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COMAH LAND USE PLANNING ASSESSMENT OF DEVELOPMENT OF FORMER CONCORDE SITE AT NAAS ROAD, DUBLIN

Technical Report Prepared For

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Technical Report Prepared By

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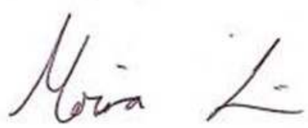
Signature		
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Date	05 March 2019	05 March 2019

EXECUTIVE SUMMARY

A land use planning assessment was completed for a proposed mixed-use development at the former Concorde Industrial Estate site on the Naas Road, Dublin 12. The proposed development is located within the Consultation Distances surrounding the BOC Gases Ireland Upper Tier COMAH establishment and the Kayfoam Woolfson Lower Tier COMAH establishment.

The assessment was completed in accordance with the Policy and Approach of the Health and Safety Authority to COMAH Risk-based Land-use Planning (HSA, 2010).

Assessment of BOC Gases Ireland Major Accident Hazards

BOC Gases Ireland is located approximately 600 m from the proposed development. BOC Gases is engaged in the manufacturing of oxygen, nitrogen, argon and hydrogen and the storage of various other gases including toxic gases. The following major accident scenarios were assessed for land use planning purposes:

- Release and dispersion of toxic chlorine gas from 1 tonne tank;
- Reboiler explosion with overpressure consequences;
- Hydrogen Compressor Jet fire with thermal radiation consequences.

The assessment results are summarised as follows:

Scenario	Consequences	Frequency	Comments
Chlorine tank release	576 m to SLOT DTL following drum drop and release duration of 5 mins (Weather Category F2) 175 m to SLOT DTL following drum drop and release duration of 5 mins (Weather Category D5) 588 m to SLOT DTL following drum drop and release duration of 20 mins (Weather Category F2) 170 m to SLOT DTL following drum drop and release duration of 20 mins (Weather Category D5) 583 m to SLOT DTL following valve shear and release duration of 30 mins (Weather Category F2) 146 m to SLOT DTL following valve shear and release duration of 30 mins (Weather Category D5)	1.25E-04 /year 4.99E-04 /year 2.34E-03 /year	• The proposed development is located approximately 603 m from the location of the chlorine tank at BOC Gases Ireland; • Distance to toxic dose levels corresponding to SLOT DTL and 1% fatality outdoors for weather category F2 and D5 (effect height, 1.5 m) do not extend to the proposed development; • Toxic dose levels corresponding to SLOT DTL and 1% fatality outdoors for weather category D5 (effect height, 1.5 m) do not extend to the proposed development; • Toxic dose levels corresponding to SLOT DTL and 1% fatality indoors for weather categories F2 and D5 (effect height, 1.5 m) do not extend to the proposed development; • Individual risk of fatality contours do not extend to the proposed development.
ASU Reboiler Explosion	80 m to 1% mortality outdoors overpressure level 118 m to 1% mortality indoors in Category 2 structures (typical 4 storey office building) 205 m to 1% mortality indoors in Category 3 structure	1E-04 /year	Personnel outdoors and indoors at the proposed development are protected from an explosion involving the reboiler at the BOC Gases ASU Individual risk of fatality contours do not extend to the proposed development.

	(residential building)		
Hydrogen Jet fire	113 m to threshold of fatality thermal radiation level 104 m to 1% mortality outdoors thermal radiation level 96 m to thermal radiation level below which persons indoors are protected	5E-06 /year	Negligible consequences outdoors at proposed development. Persons indoors are protected at proposed development. Individual risk of fatality contours (as above) do not extend to the proposed development.

Assessment of Kayfoam Woolfson Major Accident Hazards

Kayfoam Woolfson is located approximately 960 m for the proposed development. Kayfoam Woolfson are involved in the manufacture of polyurethane foams for use in soft furnishings including mattresses and pillows. Kayfoam use toluene diisocyanate (TDI) in the manufacture of the polyurethane foams which is classified as an acute toxic category 1 via inhalation. TDI has a low vapour pressure (0.1 mmHg at 25 degC). When mixed with air the density was calculated to be 1.2253 kg/m^3. TNO Effects recommends the use of the neutral gas dispersion model where the density of the material is not more than 10% heavier than air (1.24 kg/m^3) therefore the neutral gas dispersion model in TNO Effects was used.

The following major accident scenarios were assessed for land use planning purposes:

- Major leak from bulk storage tank, pool formation within storage tank bund and evaporation and dispersion of TDI from the surface of the liquid pool;
- Catastrophic tank rupture with bund overtopping pool formation within and adjacent to bund and evaporation and dispersion of TDI from the surface of the liquid pool.

The following was concluded

- In the event of an accidental release of TDI into the largest bund, toxic dose outdoor corresponding to SLOT DTL effects and 1% probability of fatality (at the effect height considered, 1.5 m) are not reached. Fatalities are not expected to arise at the proposed development as a result of this scenario;
- In the event of a catastrophic rupture of the largest TDI tank, toxic dose outdoor corresponding to SLOT DTL effects and 1% probability of fatality (at the effect height considered, 1.5 m) are not reached. Fatalities are not expected to arise at the proposed development as a result of this scenario.

Cumulative Risk

The cumulative individual risk contours for the BOC Gases Ireland and Kayfoam Woolfson sites corresponding to the boundary of the inner, middle and outer land use planning zones are illustrated as follows.

It is noted that the 1 tonne chlorine tank release scenario provides the biggest contribution to the outer LUP zone. As outlined above, toxic dose levels corresponding to SLOT DTL and 1 % probability of fatality outdoor and indoor (weather category F2 and D5) do not extend to the proposed development.

It is concluded that the outer land use planning zone does not extend to the proposed development. Therefore, on the basis of individual risk, the BOC Gases Ireland Ltd and Kayfoam Woolfson Ltd. sites do not pose a constraint to the development of the former Concorde site.

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FIGURES

1.0 INTRODUCTION

AWN Consulting Ltd. was requested by John Spain Associates to complete a land use planning assessment for a proposed mixed-use development at the former Concorde Industrial Estate site on the Naas Road, Dublin 12. The proposed development is located within the Consultation Distances surrounding the BOC Gases Ireland Upper Tier COMAH establishment and the Kayfoam Woolfson Lower Tier COMAH establishment.

This report outlines the following:

- Overview of proposed works and COMAH sites;
- Assessment methodology and criteria;
- Identification of major accident scenarios;
- Assessment of major accident hazards;
- Land Use Planning risk contours;
- Conclusions.

2.0 OVERVIEW OF PROPOSED WORKS AND COMAH SITES

2.1 Description of Development

It is proposed to construct an eight-storey mixed-use residential development at the former Concorde Industrial Estate site on the Naas Road, Dublin 12. The development will provide 492 residential accommodation across 7 floors, comprising:

- 104 no. studio apartments
- 136 no. 1 bed apartments
- 21 no. 2 bed (3p) apartments
- 231 no. 2 bed (4p) apartments

Commercial space including retail/crèche/office/enterprise space will be located at ground floor and first floor level of Block A overlooking the Naas Road. The site layout (ground floor) is illustrated in Figure 2-1.

The floor to ceiling height within the commercial spaces will allow a 2.7m clear space as per the residential spaces. Natural ventilation is provided in all habitable areas by means of openable windows. Ducts are provided from selected commercial units envisaged as having fume extract requirements to roof level. Figure 2-2 illustrates the proposed development elevation as seen from the West side (the side facing the Bluebell Industrial Estate).

The proposed development is located with the consultation distance for both BOC Gases Ireland Ltd. and Kayfoam Woolfson as set out is Schedule 8 of S.I. 600 of 2001 (Planning and Development Regulations, 2001). The locations of BOC Gases, Kayfoam and the proposed site are illustrated on Figure 2-3 below.

Figure 2-1 Proposed Development Ground Floor Layout

Figure 2-2 Proposed Development Elevation -West

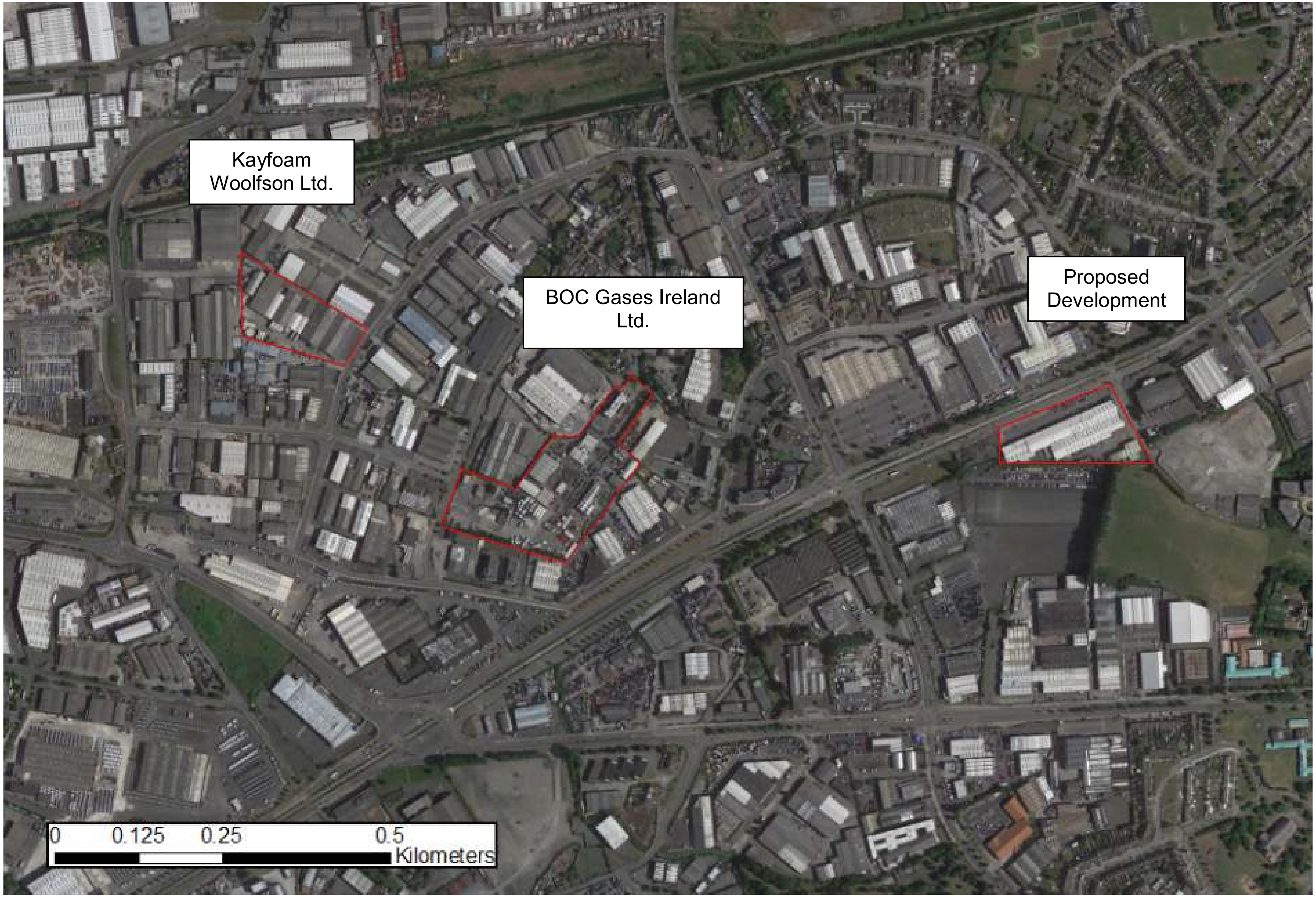

Figure 2-3 Development Location and Neighbouring Seveso Sites

2.2 BOC Gases Ireland Upper Tier COMAH Site

Information on BOC Gases Ireland Ltd. was obtained from the Health and Safety Authority (HSA) via a submission under the Access to Information on the Environment (AIE) Regulations.

BOC Gases Ireland Ltd. is located approximately 600 m from the proposed development in the Bluebell Industrial Estate, Bluebell, Dublin 12. BOC Gases Ireland is engaged in the manufacturing of oxygen, nitrogen, argon and hydrogen and the storage of various other gases including:

- Phosphine
- Acetylene
- Ethylene oxide
- Chlorine
- Hydrogen chloride
- Nitrous gas
- Anhydrous ammonia
- Tungsten hexafluoride
- Silane.

The quantities of dangerous substances on site as notified to the HSA are detailed in Table 2.1 below.

Dangerous substance	Maximum Inventory (tonnes)	Physical Form	Vessel type	Restrictive Flow Orifice (RFO) (mm)	Storage Pressure
Phosphine	0.465	Gas	Cylinder	3	4088.6 kPa
Acetylene	11	Gas	Cylinder	Not available	Not available
Oxygen	379	Liquid	Bulk Storage Vessels	Not available	Not available
Ethylene Oxide	5	Gas	Not available	Not available	Not available
Chlorine	9.1	Gas	B cylinders and Tank	7 (Tank) 3 (cylinder)	580 kPa (Tank)
Hydrogen chloride	25	Liquified Gas	Isotainer and Y cylinders	12.7 (ISO) 3 (cylinder	4200 kPa
Nitrous oxide	42.5	Gas	Isotrailer	12.7	160 barg
Anhydrous Ammonia	33.85	Gas	Isotainer and Y cylinders	12.7 (ISO) 3 (cylinder	7.9 barg (ISO)
Tungsten hexafluoride	2.83	Gas	Cylinder	Not available	Not available
Silane	5.6	Gas	Isotainer	12.7	66 barg

Table 2-1 BOC Gases Ireland Notified Substances

Liquified oxygen is produced on site at the Air Separation Unit (ASU) and stored in bulk storage vessels. Hydrogen is produced on site at the electrolytic Hydrogen Plant and is filled into cylinders in compressed form.

Table 2-2 provides information on the classification, hazard statements of products stored at BOC Gases Ireland Ltd.

Figure 2-4 illustrates the location of Hazardous installations on site at BOC Gases as notified to the HSA.

Substance	CAS #	COMAH Classification	Hazard Statements	Hazard
Hydrogen	1333-74-0	Flam. gas. Cat.1	H220	Extremely Flammable Gas
Phosphine	7803-51-2	Flam. Gas Cat.1 Acute Tox. Cat.1 Aquatic Acute Cat.1	H220 H330 H400	Extremely flammable gas Fatal if inhaled Very toxic to aquatic life
Acetylene	74-86-2	Flam. gas. Cat.1	H220	Extremely Flammable Gas
Oxygen	7782-44-7	Ox. Gas Cat.1	H270	May cause or intensity fire
Ethylene Oxide	75-21-8	Flam. Gas Cat.1 Acute Tox. Cat.3	H220 H331	Extremely flammable gas Toxic if inhaled
Chlorine	7782-50-5	Oxidising Gas Cat. 1 Acute Tox. Cat. 1 Aquatic Acute Cat.1	H270 H330 H400	May cause or intensity fire Fatal if inhaled Very toxic to aquatic life
Hydrogen chloride	7647-01-0	Acute Tox. (Inhalation - gas) Cat. 3	H331	Toxic if inhaled
Nitrous oxide	10024-97-2	Ox. gas Cat. 1	H270	May cause or intensity fire
Anhydrous Ammonia	7664-41-7	Flam. gas Cat. 2 Acute Tox. (Inhalation - gas) Cat. 3 Aquatic Acute Cat. 1 Aquatic Chronic Cat. 2	H221 H331 H400 H411	Flammable gas. Toxic if inhaled Very toxic to aquatic life Toxic to aquatic life with long lasting effects
Tungsten hexafluoride	7783-82-6	Acute Tox. 1	H330	Fatal if inhaled
Silane	7803-62-5	Flam. gas Cat. 1	H220	Extremely flammable gas

