BINNENVAART
Deployment in Inland Waterway Transport

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Breakthrough LNG deployment in Inland Waterway Transport

Activity 6.4 Evaluation report pilot test bunkering station

Nieuwegein; The Netherlands
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Revision history

Revision	Date	Author	Organization	Description
V1	23-07-2020	Pieter Kool	Pitpoint.LNG	Processing draft document
V2	06-08-2020	Salih Karaarslan	EICB	Restructuring draft document
V3	02-09-2020	Pieter Kool	PitPoint.LNG	Final document

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1 Introduction

This document describes the performance indicators that are monitored during the pilot test of the bunkering station in Cologne. The pilot test is executed according to the pilot test settings as specified in activity 1.5 of the project. The pilot test is run between October 2019 and July 2020.

Analyses are made on the following parameters:

- **Operational efficiency** of the Liquid Natural Gas (LNG) bunker installation and crew.
- **Emissions** during operation of the installation. Both the emission of LNG as well as Liquid Nitrogen (LIN) was monitored during the pilot test.
- **Quality**, **Safety** and **Security** with new LNG technology in place.

The data obtained is used to show:

- The quality of the bunker installation itself.
- The improvement in operational efficiency of the bunkering station during the pilot test period.
- The environmental impact of the bunkering station.

During the test period there have been:

- 38 clients from December 2019 until July 10th.
- 503.662 kg of LNG bunker deliveries to ships.

The quantity of LNG bunkered per month varied between 50mT and 100mT (see Figure 1: Total bunkering per month in [kg]).

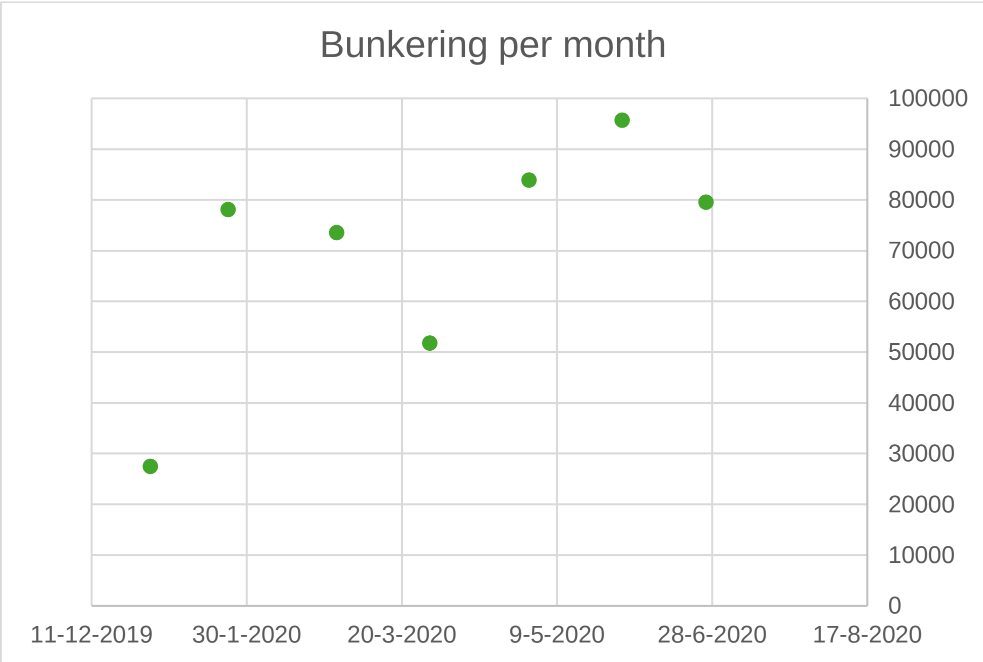

Figure 1: Total bunkering per month in [kg]

2 The data

The data was collected after the bunkering installation was commissioned. The commissioning took place in October of 2019. During the commissioning, a dry test and 2 wet tests were performed.

