EXCELERATE ENERGY

PETROBRAS TRANSPORTE S.A. TRANSPETRO

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TRBA Terminal Manual Annex 04

STS Hose Draining, Purging & Disconnection Procedure

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Contents

1.0 INTRODUCTION

001 The purpose of this Terminal Manual Annex is to enable effective communication between the LNGC ship staff and the FSRU Ship staff of the STS Hose Disconnection Procedure including the preparation such as draining and purging. The principal objective is to disconnect the STS cargo hoses in a manner that eliminates any risk of liquid release and reduces the release of hydrocarbons to the atmosphere to an absolute minimum.

002 The Draining and Purging procedure differs to a conventional LNG Discharge Terminal in the following ways:

- STS Flexible Hoses are used for the transfer; therefore, the lowest point of the transfer system is at the apex of the hose which is below the level of the manifolds as opposed to a conventional loading arm where the lowest point is the manifold which facilitates gravitational draining of the liquid.
- Due to the on-going Regas operations, the stripping header of the FSRU is not available for draining/purging after the cargo transfer.

2.0 PROCEDURE

003 The Process has four (4) logical steps.

004 It is imperative that verification of the valve positions based on the completion of cargo.

005 The four steps shall then be followed in logical order, the valve positions for each step consider that the valves positions have not been changed from the procedure in the previous step.

Process Step	Estimated Time Requires
STEP 1 - Draining of the LNGC Vertical Riser	15 mins
STEP 2: De-icing / Draining and Liquid Freeing of the Liquid STS Hoses	90 mins
STEP 3: Purging STS Hoses and Connections	150 mins
STEP 4: Disconnection of the STS Hoses	60 mins

2.1 Responsibility & Communication

006 It is highlighted that both the LNGC and FSRU Ship Staff bear responsibility for the safe conduct of the operation on board their respective vessels and that clear communication and cooperation are essential.

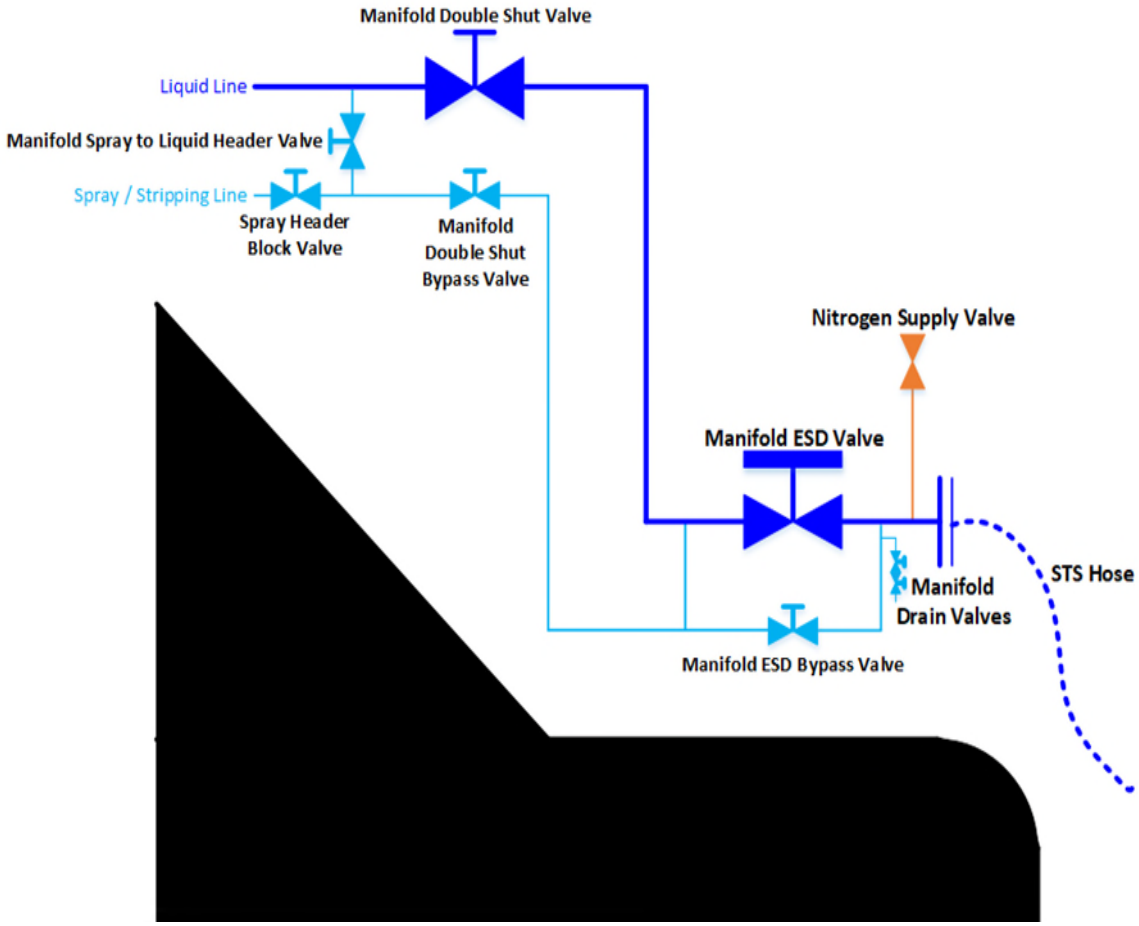
007 If any party is in any doubt of other parties' request or believes that an instruction may have been given incorrectly then it is every individual's duty to intervene, ask questions and gain clarification before proceeding to ensure the process is completed without incident.

