Initial Assessment of Vapour Cloud Explosion Risks Associated with the La Collette Fuel Depot

States of Jersey

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Initial Assessment of Vapour Cloud Explosion
Risks Associated with the La Collette Fuel Depot

A Report Prepared by
Atkins Ltd

On Behalf of
States of Jersey

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**NOTE:**

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Executive Summary

This Phase 1 study presents an initial assessment of the Vapour Cloud Explosion (VCE) risks associated with the La Collette fuel depot to other existing facilities and developments at La Collette. One of the primary objectives of this Phase 1 report was to determine whether potential VCE events at the La Collette fuel depot would lead to sufficiently high levels of risk that planning permission should be refused for the proposed Energy from Waste (EfW) facility.

These concerns were raised following the Buncefield event and publication of UK HSE’s Consultative Document CD211, which raised the possibility that developments close to large fuel depots may be more strictly controlled in future.

Atkins has undertaken a site specific analysis of the VCE risks to the proposed EfW facility and other existing developments at La Collette, based on a published approach developed for an HSE Research Report, and has drawn the following principal conclusions:

1) Based on UK HSE’s standard approach prior to Buncefield, the UK HSE would not have advised against the granting of planning permission for the proposed EfW facility.

2) Following Buncefield, it is possible that UK HSE may adopt a precautionary approach which might ‘advise against’ the proposed EfW facility. It is emphasised that this would simply be based on some relatively simple screening rules, and would not take account of any site specific factors or risk assessment results.

3) The site specific risk analysis in this report has shown that the levels of major hazard risk for individual workers at the proposed EfW facility would be about a factor of 4 below the level at which they would be considered intolerable by UK HSE.

4) Sensitivity studies have shown that the actual risks could be somewhat lower than the base case results predicted in this report, but further assessment in Phase 2 of the measures in place at the fuel depot is required before this can be assessed further.

5) The level of societal risk associated with the proposed EfW facility (i.e. the risk of multiple fatality accidents) is below UK HSE’s lower comparison value, and so is not regarded as significant. This is an important result, as one of the main reasons why UK HSE is considering stricter land use planning arrangements for petrol storage depots is to control the societal risk.

6) UK HSE’s general approach is that where their simple screening approach leads to an ‘advise against’ recommendation, and the planning authority is still minded to grant permission, then HSE wish to be satisfied that the planning authority has given ‘due weight’ to HSE’s advice (i.e. understands the risk implications). It is hoped that this report fulfils this purpose by providing a more comprehensive analysis of the risks.

7) In some extreme cases, UK HSE would consider the risks to be so high as to outweigh all other concerns, and would ‘call-in’ to the Secretary of State if a local authority was minded to grant permission. The risks associated with
the proposed EfW facility are far below the levels that would trigger such procedures.

In summary, although there is a residual risk to people at the proposed EfW facility from potential events at the fuel depot, the risks are sufficiently low that it would not be unreasonable for a planning authority to grant permission, provided that they were satisfied that the socio-economic benefits associated with the development outweighed the low levels of residual risk.

It is noted that both the fuel depot and the LPG storage site will lead to major hazard risks at other locations in the La Collette area. The acceptability of the existing risks, and the advisability of locating new developments in the La Collette area, needs to be carefully considered. These issues will be considered further in Phase 2 of this study. In the interim, it would be prudent not to grant planning permission for any new developments (other than the proposed EfW facility which has been assessed in this report) which might be inconsistent with the options currently being considered by HSE, e.g.

- No occupied buildings within 150 m of the fuel depot.
- No Sensitivity Level 2 developments within 250 m of the fuel depot (or in the LPG site and transfer line Inner Zone).

These simple guidelines are considered to be precautionary, and should not be overridden unless more detailed site specific risk assessment is undertaken and shows (as for the proposed EfW facility) that the risks are sufficiently low that it would not be unreasonable to grant planning permission.
Abbreviations and Acronyms