Table 2-2 Classification and Hazards of Products Stored at BOC Gases Ireland

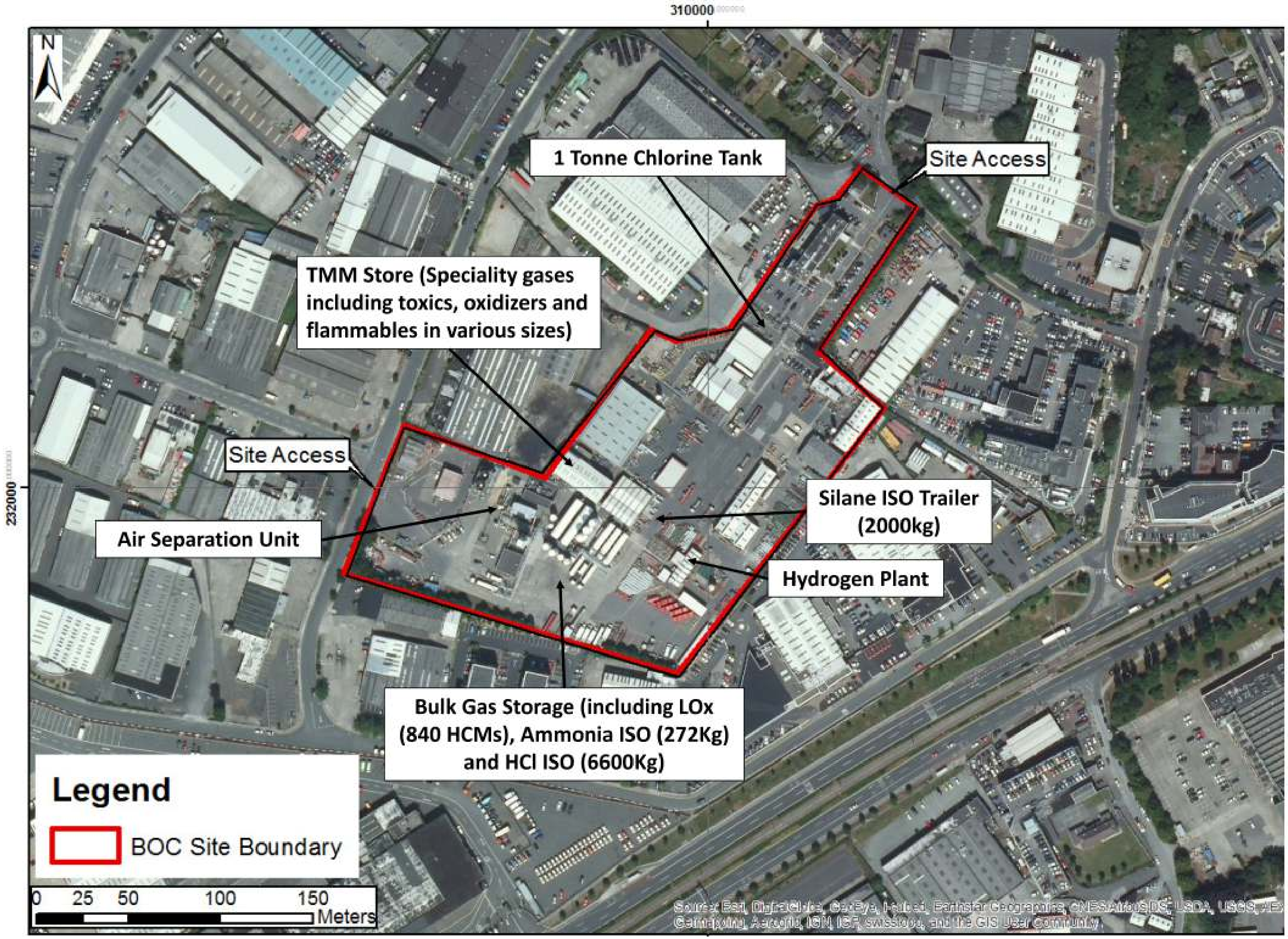

Figure 2-4 BOC Site Layout

2.3 Kayfoam Woolfson Lower Tier COMAH Site

Information on Kayfoam Woolfson Ltd. was obtained from the HSA via a submission under the Access to Information on the Environment (AIE) Regulations.

Kayfoam Woolfson is located on Bluebell Avenue in the Bluebell Industrial Estate, Dublin 12 approximately 960 m from the proposed development and is engaged in the manufacture of polyurethane foams for use in soft furnishings including mattresses and pillows.

Details of the dangerous substances stored on site as notified to the HSA are detailed in Table 2-3 below.

Dangerous substance	Maximum Inventory (tonnes)	Physical Form	Storage
2,4 Toluene diisocyanate;	85	Liquid	Indoor Bunded Tank
Diesel	1.8	Liquid	Indoor Bunded Tanks
Gas Oil	5	Liquid	Indoor Bunded Tanks

Table 2-3 Kayfoam Notified Substances

Table 2-4 provides information on the classification, hazard statements of the notified substances stored at Kayfoam Woolfson Ltd.

Substance	CAS #	COMAH Classification	Hazard Statements	Hazard
2,4 Toluene diisocyanate;	584-84-9	Acute Tox., Inhalation Cat. 1	H330	Fatal if inhaled
Diesel -DERV	68334-30-5	Flam. Liq. Cat.3 Aquatic Chronic Cat.2	H226 H411	Flammable Liquid and Vapour Toxic to aquatic life with long lasting effects
Gas Oil	68334-30-5	Flam. Liq. Cat.3 Aquatic Chronic Cat.2	H226 H411	Flammable Liquid and Vapour Toxic to aquatic life with long lasting effects

Table 2-4 Classification and Hazards of Substances Stored at Kayfoam Woolfson.

3.0 ASSESSMENT METHODOLOGY AND CRITERIA

3.1 Introduction

Trevor Kletz in his seminal work on the subject stated that the essential elements of quantitative risk assessment (QRA) are:

(i) how often is a Major Accident Hazard (MAH) likely to occur and
(ii) Consequence Analysis – what is the impact of the incident (Kletz, 1999)

Kletz also commented that another way of expressing this method of QRA is:

- How often?
- How big?
- So what?

The "how often?" question is generally answered by using frequency analysis techniques such as Event Tree Analysis (ETA) and Fault Tree Analysis (FTA), as described in the TNO Red Book (CPR 12E) (Committee for Prevention of Disasters, 1997). In the current assessment, conservative frequency data specified by the HSA for land use planning purposes in *Policy and Approach of the Health and Safety Authority to COMAH Risk-based Land-use Planning* (HSA, 2010) are applied to representative worst case major accident scenarios at the BOC Gases Ireland Bluebell and Kayfoam Woolfson sites.

The 'how big' element of the QRA was conducted following methodologies specified in the HSA's COMAH Land-Use Planning document (HSA, 2010) for estimating the consequences of fire and explosion scenarios. Where computer models were used, PHAST Version 8.11 and TNO Effects Version 10.1.9 modelling software were used. Risk contours were generated using TNO Riskcurves Version 10.1.9.

The "so what" element is perhaps the most contentious issue associated with QRA, as one is essentially asking what is an acceptable level of risk, in this case risk of fatality, posed by a facility. Individual and societal risk is quantified using TNO Riskcurves modelling software. The acceptability of the level of risk of fatality is assessed with reference to published acceptability criteria.

The Health and Safety Authority (HSA) in Ireland has specified the following tolerability criteria for individual risk of fatality at properties/developments neighbouring COMAH establishments:

- 5E-06 per year at non-residential type developments
- 1E-06 per year at residential type properties

In the UK, the following annual individual risk of fatality criteria apply to members of the public (Trbojevic, 2005):

10^{-4}	Intolerable limit for members of the public;
10^{-5}	Risk has to be reduced to the level As Low As Reasonably Practicable (ALARP);
3×10^{-6}	LUP limit of acceptability;
10^{-6}	Broadly acceptable level of risk
10^{-7}	Negligible level of risk

The UK HSE generally uses a three tier framework for risk tolerability (UK HSE, 2001):

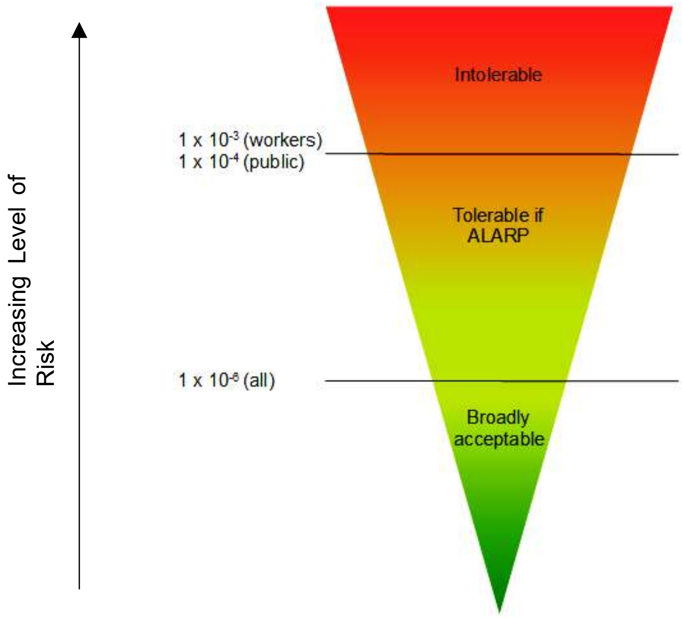

Figure 3-1 Risk Tolerability Criteria

The recommended upper risk of fatality bound for employees is set at 1×10^{-3}/year. The Chemical Industries Association (CIA, 2003) suggests that to allow only for the major hazard aspects of an employee's job, the upper bound should be reduced by a factor of 10 and thus be set at 1×10^{-4}/year for employees.

3.2 Land Use Planning and Risk Assessment

The Seveso III Directive (2012/18/EU) requires Member States to apply land-use or other relevant policies to ensure that appropriate distances are maintained between residential areas, areas of substantial public use and the environment, including areas of particular natural interest and sensitivity and hazardous establishments. For existing establishments, Member States are required to implement, if necessary, additional technical measures so that the risk to persons or the environment is maintained at an acceptable level.

The HSA is the Competent Authority in Ireland as defined by 2015 COMAH Regulations which implement the Seveso III Directive. The HSA is responsible for ensuring that the impacts of facilities which fall within the remit of this legislation are taken into account with respect to land use planning. This is achieved through the provision of technical advice to planning authorities.

A risk-based approach to land use planning near hazardous installations has been adopted by the HSA and is set out in the guidance document *Policy and Approach to COMAH Risk-based Land-use Planning* (HSA, 2010). This approach involves delineating three zones for land use planning guidance purposes, based on the potential risk of fatality from major accident scenarios resulting in damaging levels of thermal radiation (e.g. from pool fires), overpressure (e.g. from vapour cloud explosions) and toxic gas concentrations (e.g. from an uncontrolled toxic gas release).

The HSA has defined the boundaries of the Inner, Middle and Outer Land Use Planning (LUP) zones as:

10^{-5}/year	Risk of fatality for Inner Zone (Zone 1) boundary
10^{-6}/year	Risk of fatality for Middle Zone (Zone 2) boundary
10^{-7}/year	Risk of fatality for Outer Zone (Zone 3) boundary

The process for determining the distances to the boundaries of the inner, middle and outer zones for a Seveso establishment is outlined as follows:

- Determine the consequences of major accident scenarios using the modelling methodologies described in the HSA LUP Policy/Approach Document (HSA, 2010);
- Determine the severity (probability of fatality) using the probit functions specified by the HSA;
- Determine the frequency of the accident (probability of event) using data specified by the HSA; and
- Calculate the individual risk of fatality as follows:

  Risk = Frequency x Severity

The 2010 HSA Risk-Based LUP Policy/Approach document provides guidance on the type of development appropriate to the inner, middle and outer LUP zones. The advice for each zone is based on the UK Health and Safety Executive (HSE) PADHI (Planning Advice for Developments near Hazardous Installations) methodology. The PADHI methodology sets four levels of sensitivity, with sensitivity increasing from 1 to 4, to describe the development types in the vicinity of a COMAH establishment.

The Sensitivity Levels used in PADHI are based on a rationale which allows progressively more severe restrictions to be imposed as the sensitivity of the proposed development increases. The sensitivity levels are:

Level 1	Based on normal working population;
Level 2	Based on the general public – at home and involved in normal activities;
Level 3	Based on vulnerable members of the public (children, those with mobility difficulties or those unable to recognise physical danger); and
Level 4	Large examples of Level 3 and large outdoor examples of Level 2 and Institutional Accommodation.

Table 3-1 details the matrix that is used by the HSA to advise on suitable development for technical LUP purposes:

Level of Sensitivity	Inner Zone (Zone 1)	Middle Zone (Zone 2)	Outer Zone (Zone 3)
Level 1	✓	✓	✓
Level 2	×	✓	✓
Level 3	×	×	✓
Level 4	×	×	×

Table 3-1 LUP Matrix

3.3 Land Use Planning and Societal Risk

Vrijling and van Gelder (2004) have defined Societal Risk as:

"the relation between frequency and the number of people suffering from a specified level of harm in a given population from the realisation of specified hazards"

An important distinction in Societal Risk assessment is the number of persons that may be affected by off-site impacts, such as people with restricted mobility or children that may be affected by the need to rapidly evacuate a significant number of people from an area.

It is therefore prudent, when considering the Societal Risk Impacts of a development, to consider the nature and extent of a population which could be located in the vicinity of establishments with major accident hazard potential, or if adjacent lands are not already developed, to consider the nature and extent of a population which should be permitted to be located in this area.

It is recognised that it is not necessary to restrict all access by people to such lands, but it is considered prudent to restrict the number and type of persons which could be impacted.

The HSA LUP Policy and Approach document (HSA, 2010) recommends that for some types of development, particularly those involving large numbers of people, it is likely that the deciding factor from the point of view of land use planning is the societal risk, i.e. the risk of large numbers of people being affected in a single accident.

The HSA specifies the following societal risk criteria:

- Upper societal risk criterion value of 1 in 5000 for 50 fatalities (planning authority should advise against permitting the development)
- Broadly acceptable region of 1 in 100,000 for 10 fatalities (planning authority should not advise against permitting the development)
- Significant risk regions between these two values (planning authority should be advised of HSA approach to Risk-based Land Use Planning)

3.4 Consequence Modelling

The impacts of physical effects were determined by modelling accident scenarios in accordance with guidelines set out in the HSA COMAH Land Use Planning Policy document (HSA, 2010). Where computer models were used, TNO Effects Version 10.1.9 and DNV Phast Version 8.11 consequence modelling software were used.

Physical consequences from major accident scenarios associated with the proposed development relate to:

BOC Gases Ireland MAHs:

- Gas cylinder valve shear resulting in dispersion of toxic gas;
- ASU Reboiler explosion;
- Jet fire

Kayfoam Woolfson Ltd.

- Tank leak and dispersion of toxic vapour from pool.

3.4.1 Toxic Gas Exposure Criteria

The toxicity expressed by a given substance in the air is influenced by two factors, the concentration in the air (c) and the duration of exposure (t). A functional relationship between c and t can be developed, such that the end product of this relationship is a constant:

$$f(c,t) = \text{constant}$$

This constant is known as the Toxic Load and is calculated as follows:

$$\text{Toxic Load} = C^n.t$$

The UK Health and Safety Executive have set out Specified Level of Toxicity (SLOT) Dangerous Toxic Load (DTL) values. The UK HSE has defined land use planning SLOT as:

- Severe distress to almost everyone in the area;
- Substantial fraction of exposed population requiring medical attention;
- Some people seriously injured, requiring prolonged treatment;
- Highly susceptible people possibly being killed.

These criteria are fairly broad in scope, reflecting the fact that:

- There is likely to be considerable variability in the responses of different individuals affected by a major accident;
- There may be pockets of high and low concentrations of a toxic substance in the toxic cloud release, so that not everyone will get exactly the same degree of exposure; and
- The available toxicity data are not usually adequate for predicting precise dose-response effects.

The SLOT DTL value approximately equates to the toxic load which would give rise to 1% fatality. The UK HSE has also assigned Significant Likelihood of Death (SLOD) Dangerous Toxic Load (DTL) values to toxic substances. The SLOD DTL value equates to the toxic load which would give rise to a likely fatality of 50%.

The SLOT DTL and SLOD DTL values for the toxic materials assessed in this study are detailed as follows:

Substance	CAS No.	'n' value	SLOT DTL ppm^n.min	SLOD DTL ppm^n.min
Chlorine	7782-50-5	2	1.08 x 10^5	4.84 x 10^5
2,4 Toluene diisocyanate;	584-84-9	1	176	480

Table 3-2 SLOT DTL and SLOD DTL Values

3.4.1.1 Toxic Effects to Persons Outdoors

The HSA's LUP Policy and Approach Document (HSA 2010) sets out criteria for assessing the effects of a toxic gas release on persons outdoors, persons indoors and with respect to property damage.

For persons outdoors, the risk of fatality due to exposure to a toxic substance is calculated using probit equations in the form of:

$$Probit = a + b \ln (C^n.t)$$

where a, b and n are constants and (C^n.t) represents the toxic load.

A Probit (Probability Unit) function is used to convert the probability of an event occurring to percentage certainty that an event will occur. The probit variable is related to probability as follows (CCPS, 2000):

$$P = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{Y-5} \exp\left(-\frac{u^2}{2} \right) du$$ **(Equation 1)**

where P is the probability of percentage, Y is the probit variable, and u is an integration variable. The probit variable is normally distributed and has a mean value of 5 and a standard deviation of 1.

