ISTANZA PER IL RILASCIO DELL'AUTORIZZAZIONE ALLA COSTRUZIONE E ALL'ESERCIZIO DELL'OPERA FSRU RAVENNA E COLLEGAMENTO ALLA RETE NAZIONALE GASDOTTI

RICHIESTA DI INTEGRAZIONI

Ente Richiedente:

MINISTERO DELL'INTERNO
DIPARTIMENTO DEI VIGILI DEL FUOCO DEL SOCCORSO PUBBLICO E DELLA DIFESA CIVILE - COMANDO PROVINCIALE VIGILI DEL FUOCO RAVENNA

Rif: Prot. CG.2022.0000034 del 30 08 2022

Allegato_ 6 Hazop

Rev.	Descrizione	Elaborato	Verificato	Approvato	Data
0	Emissione per permessi	V.ROMANO	G.ROMANO	S.SCANDALE V.FORLIVESI	Settembre .2022

SAMSUNG HEAVY INDUSTRIES

PLAN HISTORY

Rev.	Date	Reason for Issue	Prepared by	Checked by	Approved by	Approved by Client
1	1 Sep. 2013	Issued for HN2074	JCL	GJG	HBY	

Registration; Bermuda

2074	9684495
Hull No.	IMO No.

Department; **Marine Research Institute**	Ship Type; **170,000 m³ LNG FSRU**	Class.; **DNV**
Hull No.; **HN2074**	Ship Name;	
Approved by ; H. B. Yoon Checked by ; G. J. Gweon Prepared by ; J. C. Lee	Document Title; **SAFETY REPORT** Buyer's Document No.;	
SAMSUNG HEAVY IND. CO., LTD. **GEOJE SHIPYARD, KOREA**	Builder's Document No.; **3000 – HX – 71001**	Rev. No.; **1**
	Scale; NONE / Unit; - / Consolidated No.;	-

SAMSUNG

PLAN HISTORY

Rev.	Date	Reason for Issue	Prepared by	Checked by	Approved by
-	17 April 2012	Prepared by Outfitting System Design1. Submitted to Buyer for final report.	G.J.Gweon	Du.H. Ha	Y.S. Kim

SAMSUNG

Golar/DNV

2031	9633991
Hull No.	IMO No.

Registration : MARSHALL ISLAND (65) sheets with a cover

Department; DS **Outfitting System Design 1**	Ship Type; **170,000 m^3 LNG FSRU**	Class.; **DNV**
Hull No.; **2031**	Ship Name;	
Approved by ; Y. S. Kim Checked by ; Du. H. Ha Prepared by ; G. J. Gweon (T.6178) G.J.Gweon	Document Title; **HAZOP REPORT FOR REGASFICATION PLANT** Buyer's Document No.;	
SAMSUNG HEAVY IND. CO., LTD. **GEOJE SHIPYARD, KOREA**	Builder's Document No.;	Rev. No.; -
	Scale; NONE / Unit; - / Consolidated No.;	-

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Golar LNG

FINAL REPORT for HN2031 HAZOP recommendation

The HAZOP workshop took place for 2 days, from 15th to 16th February 2012 at SHI Shipyard located in Geoje, South Korea.
According to recommendations (Total 38 items) issued from HAZOP workshop, SHI and Golar LNG has discussed and agreed for all recommendations as below and no comment is remained as open.

REC #		ACTION REQUIRED	ACTION BY	SHI REPLY	OWNER REPLY		STATUS
1.1	a)	Consider using three transmitter for action voting for LAHH and LALL to transmitter LIT-0013	SHI	Voting function for LAHH and LALL with LIT-0013/LIT-0043/LIT-0053 will be provided. Please refer to the revised P&ID as attachment #1.1-a.	Accepted		CLOSED
1.2	a)	Consider three independent pressure transmitter each with dedicated shut-off valves	SHI/GOLAR	Pressure transmitter PIT-0031C will be added without shut-off valve(root valve) due to having individual threeway valve. Please refer to the revised P&ID as attachment #1.1-a.	Arrangement in revised drawing is accepted. However, considered the concequences of faulty instrument this should be incuded in Yard supply without extra cost.		CLOSED
	b)			If the one transmitter is fault, operator can be found from comparision with skid inlet pressure. After being found the fault sensor, it can be inhibited and repaired. The remained healthy instrument still operates without system shut down. Please consider that additional sensor is not necessary, so the extra is not SHI scope.	Two (2) pressure transmitters will be provided. Deviation alarm between A & B sensor (PIT-0031A&B) will be provided. Set aprx. 20% for pressure and 5% for temperature (TE-0032A&B) as default. May be adjusted during commissioning		
1.3	a)	Clarify the control strategy for the high pressure controller on Recondenser VX-0050	SHI	Please refer to the revised Control philosophy as attachment #1.3-a.	Revised control philosophy noted. Owner would suggest that LCV-0075 closes at 10 bar. Pre-alarm should be given at 8 bar.		CLOSED
	b)			Noted. LCV-0075 will be closed at 10 bar. Pre-alarm will be at 8 bar.	Agreed		
1.4	a)	Develop strategy to handle high level in the Recondenser VX-0050 with the objective to maintain production	SHI	Please refer to the revised Control philosophy as attachment #1.3-a.	Owner accept revised control philosophy		CLOSED
1.5	a)	Verify that relevant piping and check valves on the N2 line are cryogenic type.	SHI	We confirm that the material of piping is SUS316 and the cryogenic type for the check valve(C-0024).	Noted		CLOSED
		To evaluate closing of IV-0050 on high level in Recondenser VX-0050	SHI	The close function in case of high level in Recondenser will be provided, it is not hardship. But we concerns that if we change the logic to closed the IV-0050 valve in case of recondenser PSD condition, the gas in the recondenser can not release. When the pressure is above set point, PSV shall be opened for the release of Recondenser pressure. Please refer to the revised C&E chart as attachment #1.6-a.	ref PCF for C&E which we maintain our position:(GOLAR/SHI/2031-320-001-004B): We understand your response, but IV-0050 do not need to close as part of PSD. If you define that High level in recondenser shall not give PSD. Instead you list the exact same actions as normal PSD, only that IV-0050 is closed instead of open and no action is taken on IV-0011. Then IV-0050 will still open as part of PSD for all normal cases. Only for high level in recondenser it will close. The reason we want this feature is that we see that one of the PSD that we actually can get is the high level in recondenser. If one train trip and PCV-0013A/B do not react quick enough we will reach HH level.		

1.6	a)				If IV-0050 is closed on high level, we maintain 4,5 barg in the recondenser drum. It is then simply to open drain a short while and level in reduced. If IV-0050 opened we loose pressure and cannot drain. Then we need to use nitrogen or high pressure NG to drain recondenser drum. The operator have to make changes in the safety system to be able to open pressure valves while there is high level in recondenser drum. Based on this experience we have made changes to our present systems so that IV-0050 is closed in case of high level in recondenser and IV-0011 is not closed. That way the operator can easily drain and start up again within minutes. In the cause and effect we still have that IV-0050 is closed as part of a PSD, we have only defined that HH in recondenser do not give PSD. It gives the exact same single effects as PSD apart from IV-0050 and IV-0011.		CLOSED
	b)			The IV-0050 will be closed at high-high level in recondenser and it will be opened at normal PSD (the IV-0050 would be kept closed position during the normal operation). And the IV-0011 valve will be kept open in case of recondenser HH level. For the buyer's comment deleting the PSD function at recondenser HH level, we are sorry to say that we cannot quarantee this manual operation in view of safety reason. Our clear operation concept is that the drain should be performed after all skid stop.	SHI to provide a efficient drain procedure after high-high level PSD. Golar strongly advise that IV-0050 is closed. Final acceptance to be carried out during approval of the control system.		
1.7	a)	Include cool down procedure in the Operation Procedure Manual.	SHI	SHI will provide the cool down procedure at later stage.	Noted		CLOSED
2.1	a)	Consider to implement alarm from the FE-0032 if actual flow deviate from the set-point.	SHI	The deviation alarm from FE-0032 will be provided if metered flowrate deviates from the set-point. Please refer to the revised Control philosophy as attachment #1.3-a.	Owner accepts revised control philosophy		CLOSED
3.1	a)	Check suitability of the limit switch in open deck (valid for all limit switches on the Regas facility).	SHI	It was agreed keeping the current type of limit switch as attachment #3.1-a.	Noted		CLOSED
3.2	a)	Include proper draining and drying of the piping following the hydrotest in the Commissioning Procedure - to prevent ice clogging.	SHI	As per our current arrangment, there is no possibility of water trap between recondensor and booter pumps. Please refer to attached drawing #3.2-a.	Routing of piping looks ok however trim angle of the vessel must be considered for horizontal segment. Draining and drying of the piping system should still be carried out after hydro testing.		CLOSED
	b)			Noted. Draining and drying shall be carried out after hydro testing.	Noted		
	a)	Consider to include PAHH on the PIT-1071 and PIT-1072	SHI/GOLAR	Pressure transmitter PIT-1073/1074 will be added for PAHH trip condition. Please refer to the revised P&ID as attachment #3.3-a.	In our oppinion this is a matter of safety due the Spec'break FCV 1005B which means that here is a potential for overpressureing the pipe segment.		

3.3	b)			1. IV-1007A/B has a limit switch so that the booster pump will be tripped when this valve is closed. 2. And the PSV is equipped on this line. 3. Overpressure will be only occured when the both failure of valve operation failed and booster pump not tripped. We are not consider the double failure. 4. Therefore, we strongly request Buyer to confirm the extra cost.	Buyer agreed to install with extra cost.		CLOSED
3.4	a)	Consider to include PAHH on the PIT-1041 A/B/C and PIT-1040 A/B/C	SHI	PAHH on the Pressure transmitter PIT-1040 A/B/C and PIT-1041 A/B/C and voting function will be provided for trip condition. Please refer to the revised P&ID as attachment #3.3-a.	Revised design is accepted.		CLOSED
3.5	a)	SHI to confirm the low current signal trip	SHI	SHI confirm the low current signal trip	Noted		CLOSED
3.6	a)	Confirm the capacity of the PSV-0049 and PSV-0051	SHI	We already submitted the capacity calculation twice by our letter SHI/GOLAR/2031-1503 dated 9 Jan. 2012 and SHI/GOLAR/2031-1587 dated 11 Feb. 2012.	We have reviewed the calulations. We would ask that DNV confirms that it is correct that insulation can be credited even if it is not fire proof.		CLOSED
	a)-1			It was already approved by DNV letter, PKJKR172/OJM/D32071-J-796 dated 9th Feb. 2012. Please refer to attachment #3.6-b.	We requested statement from DNV confirming that it is correct that insulation can be credited in the calculation for fire case. Further information in this respect has not been provided.		
	b)			The recondenser is protected against fire by dual layer of outer passive fire protection (PFP) and inner insulation.	Accepted		
3.7	a)	Consider moving the spec-break downstream of the valve	SHI/GOLAR	1) SHI will provide the locking device for V-n201 valves. 2) And spec-break can be moved upto the check valve Cn011A/B. EXTRA COST : Will be informed later.	Nil		CLOSED
	a)-1				We ask that DNV gives a statement which explicitly approves the spec break location.		
	b)			We asked DNV gives a statement for the spec break location and they approved our current design. Please refer to attachment #3.7-b.	We accept DNVs statement. Please include statement from DNV in final HAZOP report. Item 3.7 can be considered closed from our side.		
3.8	a)	Consider moving the check valve to inside the Regas Skid.	SHI	We do not see any reason and advantage for moving the location. Therefore we would like to keep the current location.	The comment should read: Consider moving NRV C1082/81 inside the spectacle flange and valve IV1007A/B to facilitate servicing the valve without shutting down the whole plant. Please also confirm that IV-1007A/B cannot fail-open during spectacle blind operation.		CLOSED
	b)			As DNV states that the stucking the check valve is very unlikely so that we would like to keep our current design.	Buyer accepts to keep SHI original design.		

3.9	a)	Consider suitability of the use of control valve for safety shutdown.	SHI	The control valve connected to solenoid valve that seperates between control and ESD signal. And the valve also has a safety function (Fail-Close) in case of valve failure. The safety shutdown device is not only FCV-1005 A/B but also other valve/equipment. Regardless of the control valve is failed to close, other devices can also activated. (HP booster pump stop, PSV n321/22, IV-n007A/B and pump recycle valve open)	We ask that DNV gives a statement which explicitly approves the use of control valves for safety functions.		CLOSED
	a)-1			We asked DNV gives a statement for the spec break location and they approved our current design. Please refer to attachment #3.7-b. If buyer insists to apply this item, we will check the possibility but it will be a huge cost, design and ship delivery impact. Please confirm this item by 16th March 2012.	We accept DNVs statement. Please include statement from DNV in final HAZOP report. Item 3.9 can be considered closed from our side.		
3.10	a)	Identify how to handle the trapped liquid after PSD to avoid PSV opening.	SHI	The valve (IV-n007 A/B) have a time delay for closing after FCV-n005 A/B is closed to prevent liquid trap by existing safety logic. After PSD, If the LNG/SW heat exchanger inlet control valve(FCV-n005A/B) and outlet valve(IV-n007A/B) are closed and PAHH on LNG/SW heat exchanger outlet pressure(PI-n073/74) then the outlet valve(IV-n007A/B) will be open. Re-open action is only for FCV-n005A/B is closed condition. Please refer to the revised Control philosophy as attachment #1.3-a.	We accept proposed control philosophy		CLOSED
3.11	a)	Consider implementing a bypass around FCV-1005 A/B to improve cool down time if required by heat exchanger vendor	SHI/GOLAR	We can provide the manual by pass line(1") with extra cost.			CLOSED
	a)-1				Please provide a statement from the Supplier if this function is needed.		
	b)			As per vendor email, the "cooldown function" would be not necessary as quoated below. [Quote] As long as the sea water if running fully prior to introducing the LNG, CPP does not anticipate any problems related to temperature. [Unquote]	Noted.		
3.12	a)	Review the vapor return from the HP Booster Pumps	SHI	In the skid, the HP booster pump's pot installation level is identical and the vapor section connected by vapor return line. If the vapor is generated from one pump pot, the vapor goes and shares each other and the pressure is evenly distributed. The pump pot level is controlled by LCV-1050 to prevent that the pot level is low condtion. And the KO drum with interlock function valves can block the liquid overflow to the vapor main line.	Accepted		CLOSED

4.1	a)	Consider interlock between IV-0050 and control valves feeding gas (PCV-0025, FCV-0022, PCV-0090) into the Recondenser Drum.	SHI	The interlock funtion between IV-0050 and control valves(PCV-0025, FCV-0022, PCV-0090) will be provided. Please refer to the revised Control philosophy as attachment #1.3-a.	Accepted		CLOSED
5.1	a)	To evaluate suitability of the temperature sensor for liquid detection in the KO Drum VA-0070.	SHI/GOLAR	The temperature sensor can be changed to level sensor(DP type). Please refer to the revised P&ID as attachment #1.1-a.	HAZOP comment calls for evaluation of suitability. Please submit your evaluation.		CLOSED
	b)			Please refer to document as attachment #5.1-b. Attachment #5.1-b	SHI will provide level sensor.		
6.1	a)	Consider connecting drain line to the spray line instead of the liquid main.	SHI	The size of spary line is 80A and the drain line is 150A. It is not possilbe to connect bigger line to smaller line. And this concept has already explained during the meeting in Oslo at early stage.	Our concern is that there will be pressure in liquid line during loading LNG from LNGC. Will it be possible to drain the regas-system while loading LNG?		CLOSED
	b)				Blind connections DN65 to be provided..		
6.2	a)	Propose to have rate of change alarm for the level in the pump pot during cool down.	SHI	The cool down rate will be displayed in the Regas control Mimic and the rate change alarm will be provided.Please refer to the revised Control philosophy as attachment 1.3-a.	Noted.		CLOSED
6.3	a)	Consider overpressure protection in line between IV-1090 A/B and V-1091.	SHI	We will provide the locking device for V-n091(locked open) And the safety valve where is less than 50 liter is not required(the current volume is about 5 liter).	Accepted		CLOSED
7.1	a)	Measures to handle pipeline backflow due to inadvertent opening of IV-0010.	SHI	In case of blowdown valve is open, the ESD valve will be closed.	If there is a function that the ESD valve closes if the blow down valve opens, this is accepted.		CLOSED
7.2	a)	To evaluate measures of detecting release in the NG Send-out line.	SHI/GOLAR	It is physically impossilbe to detect the gas release through the all piping in case of pipe rupture. Please inform us which point is needed for gas detection, then we can propse the quoation.	Due to the low pressure alarm and shut down in this segment, a rupture in the pipeline will be detected by low pressure alarm/shut down. Hence additional gas detectors are not considered neccessary		CLOSED
7.3	a)	To evaluate measures of liquid detection and means for boiling off liquid in the drum.	SHI/GOLAR	Temperature sensor for liquid detection of KO Drum will be added. Please refer to the revised P&ID as attachment #7.3-a (11017).	We delete request for the temperature instrument due to the gas detection in vent mast. To increase boil off (in case of liquid in drum) we will use water spraying.		CLOSED
7.4	a)	To consider non-return valve on the send-out line.	SHI/GOLAR	In case of blowdown valve is open, the ESD valve will be closed. So, it is not necessary. If requested, we will provide the check valve with extra cost and system function impact / delivery impact.	Due to the interlock between ESD valve and blow down valve we no longer considers this necessary.		CLOSED
	a)-1			*High pressure Swing check valve with butt welded type shall be applied with EXTRA COST.*	Comment withdrawn		
7.5		To evaluate the size of the segment and means / need to depressurize of the line.	SHI	Please refer to updated P&ID as attachment #7.3-a. and the calcuation for depressurize of the line as attachment #7.5-a.	Accepted		CLOSED

8.1		Include pressure transmitter on the suction and discharge side of the SW Lift Pumps.	SHI	Refer to updated P&ID #8.1-a.	Accepted		CLOSED
8.2	a)	Consider to include differential pressure transmitter on the strainer.	SHI/GOLAR	The DP transmitter will be added. Please refer to attachment #8.1-a.	dP transitters across major filters and strainers should be part of ship design and should not be charged extra.		CLOSED
	a)-1			Same configeration without DP sensor has been applied for our cooling water system in E/R as attachment # 8.2-b. And we have the suction pressure transmitter on the life pump so that we don't think the DP transmitter is necessary. Also, this is not part of regas notation as we already explained during the HAZOP. Therefore, it will be applied with EXTRA cost. Please confirm by 16th March 2012.	This item should be discussed in scheduled meeting		
	b)			To be discussed during the meeting.	Buyer agreed not to install DPT across SW strainers.		
8.3	a)	Consider current monitoring of the SW Lift Pump motor	SHI	We confirm the current monitoring of the SW lift pump motor.	Noted		CLOSED
8.4	a)	To provide DP measurement over the SW filters	SHI	We will provide the DP indication.	Noted		CLOSED
8.5	a)	Consider implementing alarm on the DPT-1153 / 1155 / 1157 / 1159	SHI/GOLAR	The alarm for DPT-1153/ 1155/ 1157 / 1159 will be provided. Please refer to the revised P&ID as attachment #3.3-a.	Noted		CLOSED
8.6	a)	To identify the need to protect SW piping and heat exchanger in the event of tube rupture.	SHI	Rupture disc will be provided as attached drawing #3.3-a and 8.6-a.	Accepted. Please provide end flange so that hoses/pipes later can be connected for overboard drain.		CLOSED
	b)			Noted. The flange shall be installed at end of pipe as attached drawing #8.6-b. Attachment #8.6-b	Accepted		
8.7	a)	Evaluate the vacuum breaker sizing and the capability of vaporizer to withstand vacuum in case of vacuum breaker failure.	SHI	The vaporizer shell side is not withstand in case of full vacuum condition. To protect the vaporizer, we already implemented the vacuum breaker on the seawater line. Please refer to the calculation sheet as attachment #8.7-a.	Accepted		CLOSED
9.1	a)	Consider moving check valve CL-304 to the downstream of recycle line.	SHI	Considering main cargo pump and emergency cargo pumping running, we cannot agree your request.	Accepted		CLOSED

DET NORSKE VERITAS

HAZOP REPORT
FOR
REGASIFICATION SYSTEM OF HN2031 170,000m^3 LNG FSRU

SAMSUNG HEAVY INDUSTRIES /
GOLAR ENERGY

DNV Project No: 2017 / PP034621
Revision 0: APRIL 2012

HAZOP Report for Regasification System of HN2013 170,000m^3 LNG FSRU	DET NORSKE VERITAS AS SDN. BHD. Level 24, Menara Weld, 76, Jalan Raja Chulan, Kuala Lumpur, Malaysia Tel: +603 2050 2888 Fax: +603 2031 0886 http://www.dnv.com
For: Samsung Heavy Engineering	
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Date of First Issue:	April 2012	Project No.	PP034621
Report No.:	PP034621	Organisation Unit:	PSEMY 472
Revision No.:	0	Subject Group:	SHE

Summary:

Det Norske Veritas AS Sdn. Bhd. has been commissioned by SHI to perform a HAZOP Study for the Regasification System of HN2013 170,000m^3 LNG FSRU.