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
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<tr>
<td>AA</td>
<td>Advise Against</td>
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<tr>
<td>ACMH</td>
<td>Advisory Committee on Major Hazards</td>
</tr>
<tr>
<td>AIChE</td>
<td>American Institute of Chemical Engineers</td>
</tr>
<tr>
<td>ALARP</td>
<td>As Low As Reasonably Practicable</td>
</tr>
<tr>
<td>ARI</td>
<td>Approximate Risk Integral</td>
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<tr>
<td>CD</td>
<td>Consultation Distance</td>
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<tr>
<td>CIA</td>
<td>Chemical Industries Association</td>
</tr>
<tr>
<td>COMAH</td>
<td>Control of Major Accident Hazards</td>
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<tr>
<td>cpm</td>
<td>Chances per million (years)</td>
</tr>
<tr>
<td>DAA</td>
<td>Don’t Advise Against</td>
</tr>
<tr>
<td>DD</td>
<td>Dangerous Dose (or worse)</td>
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<tr>
<td>DDW</td>
<td>Dangerous Dose or Worse</td>
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<tr>
<td>DETR</td>
<td>Department for the Environment, Transport and the Regions</td>
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<tr>
<td>DPZ</td>
<td>Development Proximity Zone</td>
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<tr>
<td>DT</td>
<td>Development Type</td>
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<td>DTL</td>
<td>Dangerous Toxic Load</td>
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<td>EFW</td>
<td>Energy from Waste</td>
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<tr>
<td>EV</td>
<td>Expectation Value</td>
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<tr>
<td>HID</td>
<td>Hazardous Installations Directorate (of HSE)</td>
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<td>HSA</td>
<td>Hazardous Substances Authority</td>
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<td>HSE</td>
<td>Health and Safety Executive</td>
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<tr>
<td>IZ</td>
<td>Inner Zone</td>
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<tr>
<td>LD</td>
<td>Land Division (of HSE)</td>
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<td>LPA</td>
<td>Local Planning Authority</td>
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<td>LUP</td>
<td>Land Use Planning</td>
</tr>
<tr>
<td>MAOP</td>
<td>Maximum Allowable Operating Pressure</td>
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<td>MSDU</td>
<td>Methodology and Standards Development Unit (of HID in HSE)</td>
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<tr>
<td>MZ</td>
<td>Middle Zone</td>
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<tr>
<td>N_{max}</td>
<td>Maximum number of people affected</td>
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<tr>
<td>ODPM</td>
<td>Office of the Deputy Prime Minister</td>
</tr>
<tr>
<td>OZ</td>
<td>Outer Zone</td>
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<tr>
<td>PA</td>
<td>Planning Authority</td>
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<tr>
<td>PADHI</td>
<td>Planning Advice for Developments near Hazardous Installations</td>
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<td>PCAG</td>
<td>Planning Case Assessment Guide (HSE internal documents)</td>
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<tr>
<td>PLL</td>
<td>Potential Loss of Life</td>
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<tr>
<td>PRAM</td>
<td>Pipeline Risk Assessment Model (an HSE model)</td>
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<tr>
<td>QRA</td>
<td>Quantified Risk Assessment</td>
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<tr>
<td>R2P2</td>
<td>Reducing Risks, Protecting People (HSE publication, 2001)</td>
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<tr>
<td>RI</td>
<td>Risk Integral</td>
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<tr>
<td>RoD</td>
<td>Risk of Death</td>
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<tr>
<td>SL</td>
<td>Sensitivity Level</td>
</tr>
<tr>
<td>SLOD</td>
<td>Significant Likelihood of Death</td>
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<td>SRI</td>
<td>Scaled Risk Integral</td>
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<tr>
<td>SUKOP</td>
<td>Shell UK Oil Products</td>
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<tr>
<td>tdu</td>
<td>thermal dose units (kW/m²)^{4/3}.seconds</td>
</tr>
<tr>
<td>TOR</td>
<td>Tolerability of Risk</td>
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<tr>
<td>UKMO</td>
<td>United Kingdom Meteorological Office</td>
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<td>VCE</td>
<td>Vapour Cloud Explosion</td>
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1 INTRODUCTION

1.1 BACKGROUND

There are several major hazard installations at La Collette which store and handle a range of flammable substances. The Jersey Gas Company operates an LPG storage facility, and there is also a fuel storage depot operated by Shell and Esso together, although also used by Total.

It has long been established that developments in the vicinity of such major hazard sites need to be controlled in order to ensure that people are not exposed to unacceptable levels of risk. The UK Health and Safety Executive (HSE) has in the past provided advice (HSE, 1995 and 1999) relating to the risks associated with the LPG storage and ship transfer operations at La Collette, leading to the production of an HSE 3 zone map (see Figure 1.1) which defines the zones within which certain types of development may be inadvisable from a safety point of view.

However, following the incident at Buncefield in December 2005, it has become apparent that the risks associated with fuel storage depots may have been underestimated, and the HSE has begun a process of consultation which may lead to more stringent zoning advice for such sites in the UK. In particular, one option that is being considered is that the HSE may in future adopt larger land use planning zones and may normally advise against any occupied buildings within about 150 m of such fuel depots.

This has significant implications at La Collette, as a new Energy from Waste (EfW) facility is currently being considered, and the proposed location is within 150 m of the fuel depot. In the longer term, more land is being reclaimed at La Collette, and there is clearly a need to ensure that any such future developments are adequately controlled. In order to address these issues, a Hazard Review Group (HRG) has been set up, with representatives from all the key stakeholders, including: the current fuel farm operators, Jersey Gas, the Jersey Electricity Company, Police, Fire, Planning, Harbours, Public Health, Health and Safety Inspectorate of Social Security, Property Holdings, Waterfront Enterprise Board and the Emergency Planning Officer.

Atkins Ltd has been involved in assisting local authorities, operators and developers with health and safety issues relating to land use planning for a number of years, and has recently been assisting the UK HSE in understanding the levels of risk associated with potential vapour cloud explosions (VCEs) at fuel storage depots. The States of Jersey has therefore commissioned Atkins to provide advice to the HRG in relation to the proposed EfW facility and other land use planning issues at La Collette.
1.2 OBJECTIVES AND SCOPE OF WORK

The main objective of this project is to provide advice to the HRG in relation to land use planning issues at La Collette.

Following initial discussions, it was decided that the work would be undertaken in two phases. The first phase would concentrate on the VCE risks from the fuel depot and the impact on the proposed EfW facility, and the second phase would consider the wider range of potential events at all the major hazard installations, and the implications for land use planning for the entire La Collette area.

The detailed scope of work for Phase 1 was originally defined by the States of Jersey as follows:

A) Carry out an assessment of the risks associated with a Vapour Cloud Explosion (VCE) initiated by a release of petroleum spirits from the La Collette Fuel Farm, as compared with the assessment of VCE risks associated with “Buncefield type sites (large scale petroleum storage sites)” as reported in Research Report 512, using similar methodology as that which informed RR512, i.e. inclusive of application of Atkins RiskTool.

B) Assess the risk associated with a VCE at La Collette, taking into account:

(a) Existing neighbourhood populations and hours of occupation

(b) Potential neighbourhood populations and hours of occupation of development options for La Collette 2 as envisaged in the Jersey Island Plan 2002

(c) Breakdown of maximum Fuel Farm inventories in terms of levels of flammability and tonnages

(d) History of tanker unloading operations, and associated Fuel Farm filling operations, inclusive of tonnages, pumping rates, duration of filling operations, and times of day that filling operations undertaken

C) Advise as to the maximum time period that is considered reasonably foreseeable for a release of petroleum spirit during filling operations at the Fuel Farm, and thence, the maximum vapour cloud volume that is considered reasonably foreseeable.

