เอกสารแนบ 31

แผนผังจุดติดตั้งระบบดับเพลิงของโครงการ

PTTLNG Nong Fab LNG Receiving Terminal Project

SAIPEM
SPCC Joint Venture

Fire Protection Conceptual Layout Drawing

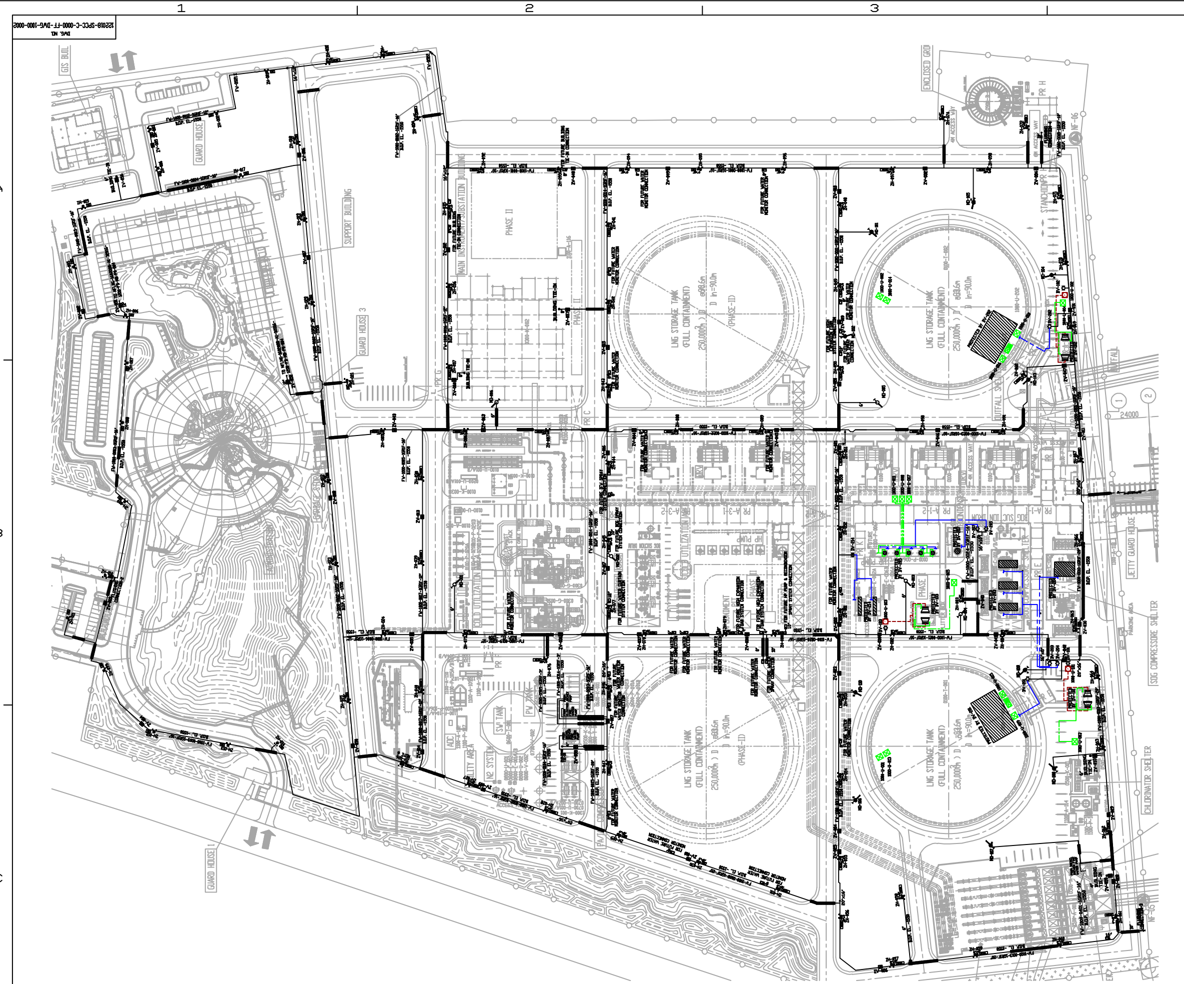
Doc. Class Z3

REV.	STATUS	DATE	REVISION DESCRIPTION	BY	CHK.	APPR.
				C.S.L	Nick	Chenkh Wei
Z1	IFB	17/11/2022	Issued For As Built	C.S.L	NICK / LIN	C.K.H / Y.J.W
S2	IFC	23/09/2020	Issued For Construction	C.S.L	C.K.H / LIN	C.C.L / Y.J.W
S1	IFC	20/01/2020	Issued For Construction	C.S.L	C.K.H / LIN	C.C.L / Y.J.W
A1	IFD	28/11/2019	Issued For Design	C.S.L	C.K.H / LIN	C.C.L / Y.J.W
R3	IFR	12/09/2019	Issued For Review	C.S.L	C.K.H / LIN	C.F.H / Y.J.W
R2	IFR	24/05/2019	Issued For Review	C.S.L	C.K.H / LIN	C.F.H / Y.J.W
R1	IFR	15/02/2019	Issued For Review	C.S.L	C.K.H / LIN	C.F.H / Y.J.W

Revision list:

Rev. Nr	Modifications:
R1	First Issue
R2	Revised as per comments of 122018-SPCC-PTT-T-02680
R3	Revised as per comments of 122018-SPCC-PTT-T-04635
A1	Revised as per comments of 122018-SPCC-PTT-T-07663
S1	Revised as per comments of 122018-SPCC-PTT-T-09989
S2	Revised as per comments of 122018-SPCC-PTT-T-11687
Z1	Issued for As Built

Hold list:



NOTES:

1. CD+8,500 = GL±0 = EL.±0
2. SECTION BLOCK VALVE SHALL BE PROVIDED SUCH THAT NO MORE THAN 300 M OR SIX (6) FIRE WATER USERS CAN BE ISOLATED BETWEEN BLOCK VALVES.
3. HYDRANT GUARD POST SHOULD BE CONSIDERED IN AREAS WHERE HEAVY TRAFFIC MAY OCCUR.
4. DELETE.
5. REFER TO FIRE FIGHTING PIPING STANDARD DRAWING 122018-SPCC-C-FF-GE-0001.
6. LOCATION OF ZH-026 IS ACCEPTED TO CLOSE TO ROAD SHOULDER.

LEGENDS:

- U/G FIRE WATER LINE
- A/G DOWNSTREAM OF DELUGE VALVE LINE
- A/G FOAM LINE
- A/G DRY CHEMICAL LINE
- HOSE REEL STATION
- HOSE REEL STATION WITH FOAM
- HOSE CABINET
- HYDRANT
- MONITOR
- HIGH LEVEL MONITOR
- PIVA WITH VALVE PIT
- GUARD POST
- FUTURE CONNECTION WITH PIT
- FOAM GENERATOR
- DRY CHEMICAL SYSTEM
- FOAM SKID
- DELUGE VALVE
- PROTECTED AREA BY WATER SPRAY
- CONCRETE SLAB FOR CROSSING ROAD
- DRY CHEMICAL SYSTEM WITH HOSE REEL

FINAL

AS BUILT

Doc. Class Z3

REV	STATUS	DESCRIPTION	BY	CHK.	APPR.	DATE
Z1	IFB	ISSUED FOR AS BUILT	C.S.L	NICK / LIN	C.K.H / Y.J.W	17/11/2022
S2	IFC	ISSUED FOR CONSTRUCTION	C.S.L	C.K.H / LIN	C.C.L / Y.J.W	23/09/2020
S1	IFC	ISSUED FOR CONSTRUCTION	C.S.L	C.K.H / LIN	C.C.L / Y.J.W	20/01/2020
A1	IFD	ISSUED FOR DESIGN	C.S.L	C.K.H / LIN	C.C.L / Y.J.W	28/11/2019
R3	IFR	ISSUED FOR REVIEW	C.S.L	C.K.H / LIN	C.F.H / Y.J.W	12/09/2019
R2	IFR	ISSUED FOR REVIEW	C.S.L	C.K.H / LIN	C.F.H / Y.J.W	24/05/2019
R1	IFR	ISSUED FOR REVIEW	C.S.L	C.K.H / LIN	C.F.H / Y.J.W	15/02/2019

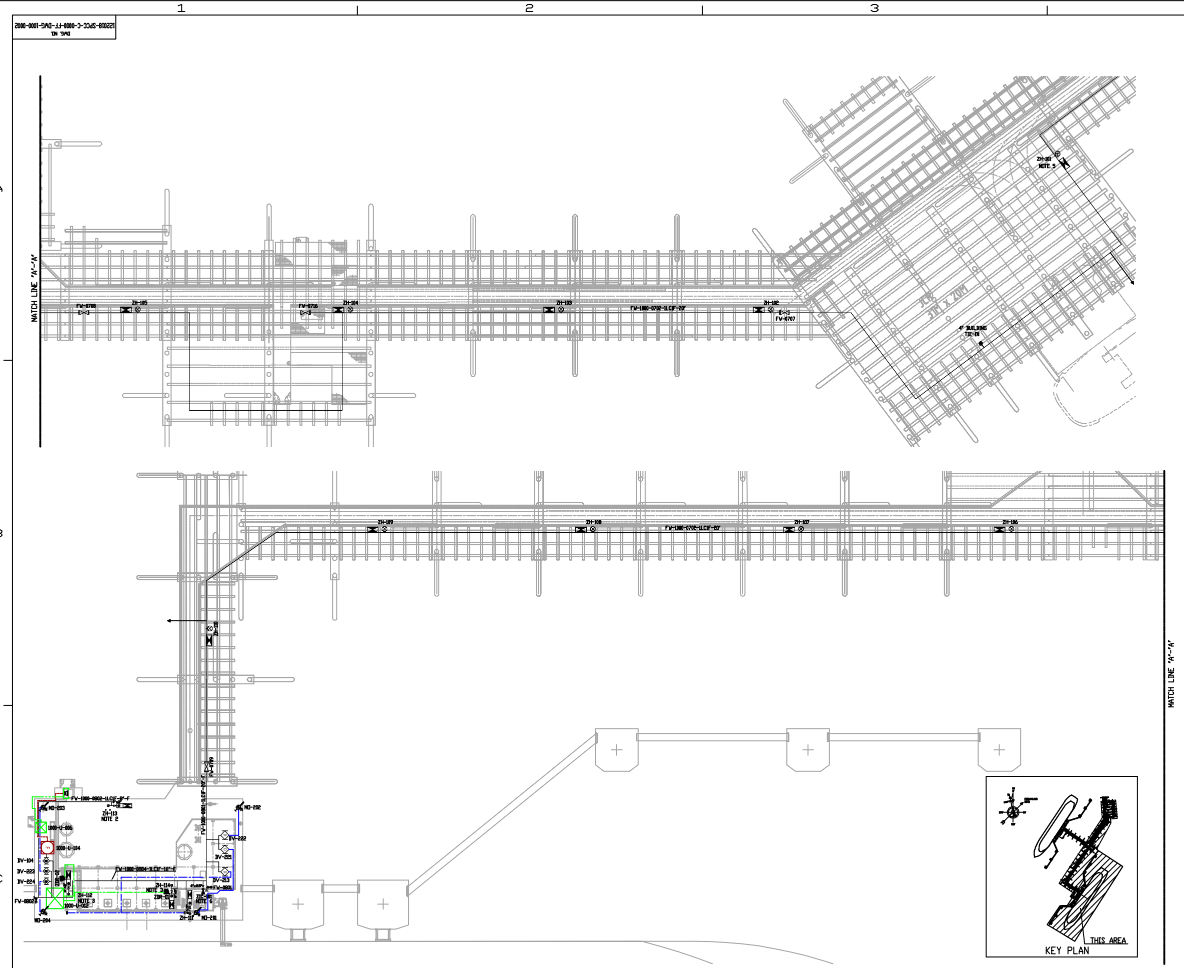
FOR

PTTLNG NONG FAB
LNG RECEIVING TERMINAL PROJECT

TITLE

FIRE PROTECTION CONCEPTUAL LAYOUT DRAWING
(1 OF 2)

EPCC	PROJ. NO.	DWG. NO.		SHEET
PTTLNG	122018	122018-SPCC-C-0000-FF-DWG-1000-0002		1 OF 2
SPCC	18E3366A	XG22-1000-001		REV. Z1
DISCIP.	FF	SIZE A1	SCALE	-



NOTES:

1. CD+8,500 = GL±0 = EL.±0
2. GUARD POST TO BE PROVIDED FOR THIS HYDRANT TO AVOID MOBILE TRUCK CLASH.
3. LOCATION OF HYDRANT IS ON 1ST FLOOR PLATFORM. (EL. 12,700)
4. REFER TO FIRE FIGHTING PIPING STANDARD DRAWING 122018-SPCC-C-FF-GE-0001.
5. DISTANCE BETWEEN ZH-101 AND ZH-102 IS ACCEPTED TO BE MORE THAN 50 M.
6. LOCATION OF INTERNATIONAL SHIP SHORE CONNECTION TO BE ON GANGWAY TOWER. (EL. 15700)

LEGEND:

- A/G FIRE WATER LINE
- A/G WATER SPRAY LINE
- A/G FOAM LINE
- A/G DRY CHEMICAL LINE
- HOSE REEL STATION WITH FOAM
- HOSE CABINET
- HYDRANT
- REMOTE MONITOR
- GUARD POST
- DRY CHEMICAL SYSTEM
- HIGH EXPANSION FOAM GENERATOR
- DELUGE SYSTEM
- DRY CHEMICAL HOSE REEL
- FOAM SKID
- HYDRANT GATE VALVE WITH INTERNATIONAL SHIP SHORE CONNECTION

FINAL

AS BUILT

Doc. Class Z3

REV	STATUS	DESCRIPTION	BY	CHK.	APPR.	DATE
Z1	IFB	ISSUED FOR AS BUILT	C.S.L	NICK / LIN	C.K.H / Y.J.W	17/11/2022
S2	IFC	ISSUED FOR CONSTRUCTION	C.S.L	C.K.H / LIN	C.C.L / Y.J.W	23/09/2020
S1	IFC	ISSUED FOR CONSTRUCTION	C.S.L	C.K.H / LIN	C.C.L / Y.J.W	20/01/2020
A1	IFD	ISSUED FOR DESIGN	C.S.L	C.K.H / LIN	C.C.L / Y.J.W	28/11/2019
R3	IFR	ISSUED FOR REVIEW	C.S.L	C.K.H / LIN	C.F.H / Y.J.W	12/09/2019
R2	IFR	ISSUED FOR REVIEW	C.S.L	C.K.H / LIN	C.F.H / Y.J.W	24/05/2019
R1	IFR	ISSUED FOR REVIEW	C.S.L	C.K.H / LIN	C.F.H / Y.J.W	15/02/2019

FOR

PTTLNG NONG FAB
LNG RECEIVING TERMINAL PROJECT

TITLE

FIRE PROTECTION CONCEPTUAL LAYOUT DRAWING
(2 OF 2)

EPCC	PROJ. NO.	DWG. NO.		SHEET
PTTLNG	122018	122018-SPCC-C-0000-FF-DWG-1000-0002		2 OF 2
SPCC	18E3366A	XG22-1000-001		REV. Z1
DISCIP.	FF	SIZE A1	SCALE	-

เอกสารแนบ 32

เอกสารตรวจสอบสภาพความพร้อมอุปกรณ์กักเก็บคราบน้ำมัน

(Oil Boom)

PTTLNG COMPANY LIMITED
3rd Floor, Energy Complex Building A 555/1
Vibhavadi Rangsit Rd., Chatuchak,
Bangkok 10900 Thailand

PRE ARRIVAL CHECKLIST FOR MARINE AND UNLOADING OPERATIONS

Ship's Name : [redacted]
Cargo No. : SLNG-OSLN3-JTJ1-2024
Arrival Date : *30 January 2024 / 08.00 LT*

☑ Berth No.1 ☐ Berth No.2

Number of the Ship : *EGT007-T2-03/2024*
Berth / Alongside : *Berth No.1 - STBD A/S*
Departure Date : *31 January 2024 / 19.00 LT*

Pre Arrival Check for Marine and Unloading Operations shall be carried out prior to the LNG Vessel arrival pilot boarding area.

No.	Equipment / System	Level	Criteria / Conditions	Status			Checked By	
				Yes	No	N/A	Title	Signatures
1	Detail of the LNG Vessel	B	Upload the name of the ship / ship dimension / number of cargo tank into the CIOMS system.	✓			Marine	
2	Mooring Pattern	B	Upload the Mooring Pattern into the CIOMS system.	✓			Marine	
3	Quick Release Hook (QRH)	A	Visual check - The QRH have no significant damage.	✓			Marine	
		A	Functional test - The QRH are working properly.	✓			Marine	
		A	Functional test - The capstans are working properly.	✓			Marine	
		A	Functional test - The emergency switch buttons are working properly.	✓			Marine	
		A	Functional test - The remote release QRH from CCR (At least once a year - tentatively in June)	✓			Marine	
4	Docking Aids System (DAS)	C	Visual check - The cover glass of the laser sensors are clear & not dirty.	✓			Marine	
		B	Functional test - The DAS is working properly.	✓			Marine	
		C	Functional test - The Large Display Board has been adjusted to the appropriate position.	✓			Marine	
5	Environment Monitoring System (EMS)	C	Visual check - The Wave & Tide Sensor has no significant damage.	✓			Marine	
		B	Visual check - The Anemometer is working properly.	✓			Marine	[redacted]
		C	Visual check - The Current Sensor is working properly.	✓			Marine	
		C	Visual check - The Wave & Tide Sensor is working properly.	✓			Marine	
		C	Visual check - The Thermometer is working properly.	✓			Marine	
		C	Visual check - The Hygrometer is working properly.	✓			Marine	
		C	Visual check - The Barometer is working properly.	✓			Marine	
6	Carry on Board computer (Labtop)	B	Visual check - The Carry on Board computer has no significant damage.	✓			Marine	
		B	Functional test - The Carry on Board computer has receiving a signal continuously.	✓			Marine	
7	Fender	B	Visual check - No significant damage & all chains connected to the appropriate position.	✓			Marine	
8	Navigation Lights	B	Visual check - The lanterns are flashing properly.	✓			Marine	
9	Navigation Buoys	B	Visual check - The Buoys are locating at the appropriate positions.	✓			Marine	
		B	Visual check - A lighting of the Buoys are flashing properly.	✓			Marine	

PTTLNG COMPANY LIMITED
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Vibhavadi Rangsit Rd., Chatuchak,
Bangkok 10900 Thailand

No.	Equipment / System	Level	Criteria / Conditions	Status			Checked By	
				Yes	No	N/A	Title	Signatures
10	Life Saving Equipment	B	Visual check - All lifebuoys are in good conditions and ready for use.	✓			Marine	
11	First Aid kit	C	Visual check - The First Aid are in good conditions and ready for use.	✓			Marine	
12	Safety System. (Jetty Area)	B	Visual check - The Windsock are in good conditions.	✓			Marine	
		C	Functional test - The Emergency Eye Wash & Emergency Shower are working properly.	✓			Marine	
13	VHF Marine Radio Equipment	A	Functional test - TX/RX tested.	✓			Marine	
14	UHF Plant Radio System	A	Functional test - TX/RX tested. (from the Jetty to CCR)	✓			Marine	
15	PABX	C	Functional test - TX/RX tested. (from the Jetty to CCR)	✓			Marine	
16	Unloading Arms	B	Visual check - The Unloading Arms's Position Monitoring System is working properly.	✓			MT & Marine	
		A	Functional test - The Remote Controls are working properly.	✓			MT & Marine	[redacted]
		A	Functional test - The Local Control Panel is working properly.	✓			MT & Marine	
		A	Functional test - The Unloading Arms are moving properly.	✓			MT & Marine	
		A	Functional test - The QCDC (ERC are working properly.)	✓			MT & Marine	
		A	QCDC Seal Dimension measurement inspection & record A: 1 B: 1 E: NEW C: NEW D: 1	✓			MT & Marine	
17	Gangway Tower	B	Visual check - The Gangway Tower has no significant damage.	✓			MT & Marine	
		A	Functional test - The Gangway is moving properly.	✓			MT & Marine	
18	Ship Shore Link System	A	Functional test - The Fiber Optic System loop-back testing satisfactory.	✓			MT & Marine	
		A	Functional test - The Electric System loop-back testing satisfactory.	✓			MT & Marine	
		A	Functional test - The Pneumatic System loop-back testing satisfactory. (In case of required via LNG Carrier)	✓			MT & Marine	
19	Oil Boom	B	Visual check - No damage on boom, counter weight and quick connector	✓			Marine	
20	Oil Separation Pit	A	Visual check - No oil film in oil separation pit	✓			Marine	
21	Golf Cart	C	Visual check - Golf cart tires are in good condition.	✓			Marine	
		C	Visual check - Sensor canera lense are clear & not dirty.	✓			Marine	
		C	Functional test - Battery level are full capacity	✓			Marine	
		C	Functional test - Steering wheel and break system are in good condition.	✓			Marine	
22	Fire Fighting System (Jetty Area)	B	Visual check - The International Ship Shore Connections are in good condition and ready to use	✓			MT & Sh./Sup.	
		B	Functional test - The Fire Monitors are moving properly. (remote control & local control panel)	✓			MT & Sh./Sup.	
		A	Functional test - The Fire Network (including Electric Fire Pump and Disel Fire Pump) is working properly.	✓			MT & Sh./Sup.	[redacted]
23	Fire and Gas Detactor. (Jetty Area)	A	Visual check - The Fire & Gas Detectors of Unloading Arm & JCR are working properly (2 Fail of 3)	✓			MT & Sh./Sup.	
		B	Visual check - The Fire & Gas Detectors of Unloading Arm & JCR are working properly (1Fail of 3)	✓			MT & Sh./Sup.	
24	CCTV	B	Visual check - CCTV are working properly.	✓			MT & Sh./Sup.	
		C	Visual check - CCTV are working properly.	✓			MT & Sh./Sup.	
25	Shut Down Valve (SDV)	A	Working properly test - SDV.	✓			MT & Sh./Sup.	

PTTLNG COMPANY LIMITED
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No.	Equipment / System	Level	Criteria / Conditions	Status			Checked by	
				Yes	No	N/A	Title	Signatures
26	Shore's Tank Readiness	A	Working properly test - Shore's Tank Level .	✓			MT & Sh./Sup.	[redacted]
		B	Working properly test - Shore's Tank Pressure.	✓			MT & Sh./Sup.	
27	Jetty Control Room	B	Visual check - Pressurized System is working properly.	✓			MT & Sh./Sup.	
		B	Visual check - Air Condition System is working properly.	✓			MT & Sh./Sup.	
28	Jetty Utilization	A	Working properly test - Jetty Nitrogen's Pressure.	✓			MT & Sh./Sup.	
		A	Working properly test - Jetty Instrument Air	✓			MT & Sh./Sup.	
		A	Working properly test - Jetty Knock Out Drum and vapour return system.	✓			MT & Sh./Sup.	
29	Sampling System	B	Visual check - Vapourizer unit A ,confirm by operable related transmitters.	✓			Labratory	[redacted]
		B	Visual check - Vapourizer unit B ,confirm by operable related transmitters.	✓			Labratory	
		B	Visual check - Level Transmitter of Gas holder	✓			Labratory	
		B	Functional test - Online GC is working properly.	✓			Labratory	

Level A: Rectify/Correct before ship arrival **Level B:** Completed before next ship arrival **Level C:** Completed as soon as possible

Conclusion and remark (if any)

[redacted]
Acknowledge By
Berth Master

[redacted]
Acknowledge By
Maintenance Division Manager

[redacted]
Acknowledge By
Operation Division Manager

PTTLNG COMPANY LIMITED
3rd Floor, Energy Complex Building A 555/1
Vibhavadi Rangsit Rd., Chatuchak,
Bangkok 10900 Thailand

PRE ARRIVAL CHECKLIST FOR MARINE AND UNLOADING OPERATIONS

Ship's Name : [redacted]
Cargo No. : 23-226-A
Arrival Date : *23 February 2024 / 07.00 LT*

☑ Berth No.1 ☐ Berth No.2

Number of the Ship : *EGT008-T2-2024*
Berth / Alongside : *Berth No.1 - STBD A/S*
Departure Date : *24 February 2024 / 13.00 LT*

Pre Arrival Check for Marine and Unloading Operations shall be carried out prior to the LNG Vessel arrival pilot boarding area.

No.	Equipment / System	Level	Criteria / Conditions	Status			Checked By	
				Yes	No	N/A	Title	Signatures
1	Detail of the LNG Vessel	B	Upload the name of the ship / ship dimension / number of cargo tank into the CIOMS system.	✓			Marine	
2	Mooring Pattern	B	Upload the Mooring Pattern into the CIOMS system.	✓			Marine	
3	Quick Release Hook (QRH)	A	Visual check - The QRH have no significant damage.	✓			Marine	
		A	Functional test - The QRH are working properly.	✓			Marine	
		A	Functional test - The capstans are working properly.	✓			Marine	
		A	Functional test - The emergency switch buttons are working properly.	✓			Marine	
		A	Functional test - The remote release QRH from CCR (At least once a year - tentatively in June)	✓			Marine	
4	Docking Aids System (DAS)	C	Visual check - The cover glass of the laser sensors are clear & not dirty.	✓			Marine	
		B	Functional test - The DAS is working properly.	✓			Marine	
		C	Functional test - The Large Display Board has been adjusted to the appropriate position.	✓			Marine	
5	Environment Monitoring System (EMS)	C	Visual check - The Wave & Tide Sensor has no significant damage.	✓			Marine	
		B	Visual check - The Anemometer is working properly.	✓			Marine	[redacted]
		C	Visual check - The Current Sensor is working properly.	✓			Marine	
		C	Visual check - The Wave & Tide Sensor is working properly.	✓			Marine	
		C	Visual check - The Thermometer is working properly.	✓			Marine	
		C	Visual check - The Hygrometer is working properly.	✓			Marine	
		C	Visual check - The Barometer is working properly.	✓			Marine	
6	Carry on Board computer (Labtop)	B	Visual check - The Carry on Board computer has no significant damage.	✓			Marine	
		B	Functional test - The Carry on Board computer has receiving a signal continuously.	✓			Marine	
7	Fender	B	Visual check - No significant damage & all chains connected to the appropriate position.	✓			Marine	
8	Navigation Lights	B	Visual check - The lanterns are flashing properly.	✓			Marine	
9	Navigation Buoys	B	Visual check - The Buoys are locating at the appropriate positions.	✓			Marine	
		B	Visual check - A lighting of the Buoys are flashing properly.	✓			Marine	

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12	Safety System. (Jetty Area)	B	Visual check - The Windsock are in good conditions.	✓			Marine	
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		A	Functional test - The Local Control Panel is working properly.	✓			MT & Marine	
		A	Functional test - The Unloading Arms are moving properly.	✓			MT & Marine	
		A	Functional test - The QCDC (ERC are working properly.)	✓			MT & Marine	
		A	QCDC Seal Dimension measurement inspection & record A: 1 B: 1 E: NEW C: NEW D: 1	✓			MT & Marine	
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18	Ship Shore Link System	A	Functional test - The Fiber Optic System loop-back testing satisfactory.	✓			MT & Marine	
		A	Functional test - The Electric System loop-back testing satisfactory.	✓			MT & Marine	
		A	Functional test - The Pneumatic System loop-back testing satisfactory. (In case of required via LNG Carrier)	✓			MT & Marine	
19	Oil Boom	B	Visual check - No damage on boom, counter weight and quick connector	✓			Marine	
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21	Golf Cart	C	Visual check - Golf cart tires are in good condition.	✓			Marine	
		C	Visual check - Sensor canera lense are clear & not dirty.	✓			Marine	
		C	Functional test - Battery level are full capacity	✓			Marine	
		C	Functional test - Steering wheel and break system are in good condition.	✓			Marine	
22	Fire Fighting System (Jetty Area)	B	Visual check - The International Ship Shore Connections are in good condition and ready to use	✓			MT & Sh./Sup.	
		B	Functional test - The Fire Monitors are moving properly. (remote control & local control panel)	✓			MT & Sh./Sup.	[redacted]
		A	Functional test - The Fire Network (including Electric Fire Pump and Disel Fire Pump) is working properly.	✓			MT & Sh./Sup.	
23	Fire and Gas Detactor. (Jetty Area)	A	Visual check - The Fire & Gas Detectors of Unloading Arm & JCR are working properly (2 Fail of 3)	✓			MT & Sh./Sup.	
		B	Visual check - The Fire & Gas Detectors of Unloading Arm & JCR are working properly (1Fail of 3)	✓			MT & Sh./Sup.	
24	CCTV	B	Visual check - CCTV are working properly.	✓			MT & Sh./Sup.	
		C	Visual check - CCTV are working properly.	✓			MT & Sh./Sup.	
25	Shut Down Valve (SDV)	A	Working properly test - SDV.	✓			MT & Sh./Sup.	

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No.	Equipment / System	Level	Criteria / Conditions	Status			Checked by	
				Yes	No	N/A	Title	Signatures
26	Shore's Tank Readiness	A	Working properly test - Shore's Tank Level .	✓			MT & Sh./Sup.	[redacted]
		B	Working properly test - Shore's Tank Pressure.	✓			MT & Sh./Sup.	
27	Jetty Control Room	B	Visual check - Pressurized System is working properly.	✓			MT & Sh./Sup.	
		B	Visual check - Air Condition System is working properly.	✓			MT & Sh./Sup.	
28	Jetty Utilization	A	Working properly test - Jetty Nitrogen's Pressure.	✓			MT & Sh./Sup.	
		A	Working properly test - Jetty Instrument Air	✓			MT & Sh./Sup.	
		A	Working properly test - Jetty Knock Out Drum and vapour return system.	✓			MT & Sh./Sup.	
29	Sampling System	B	Visual check - Vapourizer unit A ,confirm by operable related transmitters.	✓			Labratory	[redacted]
		B	Visual check - Vapourizer unit B ,confirm by operable related transmitters.	✓			Labratory	
		B	Visual check - Level Transmitter of Gas holder	✓			Labratory	
		B	Functional test - Online GC is working properly.	✓			Labratory	

Level A: Rectify/Correct before ship arrival **Level B:** Completed before next ship arrival **Level C:** Completed as soon as possible

Conclusion and remark (if any)

[redacted]
Acknowledge By
Berth Master

[redacted]
Acknowledge By
Maintenance Division Manager

[redacted]
Acknowledge By
Operation Division Manager

PRE ARRIVAL CHECK

SAMPLING SYSTEM & LAB ANALYZER

Date :	22/2/2024	Time :	8:30 AM	Operation Name :	KLANARONG I.

No.	Details	Status		Remark
		Normal	Ab normal	
LNG Sampling System :				
1	Confirm sampling system ready for coming unloading operation. (10 bars)	✓		
1.1	If communication is done via standby PLC, check the PLC in the location panel.	✓		
	Check system status (Communication, PLC Status, etc.) com5 is master PLC, com6 is standby PLC.	✓		
	* Both master and standby PLC (com6) are O.K. Master PLC (com5) is better.	✓		
1.2	Restart Computer HMI ,Abort HMI.	✓		
1.3	Heater switch on (at the front door of panel).	✓		
1.4	Check back pressure regulator for Helium is 85-87 Psig (OGC).	✓		
1.5	Install sample Cylinder and Open Valve at sampling system and set sample Cylinde in the program.	✓		
1.6	Check vacuum generate using vacuum ejector around 100 m barA / -0.9 barG.	✓		
1.7	Check Vaporizer A,B can be used.	✓		
2	Latest unloading operation, sampling system perform in normal condition.	✓		
3	Sampling system function test as schedule.	✓		
4	No issue about sampling system, if have any issue, confirm status.	✓		
LNG Analysis Part				
1	Confirm Bench Gas chromatograph (GC) ready for coming unloading operation.	✓		
2	Latest unloading operation, Gas chromatograph (GC) perform in normal condition.	✓		
3	Confirm Gas chromatograph (GC) that Prepare for analysis (minimum 2).	✓		GC1 / GC2
4	No issue about Bench Gas chromatograph (GC), if have any issue, confirm status.	✓		
5	Check pressure inside cylinder of carrier gas.	✓		
	5.1 Helium 120 bar	✓		
	5.2 Air Zero 130 bar	✓		
	Min pressure :	✓		
	- If carrier gas pressure lower than 20 Bar (250 Psi), new cylinder have to be prepared.	✓		

REPORTED BY [redacted]

MS. PREEYAPORN SUWANNAKAN

TECHNICIAN (MEASUREMENT)

22/2/2024

APPROVED BY [redacted]

MR. UKRIT CHANSODA

QUALITY MANAGEMENT

22/2/2024

PTTLNG COMPANY LIMITED
3rd Floor, Energy Complex Building A 555/1
Vibhavadi Rangsit Rd., Chatuchak,
Bangkok 10900 Thailand

PRE ARRIVAL CHECKLIST FOR MARINE AND UNLOADING OPERATIONS

Ship's Name : [redacted]
Cargo No. : A017/23-OJ015-JU008-0261
Arrival Date : *22 March 2024 / 07.00 LT*

☑ Berth No.1 ☐ Berth No.2

Number of the Ship : *PTT058-T2-11/2024*
Berth / Alongside : *Berth No.1 - STBD A/S*
Departure Date : *23 March 2024 / 16.00 LT*

Pre Arrival Check for Marine and Unloading Operations shall be carried out prior to the LNG Vessel arrival pilot boarding area.

No.	Equipment / System	Level	Criteria / Conditions	Status			Checked By	
				Yes	No	N/A	Title	Signatures
1	Detail of the LNG Vessel	B	Upload the name of the ship / ship dimension / number of cargo tank into the CIOMS system.	✓			Marine	
2	Mooring Pattern	B	Upload the Mooring Pattern into the CIOMS system.	✓			Marine	
3	Quick Release Hook (QRH)	A	Visual check - The QRH have no significant damage.	✓			Marine	
		A	Functional test - The QRH are working properly.	✓			Marine	
		A	Functional test - The capstans are working properly.	✓			Marine	
		A	Functional test - The emergency switch buttons are working properly.	✓			Marine	
		A	Functional test - The remote release QRH from CCR (At least once a year - tentatively in June)	✓			Marine	
4	Docking Aids System (DAS)	C	Visual check - The cover glass of the laser sensors are clear & not dirty.	✓			Marine	
		B	Functional test - The DAS is working properly.	✓			Marine	
		C	Functional test - The Large Display Board has been adjusted to the appropriate position.	✓			Marine	
5	Environment Monitoring System (EMS)	C	Visual check - The Wave & Tide Sensor has no significant damage.	✓			Marine	
		B	Visual check - The Anemometer is working properly.	✓			Marine	[redacted]
		C	Visual check - The Current Sensor is working properly.	✓			Marine	
		C	Visual check - The Wave & Tide Sensor is working properly.	✓			Marine	
		C	Visual check - The Thermometer is working properly.	✓			Marine	
		C	Visual check - The Hygrometer is working properly.	✓			Marine	
		C	Visual check - The Barometer is working properly.	✓			Marine	
6	Carry on Board computer (Labtop)	B	Visual check - The Carry on Board computer has no significant damage.	✓			Marine	
		B	Functional test - The Carry on Board computer has receiving a signal continuously.	✓			Marine	
7	Fender	B	Visual check - No significant damage & all chains connected to the appropriate position.	✓			Marine	
8	Navigation Lights	B	Visual check - The lanterns are flashing properly.	✓			Marine	
9	Navigation Buoys	B	Visual check - The Buoys are locating at the appropriate positions.	✓			Marine	
		B	Visual check - A lighting of the Buoys are flashing properly.	✓			Marine	

PTTLNG COMPANY LIMITED
3rd Floor, Energy Complex Building A 555/1
Vibhavadi Rangsit Rd., Chatuchak,
Bangkok 10900 Thailand

No.	Equipment / System	Level	Criteria / Conditions	Status			Checked By	
				Yes	No	N/A	Title	Signatures
10	Life Saving Equipment	B	Visual check - All lifebuoys are in good conditions and ready for use.	✓			Marine	
11	First Aid kit	C	Visual check - The First Aid are in good conditions and ready for use.	✓			Marine	
12	Safety System. (Jetty Area)	B	Visual check - The Windsock are in good conditions.	✓			Marine	
		C	Functional test - The Emergency Eye Wash & Emergency Shower are working properly.	✓			Marine	
13	VHF Marine Radio Equipment	A	Functional test - TX/RX tested.	✓			Marine	
14	UHF Plant Radio System	A	Functional test - TX/RX tested. (from the Jetty to CCR)	✓			Marine	
15	PABX	C	Functional test - TX/RX tested. (from the Jetty to CCR)	✓			Marine	
16	Unloading Arms	B	Visual check - The Unloading Arms's Position Monitoring System is working properly.	✓			MT & Marine	
		A	Functional test - The Remote Controls are working properly.	✓			MT & Marine	
		A	Functional test - The Local Control Panel is working properly.	✓			MT & Marine	
		A	Functional test - The Unloading Arms are moving properly.	✓			MT & Marine	[redacted]
		A	Functional test - The QCDC (ERC are working properly.)	✓			MT & Marine	
		A	QCDC Seal Dimension measurement inspection & record A: 1 B: 1 E: NEW C: NEW D: NEW	✓			MT & Marine	
17	Gangway Tower	B	Visual check - The Gangway Tower has no significant damage.	✓			MT & Marine	
		A	Functional test - The Gangway is moving properly.	✓			MT & Marine	
18	Ship Shore Link System	A	Functional test - The Fiber Optic System loop-back testing satisfactory.	✓			MT & Marine	
		A	Functional test - The Electric System loop-back testing satisfactory.	✓			MT & Marine	
		A	Functional test - The Pneumatic System loop-back testing satisfactory. (In case of required via LNG Carrier)	✓			MT & Marine	
19	Oil Boom	B	Visual check - No damage on boom, counter weight and quick connector	✓			Marine	
20	Oil Separation Pit	A	Visual check - No oil film in oil separation pit	✓			Marine	
21	Golf Cart	C	Visual check - Golf cart tires are in good condition.	✓			Marine	
		C	Visual check - Sensor canera lense are clear & not dirty.	✓			Marine	
		C	Functional test - Battery level are full capacity	✓			Marine	
		C	Functional test - Steering wheel and break system are in good condition.	✓			Marine	
22	Fire Fighting System (Jetty Area)	B	Visual check - The International Ship Shore Connections are in good condition and ready to use	✓			MT & Sh./Sup.	
		B	Functional test - The Fire Monitors are moving properly. (remote control & local control panel)	✓			MT & Sh./Sup.	
		A	Functional test - The Fire Network (including Electric Fire Pump and Disel Fire Pump) is working properly.	✓			MT & Sh./Sup.	
23	Fire and Gas Detactor. (Jetty Area)	A	Visual check - The Fire & Gas Detectors of Unloading Arm & JCR are working properly (2 Fail of 3)	✓			MT & Sh./Sup.	[redacted]
		B	Visual check - The Fire & Gas Detectors of Unloading Arm & JCR are working properly (1Fail of 3)	✓			MT & Sh./Sup.	
24	CCTV	B	Visual check - CCTV are working properly.	✓			MT & Sh./Sup.	
		C	Visual check - CCTV are working properly.	✓			MT & Sh./Sup.	
25	Shut Down Valve (SDV)	A	Working properly test - SDV.	✓			MT & Sh./Sup.	

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Vibhavadi Rangsit Rd., Chatuchak,
Bangkok 10900 Thailand

No.	Equipment / System	Level	Criteria / Conditions	Status			Checked by	
				Yes	No	N/A	Title	Signatures
26	Shore's Tank Readiness	A	Working properly test - Shore's Tank Level .	✓			MT & Sh./Sup.	[redacted]
		B	Working properly test - Shore's Tank Pressure.	✓			MT & Sh./Sup.	
27	Jetty Control Room	B	Visual check - Pressurized System is working properly.	✓			MT & Sh./Sup.	
		B	Visual check - Air Condition System is working properly.	✓			MT & Sh./Sup.	
28	Jetty Utilization	A	Working properly test - Jetty Nitrogen's Pressure.	✓			MT & Sh./Sup.	
		A	Working properly test - Jetty Instrument Air	✓			MT & Sh./Sup.	
		A	Working properly test - Jetty Knock Out Drum and vapour return system.	✓			MT & Sh./Sup.	
29	Sampling System	B	Visual check - Vapourizer unit A ,confirm by operable related transmitters.	✓			Labratory	[redacted]
		B	Visual check - Vapourizer unit B ,confirm by operable related transmitters.	✓			Labratory	
		B	Visual check - Level Transmitter of Gas holder	✓			Labratory	
		B	Functional test - Online GC is working properly.	✓			Labratory	

Level A: Rectify/Correct before ship arrival **Level B:** Completed before next ship arrival **Level C:** Completed as soon as possible

Conclusion and remark (if any)

[redacted]
Acknowledge By
Berth Master

[redacted]
Acknowledge By
Maintenance Division Manager

[redacted]
Acknowledge By
Operation Division Manager

PRE ARRIVAL CHECK

SAMPLING SYSTEM & LAB ANALYZER

Date : 19-Mar-2024 | Time : 2:30 PM | Operation Name : KLANARONG I.

No.	Details	Status: Normal	Status: Ab normal	Remark
LNG Sampling System :				
1	Confirm sampling system ready for coming unloading operation. (10 bars)	✓		
1.1	If communication is done via standby PLC, check the PLC in the location panel.	✓		
	Check system status (Communication, PLC Status, etc.) com5 is master PLC, com6 is standby PLC.	✓		
	* Both master and standby PLC (com6) are O.K. Master PLC (com5) is better.	✓		
1.2	Restart Computer HMI ,Abort HMI.	✓		
1.3	Heater switch on (at the front door of panel).	✓		
1.4	Check back pressure regulator for Helium is 85-87 Psig (OGC).	✓		
1.5	Install sample Cylinder and Open Valve at sampling system and set sample Cylinde in the program.	✓		
1.6	Check vacuum generate using vacuum ejector around 100 m barA / -0.9 barG.	✓		
1.7	Check Vaporizer A,B can be used.	✓		
2	Latest unloading operation, sampling system perform in normal condition.	✓		
3	Sampling system function test as schedule.	✓		
4	No issue about sampling system, if have any issue, confirm status.	✓		
LNG Analysis Part				
1	Confirm Bench Gas chromatograph (GC) ready for coming unloading operation.	✓		
2	Latest unloading operation, Gas chromatograph (GC) perform in normal condition.	✓		
3	Confirm Gas chromatograph (GC) that Prepare for analysis (minimum 2).	✓		GC1 / GC2
4	No issue about Bench Gas chromatograph (GC), if have any issue, confirm status.	✓		
5	Check pressure inside cylinder of carrier gas.	✓		
	5.1 Helium 120 bar	✓		
	5.2 Air Zero 130 bar	✓		
	Min pressure :	✓		
	- If carrier gas pressure lower than 20 Bar (250 Psi), new cylinder have to be prepared.	✓		

REPORTED BY [redacted]

MS. PREEYAPORN SUWANNAKAN

TECHNICIAN (MEASUREMENT)

19/03/2024

APPROVED BY [redacted]

MR. UKRIT CHANSODA

QUALITY MANAGEMENT

19/03/2024

PTTLNG COMPANY LIMITED
3rd Floor, Energy Complex Building A 555/1
Vibhavadi Rangsit Rd., Chatuchak,
Bangkok 10900 Thailand

PRE ARRIVAL CHECKLIST FOR MARINE AND UNLOADING OPERATIONS

Ship's Name : [redacted]
Cargo No. : CRLS_BP_LNG_2024_051
Arrival Date : *1 May 2024 / 10.00 LT*

☑ Berth No.1 ☐ Berth No.2

Number of the Ship : *EGT011-T2-18/2024*
Berth / Alongside : *Berth No.1 - STBD A/S*
Departure Date : *2 May 2024 / 19.00 LT*

Pre Arrival Check for Marine and Unloading Operations shall be carried out prior to the LNG Vessel arrival pilot boarding area.