This report documents all the the outcomes of HAZOP workshop carried out for two (2) days, i.e. 15th and 16th February 2012 at SHI Shipyard in Geoje, South Korea. The workshop was facilitated by DNV and with participation from SHI, Golar LNG, Nikkiso and Penspen / Wonil T&I.

A total of 38 recommendations were made by the HAZOP team.

Prepared by:	M. Shukran Md Farid *Risk & HSE Engineer*	Signature
Verified by	Trond Elvehoy *Principal Risk & HSE Engineer*	Signature
Approved by:	Alex Tan *Team Leader*	Signature

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☐	No distribution without permission from the client or responsible organisational unit	Key Words	HAZOP, SHE, FSRU, LNG
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A/Feb 2012	Draft	SF	ELVE	AT
0/April 2012	Final	SF	ELVE	AT

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EXECUTIVE SUMMARY

Det Norske Veritas AS Sdn. Bhd. (DNV) was commisioned by Samsung Heavy Industries (SHI) to facilitate the HAZOP Workshop for the Regasification System for HN2013 170,000m3 LNG FSRU project.

The purpose of this HAZOP workshop was to:

- Systematically examine the design system of the regas facitilties on the FSRU
- Identify potential hazards and operational problems from all conceivable possible causes
- Make judgements whether planned design or operational safeguards are adequate, or if further mitigating actions are required

The HAZOP workshop took place for 2 days, from 15th to 16th February 2012 at SHI Shipyard located in Geoje, South Korea. The workshop was facilitated by DNV and with participation from SHI, Golar Energy as well as participation from vendors such as Penspen, Wonil T&I and Nikkiso Cryo Inc.

The HAZOP was conducted based on Revision 2, 3, 4, 5 and 6 of the LNG Regasification and High Pressure NG Sendout Line Process and Utilities Instrumentation Diagrams (P&ID) plus LNG Feed Inlet and LD Compressor (BOG Inlet) drawings. A bulk of information was gathered based on the knowledge and experience of the HAZOP team members. The HAZOP scope included 9 nodes encompassing the LNG Feed Pumps, BOG Compressor, LNG Inlet & Recondenser, Regas HP Booster Pumps and Heat Exchanger, NG Sendout Line and Seawater System. As per the collective agreement of the HAZOP team, some systems have not been HAZOP'ed (e.g. Nitrogen Distribution System) due to similarity of the system with the existing system used by Golar. The systems not included in this HAZOP study are as follows:

- Nitrogen Distribution System; and
- Instrument Air System.

A total of 38 recommendations with an agreed list of action parties to these recommendations were derived from the HAZOP workshop

All actions should be given due attention by the parties responsible and shall be closed. SHI shall be responsible for assigning the action items to appropriate action parties and tracking them for completion. If for any reason an action is not implemented, the justification for this should be documented.

ABBREVIATIONS

BOG	Boil-Off Gas
DCS	Distributed Control System
DP	Design pressure
DT	Design Temperature
ESD	Emergency Shutdown
FCV	Flow Control Valve
FE	Flow Element / Flow Transmitter
F&G	Fire & Gas
Golar	Golar LNG
HC	Hydrocarbon
HP	High Pressure
KO	Knock-out
LAL	Level Alarm Low
LALL	Level Alarm Low-Low
LCV	Level Control Valve
LD	Low Duty
LNG	Liquified Natural Gas
LO	Locked Open
NG	Natural Gas
PAL	Pressure Alarm Low
PALL	Pressure Alarm Low-Low
PDT	Pressure Differential Transmitter
P&ID	Piping & Instrumentation Diagrams
PCV	Pressure Control Valve
PFD	Process Flow Diagram
PSV	Pressure Safety Valve
SDV	Shutdown Valve
SS	Stainless Steel

1 INTRODUCTION

1.1 Background

1.2 Report Structure

The overall objectives of the HAZOP report is to ensure full traceability of the study, to provide justification for the outcome of the study, and to provide results in a form which could be used for future decision making process.

The HAZOP report is structured as follows:

- Section 1 - Introduction
- Section 2 – Objectives and scope of the study
- Section 3 – Outline of HAZOP methodology
- Section 4 – HAZOP attendance register
- Section 5 – Summary of HAZOP recommendations

The P&IDs used in the HAZOP are attached in Appendix 2 and the detailed HAZOP meeting record sheets are given in Appendix 3 of this report. The attendance sheets have been compiled and are presented in Appendix 1 of this report.

2 OBJECTIVES & SCOPE OF STUDY

2.1 Objectives

The HAZOP Study is targeted to assist in meeting the requirement in providing a qualitative safety assessment on the major operability hazards to ascertain process risks related to the Regasification System for HN2013 170,000m^3 LNG FSRU.

The purpose of this HAZOP workshop was to:

- Identify major safety hazards associated with operation of the Regasification System based on the HAZOP methodology;
- Identify the controls/barriers in place to manage the identified operational hazards with regards to the facilities identified above ;
- Identify options for further improvement and make recommendations (to reduce the risks to people, asset, production and the environment); and
- Prepare a HAZOP report containing the HAZOP worksheets, findings and recommendations for use by SHI and Golar.

2.2 Scope of Work

The scope of the study was limited to the LNG Feed, Recondenser and Regasification System facilities as listed below:

- Process
  - LNG Feed Pumps;
  - Recondenser;
  - Regasification System including HP Booster Pumps and Heat Exchanger; and
  - HP NG Sendout Line.
- Utilities
  - Seawater System; and
  - Nitrogen Distribution System.

The following systems have not been HAZOP'ed as per the collective agreement of the HAZOP team:

- Nitrogen Distribution System; and
- Instrumen Air System.

3 STUDY METHODOLOGY

3.1 HAZOP Study Procedure

A HAZOP is a formal technique to systematically examine the hazards associated with the design of a facility and assess the risk associated with the hazards and sources of hazards to establish whether they are properly managed. During the HAZOP process any recommendations and actions identified to reduce the risks were recorded.

The HAZOP was performed by a team consisting of experienced engineers and operating personnel from appropriate disciplines, facilitated by an independent chairman (DNV) experienced in the use of the HAZOP methodology. The team included representation from the SHI, Golar and full and part time participation from vendors for Recondenser (Penspen), Regas Skid (Nikkiso) and LD Compressor (Cryostar). The various roles of the HAZOP team members are represented in the attendance sheet in Appendix 1. Throughout the duration of the workshop, necessary assistance was obtained from relevant personnel.

The HAZOP methodology is summarized below:

1. Identify the node to be studied;
2. Define the design intent of the node and the normal operating parameters;
3. Apply a HAZOP deviation (e.g. NO/LESS FLOW) to the node;
4. Identify all possible causes for the deviation;
5. Identify for each cause all possible consequences, without regard for the safeguards in place;
6. Identify all available safeguards to prevent the cause or to limit the consequences;
7. Recommend any new safeguards where judged necessary;
8. Repeat steps 4 to 7, using the next HAZOP deviation;
9. Repeat steps 3 to 8 until all HAZOP deviations have been applied to the node;
10. Select the next node to be studied, repeating steps 1 to 9; and
11. Repeat until all nodes are studied.

The HAZOP approach was done node by node, highlighted differently to differentiate each node's intent. By assigning these nodes, the system is able to be 'dissected' into a more manageable approach. Once the nodes have been identified and marked up, HAZOP guidewords were used to initiate causes towards these guidewords. Guidewords used involve parameters such as flow, temperature and pressure. By combining a deviation (E.g: No/less, More, As well as) to the parameters, each node is further analyzed specific to the causes arising from the guideword. Examples of guidewords are 'No/less Flow' 'High Level' and 'More Pressure'. Causes and consequences were identified for each guideword. From here, prevention/control measures to prevent the cause and mitigation barriers to manage the consequence were also identified.
A complete list of the Guidewords used for all the nodes is represented in 3.2.

Minutes of the HAZOP workshop were recorded using MS Excel. These worksheets were projected to the screen during the entire duration of the workshop. Worksheets are attached as Appendix 3.

Recommendations for actions were raised from each node studied. A compilation of all recommendations is represented in Table 4-2.

3.2 HAZOP Guide Words and Parameters

The HAZOP guide words used in this HAZOP study are shown in Table 3-1.

Table 3-1 : HAZOP Guide Words and Parameters

Deviation	Possible Causes
No Flow	Wrong routing - blockage - incorrect slip plate - incorrectly fitted check valve - burst pipe - large leak - equipment failure - (check valve, isolation valve, pump, vessel, etc.) - incorrect pressure differential - isolation on error - etc.
Reverse Flow	Defective check valve - syphon effect - incorrect differential pressure - two - way flow - emergency venting - incorrect operation - etc.
More Flow	Increased pumping capacity - increased suction pressure - reduced delivery head - greater fluid density - exchanger tube leaks - restriction orifice plates deleted - cross-connection of systems - control faults - etc.
Less Flow	Line restrictions - filter blockage - defective pumps - fouling of vessels, valves, restrictor or orifice plates - density or viscosity problems - incorrect specification of process fluid - etc.
As Well As Flow	Line-up errors, introducing additional stream into process (e.g. utility air, Nitrogen). Unexpected or undesirable contaminants are also carried over in process (sand, sludge, H2S, hydrates, etc). Liquid slugging in gas lines. Excess operating level can cause liquid carry over, in addition to the desired gas only flow.
Other Than Flow	Loss of liquid level can cause gas break through. Loss of cooling water or fin fan trip can prevent process gas from condensing (change of phase).
Part Of Flow	If chemical injection packages stop injecting into the main process. Failure of water supply to LP steam desuperheater, etc.
More Pressure	Surge problems - leakage from interconnected HP system-gas breakthrough (inadequate venting) - isolation procedures for relief valves defective - thermal overpressure-positive displacement pumps - failed open PCVs - etc.
Less Pressure	Generation of vacuum condition - condensation - gas dissolving in liquid - restricted pump/compressor suction line - undetected leakage - vessel drainage - etc.

Deviation	Possible Causes
High Level	Outlet isolated or blocked- inflow greater than outflow- control failurefaulty level measurement- incorrect calibration- filling operations- liquid in vapour lines- vessel overflow- deactivated level alarm- inadequate time to respond- interface level control- phase inversion- slug flow, condensation – Etc.
Low Level	Inlet flow stops- leak- drain valve left open- outflow greater than inflowcontrol valve malfunction- faulty level measurement- incorrect calibration- two phase flow- plugged instrument taps- inadequate residence time- inadequate mixing, excessive heating- gas in liquid lines.
More Temperature	Ambient conditions - fouled or failed exchanged tubes-fire situationcooling water failure - defective control - fired heater control failure - internal fires - reaction control failure - etc.
Less Temperature	Ambient conditions - reducing pressure - found or failed exchanged tubes - loss of heating - etc.

3.3 HAZOP Nodes

The nodes chosen for the Regasification System for HN2031 170,000m^3 LNG FSRU is shown in Table 3-2.

Table 3-2 : Nodes Selected for HN2031 LNG FSRU Regasification System HAZOP

Node	Description	P&IDs
1	LNG Inlet and Recondenser	3000-ZM-11011
2	BOG Compressor and Recondenser Vapour Inlet	3000-ZM-11011, MB601.61
3	Regas HP Booster Pumps and Heat Exchanger	3000-ZM-11011, 3000-ZM-11012
4	NG Vapour Return	3000-ZM-11011
5	Recondenser Vapour Return	3000-ZM-11011
6	Recondenser Vapour Lines	3000-ZM-11011, 3000-ZM-11012
7	NG Sendout Line	3000-ZM-11011, 3000-ZM-11012
8	Seawater System	3000-ZM-11013
9	LNG Feed Pumps	3000-ZM-11011, MB601.61

The marked-up P&IDs depicting the identified nodes above are presented in Appendix 2.

4 HAZOP WORKSHOP AND FINDINGS

4.1 HAZOP Team members & Attendance

The HAZOP workshop was attended by SHI, Golar and vendor (ad-hoc basis) personnel covering various disciplines. Facilitation and recording of notes were done by DNV.

The names and functions of each team member are furnished in Table 4-1. While complete attendance and participation was ensured throughout the workshop by main operations, maintenance and HSE personnel, specialists shared their inputs as and when required throughout the sessions.

A scanned copy of the attendance sheets are presented in Appendix 1.

Table 4-1: HAZOP Workshop Team Members

Name	Company	Designation / Discipline
Trond Elvehoy	DNV	Facilitator
Shukran Farid	DNV	Scribe
Kwangsu, Seo	SHI	Project Planning Manager
Sungjin, Hwang	SHI	Project Planning Manager
Jaehong, Shin	SHI	Marine Solution Engineer
Kiyokazu Kawabata	SHI	Vice President, Project Planning Team 1
Yong Seok, Song	SHI	Engineer
Seongjin, Ryu	SHI	Engineer
Young Jin, Kim	SHI	Project Manager
Heesung, Lee	SHI	Senior Manager
Haeki, Jang	SHI	Senior Manager
Gi Jeong, Gweon	SHI	Manager
Young Chul, Eun	SHI	Engineer
Sungjae, Moon	SHI	Marine Solution Engineer
Yong Bin, Yim	SHI	Assistant Manager (Seatrial)
Minseok, Kim	SHI	Engineer
Lars Erik Egeberg	Golar	Project Manager
Kristin Haugbraten	Golar	Project Engineer
Toni Poljanic	Golar	CH. Officer (FSRU Operator)
Bernard Germain	Penspen	Process Engineer

Name	Company	Designation / Discipline
Honghee, Lim	Wonil T & I	General Manager
John Murray	Nikkiso Cryo Inc.	Project Manager
Kota Nakano	Nikkiso Cryo Inc.	Engineer
Toshiya Suzuki	Nikkiso Cryo Inc.	Sales Manager

4.2 HAZOP Worksheets

The worksheets used for recording the findings are found in Appendix 3. This section is to describe the columns used in the worksheet.

The top of the worksheet describes the node number, node description and design intent, together with the P&ID numbers used for the HAZOP. The date of when this node was studied is also recorded.

The first column represents the deviation that is being studied via the guideword. For a selected guideword, all possible causes are listed. The 'Safeguards' column represents all preventive and mitigative measures that can be taken to prevent the possible consequence arising from the listed causes.

Recommendations recorded throughout the HAZOP workshop is presented in Section 4.3. Recommendations encompassed the need for changes to the current design, where a proposed hardware / equipment are to be added to further safeguard the design's intent. Also, recommendations produced were also on an operational base i.e. falls on the prerogative of the owner to act upon these recommendations.

4.3 Recommendations from HAZOP

A total of 38 recommendations have been proposed by the HAZOP team. SHI shall be responsible for assigning the action items to appropriate action parties and tracking them for completion. If for any reason an action is not implemented, the justification for this should be documented.

Recommendations should be read together with the HAZOP worksheets for clarity. Each recommendation has been assigned responsibility, which dictates which party shall attend to the recommendation in question. The HAZOP worksheets are presented in Appendix 3.

Recommendation for each node is numbered using prefixes, e.g. for Node 1, first recommendation will be 1.1. Recommendations that are highlighted in yellow are general recommendations that will apply for all the P&IDs.

