The comparison results show that the model is broadly in line with past data and correlations used for assigning ignition probabilities. As expected, low volatility liquid pools ('all liquid pool' data) are estimated to have a much lower likelihood of ignition than a liquid release that can generate a mist/aerosol. The levelling of the curves at high flow rates are due to the areas becoming quickly saturated with gas/vapour. In some cases, the ignition probability is estimated to fall slightly at high release rates because the plant area reaches UFL more rapidly and the inventory become exhausted more rapidly.

The ignition probabilities associated with high gas release rates in the tests are lower than those commonly used. This is probably because the estimates used to date in QRA for large releases are based on the ignition of major blowouts from past experience largely in the 1970s and 1980s. In fact, more recent blowout incident analyses suggest a lower probability of ignition ~0,1 (See C.1.7) is appropriate even for large blowouts. Large releases from a processing area (as modelled in the tests) may also be less prone to ignition than blowouts, due to the fewer ignition sources and lower inventories involved.

During the project, the model and its basis were subjected to a comprehensive peer review and application case studies amongst specialists from operating companies and relevant consulting organisations. This was to evaluate the technical validity of the model and to assess its practicability, robustness and suitability for use in QRA.

A.4 MODEL CONCLUSIONS AND RECOMMENDATIONS

A model has been developed that uses generic ignition source densities and dispersion models to provide an estimate of the probability of ignition for hydrocarbon momentum driven releases. Dispersion modelling in the immediate plant area utilises correlations from the Gas build-up Workbook from high pressure natural gas releases in naturally ventilated offshore modules [in: 7th Annual Conference on Offshore Installations: Fire and Explosion Engineering, or equates the release to a liquid or gas momentum jet.] Dispersion beyond the immediate plan area can be modelled as a passive gas cloud or a momentum jet depending on the confinement or congestion in these areas. The model also provides the facility to feed in the results from detailed dispersion modelling into the model as flammable cloud areas/ volumes and pool areas for each Area. This overrides the internal dispersion models and provides a means to investigate scenarios which are outwith the model's internal dispersion capability.

The model has been subjected to an internal technical evaluation review and limited benchmarking to test its practicality and robustness. The model and its basis have also been subjected to a comprehensive peer review and case studies amongst specialist operating company members and relevant consulting organisations. This is to evaluate the technical validity of the model and to assess its practicability, robustness and suitability for use in QRA.

In terms of future development, it is also strongly recommended that the key cell formulae in the spreadsheet model are coded up (as Visual Basic functions) to improve the clarity and ease of checking and change control of the spreadsheet. It may also be worth considering coding up the full model as a function or visual basic class object if it is to be taken forward for use in QRA. This would allow the model to be used and run more easily and would also allow improved quality and version control, and make future refinements and improvement easier to implement and manage.

It was agreed that once the ignition model had been completed and validated, it should be run to assess the ignition probability of a number of typical release scenarios and plant configurations. The results from these runs would form the basis of look-up correlations, which could then be used as a means to select appropriate ignition probabilities for use in QRA or for checking and review activities. This would provide a simple and practical means to assign ignition probabilities in most situations, avoid the need to run the model many times as part of every QRA, and allow the model to be used in situations where the QRA host programme or method is not compatible with the spreadsheet version of the ignition model.

A.5 ISSUES FOR FUTURE WORK

The following issues were identified as areas where further work may be required to improve the understanding of ignition and associated factors:

1. The issue of ignition timing and the potential for vapour ignition to result initially in a jet fire, flash fire or explosion. Could a correlation be developed to help indicate when each of these outcomes is the more likely, based on factors such as the release type, timing of ignition, dispersion factors, type of ignition etc.?
2. Potential for aerosol/mist generation from liquid releases. A better understanding of this is required to allow more appropriate correlations to be developed to support QRA generally as well as ignition modelling. This should include related aspects of the flash fraction of multi-component streams and flash fractions from superheated fluids. The current model uses a correlation which may be conservative in terms of the fraction of material that becomes entrained in the air as vapour or mist.
3. Further data collection and analysis are needed to better validate the ignition source densities and characteristics used by the model and to identify densities and characteristics for other situations relevant to offshore and onshore QRA.
4. Conduct further research into methods to allow the model to better represent open plant configurations such as those on the upper decks of offshore installations and onshore plant such as tank farms, pipelines, valve stations etc. The current model is largely based on the JIP Gas Build-up methodology, which is suited to congested and confined situations such as largely enclosed offshore modules and onshore plant between floor levels or with some walls/weather shielding/building confinement or self-shielding. The assessment of open situations with the JIP Gas Build-up methodology model is sensitive to the height of the unit selected, since this defines the area, dilution and mass flux of the resulting vapour cloud and its dispersion. A simple momentum jet approach is an alternative included within the current model, but this ignores any effect of congestion within the plant area.