No.	Equipment / System	Level	Criteria / Conditions	Status			Checked By	
				Yes	No	N/A	Title	Signatures
1	Detail of the LNG Vessel	B	Upload the name of the ship / ship dimension / number of cargo tank into the CIOMS system.	✓			Marine	
2	Mooring Pattern	B	Upload the Mooring Pattern into the CIOMS system.	✓			Marine	
3	Quick Release Hook (QRH)	A	Visual check - The QRH have no significant damage.	✓			Marine	
		A	Functional test - The QRH are working properly.	✓			Marine	
		A	Functional test - The capstans are working properly.	✓			Marine	
		A	Functional test - The emergency switch buttons are working properly.	✓			Marine	
		A	Functional test - The remote release QRH from CCR (At least once a year - tentatively in June)	✓			Marine	
4	Docking Aids System (DAS)	C	Visual check - The cover glass of the laser sensors are clear & not dirty.	✓			Marine	
		B	Functional test - The DAS is working properly.	✓			Marine	
		C	Functional test - The Large Display Board has been adjusted to the appropriate position.	✓			Marine	
5	Environment Monitoring System (EMS)	C	Visual check - The Wave & Tide Sensor has no significant damage.	✓			Marine	
		B	Visual check - The Anemometer is working properly.	✓			Marine	[redacted]
		C	Visual check - The Current Sensor is working properly.	✓			Marine	
		C	Visual check - The Wave & Tide Sensor is working properly.	✓			Marine	
		C	Visual check - The Thermometer is working properly.	✓			Marine	
		C	Visual check - The Hygrometer is working properly.	✓			Marine	
		C	Visual check - The Barometer is working properly.	✓			Marine	
6	Carry on Board computer (Labtop)	B	Visual check - The Carry on Board computer has no significant damage.	✓			Marine	
		B	Functional test - The Carry on Board computer has receiving a signal continuously.	✓			Marine	
7	Fender	B	Visual check - No significant damage & all chains connected to the appropriate position.	✓			Marine	
8	Navigation Lights	B	Visual check - The lanterns are flashing properly.	✓			Marine	
9	Navigation Buoys	B	Visual check - The Buoys are locating at the appropriate positions.	✓			Marine	
		B	Visual check - A lighting of the Buoys are flashing properly.	✓			Marine	

PTTLNG COMPANY LIMITED
3rd Floor, Energy Complex Building A 555/1
Vibhavadi Rangsit Rd., Chatuchak,
Bangkok 10900 Thailand

No.	Equipment / System	Level	Criteria / Conditions	Status: Yes	Status: No	Status: N/A	Checked By: Title	Checked By: Signatures
10	Life Saving Equipment	B	Visual check - All lifebuoys are in good conditions and ready for use.	✓			Marine	
11	First Aid kit	C	Visual check - The First Aid are in good conditions and ready for use.	✓			Marine	
12	Safety System. (Jetty Area)	B	Visual check - The Windsock are in good conditions.	✓			Marine	
		C	Functional test - The Emergency Eye Wash & Emergency Shower are working properly.	✓			Marine	
13	VHF Marine Radio Equipment	A	Functional test - TX/RX tested.	✓			Marine	
14	UHF Plant Radio System	A	Functional test - TX/RX tested. (from the Jetty to CCR)	✓			Marine	
15	PABX	C	Functional test - TX/RX tested. (from the Jetty to CCR)	✓			Marine	
16	Unloading Arms	B	Visual check - The Unloading Arms's Position Monitoring System is working properly.	✓			MT & Marine	
		A	Functional test - The Remote Controls are working properly.	✓			MT & Marine	
		A	Functional test - The Local Control Panel is working properly.	✓			MT & Marine	[redacted]
		A	Functional test - The Unloading Arms are moving properly.	✓			MT & Marine	
		A	Functional test - The QCDC (ERC are working properly.)	✓			MT & Marine	
		A	QCDC Seal Dimension measurement inspection & record A: NEW B: NEW E: 1 C: 1 D: NEW	✓			MT & Marine	
17	Gangway Tower	B	Visual check - The Gangway Tower has no significant damage.	✓			MT & Marine	
		A	Functional test - The Gangway is moving properly.	✓			MT & Marine	
18	Ship Shore Link System	A	Functional test - The Fiber Optic System loop-back testing satisfactory.	✓			MT & Marine	
		A	Functional test - The Electric System loop-back testing satisfactory.	✓			MT & Marine	
		A	Functional test - The Pneumatic System loop-back testing satisfactory. (In case of required via LNG Carrier)	✓			MT & Marine	
19	Oil Boom	B	Visual check - No damage on boom, counter weight and quick connector	✓			Marine	
20	Oil Separation Pit	A	Visual check - No oil film in oil separation pit	✓			Marine	
21	Golf Cart	C	Visual check - Golf cart tires are in good condition.	✓			Marine	
		C	Visual check - Sensor canera lense are clear & not dirty.	✓			Marine	
		C	Functional test - Battery level are full capacity	✓			Marine	
		C	Functional test - Steering wheel and break system are in good condition.	✓			Marine	
22	Fire Fighting System (Jetty Area)	B	Visual check - The International Ship Shore Connections are in good condition and ready to use	✓			MT & Sh./Sup.	
		B	Functional test - The Fire Monitors are moving properly. (remote control & local control panel)	✓			MT & Sh./Sup.	
		A	Functional test - The Fire Network (including Electric Fire Pump and Disel Fire Pump) is working properly.	✓			MT & Sh./Sup.	
23	Fire and Gas Detactor. (Jetty Area)	A	Visual check - The Fire & Gas Detectors of Unloading Arm & JCR are working properly (2 Fail of 3)	✓			MT & Sh./Sup.	[redacted]
		B	Visual check - The Fire & Gas Detectors of Unloading Arm & JCR are working properly (1Fail of 3)	✓			MT & Sh./Sup.	
24	CCTV	B	Visual check - CCTV are working properly.	✓			MT & Sh./Sup.	
		C	Visual check - CCTV are working properly.	✓			MT & Sh./Sup.	
25	Shut Down Valve (SDV)	A	Working properly test - SDV.	✓			MT & Sh./Sup.	

PTTLNG COMPANY LIMITED
3rd Floor, Energy Complex Building A 555/1
Vibhavadi Rangsit Rd., Chatuchak,
Bangkok 10900 Thailand

No.	Equipment / System	Level	Criteria / Conditions	Status			Checked by	
				Yes	No	N/A	Title	Signatures
26	Shore's Tank Readiness	A	Working properly test - Shore's Tank Level .	✓			MT & Sh./Sup.	[redacted]
		B	Working properly test - Shore's Tank Pressure.	✓			MT & Sh./Sup.	
27	Jetty Control Room	B	Visual check - Pressurized System is working properly.	✓			MT & Sh./Sup.	
		B	Visual check - Air Condition System is working properly.	✓			MT & Sh./Sup.	
28	Jetty Utilization	A	Working properly test - Jetty Nitrogen's Pressure.	✓			MT & Sh./Sup.	
		A	Working properly test - Jetty Instrument Air	✓			MT & Sh./Sup.	
		A	Working properly test - Jetty Knock Out Drum and vapour return system.	✓			MT & Sh./Sup.	
29	Sampling System	B	Visual check - Vapourizer unit A ,confirm by operable related transmitters.	✓			Labratory	[redacted]
		B	Visual check - Vapourizer unit B ,confirm by operable related transmitters.	✓			Labratory	
		B	Visual check - Level Transmitter of Gas holder	✓			Labratory	
		B	Functional test - Online GC is working properly.	✓			Labratory	

Level A: Rectify/Correct before ship arrival **Level B:** Completed before next ship arrival **Level C:** Completed as soon as possible

Conclusion and remark (if any)

[redacted]
Acknowledge By
Berth Master

[redacted]
Acknowledge By
Maintenance Division Manager

[redacted]
Acknowledge By
Operation Division Manager

PRE ARRIVAL CHECK

SAMPLING SYSTEM & LAB ANALYZER

Date : 29-Apr-2024	Time : 4:25 PM	Operation Name :	KLANARONG I.

No.	Details	Status		Remark
		Normal	Ab normal	
LNG Sampling System : (Post Unloading)				
1	Confirm sampling system ready for coming unloading operation. (10 bars)	✓		
1.1	If communication is done via standby PLC, check the PLC in the location panel.	✓		
	Check system status (Communication, PLC Status, etc.) com5 is master PLC, com6 is standby PLC.	✓		
	* Both master and standby PLC (com6) are O.K. Master PLC (com5) is better.	✓		
1.2	Restart Computer HMI ,Abort HMI.	✓		
1.3	Heater switch on (at the front door of panel).	✓		
1.4	Check back pressure regulator for Helium is 85-87 Psig (OGC).	✓		
1.5	Install sample Cylinder and Open Valve at sampling system and set sample Cylinde in the program.	✓		
1.6	Check vacuum generate using vacuum ejector around 100 m barA / -0.9 barG.	✓		
1.7	Check Vaporizer A,B can be used.	✓		
2	Latest unloading operation, sampling system perform in normal condition.	✓		
3	Sampling system function test as schedule.	✓		
4	No issue about sampling system, if have any issue, confirm status.	✓		
LNG Analysis Part				
1	Confirm Bench Gas chromatograph (GC) ready for coming unloading operation.	✓		
2	Latest unloading operation, Gas chromatograph (GC) perform in normal condition.	✓		
3	Confirm Gas chromatograph (GC) that Prepare for analysis (minimum 2).	✓		GC1 / GC2
4	No issue about Bench Gas chromatograph (GC), if have any issue, confirm status.	✓		
5	Check pressure inside cylinder of carrier gas.	✓		
	5.1 Helium 120 bar	✓		
	5.2 Air Zero 130 bar	✓		
	Min pressure :	✓		
	- If carrier gas pressure lower than 20 Bar (250 Psi), new cylinder have to be prepared.	✓		

REPORTED BY [redacted]

MS. PREEYAPORN SUWANNAKAN

TECHNICIAN (MEASUREMENT)

29-Apr-24

APPROVED BY [redacted]

MR. UKRIT CHANSODA

QUALITY MANAGEMENT

29-Apr-24

PE LNG
PE LNG Co., Ltd.
บริษัท พีอี แอลเอ็นจี จำกัด

PTTLNG COMPANY LIMITED
3rd Floor, Energy Complex Building A 555/1
Vibhavadi Rangsit Rd., Chatuchak,
Bangkok 10900 Thailand

No.	Equipment / System	Level	Criteria / Conditions	Status			Checked by	
				Yes	No	N/A	Title	Signatures
26	Shore's Tank Readiness	A	Working properly test - Shore's Tank Level .	✓			MT & Sh./Sup.	
		B	Working properly test - Shore's Tank Pressure.	✓			MT & Sh./Sup.	[redacted]
27	Jetty Control Room	B	Visual check - Pressurized System is working properly.	✓			MT & Sh./Sup.	
		B	Visual check - Air Condition System is working properly.	✓			MT & Sh./Sup.	
28	Jetty Utilization	A	Working properly test - Jetty Nitrogen's Pressure.	✓			MT & Sh./Sup.	
		A	Working properly test - Jetty Instrument Air	✓			MT & Sh./Sup.	
		A	Working properly test - Jetty Knock Out Drum and vapour return system.	✓			MT & Sh./Sup.	
29	Sampling System	B	Visual check - Vapourizer unit A ,confirm by operable related transmitters.	✓			Labratory	[redacted]
		B	Visual check - Vapourizer unit B ,confirm by operable related transmitters.	✓			Labratory	
		B	Visual check - Level Transmitter of Gas holder	✓			Labratory	
		B	Functional test - Online GC is working properly.	✓			Labratory	

Level A: Rectify/Correct before ship arrival **Level B:** Completed before next ship arrival **Level C:** Completed as soon as possible

Conclusion and remark (if any)

[redacted]
Acknowledge By
Berth Master

[redacted]
Acknowledge By
Maintenance Division Manager

[redacted]
Acknowledge By
Operation Division Manager

PRE ARRIVAL CHECK

SAMPLING SYSTEM & LAB ANALYZER

Date : 21-May-2024	Time : 2:00 PM	Operation Name : KLANARONG I.

No.	Details	Status		Remark
		Normal	Ab normal	
LNG Sampling System :				
1	Confirm sampling system ready for coming unloading operation. (10 bars)	✓		
1.1	If communication is done via standby PLC, check the PLC in the location panel.	✓		
	Check system status (Communication, PLC Status, etc.) com5 is master PLC, com6 is standby PLC.	✓		
	* Both master and standby PLC (com6) are O.K. Master PLC (com5) is better.	✓		
1.2	Restart Computer HMI ,Abort HMI.	✓		
1.3	Heater switch on (at the front door of panel).	✓		
1.4	Check back pressure regulator for Helium is 85-87 Psig (OGC).	✓		
1.5	Install sample Cylinder and Open Valve at sampling system and set sample Cylinde in the program.	✓		
1.6	Check vacuum generate using vacuum ejector around 100 m barA / -0.9 barG.	✓		
1.7	Check Vaporizer A,B can be used.	✓		
2	Latest unloading operation, sampling system perform in normal condition.	✓		
3	Sampling system function test as schedule.	✓		
4	No issue about sampling system, if have any issue, confirm status.	✓		
LNG Analysis Part				
1	Confirm Bench Gas chromatograph (GC) ready for coming unloading operation.	✓		
2	Latest unloading operation, Gas chromatograph (GC) perform in normal condition.	✓		
3	Confirm Gas chromatograph (GC) that Prepare for analysis (minimum 2).	✓		<u>GC1</u> / GC2
4	No issue about Bench Gas chromatograph (GC), if have any issue, confirm status.	✓		
5	Check pressure inside cylinder of carrier gas.	✓		
	5.1 Helium 120 bar	✓		
	5.2 Air Zero 130 bar	✓		
	Min pressure :	✓		
	- If carrier gas pressure lower than 20 Bar (250 Psi), new cylinder have to be prepared.	✓		

REPORTED BY [redacted]

MS. PREEYAPORN SUWANNAKAN

TECHNICIAN (MEASUREMENT)

21-May-24

APPROVED BY [redacted]

MR. UKRIT CHANSODA

QUALITY MANAGEMENT

21-May-24

PE LNG Co., Ltd.
บริษัท พีอี แอลเอ็นจี จำกัด

PTTLNG COMPANY LIMITED
3rd Floor, Energy Complex Building A 555/1
Vibhavadi Rangsit Rd., Chatuchak,
Bangkok 10900 Thailand

PRE ARRIVAL CHECKLIST FOR MARINE AND UNLOADING OPERATIONS

Ship's Name : [redacted]
Cargo No. : QG3-PTT31-2024-010
Arrival Date : *13 June 2024 / 06.00 LT*

☑ Berth No.1 ☐ Berth No.2

Number of the Ship : *PTT067-T2-26/2024*
Berth / Alongside : *Berth No.1 - STBD A/S*
Departure Date : *14 June 2024 / 14.00 LT*

Pre Arrival Check for Marine and Unloading Operations shall be carried out prior to the LNG Vessel arrival pilot boarding area.

No.	Equipment / System	Level	Criteria / Conditions	Status			Checked By	
				Yes	No	N/A	Title	Signatures
1	Detail of the LNG Vessel	B	Upload the name of the ship / ship dimension / number of cargo tank into the CIOMS system.	✓			Marine	[redacted]
2	Mooring Pattern	B	Upload the Mooring Pattern into the CIOMS system.	✓			Marine	
3	Quick Release Hook (QRH)	A	Visual check - The QRH have no significant damage.	✓			Marine	
		A	Functional test - The QRH are working properly.	✓			Marine	
		A	Functional test - The capstans are working properly.	✓			Marine	
		A	Functional test - The emergency switch buttons are working properly.	✓			Marine	
		A	Functional test - The remote release QRH from CCR (At least once a year - tentatively in June)	✓			Marine	
4	Docking Aids System (DAS)	C	Visual check - The cover glass of the laser sensors are clear & not dirty.	✓			Marine	
		B	Functional test - The DAS is working properly.	✓			Marine	
		C	Functional test - The Large Display Board has been adjusted to the appropriate position.	✓			Marine	
5	Environment Monitoring System (EMS)	C	Visual check - The Wave & Tide Sensor has no significant damage.	✓			Marine	
		B	Visual check - The Anemometer is working properly.	✓			Marine	
		C	Visual check - The Current Sensor is working properly.	✓			Marine	
		C	Visual check - The Wave & Tide Sensor is working properly.	✓			Marine	
		C	Visual check - The Thermometer is working properly.	✓			Marine	
		C	Visual check - The Hygrometer is working properly.	✓			Marine	
		C	Visual check - The Barometer is working properly.	✓			Marine	
6	Carry on Board computer (Labtop)	B	Visual check - The Carry on Board computer has no significant damage.	✓			Marine	
		B	Functional test - The Carry on Board computer has receiving a signal continuously.	✓			Marine	
7	Fender	B	Visual check - No significant damage & all chains connected to the appropriate position.	✓			Marine	
8	Navigation Lights	B	Visual check - The lanterns are flashing properly.	✓			Marine	
9	Navigation Buoys	B	Visual check - The Buoys are locating at the appropriate positions.	✓			Marine	
		B	Visual check - A lighting of the Buoys are flashing properly.	✓			Marine	

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Bangkok 10900 Thailand

No.	Equipment / System	Level	Criteria / Conditions	Status Yes	Status No	Status N/A	Checked By Title	Checked By Signatures
10	Life Saving Equipment	B	Visual check - All lifebuoys are in good conditions and ready for use.	✓			Marine	
11	First Aid kit	C	Visual check - The First Aid are in good conditions and ready for use.	✓			Marine	
12	Safety System. (Jetty Area)	B	Visual check - The Windsock are in good conditions.	✓			Marine	
		C	Functional test - The Emergency Eye Wash & Emergency Shower are working properly.	✓			Marine	
13	VHF Marine Radio Equipment	A	Functional test - TX/RX tested.	✓			Marine	
14	UHF Plant Radio System	A	Functional test - TX/RX tested. (from the Jetty to CCR)	✓			Marine	
15	PABX	C	Functional test - TX/RX tested. (from the Jetty to CCR)	✓			Marine	
16	Unloading Arms	B	Visual check - The Unloading Arms's Position Monitoring System is working properly.	✓			MT & Marine	
		A	Functional test - The Remote Controls are working properly.	✓			MT & Marine	
		A	Functional test - The Local Control Panel is working properly.	✓			MT & Marine	[redacted]
		A	Functional test - The Unloading Arms are moving properly.	✓			MT & Marine	
		A	Functional test - The QCDC (ERC are working properly.)	✓			MT & Marine	
		A	QCDC Seal Dimension measurement inspection & record A: NEW B: 1 E: 1 C: 1 D: NEW	✓			MT & Marine	
17	Gangway Tower	B	Visual check - The Gangway Tower has no significant damage.	✓			MT & Marine	
		A	Functional test - The Gangway is moving properly.	✓			MT & Marine	
18	Ship Shore Link System	A	Functional test - The Fiber Optic System loop-back testing satisfactory.	✓			MT & Marine	
		A	Functional test - The Electric System loop-back testing satisfactory.	✓			MT & Marine	
		A	Functional test - The Pneumatic System loop-back testing satisfactory. (In case of required via LNG Carrier)	✓			MT & Marine	
19	Oil Boom	B	Visual check - No damage on boom, counter weight and quick connector	✓			Marine	
20	Oil Separation Pit	A	Visual check - No oil film in oil separation pit	✓			Marine	
21	Golf Cart	C	Visual check - Golf cart tires are in good condition.	✓			Marine	
		C	Visual check - Sensor canera lense are clear & not dirty.	✓			Marine	
		C	Functional test - Battery level are full capacity	✓			Marine	
		C	Functional test - Steering wheel and break system are in good condition.	✓			Marine	
22	Fire Fighting System (Jetty Area)	B	Visual check - The International Ship Shore Connections are in good condition and ready to use	✓			MT & Sh./Sup.	
		B	Functional test - The Fire Monitors are moving properly. (remote control & local control panel)	✓			MT & Sh./Sup.	
		A	Functional test - The Fire Network (including Electric Fire Pump and Disel Fire Pump) is working properly.	✓			MT & Sh./Sup.	
23	Fire and Gas Detactor. (Jetty Area)	A	Visual check - The Fire & Gas Detectors of Unloading Arm & JCR are working properly (2 Fail of 3)	✓			MT & Sh./Sup.	[redacted]
		B	Visual check - The Fire & Gas Detectors of Unloading Arm & JCR are working properly (1Fail of 3)	✓			MT & Sh./Sup.	
24	CCTV	B	Visual check - CCTV are working properly.	✓			MT & Sh./Sup.	
		C	Visual check - CCTV are working properly.	✓			MT & Sh./Sup.	
25	Shut Down Valve (SDV)	A	Working properly test - SDV.	✓			MT & Sh./Sup.	

PE LNG Co., Ltd.
บริษัท พีอี แอลเอ็นจี จำกัด

PTTLNG COMPANY LIMITED
3rd Floor, Energy Complex Building A 555/1
Vibhavadi Rangsit Rd., Chatuchak,
Bangkok 10900 Thailand

No.	Equipment / System	Level	Criteria / Conditions	Status			Checked by	
				Yes	No	N/A	Title	Signatures
26	Shore's Tank Readiness	A	Working properly test - Shore's Tank Level .	✓			MT & Sh./Sup.	[redacted]
		B	Working properly test - Shore's Tank Pressure.	✓			MT & Sh./Sup.	
27	Jetty Control Room	B	Visual check - Pressurized System is working properly.	✓			MT & Sh./Sup.	
		B	Visual check - Air Condition System is working properly.	✓			MT & Sh./Sup.	
28	Jetty Utilization	A	Working properly test - Jetty Nitrogen's Pressure.	✓			MT & Sh./Sup.	
		A	Working properly test - Jetty Instrument Air	✓			MT & Sh./Sup.	
		A	Working properly test - Jetty Knock Out Drum and vapour return system.	✓			MT & Sh./Sup.	
29	Sampling System	B	Visual check - Vapourizer unit A ,confirm by operable related transmitters.	✓			Labratory	[redacted]
		B	Visual check - Vapourizer unit B ,confirm by operable related transmitters.	✓			Labratory	
		B	Visual check - Level Transmitter of Gas holder	✓			Labratory	
		B	Functional test - Online GC is working properly.	✓			Labratory	

Level A: Rectify/Correct before ship arrival **Level B:** Completed before next ship arrival **Level C:** Completed as soon as possible

Conclusion and remark (if any)

- BD4 shall be used only hook A and B due to hook “C” load cell error (to be rectify by instrument team)

[redacted]
Acknowledge By
Berth Master

[redacted]
Acknowledge By
Maintenance Division Manager

[redacted]
Acknowledge By
Operation Division Manager

PRE ARRIVAL CHECK (POST TO PRE.)

SAMPLING SYSTEM & LAB ANALYZER

Date : 10-Jun-2024	Time : 10:30 PM	Operation Name :	KLANARONG I.

No.	Details	Status		Remark
		Normal	Ab normal	
LNG Sampling System :				
1	Confirm sampling system ready for coming unloading operation. (10 bars)	✓		
1.1	If communication is done via standby PLC, check the PLC in the location panel.	✓		
	Check system status (Communication, PLC Status, etc.) com5 is master PLC, com6 is standby PLC.	✓		
	* Both master and standby PLC (com6) are O.K. Master PLC (com5) is better.	✓		
1.2	Restart Computer HMI ,Abort HMI.	✓		
1.3	Heater switch on (at the front door of panel).	✓		
1.4	Check back pressure regulator for Helium is 85-87 Psig (OGC).	✓		
1.5	Install sample Cylinder and Open Valve at sampling system and set sample Cylinde in the program.	✓		
1.6	Check vacuum generate using vacuum ejector around 100 m barA / -0.9 barG.	✓		
1.7	Check Vaporizer A,B can be used.	✓		
2	Latest unloading operation, sampling system perform in normal condition.	✓		
3	Sampling system function test as schedule.	✓		
4	No issue about sampling system, if have any issue, confirm status.	✓		
LNG Analysis Part				
1	Confirm Bench Gas chromatograph (GC) ready for coming unloading operation.	✓		
2	Latest unloading operation, Gas chromatograph (GC) perform in normal condition.	✓		
3	Confirm Gas chromatograph (GC) that Prepare for analysis (minimum 2).	✓		<u>GC1</u> / GC2
4	No issue about Bench Gas chromatograph (GC), if have any issue, confirm status.	✓		
5	Check pressure inside cylinder of carrier gas.	✓		
	5.1 Helium 120 bar	✓		
	5.2 Air Zero 130 bar	✓		
	Min pressure :	✓		
	- If carrier gas pressure lower than 20 Bar (250 Psi), new cylinder have to be prepared.	✓		

REPORTED BY [redacted]

MS. PREEYAPORN SUWANNAKAN

TECHNICIAN (MEASUREMENT)

10-Jun-24

APPROVED BY [redacted]

MR. UKRIT CHANSODA

QUALITY MANAGEMENT

10-Jun-24

เอกสารแนบ 33

แผนการตรวจสอบและบำรุงรักษาอุปกรณ์บริเวณท่าเทียบเรือ

[redacted]

[redacted]

(@DocFlow)

[redacted]

[redacted]

ptt LNG	บริษัท พีทีที แอลเอ็นจี จำกัด (LMPT2)	ระเบียบปฏิบัติ (Procedure)	
ชื่อเอกสาร: (Doc. Title)	การซ่อมและบำรุงรักษา (Maintenance Work Procedure)	รหัสเอกสาร: (Doc. Code)	P-MT-0001

[redacted]

ptt LNG	บริษัท พีทีที แอลเอ็นจี จำกัด (LMPT2)	ระเบียบปฏิบัติ (Procedure)	
ชื่อเอกสาร: (Doc. Title)	การซ่อมและบำรุงรักษา (Maintenance Work Procedure)	รหัสเอกสาร: (Doc. Code)	P-MT-0001

[redacted]

ptt LNG	บริษัท พีทีที แอลเอ็นจี จำกัด (LMPT2)	ระเบียบปฏิบัติ (Procedure)	
ชื่อเอกสาร: (Doc. Title)	การซ่อมและบำรุงรักษา (Maintenance Work Procedure)	รหัสเอกสาร: (Doc. Code)	P-MT-0001

[redacted]

ptt LNG	บริษัท พีทีที แอลเอ็นจี จำกัด (LMPT2)	ระเบียบปฏิบัติ (Procedure)	
ชื่อเอกสาร: (Doc. Title)	การซ่อมและบำรุงรักษา (Maintenance Work Procedure)	รหัสเอกสาร: (Doc. Code)	P-MT-0001

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

บริษัท พีทีที แอลเอ็นจี จำกัด (LMPT2)

ระเบียบปฏิบัติ (Procedure)

ชื่อเอกสาร: (Doc. Title) การซ่อมและบำรุงรักษา (Maintenance Work Procedure)

รหัสเอกสาร: (Doc. Code) P-MT-0001

[redacted]

บริษัท พีทีที แอลเอ็นจี จำกัด (LMPT2)

ระเบียบปฏิบัติ (Procedure)

ชื่อเอกสาร: (Doc. Title) การซ่อมและบำรุงรักษา (Maintenance Work Procedure)

รหัสเอกสาร: (Doc. Code) P-MT-0001

[redacted]

บริษัท พีทีที แอลเอ็นจี จำกัด (LMPT2)

ระเบียบปฏิบัติ (Procedure)

ชื่อเอกสาร: (Doc. Title) การซ่อมและบำรุงรักษา (Maintenance Work Procedure)

รหัสเอกสาร: (Doc. Code) P-MT-0001

[redacted]

[redacted]

บริษัท พีทีที แอลเอ็นจี จำกัด (LMPT2) | ระเบียบปฏิบัติ (Procedure)
ชื่อเอกสาร: (Doc. Title) การซ่อมและบำรุงรักษา (Maintenance Work Procedure) | รหัสเอกสาร: (Doc. Code) P-MT-0001

[redacted]

บริษัท พีทีที แอลเอ็นจี จำกัด (LMPT2) | ระเบียบปฏิบัติ (Procedure)
ชื่อเอกสาร: (Doc. Title) การซ่อมและบำรุงรักษา (Maintenance Work Procedure) | รหัสเอกสาร: (Doc. Code) P-MT-0001

[redacted]

บริษัท พีทีที แอลเอ็นจี จำกัด (LMPT2) | ระเบียบปฏิบัติ (Procedure)
ชื่อเอกสาร: (Doc. Title) การซ่อมและบำรุงรักษา (Maintenance Work Procedure) | รหัสเอกสาร: (Doc. Code) P-MT-0001

[redacted]

[redacted]

	บริษัท พีทีที แอลเอ็นจี จำกัด (LMPT2)	ระเบียบปฏิบัติ (Procedure)
ชื่อเอกสาร: (Doc. Title)	การซ่อมและบำรุงรักษา (Maintenance Work Procedure)	รหัสเอกสาร: (Doc. Code) P-MT-0001

[redacted]

	บริษัท พีทีที แอลเอ็นจี จำกัด (LMPT2)	ระเบียบปฏิบัติ (Procedure)
ชื่อเอกสาร: (Doc. Title)	การซ่อมและบำรุงรักษา (Maintenance Work Procedure)	รหัสเอกสาร: (Doc. Code) P-MT-0001

[redacted]

เอกสารแนบ 34

สำเนาบันทึกสถิติการเกิดอุบัติเหตุหรือรายงานการเกิดอุบัติเหตุของโครงการ

สถิติความปลอดภัย
บริษัท พีทีที แอลเอ็นจี จำกัด

ประจำเดือน มกราคม 2567

LMPT2

สถิติความปลอดภัยในการทำงาน LMPT2

จำนวนชั่วโมงที่ไม่เกิดอุบัติเหตุถึงขั้นหยุดงาน
Man-hours Without Lost Time Injury(LTI)

291,033 (ชั่วโมง)

จำนวนวันที่ไม่เกิดอุบัติเหตุถึงขั้นหยุดงาน
Days Without Lost Time Injury(LTI)

323 Days

ณ วันที่ 31 มกราคม 2567

สถิติความปลอดภัยในการทำงาน LMPT2

สถิติความปลอดภัย	ผู้รับเหมา	พนักงาน PTTLNG	จำนวนรวม
จำนวนชั่วโมงการทำงานที่ปลอดภัยที่เคยบันทึกได้ (ชั่วโมง)**	47,116	60,386	107,502
จำนวนชั่วโมงการทำงานที่ปลอดภัยเดือนล่าสุด(ชั่วโมง)***	20,928	8,144	29,072
จำนวนชั่วโมงการทำงานที่ปลอดภัยสะสม (ชั่วโมง)****	205,564	85,469	291,033
จำนวนอุบัติเหตุถึงขั้นหยุดงาน (Case)*****	2	0	0

หมายเหตุ
** จำนวนชั่วโมงการทำงานที่ปลอดภัยที่เคยบันทึกได้ ตั้งแต่วันที่ 21 กรกฎาคม 2565 -14 มีนาคม 2566
*** จำนวนชั่วโมงการทำงานที่ปลอดภัยเดือนล่าสุด ตั้งแต่ 1-31 มกราคม 2567
**** จำนวนชั่วโมงการทำงานที่ปลอดภัยสะสมปัจจุบันตั้งแต่ 15 มีนาคม 2566 – 31 มกราคม 2567
***** จำนวนอุบัติเหตุถึงขั้นหยุดงาน ตั้งแต่วันที่ 14 มีนาคม 2566 - 31 มกราคม 2567

ณ วันที่ 31 มกราคม 2567

สถิติความปลอดภัย บริษัท พีทีที แอลเอ็นจี จำกัด

ประจำเดือน กุมภาพันธ์ 2567

L M P T 2

สถิติความปลอดภัยในการทำงาน LMPT2

จำนวนชั่วโมงที่ไม่เกิดอุบัติเหตุถึงขั้นหยุดงาน
Man-hours Without Lost Time Injury(LTI)

314,982 (ชั่วโมง)

จำนวนวันที่ไม่เกิดอุบัติเหตุถึงขั้นหยุดงาน
Days Without Lost Time Injury(LTI)

3 5 2 Days

ณ วันที่ 29 กุมภาพันธ์ 2567

สถิติความปลอดภัยในการทำงาน LMPT2

สถิติความปลอดภัย	ผู้รับเหมา	พนักงาน PTTLNG	จำนวนรวม
จำนวนชั่วโมงการทำงานที่ปลอดภัยที่เคยบันทึกได้ (ชั่วโมง)**	47,116	60,386	107,502
จำนวนชั่วโมงการทำงานที่ปลอดภัยเดือนล่าสุด(ชั่วโมง)***	16,096	7,853	23,949
จำนวนชั่วโมงการทำงานที่ปลอดภัยสะสม (ชั่วโมง)****	221,660	93,322	314,982
จำนวนอุบัติเหตุถึงขั้นหยุดงาน (Case)*****	2	0	0

หมายเหตุ
** จำนวนชั่วโมงการทำงานที่ปลอดภัยที่เคยบันทึกได้ ตั้งแต่วันที่ 21 กรกฎาคม 2565 -14 มีนาคม 2566
*** จำนวนชั่วโมงการทำงานที่ปลอดภัยเดือนล่าสุด ตั้งแต่ 1-29 กุมภาพันธ์ 2567
**** จำนวนชั่วโมงการทำงานที่ปลอดภัยสะสมปัจจุบันตั้งแต่ 15 มีนาคม 2566 – 29 กุมภาพันธ์ 2567
***** จำนวนอุบัติเหตุถึงขั้นหยุดงาน ตั้งแต่วันที่ 14 มีนาคม 2566 - 29 กุมภาพันธ์ 2567

ณ วันที่ 29 กุมภาพันธ์ 2567

สถิติความปลอดภัย บริษัท พีทีที แอลเอ็นจี จำกัด

ประจำเดือน มีนาคม 2567

LMPT2

สถิติความปลอดภัยในการทำงาน LMPT2

จำนวนชั่วโมงที่ไม่เกิดอุบัติเหตุถึงขั้นหยุดงาน

Man-hours Without Lost Time Injury(LTI)

337,751 (ชั่วโมง)

PTTLNG's Staff

102,075 Man-hours

Contractor

235,676 Man-hours

อุบัติเหตุถึงขั้นหยุดงานล่าสุดเมื่อ วันที่ 14 มีนาคม 2566

จำนวนวันที่ไม่เกิดอุบัติเหตุถึงขั้นหยุดงาน

Days Without Lost Time Injury(LTI)

383 Days

ณ วันที่ 31 มีนาคม 2567

สถิติความปลอดภัยในการทำงาน LMPT2

สถิติความปลอดภัย	ผู้รับเหมา	พนักงาน PTTLNG	จำนวนรวม
จำนวนชั่วโมงการทำงานที่ปลอดภัย ที่เคยบันทึกได้ (ชั่วโมง)**	47,116	60,386	107,502
จำนวนชั่วโมงการทำงานที่ปลอดภัย เดือนล่าสุด(ชั่วโมง)***	14,016	8,753	22,769
จำนวนชั่วโมงการทำงานที่ปลอดภัยสะสม (ชั่วโมง)****	235,676	102,075	337,751
จำนวนอุบัติเหตุถึงขั้นหยุดงาน (Case)*****	2	0	0

หมายเหตุ

** จำนวนชั่วโมงการทำงานที่ปลอดภัยที่เคยบันทึกได้ ตั้งแต่วันที่ 21 กรกฎาคม 2565 -14 มีนาคม 2566

*** จำนวนชั่วโมงการทำงานที่ปลอดภัยเดือนล่าสุด ตั้งแต่ 1-31 มีนาคม 2567

**** จำนวนชั่วโมงการทำงานที่ปลอดภัยสะสมปัจจุบันตั้งแต่ 15 มีนาคม 2566 – 31 มีนาคม 2567

***** จำนวนอุบัติเหตุถึงขั้นหยุดงาน ตั้งแต่วันที่ 14 มีนาคม 2566 - 31 มีนาคม 2567

ณ วันที่ 31 มีนาคม 2567

สถิติความปลอดภัย
บริษัท พีทีที แอลเอ็นจี จำกัด

ประจำเดือน เมษายน 2567

LMPT2

สถิติความปลอดภัยในการทำงาน LMPT2

จำนวนชั่วโมงที่ไม่เกิดอุบัติเหตุถึงขั้นหยุดงาน
Man-hours Without Lost Time Injury(LTI)

357,502 (ชั่วโมง)

จำนวนวันที่ไม่เกิดอุบัติเหตุถึงขั้นหยุดงาน
Days Without Lost Time Injury(LTI)

413 Days

ณ วันที่ 30 เมษายน 2567

สถิติความปลอดภัยในการทำงาน LMPT2

สถิติความปลอดภัย	ผู้รับเหมา	พนักงาน PTTLNG	จำนวนรวม
จำนวนชั่วโมงการทำงานที่ปลอดภัยที่เคยบันทึกได้ (ชั่วโมง)**	47,116	60,386	107,502
จำนวนชั่วโมงการทำงานที่ปลอดภัยเดือนล่าสุด(ชั่วโมง)***	12,765	6,986	19,751
จำนวนชั่วโมงการทำงานที่ปลอดภัยสะสม (ชั่วโมง)****	248,441	109,061	357,502
จำนวนอุบัติเหตุถึงขั้นหยุดงาน (Case)*****	2	0	0

หมายเหตุ
** จำนวนชั่วโมงการทำงานที่ปลอดภัยที่เคยบันทึกได้ ตั้งแต่วันที่ 21 กรกฎาคม 2565 -14 มีนาคม 2566
*** จำนวนชั่วโมงการทำงานที่ปลอดภัยเดือนล่าสุด ตั้งแต่ 1- 30 เมษายน 2567
**** จำนวนชั่วโมงการทำงานที่ปลอดภัยสะสมปัจจุบันตั้งแต่ 15 มีนาคม 2566 – 30 เมษายน 2567
***** จำนวนอุบัติเหตุถึงชั้นหยุดงาน ตั้งแต่วันที่ 14 มีนาคม 2566 - 30 เมษายน 2567

ณ วันที่ 30 เมษายน 2567

สถิติความปลอดภัย
บริษัท พีอี แอลเอ็นจี จำกัด

PE LNG
PE LNG Co., Ltd.
บริษัท พีอี แอลเอ็นจี จำกัด

ประจำเดือน พฤษภาคม 2567

PE LNG

LMPT2

สถิติความปลอดภัยในการทำงาน LMPT2

จำนวนชั่วโมงที่ไม่เกิดอุบัติเหตุถึงขั้นหยุดงาน
Man-hours Without Lost Time Injury(LTI)

378,422 (ชั่วโมง)

จำนวนวันที่ไม่เกิดอุบัติเหตุถึงขั้นหยุดงาน
Days Without Lost Time Injury(LTI)

444 Days

ณ วันที่ 31 พฤษภาคม 2567

สถิติความปลอดภัยในการทำงาน LMPT2

สถิติความปลอดภัย	ผู้รับเหมา	พนักงาน PTTLNG	จำนวนรวม
จำนวนชั่วโมงการทำงานที่ปลอดภัยที่เคยบันทึกได้ (ชั่วโมง)**	47,116	60,386	107,502
จำนวนชั่วโมงการทำงานที่ปลอดภัยเดือนล่าสุด(ชั่วโมง)***	12,944	7,977	20,921
จำนวนชั่วโมงการทำงานที่ปลอดภัยสะสม (ชั่วโมง)****	261,384	117,038	378,422
จำนวนอุบัติเหตุถึงขั้นหยุดงาน (Case)*****	2	0	0

หมายเหตุ
** จำนวนชั่วโมงการทำงานที่ปลอดภัยที่เคยบันทึกได้ ตั้งแต่วันที่ 21 กรกฎาคม 2565 -14 มีนาคม 2566
*** จำนวนชั่วโมงการทำงานที่ปลอดภัยเดือนล่าสุด ตั้งแต่ 1- 31 พฤษภาคม 2567
**** จำนวนชั่วโมงการทำงานที่ปลอดภัยสะสมปัจจุบันตั้งแต่ 15 มีนาคม 2566 – 31 พฤษภาคม 2567
***** จำนวนอุบัติเหตุถึงขั้นหยุดงาน ตั้งแต่วันที่ 14 มีนาคม 2566 - 31 พฤษภาคม 2567

ณ วันที่ 31 พฤษภาคม 2567

สถิติความปลอดภัย
บริษัท พีอี แอลเอ็นจี จำกัด

PE LNG
PE LNG Co., Ltd.
บริษัท พีอี แอลเอ็นจี จำกัด

ประจำเดือน มิถุนายน 2567

PE LNG

L M P T 2

สถิติความปลอดภัยในการทำงาน LMPT2

จำนวนชั่วโมงที่ไม่เกิดอุบัติเหตุถึงขั้นหยุดงาน
Man-hours Without Lost Time Injury(LTI)

402,278 (ชั่วโมง)

PE LNG's Staff
124,656 Man-hours

Contractor
277,622 Man-hours

อุบัติเหตุถึงขั้นหยุดงานล่าสุดเมื่อ
วันที่ 14 มีนาคม 2566

จำนวนวันที่ไม่เกิดอุบัติเหตุถึงขั้นหยุดงาน
Days Without Lost Time Injury(LTI)

474
Days

ณ วันที่ 30 มิถุนายน 2567

สถิติความปลอดภัยในการทำงาน LMPT2

สถิติความปลอดภัย	ผู้รับเหมา	พนักงาน PTTLNG	จำนวนรวม
จำนวนชั่วโมงการทำงานที่ปลอดภัยที่เคยบันทึกได้ (ชั่วโมง)**	47,116	60,386	107,502
จำนวนชั่วโมงการทำงานที่ปลอดภัยเดือนล่าสุด(ชั่วโมง)***	16,238	7,618	23,856
จำนวนชั่วโมงการทำงานที่ปลอดภัยสะสม (ชั่วโมง)****	277,622	124,656	402,278
จำนวนอุบัติเหตุถึงขั้นหยุดงาน (Case)*****	2	0	0

หมายเหตุ
** จำนวนชั่วโมงการทำงานที่ปลอดภัยที่เคยบันทึกได้ ตั้งแต่วันที่ 21 กรกฎาคม 2565 -14 มีนาคม 2566
*** จำนวนชั่วโมงการทำงานที่ปลอดภัยเดือนล่าสุด ตั้งแต่ 1- 30 มิถุนายน 2567
**** จำนวนชั่วโมงการทำงานที่ปลอดภัยสะสมปัจจุบันตั้งแต่ 15 มีนาคม 2566 – 30 มิถุนายน 2567
***** จำนวนอุบัติเหตุถึงขั้นหยุดงาน ตั้งแต่วันที่ 14 มีนาคม 2566 - 30 มิถุนายน 2567

ณ วันที่ 30 มิถุนายน 2567

เอกสารแนบ 35

หนังสือประสานงานกับหน่วยงานท้องถิ่นกรณีขอความช่วยเหลือ
เมื่อเกิดเหตุฉุกเฉิน

บริษัท พีทีที แอลเอ็นจี จำกัด
ชั้น 3 ศูนย์เอนเนอร์ยี่คอมเพล็กซ์ อาคารเอ
555/1 ถนนวิภาวดีรังสิต แขวงจตุจักร
เขตจตุจักร กรุงเทพฯ 10900
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PTTLNG(R)047/ 66

25 มกราคม พ.ศ. 2566

เรื่อง ขอความอนุเคราะห์สนับสนุนทางการแพทย์กรณีเกิดเหตุฉุกเฉิน

เรียน ผู้อำนวยการโรงพยาบาลเฉลิมพระเกียรติสมเด็จพระเทพรัตนราชสุดาฯ สยามบรมราชกุมารี ระยอง