Table 4-2 : HAZOP Recommendations

REC #	RECOMMENDATION	ACTION BY	REMARKS[1]
1.1	Consider using three transmitters for action voting for LAHH and LALL to transmitter LIT-0013.	SHI / Golar	
1.2	Consider three independent pressure transmitters each with dedicated shut-off valves.	SHI / Golar	
1.3	Clarify the control strategy for the high pressure controller on Recondenser VX-0050.	SHI / Golar	

REC #	RECOMMENDATION	ACTION BY	REMARKS[1]
1.4	Develop strategy to handle high level in the Recondenser VX-0050 with the objective to maintain production.	SHI / Golar	
1.5	Verify that relevant piping and check valves on the N2 line are cryogenic type.	SHI / Golar	
1.6	To evaluate closing of IV-0050 on high level in Recondenser VX-0050.	SHI / Golar	
1.7	Include cool down procedure in the Operation Procedure Manual.	SHI / Golar	
2.1	Consider to implement alarm from the FE-0032 if actual flow deviates from the set-point.	SHI / Golar	
3.1	Check suitability of the limit switch in open deck (valid for all limit switches on the Regas facility).	SHI / Golar	
3.2	Include proper draining and drying of the piping following the hydrotest in the Commissioning Procedure - to prevent ice clogging.	SHI / Golar	
3.3	Consider to include PAHH on the PIT-1071 and PIT-1072.	SHI / Golar	
3.4	Consider to include PAHH on the PIT-1041 A/B/C and PIT-1040 A/B/C.	SHI / Golar	
3.5	SHI to confirm the low current signal trip	SHI / Golar	
3.6	Confirm the capacity of the PSV-0049 and PSV-0051.	SHI / Golar	
3.7	Consider moving the spec-break downstream of the valve.	SHI / Golar	DNV considered the possibility for check valve C-1011A/B being stuck in closed as unlikely. The proposed design is therefore acceptable.
3.8	Consider moving the check valve to inside the Regas Skid.	SHI / Golar	
3.9	Consider suitability of the use of control valve for safety shutdown.	SHI / Golar	DNV confirmed that it is acceptable to use the control valve FCV-1005A/B for both flow control and PSD due to solenoid valve separating functions and the additional safeguards in the system.
3.10	Identify how to handle the trapped	SHI / Golar	

REC #	RECOMMENDATION	ACTION BY	REMARKS[1]
	liquid after PSD to avoid PSV opening.		
3.11	Consider implementing a bypass around FCV-1005 A/B to improve cool down time if required by heat exchanger vendor.	SHI / Golar	
3.12	Review the vapor return from the HP Booster Pumps.	SHI / Golar	
4.1	Consider interlock between IV-0050 and control valves feeding gas (PCV-0025, FCV-0022, PCV-0090) into the Recondenser Drum.	SHI / Golar	
5.1	To evaluate suitability of the temperature sensor for liquid detection in the KO Drum VA-0070.	SHI / Golar	
6.1	Consider connecting drain line to the spray line instead of the liquid main.	SHI / Golar	
6.2	Propose to have rate of change alarm for the level in the pump pot during cool down.	SHI / Golar	
6.3	Consider overpressure protection in line between IV-1090 A/B and V-1091.	SHI / Golar	
7.1	Measures to handle pipeline backflow due to inadvertent opening of IV-0010.	SHI / Golar	
7.2	To evaluate measures of detecting release in the NG Send-out line.	SHI / Golar	
7.3	To evaluate measures of liquid detection and means for boiling off liquid in the drum.	SHI / Golar	
7.4	To consider non-return valve on the send-out line.	SHI / Golar	
7.5	To evaluate the size of the segment and means / need to depressurize of the line.	SHI / Golar	
8.1	Include pressure transmitter on the suction and discharge side of the SW Lift Pumps.	SHI / Golar	
8.2	Consider to include differential pressure transmitter on the strainer.	SHI / Golar	
8.3	Consider current monitoring of the SW Lift Pump motor.	SHI / Golar	

REC #	RECOMMENDATION	ACTION BY	REMARKS[1]
8.4	To provide DP measurement over the SW filters.	SHI / Golar	
8.5	Consider implementing alarm on the DPT-1153 / 1155 / 1157 / 1159.	SHI / Golar	
8.6	To identify the need to protect SW piping and heat exchanger in the event of tube rupture.	SHI / Golar	
8.7	Evaluate the vacuum breaker sizing and the capability of vaporizer to withstand vacuum in case of vacuum breaker failure.	SHI / Golar	
9.1	Consider moving check valve CL-304 to the downstream of recycle line.	SHI / Golar	

1. The respond(s) stated in this column is received from SHI after the HAZOP session and SHI shall seek Golar's agreement on the close-out and implementation of these recommendations.

5 REFERENCES

/1/ Samsung Heavy Industries, Regasification Control Philosophy, Doc No. 3000-IC-15050, Rev. 4, 10th February 2012.
/2/ Samsung Heavy Industries, ESD, PSD & Blowdown Philosophy, Doc No. 3000-IC-XXXX, Rev. 1, 10th February 2012.
/3/ Samsung Heavy Industries, Cause & Effect Chart, Doc No. 3000-IC-15070, Rev. 3, 10th February 2012.
/4/ Samsung Heavy Industries, Functional Design Specification, Doc No. 3000-IC-XXXX Rev. 0, 10th February 2012.
/5/ Samsung Heavy Industries, P&ID – LNG Regasification, Doc No. 3000-ZM-11011 to 11017, Rev. 3, 4, 5 and 6, 10th February 2012.

APPENDIX I
ATTENDANCE SHEET

Samsung Heavy Industries | HAZOP Workshop for Regasification System for HN2031 170,000m3 LNG FSRU | DNV

Project Title: HAZOP Study of Regasification System for HN2031 170,000m3 LBG FSRU
Date: 16th February, 2012
Venue: Conference Room-B, 5th Floor of Design Building, Koje Shipyard

No.	Attendees Name	Job Title	Company	Signature
1	Trond Elvehoy	Principal HSE Engineer	DNV	
2	M. Shukran Md Farid	HSE Engineer	DNV	
3	Shin Hyung Chang	Senior Consultant	DNV	
4	kwangsu Seo	project planning manager	SHI	
5	Sungjin Hwang	"	SHI	
6	Jaehong shin	Marine solution Engineer	SHI	
7	kyokazu kawakata	Vice president Project Planning team 1	SHI	
8	Yong Seok Song	Engineer	SHI	
9	Seong jin Ryu	Engineer	SHI	
10	John Murray	Project Manager	Nikkiso Cryo Inc	
11	Young Jin Kim	PM	SHI	
12	Heesung Lee	Section Engineer	SHI	
13	Haeki Jang	Senior Manager	SHI	
14	KOTA NAKANO	ENGINEER	NIKKISO CRYO INC	
15	Hong Hee Lim Won.I T&I	General Manager	Wonil T&I	
16	Bernard GERMAIN	Process Engineer	Rensper	BG
17	GT Jeong Gweon	Manage	CHI	
18	Jang chul Gun	Engineer	SHI	
19	Sungjae Moon	Marine Solution Engineering	SHI	
20	LARS ERIK EGEBERG	PROJECT MANAGER	GOLAR	
21	KRISTIN HALVORSEN	PROJECT ENGINEER	— " —	
22	TONI POLJANIC	CH. OFF (FSRU OPERATOR)	— " —	

Samsung Heavy Industries | HAZOP Workshop for Regasification System for HN2031 170,000m3 LNG FSRU | DNV

Project Title: HAZOP Study of Regasification System for HN2031 170,000m3 LBG FSRU
Date: 15th February, 2012
Venue: Conference Room-B, 5th Floor of Design Building, Koje Shipyard

No.	Attendees Name	Job Title	Company	Signature
1	Trond Elvehoy	Principal HSE Engineer	DNV	
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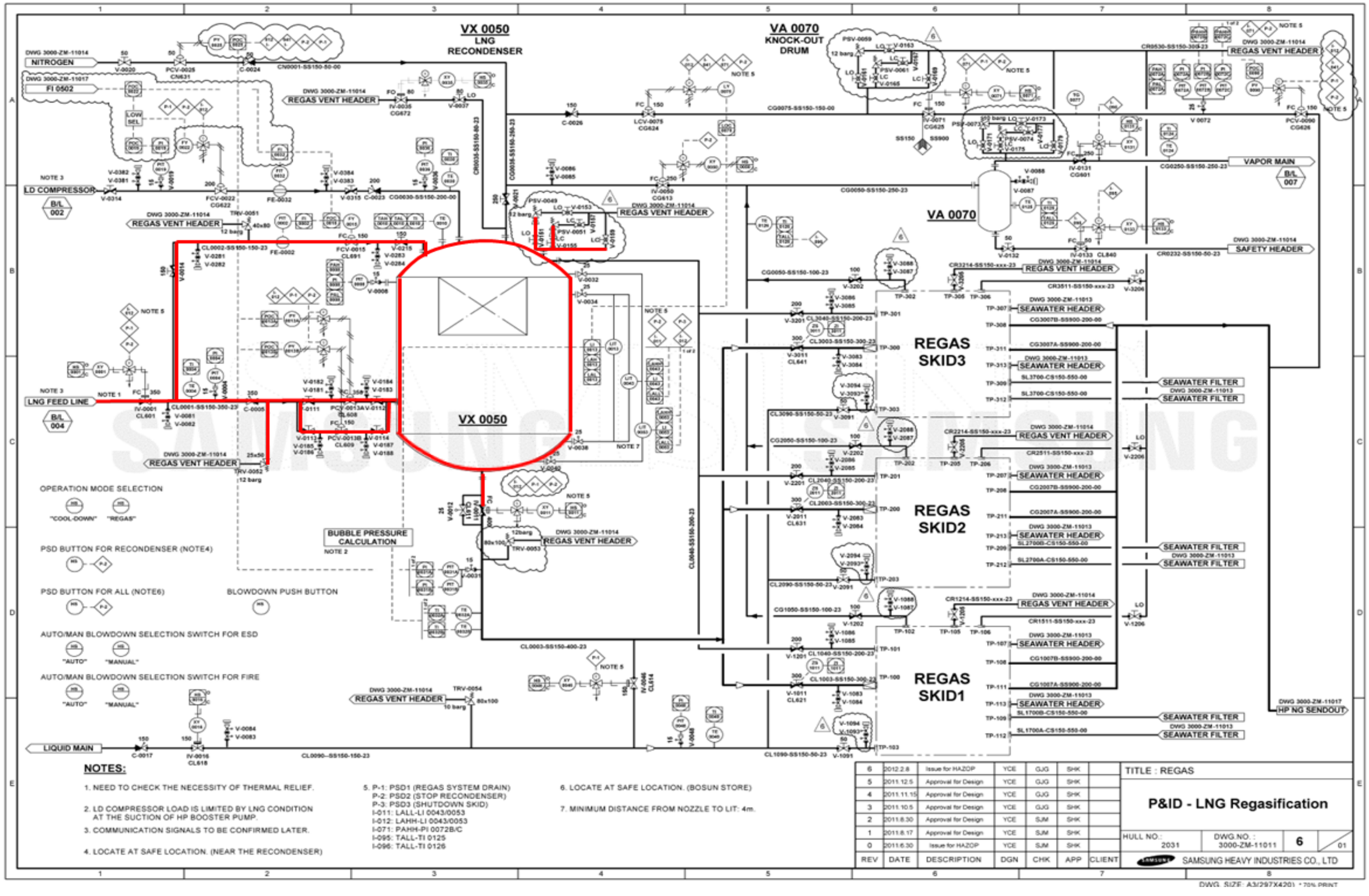
3	Shin Hyung Chang	Senior Consultant	DNV	
4	kwang su Seo	project planning manager	SHI	
5	SungJae Moon	Marine solution Engineering	SHI	
6	Seung Hyuk KIM	Principal Research Engineer	SHI	
7	GT Jeong Gweon	Manage	SHI	
8	Bernard GERMAIN	Process Engineer	Pendpen	
9	Hong hee Lim	General Manager	Woni TSI	
10	KOTA NAKANO	ENGINEER	NIKKISO CRYO INC.	
11	HAEKI JANG	Senier Manager	SHI	
12	Yong Bin Yim	~~Asst~~ A. Manager (SEATRIAL)	SHI	
13	Young Jun Kim	PM	SHI	
14	Seung Min Lee	Engineer (Sea Trial)	SHI	
15	Heesung LEE	Senien Engineer	SHI	
16	John Murray	Project Manager	Nikkiso Cryo Inc.	
17	Toshiya SUZUKI	Sales Manager	Nikkiso Co., Ltd.	
18	Yong Seok Song	Engineer	SHI	
19	Young Chul Eum	Engineer	SHI	
20	Seong jin kyu	Engineer	SHI	
21	Kiyokazu Kawabata	Vice president Project planning	SHI	
22	Minseok Kim	Engineer	SHI	
23	Joehong shim	Marine solution Engineer	SHI	
24	Sungjin Hwang	Assistant Manager	SHI	