The Probit to percentage conversion equation is (CCPS, 2000):

$$P = 50\left[1 + \frac{Y-5}{|Y-5|} erf\left(\frac{|Y-5|}{\sqrt{2}}\right)\right]$$ **(Equation 2)**

The relationship between Probit and percentage certainty is presented in the Table 3-3 (CCPS, 2000):

%	0	1	2	3	4	5	6	7	8	9
0	—	2.67	2.95	3.12	3.25	3.36	3.45	3.52	3.59	3.66
10	3.72	3.77	3.82	3.87	3.92	3.96	4.01	4.05	4.08	4.12
20	4.16	4.19	4.23	4.26	4.29	4.33	4.36	4.39	4.42	4.45
30	4.48	4.50	4.53	4.56	4.59	4.61	4.64	4.67	4.69	4.72
40	4.75	4.77	4.80	4.82	4.85	4.87	4.90	4.92	4.95	4.97
50	5.00	5.03	5.05	5.08	5.10	5.13	5.15	5.18	5.20	5.23
60	5.25	5.28	5.31	5.33	5.36	5.39	5.41	5.44	5.47	5.50
70	5.52	5.55	5.58	5.61	5.64	5.67	5.71	5.74	5.77	5.81
80	5.84	5.88	5.92	5.95	5.99	6.04	6.08	6.13	6.18	6.23
90	6.28	6.34	6.41	6.48	6.55	6.64	6.75	6.88	7.05	7.33
%	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
99	7.33	7.37	7.41	7.46	7.51	7.58	7.65	7.75	7.88	8.09

Table 3-3 Conversion from Probits to Percentage

The HSA recommends that probits be selected from the most well established sources:

- TNO (Dutch technical research organisation);
- AIChE (American Institute of Chemical Engineers); or
- HSE (UK Health and Safety Executive).

3.4.1.2 Persons Indoors

The risk to persons indoors from a toxic vapour cloud depends on the effective ventilation rate of the building, which may depend on the wind speed. Air change rates of 2.5 and 2 changes per hour are typically assumed for D5 and F2 conditions. The impact of a toxic release on an indoor population can be assessed using the same probit equations but it is necessary to modify the effective concentration and duration of exposure to take account of infiltration into the building.

3.4.2 Thermal Radiation Criteria

Fire scenarios have the potential to create hazardous heat fluxes. Therefore, thermal radiation on exposed skin poses a risk of fatality. Potential consequences of damaging radiant heat flux and direct flame impingement are categorised in Table 3-4 (HSA, 2010, CCPS, 2000, EI, 2007 and McGrattan et al, 2000).

Thermal Flux (kW/m^2)	Consequences
1 – 1.5	Sunburn
5 – 6	Personnel injured (burns) if they are wearing normal clothing and do not escape quickly
8 – 12	Fire escalation if long exposure and no protection
32 – 37.5	Fire escalation if no protection (consider flame impingement)
31.5	US DHUD, limit value to which buildings can be exposed
37.5	Process equipment can be impacted, AIChE/CCPS
Up to 350	In flame. Steel structures can fail within several minutes if unprotected or not cooled.

Table 3-4 Heat Flux Consequences

In relation to persons indoors, the HSA have specified the thermal radiation consequence criteria (from an outdoor fire) detailed in Table 3-5 (HSA, 2010).

Thermal Flux (kW/m^2)	Consequences
> 25.6	Building conservatively assumed to catch fire quickly and so 100% fatality probability
12.7 – 25.6	People are assumed to escape outdoors, and so have a risk of fatality corresponding to that outdoors
< 12.7	People are assumed to be protected, so 0% fatality probability

Table 3-5 Heat Flux Consequences Indoors

Thermal Dose Unit (TDU) is used to measure exposure to thermal radiation. It is a function of intensity (power per unit area) and exposure time:

$$\text{Thermal Dose} = I^{1.33}\, t \qquad \text{(Equation 3)}$$

where the Thermal Dose Units (TDUs) are $(kW/m^2)^{4/3}.s$, I is thermal radiation intensity (kW/m^2) and t is exposure duration (s).

The HSA recommends that the Eisenberg probit function (HSA, 2010) is used to determine probability of fatality to persons outdoors from thermal radiation as follows:

$$\text{Probit} = -14.9 + 2.56 \ln (I^{1.33}\, t) \qquad \text{(Equation 4)}$$

I Thermal radiation intensity (kW/m^2)
t exposure duration (s)

For long duration fires, such as pool fires, it is generally reasonable to assume an effective exposure duration of 75 seconds to take account of the time required to escape. With respect to exposure to thermal radiation outdoors, the Eisenberg probit relationship implies:

- 1% fatality – 966 TDUs (6.8 kW/m^2 for 75 s exposure duration) (Dangerous Dose)
- 10% fatality – 1452 TDUs (9.23 kW/m^2 for 75 s exposure duration)
- 50% fatality – 2387 TDUs (13.4 kW/m^2 for 75 s exposure duration)

3.4.3 Overpressure Criteria

Explosions scenarios can result in damaging overpressures, especially when flammable vapour/air mixtures are ignited in a congested area. Table 3-6 describes blast damage for various overpressure levels (Mannan, 2012).

Side-on Overpressure (mbar)	Description of Damage
1.5	Annoying noise
2	Occasional breaking of large window panes already under strain
3	Loud noise; sonic boom glass failure
7	Breakage of small windows under strain
10	Threshold for glass breakage
20	"Safe distance", probability of 0.95 of no serious damage beyond this value; some damage to house ceilings; 10% window glass broken
30	Limited minor structural damage
35 – 70	Large and small windows usually shattered; occasional damage to window frames
>35	Damage level for "Light Damage"
50	Minor damage to house structures
80	Partial demolition of houses, made uninhabitable
70 - 150	Corrugated asbestos shattered. Corrugated steel or aluminium panels fastenings fail, followed by buckling; wood panel (standard housing) fastenings fail; panels blown in
100	Steel frame of clad building slightly distorted
150	Partial collapse of walls and roofs of houses
150-200	Concrete or cinderblock walls, not reinforced, shattered
>170	Damage level for "Moderate Damage"
180	Lower limit of serious structural damage 50% destruction of brickwork of houses
200	Heavy machines in industrial buildings suffered little damage; steel frame building distorted and pulled away from foundations
200 – 280	Frameless, self-framing steel panel building demolished; rupture of oil storage tanks
300	Cladding of light industrial buildings ruptured
350	Wooden utility poles snapped; tall hydraulic press in building slightly damaged
350 – 500	Nearly complete destruction of houses
>350	Damage level for "Severe Damage"
500	Loaded tank car overturned
500 – 550	Unreinforced brick panels, 25 - 35 cm thick, fail by shearing or flexure
600	Loaded train boxcars completely demolished
700	Probable total destruction of buildings; heavy machine tools moved and badly damaged

Table 3-6 Blast Damage

Lees' Loss Prevention also gives the following damage criteria for process vessels (Mannan, 2012):

Peak Overpressure (mbar)	Description of Damage
	Steel floating roof petroleum tank
240	20% damage
1,380	99% damage
	Vertical cylindrical steel pressure vessel
830	20% damage
965	99% damage
	Spherical steel petroleum tank
550	20% damage
1100	99% damage

Table 3-7 Process Vessel Blast Damage

There are a number of modes of explosion injury including eardrum rupture, lung haemorrhage, whole body displacement injury, missile injury, burns and toxic exposure. Table 3-8 describes injury criteria from blast overpressure including probability of eardrum rupture and probability of fatality due to lung haemorrhage.

Probability of Eardrum Rupture (%)	Peak overpressure (mbar)
1 (threshold)	165
10	194
50	435
90	840
Probability of Fatality due to Lung Haemorrhage (%)	Peak overpressure (mbar)
1 (threshold)	1000
10	1200
50	1400
90	1750

Table 3-8 Injury Criteria from Explosion Overpressure

The HSA recommends that the Hurst, Nussey and Pape probit function (HSA, 2010) is used to determine probability of fatality to persons outdoors from overpressure as follows:

$$\text{Probit} = 1.47 + 1.35 \ln P \qquad \text{(Equation 5)}$$

P Blast overpressure (psi)

The Hurst, Nussey and Pape probit relationship implies:

- 1% fatality – 168 mbar (Dangerous Dose)
- 10% fatality – 365 mbar
- 50% fatality – 942 mbar

The HSA uses relationships published by the Chemical Industries Association (CIA) to determine the probability of fatality for building occupants exposed to blast overpressure. The CIA has developed relationships for 4 categories of buildings (CIA, 2010):

- category 1: hardened structure building (special construction, no windows);

- category 2: typical office block (four storey, concrete frame and roof, brick block wall panels);
- category 3: typical domestic dwelling (two storey, brick walls, timber floors); and
- category 4: 'portacabin' type timber construction, single storey.

The CIA relationships imply the overpressure levels corresponding to probabilities of fatality of 1%, 10% and 50% detailed in Table 3-9**.**

Probability of fatality	Overpressure Level, mbar			
	Category 1	Category 2	Category 3	Category 4
1% fatality (dangerous dose)	435	100	50	50
10% fatality	519	183	139	115
50% fatality	590	284	300	242

Table 3-9 Blast Overpressure Consequences Indoors

The UK HSE Contract Research Report 151/1997 (prepared by WS Atkins) contains building vulnerability Pressure-Impulse (PI) diagrams for various different building types. These data are the basis for the CIA overpressure vulnerability relationships detailed in Table 3-9 above.

3.5 Modelling Parameters

3.5.1 Weather Conditions

Weather conditions at the time of a major-accident have a significant impact on the consequences of the event. Typically, high wind speeds slightly increase the impact of fires, particularly pool fires.

Atmospheric Stability Class and Wind Speed

In order to adequately assess the consequences of a major-accident, weather conditions must be selected that represent the weather experienced at the site. The standard atmospheric stability classes are listed in Table 3-10**.**

A-G Stability	Conditions	Typically observed during
A	Very unstable – Sunny with light winds	Day-time
B	Unstable – Less sunny or more windy than A	Day-time
C	Moderately unstable – Very windy/sunny or overcast/light wind	Day-time
D	Neutral – little sun and high wind or overcast/windy night	Day or Night-time
E	Moderately stable – Less overcast and less windy than D	Night-time
F	Stable – Night with moderate clouds and light/moderate winds	Night-time
G	Very Stable – Possibly Fog	Night-time

Table 3-10 Atmospheric Stability Classes

The following Pasquill stability/wind speed pairs are used for consequence modelling:

- average weather conditions are represented by stability category D and a wind speed of 5 m/s, i.e. Category D5;
- worst case conditions for toxic dispersion are represented by stability category F and a wind speed of 2 m/s, i.e. Category F2;

Wind Direction

The nearest weather station to the BOC Gases Ireland and Kayfoam Woolfson sites at which hourly wind speed and direction measurements are taken is at Casement Aerodrome. Figure 3-2 illustrates a wind rose based on hourly wind speed and direction data for Casement Aerodrome (1988 – 2018). Data was obtained from the Met Eireann website. It can be seen that the prevailing wind direction is approximately from the south west (220 °).

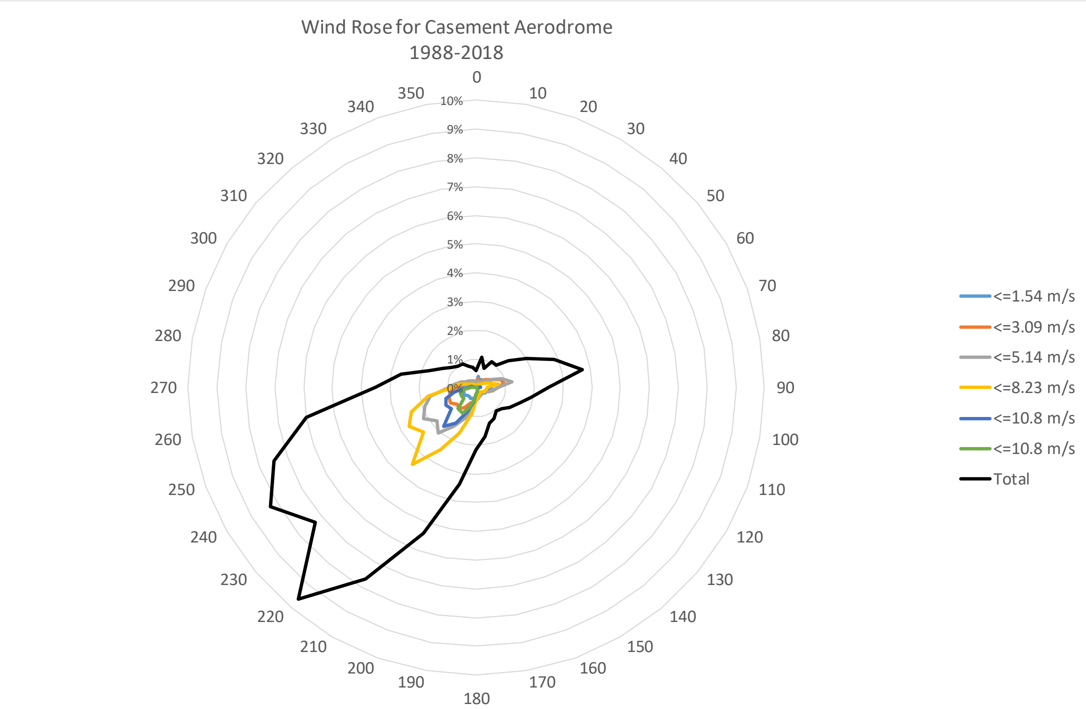

Figure 3-2 Wind Rose Casement Aerodrome Weather Station 1988 - 2018

Ambient Temperature

The ambient and surface temperature conditions significantly impact the results of the consequence modelling. Typically, atmospheric temperatures in the Bluebell area range from -4.7°C to 31°C through the year.

According to the weather data recorded between 1981 and 2010 at Casement Aerodrome, the average atmospheric temperature observed is 9.7°C. Therefore, an ambient temperature of 10°C has been selected to represent typical temperature conditions at the site.

Ambient Humidity

Weather data for Casement Aerodrome, monthly and annual mean and extreme values datasheet supplied by Met Éireann, indicates a mean morning (09:00 UTC) relative humidity of 83.6% and a mean afternoon (15:00 UTC) humidity of 73.8%. For this assessment, a representative ambient humidity of 80% has been assumed.

3.5.2 Surface Roughness

Surface roughness describes the roughness of the surface over which the cloud is dispersing. Typical values for the surface roughness are as follows (DNV PHAST Technical Reference Documentation):

Roughness length	Description
0.0002 m	Open water, at least 5 km
0.005 m	Mud flats, snow, no vegetation
0.03 m	Open flat terrain, grass, few isolated objects
0.1 m	Low crops, occasional large obstacles, x/h > 20
0.25 m	High crops, scattered large objects, 15 < x/h < 20
0.5 m	Parkland, bushes, numerous obstacles, x/h < 15
1.0 m	Regular large obstacles coverage (suburb, forest)
3.0 m	City centre with high and low rise buildings

Table 3-11 Surface Roughness

The BOC and Kayfoam establishments are in an industrial estate in the suburbs of Dublin. A surface roughness length of 1.0 m has been selected for this study.

3.6 Individual Risk Assessment Methodology

TNO Riskcurves Version 10.1.9 modelling software is used in this assessment to calculate individual risk of fatality contours and risk based land use planning zones associated with major accident scenarios.

3.7 Societal Risk Assessment Methodology

Societal Risk Index

The HSA in their COMAH land use planning guidance document (HSA, 2010) recommends that the Societal Risk Index is used as an initial screening tool in relation to societal risk to new developments in the vicinity of existing establishments.

The Societal Risk Index (SRI) is calculated using the following equation:

$$SRI = \frac{P \times R \times T}{A}$$

P population factor, defined as $(n + n^2)/2$
n number of persons at the development
R average estimated level of individual risk in cpm
T proportion of time development is occupied by n persons
A area of the development in hectares

The HSA Policy and Approach Document does not prescribe acceptability criteria for the SRI, however Hirst and Carter (Hirst and Carter, 2000) state that the significant case for societal risk is set at SRI = 2500, based on UK HSE criteria.