ANNEX B
MODELLING BASIS OF LOOK-UP CORRELATIONS

B.1 INTRODUCTION

Simple look-up correlations have been developed for assigning ignition probabilities in QRA. The objective was to use the detailed ignition probability model to generate results for a number of selected representative scenarios, and to turn these results into simple correlations that analysts could use, avoiding the need to run the detailed model for the majority of QRA applications, and also providing greater consistency. Initial work with the ignition probability model during its development showed that, for a given plant configuration and release substance, the ignition probability could be estimated from a simple correlation based on the mass release rate. This has formed the basis of the look-up correlations.

The representative scenarios and their configuration characteristics were selected and developed from a mix of experience and actual plant data. These have been chosen to represent the majority of typical release types addressed in onshore and offshore major hazard QRA.

Modelling was then undertaken for all the selected scenarios. The results of this modelling are presented here, together with full details of the basis of the scenarios modelled.

The results have then been used to develop a number of 'look-up' correlations for the range of representative onshore and offshore QRA release scenarios.

The best-fit/look-up correlations have been made available both in graphical form and as a simple MS Excel ® spreadsheet cell formula based on the release mass flow rate. Details of the correlations are provided in this publication, should readers wish to develop their own codes or spreadsheet functions for use in QRA.

The scenario modelling has also included selected sensitivity analysis to test the robustness of the ignition probability results. This has shown that the model results for the scenarios modelled are reasonably robust, with no cliff edge effects.

B.2 LOOK-UP CORRELATION CHARACTERISTICS

The results of the scenario ignition modelling have been used to derive a number of representative best-fit curve/correlations, which can be used in QRA to estimate the probability of ignition for a wide range of common scenarios.

The correlations consist of up to three gradients (grad_a, grad_b, grad_c), each of the generic form:

$\mathrm{Log}_{10}(y) = m \cdot \mathrm{Log}_{10}(x) + c$, rearranged as $y = 10^{[m\,\mathrm{Log}_{10}(x)+c]}$

Where y is the ignition probability, x is the mass release rate (kg/s), m is the 'gradient' of the correlation, and c is the y-axis 'offset' of the correlation.

Gradient a and offset a characterise the correlation between points A and B, gradient b and offset b between points B and C, and gradient c and offset c between points C and D. If an upper point is not specified, the gradient and offset values are used for all values of x (the mass flow rate) above the lower point value. Points A, B, C and D are specified as *x* values (i.e. mass release rates). Maximum and minimum values are also assigned. The correlation values are shown in Table B.1.

The look-up correlations were derived by selecting suitable 'best fit' lines to match or envelop the model results. Charts showing these 'best fit' lines and the model results they have been selected to represent are presented in Figure B.1 through to Figure B.16.

Charts showing the actual look-up correlations (Best Fit Curves) for all the scenarios are presented in Figure B.17 through to Figure B.21. These have been grouped and presented to enable comparison between related look-up correlations.

An additional correlation has been added for 'Tank Liquid – diesel, fuel oil' based on the 100 m × 100 m liquid tank correlation, but with a reduced ignition probability to reflect the lower ignition potential for liquids stored at near ambient conditions below their flashpoint (see Table 1).

The look-up correlations also include equivalents of the commonly used Cox, Lees and Ang ignition probability correlations for gas and liquid, with maximum values of 0,3 and 0,08 respectively.

A look-up function has also been developed in MS Excel, which allows the look-up correlations to be called using a simple cell function formula linked to a visual basic module in the spreadsheet: this is provided at version D1 (File name: Ukooa_pign_lookup_function_D1.xls). This spreadsheet includes the full look-up function code in visual basic.

It should be noted that other correlations can be developed to represent the ignition probability curves. An alternative set of correlations was presented in a paper by DNV at the Hazards XXIII conference in 2012 using logarithmic interpolation between the four points defining the curve. This method may be easier to implement in some cases.

