Economic Commission for Europe

19 August 2013

Inland Transport Committee

Working Party on the Transport of Dangerous Goods

Joint Meeting of Experts on the Regulations annexed to the European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN)
(ADN Safety Committee)

Twenty-second session
Geneva, 26 – 30 August 2013
Item 3 (b) of the provisional agenda
Special authorizations, derogations and equivalents

Request for issuance of derogations regarding the use of LNG for propulsion

Transmitted by the Government of the Netherlands

Attached is the proposed text of possible derogations for two tank vessels, Chemgas 851 and Chemgas 852, regarding the use of LNG for propulsion, as well as the relevant HAZID study.

Version ADN 2013

UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE (UN-ECE)

RECOMMENDATION OF THE ADMINISTRATIVE COMMITTEE RELATING TO THE ADN REGULATIONS

RECOMMENDATION No. xx/2013
of xx xx 2013

The competent Authority of The Netherlands is authorised to issue a trial certificate of approval to the motortankvessel“Chemgas 851” (ID number 55679 and BV register number 24521F), type G tanker, for use of Liquefied Natural Gas (LNG) as fuel for the propulsion installation.

Pursuant to regulation 1.5.3.2 the vessel may deviate from the regulations 7.2.3.31.1 and 9.3.2.31.1 until 30-06-2017. The Administrative committee decided that the use of LNG is sufficiently safe under the following conditions which shall be complied with at all times:

1. The vessel has a valid certificate of approval according to RIVR, based on recommendation XXX by the CCNR.
2. The vessel shall be constructed and classified under the supervision and in accordance with the applicable rules of an recognized classification society, which has special rules for LNG installations. The class shall be maintained;
3. The LNG propulsion system shall be annually surveyed by a recognized classification society;
4. A HAZID study by a recognized classification society (see annex 1) shows that the safety level of the LNG propulsion system is sufficiently safe. This study to cover, but not limited to, the following issues:
    - Interaction between cargo and LNG
    - Effect of LNG spillage on the construction
    - Effect of cargo fire on LNG installation
    - Different types of hazard posed by using LNG instead of diesel as fuel
    - An adequate safety distance during bunkering operation;
5. The liquefied natural gas consuming system is in conformity with the IGF Code, (IMO Resolution MSC 285(86), June 1st 2009, and BLG17 of February 2013 except for the items listed in annex 2;
6. The liquefied natural gas storage tanks shall comply with the requirements of the ADN building regulations in 9.3.1 for cryogenic tanks.
7. The bunkering and maintenance of the LNG propulsion system shall be done according to the procedures laid down in annex 3 and 4;

8. All crewmembers shall be trained on the dangers, the use, the maintenance and the inspection of the LNG propulsion system according to the procedures laid down in annex 5;
9. A safety rota shall be provided on board the vessel. The safety rota describes the duties of the crew. The safety rota includes a safety plan;
10. The use of LNG as fuel is included in the dangerous goods report to Trafic management and in emergency notification;
11. All data related to the use of the LNG propulsion system shall be collected by the carrier. The data shall be sent to the competent authority on request;
12. An annual evaluation report shall be sent to the secretariat of the UN-ECE for information of the administrative committee. The evaluation report shall contain at least the following information:
    a. system failure;
    b. leakage;
    c. bunkering data;
    d. pressure data;
    e. repairs and modifications of the LNG system.

Attachments:
- Annex 1. Hazid Study
- Annex 2. Overview deviations from the IGF Code
- Annex 3. Bunkering procedure
- Annex 4. Maintenance procedure
- Annex 5. Training procedure

Version ADN 2013

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RECOMMENDATION No. xx/2013
of xx xx 2013

The competent Authority of The Netherlands is authorised to issue a trial certificate of approval to the motortankvessel“Chemgas 852” (ID number 55678 and BV register number 25106R), type G tanker, for use of Liquefied Natural Gas (LNG) as fuel for the propulsion installation.

Pursuant to regulation 1.5.3.2 the vessel may deviate from the regulations 7.2.3.31.1 and 9.3.2.31.1 until 30-06-2017. The Administrative committee decided that the use of LNG is sufficiently safe under the following conditions which shall be complied with at all times:

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    b. leakage;
    c. bunkering data;
    d. pressure data;
    e. repairs and modifications of the LNG system.

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1. Hazid - April 2013

For the Chemgas 851/852 (ID 55679 & ID 55678) a Hazid study was performed in April 2013. The purposes of the studies is to identify the risks present to the specific system and ensure that safety systems have been considered and will be implemented in the design according the preventive measures mentioned in the Hazid.
The used Hazard analysis methodology is the Hazard and Operability Analysis[1] combined with the Safety/Hazard analysis[2].

The studied vessels are tankers type G according to the ADN regulations. All crew on board is trained to handle dangerous cargo and are aware of the risks of sailing with an ADN type G tanker.

In the Hazid all possible Hazards for this LNG fuelled vessel are identified and checked for their potential effects to the vessel, crew and environment. The study was performed on several days with people with different experience related to LNG systems and vessel design & operation. In Table 1 you can find a list of the participants of the Hazid.

During the Hazid we used a P & ID Fuel system as a guide. For every part we identified the following points:

- Deviation; an event (failure mode) deviated of the normal operational situation or technical status of the installation
- Cause; what leads to the deviation
- Hazard; what are the dangers of the deviation
- Potential Effects; what will be the effect to vessel, crew, environment
- Safeguards; technical solutions (design, control & monitoring systems) to reduce the probability to happen the deviation (event). Operational procedures and / or preventive measures, carried out by human, to reduce the probability to happen of the deviation (event).

During the Hazid only single failure was considered as is normal practice. During the study it was decided that a risk matrix, will not be included in this study. In such a matrix all risks are defined by taking the likelihood x impact. As both likelihood and impact are difficult to calculate and information is limited, the risk matrix is left out of this study and instead we took the position that all risks (likelihood x impact) should be addressed. The safeguards from the Hazid will serve as recommendations for the design.

2. Analysis second stage – June/July 2013

In the original design a so-called pressure build up unit was placed in the fuel storage room, under deck. With a small pipe LNG was transferred from the LNG tank to this unit where it would be vapourized. This part of the design led to the most discussion and although all hazards were defined and solved, Chemgas found a solution which increased the safety dramatically. During the June CCR meeting a new solution was briefly presented. The complete gas conditioning unit will now be placed on deck in a unit. In the LNG fuel tank a pump will be placed which will transport LNG to this unit.

[1] ABS consulting; Marine Safety, tools for risk-based decision making, ch 11; ISBN 0-86587-909-5
[2] Blanchard, B.J.; Logistics engineering and management, 291; 2004 Pearson Education, Inc.

Besides the new design a new approach towards the risks and effects of the use of LNG was discussed together with TNO. To better understand the effects of a deviation as mentioned in the Hazid, the LNG system is divided in three sections:

- Containment block; fuel storage
- Conditioning block; gas conditioning unit
- Consumer block; all items in the engine room & HPRS on tank deck

The results of the Hazid can be found at the end of this document.

Attached to this hazid-document you can find 6 drawings in which you can find the three blocks and additional information concerning the flow of LNG and NG in different stages and the places of the ESD valves:

450-001-1: General arrangement with block division
450-001-2: General arrangement with LNG & NG lines
450-001-3: P&ID Fuel system with block division
450-001-4: P&ID Fuel system with LNG & NG lines during normal operation
450-001-5: P&ID Fuel system with LNG & NG lines during time vessel is idle
450-001-6: P&ID Fuel system with LNG & NG lines during bunkering

To understand what will happen in case of a deviation as mentioned in the Hazid, in other words what will happen if LNG or NG is accidentally released in one of the blocks an analysis was made of how much LNG/NG would leak and what will be the effect. In table 2 the content of the block is added. In case of a leakage the complete block is isolated by closing of ESD valves and the total volume that might escape is known. In the table also the volume of gas on deck is added. From deck gas escapes directly into the open air. As the amounts will be less then from the conditioning block, no specific calculation is done.
For easy reference the original hazid study was also split with reference to the three blocks. Additional hazids related to the new design are added and marked by colouring the relevant row blue.
Hazids that were deleted due to the new design are crossed.

Containment of LNG and NG between ESD valves

MSN Marine Service Noord

Description See dwg 450-000 rev L	Compartment	Liquid or vapour	Content [liters]	Content of gas in nominal condition e.g. 0 atm 20degr C [liters]
Bunkerline between tank connection and shore connection (Enclosed by VL0017 and VL0005, VL0007)	containment block	liquid	110	66000
Bunkerline between tank connection and shore connection (Enclosed by VL0013 and VL0001, VL0003)	containment block	vapour	110	220
Gas conditioning unit (Enclosed by VL0011 and VL0029)	conditioning unit	liquid	700	420000
Gas conditioning unit (Enclosed by VL0014 and VL0034)	conditioning unit	vapour	750	6750
Vapour line high pressure to consumers incl vessel BT-02 (Enclosed by VL0029 and VL0030)	deck	vapour	1010	9090
Vapour line low pressure to consumers (Enclosed by VL0032 and VL0034)	deck	vapour	510	4590
Vapour lines to consumers (From VL0034 and VL 0030)	consumer block	vapour	50	450

Table 2: Content of compartments

2.1 Conclusion containment system

The largest imaginable LNG spill could occur when the LNG fuel tank ruptures.
The following safeguards were taken:

- The LNG storage tank is placed in the cargo area in compliance with existing rules and expected rules for a LNG cargo tank. This means, placed in a compartment protected by double hull and bottom.

- The complete hull, including the hold space for the LNG fuel tank, is designed with the same method as used for the so called “large cargo tanks”.
- The LNG fuel tank is a so called pressure tank, which means designed for a pressure of at least 4 bars and is of the same principle construction as pressure tanks for cargo products.
- The single wall LNG fuel tank will be insulated with a layer of 300 mm PIR and covered with a thin metal layer. The hold space will be filled with dry air.
- No tank connections below the deck are present, internal tank inspection is possible, tank equipment is in compliance with ADN rules for a cargo tank.
- The height of the insulated tank dome above deck is limited to the minimum possible height, lower than other fixed points on the ship. The dome will be protected against falling objects and direct sun radiation.

Conclusion: the risk of tank rupture is minimized as low as reasonable practical. The risk of rupture and the possible effects are less then risks and effects found in previous studies done in relation to transport of dangerous goods.