D) Assess the relative annualised societal risk associated with a VCE at La Collette compared to that reported in RR512.

E) Advise as to whether the risks are such as to indicate that the size of any Development Proximity Zone, and Consultation Zones around the Fuel Farm, to adequately protect against risks associated with a VCE, might reasonably be set at variance from those recommended in the various options in HSE Consultation Document CD211.

F) Consider how these risks might be mitigated by onsite plant and procedures, and by offsite measures and procedures.
G) Report assumptions built in to the Fuel Farm VCE risk assessment, together with any limitations of the RiskTool model, e.g. as regards on or offsite topography and obstructions.

H) Note that it is intended to commission further work to assess the risks associated with potential major accidents arising from causes other than a VCE associated with a release of petroleum spirits from the Fuel Farm, e.g. to include consideration of the risks associated with various interfaces with the sites occupied by Jersey Gas, the Fuel Farm, and Jersey Electricity, but that such risks are outside this specification.

It is emphasised that the above scope constitutes Phase 1 of the project, Phase 2 of which will consider the risks arising from causes other than a VCE associated with a release of petroleum spirits from the fuel farm, and that some of the issues identified above may need more detailed consideration in Phase 2. In view of the tight timescales, the principal objective from Phase 1 is to establish whether the VCE risks to the proposed EfW facility are so high as to be intolerable, and whether there are any risk related ‘show-stoppers’ for this proposed development.

1.3 STRUCTURE OF REPORT

Section 2 of this report begins by providing some details of the proposed developments at La Collette, concentrating in this initial report on the proposed EfW facility. Section 3 gives technical details for the fuel depot and LPG storage installations, and a general description of the nature of the types of major accident which lead to the risk. Section 4 describes the current UK land use planning system, and how it would apply to the proposed development. The options currently being considered by HSE for large fuel storage depots are also discussed. The methodology used by Atkins to assess the risk is described in Section 5, together with a summary of the principal results. The relevant issues relating to risk are discussed in Section 6, together with an assessment of the risk implications. Section 7 provides a brief summary of how this report addresses the specific items in the original scope, and the overall conclusions are presented in Section 8. Some background information relating to HSE’s current policies and procedures is included in the Appendices.
2 DETAILS OF THE PROPOSED DEVELOPMENTS AT LA COLLETTE

This Section provides some of the relevant details for the proposed EfW facility and other future developments at La Collette. An aerial view of La Collette is provided as Figure 2.1.

2.1 THE PROPOSED ENERGY FROM WASTE FACILITY

The EfW facility is proposed to be located north-east of the fuel storage depot at La Collette. The extent of the application site is shown in Figure 2.2, and a facility area plan is provided as Figure 2.3.

Some details relating to the proposed EfW facility are included in Appendix 1. This includes a summary of the building construction and details of the number of people likely to be present at the facility at various times of the day.

The proposed EfW facility occupation details can be summarised as follows:

A) Shift workers - there will be a minimum of 2 people on site all the time (i.e. 5 shifts per week).

B) Day staff - there will be up to 12 people on something approaching 9-5 weekday working (this includes staff categories such as day workers, maintenance staff and TTSD officers etc).

C) Deliveries and intermittent - a peak of about 15 people who will be on site for a short time only, perhaps 20 minutes. Many of these may come once per week, with a few 10 times a week (i.e. RCV drivers).

2.2 EXISTING DEVELOPMENTS AND LAND USE AT LA COLLETTE

Appendix 3 includes details relating to a number of the existing developments at La Collette. This information includes details on the nature of the building construction, their locations, and the average number of people likely to be present in each hour of the week. The occupancy information is divided into workers and visitors, and separate figures are given for each for weekdays and weekends. All of this information has been used in the determination of the societal risks.

2.3 OTHER FUTURE DEVELOPMENTS AT LA COLLETTE

This initial Phase 1 report does not explicitly consider any potential future developments, other than the proposed EfW facility, although it is understood that there are plans for a variety of industrial/workplace developments on the land that is currently being reclaimed.
3 THE MAJOR HAZARD INSTALLATIONS

There are 3 principal major hazards which may lead to risks at current and future developments at La Collette, namely:

- the fuel storage depot;
- the LPG storage site; and,
- the LPG and fuel transfer operations from ships, including pipelines to the above sites.

Each of these is considered in the following subsections.

It is noted that Phase 1 of this study only addresses the VCE risk associated with the fuel depot, as this is the major new issue that arose after Buncefield, and would not have been considered by HSE in any previous land use planning advice.

3.1 THE FUEL STORAGE DEPOT

The fuel farm at La Collette is operated by Esso Petroleum Limited, Shell (U.K.) Limited and Total Oil, and would be classified as a Lower Tier site under the UK COMAH Regulations. The fuel farm itself is operated by Esso and Shell together under a joint-venture arrangement, known as the Jersey Consortium Agreement. Esso and Shell have separate office facilities, loading racks and tanker parking areas. Total Oil has an office and tanker parking area and uses the Esso loading racks to fill tankers.

Shell UK Oil Products have produced a safety case for the Jersey Depot, which has been provided to Atkins. The site would not be classed as a top-tier COMAH installation, and so the safety case does not contain any quantitative risk analysis calculations.

A site layout diagram is presented in Figure 3.1, which includes the hazardous area classification and the dimensions and contents of each of the main storage tanks.

3.2 THE LPG STORAGE SITE

The LPG storage site at La Collette is operated by the Jersey Gas Company Ltd, and would be classified as a Top Tier Site under the UK COMAH Regulations (as it stores more than 200 tonnes of LPG).