APPENDIX
II
HAZOP MARKED-UPS P&ID


VX 0050
LNG
RECONDENSER
VA 0070
KNOCK-OUT
DRUM
VA 0070
VX 0050
REGAS
SKID3
REGAS
SKID2
REGAS
SKID1
NITROGEN
LD COMPRESSOR
LNG FEED LINE
LIQUID MAIN
REGAS VENT HEADER
VAPOR MAIN
SAFETY HEADER
SEAWATER HEADER
SEAWATER FILTER
HP NG SENDOUT
BUBBLE PRESSURE
CALCULATION
OPERATION MODE SELECTION
"COOL-DOWN"
"REGAS"
PSD BUTTON FOR RECONDENSER (NOTE4)
PSD BUTTON FOR ALL (NOTE6)
BLOWDOWN PUSH BUTTON
AUTO/MAN BLOWDOWN SELECTION SWITCH FOR ESD
"AUTO"
"MANUAL"
AUTO/MAN BLOWDOWN SELECTION SWITCH FOR FIRE
"AUTO"
"MANUAL"
NOTES:
1. NEED TO CHECK THE NECESSITY OF THERMAL RELIEF.
2. LD COMPRESSOR LOAD IS LIMITED BY LNG CONDITION AT THE SUCTION OF HP BOOSTER PUMP.
3. COMMUNICATION SIGNALS TO BE CONFIRMED LATER.
4. LOCATE AT SAFE LOCATION. (NEAR THE RECONDENSER)
5. P-1: PSD1 (REGAS SYSTEM DRAIN)
P-2: PSD2 (STOP RECONDENSER)
P-3: PSD3 (SHUTDOWN SKID)
I-011: LALL-LI 0043/0053
I-012: LAHH-LI 0043/0053
I-071: PAHH-PI 0072B/C
I-095: TALL-TI 0125
I-096: TALL-TI 0126
6. LOCATE AT SAFE LOCATION. (BOSUN STORE)
7. MINIMUM DISTANCE FROM NOZZLE TO LIT: 4m.
TITLE : REGAS
P&ID - LNG Regasification
HULL NO.: 2031
DWG.NO. : 3000-ZM-11011
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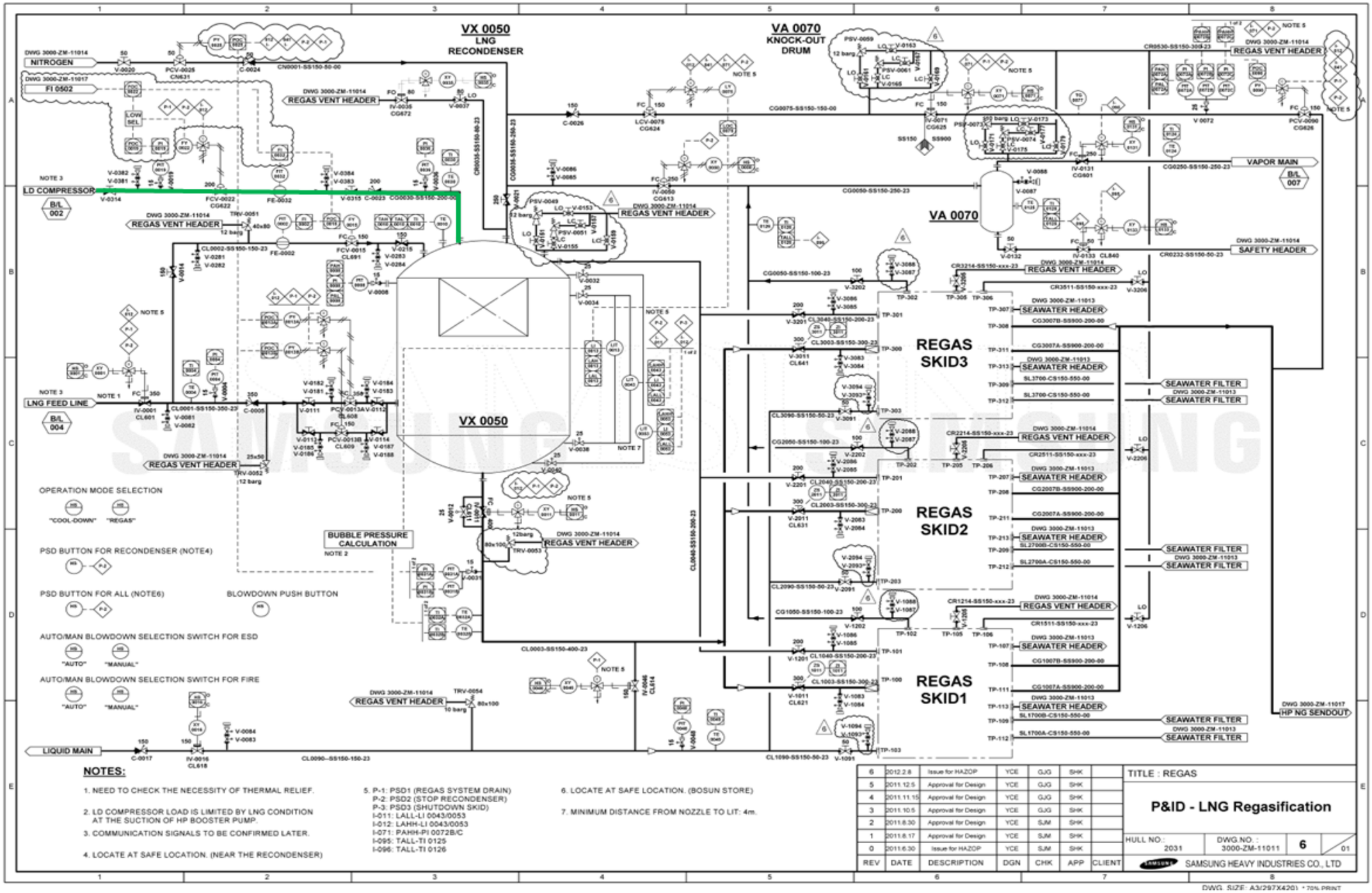
VX 0050
LNG RECONDENSER
VA 0070
KNOCK-OUT DRUM
VA 0070
VX 0050
REGAS SKID3
REGAS SKID2
REGAS SKID1
NITROGEN
LD COMPRESSOR
LNG FEED LINE
LIQUID MAIN
REGAS VENT HEADER
VAPOR MAIN
SAFETY HEADER
SEAWATER HEADER
SEAWATER FILTER
HP NG SENDOUT
BUBBLE PRESSURE CALCULATION
OPERATION MODE SELECTION
"COOL-DOWN"
"REGAS"
PSD BUTTON FOR RECONDENSER (NOTE4)
PSD BUTTON FOR ALL (NOTE6)
BLOWDOWN PUSH BUTTON
AUTO/MAN BLOWDOWN SELECTION SWITCH FOR ESD
AUTO/MAN BLOWDOWN SELECTION SWITCH FOR FIRE
"AUTO"
"MANUAL"
NOTES:
1. NEED TO CHECK THE NECESSITY OF THERMAL RELIEF.
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5. P-1: PSD1 (REGAS SYSTEM DRAIN)
P-2: PSD2 (STOP RECONDENSER)
P-3: PSD3 (SHUTDOWN SKID)
I-011: LALL-LI 0043/0053
I-012: LAHH-LI 0043/0053
I-071: PAHH-PI 0072B/C
I-095: TALL-TI 0125
I-096: TALL-TI 0126
6. LOCATE AT SAFE LOCATION. (BOSUN STORE)
7. MINIMUM DISTANCE FROM NOZZLE TO LIT: 4m.
REV DATE DESCRIPTION DGN CHK APP CLIENT
6 2012.2.8 Issue for HAZOP YCE GJG SHK
5 2011.12.5 Approval for Design YCE GJG SHK
4 2011.11.15 Approval for Design YCE GJG SHK
3 2011.10.5 Approval for Design YCE GJG SHK
2 2011.8.30 Approval for Design YCE SJM SHK
1 2011.8.17 Approval for Design YCE SJM SHK
0 2011.6.30 Issue for HAZOP YCE SJM SHK
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HULL NO.: 2031
DWG NO. : 3000-ZM-11011
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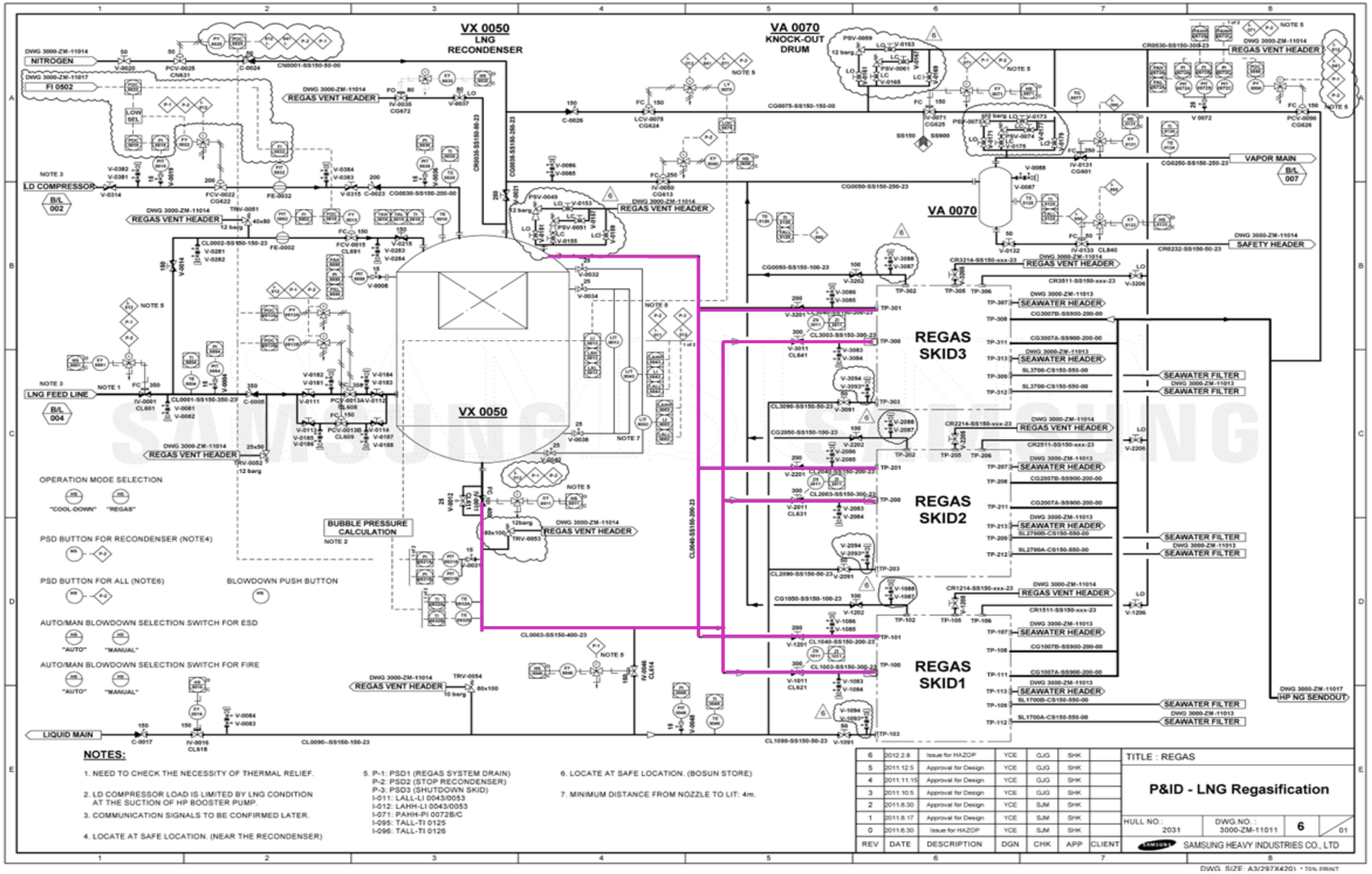
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DRUM
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SKID2
REGAS
SKID1
NITROGEN
FI 0502
LD COMPRESSOR
LNG FEED LINE
LIQUID MAIN
REGAS VENT HEADER
VAPOR MAIN
SAFETY HEADER
SEAWATER HEADER
SEAWATER FILTER
HP NG SENDOUT
OPERATION MODE SELECTION
"COOL-DOWN"
"REGAS"
PSD BUTTON FOR RECONDENSER (NOTE4)
PSD BUTTON FOR ALL (NOTE6)
BLOWDOWN PUSH BUTTON
AUTO/MAN BLOWDOWN SELECTION SWITCH FOR ESD
AUTO/MAN BLOWDOWN SELECTION SWITCH FOR FIRE
BUBBLE PRESSURE CALCULATION
NOTE 2
NOTES:
1. NEED TO CHECK THE NECESSITY OF THERMAL RELIEF.
2. LD COMPRESSOR LOAD IS LIMITED BY LNG CONDITION AT THE SUCTION OF HP BOOSTER PUMP.
3. COMMUNICATION SIGNALS TO BE CONFIRMED LATER.
4. LOCATE AT SAFE LOCATION. (NEAR THE RECONDENSER)
5. P-1: PSD1 (REGAS SYSTEM DRAIN)
P-2: PSD2 (STOP RECONDENSER)
P-3: PSD3 (SHUTDOWN SKID)
I-011: LALL-LI 0043/0053
I-012: LAHH-LI 0043/0053
I-071: PAHH-PI 0072B/C
I-095: TALL-TI 0125
I-096: TALL-TI 0126
6. LOCATE AT SAFE LOCATION. (BOSUN STORE)
7. MINIMUM DISTANCE FROM NOZZLE TO LIT: 4m.
6 2012.2.8 Issue for HAZOP YCE GJG SHK
5 2011.12.5 Approval for Design YCE GJG SHK
4 2011.11.15 Approval for Design YCE GJG SHK
3 2011.10.5 Approval for Design YCE GJG SHK
2 2011.8.30 Approval for Design YCE SJM SHK
1 2011.8.17 Approval for Design YCE SJM SHK
0 2011.6.30 Issue for HAZOP YCE SJM SHK
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TITLE : REGAS
P&ID - LNG Regasification
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DWG.NO.: 3000-ZM-11011
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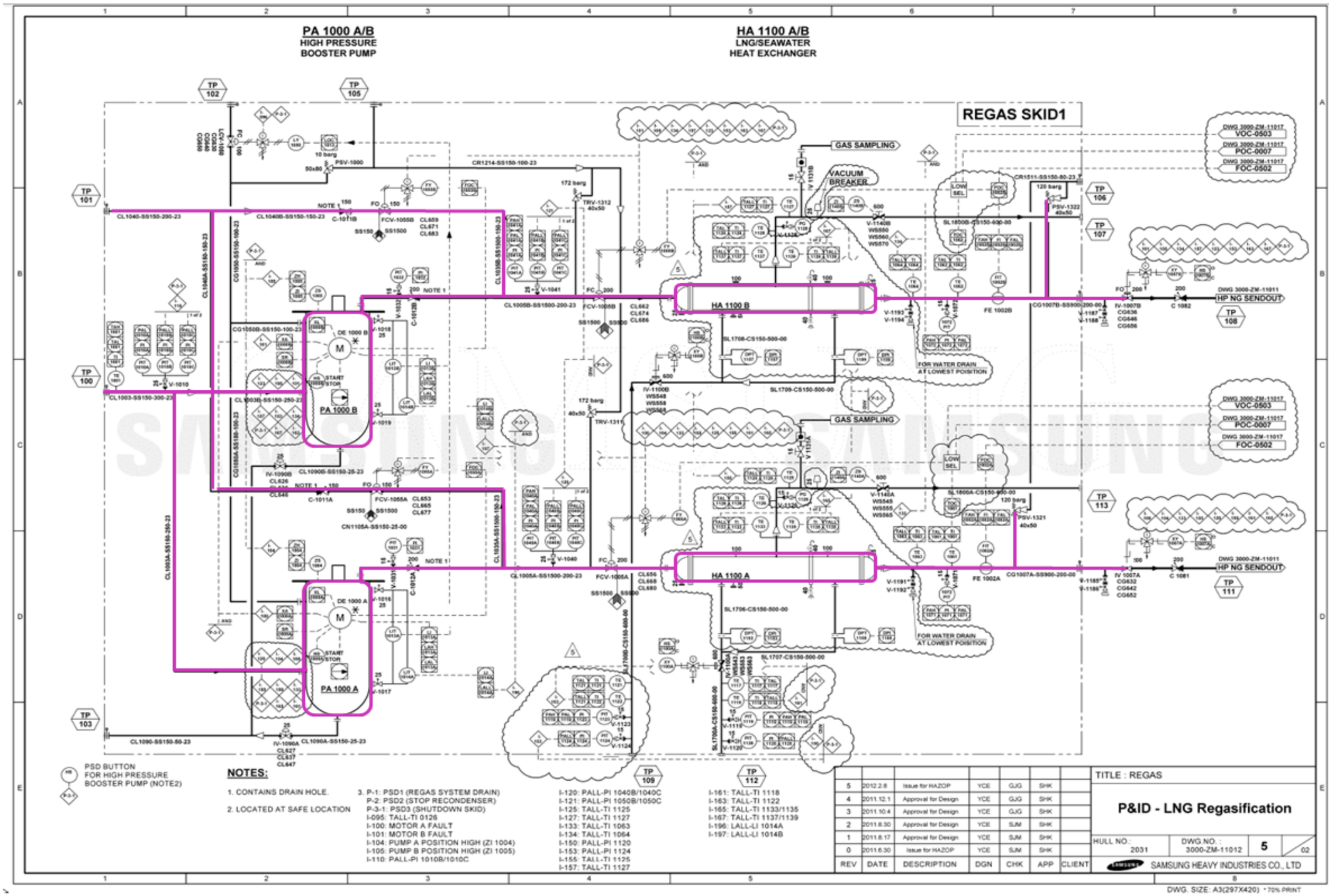
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HIGH PRESSURE
BOOSTER PUMP
HA 1100 A/B
LNG/SEAWATER
HEAT EXCHANGER
REGAS SKID1
GAS SAMPLING
VACUUM BREAKER
HA 1100 B
HA 1100 A
PA 1000 B
PA 1000 A
DE 1000 B
DE 1000 A
FOR WATER DRAIN AT LOWEST POSITION
HP NG SENDOUT
PSD BUTTON FOR HIGH PRESSURE BOOSTER PUMP (NOTE2)
NOTES:
1. CONTAINS DRAIN HOLE.
2. LOCATED AT SAFE LOCATION
3. P-1: PSD1 (REGAS SYSTEM DRAIN)
P-2: PSD2 (STOP RECONDENSER)
P-3-1: PSD3 (SHUTDOWN SKID)
I-095: TALL-TI 0126
I-100: MOTOR A FAULT
I-101: MOTOR B FAULT
I-104: PUMP A POSITION HIGH (ZI 1004)
I-105: PUMP B POSITION HIGH (ZI 1005)
I-110: PALL-PI 1010B/1010C
I-120: PALL-PI 1040B/1040C
I-121: PALL-PI 1050B/1050C
I-125: TALL-TI 1125
I-127: TALL-TI 1127
I-133: TALL-TI 1063
I-134: TALL-TI 1064
I-150: PALL-PI 1120
I-153: PALL-PI 1124
I-155: TALL-TI 1125
I-157: TALL-TI 1127
I-161: TALL-TI 1118
I-163: TALL-TI 1122
I-165: TALL-TI 1133/1135
I-167: TALL-TI 1137/1139
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I-197: LALL-LI 1014B
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P&ID - LNG Regasification
HULL NO.: 2031
DWG NO. : 3000-ZM-11012
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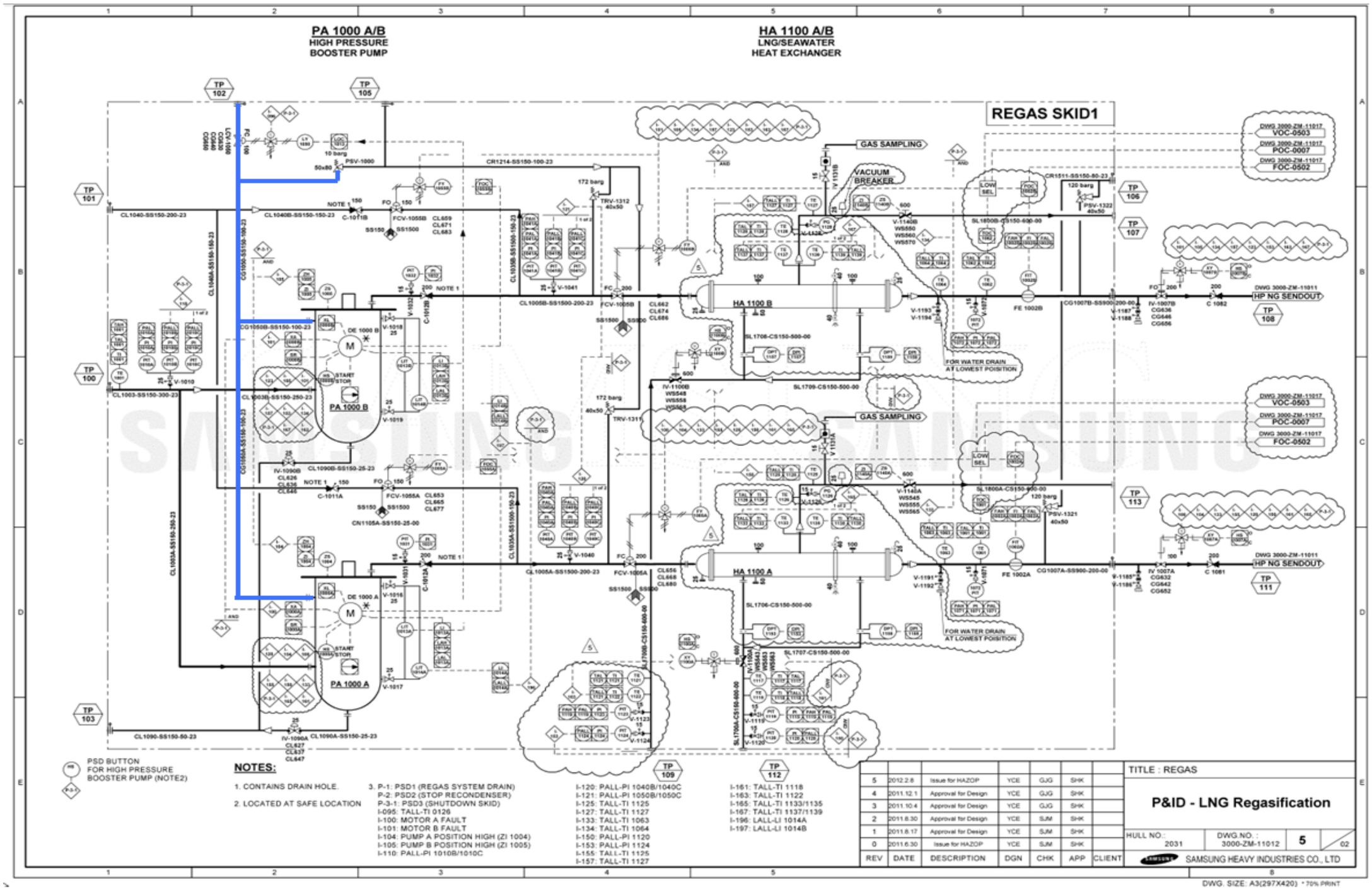
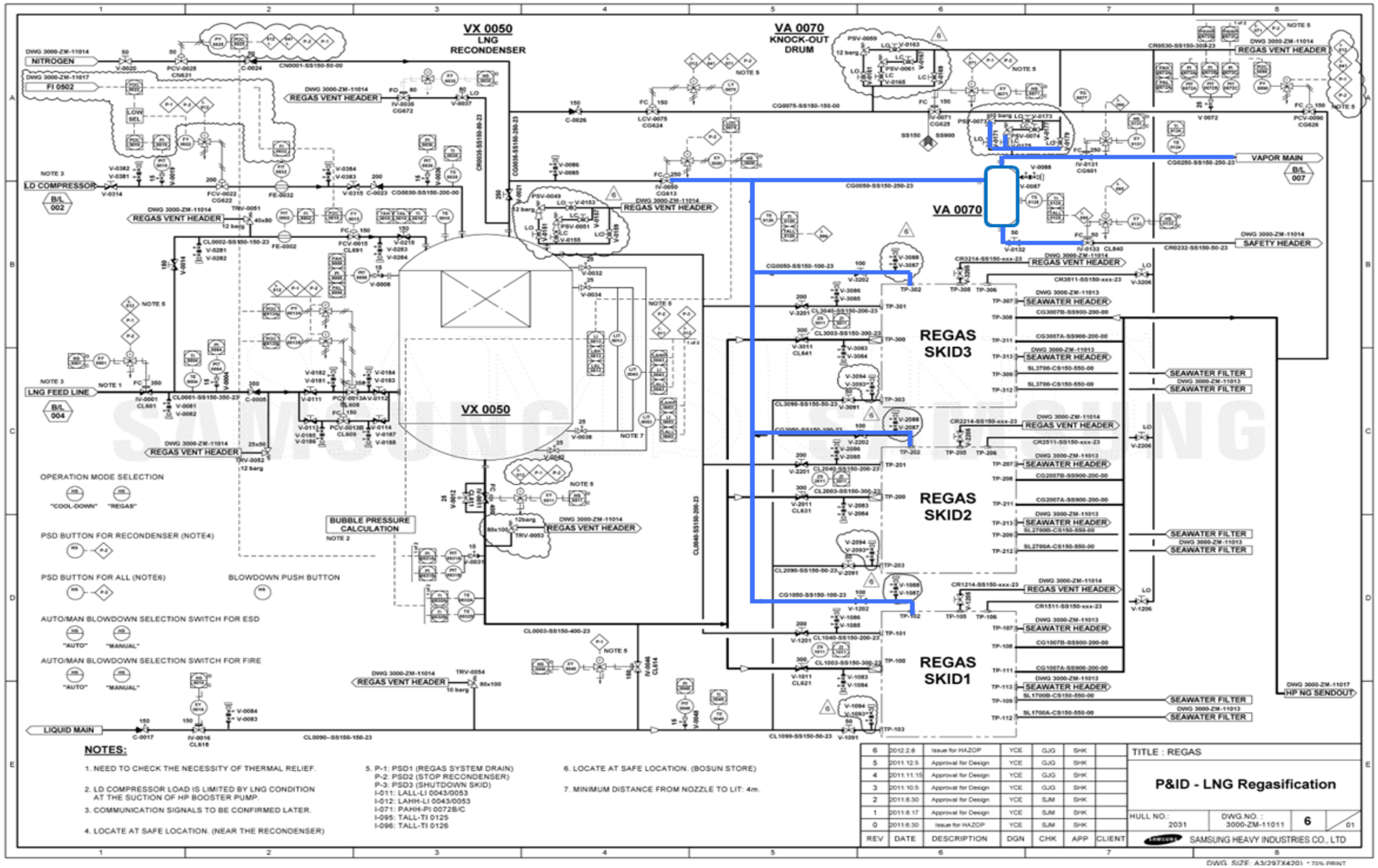
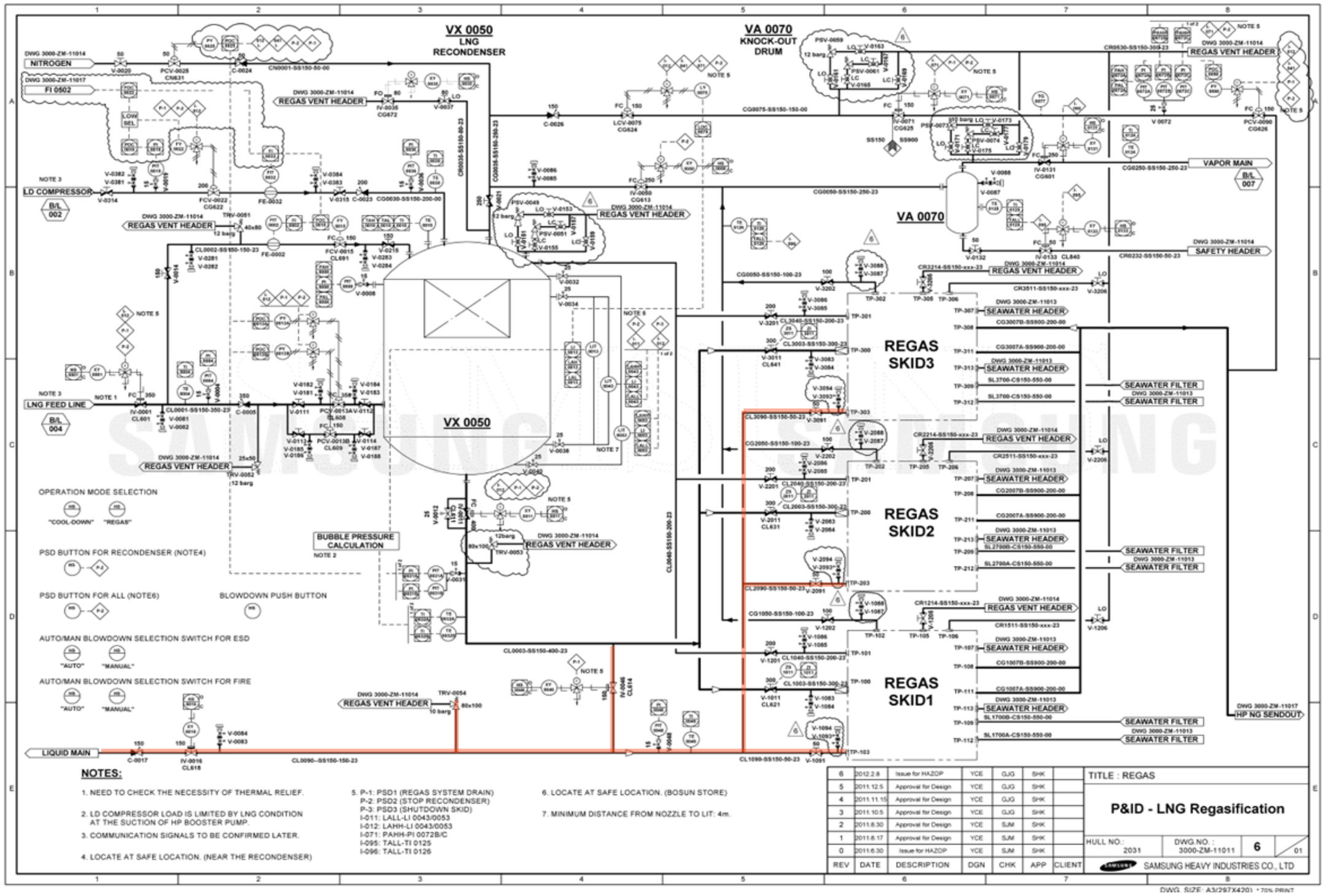