2.1 Data sources

The data sources used for this report are:

- Incident reports: number of incidents and type of incidents.
- Bunker safety checklist: The current checklist that will be used will be the IAPH checklist. Monitoring the number of customers and quantity of LNG sold and the timestamps required to monitor the efficiency of the transition.
- Timesheets:
    - Time at location Crew/Ship: Time noted here is the time agreed upon during the bunker request. Actual arrival time ship can be earlier than specified.
    - Start bunkering: The start bunkering times are automatically generated by the flow computer. The start time coincides with the start of LNG transfer.
    - End bunkering: The stop bunkering times are automatically generated by the flow computer. The stop time coincides with the stop of the pump stops.
    - Leave site: This is the time when the operator leaves the site.
- Manifest: Quantities and times were logged directly from the manifest.
- LIN drops: Every month our supplier sends us a monthly update on LIN delivered on site. These were used as a basis for total LIN consumption.

3 Operational efficiency

It was expected that during the start of the installation there would be a learning curve in managing the operations. This will be reflected in the efficiency in how quick the personnel can run the operations. In **Fout! Verwijzingsbron niet gevonden.** (see Appendix), operators have logged times during the operation. The time spent on site both during bunkering and activities before and after was used as a qualitative measurement for the operational efficiency.

- Total time per service
- Time for cooling system
- Number of customers/month
- Number of LIN drops/month

The efficiency of the installation is a qualitative comparison between bunker activities at the starting phase and later phases in time. The average time of a vessel on site of the bunker station is 3 hours and 56 minutes. The average time spent for the bunkering is 1 hours and 31 minutes.

From the time sheets we were not able to see a clear improvement in time spent on site (see Figure 2: Total time spent on bunkering per customer). It can be observed that initially there were both significantly longer as well as shorter stays. We can see that later there is less variation compared to the earlier bunkering. The lack of impact that can be observed from the timesheets is not what was expected. During the start of commercial bunkering lost time was often experienced due to lack of experience of operator or ship crew. That there was no significant decrease in operational time could be contributed to the following:

- Initially bunker quantities were between 8mT and 13mT. After the first two months we indicated to our client that larger quantities significantly brought down our operational costs. This has led to fewer bunker requests but for more LNG. The larger quantities resulted in longer operational time.

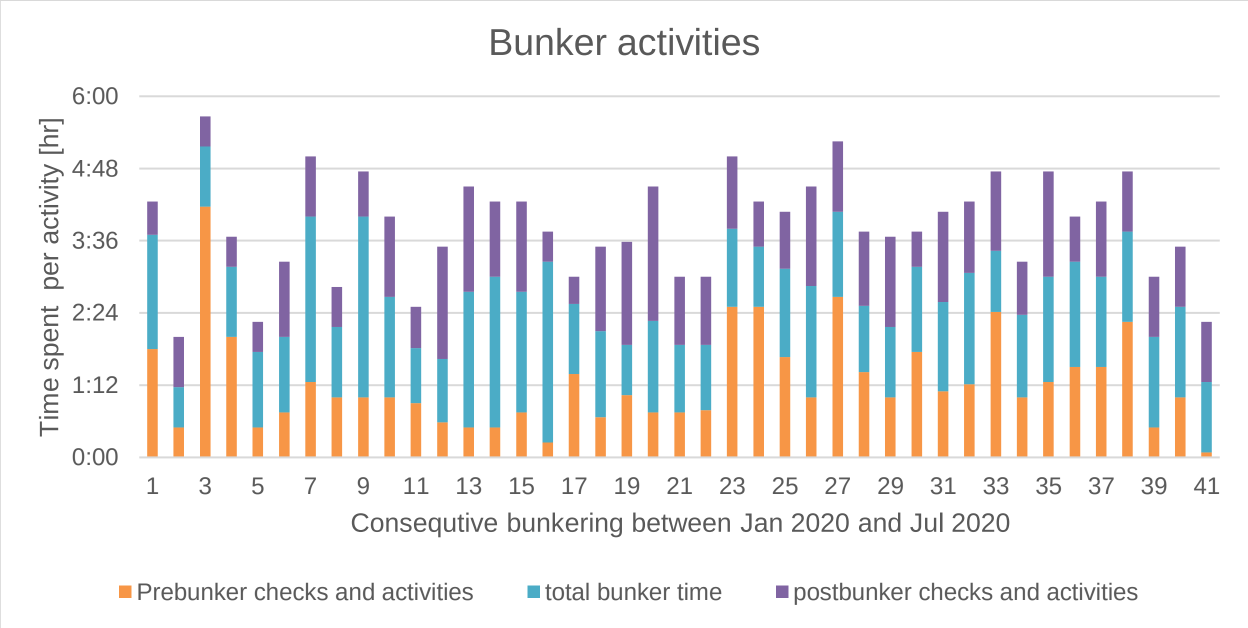

Figure 2: Total time spent on bunkering per customer.