2.2 Conclusion conditioning system
A stainless steel drip tray of approximately 1000 LTR, free from the deck, with an overboard drain, is placed under the conditioning system to prevent the ships deck against cold liquid. The maximum volume of the liquid spill will be 700 L , taking into account the time needed to close the ESD valves. The calculated time to vaporize the liquid is about @@ minutes. Smaller leakages are more likely than leakage of the total volume of the conditioning system, but if the total volume is set free, the risk is within an acceptable margin. The ship remains operational, the main engine keeps running, the auxiliary diesel engine starts automatically.

2.3 Conclusion consuming system
For each auxiliary engine; in the HPRS, located on the tankdeck, the NG pressure is reduced to about 1 bar. The NG enters the engine room via a double wall line to the LPRS, where the pressure is further reduced to about 50 mbars and then runs via a single wall line led to the air-inlet of the engine. Outer boundaries of the double wall line and LPRS are gastight and gas leakage will be detected and ventilated to a safe space on the open deck. Leakage of NG from the short single wall parts, about **50** mbars, will be detected by the gas detection above the auxiliary engines in the engineroom. If gas is detected, the ESD in the in the associated supply line will be activated.

Concerning the main engine: In the gas conditioning block the NG pressure is reduced to 6 bars. Via a double wall line the NG is led to gasticht valve cabinet in the engine room where the pressure is further reduced to about 5 bar. From there, via a double wall line, the NG goes to the engine cylinders. Gasleakage will be detected and ventilated to a safe place on the open deck.

Because of the the double wall/ enclosure layout of the NG pipe system, no gas leakage into the engineroom can occur.
The total amount of gasleakage from the double wall/ enclosure piping system and ventilated to open deck is 50 l.
The gasleakage amount into the engineroom from the short and almost pressureless single wall parts of the system, also monitored by local gasdetection in the engineroom and safeguarded by ESD valve, will be extremely low.

Table 1: List of participants

Participant	Company	11/04/2013	12/04/2013	16/04/2013	25/04/2013
J.H. Klok (facilitator)	Goeree Maritime	1	1	1	1
E.W.P. den Haan (scribe)	Bureau Veritas	1	1	1	1
F. Kersbergen	Bureau Veritas	1	1	1	1

L. Korvink	ILT (Dutch authorities)		1		
A. Smit Roeters	Chemgas	1	1	1	1
J. Huis	Chemgas	1	1	1	1
M. Dane	Chemgas	1	1		1
L.de Jong	Chemgas	1	1		
A. van der Ven	Chemgas	1	1	1	
D. van Kempen	Chemgas	1	1		
J. Kuijs	Chemgas				
J. Penninga	Wartsila	1			
K. Vonk	Wartsila	1			
R. van der Sanden	Wartsila	1	1		
B. Kruyt	Wartsila		1		
J. Lont	Sandfirden		1		
P. van Galen	Sandfirden		1		
R. van Berkum	Cryovat		1		
G. Eising	MSN	1	1		
G. Leeuwis	MSN	1	1		
L. Vredeveldt (observer)	TNO			1	1

General

nb	Deviation	Cause	Hazard	Potential Effects	Safeguards;
0		General	General	Main engine switches to gasoil; diesel aux. engine starts	Preventive maintenance measures; Fuel tank designed according ADN Rules
16	Loss of ventilation in double wall system (each engine)	Mechanical & electrical failure	No circulation which may lead to accumulation of NG in double wall	unsafe atmosphere in double wall	gas supply to engine affected stopped by safety system (including alarm)
17	Fire on deck	External	Fire	Pressure build up in tank & piping	Waterspray system and fire fighting equipment; Fire fighting procedures
18	Fire in engine room	External to the gas system	Fire & smoke	Damage to vessel, black out, human injuries	Detection and (fixed) fire fighting system; ESD; Fire fighting procedures
15a	Leaking of LNG pipe system on open deck	Human error; trapped liquid; collision & dropped objects; fatigue and corrosion	Brittle fracture ship structure; fire on deck	loss of structural integrity; danger to humans, (parts of) vessel and cargo	LNG outside high stressed area only;waterspray system for protection vital parts of vessel; ample drip trays provided; relief valve return to tank; ESD
15b	Leaking of NG pipe system on open deck	Collision & dropped objects; fatigue and corrosion	NG release/Fire	Minor environmental pollution & danger to humans, (parts of) vessel and cargo	ESD ; waterspray system for protection vital parts of vessel

Containment 1/2

nb	Deviation	Cause	Hazard	Potential Effects	Safeguards;
~~8a~~	~~Small leakage PBU unit below deck~~	~~Pipe fracture because of fatigue~~	~~LNG in secondary barrier~~	~~Gas around PBU; unsafe atmosphere in double wall~~	~~Pressure / Temperature control in double wall. Overpressure leaded back to the fuel tank.~~
8b	Deterioration tank insulation material	Ageing of material	No hazards	Very slow increase of the rate of pressure build-up; Holding time diminishes	During engineering phase ageing is taken into consideration
8c	No LNG consumption	Any reason	Pressure build up in tank which may lead to unintentional venting	Possible injury	Venting pipe (height above deck acc requirements) in vertical direction; possibility for de bunkering
8d	Rupture of tank ~~connection branch below deck~~	Collision, grounding, fatigue, thermal	LNG spill in fuel storage hold space	brittle fracture, NG in fuel storage hold space, causing unsafe atmosphere.	Special attention to design and construction of hull similar to so-called large cargo tanks.

Containment 2/2

nb	Deviation	Cause	Hazard	Potential Effects	Safeguards;
9a	Flooding of fuel storage hold space	~~Leakage of heating medium and leakage from deck~~	NG in the double wall space around the PBU unit and into heating system; water in storage hold may accumulate and damage insulation	Damage to construction, piping and connections	Bilge/Flooding alarm; anti-floatation device provided; non return valve in bilge system; Gas leakage in the heating medium is leaded to a safe place;
9b	Temperature too low in fuel tank space	Heat absorption by LNG tank	Cold ship structure	Brittle fracture	Equilibrium between heat ingress and cold absorption calculated; temperature is monitored
14	Mechanical damage from outside on dome	Collision (with bridge) & dropped objects	NG release/Fire	Minor environmental pollution & danger to humans, (parts of) vessel and cargo	Dome below max air draft & waterspray system for protection vital parts of vessel; Diesel auxiliary engine can be started to replace electrical power

Conditioning 1/3

nb	Deviation	Cause	Hazard	Potential Effects	Safeguards;
1a	Gas conditioner; heating or circulation stops	Rupture of piping of glycol within exchanger	LNG in glycol system	Pump malfunctions/runs hot; pressure build up in glycol system; icing in glycol	LNG supply to and from heat exchanger closes; Safety pressure valve on glycol system; glycol supply to and from heat exchanger closes
1b		Failure of glycol system (malfunction, rupture or electrical failure or too low temperature)	No vapourisation of LNG	LNG (liquid) to engine room	Closing of flow control valve;
2a	Malfuntioning of flow control valve	Mechanical failure (stays open)	No vapourisation of LNG	LNG (liquid) to engine room	Temperature transmitter on vapour line to engines, if temp is too low shut off fuel supply to engine
2b		Mechanical failure (closes)	No hazards	Main engine switches to gasoil (dual fuel);	Preventive maintenance measures; diesel aux. engine starts
2c	LNG in NG main supply line	Malfunction of evaporator system	Liquid to gas valve unit & HPRS; thermal stresses;	Main engine switches to gasoil, aux engines stops; gasoil engine starts	Temperature transmitter on vapour line to engines, if temp is too low shut off fuel supply to engine; Operational procedures

Conditioning 2/3

nb	Deviation	Cause	Hazard	Potential Effects	Safeguards;
3a	Failure of temperature & pressure control system	No electrical power supply	No hazards	Main engine switches to gasoil (dual fuel);	Preventive maintenance measures; Fail to close valve; diesel aux . engine starts
3b		Sensor failure	See 2		Self sensor test; Calibration sensor
3c		Processor failure	See 2		Self processor test
3d		Wire break	See 2b		
~~6a~~	~~Pressure build-up unit; heating or circulation stops~~	~~Rupture of piping of glycol within exchanger~~	~~LNG in glycol system~~	~~Pump malfunctions/runs hot; pressure build up in glycol system; icing in glycol~~	~~LNG supply to and from heat exchanger closes; Safety pressure valve on glycol system; glycol supply to and from heat exchanger closes~~
~~6b~~	-	~~Failure of glycol system (malfunction, rupture or electrical failure or too low temperature)~~	~~No vapourisation of LNG -> no hazard~~	-	-

Conditioning 3/3

nb	Deviation	Cause	Hazard	Potential Effects	Safeguards;
~~7a~~	~~Malfuntioning of flow control valve~~	~~Mechanical failure (stays open)~~	~~Increasing tank pressure~~	~~ESD blocks LNG vapourisation~~	~~Pressure transmitter on tank, if pressure is too high shut off liquid supply to pressure build-up unit~~
~~7b~~	-	~~Mechanical failure (closes)~~	~~No hazards~~	-	-
Add	Leakage of process vessel				

ANY OTHER?