The installation consists of 9 mounded LPG storage vessels (2x85 te, 2x100 te, and 5x200 te). The installation is supplied by ship at the nearby jetty from which the LPG is transported to the site by pipeline. The LPG is vaporised for mixing with a small volume of air for transmission off-site, and 13 te and 5 te road tankers are also filled on site for distribution (HSE, 1999).

The Jersey Gas Company Ltd has produced a detailed COMAH Safety Report (April 2004) which has been provided to Atkins. The report includes some quantified risk assessment calculations involving a variety of major accident scenarios.
3.3 THE LPG AND FUEL TRANSFER OPERATIONS

LPG and other fuels are delivered to Jersey by ships, which berth at the jetty on the west side of La Collette. A number of pipelines carry the LPG and other fuels to the LPG storage site and to the fuel depot.

Some details of these operations are provided in the installation safety cases.

It is noted that further details of pipelines, flow rates, routes, etc. will be required for Phase 2 of this study.

3.4 NATURE OF RISKS

Whilst the likelihood of a leak of gas/flammable liquid is relatively low, there is always a chance that corrosion, structural failure, human error or third party activity could lead to an accidental release. The severity of the incident will depend on the size of the breach, which could be anything from a tiny pinhole to catastrophic rupture. The main types of major accident event which could occur at the major hazard sites at La Collette would result from the ignition of a flammable release and are:

- **Fireball** – If a large release of gas (LPG) is ignited within a few seconds then a large fireball lasting 10 to 15 seconds may be produced, with very high levels of thermal radiation in all directions. The initial large fireball would probably be followed by a jet fire (see below).

- **BLEVE** – Boiling Liquid Expanding Vapour Explosion. A BLEVE is a sudden catastrophic vessel failure, usually due to fire impingement on an LPG vessel, leading to a major fireball and some blast overpressure. The likelihood of such events for fully mounded LPG tanks is generally considered to be negligible, although it could still occur for LPG road tankers.

- **Jet Fire** – Any ignition of gas or pressurised liquid will burn back to the point of release and may form a jet fire. Depending on the nature of the failure, the jet fire may be directed horizontally or vertically. Jet fires continue to burn for as long as the release of gas is not isolated, and the prolonged thermal radiation (or flame impingement) can lead to significant risks, although the impact tends to be relatively local.

- **Flash Fire** – If a release of gas (LPG or petroleum vapours) is not ignited within a few seconds of the release, then a cloud of gas will disperse downwind some distance from the point of release. If this cloud then finds a source of ignition, the area covered by the vapour cloud will burn rapidly as a flash fire, with significant risks to all those within the flash fire envelope. The flash fire would probably be followed by a jet fire.

- **Vapour Cloud Explosion** – This is similar to a flash fire, except that if the vapour cloud is in a partially confined area, then the ignition of the cloud could also lead to a vapour cloud explosion (VCE), generating significant levels of blast overpressure, which would present a risk to people beyond the flash fire envelope.

For the fuel farm, the major concern is a VCE, such as occurred at Buncefield, although there may also be risks from flash fires and pool fires.

For the LPG storage site, the worst case events would be major fireballs following catastrophic vessel failure, but lesser events, such as flash fires and VCEs could also have significant off-site impact. Jet fires tend to be more local in their effects.
4 THE UK HSE LAND USE PLANNING SYSTEM

Although the States of Jersey has not introduced similar land use planning legislation to that in place in the UK which addresses development near major hazard sites, the approach adopted by the UK authorities is generally referred to in identifying standards and approaches which are considered suitable for Jersey.

The following subsections therefore deal with how the UK approach to land use planning applies to La Collette, and the proposed EfW facility in particular.

4.1 HAZARD AND RISK DEFINITIONS

In order to understand how the land use planning system operates, it is important to have a clear understanding of the key terminology.

A hazard is simply an item of equipment or process which could lead to harm, i.e. it is the thing which presents the risk, such as a fuel tank or pipeline containing a hazardous substance.

A risk is the chance of specified level of harm occurring, such as the chance of fatality per year.

There are two main types of risk which may be relevant:

The individual risk is the chance of a particular individual incurring a specified level of harm (e.g. fatality). Individual risks are generally calculated for a hypothetical individual at a particular location, such as a member of a residential population who spends all their time at home, or a worker who spends say 25% of their time at a work location. Individual risks are often quoted in cpm (chances of occurring per million years).

The societal risk is a more complex measure which reflects the likelihood of numbers of people being affected.

The societal risk can be characterised in a number of ways:

f-n pairs – A series of pairs of values for every possible major accident event, each pair giving the frequency (f) of the event and the number (n) of people affected by that event. This approach is rarely presented as there may be hundreds of such pairs.

FN curve – A graph which shows the cumulative frequency (F) of all events that could lead to N or more people being affected. This curve is derived from the basic f-n pairs, but is much easier to interpret.

Expectation Value (EV) or Potential Loss of Life (PLL) – The average number of people affected per year. It corresponds to the sum of the products of the f-n pairs, and is equal to the area under the FN curve. It provides a simple single measure of the societal risk, and is particularly useful in Cost Benefit Analysis (CBA).

Scaled Risk Integral (SRI) – A simple measure of societal risk devised by HSE for considering specific developments, which takes account of the number of people at the development, the risk to which they are exposed, and the area of the development (see Section 6.5).
4.2 SUMMARY OF UK HSE’S LAND USE PLANNING METHODOLOGY

The HSE is responsible for providing advice to Local Planning Authorities on proposed developments in the vicinity of major hazard sites in the UK. The HSE uses information provided by the site operators, generally in the Hazardous Substances Consent applications, to define the extents of 3 zones (Inner, Middle and Outer), which correspond to areas of progressively lower levels of risk.