2.2 Process Safety – Two Person Check

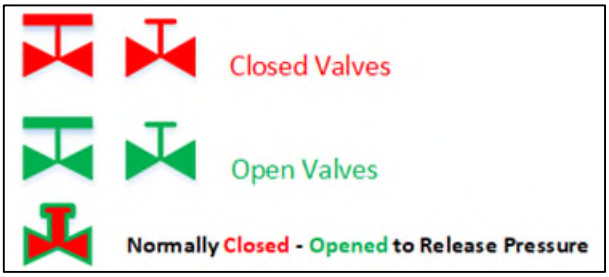
008 The operation of valves at the manifold and the measurement of gas readings during the draining, purging, and disconnection should be independently checked by an additional competent person on both the LNGC and FSRU, thus significantly reducing the likelihood of human error or omission.

2.3 Process Terminology

009 The following pipeline diagram key will be used during the procedure to highlight which valves are closed or open in the process.



010 The below-recognized industry terminology shall be used during the process to avoid confusion:



2.4 Preparations after Cargo Transfer is completed

011 Both the LNGC and FSRU shall assure maximum Nitrogen Buffer Tank pressure and readiness of Nitrogen Production Units to counter the high Nitrogen demand.

012 Both the LNGC and FSRU shall assure the availability of Fire Hoses for warming up the liquid transfer hoses during draining and purging.

013 The following action shall be taken:

1. Sea water spray shall be directed onto the LNG hoses bight to speed up de-icing and vaporization of remaining LNG in the hose until the pressure reaches 4-5 bar and then opening the LNGC manifold bypass valves until the hoses are liquid free.
2. No water shall be sprayed on the hoses or manifold on LNGC side but only at hose bends and at FSRU side.
3. The pressure increase shall be released to the FSRU.
4. LNG evaporates which consequently assist in liquid displacement in the lines.
5. Both vessels shall conduct this operation concurrently.
6. Both vessels shall provide N2 for purging the hoses.
7. The following pipeline diagram key shall be used during the procedure to highlight the status of the valves.

014 The ESD Cable shall only be disconnect just before the physical disconnection of the STS Hoses in order not to get damaged with STS hose disconnection. The reason for this is that it allows the option to keep the vapor return open for Gas Management purposes if needed. It shall stay connected for ESD valves and ESD logic to function.

