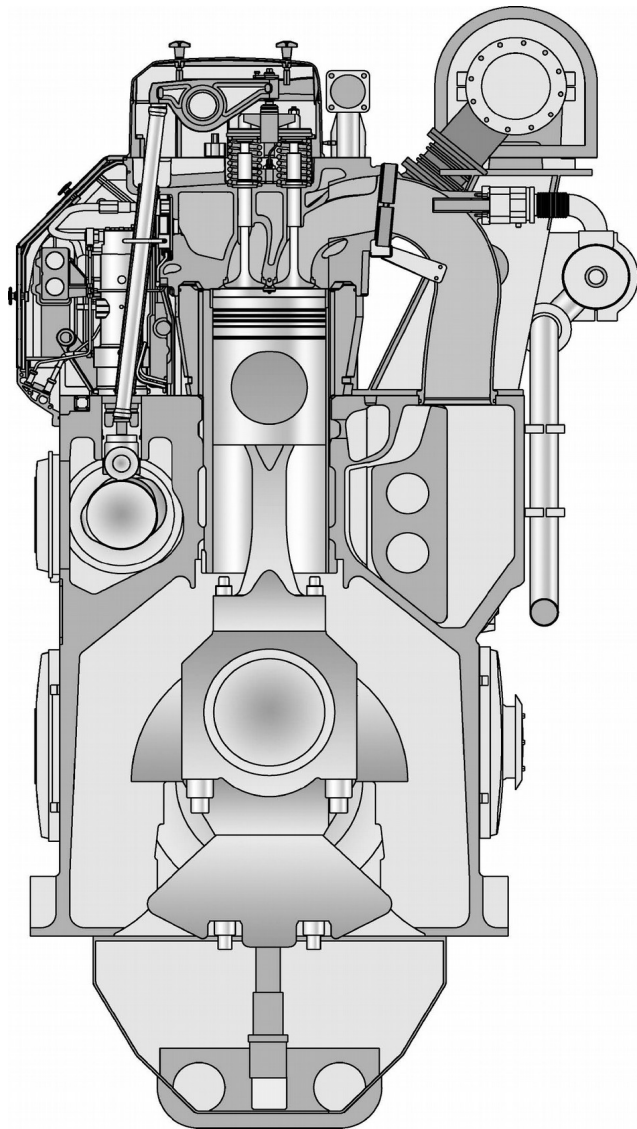


# Dual-Fuel Diesel Electric simulator type C



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2018

# 1 Vessel data sheet

Dead load capacity	55,000 dwt
Length	218 m
Width	31,8 m
Maximum speed	23 kt
Propulsive power	21000 kW
Electric propulsion motors	2
DA	4 x Wärtsilä 8L50DF (4 x 7,600 kW)
Main bus bar voltage	6.6kV
Main bar	4x400V
Bow thrusters	2
Stern thruster	1

TABLE 1: Main Features

## Dual Fuel Engines

### Wartsila 8L50DF

- 7600 kW
- bore 500 mm
- 8 cylinders in line
- an air cooler
- Two turbo-soufflantes
- 500 rpm
- gas mode / DO-HFO / backup (without pilot injection)

## 2 Systems addressed

The systems represented by the DFDE simulator are as follows:

- IAS (Integrated Automation System) control system
- Alarm management,
- Electrical power management,
- Propulsion system.
- GE Dual Fuel management,
- LNG Operations Control System (Control System)
- LNG refuelling (truck, barge or pipe),
- Monitoring of operations,
- Gas quality,
- ESD system,
- LNG Storage
- Gas operations before supplying the groups.

### 3 Start-up

- 1 Load the *DEDF42-CF* program,
- 2 Load the initial cold ship condition,

Start the simulation with F1 then Home, the most common keyboard shortcuts are :

Shortcut	Function
F1	Run
F2	Freeze
F3	Stop
Shift+F6	Initial condition
Home	Main page
Pg Up	Increase the page
Pg Down	Decrease the page
F12	Ack buzzer