When a planning application is received by HSE for a development which falls within the Consultation Distance (which is defined by the outer limit of the Outer Zone), the HSE uses a set of rules to determine the Sensitivity Level (1 to 4) of the proposed development, and then applies the following decision matrix to determine whether or not to advise against the development, depending on sensitivity and location.

<table>
<thead>
<tr>
<th>Level of Sensitivity</th>
<th>Inner Zone</th>
<th>Middle Zone</th>
<th>Outer Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>Don’t Advise Against</td>
<td>Don’t Advise Against</td>
<td>Don’t Advise Against</td>
</tr>
<tr>
<td>Level 2</td>
<td>Advise Against</td>
<td>Don’t Advise Against</td>
<td>Don’t Advise Against</td>
</tr>
<tr>
<td>Level 3</td>
<td>Advise Against</td>
<td>Advise Against</td>
<td>Don’t Advise Against</td>
</tr>
<tr>
<td>Level 4</td>
<td>Advise Against</td>
<td>Advise Against</td>
<td>Advise Against</td>
</tr>
</tbody>
</table>

A copy of the HSE Planning Advice for Developments near Hazardous Installations (PADHI) is included as Annex 1. This gives full definitions of all the sensitivity levels.
4.3 APPLICATION OF PADHI TO PROPOSED DEVELOPMENT

The HSE has calculated (see Section 4.4) the land use planning zones for the LPG storage site and ship transfer operations as shown in Figure 1.1. Land use planning zones have not been developed for the Fuel Farm. In general, the Inner, Middle and Outer Zones for a large scale petroleum storage site would, in the past, have been set at 120, 135 and 185 m from the site fence or flammable storage bund (depending on the definition of the vessel storage area in the Hazardous Substances Consent application). This is illustrated in Figure 4.1.

Furthermore, the current Consultation CD211 (see Section 4.5) suggests that the LUP zones for such sites could be increased to 250, 300 and 400 m, perhaps with a Development Proximity Zone (DPZ) of 150 m, as illustrated in Figure 4.2.

4.3.1 The Proposed EfW Facility

It is noted that, according to PADHI (see Annex 1), a development which straddles two zones is taken to be in the innermost of the two zones if more than 10% of the area of the development falls within the innermost of the zones. Even so, comparison of the existing zones in Figure 1.1 (which are now considered obsolete as they don’t consider the fuel farm) and Figure 2.2 indicates that the majority of the development (particularly the buildings) lies beyond the Middle Zone boundary, and so would be treated as being Outer Zone.

Examination of PADHI (see DT 1.1 in Table 1 in Section 4 of Annex 1) also indicates that the proposed EfW facility would be considered to be a Sensitivity Level 1 development, as it has less than 100 occupants and it has been confirmed that it would have less than 3 occupied storeys.

Hence, based on Table 4.1 above, HSE would in the past not have advised against any such development, even in the Inner Zone.

It should be noted that, for reasons noted in Sections 4.4 and 4.5 below, Atkins considers that, even before the latest potential increases in zone sizes associated with CD211, the proposed EfW facility should have been considered to be in the Inner Zone for the fuel depot. However, this does not affect the conclusion that in the past the proposed EfW facility would not have been advised against by HSE, if a land use planning matrix for the fuel farm had been adopted, as Sensitivity Level 1 developments are not advised against in the Inner Zone.

4.3.2 Other Future Developments at La Collette

These have not yet been identified to Atkins, and are beyond the scope of this Phase 1 study, but will each need to be considered before planning permission is granted. It is intended that Phase 2 of this study will provide useful information to aid land use planning in relation to future developments.
4.4 DETAILS OF HSE’S RISK ASSESSMENT

The existing HSE land use planning zones described in Section 4.3 and Figure 1.1 are based on calculations undertaken by UK HSE. The original calculations were undertaken in 1995, and these were revised in 1999 to take account of the mounding of the LPG vessels at the LPG Storage Site.

Levels of individual risk are generally quantified in terms of the probability of harm per year e.g. 0.000001/year or $10^{-6}$/year, which would be equivalent to one chance per million years (i.e. 1 cpm).

The three HSE zones normally correspond to the following levels of risk:

- **Inner Zone**: $10^{-5}$/year (10 cpm)
- **Middle Zone**: $10^{-6}$/year (1 cpm)
- **Outer Zone**: $3 \times 10^{-7}$/year (0.3 cpm)

where the risk is that of a typical member of a residential population receiving a ‘dangerous dose’, in this case of thermal radiation, which corresponds to the following levels of harm:

- Severe distress to all;
- A substantial number requiring medical attention;
- Some requiring hospital treatment; and,
- Some (about 1%) fatalities.

The risk of fatality for an individual is obviously lower than the risk of receiving a dangerous dose, but probably not by very much for the type of major accidents considered here.

It is noted that the existing HSE land use planning zones in Figure 1.1 do not appear to have taken any account of the fuel farm. This is simply because UK HSE was never asked to consider the risks associated with the fuel farm. The UK HSE has, for many years, defined land use planning zones for fuel storage depots based on the potential consequences of a ‘worst case’ pool fire scenario (rather than specific levels of risk). HSE’s Planning Case Assessment Guide (PCAG) Chapter 1E states that the LUP zones for large atmospheric storage tanks (>175 m³) for substances such as petrol/gasoline and JP5/kerosene should be 120, 130 and 185 m, based on the calculated hazard ranges to 1800, 1000 and 500 tdu respectively, which are the standard thermal dose criteria adopted by HSE for this purpose.
4.5 IMPLICATIONS OF CURRENT CONSULTATION

Following the incident at Buncefield in December 2005, the HSE is currently consulting on various options in terms of possible stricter land use planning arrangements around large scale petroleum storage sites. The HSE consultation process runs from 27 February 2007 to 22 May 2007, and details can be found at http://www.hse.gov.uk/consult/condocs/cd211.htm.