3.0 STEP 1 - DRAINING OF THE LNGC VERTICAL RISER

3.1 General

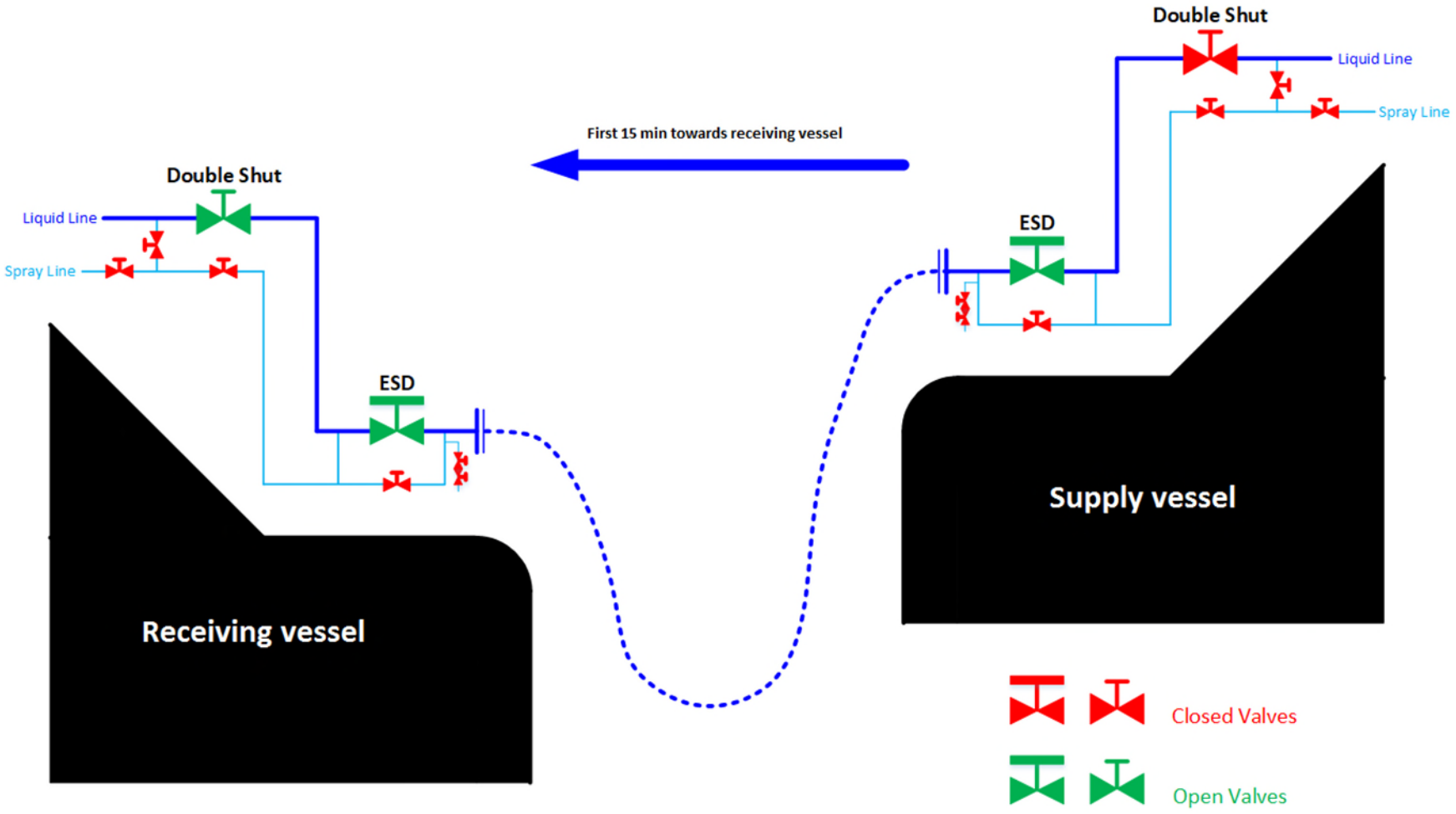
3.2 LNGC Procedure – Draining LNGC Vertical Riser

1. Close LNGC Spray Header Block Valve (Verification) ☐
2. Close LNGC Manifold Spray to Liquid Header Valve (Verification) ☐
3. Close LNGC Manifold Double Shut Bypass Valve (Verification) ☐
4. Close LNGC Manifold ESD Bypass Valve (If Applicable) (Verification) ☐
5. Close LNGC Manifold Drain Valves (Verification) ☐
6. Open LNGC Manifold ESD Valve (Verification) ☐
7. Close LNGC Manifold Double Shut Valve ☐

3.3 FSRU Procedure – Draining LNGC Vertical Riser

1. Close FSRU Spray Header Block Valve (Verification) ☐
2. Close FSRU Manifold Spray to Liquid Header Valve (Verification) ☐
3. Close FSRU Manifold Double Shut Bypass Valve (Verification) ☐
4. Close FSRU Manifold ESD Bypass Valve (Verification) ☐
5. Close FSRU Manifold Drain Valves (Verification) ☐
6. Open FSRU Manifold Double Shut Valves (Verification) ☐
7. Open FSRU Manifold ESD valves (Verification) ☐