PA 1000 A/B
HIGH PRESSURE
BOOSTER PUMP
HA 1100 A/B
LNG/SEAWATER
HEAT EXCHANGER
REGAS SKID1
GAS SAMPLING
VACUUM BREAKER
HA 1100 B
HA 1100 A
PA 1000 B
PA 1000 A
DE 1000 B
DE 1000 A
FOR WATER DRAIN AT LOWEST POSITION
HP NG SENDOUT
PSD BUTTON FOR HIGH PRESSURE BOOSTER PUMP (NOTE2)
NOTES:
1. CONTAINS DRAIN HOLE.
2. LOCATED AT SAFE LOCATION
3. P-1: PSD1 (REGAS SYSTEM DRAIN)
P-2: PSD2 (STOP RECONDENSER)
P-3-1: PSD3 (SHUTDOWN SKID)
I-095: TALL-TI 0126
I-100: MOTOR A FAULT
I-101: MOTOR B FAULT
I-104: PUMP A POSITION HIGH (ZI 1004)
I-105: PUMP B POSITION HIGH (ZI 1005)
I-110: PALL-PI 1010B/1010C
I-120: PALL-PI 1040B/1040C
I-121: PALL-PI 1050B/1050C
I-125: TALL-TI 1125
I-127: TALL-TI 1127
I-133: TALL-TI 1063
I-134: TALL-TI 1064
I-150: PALL-PI 1120
I-153: PALL-PI 1124
I-155: TALL-TI 1125
I-157: TALL-TI 1127
I-161: TALL-TI 1118
I-163: TALL-TI 1122
I-165: TALL-TI 1133/1135
I-167: TALL-TI 1137/1139
I-196: LALL-LI 1014A
I-197: LALL-LI 1014B
TITLE : REGAS
P&ID - LNG Regasification
HULL NO.: 2031
DWG.NO.: 3000-ZM-11012
5
02
SAMSUNG HEAVY INDUSTRIES CO., LTD
DWG. SIZE: A3(297X420) * 70% PRINT


VX 0050
LNG
RECONDENSER
VA 0070
KNOCK-OUT
DRUM
VA 0070
VX 0050
REGAS
SKID3
REGAS
SKID2
REGAS
SKID1
NITROGEN
FI 0502
REGAS VENT HEADER
LD COMPRESSOR
LNG FEED LINE
LIQUID MAIN
VAPOR MAIN
SAFETY HEADER
SEAWATER HEADER
SEAWATER FILTER
HP NG SENDOUT
BUBBLE PRESSURE
CALCULATION
OPERATION MODE SELECTION
"COOL-DOWN"
"REGAS"
PSD BUTTON FOR RECONDENSER (NOTE4)
PSD BUTTON FOR ALL (NOTE6)
BLOWDOWN PUSH BUTTON
AUTO/MAN BLOWDOWN SELECTION SWITCH FOR ESD
AUTO/MAN BLOWDOWN SELECTION SWITCH FOR FIRE
"AUTO"
"MANUAL"
NOTES:
1. NEED TO CHECK THE NECESSITY OF THERMAL RELIEF.
2. LD COMPRESSOR LOAD IS LIMITED BY LNG CONDITION AT THE SUCTION OF HP BOOSTER PUMP.
3. COMMUNICATION SIGNALS TO BE CONFIRMED LATER.
4. LOCATE AT SAFE LOCATION. (NEAR THE RECONDENSER)
5. P-1: PSD1 (REGAS SYSTEM DRAIN)
P-2: PSD2 (STOP RECONDENSER)
P-3: PSD3 (SHUTDOWN SKID)
I-011: LALL-LI 0043/0053
I-012: LAHH-LI 0043/0053
I-071: PAHH-PI 0072B/C
I-095: TALL-TI 0125
I-096: TALL-TI 0126
6. LOCATE AT SAFE LOCATION. (BOSUN STORE)
7. MINIMUM DISTANCE FROM NOZZLE TO LIT: 4m.
TITLE : REGAS
P&ID - LNG Regasification
HULL NO.: 2031
DWG NO. : 3000-ZM-11011
6
01
SAMSUNG HEAVY INDUSTRIES CO., LTD
REV DATE DESCRIPTION DGN CHK APP CLIENT
6 2012.2.8 Issue for HAZOP YCE GJG SHK
5 2011.12.5 Approval for Design YCE GJG SHK
4 2011.11.15 Approval for Design YCE GJG SHK
3 2011.10.5 Approval for Design YCE GJG SHK
2 2011.8.30 Approval for Design YCE SJM SHK
1 2011.8.17 Approval for Design YCE SJM SHK
0 2011.6.30 Issue for HAZOP YCE SJM SHK


VX 0050
LNG RECONDENSER
VA 0070
KNOCK-OUT DRUM
VA 0070
VX 0050
REGAS SKID3
REGAS SKID2
REGAS SKID1
NITROGEN
LD COMPRESSOR
LNG FEED LINE
LIQUID MAIN
REGAS VENT HEADER
VAPOR MAIN
SAFETY HEADER
SEAWATER HEADER
SEAWATER FILTER
HP NG SENDOUT
BUBBLE PRESSURE CALCULATION
OPERATION MODE SELECTION
"COOL-DOWN"
"REGAS"
PSD BUTTON FOR RECONDENSER (NOTE4)
PSD BUTTON FOR ALL (NOTE6)
BLOWDOWN PUSH BUTTON
AUTO/MAN BLOWDOWN SELECTION SWITCH FOR ESD
AUTO/MAN BLOWDOWN SELECTION SWITCH FOR FIRE
"AUTO"
"MANUAL"
NOTES:
1. NEED TO CHECK THE NECESSITY OF THERMAL RELIEF.
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I-071: PAHH-PI 0072B/C
I-095: TALL-TI 0125
I-096: TALL-TI 0126
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7. MINIMUM DISTANCE FROM NOZZLE TO LIT: 4m.
TITLE : REGAS
P&ID - LNG Regasification
HULL NO.: 2031
DWG NO. : 3000-ZM-11011
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SAMSUNG HEAVY INDUSTRIES CO., LTD
REV DATE DESCRIPTION DGN CHK APP CLIENT
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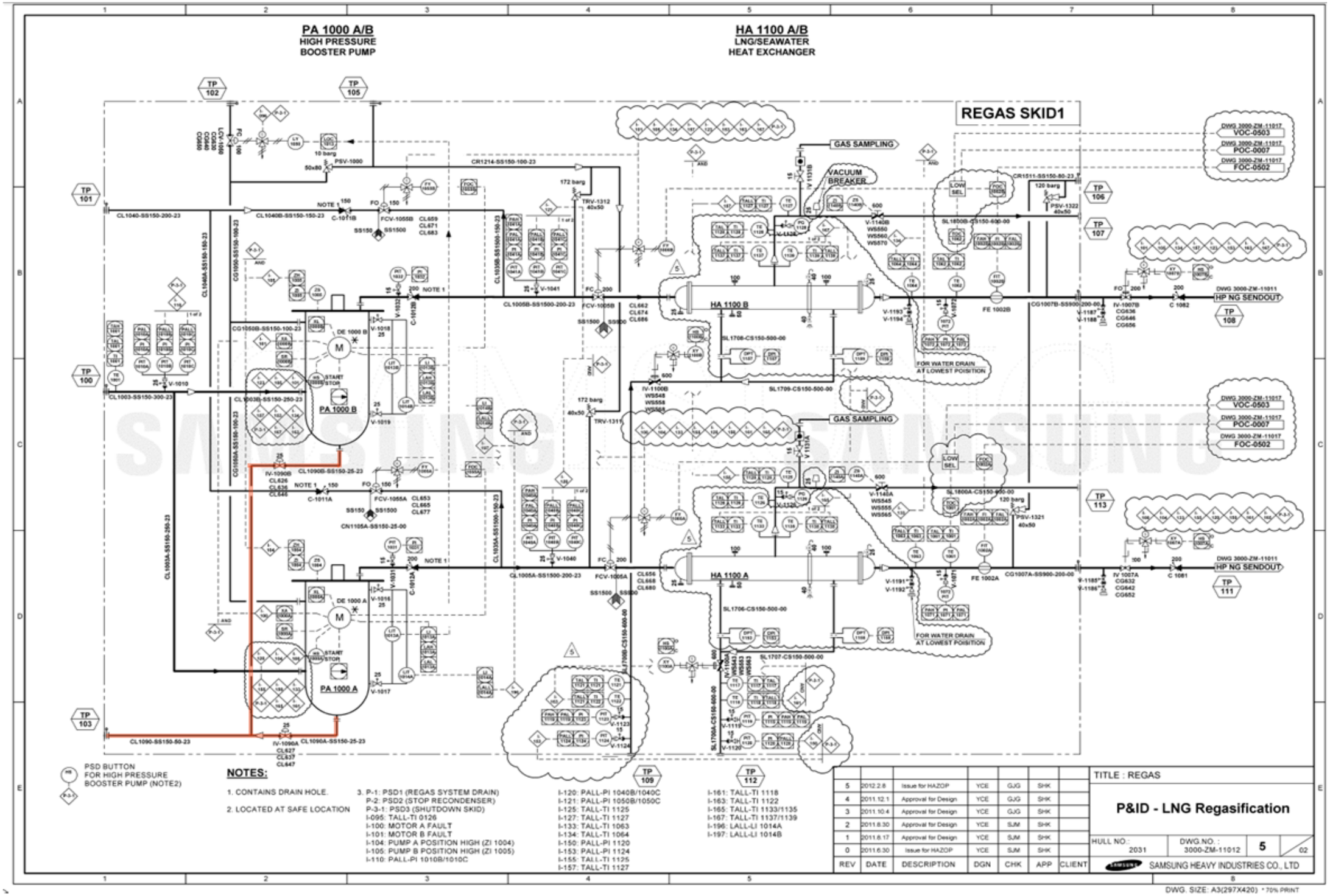
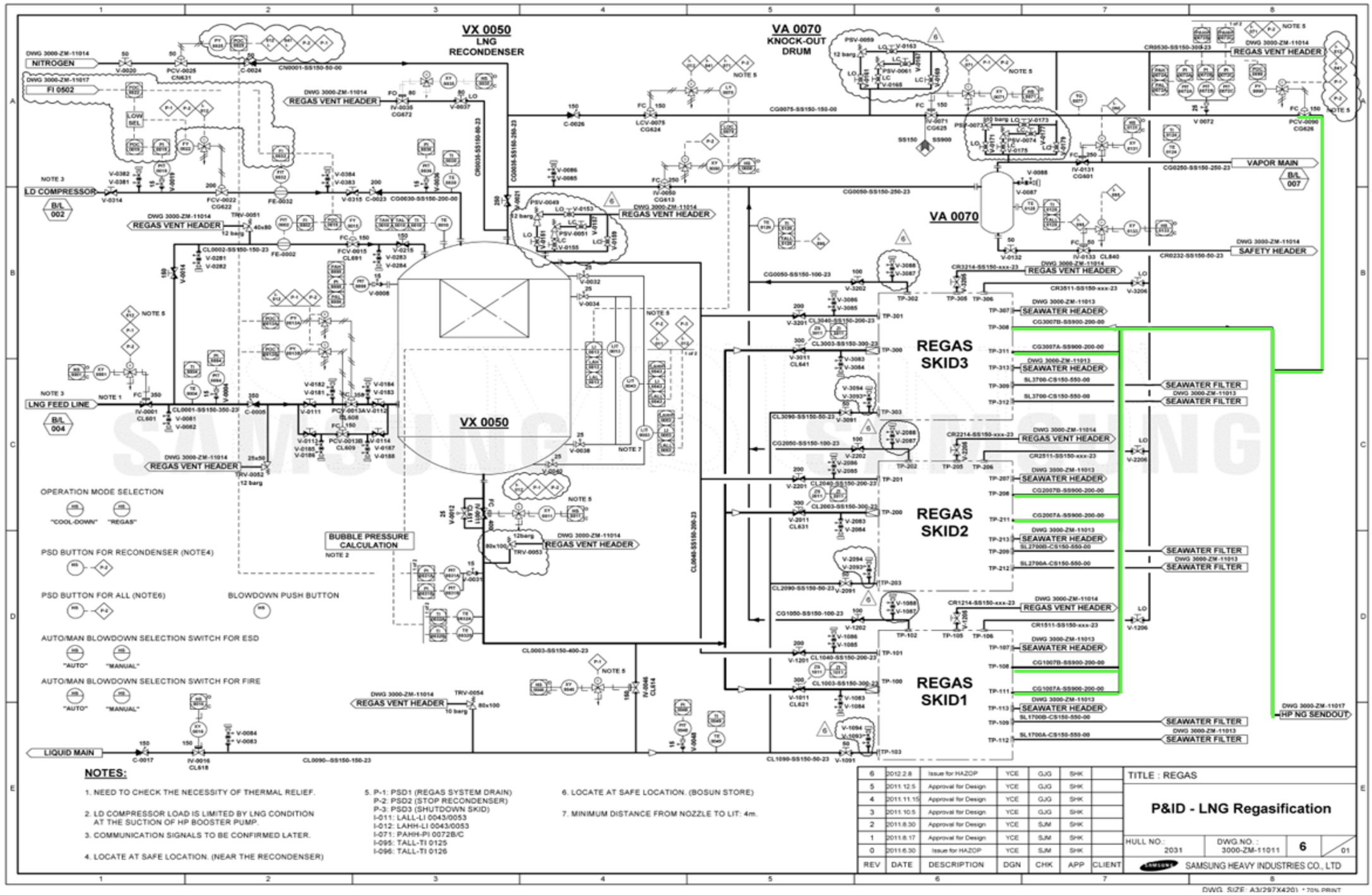
0 2011.6.30 Issue for HAZOP YCE SJM SHK