Consuming 1/3

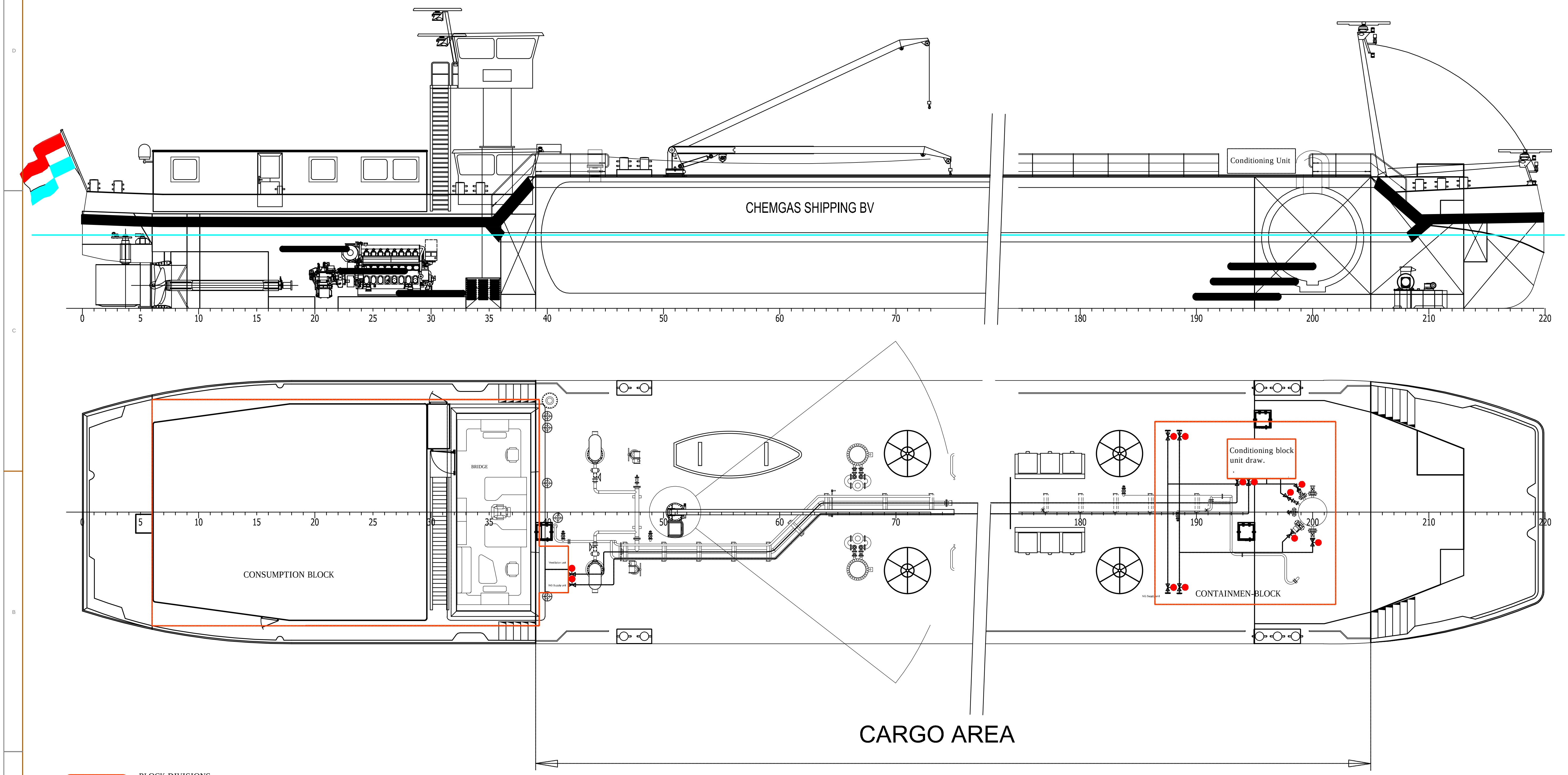
nb	Deviation	Cause	Hazard	Potential Effects	Safeguards;
4a	Failure of gas valve unit	Internal malfunction	Leakage of NG in gas valve cabinet	Gas detection in double wall unit	Shut down gas system main engine, switch to gasoil
4b		Mechanical failure (stays open)	No hazard		Engine can withstand 8 bar pressure
4c		Mechanical failure (closes)	No hazard	Main engine switches to gasoil (dual fuel);	
5a	NG leakage in engine feed system	Internal malfunction	Internal leakage of NG	NG in double wall unit	Shut down gas system, switch to gasoil, complete double wall engine gas unit; type approved engine; gas detection in double wall unit
5b	NG in exhaust system	Misfire	Combustion of NG in exhaust system	Rupture of exhaust system; exhaust gases in engine room	Rupture disc, ventilation of exhaust pipe after engine stops; fire detection; Shut down gas system main engine, switch to gasoil
5c	NG in crankcase	Internal leakage	Explosion in crankcase	Main engine stops & damage to engine	FMEA being carried by Wartsila: Gas detection in crankcase ventilation will be fitted if FMEA indicates requirement to do so.

Consuming 2/3

nb	Deviation	Cause	Hazard	Potential Effects	Safeguards;
5d	Component failure (electrical)		No additionals hazards compared to ordinary gasoil engines		Standard Wartsila Control & monitoring system
5e	Gas leakage into cool water system	Internal leakage	No hazards within cool water system	Accumulation into safe zone	low level alarm on cooling water & ventilation of expansion tank to safe place
5f	Backfire of engine	Incorrect air-fuel mixture, leaking inlet valve or incorrect ignition timing	Flame form inlet system; scatttered parts from inlet system due to pressure wave; flame in gas train	Damage to inlet system engine or engine room & operators	System to detect backfire and shut-down engine immediately to prevent new backfires
10a	Internal failure of HPRS	Mechanical failure	High pressure on low pressure system	NG blow off outside engine room	ESD valve aux engine closes
10b	NG leakage from HPRS	Mechanical failure	NG leakage in atmospere	Environmental pollution	In the HPRS the pressure is reduced to 1 bar maximum
11a	Internal failure of LPRS	Mechanical failure	No hazard as system can handle 50 mbar	50 mbar in where 0 mbar should be, aux engine stops	Pressure detection
11b	NG leakage from LPRS	Mechanical failure	Leakage of NG into LPRS system	NG in double wall unit	Shut down gas system, complete double wall engine gas unit; type approved engine; gas detection in double wall unit

Consuming 3/3

nb	Deviation	Cause	Hazard	Potential Effects	Safeguards;
12	NG leakage of single wall fuel pipe	Mechanical failure	Possible minor NG leakage in engine room	unsafe atmosphere in engine room	Gas detection & ventilation
13a	NG in exhaust system	Misfire	No hazard because of too lean mixture	No effect	
13b	NG in crankcase	Internal leakage	No hazard internal closed circuit due to size of cylinders and lean burn principle	No effect	Carter ventialtion; Gas detection & ventilation
13c	Component failure		No additionals hazards compared to ordinary gasoil engines	No effect	
13d	Minor gas leakage into cool water system	Internal leakage	Accumulation of NG into engine room	unsafe atmosphere in engine room	low level alarm on cooling water & ventilation of expansion tank to open air
13e	Backfire	Incorrect air-fuel mixture	No hazards	Pressure shock in inlet	Engine control system
Add1	"groene leiding" -> vanuit tank direct naar HPRS				



BLOCK DIVISIONS

ESD VALVES

BLOCK DIVISION TRIPLE 'C' PRINCIPLE

PRINCIPAL DIMENSIONS

LENGTH O.A.	110,00 m
LENGTH MLD.	109,95 m
BREADTH O.A.	11,37 m
BREADTH MLD.	11,32 m
DEPTH	5,65 m
DRAUGHT Ballast	2,25 m
DRAUGHT Construction	3,15 m
CARGOTANK CAPACITY	2620 m³

MSN
VOORLOPIG
PRELIMINARY
d.d. 17-04-2013

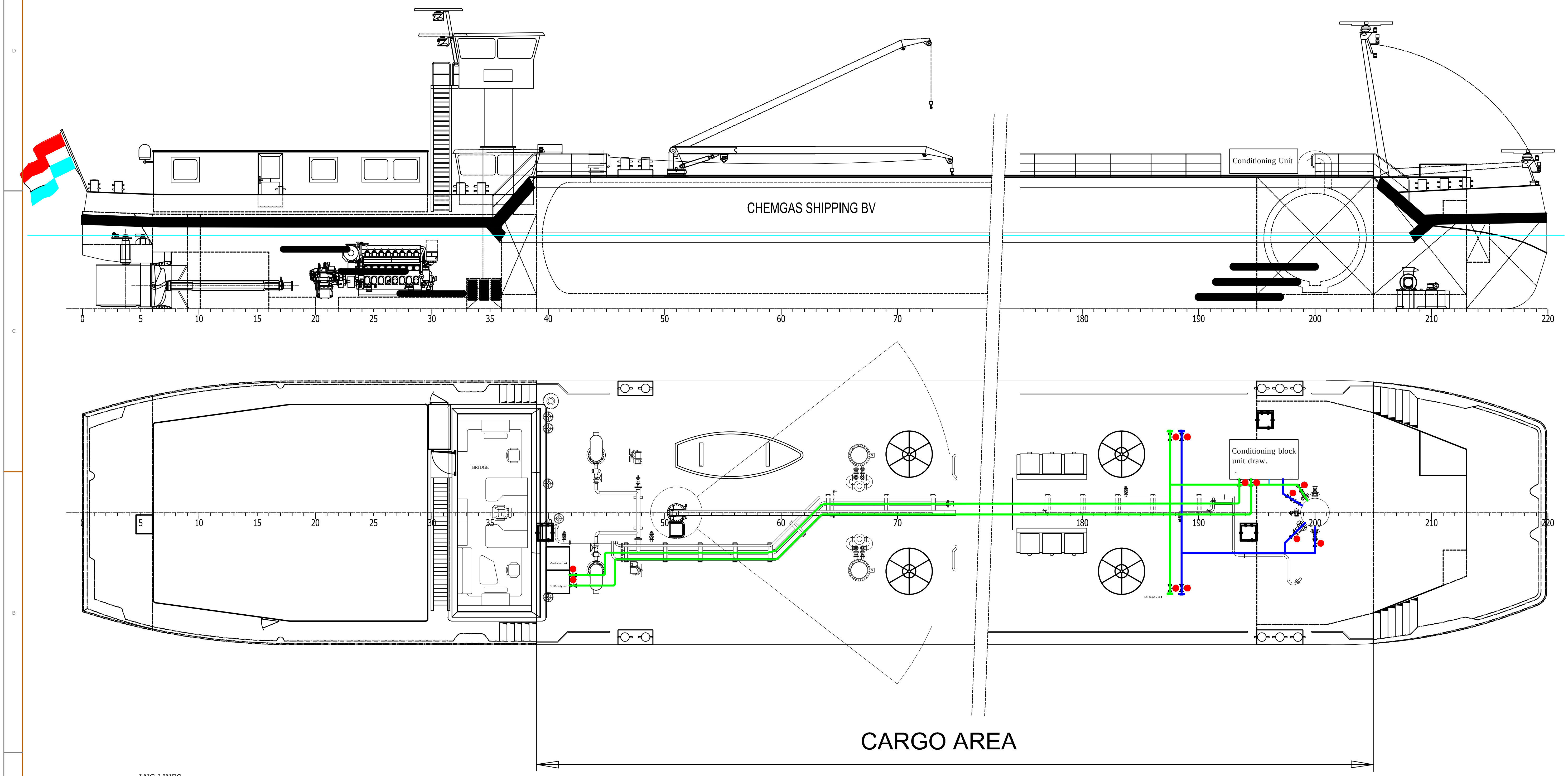
WIJZ. (REV.)	WIJZ. OMSCHRIJVING (REV. DESCRIPTION)	GEC. DOOR: (CHECKED BY)	DATUM (DATE)
L	removed EH-03, changed cap.	MSM	22-07-2013
K	Added Electric heater	MSM	17-07-2013
J	Added buffertank for gas conditioning,	MSM	12-07-2013
I	Changed manhole, feedpump LNG added	MSM	04-06-2013
H	Changed PBU unit into electric heater	GLE	21-05-2013

