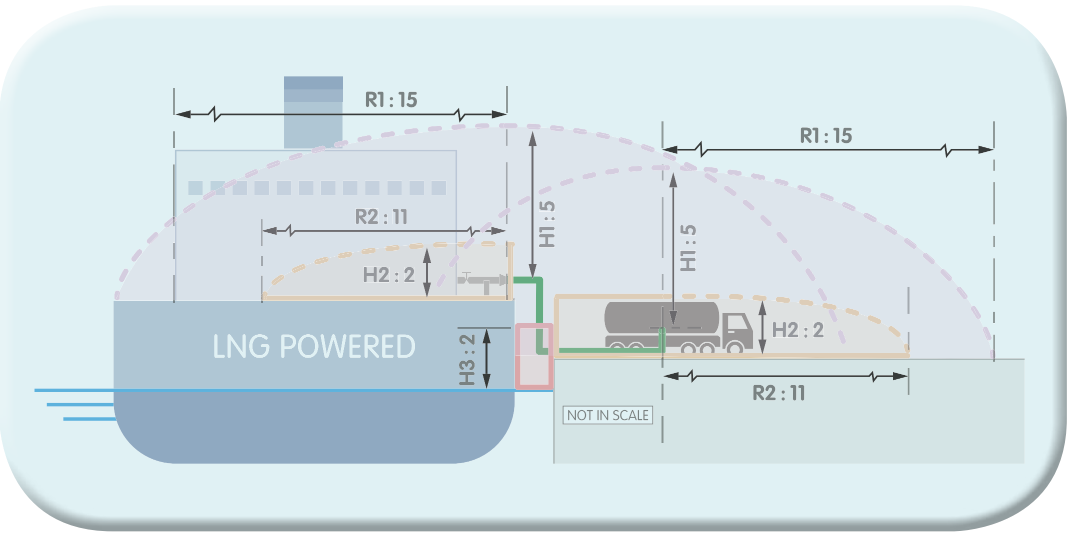
GD A004-06

gas as a marine fuel

BASiL

Bunkering Area Safety information LNG

User Guide



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Disclaimer

The **BASiL** program has been developed using the best currently available information based on a number of industry tests concerning the behaviour and dispersal of gas under pressure.

Whilst SGMF has endeavoured to ensure the program is based on the most up to date information and is correct, we make no representations or warranties of any kind, express or implied, about the completeness, accuracy or reliability of the information contained in the program or the suitability of the information to any individual bunkering. The program is for general information and guidance only and is to be used at the user's own risk as part of their assessment of the controlled zone during any LNG bunkering operation.

In no event shall SGMF be liable for any loss or damage of whatsoever nature arising from the use of the **BASiL** program.

Every effort is made to keep the **BASiL** program running smoothly. However, SGMF takes no responsibility for, and will not be liable for the program being temporarily unavailable due to technical issues beyond our control.

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Introduction

BASiL is SGMF's automated Bunkering Area Safety Information for LNG model. It can be used to manage bunkering risks on a consistent basis through the definition of a safety zone that depends on the type of bunkering operation being undertaken.

This document provides step-by-step guidance on what information is needed and the format to submit it on the website, so the bunkering safety zone can be calculated.

It is strongly recommended that this User Guide is read fully and understood prior to using the **BASiL** model. In addition, it should be read in conjunction with SGMF publication **Recommendation of Controlled Zones during LNG bunkering** (FP02-01) (ISBN No: 978-0-9933164-8-7) which can be downloaded from the Member Portal / Library / Publications.

For the best experience of using the BASiL model it is recommended that either Chrome or Mozilla Firefox browsers be used to access the SGMF website.

Reports

Members – SGMF Members can run complimentary reports on a fair use basis.

Non-members – can purchase a set of three (3) reports from the web-shop. Payments for reports can only be made via PayPal (using a credit card). A copy of the publication **Recommendation of Controlled Zones during LNG bunkering** will be sent by courier as part of this purchase.

It is essential that all BASiL users read and fully understand this User Guide and the SGMF publication Recommendation of Controlled Zones during LNG bunkering.

Please ensure you add **basil@sgmf.info** to your safe senders list in your Email program so communications relating to your reports go directly to your Inbox.

Access to BASiL

Members
To enable the Primary contact to control who uses the complimentary reports **BASiL** will only be available by default to the Primary contact within each Member Company. Where the Primary contact wants to make it available to other people within their organisation, they will need to send an email to the Secretariat requesting this. The email should be sent to **basil@sgmf.info**. Secondary contacts can also make the same request to the Secretariat; however, the request will only be granted once permission has been approved by the Primary contact.

Non-members
Non-members do not have access to run BASiL reports immediately as they need to read and understand this User Guide and the SGMF publication Recommendation of Controlled Zones during LNG bunkering. As this will be sent by courier, there will be a delay of 7-10 working days from the date of purchase before the user can access the BASiL tool from the website.

User Experience Feedback

Members are strongly encouraged to give feedback from their experience of using the **BASiL** tool so that the comments can be considered and possibly incorporated in future revision of the model. Feedback should be sent by email to: **basil@sgmf.info** together with any relevant information / screenshots.

BASiL Input Parameters

Definitions

Information only: these types of variables **are not used** by the **BASiL** model calculation and are only included as information in the final report.

Calculation variable input: these types of variables **are used** directly by the **BASiL** model calculation; changing their value might change the final model output.

Graphic & Layout information: These types of variables **are not used** by the **BASiL** model calculation but are used to provide a graphic layout in the final report.

Step 1 – Project Information

Variable	Comments / Remarks	Type of Variable
Project Name	This is the reference to your specific project name and number which will be included on the final **BASiL** report.	Information only
Project Description	This is a short description of your project which will be included on the final **BASiL** report.	Information only

Step 2 – Location Details

Variable	Comments / Remarks	Type of Variable
Latitude	Please insert the latitude of your project and operation location	Calculation variable input
Longitude	Please insert the longitude of your project and operation location	Calculation variable input
HELP	Latitude and Longitude of your project and operation location are used to upload the correct database information of the typical and approximate atmospheric condition of your project area. *See FP02-01 page 84.* BASiL will use the nearest location in its database to calculate atmospheric parameters. The database consists of 164 ports worldwide where published data over a long-time span is available. Weather and therefore atmospheric parameters are largely a function of latitude and change only slowly. The presence of large land masses and their impact on climate mean that a longitude is also required to select a suitable location. Atmospheric parameters only have a secondary effect on BASiL calculations so precise locations are not required. The Secretariat are able to adjust atmospheric conditions if a strong case can be made and appropriate data provided. *Note:* 0 / 90° is north equator, -90 / - 0° is south of equator 0 / 180° is east of Greenwich, -180 / - 0° is west of Greenwich e.g.: New York 40.7128° N, 74.0060° W, **enter: Latitude 40.7 Longitude -74.0** Sydney 33.8688° S, 151.2093° E, **enter: Latitude -33.8 Longitude 151.2**	

Step 3 – LNG Supply Specification

Variable	Comments / Remarks	Type of Variable
Supply Storage Pressure [barg]	Please insert the supply storage tank pressure. This information is used in conjunction with the supply temperature to evaluate the quality of the LNG, specifically its vapour pressure. This is used to determine how much LNG will flash when the leak occurs and how quickly the LNG flow will decay after ESD has been initiated. *Note:* • **maximum value allowed 11 barg** • **this value should be equal or less than the supply transfer pressure - see Step 3 of 7.**	Calculation variable input
Is Storage Temperature Known? **LNG Storage Temperature [°C]**	Please insert the supply storage tank temperature if known. *Note:* • **value allowed -140 to -160 °C** • if unknown BASiL calculates the temperature of the LNG assuming that it is saturated at the supply storage pressure BASiL will check that the LNG provided at the defined storage temperature and pressure is at or below its stauration point, effectively whether it is a liquid or gas. If it calculates that the LNG is actually gas an error will be produced asking for a revised temperature.	Calculation variable input
LNG Net Calorific Value Reference	Choice list option: Please select the reference from the drop-down menu. Different countries use different methods to calculate the calorific value which can result in significant variation in the CVs produced. BASiL provides a list of the common reference temperatures used, for example 15/0 where 15°C is the combustion reference and 0°C is the metering reference. The user should select the reference temperatures for the country where the bunkering will take place. A list of countries is provided as a guide only. BASiL does all its calculations at 15° combustion temperature and 15°C metering temperature (UK basis). It needs this information to recalculate the net calorific value provided to the correct value for use.	
LNG Net Calorific Value [MJ/m³]	Please insert LNG Net Calorific Value which is used as a proxy for the LNG composition. BASiL will use this data to determine the LNG saturation conditions and, if not specified, density. Note: BASiL will recalculate the calorific value given to its base reference conditions of at 15°C/15°C, 1.01325 bar. **For USA (60/60°F) enter a value between 910 and 1070 btu/scf. For all other locations BASiL will accept a value between 34 to 40 MJ/Nm³.**	Calculation variable input

