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Considerarions on Triple Banking Operation

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ABSTRACT

These paper arises from an FSU (Floating Storage Unit) project in which we have been directly involved on board the LNG vessel Seapeak Hispania. We have attended triple banking operations inside and outside of working hours and investigated the documentation and protocols necessary to carry out this type of operations, being on this ship the first time it has been carried out in the history of the company. Merchant navy.

Understanding what triple banking is and what the on-board procedure is to be able to carry it out have been the two points on which We have focused in this work since it is an operation that has not been seen before and of which the books They do not speak, therefore, participation and research on board have been the key aspects for the development of this work.

As a result, We have obtained the necessary information to publicize this type of operations through the procedure used to carry out a safe operation, thus avoiding material or human losses.

1. Introduction.

Liquefied natural gas (LNG) is natural gas that has been processed to be transported in liquid form. It is used to monetise remote and isolated reserves, where it is not economical to bring the gas to market directly either by pipeline or by electricity generation. Natural gas is transported in liquid form (at atmospheric pressure and -163 °C). This makes it cost-effective to transport, as the volume it occupies under these conditions is 1/600th of the volume it will occupy at the time of consumption. It is transported in special ships called LNG carriers. LNG is odourless, colourless, its density (relative to water) is 0.45 and it only burns if it comes into contact with air at concentrations of 5 to 15 %.

LNG is transported at atmospheric pressure in specially constructed double-hulled vessels. The cargo containment system is designed and constructed using special insulation and tank materials to ensure the safe transport of this cryogenic cargo.

The LNG in the ship's cargo tanks is kept at its saturation temperature (-161 °C) throughout the voyage, but a small amount of vapour is allowed to dissipate by boiling off, in a process called 'self-cooling'. The evaporated gas is used to drive the ship's engines' or, in this case, to fuel the steam boilers (Wikipedia, n.d.).

The triple banking operation (TBO) consists of the simultaneous offloading of a loading vessel, which we will call LNG, to the FSU (Floating Storage Unit) and in turn to a Shuttle Vessel (SV). In this case, when we talk about FSU, we are referring to the vessel Seapeak Hispania, which will be the 'intermediary' between the LNG and the SV.

For these operations we must assume that due to the characteristics of the FSU (steam turbine without reliquefaction plant or GCU) its capacity to manage evaporation is very limited and it cannot receive steam return from the SV during the operation. In addition to this, it is also recommended that the LNG can assume a high vapour return rate. The temperature and pressure of the cargo on arrival at the FSU should be as low as possible.

2. Methodology.

A triple banking loading operation generally refers to a logistics and operational strategy used in industries such as ship-

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ping, transport, and logistics, where multiple modes of transport or loading mechanisms are utilized simultaneously to optimize efficiency. This methodology is often employed to improve turnaround times, reduce costs, and enhance service levels.

2.1. Objective Definition.

Clearly define the operational goals of the triple banking loading operation, such as:

- Reducing loading and unloading times.
- Minimizing idle times for vehicles or equipment.
- Maximizing the throughput of goods in a facility.

2.2. Planning and Design.

Site Analysis: Evaluate the logistics site layout to understand the flow of goods, access points for loading/unloading, and storage capabilities.

Transportation Modes - Maritime Transport: Ships for international shipping.

Loading Protocols: Establish protocols for how cargo will be loaded, including safety standards and best practices.

Coordination and Communication: Communication Systems: Implement real-time communication systems (like radios or apps) for quick coordination between teams managing the different loading operations.

2.3. Execution of Loading Operations: Safety Checks.

Ensure all safety protocols are adhered to during loading, such as securing cargo and following operational safety guidelines.

The methodology behind a triple banking loading operation involves a comprehensive approach that incorporates strategic planning, real-time execution, performance monitoring, and continuous improvement. By effectively integrating multiple loading mechanisms, organizations can achieve enhanced operational efficiency, reduce costs, and improve service delivery.

Figure 1: Triple Banking Operation.

Source: Reganosa Company.

Figure 2: Opening and Closure: CTS Furcata Vessel.