GET. DOOR: (DRAWN BY:) GLE — DATUM: (DATE:) 31-01-13 — GEC. DOOR: (CHECKED BY:) — DATUM: (DATE:) — SCHAAL: (SCALE:) NONE

MARINE SERVICE NOORD B.V.
ENGINEERING -- PIPING SYSTEMS -- ENGINEROOM INSTALLATION.
P.O. BOX 120 9600 AC HOOGEZAND PHONE 31(0)598-319619 FAX 31(0)598-319630
e-mail: msn@msholding.nl web-site: http://www.msholding.nl

TEKENING OMSCHRIJVING: (DRAWING DESCRIPTION:) General arrangement with block division

PROJECT NR.: (PROJECT NR.:) CG012 — TEKENING NR.: (DRAWING NR.:) 450-001/1 — KLASSE: (CLASSIFICATION:) — AUTORITEIT (AUTHORITY:) — FORMAAT: (SIZE:) A1



LNG LINES

NG LINES

ESD VALVES

CARGO AREA LIMITATION LNG / NG TRANSFERLINES

PRINCIPAL DIMENSIONS

LENGTH O.A.	110,00 m
LENGTH MLD.	109,95 m
BREADTH O.A.	11,37 m
BREADTH MLD.	11,32 m
DEPTH	5,65 m
DRAUGHT Ballast	2,25 m
DRAUGHT Construction	3,15 m
CARGOTANK CAPACITY	2620 m^3

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GET. DOOR: (DRAWN BY:) GLE DATUM: (DATE:) 31-01-13 GEC. DOOR: (CHECKED BY:) DATUM: (DATE:) SCHAAL: (SCALE:) NONE

MARINE SERVICE NOORD B.V.
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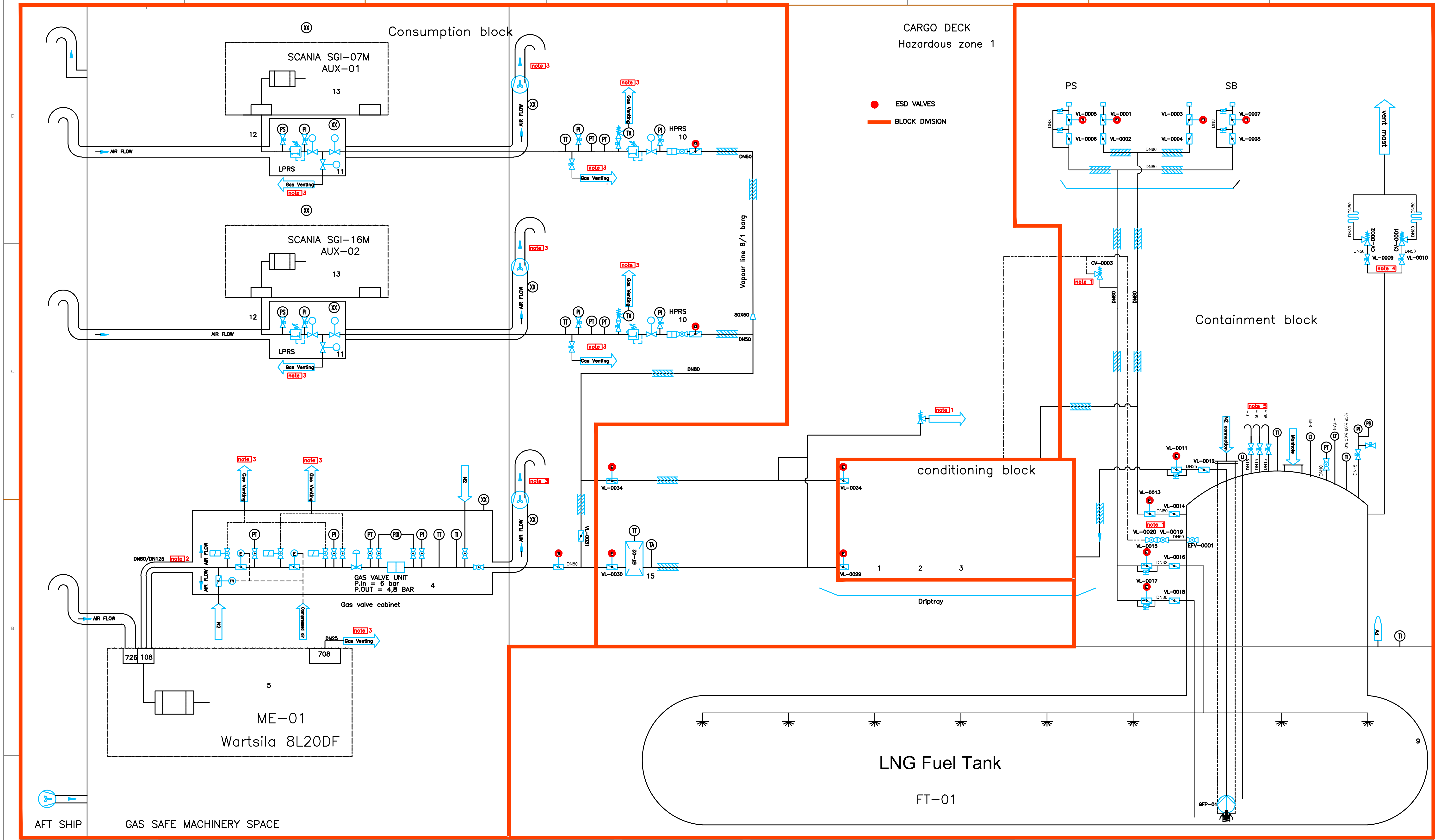
TEKENING OMSCHRIJVING: (DRAWING DESCRIPTION:) General arrangement with LNG & NG lines
LNG/NG TRANSFERLINES

PROJECT NR.: (PROJECT NR.:) CG012 TEKENING NR.: (DRAWING NR.:) 450-001/2 KLASSE: (CLASSIFICATION:) AUTORITEIT (AUTHORITY:) FORMAAT: (SIZE:) A1



Notes:

1. All pressure relief valves connected to tank dome and ball valves sealed in open position
2. Length of fuel pipe max. 10 mtr.
3. Gas venting lines venting to safe place
4. Provide with a secure system in such manner that only one safety valve can be closed.
5. Test connections on several heights, diameter transit dome 1,5mm
6. All operable valves to be fitted with nameplate

Reference diagrams:

LEGENDA

Symbol	Description	Symbol	Description	Symbol	Description	Symbol	Description
	Control valve	PDI	Differential pressure indicator	LT	Level transmitter	HPRS	High pressure reducing set 6bar - 50mbar
	Relief valve	PT	Pressure transmitter		Double walled pipe	LPRS	Low pressure reducing set 50mbar-0
	Ball valve	PI	Pressure indicator	PV	PV valve		Exchanged submergible pump with bottom valve
	Actuator	PS	Pressure switch		Dry brake coupling		
	ESD valve	TT	Temperature transmitter		Needle valve		
	ESD Wartsila control	TI	Temperature indicator		Insulation (HDPE)		
	ESD Scania control	LI	Level indicator				
EFV	Excessive flow valve	XX	Gas detection				
	Valve						

Tag no.	Description	Flow (m³/h)	Pres. (barg)	Power (kW)	Cap. (m³)
ME-01	Main engine Wartsila			1320	
AUX-01	Scania SGI-16M			285	
AUX-02	Scania SGI-07M			110	
BT-02	Buffer vessel				
FT-01	Fuel tank				88
GC-01	conditioning unit				
GFP-01	Gas Fuel pump	4	8	2	
LT-0001	Leak Tray				1,5

MSN
VOORLOPIG
PRELIMINARY
d.d. 17-04-2013

WIJZ. (REV.)	WIJZ. OMSCHRIJVING (REV. DESCRIPTION)	GEC. DOOR: (CHECKED BY)	DATUM (DATE)
L	removed EH-03, changed cap.	MSM	22-07-2013
K	Added Electric heater	MSM	17-07-2013
J	Added buffertank for gas conditioning,	MSM	12-07-2013
I	Changed manhole, feedpump LNG added	MSM	04-06-2013
H	Changed PBU unit into electric heater	GLE	21-05-2013

GET. DOOR: (DRAWN BY:) GLE — DATUM: (DATE:) 31-01-13 — GEC. DOOR: (CHECKED BY:) — DATUM: (DATE:) — SCHAAL: (SCALE:) NONE

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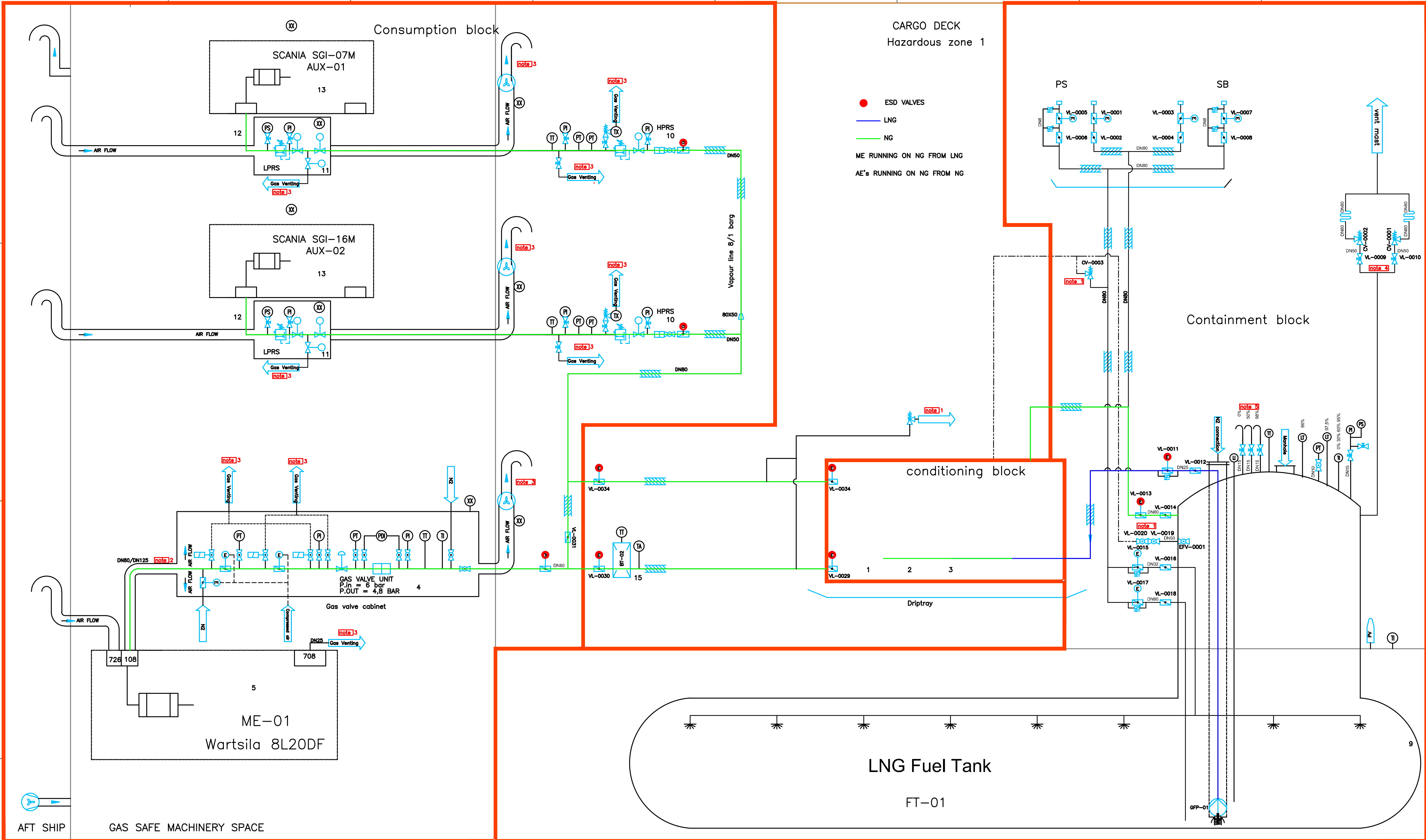
TEKENING OMSCHRIJVING: (DRAWING DESCRIPTION:) P&ID Fuel System with block division