The HSE has decided that the extent of the land use planning zones for such sites should perhaps no longer be based on the postulated worst case pool fire scenario (leading to zones of 120, 135 and 185 m for a site with large tanks), but rather on the observed effects of the Buncefield explosion. This leads to the following results:

<table>
<thead>
<tr>
<th>Zone</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inner Zone</td>
<td>250 m</td>
</tr>
<tr>
<td>Middle Zone</td>
<td>300 m</td>
</tr>
<tr>
<td>Outer Zone</td>
<td>400 m</td>
</tr>
</tbody>
</table>

The four main options being considered within the consultation process can be summarised as:

- **Option 1** Continue to apply existing smaller LUP zones and PADHI approach. This would continue to allow significant industrial development close to such sites, with the potential for major impacts such as occurred at Buncefield, which may not be considered acceptable. This option takes into account the possible improvement of control measures post-Buncefield.

- **Option 2** Simply apply PADHI with the revised 250, 300, 400 m zones. This does not appear to be sensible as it would still allow significant industrial development very close to such sites.

- **Option 3** As Option 2, but advise against all normally occupied buildings within the 250 m Inner Zone. This would control the risks very effectively, but would have a major effect in terms of planning blight at some sites.

- **Option 4** As Option 3, but only advise against all normally occupied buildings within a smaller 150 m Development Proximity Zone. This would control the majority of the risks whilst having less impact in terms of planning blight.

It is not known which, if any, of these approaches HSE will eventually adopt, but this is not too critical in terms of this study for La Collette. Any of the options would only represent an initial screening approach, designed to identify all those cases where the risks may be significant. Atkins would always recommend that the results of a detailed site specific risk assessment provides a more robust basis for making any planning decisions, and this is the approach that is now being adopted for La Collette.

It is emphasised that, following the consultation exercise, any changes implemented by HSE to their land use planning approach will not be retrospective, and would only affect advice on future planning applications.
5 ASSESSMENT OF VAPOUR CLOUD EXPLOSION RISKS

None of the previous land use planning assessments for La Collette Fuel Farm has considered the Vapour Cloud Explosion (VCE) risk associated with a potential Buncefield type event. This section therefore provides an initial assessment of the risks associated with such events, and their implications for the proposed EfW facility.

It should be remembered that considering the risks from just this single type of event, for just this additional population, does not give an overall assessment of the risk. However, the intention is that it should be sufficient to demonstrate whether the risks from such VCE events are likely to lead to overall risks which are so high that the levels of risk associated with the proposed development might be considered intolerable.

5.1 METHODOLOGY

The approach adopted is identical to that adopted by Atkins in RR 512 (HSE, 2007), which was commissioned by HSE in order to help understand the levels of risk associated with VCEs at large scale petroleum storage depots.

The methodology is based on the following assumptions:

1. The likelihood of a Buncefield type VCE event at a large scale petroleum storage depot is $10^{-4}$/year per installation.
2. The VCE event could be centred anywhere on site (for practical purposes, in this assessment for La Collette, the frequency has been uniformly distributed between the locations of all the main fuel storage tanks).
3. The magnitude of the overpressures generated by the VCE is defined as that arising from a 50,000 $m^3$ VCE with an ignition strength of 7 and a combustion energy of 3.5 MJ/$m^3$ using the TNO multi-energy method (Van den Berg, 1985).

Individual risks of receiving a dangerous dose or worse (140 mbar) have been calculated, as have risks of fatality using a probit of $Y = 1.47 + 1.35 \ln(P)$, with $P$ in psi (Hurst, Nussey and Pape, 1989) for the risk to people outdoors, and the Chemical Industries Association (CIA, 2003) vulnerability Curve 2 (typical office block: four storey, concrete frame and roof, brick block wall panels) for the risk to people indoors.

It is noted that probits and vulnerability curves are both standard approaches for relating the probability of fatality to the level of explosion overpressure.

The distribution of population at the proposed EfW plant is defined in Appendix 1. This information has been used as the basis of the societal risk calculations.

The individual and societal risks have been calculated using the Atkins RiskTool software, which takes into account all the relevant factors in order to calculate the individual and societal risk. This is all identical to the approach adopted in RR512 (HSE, 2007), except that here the societal risks are based on the actual proposed EfW facility population and actual populations at other sites within La Collette, rather than a hypothetical population distribution.

The principal uncertainties in the above approach relate to:

- the likelihood of the event;
- the size of the vapour cloud; and,
- the probability of fatality for people indoors.
The assumptions adopted in this report are identical to those in RR512, which were discussed between Atkins and HSE, and which were considered to provide a reasonably cautious best estimate approach.

It is possible that the fixed roof design of the tanks at La Collette, and the lower frequency of stable weather conditions (see Appendix 2) might justify the adoption of a lower likelihood or size for such major VCE events, and this is considered further in Section 5.4.

The sensitivity of the results to the probability of fatality for people indoors has been investigated by using different overpressure vulnerability relationships. The use of CIA Curve 2 (typical domestic building) leads to similar results for the proposed EfW facility, and the use of American Institute of Chemical Engineers (AIChE) Category B (steel-frame/metal sided pre-engineered building) increases the risks by about 50% (although this relationship appears to be somewhat conservative compared with others commonly adopted).
5.2 **CONSEQUENCE ANALYSIS RESULTS**

The table below summarises the distances at which specified levels of explosion overpressure would occur, and the typical effects that this would have (based on AIChE, 1994).