3.4 STEP 1 DIAGRAM - Draining of the LNGC Vertical Riser



4.0 STEP 2 - DRAINING AND LIQUID FREEING OF THE LIQUID STS HOSES

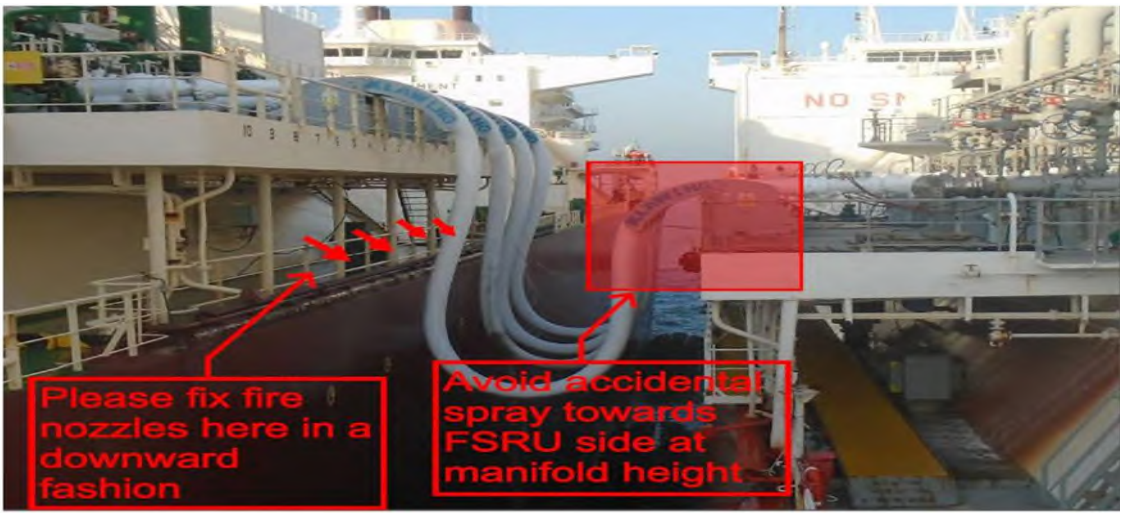
4.1 General Procedure – Both Ships

1. Stop water deluge system. ☐
2. Stop water curtain. ☐
3. LNGC and FSRU shall provide water hoses for warming up the liquid transfer hoses. ☐
4. Drains and vents to the atmosphere shall not be opened. ☐
5. Sufficient crew shall be available to start spraying on all Liquid STS Hoses. ☐
6. Drain water under manifold – remove dam. ☐
7. Close unnecessary fire line consumers e.g. anchor wash. ☐
8. The vapor return may be re-opened to take vapor from LNGC if requested by LNGC at the discretion of the FSRU depending on the FSRU cargo tank pressures. ☐

4.2 De-Icing – Both Ships

1. Fire hoses using sea water, rigged under the manifold drip tray on both the LNGC and FSRU shall be used to spraying on the lower bend and the vertical length of the liquid hoses. ☐
2. Start seawater spray on the lower hose bends below the manifold (ensure 4 firehoses and 4 nozzles are prepared in advance). See below for guidance on how to set up the seawater spray correctly. ☐

⊗	Seawater spray on the lower hose bends below the manifold only No FW spray on the STS hoses, only FW spray on hard piping.



3. The LNGC must apply freshwater (FW) spray ONLY on the LNGC hard piping outboard of the manifold valves (ensure 2 freshwater hoses are prepared in advance). See below for guidance on how to correctly de-ice the manifold piping. ☐

4. The progress of de-icing the STS Hoses can be monitored by temporarily stopping the water spray on the lower bend of the hose and observing if icing still occurs. ☐
5. The spraying of seawater on the lower bend of the liquid transfer hoses from under the manifold drip tray shall continue throughout until all STS Transfer hoses are completely purged. ☐