SaabTankRadar G3 — **CUSTODY TRANSFER DATA**

Snapshot (load)

SHIPNAME		
DATE (DD/MM/YYYY)	23-10-2023	
LOCAL TIME (HH:MM)	18:05	
PORT NAME	SASSNITZ ANCHORA	
VOYAGE/CARGO NO.	2023-10	
CHIEF OFFICER		
TRIM (METRES)	0.09	BY HEAD
LIST (DEGREES)	0.11	TO PORT
AVERAGE TEMP. VAPOR	-102.5	DEG.C
AVERAGE TEMP. LIQUID	-159.7	DEG.C
AVG. PRESS.VAPOR	1,101	mBar(a)
ATMOSPHERIC PRESSURE	1,012	mBar(a)

LEVEL MEASUREMENT (M)	TANK4	TANK3	TANK2	TANK1
NO.1	2.471	0.297	1.685	0.247
NO.2	2.470	0.296	1.686	0.248
NO.3	2.472	0.297	1.683	0.248
NO.4	2.473	0.296	1.684	0.250
NO.5	2.471	0.298	1.686	0.249
AVERAGE LEVEL (M)	2.471	0.297	1.685	0.248
TRIM CORRECTION (M)	0.006	0.006	0.006	0.004
LIST CORRECTION (M)	0.002	0.002	0.002	0.002
CORRECTED LEVEL (M)	2.479	0.305	1.693	0.254
TEMPERATURE (DEG.C.)				
TOP	-112.17 V	-61.30 V	-66.83 V	-74.96 V
95%	-140.70 V	-79.46 V	-78.92 V	-97.01 V
85%	-145.52 V	-81.26 V	-80.30 V	-98.32 V
50%	-124.81 V	-87.70 V	-94.17 V	-98.82 V
10%	-155.66 V	-120.82 V	-144.56 V	-107.51 V
BOTTOM	-159.67 L	-159.63 L	-159.68 L	-159.69 L
AVG. VAPOR TEMP. (DEG.C.)	-135.77	-86.11	-92.96	-95.32
AVG. LIQUID TEMP. (DEG.C.)	-159.67	-159.63	-159.68	-159.69
VAPOR PRESS. (mBar(a))	1,102	1,102	1,099	1,102
VOLUME (m3)	3,328.199	408.124	2,369.154	175.377
VOLUME SUMMED (m3)	6,280.854	(A)		

SaabTankRadar G3 — **CUSTODY TRANSFER DATA**

Scheduled (load)

SHIPNAME		
DATE (DD/MM/YYYY)	23-10-2023	
LOCAL TIME (HH:MM)	22:50	
PORT NAME	SASSNITZ ANCHORA	
VOYAGE/CARGO NO.	2023-10	
CHIEF OFFICER		
TRIM (METRES)	0.00	EVEN KEEL
LIST (DEGREES)	0.02	TO PORT
AVERAGE TEMP. VAPOR	-99.1	DEG.C
AVERAGE TEMP. LIQUID	-159.3	DEG.C
AVG. PRESS.VAPOR	1,139	mBar(a)
ATMOSPHERIC PRESSURE	1,011	mBar(a)

LEVEL MEASUREMENT (M)	TANK4	TANK3	TANK2	TANK1
NO.1	0.789	0.303	0.295	0.258
NO.2	0.786	0.303	0.295	0.258
NO.3	0.782	0.303	0.295	0.258
NO.4	0.778	0.303	0.295	0.257
NO.5	0.774	0.303	0.295	0.257
AVERAGE LEVEL (M)	0.782	0.303	0.295	0.258
TRIM CORRECTION (M)	0.000	0.000	0.000	0.000
LIST CORRECTION (M)	0.000	0.000	0.000	0.000
CORRECTED LEVEL (M)	0.782	0.303	0.295	0.258
TEMPERATURE (DEG.C.)				
TOP	-85.60 V	-60.67 V	-61.66 V	-68.73 V
95%	-122.88 V	-78.10 V	-90.59 V	-91.92 V
85%	-126.60 V	-80.22 V	-94.99 V	-94.24 V
50%	-128.00 V	-86.20 V	-101.60 V	-98.16 V
10%	-131.91 V	-118.24 V	-141.19 V	-119.86 V
BOTTOM	-159.44 L	-159.17 L	-159.36 L	-159.23 L
AVG. VAPOR TEMP. (DEG.C.)	-119.00	-84.69	-98.01	-94.58
AVG. LIQUID TEMP. (DEG.C.)	-159.44	-159.17	-159.36	-159.23
VAPOR PRESS. (mBar(a))	1,139	1,139	1,137	1,139
VOLUME (m3)	995.248	405.421	394.699	178.172
VOLUME SUMMED (m3)	1,973.540	(A)		

Source: Authors.

Figure 3: Opening and Closure: CTS Fraseri Vessel.