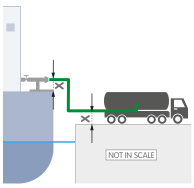
Variable	Comments / Remarks	Type of Variable
Is LNG Density Known? **LNG Density [kg/m^3]**	Please insert the LNG density if known. BASiL uses the LNG density to convert volume based flow and velocity parameters to a mass basis. All the dispersion calculations are based on mass flowrates. *Note:* • **values allowed 420 to 480 kg/m^3** • if unknown BASiL will calculate a mass density based on the calorific value provided	Calculation variable input

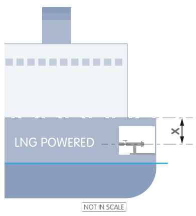
Step 4 – Bunkering Overview

Variable	Comments / Remarks	Type of Variable
Bunkering Type	Choice list option: **Road Tanker** or **Bunker Vessel** This information is used to verify the consistency of the data provided against a specific bunkering scenario and to produce a simplified graphical representation of the bunkering layout which will be included in the final report.	Graphic & Layout information
Volume Transfer [m³]	Please insert the total volume in m³ transferred during the whole operation.	Calculation variable input
Volume Transfer Time [minutes]	Please insert the total time of the actual volume transfer in minutes from start of pumping/transfer to end of topping up. BASiL uses the transfer time and transfer volume to estimate the velocity within the bunkering system. Velocity, in mass terms, is crucial to estimating how leaks behave and therefore the size of the safety zone. BASiL has limits on velocities in the transfer system and will request a larger or smaller transfer system size if these limits are exceeded. If a user wishes to be conservative, they should provide volume and transfer time for the peak flowrate that they envisage occurring, for example ignoring the slow start up flows and the reduced flows during tank topping off.	Calculation variable input
Transfer System (Hose) Diameter	Choice list option: Choose from **2, 3, 4, 6 or 8** inches diameter of the actual transfer line (hose diameter or loading arm piping diameter). The leak size is based on a hole diameter which itself is based on the transfer system diameter. The transfer system diameter will be checked against the flow velocity for compatibility.	Calculation variable input

Variable	Comments / Remarks	Type of Variable
Transfer Pressure [barg]	Please insert the transfer/bunker pressure. The transfer pressure is very important in calculating the safety zone in BASiL. The higher the pressure the more flashing occurs at the leak producing more gas and less liquid. A maximum transfer pressure of 20 barg is used. Vessel manifolds are normally designed for Class 150 strength which is about this pressure limit (temperature dependent). A lower limit is also used. The transfer system has a pressure drop which is dependent on the diameter and length of the system/hose. There is also often a height difference between the two manifolds to overcome. In the most positive conditions, a transfer pressure may be 0.5 - 1 barg but in most scenarios will be substantially larger, say 4 - 6 barg. BASiL cannot estimate the pressure drop as the hose/arm configuration are manufacturer specific. *Note:* • **Value should be above 0.5 barg and below 20 barg** • this value should be equal or greater than the supply storage pressure – entered at Step 3. Otherwise a minimum transfer pressure of 0.5 barg will be applied.	Calculation variable input
Primary Leak Source HELP	BASiL uses the primary leak source with the transfer system/hose diameter to determine the hole size of the leak. The Secretariat is able to change the hole size if a strong case is made - however, SGMF will only change the hole size by increasing the hole diameter. SGMF will not reduce the hole size below that specified in FP02-1 and encoded in BASiL. Choice list option, please select: • **Hose Failure** for a bunker system where flexible hoses are employed. • **Fitting/Flange Failure** for a loading arm type with rigid pipes and swivel joint bunker system.	Calculation variable input
	Fitting/Flange Failure might be used where the failure of a hose system is not considered realistic. For example, because the bunkering hose primary containment (inner hose) is located inside another hose, secondary containment (outer hose). The "outer hose" is capable to withstand a cryogenic leak and the annular space is monitored leak detection system.	

Step 5 – Transfer System Layout

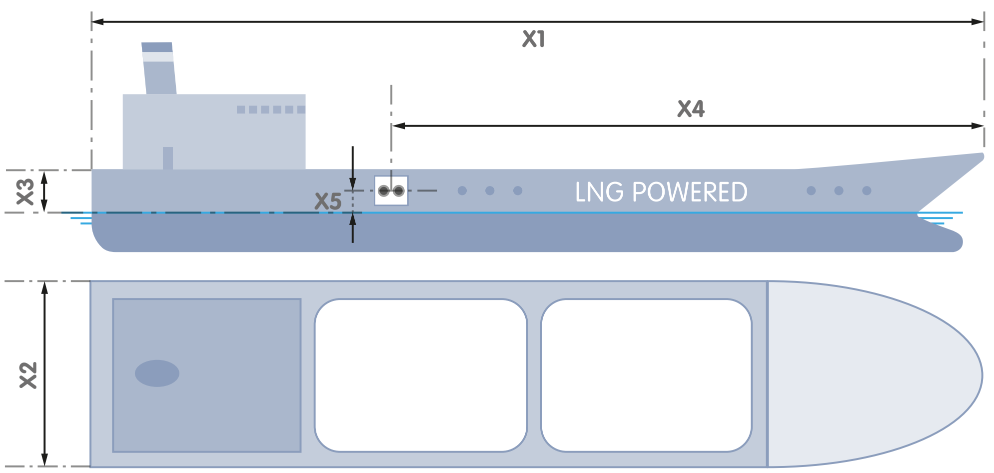
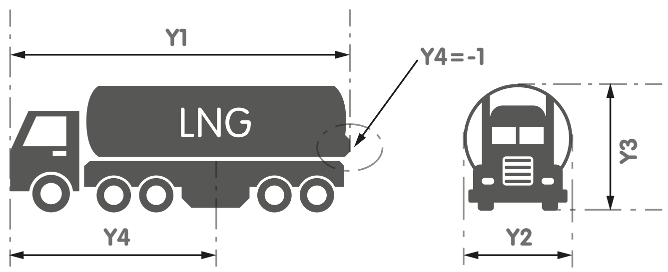
Variable	Comments / Remarks	Type of Variable
ESD Type	Choice list option, please select: • **Fast Acting and Fully Automatic (10s)** for a system which **acts within 10 seconds from triggering ESD signal to flow stop and full valve closure (ESD1).** These systems typically comprise of a fast closing valve (actuation time of less than 5 sec) triggered by an automatic leak detection system (not based on gas detection) on both supplier and receiver bunkering manifolds, that automatically triggers the shutdown. • **Fully Automatic (30s)** for a system which **acts within 30 seconds from triggering ESD signal to flow stop and full valve closure (ESD1).** These systems typically comprise of a fast-acting valve (actuation time of less than 10 sec) triggered by an automatic leak detection system (including gas detection) on both supplier and receiver bunkering manifolds, that automatically triggers the shutdown. • **Semi-Automatic (2 min)** for a system which nominally **acts within 2 minutes from alarm to flow stop and full valve closure (ESD1).** These systems typically involve an operator reacting to an alarm from an automatic leak detection system and activating the shutdown on both supplier and receiver bunkering manifolds. • **Fully-Manual (10 min)** for a system which nominally **acts within 10 minutes from alarm to flow stop and full valve closure (ESD1).** These systems typically involve an operator reacting to an alarm from an automatic leak detection system and manually shutting down both supplier and receiver bunkering manifolds.	Graphic & Layout information
Minimum Hose Elevation [m]  	This is the **minimum hose elevation** above a continuous solid surface such as a vessel's deck or a quayside. This should be assessed in consideration of supplier and receiver manifold arrangements, as well as the hose transfer/bunker system layout **(e.g. the jetty ground or the deck below the manifolds).** If a hose is lying on the ground/deck, there can be no mixing beneath the hose which results in longer times to full gas dispersion and therefore a larger safety zone. As the hose is lifted higher off the ground more mixing can occur beneath it. The effect reduces fairly rapidly with a height of 0.3 m providing most of the benefit and further improvement is small above this height. *Notes:* • **0-5m elevation is allowed.** • For hoses touching a surface (e.g. saddles, deck, etc.) for a section of 0.5m or less please insert "0". • For hoses with a minimum hose elevation greater than 5 metres please enter "5".	Calculation variable input

Variable	Comments / Remarks	Type of Variable
Hose Entry Location	Choice list option, please select: • **On Deck** – the bunkering station is located on an open deck of the receiving vessel. The obstacles to gas dispersing in any direction are very limited resulting in good mixing and shorter dispersion distances • **Semi-enclosed** – the bunkering station is located in the side of the receiving vessel via a hull recess and/or behind a door or hatch or a location on deck which is substantially enclosed by ship structures, piping, etc. Dispersion is limited by these physical structures so dispersion distance may be longer.	Calculation variable input
Distance Below Deck [m] 	For **Semi-enclosed** bunkering location only. BASiL requires the vertical distance between the bunkering manifold flange and the first open deck of the vessel directly above it, normally at the ship side. BASiL uses this information to determine whether a vertically upwards release achieves sufficient height to flow across the main deck of the vessel. *Notes:* • **1-30m vertical distance is allowed.** • For vertical distance greater than 30 metres please enter "30".	Calculation variable input

