNG trucks or containers)*
- *Transshipments*
  - *Considerations about the change in composition due to flash gas*
  - *Gas quality determination*
- *Use of the RAMAN analyzer (sole a reference is made in the current edition)*
- *Use of flow meter for custody transfer measurements*
- *Use of portable vaporizer/chromatograph (which could be useful for counter expertise)*
- *Rules for ship level meter filtering (as the modification of the filtering could make a 200-300 m3 difference)*

The link for downloading the 6th edition of GIIGNL Custody Transfer Handbook is:

https://giignl.org/document/custody-transfer-handbook-6th-edition-2021/

Decisions were as follows:

- Mr. Jiménez (Enagas) will send comments to CTHB Task Force leader (Fluxys LNG), notably for drafting a paragraph integrating some small-scale LNG transfer operations (such as bunkering, STS transfer, fueling of ships and trucks, filling of LNG trucks or containers).
- Mr. Jiménez (Enagas) will give a presentation at next TSG meeting on his updating proposal.
- CTHB Task Force leader (Fluxys LNG) will discuss with Enagas, Equinor and Singapore LNG, the subjects to be considered for next revision of CHTB.
- CTHB Task Force leader (Fluxys LNG) will consider addressing partial loading/unloading, as well as transshipment, in next revision of CTHB.
- Next revision of CTHB will ensure that §2.3.5. on periodic instruments recalibration is clear enough.
- CTHB Task Force leader (Fluxys LNG) will report at next TSG meeting on the proposals for updating the CTHB.

A6.2. Rollover in LNG Storage Tanks

A roll-over on ships/FSU/SFSRU is credible (some case were reported in Klaipeda, Mejillones, Moss ship after partial unloading/reloading). Shell proposed to launch a study on rollover onboard FSRUs or FSUs, completing the rollover report issued in 2015 for on-land LNG tanks.

See: https://giignl.org/wp-content/uploads/2021/08/rollover_in_lng_storage_tanks_public_document_low-res.pdf

Decisions were as follows:

- A Task Force is constituted for a study on rollover onboard FSRUs or FSUs, completing the rollover report for on-land LNG tanks.
- The members of the Task Force at this stage are: Shell (Task Force Leader), Engie and N.V. Nederlandse Gasunie.
- Task Force Leader will prepare a proposal of work to be carried out, and will submit it to Central-Office, TSG Chairman and TSG Secretary.
- Central-Office will circulate the proposal, asking for more volunteers to join the Task Force.
- Task Force Leader will present the scope of work at next TSG meeting.

A6.3. LNG quality & compatibility

Last update of the composition table which used to be published in GIIGNL annual report on the LNG industry was issued more than 10 years ago (2012):

https://giignl.org/wp-content/uploads/2021/07/giignl_the_lng_industry_2012.pdf

The composition table appeared in later reports but without being updated. Finally it was deleted from the annual report as it was not representative anymore of the LNG international market (for instance, US and Australian LNG were not in).

TSG Chairman proposed to launch a joint Task Force with GIIGNL Commercial Study group, trying to overcome the confidentiality issue which prevented the update of this composition table.

Decisions were as follows:

- TSG Chairman will liaise with CSG Chairman and Equinor for launching a Task Force on LNG quality and compatibility. He will report on the progress at next TSG meeting.

Agenda Item 7: OTHER MATTERS

A7.1. New study subjects

It is reminded that this creative part of the meeting is of highest importance, since it allows to bring added value to the TSG in order to help the LNG industry in today's activities and preparing for the future.

As a reminder, all TSG members are asked to think about new study ideas to be discussed at next TSG meeting. To date, several ideas have been proposed, such as:

- Standardizing the design of LNG trucks (connections, overfill detection systems..), in order to develop unmanned truck loading stations. Standardization for truck loading facilities (including connections) is a subject of interest for several TSG members (such as Dunkerque LNG, Fluxys LNG or Gate LNG).
- Developing a technical paper on green gases (Bio-LNG, Liquefied Synthetic Methane and LH2)
- Infrastructure synergies for LNG and LH2, LNG and ammonia.
- New O&M philosophy in an environment where more flexibility is required (zero send-out to peak send-out, additional services such as truck loading, transshipment, ship reloading..).
- Benchmarking of maintenance of the main LNG equipment.
- Providing design, operational or safety recommendations for the operation of floating or small-scale facilities.

Also, some existing studies could be slightly updated such as:

- Cold recovery: the Rankine cycle in Barcelona has been upgraded.
- Roll-over: Appendix A is to be deleted from the text as the public document is referring to it but the appendix, on purpose, is not attached.
- Technical manual on emissions: GWP of CH4 is now 32 instead of 20 in the documents. Some new technologies to be added, such as flexibles.
- Updating previous publications (earthquake guidelines, environment impacts of LNG facilities, cold recovery, update the 2005 TSG report on LNG Maintenance Strategy Benchmarking).

Decisions were as follows :

- Each member is encouraged to propose new subjects to be developed by the Technical Study Group.

A7.3. Coordination with other LNG bodies (IGU, ISO, SIGTTO, GLE, GERG, Marcogaz, ...)

New Chairman of Marcogaz WG LNG (Mr. Zero Andrzej from PSG) proposed on September 20, 2023, to his WG members, to launch a study on LNG quality in cooperation with Marcogaz WG Gas quality.

Mr. Lana (Enagas), who used to work on this subject within GIIGNL/TSG, as former representative of Enagas, is involved in the work proposed by Marcogaz.

Agenda Item 9. VERBAL REPORTS BY MEMBERS ON TOPICAL LNG MATTERS

The round table (All members) of recent LNG development in existing FSRU / Terminals had to be postponed to next TSG meeting, due to the tight schedule of this 75th TSG meeting.

In particular, Mr. Mulji (MOL LNG Transport) prepared a presentation on MOL FSRU Business / Technical Operations, which is postponed to next TSG meeting (however the PwPt slides are already available, since they are posted with the present minutes on the private area of GIIGNL website).