SaabTankRadar G3 — **CUSTODY TRANSFER DATA**

Scheduled (load)

SHIPNAME		
DATE (DD/MM/YYYY)	18-10-2023	
LOCAL TIME (HH:MM)	20:40	
PORT NAME	SASSNITZ ANCHORA	
VOYAGE/CARGO NO.	2023-10	
CHIEF OFFICER		
TRIM (METRES)	0.04	BY STERN
LIST (DEGREES)	0.05	TO STBD
AVERAGE TEMP. VAPOR	-103.5	DEG.C
AVERAGE TEMP. LIQUID	-159.6	DEG.C
AVG. PRESS.VAPOR	1,120	mBar(a)
ATMOSPHERIC PRESSURE	1,013	mBar(a)

LEVEL MEASUREMENT (M)	TANK4	TANK3	TANK2	TANK1
NO.1	5.125	0.409	0.405	3.572
NO.2	5.130	0.409	0.405	3.567
NO.3	5.125	0.408	0.405	3.571
NO.4	5.125	0.408	0.404	3.570
NO.5	5.129	0.409	0.405	3.572
AVERAGE LEVEL (M)	5.127	0.409	0.405	3.570
TRIM CORRECTION (M)	-0.003	-0.003	-0.003	-0.002
LIST CORRECTION (M)	-0.001	-0.001	-0.001	-0.001
CORRECTED LEVEL (M)	5.123	0.405	0.401	3.567
TEMPERATURE (DEG.C.)				
TOP	-86.38 V	-70.14 V	-54.27 V	-114.42 V
95%	-105.44 V	-93.77 V	-72.51 V	-148.20 V
85%	-107.87 V	-96.21 V	-74.76 V	-149.02 V
50%	-112.60 V	-99.93 V	-81.92 V	-149.61 V
10%	-159.64 L	-126.77 V	-118.52 V	-159.38 L
BOTTOM	-159.60 L	-159.67 L	-159.34 L	-159.76 L
AVG. VAPOR TEMP. (DEG.C.)	-103.07	-97.36	-80.40	-140.31
AVG. LIQUID TEMP. (DEG.C.)	-159.62	-159.67	-159.34	-159.57
VAPOR PRESS. (mBar(a))	1,120	1,119	1,117	1,123
VOLUME (m3)	7,361.425	543.713	538.391	2,849.750
VOLUME SUMMED (m3)	11,293.279	(A)		

SaabTankRadar G3 — **CUSTODY TRANSFER DATA**

Snapshot (load)

SHIPNAME		
DATE (DD/MM/YYYY)	19-10-2023	
LOCAL TIME (HH:MM)	01:36	
PORT NAME	SASSNITZ ANCHORA	
VOYAGE/CARGO NO.	2023-10	
CHIEF OFFICER		
TRIM (METRES)	0.34	BY STERN
LIST (DEGREES)	0.03	TO STBD
AVERAGE TEMP. VAPOR	-104.7	DEG.C
AVERAGE TEMP. LIQUID	-159.6	DEG.C
AVG. PRESS.VAPOR	1,115	mBar(a)
ATMOSPHERIC PRESSURE	1,009	mBar(a)

LEVEL MEASUREMENT (M)	TANK4	TANK3	TANK2	TANK1
NO.1	3.940	0.428	0.423	0.343
NO.2	3.967	0.428	0.426	0.342
NO.3	3.978	0.427	0.425	0.346
NO.4	3.979	0.428	0.424	0.343
NO.5	3.984	0.428	0.426	0.343
AVERAGE LEVEL (M)	3.970	0.428	0.425	0.343
TRIM CORRECTION (M)	-0.022	-0.023	-0.023	-0.014
LIST CORRECTION (M)	-0.001	-0.001	-0.001	-0.001
CORRECTED LEVEL (M)	3.947	0.404	0.401	0.328
TEMPERATURE (DEG.C.)				
TOP	-74.43 V	-68.77 V	-54.30 V	-86.70 V
95%	-116.60 V	-91.87 V	-72.63 V	-142.64 V
85%	-119.66 V	-93.90 V	-74.87 V	-145.44 V
50%	-121.79 V	-98.12 V	-81.95 V	-148.22 V
10%	-159.60 L	-125.41 V	-119.26 V	-152.14 V
BOTTOM	-159.48 L	-159.63 L	-159.30 L	-159.85 L
AVG. VAPOR TEMP. (DEG.C.)	-108.12	-95.61	-80.60	-135.03
AVG. LIQUID TEMP. (DEG.C.)	-159.54	-159.63	-159.30	-159.85
VAPOR PRESS. (mBar(a))	1,116	1,115	1,112	1,115
VOLUME (m3)	5,537.020	542.352	538.391	227.253
VOLUME SUMMED (m3)	6,845.016	(A)		

Source: Authors.