สิ่งที่ส่งมาด้วย 1. แผนที่ตั้งสถานีแอลเอ็นจี มาบตาพุด แห่งที่ 2 บริษัท พีทีที แอลเอ็นจี จำกัด
2. เอกสารข้อมูลความปลอดภัยสารเคมี Safety Data Sheet (SDS)

ด้วยสถานีแอลเอ็นจี มาบตาพุด แห่งที่ 2 บริษัท พีทีที แอลเอ็นจี จำกัด (บริษัทฯ) ตั้งอยู่ที่ 8/2 ถนนโรงปุ๋ย ตำบลมาบตาพุด อำเภอเมืองระยอง จังหวัดระยอง ดำเนินกิจการรับ จัดเก็บ และแปรสภาพก๊าซธรรมชาติเหลวเป็นก๊าซธรรมชาติ เพื่อจัดส่งเข้าสู่โครงข่ายระบบท่อส่งก๊าซธรรมชาติ ทั้งนี้เพื่อเตรียมความพร้อมในการตอบสนองต่อเหตุฉุกเฉินให้มีประสิทธิภาพในด้านการช่วยเหลือผู้บาดเจ็บ บริษัทฯ อาจมีความจำเป็นต้องขอรับการสนับสนุนทางการแพทย์จากโรงพยาบาลเฉลิมพระเกียรติสมเด็จพระเทพรัตนราชสุดาฯ สยามบรมราชกุมารี ระยอง (โรงพยาบาลฯ)

ดังนั้น บริษัทฯ จึงใคร่ขอความอนุเคราะห์จากโรงพยาบาลฯ ในการสนับสนุนทางการแพทย์กรณีเกิดเหตุฉุกเฉิน พร้อมทั้งได้จัดส่งข้อมูลแผนที่ตั้งของบริษัทฯ และเอกสารข้อมูลความปลอดภัยสารเคมี Safety Data Sheet (SDS) เพื่อเป็นข้อมูลในการเตรียมความพร้อมการเข้าถึงพื้นที่และการช่วยเหลือผู้บาดเจ็บตามที่กล่าวมาข้างต้น โดยบริษัทฯ จะติดต่อไปที่หมายเลข 1669 เพื่อแจ้งรายละเอียดและขอสนับสนุนทางด้านการแพทย์ในการช่วยเหลือผู้บาดเจ็บ

จึงเรียนมาเพื่อทราบและขอความอนุเคราะห์

[redacted]

[redacted]

บริษัท พีทีที แอลเอ็นจี จำกัด
ชั้น 3 ศูนย์เอนเนอร์ยี่คอมเพล็กซ์ อาคารเอ
555/1 ถนนวิภาวดีรังสิต แขวงจตุจักร
เขตจตุจักร กรุงเทพฯ 10900
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PTTLNG(R)048/ 66

25 มกราคม พ.ศ. 2566

เรื่อง ขอความอนุเคราะห์สนับสนุนทางการแพทย์กรณีเกิดเหตุฉุกเฉิน

เรียน ผู้อำนวยการโรงพยาบาลบ้านฉาง

สิ่งที่ส่งมาด้วย 1. แผนที่ตั้งสถานีแอลเอ็นจี มาบตาพุด แห่งที่ 2 บริษัท พีทีที แอลเอ็นจี จำกัด
2. เอกสารข้อมูลความปลอดภัยสารเคมี Safety Data Sheet (SDS)

ด้วยสถานีแอลเอ็นจี มาบตาพุด แห่งที่ 2 บริษัท พีทีที แอลเอ็นจี จำกัด (บริษัทฯ) ตั้งอยู่ที่ 8/2 ถนนโรงปุ๋ย ตำบลมาบตาพุด อำเภอเมืองระยอง จังหวัดระยอง ดำเนินกิจการรับ จัดเก็บ และแปรสภาพก๊าซธรรมชาติเหลวเป็นก๊าซธรรมชาติ เพื่อจัดส่งเข้าสู่โครงข่ายระบบท่อส่งก๊าซธรรมชาติ ทั้งนี้เพื่อเตรียมความพร้อมในการตอบสนองต่อเหตุฉุกเฉินให้มีประสิทธิภาพในด้านการช่วยเหลือผู้บาดเจ็บ บริษัทฯ อาจมีความจำเป็นต้องขอรับการสนับสนุนทางการแพทย์จากโรงพยาบาลบ้านฉาง (โรงพยาบาลฯ) ในกรณีดังกล่าว

ดังนั้น บริษัทฯ จึงใคร่ขอความอนุเคราะห์จากโรงพยาบาลฯ ในการสนับสนุนทางการแพทย์กรณีเกิดเหตุฉุกเฉิน พร้อมทั้งได้จัดส่งข้อมูลแผนที่ตั้งของบริษัทฯ และเอกสารข้อมูลความปลอดภัยสารเคมี Safety Data Sheet (SDS) เพื่อเป็นข้อมูลในการเตรียมความพร้อมการเข้าถึงพื้นที่และการช่วยเหลือผู้บาดเจ็บตามที่กล่าวมาข้างต้น โดยบริษัทฯ จะติดต่อไปที่หมายเลข 1669 เพื่อแจ้งรายละเอียดและขอสนับสนุนทางด้านการแพทย์ในการช่วยเหลือผู้บาดเจ็บ

จึงเรียนมาเพื่อทราบและขอความอนุเคราะห์

[redacted]

[redacted]

บริษัท พีทีที แอลเอ็นจี จำกัด
ชั้น 3 ศูนย์เอนเนอร์ยี่คอมเพล็กซ์ อาคารเอ
555/1 ถนนวิภาวดีรังสิต แขวงจตุจักร
เขตจตุจักร กรุงเทพฯ 10900
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PTTLNG(R)049 / 66

25 มกราคม พ.ศ. 2566

เรื่อง ขอความอนุเคราะห์สนับสนุนทางการแพทย์กรณีเกิดเหตุฉุกเฉิน

เรียน ผู้อำนวยการโรงพยาบาลระยอง

สิ่งที่ส่งมาด้วย 1. แผนที่ตั้งสถานีแอลเอ็นจี มาบตาพุด แห่งที่ 2 บริษัท พีทีที แอลเอ็นจี จำกัด
2. เอกสารข้อมูลความปลอดภัยสารเคมี Safety Data Sheet (SDS)

ด้วยสถานีแอลเอ็นจี มาบตาพุด แห่งที่ 2 บริษัท พีทีที แอลเอ็นจี จำกัด (บริษัทฯ) ตั้งอยู่ที่ 8/2 ถนนโรงปุ๋ย ตำบลมาบตาพุด อำเภอเมืองระยอง จังหวัดระยอง ดำเนินกิจการรับ จัดเก็บ และแปรสภาพก๊าซธรรมชาติเหลวเป็นก๊าซธรรมชาติ เพื่อจัดส่งเข้าสู่โครงข่ายระบบท่อส่งก๊าซธรรมชาติ ทั้งนี้เพื่อเตรียมความพร้อมในการตอบสนองต่อเหตุฉุกเฉินให้มีประสิทธิภาพในด้านการช่วยเหลือผู้บาดเจ็บ บริษัทฯ อาจมีความจำเป็นต้องขอรับการสนับสนุนทางการแพทย์จากโรงพยาบาลระยอง (โรงพยาบาลฯ) ในกรณีดังกล่าว

ดังนั้น บริษัทฯ จึงใคร่ขอความอนุเคราะห์จากโรงพยาบาลฯ ในการสนับสนุนทางการแพทย์กรณีเกิดเหตุฉุกเฉิน พร้อมทั้งได้จัดส่งข้อมูลแผนที่ตั้งของบริษัทฯ และเอกสารข้อมูลความปลอดภัยสารเคมี Safety Data Sheet (SDS) เพื่อเป็นข้อมูลในการเตรียมความพร้อมการเข้าถึงพื้นที่และการช่วยเหลือผู้บาดเจ็บตามที่กล่าวมาข้างต้น โดยบริษัทฯ จะติดต่อไปที่หมายเลข 1669 เพื่อแจ้งรายละเอียดและขอสนับสนุนทางด้านการแพทย์ในการช่วยเหลือผู้บาดเจ็บ

จึงเรียนมาเพื่อทราบและขอความอนุเคราะห์

[redacted]

[redacted]

บริษัท พีทีที แอลเอ็นจี จำกัด
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PTTLNG(R)050/ 66

25 มกราคม พ.ศ. 2566

เรื่อง ขอความอนุเคราะห์สนับสนุนกรณีเกิดเหตุฉุกเฉิน

เรียน หัวหน้างานป้องกันและบรรเทาสาธารณภัยเทศบาลเมืองมาบตาพุด

สิ่งที่ส่งมาด้วย 1. แผนที่ตั้งสถานีแอลเอ็นจี มาบตาพุด แห่งที่ 2 บริษัท พีทีที แอลเอ็นจี จำกัด
2. เอกสารข้อมูลความปลอดภัยสารเคมี Safety Data Sheet (SDS)

ด้วยสถานีแอลเอ็นจี มาบตาพุด แห่งที่ 2 บริษัท พีทีที แอลเอ็นจี จำกัด (บริษัทฯ) ตั้งอยู่ที่ 8/2 ถนนโรงปุ๋ย ตำบลมาบตาพุด อำเภอเมืองระยอง จังหวัดระยอง ดำเนินกิจการรับ จัดเก็บ และแปรสภาพก๊าซธรรมชาติเหลวเป็นก๊าซธรรมชาติ เพื่อจัดส่งเข้าสู่โครงข่ายระบบท่อส่งก๊าซธรรมชาติ ทั้งนี้กรณีเกิดเหตุฉุกเฉินที่เกินขีดความสามารถของบริษัทฯ นั้น บริษัทฯ อาจมีความจำเป็นต้องขอรับการสนับสนุนจากเทศบาลเมืองมาบตาพุด

ดังนั้น บริษัทฯ จึงใคร่ขอความอนุเคราะห์จากเทศบาลเมืองมาบตาพุดในการให้การสนับสนุนกรณีดังกล่าว พร้อมทั้งได้จัดส่งข้อมูลแผนที่ตั้งของบริษัทฯ และเอกสารข้อมูลความปลอดภัยสารเคมี Safety Data Sheet (SDS) ดังสิ่งที่ส่งมาด้วย 1 และ 2 เพื่อเป็นข้อมูลในการเตรียมความพร้อมการเข้าถึงพื้นที่และตอบโต้เหตุฉุกเฉินต่อไป

จึงเรียนมาเพื่อทราบและขอความอนุเคราะห์

[redacted]

[redacted]

บริษัท พีทีที แอลเอ็นจี จำกัด
ชั้น 3 ศูนย์เอนเนอร์ยี่คอมเพล็กซ์ อาคารเอ
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PTTLNG(R)051/66

25 มกราคม พ.ศ. 2566

เรื่อง ขอความอนุเคราะห์สนับสนุนกรณีเกิดเหตุฉุกเฉิน

เรียน หัวหน้าสำนักงานป้องกันและบรรเทาสาธารณภัยจังหวัดระยอง

สิ่งที่ส่งมาด้วย 1. แผนที่ตั้งสถานีแอลเอ็นจี มาบตาพุด แห่งที่ 2 บริษัท พีทีที แอลเอ็นจี จำกัด
2. เอกสารข้อมูลความปลอดภัยสารเคมี Safety Data Sheet (SDS)

ด้วยสถานีแอลเอ็นจี มาบตาพุด แห่งที่ 2 บริษัท พีทีที แอลเอ็นจี จำกัด (บริษัทฯ) ตั้งอยู่ที่ 8/2 ถนนโรงปุ๋ย ตำบลมาบตาพุด อำเภอเมืองระยอง จังหวัดระยอง ดำเนินกิจการรับ จัดเก็บ และแปรสภาพก๊าซธรรมชาติเหลวเป็นก๊าซธรรมชาติ เพื่อจัดส่งเข้าสู่โครงข่ายระบบท่อส่งก๊าซธรรมชาติ ทั้งนี้กรณีเกิดเหตุฉุกเฉินที่เกินขีดความสามารถของบริษัทฯ นั้น บริษัทฯ อาจมีความจำเป็นต้องขอรับการสนับสนุนจากสำนักงานป้องกันและบรรเทาสาธารณภัยจังหวัดระยอง

ดังนั้น บริษัทฯ จึงใคร่ขอความอนุเคราะห์จากสำนักงานป้องกันและบรรเทาสาธารณภัยจังหวัดระยองในการให้การสนับสนุนกรณีดังกล่าว พร้อมทั้งได้จัดส่งข้อมูลแผนที่ตั้งของบริษัทฯ และเอกสารข้อมูลความปลอดภัยสารเคมี Safety Data Sheet (SDS) ดังสิ่งที่ส่งมาด้วย 1 และ 2 เพื่อเป็นข้อมูลในการเตรียมความพร้อมการเข้าถึงพื้นที่และตอบโต้เหตุฉุกเฉินต่อไป

จึงเรียนมาเพื่อทราบและขอความอนุเคราะห์

[redacted]

[redacted]

บริษัท พีทีที แอลเอ็นจี จำกัด
ชั้น 3 ศูนย์เอนเนอร์ยี่คอมเพล็กซ์ อาคารเอ
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PTTLNG(R)052 / 66

25 มกราคม พ.ศ. 2566

เรื่อง ขอความอนุเคราะห์สนับสนุนกรณีเกิดเหตุฉุกเฉิน

เรียน ผู้กำกับการสถานีตำรวจภูธรมาบตาพุด

สิ่งที่ส่งมาด้วย ข้อมูลติดต่อและแผนที่ตั้งสถานีแอลเอ็นจี มาบตาพุด แห่งที่ 2 บริษัท พีทีที แอลเอ็นจี จำกัด

ด้วยสถานีแอลเอ็นจี มาบตาพุด แห่งที่ 2 บริษัท พีทีที แอลเอ็นจี จำกัด (บริษัทฯ) ตั้งอยู่ที่ 8/2 ถนนโรงปุ๋ย ตำบลมาบตาพุด อำเภอเมืองระยอง จังหวัดระยอง ดำเนินกิจการรับ จัดเก็บ และแปรสภาพก๊าซธรรมชาติเหลวเป็นก๊าซธรรมชาติ เพื่อจัดส่งเข้าสู่โครงข่ายระบบท่อส่งก๊าซธรรมชาติ ทั้งนี้กรณีที่เกิดเหตุฉุกเฉิน บริษัทฯ อาจมีความจำเป็นต้องขอรับการสนับสนุนจากสถานีตำรวจภูธรมาบตาพุด

ดังนั้น บริษัทฯ จึงใคร่ขอความอนุเคราะห์จากสถานีตำรวจภูธรมาบตาพุด ในการให้การสนับสนุนกรณีดังกล่าว พร้อมทั้งได้จัดส่งข้อมูลติดต่อและแผนที่ตั้งของบริษัทฯ มาดังสิ่งที่ส่งมาด้วย

จึงเรียนมาเพื่อทราบและขอความอนุเคราะห์

[redacted]

[redacted]

บริษัท พีทีที แอลเอ็นจี จำกัด
ชั้น 3 ศูนย์เอนเนอร์ยี่คอมเพล็กซ์ อาคารเอ
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เขตจตุจักร กรุงเทพฯ 10900
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PTTLNG(R)053 / 66

25 มกราคม พ.ศ. 2566

เรื่อง ขอความอนุเคราะห์สนับสนุนกรณีเกิดเหตุฉุกเฉิน

เรียน ผู้กำกับการสถานีตำรวจภูธรห้วยโป่ง

สิ่งที่ส่งมาด้วย ข้อมูลติดต่อและแผนที่ตั้งสถานีแอลเอ็นจี มาบตาพุด แห่งที่ 2 บริษัท พีทีที แอลเอ็นจี จำกัด

ด้วยสถานีแอลเอ็นจี มาบตาพุด แห่งที่ 2 บริษัท พีทีที แอลเอ็นจี จำกัด (บริษัทฯ) ตั้งอยู่ที่ 8/2 ถนนโรงปุ๋ย ตำบลมาบตาพุด อำเภอเมืองระยอง จังหวัดระยอง ดำเนินกิจการรับ จัดเก็บ และแปรสภาพก๊าซธรรมชาติเหลวเป็นก๊าซธรรมชาติ เพื่อจัดส่งเข้าสู่โครงข่ายระบบท่อส่งก๊าซธรรมชาติ ทั้งนี้กรณีที่เกิดเหตุฉุกเฉิน บริษัทฯ อาจมีความจำเป็นต้องขอรับการสนับสนุนจากสถานีตำรวจภูธรห้วยโป่ง

ดังนั้น บริษัทฯ จึงใคร่ขอความอนุเคราะห์จากสถานีตำรวจภูธรห้วยโป่ง ในการให้การสนับสนุนกรณีดังกล่าว พร้อมทั้งได้จัดส่งข้อมูลติดต่อและแผนที่ตั้งของบริษัทฯ มาดังสิ่งที่ส่งมาด้วย

จึงเรียนมาเพื่อทราบและขอความอนุเคราะห์

[redacted]

[redacted]

บริษัท พีทีที แอลเอ็นจี จำกัด
ชั้น 3 ศูนย์เอนเนอร์ยี่คอมเพล็กซ์ อาคารเอ
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PTTLNG(R)054 / 66

25 มกราคม พ.ศ. 2566

เรื่อง ขอความอนุเคราะห์สนับสนุนกรณีเกิดเหตุฉุกเฉิน

เรียน ผู้กำกับการสถานีตำรวจภูธรเมืองระยอง

สิ่งที่ส่งมาด้วย ข้อมูลติดต่อและแผนที่ตั้งสถานีแอลเอ็นจี มาบตาพุด แห่งที่ 2 บริษัท พีทีที แอลเอ็นจี จำกัด

ด้วยสถานีแอลเอ็นจี มาบตาพุด แห่งที่ 2 บริษัท พีทีที แอลเอ็นจี จำกัด (บริษัทฯ) ตั้งอยู่ที่ 8/2 ถนนโรงปุ๋ย ตำบลมาบตาพุด อำเภอเมืองระยอง จังหวัดระยอง ดำเนินกิจการรับ จัดเก็บ และแปรสภาพก๊าซธรรมชาติเหลวเป็นก๊าซธรรมชาติ เพื่อจัดส่งเข้าสู่โครงข่ายระบบท่อส่งก๊าซธรรมชาติ ทั้งนี้กรณีที่เกิดเหตุฉุกเฉิน บริษัทฯ อาจมีความจำเป็นต้องขอรับการสนับสนุนจากสถานีตำรวจภูธรเมืองระยอง

ดังนั้น บริษัทฯ จึงใคร่ขอความอนุเคราะห์จากสถานีตำรวจภูธรเมืองระยอง ในการให้การสนับสนุนกรณีดังกล่าว พร้อมทั้งได้จัดส่งข้อมูลติดต่อและแผนที่ตั้งของบริษัทฯ มาดังสิ่งที่ส่งมาด้วย

จึงเรียนมาเพื่อทราบและขอความอนุเคราะห์

[redacted]

[redacted]

บริษัท พีทีที แอลเอ็นจี จำกัด
ชั้น 3 ศูนย์เอนเนอร์ยี่คอมเพล็กซ์ อาคารเอ
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PTTLNG(R)055 / 66

25 มกราคม พ.ศ. 2566

เรื่อง ขอความอนุเคราะห์สนับสนุนกรณีเกิดเหตุฉุกเฉิน

เรียน ผู้กำกับการหน่วยบริการประชาชนตำรวจน้ำระยอง

สิ่งที่ส่งมาด้วย ข้อมูลติดต่อและแผนที่ตั้งสถานีแอลเอ็นจี มาบตาพุด แห่งที่ 2 บริษัท พีทีที แอลเอ็นจี จำกัด

ด้วยสถานีแอลเอ็นจี มาบตาพุด แห่งที่ 2 บริษัท พีทีที แอลเอ็นจี จำกัด (บริษัทฯ) ตั้งอยู่ที่ 8/2 ถนนโรงปุ๋ย ตำบลมาบตาพุด อำเภอเมืองระยอง จังหวัดระยอง ดำเนินกิจการรับ จัดเก็บ และแปรสภาพก๊าซธรรมชาติเหลวเป็นก๊าซธรรมชาติ เพื่อจัดส่งเข้าสู่โครงข่ายระบบท่อส่งก๊าซธรรมชาติ ทั้งนี้กรณีที่เกิดเหตุฉุกเฉิน บริษัทฯ อาจมีความจำเป็นต้องขอรับการสนับสนุนจากหน่วยบริการประชาชนตำรวจน้ำระยอง

ดังนั้น บริษัทฯ จึงใคร่ขอความอนุเคราะห์จากหน่วยบริการประชาชนตำรวจน้ำระยอง ในการให้การสนับสนุนกรณีดังกล่าว พร้อมทั้งได้จัดส่งข้อมูลติดต่อและแผนที่ตั้งของบริษัทฯ มาดังสิ่งที่ส่งมาด้วย

จึงเรียนมาเพื่อทราบและขอความอนุเคราะห์

[redacted]

[redacted]

1. ข้อมูลเกี่ยวกับสารเคมีอันตราย (Identification of the hazardous substance)

1.1 ข้อบ่งชี้สารเคมี

ชื่อทางการค้า : Liquified Natural Gas (LNG)ชื่อสารเคมี : LNG "High Methane Natural Gas"

ชื่ออื่น : ก๊าซธรรมชาติเหลว

สูตรเคมี : CH_4

CAS No. : LNG – 68410-63-9

1.2 ผู้ผลิต/ผู้นำเข้า/ : บริษัท ปตท. จำกัด มหาชน (จัดเก็บ ณ บริษัท พีทีที แอลเอ็นจี จำกัด)

ที่อยู่ 8/2..ถ.โรงปุ๋ย..ต.มาบตาพุด..อ.เมือง..จ.ระยอง...21150 โทรศัพท์ : 038978227-8276

โทรสาร : 038978290 โทรศัพท์ฉุกเฉิน : 038978266

Email : [redacted]

1.3 ข้อแนะนำและข้อจำกัดในการใช้ ต้องมีการบริหารจัดการการรับ กักเก็บ การเกิด Boil of gas และการแปรสภาพก๊าซธรรมชาติเหลว

1.4 การใช้ประโยชน์: จัดเก็บในถัง LNG และแปรสภาพก่อนส่งผ่านเข้าระบบท่อของ ปตท.

ปริมาณสูงสุดที่มีไว้ในครอบครอง: 500,000 ลูกบาศก์เมตร

1.5 อื่นๆ..-..

2. การบ่งชี้ความเป็นอันตราย (Hazards Identification)

2.1 การจำแนกประเภท

ความเป็นอันตรายทางกายภาพ : เป็นก๊าซไวไฟ และอันตรายหากสัมผัสกับร่างกายโดยตรงจากอันตรายจาก Cold burn

ความเป็นอันตรายต่อสุขภาพ : ไม่มีสารประกอบที่เป็นพิษ ไม่มีคุณสมบัติการกัดกร่อน

ความเป็นอันตรายต่อสิ่งแวดล้อม : กรณีเกิดการรั่วไหลไม่ต้องกาจัดเนื่องจากก๊าซจะระเหยไปในอากาศได้อย่างรวดเร็ว ไม่ทิ้งสารตกค้าง

ความเป็นอันตรายอื่น : การติดไฟเกิดขึ้นได้ต้องอยู่ในสถานะก๊าซ สภาพแวดล้อมปิดและมีค่าปริมาณก๊าซในอากาศระหว่าง 5-15% แล้วมีการก่อให้เกิดประกายไฟในบริเวณที่มีก๊าซอยู่ความไวต่อการติดไฟของแก๊สธรรมชาติสูงกว่าแก๊สปิโตรเลียมเหลว

2.2 องค์ประกอบตามฉลาก

รูปสัญลักษณ์ :

คำสัญญาณ...... Extremely flammable liquids and vapor..........

ข้อความแสดงอันตราย............... Extremely flammable liquids and vapor..................

ข้อควรระวังหรือข้อปฏิบัติเพื่อป้องกันอันตราย.........................สารไวไฟ.........................

2.3 อื่นๆ...-...

3. องค์ประกอบและข้อมูลเกี่ยวกับส่วนผสม (Composition / Information on ingredients)

องค์ประกอบ	ชื่อสารเคมี	CAS. No.	ปริมาณโดยน้ำหนัก(% by weight) (Rich LNG)	ปริมาณโดยน้ำหนัก(% by weight) (Lean LNG)	ค่ามาตรฐานความปลอดภัย LD50	ค่ามาตรฐานความปลอดภัย TLV
1.	Methane	74-82-8	90.00	93.00	N/A	N/A
2	Ethane	74-84-0	6.00	6.00	N/A	N/A
3	Propane	74-98-6	2.50	1.00	N/A	N/A
4	Butane	75-28-5	1.00	1.00	N/A	N/A
5	Pentane	78-78-4	0.01	0.01	N/A	N/A
6	Carbon dioxide	124-38-9	0.70	0.70	N/A	N/A
7	Nitrogen	7727-37-9	0.60	0.60	N/A	N/A
8	Oxygen	7782-44-7	0.10	0.10	N/A	N/A

4. มาตรการปฐมพยาบาล (First Aid Measures)

4.1 กรณีได้รับทางการหายใจ : หลีกเลี่ยงการเข้าไปอยู่ในที่อับอากาศจาก LNG เพราะอาจขาดอากาศหายใจ

4.2 กรณีได้รับทางผิวหนังหรือดวงตา : กรณีได้รับอันตรายจากการสัมผัส LNG จะเกิด Cold burn กับผิวหนังหรืออวัยวะสัมผัส ให้ล้างด้วยน้าสะอาดอุณหภูมิปกติ เป็นเวลา 10 นาที และรีบนาผู้ประสบเหตุส่งแพทย์ทันที

4.3 กรณีได้รับทางการกลืนกิน : หากพบ LNG ที่อาจจะหกล้นและปนเปื้อนเข้าสู่ผู้ประสบเหตุในทางเดินอาหารให้รีบนาผู้ประสบเหตุส่งแพทย์ทันที

4.4 อื่นๆ...

5. มาตรการผจญเพลิง (Fire Fighting Measures)

5.1 สารดับเพลิงที่ห้ามใช้และสารดับเพลิงที่เหมาะสม : ห้ามใช้น้าดับฉีดเข้าไปในจุดที่มีการรั่วไหลโดยตรงเพราะจะทาให้ LNG ขยายตัวอย่างรวดเร็ว(Rapid phase transition, RPT) สารดับเพลิงที่แนะนาให้ใช้ดับเพลิง LNG คือ ผงเคมีแห้ง และ กรณีที่รั่วไหลลงภาชนะรองรับ เช่น Impoundment pit ให้ใช้ High expansion foam ในการปิดคลุม

5.2 ความเป็นอันตรายเฉพาะที่เกิดขึ้นจากสารเคมี : LNG ขยายตัวอย่างรวดเร็ว(Rapid phase transition, RPT หากถูกเร่งปฏิกิริยา เช่น การฉีดน้าดับเพลิงเข้าสู่ LNG ที่ติดไฟโดยตรง

5.3 อุปกรณ์พิเศษสาหรับนักผจญเพลิง : ชุดผจญเพลิง และ SCBA

5.4 อื่นๆ...

6. มาตรการจัดการเมื่อมีการหก รั่วไหล (Accidental Release Measures)

6.1 ข้อควรระวังส่วนบุคคล อุปกรณ์ป้องกันอันตราย และขั้นตอนการปฏิบัติงานฉุกเฉิน : เมื่อเกิดการรั่วไหลที่ควบคุมปิดกั้นพื้นที่ ปิดวาล์วของภาชนะบรรจุ หรือท่อ ทาการระงับเหตุหากสามารถทาได้ และแจ้งเบอร์ฉุกเฉิน 038-97-8266

6.2 วิธีการ และวัสดุสาหรับกักเก็บและทาความสะอาด : กรณีเกิดการรั่วไหลไม่ต้องกาจัดเนื่องจากก๊าซจะระเหยไปในอากาศได้อย่างรวดเร็ว ไม่ทิ้งสารตกค้าง แต่ต้องมีการควบคุมปิดกั้นพื้นที่เพื่อป้องกันแหล่งความร้อนและผู้ไม่เกี่ยวข้อง

6.3 ข้อควรระวังด้านสิ่งแวดล้อม : ....-...

6.4 อื่นๆ...-...

7. การขนถ่าย เคลื่อนย้าย และการจัดเก็บ (Handling And Storage)

7.1 ข้อควรระวังและหลีกเลี่ยง : การขนถ่าย เคลื่อนย้าย และการจัดเก็บ ให้ห่างจากแหล่งความร้อนและประกายไฟ

7.2 วิธีการจัดเก็บอย่างปลอดภัย : จัดเก็บในภาชนะบรรจุที่ได้มาตรฐานและมีการรับรอง

7.3 อื่นๆ.........................-...

8. การควบคุมการรับสัมผัสและการป้องกันส่วนบุคคล (Exposure controls and personal protection)

8.1 ค่าขีดจำกัดความเข้มข้นของสารเคมีอันตราย (TLV)

กฎหมายว่าด้วยความปลอดภัย อาชีวอนามัย และสภาพแวดล้อมในการทำงาน

OSHA..-......ppm...

NIOSH..-.......ppm...

ACGIH..-.......ppm...

อื่นๆ..-...

8.2 การควบคุมทางวิศวกรรมที่เหมาะสม..........จัดการตามมาตรฐาน NFPA 59A...........

8.3 อุปกรณ์ป้องกันอันตรายส่วนบุคคล........ชุดป้องกันความเย็นสำหรับงาน Truck loading และ ชุด Frame resistant clothing ป้องกัน Flash fire หรับงาน Unloading หรือเปิดอุปกรณ์ ท่อ LNG.

ระบบหายใจ : ....-...

ตา : ....หน้ากาก Face shield สำหรับงาน Truck loading...............................

ผิวหนัง : .... ชุดคลุมป้องกันความเย็นสำหรับงาน Truck loading รวมถึงถุงมือป้องกันความเย็น

8.4 อื่นๆ...

9. คุณสมบัติทางกายภาพและทางเคมี (Physical And chemical Properties)

9.1 ลักษณะทั่วไป : ไม่มีสี

9.2 กลิ่น : ไม่มี

9.3 ค่าความเป็นกรดด่าง (pH) :

9.4 จุดหลอมเหลวและจุดเยือกแข็ง : - 182 องศาเซลเซียส

9.5 จุดเดือด : -162 องศาเซลเซียส

9.6 จุดวาบไฟ : -218 องศาเซลเซียส

9.7 อัตราการระเหย : -

9.8 ความสามารถในการลุกติดไฟ : -

9.9 ค่าขีดจำกัดสูงสุดและต่ำสุดของความไวไฟหรือของการระเบิด : 5% และ 15%

9.10 ความดันไอ : -

ptt LNG	แบบฟอร์มข้อมูลความปลอดภัยของสารเคมี (Safety Data Sheet: SDS)	F-QS-0109 Rev.00	
	ชื่อสารเคมี : Liquified Natural Gas (LNG)	SDS No.:	021

9.11 ความหนาแน่นไอ(Air = 1) : 0.55

9.12 ความหนาแน่นสัมพัทธ์ : -

9.13 ความถ่วงจาเพาะ : 0.42 g/cm3

9.14 ความสามารถในการละลายได้ :

9.15 อุณหภูมิที่ลุกติดไฟได้เอง : 540 องศาเซลเซียส

9.16 มวลโมเลกุล : -

9.17 อื่นๆ :

10. ความเสถียร และการไวต่อปฏิกิริยา (Stability and Reactivity)

10.1 ความเสถียรทางเคมี : เสถียร

10.2 สิ่งที่เข้ากันไม่ได้ : -

10.3 วัตถุอื่นๆ ที่ควรหลีกเลี่ยง : Strong Oxidizers

10.4 สภาวะที่ควรหลีกเลี่ยง : เก็บให้ห่างจากแหล่งความร้อนและประกายไฟ

10.5 สารเคมีอันตรายหากเกิดการสลายตัว : -

10.6 อื่นๆ...-...

11. ข้อมูลด้านพิษวิทยา (Toxicological Information)

11.1 LD50 / LC50

โดยทางปาก (mg/kg) : N/A

โดยทางผิวหนัง (mg/kg) : N/A

โดยทางสูดหายใจ (mg/l) : N/A

11.2 ความเป็นพิษ : N/A

11.3 จัดอยู่ในกลุ่มสารก่อมะเร็ง/ก่อกลายพันธุ์ตาม : N/A

11.4 อื่นๆ : N/A

12. ข้อมูลผลกระทบต่อระบบนิเวศน์ (Ecological Information)

12.1 ความเป็นพิษต่อระบบนิเวศน์ : ไม่ตกค้างในสิ่งแวดล้อม

12.2 การตกค้างยาวนาน : N/A

ptt LNG	แบบฟอร์มข้อมูลความปลอดภัยของสารเคมี (Safety Data Sheet: SDS)	F-QS-0109 Rev.00	
	ชื่อสารเคมี : Liquified Natural Gas (LNG)	SDS No.:	021

12.3 ผลกระทบอื่นๆ : N/A

13. ข้อพิจารณาในการกำจัด (Disposal considerations) : หากรั่วไหลให้ปิดกั้นพื้นที่ เพื่อป้องกันแหล่งความร้อนและบุคคล เพื่อให้ LNG ระเหยหมดไปโดยไม่เกิดไฟไหม้และอันตรายต่อคน

14. ข้อมูลเกี่ยวกับการขนส่ง (Transport Information)

14.1 หมายเลขสหประชาชาติ (UN Number) : UN1972, Methane, refrigerated liquid

14.2 ชื่อในการขนส่ง : N/A

14.3 ประเภทความเป็นอันตรายสำหรับการขนส่ง (Transport Hazard Class) N/A

14.4 กลุ่มการบรรจุ (Packing Group) Flammable gas / 1972 Methane, refrigerated liquid

14.5 การขนส่งด้วยภาชนะขนาดใหญ่ N/A

14.6 อื่นๆ N/A

15. ข้อมูลเกี่ยวกับระเบียบ ข้อบังคับของหน่วยงานที่เกี่ยวข้อง (Regulatory Information)

15.1 กระทรวงแรงงาน : กฎกระทรวงฯ เรื่องกำหนดมาตรฐานในการบริหาร จัดการ และดำเนินการด้านความปลอดภัย อาชีวอนามัย และสภาพแวดล้อมในการทำงานเกี่ยวกับสารเคมีอันตราย พ.ศ. 2556 และประกาศกรมสวัสดิการและคุ้มครองแรงงาน เรื่องบัญชีรายชื่อสารเคมีอันตราย พ.ศ. 2556 และประกาศกรมสวัสดิการและคุ้มครองแรงงาน เรื่องแบบบัญชีรายชื่อสารเคมีอันตรายและรายละเอียดข้อมูลความปลอดภัยของสารเคมีอันตราย พ.ศ. 2556

15.2 กระทรวงอุตสาหกรรม : ประกาศกระทรวงอุตสาหกรรม เรื่อง บัญชีรายชื่อวัตถุอันตราย พ.ศ. 2556 เรื่อง บัญชี 5 ที่กรมโรงงานอุตสาหกรรมรับผิดชอบ

15.3 กระทรวงสาธารณสุข...-......................................

15.4 กระทรวงทรัพยากรธรรมชาติและสิ่งแวดล้อม.........................-....................................

15.5 กระทรวงคมนาคม..-......................................

15.6 อื่นๆข้อบังคับคณะกรรมการการนิคมอุตสาหกรรมแห่งประเทศไทย ว่าด้วยหลักเกณฑ์ วิธีการและเงื่อนไขในการประกอบกิจการในนิคมอุตสาหกรรม (ฉบับที่ ๔) พ.ศ. ๒๕๕๙ เงื่อนไขเกี่ยวกับมาตรฐานการจัดการความปลอดภัยกระบวนการผลิตและการตรวจประเมินความปลอดภัยกระบวนการผลิตในนิคมอุตสาหกรรม (มีผลบังคับใช้ 7 เมษายน 2561)

16. ข้อมูลอื่น ๆ (Other Information)

ptt LNG	แบบฟอร์มข้อมูลความปลอดภัยของสารเคมี (Safety Data Sheet: SDS)	F-QS-0109 Rev.00	
	ชื่อสารเคมี : Liquified Natural Gas (LNG)	SDS No.:	021

16.1 สัญลักษณ์ NFPA

16.2 แหล่งข้อมูลและเอกสารที่ใช้ทำรายละเอียดข้อมูลความปลอดภัยของสารเคมีอันตราย : Data Sheet (Liquefied Natural Gas, LNG)

16.3 อื่นๆ : OSHA, ศูนย์ข้อมูลวัตถุอันตรายและเคมีภัณฑ์ กรมควบคุมมลพิษ

บริษัท พีทีที แอลเอ็นจี จำกัด

เลขที่ 8/1 นิคมอุตสาหกรรมมาบตาพุด ถนนไอ-8 ตำบลมาบตาพุด อำเภอเมือง จังหวัดระยอง

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E-mail: [redacted]

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LOCATION

เอกสารแนบ 36

ตัวอย่าง Work Permit การทำงานในพื้นที่เสี่ยงอันตราย

เล่มที่ ____________

บริษัท พีทีที แอลเอ็นจี จำกัด

เลขที่ M-E-24-0727

ใบอนุญาตทำงานธรรมดา (COLD WORK PERMIT)

JOB NO.__________

[redacted]

ต้นฉบับ : สำหรับผู้ขออนุญาต และติดแสดงใบอนุญาตฉบับนี้ให้เห็นชัดเจนในจุดที่ทำงาน

สำเนา : 1. สำหรับผู้อนุญาต และส่งส่วน ปส. เมื่อใบอนุญาตเลิกใช้งานแล้ว 2. สำหรับผู้ควบคุมงาน

0014

ต้นฉบับ

F-QS-0013 Rev.00

เล่มที่ ____________

บริษัท พีทีที แอลเอ็นจี จำกัด

ใบอนุญาตทำงานร้อน (HOT WORK PERMIT)

เลขที่ ____________

JOB NO. DCP-2024-H164

[redacted]

ต้นฉบับ : สำหรับผู้ขออนุญาต และติดแสดงใบอนุญาตฉบับนี้ให้เห็นชัดเจนในจุดที่ทำงาน

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0005 **ต้นฉบับ**

LMPTQ-I-24-096

เล่ม ___

บริษัท พีทีที แอลเอ็นจี จำกัด

เลขที่ ___

ใบอนุญาตทำงานธรรมดา (COLD WORK PERMIT)

JOB NO.___

[redacted]

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0016

ต้นฉบับ

F-QS-0013 Rev.00

LMPT2-I-24-098

เล่มที่ ________

บริษัท พีทีที แอลเอ็นจี จำกัด

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ใบอนุญาตทำงานร้อน (HOT WORK PERMIT)

JOB NO. ________

[redacted]

ต้นฉบับ : สำหรับผู้ขออนุญาต และติดแสดงใบอนุญาตฉบับนี้ให้เห็นชัดเจนในจุดที่ทำงาน

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0017

ต้นฉบับ

เล่มที่ ____

บริษัท พีทีที แอลเอ็นจี จำกัด

เลขที่ ____

ใบอนุญาตทำงานธรรมดา (COLD WORK PERMIT)

JOB NO. MT-24-389

[redacted]

ต้นฉบับ : สำหรับผู้ขออนุญาต และติดแสดงใบอนุญาตฉบับนี้ให้เห็นชัดเจนในจุดที่ทำงาน

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เล่มที่ ____________

บริษัท พีทีที แอลเอ็นจี จำกัด

เลขที่ PT-24/012

ใบอนุญาตทำงานร้อน (HOT WORK PERMIT)

JOB NO.__________

[redacted]

ต้นฉบับ : สำหรับผู้ขออนุญาต และติดแสดงใบอนุญาตฉบับนี้ให้เห็นชัดเจนในจุดที่ทำงาน

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ต้นฉบับ

เล่มที่ ____________

บริษัท พีทีที แอลเอ็นจี จำกัด

เลขที่ M-E-14-0828

ใบอนุญาตทำงานธรรมดา (COLD WORK PERMIT)

JOB NO. ____________

[redacted]

ต้นฉบับ : สำหรับผู้ขออนุญาต และติดแสดงใบอนุญาตฉบับนี้ให้เห็นชัดเจนในจุดที่ทำงาน

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ต้นฉบับ

เล่มที่ ______

บริษัท พีทีที แอลเอ็นจี จำกัด

เลขที่ ______

ใบอนุญาตทำงานร้อน (HOT WORK PERMIT)

JOB NO. MTE-24-0190

[redacted]

ต้นฉบับ : สำหรับผู้ขออนุญาต และติดแสดงใบอนุญาตฉบับนี้ให้เห็นชัดเจนในจุดที่ทำงาน

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ต้นฉบับ

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บริษัท พีทีที แอลเอ็นจี จำกัด

เลขที่ MT-E-24-0832

ใบอนุญาตทำงานธรรมดา (COLD WORK PERMIT)

JOB NO. __________

[redacted]

ต้นฉบับ : สำหรับผู้ขออนุญาต และติดแสดงใบอนุญาตฉบับนี้ให้เห็นชัดเจนในจุดที่ทำงาน

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เลขที่ MTE-24-0189

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LO.003.

ต้นฉบับ

เล่มที่ ________

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ใบอนุญาตทำงานร้อน (HOT WORK PERMIT)

JOB NO. ศท-94-614

[redacted]

ต้นฉบับ : สำหรับผู้ขออนุญาต และติดแสดงใบอนุญาตฉบับนี้ให้เห็นชัดเจนในจุดที่ทำงาน

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10.01

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F-QS-0014 Rev.00

เอกสารแนบ 37

QRA

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Nong Fab LNG Receiving Terminal Project (EPC)

Quantitative Risk Assessment (QRA) Report

SAIPEM S.A. - CTCI CORPORATION JOINT VENTURE (SPCC)

PTT LNG COMPANY LIMITED (PTTLNG)

iresc

Nong Fab LNG Receiving Terminal Project (EPC)

Quantitative Risk Assessment (QRA) Report

Document No: 11-2-18-036-QRA-07

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1 INTRODUCTION

PTT LNG Company Limited (PTTLNG) is planning to develop a second Liquefied Natural Gas (LNG) receiving, storage, regasification and export terminal. The LNG terminal is proposed to be located in Baan Nong Fab, Muang District, Rayong Province of Thailand. Saipem S.A. - CTCI Corporation Joint Venture (SPCC) is the EPC Contractor for this Nong Fab LNG Receiving Terminal Project.

IRESC, an independent consultant, was engaged by SPCC to carry out a Quantitative Risk Assessment (QRA) for the EPC stage of the Project. The final QRA report was issued on 14 June 2021 to take into account modifications encompassing relocation of equipment in Gas Turbine Generator (GTG) and metering area [3]. Following this work, the latest revisions to NFPA 59A has led to an initiative of carrying out update to the QRA study which is documented in Annexure E in this report.

1.1 STUDY BACKGROUND

The Nong Fab LNG Receiving Terminal is being proposed to manage the rapid increase in gas demand in Thailand and absorb the LNG imports that exceed the capacity of the existing Map Ta Phut LNG Receiving Terminal.

The LNG terminal will be developed in two phases. The LNG terminal will have a design capacity of 7.5 MMTPA with +20% swing for gas send-out capacity in Phase I. An additional 7.5 MMTPA will be developed for Phase II in future.

The proposed LNG terminal will include the following mainly facilities:

- Two Unloading Berths (one for Phase I and additional one for Phase II);
- Four 250,000 m^3 LNG Storage Tanks (two tanks for Phase I and additional two tanks for Phase II);
- BOG Compressors;
- HP Pumps;
- Recondensers;
- Open Rack Vaporisers (ORVs) / Intermediate Fluid Vaporisers (IFVs);
- Metering Station; and
- NG send-out System

1.2 OBJECTIVES

The main objective of this QRA study is to quantify the risk arising from the Nong Fab LNG Terminal operations after the completion of Phase II development. The estimated risks are

presented in the form of individual risk contours (or iso-risk contours) and societal risk presented as F-N curves. These are compared with international criteria to judge the acceptability of the risks. Recommendations are provided as appropriate in light of the QRA findings, with the aim to reduce the risk to As Low As Reasonably Practicable (ALARP).