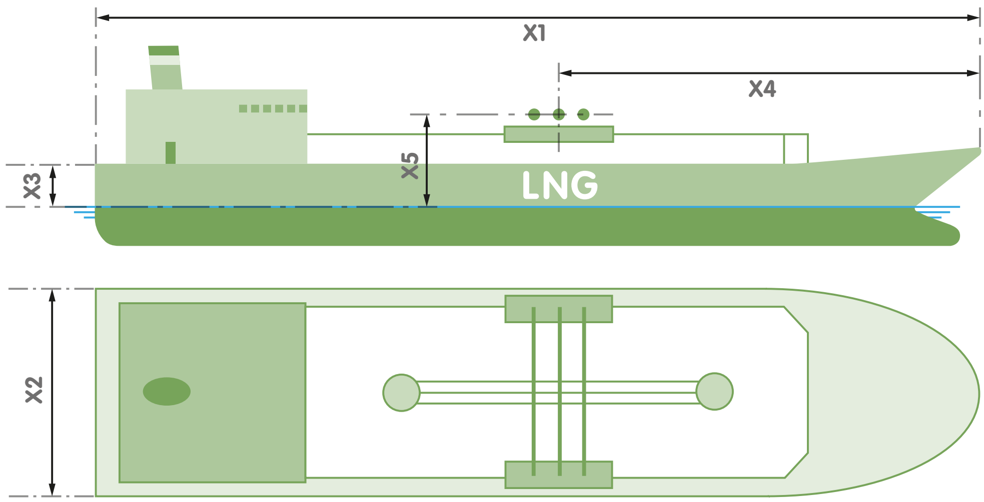
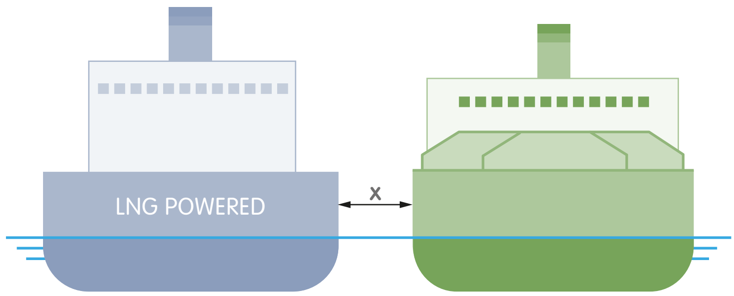
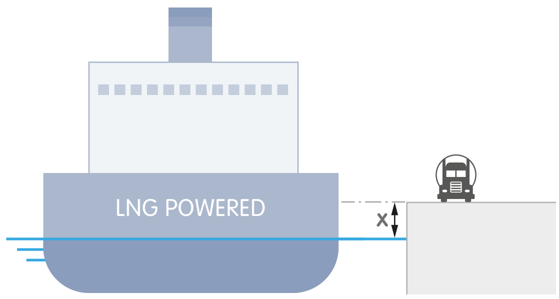
Step 6 – Vessel/s and Truck Layout

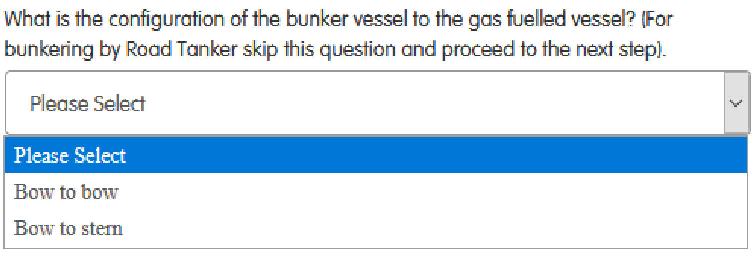
To be completed if known, this information is only used for graphic and layout output purposes. If not known BASiL will use generic values to produce the graphics in the output.

Please check that, if provided, the information is correct. There have been several incidents of users confusing data between the gas-fuelled ship and the bunker vessel which has resulted in the bunkering hose being underwater. BASiL doesn't like that!

<table>
<tr><th>Variable</th><th>Comments / Remarks</th><th>Type of Variable</th></tr>
<tr><td rowspan="2">Gas Fuelled Ship:
- Length LOA [m]
- Beam [m]
- Height of main deck above water [m]
- Manifold to Bow [m]
- Manifold Above Water [m]</td><td>Please insert dimensions of Gas Fuelled ship in m.
X1: Length LOA [m]
X2: Beam [m]
X3: Height of main deck above water [m]
X4: Manifold to Bow [m]
X5: Manifold Above Water [m]</td><td>Graphic & Layout information</td></tr>
<tr><td colspan="2">
</td></tr>
<tr><td rowspan="2">Road Tanker:
- Length of road tanker and tractor [m]
- Width of road tanker [m]
- Height of road tanker [m]
- Manifold distance from front of tractor unit (m)</td><td>Please insert dimensions of road Tanker in m.
Y1: Length of road tanker and tractor [m]
Y2: Width of road tanker [m]
Y3: Height of road tanker [m]
Y4: Manifold distance from front of tractor unit (m)</td><td>Graphic & Layout information</td></tr>
<tr><td colspan="2">
</td></tr>
<tr><td></td><td colspan="2">BASiL assumes that the manifold of the road tanker is located on the side of the vehicle between the tractor unit and the rear wheels.

If the road tanker has its manifold located at the rear of the tank insert a value "-1" and BASiL will locate the manifold in the centre of the rear of the tanker.</td></tr>
</table>

Variable	Comments / Remarks	Type of Variable
Bunker Vessel: **- Length LOA [m]** **- Beam [m]** **- Height of main deck above water [m]** **- Manifold to Bow [m]** **- Manifold Above Water [m]** HELP	Please insert dimensions of Bunker Vessel in m *X1: Length LOA [m]* *X2: Beam [m]* *X3: Height of main deck above water [m]* *X4: Manifold to Bow [m]* *X5: Manifold Above Water [m]* 	Graphic & Layout information
Distance Between Vessels or vessel and quayside [m] HELP	Please provide mooring distance / fender spacing from Bunker vessel and gas-fuelled ship or quayside and gas-fuelled ship 	Graphic & Layout information
Quayside height above water [m] HELP	Please insert distances in m of the quayside from the waterline. 	Graphic & Layout information

Variable	Comments / Remarks	Type of Variable
Bunkering Configuration	If a bunker vessel is used, BASiL needs to know the configuration of the STS. Are the two vessels pointing bow to bow or bow to stern. 	Graphic & Layout information

BASiL Report Explained

BASiL produces a standard project safety zone report which provides the set of safety distances for the bunkering operation according to the input parameter provided by the user. A simplified graphical representation of the safety zone is also provided as an aid for the user.

The BASiL report consists of two pages. On the first page all the data provided by the user along with some calculations, for example saturation temperature or flow velocity, provided by BASiL through error checking.

The second page contains the output of the BASiL calculations - the safety distances. It also includes the graphical representation of STS process and the safety zones. An example of a BASiL standard project safety zone report is provided below.

BASiL
Bunkering Area Safety Information LNG

Bunkering Area Safety information for LNG (BASiL)

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Safety Distance estimation results from BASiL v1.3, January 2021

Part A

Project	*Case Study 2 Scenario B*
Organisation	*SGMF STAFF*
Request from	*ADMIN ADMIN*
On	*14/05/2021*

Run Description:
Ship to Ship operation where the same quantity of LNG (1000m3) has been transferred at higher or lower flow rate between the two vessels.

Part B

Input Parameters

Location details			
Lattitude	51	Longitude	4
nearest port	Antwerp		(51.2 4.47)
Bunkering overiew			
Volume transferred	1000 m^3	over	70 minutes
peak flow	857.1 m^3/h	velocity	7.3 m/s
From a	Bunker vessel		
Using a	8 inch hose transfer system		
Operating at	6 barg		
Failure scenario			
Leak Source	Hose failure		
LNG supply specification			
LNG storage pressure	1 barg		
LNG storage temperature	-159 °C (saturation= -151.3 °C)		
LNG net calorific value (LHV)	37 MJ/Nm3		37.00 MJ/Nm^3
Reference conditions	15/15°C		at 15/15°C
Canada, Croatia, India, Ireland, Italy, Romania, Slovenia, Turkey, UAE, UK			
LNG density	455.0 kg/m^3		
Transfer System layout			
ESD type	fully automatic (30 s)		
Minimum hose elevation	5 m		
Hose entry location	semi enclosed		
Distance below deck	4 m		

Ref: A00159 output file: SGMFA00159BASiL.pdf

Part C

Bunkering Configuration

STS Configuration	bow to stern	
Vessel layout	Gas fuelled ship	Bunker vessel
Length	160 m	110 m
Beam/width	22 m	19 m
Main deck above water	7 m	5.5 m
Manifold to bow IGF ship/stern bunker v	120 m	50 m
Manifold/Manifold height above water	0 m	
Distance between vessels		3.5 m
Vessel details used to create layout drawings only		

Part D

SGMF

Data entered by	Krishna Ruparelia	On	14/05/2021
For	SGMF STAFF		

SGMF Disclaimer: The BASiL program has been developed using the best currently available information based on a number of industry tests concerning the behaviour and dispersal of gas under pressure. Whilst SGMF has endeavoured to ensure the program is based on the most up to date information and is correct, we make no representations or warranties of any kind, express or implied, about the completeness, accuracy or reliability of the information contained in the program or the suitability of the information to any individual bunkering. The program is for general information and guidance only and is to be used at the user's own risk as part of their assessment of the controlled zone during any LNG bunkering operation. Every effort is made to keep the BASiL program running smoothly. However, SGMF takes no responsibility for, and will not be liable for the program being temporarily unavailable due to technical issues beyond our control. In no event shall SGMF be liable for any loss or damage of whatsoever nature arising from the use of the BASiL program.