Table B.1: Look-up correlation characteristics

No.	Type	max_p	min_p	point a	grad_a	offset_a	point b	grad_b	offset_b	point c	grad_c	offset_c	point d
	Onshore Scenarios												
1	Pipe Liquid Industrial	0,07	0,001	0,1	0,558795	–2,18593	70	N	N	0	N	N	0
2	Pipe Liquid Rural	0,007	0,001	0,1	0,605288	–2,13944	0,3	0,127125	–2,38946	70	N	N	0
3	Pipe Gas LPG Industrial	1	0,001	0,1	0,739652	–2,21896	1000	N	N	0	N	N	0
4	Pipe Gas LPG Rural	1	0,001	0,1	0,129819	–2,82879	10	0,80103	–3,5	1000	N	N	0
5	Small Plant Gas LPG	0,6	0,001	0,1	0,356547	–2,60206	1	1,56813	–2,60206	3	0,734824	–2,20447	1 000
6	Small Plant Liquid	0,1	0,001	0,1	0,338819	–2,61979	1	0,809894	–2,61979	100	N	N	0
7	Small Plant Liquid Bund	0,013	0,001	0,1	0,338819	–2,61979	1	0,809894	–2,61979	100	N	N	0
8	Large Plant Gas LPG	0,65	0,001	0,1	0,356547	–2,60206	1	1	–2,60206	100	N	N	0
9	Large Plant Liquid	0,13	0,001	0,1	0,356547	–2,60206	1	0,840621	–2,60206	100	N	N	0
10	Large Plant Liquid Bund	0,05	0,001	0,1	0,338819	–2,61979	1	0,809894	–2,61979	100	N	N	0
11	Large Plant Confined Gas LPG	0,7	0,001	0,1	0,356547	–2,60206	1	1,211604	–2,60206	70	0,31737	–0,95211	1 000
12	Tank Liquid 300 × 300 m Bund	0,12	0,001	0,1	0,075721	–2,90309	1	0,395757	–2,90309	7	0,88091	–3,31309	500
13	Tank Liquid 100 × 100 m Bund	0,015	0,001	0,1	0,075721	–2,90309	1	0,395757	–2,90309	7	0,88091	–3,31309	500
14	Tank Gas LPG Storage Plant	1	0,001	0,1	0,023065	–2,93554	1	1,458907	–2,93554	100	N	N	0
15	Tank Gas LPG Storage Industrial	1	0,001	0,1	0,023065	–2,93554	1	1,145784	–2,93554	100	0,647338	–1,93865	700
16	Tank Gas LPG Storage Rural	0,5	0,001	0,1	0,023065	–2,93554	1	1,123063	–2,93554	10	0,40624	–2,21872	1 000
	Offshore Scenarios												
17	Offshore Process Liquid	0,0175	0,001	0,1	0,400548	–2,55806	100	N	N	0	N	N	0
18	Offshore Process Liquid NUI	0,01	0,001	0,1	0,400548	–2,55806	100	N	N	0	N	N	0
19	Offshore Process Gas Opendeck NUI	0,025	0,001	0,1	0,037789	–2,92082	1	0,880788	–2,92082	30	N	N	0
20	Offshore Process Gas Typical	0,04	0,001	0,1	0,768182	–2,19042	3	0,390377	–2,01017	10	N	N	0
21	Offshore Process Gas Large Module	0,05	0,001	0,1	0,845058	–2,11355	5	0,285097	–1,72215	30	N	N	0
22	Offshore Process Gas Congested or Mechanical Vented Module	0,04	0,001	0,1	1,134699	–1,82391	1	0,216588	–1,82391	50	N	N	0
23	Offshore Riser	0,025	0,001	0,1	0,525219	–2,43339	30	N	N	0	N	N	0
24	Offshore FPSO Gas	0,15	0,001	0,1	0,072551	–2,88606	1	1,213764	–2,88606	50	N	N	0
25	Offshore FPSO Gas Wall	0,15	0,001	0,1	0,544175	–2,41443	0,3	1,231261	–2,05517	10	N	N	0
26	Offshore FPSO Liquid	0,028	0,001	0,1	0,468588	–2,49002	100	N	N	0	N	N	0
27	Offshore Engulf – blowout – riser	0,1	0,001	0,1	0,652869	–2,30574	100	N	N	0	N	N	0
	For Comparison												
28	Cox, Lees, Ang – Gas	0,3	0	0,1	0,641939	–1.80676	100	N	N	0	N	N	0
29	Cox, Lees, Ang – Liquid	0,08	0	0,5	0,392472	–1.88185	100	N	N	0	N	N	0
	Special (Derived) Scenarios												
30	Tank Liquid – diesel, fuel oil	0,0024	0,001	0,1	0,010724	–2,98928	1	0,067994	–2,98928	7	0,554906	–3,40076	500

Note: 'N' as a gradient or offset means 'not applicable', 0 as a point also means 'not applicable'.