This QRA study has covered all facilities of the terminal after Phase II expansion, which will have a nominal LNG unloading rate of 15 MMTPA with a gas throughput of 18 MMTPA, but excludes the following:

- Risks associated with the LNG carrier operations, manoeuvring, collision or grounding;
- Construction phase risks during Phase II expansion; and
- Analysis of impact of hazards arising from adjoining facilities.

2 NONG FAB LNG RECEIVING TERMINAL FACILITIES

The new LNG Terminal will be designed to handle a maximum LNG throughput of 15 MMTPA (nominal flow rate) with a peak capacity of 18 MMTPA. The overall plot plan of the LNG terminal is illustrated in Figure 2.1, while the detailed layouts for the process area and berth areas are presented in Figure 2.2 to Figure 2.3.

Figure 2.1 Plot Plan for Nong Fab LNG Terminal (Overall) [1]

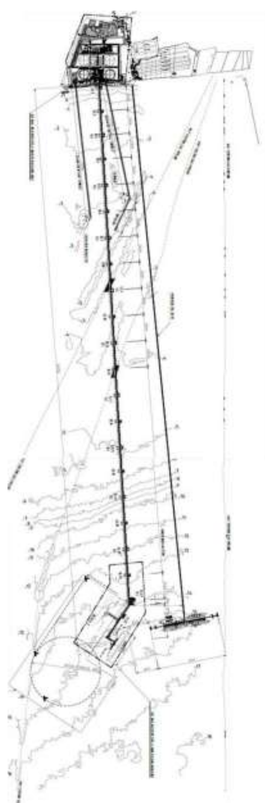


Figure 2.2 Plot Plan for Nong Fab LNG Terminal (Process Area) [2]

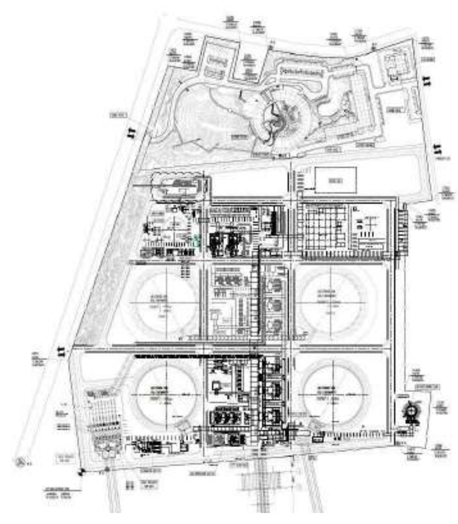
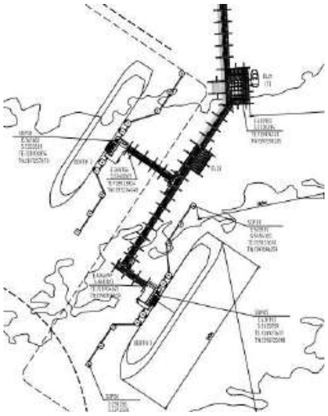


Figure 2.3 Plot Plan for Nong Fab LNG Terminal (Berth Area) [4]



2.1 LNG IMPORT/ EXPORT FACILITIES

A total of two berths will be constructed and the jetty will be about 5.5 km from the shore. The two berths are designed for unloading from LNG carriers with nominal capacities ranging from 125,000 m^3 to 266,000 m^3. Each of the two berths will have four 20" LNG unloading arms, designed to accommodate a total unloading rate of 14,000 m^3/hr and one 20" vapour return arm designed for the same capacity. The LNG cargo will be pumped by the ship's cargo pumps and delivered to the LNG storage tanks on the terminal side. The terminal adopts a dual unloading header design for transferring LNG between the terminal and the jetty. The LNG storage tanks will be of full containment type with a capacity of 250,000 m^3 each. Terminal-side BOG compressors will be used for vapour return during unloading.

2.2 LNG STORAGE

Two 250,000 m^3 full containment LNG storage tanks will be installed in Phase I with future provision for two additional tanks in Phase II of the same size. All LNG tanks will have the same design with an inner shell of 9% Ni steel and a full concrete outer shell (including roof). The LNG storage tanks will be kept at near ambient pressure and cryogenic conditions (about

-160 °C). In case of any LNG leakage from the primary tank, the outer tank will contain the LNG and the excess vapour generated is vented from the outer tank in a controlled manner. Three LP in-tank centrifugal submerged pumps are provided for each tank and are capable of supplying LNG for send-out at approximately 9 barg. Each LP pump has a design capacity of 525 m^3/h for LNG delivery.

2.3 BOIL-OFF GAS (BOG) TREATMENT SYSTEM

The boil-off gas (BOG) generated in the LNG storage tanks will be collected in a BOG header. The BOG will be sent to the BOG compressors through BOG Suction Drums. Three BOG compressors will be provided in Phase I with a common suction drum. An additional train with three BOG compressors and a BOG Suction Drum is planned for Phase II. One BOG compressor is always running in normal operation, while two are required during unloading operations to handle the higher BOG generation rate as well as return some of the BOG to the LNG carrier. A desuperheater is also provided at the jetty head for each of the headers to cool down the return gas before returning to the ship cargo tank. Each of the compressors (with capacity control by steps at an increment of 25%) can deliver BOG at 8.5 barg with a capacity of 16.2 t/hr.

During unloading operations, part of the compressor discharge is routed back to the ship via the vapour return line. When unloading operations are not in service, the entire BOG stream is compressed and recovered in the BOG Recondenser. The BOG Recondenser consists of a packed bed with stainless steel pall rings where BOG is brought into contact with LNG for recondensation. The condensed BOG/ LNG from the BOG Recondenser bottoms is routed to the HP Pump suction. Each compressor train will be provided with its own BOG Recondenser.

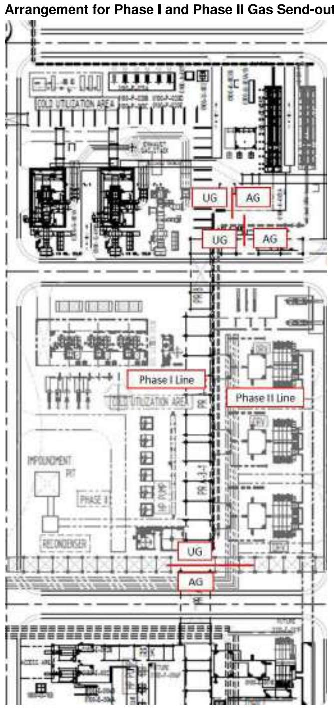
2.4 LNG TRANSFER AND SEND-OUT SYSTEM

Send-out from the LP pumps is sent to the suction of HP LNG Pumps, with a small amount injected to the Recondenser for BOG recondensation. When carrier unloading is not in operation, the entire LNG flow from the LP pumps will be routed to the unloading header to maintain the line under cryogenic conditions before entering the LP header, while the LP LNG is sent directly to the LP header during LNG ship unloading.

The required pressure of the send-out gas at the terminal battery limit is 86.2 barg. To achieve this send-out pressure, a total of six HP LNG Pumps will be installed for Phase I (including one as spare) and an additional six will be installed for Phase II in order to meet the LNG norminal send-out rate of 856 t/hr (maximum send-out rate is 1028 t/hr) for each phase. Correspondingly, five open-rack seawater vaporisers (plus one as spare) for Phase I and five (plus one as spare) for Phase II, with the same capacity as the HP pumps, will be installed to vaporize the pressurized LNG to natural gas. The send-out gas (natural gas) is then routed to the gas metering station before entering the 34" send-out gas header/ pipeline. Part of the

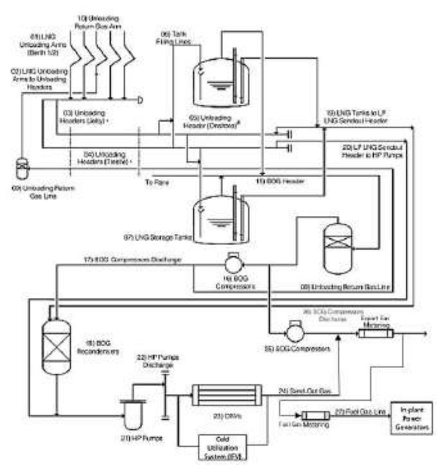
Phase I Gas Send-out Header and majority of the Phase II Gas Send-out Header are installed belowground as shown in Figure 2.4.

Figure 2.4 Piping Arrangement for Phase I and Phase II Gas Send-out Header



A schematic of the Nong Fab LNG Receiving Terminal facilities is presented in Figure 2.5. The equipment considered in this QRA study is summarized in Table 2.1.

Figure 2.5 Schematic for PTT Nong Fab LNG Terminal Facilities*^



Note:
Dual unloading headers are provided for each phase. In other words, a total of four unloading headers will be available in jetty, trestle and onshore sections in Phase II;
* Exact same scheme will be installed in Phase II to provide a completely separated configuration; and
^ Simultaneous operation of unloading system has been considered.

Table 2.1 Main Process Facilities for the Nong Fab LNG Terminal

Process Facility	No. of Equipment	
	Phase I	Phase II
Berth	1 (Berth 1)	2 (Berth 2)
Liquid Unloading Arm	4 (Unloading)	4 (Unloading)
Vapour Return Arm	1 (Unloading)	1 (Unloading)
Return Gas KOD	1	1
De-superheater	1	1
LNG Storage Tanks	2	2
LP LNG Pumps	3 in each storage tank	3 in each storage tank
BOG Compressors	3	3
BOG Suction Drum	1	1
BOG Recondenser	1	1
HP LNG Pumps	5 (+1)*	5 (+1)*
Open Rack Vaporisers (ORV)	5 (+1)*	5 (+1)*
Intermediate Fluid Vaporisers (IFV)	2	2
Send-out Gas Compressors	2	-

* Number in bracket indicates spare equipment.

2.5 TERMINAL OPERATIONS AND ASSUMPTIONS

2.5.1 Modes of Operation

The following operation modes are envisaged for the Nong Fab Receiving Terminal:

Holding Mode (Normal Operation Mode)

Gas send-out operation is performed without LNG unloading. LNG is continuously pumped out from the LNG storage tanks and vaporised by the ORVs for gas send-out. During this operation mode, all LP LNG is sent to LP header through the unloading header to maintain the unloading headers under cryogenic conditions. This is the most prevalent mode of operation.

Ship Unloading Mode

LNG unloading from a carrier is performed in parallel to gas send-out operations. The terminal is designed to unload LNG from one carrier at Berth 1 and another at Berth 2 simultaneously.

Zero Send-out Mode

Gas send-out is suspended for any reason or planned shutdown. The Recondensers cannot condense any BOG as there is no LNG flow in this mode. Thus, BOG is diverted to the Send-out Gas Compressors and exported directly to gas send-out pipelines.

2.5.2 Material composition

The LNG and BOG compositions may vary depending on the sources of LNG. The compositions for LNG and BOG used in this study were taken from the Project Process and Plant Basis of Design [5] as summarised in Table 2.2 and Table 2.3. Rich LNG and rich BOG were considered as the basis for this QRA study.

Table 2.2 LNG Compositions (by mol%)

Component	Lean LNG	Rich LNG	High N_2 LNG
N_2	0.15	0.00	1.00
Methane	99.84	87.24	93.40
Ethane	0.01	8.45	3.90
Propane	0.00	3.15	1.12
Iso-butane	0.00	1.11	0.58
Iso-pentane	0.00	0.05	0.00

Table 2.3 BOG Compositions (by mol%)

Component	Lean BOG	Rich BOG	High N_2 BOG
N_2	3.35	0.00	22.56
Methane	96.65	99.98	77.43
Ethane	0.00	0.02	0.00

2.5.3 Assumptions for Terminal Operations

The Nong Fab LNG Terminal is designed to receive and send-out LNG of 15 MMTPA with a peak capacity of 18 MMTPA upon completion of the Phase II development. The number of carrier unloading operations required per year has been estimated to vary from 136 (assuming all large carriers of 266,000 m^3 nominal capacity) to 289 (assuming all small carriers of 125,000 m^3 nominal capacity) times per year. It will take approximately 20 hours and 13 hours to unload from large and small carriers, respectively, which correspond to the maximum unloading rate of 14,000 m^3/hr and 11,000 m^3/hr.

A summary of the unloading operations considered in this QRA is presented in Table 2.4 . The total unloading time per year was estimated based on the time required for large carrier unloading, i.e. 136 operations / year x 20 hours/ operation = 2720 hours/ year. The utilisation rate for unloading operations was assumed to be distributed equally between Berths 1 and 2. It is noted that simultaneous unloading operation was considered in the modelling.

Table 2.4 Summary of Unloading Operations Considered in the QRA

Parameters	Unloading Operation
Terminal Unloading/ Reloading Capacity (MMTPA)	15
Nominal Carrier Capacity (m^3)	266,000
Unloading/ Reloading Rate (m^3/hr)	14,000
No. of Operations (operations/ year)	136
Unloading/ Re-loading Time per Operation (hr)	20
Total Unloading/ Reloading Time (hr/ year)	2,720

3 PROJECT SITE DESCRIPTION

The proposed site for the Nong Fab LNG terminal is in Baan Nong Fab, Muang District in Rayong Province, approximately 200 km away from Bangkok in Thailand. Figure 3.1 depicts the LNG Terminal site location as part of the Map Ta Phut Industrial Estates along with the other developed industrial sites in the vicinity.

The LNG terminal comprises of two main areas, i.e. process and jetty area. The terminal site is approximately 34 hectares, with 520 m of ocean frontage. Towards the land side, there is a residential area situated merely across the road to the northwest from the terminal site. Apart from this residential community, the terminal site is surrounded by predominantly industrial facilities, including the adjacent LDPE plant and polymer logistics facilities. Also in the vicinity are two currently vacant plots of land, one is owned by Padang Industrial to the north of the terminal and one is owned by Italian Thai Co., Ltd to the east by the sea. Industrial facilities are thus expected to be developed in these vacant areas in future.

The jetty of the LNG terminal is located about 1.5 km to the west of Map Ta Phut Industrial Estate Port. It extended southwards by approximately 5.5 km from the shore into the sea. There are two other similar jetty/ berth facilities in the neighbourhood, including an existing chemicals berth owned by PTT Global Chemical Public Company Limited and a currently developing berth owned by Italian Thai Development Co., Ltd.

Details of the population considered in the QRA are described in Section 3.1.

Figure 3.1 Nong Fab LNG Terminal Site & Surrounding Industrial Facilities

1. PTT Phenol Co., Ltd (PTTPhenol)
2. Bangkok Industrial Gas Co., Ltd. (BIG) Nongfab H2 Plant
3. HMC Polymers Co., Ltd PDH Plant
4. Thai Oleochemicals Company Limited
5. NPC Safety and Environmental Service Co.,Ltd.
6. PTT Maintenance and Engineering Company Limited (PTTME)
7. Residential Community
8. Undeveloped plot of land owned by Padang Industrial
9. PTT Global Chemical Public Company Limited (PTTGC) LDPE Plant
10. Thai Polyacetal Co., Ltd.
11. PTT Polymer Logistics
12. TTCL Public Company Limited - D184 Site Project
13. Undeveloped site owned by Italian Thai Co., Ltd
14. PTT Global Chemical Public Company Limited (PTTGC) Terminal
15. Proposed ITD (Italian Thai Development Co., Ltd.) berth
16. NS BlueScope (Thailand) Limited

3.1 POPULATION

As noted in the previous subsection, to the north-west of the LNG Terminal is a residential area where significant population may be expected. Within this area, Nong Fab School and Nong Fab Takkinaram Temple have been identified as the main sensitive establishments of concern, to which a greater degree of scrutiny of the risk level is warranted as per NFPA 59A [6]. Also subject to the risk assessment is the industrial population in the vicinity. However, while detailed population information for these industrial areas is not available, the general population data available for the districts covering the project site have been used to estimate the population in these areas. The near field (within 1 km radius) off-site population of concern are illustrated in Figure 3.2.

Figure 3.2 Sensitive Establishments Identified in the Vicinity of Nong Fab LNG Terminal

For far-field, the population within 12 km radius from the LNG terminal has been considered, as indicated in Figure 3.3. The population data considered in the QRA is presented in Table 3.1, which is taken from National Statistic Office of Rayong. In this QRA, it is assumed that the population density is the same for the entire district/ sub-district. It is further assumed that the population distribution between indoor and outdoor location is respectively 50% and 50% during day time, and 80% and 20%, during night time.

Figure 3.3 Area within 12 km radius from Nong Fab LNG Terminal

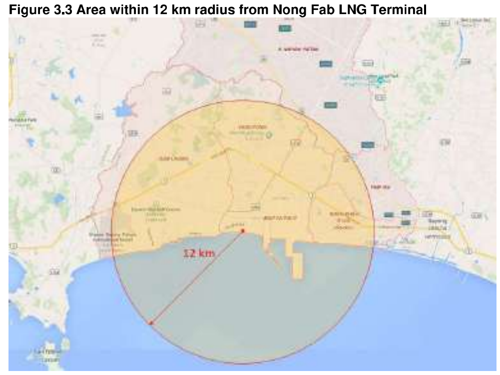


Table 3.1 Population Information

Population Centre/ District	Population
Population Centres	
Nong Fab Takkinaram Temple [7]	30
Nong Fab School [7]	182
Nong Fab Community [8]	1,281
District/ Sub-district, including industrial sites [6] [9]*	
Noen Phra	39,968
Map Ta Phut	66,478
Ban Chang	73,022
Huai Pong	20,513
Thap Ma	28,307
Nikhom Phatthana	17,877

* Population cited refers to total population for the entire district/ sub-district

3.2 METEOROLOGICAL DATA

The climate data collected from the Rayong Station [10] and data from the basis of design [11] are used as the basis for this QRA study as presented in Table 3.2.

Table 3.2 Climate Data

Design Parameter	Rayong Station
Average Ambient temperature	28 °C
Average Barometric pressure	1,009 mbar
Average relative humidity	89 %
Daily Maximum rainfall	140 mm

An analysis of the wind data collected from the weather stations was conducted and presented in Table 3.3. For consistency, the two representative wind conditions considered for this QRA are taken from the FEED QRA Report [12], 5/D, i.e. stability class D (Neutral) and strong wind conditions of 5 m/s, and 2/F, i.e. stability class F (Stable) with a wind speed of 2 m/s. It is further assumed that these two wind conditions are equally likely, i.e. each with 50% probability, to represent the day time and calm night-time conditions, respectively.

Table 3.3 Wind Data – Rayong Station

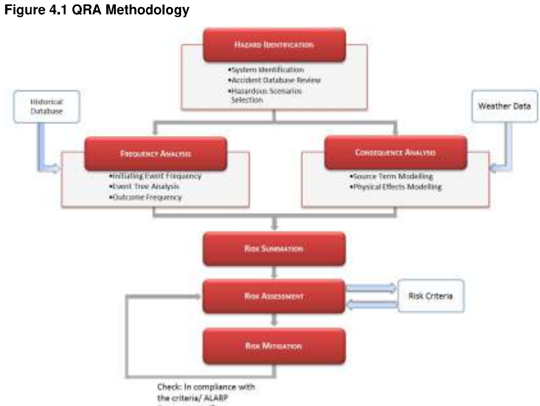
Wind Speed (m/s)	2	5
Atmospheric Stability	F	D
Wind Direction	Percentage of Occurrence	
0	10%	10%
45	0%	0%
90	0%	0%
135	4%	4%
180	13%	13%
225	23%	23%
270	0%	0%
315	0%	0%

4 QRA METHODOLOGY OVERVIEW

A brief overview of the QRA methodology is presented in this section. Further details are provided in the following sections of this report.

A detailed study approach as given by the American Institute of Chemical Engineers Center for Chemical Process Safety (CCPS CPQRA) [13] has been adopted to conduct the QRA. The key elements of this procedure are outlined in Figure 4.1.

Figure 4.1 QRA Methodology



The QRA begins with hazard identification which involves a review of the hazardous properties of the materials processed and stored at the plant and review of worldwide incidents at similar facilities, whereby all relevant hazards are identified and the ways in which those hazards are realised. Specifically, this QRA adopted a 'top down' or 'methodical rupture' approach [14], involving consideration of potential leaks and major releases from fracture of all process pipes, equipment and vessels. As a result, a comprehensive list of potential loss of containment sources is generated as a basis for the subsequent consequence and frequency analysis.

Consequence analysis aims to obtain an estimate of the impact on people of loss of containment events of flammable or toxic substances. This includes the following primary components which are performed with consequence modelling software:

- Source term/ discharge modelling
- Dispersion modelling
- Fire and explosion modelling
- Effects modelling

The likelihood of each loss of containment event identified is estimated in the frequency analysis. By the use of generic failure frequency data, the initiating frequency of the loss of containment event can be estimated. The undesired outcome event (e.g. fire, explosion or toxic gas dispersion) frequencies can be then derived using Event Tree Analysis (ETA). ETA allows the identification and quantification of possible event outcomes in a systematic, logical way following the initiating event. An 'event tree' is developed that graphically illustrates all possible outcomes following realisation of the initiating event; it depicts the chronological sequence of events that could occur following the initiating event, including escalation and mitigation.

Risk estimation combines the estimates of likelihood and consequence for the identified hazardous events to produce a measure of the level of risk, presented as individual risk contours for example.

As part of this QRA, a frequency-based blast assessment for occupied buildings & LNG storage tanks was also carried out to assess the impact on plant buildings and to provide input to the plant building design. This assessment quantifies the impairment likelihood of the concerned buildings, taking into account all identified explosion scenarios and unignited release scenarios. Study results will be presented in the form of Overpressure Exceedance curves (for explosion scenarios). Based on the results of the Blast Study, the Design Accidental Load (DAL) for each building of concern was recommended. For LNG storage tank concrete walls, the DAL for LNG storage tanks will be evaluated based on the maximum overpressure experienced by the LNG storage tank concrete walls.

The QRA was conducted using DNV PHAST 6.7 and IRESC's in-house risk integration tool was used for performing risk summation.

5 HAZARD IDENTIFICATION

Hazard identification involves a review of the hazardous properties of the materials processed and stored at the plant, a review of worldwide incidents at similar facilities and inputs from other studies such as HAZOP/ HAZID etc., whereby all relevant hazards will be identified and

the ways in which those hazards are realised. As a result, a comprehensive list of potential loss of containment sources is generated as a basis for the subsequent consequence and frequency analysis.

5.1 HAZARDOUS PROPERTIES OF LNG

LNG is non-toxic and non-corrosive. Its hazards arise from its cryogenic temperatures and flammable properties. If released to the atmosphere, LNG vaporises to form a vapour cloud. Due to the low temperatures, this vapour cloud is heavier than air and tends to slump as it disperses in the atmosphere. Methane is flammable between 5%vol (LFL) to 15%vol (UFL).

If an LNG spill is ignited, one of several hazardous outcomes may occur, depending on release conditions and time of ignition:

Pool Fire
Spillage of a flammable liquid such as LNG tends to form a spreading pool on the ground. Ignition of this this pool produces a pool fire.

Jet Fire
Jet fires result from ignition of a pressurised release of flammable gas or liquid. The pressure behind the release produces a high velocity jet of gas and/or liquid which entrains air to form a flammable mixture. Ignition of this mixture produces a jet fire. It follows that jet fires may only occur where LNG or NG is being handled under pressure.

Flash Fire
Following an LNG or NG release, if there is no immediate ignition, the vapour will disperse in the atmosphere and gradually be diluted. Some portion of this vapour cloud will have a concentration between the upper flammability limit (about 15%vol) and lower flammability limit (about 5%vol). If this flammable portion of the cloud subsequently comes in contact with an ignition source, the vapour cloud may ignite and burn rapidly with a sudden flash. This is termed a flash fire and is distinct from a vapour cloud explosion in that flame speeds are lower and no significant overpressure is generated. However, direct contact with the burning vapours by persons within the flash fire envelope may cause fatalities. Thermal radiation effects from flash fires are however not significant due to the short duration of the flash fire.

Vapour Cloud Explosion
Since the reactivity of methane is low, a flash fire is the most likely outcome from a delayed ignition of an LNG release. Flame speeds are generally too low to generate damaging overpressures if the vapour cloud is ignited in an unconfined, uncongested area. However, if a vapour cloud is allowed to accumulate in a confined and/ or congested area such as congested process areas, and is then ignited, a vapour cloud explosion (VCE) may result.

Fireball
A fireball would result from immediate ignition of a large release such as from cold catastrophic rupture of a pressurised vessel. Ignition of the rapidly released materials will form a ball of flame rising rapidly into the air and burning out in a short time. This scenario was considered for catastrophic failure of the Recondenser.

BLEVE
A boiling liquid expanding vapour explosion (BLEVE) is an explosion caused by the rupture of a vessel containing a pressurised liquid above its boiling point. A BLEVE involves a rapid phase transition in which a liquid contained above its atmospheric boiling point being rapidly depressurised, causing a nearly instantaneous transition from liquid to vapour with a corresponding energy release. A BLEVE is often accompanied by a large fireball if a flammable liquid is involved, since an external fire impinging on the vapour space of a pressure vessel is a common BLEVE scenario. BLEVE was considered for the Recondenser.

Rapid Phase Transition (RPT)
When LNG comes in contact with water in the event of loss of containment, the cryogenic LNG is rapidly driven to its superheat limit, resulting in spontaneous and explosive boiling of LNG. This is termed Rapid Phase Transition. Though the vapour is generated very rapidly, the impact is localized, causing only marginal overpressures. This may be sufficient to break nearby windows but damage to equipment is not expected. RPT is not expected to present a significant hazard to the occupied buildings onsite or offsite population, and hence is not considered further in this analysis.

5.2 REVIEW OF LNG PAST INCIDENTS

A review of industry incidents related to LNG Terminals was undertaken using well established International accident databases such as Major Accidents Reporting System (eMARS) maintained by the Major Accidents Hazards Bureau (MAHB), Emergency Response Notification System (ERNS) maintained by Right To Know Network (RTK), etc. Some of the major LNG related incidents are briefly described in the following paragraphs.

LNG Tank Failure - Cleveland, Ohio, USA, 1944 [15]
This incident occurred in 1944 at a peak shaving facility in Ohio. An LNG Tank built with a steel alloy comprising of low nickel content failed due to brittle failure of the alloy upon exposure to LNG. The LNG spill resulted in a vapour cloud which filled the streets and sewer system which subsequently ignited leading to 128 fatalities. This incident lead to the inclusion of the use of 9% nickel for LNG Tank construction within the relevant design codes.

LNG spill post unloading – Methane Princess, 1965 [16]
The LNG Unloading Arms were prematurely disconnected before the lines were completely drained. This led to LNG liquid passing through the partially opened valve and spilling on the

drip pan placed underneath the arms. Although seawater was applied as a preventive measure, a star shaped fracture occurred on the deck plating.

Tank Rollover – La Spezia, Italy, 1971 [16]
During unloading operations, the LNG Storage Tank developed a sudden pressure rise resulting in discharge of LNG vapours from the tank safety valves and vents. This resulted in slight damage to the tank roof. However, no ignition occurred. The main reason for this incident was attributed to rollover (two layers if LNG of different densities within the tank).

LNG Tank Fire during construction – Staten Island, USA, 1973 [17]
During the construction of an LNG Storage Tank, a fire occurred in the tank interiors leading to a sudden pressure build up in the tank. This led to lifting/ dislodging of the roof and an internal collapse of the roof on to the workers inside the tank. The incident resulted in a total of 37 fatalities which were attributed to a construction-based incident, rather than process related.

LNG Tank bottom pipe failure – Das Island, UAE, 1978 [16]
The bottom pipe connection of a double walled tank (with 9% nickel steel inner wall and carbon steel outer wall) failed. A large vapour cloud was formed as a result of the failure. However, there was no ignition of this cloud and as a result no damage or injuries occurred.

LNG Storage Tank PSV Release – 1993 [18]
LNG Storage tank PSVs lifted during static mode i.e. when the tank was not being filled. The relief valves opened and closed a few times before the pressure eventually steadied. Icing was found to occur on pallet valves along with a small crack in the outer skin due to valve hammer. No injury or damage was reported. However, in the event of an immediate ignition of the release, there could have been potential damage to the tank roof upon been subjected to high levels of radiation.

Explosion – Skikda, Algeria, 2004 [19]
The explosion of a steam drum was caused by additional vapour drawn into the steam boiler from a leak in the refrigerant system. The steam drum was located in close proximity to the primary leak which resulted in an ignition of the vapour cloud producing an explosion and fireball. The fire and explosion resulted in 27 fatalities and 72 injuries and took about 8 hours to extinguish.

LNG Unloading Arm Leak - SABINE PASS LNG, Cameron, LA, 2012 [20]
LNG was discharged from an unloading arm at the seal during the transfer operation. The overall quantity of LNG discharged was less than one gallon. The LNG vaporised without causing damage to other surfaces in the vicinity. The transfer operation was stopped and maintenance was undertaken for making repair. No fire, damage or injury was reported.

Lightning Strike - Arizona, USA, 2012 [20]

A lightning strike occurred to the LNG Storage Tank vent which resulted in a fire. The fire was however, put out in about 30 seconds upon activation of ESD system by fire detection system. No injury or damage was reported.

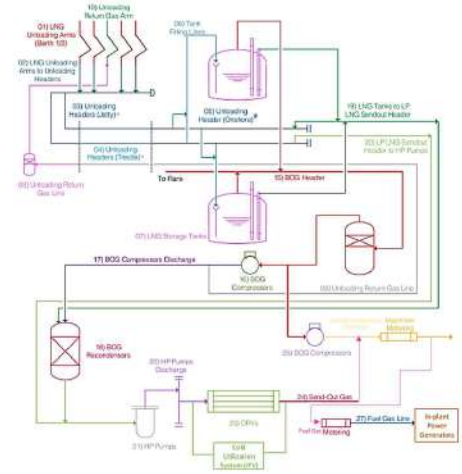
Based on the review, it is concluded that overall LNG facilities have demonstrated a high safety record. No members of the public have been impacted by LNG related incidents since 1944. Additionally, there is an improved understanding regarding handling of cryogenic materials as well as the adoption of high nickel steels for LNG tank construction. Although there have been minor fires and small releases in existing LNG facilities, the hazard was promptly handled by the plant personnel and impact was limited to the plant site. From the above incidents, it may also be concluded that the main hazards arise from the flammable properties of LNG and the risk of fires and explosions.

5.3 HAZARDOUS SCENARIOS IDENTIFICATION

The LNG terminal was divided into 27 sections for analysis, based on process conditions (with reference to the Project Process and Plant Basis of Design [5]) and the provision of emergency shutdown valves for isolation. The hazard sections and the process data considered in the QRA are listed in Table 5.1 and a schematic of the hazardous sections is presented in Figure 5.1.

The storage tanks for the Nong Fab LNG Terminal will be of full containment type with very low failure frequency and details are discussed in Section 7.1.2. Nevertheless, LNG tank failure scenarios have been considered in this QRA.

Figure 5.1 Schematic of the Hazardous Sections*^



Note:
Dual unloading headers are provided for each phase. In other words, a total of four unloading headers will be available in jetty, trestle and onshore sections in Phase II;
* Exact same scheme will be installed in Phase II to provide a completely separated configuration; and
^ Simultaneous operation of unloading system has been considered.

Table 5.1 Hazardous Sections for QRA study

Section Tag	Section Description	Phase (L/G)	Pressure (barg)	Temperature (degC)	Density (kg/m3)*	Mass Flow Rate (kg/s)	HMB Stream
01U	LNG Unloading Arms - Unloading Mode	L	4.4	-158	467	1,816	Case 1-3/ L-1A
02U	LNG Unloading Arms to Unloading Header - Unloading Mode	L	3.2	-157.7	466.4	1,814	Case 1-3/ L-2A/B
03U	Unloading Header (Jetty) - Unloading Mode	L	3.2	-157.7	466.4	1,814	Case 1-3/ L-2A/B
03H	Unloading Header (Jetty) - Holding Mode	L	12.1	-157.1	466.3	54	Case 1-26/ L-2A
04U	Unloading Header (Trestle) - Unloading Mode	L	3.2	-157.7	466.4	1,814	Case 1-3/ L-2A/B
04H	Unloading Header (Trestle) - Holding Mode	L	12.1	-157.1	466.3	54	Case 1-26/ L-2A
05U	Unloading Header (Onshore) - Unloading Mode	L	3.2	-157.7	466.4	1,814	Case 1-3/ L-2A/B
05H	Unloading Header (Onshore) - Holding Mode	L	12.1	-157.1	466.3	54	Case 1-26/ L-2A
06U	Tank Filling Line to Tank - Unloading Mode	L	0.25	-157.7	466.3	1,814	Case 1-3/ L-2A/B
06H	Tank Filling Line to Tank - Holding Mode	L	12.1	-157.1	466.3	109	Case 1-26/ L-2A
070	LNG Storage Tank	L	0.19	-155	454.9	-	-
08U	Return Gas Line (Onshore and Trestle) - Unloading Mode	G	8.5	-13.9	7.3	10	Case 1-3/ B-13
09U	Return Gas Line (Jetty Boundary to Desuperheater) - Unloading Mode	G	8.5	-13.9	7.3	10	Case 1-3/ B-15
10U	Return Gas Arm - Unloading Mode	G	0.15	-140	1.7	5	Case 1-3/ B-15
150	BOG Header (LNG Tanks to BOG Compressors)	G	0.18	-149.1	1.9	10	Case 1-3/ B-11
160	BOG Compressors	G	0.08	-148.9	1.7	10	Case 1-3/ B-12
170	BOG Compressors Discharge	G	8.5	-13.9	7.3	10	Case 1-3/ B-13
180	BOG Recondenser	L	11.9	-157.2	466.5	43	Case 1-3/ L-22

Section Tag	Section Description	Phase (L/G)	Pressure (barg)	Temperature (degC)	Density (kg/m3)*	Mass Flow Rate (kg/s)	HMB Stream
190	LNG Tanks to LP LNG Send-out Header (including LP LNG from tank to LP LNG Send-out Header, LP LNG Send-out Header and Recondenser Mixing Line)	L	11.3	-155.3	463.7	284	Case 1-9/ L-23
200	HP Pump suction LNG lines	L	8.1	-151.3	456.5	287	Case 1-3/L-25
210	HP Pumps	L	8.1	-151.3	456.5	287	Case 1-3/L-25
220	HP Pumps Discharge	L	104.2	-146.4	458.2	287	Case 1-3/L-26
230	ORV/ IFV	L	104.2	-146.4	458.2	287	Case 1-3/L-26
240	Send-out Gas from ORV/ IFV	G	86.2	15.7	89.7	286	Case 1-3/G-1
250	SOG Compressors	G	86.2	48	60.6	4	Case 1-26/B-14
260	SOG Compressors Discharge	G	88	48	60.6	4	Case 1-26/B-14
270	Fuel Gas Line	G	35	-13.4	37	1	Case 1-3/G-3

Note:
* Density is calculated using PHAST based on the process condition.

6 CONSEQUENCE ANALYSIS

Consequence modelling is used to predict the size, shape, and orientation of hazard zones resulting from releases of hazardous material. It generally comprises the following elements:

- Source term/ discharge modelling: This involves estimation of discharge rate, release duration and other physical properties of the released material, such as temperature and pressure. These estimated parameters are then set as the initial conditions for the subsequent dispersion or fire effects modelling.
- Dispersion modelling: This involves mathematical simulation of how the released materials disperse in the ambient atmosphere. Downwind and crosswind concentrations are determined to find the gas cloud hazard footprint.
- Fire and explosion modelling: If the released material comes into contact with an ignition source, it can result in a range of possible fire outcomes such as jet fire, pool fire, flash fire, fireball or explosion, depending on the source term conditions, time of ignition, the strength of ignition source, etc. It is possible to predict the fire behaviour with numerical or empirical models, whereby the size of the flame and the heat radiation zone can be estimated. Similarly, blast overpressure resulting from a gas explosion can also be predicted with mathematic models.
- Effects modelling: This involves determination of the magnitude of damage caused by exposure to fire, heat radiation, overpressure or toxin. With the help of probit functions, the probability of fatality or injury can be related to thermal radiation levels and exposure duration. Similarly, the harm probability can be determined for different explosion overpressure levels.
- Mitigation: By altering the source term of the models, it is possible to quantify the reduction of hazardous zone from a release due to the effects of mitigation measures such as impoundment basins.

For this QRA, DNV PHAST V6.7 was used to model all consequences.

6.1 LEAK SIZES

Four hole sizes were considered in this study, which are the same as FEED QRA [12], including:

- Full bore rupture of piping or catastrophic vessel failure;
- 100 mm release, representing a large leak;

- 50 mm release, representing a significant leak from equipment such as a flange or instrument tapping failure; and
- 12.5 mm release, representing pin-hole leakage.

6.2 SOURCE TERM MODELLING

6.2.1 Release Rate Calculation

In the event of a catastrophic rupture of a vessel, the Instantaneous Model in PHAST was used to model the rapid release of the entire inventory, where the material in the vessel is expanded from initial conditions to atmospheric pressure. For releases from holes in pipes/ vessels, release rate was calculated using standard orifice type calculations based on process conditions and leak size.

For gas releases, the pressure in the system, and hence the release rate, will slowly decrease following isolation, resulting in a time dependent release. As a conservative approach, the calculated initial release rate was assumed constant over the release duration for such scenarios.

For large leaks from liquid streams (e.g. guillotine failure of pipes, 100 mm leaks etc.), the release rate calculated from orifice type calculations is compared with the pumping rate. If the calculated release rate exceeds the normal pumping rate, the discharge rate was capped at 1.3 times the pumping rate to reflect pump curve characteristics. This was applied to all leak locations downstream of a pump.

A summary of the discharge rate modelling results is shown in Table 6.1.

Table 6.1 Discharge Rate Summary

Section No.	Section Description	Hole Size (mm)	Release Rate (kg/s)
01U	LNG Unloading Arms - Unloading Mode	012	1.4
		050	23.7
		100	94.8
		RUP	2,350
02U	LNG Unloading Arms to Unloading Header - Unloading Mode	012	1.2
		050	20.2
		100	80.8
		RUP	2,350
03U	Unloading Header (Jetty) - Unloading Mode	012	1.2
		050	20.2
		100	80.8
		RUP	2,350

Section No.	Section Description	Hole Size (mm)	Release Rate (kg/s)
03H	Unloading Header (Jetty) - Holding Mode	012	2.3
		050	39.2
		100	69.9
		RUP	69.9
04U	Unloading Header (Trestle) - Unloading Mode	012	1.2
		050	20.2
		100	80.8
		RUP	2,350
04H	Unloading Header (Trestle) - Holding Mode	012	2.3
		050	39.2
		100	69.9
		RUP	69.9
05U	Unloading Header (Onshore) - Unloading Mode	012	1.2
		050	20.2
		100	80.8
		RUP	2,350
05H	Unloading Header (Onshore) - Holding Mode	012	2.3
		050	39.2
		100	69.9
		RUP	69.9
06U	Tank Filling Line to Tank - Unloading Mode	012	0.3
		050	5.6
		100	22.6
		RUP	2,350
06H	Tank Filling Line to Tank - Holding Mode	012	2.3
		050	39.2
		100	141.2
		RUP	141.2
070	LNG Storage Tank	CAT	-
08U	Return Gas Line (Onshore and Trestle) - Unloading Mode	012	0.2
		050	3.0
		100	11.9
		RUP	110.8
09U	Return Gas Line (Jetty Boundary to Desuperheater) - Unloading Mode	012	0.2
		050	3.0
		100	11.9
		RUP	110.8
		CAT	-
10U	Return Gas Arm - Unloading Mode	012	0.014
		050	0.3
		100	1.0

Section No.	Section Description	Hole Size (mm)	Release Rate (kg/s)
		RUP	26.7
150	BOG Header (LNG Tanks to BOG Compressors)	012	0.017
		050	0.3
		100	1.2
		RUP	99.1
		CAT	-
160	BOG Compressors	012	0.011
		050	0.2
		100	0.38
		RUP	64.5
170	BOG Compressors Discharge	012	0.2
		050	3.0
		100	11.9
		RUP	197
180	BOG Recondenser	012	2.2
		050	38.9
		100	155.6
		CAT	-
190	LNG Tanks to LP LNG Send-out Header (including LP LNG from tank to LP LNG Send-out Header, LP LNG Send-out Header and Recondenser Mixing Line)	012	2.2
		050	37.8
		100	151.2
		RUP	371.4
200	HP Pump suction LNG lines	012	1.8
		050	31.8
		100	127.1
		RUP	371.6
210	HP Pumps	012	1.8
		050	31.8
		100	127.1
		RUP	371.6
220	HP Pumps Discharge	012	6.5
		050	113.1
		100	372.4
		RUP	372.4
230	ORV/ IFV	012	6.85
		050	113.1
		100	372.4
		RUP	372.4
240	Send-out Gas from ORV/ IFV	012	1.7
		050	28.7
		100	114.6

Section No.	Section Description	Hole Size (mm)	Release Rate (kg/s)
		RUP	2,100
250	SOG Compressors	012	1.5
		050	26.7
		100	106.8
		RUP	110
260	SOG Compressors Discharge	012	1.5
		050	26.7
		100	106.8
		RUP	248.2
270	Fuel Gas Line	012	0.7
		050	11.9
		100	47.8
		RUP	49.3

6.2.2 Release Duration & Inventory

Release duration is another important output from the discharge modelling which is determined by the upstream inventory and means of leak detection and isolation. The total release inventory was calculated as the sum of the piping/ equipment inventory within the isolatable section and the inflow inventory until isolation is achieved. The total release inventory was calculated for each of the identified hazardous sections.

Typically, the time required for isolation will vary between normal process area and jetty area due to differences in operation, and safety measures in place. With the provision of low temperature, gas and fire detectors and emergency shutdown system, it was assumed that isolation can be achieved within 2 minutes under normal conditions. However, it is possible for the isolation system to fail, in which case it is assumed that manual intervention can achieve isolation within 10 minutes. In the event of unloading arm failure, a shorter isolation time of 30 seconds (for isolation success case) and 2 minutes (for isolation failure case) was assumed, taking into consideration the additional safety measures such as excessive movement detection and isolation in the unloading arm, and the presence of operators in the vicinity to activate emergency shutdown manually during unloading operations.

6.2.3 LNG/ NG Source Terms

The loss of containment of LNG can result in a wide range of behaviour, including liquid jets, two phase jets, evaporating pools, etc., depending on factors such as the storage conditions. The LNG source terms relevant to the study can be broadly categorised as jet releases and pool spread and vaporisation.

Jet Release (liquid and two-phase)

For the case of an unobstructed jet, a large fraction of the LNG may vaporise in the air before the liquid rains out and forms a pool. The amount of vaporisation from the jet will depend on the ambient temperature, the pressure and temperature of the LNG, the initial velocity of the liquid, the orifice size, the fluid trajectory, atomisation of the liquid spray and the entrainment rate of fresh air. Jet releases were modelled as unobstructed horizontal releases as this tends to give the most vaporisation and largest consequence distances and is hence conservative.

Pool Spread and Vaporisation

Formation of a liquid pool allows the LNG to spread from the release point, absorb heat from the ground and create an extended area source of gas. Lower pressure releases of LNG with a larger liquid fraction are expected to produce liquid pools. Vessels will be unable to maintain pressure in the event of catastrophic failures or large leaks from liquid piping systems (where discharge rate is limited to pump volumetric flow rate). With these lower pressure releases, release momentum is lower and hence air entrainment and aerosol formation is less. This implies less heat transfer with the air and more liquid rainout to the ground to form a pool.