Page 1 of 2

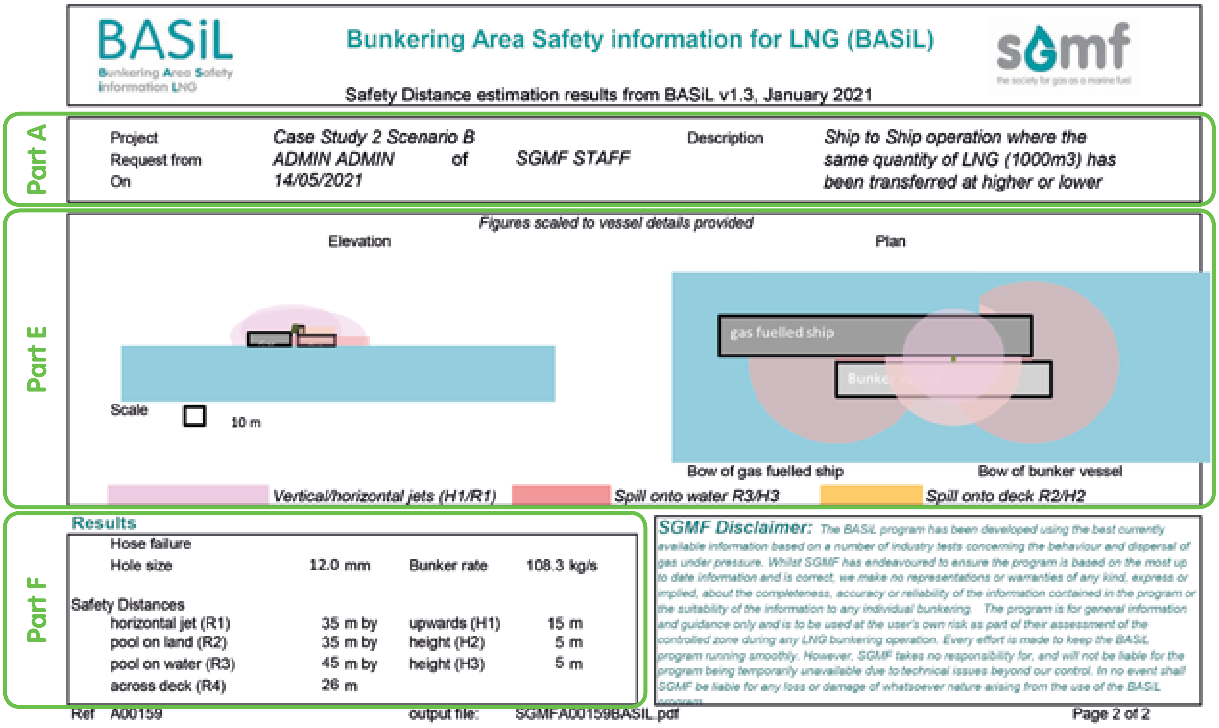
Part A: Includes project information and description as provided by the user

Part B: Includes project parameters and variables (inputs) as provided by the user and used by BASiL for the safety distances calculation.

The average transfer flow rate in [m^3/h] is given as reference based on the volume and transfer time provided.

Part C: Includes project scenario ship/s or truck dimensions as provided by the user and used by BASiL to create the simplified graphical representation of the safety zone.

Part D: Includes information on when the BASiL calculation has been performed and who produced the report at the Secretariat.



BASiL
Bunkering Area Safety information LNG

Bunkering Area Safety information for LNG (BASiL)

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Safety Distance estimation results from BASiL v1.3, January 2021

Part A

Project	*Case Study 2 Scenario B*			Description	*Ship to Ship operation where the same quantity of LNG (1000m3) has been transferred at higher or lower*
Request from	*ADMIN ADMIN*	of	*SGMF STAFF*		
On	*14/05/2021*				

Part E

Figures scaled to vessel details provided

Part F

Results

Hose failure				
Hole size	12.0 mm	Bunker rate	108.3 kg/s	
Safety Distances				
horizontal jet (R1)	35 m by	upwards (H1)	15 m	
pool on land (R2)	35 m by	height (H2)	5 m	
pool on water (R3)	45 m by	height (H3)	5 m	
across deck (R4)	26 m			

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Ref A00159 output file: SGMFA00159BASIL.pdf Page 2 of 2

Part E: Includes a simplified graphical representation of the safety zone for the given parameters and bunkering scenario.

Part F: Includes the output results of the BASiL calculation.

Safety distances are expressed in metres according to the applicable dispersion model and "hole size". For hole sizes used in BASiL and their rationale please refer to "Recommendations of Controlled Zones during LNG Bunkering" publication chapter 5.3.

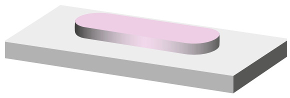
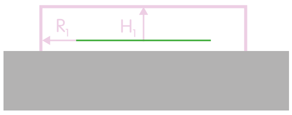
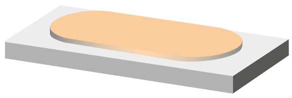
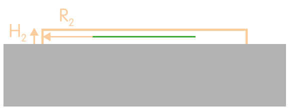
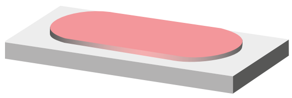
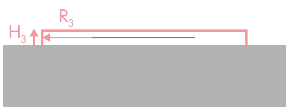
The unique report reference number e.g. *Ref:A00159* can be found on the lower left corner of each report's page.

Reading the Results

BASiL produces up to three sets of safety distances, one for each orientation of leak, defining the potential reach of the Safety Zone.

- Jet leak - horizontal and vertically upwards dispersion (H1 and R1)
- downwards dispersion onto land (H2 and R2) and onto water (H3 and R3)
- if the bunkering location is below deck, an additional distance – R4 – is shown which indicates how much of a vertically upwards release reaches the main deck and disperses across it

The **Safety Zone** can be defined as the three-dimensional envelope of distances inside which the majority of leak events occur and where, in exceptional circumstances, there is a recognised potential for a leak of natural gas or LNG to harm life or damage equipment/infrastructure.

Release	Distance		Application	Plan/elevation	3D view
Horizontal jet	Radius (horizontal) from hose	R1	Radius is applied horizontally along length of transfer system and at ends of hose.		
Vertically upwards jet	Height above hose	H1	Height is applied above the height of hose over the horizontal extent of the Safety Zone defined by the horizontal radius.		
Downward release onto land/ deck	Radius (horizontal) from hose	R2	Radius is applied horizontally along length of hose above the land or ship deck and at end of hose.		
	Height above land or ship deck	H2	Height is applied above the land or ship deck over the horizontal extent of the Safety Zone defined by the horizontal radius.		
Downward release onto water	Radius (horizontal)	R3	Radius is applied horizontally at end of gap between ship and land or ship and bunker vessel.		
	Height above water	H3	Height is applied above sea over the horizontal extent of the Safety Zone defined by the horizontal radius.		

Green line in all drawings represents the transfer system

BASiL Results Examples

The following Case Studies have been selected by SGMF and safety distances calculated with the BASiL modelling tool to provide the reader with a guide reference of how safety distances are affected by some of the key inputs parameters and variables.

For each of the seven Case Studies, two different scenarios (A & B) have been analysed where typically only one or two parameters have been altered while keeping all the remaining constant to understand their influence on the final dimensions of the safety zone.

	Description	Scenario A Parameter	Scenario B Parameter
Case Study 1 Location	Truck to Ship operation performed in two different geographical locations with different atmospheric conditions, scenario A and B.	Narvik, Norway	Houston, USA
Case Study 2 Transfer Time (Flow Rate & Hose Diameter)	Ship to Ship operation where the same quantity of LNG (1000m^3) has been transferred at higher or lower flow rate between the two vessels.	4" hose – transfer time 240 minutes (~250 m^3/h average)	8" hose – transfer time 70 minutes (~860 m^3/h average)
Case Study 3 Means of Transfer	Ship to Ship operation where the transfer is performed with a hose or hard arm.	Hose Failure	Fitting/Flange Failure
Case Study 4 ESD time	Truck to Ship operation where the ESD type has been changed to represent different leak detections and ESD trigging systems of the two scenarios.	Fast Acting and Fully Automatic (10s)	Fully-Manual (10 min)
Case Study 5 Hose elevation	Truck to Ship operation performed with hoses at two different elevations from the ground.	0 metre elevation	1.5 metre elevation
Case Study 6 Net Calorific Value	Ship to Ship operation where during transfer different calorific value LNG is transferred.	34 MJ/Nm^3	40 MJ/Nm^3
Case Study 7 Transfer Pressure	Ship to Ship operation where different transfer pressures have been used.	4 barg	10 barg

NOTE:
The following case studies are only intended as examples of potential outputs from BASiL calculation and shall not be used as representations of real cases safety distances.