The look-up correlations take the form of a number of log-log gradients chosen to match or envelop the model results. In some of the larger LPG release cases for pipelines and tanks in open areas, the 'open' and 'openj' configuration modelling gives noticeably different ignition probabilities. The 'open' configuration modelling results are more representative of an LPG release that causes rain-out and pool formation followed by rapid evaporation, resulting in relatively passive wind driven dispersion, whereas the 'openj' case would be more representative of a vapour momentum jet release. In practice, actual releases are likely to exhibit behaviour somewhere between these extremes, so for these cases, the look-up correlation has taken a mid-line between the 'open' and 'openj' results.

B.3 DEVELOPMENT OF REPRESENTATIVE 'LOOK-UP' SCENARIOS

The work to develop the ignition probability model showed that, for a given scenario, the ignition probability varies with the mass flow rate, and that this relationship can be represented by a relatively simple correlation.

The objective of this follow-on work was to develop 'look-up' tables or correlations for a range of representative scenarios to provide an easy to use reference for ignition probabilities for use in QRA. These tables/correlations would be supported by guidance on how to select a suitable representative scenario, interpret and apply the data, consider sensitivities etc. This is aimed at making the model easier to use. It avoids the need to run the detailed model for every scenario, and also uses the ignition model developer's detailed knowledge of the model to provide the most appropriate means to represent the scenarios. The look-up tables should also ensure a more consistent application of the ignition probability model in QRA.

The range of situations addressed by the look-up tables is intended to represent the majority of typical QRA scenarios. This should mean that many QRAs would only need to use the look-up tables to select suitable ignition probabilities for the scenarios being considered. If some of the scenarios being modelled do not fall within the range of representative scenarios in the look-up tables, then the full model can be used to estimate an appropriate ignition probability.

The Ignition Probability Model (Version C2 dated 25/02/2004) has been used to model the representative offshore and onshore scenarios to provide a series of simple mass release rate based ignition probability correlations for use in QRA.

The following representative scenarios have been assessed:

- Release types:
  - Gas releases.
  - LPG (flashing liquefied gas) releases, where appropriate.
  - Pressurised liquid oil releases – leading to a spray release with flashing/ evaporation/aerosol formation.
  - Low pressure liquid oil releases – leading to a spreading pool only (no aerosol formation or flashing).
- Release rates:
  - From 0,1 to 1 000 kg/s.
- Onshore configurations:
  - Cross-country pipeline (high pressure natural gas, LPG, and a flammable liquid in either an 'industrial/near urban' area or in a rural area).

  - Storage (multi-tank farm with LPG at pressure (medium and large inventories), and an ambient flammable liquid e.g. petrol/gasoline/crude oil in two situations (medium and large inventories), one within a processing plant complex and the other in a remote location).
  - Small plant (high pressure vapour, two-phase and flammable liquid spill for two typical small plant configurations e.g. semi-enclosed plant and an open but relatively congested plant on a small manufacturing site).
  - Large plant (high pressure vapour, two-phase and flammable liquid spill): this would involve the same leak scenarios as for small plant, but with different plant and surrounding area dimensions and ignition characteristics based on two large plant configurations e.g. within a petroleum refinery/large petrochemical complex.
- Offshore configurations:
  - Normally unattended installation processing facility.
  - Floating production and storage – deck processing facility.
  - Integrated deck platform – open process module (e.g. NUI or open upper deck).
  - Integrated deck platform – partially enclosed process module (e.g. 'tunnel' type between decks, limited windwall only) – two different congestion and confinement levels.
  - Integrated deck platform – enclosed process module with mechanical ventilation – two different ventilation rates.
  - Integrated deck platform – partially enclosed compression module (e.g. 'tunnel' type between decks, limited windwall only) – two different congestion and confinement levels.
  - Wellhead module.
  - Riser.
  - Release engulfing the platform (e.g. blowout or massive riser event).

The detailed characteristics of the configurations selected are described in the following sections.

B.4 GENERAL BASIS AND ASSUMPTIONS FOR 'LOOK-UP' SCENARIOS

The modelling adopted a number of generic release materials (fluids) to be evaluated, and also included a number of general assumptions or bases that were applicable to all or main groups of scenarios. The general bases and assumptions are detailed in the following sections.