4.0 IDENTIFICATION OF MAJOR ACCIDENT HAZARDS

A major accident is defined in the 2015 COMAH Regulations as:

> *"an occurrence such as a major emission, fire, or explosion resulting from uncontrolled developments in the course of the operation of any establishment covered by these Regulations, and leading to serious danger to human health or the environment, immediate or delayed, inside or outside the establishment, and involving one or more dangerous substances"*

4.1 BOC Gases Ireland MAH Scenarios

As described in Section 2.2 above, BOC Gases are engaged in the manufacture of oxygen, nitrogen, argon and hydrogen and the storage of various toxic gases.

The Information for Land-Use Planning provided in Section 4 of the 2018 notification submission for BOC Gases Ireland provides the major accident scenarios arising at the BOC Gases Bluebell site.

Major Accidents with Toxic Dispersion Consequences

LUP 1 of the BOC notification describes the storage of toxic gas drums and cylinders on site including the storage of a 1 tonne chlorine tank.

The risk associated with the storage of the tonne chlorine tanks at the Bluebell site have been chosen as the representative toxic release scenario for the BOC Gases Ireland Bluebell site for the following reasons:

- As illustrated in Figure 2-4, the chlorine tank is closest hazardous installation involving toxic gas to the proposed development;
- The chlorine release consequence modelling results reported in the Consequence Assessment in Section 2 of the BOC Safety Report (obtained by AIE request submitted to the HSA) resulted in the greatest distances to toxic endpoints.

The HSA's LUP Policy and Approach Document (HSA 2010) provides the following representative scenario for a chlorine drum store:

Scenario	Description	Release Rate	Release duration (mins)	Likelihood (cpm)
1	Drum drop (large 13 mm hole in drum)	2.84 kg/s	5	1.2 per drum movement
2	Drum drop (small 7 mm hole in drum)	0.7 kg/s	20	4.8 per drum movement
3	Valve damage (shearing liquid valve	0.45 kg/s	30	22.5 per drum movement

Table 4-1 1 Tonne Chlorine Tank Representative Scenarios (HSA 2010)

Major Accidents with Overpressure Consequences

The Air Separation Unit on site is a process unit in which air is separated into its component gases (Nitrogen and Oxygen) by distillation at low temperatures and comprises distillation columns, heat exchangers and adsorbers. Hydrocarbon build-up within the reboiler unit (e.g. due to dry boiling) can lead to an explosion hazard.

An ASU reboiler explosion has been chosen to represent the worst case major accident scenario with overpressure consequences on site at BOC Gases Ireland Bluebell based on the results reported in the consequence assessment in Section 2 of the BOC Safety Report.

Major Accidents with Thermal Radiation Consequences

Hydrogen is produced on site at the electrolytic Hydrogen Plant and is filled into cylinders in compressed form. The potential for a jet fire from the hydrogen compressor is assessed as part of this LUP study.

4.2 Kayfoam Woolfson MAH Scenarios

As described in Section 2.3 above, Kayfoam Woolfson are involved in the manufacture of polyurethane foams for use in soft furnishings including mattresses and pillows.

Storage of Toxic Liquid in Bulk Tanks

Kayfoam use toluene diisocyanate (TDI) in the manufacture of the polyurethane foams which is classified as an acute toxic category 1 via inhalation.

TDI is stored indoors in 6 no. bulk tanks. The tanks are located within 3 no. internal bunds. The tank and bund dimensions are outlined below:

Bund	Bund dimensions (m)	Bund Volume (m3)	No. of Tanks	Tank 1 dimensions	Tank 2 dimensions	Tank 3 dimensions
A	7.65 x ~6.6 x 1.05	44.5	3	T1 r=1.04; H=3.812	T2 r=1.05; H=3.825	T4 r=1.05; H=3.826
B	2.82 x 6.33 x 1.32	23.9	2	T3 r=1.05; H= 4.445	T65 T1 r=1.05; H=4.443	-
C	3.25 x 2.88 x 1.92	17.9	1	T65 T2 r=0.98; H=4.2	-	-

Table 4-2 Toluene Diisocyanate Tank and Bund Dimensions

The TDI is delivered to the site via a specified route approximately once a week.

The HSA's LUP Policy and Approach Document (HSA 2010) specifies the following scenarios for sites storing toxic liquids in atmospheric bulk tanks:

- Major failure leading to the bund area being covered (frequency 1E-04/year per vessel);
- Catastrophic failure leading to larger spillage (frequency 1E-05 per year per vessel);
- Failure during road tanker on/off loading (frequency 3E-07 per operation).

TDI is stored indoors within 3 no. bunds at the Kayfoam Woolfson site. Information on the ventilation rates within the site building is unavailable therefore the toxic dispersion scenarios will be modelled as outdoor releases. Consequently, the following scenarios are considered to be representative of the major accidents at the Kayfoam site:

- Major leak from bulk storage tank, pool formation within storage tank bund and evaporation and dispersion of TDI from the surface of the liquid pool;
- Catastrophic tank rupture with bund overtopping pool formation within and adjacent to bund and evaporation and dispersion of TDI from the surface of the liquid pool.

Storage of Class III Petroleum Products

Kayfoam store Class III petroleum products (Diesel (Derv) and gas oil) on site for the purpose of fuelling forklift trucks, cars and the back-up power for the sprinkler system.
Diesel and Gas oil are stored at atmospheric temperature and pressure in 3 no. tanks across 2 no. bunds. The tank and bund dimensions are outlined below:

Bund	Bund dimensions (m)	No of tanks in bund	Contents of 1st Tank	Dimensions of 1st Tank	Contents of 2nd Tank	Dimension of 2nd Tank
1	3 x 2.05 x 1.5	2	Gas Oil	2.3 x 1.1 x 1.25	Derv	2.3 x 0.75 x 1.25
2	1 x 1.49	1	Gas Oil	2.5 x 0.75 x 1.4	-	-

Table 4-3 Class III Petroleum Products Tank and Bund Dimensions

The HSA's LUP Policy and Approach Document (HSA 2010) advise the following with respect to Class III petroleum products:

"Provided there are no other flammable substances on site or in the vicinity close enough to initiate a major accident on the site and it is clear that any credible spill will remain on site, the probability of a Class III Fire should not be considered credible."

The storage tanks are located indoors at the Kayfoam site and there are no other flammable substances on site therefore a fire involving the diesel and fuel oil at Kayfoam is not considered in this assessment.

5.0 ASSESSMENT OF BOC GASES IRELAND MAJOR ACCIDENT HAZARDS

5.1 Release and Dispersion of Toxic Chlorine Gas

The following representative release scenarios for the 1 tonne chlorine tank at BOC Gases Ireland were assessed using DNV Phast Version 8.11:

- Drum drop (large 13 mm hole in drum) (Duration 5 minutes)
- Drum drop (small 7 mm hole in drum) (Duration 20minutes)
- Valve damage (shearing liquid valve) (Duration 30 minutes)

Table 5-1 details probit equations that have been published for chlorine.

Substance	Publisher	A	B	n	Unit	Time	Reference
Chlorine	TNO	-4.86	0.5	2.75	ppm	Minutes	Phast Modelling Software
Chlorine	AICHE	-8.29	0.92	2	ppm	Minutes	AICHE Guidelines for CPQRA

Table 5-1 Chlorine Probits

5.1.1 Toxic Dispersion Model Inputs

Model inputs are detailed in Table 5-2 below.

Parameter	Details	Source/Assumption
Scenario	Leak model	Release of Cl_2 from 1 tonne tank
Material	Chlorine	-
Tank Inventory	1 tonne	BOC Gases Ireland
Temperature of substance	Ambient	BOC Gases Ireland
Pressure	5.8 barg	BOC Gases Ireland
Hole diameter	13mm 7mm	HSA Large hole following drum drop. BOC Gases Ireland (diameter of restricted flow orifice)
Release duration	5 min 20 min 30 min	Recommended by HSA
Release Direction	Horizontal	Worst case assumption
Wind speed	2 m/s, 5 m/s	Recommended by HSA as worst case modelling conditions
Pasquill Stability Factor	D, F	
Atmospheric temperature	10 degC	Met Éireann average measured at Casement Aerodrome Synoptic Station (1988 -2018)

Table 5-2 Chlorine Dispersion: Model Inputs

Phast Version 8.11 predicts the following release rates for the 5 min, 20 min and 30 min release durations respectively:

- Drum drop (large 13 mm hole in drum) (Duration 5 minutes) 3.33 kg/s
- Drum drop (small 7 mm hole in drum) (Duration 20minutes) 0.83 kg/s
- Valve damage (shearing liquid valve) (Duration 30 minutes) 0.56 kg/s

5.1.2 Toxic Gas Dispersion Consequence Results

Table 5-3 details the distances to the SLOT DTL and SLOD DTL outdoors, and the distances to toxic doses outdoors corresponding to 1% and 50% probability of fatality outdoors for the TNO Probit equations (at 1.5 m above ground level).

Toxic Dose	n	Toxic Dose	Category D5		Category F2	
			Distance (m)	Width	Distance (m)	Width
		ppm^n.min	Outdoors	m	Outdoors	m
Release through 13 mm hole for 5 minutes						
SLOT DTL	2	1.08E05	175	30	576	91
SLOD DTL	2	4.84E05	106	23	303	74
1% Fatality – TNO Probit	2.75	3.16E06	179	31	539	93
50% Fatality – TNO Probit	2.75	3.32E08	59	15	110	50
Release through 7 mm hole for 20 minutes release						
SLOT DTL	2	1.08E05	170	22	588	75
SLOD DTL	2	4.84E05	105	18	318	63
1% Fatality – TNO Probit	2.75	3.16E06	147	22	539	73
50% Fatality – TNO Probit	2.75	3.32E08	49	11	111	41
Valve shear release for 30 minutes						
SLOT DTL	2	1.08E05	146	20	583	66
SLOD DTL	2	4.84E05	92	16	316	55
1% Fatality – TNO Probit	2.75	3.16E06	148	19	518	66
50% Fatality – TNO Probit	2.75	3.32E08	49	10	109	38

Table 5-3 Chlorine Drum Release Scenarios: Distance to Toxic Endpoints Outdoors

Figure 5-1 and Figure 5-2 illustrate contours corresponding to the SLOT and SLOD DTL outdoors (at effect height 1.5 m) following a chlorine drum drop for weather category F2 and D5 respectively. The shape of the contour is shown for the prevailing wind direction as well as the total effect zone taking account of all possible wind directions.

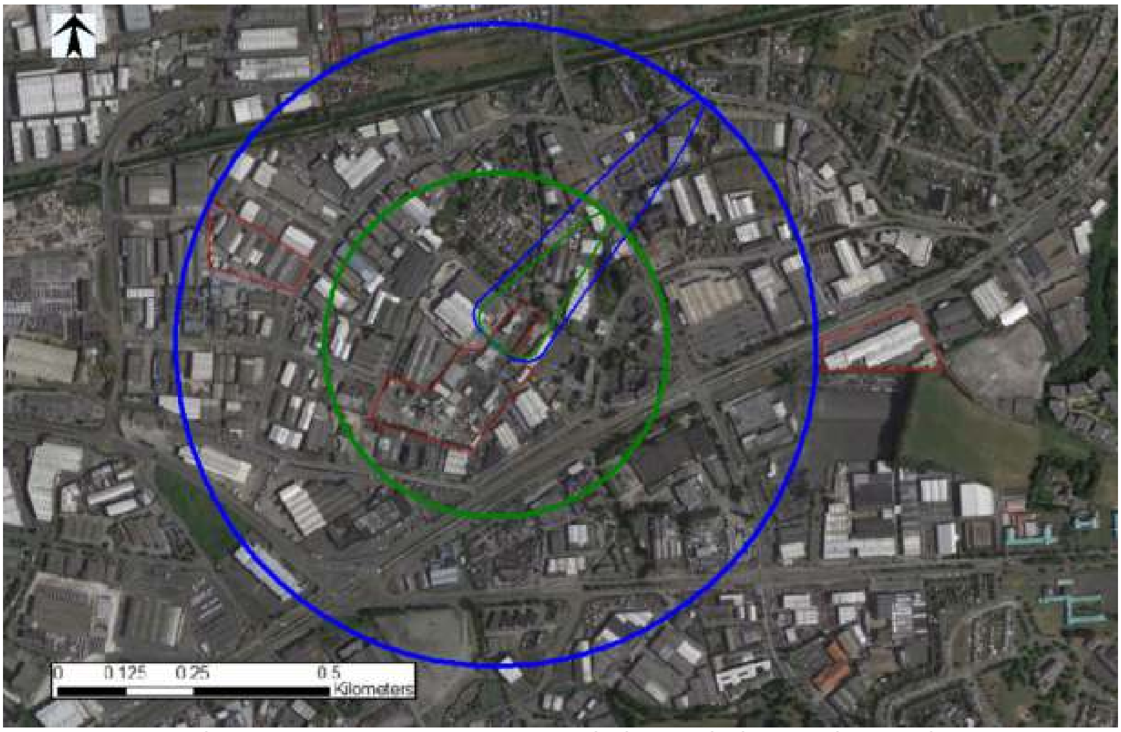

Figure 5-1 Chlorine Drum Drop 20 min release: SLOT and SLOD DTL Outdoor Contours (Category F2)

SLOT DTL Contour	SLOD DTL Contour
SLOT DTL Effect Zone	SLOD DTL Effect Zone

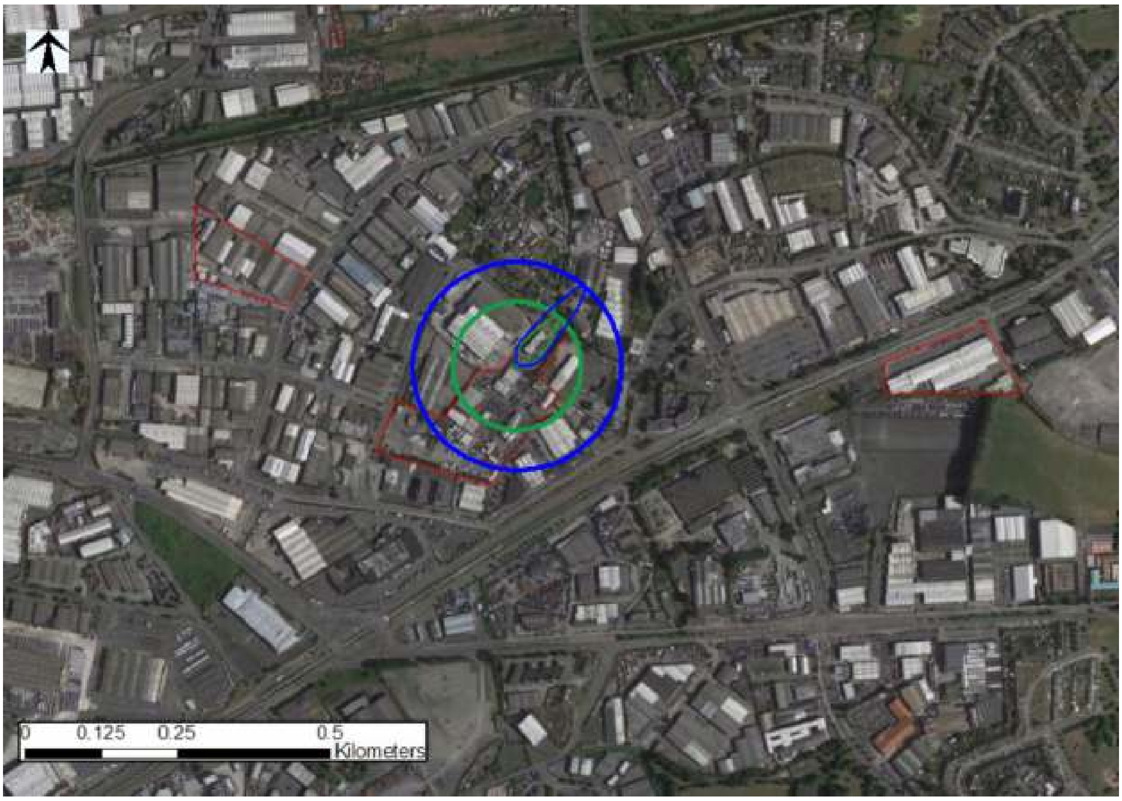

Figure 5-2 Chlorine Drum Drop 5 min release: SLOT and SLOD DTL Outdoor Contours (Category D5)

SLOT DTL Contour	SLOD DTL Contour
SLOT DTL Effect Zone	SLOD DTL Effect Zone

As illustrated, the toxic dose levels corresponding to the SLOT DTL outdoor hazard range from a release from a 1 tonne chlorine drum (weather category F2) do not extend to the proposed development.

As illustrated in Figure 5-2, the toxic dose levels corresponding to the SLOT DTL outdoor contours for weather category D5 (representing daytime weather conditions) does not extend to the proposed development.