Case Study 1 – Location

Input Parameters

	Scenario A Parameter	Scenario B Parameter
Project Name	Case Study 1 Location	
Project Description	Truck to Ship operation performed in two different geographical locations with different atmospheric conditions from: scenario A Narvik, Norway and scenario B Houston, USA	
Latitude	68.4	29.7
Longitude	17.4	-95.3
Supply Storage Pressure [barg]	2	
LNG Storage Temperature	-157°C	
LNG Net Calorific Value Reference	15/15°C	
LNG Net Calorific Value (MJ/m³)	37	
LNG Density [kg/m³]	455	
Bunkering Type	Road Tanker	
Volume Transfer [m³]	45	
Volume Transfer Time [minutes]	75	
Hose System Diameter [inch]	2	
Transfer Pressure [barg]	4	
Primary Leak Source	Hose Failure	
ESD Type	Fully Automatic (30s)	
Minimum Hose Elevation [m]	0	
Hose Entry Location	On Deck	
Distance Below Deck [m]	NA	

BASiL Output results (m)

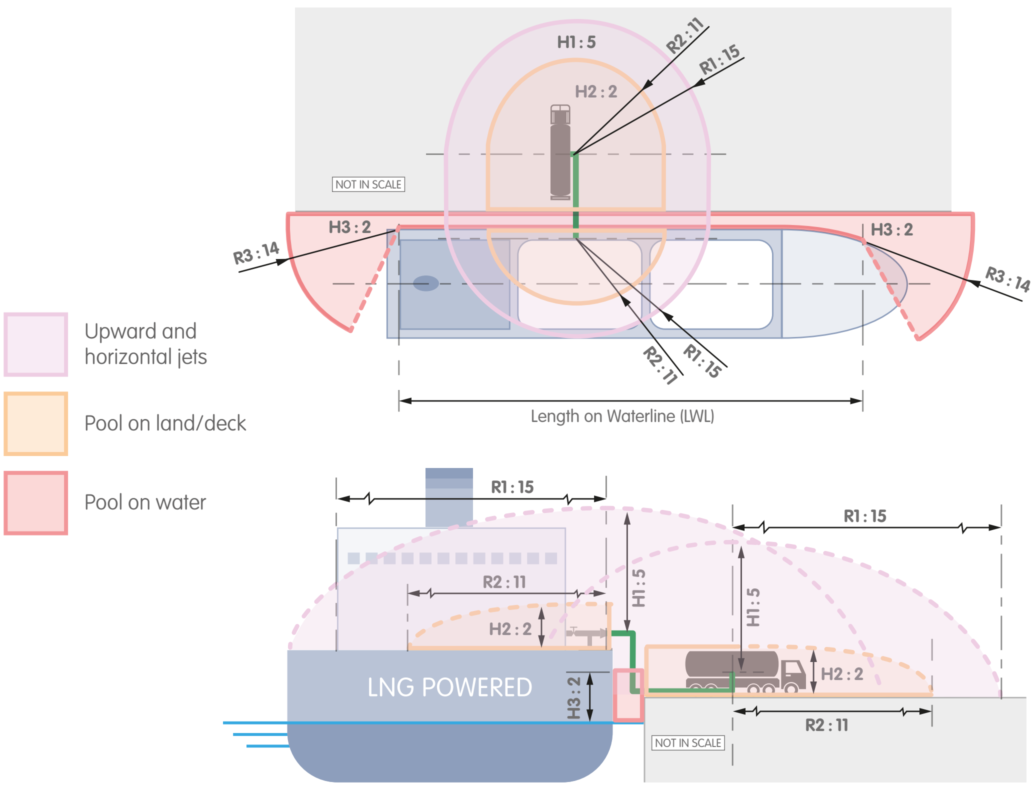
Case Study 1	Scenario A		Scenario B	
Jet leak	R1	15	R1	15
	H1	5	H1	5
Pool on Land / Deck	R2	11	R2	12
	H2	2	H2	2
Pool on Water	R3	14	R3	14
	H3	2	H3	2
Pool across the above deck	R4	NA	R4	NA

Case Study 1 Scenario A / Graphical Representation

Houston is warmer and more humid than Narvik. This means there is more energy in the atmosphere causing the pool of LNG to boil faster, creating more gas. However, the increased atmospheric energy means that the gas cloud disperses faster.

In Narvik the atmosphere is cooler and more stable so the pool will boil slower but the resulting gas cloud will spread further before dispersing to LFL.

These two phenomena oppose each other so, in this case, the result is very similar.



Case Study 2 – Transfer Time (Flow Rate & Hose Diameter)

Input Parameters

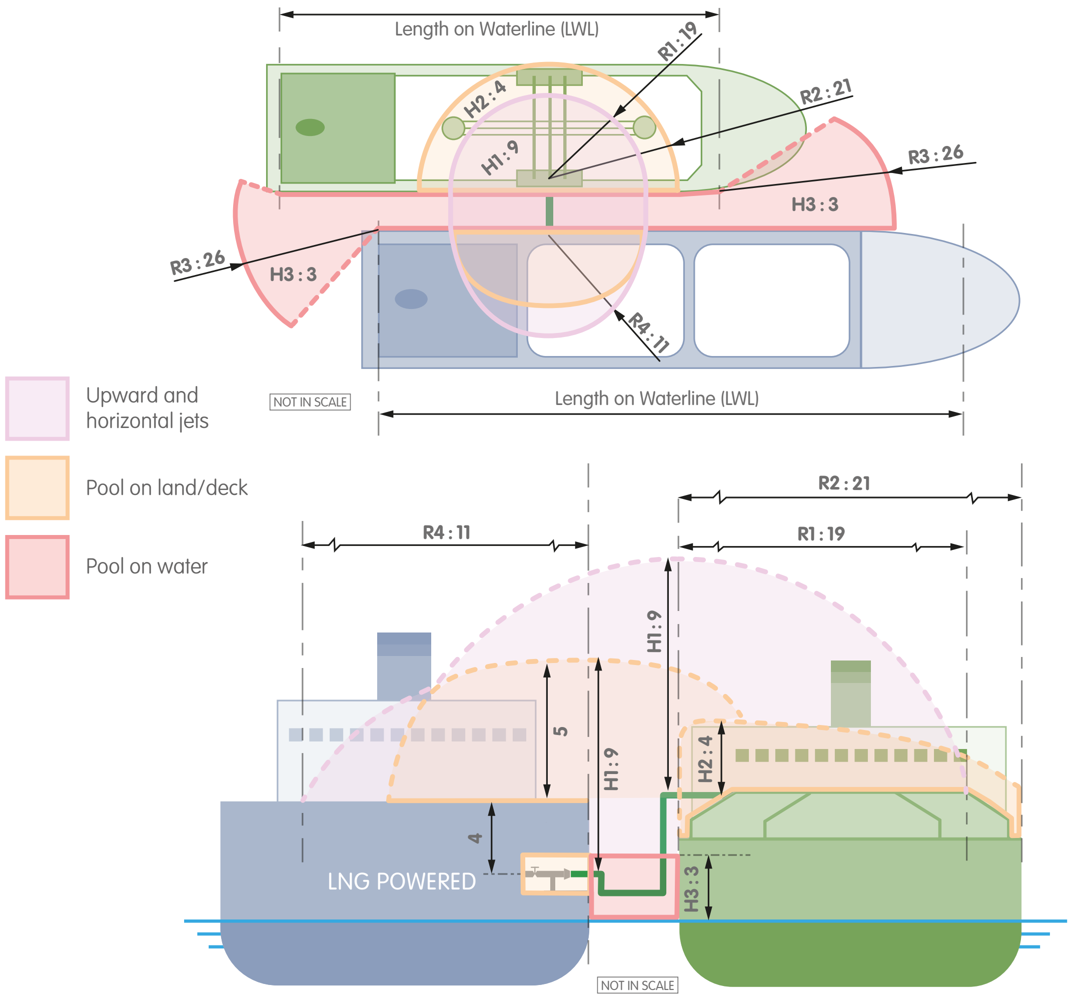
	Scenario A Parameter	Scenario B Parameter
Project Name	Case Study 2 Transfer Time	
Project Description	Ship to Ship operation where same quantity of LNG (1000m^3) has been transferred at higher or lower flow rate between the two vessels.	
Latitude	51.2	
Longitude	4.4	
Supply Storage Pressure [barg]	1	
LNG Storage Temperature	-159°C	
LNG Net Calorific Value Reference	15/15°C	
LNG Net Calorific Value (MJ/m^3)	37	
LNG Density [kg/m^3]	455	
Bunkering Type	Bunker Vessel	
Volume Transfer [m^3]	1000	
Volume Transfer Time [minutes]	240 (~250 m^3/h average)	70 (~860 m^3/h average)
Hose System Diameter [inch]	4	8
Transfer Pressure [barg]	6	
Primary Leak Source	Hose Failure	
ESD Type	Fully Automatic (30s)	
Minimum Hose Elevation [m]	5	
Hose Entry Location	Semi-enclosed	
Distance Below Deck [m]	4	

BASiL Output results (m)

Case Study 2	Scenario A		Scenario B	
Jet leak	R1	19	R1	35
	H1	9	H1	15
Pool on Land / Deck	R2	21	R2	35
	H2	4	H2	5
Pool on Water	R3	26	R3	45
	H3	3	H3	5
Pool across the above deck	R4	11	R4	26

Case Study 2 Scenario A - Graphical Representation

The higher volumetric (mass) flowrate has more momentum passing through the hole. It takes a longer distance for this higher velocity to slow and therefore disperse so the safety distance is larger.