4.3 LNGC Procedure – Liquid Freeing

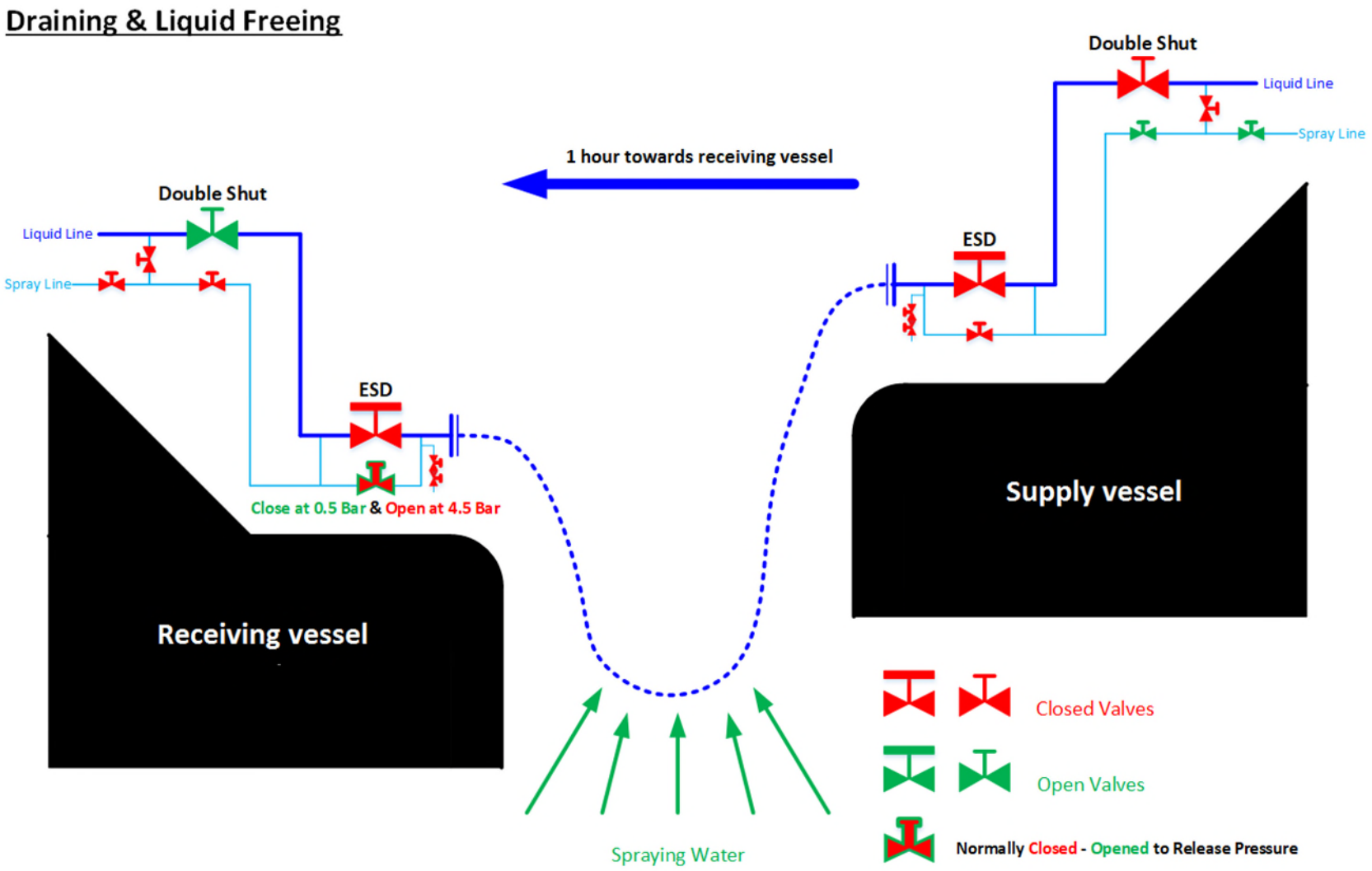
1. Close LNGC Manifold ESD Valve. ☐
2. Close LNGC Manifold Double Shut Bypass Valve. ☐
3. Open LNGC Spray Header Block Valve - this is to avoid a liquid trap between the Manifold ESD valve and the Manifold Double Shut Valve. ☐

4.4 FSRU Procedure – Liquid Freeing

1. Close FSRU Manifold ESD Valve. ☐
2. Liquid trapped in the hoses shall start to evaporate. The pressure in the STS Hoses shall increase. ☐
3. Open FSRU Manifold ESD Bypass Valve when individual FSRU Manifold Pressures reach 4.5 bar thus releasing the pressure towards the FSRU. ☐
4. Close FSRU Manifold ESD Bypass Valve when FSRU Manifold Pressures drop to 0.5 Bar STS. ☐
5. Repeat Steps 3 & 4 for 1 hour.

	The pressure STS Hoses shall stabilize and increase less rapidly towards the end of the process when the Manifold ESD Valves and Manifold ESD Bypass Valves are closed.

4.5 STEP 2 DIAGRAM - Draining and Liquid Freeing of the Liquid STS Hoses



5.0 STEP 3 – PURGING STS HOSES AND CONNECTIONS

5.1 General

5.1.1 Nitrogen Hoses specifications

015 The number of Nitrogen supply hoses supplied by the FSRU and LNGC shall be agreed during the pre-transfer meeting and connected to the purging connection depending on the STS Transfer Hose Configuration – one nitrogen hoses connected per a manifold:

- Five (5) Nitrogen Hoses (L1-L2-V-L3-L4)
- Four (4) Nitrogen Hoses (L2-V-L3-L4)
- Three (3) Nitrogen Hoses (L2-V-L3) or (V-L3-L4)
- Three (3) Nitrogen Hoses (V-L3-L4)

016 When the LNGC has an ESD Manifold Valve Bypass then the nitrogen purge will be from the FSRU towards the LNGC, therefore the Nitrogen Hoses will be connected at the FSRU manifold purge connection. To speed up the purging operation it is expected that the LNGC assist with the Nitrogen Supply, therefore the LNGC should have the below specified N2 Hose and Flange Specification ready upon arrival for inspection by the FSRU Cargo Engineer.