TABLE 2: Keyboard shortcuts

*Note that these shortcuts are also accessible via Menu Operation*

### 4 Cold ship start sequence

#### 4.1 Overall process

Stage	Action	Page
1	Line up for MDO from MDO Service tank to DGs via the Emergency Fuel Feed Pump	(MD455 & 460)
2	Line up DG LO system	(md 305 & 310)
3	Line up DG cooling water system	(MD405-410)
4	Start DG from local stand and connect it to main switchboard Note ! Connect electrical consumers to main switchboard to achieve heating from DGs.	(MD205-220) and MD105
6	Line up for normal fuel supply	(MD460)
7	Prepare ventilation	
8	Prepare LNG supplier for bunkering (truck, ship or terminal) (MD480)	
9	Prepare vessel for bunkering	(MD510 & 755)
10	Line up for heating of LNG	(MD515)
11	Prepare Gas Supply to DGs	
12	DO/HFO-Gas Change Over	
13	Line up and start up next Diesel Engine, start on Gas and connect to main switch board	
14	Prepare for start up of propulsion from engine control room	
15	Transfer control position to bridge	
16	Ready for Departure	

TABLE 3: Main steps

## 4.2 Procurement

### 4.2.1 Equipment

The vessel is equipped with two type C tanks for a total capacity of 400m<sup>3</sup>. The two tanks are maintained at 5 bar at a temperature of -127°C. The ship is equipped with two nitrogen tanks for inerting, in particular of the supply pipes, but also for pressurising the FWHT expansion box, the system is pressurised to 8bar.

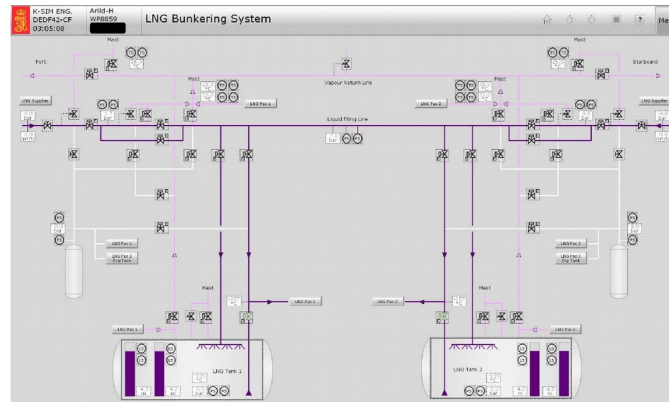


FIGURE 1: LNG Bunkering System

Each tank is equipped with a spray line that will allow:

- Refrigeration of the tank by vaporizing droplets during a cooling procedure,

- Tank pressure management during the supply operation,

The steam return lines and liquid lines are designed to be able to be interconnected.

### 4.3 LNG supply

The pressure delivered to the GUV during operation is 6.3bar to deliver the gas to 2.3bar in the engine intake pipe, at a temperature of 34.1°C.

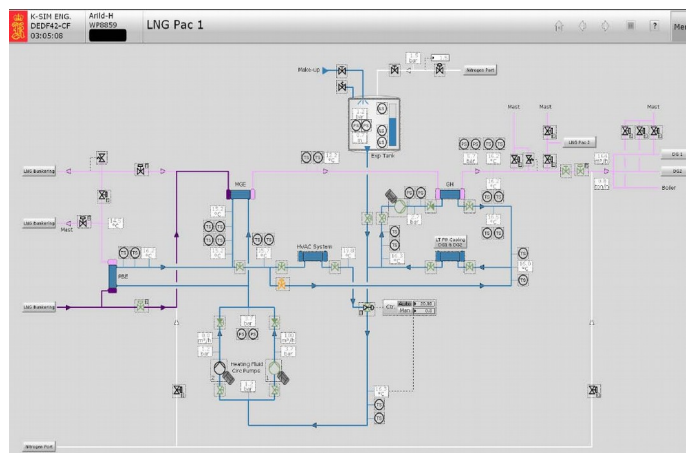


FIGURE 2: LNG pac

## 4.4 Evaporators

### 4.4.1 Pressure Build Up Evaporator

*The Pressure Build Up Evaporator* allows the tank to be pressurized to **5.3bar**, the gas is vaporized by the BT fresh water circuit (*LT FW*) through a silicone gel (Syltherm) that acts as an interface between the ED and the gas. The pressure is applied:

After the Initial Build Up operation,  
in operation afin to prevent the pressure drop in the vessel caused by the

gas consumption, the steam produced returns to the tank.

### 4.4.2 Main Gas Evaporator

*The Main Gas Evaporator* is used to manage the gas pressure delivered to the engine. It takes the gas in liquid phase and vaporizes it. The pressure is regulated by regulating valves before and after the evaporators.