Case Study 3 - Means of Transfer

Input Parameters

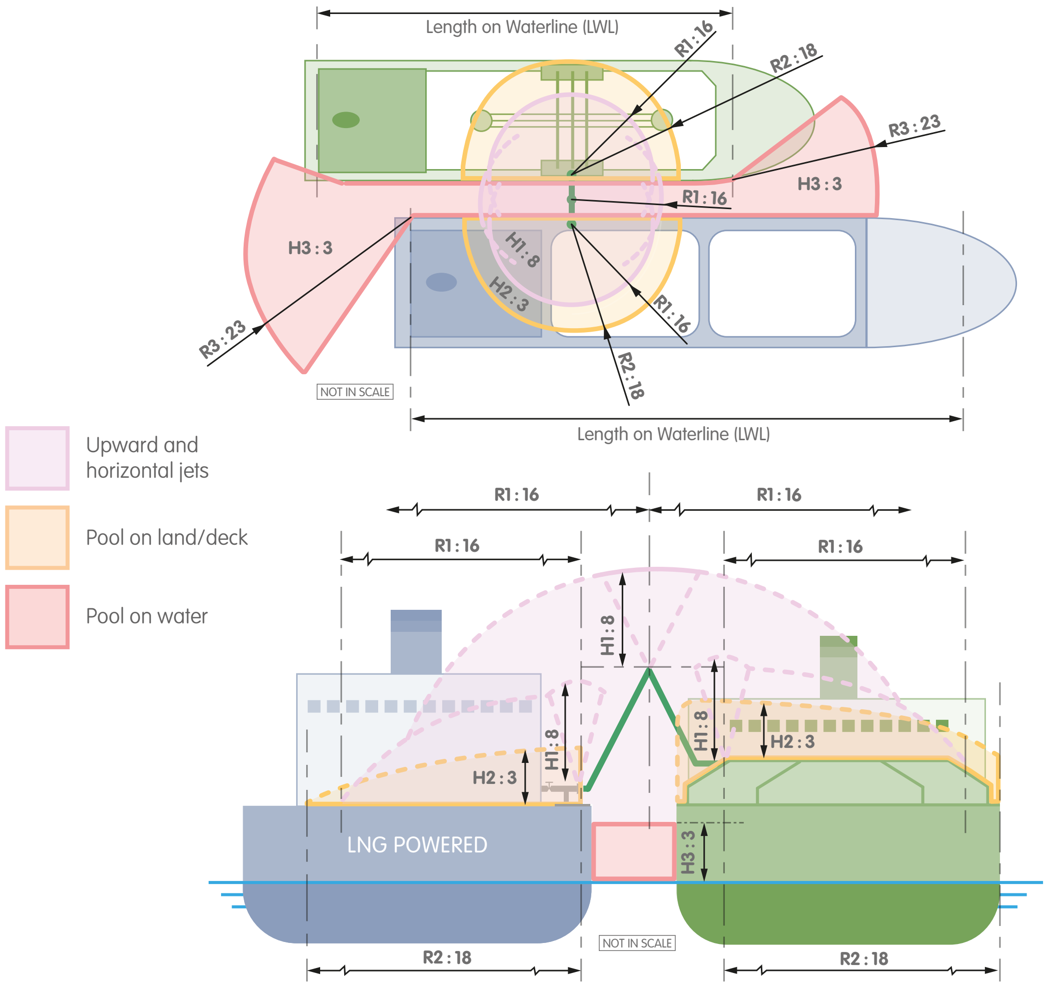
	Scenario A Parameter	Scenario B Parameter
Project Name	Case Study 3 Mean of Transfer	
Project Description	Ship to Ship operation where the transfer is performed with a hose or hard arm.	
Latitude	51.2	
Longitude	4.4	
Supply Storage Pressure [barg]	1	
LNG Storage Temperature	-159°C	
LNG Net Calorific Value Reference	15/15°C	
LNG Net Calorific Value (MJ/m³)	37	
LNG Density [kg/m³]	455	
Bunkering Type	Bunker Vessel	
Volume Transfer [m³]	7000	
Volume Transfer Time [minutes]	450	
Hose System Diameter [inch]	8	
Transfer Pressure [barg]	6	
Primary Leak Source	Hose Failure (Hose transfer system)	Fitting/Flange Failure (Loading arm)
ESD Type	Fully Automatic (30s)	
Minimum Hose Elevation [m]	5	
Hose Entry Location	On Deck	
Distance Below Deck [m]	NA	

BASiL Output results (m)

Case Study 3	Scenario A		Scenario B	
Jet leak	R1	35	R1	16
	H1	15	H1	8
Pool on Land / Deck	R2	35	R2	18
	H2	5	H2	3
Pool on Water	R3	45	R3	23
	H3	5	H3	3
Pool across the above deck	R4	NA	R4	NA

Case Study 3 Scenario B - Graphical Representation

The hole sizes are different because of the change failure scenario. A flange leak is much smaller than a hose hole. The dispersion distances reflect that as less material is ejected from the smaller flange hole.



Case Study 4 - ESD time

Input Parameters

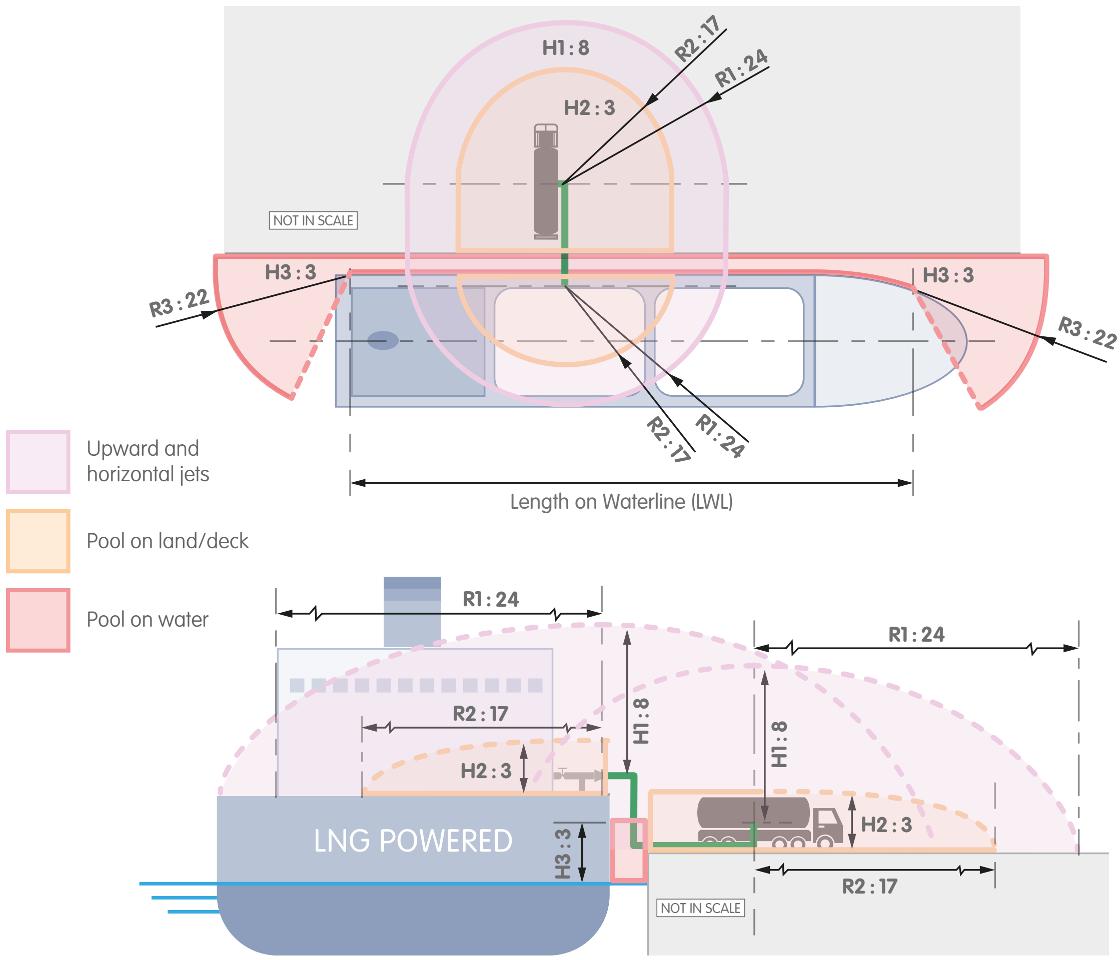
	Scenario A Parameter	Scenario B Parameter
Project Name	Case Study 4 ESD time	
Project Description	Truck to Ship operation where the ESD type has been changed to represent different leak detections and ESD trigging systems of the two scenarios.	
Latitude	51.2	
Longitude	4.4	
Supply Storage Pressure [barg]	2	
LNG Storage Temperature	-157°C	
LNG Net Calorific Value Reference	15/15°C	
LNG Net Calorific Value (MJ/m³)	37	
LNG Density [kg/m³]	455	
Bunkering Type	Road Tanker	
Volume Transfer [m³]	90	
Volume Transfer Time [minutes]	45	
Hose System Diameter [inch]	3	
Transfer Pressure [barg]	6	
Primary Leak Source	Hose Failure	
ESD Type	**Fast Acting and Fully Automatic (30s)**	**Fully-Manual (10 min)**
Minimum Hose Elevation [m]	0	
Hose Entry Location	On Deck	
Distance Below Deck [m]	NA	