PROJECT NR.: (PROJECT NR.:) CG012 — TEKENING NR.: (DRAWING NR.:) 450-001/3 — KLASSE: (CLASSIFICATION:) — AUTORITEIT (AUTHORITY:) — FORMAAT: (SIZE:) A1



Notes:

1. All pressure relief valves connected to tank dome and ball valves sealed in open position
2. Length of fuel pipe max. 10 mtr.
3. Gas venting lines venting to safe place
4. Provide with a secure system in such manner that only one safety valve can be closed.
5. Test connections on several heights, diameter transit dome 1,5mm
6. All operable valves to be fitted with nameplate

Reference diagrams:

LEGENDA

Symbol	Description
	Control valve
	Relief valve
	Ball valve
	Actuator
	ESD valve
	ESD Wartsila control
	ESD Scania control
	Excessive flow valve
	Valve
PDI	Differential pressure indicator
PT	Pressure transmitter
PI	Pressure indicator
PS	Pressure switch
TT	Temperature transmitter
TI	Temperature indicator
LI	Level indicator
XX	Gas detection
LT	Level transmitter
	Double walled pipe
PV	PV valve
	Dry brake coupling
	Needle valve
	Insulation (HDPE)
HPRS	High pressure reducing set 6bar - 50mbar
LPRS	Low pressure reducing set 50mbar-0
	Exchanged submergible pump with bottom valve

Tag no.	Description	Flow (m³/h)	Pres. (barg)	Power (kW)	Cap. (m³)
ME-01	Main engine Wartsila			1320	
AUX-01	Scania SGI-16M			285	
AUX-02	Scania SGI-07M			110	
BT-02	Buffer vessel				
FT-01	Fuel tank				88
GC-01	conditioning unit				
GFP-01	Gas Fuel pump	4	8	2	
LT-0001	Leak Tray				1,5

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PRELIMINARY
d.d. 17-04-2013

WIJZ. (REV.)	WIJZ. OMSCHRIJVING (REV. DESCRIPTION)	GEC. DOOR: (CHECKED BY)	DATUM (DATE)
L	removed EH-03, changed cap.	MSM	22-07-2013
K	Added Electric heater	MSM	17-07-2013
J	Added buffertank for gas conditioning,	MSM	12-07-2013
I	Changed manhole, feedpump LNG added	MSM	04-06-2013
H	Changed PBU unit into electric heater	GLE	21-05-2013

GET. DOOR: (DRAWN BY:) GLE DATUM: (DATE:) 31-01-13 GEC. DOOR: (CHECKED BY:) DATUM: (DATE:) SCHAAL: (SCALE:) NONE

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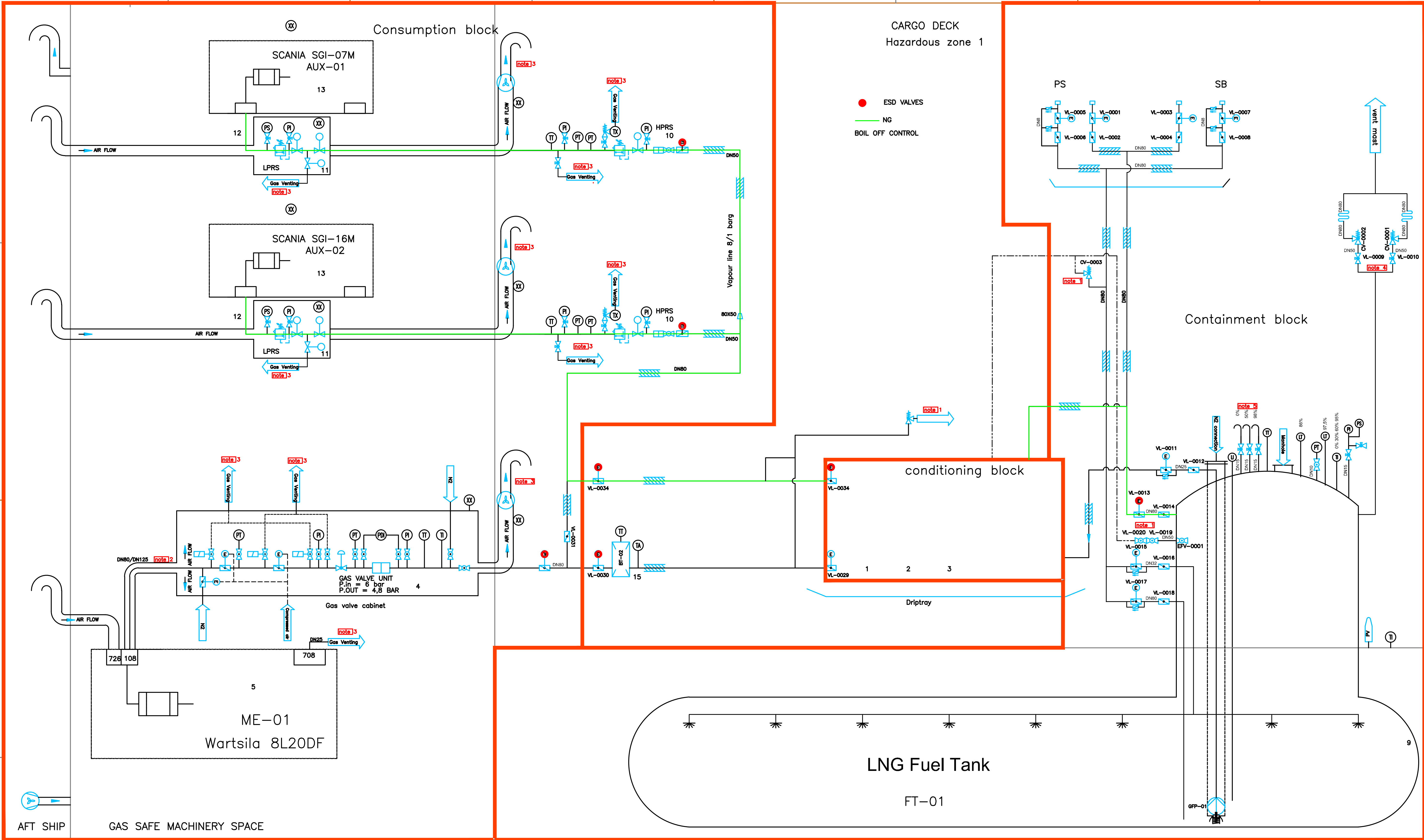
TEKENING OMSCHRIJVING: (DRAWING DESCRIPTION:) P&ID Fiel system with LNG & NG lines during normal operation

PROJECT NR.: (PROJECT NR.:) CG012 TEKENING NR.: (DRAWING NR.:) 450-001/4 KLASSE: (CLASSIFICATION:) AUTORITEIT (AUTHORITY:) FORMAAT: (SIZE:) A1



Notes:

1. All pressure relief valves connected to tank dome and ball valves sealed in open position
2. Length of fuel pipe max. 10 mtr.
3. Gas venting lines venting to safe place
4. Provide with a secure system in such manner that only one safety valve can be closed.
5. Test connections on several heights, diameter transit dome 1,5mm
6. All operable valves to be fitted with nameplate

Reference diagrams:

LEGENDA

Symbol	Description	Symbol	Description	Symbol	Description	Symbol	Description
	Control valve	PDI	Differential pressure indicator	LT	Level transmitter	HPRS	High pressure reducing set 6bar - 50mbar
	Relief valve	PT	Pressure transmitter		Double walled pipe	LPRS	Low pressure reducing set 50mbar-0
	Ball valve	PI	Pressure indicator	PV	PV valve		Exchanged submergible pump with bottom valve
	Actuator	PS	Pressure switch		Dry brake coupling		
	ESD valve	TT	Temperature transmitter		Needle valve		
EW	ESD Wartsila control	TI	Temperature indicator		Insulation (HDPE)		
ES	ESD Scania control	LI	Level indicator				
EFV	Excessive flow valve	XX	Gas detection				
	Valve						

Tag no.	Description	Flow (m³/h)	Pres. (barg)	Power (kW)	Cap. (m³)
ME-01	Main engine Wartsila			1320	
AUX-01	Scania SGI-16M			285	
AUX-02	Scania SGI-07M			110	
BT-02	Buffer vessel				
FT-01	Fuel tank				88
GC-01	conditioning unit				
GFP-01	Gas Fuel pump	4	8	2	
LT-0001	Leak Tray				1,5

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PRELIMINARY
d.d. 17-04-2013

WIJZ. (REV.)	WIJZ. OMSCHRIJVING (REV. DESCRIPTION)	GEC. DOOR: (CHECKED BY)	DATUM (DATE)
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H	Changed PBU unit into electric heater	GLE	21-05-2013