The commercial units on the ground and first floors of the proposed development are not expected be occupied outside normal working hours (8am – 8pm). The commercial units on the ground floor and first floor units will have natural ventilation provided via openable windows.

Figure 5-3 and Figure 5-4 below illustrate toxic dose indoors at ground level (effect height 1.5 m) vs distance for the release scenario for Weather Category F2 and D5 respectively.

Figure 5-5 and Figure 5-6 below illustrate probability of fatality indoors at ground level (effect height 1.5 m) vs distance for the release scenario for Weather Category F2 and D5 respectively.

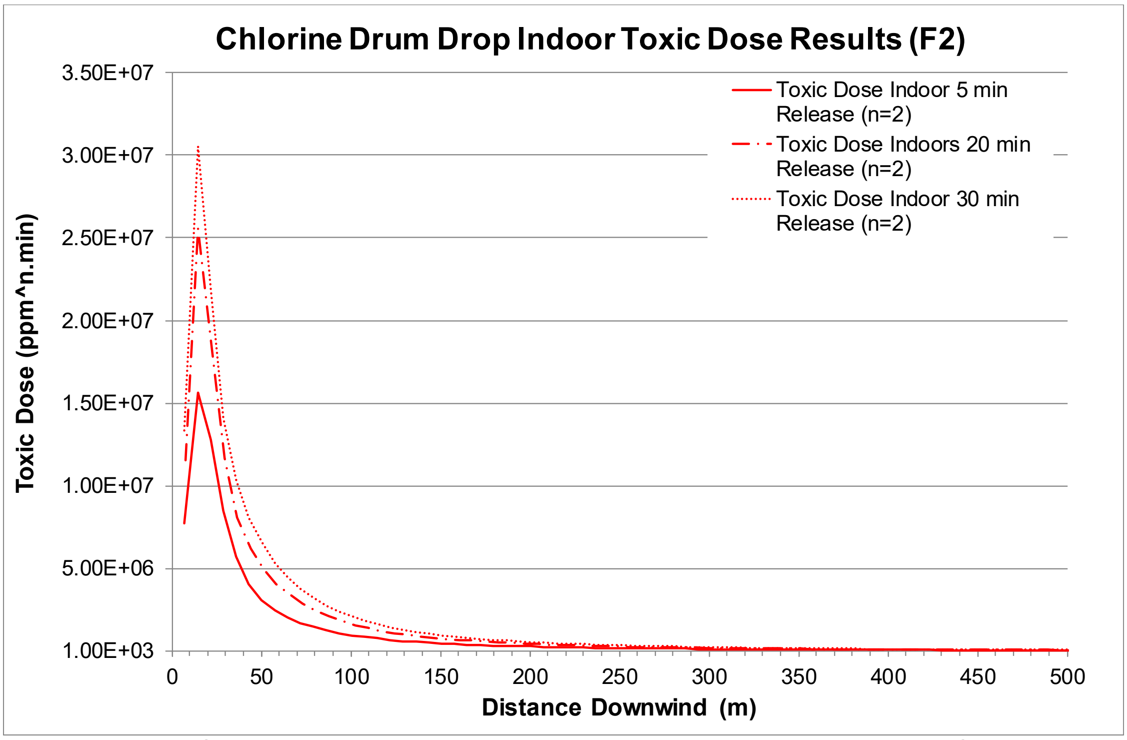

Figure 5-3 Chlorine Drum Toxic Release: Toxic Dose Indoor vs Distance Weather Category F2 (effect height 1.5 m)

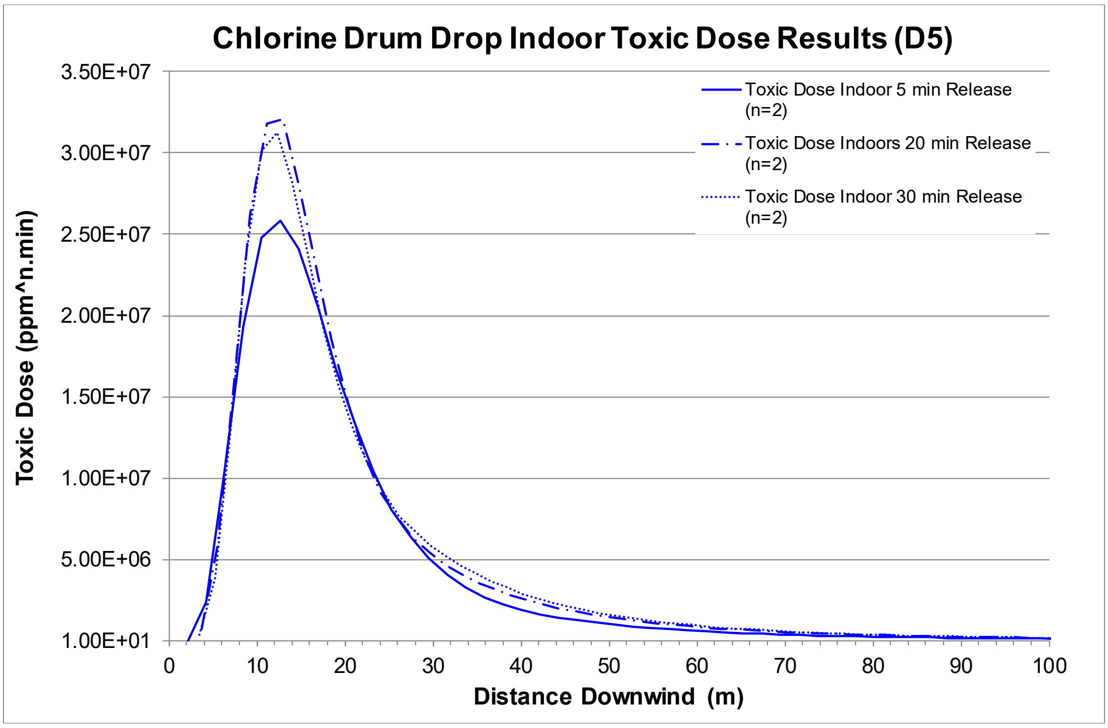

Figure 5-4 Chlorine Drum Toxic Release: Toxic Dose Indoor vs Distance Weather Category D5 (effect height 1.5 m)

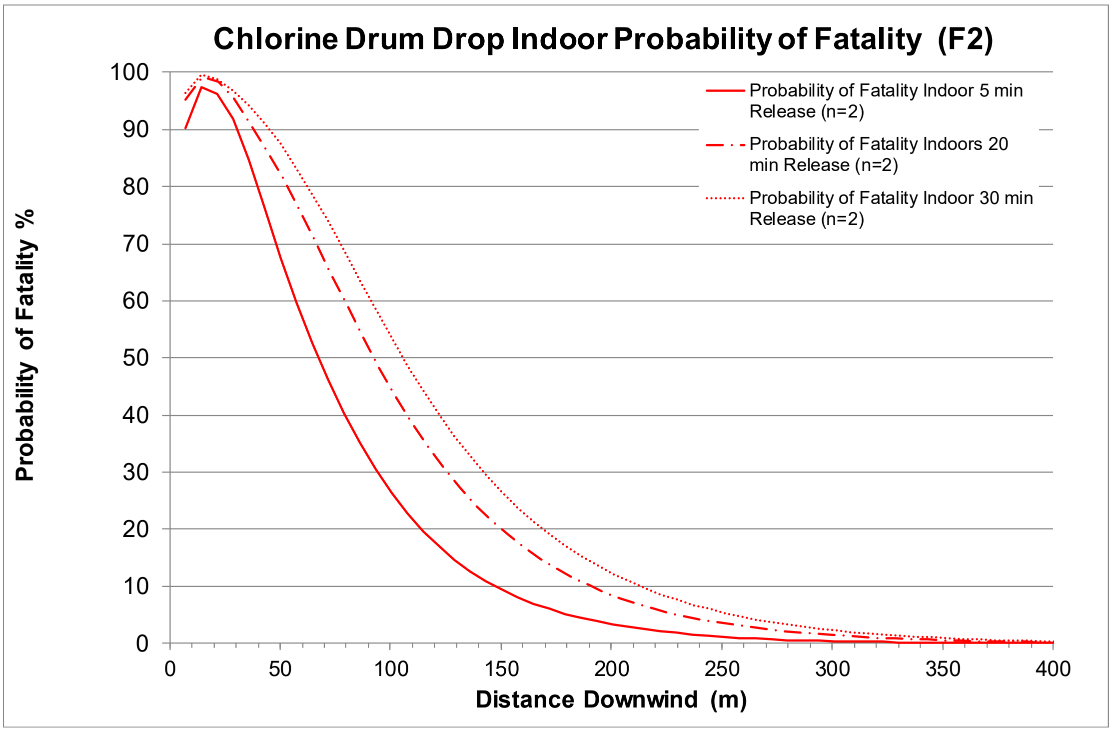

Figure 5-5 Chlorine Drum Toxic Release: Probability of Fatality Indoor vs Distance Weather Category F2 (effect height 1.5 m)

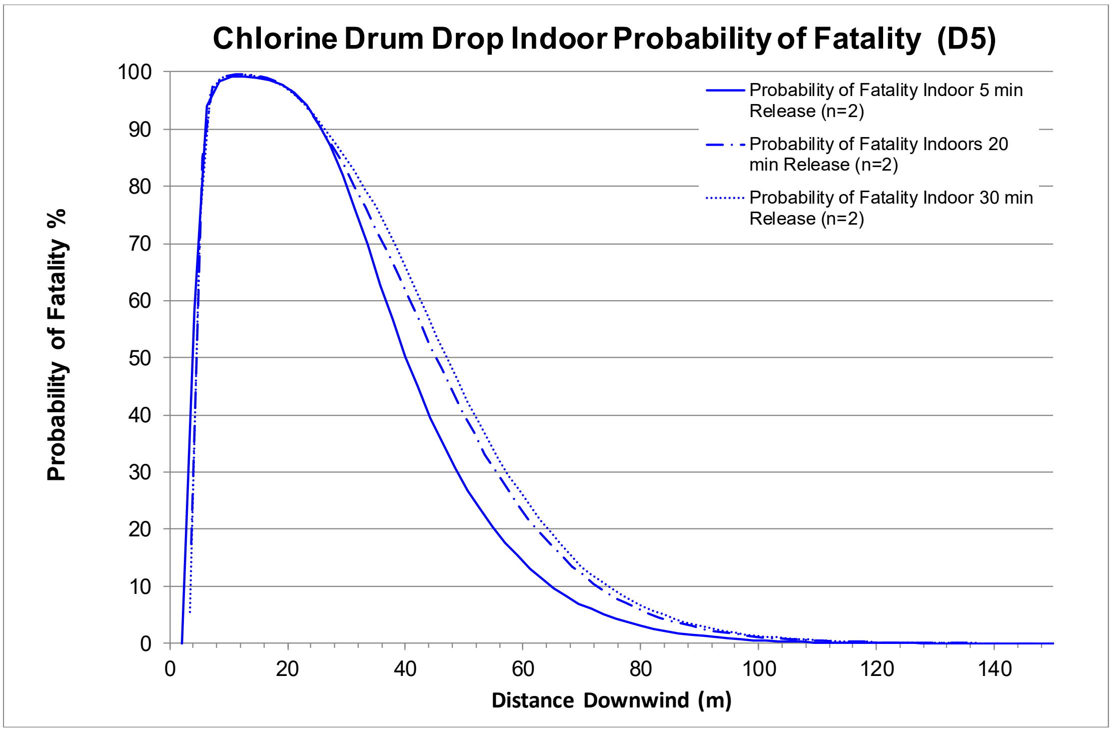

Figure 5-6 Chlorine Drum Toxic Release: Probability of Fatality Indoor vs Distance Weather Category D5 (effect height 1.5 m)

Toxic consequences observed indoors at ground floor (effect height 1.5 m) and first floor levels (effect height 6 m) of the proposed development are summarised in Table 5-4 below:

Building	Air Intake Height	Distance to air intake	Toxic Consequences
Ground Floor Units	40.5 m O.D. 1.5 m above release	Approximately 600 m	< 0.01% lethality Negligible
First Floor Commercial and Residential Units	46.53 m O.D. 6 m above release	Approximately 600 m	< 0.01% lethality Negligible

Table 5-4 Toxic Consequences Indoors at the Proposed Development

In the event of a release of chlorine gas from the 1 tonne drum at BOC Gases Ireland the following is concluded:

- Toxic dose levels corresponding to 1% fatality outdoors for weather category F2 (night time weather conditions) (effect height, 1.5 m) do not extend to the proposed development;
- Toxic dose levels corresponding to 1% fatality outdoors for weather category D5 (representing daytime weather conditions) (effect height, 1.5 m) do not extend to the proposed development;
- Toxic dose levels corresponding to 1% fatality indoors (effect height, 1.5 m) for weather categories F2 and D5 do not extend to the proposed development;
- Persons indoors and outdoors are protected.

5.1.3 Chlorine Release Frequency

The HSA's Land use Planning document (HSA, 2010) recommends the following frequencies for a release of chlorine from a 1 tonne drum:

Drum drop (large 13 mm hole in drum)	1.2 cpm per drum movement
Drum drop (small 7 mm hole in drum)	4.8 cpm per drum movement
Valve damage (shearing liquid valve)	22.5 cpm per drum movement

BOC Gases Ireland store 1 no. 1 tonne chlorine drum on site at a time. It is assumed that one drum of chlorine is sold per week, and that there are 2 no. movements per drum representing loading and unloading of the drum on site.
The frequencies used in the risk analysis are therefore:

Drum drop (large 13 mm hole in drum)	1.25E-04/year
Drum drop (small 7 mm hole in drum)	4.99E-04/year
Valve damage (shearing liquid valve)	2.34E-03/year

5.1.4 Chlorine Drum Individual Risk Contours

Individual risk contours were modelled using TNO Riskcurves Version 10.1.9 modelling software. The inputs to the model include consequence results (in Section 5.1.2), event frequency and wind speed and direction frequency data for Casement Aerodrome weather station (see Section 3.5). The Hurst Nussey Pape probit function is used to determine vulnerability from toxic dispersion results.

Figure 5-7 illustrates the cumulative individual risk of fatality contours for the chlorine release events.

Figure 5-7 Chlorine Drum: Individual Risk of Fatality Contours

5.2 ASU Reboiler

A reboiler explosion scenario involving a mixture of hydrocarbon and oxygen was identified as a potential major accident hazard at the ASU at BOC Gases Ireland.

5.2.1 Reboiler Explosion Model Inputs

Section 4 of the 2016 Notification document for BOC Gases Ireland provides a TNT equivalent mass of 6700 kg for assessing a hydrocarbon/oxygen mixture explosion on site. This value was used in the TNO Effects Version 10.1.9 Explosion Model (TNT Equivalency Model).

5.2.2 Reboiler Explosion Overpressure Consequences

Figure 5-8 illustrates the level of overpressure with distance following an explosion at the ASU reboiler.

Table 5-5 presents distances to overpressure levels associated with specified levels of probability of fatality to persons outdoors and to persons indoors in Category 2 (office type) buildings, Category 3 buildings (residential dwellings) and Category 4 buildings (Portacabins).