Impoundment basins are provided to contain LNG leaks up to a certain volume, beyond which the pool is likely to spread beyond the impoundment pit. The impoundment pits provided at various locations of the plant are presented in Figure 6.1, with their respective volume and surface areas shown in Table 6.2. In order to reflect this in the modelling, the total release inventory was compared against the impoundment pit volume. If the release inventory is larger than the impoundment pit volume, overfilling of the pit is expected and these scenarios were modelled as unconfined pools with no credit from impoundment pit. The scenarios considered as confined pool are presented in Annexure A.

Figure 6.1 Impoundment Pit Locations – Process Area

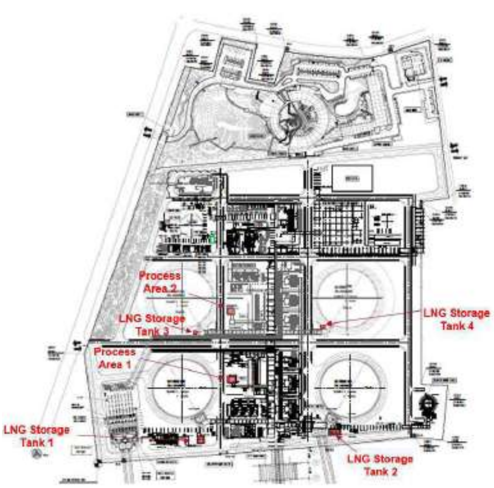


Figure 6.2 Impoundment Pit Locations – Jetty Area

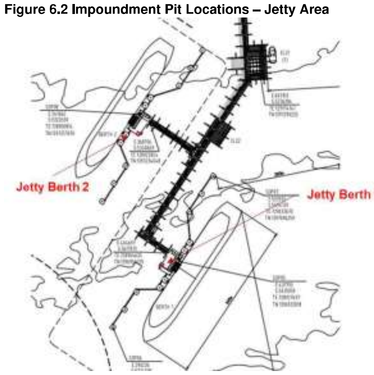


Table 6.2 Impoundment Pit Dimensions [21]

Impoundment Pit	Length (m)	Width (m)	Area (m^2)	Depth (m)	Net Vol. (m^3)
Jetty Berth 1	2	2	4	3	12
Jetty Berth 2	2	2	4	3	12
Process Area 1	10	10	100	8	800
Process Area 2	10	10	100	8	800
LNG Storage Tank 1	10	10	100	8	800
LNG Storage Tank 2	15.6	6.4	100	8	800
LNG Storage Tank 3	10	10	100	8	800
LNG Storage Tank 4	10	10	100	8	800

Gas Release

All gas phase releases are assumed to be under pressure and form a high momentum jet. This jet entrains air to form a flammable gas cloud. Since momentum jet releases are modelled as steady-state releases at the initial discharge rate, and there will be sufficient inventory to maintain a release for some time, particularly for the smaller leak sizes, there is no difference between 2 minutes and 10 minutes gas releases in the consequence modelling.

6.3 DISPERSION MODELLING

Dispersion modelling involves mathematical simulations of how the released materials disperse in the ambient atmosphere. Downwind and crosswind concentrations were determined to find the gas cloud hazard footprint. Vapour dispersion modelling for NG/ LNG releases was conducted using the PHAST's Unified Dispersion Model (UDM). The model considers the following aspects of vapour cloud behaviour in dispersion modelling:

- Continuous, instantaneous or time-varying releases
- Jet, heavy-gas and passive dispersion
- Elevated, touchdown and ground level dispersion
- Droplet dispersion, rainout and droplet vaporisation
- Dispersion over land or water surfaces

The UDM vapour dispersion model was validated and approved by the U.S. government in 2011[1] for modelling of LNG dispersion.

The LNG Terminal is approximately 8 m above sea level. The concrete sea wall at the terminal sea shore boundary and the slumping nature of cold LNG vapour are assumed to reduce the dispersion distance of flammable gas cloud generated by an LNG pool formed on sea surface following any loss of containment scenarios from the headers on trestle. The effect of such elevation difference was taken into consideration in reducing the dispersion consequence distance associated with headers on the trestle.

[1] The scenarios approved are dispersion from circular shaped LNG pools, dispersion from LNG pools in impoundments with low aspect ratios, dispersion from releases in any direction, including releases from flashing, venting, and pressure relief.

6.4 FIRE AND EXPLOSION MODELLING

6.4.1 Flash Fire

A flash fire results from delayed ignition of a flammable vapour cloud, generated either through vaporisation directly from the release, or from vaporising pools. The main hazards of a flash fire being direct flame contact.

The area of possible direct flame contact effects is determined as the distance to the lower flammability limit (LFL) of the vapour cloud. Due to the extreme short duration of a flash fire, radiation effects are negligible.

6.4.2 Jet Fire

A jet fire results from immediate ignition of the flammable gas or liquid from a pressurised release. The main hazards from a jet fire are direct flame contact and radiation, both of which are modelled using default parameters in PHAST, with release orientation set at horizontal non-impinging.

6.4.3 Pool Fire

A pool fire results from upon ignition of a liquid LNG pool due to failure of process vessel/ piping. Both confined and unconfined pool fires were modelled in this study.

Bund/ confined pool fires were modelled for scenarios where impoundment pit is assumed to be effective, i.e. where released LNG does not exceed impoundment pit volume. The surface area of the impoundment pit was modelled as the equivalent area of the pool fire. For scenarios where unconfined pool fire is to be modelled, the pool fire was modelled as early pool fire which takes into account the release rates, rainout, pool spreading and vaporisation rates.

6.4.4 Vapour Cloud Explosion (VCE)

When a flammable vapour cloud forms, disperses and accumulates in areas with high congestion or confinement, and is then ignited, a Vapour Cloud Explosion (VCE) may result.

The Baker-Strehlow Tang (BST) model was used in modelling the overpressure generated from a VCE. The overall process performed for VCE modelling is as follows (CCPS):

- Predict the energy of the explosion. In this step, the mass of fuel involved in the explosion is predicted based on dispersion modelling and the intersection of the predicted cloud with the congested/confined volume estimated. A ground reflection factor may be used, where appropriate to account for explosions occurring close to ground level.
- Predict the severity of the explosion. For BST model, the flame speed was calculated based on the congestion and confinement level of the Potential Explosion Site (PES) and fuel reactivity.
- Determine blast parameters in the dimensionless curves. The blast curves use severity/ flame speed and energy, and stand-off distance (distance from blast source to receptor) to determine scaled overpressure, impulse/ duration, and other parameters.
- Un-scale the blast parameters. The blast parameters are then converted from dimensionless to dimensional parameters using atmospheric pressure, explosion energy, and speed of sound.
- Apply reflection factors and other corrections. Reflection factors and other factors to account for real-world geometry effects can be applied to the blast prediction

A total of seven (7) representative Potential Explosion Sites (PES) in the process area and two (2) in the jetty area were identified based on the plot plan. These PESs are shown in Figure 6.3 and Figure 6.4.

The BST methodology requires selection of the maximum flame speed based on three main parameters: fuel reactivity, confinement, and congestion. The fuel reactivity of natural gas is

considered to be low. The volume, levels of confinement and congestion considered for each PES are summarised in Table 6.3.

As a simplified approach, it is assumed that all PES in process areas will be saturated with flammable gas for all leak scenarios in the process area. The same assumptions were also applied for PES in the jetty area. Although there is some degree of conservatism in this approach; it is considered to be a reasonable assumption since the VCE effects are not a significant contributor to the overall risks, as will be seen in the later risk analyses.

A Building Risk Analysis is performed in Section 9 to study the potential explosion impact to the LNG Storage tanks and onsite buildings.

Figure 6.3 Potential Explosion Sites (PES) – Process Area

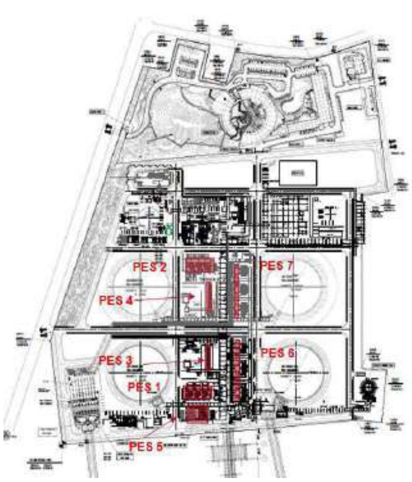


Figure 6.4 Potential Explosion Sites (PES) – Jetty Area

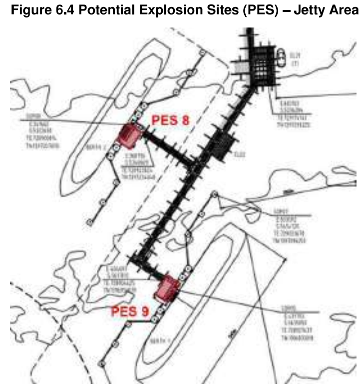


Table 6.3 Details of PES

PES	Description	Volume (m^3)	Level of Congestion	Level of Confinement
1	BOG Compressors – Phase I	8,100	M	2.5
2	BOG Compressors – Phase II	5,200	M	2.5
3	HP Pumps – Phase I	3,500	M	2.5
4	HP Pumps – Phase II	2,300	M	2.5
5	Send-out Gas Compressors	5,200	M	2.5
6	Open Rack Vaporizers – Phase I	9,300	M	3
7	Open Rack Vaporizers – Phase II	6,300	M	3
8	Berth 1 – Phase I	5,800	M	2.5
9	Berth 2 – Phase II	5,800	M	2.5

6.4.5 Fireball

A fireball would result from immediate ignition of a release resulting from cold catastrophic rupture of a pressurised vessel. Ignition of the rapidly released materials will form a ball of flame rising rapidly into the air and burning out in a short time. Fireballs were considered for instantaneous failure of process vessels such as BOG Recondenser.

6.5 END POINT CRITERIA

Probit functions are used to estimate the probability of fatality due to a physical effect, e.g. thermal radiation, overpressure etc.

6.5.1 Flash Fires

All persons outdoor within the flash fire envelope (LFL contour) are assumed to be fatally injured i.e. fatality rate of 100%. Persons outside the LFL contour are assumed to be unaffected by the incident. A factor of 0.1 was considered for persons inside building to allow for the shielding protection offered by the building.

6.5.2 Thermal Radiation

As discussed in the previous section, the main hazard for jet fire, pool fire and fireball is personnel being exposed to the thermal radiation. The probability of fatality due to the exposure to thermal radiation can be calculated with the probit equation [22] in the following form:

$$\mathrm{Pr} = -36.38 + 2.56 \times \ln\left(Q^{4/3} \times t\right)$$

Where,

Pr is the probit;

Q is the heat radiation (Wm^{-2}); and

t is the exposure time (s).

While both pool fire and jet fire scenarios in this study are expected to last for some duration, the exposure time, *t*, is limited to a maximum of 30s. This is considered a reasonable time for an able person to seek shelter from the fire. Since fireball scenarios are usually of short duration (less than 30 seconds), the probit was calculated using the actual fireball duration as the exposure time.

For risk calculation purposes, three levels of thermal radiation were used, as summarised in Table 6.4. These correspond to a probability of fatality of 1%, 50% and 99.9%.

Table 6.4 End Points for Consequence Modelling

Thermal Radiation (kW/m²)	Probability of Fatality	Geometric Mean
7.3	1%	} 7%
14.1	50%	
35.5	99.9%	} 70.7%

The fatality calculation uses the geometric mean for estimating the probability of fatality for areas between two radiation levels. For example, those persons exposed to radiation levels between the 7.3 and 14.1 kW/m² contours will have a probability of fatality between 1% and 50%. Taking the geometric mean of these values (7%) is a reasonably accurate area-weighted average fatality rate over this area. In addition to thermal radiation effects, 100% fatality is also assumed for any person outdoors who is within the flame zone of a pool fire, jet fire or fireball.

Similar to flash fire scenarios, a factor of 0.1 was applied on probability of fatality for persons indoor.

6.5.3 Overpressure Effects

The following probit equation [22] for lung damage was used to obtain the overpressure end points for personnel outdoors:

$$\mathrm{Pr} = -77.1 + 6.91 \times \ln\left(p^{0}\right)$$

Where,
Pr is the Probit; and
p^0 is the peak overpressure (Pa).

In contrast, persons indoor have a higher harm probability due to building collapse and flying debris such as breaking windows. For consistency, the fatality probabilities used in this study were taken from FEED QRA Report [12]. The end points for overpressure modelling are listed in Table 6.5.

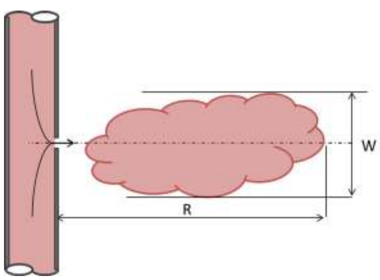
Table 6.5 End Points for Overpressure Effect Modelling

Probability of Fatality	Overpressure (bar)	
	Indoor	Outdoor
1%	0.1	1
50%	0.28	1.45
99%	1	2

6.6 CONSEQUENCE RESULTS AND ANALYSIS

The effects zone for each hazardous outcome is presented in terms of the maximum downwind extent and hazard width as shown in Figure 6.5. A full set of the consequence modelling results are presented in Annexure B.

Figure 6.5 Presentation of Consequence Results



Where
R: maximum downwind range of consequence
W: maximum width of consequence

6.7 FLAMMABLE GAS DISPERSION AND THERMAL RADIATION ANALYSIS

6.7.1 Impoundment Pits

The NFPA 59A [6] requires that the thermal radiation flux from a fire in an impounding area shall not exceed 5 kW/m² at the property line and the vapour dispersion distance to ½ LFL does not extend beyond the property limit.

As part of this LNG Terminal, impoundment pits will be provided at the jetty, near LNG storage tanks and process area to collect any LNG spillage from the nearby piping and equipment. A dispersion and radiation analysis was carried out for the impoundment pits using PHAST V6.7. The modelling parameters are summarised below:

- Rich LNG composition considered in the modelling (refer to Table 2.2);
- Weather condition of 2F considered for flammable gas dispersion analysis and 10C for thermal radiation analysis, representing the worst case whether conditions for the site;
- Solar radiation of 1 kW/m²;
- Average ambient temperature of 28 °C and relative humidity of 89%;
- Surface roughness of 100 mm; and
- High expansion foam provided for the Process Area and LNG Storage Tank impoundment pits as mitigation measure, which reduces the LNG pool evaporation rate to 40% of the unmitigated case and thereby reduces the flammable dispersion distances. In addition, based on high expansion foam vendor feedback [23], high expansion foam can reduce thermal radiation by 90%.

The consequence distances for thermal radiation and flammable gas dispersion from the impoundment pits are summarised in Table 6.6 and the side view of the dispersion contours are presented in Annexure C.

Table 6.6 Impoundment Pit Thermal Radiation and Flammable Gas Dispersion Distances

Description	Pit Area (m²)	Distance to LFL (m)	Distance to Thermal Radiation (m)		
		½ LFL	30 kW/m²	15 kW/m²	5 kW/m²
Jetty Berth	4	76	3	5	7
Process Area	100	140	Not Reach	6	23
LNG Storage Tank	100	140	Not Reach	6	23

The radiation and dispersion contours for the Jetty Berth impoundment pit are shown in Figure 6.6 and Figure 6.7, respectively. As shown, the ½ LFL and 5 kW/m² contours are confined within the Jetty area.

Figure 6.6 Thermal Radiation Contour for Jetty Berth 1 Impoundment Pit

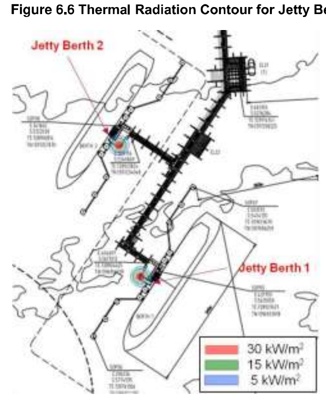
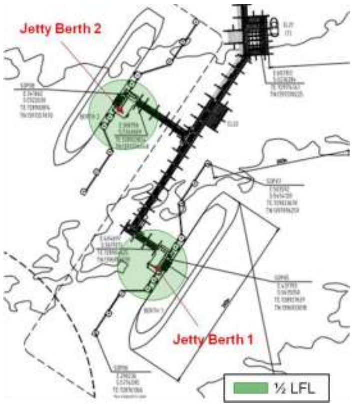


Figure 6.7 ½ LFL Contour for Jetty Berth 1 Impoundment Pit



The radiation and dispersion contours for the terminal-side impoundment pits are shown in Figure 6.8 to Figure 6.11. With the mitigation effect of the high expansion foam, both the 5 kW/m^2 and the ½ LFL contour are confined within the site boundary, also the 15 kW/m^2 contours are confined around the impoundment pits only without impacting any other equipment / storage tank; therefore, no further mitigation is required in this regard.

Figure 6.8 Thermal Radiation Contour for Process Area Impoundment Pits

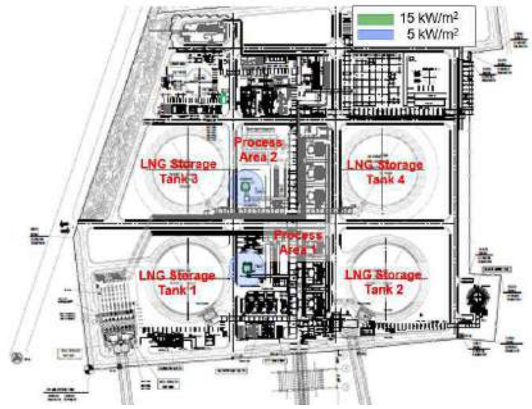


Figure 6.9 Thermal Radiation Contour with for LNG Storage Tank Impoundment Pits

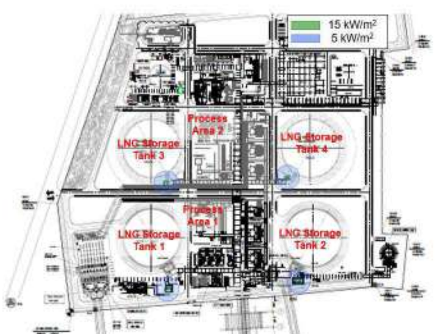


Figure 6.10 ½ LFL Contour with for Process Area Impoundment Pits

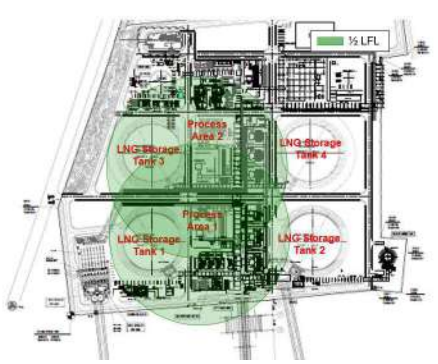
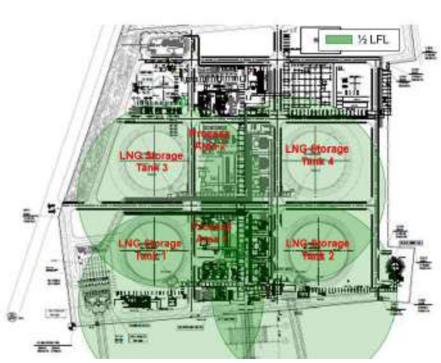


Figure 6.11 ½ LFL Contour for LNG Storage Tank Impoundment Pits



6.7.2 LNG Tank PSVs

A LNG Tanks – Atmospheric PSVs' Dispersion and Radiation Calculation was performed by SPCC [24] for PSV relief cases on the LNG storage tanks to demonstrate conformity to the following requirements from NFPA 59 A [6] and BS EN 1473 [25]:

- The average concentration of LNG vapours at the property line do not exceed ½ LFL for a design leak;
- For fire cases, the thermal radiation levels at the property line do not exceed 5 kW/m^2; and,
- Radiation levels on the concrete walls and roof of the full containment storage tanks do not exceed 32 kW/m^2.

Both ignited and unignited PSV release cases were investigated in the report. The result for ignited PSV release scenario showed that with a PSV tail pipe length of 23 m, the radiation level at the concrete dome top is within the acceptable limit of 32 kW/m^2. The thermal radiation levels at the main operating platform and the PSV platform do not exceed the acceptable limit of 15 kW/m^2. The radiation level at grade and on external wall of the adjacent LNG tank are less than 5 kW/m^2. The result for unignited PSV release scenario showed that under 2 m/s wind speed, personnel on tank top during PSV lifting will not be directly exposed to flammable gas clouds. The ½ LFL contour of the LNG cloud also does not exceed beyond the property line.

The followings are recommended in the SPCC study [24]:

- The length of PSVs tail pipe outlet shall be at 23 m from the tank dome centre.
- Operating procedure shall be followed for personnel working at tank platform in case of accidental ignition of PSV release to prevent the personnel exposure to thermal radiation/ flammable gas cloud.

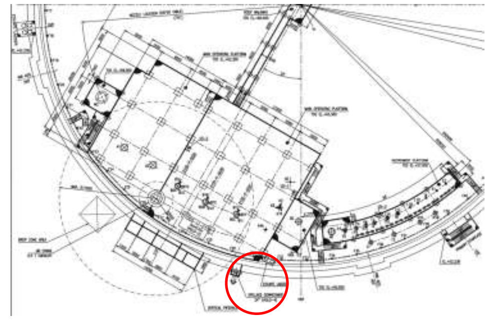
6.7.3 LNG Storage Tank Roof Fires

Tank roof failure and subsequent fire for a full containment tank is normally not considered in the design or in the risk assessment. This also in line with BS EN 1473 [25] which states that tank failure scenarios (including tank roof or tank body release) are not required to be considered in risk assessment if full containment tanks of pre-stressed concrete are used.

In the 2013 edition of NFPA 59A (2013, Section 5.3.4.2) states that full containment LNG containers shall be spaced considering "A fire over the whole surface of the liquid contained in the tank, assuming the roof is completely lost". Such requirement was removed in the 2016 edition of NFPA 59A [6].

With regard to LNG piping failure at the LNG tank roof, the flooring of the operating / PSV platform is provided with collection pan to collect the spillage and prevent accumulation of LNG spill on the platform. The LNG released are expected to be directed to the grade and subsequently collected in the impoundment pit from the side of LNG Storage Tank and spillage downcomer. In light of these, the scenario of tank roof fire due to LP LNG pump spillage is not considered in the QRA study. The schematic of the main operating platform and PSV/ VSV platform on the LNG Storage Tank is presented in Figure 6.12.

Figure 6.12 LNG Tank Layout [26]

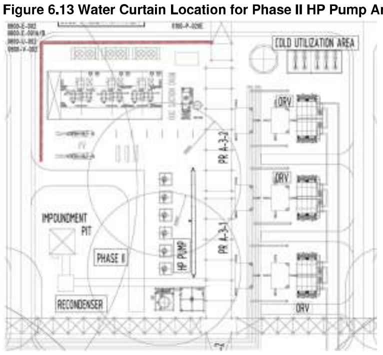


6.8 CONSEQUECNCE MITIGATION

6.8.1 Water Curtain near Phase II HP Pumps

Water curtain is installed near the Phase II HP pump area, as presented in Figure 6.13. With this installation, the flammable gas concentration after passing through the water curtain is reduced due to air entrainment and dilution effect of the water curtain. A reduction factor of 50% is used in the assessment, the same as the reduction factor implemented in the FEED QRA study for gas dispersion through water curtain [32]. This reduction is applied for flash fire consequences of HP Pump suction lines section with wind blowing from the HP Pump area towards the water curtain (i.e. wind blowing from Plant North and Plant North-West). It is worth to note that the intention for installing water curtain near the Phase II HP Pumps area is to mitigate the flash fire consequence due to leakage at HP Pump suction, and flash fire with subsequent jet fire / pool fire is not considered as simultaneous events in the QRA study.

Figure 6.13 Water Curtain Location for Phase II HP Pump Area



7 FREQUENCY ANALYSIS

7.1 INITIATING EVENT FREQUENCY

7.1.1 Base Frequencies

The initiating leak event frequencies for the new LNG Receiving Terminal were derived from historical data of similar facilities. The generic frequencies dataset selected for this QRA are presented in Table 7.1. The selected frequencies are the same as the frequencies used in FEED QRA study [12].

Table 7.1 Base Leak Frequencies

Equipment	Release Scenario	Frequency	Unit	Reference
Unloading Arm	i) Leak	3.00E-06	per operating hour	COVO Study [27]
	ii) Full bore rupture	3.00E-08	per operating hour	COVO Study
Pipe Size 600mm to 900mm	i) 12.5 & 50 mm hole	1.00E-07	per metre per year	Hawksley [28]
	ii) 100 mm hole	7.00E-08	per metre per year	Hawksley
	iii) Full bore rupture	3.00E-08	per metre per year	Hawksley
Pipe Size 400mm to 500mm	i) 12.5 & 50 mm hole	3.00E-07	per metre per year	Hawksley
	ii) 100 mm hole	1.10E-07	per metre per year	Hawksley
	iii) Full bore rupture	5.00E-08	per metre per year	Hawksley

Equipment	Release Scenario	Frequency	Unit	Reference
Pipe Size 200mm to 250mm	i) 12.5 & 50 mm hole	7.00E-07	per metre per year	Hawksley
	ii) 100 mm hole	3.00E-07	per metre per year	Hawksley
	iii) Full bore rupture	1.20E-07	per metre per year	Hawksley
Pipe Size 150mm to 175mm	i) 12.5 & 50 mm hole	9.00E-07	per metre per year	Hawksley
	ii) 100 mm hole	4.00E-07	per metre per year	Hawksley
	iii) Full bore rupture	1.50E-07	per metre per year	Hawksley
Pumps	i) Leak	5.00E-05	per year	"Purple Book" [29]
	ii) Catastrophic rupture	1.00E-05	per year	"Purple Book"
Process vessel	i) 12. 5 mm hole	1.00E-05	per year	Crossthwaite [30]
	ii) 50 & 100 mm hole	5.00E-06	per year	Crossthwaite
	iii) Rupture	2.00E-06	per year	Crossthwaite
ORV	I) Leak	1.00E-03	per year	"Purple Book"
	II) Rupture	1.00E-05	per year	"Purple Book"
Compressor	i) Leak	4.40E-03	per year	RIVM [31]
	ii) Rupture	1.00E-04	per year	RIVM
LNG Tank	i) Rupture	1.00E-08	per year	RIVM

7.1.2 Review of Base Frequency Data

A number of sources are referenced for the base frequency data listed in Table 7.1, including a few older sources such as COVO (1982) [27], Hawksley (1984) [28] and Crossthwaite (1988) [30], to be consistent with the previous QRA studies for PTT LNG [12] [34]. Despite this, a comparison of the QRA failures data was performed against the recent, recognised failure data sources, including UK HSE Land Use Planning (LUP) [35], Dutch Reference Manual Bevi Risk Assessment (RIVM) [31] and NFPA 59A (2016) [6], as summarised in Table 7.2. In general, the base failure frequencies adopted in this QRA for piping, vessels and canned pumps are in good agreement with the UK HSE LUP, and NFPA, and considered comparable with the RIVM.

Table 7.2 Comparison of Leak Frequencies

Source	Hole sizes*	Pipework: Pipe size 600-900 mm	Pipework: Pipe size 400-500 mm	Pipework: Pipe size 200-250mm	Pipework: Pipe size 150-175 mm	Canned Pump	Compressor	Vessel	Heat Exchanger (ORV/ IFV)	Unloading Arm
		(/m-year)	(/m-year)	(/m-year)	(/m-year)	(/year)	(/year)	(/year)	(/year)	(/hour)
UK HSE	Small	1.1E-06	1.3E-06	1.7E-06	1.7E-06	-	-	5.5E-05	-	-
	Medium	1.0E-07	2.0E-07	4.0E-07	4.0E-07	-	2.7E-04	5.0E-06	-	1.2E-06
	Large	4.0E-08	7.0E-08	2.0E-07	2.0E-07	-	2.9E-06	6.0E-06	-	9.5E-07
RIVM	Small	-			-	-	-	1.0E-04	1.0E-03	-
	Medium	5.0E-07			2.0E-06	5.0E-05	4.4E-03	5.0E-06	1.0E-05	3.0E-07
	Large	1.0E-07			3.0E-07	1.0E-05	1.0E-04	5.0E-06	-	3.0E-08
NFPA	Rupture	1.0E-07				-	1.0E-04	5.0E-07	5.0E-05	3.0E-08
Base Frequency	Small	1.0E-07	3.0E-07	7.0E-07	9.0E-07	-	-	1.0E-05	1.0E-03	-
	Medium	7.0E-08	1.1E-07	3.0E-07	4.0E-07	5.0E-05	4.4E-03	5.0E-06	1.0E-05	3.0E-06
	Large	3.0E-08	5.0E-08	1.2E-07	1.5E-07	1.0E-05	1.0E-04	2.0E-06	-	3.0E-08

Note:
* Small – 12.5 mm leak; Medium – 50 mm leak; and Large – 100 mm leak

Full Containment Tanks

A full containment tank consists of a primary container for the liquid and a secondary container. The latter is designed to collect both the liquid and the vapour in the event of a failure of the primary container and can withstand all possible stresses, such as explosions (static compression stress of 0.3 bar for 300 ms), fragments and cold thermal stress. The outer roof is supported by the second containment housing and is able to withstand stresses, such as explosions.

Both RIVM and NFPA 59A (2016 version) [6] suggests a frequency of 1×10^{-8} per year to be considered for instantaneous failure of both primary and secondary containments of the tank leading to release of the entire contents for full containment tanks. It is also stated in BS EN 1473 (2016) [25] that tank failure scenarios (including tank roof or tank body release) are not required to be considered in risk assessment if full containment tanks of pre-stressed concrete are used. Despite the very low frequency associated with full containment type LNG Storage tank, tank failure scenario has been considered in this QRA.

7.1.3 Leak Frequency Reduction with Flange Guard Installation on LP LNG Header

For the LP LNG Header, flange guards are installed for the containment of leaks and spray-outs from flange connections, which serves as a barrier minimizing the jet effects of high pressure LNG release. As such, LNG releases at flanges was assumed to result in pool fire and flash fire.

A detailed parts count of different components (i.e. valves, flanges, instrument, piping, etc.) using P&IDs [37] was performed for LP LNG Header sections. The parts count estimated was combined with the generic leak frequency data [33], and a reduction factor for each hole size were applied based on the estimated flange release frequency contribution.

7.1.4 Leak Frequency Estimates

Since all LNG piping are welded with flanges present only at equipment connections, piping failure frequencies are estimated simply as a function of pipe length rather than through a detailed parts count of flanges and valves.

Notably, there has been no major LNG loss of containment accident in the history of modern LNG facilities. As the generic failure data was derived based on various oil and gas and other process facilities, it is considered conservative to apply such data for LNG facilities, due to:

- LNG facilities are clean and corrosion free service, unlike other manufacturing facilities which involves handling of fluids containing H_2S, CO_2, etc.
- LNG pipes will have minimum number of flanges and joints and use welded connections to the extent possible.

- DNV have compared failure rate data for LNG facilities with general failure data and found that LNG failure frequencies may be significantly lower, around 40% to 65% of the general failure data. [32]

Considering the above, a modifying factor of 0.5 was taken for pipeworks in LNG service.

A count of equipment numbers in each of the process sections was made from a review of the Process Flow Diagram (PFD) [38] and pipework lengths were estimated from the terminal plot plans. These were combined with the generic failure frequency as given in Table 7.1 to determine the release frequency for each section. For systems which operate only intermittently (e.g. loading arms, unloading header, etc.), operating factors were considered in the frequency analysis based on the anticipated time in operation over the year.

The calculated leak frequency results are summarised in Table 7.3.

Table 7.3 Leak Frequencies of Plant Sections

Section No.	Description	Equipment Type	No. of Equipment	Operating Factor^	Total Piping Length (m)	Diameter (inches)	Leak Frequency: 12mm	Leak Frequency: 50mm	Leak Frequency: 100mm	Leak Frequency: RUP	Leak Frequency: CAT
01U	LNG Unloading Arms - Unloading Mode	Loading Arm	8	1,360‡	-	28	1.09E-02	1.09E-02	1.09E-02	3.26E-04	0.00E+00
02U*	LNG Unloading Arms to Unloading Header - Unloading Mode	Piping	-	0.16	510	42	3.95E-06	3.95E-06	2.77E-06	1.19E-06	0.00E+00
03U*	Unloading Header (Jetty) - Unloading Mode	Piping	-	0.16	530	42	4.10E-06	4.10E-06	2.87E-06	1.23E-06	0.00E+00
03H*	Unloading Header (Jetty) - Holding Mode	Piping	-	0.84	530	42	2.23E-05	2.23E-05	1.56E-05	6.68E-06	0.00E+00
04U*	Unloading Header (Trestle) - Unloading Mode	Piping	-	0.16	25,450	42	1.97E-04	1.97E-04	1.38E-04	5.92E-05	0.00E+00
04H*	Unloading Header (Trestle) - Holding Mode	Piping	-	0.84	25,450	42	1.07E-03	1.07E-03	7.52E-04	3.22E-04	0.00E+00
05U*	Unloading Header (Onshore) - Unloading Mode	Piping	-	0.16	530	42	4.09E-06	4.09E-06	2.86E-06	1.23E-06	0.00E+00
05H*	Unloading Header (Onshore) - Holding Mode	Piping	-	0.84	530	42	2.22E-05	2.22E-05	1.56E-05	6.67E-06	0.00E+00
06U*	Tank Filling Lines - Unloading Mode	Piping	-	0.16	650	42	4.12E-06	4.12E-06	2.88E-06	1.23E-06	0.00E+00
06H*	Tank Filling Lines - Holding Mode	Piping	-	0.84	650	42	2.24E-05	2.24E-05	1.57E-05	6.72E-06	0.00E+00
070	LNG Storage Tanks	Tank	4	1.00	-	42	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.00E-08
08U	Return Gas Line (Onshore and Trestle) - Unloading Mode	Piping	-	0.16	13,1120	12	1.43E-03	6.11E-04	6.11E-04	2.44E-04	0.00E+00
09U	Return Gas Line (Jetty Boundary to Desuperheater) - Unloading Mode	Process Vessel	2	0.16	690	12	7.30E-05	3.20E-05	3.18E-05	1.21E-05	6.21E-07
10U	Return Gas Arm - Unloading Mode	Loading Arm	2	1,360‡	-	28	2.72E-03	2.72E-03	2.72E-03	8.16E-05	0.00E+00
150	BOG Header (LNG Tanks to BOG Compressors)	Process Vessel	2	1.00	780	36	9.76E-05	8.76E-05	6.43E-05	2.33E-05	4.00E-06
160	BOG Compressors	Compressor	6	1.00	-	36	0.00E+00	2.64E-02	0.00E+00	6.00E-04	0.00E+00
170	BOG Compressors Discharge	Piping	-	1.00	300	16	8.91E-05	3.27E-05	3.27E-05	1.49E-05	0.00E+00
180	BOG Recondenser	Process Vessel	2	1.00	-	10	2.00E-05	1.00E-05	1.00E-05	0.00E+00	4.00E-06
190*	LNG Tanks to LP LNG Send-out Header (including LP LNG from tank to LP LNG Send-out Header, LP LNG Send-out Header and Recondenser Mixing Line)	Piping	-	1.00	670	20	9.43E-05	3.54E-05	3.14E-05	1.57E-05	0.00E+00
200*	HP Pump suction LNG lines	Piping	-	1.00	250	10	7.83E-05	3.50E-05	3.26E-05	9,23E-06	0.00E+00
210	HP Pumps	Pump	10	1.00	-	24	0.00E+00	5.00E-04	0.00E+00	1.00E-04	0.00E+00
220*	HP Pumps Discharge	Piping	-	1.00	960	18	1.44E-04	5.29E-05	5.29E-05	2.40E-05	0.00E+00
230	ORV/ IFV	Heat Exchanger	14	0.71	-	18	1.00E-02	1.00E-04	0.00E+00	0.00E+00	0.00E+00
240	Send-out Gas from ORV/ IFV	Piping	-	1.00	1,160	24	1.16E-04	1.16E-04	8.13E-05	3.49E-05	0.00E+00
250	SOG Compressors	Compressor	2	0.02#	-	4	0.00E+00	1.69E-04	0.00E+00	3.85E-06	0.00E+00
260	SOG Compressors Discharge	Piping	-	0.02#	390	4	6.69E-06	2.97E-06	2.97E-06	1.12E-06	0.00E+00
270	Fuel Gas Line	Piping	-	1.00	290	3	2.60E-04	1.16E-04	1.16E-04	4.34E-05	0.00E+00

Note:
* A modifying factor of 0.5 is applied for all pipework in LNG services
^ Operating factors are calculated based on fraction of time in operation
\# Operating factor for Send-out Gas Compressor is calculated based on an assumption that the LNG terminal will operate with zero send-out mode for one week per year
‡ Operating hour of each unloading or return gas arm

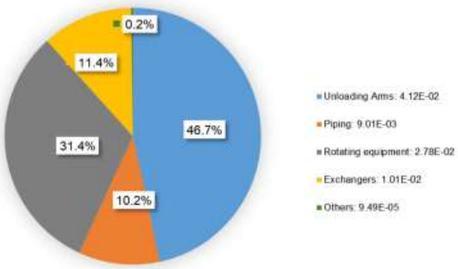
7.1.5 Leak Frequency Analysis

The total leak frequency of the terminal was estimated as 0.088 per year. An analysis of the main contributors to the overall leak frequency was performed based on component, leak size and location, as presented in Figure 7.1, Figure 7.2 and Figure 7.3, respectively.

Leak Frequency (by component)

As presented in the figure below, the LNG unloading arms were identified as the major leak source at the terminal, accounting for about 46.7% of all leaks. The rotating equipment (i.e. pumps and compressors) and ORVs are the next highest contributors to overall leak frequency, contributing to about 31.4% and 11.4% of all leaks respectively. The piping system accounted for another 10.2% and the balance total leak frequency was estimated to be about 9.49E-05 per year.

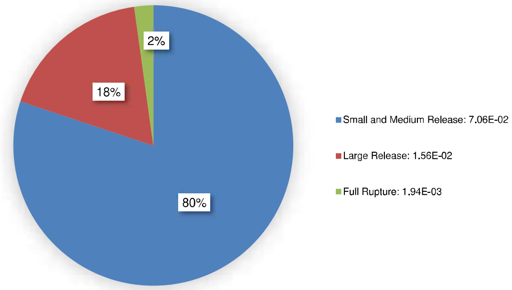
Figure 7.1 Leak Frequency Distribution by Component



Leak Frequency (by leak size)

About 80% of all leaks were observed due to small (12.5 mm) and medium (50 mm) leaks. Large leaks (100 mm) contribute to a further 18%, while catastrophic failures or full bore ruptures contribute only to about 2% of the total leak frequency.

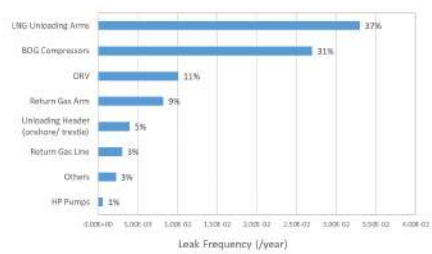
Figure 7.2 Leak Frequency Distribution by Leak



Leak Frequency (by section)

Unloading arms at Berth 1 and Berth 2 contribute to the highest percentage of the total leak frequency, accounting for 37%. The next major contributor is the BOG compressor trains, comprising 31%, followed by ORVs (11%) and return gas arms (9%). All remaining sections combine for around 12% of the total leak frequency.

Figure 7.3 Leak Frequency Distribution by Section



7.2 EVENT TREE ANALYSIS

7.2.1 Event Tree

Various hazardous events may arise depending on the release conditions (e.g. instantaneous or continuous release, rainout and vaporisation of the released material) as well as the type of ignition (e.g. immediate or delayed ignition).The frequencies of these undesired outcome events such as flash fire, pool fire, jet fire, explosion, etc. were derived using Event Tree Analysis (ETA).

ETA is an analysis technique which identifies different possible outcomes following an initiating event and estimates the probabilities for each of these outcomes. An Event Tree (ET) starts with an initiating event and proceeds by examining each contributing factor in chronological order to identify all possible outcomes. The frequency of event outcome is estimated by multiplying the initiating event frequency and probabilities of all contributing factors leading to the specific hazardous event.

Generic Event Tree for LNG Releases

The generic event tree used for modelling LNG releases from process sections and pipework is presented in Figure 7.4. For release scenarios involving LNG, various fire events can occur upon ignition. For a pressurised release scenario, in case the release is immediately ignited, a jet fire/ pool fire will result based on the leak size and stream conditions. Based on discharge modelling, a high pressure release from a leak is assumed to result in an ignitable jet, otherwise, a pool is formed. In case of delayed ignition, either vapour cloud explosion or flash

fire can result, where the corresponding event outcome frequency depends upon the explosion probability.

Generic Event Tree for Flammable Gas Releases

The generic event tree used for modelling flammable gas releases from process sections and pipework is presented in Figure 7.5. For release scenarios involving flammable gas, various fire events can occur upon ignition. For a pressurised release scenario, in case the release is immediately ignited, a jet fire/ fireball will result based on the leak size and stream conditions. In case of delayed ignition, either vapour cloud explosion or flash fire can result, where the corresponding event outcome frequency depends upon the explosion probability.

Generic Event Tree for Instantaneous Releases

The generic event tree used for modelling instantaneous releases for example due to catastrophic rupture of pressurised vessels is presented in Figure 7.6. For instantaneous releases such as the catastrophic rupture of the Recondenser, a fireball will result. In case of delayed ignition, either vapour cloud explosion or flash fire can result, where the corresponding event outcome frequency depends upon the explosion probability.

Figure 7.4 Generic Event Tree for LNG Releases

Release	Isolation	Ignition	Explosion	Delay 1/2	Hazardous Outcome
	Success	Immediate			Jet Fire/ Pool Fire
		Delayed	Yes		Vapour Cloud Explosion
			No	D1	Flash Fire over plant area
				D2	Flash Fire (Full Extent)
		No			No ignition
	Failure	Immediate			Jet Fire/ Pool Fire (with potential escalation)
		Delay	Yes		Vapour Cloud Explosion
			No	D1	Flash Fire over plant area
				D2	Flash Fire (Full Extent)
		No			No ignition

Figure 7.5 Generic Event Tree for Flammable Gas Releases

Release	Isolation	Ignition	Explosion	Delay 1/2	Hazardous Outcome
	Success	Immediate			Jet Fire
		Delayed	Yes		Vapour Cloud Explosion
			No	D1	Flash Fire over plant area
				D2	Flash Fire (Full Extent)
		No			No ignition
	Failure	Immediate			Jet Fire (with potential escalation)
		Delay	Yes		Vapour Cloud Explosion
			No	D1	Flash Fire over plant area
				D2	Flash Fire (Full Extent)
		No			No ignition

Figure 7.6 Generic Event Tree for Instantaneous Releases

Release	Isolation	Ignition	Explosion	Delay 1/2	Hazardous Outcome
		Immediate			Fireball followed by Jet Fire
		Delayed	Yes		Vapour Cloud Explosion
			No	D1	Flash Fire over plant area

				D2	Flash Fire (Full Extent)
		No			No ignition

7.2.2 Isolation

With the provision of leak detection systems (e.g. flammable gas/ fire detectors and low temperature detectors) in the plant together with logic to initiate emergency shutdown using isolation valves, the inventory of a release can be limited; hence mitigating the consequence.

However, the isolation system may fail due to various factors such as failure of leak detection due to degradation of detectors between tests, gas not reaching detectors, flames not visible from detectors or isolation valves failing to close on demand (e.g. failure of actuators or solenoids). A general probability of failure on demand of 0.1 was assumed accounting for detection or isolation failure and a probability of 0.9 for isolation success.