3. Results.

3.1. Procedure for triple banking operations.

3.1.1. LNG arrival and hose connection.

There are two scenarios that can occur in this type of operation:

1. Having an SV moored to port alongside the FSU engaged in STS (Ship to Ship) operations.
2. Not having a SV moored alongside.

For the first one, FSU, i.e. the vessel Seapeak Hispania, will unload the SV with a cargo pump being a common or ‘ship to ship’ (STS) unloading. The loading operations must be stopped before the LNG carrier mooring manoeuvre begins.

For the second, which is the most frequent, LNG will approach the starboard side and, for legislative reasons with Germany, until the mooring manoeuvre with the LNG carrier is completed no further manoeuvre with the SV can take place.

Once the LNG vessel is moored to FSU’s starboard side, the mooring manoeuvre of the SV to the port side can commence.

Once both mooring manoeuvres have been completed, both vessels will be handed over the materials required for the operation.

For dual connection, 16‘ to 8’ reducers (total 8 hoses) will be installed on the port LNG manifold (liquid 3 and 4 + vapour). The hoses shall be inerted with nitrogen (N2) before starting the operation.

The connection of the hoses will be carried out by LNG personnel and using the FSU vessel's crane. The same shall be done for the connection of hoses to the SV.

After completion of the hose connection on both sides a pressure/leak test shall be performed with nitrogen at a pressure of 5 bar for liquid hoses and 2 bar for vapour hoses.

3.1.2. ESD (Emergency shutdown) test procedure.

Once the pressure test is successfully completed, an ESD test will be carried out between LNG, FSU and SV. For this purpose an electrical connection cable shall be sent to both vessels to have ESD communication and start testing.

1. Ensure that the pressure in the hoses has been fully relieved after the pressure test.
2. The electrical system shall be used and a cable shall be transferred from FSU to both vessels.
3. All parts shall be connected to the system in override condition in order to avoid unwanted ESD tripping.
4. Once the link is found to be in good condition on both sides, LNG, SV and FSU shall organise and align the system for further testing. The ESD valves on both sides must be open (ensure that no pressure has built up in the hoses before opening the valves).
5. Due to the configuration of the ESD system, FSU must stop burning gas for testing. This will compromise the pressure management in the FSU tanks, so these operations should be performed as quickly as possible to minimise the pressure build-up.
6. After removal of the override on both sides, three hot ESD tests shall be performed from FSU to LNG and SV and vice versa. Hot ESD is the test before cooling of the hoses.
7. For cold conditions, an open/close test of the ESD valves shall be performed provided that the system operates correctly during the cold stroke test.
8. Once the system is supported on both sides. The bond shall be maintained in line between the three parts.

3.1.3. Management of generated steam.

The management of the generated vapour is a key part of the whole OTB procedure. Due to the characteristics of the FSU, its capacity to handle large amounts of evaporation is limited, so during this operation the reception of evaporation from the SV will be impossible.

The LNG will have to arrive at the FSU with the minimum pressure and temperature in its tanks to be able to handle the excess boil-off gas generated in the FSU, especially during the first stage of the operation.

1. Upon completion of the hot ESD test, LNG shall open its ESD steam valves to be ready to receive steam from the FSU.
2. FSU shall control the steam flow through its control valve.
3. The ideal situation should be to manage the pressure only from the free flow from FSU to LNG. This will only be possible if LNG and FSU can keep their pressure stable during the whole operation.
4. In case FSU or LNG cannot keep their pressure stable by free flow, the flow should be reduced or even the loading operation should be stopped until the pressure is manageable.
5. Evaporation management shall continue until the time of steam hose disconnection after draining and purging of the hoses.

3.1.4. Hose Cooling.

The cargo lines on FSU and LNG will be cooled prior to the arrival of the LNG. Only the cargo hoses and manifolds shall be cooled before the start of operations, i.e. the hoses connecting the two vessels.