- Hose Length: Minimum 35 Meters
- Flanges x 2 pieces.
- Outer Diameter (O.D.): 90 mm
- Pitch Circle Diameter (P.C.D.): 60 mm
- Hole Size: 15 mm
- Flange Size: ½”

5.1.2 Scenarios

017 LNGC **HAS** ESD Manifold Valve Bypass – Purge towards the **LNGC**

018 LNGC **DOES NOT** have Manifold Valve Bypass – Purge towards the **FSRU**

5.1.3 General Procedure – Both Ships

019 Connect nitrogen hose at vessel manifold purge connection

020 The spraying of seawater on the lower bend of the liquid transfer hoses from under the manifold drip tray shall continue throughout until all STS Transfer hoses are completely purged.

021 The bolts and the spool pieces shall defrost and warm up naturally during the purging process in the ambient air temperature – the LNGC should not spray water on the STS Hoses or Reducers on the LNGC Vessel Manifold.

5.1.4 Minimum Performance Standard – Completion of Purging

022 At periodic intervals, the vent in way of the manifold shall be opened and the vapor is tested using a meter calibrated for measuring methane in nitrogen. The drain valves should remain closed at this time to avoid releasing potentially dangerous gas cloud. Purging is complete when 2% by Volume is reached.

5.2 Purging Towards LNGC

5.2.1 FSRU Procedure – Purging STS Hoses & Connections

1. Connect nitrogen supply hose to purging connection of FSRU. ☐
2. Pressurize the purge valve on the manifold to avoid backflow of LNG in the hose. ☐
3. Open purge connection. ☐
4. Close FSRU Manifold ESD Bypass Valve. ☐

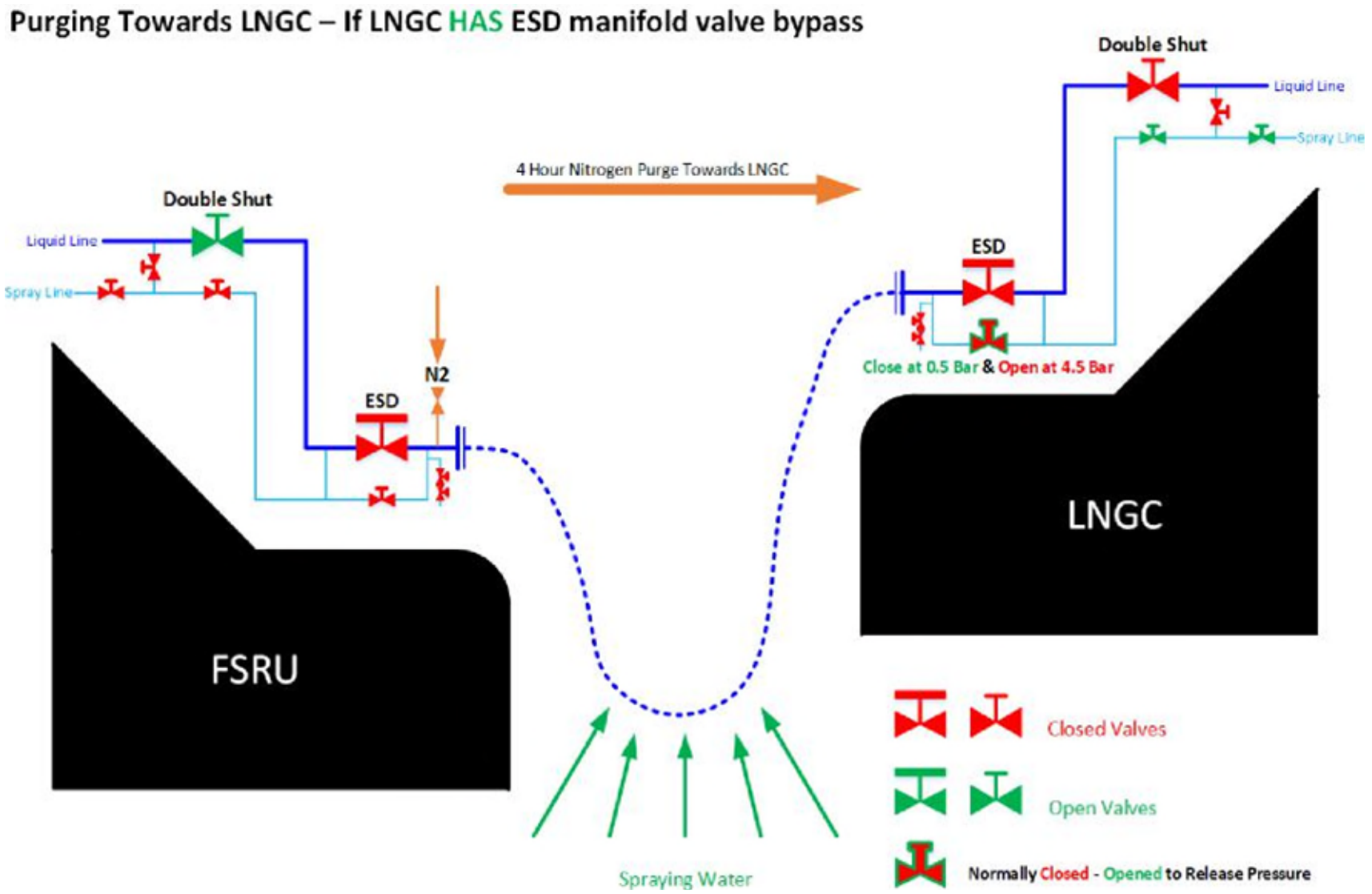
5.2.2 LNGC Procedure – Purging STS Hoses & Connections