BASiL Output results (m)

Case Study 4	Scenario A		Scenario B	
Jet leak	R1	24	R1	24
	H1	8	H1	8
Pool on Land / Deck	R2	17	R2	17
	H2	3	H2	3
Pool on Water	R3	21	R3	22
	H3	3	H3	3
Pool across the above deck	R4	NA	R4	NA

Case Study 4 Scenario B - Graphical Representation

The jet leaks establish themselves very quickly so there is no change in R1 and H2. However, the ESD time determines how much liquid ends up in the pool and therefore its size. The larger the pool the greater the dispersion distance



Case Study 5 - Hose elevation

Input Parameters

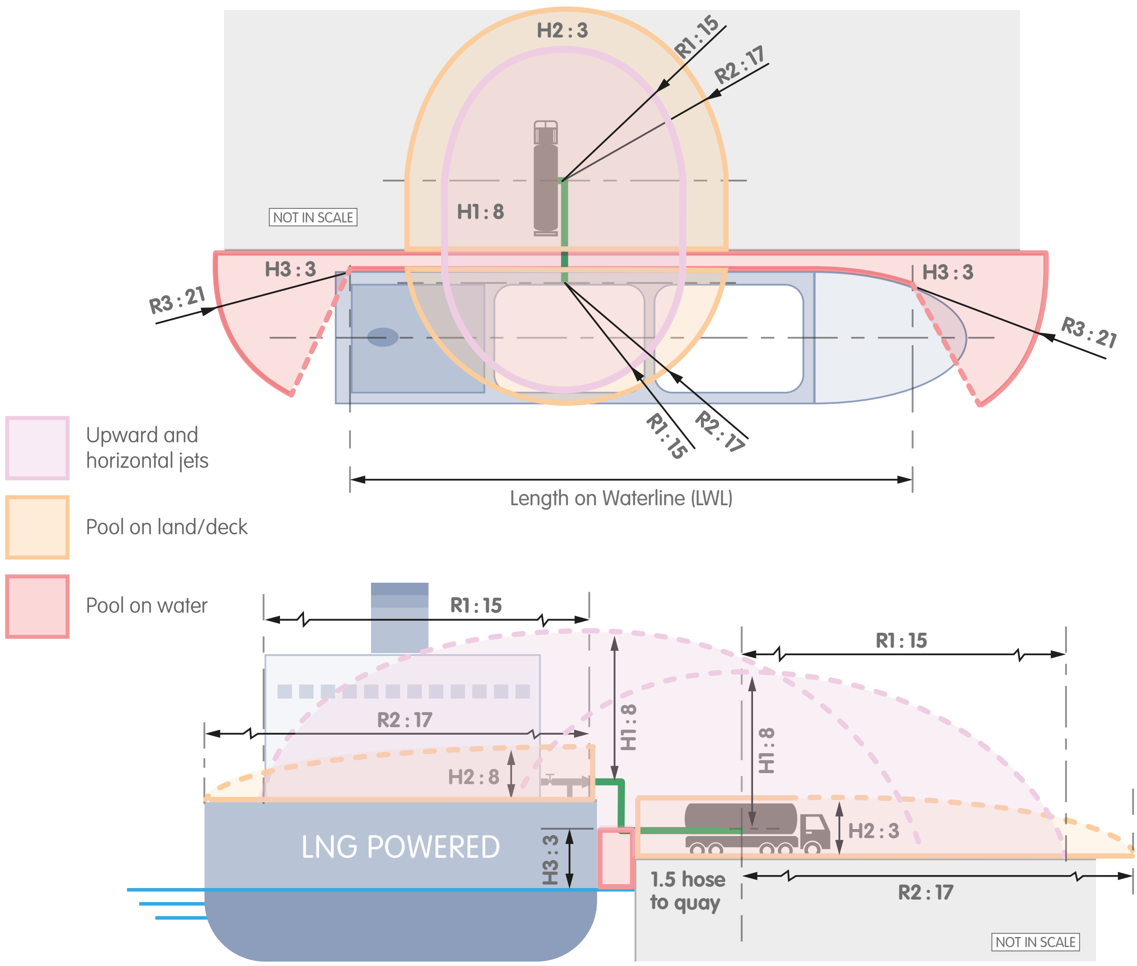
	Scenario A Parameter	Scenario B Parameter
Project Name	Case Study 5 Hose elevation	
Project Description	Truck to Ship operation performed with hoses with two different elevations from the ground.	
Latitude	51.2	
Longitude	4.4	
Supply Storage Pressure [barg]	2	
LNG Storage Temperature	-157°C	
LNG Net Calorific Value Reference	15/15°C	
LNG Net Calorific Value (MJ/m³)	37	
LNG Density [kg/m³]	455	
Bunkering Type	Road Tanker	
Volume Transfer [m³]	90	
Volume Transfer Time [minutes]	45	
Hose System Diameter [inch]	3	
Transfer Pressure [barg]	6	
Primary Leak Source	Hose Failure	
ESD Type	Fully Automatic (30s)	
Minimum Hose Elevation [m]	0	1.5
Hose Entry Location	On Deck	
Distance Below Deck [m]	NA	

BASiL Output results (m)

Case Study 5	Scenario A		Scenario B	
Jet leak	R1	24	R1	15
	H1	8	H1	8
Pool on Land / Deck	R2	17	R2	17
	H2	3	H2	3
Pool on Water	R3	21	R3	21
	H3	3	H3	3
Pool across the above deck	R4	NA	R4	NA

Case Study 5 Scenario B - Graphical Representation

In Scenario A there is no potential for the gas to mix beneath the hose and therefore gas dispersion in the jet takes longer and the safety zone must be extended to complete the longer dispersion to LFL



Case Study 6 – Net Calorific Value

Input Parameters

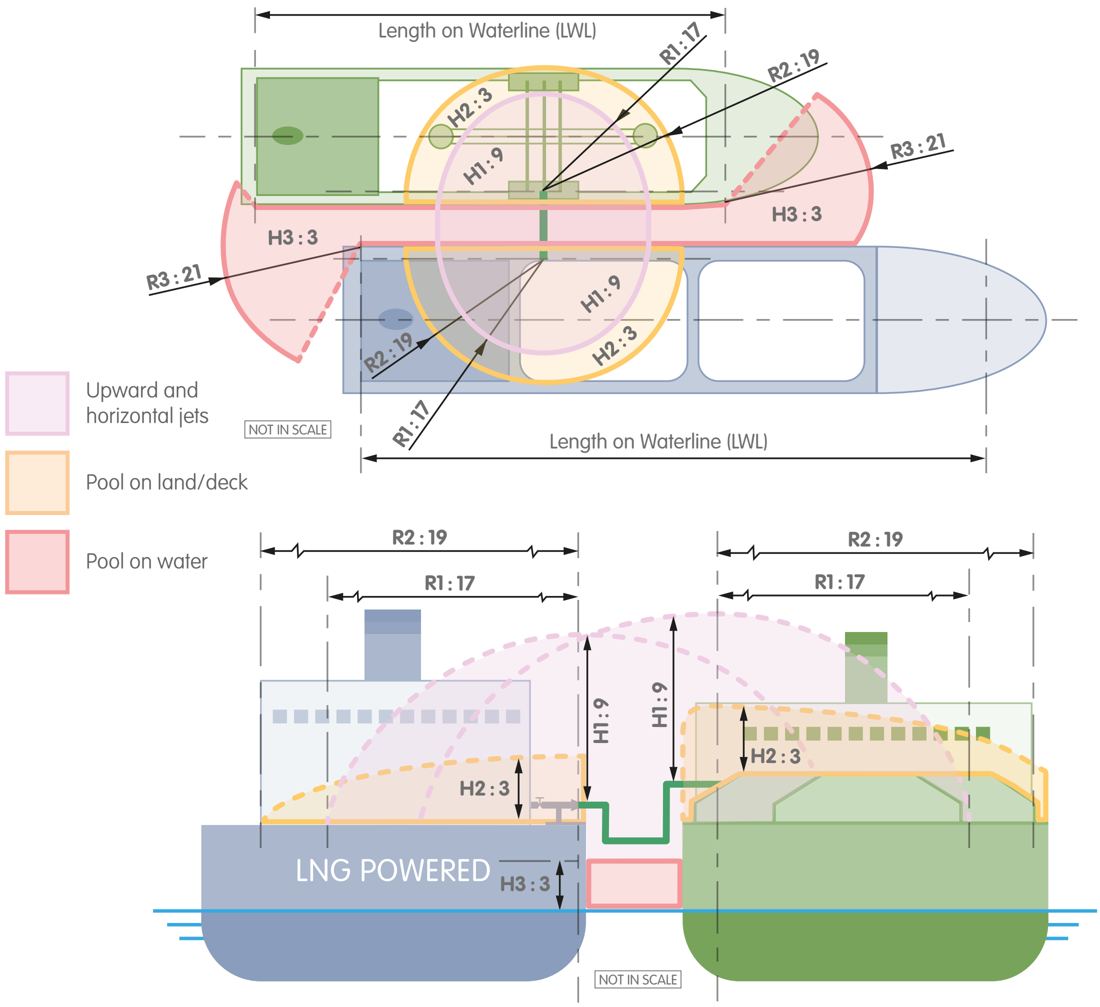
	Scenario A Parameter	Scenario B Parameter
Project Name	Case Study 6 Calorific Value	
Project Description	Ship to Ship operation where during transfer different calorific value LNG is transferred.	
Latitude	51.2	
Longitude	4.4	
Supply Storage Pressure [barg]	1	
LNG Storage Temperature	-159°C	
LNG Net Calorific Value Reference	15/15°C	
LNG Net Calorific Value (MJ/m³)	34	40
LNG Density [kg/m³]	455	
Bunkering Type	Bunker Vessel	
Volume Transfer [m³]	1000	
Volume Transfer Time [minutes]	240	
Hose System Diameter [inch]	4	
Transfer Pressure [barg]	6	
Primary Leak Source	Hose Failure	
ESD Type	**Fast Acting and Fully Automatic (10s)**	
Minimum Hose Elevation [m]	3	
Hose Entry Location	On Deck	
Distance Below Deck [m]	NA	