### 4.4.3 Gas Heater

*The Gas Heater* provides the finalisation temperature and pressure control for the engine. It has an independent ED circuit to manage the finale phase of the heating system. The discharge pressure of the evaporators (PBE, GVE) is regulated by the valve (V96) which redirects part of the flow to the Gas Heater. During free operation, the set point of this valve is 40%.

*Note: the expansion tank has a nitrogen supply afin to maintain the tank pressure. It is also equipped with a gas detection system;*

## 4.5 Safety valves

The safety valves are located at different points in the circuit, their set pressure is **9bar**. Their discharge is carried out at the degassing mast.

## 5 Shutdown

Several shutdown situations are planned:

TAS (Tank Shutdown) :

In case of failure of the *LNG PAC* circuit, the vents open afin to depressurize the pipework and the closed automatic valves. A liquid phase gas return system sequenced to the tank ensures that only the minimum amount of gas is vaporized.

CB (Close Bunkering) :

During the fin supply operation, by closing the bunkering valves or in case of high level or high pressure in the tank,

BS (Bunkering Shutdown) :

Supply valves if closed manually during operation cause a shutdown.

ELS (Engine Line Shutdown) : In the event of an incident on the gas supply circuit, the inlet and outlet valves at the MGE, and the interconnection valve are closed, the shutdown signal is sent to the GVU.

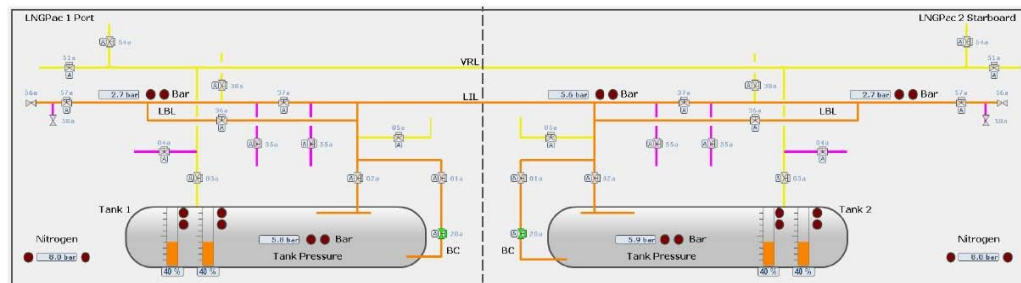
## 5.1 Gas and ESD detection

The detection is based on the detection of gas and oxygen. A pre-alarm and an alarm whose threshold can be configuré in the *Gas Detector Panel*.

## 6 Control System (LNG Monitor)

The control system largely automates the procedures related to the gas circuit and allows the control and monitoring of operations.

### 6.0.1 Control Box Command



It allows operations on the fuel to be carried out and their progress to be monitored.

FIGURE 4: Disposition Storage tank

The tables below illustrate each sequence automatically of the different elements of the circuit.

### **Vapour Return Valve (VRL)**

<b>Command</b>	<b>Effect</b>
Auto	Puts valves in vapour line to Auto control (V51 and V54)
Manual	Puts valves in vapour line to Manual control (V51 and V54)
Activate	Will open VRL discharge valve (V51)
Deactivate	Will close VRL discharge valve (V51)
Inert	Will operate inert valve (V04) and vent valve (V54)
Inert from Supplier	Will operate VRL discharge valve (V51) and vent valve (V54)
Inert to Supplier	Will operate inert valve (V04) and VRL discharge valve (V51)
Depressurize	Will open vent valve (V54). Note! Must be manually closed.
Select Bunker station 1	The valves (above listed) connected to VRL at bunker station 1 are controlled by the control system
Select Bunker station 2	The valves (above listed) connected to VRL at bunker station 2 are controlled by the control system

### **Liquid Interconnection Line (LIL)**

<b>Command</b>	<b>Effect</b>
Auto	Puts valves in LIL to Auto control (inert valve V55, vent valve V05, spray tank valve V02 and LIL supply valve V01)
Manual	Puts valves in LIL to Manual control (inert valve V55, vent valve V05, spray tank valve V02 and LIL supply valve V01)
Inert	Operates vent valve V05 and inert valve V55
Activate	Will open LIL supply valve V01.
Drain	Will operate LNG spray valve (V01) and inert valve (V55)
Select Tank 1	The valves (above listed) connected to LIL and tank 1 are controlled by the control system
Select Tank 2	The valves (above listed) connected to LIL and tank 2 are controlled by the control system
Select Both Tanks	The valves (above listed) connected to LIL and both tanks are controlled by the control system
Spray Control Auto	Top spray valve V02 is controlled by tank pressure
Open Top/Spray Valve	Manual opening of top spray valve V02

Note! The bottom connection must be activated before LIL supply valve (V01) can be activated.