As discussed earlier in Section 6.2.2, if automatic isolation is successful, isolation is assumed to be achieved within 2 minutes (30 seconds for jetty unloading/ reloading). If, however, automatic isolation fails, the release could last for longer durations. Nevertheless, manual isolation can still be undertaken in such a case, for which the duration of release was assumed to be 10 minutes (2 minutes for jetty unloading/ reloading).

7.2.3 Ignition and Explosion Probability

As shown in the ETA models, the probability of various fire events including explosion depends on the ignition probability and probability of explosion given ignition, both of which were taken from the Cox, Lees and Ang model [39] as presented in Table 7.4.

Table 7.4 Overall Ignition Probability and Explosion Probability

Leak Size	Total Ignition Probability		Explosion Probability (Given Ignition)
	Gas	Liquid	
Minor (1 kg/s)	0.01	0.01	0.04
Major (1-50 kg/s)	0.07	0.03	0.12
Massive (>50 kg/s)	0.3	0.08	0.3

While the overall ignition probability was determined using the Cox, Lees and Ang [39], the possibility of immediate and delayed ignition was also considered. Immediate ignition, also

referred to as 'direct ignition', describes ignition near to the time and point of the release itself. Such an immediate ignition may result through auto-ignition, electrostatic discharges or due to presence of ignition sources in the immediate vicinity, e.g. a damaged electric cable. Non-immediate ignition or delayed ignition is also considered in this study to describe the potential for ignition of the flammable cloud as it disperses from the point of release.

It is likely that the flammable gas cloud is ignited within the terminal area due to the potential ignition sources such as flare and rotating equipment. This will result in a flash fire over the LNG terminal area. However, if ignition does not occur within the terminal, then the flammable gas cloud can further disperse and expand until it reaches an ignition source offsite. The maximum size of such an offsite flash fire would be limited to its maximum dispersion extent at steady state (i.e. fully developed gas cloud). In order to capture the said effects on the flash fire due to on-site and off-site ignition, the following two delayed ignition scenarios were considered in the QRA:

- Dispersion of gas and subsequent ignition prior to reaching the site boundary (ignition time referred to as Delay 1, resulting in Flash Fire 1)
- Dispersion to LFL (fully developed cloud) and subsequent ignition (ignition time referred to as Delay 2, resulting in Flash Fire 2)

The IP Ignition Report [40] was used as the basis to determine the possibility of immediate, delay 1 and delay 2 ignitions. A comparison of the cumulative ignition probability over time for a scenario given ignition (relative probability of ignition over time) is extracted from the IP ignition report and presented in Table 7.5.

Table 7.5 Ignition Probability over Time

Type	Relative Probability of Ignition within Time, t (s)					
	1	10	30	100	1000	>1000
Plant	0.22	0.29	0.36	0.63	0.94	1.0

For a given ignition, it can be observed that approximately 22% of the time that it is ignited instantaneously upon release, or ignited by a source in the immediate area of the leak (i.e. within 1s upon release). The relative probability of ignition increases over time as the flammable gas cloud continues to grow in size, and the probability eventually approaches unity as the gas cloud develops to its full extent and persists for longer periods (>1000 s).

For the purpose of QRA, the time of ignition beyond 10s may be regarded as delayed ignition. Correspondingly, immediate and delayed ignition can be assumed to be 30% and 70%,

respectively, of the total ignition probability, based on the ignition time distribution in Table 7.5. Furthermore, as typically gas clouds from large releases (i.e. 100 mm leaks and ruptures scenarios) in the process area can disperse to the terminal boundary within 100 to 300 s, it was estimated that approximately 70% of ignition occurs within plant boundary (including 30% of immediate ignition). Hence, the probabilities of immediate, delay 1 and 2 ignition were assumed as 30%, 40% and 30%, respectively.

7.2.4 Event Outcome

By applying the appropriate event tree models (Figure 7.4 to Figure 7.6) to each of the initiating events, the frequency of each outcome event such as jet fire, flash fire was estimated. The complete list of outcome events is provided in Table 7.6 and the event frequencies for all scenarios are included in Annexure D.

Table 7.6 Hazardous Outcome Events Modelled

Section No.	Section Description	Leak Size	Hazardous Outcomes				
			JF	PF	FB	FF	VE
01U	LNG Unloading Arms - Unloading Mode	012	Y	-	-	Y	Y
		050	Y	-	-	Y	Y
		100	Y	-	-	Y	Y
		RUP	-	Y	-	Y	Y
02U	LNG Unloading Arms to Unloading Header - Unloading Mode	012	Y	-	-	Y	Y
		050	Y	-	-	Y	Y
		100	Y	-	-	Y	Y
		RUP	-	Y	-	Y	Y
03U	Unloading Header (Jetty) - Unloading Mode	012	Y	-	-	Y	Y
		050	Y	-	-	Y	Y
		100	Y	-	-	Y	Y
		RUP	-	Y	-	Y	Y
03H	Unloading Header (Jetty) - Holding Mode	012	Y	-	-	Y	Y
		050	Y	-	-	Y	Y
		100	Y	-	-	Y	Y
		RUP	-	Y	-	Y	Y
04U	Unloading Header (Trestle) - Unloading Mode	012	Y	-	-	Y	Y
		050	Y	-	-	Y	Y
		100	Y	-	-	Y	Y
		RUP	-	Y	-	Y	Y
04H	Unloading Header (Trestle) - Holding Mode	012	Y	-	-	Y	Y
		050	Y	-	-	Y	Y
		100	Y	-	-	Y	Y

Section No.	Section Description	Leak Size	Hazardous Outcomes				
			JF	PF	FB	FF	VE
		RUP	-	Y	-	Y	Y
05U	Unloading Header (Onshore) - Unloading Mode	012	Y	-	-	Y	Y
		050	Y	-	-	Y	Y
		100	Y	-	-	Y	Y
		RUP	-	Y	-	Y	Y
05H	Unloading Header (Onshore) - Holding Mode	012	Y	-	-	Y	Y
		050	Y	-	-	Y	Y
		100	Y	-	-	Y	Y
		RUP	-	Y	-	Y	Y
06U	Tank Filling Lines - Unloading Mode	012	-	Y	-	Y	Y
		050	-	Y	-	Y	Y
		100	-	Y	-	Y	Y
		RUP	-	Y	-	Y	Y
06H	Tank Filling Lines - Holding Mode	012	-	Y	-	Y	Y
		050	-	Y	-	Y	Y
		100	-	Y	-	Y	Y
		RUP	-	Y	-	Y	Y
070	LNG Storage Tanks	CAT	-	Y	-	Y	Y
08U	Return Gas Line (Onshore and Trestle) - Unloading Mode	012	Y	-	-	Y	Y
		050	Y	-	-	Y	Y
		100	Y	-	-	Y	Y
		RUP	Y	-	-	Y	Y
09U	Return Gas Line (Jetty Boundary to Desuperheater) - Unloading Mode	012	Y	-	-	Y	Y
		050	Y	-	-	Y	Y
		100	Y	-	-	Y	Y
		RUP	Y	-	-	Y	Y
		CAT	-	-	Y	Y	Y
10U	Return Gas Arm - Unloading Mode	012	Y	-	-	Y	Y
		050	Y	-	-	Y	Y
		100	Y	-	-	Y	Y
		RUP	Y	-	-	Y	Y
150	BOG Header to BOG Compressors	012	Y	-	-	Y	Y
		050	Y	-	-	Y	Y
		100	Y	-	-	Y	Y
		RUP	Y	-	-	Y	Y
		CAT	-	-	Y	Y	Y
160	BOG Compressors	050	Y	-	-	Y	Y

Section No.	Section Description	Leak Size	Hazardous Outcomes				
			JF	PF	FB	FF	VE
		RUP	Y	-	-	Y	Y
170	BOG Compressors Discharge	012	Y	-	-	Y	Y
		050	Y	-	-	Y	Y
		100	Y	-	-	Y	Y
		RUP	Y	-	-	Y	Y
180	BOG Recondenser	012	Y	-	-	Y	Y
		050	Y	-	-	Y	Y
		100	Y	-	-	Y	Y
		CAT	-	-	Y	Y	Y
190	LNG Tanks to LP LNG Send-out Header (including LP LNG from tank to LP LNG Send-out Header, LP LNG Send-out Header and Recondenser Mixing Line)	012	Y	-	-	Y	Y
		050	Y	-	-	Y	Y
		100	Y	-	-	Y	Y
		RUP	-	Y	-	Y	Y
200	HP Pump suction LNG lines	012	Y	-	-	Y	Y
		050	Y	-	-	Y	Y
		100	Y	-	-	Y	Y
		RUP	-	Y	-	Y	Y
210	HP Pumps	050	Y	-	-	Y	Y
		RUP	-	Y	-	Y	Y
220	HP Pumps Discharge	012	Y	-	-	Y	Y
		050	Y	-	-	Y	Y
		100	Y	-	-	Y	Y
		RUP	-	Y	-	Y	Y
230	ORV/ IFV	012	Y	-	-	Y	Y
		050	Y	-	-	Y	Y
240	Send-out Gas from ORV/ IFV	012	Y	-	-	Y	Y
		050	Y	-	-	Y	Y
		100	Y	-	-	Y	Y
		RUP	Y	-	Y	Y	Y
250	SOG Compressors	050	Y	-	-	Y	Y
		RUP	Y	-	Y	Y	Y
260	SOG Compressors Discharge	012	Y	-	-	Y	Y
		050	Y	-	-	Y	Y
		100	Y	-	-	Y	Y
		RUP	Y	-	Y	Y	Y
270	Fuel Gas Line	012	Y	-	-	Y	Y
		050	Y	-	-	Y	Y

Section No.	Section Description	Leak Size	Hazardous Outcomes				
			JF	PF	FB	FF	VE
		100	Y	-	-	Y	Y
		RUP	Y	-	Y	Y	Y

8 RISK SUMMATION AND EVALUATION

8.1 RISK CRITERIA

8.1.1 Risk Measures

Risk Summation involves integration of the likelihood and consequence results to derive the total risk. The products of the frequency and consequence for each outcome event are summed and the total risk is expressed in terms of individual risk and societal risk.

Risk summation was performed using IRESC's in-house risk summation software.

8.1.2 Individual Risk (IR) Criteria

IR is defined as the frequency at which an individual may be expected to sustain a given level of harm from the realisation of specified hazards. IR is presented in the form of iso-risk contours around the facility.

The Health Safety Executive (UKHSE) IR criteria was selected for this project, which states that the individual risk to third parties from a facility should not exceed 1×10^{-6} per year for residential areas (offsite IR), 1×10^{-5} per year at neighbouring industrial sites and 1×10^{-3} per year on site (onsite IR). As some population centres (e.g. schools, communities etc.) have been identified in vicinity to the site, the 3×10^{-7} per year criterion from NFPA 59A was also reviewed. These individual risk criteria are summarised in Table 8.1.

Table 8.1 Individual Risk Criteria

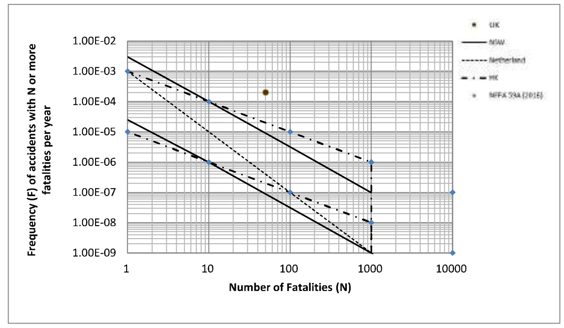
IR Criteria (per year)	The HSE	NFPA 59A (2016)
1 x 10^{-3}	Unacceptable for onsite IR (Fixed Installation)	
1 x 10^{-4}	Unacceptable for offsite IR (Fixed Installation)	
1 x 10^{-5}	Risk has to be reduced to the level As Low As Reasonably Practicable (ALARP)	Not permitted: Residential, office, and retail Permitted: Occasionally occupied developments (e.g., pump houses, transformer stations)
1 x 10^{-6}	Broadly acceptable level of risk	Not permitted: Shopping centres, large-scale retail outlets, restaurants, etc. Permitted: Work places, retail and ancillary services, residences in areas of 28 to 90 persons/ hectare density
3 x 10^{-7}		Not permitted: Churches, schools, hospitals, major public assembly areas, and other sensitivity establishments Permitted: All other structures and activities

8.1.3 Societal Risk (SR) Criteria

Societal risk is defined as the risk to a group of people due to all hazards arising from a hazardous installation or activity. The societal risk is expressed in the form of an F-N (Frequency-Number) curve for this project.

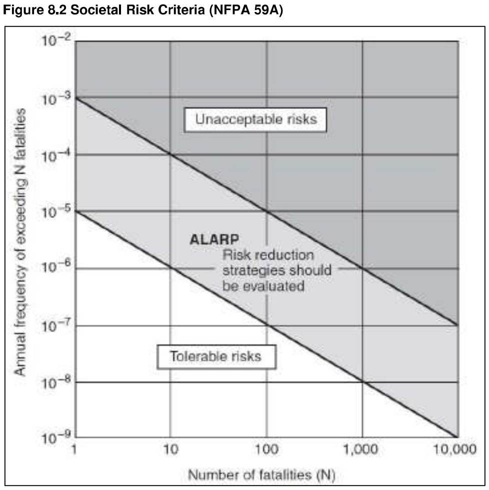
The societal risk criteria adopted by the UK, Hong Kong, the Netherlands, New South Wales, Australia (NSW) and the criteria recommended in NFPA 59A (2016) are summarised in Figure 8.1. It may be noted that in Hong Kong, NSW, and NFPA 59A (2016), two F-N risk lines are used to demark the 'acceptable or tolerable', 'unacceptable' and 'As Low As reasonably Practicable' (ALARP) risk levels. On the other hand, only one F-N risk line is used to separate the 'tolerable' and 'unacceptable' societal risk regions in the Netherlands. There is no societal risk criterion adopted in the UK at the regulatory level. An indicative reference of 50 fatalities at a frequency of 1 in 5,000 years as proposed in the UK HSE report (R2P2) is also shown in the figure for comparison. In general it is seen that the maximum tolerable societal risk for a single fatality is around 1 x 10^{-3} per year, while the maximum tolerable societal risk for about 1,000 fatalities is around 1 x 10^{-6}/ 1 x 10^{-7} per year.

Figure 8.1 Societal Risk Criteria Comparison



The societal risk criteria recommended by NFPA 59A (2016) were selected for this project and presented in Figure 8.2.

Figure 8.2 Societal Risk Criteria (NFPA 59A)



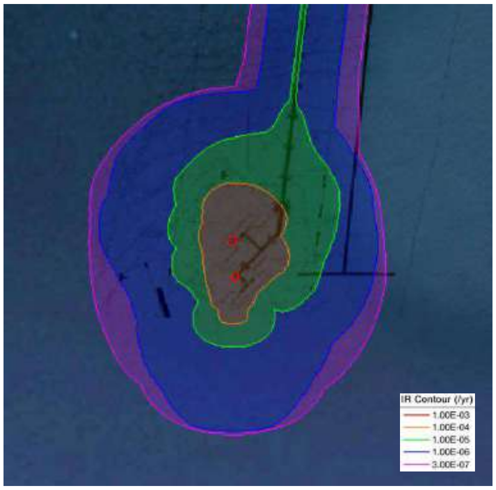
8.2 INDIVIDUAL RISK RESULTS – PHASE I + II

8.2.1 Individual Risk Results – Phase I + II

The Individual Risk (IR) results for Phase I + II in the form of iso-risk contours for the facility are presented in Figure 8.3 to Figure 8.4.

Figure 8.3 Individual Risk Contours for Nong Fab LNG Terminal (Process Area – Phase I + II)

Figure 8.4 Individual Risk Contours for Nong Fab LNG Terminal (Jetty Area – Phase I + II)



As shown in Figure 8.3, the maximum individual risk for process area in Phase I + II is below 1 x 10^{-4} per year (such level is not reached and hence not generated in the figure), which is considered to be acceptable for onsite workers including building occupants. The 1 x 10^{-5} per year contour is confined within the process area. The 1 x 10^{-6} per year (criteria for residential area) IR contour extends approximately 100 m from the site boundary to the east, encroaching the vacant land which is reserved for industrial development. This is considered acceptable. The 1 x 10^{-6} per year IR contour also slightly exceeds the western site boundary; although the affected area is currently undeveloped and unoccupied, the plot has been designated for residential development. As such, it is recommended that administrative method in the form of detailed emergency response plan to be developed for the offsite area. Therefore, this enables an effective communication channel to the nearby residential area

and emergency responders, in order to facilitate timely evacuation when required. For the public road near the western boundary, traffic light and management system / procedure may be developed to restrict the incoming traffic to the immediate road section near the LNG terminal in the event of an emergency in the LNG terminal.

With respect to the risk to sensitive establishments (see section 3.1), the 3 x 10^{-7} per year contour does not reach any sensitive premises, except the vacant land to the west of the proposed terminal. Nevertheless, it is recommended to closely monitor any further residential/ community development in the vicinity of the terminal.

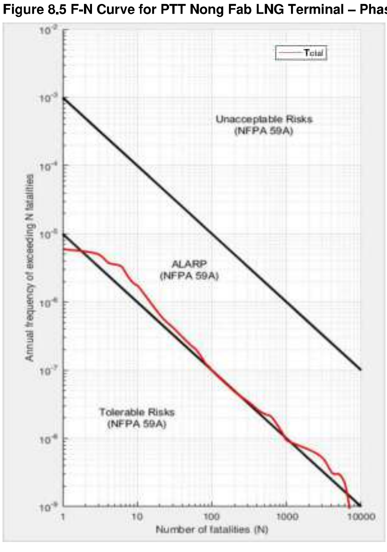
With regard to the proposed jetty of the LNG terminal (Figure 8.4), most of the area in the jetty is exposed to a risk level below 1 x 10^{-3} per year, except two localised spots around the unloading arms. The 1 x 10^{-5} per year contour extends to around 500 m from the jetty head, covering some portion of the future third party jetty on the east side. It is recommended that communication channel with the third party facility (which is yet to be built as of writing of this QRA) be developed in the future. This communication channel can be used during unloading operation as well as emergency situations. In the future, it is also recommended to minimise simultaneous operation of the adjacent third party jetty when an LNG carrier is berthed. This can control the risk to other passing vessels and reduce the probability of collision between external vessels and the LNG carriers. This aspect may be reviewed again in the future when the third party jetty is actually being constructed. In addition, a marine exclusion zone around the jetty area should be implemented to further control the risk in the area.

8.3 SOCIETAL RISK RESULTS – PHASE I + II

8.3.1 F-N Curve – Phase I + II

Figure 8.5 presents the Societal Risk (SR) results in Phase I + II, which are expressed as FN curve overlaid on the project risk criteria for comparison. The FN curve has considered only the offsite population, whereas the terminal personnel were not subject to societal risk assessment.

Figure 8.5 F-N Curve for PTT Nong Fab LNG Terminal – Phase I + II



The F-N curve for Nong Fab LNG Terminal in Phase I + II lies within the low ALARP region of the NFPA 59A criteria. Although some area in the proposed terminal vicinity is presently vacant, population was assigned in these areas for assessment, in attempt to account for the potential future population. The maximum number of potential fatalities, N, is expected to be around 8,200 but the corresponding annual frequency (F) is extremely low, in the range of 1 x 10^{-9} per year. Such a worst case scenario was found to be related to catastrophic failure of the LNG storage tanks, which involves instantaneous failure of both inner and outer shell of the tank leading to release of the entire content; the unlikely catastrophe could result in a massive amount LNG release with flammable pool and gas cloud extending several kilometres offsite based on PHAST modelling. Nevertheless, it is again emphasised that the likelihood of the event is extremely low and the corresponding societal risk level (i.e. FN point at N = 8,200) is within the acceptable region of the NFPA 59A criteria.

8.3.2 Potential Loss of Life (PLL) – Phase I + II

The Potential Loss of Life (PLL) takes into account the population and their locations, and can be thought of as an equivalent number of fatalities per year. Although there are no acceptability criteria for PLL, it is a useful measure of societal risk as it allows easy identification of the top scenarios that affect offsite population.

For the proposed LNG terminal, the total PLL in Phase I + II was found to be 1.13 x 10^{-4} per year. A breakdown of the main risk contributing scenarios to PLL is presented in Table 8.2.

The top two risk contributing scenarios are found to be pool fire and flash fire scenarios resulting from catastrophic rupture of the LNG Storage Tanks. This is due to large effect distance despite exhibiting very low frequency associated with full containment type LNG Storage tank.

The flash fire from the piping from LNG Tanks to LP LNG Sender Header and fireball due to rupture of Gas Send-out Header is respectively the third and fourth major contributor to the offsite risk, and together they account for about 23% of the total risk. Other contributing scenarios are all related to flash fires resulting from large failure or rupture of LNG piping at various locations. These scenarios typically have effect distances ranging from 500 m to 1100 m.

It is worth noting that the proposed LNG terminal has already incorporated with some significant risk mitigation measures - a notable example is that the Send-out gas header (Phase II section) is buried underground with a view to reducing the jet fire impact to the offsite areas.

Table 8.2 Top Contributors to Offsite PLL in Phase I + II

Scenarios Tag	Description	PLL	Percentage
070_CAT_PF	Pool fire due to catastrophic rupture of LNG Storage Tanks	1.61E-05	14.3%
070_CAT_FF	Flash fire due to catastrophic rupture of LNG Storage Tanks	1.38E-05	12.3%
191_100_FF (Phase 2)	Flash fire due to 100 mm leak of LNG line from LNG Tanks to LP LNG Send-out header (Phase II)	1.32E-05	11.7%
240_RUP_FB (Phase 1)	Fireball due to rupture of Gas Send-out Header (Phase I)	1.26E-05	11.2%
180_CAT_FF (Phase 2)	Flash fire due to catastrophic rupture of BOG Recondenser (Phase II)	1.26E-05	11.2%
180_CAT_FF (Phase 1)	Flash fire due to catastrophic rupture of BOG Recondenser (Phase I)	9.05E-06	8.0%
240_RUP_FB (Phase 2)	Fireball due to rupture of Gas Send-out Header (Phase II)	8.10E-06	7.2%
220_100_FF (Phase 2)	Flash fire due to 100 mm leak of HP Pump discharge to ORV (Phase II)	5.65E-06	5.0%
060_RUP_FF	Flash fire due to rupture of tank filling lines to LNG Storage Tanks during unloading mode	5.09E-06	4.5%
191_100_FF (Phase 1)	Flash fire due to 100 mm leak of LNG line from LNG Tanks to LP LNG Send-out header (Phase I)	2.51E-06	2.2%
220_100_FF (Phase 1)	Flash fire due to 100 mm leak of HP Pump discharge to ORV (Phase II)	2.25E-06	2.0%
052_RUP_FF (Phase 1)	Flash fire due to rupture of unloading header (onshore) during unloading mode (Phase I)	2.01E-06	1.8%
052_RUP_FF (Phase 2)	Flash fire due to rupture of unloading header (onshore) during unloading mode (Phase II)	2.00E-06	1.8%
200_100_FF (Phase 2)	Flash fire due to 100 mm leak of LNG line from HP Pump suction LNG lines (Phase II)	1.43E-06	1.3%
180_100_FF (Phase 2)	Flash fire due to 100 mm leak of BOG Recondenser (Phase II)	1.38E-06	1.2%
180_100_FF (Phase 1)	Flash fire due to 100 mm leak of BOG Recondenser (Phase I)	9.27E-07	0.8%
-	Others	3.87E-06	3.4%
	Total	**1.13E-04**	**100%**

8.4 INDIVIDUAL RISK RESULTS – PHASE I

8.4.1 Individual Risk Results – Phase I

The Individual Risk (IR) results for Phase I in the form of iso-risk contours for the facility are presented in Figure 8.6 to Figure 8.7.

Figure 8.6 Individual Risk Contours for Nong Fab LNG Terminal (Process Area – Phase I)

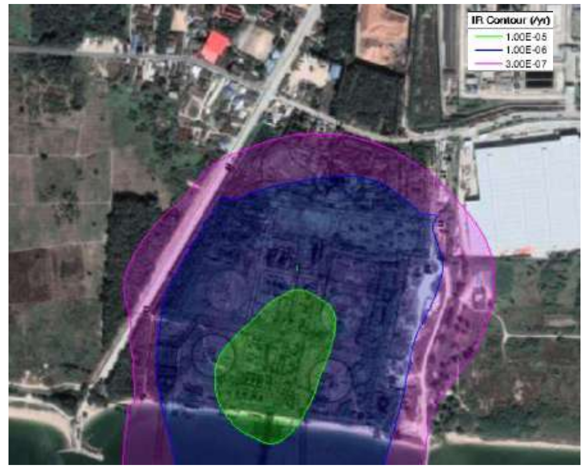
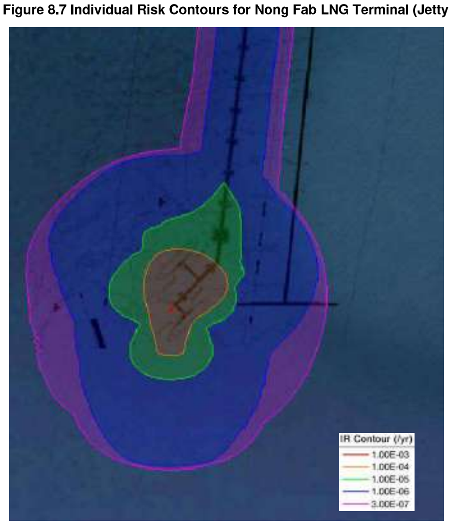


Figure 8.7 Individual Risk Contours for Nong Fab LNG Terminal (Jetty Area – Phase I)



Similar to Phase I + II outcome, the maximum individual risk for process area in Phase I is below 1 x 10^{-4} per year (such level is not reached and hence not generated in the figure), which is considered to be acceptable for onsite workers including building occupants. The 1 x 10^{-5} per year contour is confined within the process area. The 1 x 10^{-6} per year (criteria for residential area) IR contour extends approximately 50 m from the site boundary to the east, but does not encroach the vacant land which is reserved for industrial development. The 1 x 10^{-6} per year IR contour extends slightly past the western site boundary but does not reach any populated features including public roads. This is considered acceptable.

With respect to the risk to sensitive establishments (see section 3.1), the 3 x 10^{-7} per year contour does not reach any sensitive areas/ premises, except the vacant land to the west of

the proposed terminal. Nevertheless, it is recommended to closely monitor any further residential/ community development in the vicinity of the terminal.

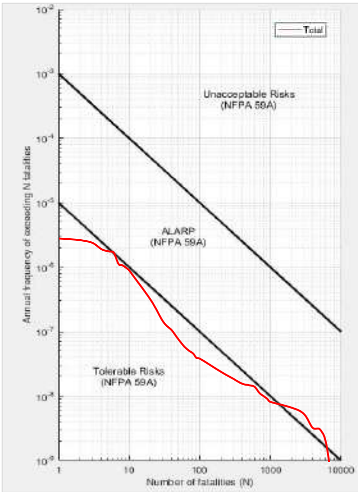
With regard to the proposed jetty of the LNG terminal (Figure 8.4), most of the area in the jetty is exposed to a risk level below 1 x 10^{-3} per year, except one localised spot around the unloading arms at Berth 1. The 1 x 10^{-5} per year contour extends to around 400 m from the jetty head and nearly touches the future third party jetty on the east side. It is recommended that communication channel with the third party facility (which is yet to be built as of writing this report) be developed in the future. This communication channel can be used during unloading operation as well as emergency situations. In the future, it is also recommended to minimise simultaneous operation of the adjacent third party jetty when an LNG carrier is berthed. This can control the risk to other passing vessels and reduce the probability of collision between external vessels and the LNG carriers. This aspect may be reviewed again in the future when the third party jetty is actually being constructed. In addition, a marine exclusion zone around the jetty area should be implemented to further control the risk in the area.

8.5 SOCIETAL RISK RESULTS – PHASE I

8.5.1 F-N Curve – Phase I

Figure 8.8 presents the Societal Risk (SR) results in Phase I, which are expressed as FN curve overlaid on the project risk criteria for comparison. The FN curve has considered only the offsite population, whereas the terminal personnel were not subject to societal risk assessment.

Figure 8.8 F-N Curve for PTT Nong Fab LNG Terminal – Phase I



The majority of the F-N curve for Nong Fab LNG Terminal in Phase I lies within the tolerable risk region of the NFPA 59A criteria, except a small section of curve, at F < 10^{-8} per yer,

resides in the low ALARP region. Although some area in the proposed terminal vicinity is presently vacant, population was assigned in these areas for assessment, in attempt to account for the potential future population. The maximum number of potential fatalities, N, is expected to be around 8,200 but the corresponding annual frequency (F) is extremely low, in the range of 1 x 10^{-9} per year which is the same as the Phase I + II assessment. Such a worst case scenario was found to be related to catastrophic failure of the LNG storage tanks, which involves instantaneous failure of both inner and outer shell of the tank leading to release of the entire content; the unlikely catastrophe could result in a massive amount LNG release with flammable pool and gas cloud extending several kilometres offsite based on PHAST modelling. Nevertheless, it is again emphasised that the likelihood of the event is extremely low and the corresponding societal risk level (i.e. FN point at N = 8,200) is within the acceptable region of the NFPA 59A criteria.

8.5.2 Potential Loss of Life (PLL) – Phase I

The Potential Loss of Life (PLL) takes into account the population and their locations, and can be thought of as an equivalent number of fatalities per year. Although there are no acceptability criteria for PLL, it is a useful measure of societal risk as it allows easy identification of the top scenarios that affect offsite population.

For the proposed LNG terminal, the total PLL in Phase I was found to be 6.67 x 10^{-5} per year. A breakdown of the main risk contributing scenarios to PLL is presented in Table 8.3.

In line with Phase I + II findings, the top two risk contributing scenarios are found to be pool fire and flash fire scenarios resulting from catastrophic rupture of the LNG Storage Tanks. This is due to large effect distance despite exhibiting very low frequency associated with full containment type LNG Storage tank.

The fireball due to rupture of Gas Send-out Header and flash fire attributed to catastrophic rupture of BOG Recondenser is respectively the third and fourth major contributor to the offsite risk, and together they account for about 32% of the total risk. Other contributing scenarios are all related to flash fires resulting from large failure or rupture of LNG piping at various locations. These scenarios typically have effect distances ranging from 500 m to 1100 m.

Table 8.3 Top Contributors to Offsite PLL in Phase I

Scenarios Tag	Description	PLL	Percentage
070_CAT_PF	Pool fire due to catastrophic rupture of LNG Storage Tanks	1.61E-05	24.2%
070_CAT_FF	Flash fire due to catastrophic rupture of LNG Storage Tanks	1.38E-05	20.7%
240_RUP_FB (Phase 1)	Fireball due to rupture of Gas Send-out Header (Phase I)	1.26E-05	18.9%
180_CAT_FF (Phase 1)	Flash fire due to catastrophic rupture of BOG Recondenser (Phase I)	9.03E-06	13.5%
060_RUP_FF	Flash fire due to rupture of tank filling lines to LNG Storage Tanks during unloading mode	5.09E-06	7.6%
191_100_FF (Phase 1)	Flash fire due to 100 mm leak of LNG line from LNG Tanks to LP LNG Send-out header (Phase I)	2.89E-06	4.3%
220_100_FF (Phase 1)	Flash fire due to 100 mm leak of HP Pump discharge to ORV (Phase I)	2.39E-06	3.6%
200_100_FF (Phase 1)	Flash fire due to 100 mm leak of LNG line from HP Pump suction LNG lines (Phase I)	1.72E-06	2.6%
180_100_FF (Phase 1)	Flash fire due to 100 mm leak of BOG Recondenser (Phase I)	8.90E-07	1.3%
051_RUP_FF (Phase 1)	Flash fire due to rupture of unloading header (onshore) during unloading mode (Phase I)	8.01E-07	1.2%
060_100_FF	Flash fire due to 100 mm leak of of tank filling lines to LNG Storage Tanks during unloading mode	6.47E-07	1.0%
-	Others	6.72E-07	1.0%
	Total	**6.67E-05**	**100%**

9 BUILDING BLAST DESIGN ACCIDENT LOAD

The building blast Design Accident Load (DAL) was estimated for new plant buildings which are intended for occupancy. Assessment has also made for LNG tanks which contain large amount of flammable inventory. A list of all buildings studied is summarised in Table 9.1. The locations of buildings are shown in Figure 9.1 and Figure 9.2.

Figure 9.1 Overall View of Plant Buildings and Structures for BRA (Process Area)

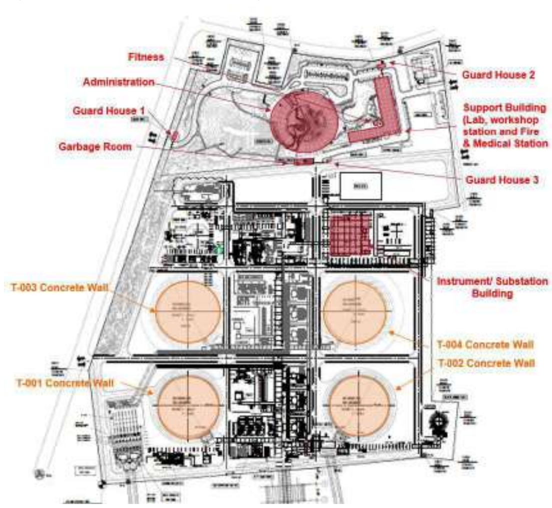


Figure 9.2 Overall View of Plant Buildings and Structures for BRA (Berth Area)

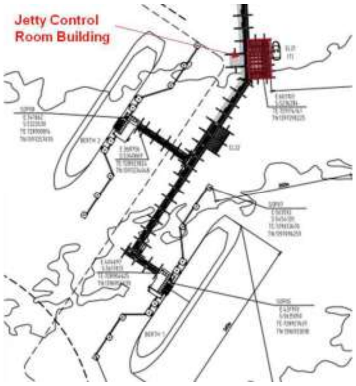


Table 9.1 Plant Buildings and Structures considered in BRA

Building / Structure	Description
B-001	Main Building (Administration)
B-002	Support Building (Lab & Workshop Station)
B-003	Support Building (Fire & Medical Station)
B-004	Guard House 1
B-005	Guard House 2
B-006	Guard House 3
B-007	Pump Room
B-008	Public WC
B-009	Fitness
B-010	Instrument/ Substation Building
B-011	Jetty Control Room
T-001	Concrete walls of LNG Tank T-001
T-002	Concrete walls of LNG Tank T-002
T-003	Concrete walls of LNG Tank T-003
T-004	Concrete walls of LNG Tank T-004

It is to be noted that based on occupancy information provided by SPCC [41], CPMS rack room is deemed not required to be assessed as part of BRA.

The explosion risk results are expressed in the form of overpressure and impulse exceedance curve as illustrated in Figure 9.3 and Figure 9.4 respectively. The maximum overpressure and impulse of each building is presented in Table 9.2, while Table 9.3 tabulated building overpressure and impulse at the exceedance frequency of 1 x 10^{-4} per year.

As can be seen from Figure 9.3 (Table 9.3), the overpressure at 1 x 10^{-4} per year exceedance frequency is in the range of 0.01 to 0.055 bar for all buildings. Jetty Control Room Building has the highest overpressure value of 0.055 bar considering the relatively higher leak frequency of the LNG unloading arms and thus the likelihood of explosion. The overpressure values should be taken forward to the design for buildings.

As for LNG tanks, they are subjected to higher overpressures because the LNG tanks are located in the process area, closed to a number of PESs in the area (i.e. BOG Compressor shelters, HP Pumps, and ORVs). Nonetheless, no significant damage to the tanks is expected even in the worst case explosion scenario for which the maximum overpressures observed at the tanks are not exceeding 0.3 bar.

Figure 9.3 Explosion Overpressure Exceedance Curve for Occupied Buildings and LNG Tanks

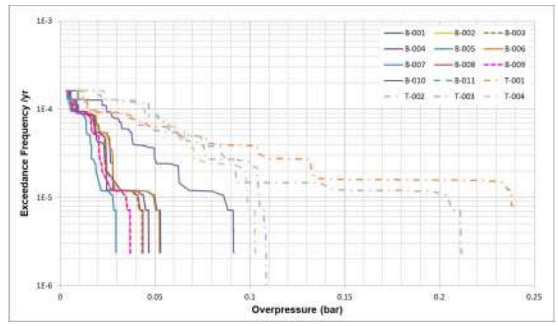


Figure 9.4 Explosion Impulse Exceedance Curve for Occupied Buildings and LNG Tanks

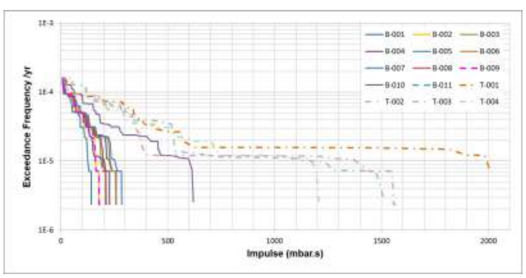


Table 9.2 Maximum Overpressure and Impulse for Buildings and LNG Tanks

Building / Structure	Max. Overpres. (bar)	Associated Impulse (mbar.s)	Max. Impulse (mbar.s)	Associated Overpres. (bar)
B-001	0.05	2.60	2.60	0.05
B-002	0.04	1.79	1.79	0.04
B-003	0.04	2.11	2.11	0.04
B-004	0.05	2.29	2.29	0.05
B-005	0.03	1.43	1.43	0.03
B-006	0.05	2.58	2.58	0.05
B-007	0.06	2.86	2.86	0.06
B-008	0.04	2.13	2.13	0.04
B-009	0.04	1.80	1.80	0.04
B-010	0.09	4.59	6.20	0.06
B-011	0.06	2.39	2.39	0.06
T-001	0.24	20.03	20.03	0.24
T-002	0.11	14.68	15.07	0.11
T-003	0.21	15.66	15.66	0.21
T-004	0.10	5.26	12.07	0.10

Table 9.3 Overpressure and Impulse for Buildings and LNG Tanks at 1 x10^{-4}/yr exceedance frequency

Building / Structure	Overpressure (bar)	Impulse (mbar.s)
B-001	0.01	0.13
B-002	0.01	0.16
B-003	0.01	0.13
B-004	0.01	0.09
B-005	0.01	0.07
B-006	0.01	0.19
B-007	0.01	0.19
B-008	0.01	0.15
B-009	0.01	0.16
B-010	0.02	1.64
B-011	0.06	2.39
T-001	0.01	0.40
T-002	0.05	3.14
T-003	0.01	0.34
T-004	0.05	0.84

10 CONCLUSIONS AND RECOMMENDATIONS

A Quantitative Risk Assessment (QRA) for the Nong Fab LNG Terminal was conducted covering all the project facilities in Phase I and Phase II development. The nominal LNG unloading rate of 15 MMTPA with a gas throughput of 18 MMTPA was taken as the basis of the study. The risk results were calculated and expressed in the form of individual risk and societal risk for comparison and analysis. The conclusions drawn from the QRA for Phase I + II are summarised below:

- The highest risk area is the jetty area with maximum outdoor IR exceeding 1 x 10^{-3} per year and the 1 x 10^{-5} per year contour extends approximately to a radius of 500 m from the jetty area.

- With regard to the process area, the 1 x 10^{-5} per year contour is contained within the plant boundary. Though 1 x 10^{-6} per year contour extends slightly beyond the plant boundary to the east and the west, it does not encroach into the residential areas. Also, the 3 x 10^{-7} per year contour does not reach any of the residential areas beyond the LNG terminal, hence meeting the NFPA criterion for sensitive establishments.

- Analysis of societal risk has shown that the part of the FN curve lies in the low ALARP region. Pool fire and flash fire due to catastrophic rupture of the LNG Storage Tanks, flash fire from the piping from LNG Tanks to LP LNG Sender Header and fireball due to rupture of Gas Send-out Header, were identified as the top risk contributors.

- Vapour dispersion and thermal radiation analysis was conducted for the impoundment pits. Mitigation measures including high expansion foam have been considered in the analysis. The results show compliance with the NFPA 59A standard, in regards of the spacing requirements and control of potential flammable hazards. Vapour dispersion and thermal radiation analysis was also conducted for the PSVs on LNG tanks by SPCC [24]. The results show compliance with the NFPA 59A and BS EN 1473 standards, in regards of the spacing requirements and control of potential flammable hazards.

The conclusion drawn from the Building Blast Design Accidental Load is summarised below:

- The overpressure at 1 x 10^{-4} per year exceedance frequency is broadly in the range of 0.01 to 0.06 bar for LNG Tanks, Jetty Control Room Building, and other occupied buildings. These overpressure values should be taken forward for building design.

Based on the analysis conducted for the facility, the following recommendations are made:

- As the risk in the jetty area is relatively high (i.e. the 1 x 10^{-5} per year contour extends beyond 500 m from the jetty), it is recommended to provide a proper marine exclusion zone for better control over vessel movement in this area while LNG carriers are berthed.

- Since a future 3rd party jetty may be built very close to the east side of LNG terminal jetty, it is recommended to implement additional control measure in the future when the 3rd party jetty is actually being constructed. This may include developing a communication channel with the 3rd party jetty to be used during unloading operation as well as emergency situations. It is also recommended to minimise simultaneous operation of the adjacent 3rd party jetty when a LNG carrier is berthed

- It is also recommended that the residual risk for the undeveloped potential residential area near the western boundary of the terminal may be controlled by administrative method that a detailed emergency response plan be developed for the offsite area. For the public road near the western boundary, traffic light and management system / procedure may be developed to restrict the incoming traffic to the immediate road section near the LNG terminal in the event of an emergency in the LNG terminal. Furthermore, close monitoring of any further residential/ community development in the vicinity of the terminal should also be considered. It is thus recommended that the QRA be updated regularly, for instance every 3 years, during the operational phase of the terminal so as to capture the potential change in the surrounding environment.

- High expansion foam has been considered in the analysis to mitigate the dispersion and radiation effect from impoundment pits. Hence, proper actuation systems (e.g. based on F&G/ cold detection) should be provided to actuate high expansion foam in case any LNG is collected in the pit. One should also ensure a high reliability for such actuation system in order to justify the credit taken.

- Although LNG tank (full containment tank) failure frequency is very low, tank rupture scenario has been considered in the QRA. It is recommended to monitor developments adjoining the boundary for any potential large fire and explosion events originating from neighbouring industrial sites that could threaten the integrity of the tank. Measures should be taken with local authorities to prevent such impacts.

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- In consideration of the close proximity of the population centres, it is recommended that the Emergency Response Plan for the Nong Fab LNG Terminal should include channels for communication and arrangements for evacuation of the school, temple and community centres in case of emergency.

- With regard to LNG tank PSV release scenario, it is recommended in the SPCC study [24] that the length of PSVs tail pipe outlet shall be at 23 m from the tank dome centre. Operating procedure shall also be followed for personnel working at tank platform in case of accidental ignition of PSV release to prevent the personnel exposure to thermal radiation/ flammable gas cloud.

- Although the overpressures experienced at occupied building are low in range of 0.01 to 0.06 bar, window breakage can still occur at these overpressure levels, which can cause injury to personnel. Hence it is recommended that windows to be minimized for plant buildings or toughened glass to be used if windows are provided.