1. Allow nitrogen pressure in the STS Hoses and Connections to increase to 4.5 bar. ☐
2. Open LNGC Manifold ESD Bypass Valve thus releasing the pressure into the LNGC Spray Line. ☐
3. Allow pressure in the STS Hoses and Connections to reduce back to 0.5 bar. ☐
4. Close LNGC Manifold ESD Bypass Valve. ☐
5. Repeat Stages 1 to 4 for significant time until the Hydrocarbon reading at the LNGC Manifold is 2% by Volume. ☐

	Pressure release should be well coordinated and the pressure in the stripping header should be checked regularly. Only one manifold ESD bypass valve shall be open at any one time to avoid a liquid flow from one hose into the other.

	Adequate time should be allowed between the opening of each Manifold ESD Bypass Valve in order to ensure stabilization of the pressure in the stripping line.

5.3 STEP 3 DIAGRAM - Purging Towards LNGC



5.4 Purging Towards FSRU

023 If the LNGC does not have a Manifold ESD Bypass Valve, purging shall be done from the LNGC towards the FSRU. The pressure shall be released into the tank using the liquid header as the stripping header is in use for Regas operations. When purging towards the FSRU there should be no change in the pipeline and valve setting from the Draining and Liquid Freeing procedure.

5.4.1 LNGC Procedure – Purging STS Hoses & Connections

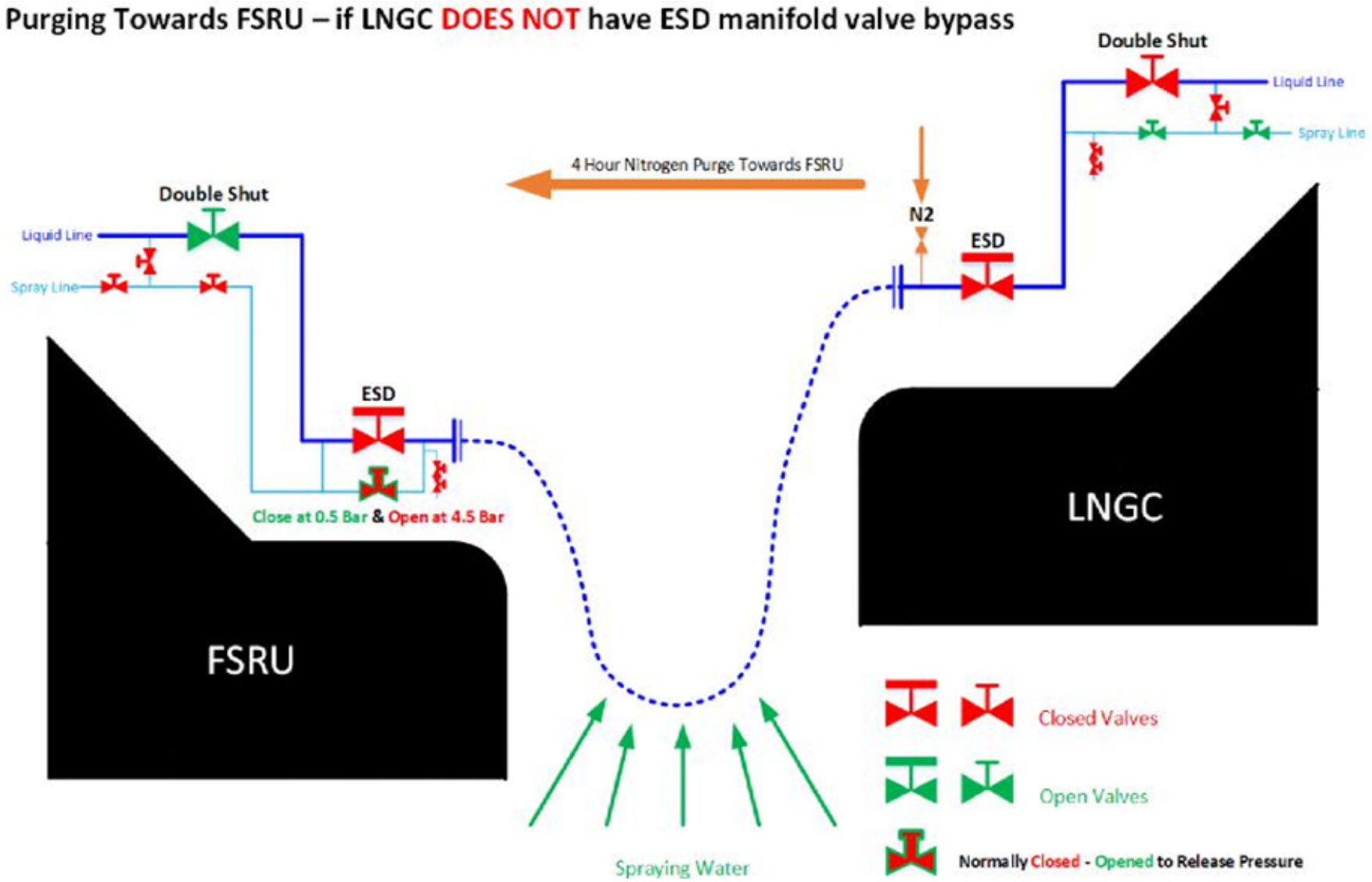
1. Connect nitrogen supply hose to purging connection of LNGC. ☐
2. Pressurize the purge valve continuous on the manifold to avoid backflow of LNG in the hose. ☐
3. Open purge connection. ☐

5.4.2 FSRU Procedure – Purging STS Hoses & Connections

1. Allow nitrogen pressure in the STS Hoses and Connections to increase to 4.5 bar. ☐
2. Open FSRU Manifold ESD Bypass Valve thus releasing the pressure into the liquid line. ☐