<table>
<thead>
<tr>
<th>Overpressure (kPa)</th>
<th>Description of Damage</th>
<th>Distance (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.15</td>
<td>Annoying noise</td>
<td>14,264</td>
</tr>
<tr>
<td>0.2</td>
<td>Occasional breaking of large window panes already under strain</td>
<td>11,011</td>
</tr>
<tr>
<td>0.3</td>
<td>Loud noise; sonic boom glass failure</td>
<td>7,465</td>
</tr>
<tr>
<td>0.7</td>
<td>Breakage of small windows under strain</td>
<td>3,567</td>
</tr>
<tr>
<td>1</td>
<td>Threshold for glass breakage</td>
<td>2,587</td>
</tr>
<tr>
<td>2</td>
<td>“Safe distance”; probability of 0.95 of no serious damage beyond this value; some damage to house ceilings; 10% window glass broken</td>
<td>1,387</td>
</tr>
<tr>
<td>3</td>
<td>Limited minor structural damage</td>
<td>963</td>
</tr>
<tr>
<td>3.5 - 7</td>
<td>Large and small windows usually shattered; occasional damage to window frames</td>
<td>447 – 838</td>
</tr>
<tr>
<td>3.5 - 7</td>
<td>Damage level for “Light Damage”</td>
<td>838</td>
</tr>
<tr>
<td>5</td>
<td>Minor damage to house structures</td>
<td>608</td>
</tr>
<tr>
<td>8</td>
<td>Partial demolition of houses, made uninhabitable</td>
<td>407</td>
</tr>
<tr>
<td>7 - 15</td>
<td>Corrugated asbestos shattered. Corrugated steel or aluminium panels fastenings fail, followed by buckling; wood panel (standard housing) fastenings fail; panels blown in</td>
<td>251 – 447</td>
</tr>
<tr>
<td>10</td>
<td>Steel frame of clad building slightly distorted</td>
<td>343</td>
</tr>
<tr>
<td>15</td>
<td>Partial collapse of walls and roofs of houses</td>
<td>251</td>
</tr>
<tr>
<td>15 - 20</td>
<td>Concrete or cinderblock walls, not reinforced, shattered</td>
<td>205 – 251</td>
</tr>
<tr>
<td>18</td>
<td>Damage level for “Moderate Damage”</td>
<td>230</td>
</tr>
<tr>
<td>18</td>
<td>Lower limit of serious structural damage 50% destruction of brickwork of houses</td>
<td>221</td>
</tr>
<tr>
<td>20</td>
<td>Heavy machines in industrial buildings suffered little damage; steel frame building distorted and pulled away from foundations</td>
<td>205</td>
</tr>
<tr>
<td>20 - 28</td>
<td>Frameless, self-framing steel panel building demolished; rupture of oil storage tanks</td>
<td>164 - 205</td>
</tr>
<tr>
<td>30</td>
<td>Cladding of light industrial buildings ruptured</td>
<td>157</td>
</tr>
<tr>
<td>35</td>
<td>Wooden utility poles snapped; tall hydraulic press in building slightly damaged</td>
<td>142</td>
</tr>
<tr>
<td>35 - 50</td>
<td>Nearly complete destruction of houses</td>
<td>112 – 142</td>
</tr>
<tr>
<td>&gt;35</td>
<td>Damage level for “Severe Damage”</td>
<td>142</td>
</tr>
<tr>
<td>50</td>
<td>Loaded tank car overturned</td>
<td>112</td>
</tr>
<tr>
<td>50 - 55</td>
<td>Unreinforced brick panels, 25 - 35 cm thick, fail by shearing or flexure</td>
<td>104 – 112</td>
</tr>
<tr>
<td>60</td>
<td>Loaded train boxcars completely demolished</td>
<td>97</td>
</tr>
<tr>
<td>70</td>
<td>Probable total destruction of buildings; heavy machine tools moved and badly damaged</td>
<td>86</td>
</tr>
<tr>
<td>&gt;83</td>
<td>Damage level for “Total destruction”</td>
<td>72</td>
</tr>
</tbody>
</table>
5.3 RISK ASSESSMENT RESULTS

5.3.1 Individual Risk

Figures 5.1a and 5.1b show the individual risk of fatality for a hypothetical workplace population which is present for 25% of the time and is outdoors for 10% of the time. Figure 5.2 is similar except that it relates to the risk of receiving a dangerous dose or worse of overpressure (140 mbar). The results for population groups with different characteristics would be slightly different. Each figure shows risk contours at 1.0E-05, 1.0E-06 and 3.0E-07/year (i.e. 10^{-5}, 10^{-6} and 3 \times 10^{-7}/year, or 10, 1 and 0.3 cpm respectively), as discussed in Section 4.4.

The levels of individual risk of fatality from a VCE at various parts of the proposed EfW facility for such a workplace population are in the range 10 to 18 cpm, depending on the precise location within the facility.

It is emphasised that this only represents the risks from VCEs, and that if other events, such as pool fires and flash fires at the fuel depot, could also impact on the proposed EfW facility then the overall risks will be somewhat higher. This issue will be considered further in Phase 2 of this study, but it is likely that the overall total risk from all events could be around 25 cpm, although this still needs to be confirmed by calculation, and could be somewhat higher.

However, it is worth noting that Figure 1.1 indicates that the LPG storage site and ship transfer operations only lead to about a 1 cpm (i.e. Middle/Outer Zone boundary) risk (of receiving a dangerous dose or worse) at the proposed EfW facility, indicating that the bulk of the risk at the proposed EfW facility is, based on the calculations in this report, from the fuel depot.

5.3.2 Societal Risk

The societal risk associated with potential VCEs and the actual population (see Appendix 1) at the proposed EfW facility is illustrated in Figure 5.3 in terms of an FN curve. This shows the cumulative frequency of events leading to N or more fatalities. It is noted that the maximum number of predicted fatalities is about 29, which would occur in those time periods when the proposed EfW facility had the maximum occupancy.