PA 1000 A/B
HIGH PRESSURE
BOOSTER PUMP
HA 1100 A/B
LNG/SEAWATER
HEAT EXCHANGER
REGAS SKID1
GAS SAMPLING
VACUUM BREAKER
HP NG SENDOUT
FOR WATER DRAIN AT LOWEST POISITION
PA 1000 B
PA 1000 A
HA 1100 B
HA 1100 A
PSD BUTTON FOR HIGH PRESSURE BOOSTER PUMP (NOTE2)
NOTES:
1. CONTAINS DRAIN HOLE.
2. LOCATED AT SAFE LOCATION
3. P-1: PSD1 (REGAS SYSTEM DRAIN)
P-2: PSD2 (STOP RECONDENSER)
P-3-1: PSD3 (SHUTDOWN SKID)
I-095: TALL-TI 0126
I-100: MOTOR A FAULT
I-101: MOTOR B FAULT
I-104: PUMP A POSITION HIGH (ZI 1004)
I-105: PUMP B POSITION HIGH (ZI 1005)
I-110: PALL-PI 1010B/1010C
I-120: PALL-PI 1040B/1040C
I-121: PALL-PI 1050B/1050C
I-125: TALL-TI 1125
I-127: TALL-TI 1127
I-133: TALL-TI 1063
I-134: TALL-TI 1064
I-150: PALL-PI 1120
I-153: PALL-PI 1124
I-155: TALL-TI 1125
I-157: TALL-TI 1127
I-161: TALL-TI 1118
I-163: TALL-TI 1122
I-165: TALL-TI 1133/1135
I-167: TALL-TI 1137/1139
I-196: LALL-LI 1014A
I-197: LALL-LI 1014B
TITLE : REGAS
P&ID - LNG Regasification
HULL NO.: 2031
DWG.NO.: 3000-ZM-11012
5
02
SAMSUNG HEAVY INDUSTRIES CO., LTD
DWG. SIZE: A3(297X420) * 70% PRINT


VX 0050
LNG
RECONDENSER
VA 0070
KNOCK-OUT
DRUM
VA 0070
VX 0050
REGAS
SKID3
REGAS
SKID2
REGAS
SKID1
NITROGEN
FI 0502
LD COMPRESSOR
B/L 002
LNG FEED LINE
B/L 004
LIQUID MAIN
REGAS VENT HEADER
VAPOR MAIN
B/L 007
SAFETY HEADER
SEAWATER HEADER
SEAWATER FILTER
HP NG SENDOUT
BUBBLE PRESSURE CALCULATION
OPERATION MODE SELECTION
"COOL-DOWN"
"REGAS"
PSD BUTTON FOR RECONDENSER (NOTE4)
PSD BUTTON FOR ALL (NOTE6)
BLOWDOWN PUSH BUTTON
AUTO/MAN BLOWDOWN SELECTION SWITCH FOR ESD
AUTO/MAN BLOWDOWN SELECTION SWITCH FOR FIRE
"AUTO"
"MANUAL"
NOTES:
1. NEED TO CHECK THE NECESSITY OF THERMAL RELIEF.
2. LD COMPRESSOR LOAD IS LIMITED BY LNG CONDITION AT THE SUCTION OF HP BOOSTER PUMP.
3. COMMUNICATION SIGNALS TO BE CONFIRMED LATER.
4. LOCATE AT SAFE LOCATION. (NEAR THE RECONDENSER)
5. P-1: PSD1 (REGAS SYSTEM DRAIN)
P-2: PSD2 (STOP RECONDENSER)
P-3: PSD3 (SHUTDOWN SKID)
I-011: LALL-LI 0043/0053
I-012: LAHH-LI 0043/0053
I-071: PAHH-PI 0072B/C
I-095: TALL-TI 0125
I-096: TALL-TI 0126
6. LOCATE AT SAFE LOCATION. (BOSUN STORE)
7. MINIMUM DISTANCE FROM NOZZLE TO LIT: 4m.
REV DATE DESCRIPTION DGN CHK APP CLIENT
6 2012.2.8 Issue for HAZOP YCE GJG SHK
5 2011.12.5 Approval for Design YCE GJG SHK
4 2011.11.15 Approval for Design YCE GJG SHK
3 2011.10.5 Approval for Design YCE GJG SHK
2 2011.8.30 Approval for Design YCE SJM SHK
1 2011.8.17 Approval for Design YCE SJM SHK
0 2011.6.30 Issue for HAZOP YCE SJM SHK
TITLE : REGAS
P&ID - LNG Regasification
HULL NO.: 2031
DWG.NO. : 3000-ZM-11011
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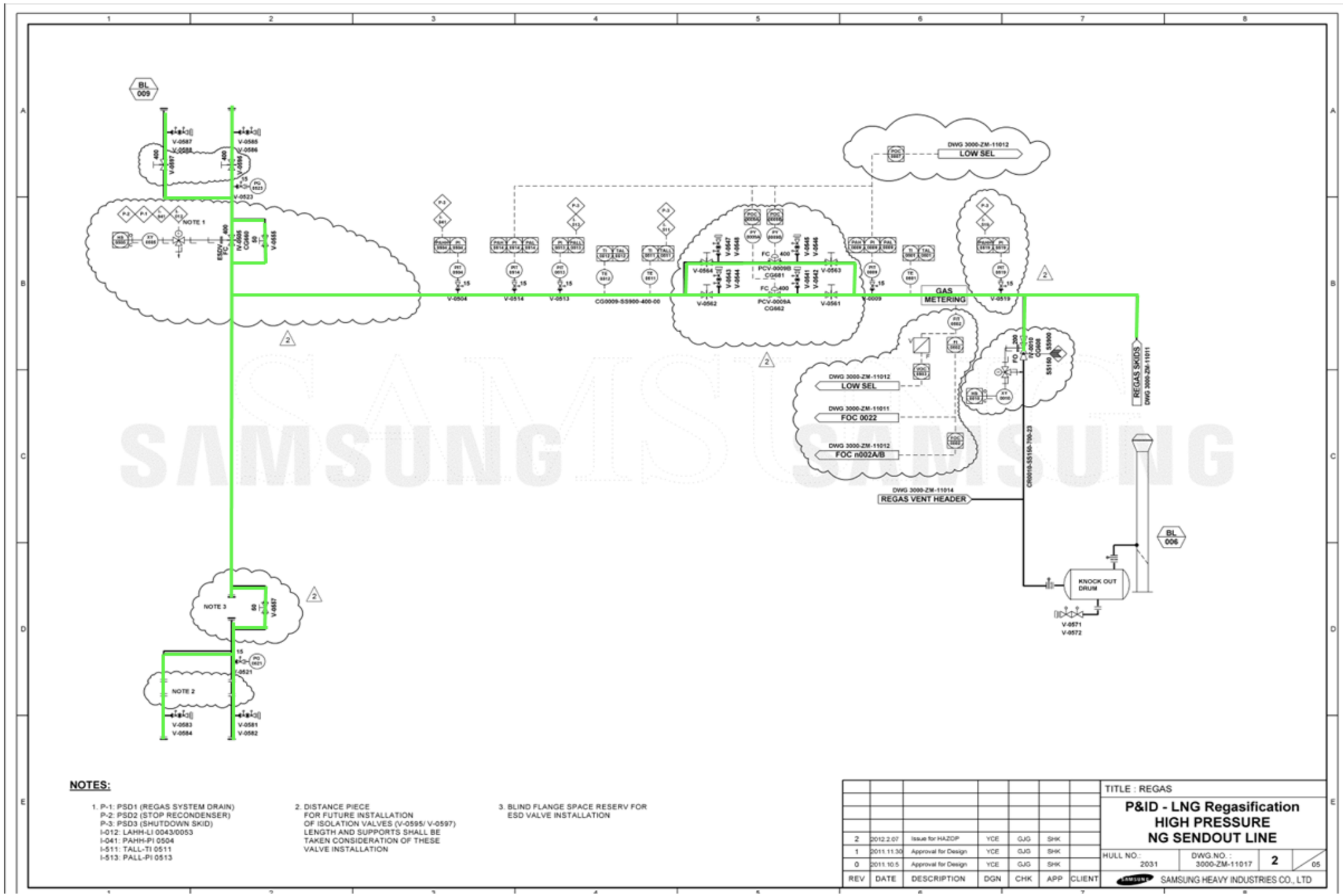
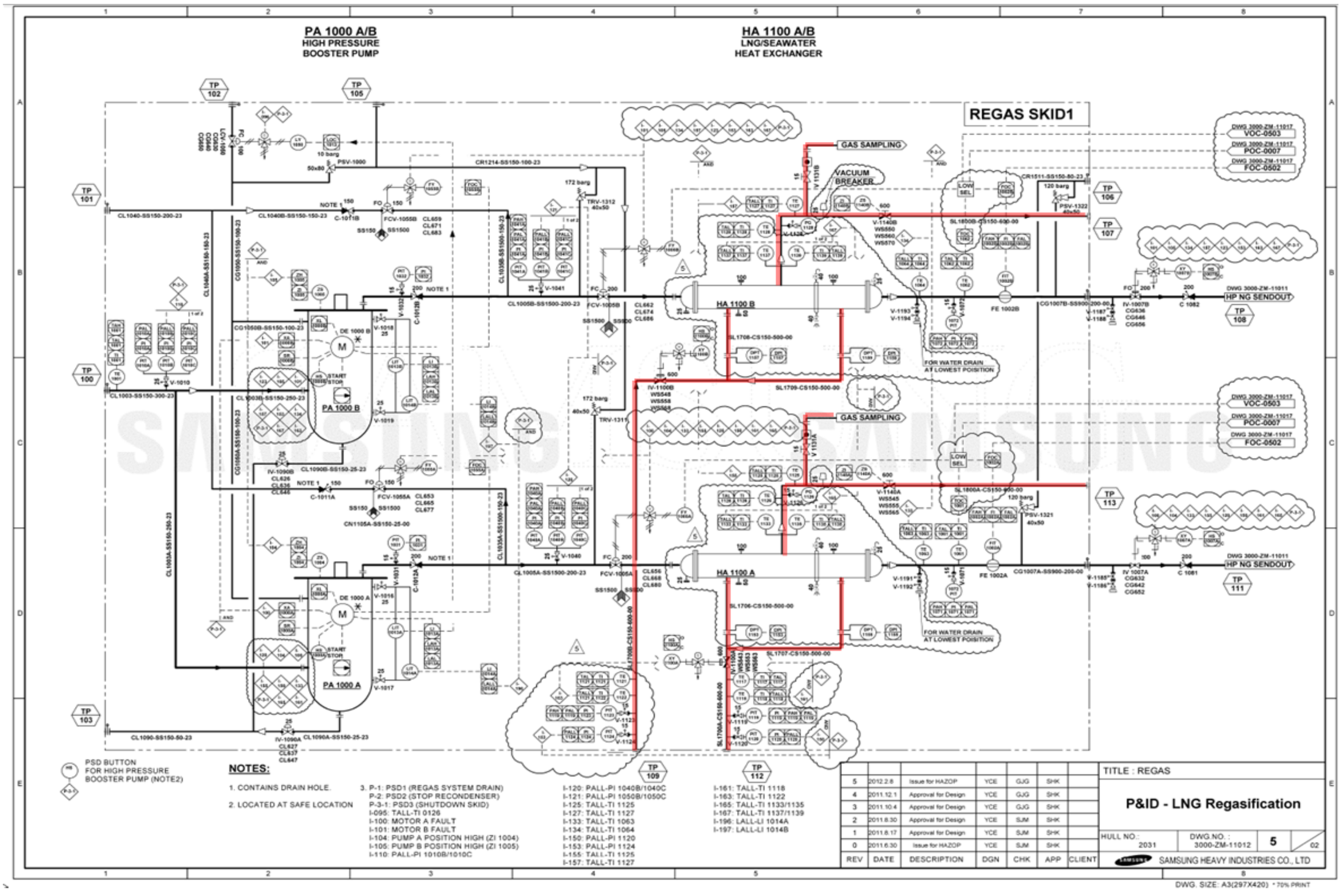
SAMSUNG HEAVY INDUSTRIES CO., LTD
DWG. SIZE: A3(297X420) * 70% PRINT


BL 009
V-0587
V-0588
V-0585
V-0586
V-0523
NOTE 1
V-0555
V-0504
V-0514
V-0513
CG0009-SS900-400-00
V-0564
V-0562
PCV-0009B
CG681
PCV-0009A
CG662
V-0563
V-0561
V-0009
GAS METERING
V-0519
DWG 3000-ZM-11012
LOW SEL
DWG 3000-ZM-11011
FOC 0022
DWG 3000-ZM-11012
FOC n002A/B
DWG 3000-ZM-11014
REGAS VENT HEADER
REGAS SKIDS
DWG 3000-ZM-11011
KNOCK OUT DRUM
V-0571
V-0572
BL 006
NOTE 3
V-0557
NOTE 2
V-0583
V-0584
V-0581
V-0582
NOTES:
1. P-1: PSD1 (REGAS SYSTEM DRAIN)
P-2: PSD2 (STOP RECONDENSER)
P-3: PSD3 (SHUTDOWN SKID)
I-012: LAHH-LI 0043/0053
I-041: PAHH-PI 0504
I-511: TALL-TI 0511
I-513: PALL-PI 0513
2. DISTANCE PIECE FOR FUTURE INSTALLATION OF ISOLATION VALVES (V-0595/ V-0597) LENGTH AND SUPPORTS SHALL BE TAKEN CONSIDERATION OF THESE VALVE INSTALLATION
3. BLIND FLANGE SPACE RESERV FOR ESD VALVE INSTALLATION
2 2012.2.07 Issue for HAZOP YCE GJG SHK
1 2011.11.30 Approval for Design YCE GJG SHK
0 2011.10.5 Approval for Design YCE GJG SHK
REV DATE DESCRIPTION DGN CHK APP CLIENT
TITLE : REGAS
P&ID - LNG Regasification
HIGH PRESSURE
NG SENDOUT LINE
HULL NO.: 2031
DWG.NO. : 3000-ZM-11017
2
05
SAMSUNG HEAVY INDUSTRIES CO., LTD


PA 1000 A/B
HIGH PRESSURE
BOOSTER PUMP
HA 1100 A/B
LNG/SEAWATER
HEAT EXCHANGER
REGAS SKID1
GAS SAMPLING
VACUUM BREAKER
HA 1100 B
HA 1100 A
PA 1000 B
PA 1000 A
DE 1000 B
DE 1000 A
FOR WATER DRAIN AT LOWEST POSITION
HP NG SENDOUT
PSD BUTTON FOR HIGH PRESSURE BOOSTER PUMP (NOTE2)
NOTES:
1. CONTAINS DRAIN HOLE.
2. LOCATED AT SAFE LOCATION
3. P-1: PSD1 (REGAS SYSTEM DRAIN)
P-2: PSD2 (STOP RECONDENSER)
P-3-1: PSD3 (SHUTDOWN SKID)
I-095: TALL-TI 0126
I-100: MOTOR A FAULT
I-101: MOTOR B FAULT
I-104: PUMP A POSITION HIGH (ZI 1004)
I-105: PUMP B POSITION HIGH (ZI 1005)
I-110: PALL-PI 1010B/1010C
I-120: PALL-PI 1040B/1040C
I-121: PALL-PI 1050B/1050C
I-125: TALL-TI 1125
I-127: TALL-TI 1127
I-133: TALL-TI 1063
I-134: TALL-TI 1064
I-150: PALL-PI 1120
I-153: PALL-PI 1124
I-155: TALL-TI 1125
I-157: TALL-TI 1127
I-161: TALL-TI 1118
I-163: TALL-TI 1122
I-165: TALL-TI 1133/1135
I-167: TALL-TI 1137/1139
I-196: LALL-LI 1014A
I-197: LALL-LI 1014B
TITLE : REGAS
P&ID - LNG Regasification
HULL NO.: 2031
DWG.NO. : 3000-ZM-11012
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02
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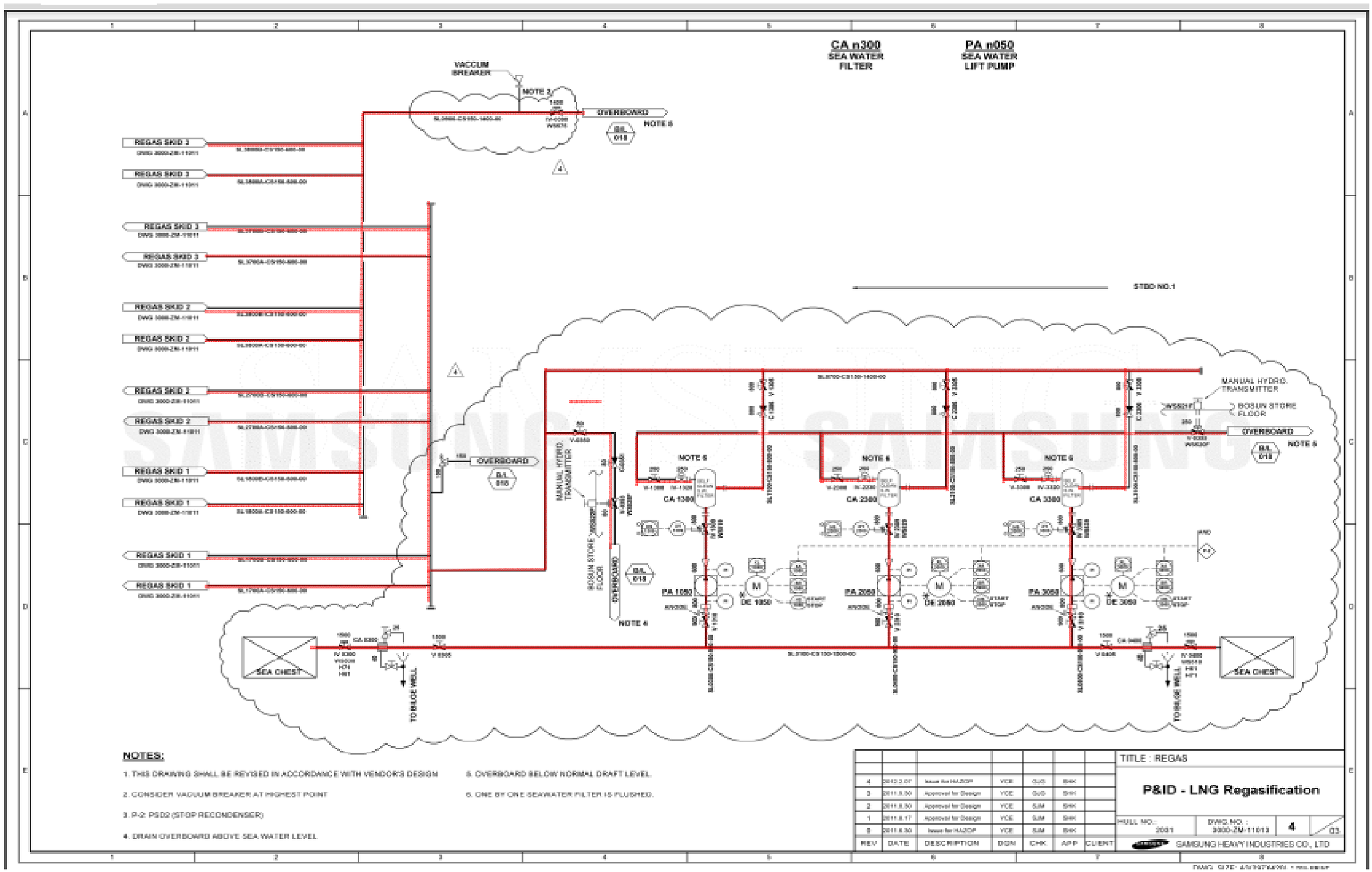

NOTES:

1. THIS DRAWING SHALL BE REVISED IN ACCORDANCE WITH VENDOR'S DESIGN
2. CONSIDER VACUUM BREAKER AT HIGHEST POINT
3. P-2: PSD2 (STOP RECONDENSER)
4. DRAIN OVERBOARD ABOVE SEA WATER LEVEL
5. OVERBOARD BELOW NORMAL DRAFT LEVEL
6. ONE BY ONE SEAWATER FILTER IS FLUSHED.