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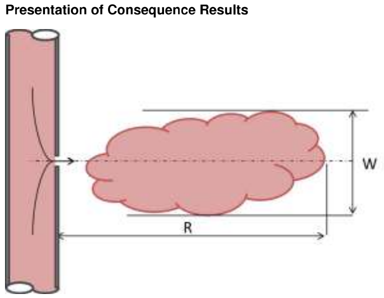
ANNEXURE A – IMPOUNDMENT PIT SCENARIOS

Table A.1 Scenarios Considered in Impoundment Pit

Section	Leak Size	IS/ IF	Release Volume (m^3)	Impoundment Pit
05U	RUP	IS	649	Tank 1-4
05H	RUP	IF	281	Tank 1-4
05H	RUP	IS	208	Tank 1-4
05U	RUP	IF	796	Tank 1-4
06H	RUP	IF	303	Tank 1-4
06H	RUP	IS	158	Tank 1-4
06U	012	IF	<10	Tank 1-4
06U	012	IS	<10	Tank 1-4
06U	050	IF	<10	Tank 1-4
06U	050	IS	<10	Tank 1-4
06U	100	IF	29	Tank 1-4
06U	100	IS	<10	Tank 1-4
06U	RUP	IS	728	Tank 1-4
190	RUP	IF	594	Process 1-2
190	RUP	IS	211	Process 1-2
190	RUP	IF	187	Process 1-2
190	RUP	IS	130	Process 1-2
200	RUP	IF	500	Process 1-2
200	RUP	IS	107	Process 1-2
210	RUP	IF	500	Process 1-2
210	RUP	IS	107	Process 1-2
220	RUP	IF	557	Process 1-2
220	RUP	IS	167	Process 1-2
230	RUP	IF	557	Process 1-2
230	RUP	IS	167	Process 1-2

ANNEXURE B – CONSEQUENCE RESULTS

Presentation of Consequence Results



Where
R: maximum downwind range of consequence
W: maximum width of consequence

Table B.1 Jet Fire Consequence

Section Tag	Lea Size (mm)	IS/ IF	End Point	2F		5D	
				R	W	R	W
01U	012	IF	Flame Length	22	18	17	15
		IF	35.5kW/m²	24	7	20	9
		IF	14.1kW/m²	28	17	24	18
		IF	7.3kW/m²	31	26	27	26
		IS	Flame Length	22	18	17	15
		IS	35.5kW/m²	24	7	20	9
		IS	14.1kW/m²	28	17	24	18
		IS	7.3kW/m²	31	26	27	26
	050	IF	Flame Length	72	59	56	51
		IF	35.5kW/m²	85	33	72	41
		IF	14.1kW/m²	99	71	84	73
		IF	7.3kW/m²	111	100	96	98
		IS	Flame Length	72	59	56	51
		IS	35.5kW/m²	85	33	72	41
		IS	14.1kW/m²	99	71	84	73
		IS	7.3kW/m²	111	100	96	98
	100	IF	Flame Length	129	105	100	90
		IF	35.5kW/m²	156	71	131	84
		IF	14.1kW/m²	180	139	155	141
		IF	7.3kW/m²	203	192	177	188
		IS	Flame Length	129	105	100	90
		IS	35.5kW/m²	156	71	131	84
		IS	14.1kW/m²	180	139	155	141
		IS	7.3kW/m²	203	192	177	188
02U	012	IF	Flame Length	21	17	16	15
		IF	35.5kW/m²	23	7	19	8
		IF	14.1kW/m²	27	15	22	17
		IF	7.3kW/m²	30	24	26	24
		IS	Flame Length	21	17	16	15
		IS	35.5kW/m²	23	7	19	8
		IS	14.1kW/m²	27	15	22	17
		IS	7.3kW/m²	30	24	26	24
	050	IF	Flame Length	69	57	53	48

Section Tag	Lea Size (mm)	IS/ IF	End Point	2F		5D	
				R	W	R	W
		IF	35.5kW/m^2	80	30	67	38
		IF	14.1kW/m^2	93	66	79	68
		IF	7.3kW/m^2	104	94	91	92
		IS	Flame Length	69	57	53	48
		IS	35.5kW/m^2	80	30	67	38
		IS	14.1kW/m^2	93	66	79	68
		IS	7.3kW/m^2	104	94	91	92
	100	IF	Flame Length	122	102	95	85
		IF	35.5kW/m^2	146	64	123	77
		IF	14.1kW/m^2	170	129	146	132
		IF	7.3kW/m^2	191	180	167	176
		IS	Flame Length	122	102	95	85
		IS	35.5kW/m^2	146	64	123	77
		IS	14.1kW/m^2	170	129	146	132
		IS	7.3kW/m^2	191	180	167	176
03H	012	IF	Flame Length	26	19	20	17
		IF	35.5kW/m^2	29	10	24	12
		IF	14.1kW/m^2	33	22	29	23
		IF	7.3kW/m^2	37	32	32	32
		IS	Flame Length	26	19	20	17
		IS	35.5kW/m^2	29	10	24	12
		IS	14.1kW/m^2	33	22	29	23
		IS	7.3kW/m^2	37	32	32	32
	050	IF	Flame Length	85	63	66	57
		IF	35.5kW/m^2	103	44	86	53
		IF	14.1kW/m^2	118	89	101	91
		IF	7.3kW/m^2	132	124	116	121
		IS	Flame Length	85	63	66	57
		IS	35.5kW/m^2	103	44	86	53
		IS	14.1kW/m^2	118	89	101	91
		IS	7.3kW/m^2	132	124	116	121
	100	IF	Flame Length	116	99	90	81
		IF	35.5kW/m^2	138	59	117	72
		IF	14.1kW/m^2	161	121	138	124

Section Tag	Lea Size (mm)	IS/ IF	End Point	2F		5D	
				R	W	R	W
		IF	7.3kW/m^2	181	169	157	165
		IS	Flame Length	116	99	90	81
		IS	35.5kW/m^2	138	59	117	72
		IS	14.1kW/m^2	161	121	138	124
		IS	7.3kW/m^2	181	169	157	165
03U	012	IF	Flame Length	21	17	16	15
		IF	35.5kW/m^2	23	7	19	8
		IF	14.1kW/m^2	27	15	22	17
		IF	7.3kW/m^2	30	24	26	24
		IS	Flame Length	21	17	16	15
		IS	35.5kW/m^2	23	7	19	8
		IS	14.1kW/m^2	27	15	22	17
		IS	7.3kW/m^2	30	24	26	24
	050	IF	Flame Length	69	57	53	48
		IF	35.5kW/m^2	80	30	67	38
		IF	14.1kW/m^2	93	66	79	68
		IF	7.3kW/m^2	104	94	91	92
		IS	Flame Length	69	57	53	48
		IS	35.5kW/m^2	80	30	67	38
		IS	14.1kW/m^2	93	66	79	68
		IS	7.3kW/m^2	104	94	91	92
	100	IF	Flame Length	122	102	95	85
		IF	35.5kW/m^2	146	64	123	77
		IF	14.1kW/m^2	170	129	146	132
		IF	7.3kW/m^2	191	180	167	176
		IS	Flame Length	122	102	95	85
		IS	35.5kW/m^2	146	64	123	77
		IS	14.1kW/m^2	170	129	146	132
		IS	7.3kW/m^2	191	180	167	176
04H	012	IF	Flame Length	26	19	20	17
		IF	35.5kW/m^2	29	10	24	12
		IF	14.1kW/m^2	33	22	29	23
		IF	7.3kW/m^2	37	32	32	32
		IS	Flame Length	26	19	20	17

Section Tag	Lea Size (mm)	IS/ IF	End Point	2F		5D	
				R	W	R	W
		IS	35.5kW/m^2	29	10	24	12
		IS	14.1kW/m^2	33	22	29	23
		IS	7.3kW/m^2	37	32	32	32
	050	IF	Flame Length	85	63	66	57
		IF	35.5kW/m^2	103	44	86	53
		IF	14.1kW/m^2	118	89	101	91
		IF	7.3kW/m^2	132	124	116	121
		IS	Flame Length	85	63	66	57
		IS	35.5kW/m^2	103	44	86	53
		IS	14.1kW/m^2	118	89	101	91
		IS	7.3kW/m^2	132	124	116	121
	100	IF	Flame Length	116	99	90	81
		IF	35.5kW/m^2	138	59	117	72
		IF	14.1kW/m^2	161	121	138	124
		IF	7.3kW/m^2	181	169	157	165
		IS	Flame Length	116	99	90	81
		IS	35.5kW/m^2	138	59	117	72
		IS	14.1kW/m^2	161	121	138	124
		IS	7.3kW/m^2	181	169	157	165
04U	012	IF	Flame Length	21	17	16	15
		IF	35.5kW/m^2	23	7	19	8
		IF	14.1kW/m^2	27	15	22	17
		IF	7.3kW/m^2	30	24	26	24
		IS	Flame Length	21	17	16	15
		IS	35.5kW/m^2	23	7	19	8
		IS	14.1kW/m^2	27	15	22	17
		IS	7.3kW/m^2	30	24	26	24
	050	IF	Flame Length	69	57	53	48
		IF	35.5kW/m^2	80	30	67	38
		IF	14.1kW/m^2	93	66	79	68
		IF	7.3kW/m^2	104	94	91	92
		IS	Flame Length	69	57	53	48
		IS	35.5kW/m^2	80	30	67	38
		IS	14.1kW/m^2	93	66	79	68

Section Tag	Lea Size (mm)	IS/ IF	End Point	2F		5D	
				R	W	R	W
		IS	7.3kW/m^2	104	94	91	92
	100	IF	Flame Length	122	102	95	85
		IF	35.5kW/m^2	146	64	123	77
		IF	14.1kW/m^2	170	129	146	132
		IF	7.3kW/m^2	191	180	167	176
		IS	Flame Length	122	102	95	85
		IS	35.5kW/m^2	146	64	123	77
		IS	14.1kW/m^2	170	129	146	132
		IS	7.3kW/m^2	191	180	167	176
05H	012	IF	Flame Length	26	19	20	17
		IF	35.5kW/m^2	29	10	24	12
		IF	14.1kW/m^2	33	22	29	23
		IF	7.3kW/m^2	37	32	32	32
		IS	Flame Length	26	19	20	17
		IS	35.5kW/m^2	29	10	24	12
		IS	14.1kW/m^2	33	22	29	23
		IS	7.3kW/m^2	37	32	32	32
	050	IF	Flame Length	85	63	66	57
		IF	35.5kW/m^2	103	44	86	53
		IF	14.1kW/m^2	118	89	101	91
		IF	7.3kW/m^2	132	124	116	121
		IS	Flame Length	85	63	66	57
		IS	35.5kW/m^2	103	44	86	53
		IS	14.1kW/m^2	118	89	101	91
		IS	7.3kW/m^2	132	124	116	121
	100	IF	Flame Length	116	99	90	81
		IF	35.5kW/m^2	138	59	117	72
		IF	14.1kW/m^2	161	121	138	124
		IF	7.3kW/m^2	181	169	157	165
		IS	Flame Length	116	99	90	81
		IS	35.5kW/m^2	138	59	117	72
		IS	14.1kW/m^2	161	121	138	124
		IS	7.3kW/m^2	181	169	157	165
05U	012	IF	Flame Length	21	17	16	15

Section Tag	Lea Size (mm)	IS/ IF	End Point	2F		5D	
				R	W	R	W
		IF	35.5kW/m^2	23	7	19	8
		IF	14.1kW/m^2	27	15	22	17
		IF	7.3kW/m^2	30	24	26	24
		IS	Flame Length	21	17	16	15
		IS	35.5kW/m^2	23	7	19	8
		IS	14.1kW/m^2	27	15	22	17
		IS	7.3kW/m^2	30	24	26	24
	050	IF	Flame Length	69	57	53	48
		IF	35.5kW/m^2	80	30	67	38
		IF	14.1kW/m^2	93	66	79	68
		IF	7.3kW/m^2	104	94	91	92
		IS	Flame Length	69	57	53	48
		IS	35.5kW/m^2	80	30	67	38
		IS	14.1kW/m^2	93	66	79	68
		IS	7.3kW/m^2	104	94	91	92
	100	IF	Flame Length	122	102	95	85
		IF	35.5kW/m^2	146	64	123	77
		IF	14.1kW/m^2	170	129	146	132
		IF	7.3kW/m^2	191	180	167	176
		IS	Flame Length	122	102	95	85
		IS	35.5kW/m^2	146	64	123	77
		IS	14.1kW/m^2	170	129	146	132
		IS	7.3kW/m^2	191	180	167	176
06H	012	IF	Flame Length	26	19	20	17
		IF	35.5kW/m^2	29	10	24	12
		IF	14.1kW/m^2	33	22	29	23
		IF	7.3kW/m^2	37	32	32	32
		IS	Flame Length	26	19	20	17
		IS	35.5kW/m^2	29	10	24	12
		IS	14.1kW/m^2	33	22	29	23
		IS	7.3kW/m^2	37	32	32	32
	050	IF	Flame Length	85	63	66	57
		IF	35.5kW/m^2	103	44	86	53
		IF	14.1kW/m^2	118	89	101	91

Section Tag	Lea Size (mm)	IS/ IF	End Point	2F		5D	
				R	W	R	W
		IF	7.3kW/m^2	132	124	116	121
		IS	Flame Length	85	63	66	57
		IS	35.5kW/m^2	103	44	86	53
		IS	14.1kW/m^2	118	89	101	91
		IS	7.3kW/m^2	132	124	116	121
	100	IF	Flame Length	116	99	90	81
		IF	35.5kW/m^2	138	59	117	72
		IF	14.1kW/m^2	161	121	138	124
		IF	7.3kW/m^2	181	169	157	165
		IS	Flame Length	116	99	90	81
		IS	35.5kW/m^2	138	59	117	72
		IS	14.1kW/m^2	161	121	138	124
		IS	7.3kW/m^2	181	169	157	165
08U	012	IF	Flame Length	6	1	6	1
		IF	35.5kW/m^2	0	0	0	0
		IF	14.1kW/m^2	0	0	0	0
		IF	7.3kW/m^2	5	1	5	1
		IS	Flame Length	6	1	6	1
		IS	35.5kW/m^2	0	0	0	0
		IS	14.1kW/m^2	0	0	0	0
		IS	7.3kW/m^2	5	1	5	1
	050	IF	Flame Length	20	6	21	6
		IF	35.5kW/m^2	20	7	21	7
		IF	14.1kW/m^2	24	17	25	17
		IF	7.3kW/m^2	27	26	27	25
		IS	Flame Length	20	6	21	6
		IS	35.5kW/m^2	20	7	21	7
		IS	14.1kW/m^2	24	17	25	17
		IS	7.3kW/m^2	27	26	27	25
	100	IF	Flame Length	37	14	39	13
		IF	35.5kW/m^2	38	20	40	20
		IF	14.1kW/m^2	46	41	48	40
		IF	7.3kW/m^2	53	58	54	58
		IS	Flame Length	37	14	39	13

Section Tag	Lea Size (mm)	IS/ IF	End Point	2F		5D	
				R	W	R	W
		IS	35.5kW/m^2	38	20	40	20
		IS	14.1kW/m^2	46	41	48	40
		IS	7.3kW/m^2	53	58	54	58
	RUP	IF	Flame Length	86	41	91	37
		IF	35.5kW/m^2	95	70	99	72
		IF	14.1kW/m^2	120	124	125	126
		IF	7.3kW/m^2	143	175	145	176
		IS	Flame Length	86	41	91	37
		IS	35.5kW/m^2	95	70	99	72
		IS	14.1kW/m^2	120	124	125	126
		IS	7.3kW/m^2	143	175	145	176
09U	012	IF	Flame Length	6	1	6	1
		IF	35.5kW/m^2	0	0	0	0
		IF	14.1kW/m^2	0	0	0	0
		IF	7.3kW/m^2	5	1	5	1
		IS	Flame Length	6	1	6	1
		IS	35.5kW/m^2	0	0	0	0
		IS	14.1kW/m^2	0	0	0	0
		IS	7.3kW/m^2	5	1	5	1
	050	IF	Flame Length	20	6	21	6
		IF	35.5kW/m^2	20	7	21	7
		IF	14.1kW/m^2	24	17	25	17
		IF	7.3kW/m^2	27	26	27	25
		IS	Flame Length	20	6	21	6
		IS	35.5kW/m^2	20	7	21	7
		IS	14.1kW/m^2	24	17	25	17
		IS	7.3kW/m^2	27	26	27	25
	100	IF	Flame Length	37	14	39	13
		IF	35.5kW/m^2	38	20	40	20
		IF	14.1kW/m^2	46	41	48	40
		IF	7.3kW/m^2	53	58	54	58
		IS	Flame Length	37	14	39	13
		IS	35.5kW/m^2	38	20	40	20
		IS	14.1kW/m^2	46	41	48	40

Section Tag	Lea Size (mm)	IS/ IF	End Point	2F		5D	
				R	W	R	W
		IS	7.3kW/m^2	53	58	54	58
	RUP	IF	Flame Length	86	41	91	37
		IF	35.5kW/m^2	95	70	99	72
		IF	14.1kW/m^2	120	124	125	126
		IF	7.3kW/m^2	143	175	145	176
		IS	Flame Length	86	41	91	37
		IS	35.5kW/m^2	95	70	99	72
		IS	14.1kW/m^2	120	124	125	126
		IS	7.3kW/m^2	143	175	145	176
10U	012	IF	Flame Length	3	1	3	0
		IF	35.5kW/m^2	0	0	0	0
		IF	14.1kW/m^2	0	0	0	0
		IF	7.3kW/m^2	0	0	0	0
		IS	Flame Length	3	1	3	0
		IS	35.5kW/m^2	0	0	0	0
		IS	14.1kW/m^2	0	0	0	0
		IS	7.3kW/m^2	0	0	0	0
	050	IF	Flame Length	8	3	10	1
		IF	35.5kW/m^2	0	0	0	0
		IF	14.1kW/m^2	7	2	0	0
		IF	7.3kW/m^2	9	6	11	3
		IS	Flame Length	8	3	10	1
		IS	35.5kW/m^2	0	0	0	0
		IS	14.1kW/m^2	7	2	0	0
		IS	7.3kW/m^2	9	6	11	3
	100	IF	Flame Length	14	5	18	2
		IF	35.5kW/m^2	8	2	17	1
		IF	14.1kW/m^2	15	10	18	5
		IF	7.3kW/m^2	18	17	19	9
		IS	Flame Length	14	5	18	2
		IS	35.5kW/m^2	8	2	17	1
		IS	14.1kW/m^2	15	10	18	5
		IS	7.3kW/m^2	18	17	19	9
	RUP	IF	Flame Length	55	12	65	12

Section Tag	Lea Size (mm)	IS/ IF	End Point	2F		5D	
				R	W	R	W
		IF	35.5kW/m^2	53	38	72	37
		IF	14.1kW/m^2	67	72	77	71
		IF	7.3kW/m^2	79	104	82	104
		IS	Flame Length	55	12	65	12
		IS	35.5kW/m^2	53	38	72	37
		IS	14.1kW/m^2	67	72	77	71
		IS	7.3kW/m^2	79	104	82	104
150	012	IF	Flame Length	3	1	3	0
		IF	35.5kW/m^2	0	0	0	0
		IF	14.1kW/m^2	0	0	0	0
		IF	7.3kW/m^2	0	0	0	0
		IS	Flame Length	3	1	3	0
		IS	35.5kW/m^2	0	0	0	0
		IS	14.1kW/m^2	0	0	0	0
		IS	7.3kW/m^2	0	0	0	0
	050	IF	Flame Length	9	3	11	2
		IF	35.5kW/m^2	0	0	0	0
		IF	14.1kW/m^2	8	2	11	1
		IF	7.3kW/m^2	9	7	12	4
		IS	Flame Length	9	3	11	2
		IS	35.5kW/m^2	0	0	0	0
		IS	14.1kW/m^2	8	2	11	1
		IS	7.3kW/m^2	9	7	12	4
	100	IF	Flame Length	15	6	18	2
		IF	35.5kW/m^2	10	2	18	1
		IF	14.1kW/m^2	16	12	19	5
		IF	7.3kW/m^2	19	19	20	10
		IS	Flame Length	15	6	18	2
		IS	35.5kW/m^2	10	2	18	1
		IS	14.1kW/m^2	16	12	19	5
		IS	7.3kW/m^2	19	19	20	10
	RUP	IF	Flame Length	94	28	109	28
		IF	35.5kW/m^2	96	79	125	79
		IF	14.1kW/m^2	122	142	136	142

Section Tag	Lea Size (mm)	IS/ IF	End Point	2F		5D	
				R	W	R	W
		IF	7.3kW/m^2	146	202	147	203
		IS	Flame Length	94	28	109	28
		IS	35.5kW/m^2	96	79	125	79
		IS	14.1kW/m^2	122	142	136	142
		IS	7.3kW/m^2	146	202	147	203
160	050	IF	Flame Length	8	2	10	1
		IF	35.5kW/m^2	0	0	0	0
		IF	14.1kW/m^2	0	0	0	0
		IF	7.3kW/m^2	8	4	0	0
		IS	Flame Length	8	2	10	1
		IS	35.5kW/m^2	0	0	0	0
		IS	14.1kW/m^2	0	0	0	0
		IS	7.3kW/m^2	8	4	0	0
	RUP	IF	Flame Length	82	22	103	22
		IF	35.5kW/m^2	90	67	116	60
		IF	14.1kW/m^2	106	120	124	115
		IF	7.3kW/m^2	120	171	132	167
		IS	Flame Length	82	22	103	22
		IS	35.5kW/m^2	90	67	116	60
		IS	14.1kW/m^2	106	120	124	115
		IS	7.3kW/m^2	120	171	132	167
170	012	IF	Flame Length	6	1	6	1
		IF	35.5kW/m^2	0	0	0	0
		IF	14.1kW/m^2	0	0	0	0
		IF	7.3kW/m^2	5	1	5	1
		IS	Flame Length	6	1	6	1
		IS	35.5kW/m^2	0	0	0	0
		IS	14.1kW/m^2	0	0	0	0
		IS	7.3kW/m^2	5	1	5	1
	050	IF	Flame Length	20	6	21	6
		IF	35.5kW/m^2	20	7	21	7
		IF	14.1kW/m^2	24	17	25	17
		IF	7.3kW/m^2	27	26	27	25
		IS	Flame Length	20	6	21	6

Section Tag	Lea Size (mm)	IS/ IF	End Point	2F		5D	
				R	W	R	W
		IS	35.5kW/m^2	20	7	21	7
		IS	14.1kW/m^2	24	17	25	17
		IS	7.3kW/m^2	27	26	27	25
	100	IF	Flame Length	37	14	39	13
		IF	35.5kW/m^2	38	20	40	20
		IF	14.1kW/m^2	46	41	48	40
		IF	7.3kW/m^2	53	58	54	58
		IS	Flame Length	37	14	39	13
		IS	35.5kW/m^2	38	20	40	20
		IS	14.1kW/m^2	46	41	48	40
		IS	7.3kW/m^2	53	58	54	58
	RUP	IF	Flame Length	107	53	113	48
		IF	35.5kW/m^2	121	94	126	98
		IF	14.1kW/m^2	153	163	159	166
		IF	7.3kW/m^2	185	229	187	231
		IS	Flame Length	107	53	113	48
		IS	35.5kW/m^2	121	94	126	98
		IS	14.1kW/m^2	153	163	159	166
		IS	7.3kW/m^2	185	229	187	231
180	012	IF	Flame Length	26	19	20	17
		IF	35.5kW/m^2	29	10	24	12
		IF	14.1kW/m^2	33	22	28	23
		IF	7.3kW/m^2	37	32	32	31
		IS	Flame Length	26	19	20	17
		IS	35.5kW/m^2	29	10	24	12
		IS	14.1kW/m^2	33	22	28	23
		IS	7.3kW/m^2	37	32	32	31
	050	IF	Flame Length	85	63	66	57
		IF	35.5kW/m^2	102	44	86	53
		IF	14.1kW/m^2	117	89	101	90
		IF	7.3kW/m^2	131	124	115	120
		IS	Flame Length	85	63	66	57
		IS	35.5kW/m^2	102	44	86	53
		IS	14.1kW/m^2	117	89	101	90

Section Tag	Lea Size (mm)	IS/ IF	End Point	2F		5D	
				R	W	R	W
		IS	7.3kW/m^2	131	124	115	120
	100	IF	Flame Length	152	112	118	102
		IF	35.5kW/m^2	187	67	157	106
		IF	14.1kW/m^2	215	173	186	174
		IF	7.3kW/m^2	242	237	213	230
		IS	Flame Length	152	112	118	102
		IS	35.5kW/m^2	187	67	157	106
		IS	14.1kW/m^2	215	173	186	174
		IS	7.3kW/m^2	242	237	213	230
190	012	IF	Flame Length	25	19	20	17
		IF	35.5kW/m^2	29	10	24	12
		IF	14.1kW/m^2	33	21	28	23
		IF	7.3kW/m^2	37	31	32	31
		IS	Flame Length	25	19	20	17
		IS	35.5kW/m^2	29	10	24	12
		IS	14.1kW/m^2	33	21	28	23
		IS	7.3kW/m^2	37	31	32	31
	050	IF	Flame Length	84	62	65	57
		IF	35.5kW/m^2	101	44	85	52
		IF	14.1kW/m^2	116	87	100	89
		IF	7.3kW/m^2	130	122	114	119
		IS	Flame Length	84	62	65	57
		IS	35.5kW/m^2	101	44	85	52
		IS	14.1kW/m^2	116	87	100	89
		IS	7.3kW/m^2	130	122	114	119
	100	IF	Flame Length	150	112	117	102
		IF	35.5kW/m^2	185	90	156	105
		IF	14.1kW/m^2	213	170	184	171
		IF	7.3kW/m^2	239	234	211	227
		IS	Flame Length	150	112	117	102
		IS	35.5kW/m^2	185	90	156	105
		IS	14.1kW/m^2	213	170	184	171
		IS	7.3kW/m^2	239	234	211	227
200	012	IF	Flame Length	24	18	19	16

Section Tag	Lea Size (mm)	IS/ IF	End Point	2F		5D	
				R	W	R	W
		IF	35.5kW/m^{2}	27	9	23	11
		IF	14.1kW/m^{2}	31	20	26	21
		IF	7.3kW/m^{2}	35	29	30	29
		IS	Flame Length	24	18	19	16
		IS	35.5kW/m^{2}	27	9	23	11
		IS	14.1kW/m^{2}	31	20	26	21
		IS	7.3kW/m^{2}	35	29	30	29
	050	IF	Flame Length	79	61	62	55
		IF	35.5kW/m^{2}	95	40	80	48
		IF	14.1kW/m^{2}	109	81	94	83
		IF	7.3kW/m^{2}	122	114	107	111
		IS	Flame Length	79	61	62	55
		IS	35.5kW/m^{2}	95	40	80	48
		IS	14.1kW/m^{2}	109	81	94	83
		IS	7.3kW/m^{2}	122	114	107	111
	100	IF	Flame Length	142	109	110	97
		IF	35.5kW/m^{2}	173	83	146	96
		IF	14.1kW/m^{2}	200	158	172	160
		IF	7.3kW/m^{2}	225	218	198	211
		IS	Flame Length	142	109	110	97
		IS	35.5kW/m^{2}	173	83	146	96
		IS	14.1kW/m^{2}	200	158	172	160
		IS	7.3kW/m^{2}	225	218	198	211
210	050	IF	Flame Length	79	61	62	55
		IF	35.5kW/m^{2}	95	40	80	48
		IF	14.1kW/m^{2}	109	81	94	83
		IF	7.3kW/m^{2}	122	114	107	111
		IS	Flame Length	79	61	62	55
		IS	35.5kW/m^{2}	95	40	80	48
		IS	14.1kW/m^{2}	109	81	94	83
		IS	7.3kW/m^{2}	122	114	107	111
220	012	IF	Flame Length	35	21	27	19
		IF	35.5kW/m^{2}	41	16	34	19
		IF	14.1kW/m^{2}	46	33	39	34

Section Tag	Lea Size (mm)	IS/ IF	End Point	2F		5D	
				R	W	R	W
		IF	7.3kW/m^{2}	51	47	45	47
		IS	Flame Length	35	21	27	19
		IS	35.5kW/m^{2}	41	16	34	19
		IS	14.1kW/m^{2}	46	33	39	34
		IS	7.3kW/m^{2}	51	47	45	47
	050	IF	Flame Length	118	72	92	65
		IF	35.5kW/m^{2}	144	71	121	81
		IF	14.1kW/m^{2}	164	132	141	134
		IF	7.3kW/m^{2}	183	183	161	178
		IS	Flame Length	118	72	92	65
		IS	35.5kW/m^{2}	144	71	121	81
		IS	14.1kW/m^{2}	164	132	141	134
		IS	7.3kW/m^{2}	183	183	161	178
	100	IF	Flame Length	200	126	156	115
		IF	35.5kW/m^{2}	250	133	210	150
		IF	14.1kW/m^{2}	285	240	246	240
		IF	7.3kW/m^{2}	319	328	282	319
		IS	Flame Length	200	126	156	115
		IS	35.5kW/m^{2}	250	133	210	150
		IS	14.1kW/m^{2}	285	240	246	240
		IS	7.3kW/m^{2}	319	328	282	319
230	012	IF	Flame Length	35	21	27	19
		IF	35.5kW/m^{2}	41	16	34	19
		IF	14.1kW/m^{2}	46	33	39	34
		IF	7.3kW/m^{2}	51	47	45	47
		IS	Flame Length	35	21	27	19
		IS	35.5kW/m^{2}	41	16	34	19
		IS	14.1kW/m^{2}	46	33	39	34
		IS	7.3kW/m^{2}	51	47	45	47
	050	IF	Flame Length	118	72	92	65
		IF	35.5kW/m^{2}	144	71	121	81
		IF	14.1kW/m^{2}	164	132	141	134
		IF	7.3kW/m^{2}	183	183	161	178
		IS	Flame Length	118	72	92	65

Section Tag	Lea Size (mm)	IS/ IF	End Point	2F		5D	
				R	W	R	W
		IS	35.5kW/m^{2}	144	71	121	81
		IS	14.1kW/m^{2}	164	132	141	134
		IS	7.3kW/m^{2}	183	183	161	178
240	012	IF	Flame Length	15	5	16	4
		IF	35.5kW/m^{2}	14	3	15	3
		IF	14.1kW/m^{2}	17	11	18	10
		IF	7.3kW/m^{2}	20	17	20	17
		IS	Flame Length	15	5	16	4
		IS	35.5kW/m^{2}	14	3	15	3
		IS	14.1kW/m^{2}	17	11	18	10
		IS	7.3kW/m^{2}	20	17	20	17
	050	IF	Flame Length	52	21	55	20
		IF	35.5kW/m^{2}	55	34	59	34
		IF	14.1kW/m^{2}	68	64	71	64
		IF	7.3kW/m^{2}	79	91	81	91
		IS	Flame Length	52	21	55	20
		IS	35.5kW/m^{2}	55	34	59	34
		IS	14.1kW/m^{2}	68	64	71	64
		IS	7.3kW/m^{2}	79	91	81	91
	100	IF	Flame Length	87	41	92	38
		IF	35.5kW/m^{2}	96	72	100	74
		IF	14.1kW/m^{2}	122	126	127	128
		IF	7.3kW/m^{2}	146	178	148	179
		IS	Flame Length	87	41	92	38
		IS	35.5kW/m^{2}	96	72	100	74
		IS	14.1kW/m^{2}	122	126	127	128
		IS	7.3kW/m^{2}	146	178	148	179
	RUP	IF	Flame Length	333	201	337	201
		IF	35.5kW/m^{2}	406	326	255	289
		IF	14.1kW/m^{2}	512	554	282	491
		IF	7.3kW/m^{2}	618	773	637	786
		IS	Flame Length	333	201	337	201
		IS	35.5kW/m^{2}	406	326	255	289
		IS	14.1kW/m^{2}	512	554	282	491

Section Tag	Lea Size (mm)	IS/ IF	End Point	2F		5D	
				R	W	R	W
		IS	7.3kW/m^{2}	618	773	637	786
250	050	IF	Flame Length	51	21	54	19
		IF	35.5kW/m^{2}	53	33	57	33
		IF	14.1kW/m^{2}	66	62	69	62
		IF	7.3kW/m^{2}	77	88	79	88
		IS	Flame Length	51	21	54	19
		IS	35.5kW/m^{2}	53	33	57	33
		IS	14.1kW/m^{2}	66	62	69	62
		IS	7.3kW/m^{2}	77	88	79	88
	RUP	IF	Flame Length	70	31	74	29
		IF	35.5kW/m^{2}	75	52	80	53
		IF	14.1kW/m^{2}	94	94	98	95
		IF	7.3kW/m^{2}	111	133	113	133
		IS	Flame Length	70	31	74	29
		IS	35.5kW/m^{2}	75	52	80	53
		IS	14.1kW/m^{2}	94	94	98	95
		IS	7.3kW/m^{2}	111	133	113	133
260	012	IF	Flame Length	15	4	16	4
		IF	35.5kW/m^{2}	14	3	15	3
		IF	14.1kW/m^{2}	17	10	17	10
		IF	7.3kW/m^{2}	19	17	19	16
		IS	Flame Length	15	4	16	4
		IS	35.5kW/m^{2}	14	3	15	3
		IS	14.1kW/m^{2}	17	10	17	10
		IS	7.3kW/m^{2}	19	17	19	16
	050	IF	Flame Length	51	21	54	19
		IF	35.5kW/m^{2}	53	33	57	33
		IF	14.1kW/m^{2}	66	62	69	62
		IF	7.3kW/m^{2}	77	88	79	88
		IS	Flame Length	51	21	54	19
		IS	35.5kW/m^{2}	53	33	57	33
		IS	14.1kW/m^{2}	66	62	69	62
		IS	7.3kW/m^{2}	77	88	79	88
	100	IF	Flame Length	85	40	90	37

Section Tag	Lea Size (mm)	IS/ IF	End Point	2F		5D	
				R	W	R	W
		IF	$35.5kW/m^2$	94	69	99	71
		IF	$14.1kW/m^2$	118	122	123	124
		IF	$7.3kW/m^2$	141	172	143	173
		IS	Flame Length	85	40	90	37
		IS	$35.5kW/m^2$	94	69	99	71
		IS	$14.1kW/m^2$	118	122	123	124
		IS	$7.3kW/m^2$	141	172	143	173
	RUP	IF	Flame Length	117	59	123	53
		IF	$35.5kW/m^2$	134	105	139	110
		IF	$14.1kW/m^2$	169	182	176	185
		IF	$7.3kW/m^2$	205	255	207	257
		IS	Flame Length	117	59	123	53
		IS	$35.5kW/m^2$	134	105	139	110
		IS	$14.1kW/m^2$	169	182	176	185
		IS	$7.3kW/m^2$	205	255	207	257
270	012	IF	Flame Length	10	3	11	2
		IF	$35.5kW/m^2$	0	0	0	0
		IF	$14.1kW/m^2$	11	5	11	4
		IF	$7.3kW/m^2$	12	9	12	8
		IS	Flame Length	10	3	11	2
		IS	$35.5kW/m^2$	0	0	0	0
		IS	$14.1kW/m^2$	11	5	11	4
		IS	$7.3kW/m^2$	12	9	12	8
	050	IF	Flame Length	37	14	39	13
		IF	$35.5kW/m^2$	38	20	40	20
		IF	$14.1kW/m^2$	46	41	48	40
		IF	$7.3kW/m^2$	53	58	54	58
		IS	Flame Length	37	14	39	13
		IS	$35.5kW/m^2$	38	20	40	20
		IS	$14.1kW/m^2$	46	41	48	40
		IS	$7.3kW/m^2$	53	58	54	58
	100	IF	Flame Length	63	27	67	26
		IF	$35.5kW/m^2$	67	45	72	46
		IF	$14.1kW/m^2$	84	83	88	83

Section Tag	Lea Size (mm)	IS/ IF	End Point	2F		5D	
				R	W	R	W
		IF	$7.3kW/m^2$	99	117	101	117
		IS	Flame Length	63	27	67	26
		IS	$35.5kW/m^2$	67	45	72	46
		IS	$14.1kW/m^2$	84	83	88	83
		IS	$7.3kW/m^2$	99	117	101	117
	RUP	IF	Flame Length	64	28	68	26
		IF	$35.5kW/m^2$	68	46	73	47
		IF	$14.1kW/m^2$	86	84	90	84
		IF	$7.3kW/m^2$	101	119	103	119
		IS	Flame Length	64	28	68	26
		IS	$35.5kW/m^2$	68	46	73	47
		IS	$14.1kW/m^2$	86	84	90	84
		IS	$7.3kW/m^2$	101	119	103	119

***IS: isolation success; IF: isolation fail; RUP: Rupture**

Table B.2 Pool Fire Consequence

Section Tag	Lea Size (mm)	IS/ IF	End Point	2F		5D	
				R	W	R	W
01U	RUP	IF	Flame Length	88	176	88	176
		IF	$35.5kW/m^2$	199	327	235	349
		IF	$14.1kW/m^2$	318	556	341	567
		IF	$7.3kW/m^2$	421	767	438	769
		IS	Flame Length	57	115	57	114
		IS	$35.5kW/m^2$	141	225	167	241
		IS	$14.1kW/m^2$	227	390	243	396
		IS	$7.3kW/m^2$	301	542	312	541
02U	RUP	IF	Flame Length	88	175	88	175
		IF	$35.5kW/m^2$	199	326	234	348
		IF	$14.1kW/m^2$	317	556	341	566
		IF	$7.3kW/m^2$	421	766	437	768
		IS	Flame Length	88	175	88	175
		IS	$35.5kW/m^2$	199	326	234	348
		IS	$14.1kW/m^2$	317	556	341	566
		IS	$7.3kW/m^2$	421	766	437	768
03H	RUP	IF	Flame Length	15	30	15	30
		IF	$35.5kW/m^2$	49	70	59	76
		IF	$14.1kW/m^2$	79	127	85	130
		IF	$7.3kW/m^2$	105	180	110	180
		IS	Flame Length	15	30	15	30
		IS	$35.5kW/m^2$	49	70	59	76
		IS	$14.1kW/m^2$	79	127	85	130
		IS	$7.3kW/m^2$	105	180	110	180
03U	RUP	IF	Flame Length	88	175	88	175
		IF	$35.5kW/m^2$	199	326	234	348
		IF	$14.1kW/m^2$	317	556	341	566
		IF	$7.3kW/m^2$	421	766	437	768
		IS	Flame Length	88	175	88	175
		IS	$35.5kW/m^2$	199	326	234	348
		IS	$14.1kW/m^2$	317	556	341	566
		IS	$7.3kW/m^2$	421	766	437	768
04H	RUP	IF	Flame Length	15	30	15	30

Section Tag	Lea Size (mm)	IS/ IF	End Point	2F		5D	
				R	W	R	W
		IF	$35.5kW/m^2$	49	70	59	76
		IF	$14.1kW/m^2$	79	127	85	130
		IF	$7.3kW/m^2$	105	180	110	180
		IS	Flame Length	15	30	15	30
		IS	$35.5kW/m^2$	49	70	59	76
		IS	$14.1kW/m^2$	79	127	85	130
		IS	$7.3kW/m^2$	105	180	110	180
04U	RUP	IF	Flame Length	88	175	88	175
		IF	$35.5kW/m^2$	199	326	234	348
		IF	$14.1kW/m^2$	317	556	341	566
		IF	$7.3kW/m^2$	421	766	437	768
		IS	Flame Length	88	175	88	175
		IS	$35.5kW/m^2$	199	326	234	348
		IS	$14.1kW/m^2$	317	556	341	566
		IS	$7.3kW/m^2$	421	766	437	768
05H	RUP	IF	Flame Length	15	30	15	30
		IF	$35.5kW/m^2$	49	70	59	76
		IF	$14.1kW/m^2$	79	127	85	130
		IF	$7.3kW/m^2$	105	180	110	180
		IS	Flame Length	15	30	15	30
		IS	$35.5kW/m^2$	49	70	59	76
		IS	$14.1kW/m^2$	79	127	85	130
		IS	$7.3kW/m^2$	105	180	110	180
05U	Rup	IF	Flame Length	88	175	88	175
		IF	$35.5kW/m^2$	199	326	234	348
		IF	$14.1kW/m^2$	317	556	341	566
		IF	$7.3kW/m^2$	421	766	437	768
06H	RUP	IF	Flame Length	15	30	15	30
		IF	$35.5kW/m^2$	49	70	59	76
		IF	$14.1kW/m^2$	79	127	85	130
		IF	$7.3kW/m^2$	105	180	110	180
		IS	Flame Length	15	30	15	30
		IS	$35.5kW/m^2$	49	70	59	76
		IS	$14.1kW/m^2$	79	127	85	130

Section Tag	Lea Size (mm)	IS/ IF	End Point	2F		5D	
				R	W	R	W
		IS	7.3kW/m^2	105	180	110	180
06U	RUP	IF	Flame Length	88	175	88	175
		IF	35.5kW/m^2	199	326	234	348
		IF	14.1kW/m^2	317	556	341	566
		IF	7.3kW/m^2	421	766	437	768
070	CAT	IF	Flame Length	1338	2676	1315	2631
		IF	35.5kW/m^2	1897	3539	2032	3553
		IF	14.1kW/m^2	2767	5255	2873	5217
		IF	7.3kW/m^2	3511	6754	3582	6679
		IS	Flame Length	1338	2676	1315	2631
		IS	35.5kW/m^2	1897	3539	2032	3553
		IS	14.1kW/m^2	2767	5255	2873	5217
		IS	7.3kW/m^2	3511	6754	3582	6679

***IS: isolation success; IF: isolation fail; RUP: Rupture; CAT: catastrophic rupture**

Table B.3 Flash Fire Consequence

Section Tag	Lea Size (mm)	IS/ IF	End Point	2F		5D	
				R	W	R	W
01U	012	IF	LFL	49	17	29	3
		IS	LFL	49	17	29	3
	050	IF	LFL	206	172	146	36
		IS	LFL	206	172	146	36
	100	IF	LFL	411	331	268	80
		IS	LFL	408	329	269	80
	RUP	IF	LFL	982	1698	805	474
		IS	LFL	952	1051	518	212
02U	012	IF	LFL	45	17	27	3
		IS	LFL	45	17	27	3
	050	IF	LFL	189	159	133	33
		IS	LFL	189	159	133	33
	100	IF	LFL	386	299	241	73
		IS	LFL	386	299	241	73
	RUP	IF	LFL	1227	2190	783	762
		IS	LFL	1163	1888	783	635
03H	012	IF	LFL	54	10	36	3
		IS	LFL	54	10	36	3
	050	IF	LFL	282	137	194	42
		IS	LFL	282	137	194	42
	100	IF	LFL	377	268	218	67
		IS	LFL	376	267	218	67
	RUP	IF	LFL	362	263	164	82
		IS	LFL	344	260	164	81
03U	012	IF	LFL	45	17	27	3
		IS	LFL	45	17	27	3
	050	IF	LFL	189	159	133	33
		IS	LFL	189	159	133	33
	100	IF	LFL	386	299	241	73
		IS	LFL	386	299	241	73
	RUP	IF	LFL	1234	2189	783	762
		IS	LFL	1172	1930	783	657
04H	012	IF	LFL	54	10	36	3

Section Tag	Lea Size (mm)	IS/ IF	End Point	2F		5D	
				R	W	R	W
		IS	LFL	54	10	36	3
	050	IF	LFL	282	137	194	42
		IS	LFL	282	137	194	42
	100	IF	LFL	377	268	218	67
		IS	LFL	377	268	218	67
	RUP	IF	LFL	335	266	164	85
		IS	LFL	335	266	164	85
04U	012	IF	LFL	45	17	27	3
		IS	LFL	45	17	27	3
	050	IF	LFL	189	159	133	33
		IS	LFL	189	159	133	33
	100	IF	LFL	386	299	241	73
		IS	LFL	386	299	241	73
	RUP	IF	LFL	680	821	381	317
		IS	LFL	680	821	381	317
05H	012	IF	LFL	54	10	36	3
		IS	LFL	54	10	36	3
	050	IF	LFL	282	137	194	42
		IS	LFL	282	137	194	42
	100	IF	LFL	374	265	219	66
		IS	LFL	366	262	219	64
	RUP	IF	LFL	330	252	165	75
		IS	LFL	315	261	164	69
05U	012	IF	LFL	45	17	27	3
		IS	LFL	45	17	27	3
	050	IF	LFL	189	159	133	33
		IS	LFL	189	159	133	33
	100	IF	LFL	386	299	241	73
		IS	LFL	386	299	241	73
	RUP	IF	LFL	1223	2156	783	761
06H	012	IF	LFL	54	10	36	3
		IS	LFL	54	10	36	3
	050	IF	LFL	282	137	194	42
		IS	LFL	282	137	194	42