4 Emissions

The bunker installation has been designed for zero boil off. Means to ensure that no methane gas is vented off to the environment, a LIN cooling spiral is installed in the LNG tank. Liquid nitrogen is used to cool the LNG during normal operation. During the test run it was expected that:

- No venting of Methane gas to be observed
- No methane or LIN leaks to be observed
- LIN usage was kept to reasonable amounts

All these factors were monitored during the pilot period.

4.1 Venting of (natural) gas

During the operations, no venting of natural gas took place.

4.2 Leaks

All leaks were monitored and reported. The installation is built and maintained to minimize leaks and prevent venting of methane.

Methane leaks
No methane leaks were observed during the test period.

Nitrogen Leaks
The PSV valve that was positioned above the economizer of the LIN tank was venting GAN. After exchanging the valve for a new one the issue fixed. Leaking of PSV valves is an issue we are familiar with. The leaking caused nitrogen to leak via the PSV instead of the economizer. No additional nitrogen was vented due to this defect.

4.3 Monthly LIN usage

The quantity of LIN used every month illustrates if the installation performs efficiently. LIN usage was monitored from the commissioning that was started in October 2019 until the end of the test period in July 2020. The usage changed dramatically as can be observed in Figure 3: Total LIN drops per month in [kg] during this period. We have therefore defined events that greatly influenced the LIN usage:

- July 3rd, 2019 : Commissioning of installation – LIN tank was filled with LIN for the first time.
- October 1st, 2019: First wet run.
- Mid October 2019: A sharp decrease in LIN usage was observed after the insulation was installed. The change is contributed to both the installation of insulation as a well as a drop in ambient temperature.
- End of December 2019: The start of commercial bunkering. Due to the frequency of cold LNG drops, LIN was no longer required to cool the system. The only LIN consumption that can be observed is due to the boil off in the LIN tank.

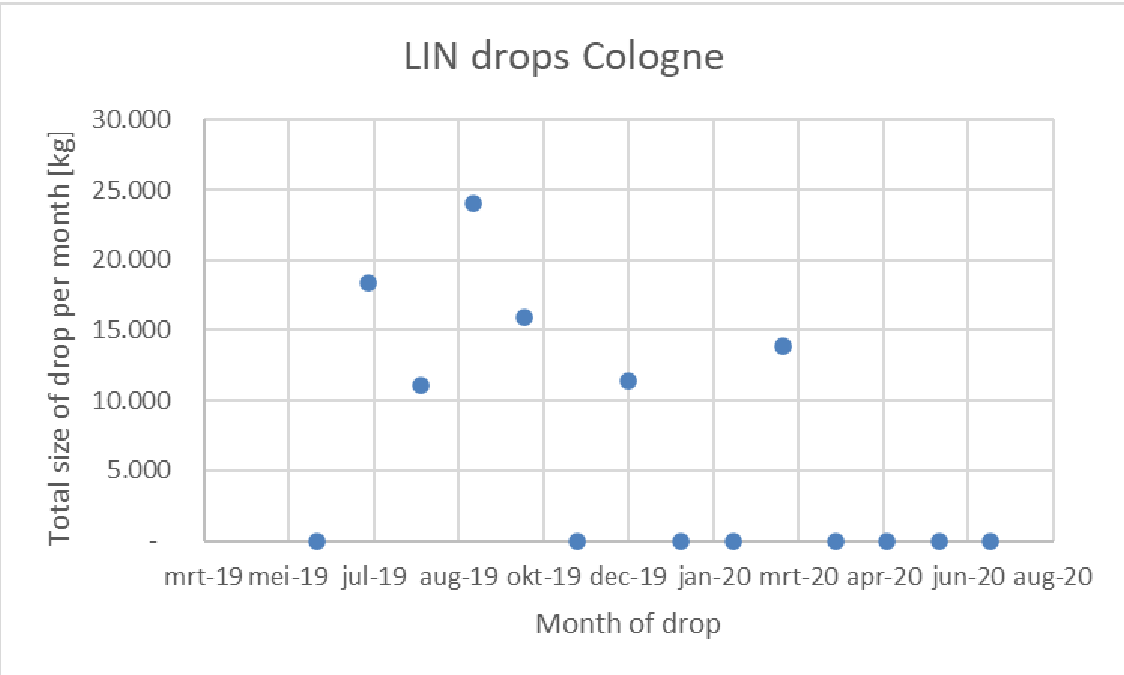

Figure 3: Total LIN drops per month in [kg]

The lack of LIN that is required during operations is illustrative of an energy efficient operation. For future bunker stations a smaller LIN tank will be evaluated.