REV	DATE	DESCRIPTION	DSN	CHK	APP	CLIENT
4	2012.2.07	Issue for HAZOP	YCE	GJO	SHK	
3	2011.8.30	Approval for Design	YCE	GJO	SHK	
2	2011.8.30	Approval for Design	YCE	SJM	SHK	
1	2011.8.17	Approval for Design	YCE	SJM	SHK	
0	2011.8.30	Issue for HAZOP	YCE	SJM	SHK	

TITLE : REGAS

P&ID - LNG Regasification

HULL NO.: 2031 | DWG NO. : 3000-ZM-11013 | 4 | 03

SAMSUNG HEAVY INDUSTRIES CO., LTD

APPENDIX
III
HAZOP RECORDING SHEETS

Project: HAZOP Study of Regasification System for HN2031 170,000m3 LNG FSRU
Node No: 1
Node Description: LNG Inlet & Re-condenser
Drawing No: 3000-ZM-11011
Session Date: 15th February 2012

DEVIATION	POSSIBLE CAUSES	CONSEQUENCES	SAFEGUARDS	REC #	ACTION REQUIRED	ACTION BY	COMPLETION DATE	SIGN
NO / LESS FLOW	No flow from LNG feed pump	(1) Cavitation / Damage to the HP Booster Pump(s) (2) Shutdown of the whole system (3) Gas blow-by through the system (system filled with BOG)	(1) LALL / LAL on the VX-0050 (2) PAL-0008 on the vessel (3) Trip of HP Booster Pump(s) (4) Shutdown of the BOG system					
	Inlet valves (manual and control valves) on the main LNG feed line closed	Same as above	Same as above					
	FCV-0015 fail closed	Level drop in the Recondenser due to excessive BOG	(1) LAL-0013 and LALL-0043 / 0053 will trigger alarm and trip the system (2) FIT-0002					
	FE-0002 failed	Level drop in the Recondenser	(1) LAL-0013 and LALL-0043 / 0053 will trigger alarm and trip the system					
	Outlet valves closed	(1) Cavitation / Damage to the HP Booster Pump(s) (2) Shutdown of the whole system (3) Risk of filling LNG into BOG line and N2 line and also back to vapor main	(1) LAH-0013 / 0043 / 0053 will trigger alarm (2) PAH-0008 (3) Check valves on each inlet lines (4) LAHH-0043 / 0053 will trigger PSD (5) IV-0011 close will cause shutdown - PSD					

Project: HAZOP Study of Regasification System for HN2031 170,000m3 LNG FSRU
Node No: 1
Node Description: LNG Inlet & Re-condenser
Drawing No: 3000-ZM-11011
Session Date: 15th February 2012

DEVIATION	POSSIBLE CAUSES	CONSEQUENCES	SAFEGUARDS	REC #	ACTION REQUIRED	ACTION BY	COMPLETION DATE	SIGN
	Recondenser VX-0050 leak	Cryogenic spill Damage to deck / hull structure	(1) LALL-0043/0053 (2) F&G detectors (3) Spill tray and overboard drain	1.1	Consider using three transmitter for action voting for LAHH and LALL to transmitter LIT-0013			
	Pressure control PIT-0031A/B wrong reading	Restricted flow / close of inlet valves	(1) LALL / LAL on the VX-0050 (2) PAL-0008 on the vessel (3) Trip of HP Booster Pump(s) (4) Shutdown of the BOG system	1.2	Consider three independent pressure transmitter each with dedicated shut-off valves	SHI		
	Level control wrong reading / error	(1) More make-up gas into the system - lead to higher pressure (2) Insufficient flow of LNG	(1) LAHH-0043 / 0053 will trigger PSD (2) PAH-0008					
MORE FLOW	Control valve PCV-0013 A/B too much open	(1) Pressure at the bottom of the Recondenser will increase - cons. Pressure at the top will increase and reduce BOG (2) High level in the Recondenser	LAHH-0043 / 0053 will trigger PSD	1.3	Clarify the control strategy for the high pressure controller on Recondenser VX-0050	SHI		
				1.4	Develop strategy to handle high level in the Recondenser VX-0050 with the objective to maintain production	SHI		
	Failure of FE-0002	Drop of pressure in the Recondenser	(1) LAH-0013 and LAHH-0043 / 0053 (2) Back-up from sales gas will maintain pressure in Recondenser					
AS WELL AS FLOW	No issues identified							

Project: HAZOP Study of Regasification System for HN2031 170,000m3 LNG FSRU
Node No: 1
Node Description: LNG Inlet & Re-condenser
Drawing No: 3000-ZM-11011
Session Date: 15th February 2012

DEVIATION	POSSIBLE CAUSES	CONSEQUENCES	SAFEGUARDS	REC #	ACTION REQUIRED	ACTION BY	COMPLETION DATE	SIGN
PART OF FLOW	No issues identified							
OTHER THAN FLOW	No issues identified							
REVERSE FLOW	Overflow of the Recondenser	(1) Liquid backflow to the BOG (2) Liquid backflow to the Vapor Main (3) Liquid backflow to the N2 line	(1) Cryogenic check valve (C-0023) provided at the BOG inlet line (2) LAHH-0043 and 0053 will trigger PSD (3) Cryogenic check valve (C-0024) is provided on the N2 line (4) TALL-0125 on the KO Drum VA-0070	1.5	Verify that relevant piping and check valves on the N2 line are cryogenic type.	SHI		
				1.6	To evaluate closing of IV-0050 on high level in Recondenser VX-0050	SHI		
	LNG feed pump(s) trips	Gas blow-by to the cargo tanks - no serious consequence						
NO / LESS PRESSURE	No flow from BOG	Same as NO FLOW Case	Same as NO FLOW Case					
	PSV-0049 / 0051 passing	(1) Waste of gas (2) Discharge of gas to atm.	(1) Gas sampling on the vent mast (2) Redundancy on the PSV					
	Insufficient make-up gas	Same as NO FLOW of BOG Case	Same as NO FLOW of BOG Case					
	Leakage from pipings / vessel	Same as NO FLOW Case - cryogenic spill	Same as NO FLOW Case - cryogenic spill					
	Inlet valve closed	Same as NO FLOW Case	Same as NO FLOW Case					
	Low frequency on the feed pump(s)	Same as REVERSE FLOW Case	Trip of the pumps					

Project: HAZOP Study of Regasification System for HN2031 170,000m3 LNG FSRU
Node No: 1
Node Description: LNG Inlet & Re-condenser
Drawing No: 3000-ZM-11011
Session Date: 15th February 2012

DEVIATION	POSSIBLE CAUSES	CONSEQUENCES	SAFEGUARDS	REC #	ACTION REQUIRED	ACTION BY	COMPLETION DATE	SIGN
MORE PRESSURE	Standstill and closed outlet	Vessel rupture	PSV-0049 / 0051 PAH-0008 gives pressure high alarm					
	Outlet valves closed	Same as NO FLOW Case	Same as NO FLOW Case					
	Too quick cool down	Vessel rupture	PSV-0049 / 0051 PAH-0008 gives pressure high alarm	1.7	Include cool down procedure in the Operation Procedure Manual.	SHI		
LESS TEMP.	Not Applicable							
MORE TEMP.	No issues identified							
NO / LESS LEVEL	No flow from LNG feed pump	(1) Cavitation / Damage to the HP Booster Pump(s) (2) Shutdown of the whole system (3) Gas blow-by through the system (system filled with BOG)	(1) LALL / LAL on the VX-0050 (2) PAL-0008 on the vessel (3) Trip of HP Booster Pump(s) (4) Shutdown of the BOG system					
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	FE-0002 failed	Level drop in the Recondenser	(1) LAL-0013 and LALL-0043 / 0053 will trigger alarm and trip the system					

Project: HAZOP Study of Regasification System for HN2031 170,000m3 LNG FSRU
Node No: 1
Node Description: LNG Inlet & Re-condenser
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Session Date: 15th February 2012

DEVIATION	POSSIBLE CAUSES	CONSEQUENCES	SAFEGUARDS	REC #	ACTION REQUIRED	ACTION BY	COMPLETION DATE	SIGN
	Outlet valves closed	(1) Cavitation / Damage to the HP Booster Pump(s) (2) Shutdown of the whole system (3) Risk of filling LNG into BOG line and N2 line and also back to vapor main	(1) LAH-0013 / 0043 / 0053 will trigger alarm (2) PAH-0008 (3) Check valves on each inlet lines (4) LAHH-0043 / 0053 will trigger PSD (5) IV-0011 close will cause shutdown - PSD					
	Recondenser VX-0050 leak	Cryogenic spill Damage to deck / hull structure	(1) LALL-0043/0053 (2) F&G detectors (3) Spill tray and overboard drain					
	Pressure control PIT-0031A/B wrong reading	Restricted flow / close of inlet valves	(1) LALL / LAL on the VX-0050 (2) PAL-0008 on the vessel (3) Trip of HP Booster Pump(s) (4) Shutdown of the BOG system					
MORE LEVEL	Control valve PCV-0013 A/B too much open	Pressure at the bottom of the Recondenser will increase - cons. Pressure at the top will increase and reduce BOG	LAHH-0043 / 0053 will trigger PSD					
	Failure of FE-0002	Drop of pressure in the Recondenser	(1) LAH-0013 and LAHH-0043 / 0053 (2) Back-up from sales gas will maintain pressure in Recondenser					

Project: HAZOP Study of Regasification System for HN2031 170,000m3 LNG FSRU
Node No: 2
Node Description: BOG Compressor & Re-condenser Vapor Inlet
Drawing No: 3000-ZM-11011, 3000-ZM-11012
Session Date: 15th February 2012

DEVIATION	POSSIBLE CAUSES	CONSEQUENCES	SAFEGUARDS	REC #	ACTION REQUIRED	ACTION BY	COMPLETION DATE	SIGN
NO / LESS FLOW	Manual valves closed	Loss of recondensing capacity Increasing venting or burning - environmental issue	FE-0032					
	LD Compressor failure	Loss of recondensing capacity Increasing venting or burning - environmental issue	FE-0032					
	FCV-0022 fail closed	Loss of recondensing capacity Increasing venting or burning - environmental issue	FE-0032					
	Too high pressure in Recondenser	Loss of recondensing capacity Increasing venting or burning - environmental issue	FE-0032					
	Crossover line left opened - CG-931	Loss of recondensing capacity Increasing venting or burning - environment issue	FE-0032	2.1	Consider to implement alarm from the FE-0032 if actual flow deviates from the set-point.	SHI		
MORE FLOW	FCV-0022 inadvertently open	Compressor motor get overloaded	Control and alarm of the compressor will limit the flow and trip compressor					
AS WELL AS FLOW	No issues identified							

Project: HAZOP Study of Regasification System for HN2031 170,000m3 LNG FSRU
Node No: 2
Node Description: BOG Compressor & Re-condenser Vapor Inlet
Drawing No: 3000-ZM-11011, 3000-ZM-11012
Session Date: 15th February 2012

DEVIATION	POSSIBLE CAUSES	CONSEQUENCES	SAFEGUARDS	REC #	ACTION REQUIRED	ACTION BY	COMPLETION DATE	SIGN
PART OF FLOW	No issues identified							
OTHER THAN FLOW	No issues identified							
REVERSE FLOW	See NO FLOW Case for Node 4	See NO FLOW Case for Node 4	See NO FLOW Case for Node 4					
NO / LESS PRESSURE	Same as NO FLOW Case	Same as NO FLOW Case	Same as NO FLOW Case					
MORE PRESSURE	Same as MORE FLOW Case	Same as MORE FLOW Case	Same as MORE FLOW Case					
LESS TEMP.	No issues identified							
MORE TEMP.	No issues identified							
NO / LESS LEVEL	No issues identified							
MORE LEVEL	No issues identified							

Project: HAZOP Study of Regasification System for HN2031 170,000m3 LNG FSRU
Node No: 3
Node Description: Regas Booster Pumps & Heat Exchanger
Drawing No: 3000-ZM-11011, 3000-ZM-11012
Session Date: 15th February 2012

DEVIATION	POSSIBLE CAUSES	CONSEQUENCES	SAFEGUARDS	REC #	ACTION REQUIRED	ACTION BY	COMPLETION DATE	SIGN
NO / LESS FLOW	V-1011 closed	Cavitation of the HP Booster Pumps PA-1000 A/B - lead to damage to the pump	(1) PAL-1010 A/B/C (2) Permissive when start-on the pump (3) Limit switch stop the pump	3.1	Check suitability of the limit switch in open deck (valid for all limit switches on the Regas facility).	SHI		
	Clogged filter at the upstream of the HP Booster Pump	Low suction pressure and lead to the damage to the pump i.e. overheating.	Shutdown of the system on lower pressure - PALL-1010 A/B/C	3.2	Include proper draining and drying of the piping following the hydrotest in the Commissioning Procedure - to prevent ice clogging.	SHI		
	IV-1007 A/B closed	High pressure in the Heat Exchanger HA-1100 A/B	PSV-1321 / 1322	3.3	Consider to include PAHH on the PIT-1071 and PIT-1072	SHI		
				3.4	Consider to include PAHH on the PIT-1041 A/B/C and PIT-1040 A/B/C	SHI		
	FCV-1005 A/B closed	Low / no flow from the HP Booster Pumps - damage to the pumps	(1) Min. flow recycle line (2) PAH-1040 A / PAH-1041 A					
	Booster pumps failure	Loss of production						
	Check valve stucked in close position - 1012 A/B	(1) Damage to the HP Booster Pump (2) Loss of production	Low current signal to trip pump	3.5	SHI to confirm the low current signal trip	SHI		
	FCV-1055 A/B stucked open	Excess recycle	(1) Recycle flow alarm is provided on min. recyclie line (2) PSV on the VX-0050 design for excess pump recycle	3.6	Confirm the capacity of the PSV-0049 and PSV-0051	SHI		
	V-1201 in close position	Potential pipe rupture	No safeguards identified	3.7	Consider moving the spec-break downstream of the valve	SHI		
	Check valve C-1011 A/B stucked in close position	Potential pipe rupture	No safeguards identified					

Project: HAZOP Study of Regasification System for HN2031 170,000m3 LNG FSRU
Node No: 3
Node Description: Regas Booster Pumps & Heat Exchanger
Drawing No: 3000-ZM-11011, 3000-ZM-11012
Session Date: 15th February 2012

DEVIATION	POSSIBLE CAUSES	CONSEQUENCES	SAFEGUARDS	REC #	ACTION REQUIRED	ACTION BY	COMPLETION DATE	SIGN
	Check valve stucked in close position - outlet of C-1081 / 1082	High pressure in the Heat Exchanger HA-1100 A/B	PSV-1321 / 1322	3.8	Consider moving the check valve to inside the Regas Skid.	SHI		
MORE FLOW	FCV-1005 A/B too much open	Insufficient vaporization of LNG	(1) TALL-1063 / TALL-1064 (2) TAL-1061 / TAL-1062 (3) TALL-0511 and TAL-0512 / TAL-0501 (4) TALL-1135 / TALL-1133 / TALL-1139 / TALL-1137 will trigger shutdown of the train (5) TALL-1125 / 1127 will trigger shutdown of the train					
AS WELL AS FLOW	Water in the system	Freezing up the suction filter of the HP Booster Pump and lead to the damage to the pump i.e. overheating.	Shutdown of the skid on lower pressure - PALL-1010 A/B/C					
PART OF FLOW	No issues identified							
OTHER THAN FLOW	No issues identified							

Project: HAZOP Study of Regasification System for HN2031 170,000m3 LNG FSRU
Node No: 3
Node Description: Regas Booster Pumps & Heat Exchanger
Drawing No: 3000-ZM-11011, 3000-ZM-11012
Session Date: 15th February 2012

DEVIATION	POSSIBLE CAUSES	CONSEQUENCES	SAFEGUARDS	REC #	ACTION REQUIRED	ACTION BY	COMPLETION DATE	SIGN
REVERSE FLOW	One train in a skid not running	(1) Backspinning from the HP Booster Pumps (2) Overpressure on the lower pressure piping (3) Vapor backflow to upstream of the operating pump	(1) Backflow will be vapor and less likely to result in backspinning (2) Check valves C-1081 / 1082 and C-1012 A/B (3) FCV-1005 A/B					
NO / LESS PRESSURE	Leak or rupture in the system / skid	Cryogenic spill	(1) F&G detection (2) ESD and blowdown (3) Spill tray and overboard drain - HP Booster Pumps only					
	Pump malfunction	(1) Loss of production (2) Reverse flow from other train	(1) Backflow will be vapor and less likely to result in backspinning (2) Check valves C-1081 / 1082 and C-1012 A/B (3) FCV-1005 A/B					
	PSV or TRV passing	Loss of production	Gas sampling on the vent mast will trigger alarm					
MORE PRESSURE	Same as NO FLOW Case	Same as NO FLOW Case	Same as NO FLOW Case					
	FCV-1005 A/B failed open	Potential overpressure downstream of the valve	(1) PSV-1321 / 1322 (2) PAL-1071 / PAL-1072	3.9	Consider suitability of the use of control valve for safety shutdown.	SHI		
	Trapped liquid LNG in the isolated train (vaporizer segment)	Tube rupture	(1) PSV-1321 / 1322 (2) PAH-1071 / 1072	3.10	Identify how to handle the trapped liquid after PSD to avoid PSV opening.	SHI		

Project: HAZOP Study of Regasification System for HN2031 170,000m3 LNG FSRU
Node No: 3
Node Description: Regas Booster Pumps & Heat Exchanger
Drawing No: 3000-ZM-11011, 3000-ZM-11012
Session Date: 15th February 2012