B.4.1 Fluids considered

A range of release materials was considered to encompass the majority of offshore and onshore hydrocarbon production and processing situations. These included gas (essentially taken as methane/natural gas), LPG and an oil based liquid with a small flash fraction, and one with no flashing.

A liquid flash fraction of 15 % was assumed for the offshore oil/liquid scenarios (artificially fixed by setting the release pressure = 0,27 barg), since offshore hydrocarbon liquids can contain significant light fractions, as well as being subject to aerosol generation from edge effects from pressurised releases.

A liquid flash fraction of 10 % was assumed for the onshore oil/liquid scenarios (artificially fixed by setting the release pressure = 0,175 barg), as it was considered that this may be more appropriate for the degree of aerosol generation resulting from edge effects around the edges of the release with high pressure liquids, with little or no flash fraction.

The gas/LPG scenarios provide an indication of the ignition probability if all or most of the liquid was expected to atomise or vaporise on release.

A summary of the fluid parameters and properties used in the model is given in Table B.2.

Table B.2: Release materials and properties

Material	Classification in model	Molecular weight of vapour/flash component, kg/kmol	UFL, volume fraction	LFL, volume fraction	Liquid phase density, kg/m³
Gas – assume methane/ natural gas	Gas	17	0,15	0,05	–
LPG – assume propane/ butane mix	Liquid A	50	0,10	0,02	500
Liquid with some flashing-off on release e.g. offshore condensate	Liquid C, with 10 %–15 % flash fraction	100	0,10	0,02	850
Liquid – assume heptane/oil	Liquid C	100	0,10	0,02	850

It should be noted that the ignition model includes a correlation to estimate the flash/ atomised fraction of liquid releases based on the CCPS 'Release' model work; the main factor in determining the fraction atomised is the release pressure. However, this correlation is based on test and analysis results for small releases. The mechanical interactions causing aerosol formation may be largely due to edge effects between the fluid and the hole edge/ wall. Therefore, the correlation may not be suited to large releases through large holes. This is one reason why the model scenarios selected for the look-up correlations work used predetermined 'flash' fractions more consistent with past QRA approaches and experience rather than the model in-built correlation.

B.4.2 Release rates

A number of release rates were modelled, covering a wide range of spill sizes. These ranged from 0,1 to 1 000 kg/s. Selected modelling at higher release rates was also undertaken where appropriate. The releases rates modelled are shown in Table B.3; these were selected to provide suitable data points on a log-log plot, the most appropriate form of presentation for the ignition model results.

Table B.3: Release mass flow rates used

Release mass flowrate. Kg/s
0,1
0,3
0,5
0,7
1
3
5
7
10
30
50
70
100
300
500
700
1 000

B.4.3 Wind speed

A wind speed of 5 m/s was selected as the basis for all the modelling. This is a typical onshore value, and an analysis of UK North Sea offshore data indicated a median wind speed of approximately 6 m/s. Sensitivity analysis at 2 m/s and 8 m/s shows no major differences in the ignition probability.

An average wind speed has been selected to provide look-up correlations reflecting averaged conditions, since it is envisaged that the look-up correlation ignition probabilities will be used in QRAs covering a wide range of weather situations.

If ignition probabilities are needed to reflect very specific wind conditions, then it is suggested that the full ignition probability model is used. This includes the ability to manually input the results from dispersion simulations, overriding the simple dispersion correlations embedded in the model. It is suggested that this feature is utilised for specific dispersion conditions where detailed dispersion modelling results are available.

B.4.4 Liquid pool sizes

Pool sizes for all onshore spills (from plant, pipeline or storage) were generally taken to be limited to a maximum of 100 m by 100 m (10 000 m^2) by bunds, drainage systems, or other natural or human-made restrictions. Modelling was also carried out using a maximum pool size of 300 m by 300 m (90 000 m^2) to take account of very large crude oil storage tank areas and large multi-tank bunds. This was achieved by adding a maximum pool size limit to the ignition model for these scenarios. No restriction was used for the offshore scenarios, since the overall installation sizes were smaller than 10 000 m^2.

For onshore plant releases, an additional case was considered where the plant area could be considered to be bunded (either by drains, bunds, kerbing etc.), such that the spill would not spread out beyond the plant area (Area 1). In these cases, the maximum pool area was limited to the smaller of 10 000 m^2 and the Area 1 plant area.

For pipeline releases, Area 3 (the total area of the site) was taken to be 10 000 m^2 (i.e. approximating to a 100 m pipeline corridor); this is the surface area limit to which any pool was allowed to spread.

The model assumes liquid pools cannot spread into Area 4 (offsite).