#### Vapour Return Valve (VRL)

Command	Effect
Auto	Puts valves in vapour line to Auto control (V51 and V54)
Manual	Puts valves in vapour line to Manual control (V51 and V54)
Activate	Will open VRL discharge valve (V51)
Deactivate	Will close VRL discharge valve (V51)
Inert	Will operate inert valve (V04) and vent valve (V54)
Inert from Supplier	Will operate VRL discharge valve (V51) and vent valve (V54)
Inert to Supplier	Will operate inert valve (V04) and VRL discharge valve (V51)
Depressurize	Will open vent valve (V54). Note! Must be manually closed.
Select Bunker station 1	The valves (above listed) connected to VRL at bunker station 1 are controlled by the control system
Select Bunker station 2	The valves (above listed) connected to VRL at bunker station 2 are controlled by the control system

#### Liquid Bunker Line (LBL)

Command	Effect
Auto	Valves connected to bunker line are controlled by the control system
Manual	Valves connected to bunker line are manually controlled
Activate ESD Com	ESD communication with the supplier is established
Deactivate ESD Com	ESD communication is deactivated
Inert	Operates inert valve V55, bunkering valve V36 and vent valve V38
Cool	Will open LNG spray valve (V01), LBL stripping valve (V36) and LBL supply valve (V37) to cool down bunker line
Drain	Operates inert valve (V35) and bunker line valve (V36)
Start	Will open LBL supply valve (V57)
Stop	Will close LBL supply valve (V57)
Activate	Will open LBL supply valve (V37)
Deactivate	Will close LBL supply valve (V37)
Emergency Stop	Will close LBL main supply valve (V57)
Control Reset	Reset LBL trip

Note! Bunkering is not possible until ESD communication is established.

Note! Spray valve (V02) must be open to enable drain.

Note! Bunker line must be in "Cooled" state before drain is possible.

#### Engine Line (EL)

Command	Effect
Auto	Valves connected to EL are controlled by the control system
Manual	Valves connected to EL are manually controlled
Inert	Operate engine line inerting valve (V30) and vent valves GV1, GV2 and GV3.
Activate	Opens engine line gas valve (V27)
Close	Closing engine line gas valve (V27)
Emergency Stop	Will shut down BC, MGE, EL and Storage Tank
Reset	Reset trips and shutdowns
Close	Will close tank BC valve (V20)
Emergency Stop	Will shut down BC, MGE, EL and Storage Tank
Reset	Reset trips and shutdowns

#### Liquid Interconnection Line (LIL)

Command	Effect
Auto	Puts valves in LIL to Auto control (inert valve V55, vent valve V05, spray tank valve V02 and LIL supply valve V01)
Manual	Puts valves in LIL to Manual control (inert valve V55, vent valve V05, spray tank valve V02 and LIL supply valve V01)
Inert	Operates vent valve V05 and inert valve V55
Activate	Will open LIL supply valve V01.
Drain	Will operate LNG spray valve (V01) and inert valve (V55)
Select Tank 1	The valves (above listed) connected to LIL and tank 1 are controlled by the control system
Select Tank 2	The valves (above listed) connected to LIL and tank 2 are controlled by the control system
Select Both Tanks	The valves (above listed) connected to LIL and both tanks are controlled by the control system
Spray Control Auto	Top spray valve V02 is controlled by tank pressure
Open Top/Spray Valve	Manual opening of top spray valve V02

Note! The bottom connection must be activated before LIL supply valve (V01) can be activated.