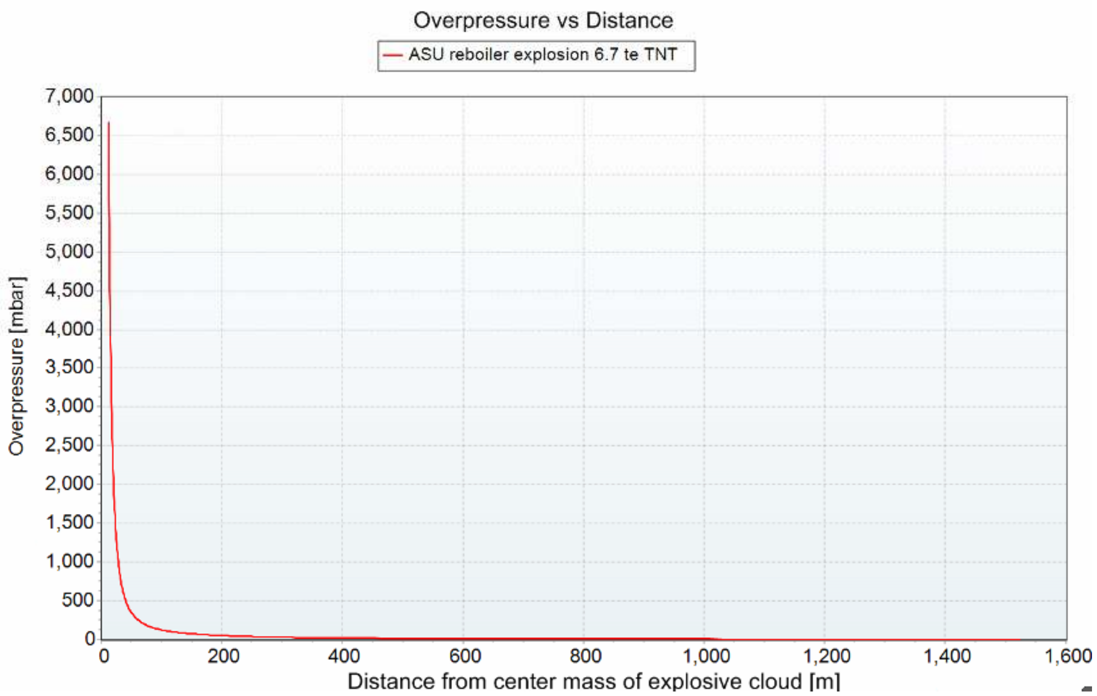

Figure 5-8 Reboiler Explosion: Overpressure vs. Distance

Probability of fatality	Persons outdoors	
	Overpressure level	Distance
	mbar	(m)
1%	168	80
10%	365	48
50%	942	29
Probability of fatality	Persons indoors: Category 2 (typical office block)	
	Overpressure level	Distance
	mbar	(m)
1%	100	118
10%	183	76
50%	284	56
Probability of fatality	Persons indoors: Category 3 (residential dwellings)	
	Overpressure level	Distance
	mbar	(m)
1%	50	205
10%	139	92
50%	300	54
Probability of fatality	Persons indoors: Category 4 (Portacabins)	
	Overpressure level	Distance
	mbar	(m)
1%	50	205
10%	115	106
50%	242	62

Table 5-5 Reboiler Explosion: Calculated Distances at Specified Overpressure Levels

5.2.3 Probability of Fatality from Reboiler Explosion

The probability of fatality outdoors from the overpressure consequences following a reboiler explosion at BOC Gases Ireland is calculated using the Hurst Nussey Pape Probit Equation. The probability of fatality indoors from the overpressure consequences of an explosion was determined using the CIA relationships (CIA, 2010) for different building types. The risk of fatality is the product of the probability of fatality and the likelihood of the event.

The probability of fatality with distance outdoors and indoors for the ASU reboiler explosion scenario is illustrated on Figure 5-9.

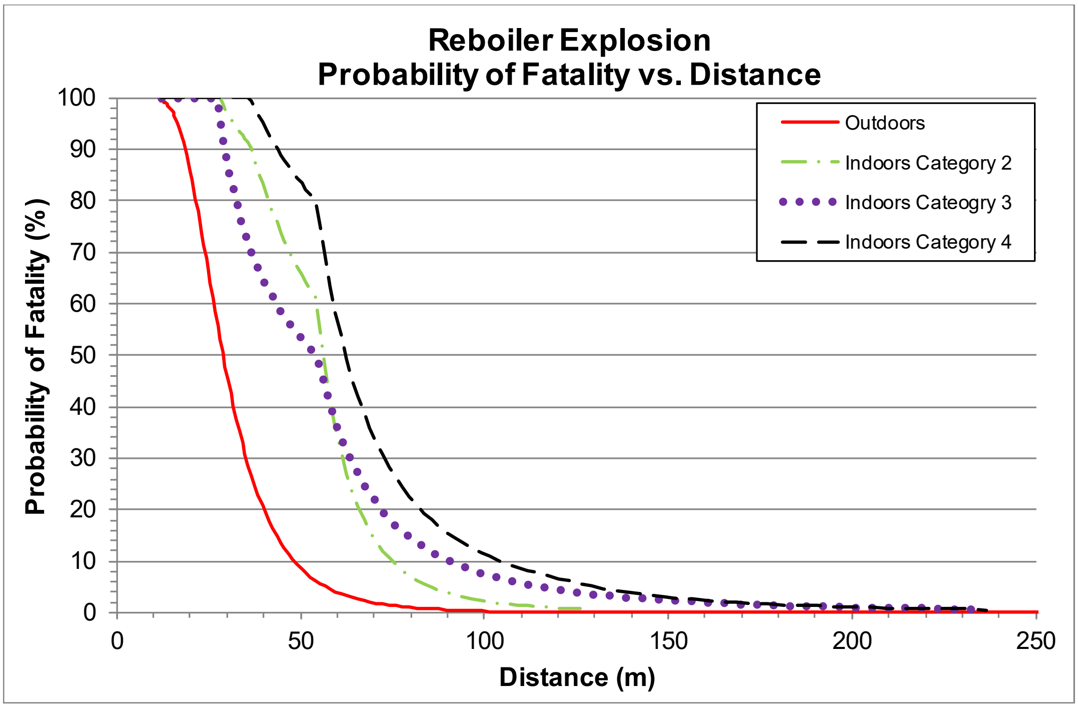

Figure 5-9 Reboiler Explosion: Probability of Fatality vs. Distance

The distance to the overpressure level corresponding to 1% mortality outdoors is 80 m, 1% mortality indoors in Category 2 type structures (representative of office building at ground floor and first floor levels of the proposed development) is 118 m and 1% mortality indoors in residential dwellings is 205 m. These contours are illustrated on Figure 5-10.

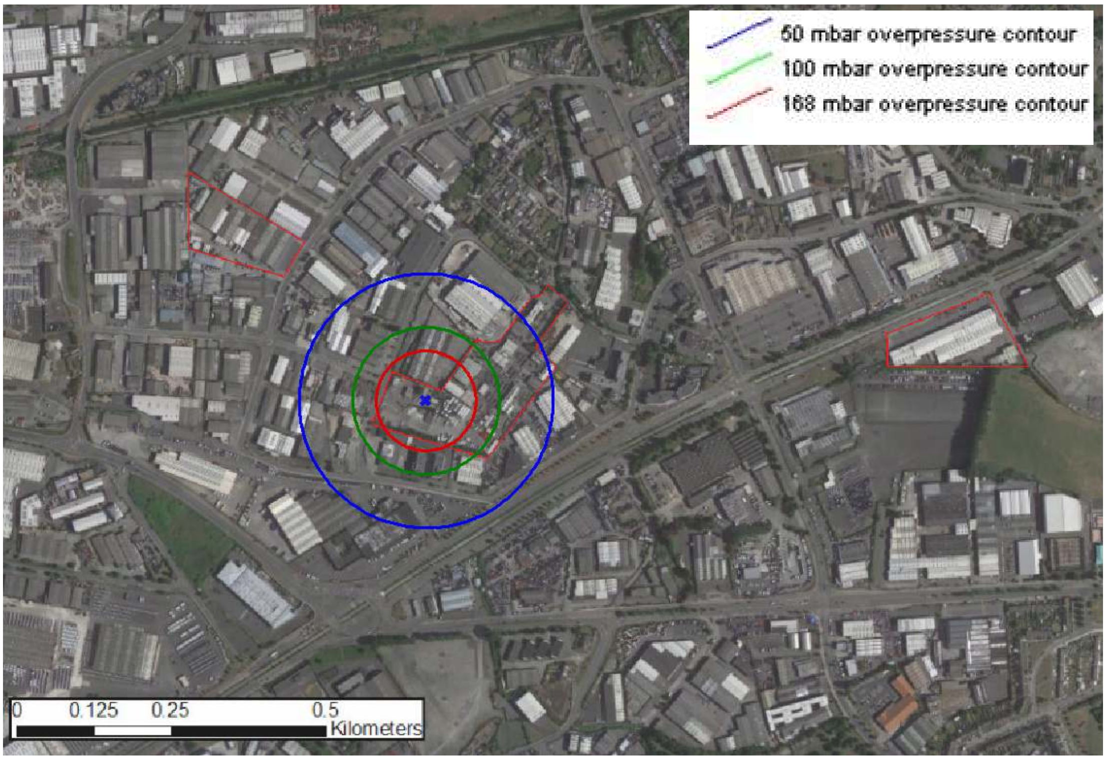

Figure 5-10 Reboiler Explosion: Overpressure Contours

It is concluded that the personnel outdoors and indoors at the proposed development are protected from an explosion involving the reboiler at the BOC Gases ASU.

5.2.4 Reboiler Explosion Frequency

The HSA's LUP Policy and Approach Document (HSA 2010) specifies a conservative frequency of 1E-04/year when assessing an explosion in a process area.

5.2.5 Reboiler Explosion Individual Risk Contours

Figure 5-11 illustrates the cumulative individual risk of fatality contours for the chlorine release events.

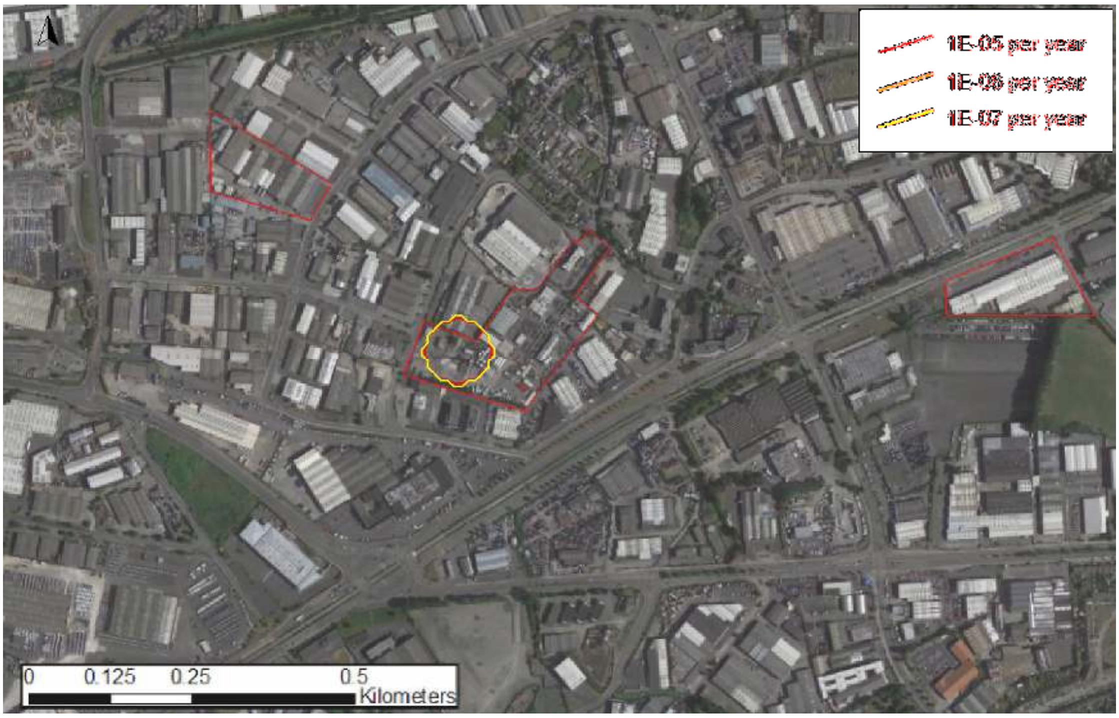

Figure 5-11 Reboiler Explosion: Individual Risk of Fatality Contours

5.3 Hydrogen Jet Fire

As discussed in Section 4.0 above, hydrogen is produced on site at the electrolytic Hydrogen Plant and is filled into cylinders in compressed form. The potential for a jet fire from the hydrogen compressor is assessed herein.

5.3.1 Hydrogen Jet fire Model Inputs

TNO Effects Version 10.9.1 was used to model a leak and jet fire involving the hydrogen compressor. Section 4 of the 2016 Notification document for BOC Gases Ireland provides the following modelling parameters for a loss of containment of hydrogen:

- Volume of material 0.5 m^3
- Vessel Pressure 20101 kPa
- Orifice diameter 0.05 m

Receiver height was specified as 1.5 m. As per HSA policy (HSA, 2010), calculations were undertaken for 5 m/s wind speed and radiation levels are calculated in the downwind direction. Thermal dose and probability of fatality is based on a 75 s exposure duration.

5.3.2 Hydrogen Jet Fire Thermal Radiation Consequences

Table 5-6 presents the jet fire model outputs.

Parameter	Units	Category D5
Flame Emissive Power	kW/m^2	71
Jet Velocity	m/s	2437.9
Frustrum Lift Off Height	m	15
Frustrum Length	m	62
Frustrum Base Width	m	1.1018
Frustrum Tip Width	m	20.02

Table 5-6 Hydrogen Leak and Jet Fire Model Outputs

Thermal radiation vs. distance is illustrated on Figure 5-12 below:

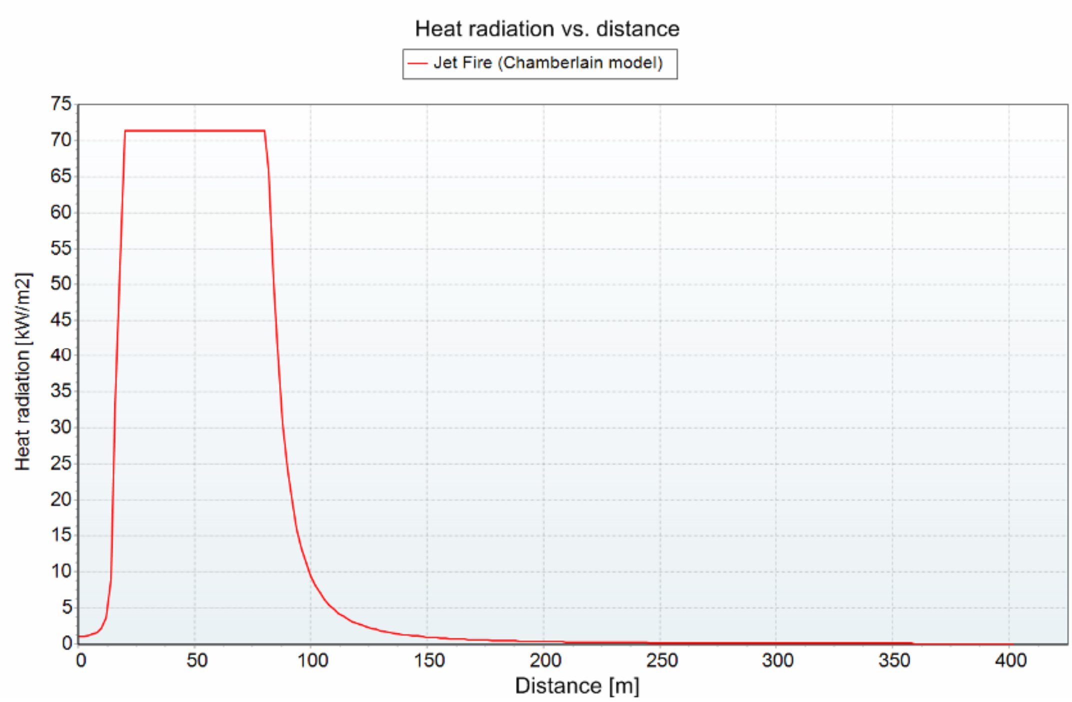

Figure 5-12 Hydrogen Jet Fire: Thermal Radiation vs. Distance

Thermal radiation results are summarised as follows:

Thermal radiation level, kW/m^2	Thermal dose units based on 75 s exposure duration, T $(k/m^2)^{4/3}.s$	Consequences	Distance (m)
4.1	490	Threshold of fatality	113
6.8	960	1% mortality outdoors	104
12.7	2204	Persons indoors protected	96
25.6	5598	100% fatality indoors	90

Table 5-7 Hydrogen Jet Fire: Thermal Radiation Results

The worst case contours are illustrated on the following figures:

- Figure 5-13 threshold of fatality outdoors contour (4.1 kW/m^2)

- Figure 5-14 persons protected indoors contour (12.7 kW/m^2)

The shape of the thermal radiation contour is illustrated for the prevailing wind direction (220 deg) as well as the effect zone which takes account of all possible wind directions.