GET. DOOR: (DRAWN BY:) GLE DATUM: (DATE:) 31-01-13 GEC. DOOR: (CHECKED BY:) DATUM: (DATE:) SCHAAL: (SCALE:) NONE

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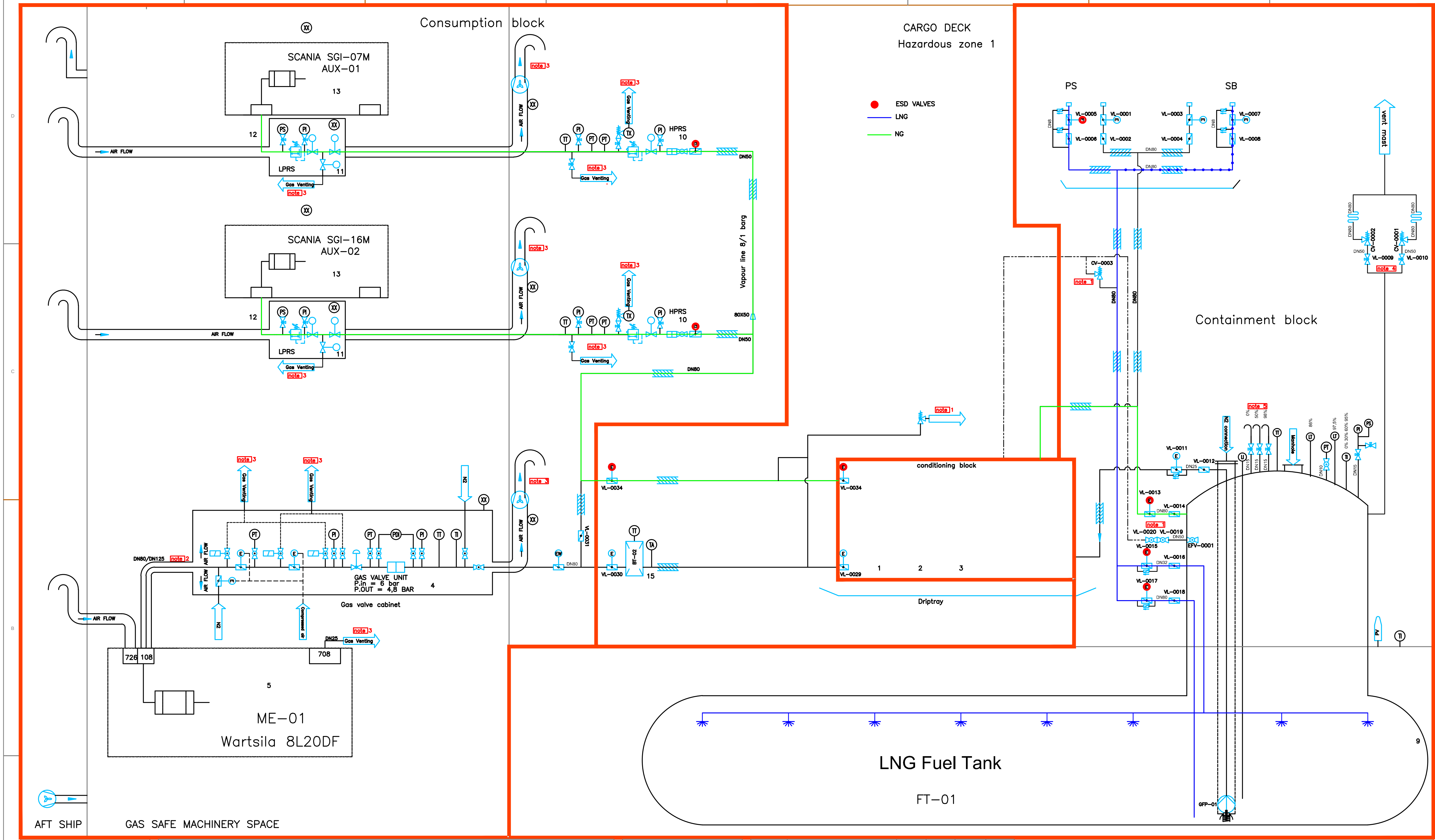
TEKENING OMSCHRIJVING: (DRAWING DESCRIPTION:) P&ID Fiel system with LNG & NG lines during boil-off control

PROJECT NR.: (PROJECT NR.:) CG012 TEKENING NR.: (DRAWING NR.:) 450-001/5 KLASSE: (CLASSIFICATION:) AUTORITEIT (AUTHORITY:) FORMAAT: (SIZE:) A1



Notes:

1. All pressure relief valves connected to tank dome and ball valves sealed in open position
2. Length of fuel pipe max. 10 mtr.
3. Gas venting lines venting to safe place
4. Provide with a secure system in such manner that only one safety valve can be closed.
5. Test connections on several heights, diameter transit dome 1,5mm
6. All operable valves to be fitted with nameplate

Reference diagrams:

LEGENDA

Symbol	Description	Symbol	Description	Symbol	Description	Symbol	Description
	Control valve	PDI	Differential pressure indicator	LT	Level transmitter	HPRS	High pressure reducing set 6bar - 50mbar
	Relief valve	PT	Pressure transmitter		Double walled pipe	LPRS	Low pressure reducing set 50mbar-0
	Ball valve	PI	Pressure indicator	PV	PV valve		Exchanged submergible pump with bottom valve
	Actuator	PS	Pressure switch		Dry brake coupling		
	ESD valve	TT	Temperature transmitter		Needle valve		
EW	ESD Wartsila control	TI	Temperature indicator		Insulation (HDPE)		
ES	ESD Scania control	LI	Level indicator				
EFV	Excessive flow valve	XX	Gas detection				
	Valve						

Tag no.	Description	Flow (m³/h)	Pres. (barg)	Power (kW)	Cap. (m³)
ME-01	Main engine Wartsila			1320	
AUX-01	Scania SGI-16M			285	
AUX-02	Scania SGI-07M			110	
BT-02	Buffer vessel				
FT-01	Fuel tank				88
GC-01	conditioning unit				
GFP-01	Gas Fuel pump	4	8	2	
LT-0001	Leak Tray				1,5

MSN
VOORLOPIG
PRELIMINARY
d.d. 17-04-2013

WIJZ. (REV.)	WIJZ. OMSCHRIJVING (REV. DESCRIPTION)	GEC. DOOR: (CHECKED BY)	DATUM (DATE)
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I	Changed manhole, feedpump LNG added	MSM	04-06-2013
H	Changed PBU unit into electric heater	GLE	21-05-2013

GET. DOOR: (DRAWN BY:) GLE DATUM: (DATE:) 31-01-13 GEC. DOOR: (CHECKED BY:) DATUM: (DATE:) SCHAAL: (SCALE:) NONE

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TEKENING OMSCHRIJVING: (DRAWING DESCRIPTION:) P&ID Fiel system with LNG & NG lines during bunkering

PROJECT NR.: (PROJECT NR.:) CG012 TEKENING NR.: (DRAWING NR.:) 450-001/6 KLASSE: (CLASSIFICATION:) AUTORITEIT (AUTHORITY:) FORMAAT: (SIZE:) A1

Annex 2: Chemgas 851/852

Deviations from Res.MSC.285 (86), June 2009

MSC 285	**Chemgas 851/852**	**Relation to project description**
1.1.2 Application	IGF code should apply in addition to Solas. This should read “in addition to CCR/ADN requirements” for inland nav.ships.	Chapter 1
1.3.25 Definitions	Risk assessment. The definition of “risk” in 2.2.33 includes likelyhood. In our HAZID this is not taken into account. See hazid study)	Hazid study
2.8.1.4 LNG storage tank	As 6 meter is not possible due to air draft in inland waters, vent mast is in accordance with ADN regulations	Chapter 2.3
2.8.4.2 Storage in enclosed spaces	Double hull structure at the location of the fuel storage tank is strengthened similar to hull structure for cargo tanks as requested by ADN	Chapter 2.2

As the IGF code is still developping a similar comparison was done with the latest version from February 2013.

Deviations from BLG 17/WP.5/Add.1, February 2013

BLG17	**Chemgas 851/852**	**Relation to project description**
2.1.3 Application	IGF code should apply in addition to Solas. This should read “in addition to CCR/ADN requirements” for inland navigation vessels	Chapter 1
4.2.1 Definitions	Risk assessment. The definition of “risk” in 2.2.33 includes likelyhood. In our HAZID this is not taken into account. See hazid study)	Hazid study
5.3.4.1/5.3.5 Tank location	Double hull structure at the location of the fuel storage tank is strengthened similar to hull structure for cargo tanks as requested by ADN	Chapter 2.2
6.4.1.4 LNG tank	IGF Code mentions containment system shall be designed in accordance with North Atlantic environmental conditions, in this case North Atlantic should read inland waters	Chapter 1
6.4.9.3.3.8 Design loads	IGF Code describes statis heel loads, this vessel complies with class & statutory rules for inland vessels and design loads will be according these requirements.	Chapter 1
6.7.2.7.3 Pressure relief system	As 6 meter is not possible due to air draft in inland waters, vent mast is in accordance with ADN regulations	Chapter 2.3
6.7.2.9 Pressure relief system	IGF description of dealing with fual gas vent outlets. Vessel is designed for inland waters and all is addressed in Hazid	Hazid Study

Annex 3

Liquefied natural gas bunkering procedure

1. PURPOSE

To fill the liquefied natural gas storage tank(s) in a safe way, the following procedures shall be followed closely:

2. GENERAL

Before the vessel's liquefied natural gas storage tanks can be filled, the competent authority shall be informed. The authority could demand for extra safety precautions. The authority's approval for the bunker transfer must be available before bunkering has started.
As long as there are no regulations for liquefied natural gas bunker transfer the following can be used as guidance, where applicable:

- General bunker transfer procedures for oil fuel
- Precautions and procedures for cargo filling and –discharge by inland waterway tank vessels

3. PRE-FILLING

Before liquefied natural gas transfer has commenced, warning signs shall be placed, the bunker checklist in appendix A has to be filled in and signed both by a vessel's representative and the delivery truck driver.
After all questions on the bunker checklist are answered positive and the delivery truck driver has received all necessary documentation, transfer can commence.

4. FILLING

During transfer the following items shall continuously be checked:

- The gas pipes, -hose and connectors for leakage,
- The mooring lines,
- Forces on the transfer hose,
- Tank pressure, which can be controlled by use of the top filling spray facility (with this procedure a vapour return is not required).

5. POST-FILLING

After liquefied natural gas transfer, and after the transferhose is disconnected, warning signs on the shore can be removed. At this time the vessel's representative shall inform the crew and the competent authorities that the transfer is finished.