3. Allow pressure in the STS Hoses and Connections to reduce back to 0.5 bar. ☐
4. Close FSRU Manifold ESD Bypass Valve. ☐
5. Repeat Stages 1 to 4 until the Hydrocarbon reading at the FSRU Manifold is 2% by Volume. ☐

	Pressure release should be well coordinated and the pressure in the stripping header should be checked regularly. Only one manifold ESD bypass valve shall be open at any one time to avoid a liquid flow from one hose into the other.

5.5 STEP 3 DIAGRAM - Purging Towards FSRU



6.0 STEP 4 - STS HOSE DISCONNECTION

	Disconnect ESD Cable
	All STS hoses shall be purged prior commencing STS hose disconnection whereby the methane content shall be verified at below 2% by volume on all STS Hoses prior to disconnection.

024 Once purging has been completed:

1. Close LNGC Manifold ESD Bypass Valve. ☐
2. Close LNGC Manifold Double Shut Bypass Valve. ☐
3. Close LNGC Spray Header Block Valve. ☐
4. Close FSRU Manifold ESD Bypass Valve. ☐
5. Close the FSRU Manifold Double Shut Valve. ☐
6. Open FSRU Manifold Drain Valve. ☐
7. Nitrogen hoses should be transferred and connected to the purging connections on the LNGC Liquid and Vapour manifold lines, this shall enable a continuous flow of Nitrogen from the LNGC towards the FSRU. ☐
8. Before disconnection, a final check shall be made to ensure that the methane content remains below 2 % by Volume and that the line is liquid free via the drain valves. If both checks indicate safe condition, then proceed. ☐
9. Stop the Nitrogen Supply to the LNGC Manifold. ☐
10. Open LNGC Manifold Drain Valve and fully depressurize the manifold – drain valves should remain open until the hoses have been completely disconnected. ☐

6.1 STEP 4 DIAGRAM - STS Hose Disconnection