1. Before starting the FSU's spray pump, the LNG shall be lined up to cool its cargo lines by opening the ESD valves and double shut-off valves on liquid arms 3 and 4.
2. The LNG vapour ESD valve and also the intermediate valves shall be opened to allow vapour to flow to its side when necessary. FSU will open the manifold valve but keep the regulating valves closed until such time as it needs to send return steam.
3. The FSU will start a recirculating spray pump and cool its spray manifold for approximately 20 minutes.
4. After the spray manifold has cooled down, the FSU will open the cooling valves on manifolds 3 and 4.
5. The liquid flow to the hoses must be slow in the first stage due to the large amount of vapour generated. The cooling rate will be gradually increased while controlling the pressure increase. In this case the flow rate has to be reduced.
6. When the collectors, LNG, SV and FSU, are completely frozen, the cooling is completed. This usually takes 45 to 60 minutes.

3.1.5. Initiate loading from LNG.

The intention of the OTB is to charge the SV with the elevated pressure in the liquid manifold of the FSU during the unloading of the LNG.

Obviously, there must be no pressure in the FSU liquid manifold to start this operation.

We assume that all lines, manifolds and hoses of the three vessels involved in the operation are cold and ready to deliver / receive cargo.

1. In the SV, the ESD valves and double shut-off valves for liquid hoses should be open and ready to receive cargo.
2. On the FSU port side manifolds, the ESD valves on the liquid hoses shall be open and the double shut-off valves shall be closed.
3. At the LNG manifold, the liquid and vapour ESD valves shall be open. The vapour return lines and valves shall be aligned to receive vapour from the FSU.

4. On the FSU starboard manifold, the liquid and ESD vapour valves shall be open. The intermediate vapour valves shall be closed and ready for operation as soon as it is necessary to handle boil-off gas.
5. In the FSU, at least two tanks shall be fully open and the other two partially open.
6. The LNG will begin to start up its pumps, putting the first one into recirculation and opening the butterfly valve slowly to allow filling the liquid manifolds on both vessels and hoses without any pressure increase. At this point the loading operation begins.
7. Once the first pump is aligned at minimum speed and after verifying that all lines, manifolds and hoses are in good condition, FSU and LNG shall agree to start the following pumps until a maximum LNG manifold pressure of 5 bar is reached which shall be considered as full rate.
8. At the same time, when the FSU reaches a pressure of 2 bar in its liquid manifold, the double shut-off valves of the port liquid manifold shall be progressively opened until 100% is reached. This shall result in a pressure drop in the liquid manifold of the FSU.
9. The next key step in the operation is to stabilise the pressure in the FSU liquid manifold to allow liquid to flow into the SV. This pressure will depend on the rate required by the SV. At this stage, the FSU has no means of knowing the flow to the SV (there is no flow meter on board), so continuous feedback from the SV will be necessary to know an approximate rate.
10. Once the LNG is being discharged at the required rate, the pressure in the liquid manifold of the FSU will be managed in closed operation with the SV and the LNG opening or closing the cargo tank valves in the FSU. This operation shall cause a variation in the pressure in the LNG unloading pumps and shall therefore be carried out in a smooth manner and with active communication with the crew of the vessel.
    On board, we think of it as having 5 tanks, i.e. 4 FSU tanks and one SV tank. Therefore, if we throttle the filling valve of one of the FSU tanks, it will increase the flow to the SV tank.
11. We will always be filling all 4 FSU tanks at the same time but limiting the flow into each tank to avoid heating any of the cargo tanks and not having to use the spray pump to cool them as this would generate boil-off gas and further increase the pressure in the cargo tanks.
12. There will be different scenarios during OTB depending on the timing of the operations and, the pressures in the FSU will change causing variations in the SV flow rate and pressure in the LNG. These scenarios are:
    - Pump intensification in LNG.
    - Deceleration of pumps in LNG.
    - Filling of tanks in FSU.
    - Changing/adjusting the rates of loading tanks at FSU.
    - Start of loading in SV.
    - Filling of tanks in SV.
    - Finished loading in SV.

    Most sensitive to pressure changes is filling and end of loading in SV and FSU.

3.1.6. Tank filling and final loading in SV during TBO.

1. 1 hour's notice is required from the SA prior to the commencement of the filling/defuelling of its tanks.
2. As SV requires to reduce the rate, FSU will reduce the pressure in its liquid manifold via the tank valves if load conditions permit. Otherwise, the LNG should reduce the flow rate.
3. At the same time, FSU will start to gradually close its double shut-off valves on the port side manifolds, closely checking that the pressure in the liquid manifold does not increase too much.
4. The FSU shall continue to close the double shut-off valves as required by the SV until both tanks are full. When the double shut-off valves are completely closed, the loading of the SV can be considered completed.
5. The SV has to leave its ESD valves double-closed and at least one tank open to allow the lines to drain.
6. Once the SV charging lines are depressurised, the FSU will close its ESD valves on the port manifold to begin draining, purging and disconnecting the charging hoses.