DEVIATION	POSSIBLE CAUSES	CONSEQUENCES	SAFEGUARDS	REC #	ACTION REQUIRED	ACTION BY	COMPLETION DATE	SIGN
LESS TEMP.	See MORE FLOW Case - FCV-1005 stucked open	See MORE FLOW Case	See MORE FLOW Case	3.11	Consider implementing a bypass around FCV-1005 A/B to improve cool down time if required by heat exchanger vendor	GOLAR / SHI		
MORE TEMP.	No issues identified							
NO / LESS LEVEL	Low level in the HP Booster Pumps suction pot	Cavitation of the HP Booster Pumps PA-1000 A/B - lead to damage to the pump	LAL-1013 A/B will trigger alarm LALL-1014 A/B will shutdown the train					
	Failure of the level indicator LIT-1013 A/B	Cavitation of the HP Booster Pumps PA-1000 A/B - lead to damage to the pump	LALL-1014 A/B will shutdown the train					
HIGH / MORE LEVEL	More level in the HP Booster Pumps suction pot	Overflow to the vent line	LAH-1013 A/B TALL-1026	3.12	Review the vapor return from the HP Booster Pumps	SHI		
OTHER ISSUES								

Project: HAZOP Study of Regasification System for HN2031 170,000m3 LNG FSRU
Node No: 4
Node Description: NG Vapor Return
Drawing No: 3000-ZM-11011, 3000-ZM-11012
Session Date: 16th February 2012

DEVIATION	POSSIBLE CAUSES	CONSEQUENCES	SAFEGUARDS	REC #	ACTION REQUIRED	ACTION BY	COMPLETION DATE	SIGN
NO / LESS FLOW	PCV-0090 fail closed	Level of LNG inside Recondenser increase Liquid backflow to the BOG Compressor Liquid carryover to the KO Drum	Check valve C-0023 on the BOG line LAHH-0043 / 0053 will close FCV-0022 LAH-0013 will trigger alarm					
	IV-0071 fail closed	Same as above	Same as above					
	LCV-0075 fail closed	Same as above	Same as above					
	C-0026 stucked in close position	Same as above	Same as above					
	PSV-0059 and 0061 passing	Same as above	Same as above					
MORE FLOW	PCV-0090 stucked open	Increase flow into the Recondenser drum Low level in the Recondenser Drum	LALL-0043 / LALL-0053 LAL-0013 will trigger alarm PAH-0072 IV-0071 closed PSV-0059 / 0061					
	LCV-0075 stucked open	Increase flow into the Recondenser drum Low level in the Recondenser Drum	LALL-0043 / LALL-0053 LAL-0013 will trigger alarm PAH-0072 PSV-0059 / 0061	4.1	Consider interlock between IV-0050 and control valves feeding gas (PCV-0025, FCV-0022, PCV-0090) into the Recondenser Drum.	SHI		
AS WELL AS FLOW	PCV-0025 inadvertently open	Same as MORE FLOW Case above	Same as MORE FLOW Case above					
PART OF FLOW	No issues identified							

Project: HAZOP Study of Regasification System for HN2031 170,000m3 LNG FSRU
Node No: 4
Node Description: NG Vapor Return
Drawing No: 3000-ZM-11011, 3000-ZM-11012
Session Date: 16th February 2012

DEVIATION	POSSIBLE CAUSES	CONSEQUENCES	SAFEGUARDS	REC #	ACTION REQUIRED	ACTION BY	COMPLETION DATE	SIGN
OTHER THAN FLOW	No issues identified							
REVERSE FLOW	No issues identified							
NO / LESS PRESSURE	Same as NO FLOW Case	Same as NO FLOW Case	Same as NO FLOW Case					
MORE PRESSURE	LCV-0075 fail closed	Potential overpressure of the line	PSV-0059 and PSV-0061 PAHH-0072 B/C PAH-0072 A					
	PCV-0090 stucked open	Potential overpressure of the line	IV-0071 closed PAHH-0072 B/C PAH-0072 A PSV-0059 and PSV-0061					
LESS TEMP.	No issues identified							
MORE TEMP.	No issues identified							
NO / LESS LEVEL	No issues identified							
MORE LEVEL	No issues identified							

Project: HAZOP Study of Regasification System for HN2031 170,000m3 LNG FSRU
Node No: 5
Node Description: Booster Pump Vapour Return
Drawing No: 3000-ZM-11011, 3000-ZM-11012
Session Date: 15th February 2012

DEVIATION	POSSIBLE CAUSES	CONSEQUENCES	SAFEGUARDS	REC #	ACTION REQUIRED	ACTION BY	COMPLETION DATE	SIGN
NO / LESS FLOW	LCV-1050 stucked close	Low level in the HP Booster Pumps suction pot - potential for cavitation Pressure build up in Recondenser drum and HP Booster Pump suction pot	(1) LALL-1014 A/B (2) LAL-1013 A/B					
	IV-0050 closed	Pressure build up in Recondenser drum	(1) PSV-0049 / PSV-0051 (2) PAH-0008					
	IV-0131 and IV-0133 closed	Pressure build up in Recondenser drum and HP Booster Pump suction pot	(1) PSV-0073 or PSV-0074 on KO Drum (2) PAH-0008 on the Recondenser (3) LAL-1013 A/B on HP Booster Pump suction pot (4) PSV-0049 or PSV-0051 on Recondenser (5) PSV-1000 on HP Booster Pump vent line					
MORE FLOW	LCV-1050 failed open	Liquid flow into the KO Drum	(1) Drain to the safety header (2) TALL-0125	5.1	To evaluate suitability of the temperature sensor for liquid detection in the KO Drum VA-0070.	SHI		
	IV-0050 stucked open	(1) Pressure drop in Recondenser (2) High level in Recondenser	(1) LAHH-0043 / LAHH-0053 (2) PAL-0008					
AS WELL AS FLOW	No issues identified							

Project: HAZOP Study of Regasification System for HN2031 170,000m3 LNG FSRU
Node No: 5
Node Description: Booster Pump Vapour Return
Drawing No: 3000-ZM-11011, 3000-ZM-11012
Session Date: 15th February 2012

DEVIATION	POSSIBLE CAUSES	CONSEQUENCES	SAFEGUARDS	REC #	ACTION REQUIRED	ACTION BY	COMPLETION DATE	SIGN
PART OF FLOW	No issues identified							
OTHER THAN FLOW	No issues identified							
REVERSE FLOW	No issues identified							
NO / LESS PRESSURE	LCV-1050 stucked open	Liquid flow into the KO Drum	(1) Drain to the safety header (2) TALL-0125					
MORE PRESSURE	No issues identified							
LESS TEMP.	No issues identified							
MORE TEMP.	No issues identified							
NO / LESS LEVEL	No issues identified							
HIGH / MORE LEVEL	No issues identified							

Project: HAZOP Study of Regasification System for HN2031 170,000m3 LNG FSRU
Node No: 6
Node Description: Re-condenser Drain Line
Drawing No: 3000-ZM-11011, 3000-ZM-11012
Session Date: 15th February 2012

DEVIATION	POSSIBLE CAUSES	CONSEQUENCES	SAFEGUARDS	REC #	ACTION REQUIRED	ACTION BY	COMPLETION DATE	SIGN
NO / LESS FLOW	IV-0016 closed	Inability to drain	No safeguards required / identified					
	V-1091 closed	Inability to drain	No safeguards required / identified					
	IV-1090 A/B closed	Inability to drain	No safeguards required / identified					
	Valves on Liquid Main closed	Inability to drain	No safeguards required / identified					
	IV-0046 closed	Inability to cool down and emergency drain	No safeguards required / identified	6.1	Consider connecting drain line to the spray line instead of the liquid main.	SHI		
MORE FLOW	IV-1090 A/B closed during cool down	Damage to the motor of the pump	No safeguards identified	6.2	Propose to have rate of change alarm for the level in the pump pot during cool down.	SHI		
	IV-1090 A/B open during normal operation	Damage to the pump	(1) PSD on LALL-1014 A/B (2) Isolation valve V-1091					
AS WELL AS FLOW	No issues identified							
PART OF FLOW	No issues identified							
OTHER THAN FLOW	No issues identified							
REVERSE FLOW	Backflow to the drain during cargo transfer	No serious consequences	(1) Check valve C-0017 (2) IV-0016 (3) V-1091					
NO / LESS PRESSURE	No issues identified							
MORE PRESSURE	Trapped liquid in the drain line	Pipe rupture	TRV-0054 for line downstream of V-1091	6.3	Consider overpressure protection in line between IV-1090 A/B and V-1091.	SHI		
LESS TEMP.	No issues identified							
MORE TEMP.	No issues identified							
NO / LESS LEVEL	No issues identified							
MORE LEVEL	No issues identified							

Project: HAZOP Study of Regasification System for HN2031 170,000m3 LNG FSRU
Node No: 7
Node Description: NG Send Out Line
Drawing No: 3000-ZM-11011, 3000-ZM-110117
Session Date: 16th February 2012

DEVIATION	POSSIBLE CAUSES	CONSEQUENCES	SAFEGUARDS	REC #	ACTION REQUIRED	ACTION BY	COMPLETION DATE	SIGN
NO / LESS FLOW	IV-0010 failed open	Gas to the vent mast	Gas sampling in the vent mast PIT-0009 will trigger alarm PAL-0009	7.1	Measures to handle pipeline backflow due to inadvertent opening of IV-0010.	SHI		
	PCV-0009A/B closed	High pressure in the Heat Exchanger HA-1100 A/B HP Booster pumps overpressuring the line	PSV-1321 / 1322 PAH-0009 PAHH-0519 Redundancy on the PCV-0009 A/B POC-0007 will close the FCV-1005 A/B					
	Manual valves closed	Same as above	PSV-1321 / 1322 PAH-0009 PAHH-0519 POC-0007 will close the FCV-1005 A/B					
	Pipe rupture	Loss of containment - potential for fire and gas explosion	F&G detection & ESD PALL-0513 will trigger ESD PAL-0514 will trigger alarm	7.2	To evaluate measures of detecting release in the NG Send-out line.	SHI		
MORE FLOW	No issues identified							
AS WELL AS FLOW	Liquid carryover from Regas Skid (during blowdown)	Liquid in the KO Drum Potential carryover to the vent mast	Sizing of the KO Drum catering for carryover during blowdown Material selection	7.3	To evaluate measures of liquid detection and means for boiling off liquid in the drum.	SHI		
PART OF FLOW	No issues identified							

Project: HAZOP Study of Regasification System for HN2031 170,000m3 LNG FSRU
Node No: 7
Node Description: NG Send Out Line
Drawing No: 3000-ZM-11011, 3000-ZM-110117
Session Date: 16th February 2012

DEVIATION	POSSIBLE CAUSES	CONSEQUENCES	SAFEGUARDS	REC #	ACTION REQUIRED	ACTION BY	COMPLETION DATE	SIGN
OTHER THAN FLOW	No issues identified							
REVERSE FLOW	Pipe rupture with reverse flow from the pipeline	Loss of containment - potential for fire and gas explosion	F&G detection & ESD PALL-0513 will trigger ESD PAL-0514 will trigger alarm	7.4	To consider non-return valve on the send-out line.	SHI		
NO / LESS PRESSURE	Loss of I.A. or signal during emergency	Gas trapped between IV-0505 and PCV-0009 A/B (both FC)	PAH-0514 will trigger alarm	7.5	To evaluate the size of the segment and means / need to depressurize of the line.	SHI		
MORE PRESSURE	PCV-0009A/B stucked open	High pressure in the pipeline	PAH-0009 PAHH-0504 Redundancy on the PCV-0009 A/B POC-0007 will close the FCV-1005 A/B					
LESS TEMP.	Low temp. during depressurization	Brittle failure of valves	TAL-0512 / TAL-0501 TALL-0511 Adequate design temperature					
MORE TEMP.	No issues identified							
NO / LESS LEVEL	No issues identified							
MORE LEVEL	See AS WELL AS FLOW Case	See AS WELL AS FLOW Case	See AS WELL AS FLOW Case					

Project: HAZOP Study of Regasification System for HN2031 170,000m3 LNG FSRU
Node No: 8
Node Description: Seawater System
Drawing No: 3000-ZM-11013
Session Date: 16th February 2012

DEVIATION	POSSIBLE CAUSES	CONSEQUENCES	SAFEGUARDS	REC #	ACTION REQUIRED	ACTION BY	COMPLETION DATE	SIGN
NO / LESS FLOW	Marine growth in the sea chest	(1) Insufficient vaporization (2) LNG carryover to the NG Send-out line	Hypochloride injection Redundant sea chest TALL-1063 / 1064 TAL-1061 / 1062 PAL-1119 / 1123 PALL-1124 / 1119	8.1	Include pressure transmitter on the suction and discharge side of the SW Lift Pumps.	SHI		
	SW Lift Pump failure	(1) Insufficient vaporization (2) LNG carryover to the NG Send-out line (3) Freezing on the vaporizer	TALL-1063 / 1064 TAL-1061 / 1062 PAL-1119 / 1123 PALL-1124 / 1119 Redundancy on SW Lift Pumps Automatic gas flow reduction of the HP Booster Pumps					
	Clogged strainer	(1) Insufficient vaporization (2) LNG carryover to the NG Send-out line (3) Freezing on the vaporizer (4) Pump damage due to cavitation	(1) Redundancy on the intake line (2) Pump trip on low suction pressure (3) Vibration sensor on the pump	8.2	Consider to include differential pressure transmitter on the strainer.	GOLAR / SHI		
				8.3	SHI / Golar	SHI		

Project: HAZOP Study of Regasification System for HN2031 170,000m3 LNG FSRU
Node No: 8
Node Description: Seawater System
Drawing No: 3000-ZM-11013
Session Date: 16th February 2012

DEVIATION	POSSIBLE CAUSES	CONSEQUENCES	SAFEGUARDS	REC #	ACTION REQUIRED	ACTION BY	COMPLETION DATE	SIGN
	Clogged of the SW filter CA-n300	Same as above	(1) Automatic self-cleaning (2) DP measurement - vendor to provide (3) Redundant SW Lift Pumps (4) Pump trip on high discharge pressure (5) Vibration sensor on the pump	8.4	To provide DP measurement over the SW filters	SHI		
	Manual valves closed	Same as above	TALL-1063 / 1064 TAL-1061 / 1062 PAL-1119 / 1123 PALL-1124 / 1119 Redundancy on SW Lift Pumps					
	Clogged heat exchanger / vaporiser due to ice	(1) Shell rupture (2) Insufficient vaporization (3) LNG carryover to the NG Send-out line	DPT-1153 / 1155 / 1157 / 1159 will estimate flow through orifice TALL-1063 / 1064 TALL-1061 / 1062 PAH-1119 / 1123	8.5	Consider implementing alarm on the DPT-1153 / 1155 / 1157 / 1159	SHI / GOLAR		
	Air pocket in the line	Same as above	DPT-1153 / 1155 / 1157 / 1159 will estimate flow through orifice TALL-1063 / 1064 TALL-1061 / 1062 PAH-1119 / 1123					
MORE FLOW	No issues							

Project: HAZOP Study of Regasification System for HN2031 170,000m3 LNG FSRU
Node No: 8
Node Description: Seawater System
Drawing No: 3000-ZM-11013
Session Date: 16th February 2012

DEVIATION	POSSIBLE CAUSES	CONSEQUENCES	SAFEGUARDS	REC #	ACTION REQUIRED	ACTION BY	COMPLETION DATE	SIGN
	identified							
AS WELL AS FLOW	Tube leak in the heat exchanger	LNG or gas into the water line Overpressurizing the seawater line	Gas sampling in the seawater line	8.6	To identify the need to protect SW piping and heat exchanger in the event of tube rupture.	SHI		
PART OF FLOW	No issues identified							
OTHER THAN FLOW	No issues identified							
REVERSE FLOW	Same as AS WELL AS FLOW Case	Same as AS WELL AS FLOW Case	Same as AS WELL AS FLOW Case					
NO / LESS PRESSURE	Same as NO FLOW Case	Same as NO FLOW Case	Same as NO FLOW Case					
	Vacuum in pipeline due to siphon effect	Collapse of the heat exchanger	Vacuum breaker on the water outlet of each heat exhanger and the main outlet of the SW dump line.	8.7	Evaluate the vacuum breaker sizing and the capability of vaporizer to withstand vacuum in case of vacuum breaker failure.	SHI		
MORE PRESSURE	See AS WELL AS FLOW Case	See AS WELL AS FLOW Case	See AS WELL AS FLOW Case					
LESS TEMP.	No issues identified							
MORE TEMP.	No issues identified							
NO / LESS LEVEL	No issues identified							
MORE LEVEL	No issues identified							

Project: HAZOP Study of Regasification System for HN2031 170,000m3 LNG FSRU
Node No: 9
Node Description: LNG Feed Pumps
Drawing No: MB601.61
Session Date: 16th February 2012

DEVIATION	POSSIBLE CAUSES	CONSEQUENCES	SAFEGUARDS	REC #	ACTION REQUIRED	ACTION BY	COMPLETION DATE	SIGN
NO / LESS FLOW	LNG Feed Pump failure	Reduced capacity	Redundancy on the no. of the pump					
	Recycle valve CL-309 stucked open	Reduced capacity	Redundancy on the no. of the pump					
	Control valve CL-303 stucked close	Reduced capacity Damage to the pump - overheating	Permissive prevent the pump to start if valve is closed Deviation alarm Current trip					
	Check valve CL-304 stucked close	Reduced capacity Damage to the pump - overheating	Current trip					
	No liquid in the tank	Reduced capacity Damage to the pump	Level alarm in the tank Start level interlock					
MORE FLOW	CL-309 locked in open position	Reduce flow to Recondenser Production of vapor and heating of LNG overtime	Deviation alarm Low pressure alarm (if only one pump is running)					
AS WELL AS FLOW	No issues identified							
PART OF FLOW	No issues identified							
OTHER THAN FLOW	No issues identified							
REVERSE FLOW	One pump trips during multi-pump operations	LNG backflow to the tripped pump recycle	Logic to close CL-308 upon pump trip	9.1	Consider moving check valve CL-304 to the downstream of recycle line.	SHI		
NO / LESS PRESSURE	No issues identified							

Project: HAZOP Study of Regasification System for HN2031 170,000m3 LNG FSRU
Node No: 9
Node Description: LNG Feed Pumps
Drawing No: MB601.61
Session Date: 16th February 2012

DEVIATION	POSSIBLE CAUSES	CONSEQUENCES	SAFEGUARDS	REC #	ACTION REQUIRED	ACTION BY	COMPLETION DATE	SIGN
MORE PRESSURE	No issues identified							
LESS TEMP.	No issues identified							
MORE TEMP.	Too rapid cool down during start-up	Failure of downstream equipment	Spray pump with the throttling CL-309					
NO / LESS LEVEL	Same as NO FLOW Case - No liquid in the tank	Same as NO FLOW Case - No liquid in the tank	Same as NO FLOW Case - No liquid in the tank					
MORE LEVEL	No issues identified							

DNV

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