#### Pressure Build Up Evaporator (PBE)

Command	Effect
Auto	Valves connected to PBE are controlled by the control system
Manual	Valves connected to PBE are manually controlled
Activate	The PBE Outlet Gas return valve (V16) will be controlled by the control system and open/close depending on tank pressure
Close	Will close the PBE Outlet Gas return valve (V16)
Emergency Stop	Will close PBE Outlet Gas return valve (V16)
Reset	Resets tripped PBE (PBE has to be reactivated)

#### Gas Interconnection Line (GIL)

Command	Effect
Auto	Valves connected to GIL are controlled by the control system
Manual	Valves connected to GIL are manually controlled
Inert	Operate GIL inert valve (V29) and GIL ventilation valve (V25)
Activate	Will open GIL valve (V28) in both Pacs
Close	Will close GIL valve (V28) in both Pacs
Emergency Stop	Will shut down BC, MGE, EL and Storage Tank
Reset	Reset trips and shutdowns

Note! It's not possible to activate GIL if both engine lines (EL) are active. This may cause a change over to DO/HFO for the DGs fed from the LNG Pac that is going to be closed down. Both EL and MGE have to be closed before GIL activation is enabled.



## Diesel Alternator starting procedure Power supply

**Prerequisites** The following circuits must be arranged: (Valves open, auxiliary pumps started)

- 1 EDBT
- 2 Oil
- 3 DO (the DO emergency pump runs on Emergency Fuel Feed Pump compressed air)

*Note: Compressed air is always available.* Before starting a group, it is necessary to switch it to DO/HFO mode, be aware that in back-up mode (by default) it is impossible to switch to gas mode without stopping it.

**Start-up:**

- 1 Open the flap (flap),
- 2 Make an electric turn and then disengage the turning gear,
- 3 Make a Blow turn,
- 4 Go back to local,
- 5 Acknowledge alarms,
- 6 Switch to run mode on the selector switch,
- 7 Start and observe the temperature rise of the exhausts,
- 8 If the settings are correct, switch the group to remote.

We can then arrange the power supply on the main bars and disposal of the consumers.

- 1 Connect the main circuit breaker,
- 2 Supply the complete busbar system,

14. Feed consumers. It is now possible to arrange the main and auxiliary pumps of the ED and oil circuits in automatic mode.

Pass the DG1 in priority 1 / auto / alone on bus

Stop the MDO air pump.

**Attention:**

The ED temperature regulation can only be switched automatically on the IAS. It is necessary:

- Pass the three-way remote control valves through the circuit,
- Then on the IAS in the FW Cooling System page, pass the corresponding valves

in a car. The valve then turns orange to indicate that it is regulating.

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## Procedure for supplying GNLC tanks at room temperature

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In this example we will use the truck and the supply will be made on the port tank. The following steps must be followed:

### Truck side preparations

A leak test of the liquid and vapour line valves must be carried out.

- 1 Inert the liquid and vapour lines,
- 2 Stop the inerting and check the absence of leaks,
- 3 Put the lines in the air,
- 4 Close the valves of the liquid and steam lines.

When the ship is ready (full seal removed), connect the loading arm. Warn the board that an ESD test must be conducted.

*Note that the edge can inert the truck and the truck can inert the edge.*

### Edge preparations

Operations will be conducted from the "LNG Monitor System" page.

Inertage

- 1 Open the flange on the ship side and connect the flexible of the truck,
- 2 Installation of the water curtain,
3. Inerting with nitrogen, during this operation, the Inert command must be sent twice for :
  - (a) Depressurize
  - (b) Inerting

*In inerting operations, be careful not to "activate"!*

The operations will be carried out in "automatic" mode, select "All in auto". Inerting is conducted from the tank to the connection.

- Bottom Connection (BC) Inerting
- Inertage of Liquid Interconnection Line (LIL)
- Inertage of the Port Liquid Bunker Line (LBL)

- 1 Open (activate) Bottom Connection 1 (V20),
- 2 Open (activate) the Liquid Interconnection Line (select tank 1 / activate) (V01),
- 3 Open the Top Spray High Boom (LIL) (V02),
- 4 Activate the Liquid Bunker Line (V37),
- 5 Open the head valve (V57) manually
- 6 Activate and test the ESD (the LIL valve (V57) must close)

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### III

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A leak test (Leak Test) must now be performed on the loading flange, for this purpose:

- 1 Pressurize the line between the truck and the head valve (V57) with nitrogen (8 bar),
- 2 Open the nitrogen supply valve and the valve (V58 MD510),
- 3 Close the supply valve and vérifier the absence of leakage (pressure at 8 bar),
- 4 vent through the vent (V10 MD510),
- 5 close the vent.