3.1.7. Filling of tanks and completion of loading in FSU during TBO.

1. The FSU shall give one hour and 5 minutes' notice to the LNG.
2. The FSU shall request a flow reduction from the LNG (this shall also result in a load flow reduction in the RV as long as the OTB is followed).
3. The FSU shall start closing the tanks one by one and operate its valves slowly to avoid excessive pressure build-up.
4. The FSU will continue to close the tanks gradually in coordination with the reduction of the LNG flow.
5. The last step of the refuelling will require always keeping at least one tank open in the FSU with the LNG pump flow rate at minimum (min. 700 max. 1000 m^3/h) before stopping the refuelling.
6. Once it has been confirmed that the load has been stopped and the manifold pressure in the FSU and LNG has decreased, the ESD manifold liquid valves on both manifolds can be closed. The vapour return will remain open.

3.1.8. Draining, purging and disconnecting LNG hoses.

In this case, draining and purging of hoses should be done from the LNG to the FSU due to the difference in heights. However, this is not the case.

For this operation the final pressure in the tanks should be as low as possible and the steam hose will be disconnected last.

1. After loading/unloading is completed and the manifold valves are closed, the liquid hoses should be sprayed with water at the lower bend where the liquid gas tends to accumulate in order to perform a warm-up so that no liquid remains in the hoses.
2. The heating of the hoses will cause the pressure in the hoses to start to increase. When this pressure reaches 5 bar, it will be released to the LNG tanks through the liquid line directly or through bypass valves to the spray manifold.
3. This operation shall be repeated until it is observed that the lower elbow of the hoses does not freeze.
4. At this stage, the purge manifolds of the FSU and LNG must be opened slightly to check that no liquid gas is flowing.
5. The next step is the purging of the liquid hoses with nitrogen. The pressure will be increased to 5 bar with nitrogen and released to the LNG tanks through manifold and spray manifold shut-off valves. As seen in this operation, 3 purge cycles of 15 minutes of pressure increase (up to 5 bar) and 5 minutes of depressurisation are performed. At the end of the 3 cycles of 20 minutes this operation ends. The CH4 measurement in the LNG (the side to be disconnected) must fall below 80% LEL. At this point the hoses are considered 'liquid free' and disconnection of the liquid hoses can begin.
6. The ESD valves on the vapour hoses can now be closed to begin purging.
7. In this case, the blowdown will be done to the LNG because nitrogen cannot flow into the FSU vapour header because it always burns only gas and the presence of nitrogen in the header can cause the boilers to shut down.

Again, when the CH4 (methane) measurement in the LNG (the side to be disconnected) falls below 80 % of the LEL, we can consider the hose to be free of gas and disconnection can begin. This is achieved by performing a continuous sweep with nitrogen.

Conclusions.

The triple banking operations, initiated by the FSU project in northern Germany to supply gas from Russia, is a good activity proposal to speed up the loading of the different supply vessels while the gas pipeline is being built in the northern part of the country. On the other hand, there are aspects of the project that need to be improved that are essential for the safety of the operation. These include the following:

- The vessel 'Seapeak Hispania', lacking a GCU (gas combustion unit) and a reliquefaction plant, is not capable of managing the amount of steam generated on board by itself. Because of this, we have encountered problems with pressure build-up in the cargo tanks and had to stop operations until the pressure dropped to a safer level.

  At this very point we encounter another problem as it is necessary to cool the lines and tanks again which will generate more 'boil off' thus increasing the pressure in the tanks.

- External forces have been a weight handicap during operations as they are another factor to be taken into account for the safety of the operation. There are stipulated reference values that are fundamental to stop cargo operations whether they are triple banking or STS. This, during a triple banking operation, entails the mobilisation of many crew members and man-hours to disconnect both manifolds, as in bad weather it is not enough to stop operations, it is also necessary to undock both vessels to avoid, among other problems, the rupture of cargo hoses.

- The last point as a weight improvement aspect that I have noticed concerns the safety of the crew. The emergency plan for leaving the ship during the triple banking operations was slightly modified by including a life raft on the port side and another on the starboard side at the stern.

References.

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