The revised (version D1) ignition model includes the ability to specify a maximum (limiting) pool area in the Summary sheet data input cell – 'Maximum Liquid Pool Area, m^2, optional manual input', Cell B14. Alternatively, fixed liquid pool areas can be individually set further down the Summary Sheet input data form for Area 1 through to Area 3, see Cells B41, B49, B57.

B.4.5 Onsite offices and administration areas

The model includes a specific ignition source type for offices on site. This includes a relatively high ignition source density, and is intended for use in situations where flammable vapour clouds can enter an office complex. The 'office' ignition source densities are used in the modelling to estimate the contribution to the ignition probability for a process release due to the presence of offices or other accommodation areas.

The 'office' ignition source type (Type 11) has been used to represent accommodation units on offshore installations, since these typically consist of high-density living areas, with galleys, workshops, utility rooms etc. The extent to which gas could enter these areas has been addressed by setting the area type to 'enclosed', so there is limited ingress into the office area (up to 10 % of the total area affected). This is considered conservative, given the typical design of offshore accommodation units to resist gas ingress, for example, by maintaining a positive pressure in the area and having suitable heating, ventilation and air conditioning (HVAC) inlets with gas detection and shut-off systems.

General (i.e. non plant) areas of onshore sites have not been modelled using the office ignition type. These areas typically consist of open ground, with access roads, car parking, various offices, stores, workshops etc. Applying the office ignition type to mixed-use areas of this nature would be overly conservative. The 'offsite industrial' ignition source type (Type 12) provides a more suitable and appropriate ignition source for use in these areas; this has been used for all onshore general site areas.

A summary of the area ignition types available in the model is presented in Table 3.

B.4.6 Liquid only spills – no flashing or atomisation

Selecting the 'open' ventilation configuration option for the Area 1 area (see Summary Sheet Cell B35 in the spreadsheet model) would cause earlier versions of the model to return a #DIV/0 error if the liquid modelled is being treated purely as a liquid, i.e. with no flashing or atomisation. This is because the model was looking for a vapour source term from Area 1 into Area 2: since there is no vapour component, an error was generated.

To avoid this error, the 'openj' ventilation configuration option (see Table 2) was selected for some of the liquid (no flash or atomisation) scenarios instead of the 'open' option, even though the gas and flashing runs had been modelled using the 'open' option due to the configuration of the area. This makes no difference to the ignition modelling, since no vapour is involved, and prevents the #DIV/0 error in the spreadsheet.

Version D1 of the ignition probability model includes an error trap to prevent this #DIV/0 error occurring when a liquid only release is specified.

B.4.7 Pressures

Different values were used for the pressure of the material being released, depending on the type of module or system being evaluated.

It should be noted that the pressure has no effect on the ignition probability for gas or vapour releases as calculated by the ignition model; the dispersion equations used for these are mass release rate based.

The pressure is used in the ignition model for liquid releases, and feeds into the vaporisation/flash/atomisation calculation, which determines the fraction of the mass flow that does not rain out or remain as liquid. In general, the correlation used gives near total atomisation/flashing above 5 barg (~99,5 % flash at 5 barg). Increasing the pressure above this would have little or no effect.

The pressure is also used in the ignition model to estimate the dispersion distances for flashing liquid jets (Liquid A or Liquid C types), see Table B.2. The dispersion distances for liquid jets are strongly correlated to the hole size, so the pressure is used in conjunction with the mass release rate to derive an effective hole size; this is then used in the liquid jet dispersion correlation. This means that lower pressures will give longer hazard ranges, since these imply a larger hole size for a given release rate. The effects are only likely to be significant if the 'openj' configuration is selected (see Summary Sheet Cell B35 in the model) since, for these types of release, the model uses the liquid jet model to estimate the dispersion of the vapour/aerosol in all Areas 1–4. The 'open' configuration would also use the liquid jet model in Area 1, but then reverts to a passive dispersion model for Areas 2–4.

A flash fraction of 15 % was assumed for the offshore scenarios (artificially fixed by setting the release pressure = 0.27 barg), since offshore hydrocarbon liquids can contain significant light fractions, as well as being subject to aerosol generation from edge effects from pressurised releases.

A flash fraction of 10 % was assumed for the onshore scenarios (artificially fixed by setting the release pressure = 0.175 barg), as it was considered that this may be more appropriate for the degree of aerosol generation resulting from edge effects around the edges of the release with high pressure liquids, with little or no flash fraction.

The pressures adopted for the representative scenarios are summarised in Table B.4.