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5 Quality, safety, and security

To determine the quality, safety and security impact of the installation, corrective maintenance incident reports were used. The maintenance report will affect the OPEX, durability, reliability, and quality of service of the bunker installation. The results from the report will give a qualitative indication and not a quantitative of what to expect. The following failures and fixes occurred in 2020:

- A car driver drove into the main gate during drag race in the street. The crash deformed the gate and had to be replaced. Nobody was injured during the incident.
- A PSV on the LIN tank was leaking. The Economizer below the PSV was supposed to decrease the pressure before the PSV was activated. However due to a faulty PSV this did not happen.
- Connectivity issues between flowmeter and flow computer.
- Slow moving loading arm due to leaking seals (internal leakage). The seals were replaced.
- HPU of loading arm contained water due to leaks. The leaks were sealed.

Of the issues mentioned, the connectivity between flowmeter and flow computer is the only one that has led to downtime for the client. The client was able to mitigate the down time by offloading goods before returning.

6 Conclusion

6.1 Operational efficiency

Operational efficiency was benchmarked over the test period with aid from a time log sheet. The data from this time log shows that even though the average time per bunkering did not drop significantly, there was less variance in between ships. This shows us a more consistent operation which would coincide with our own experience. We expect that this would furthermore improve if/when we would have a fulltime operator on site. This is however not possible with the number of LNG ship currently sailing along the Rhine.

6.2 Emissions

The installation required large amounts of LIN for cooling right after its commissioning. The demand for LIN dropped significantly after insulation was installed on the piping equipment. Furthermore, a steep drop was observed after commercial bunkering had started. The frequency of LNG drops ensures that LIN cooling is no longer essential for standard operations. Important factors that ensure cooling is not required are:

- Drops of LNG are frequent – continuous influx of cold LNG keeps the temperature low.
- Quantities required are large – Before every bunkering pump and pipes are cooled with LNG. The cooling introduces heat into the LNG tank. As the customers bunker large quantities of LNG the influx of heat is relatively small.
- Influx of heat via the tank is relatively small – The double walled insulated LNG tank transmits heat very poorly. LNG can stay cold inside the tank over a long period of time without requiring external cooling.

6.3 Quality, safety, and security

QSS was monitored via incident reports and corrective maintenance reports. The results are as follows:

- Zero LTI's reported.
- Zero near miss incidents reported.

- Downtime was essentially observed during operations, which can be contributed to: Inexperience of operators, inexperience of ship crew and technical downtime due to component failure. The total downtime was not reported however with the current incident reports.