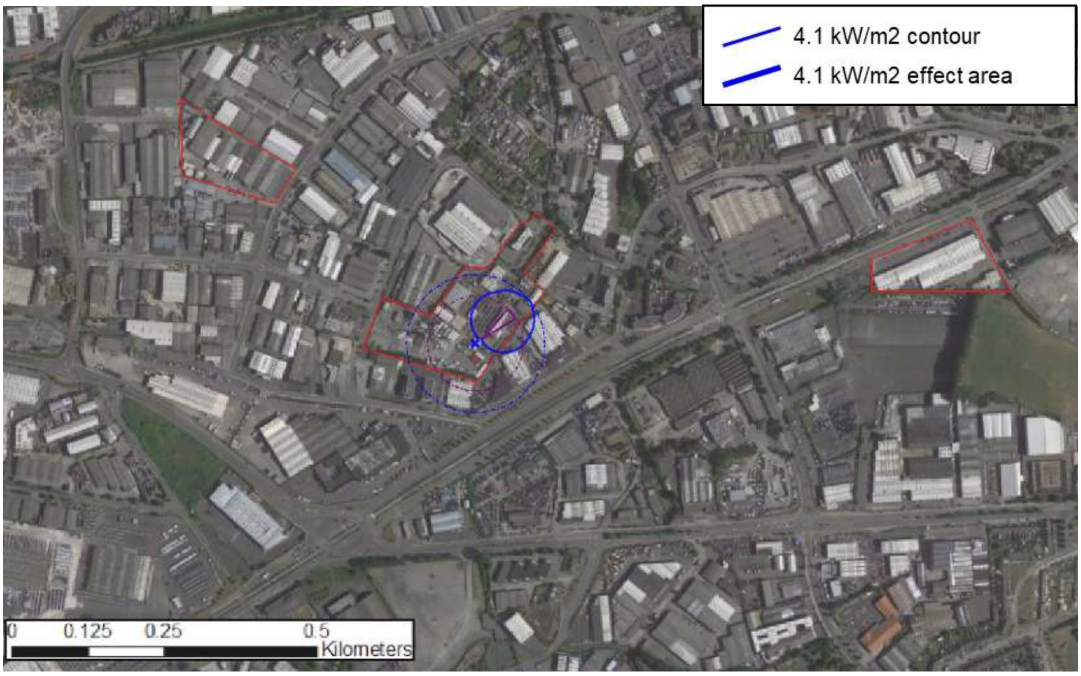

Figure 5-13 Hydrogen Jet Fire: Threshold of Fatality Outdoors Contour

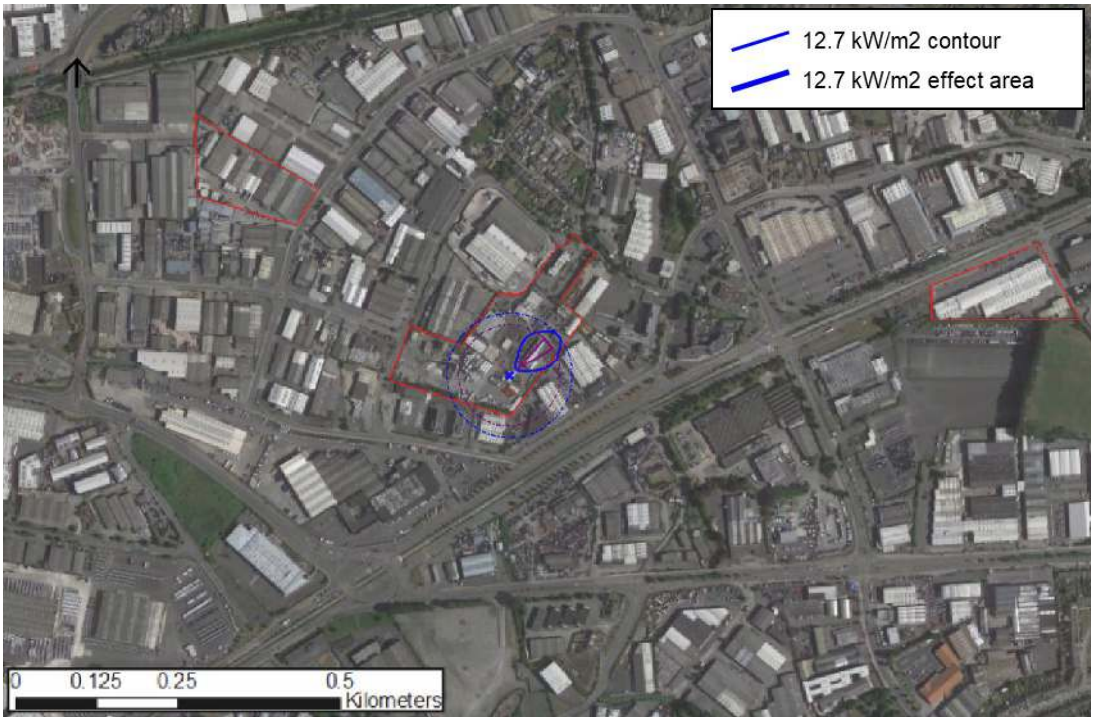

Figure 5-14 Hydrogen Jet Fire: Persons Protected Indoors Contour

The following is concluded:

- The thermal radiation level corresponding to the threshold of fatality does not reach the proposed development, persons outdoors at this location would not be exposed to harmful levels of thermal radiation;
- The thermal radiation level below which persons in indoor locations are protected does not extend to the proposed development, persons indoors at this location are protected from the thermal radiation consequences of an uncontained jet fire at the BOC Gases Hydrogen Plant.

5.3.3 Hydrogen Jet Fire Frequency

The HSA's Land Use Planning document (HSA, 2010) does not recommend a frequency for a gas leak from a pressurised vessel however the UK HSE Planning Case Assessment Guide Chapter 6K specifies a failure rate of 5E-06/year for a release through a 50 mm diameter hole in a pressure vessel.

5.3.4 Hydrogen Jet Fire Individual Risk Contours

Individual risk contours were modelled using TNO Riskcurves Version 10.1 modelling software. The inputs to the model include consequence results (in Section 5.3), event frequency (5E-06 per year) and wind speed and direction frequency data for Casement Aerodrome weather station (see Section 3.5). The Hurst Nussey Pape probit function is used to determine vulnerability from thermal radiation results.

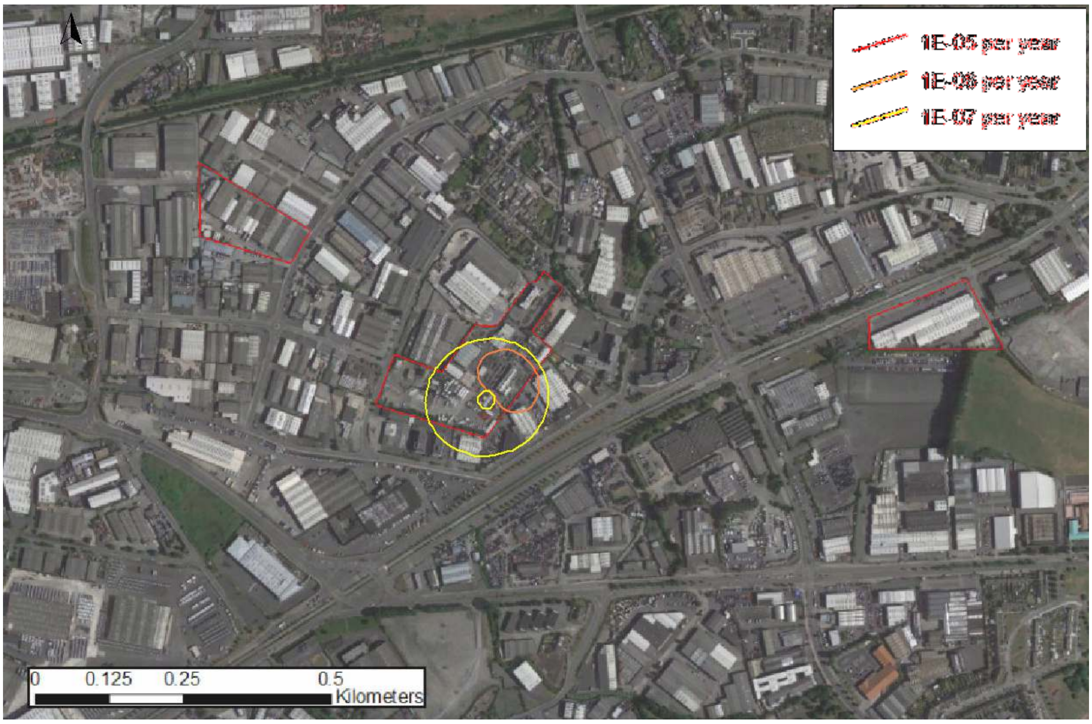

Figure 5-15 Hydrogen Jet Fire: Individual Risk of Fatality Contours

5.4 Cumulative Individual Risk of Fatality from BOC Gases Ireland

Individual risk of fatality contours have been calculated for a representative set of major accident hazard scenarios associated with BOC Gases Ireland. Individual risk of fatality contours (corresponding to the boundaries of the inner, middle and outer risk based land use planning zones) are illustrated on as follows.

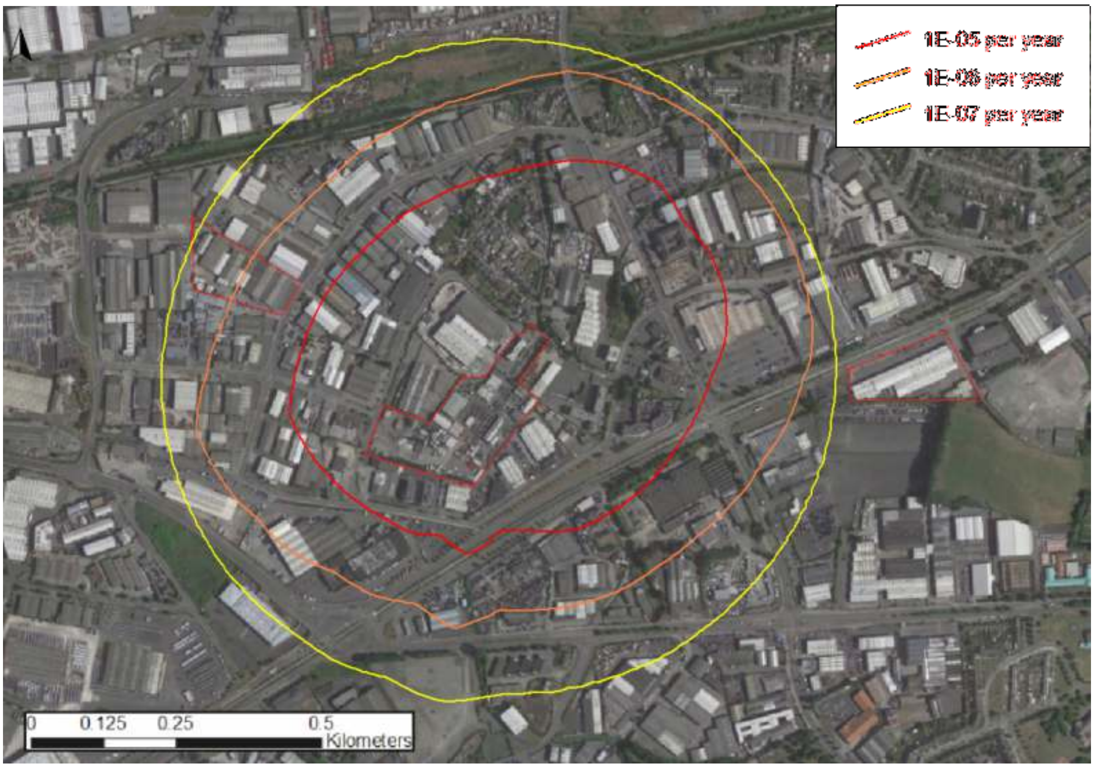

Figure 5-16 Cumulative Risk Arising from BOC Gases Ireland

As illustrated above, the individual risk of fatality contours corresponding to the boundaries of the inner, middle and outer risk based land use planning zones do not extend to the proposed development. The individual level of risk observed at the proposed development is negligible.

6.0 ASSESSMENT OF KAYFOAM WOOLFSON MAJOR ACCIDENT HAZARDS

As outlined in Section 4.2, the following major accidents scenarios were identified for the Kayfoam Woolfson site due to the storage of toluene diisocyanate (TDI) in atmospheric bulk tanks:

- Major leak from bulk storage tank, pool formation within storage tank bund and evaporation and dispersion of TDI from the surface of the liquid pool;
- Catastrophic tank rupture with bund overtopping pool formation within and adjacent to bund and evaporation and dispersion of TDI from the surface of the liquid pool.

Table 6-1 details the proposed probit equation published for TDI.

Substance	Publisher	A	B	n	Unit	Time	Reference
Toluene diisocyanate	RIVM (Netherlands National Institute for Public Health and the Environment)	-7.84	1	2	Mg/m^3	Minutes	https://www.rivm.nl/tolueendiisocyanaat

Table 6-1 Toluene diisocyanate Probit

6.1 Major Leak of TDI from Bulk Storage Tank

6.1.1 Toxic Dispersion Model Inputs

It is assumed that a major leak occurs from the largest TDI storage tank (capacity 15.4 m^3) resulting in the formation of a pool of liquid TDI within the bund, and evaporation and dispersion of TDI vapour from the surface of the liquid pool.

The TNO Effects Version 10.1.9 pool evaporation and dense gas dispersion models were used to model the evaporation and dispersion TDI vapour from the surface of a pool of liquid following this accident scenario. The pool evaporation model inputs are detailed in Table 6-2.

Parameter	Details	Units	Source/Assumption
Material	Toluene Diisocyanate	-	-
Pool size	50.4	m^2	Area of largest bund
Volume of TDI	15.4	m^3	Volume of largest tank

Table 6-2 Toluene Diisocyanate Pool Evaporation and Dispersion: Model Inputs

TNO Effects predicts an evaporation rate from the pool of TDI of 1.24E-05 kg/s and a density of 1.225 kg/m^3 after mixing with air. TNO Effects recommends the use of the neutral gas dispersion model where the density of the material is not more than 10% heavier than air (1.24 kg/m^3).

6.1.2 Toxic Gas Dispersion Results

The neutral gas dispersion model in TNO Effects Version 10.1.9 modelling software was used to model the dispersion of TDI vapour as it evaporates from the surface of the spilled liquid.

Figure 6-1 illustrates the toxic dose vs. distance downwind for weather categories D5 and F2 (Probit n=1 and n=2).

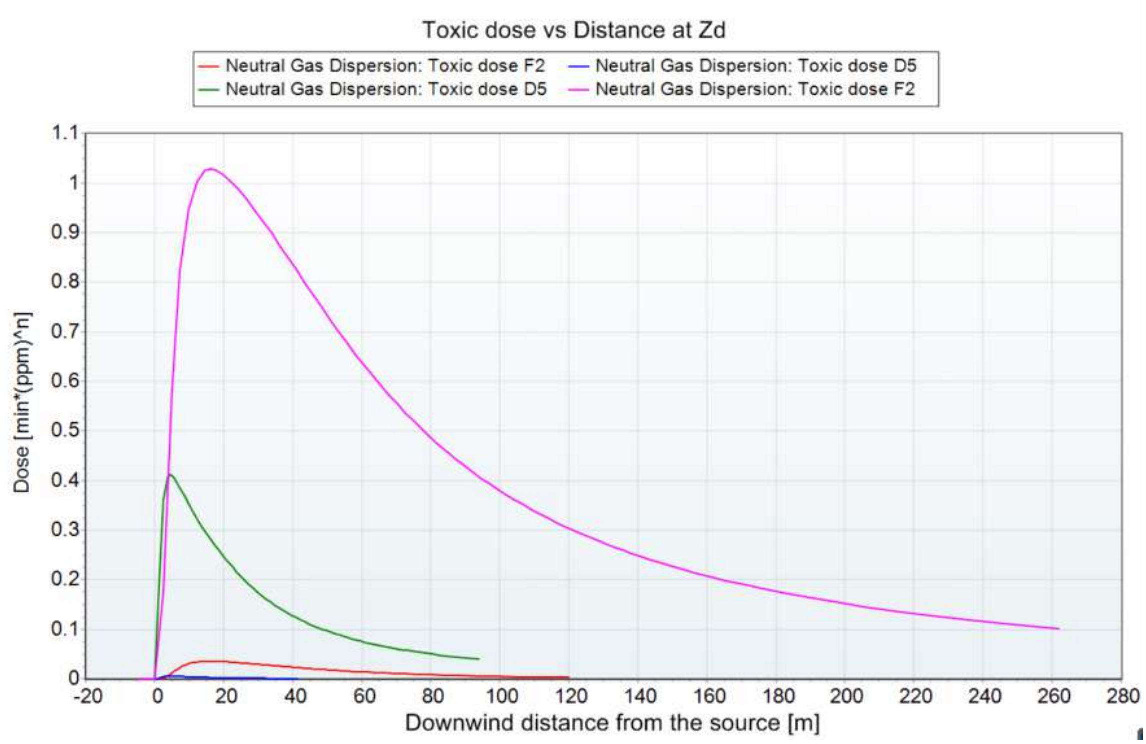

Figure 6-1 TDI Tank Leak: Toxic Dose vs. Distance Downwind

Table 6-3 details the distances to the SLOT DTL and SLOD DTL outdoors, and the distances to toxic doses outdoors corresponding to 1% and 50% probability of fatality outdoors (at 1.5 m AGL).