Section Tag	Lea Size (mm)	IS/ IF	End Point	2F		5D	
				R	W	R	W
	100	IF	LFL	377	267	218	67
		IS	LFL	375	266	218	66
	RUP	IF	LFL	330	252	165	75
		IS	LFL	315	261	164	69
06U	RUP	IF	LFL	1226	2152	783	762
070	CAT	IF	LFL	11987	7018	7900	4698
		IS	LFL	11987	7018	7900	4698
08U	012	IF	LFL	4	0	3	0
		IS	LFL	4	0	3	0
	050	IF	LFL	16	1	14	1
		IS	LFL	16	1	14	1
	100	IF	LFL	38	3	37	3
		IS	LFL	38	3	37	3
	RUP	IF	LFL	141	12	140	11
		IS	LFL	141	12	140	11
09U	012	IF	LFL	4	0	3	0
		IS	LFL	4	0	3	0
	050	IF	LFL	16	1	14	1
		IS	LFL	16	1	14	1
	100	IF	LFL	38	3	37	3
		IS	LFL	38	3	37	3
	RUP	IF	LFL	141	12	140	11
		IS	LFL	141	12	140	11
	CAT	IF	LFL	535	115	287	85
		IS	LFL	360	70	211	50
10U	012	IF	LFL	2	0	2	0
		IS	LFL	2	0	2	0
	050	IF	LFL	7	1	5	1
		IS	LFL	7	1	5	1
	100	IF	LFL	16	2	11	1
		IS	LFL	16	2	11	1
	RUP	IF	LFL	78	9	90	8
		IS	LFL	78	9	90	8
150	012	IF	LFL	2	0	2	0

Section Tag	Lea Size (mm)	IS/ IF	End Point	2F		5D	
				R	W	R	W
		IS	LFL	2	0	2	0
	050	IF	LFL	7	1	6	1
		IS	LFL	7	1	6	1
	100	IF	LFL	17	2	12	1
		IS	LFL	17	2	12	1
	RUP	IF	LFL	128	17	152	14
		IS	LFL	128	17	152	14
	CAT	IF	LFL	650	146	336	111
		IS	LFL	433	88	238	66
160	050	IF	LFL	6	1	5	1
		IS	LFL	6	1	5	1
	RUP	IF	LFL	101	14	121	12
		IS	LFL	101	14	121	12
170	012	IF	LFL	4	0	3	0
		IS	LFL	4	0	3	0
	050	IF	LFL	16	1	14	1
		IS	LFL	16	1	14	1
	100	IF	LFL	38	3	37	3
		IS	LFL	38	3	37	3
	RUP	IF	LFL	190	16	189	14
		IS	LFL	190	16	189	14
180	012	IF	LFL	54	10	36	3
		IS	LFL	54	10	36	3
	050	IF	LFL	281	139	193	41
		IS	LFL	281	139	193	41
	100	IF	LFL	574	292	380	102
		IS	LFL	571	288	380	102
	CAT	IF	LFL	1075	500	645	210
		IS	LFL	963	446	573	187
190	012	IF	LFL	54	11	35	3
		IS	LFL	54	11	35	3
	050	IF	LFL	278	143	190	41
		IS	LFL	278	143	190	41
	100	IF	LFL	570	303	375	102

Section Tag	Lea Size (mm)	IS/ IF	End Point	2F		5D	
				R	W	R	W
		IS	LFL	568	298	374	101
200	012	IF	LFL	52	12	33	3
		IS	LFL	52	12	33	3
	050	IF	LFL	253	162	172	40
		IS	LFL	253	162	172	40
	100	IF	LFL	517	340	335	93
		IS	LFL	513	329	334	92
210	050	IF	LFL	253	162	172	40
		IS	LFL	253	162	172	40
220	012	IF	LFL	46	4	44	3
		IS	LFL	46	4	44	3
	050	IF	LFL	236	35	267	27
		IS	LFL	236	35	267	27
	100	IF	LFL	453	100	550	79
		IS	LFL	453	100	550	79
230	012	IF	LFL	46	4	44	3
		IS	LFL	46	4	44	3
	050	IF	LFL	236	35	267	27
		IS	LFL	236	35	267	27
240	012	IF	LFL	11	1	9	1
		IS	LFL	11	1	9	1
	050	IF	LFL	66	6	64	5
		IS	LFL	66	6	64	5
	100	IF	LFL	126	12	143	11
		IS	LFL	126	12	143	11
	RUP	IF	LFL	436	60	452	58
		IS	LFL	436	60	452	58
250	050	IF	LFL	62	6	61	5
		IS	LFL	62	6	61	5
	RUP	IF	LFL	91	9	100	8
		IS	LFL	91	9	100	8
260	012	IF	LFL	11	1	9	1
		IS	LFL	11	1	9	1
	050	IF	LFL	62	6	61	5

Section Tag	Lea Size (mm)	IS/ IF	End Point	2F		5D	
				R	W	R	W
		IS	LFL	62	6	61	5
	100	IF	LFL	136	12	134	10
		IS	LFL	136	12	134	10
	RUP	IF	LFL	176	18	178	16
		IS	LFL	176	18	178	16
270	012	IF	LFL	7	1	6	1
		IS	LFL	7	1	6	1
	050	IF	LFL	38	3	37	3
		IS	LFL	38	3	37	3
	100	IF	LFL	89	8	88	7
		IS	LFL	89	8	88	7
	RUP	IF	LFL	91	8	89	7
		IS	LFL	91	8	89	7

***IS: isolation success; IF: isolation fail; RUP: Rupture; CAT: catastrophic rupture**

Table B.4 Fireball Consequence

Section Tag	Lea Size (mm)	IS/ IF	Lethality	2F		5D	
				R	W	R	W
09U	CAT	IF	0.01	11	22	11	22
			1.00	7	15	7	15
		IS	0.01	11	22	11	22
			1.00	7	15	7	15
150	CAT	IF	0.01	14	28	14	28
			0.5	2	4	2	4
			1.00	10	19	10	19
		IS	0.01	14	28	14	28
			0.5	2	4	2	4
			1.00	10	19	10	19
180	CAT	IF	0.01	39	78	39	78
			0.5	28	55	28	55
			0.99	15	29	15	29
			1.00	18	35	18	35
		IS	0.01	39	78	39	78
			0.5	28	55	28	55
			0.99	15	29	15	29
			1.00	18	35	18	35
240	RUP	IF	0.01	418	836	418	836
			0.5	265	529	265	529
			0.99	117	235	117	235
			1.00	117	233	117	233
		IS	0.01	418	836	418	836
			0.5	265	529	265	529
			0.99	117	235	117	235
			1.00	117	233	117	233
250	RUP	IF	0.01	60	119	60	119
			0.5	40	81	40	81
			0.99	29	58	29	58
			1.00	22	45	22	45
		IS	0.01	60	119	60	119
			0.5	40	81	40	81
			0.99	29	58	29	58

Section Tag	Lea Size (mm)	IS/ IF	Lethality	2F		5D	
				R	W	R	W
			1.00	22	45	22	45
260	RUP	IF	0.01	59	119	59	119
			0.5	40	81	40	81
			0.99	29	57	29	57
			1.00	22	45	22	45
		IS	0.01	59	119	59	119
			0.5	40	81	40	81
			0.99	29	57	29	57
			1.00	22	45	22	45
270	RUP	IF	0.01	20	40	20	40
			0.5	17	34	17	34
			0.99	9	19	9	19
			1.00	10	20	10	20
		IS	0.01	20	40	20	40
			0.5	17	34	17	34
			0.99	9	19	9	19
			1.00	10	20	10	20

*IS: isolation success; IF: isolation fail; RUP: Rupture; CAT: catastrophic rupture

Table B.5 VCE Consequence

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
01U	050	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	12	24
				0.1 bar	89	178
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	11	22
				0.1 bar	81	162
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	12	24
				0.1 bar	89	178
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	11	22
				0.1 bar	81	162
	100	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	12	24
				0.1 bar	89	178
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	12	24
				0.1 bar	89	178
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	12	24

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	89	178
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	12	24
				0.1 bar	89	178
	RUP	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	12	24
				0.1 bar	89	178
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	12	24
				0.1 bar	89	178
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	12	24
				0.1 bar	89	178
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	12	24
				0.1 bar	89	178
02U	050	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	12	24
				0.1 bar	89	178
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	10	20

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	75	150
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	12	24
				0.1 bar	89	178
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	10	20
				0.1 bar	75	150
	100	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	12	24
				0.1 bar	89	178
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	12	24
				0.1 bar	89	178
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	12	24
				0.1 bar	89	178
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	12	24
				0.1 bar	89	178
	RUP	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	12	24

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	89	178
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			5D	1 bar	Not Reached	Not Reached
				0.28 bar	12	24
				0.1 bar	89	178
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			2F	1 bar	Not Reached	Not Reached
				0.28 bar	12	24
		IS		0.1 bar	89	178
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			5D	1 bar	Not Reached	Not Reached
				0.28 bar	12	24
				0.1 bar	89	178
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			2F	1 bar	Not Reached	Not Reached
				0.28 bar	4	8
		IF		0.1 bar	31	62
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			5D	1 bar	Not Reached	Not Reached
				0.28 bar	3	6
03H	012			0.1 bar	25	50
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			2F	1 bar	Not Reached	Not Reached
				0.28 bar	4	8
		IS		0.1 bar	31	62
				2 bar	Not Reached	Not Reached
			5D	1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	3	6

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	25	50
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			2F	1 bar	Not Reached	Not Reached
				0.28 bar	12	24
		IF		0.1 bar	89	178
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			5D	1 bar	Not Reached	Not Reached
				0.28 bar	12	24
	050			0.1 bar	89	178
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			2F	1 bar	Not Reached	Not Reached
				0.28 bar	12	24
		IS		0.1 bar	89	178
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			5D	1 bar	Not Reached	Not Reached
				0.28 bar	12	24
				0.1 bar	89	178
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			2F	1 bar	Not Reached	Not Reached
				0.28 bar	12	24
		IF		0.1 bar	89	178
				2 bar	Not Reached	Not Reached
	100			1.45 bar	Not Reached	Not Reached
			5D	1 bar	Not Reached	Not Reached
				0.28 bar	12	24
				0.1 bar	89	178
				2 bar	Not Reached	Not Reached
		IS	2F	1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	12	24

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	89	178
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			5D	1 bar	Not Reached	Not Reached
				0.28 bar	12	24
				0.1 bar	89	178
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			2F	1 bar	Not Reached	Not Reached
				0.28 bar	12	24
		IF		0.1 bar	89	178
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			5D	1 bar	Not Reached	Not Reached
				0.28 bar	12	24
	RUP			0.1 bar	89	178
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			2F	1 bar	Not Reached	Not Reached
				0.28 bar	12	24
		IS		0.1 bar	89	178
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			5D	1 bar	Not Reached	Not Reached
				0.28 bar	12	24
				0.1 bar	89	178
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			2F	1 bar	Not Reached	Not Reached
				0.28 bar	4	8
03U	012	IF		0.1 bar	31	62
				2 bar	Not Reached	Not Reached
			5D	1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	2	4

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	19	38
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			2F	1 bar	Not Reached	Not Reached
				0.28 bar	4	8
		IS		0.1 bar	31	62
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			5D	1 bar	Not Reached	Not Reached
				0.28 bar	2	4
				0.1 bar	19	38
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			2F	1 bar	Not Reached	Not Reached
				0.28 bar	12	24
		IF		0.1 bar	89	178
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			5D	1 bar	Not Reached	Not Reached
				0.28 bar	10	20
	050			0.1 bar	75	150
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			2F	1 bar	Not Reached	Not Reached
				0.28 bar	12	24
		IS		0.1 bar	89	178
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			5D	1 bar	Not Reached	Not Reached
				0.28 bar	10	20
				0.1 bar	75	150
				2 bar	Not Reached	Not Reached
	100	IF	2F	1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	12	24

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	89	178
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			5D	1 bar	Not Reached	Not Reached
				0.28 bar	12	24
				0.1 bar	89	178
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			2F	1 bar	Not Reached	Not Reached
				0.28 bar	12	24
		IS		0.1 bar	89	178
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			5D	1 bar	Not Reached	Not Reached
				0.28 bar	12	24
				0.1 bar	89	178
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			2F	1 bar	Not Reached	Not Reached
				0.28 bar	12	24
		IF		0.1 bar	89	178
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			5D	1 bar	Not Reached	Not Reached
				0.28 bar	12	24
	RUP			0.1 bar	89	178
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			2F	1 bar	Not Reached	Not Reached
				0.28 bar	12	24
		IS		0.1 bar	89	178
				2 bar	Not Reached	Not Reached
			5D	1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	12	24

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	89	178
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			2F	1 bar	Not Reached	Not Reached
				0.28 bar	5	10
		IF		0.1 bar	31	62
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			5D	1 bar	Not Reached	Not Reached
				0.28 bar	3	6
	012			0.1 bar	23	46
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			2F	1 bar	Not Reached	Not Reached
				0.28 bar	5	10
		IS		0.1 bar	31	62
				2 bar	Not Reached	Not Reached
04H				1.45 bar	Not Reached	Not Reached
			5D	1 bar	Not Reached	Not Reached
				0.28 bar	3	6
				0.1 bar	23	46
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			2F	1 bar	Not Reached	Not Reached
				0.28 bar	14	28
		IF		0.1 bar	100	200
				2 bar	Not Reached	Not Reached
	050			1.45 bar	Not Reached	Not Reached
			5D	1 bar	Not Reached	Not Reached
				0.28 bar	13	26
				0.1 bar	98	196
				2 bar	Not Reached	Not Reached
		IS	2F	1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	100	200
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			5D	1 bar	Not Reached	Not Reached
				0.28 bar	13	26
				0.1 bar	98	196
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			2F	1 bar	Not Reached	Not Reached
				0.28 bar	14	28
		IF		0.1 bar	100	200
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			5D	1 bar	Not Reached	Not Reached
				0.28 bar	14	28
	100			0.1 bar	100	200
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			2F	1 bar	Not Reached	Not Reached
				0.28 bar	14	28
		IS		0.1 bar	100	200
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			5D	1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			2F	1 bar	Not Reached	Not Reached
				0.28 bar	14	28
	RUP	IF		0.1 bar	100	200
				2 bar	Not Reached	Not Reached
			5D	1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	100	200
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			2F	1 bar	Not Reached	Not Reached
				0.28 bar	14	28
		IS		0.1 bar	100	200
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
			5D	1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
		IF		1 bar	Not Reached	Not Reached
				0.28 bar	4	8
	012			0.1 bar	29	58
				2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
		IS	2F	1 bar	Not Reached	Not Reached
				0.28 bar	4	8
				0.1 bar	29	58
				2 bar	Not Reached	Not Reached
04U				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
		IF		0.1 bar	100	200
				2 bar	Not Reached	Not Reached
	050			1.45 bar	Not Reached	Not Reached
			5D	1 bar	Not Reached	Not Reached
				0.28 bar	10	20
				0.1 bar	75	150
				2 bar	Not Reached	Not Reached
		IS	2F	1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	10	20
				0.1 bar	75	150
	100	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
	RUP	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	100	200
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
05H	012	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	5	10
				0.1 bar	31	62
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	3	6
				0.1 bar	23	46
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	5	10
				0.1 bar	31	62
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	3	6
				0.1 bar	23	46
	050	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	13	26
				0.1 bar	98	196
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	13	26
				0.1 bar	98	196
	100	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	100	200
	RUP	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
05U	012	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	5	10
				0.1 bar	31	62
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	3	6
				0.1 bar	18	36
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	5	10

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	31	62
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	3	6
				0.1 bar	18	36
	050	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	10	20
				0.1 bar	75	150
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	10	20
				0.1 bar	75	150
	100	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	100	200
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
	RUP	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
06U			2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
070	CAT		2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
08U	100	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	4	8
				0.1 bar	28	56
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	4	8
				0.1 bar	28	56
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	4	8
				0.1 bar	28	56
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	4	8

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	28	56
	RUP	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	12	24
				0.1 bar	84	168
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	10	20
				0.1 bar	75	150
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	12	24
				0.1 bar	84	168
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	10	20
				0.1 bar	75	150
09U	100	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	3	6
				0.1 bar	25	50
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	3	6
				0.1 bar	25	50
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	3	6

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	25	50
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	3	6
				0.1 bar	25	50
	RUP	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	11	22
				0.1 bar	83	166
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	10	20
				0.1 bar	75	150
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	11	22
				0.1 bar	83	166
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	10	20
				0.1 bar	75	150
	CAT	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	12	24
				0.1 bar	88	176
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	12	24

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	88	176
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	12	24
				0.1 bar	88	176
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	12	24
				0.1 bar	88	176
150	RUP	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	13	26
				0.1 bar	99	198
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	13	26
				0.1 bar	99	198
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	13	26
				0.1 bar	99	198
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	13	26
				0.1 bar	99	198
	CAT	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	13	26

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	99	198
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	13	26
				0.1 bar	99	198
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	13	26
				0.1 bar	99	198
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	13	26
				0.1 bar	99	198
160	RUP	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	13	26
				0.1 bar	99	198
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	13	26
				0.1 bar	95	190
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	13	26
				0.1 bar	99	198
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	13	26

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	95	190
170	100	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	4	8
				0.1 bar	28	56
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	4	8
				0.1 bar	28	56
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	4	8
				0.1 bar	28	56
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	4	8
				0.1 bar	28	56
	RUP	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	13	26
				0.1 bar	99	198
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	13	26
				0.1 bar	99	198
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	13	26

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	99	198
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	13	26
				0.1 bar	99	198
180	012	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	5	10
				0.1 bar	31	62
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	3	6
				0.1 bar	23	46
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	5	10
				0.1 bar	31	62
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	3	6
				0.1 bar	23	46
	050	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	13	26

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	98	196
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	13	26
				0.1 bar	98	196
	100	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
	CAT	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
190	012	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	5	10
				0.1 bar	31	62
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	3	6
				0.1 bar	23	46
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	5	10
				0.1 bar	31	62
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	3	6

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	23	46
	050	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	97	194
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	97	194
	100	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
200	012	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	5	10
				0.1 bar	31	62
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	3	6
				0.1 bar	23	46
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	5	10
				0.1 bar	31	62
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	3	6
				0.1 bar	23	46
	050	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	13	26

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	92	184
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	13	26
				0.1 bar	92	184
	100	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
210	050	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	13	26
				0.1 bar	92	184
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	13	26
				0.1 bar	92	184
220	012	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	4	8
				0.1 bar	28	56
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	4	8
				0.1 bar	28	56
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	4	8
				0.1 bar	28	56
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	4	8

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	28	56
	050	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
	100	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
230	012	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	Not Reached	Not Reached
				0.1 bar	10	20
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	Not Reached	Not Reached
				0.1 bar	10	20
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	Not Reached	Not Reached
				0.1 bar	10	20
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	Not Reached	Not Reached
				0.1 bar	10	20
	050	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	13	26
				0.1 bar	99	198
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	13	26

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	99	198
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	13	26
				0.1 bar	99	198
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	13	26
				0.1 bar	99	198
240	RUP	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	Not Reached	Not Reached
				0.1 bar	Not Reached	Not Reached
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	Not Reached	Not Reached
				0.1 bar	Not Reached	Not Reached
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	Not Reached	Not Reached
				0.1 bar	33	66
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	Not Reached	Not Reached
				0.1 bar	30	60
250	050	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	5	10

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	39	78
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	5	10
				0.1 bar	37	74
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	5	10
				0.1 bar	39	78
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	5	10
				0.1 bar	37	74
	RUP	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	8	16
				0.1 bar	61	122
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	8	16
				0.1 bar	56	112
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	8	16
				0.1 bar	61	122
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	8	16

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	56	112
260	050	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	5	10
				0.1 bar	39	78
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	5	10
				0.1 bar	37	74
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	5	10
				0.1 bar	39	78
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	5	10
				0.1 bar	37	74
	100	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	11	22
				0.1 bar	81	162
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	10	20
				0.1 bar	74	148
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	11	22

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	81	162
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	10	20
				0.1 bar	74	148
	RUP	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	14	28
				0.1 bar	100	200
270	050	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	4	8
				0.1 bar	28	56
		IS		2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	4	8

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	28	56
	100	IF		2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	7	14
				0.1 bar	53	106
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	7	14
				0.1 bar	48	96
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	7	14
				0.1 bar	48	96
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	6	12
				0.1 bar	47	94
	RUP	IF	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	8	16
				0.1 bar	55	110
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	7	14
				0.1 bar	50	100
		IS	2F	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	7	14

Section Tag	Leak Size (mm)	IS / IF	Weather	End Point	R	W
				0.1 bar	50	100
			5D	2 bar	Not Reached	Not Reached
				1.45 bar	Not Reached	Not Reached
				1 bar	Not Reached	Not Reached
				0.28 bar	7	14
				0.1 bar	48	96

***IS: isolation success; IF: isolation fail; RUP: Rupture; CAT: catastrophic rupture**

Table B.6 Impoundment Pit Pool Fire

Section Tag	End Point	2F		5D	
		R	W	R	W
Jetty Impoundment Pit 1	Flame Length	1	2	1	2
	35.5kW/m²	6	9	6	9
	14.1kW/m²	4	6	5	6
	7.3kW/m²	2	4	2	4
Jetty Impoundment Pit 2	Flame Length	1	2	1	2
	35.5kW/m²	6	9	6	9
	14.1kW/m²	4	6	5	6
	7.3kW/m²	2	4	2	4
Process Area Impoundment Pit 1	Flame Length	6	11	6	11
	35.5kW/m²	43	71	45	71
	14.1kW/m²	33	49	35	51
	7.3kW/m²	20	26	25	29
Process Area Impoundment Pit 2	Flame Length	6	11	6	11
	35.5kW/m²	43	71	45	71
	14.1kW/m²	33	49	35	51
	7.3kW/m²	20	26	25	29
LNG Storage Tank Impoundment Pit 1	Flame Length	5	11	5	11
	35.5kW/m²	40	67	43	67
	14.1kW/m²	31	46	33	48
	7.3kW/m²	19	25	23	27
LNG Storage Tank Impoundment Pit 2	Flame Length	6	11	6	11
	35.5kW/m²	43	71	45	71
	14.1kW/m²	33	49	35	51
	7.3kW/m²	20	26	25	29
LNG Storage Tank Impoundment Pit 3	Flame Length	5	11	5	11
	35.5kW/m²	40	67	43	67
	14.1kW/m²	31	46	33	48
	7.3kW/m²	19	25	23	27
LNG Storage Tank Impoundment Pit 4	Flame Length	6	11	6	11
	35.5kW/m²	43	71	45	71
	14.1kW/m²	33	49	35	51
	7.3kW/m²	20	26	25	29

Table B.7 Impoundment Pit Flash Fire

Section Tag	End Point	2F		5D	
		R	W	R	W
Jetty Impoundment Pit 1	LFL	49	14	14	6
Jetty Impoundment Pit 2	LFL	49	14	14	6
Process Area Impoundment Pit 1	LFL	149	55	35	16
Process Area Impoundment Pit 2	LFL	149	55	35	16
LNG Storage Tank Impoundment Pit 1	LFL	145	52	33	16
LNG Storage Tank Impoundment Pit 2	LFL	146	53	35	15
LNG Storage Tank Impoundment Pit 3	LFL	145	52	33	16
LNG Storage Tank Impoundment Pit 4	LFL	146	53	35	15

ANNEXURE C –SIDE VIEWS OF IMPOUNDMENT PIT DISPERSION SCENARIOS

Figure C.1 Dispersion Side View Contour of Tank/ Process Impoundment Pit

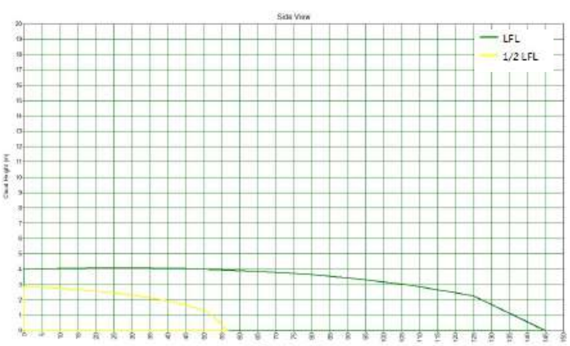
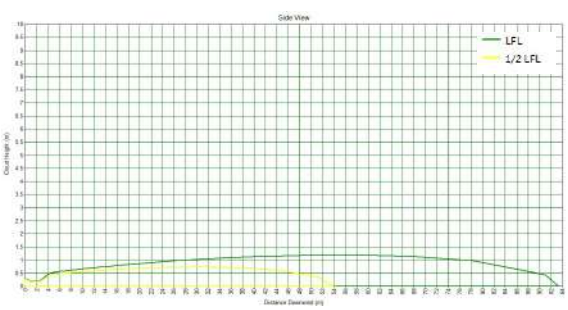


Figure C.2 Dispersion Side View Contour of Jetty Impoundment Pit



ANNEXURE D – EVENT FREQUENCIES

Table D.1 Event Frequencies

Section Tag	Leak Size (mm)	IS / IF	Event Frequency (/yr)					
			JF	PF	FB	FF	VE	UR
01U	012	IS	2.06E-04	-	-	4.22E-04	5.76E-05	9.11E-03
		IF	2.28E-05	-	-	4.69E-05	6.40E-06	1.01E-03
	050	IS	2.06E-04	-	-	4.22E-04	5.76E-05	9.11E-03
		IF	2.28E-05	-	-	4.69E-05	6.40E-06	1.01E-03
	100	IS	8.81E-04	-	-	1.44E-03	6.17E-04	6.85E-03
		IF	9.79E-05	-	-	1.60E-04	6.85E-05	7.62E-04
	RUP	IS	-	2.64E-05	-	4.32E-05	1.85E-05	2.06E-04
		IF	-	2.94E-06	-	4.80E-06	2.06E-06	2.28E-05
02U	012	IS	7.47E-08	-	-	1.53E-07	2.09E-08	3.31E-06
		IF	8.30E-09	-	-	1.70E-08	2.32E-09	3.68E-07
	050	IS	7.47E-08	-	-	1.53E-07	2.09E-08	3.31E-06
		IF	8.30E-09	-	-	1.70E-08	2.32E-09	3.68E-07
	100	IS	2.24E-07	-	-	3.66E-07	1.57E-07	1.74E-06
		IF	2.49E-08	-	-	4.07E-08	1.74E-08	1.94E-07
	RUP	IS	-	9.61E-08	-	1.57E-07	6.72E-08	7.47E-07
		IF	-	1.07E-08	-	1.74E-08	7.47E-09	8.30E-08
03U	012	IS	7.74E-08	-	-	1.59E-07	2.17E-08	3.43E-06
		IF	8.60E-09	-	-	1.77E-08	2.41E-09	3.81E-07
	050	IS	7.74E-08	-	-	1.59E-07	2.17E-08	3.43E-06
		IF	8.60E-09	-	-	1.77E-08	2.41E-09	3.81E-07
	100	IS	2.32E-07	-	-	3.79E-07	1.63E-07	1.81E-06
		IF	2.58E-08	-	-	4.21E-08	1.81E-08	2.01E-07
	RUP	IS	-	9.95E-08	-	1.63E-07	6.97E-08	7.74E-07
		IF	-	1.11E-08	-	1.81E-08	7.74E-09	8.60E-08
03H	012	IS	4.21E-07	-	-	8.65E-07	1.18E-07	1.87E-05
		IF	4.68E-08	-	-	9.61E-08	1.31E-08	2.07E-06
	050	IS	4.21E-07	-	-	8.65E-07	1.18E-07	1.87E-05
		IF	4.68E-08	-	-	9.61E-08	1.31E-08	2.07E-06
	100	IS	1.26E-06	-	-	2.06E-06	8.84E-07	9.83E-06
		IF	1.40E-07	-	-	2.29E-07	9.83E-08	1.09E-06
	RUP	IS	-	5.41E-07	-	8.84E-07	3.79E-07	4.21E-06
		IF	-	6.02E-08	-	9.83E-08	4.21E-08	4.68E-07

Section Tag	Leak Size (mm)	IS / IF	Event Frequency (/yr)					
			JF	PF	FB	FF	VE	UR
04U	012	IS	3.73E-06	-	-	7.66E-06	1.05E-06	1.65E-04
		IF	4.15E-07	-	-	8.52E-07	1.16E-07	1.84E-05
	050	IS	3.73E-06	-	-	7.66E-06	1.05E-06	1.65E-04
		IF	4.15E-07	-	-	8.52E-07	1.16E-07	1.84E-05
	100	IS	1.12E-05	-	-	1.83E-05	7.84E-06	8.71E-05
		IF	1.24E-06	-	-	2.03E-06	8.71E-07	9.68E-06
	RUP	IS	-	4.80E-06	-	7.84E-06	3.36E-06	3.73E-05
		IF	-	5.33E-07	-	8.71E-07	3.73E-07	4.15E-06
04H	012	IS	2.03E-05	-	-	4.17E-05	5.69E-06	8.99E-04
		IF	2.26E-06	-	-	4.63E-06	6.32E-07	9.99E-05
	050	IS	2.03E-05	-	-	4.17E-05	5.69E-06	8.99E-04
		IF	2.26E-06	-	-	4.63E-06	6.32E-07	9.99E-05
	100	IS	6.09E-05	-	-	9.95E-05	4.27E-05	4.74E-04
		IF	6.77E-06	-	-	1.11E-05	4.74E-06	5.27E-05
	RUP	IS	-	2.61E-05	-	4.27E-05	1.83E-05	2.03E-04
		IF	-	2.90E-06	-	4.74E-06	2.03E-06	2.26E-05
05U	012	IS	7.72E-08	-	-	1.59E-07	2.16E-08	3.42E-06
		IF	8.58E-09	-	-	1.76E-08	2.40E-09	3.80E-07
	050	IS	7.72E-08	-	-	1.59E-07	2.16E-08	3.42E-06
		IF	8.58E-09	-	-	1.76E-08	2.40E-09	3.80E-07
	100	IS	2.32E-07	-	-	3.79E-07	1.62E-07	1.80E-06
		IF	2.57E-08	-	-	4.21E-08	1.80E-08	2.00E-07
	RUP	IS	-	9.93E-08	-	1.62E-07	6.95E-08	7.72E-07
		IF	-	1.10E-08	-	1.80E-08	7.72E-09	8.58E-08
05H	012	IS	4.20E-07	-	-	8.63E-07	1.18E-07	1.86E-05
		IF	4.67E-08	-	-	9.59E-08	1.31E-08	2.07E-06
	050	IS	4.20E-07	-	-	8.63E-07	1.18E-07	1.86E-05
		IF	4.67E-08	-	-	9.59E-08	1.31E-08	2.07E-06
	100	IS	1.26E-06	-	-	2.06E-06	8.83E-07	9.81E-06
		IF	1.40E-07	-	-	2.29E-07	9.81E-08	1.09E-06
	RUP	IS	-	5.40E-07	-	8.83E-07	3.78E-07	4.20E-06
		IF	-	6.00E-08	-	9.81E-08	4.20E-08	4.67E-07
06U	012	IS	-	1.11E-08	-	2.49E-08	1.04E-09	3.67E-06

Section Tag	Leak Size (mm)	IS / IF	Event Frequency (/yr)					
			JF	PF	FB	FF	VE	UR
		IF	-	1.23E-09	-	2.77E-09	1.15E-10	4.07E-07
	050	IS	-	7.78E-08	-	1.60E-07	2.18E-08	3.44E-06
		IF	-	8.64E-09	-	1.77E-08	2.42E-09	3.83E-07
	100	IS	-	2.33E-07	-	3.81E-07	1.63E-07	1.82E-06
		IF	-	2.59E-08	-	4.24E-08	1.82E-08	2.02E-07
	RUP	IS	-	1.00E-07	-	1.63E-07	7.00E-08	7.78E-07
		IF	-	1.11E-08	-	1.82E-08	7.78E-09	8.64E-08
06H	012	IS	6.05E-08	-	-	1.35E-07	5.64E-09	2.00E-05
		IF	6.72E-09	-	-	1.50E-08	6.27E-10	2.22E-06
	050	IS	4.23E-07	-	-	8.69E-07	1.19E-07	1.87E-05
		IF	4.70E-08	-	-	9.66E-08	1.32E-08	2.08E-06
	100	IS	1.27E-06	-	-	2.07E-06	8.89E-07	9.88E-06
		IF	1.41E-07	-	-	2.30E-07	9.88E-08	1.10E-06
	RUP	IS	-	5.44E-07	-	8.89E-07	3.81E-07	4.23E-06
		IF	-	6.05E-08	-	9.88E-08	4.23E-08	4.70E-07
070	CAT	-	-	3.60E-09	-	5.88E-09	2.52E-09	2.80E-08
08U	012	IS	3.85E-06	-	-	8.62E-06	3.59E-07	1.27E-03
		IF	4.28E-07	-	-	9.58E-07	3.99E-08	1.41E-04
	050	IS	1.15E-05	-	-	2.37E-05	3.23E-06	5.11E-04
		IF	1.28E-06	-	-	2.63E-06	3.59E-07	5.68E-05
	100	IS	1.15E-05	-	-	2.37E-05	3.23E-06	5.11E-04
		IF	1.28E-06	-	-	2.63E-06	3.59E-07	5.68E-05
	RUP	IS	1.98E-05	-	-	3.23E-05	1.39E-05	1.54E-04
		IF	2.20E-06	-	-	3.59E-06	1.54E-06	1.71E-05
09U	012	IS	1.97E-07	-	-	4.42E-07	1.84E-08	6.51E-05
		IF	2.19E-08	-	-	4.91E-08	2.04E-09	7.23E-06
	050	IS	5.66E-07	-	-	1.16E-06	1.57E-07	2.69E-05
		IF	6.29E-08	-	-	1.29E-07	1.75E-08	2.99E-06
	100	IS	5.65E-07	-	-	1.16E-06	1.57E-07	2.67E-05
		IF	6.28E-08	-	-	1.29E-07	1.75E-08	2.97E-06
	RUP	IS	9.64E-07	-	-	1.58E-06	6.72E-07	7.68E-06
		IF	1.07E-07	-	-	1.75E-07	7.47E-08	8.53E-07
	CAT	-	-	-	1.30E-08	2.68E-08	3.65E-09	5.78E-07

Section Tag	Leak Size (mm)	IS / IF	Event Frequency (/yr)					
			JF	PF	FB	FF	VE	UR
10U	012	IS	7.34E-06	-	-	1.65E-05	6.85E-07	2.42E-03
		IF	8.16E-07	-	-	1.83E-06	7.62E-08	2.69E-04
	050	IS	7.34E-06	-	-	1.65E-05	6.85E-07	2.42E-03
		IF	8.16E-07	-	-	1.83E-06	7.62E-08	2.69E-04
	100	IS	7.34E-06	-	-	1.65E-05	6.85E-07	2.42E-03
		IF	8.16E-07	-	-	1.83E-06	7.62E-08	2.69E-04
	RUP	IS	1.54E-06	-	-	3.17E-06	4.32E-07	6.83E-05
		IF	1.71E-07	-	-	3.52E-07	4.80E-08	7.59E-06
150	012	IS	2.63E-07	-	-	5.90E-07	2.46E-08	8.69E-05
		IF	2.93E-08	-	-	6.56E-08	2.73E-09	9.66E-06
	050	IS	2.36E-07	-	-	5.30E-07	2.21E-08	7.80E-05
		IF	2.63E-08	-	-	5.88E-08	2.45E-09	8.67E-06
	100	IS	1.22E-06	-	-	2.50E-06	3.40E-07	5.38E-05
		IF	1.35E-07	-	-	2.77E-07	3.78E-08	5.98E-06
	RUP	IS	1.88E-06	-	-	3.08E-06	1.32E-06	1.47E-05
		IF	2.09E-07	-	-	3.42E-07	1.47E-07	1.63E-06
	CAT	-	-	-	3.60E-07	5.88E-07	2.52E-07	2.80E-06
160	050	IS	7.13E-05	-	-	1.60E-04	6.65E-06	2.35E-02
		IF	7.92E-06	-	-	1.77E-05	7.39E-07	2.61E-03
	RUP	IS	4.86E-05	-	-	7.94E-05	3.40E-05	3.78E-04
		IF	5.40E-06	-	-	8.82E-06	3.78E-06	4.20E-05
170	012	IS	2.41E-07	-	-	5.39E-07	2.25E-08	7.94E-05
		IF	2.67E-08	-	-	5.99E-08	2.50E-09	8.82E-06
	050	IS	6.18E-07	-	-	1.27E-06	1.73E-07	2.74E-05
		IF	6.86E-08	-	-	1.41E-07	1.92E-08	3.04E-06
	100	IS	6.18E-07	-	-	1.27E-06	1.73E-07	2.74E-05
		IF	6.86E-08	-	-	1.41E-07	1.92E-08	3.04E-06
	RUP	IS	1.20E-06	-	-	1.97E-06	8.42E-07	9.36E-06
		IF	1.34E-07	-	-	2.18E-07	9.36E-08	1.04E-06
180	012	IS	3.78E-07	-	-	7.76E-07	1.06E-07	1.67E-05
		IF	4.20E-08	-	-	8.62E-08	1.18E-08	1.86E-06
	050	IS	1.89E-07	-	-	3.88E-07	5.29E-08	8.37E-06
		IF	2.10E-08	-	-	4.31E-08	5.88E-09	9.30E-07

Section Tag	Leak Size (mm)	IS / IF	Event Frequency (/yr)					
			JF	PF	FB	FF	VE	UR
	100	IS	8.10E-07	-	-	1.32E-06	5.67E-07	6.30E-06
		IF	9.00E-08	-	-	1.47E-07	6.30E-08	7.00E-07
	CAT	-	-	-	3.60E-07	5.88E-07	2.52E-07	2.80E-06
190	012	IS	1.90E-06	-	-	3.90E-06	5.32E-07	8.42E-05
		IF	2.11E-07	-	-	4.34E-07	5.92E-08	9.36E-06
	050	IS	6.97E-07	-	-	1.43E-06	1.95E-07	3.09E-05
		IF	7.75E-08	-	-	1.59E-07	2.17E-08	3.43E-06
	100	IS	2.99E-06	-	-	4.88E-06	2.09E-06	2.32E-05
		IF	3.32E-07	-	-	5.42E-07	2.32E-07	2.58E-06
	RUP	IS	-	1.36E-06	-	2.22E-06	9.51E-07	1.06E-05
		IF	-	1.51E-07	-	2.47E-07	1.06E-07	1.17E-06
200	012	IS	1.68E-06	-	-	3.45E-06	4.70E-07	7.44E-05
		IF	1.87E-07	-	-	3.83E-07	5.22E-08	8.26E-06
	050	IS	7.20E-07	-	-	1.48E-06	2.02E-07	3.19E-05
		IF	8.00E-08	-	-	1.64E-07	2.24E-08	3.54E-06
	100	IS	3.08E-06	-	-	5.04E-06	2.16E-06	2.40E-05
		IF	3.43E-07	-	-	5.60E-07	2.40E-07	2.67E-06
	RUP	IS	-	1.23E-06	-	2.02E-06	8.64E-07	9.60E-06
		IF	-	1.37E-07	-	2.24E-07	9.60E-08	1.07E-06
210	050	IS	9.45E-06	-	-	1.94E-05	2.65E-06	4.19E-04
		IF	1.05E-06	-	-	2.16E-06	2.94E-07	4.65E-05
	RUP	IS	-	8.10E-06	-	1.32E-05	5.67E-06	6.30E-05
		IF	-	9.00E-07	-	1.47E-06	6.30E-07	7.00E-06
220	012	IS	2.73E-06	-	-	5.60E-06	7.63E-07	1.21E-04
		IF	3.03E-07	-	-	6.22E-07	8.48E-08	1.34E-05
	050	IS	4.28E-06	-	-	7.00E-06	3.00E-06	3.33E-05
		IF	4.76E-07	-	-	7.78E-07	3.33E-07	3.70E-06
	100	IS	4.28E-06	-	-	7.00E-06	3.00E-06	3.33E-05
		IF	4.76E-07	-	-	7.78E-07	3.33E-07	3.70E-06
	RUP	IS	-	1.95E-06	-	3.18E-06	1.36E-06	1.51E-05
		IF	-	2.16E-07	-	3.53E-07	1.51E-07	1.68E-06
230	012	IS	1.89E-04	-	-	3.88E-04	5.29E-05	8.37E-03
		IF	2.10E-05	-	-	4.31E-05	5.88E-06	9.30E-04

Section Tag	Leak Size (mm)	IS / IF	Event Frequency (/yr)					
			JF	PF	FB	FF	VE	UR
	050	IS	8.10E-06	-	-	1.32E-05	5.67E-06	6.30E-05
		IF	9.00E-07	-	-	1.47E-06	6.30E-07	7.00E-06
240	012	IS	2.20E-06	-	-	4.51E-06	6.15E-07	9.72E-05
		IF	2.44E-07	-	-	5.01E-07	6.83E-08	1.08E-05
	050	IS	2.20E-06	-	-	4.51E-06	6.15E-07	9.72E-05
		IF	2.44E-07	-	-	5.01E-07	6.83E-08	1.08E-05
	100	IS	6.59E-06	-	-	1.08E-05	4.61E-06	5.12E-05
		IF	7.32E-07	-	-	1.20E-06	5.12E-07	5.69E-06
	RUP	IS	2.82E-06	-	2.82E-06	4.61E-06	1.98E-06	2.20E-05
		IF	3.14E-07	-	3.14E-07	5.12E-07	2.20E-07	2.44E-06
250	050	IS	3.20E-06	-	-	6.57E-06	8.96E-07	1.42E-04
		IF	3.55E-07	-	-	7.30E-07	9.95E-08	1.57E-05
	RUP	IS	-	-	3.12E-07	5.09E-07	2.18E-07	2.42E-06
		IF	-	-	3.46E-08	5.65E-08	2.42E-08	2.69E-07
260	012	IS	1.26E-07	-	-	2.60E-07	3.54E-08	5.60E-06
		IF	1.41E-08	-	-	2.89E-08	3.93E-09	6.22E-07
	050	IS	5.62E-08	-	-	1.15E-07	1.57E-08	2.49E-06
		IF	6.24E-09	-	-	1.28E-08	1.75E-09	2.77E-07
	100	IS	2.41E-07	-	-	3.93E-07	1.69E-07	1.87E-06
		IF	2.68E-08	-	-	4.37E-08	1.87E-08	2.08E-07
	RUP	IS	-	-	9.03E-08	1.48E-07	6.32E-08	7.03E-07
		IF	-	-	1.00E-08	1.64E-08	7.03E-09	7.81E-08
270	012	IS	4.92E-06	-	-	1.01E-05	1.38E-06	2.18E-04
		IF	5.47E-07	-	-	1.12E-06	1.53E-07	2.42E-05
	050	IS	2.19E-06	-	-	4.49E-06	6.13E-07	9.69E-05
		IF	2.43E-07	-	-	4.99E-07	6.81E-08	1.08E-05
	100	IS	9.38E-06	-	-	1.53E-05	6.56E-06	7.29E-05
		IF	1.04E-06	-	-	1.70E-06	7.29E-07	8.10E-06
	RUP	IS	3.52E-06	-	3.52E-06	5.74E-06	2.46E-06	2.73E-05
		IF	3.91E-07	-	3.91E-07	6.38E-07	2.73E-07	3.04E-06