BASiL Output results (m)

Case Study 6	Scenario A		Scenario B	
Jet leak	R1	17	R1	21
	H1	9	H1	10
Pool on Land / Deck	R2	19	R2	21
	H2	3	H2	4
Pool on Water	R3	21	R3	23
	H3	3	H3	3
Pool across the above deck	R4	NA	R4	NA

Case Study 6 Scenario A - Graphical Representation

The LNG with the larger calorific value contains more higher hydrocarbons which are less volatile than methane and take longer to disperse.



Case Study 7 – Transfer Pressure

Input Parameters

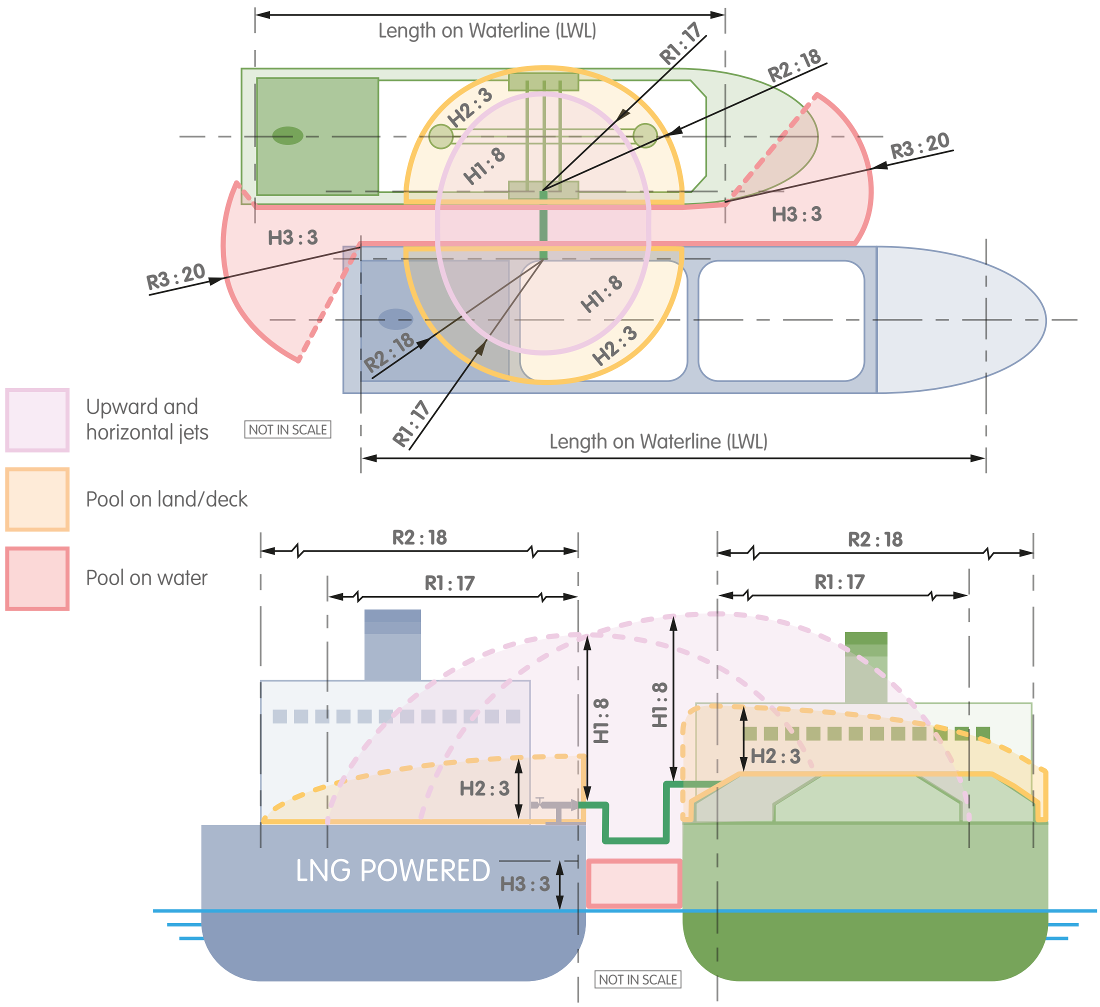
	Scenario A Parameter	Scenario B Parameter
Project Name	Case Study 7 Transfer Pressure	
Project Description	Ship to Ship operation where different transfer pressure has been used.	
Latitude	51.2	
Longitude	4.4	
Supply Storage Pressure [barg]	1	
LNG Storage Temperature	-159°C	
LNG Net Calorific Value Reference	15/15°C	
LNG Net Calorific Value (MJ/m³)	37	
LNG Density [kg/m³]	455	
Bunkering Type	Bunker Vessel	
Volume Transfer [m³]	1000	
Volume Transfer Time [minutes]	240	
Hose System Diameter [inch]	4	
Transfer Pressure [barg]	4	10
Primary Leak Source	Hose Failure	
ESD Type	**Fast Acting and Fully Automatic (10s)**	
Minimum Hose Elevation [m]	3	
Hose Entry Location	On Deck	
Distance Below Deck [m]	NA	

BASiL Output results (m)

Case Study 7	Scenario A		Scenario B	
Jet leak	R1	17	R1	22
	H1	8	H1	11
Pool on Land / Deck	R2	18	R2	22
	H2	3	H2	4
Pool on Water	R3	20	R3	24
	H3	3	H3	3
Pool across the above deck	R4	NA	R4	NA

Case Study 7 Scenario A - Graphical Representation

The larger transfer pressure results in increased momentum in the jet which goes further before dispersing leading to a larger safety zone.



FAQ's

Is BASiL able to take in to account the wind direction and force if this blown from FWD or from AFT of the vessel?

The BASiL model is generic. It is looking at the worst case - which could include any wind direction. BASiL produces "circular" safety distances - i.e. the worst case is transposed to all directions. The wind speed is selected based on the greatest dispersion for Pasquil stabilities of A, B, C and D. Normally this would be a co-flowing wind >6 m/s under Pasquill Stability D.

Is BASiL able to take account of the design/shape of the vessel as factor in the dispersion model?

Specific vessel geometries are not considered, since BASiL is a generic model. The only exception is that geometry is used to prohibit some scenarios for example as the height of the cloud is lower than the main deck of the vessel.

Can BASiL calculate the cloud dispersion area around vent masts?

BASiL is designed to calculate LNG vaporising into gas leaks where the vaporisation process takes energy and therefore increases distance. A gas leak, with no vaporisation process, typical of a vent is not part of BASiL calculation.

SGMF briefly looked at some vent mast results to make sure that the vent mast never determined the safety distance. When this was established the BASiL database was configured for LNG use only.

Can BASiL calculate the cloud dispersion area from a loading arm flange leak/failure?

Yes, simply select as **"Primary Leak Source"** variable **"Fitting/Flange Failure"** when you are completing the request form. BASiL will calculate the safety distance based on a flange or swivel joint failure scenario of a traditional marine loading arm.

Notes

BASiL

Bunkering Area Safety information LNG