Toxic Dose	n	Toxic Dose	Category D5		Category F2	
		ppm^n.min	Distance (m)	Contour Dimensions	Distance (m)	Contour Dimensions
SLOT DTL	1	176	Not reached	-	Not reached	-
SLOD DTL	1	480	Not reached	-	Not reached	-
1% Fatality – RIVM Probit	2	2.12E+04	Not reached	-	Not reached	-
50% Fatality – RIVM Probit	2	2.18E+05	Not reached	-	Not reached	-

Table 6-3 TDI Tank Leak: Distances to Toxic Dose Endpoints Outdoors

It can be seen from the toxic dose results presented above that in the event of an accidental release of TDI into the bund outdoor toxic consequences (at the effect height considered, 1.5 m) are less than those associated with SLOT effects and 1% probability of fatality. Fatalities outdoors are not expected to arise at the proposed development as a result of this scenario.

6.1.3 Frequency of TDI Tank Spill

The risk of fatality arising from a major accident scenario is the product of the probability of event and probability of fatality.

The HSA Land Use Planning Guidance (HSA, 2010) recommends a frequency value of 1 x 10^{-4} per year per vessel for a major spill from a bulk storage tank leading to a bund area being covered. There are 6 No. TDI indoor tanks at the Kayfoam Woolfson site therefore a frequency value of 6 x 10^{-4} /year is used.

6.2 Catastrophic Tank Rupture

It is assumed that the largest TDI storage tank ruptures catastrophically resulting in 50% of the contents overtopping the bund. The consequences and level of individual risk of fatality from the evaporation and dispersion of TDI vapour from the surface of a liquid pool are investigated herein.

6.2.1 Model Inputs

The TNO Effects Version 10.1.9 pool evaporation and neutral gas dispersion models were used to model the evaporation and dispersion TDI vapour from the surface of a pool of liquid following this accident scenario.

It is assumed that 50% of the released liquid will overtop the bund (based on HSA COMAH LUP Guidance, 2010). The worst case event is taken to be a circular pool located adjacent to the storage bund (i.e. due to bund overtopping or bund failure).

The radius (R) of the pool is taken to be given by:

$R = 6.85\ V^{0.44537}$

with R in metres and V (volume of liquid in pool) in cubic metres, subject to a maximum diameter of 100 m (which occurs when V = 87 m^3), which should not normally be exceeded (unless there are special circumstances).

The discharge model inputs are detailed in Table 6-4.

Parameter	Details	Units	Source/Assumption
Material	TDI	-	-
Volume	15.4	m^3	Volume of largest TDI Tank
Pool size	959	m^2	Size of bund plus area occupied by overtopped fraction of released material (908 m^2)

Table 6-4 TDI Tank Catastrophic Rupture: Model Inputs

6.2.2 Toxic Gas Dispersion Consequences

Figure 6-2 illustrates the toxic dose vs. distance downwind for weather categories D5 and F2 (Probit n=1 and n=2).

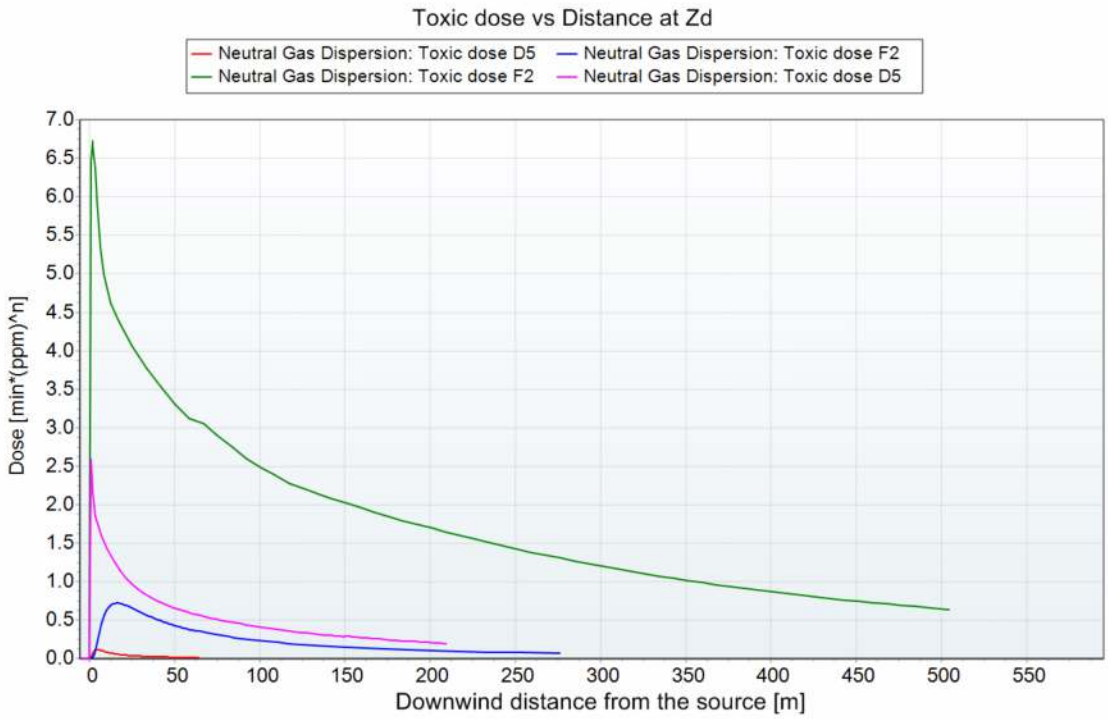

Figure 6-2 TDI Tank Catastrophic Rupture: Toxic Dose vs. Distance Downwind

Table 6-5 details the distances to the SLOT DTL and SLOD DTL outdoors, and the distances to toxic doses outdoors corresponding to 1% and 50% probability of fatality outdoors (at 1.5 m AGL) following a catastrophic rupture of the largest TDI tank.

Toxic Dose	n	Toxic Dose	Category D5		Category F2	
		ppm^n.min	Distance (m)	Contour Dimensions	Distance (m)	Contour Dimensions
SLOT DTL	1	176	Not reached	-	Not reached	-
SLOD DTL	1	480	Not reached	-	Not reached	-
1% Fatality – RIVM Probit	2	2.12E+04	Not reached	-	Not reached	-
50% Fatality – RIVM Probit	2	2.18E+05	Not reached	-	Not reached	-

Table 6-5 TDI Tank Catastrophic Rupture: Distances to Toxic Dose Endpoints Outdoors

It can be seen from the toxic dose results presented above that in the event of a catastrophic rupture of the largest TDI tank outdoor toxic consequences (at the effect height considered, 1.5 m) are less than those associated with SLOT effects and 1% probability of fatality. Fatalities outdoors are not expected to arise at the proposed development as a result of this scenario.

6.2.3 Frequency of TDI Tank Rupture

The risk of fatality arising from a major accident scenario is the product of the probability of event and probability of fatality.

The HSA Land Use Planning Guidance (HSA, 2010) recommends a frequency value of 1 x 10^{-5} per year per vessel for catastrophic failure from a bulk storage tank leading to a larger spill. There are 6 No. TDI indoor tanks at the Kayfoam Woolfson site therefore a frequency value of 6 x 10^{-5} /year is used.

7.0 LAND USE PLANNING RISK CONTOURS

The cumulative individual risk contours for the BOC Gases Ireland Ltd. and Kayfoam Woolfson sites were modelled using Riskcurves Version 10.1.9 and are illustrated on Figure 7-1.

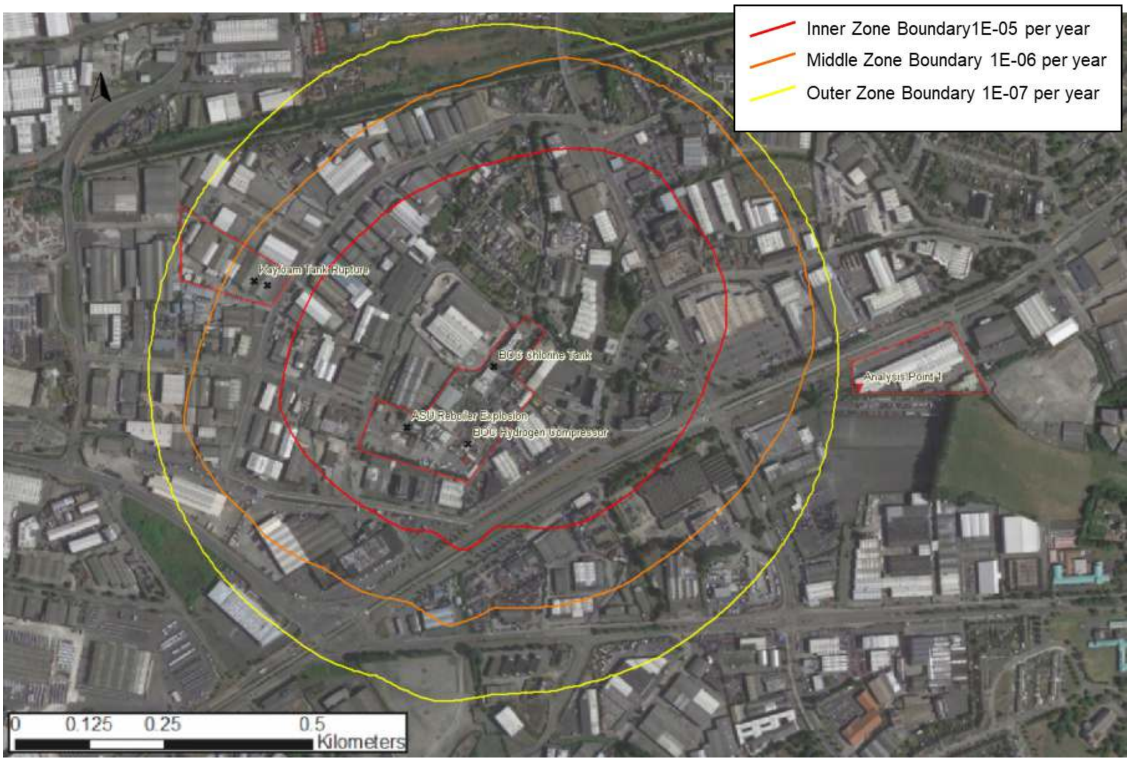

Figure 7-1 Individual Risk of Fatality Contours for BOC Gases Ireland and Kayfoam Woolfson

It is noted that the 1 tonne chlorine tank release scenario provides the biggest contribution to the outer LUP zone.

In the event of a release of chlorine gas from the 1 tonne drum at BOC Gases Ireland the following is concluded as discussed in Section 5.1.2 above:

- Toxic dose levels corresponding to 1% fatality outdoors for weather category F2 (night time weather conditions) (effect height, 1.5 m) do not extend to the proposed development;
- Toxic dose levels corresponding to 1% fatality outdoors for weather category D5 (representing daytime weather conditions) (effect height, 1.5 m) do not extend to the proposed development;
- Toxic dose levels corresponding to 1% fatality indoors (effect height, 1.5 m) for weather categories F2 and D5 do not extend to the proposed development;
- Persons indoors and outdoors during the daytime hours are protected (represented by weather category D5).

It is concluded that the outer land use planning zone does not extend to the proposed development. Therefore, on the basis of individual risk, the BOC Gases Ireland Ltd and Kayfoam Woolfson Ltd. sites do not pose a constraint to the development of the former Concorde site.

8.0 CONCLUSION

A land use planning assessment was completed addressing potential constraints posed by the BOC Gases Ireland Upper Tier COMAH establishment and the Kayfoam Woolfson Lower Tier COMAH establishment to the development of the former Concorde Industrial Estate site on the Naas Road, Dublin 12.

The assessment was completed in accordance with the Policy and Approach of the Health and Safety Authority to COMAH Risk-based Land-use Planning (HSA, 2010).

Assessment of BOC Gases Ireland Major Accident Hazards

BOC Gases Ireland is engaged in the manufacturing of oxygen, nitrogen, argon and hydrogen and the storage of various other gases including toxic gases. The following major accident scenarios were assessed for land use planning purposes:

- Release and dispersion of toxic chlorine gas from 1 tonne tank
- Reboiler explosion with overpressure consequences
- Hydrogen Compressor Jet fire

The assessment results are summarised as follows:

Scenario	Consequences	Frequency	Comments
Chlorine tank release	576 m to SLOT DTL following drum drop and release duration of 5 mins (Weather Category F2) 175 m to SLOT DTL following drum drop and release duration of 5 mins (Weather Category D5)	1.25E-04 /year	• The proposed development is located approximately 603 m from the location of the chlorine tank at BOC Gases Ireland; • Distance to toxic dose levels corresponding to SLOT DTL and 1% fatality outdoors for weather category F2 and D5 (effect height, 1.5 m) do not extend to the proposed development; • Toxic dose levels corresponding to SLOT DTL and 1% fatality outdoors for weather category D5 (effect height, 1.5 m) do not extend to the proposed development; • Toxic dose levels corresponding to SLOT DTL and 1% fatality indoors for weather categories F2 and D5 (effect height, 1.5 m) do not extend to the proposed development; • Individual risk of fatality contours do not extend to the proposed development.
	588 m to SLOT DTL following drum drop and release duration of 20 mins (Weather Category F2) 170 m to SLOT DTL following drum drop and release duration of 20 mins (Weather Category D5)	4.99E-04 /year	
	583 m to SLOT DTL following valve shear and release duration of 30 mins (Weather Category F2) 146 m to SLOT DTL following valve shear and release duration of 30 mins (Weather Category D5)	2.34E-03 /year	
ASU Reboiler Explosion	80 m to 1% mortality outdoors overpressure level 118 m to 1% mortality indoors in Category 2 structures (typical 4 storey office building) 205 m to 1% mortality indoors in Category 3 structure (residential building)	1E-04 /year	Personnel outdoors and indoors at the proposed development are protected from an explosion involving the reboiler at the BOC Gases ASU Individual risk of fatality contours (as above) do not extend to the proposed development

Hydrogen Jet fire	113 m to threshold of fatality thermal radiation level 104 m to 1% mortality outdoors thermal radiation level 96 m to thermal radiation level below which persons indoors are protected	5E-06 /year	Negligible consequences outdoors at proposed development Persons indoors are protected at proposed development Individual risk of fatality contours (as above) do not extend to the proposed development

Assessment of Kayfoam Woolfson Major Accident Hazards

Kayfoam Woolfson are involved in the manufacture of polyurethane foams for use in soft furnishings including mattresses and pillows.

Kayfoam use toluene diisocyanate (TDI) in the manufacture of the polyurethane foams which is classified as an acute toxic category 1 via inhalation. TDI has a very low vapour pressure (0.1 mmHg at 25 degC). When mixed with air the density was calculated to be 1.2253 kg/m^3. TNO Effects recommends the use of the neutral gas dispersion model where the density of the material is not more than 10% heavier than air (1.24 kg/m^3) therefore the neutral gas dispersion model in TNO Effects was used.

The following major accident scenarios were assessed for land use planning purposes:

- Major leak from bulk storage tank, pool formation within storage tank bund and evaporation and dispersion of TDI from the surface of the liquid pool;
- Catastrophic tank rupture with bund overtopping pool formation within and adjacent to bund and evaporation and dispersion of TDI from the surface of the liquid pool.

The following was concluded:

- In the event of an accidental release of TDI into the largest bund, toxic dose outdoor corresponding to SLOT DTL effects and 1% probability of fatality (at the effect height considered, 1.5 m) are not reached. Fatalities outdoors are not expected to arise at the proposed development as a result of this scenario;
- In the event of a catastrophic rupture of the largest TDI tank, toxic dose outdoor corresponding to SLOT DTL effects and 1% probability of fatality (at the effect height considered, 1.5 m) are not reached. Fatalities outdoors are not expected to arise at the proposed development as a result of this scenario.

Cumulative Risk

The cumulative individual risk contours for the BOC Gases Ireland and Kayfoam Woolfson sites corresponding to the boundary of the inner, middle and outer land use planning zones are illustrated as follows.

It is noted that the 1 tonne chlorine tank release scenario provides the biggest contribution to the outer LUP zone. As outlined above, toxic dose levels corresponding to SLOT DTL and 1 % probability of fatality outdoor and indoor (weather category F2 and D5) do not extend to the proposed development.

It is concluded that the outer land use planning zone does not extend to the proposed development. Therefore, on the basis of individual risk, the BOC Gases Ireland Ltd and Kayfoam Woolfson Ltd. sites do not pose a constraint to the development of the former Concorde site.

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