Appendix A (template)

Liquefied natural gas bunker checklist	
Precautions and appointments made for transfer of liquefied natural gas	
- Vessel's particulars .... (Vessel's name)	.... (European vessel identification number)
- Truck's particulars .... (Company name)	.... (Plate number)
- Bunker location .... (Address) .... (Date)	.... (Place) .... (Time)
Liquefied natural gas related particulars	
Quantity in m^3:	
Emergency procedure	
Filling must be stopped immediately in case of any leakage. All valves have to be set in their safe position. A red flashlight on the vessel will indicate the abnormal situation described. The truck driver will stop the liquefied natural gas transfer immediately. All personnel will evacuate the bunker area immediately in accordance with the safety rota.	

The start of the liquefied natural gas transfer is only allowed if all questions raised on the following checklist are answered 'yes' and both responsible persons have signed the list.
If one of the questions cannot be answered 'yes', liquefied natural gas transfer is **NOT** allowed.

Liquefied natural gas bunker checklist			
		Vessel	Truck
1.	Is the competent authority's permit for the liquefied natural gas transfer in the designated area available?	○	--
2.	Are the requirements of local regulations and of the competent authority met?	○	--
3.	Is the competent authority informed that liquefied natural gas transfer will be commenced?	○	--
4.	Is the vessel well moored?	○	--
5.	Is the lighting, both on the truck and on the vessel (bunker manifold and escape routes), sufficient and in good working order?	○	○
6.	Are the signs, that designate the safe area around the tank truck on the shore, placed?	--	○
7.	Are all for any possible leakage necessary drip-trays placed and is the water spray installation for immediate use available?	○	--
8.	Is the liquefied natural gas transfer hose properly supported and are there no extreme forces or stress on the hose?	○	○
9.	Are the liquefied natural gas transfer hose and break away coupling in good condition?	○	○
10.	Is the ground cable connected in the right way?	--	○
11.	Are all means of communication between truck, bunker manifold and wheelhouse checked and in working condition?	○	○
12.	Are all safety and control devices on the liquefied natural gas installation checked and in good working order?	○	--
13	Is the amount of liquefied natural gas that will be transferred agreed?	○	○
14.	Do the ordered liquefied natural gas specifications apply on the delivered liquefied natural gas specifications?	○	○
15.	Is the emergency stop procedure discussed with, and understood by, the truck driver?	○	○
16.	Is there a liquefied natural gas quality certificate available?	○	○
17.	Has the crew been informed that the liquefied natural gas transfer has commenced?	○	--
18.	Is for the whole time of the filling or emptying of the liquid natural gas storage tank a continuous supervision by the responsible persons of the vessel and the truck ensured?	○	○
19.	Are there suitable means of escape in case of emergency available?	○	

Checked and signed:	
Vessel's responsible person: .... (Name in capitals) .... (Signature)	Tank truck's responsible person: .... (Name in capitals) .... (Signature)

Annex 4

Description of the training of the crew on board of liquefied natural gas driven inland waterway vessels

A. Introduction

The main purpose of the course is to familiarise the crew of inland waterway vessels with the properties and hazards of liquefied natural gas and to gain knowledge on how to work with liquefied natural gas as fuel on board the vessel; for instance in case of operation, bunkering and maintenance.

The course will include a theoretical part, consisting of the topics mentioned under B and a practical training on board the vessel in which the theoretical items will be dealt with in practice.

The selection of a suitable training institute and the extent of the training will be in accordance with, and determined by the competent authority. Every 2.5 years, the training shall be repeated.

After successful participation, the crew will be issued a certificate by the training institute.

B. The liquefied natural gas course will cover the following topics:

1. Legislation

1.1 General legislation / best practice for ADN, ROSR, European Directive EU 2006/87 and new developments

1.2 Available international legislation concerning liquefied natural gas (for seagoing / best practices) IMO, IMDG and new developments

1.3 Rules of the classification society which has classed the vessel

1.4 Legislation concerning health and safety

1.5 Local regulations and permits

1.6 Recommendations according to ADN and RVIR

2. Introduction to liquefied natural gas

2.1 The definition of liquefied natural gas, critical temperatures, liquefied natural gas hazards, atmospheric conditions

2.2 Compositions and qualities of liquefied natural gas, liquefied natural gas-quality certificates

2.3 MSDS (safety sheet): physical / product characteristics

2.4 Environmental properties

3. Safety

3.1 Hazards and risks

3.2 Risk management

3.3 The use of personal protection

4. The techniques of the liquefied natural gas installation

4.1 General configuration
4.2 Explanation of the effects of liquefied natural gas
4.3. Temperatures and pressures
4.4 Valves and automatic controls, ATEX
4.5. Alarms
4.6 Materials (hoses, pressure relief valves)
4.7 Ventilation

5. Service & checks of the liquefied natural gas installation

5.1 Daily maintenance
5.2 Weekly maintenance
5.3 Periodical maintenance
5.4 Failures
5.5 Documentation of maintenance work

6. Bunkering of liquefied natural gas

6.1 Bunkering procedure liquefied natural gas
6.4 Gas freeing / flushing of the liquefied natural gas system
6.5 Check lists and delivery certificate

7. Preparation of the liquid natural gas system for maintenance of the vessel

7.1 Gas free certificate
7.2 Gas freeing / flushing of the liquefied natural gas system before docking
7.2 Inerting of the liquefied natural gas system
7.3 Procedure de-bunkering of the bunker tank
7.4 First filling of the liquefied natural gas bunker tank (cool down)
7.5 Start up after dock period

8. Emergency scenarios

8.1 Emergency plan
8.2 Liquefied natural gas spill on deck
8.3 Liquefied natural gas skin contact
8.4 Release of natural gas on deck
8.5 Release of natural gas in enclosed spaces (power stations)
8.6 Fire on deck in the vicinity of the liquefied natural gas storage tank.
8.7 Fire in engine rooms
8.8 Specific hazard in case of transport of dangerous goods
8.9 Grounding/collision of the vessel

Project description

Contents

1. Introduction

Chemgas is a shipping company for inland and seagoing gas carriers with 48 years of experience in the transport of gasses. Currently, Chemgas is planning on building a gas carrier (ADN type G) which will use LNG as fuel and transports the common gasses as allowed by the ADN. The ship will be equipped with a dual fuel engine in order to switch to diesel in case of problems with the LNG system or a lack of LNG bunkerfacilities.

The ship will be built under Bureau Veritas class and shall comply with the legislation of RosR and ADN. Class will be maintained. In addition the design will comply, in as far as relevant for inland shipping, with the requirements of the IGF code as being developed by IMO. Because LNG is not allowed as fuel for propulsion, for both the CCR committee in Strasbourg and the ADN committee in Geneva a request for recommendation is submitted.

At the end of this project description a list of terms and abbreviations is added.

1.1 Update of design and project documentation

After the presentation of the project in Bruxelles in June 2013, some changes were made both to the LNG/NG system and the project documentation. The main update on the LNG/NG system is that a solution has been found to avoid tank connections below the deck. This is in line with the philosophy of the current ADN for type G vessels (ADN 9.3.1.11.6.(c)).

The differences are:

- The pressure build up unit is replaced by a submerged pump within the LNG tank.
- The system lay out has been updated and divided into 3 blocks, being consumers, conditioning and containment.
- A list of terms and abbreviations has been added in both project description and Hazid.
- The lay out of the project description has been updated in accordance with a proposal of the German delegation.
- The chapter on ESD is moved from the Hazid to chapter 4 of the project description.
- Annex 2 (deviations from the IGF code) has been updated in accordance with questions raised during the meeting in Bruxelles.
- The Hazid is adapted to reflect the new system as mentioned in paragraph 2 of the Hazid.

2. Ships data

2.1 Introduction

The vessel will have the following main dimensions:

Length over all	110,00 m
Breadth	11,40 m
Depth	5,65 m
Max draft	3,15 m
Airdraft	4,60 m (in ballast condition)

The cargo tank capacity is 6 tanks of 437m3 each, adding up to 2620 m3 in total. Due to the size of the cargo tanks, the design complies with ADN 9.3.4. In appendix 1, the general arrangement of the vessel is added.

2.2 Fuel tank

The LNG fuel tank is a cylindrical independent pressure vessel, as defined in ADN, for a working pressure of at least 4 bars overpressure. The total tank volume is about 85 m3. The LNG fuel tank fully complies with the existing ADN requirements for a refrigerated cargo tank. The tank is of single wall construction in order to allow the fitting of necessary connections for piping, equipment and access for inspection. The tank is located below the uppermost deck, while the dome of the tank protrudes through the uppermost deck as is usually done with cargo tanks. All connections to the tank are located above deck at the dome. The access for inspection allows for the possibility to conduct periodical inspections on the tank construction. The tank is positioned in transverse direction on tank seatings as required for cargo tanks.

Excessive transfer of low temperatures to the ship's construction is prevented. The insulation complies with the requirements of the classification society and shall consist of 300mm PIR-insulation with a metal outer layer in order to minimize the absorption of moisture and avoid damage to the insulation. The LNG tank space is equipped with dry air for additional protection against the absorption of moisture.

The tank is placed in the forward part of the vessel in a separate compartment below deck within the cargo area. The tank space has a double bottom and double hull construction in accordance with ADN requirements for cargo tank locations. The hull in way of the fuel tank is designed in a similar way as is done for "large" cargo tanks. This means that in the event of a collision the shell absorbs more energy than a standard hull construction (ADN 9.3.4).

The construction of the tank is such that it can resist an internal pressure of 10 bars. The relief pressure of the safety valves on the tanks will be so designed that the vessel can remain in idle condition for not less than 15 days without the necessity to blow off, as required in the IGF code.

2.3 Piping and installations

The electric equipment for the part of the LNG/NG system which is located within the cargo area complies with the requirements set forth for the cargoes to be carried and, in addition, to those applicable to LNG.

LNG runs from the tank dome on open deck to the gas conditioning unit where the evaporation will take place and the temperature of the NG is increased to at least 0^{o} Celsius. The pressure can be adjusted to a maximum of 8 bars. Under these conditions the NG will be lead to the main and auxiliary engines within the engine room.

The connections at the tank dome, all located above deck, are equipped with the following:

- Gas and liquid lines are equipped with an ESD valve and an hand operated valve, both located as close to the dome as possible with the exception of connections with a diameter restriction of 1,5 mm.
- Safety valves of piping which may contain liquid are directed to the LNG fuel tank by means of 2 hand operated valves at the dome and with an excessive flow valve within the tank.
- Hand operated valves are fitted below both tank safety valves. It is not possible to close both valves at the same time and the closing is only allowed in order to exchange a safety relieve valve.