#### Cooling of tanks

- 1 Open the manual isolation valve (V56 MD510)
- 2 Control the steam cooling by the liquid line of the low-flow truck (5 m<sup>3</sup>/h), select *VAPOUR* then *ON*. The temperature
- 3 Start of the control box (V57) by the LBL,
- 4 Cold descent to -60°C du pipework and tank,
- 5 Opening of the liquid line and progressive rise up to 400m<sup>3</sup>/h,
- 6 Vaporization (spray) in auto (LIL), lower the pressure set point (Setpoint Bunkering) to 1.0bar, this has the effect of keeping the tank as cold as possible by playing on the vaporization.

#### LNG supply begins

If the back pressure increases in the tank, open the steam return line.

#### Finalization

- 1 at 85%, ask the truck to chase the liquid with steam (1 minute at 5 m<sup>3</sup>/h),
- 2 Stop the supply through the Control Box (Stop LBL) (V57),
- 3 Disable (V37) and purge the BL (V35, V36), for this purpose it is necessary to open on the spray of the (LBL),
- 4 inert the liquid line (inert LBL) (V55, V36, V38) (2 times),
- 5 purge the LIL through the spray line (V55) and inverter (V05) (twice),
- 6 Disconnect the flange, supply operation completed.

## Cold tank GNLC supply procedure

This procedure applies most of the time, in fact, if an LNG stub exists in the tank it is considered cold.

- 1 Establish the connection with the terminal, as soon as the connection is established, the ESD is connected,
- 2 Test the ESD, (V57)
- 3 Vérifier the tightness of the connection,
- 4 Enable CB
- 5 Activate the LIL from the control box by activating: "tanks Activate",
- 6 from the LBL control box select "cool" then "activate" and enfin "start"

*The manual valves must be correctly positioned to allow the controlled valve to be opened.*

- 1 Enable steam return (V03 and V51)
- 2 Open the barge or terminal side of the liquid and steam valve, wait until the pressure is 4.5bar,
- 3 Start the supply operation (from 50m<sup>3</sup>/h to 400m<sup>3</sup>/h)
- 4 At 85%, start reducing the liquid flow and ask the barge to open the vapor bunkering line afin to pressurize the lines to push the liquid,
- 5 When there is no more liquid flow, wait 30sec to empty the lines and then stop the supply operation (STOP and deactivate from the LBL control box),
- 6 Purge the LBL (drain),
- 7 Purge the LBL,
- 8 Inert LIL,

15. Inerter LBL, It is now necessary to disconnect the flexible:

- 1 Inert the edge with nitrogen via the (V58),
- 2 When the nitrogen pressure reaches 8bar, purge the liquid line to the barge,
- 3 Close the valve (V58), open the vent of the liquid line of the barge,
- 4 When pressure is zero, close the vent to the barge,
- 5 Close the liquid part on the barge side.

Afin not to send gas to the atmosphere when disconnecting, the HHT must be inert.

- Inform the barge of the opening of the HHT vent,
- Manually set the HHT,
- Close the steam return (V03),
- Open on nitrogen (V04) to inert towards the barge,
- When the inerting is complete, close the valves and return the HHT to auto,
- Disable and inert the HHT from the control box,

- purges the HHT to the barge and when the pressure is zero, stop and isolate the inerting,
- When the flexible is depressurized, close the manual supply valve (V56),
- Disconnect the flexible and place the full flange,
- Purge the line by opening the valve (V56) and (V58) several times
- Inert by opening the valve (V10)

End of the procurement operation.

## Conversion from engines to gas

### LNG provision

The heating system for the evaporators must be installed;

- 1 Vérifier the level of the expansion box and place the expansion valve 1.5 bar of nitrogen,
- 2 Arrange the water circuit, regulation in automatic,
- 3 Arrange the HVAC air conditioning,
  
4. Start the pumps. Arrangement of the gas supply to the engines.
  - 1 Activate the CB, if it has been depressurized, it must first be inerted,
  - 2 Activate the Pressure Build Evaporator the pressure set point must be 5bar,
  - 3 Activate the Engine Line,
  - 4 When the tank pressure is correct, activate the Main Gas Evaporator, the inerter

if necessary, the Gas Interconnection Line connection can be activated, but you must nevertheless:

- Have an MGE in service,
- Have the other MGE stopped but pressurized.

The gas is arranged.

### Conversion from engines to gas

- 1 The engine compartment ventilation must be started and then switched to auto
- 2 The manual supply valve for the GVU (V051) must be installed,
- 3 The GVU control in auto,
  
4. The Mode gas is available. It is possible to start directly with gas.