Appendix: Time log

	day		date	time arrival Ship	time arrival Noordtec	time start	time end	leave site Noordtec	ship	month	time on site -ship	time on site -Operator	total bunker time	days between trips
	Saturday													
	Sunday													
WET001	*4*		1-okt-19						***RPG Bristol***					
WET002	*5*	*Okt*	30-okt-19						***RPG Bristol***	15023,38				
COL001	*1*		28-dec-19	15:00	15:00	16:48	18:42	19:15	RPG Stockholm		3:42	4:15	1:54	
COL002	*3*	*dec-19*	30-dec-19	09:00	9:00	9:30	10:10	11:00	RPG Bristol	27471,75	1:10	2:00	0:40	
COL003	*5*		1-jan-20	12:00	12:00	16:10	17:10	17:40	RPG Stutgart		5:10	5:10	1:00	
COL004	*7*		10-jan-20	08:30	8:30	10:30	11:40	12:10	RPG Stutgart		3:10	3:40	1:10	9
COL005	*1*		11-jan-20	08:30	8:30	9:00	10:15	10:45	RPG Stockholm		1:45	2:15	1:15	14
COL006	*1*		11-jan-20	14:30	14:30	15:15	16:30	17:45	RPG Bristol		2:00	3:15	1:15	12
COL007	*2*		19-jan-20	07:30	7:15	8:30	11:15	12:15	RPG Stockholm		3:45	5:00	2:45	8
COL008	*6*		23-jan-20	13:00	13:00	14:00	15:10	15:50	RPG Bristol		2:10	2:50	1:10	12
COL009	*7*	*jan-20*	24-jan-20	15:30	15:00	16:00	19:00	19:45	RPG Stutgart	78126	3:30	4:45	3:00	14
COL010	*2*		2-feb-20	10:00	10:00	11:00	12:40	14:00	RPG Stockholm		2:40	4:00	1:40	14
COL011	*6*		6-feb-20	14:00	14:00	14:54	15:49	16:30	RPG Stutgart		1:49	2:30	0:55	13
COL012	*2*		9-feb-20	11:00	11:00	11:35	12:38	14:30	RPG Bristol		1:38	3:30	1:03	17
COL013	*7*		21-feb-20	08:30	08:30	9:00	11:15	13:00	RPG Stockholm		2:45	4:30	2:15	19
COL014	*2*		23-feb-20	08:30	08:30	9:00	11:30	12:45	RPG Stutgart		3:00	4:15	2:30	17
COL015	*7*	*feb-20*	28-feb-20	09:15	09:15	10:00	12:00	13:30	RPG Bristol	73560	2:45	4:15	2:00	19
COL016	*7*		6-mrt-20	11:45	11:45	12:00	15:00	15:30	RPG Stockholm		3:15	3:45	3:00	14
COL017	*5*		18-mrt-20	08:00	08:00	09:23	10:33	11:00	RPG Bristol		2:33	3:00	1:10	24
COL018	*5*		25-mrt-20	08:30	09:00	9:40	11:06	12:30	RPG Stutgart		2:36	3:30	1:26	26
COL019	*2*	*mrt-20*	29-mrt-20	10:45	10:45	11:47	12:37	14:20	RPG Bristol	51826	1:52	3:35	0:50	23
COL020	6		2-apr-20	12:00	12:00	12:45	14:16	16:30	RPG Stockholm		2:16	4:30	1:31	27
COL021	4		7-apr-20	11:30	11:30	12:15	13:22	14:30	RPG Stutgart		1:52	3:00	1:07	13
COL022	7		17-apr-20	11:30	11:30	12:17	13:22	20:30	RPG Stockholm		1:52	9:00	1:05	15
COL023	7		17-apr-20	08:30	08:30	11:00	12:18	13:30	RPG Bristol		3:48	5:00	1:18	19
COL024	7		17-apr-20	12:00	12:00	14:30	15:30	16:15	RPG Stutgart		3:30	4:15	1:00	10
COL025	6	*apr-20*	30-apr-20	08:30	08:45	10:25	11:53	12:50	RPG Bristol	83920	3:23	4:05	1:28	13
COL026	3		4-mei-20	09:45	09:45	10:45	12:36	14:15	RPG Stockholm		2:51	4:30	1:51	17
COL027	1		9-mei-20	16:00	16:00	18:40	20:05	21:15	RPG Stutgart		4:05	5:15	1:25	22
COL028	2		17-mei-20	10:45	10:45	12:10	13:16	14:30	RPG Stockholm		3:45	3:45	1:06	17
COL029	3		25-mei-20	12:50	12:50	13:50	15:00	16:30	RPG Stutgart		3:40	3:40	1:10	21
COL030	6		28-mei-20	08:00	08:00	9:45	11:10	11:45	RPG Bristol		3:45	3:45	1:25	19
COL031	1	*mei-20*	30-mei-20	08:40	08:40	9:46	11:15	12:45	RPG Stockholm	95688	4:05	4:05	1:29	13
COL032	1		6-jun-20	15:30	15:30	16:43	18:34	19:45	Ecotanker 3		4:15	4:15	1:51	
COL033	4		9-jun-20	08:00	08:00	10:25	11:26	12:45	RPG Stutgart		4:45	4:45	1:01	15
COL034	4		23-jun-20	08:00	08:00	9:00	10:22	11:15	RPG Bristol		3:15	3:15	1:22	26
COL035	7		26-jun-20	07:15	07:15	8:30	10:15	12:00	RPG Stutgart		4:45	4:45	1:45	17
COL036	7	jun-20	26-jun-20	12:00	12:00	13:30	15:15	16:00	RPG Stockholm	79569	4:00	4:00	1:45	27
COL037	1		11-jul-20	09:30	09:30	11:00	12:30	13:45	RPG Stutgart		4:15	4:15	1:30	15

Figure 4: Timesheet as filled out by our operator