The discharge from the tank safety valves is lead to a vent mast with an opening height upto the air draft with a minimum height of 1 meter above deck. The opening of the vent mast is located within the cargo area and has a minimum distance of 10 meter to the openings, accesses and engine outlets located outside the cargo area in accordance with the IGF code. The pressure build up within the LNG fuel tank will be gradually and the discharge will not be sudden. This will be known well in advance and necessary measures, as prescribed in the ship's manual, can be taken to prevent the discharge.

The LNG bunkering connections are located both on port- and starboard side on open deck within the cargo area and are located at a minimum distance of 6 meter from the openings, accesses and engine outlets located outside the cargo area. In the event of emergency it is possible to discharge the LNG fuel tank.

The gas conditioning unit is located on open deck within the cargo area and also at least 6 meter away from the openings.

Where leakage of LNG is possible, drip trays of stainless steel are provided. These drip trays are free from the deck construction and have a drain leading outside the vessel. This is done to protect the ships construction from low temperatures.

2.4 Engine room

The engine room will be designed and executed as a gas safe machinery space. This means that all gas piping, valves, reducers and connections are of the double wall principle or located within a gastight casing, with the exception of a small length of single wall piping for a pressure of 50 mbar between the LPRS and the auxiliary engine. This in accordance with the IGF code. The casing is equipped with a gas detection system and provided with ventilation leading to a safe location on open deck.

In case of a failure in the gas supply, the main engine will, without interruption, automatically switch from gas to diesel. If a NG auxiliary engine stops, the second NG auxiliary engine will automatically be started. If this second NG auxiliary engine is also stopped, an automatic switchover to a diesel generator is started. This diesel generator is located in the forward part of the vessel. This automatic take over of the auxiliary engines has no influence on the propulsion and safety aspects of the vessel.

The evaporator/heater will be indirectly heated using the cooling water of the engines. This is done indirectly in order to prevent that possible leakage of gas is lead to the engine room.

3. Fire protection

The vessel is a type-G vessel with all required fire extinguishing systems. In addition, the vessel is equipped with a water spray installation within the cargo area for the cargoes to be carried. In case of LNG leakage on deck, this installation can also be used to assist in the quick evaporation of LNG and to cool down and/or protect other parts of the vessel.

4. Safety provisions &ESD

4.1 Safety provisions

In relation to various dangerous situations, scenarios have been envisaged which will be mentioned in the ship's manual.

In the ship's manual procedures will be prescribed which deal with the following issues:

- Fire in the engine room
- Fire on deck
- Collision
- Grounding
- Damage from falling objects
- Bunkering
- Discharge of the LNG fuel tank
- Purging
- Pressure build up which may lead to discharge

4.2 ESD system

The ESD system makes sure that, in case of a possible irregularity with the LNG/NG system, the consequences will be prevented or minimized by shutting down (parts of) the system. In this paragraph the various ESD parts are described.

4.2.1 ESD during LNG bunkering

The ESD will be activated automatically in the event of filling the LNG tank above the allowed limit. In the wheelhouse and on suitable places on deck, the emergency switches are positioned with a text plate indicating "emergency stop bunkering" to manually activate the ESD. In addition a portable emergency stop is available to be carried onboard the bunker barge or the bunkering station ashore.

After activating the ESD system, the following will occur:

- The valves on the bunker manifold in use will be automatically closed.
- An audible and visible alarm will be activated
- A signal will be send to the bunkerer.

4.2.2 Additional ESD valves on deck

In the event of a casualty all ESD valves on deck can be closed simultaneously by pressing a LNG emergency stop button. The LNG pump will be stopped immediately. The emergency stop button will be placed on 3 locations on deck and 1 in the wheelhouse.

4.2.3 ESD valves in the NG lines to the main engine

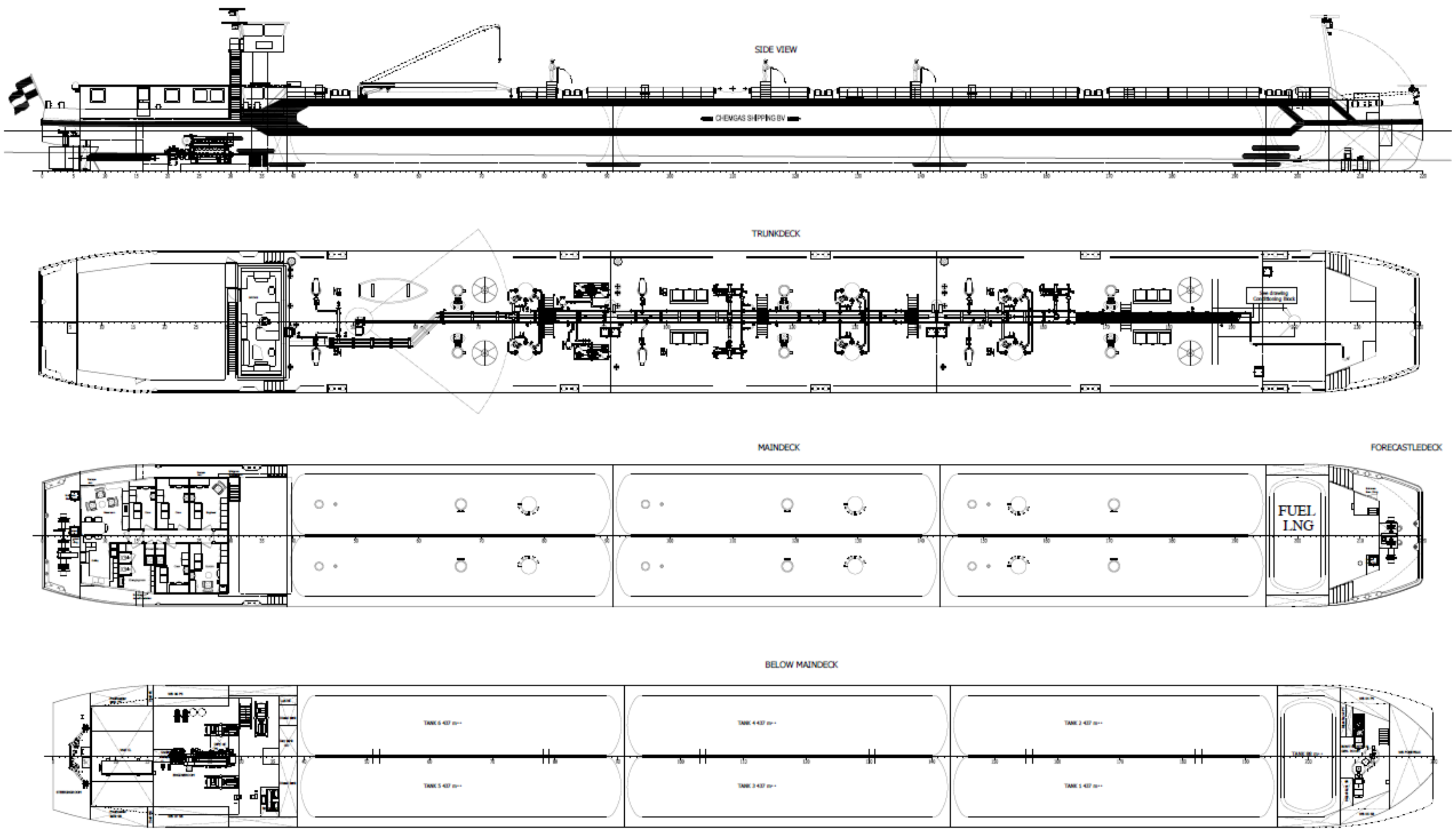
The ESD valve closes automatically if the gas detection system within the gas valve unit of the Wärtsilä dual-fuel main engine is activated. It can also be closed in the wheelhouse by activating the emergency stop “closing NG supply to main engine”. This ESD valve will be supplied by the engine manufacturer. Due to the closing of the valve, the main engine will switch over to diesel and remain fully functional. The gas/air mixture within the gas valve unit will be ventilated to a safe location on open deck.

4.2.4 ESD valves in the NG lines to the auxiliary engines

When the gas detection system above one of the auxiliary engines or within the LPRS is activated, the NG supply to the auxiliary engine in question is shut down and an alarm will sound within the wheelhouse and accommodation. As a consequence, the auxiliary engine will stop and the other NG auxiliary engine will be started automatically.

List of terms and abbreviations

Abbreviation	Explanation
ADN	"Accord Européen relative au transport International des marchandises Dangereuses par voies de Navigation intérieures.
ALARP	As Low As Reasonably Possible
BLG 17 wp.5/add1	Draft IGF code 2013
Cargo area	Part of vessel where all cargo tanks &LNG fuel tank are located
Cause	What leads to the deviation
Conditioning block	Transfer LNG to NG
Consumer block	Part where NG is consumed/used, aux engines, incl gas valve unit & HPRS
Containment block	Storage of LNG & bunker connections
De-bunkering	
Deviation	An event (failure mode) deviated of the normal operational situation or technical status of the installation
ESD	Emergency Shut Down
Fail safe valve	Close automatically after any failure of the control system
FMEA	Failure Mode Effect Analysis
Gas safe machinery space	Arrangements in machinery spaces are sucht tat the spaces are considered gas safe under all conditions, normal as well as abnormal conditions, ie inherently gas safe (BLG 17)
Gas valve block	Regulator of gas on deck
Gas valve cabinet	Gas regulator for main engine
Hazard	What are the dangers of the deviation
HPRS	High Pressure Reducing Station
ID	Indentification number used by Dutch Authorities
IGF-Code	International Code of Safety for Gas-fuelled Ships
LNG	Liquified Natural Gas
LPRS	Low Pressure Reducing Station
NG	Natural Gas
P&ID fuel system	Process & Instrumentation Diagram
PIR	Insulation of tank
Potential effects	What ill be the effect to vesse, crew, environment
PS	Port Side
Purging	Replace present gas in tank or pipe with another gas.
RosR	Rhine Rules
Safeguards	Technical solutions (design, control & monitoring systems) to reduce the probability to happen the deviation (event). Operational procedures and/or preventive measures, carried out by human, to reduce the probability to happen of the deviation (event).
SB	Starboard Side



PRINCIPAL DIMENSIONS

LENGTH O.A.	110,00 m
LENGTH MLD.	109,95 m
BREADTH O.A.	11,37 m
BREADTH MLD.	11,32 m
DEPTH	5,65 m
DRAUGHT Ballast	2,25 m
DRAUGHT Construction	3,15 m

1:100

GENERAL ARRANGEMENT

A0

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