Figure 5.3 also shows the upper and lower comparison lines used by the HSE (Hirst and Carter, 2002 and HSE SPC 12). This shows that the risks are slightly above the broadly acceptable (negligible) level, but are well below the upper comparison line (where risks may be considered intolerable). A large number of major hazard sites in the UK would have FN curves at significantly higher levels.

The Expectation value (EV) or Potential Loss of Life (PLL) for this FN curve is about 0.0004 fatalities per year (or 500 in units of cpm). This can be thought of as the average number of fatalities that would be expected per year over the long term, i.e. the result corresponds to 1 fatality every 2,500 years, or to incidents involving 10 fatalities every 25,000 years.

There are no generally accepted criteria for the EV, although the total EV for top tier COMAH establishments is often of the order of 0.01 fatalities/year. However, it is interesting to note that the upper and lower FN comparison lines quoted by Hirst and Carter (2002) correspond to EVs of 0.00046 and 0.069, implying that the societal risk calculated here is only very marginally above the level that would be considered broadly acceptable (not significant), and well below intolerable levels. It is also worth
noting that RR512 (Table 10 in HSE, 2007) considered a number of hypothetical sites whose total EVs ranged from 0.007 to 0.062.

It is emphasised that the societal risk and EV calculated here only relate to VCEs, and only consider the proposed EfW facility population, and so are not directly comparable with criteria or results for overall installations. However, the results do seem to indicate that the additional societal risk increment associated with the consideration of such events for the proposed EfW facility is unlikely to be sufficiently significant to make the proposed EfW facility intolerable in terms of societal risk.

The detailed population information for the La Collette area in Appendix 3 has been used to calculate the overall societal risk associated with potential VCEs at the fuel farm. Preliminary results give a total EV of about 0.002 fatalities/year, indicating that the population associated with the proposed EfW facility contributes about 20% of the overall societal risk. The worst case event is predicted to involve up to over a hundred fatalities, although this is probably a conservative estimate as Atkins has adopted fairly cautious assumptions about the vulnerability of people in buildings. Figure 5.4 presents an overall FN curve for VCEs at the fuel farm, which shows that although the risks are above the lower comparison line, they are still well below the upper comparison line and R2P2 point. These levels of societal risk are broadly consistent with what would be expected for a typical major hazard site, and are at least an order of magnitude less severe than for some major hazard sites in the UK. The risks should be regarded as ‘Tolerable if ALARP (As Low As Reasonably Practicable)’, and so it is recommended that action be taken to review whether there is anything further that can reasonably practicably be done to reduce the risks (both in terms of the fuel farm and populations at risk).

For example, as an initial step in determining whether the risks are ALARP, it is recommended that the fuel farm facility be reviewed against published guidance in HSG176, HSG186, IP19 and the recommendations arising from the Buncefield inquiry. Such a study is currently being planned, and will help inform the more comprehensive calculations in Phase 2 of this study.

5.4 SENSITIVITY STUDY RESULTS

The results quoted in Section 5.3 above represent a precautionary risk based analysis based on the information currently available to Atkins. It is consistent with the approach adopted in RR512 and is therefore considered to be robust.

However, in order to assess the sensitivity of the results to some of the key assumptions, a number of simple sensitivity studies have been undertaken. It is emphasised that these results are less robust, and rely on some expert judgement.

5.4.1 Meteorological Conditions

The event at Buncefield occurred in relatively unusual weather conditions (i.e. calm, stable weather). The likelihood of such stable conditions at most sites in the UK is typically 20 to 40%, tending to be higher for inland sites. However, examination of the ‘wind over sea’ data in Appendix 2 indicates that the total frequency of stable (E, F, G) conditions at La Collette is around 12%. Hence, it would not be unreasonable to assume that the likelihood of a Buncefield type VCE at La Collette is somewhat lower than the precautionary value of $10^{-4}$/year adopted in RR512.

Based on the above data, it is reasonable to assume that the basic event frequency for the VCE could be reduced by a factor of two, leading to levels of individual VCE risk at
the proposed EfW facility of 5 to 9 cpm, rather than the 10 to 18 cpm quoted in Section 5.3.

Similarly, the EV would be reduced by a factor of two, and the FN curve shifted downwards by a factor of two, so that it would only just cross the HSE lower comparison line.

5.4.2 Fuel Farm Design

The HSE have concluded that any site which meets the following conditions should be considered as having a significant risk associated with potential Buncefield type VCEs.

‘Petrol stored at COMAH top and lower tier sites in vertical, cylindrical, non-refrigerated, above ground storage tanks with side walls greater than 5 metres in height and where the filling rate is greater than 100 cubic metres/hour’

The La Collette fuel depot meets all of these conditions, and so there is no easy justification for assuming that such events are less likely to occur at La Collette, or that they would be less severe.

However, it is considered likely that the design of the tanks at La Collette (fixed roof rather than floating roof) probably does reduce the likelihood of such events. Similarly, assuming that the fuel depot operators have implemented all the findings and recommendations resulting from the Buncefield investigation, then this is also likely to reduce the probability of a major VCE event occurring.

It is emphasised that Atkins has not inspected the fuel depot site, or received any information which might help justify the above assumptions. Such work was not included within the Phase 1 study, but may be included within Phase 2. However, even then, it is emphasised that any conclusions reached on the efficacy of risk reduction measures will rely to some extent on expert judgement, and will necessarily be less robust than the analysis described in Section 5.3.

Nevertheless, the effect of a reduction in the likelihood of a VCE is similar to that in Section 5.4.1, i.e. a factor of two reduction in the likelihood of the VCE event would simply lead to a factor of two reduction in the VCE risks.

It is noted that if the VCE risks are very well controlled, then other events such as major pool fires may become the dominant risk at the proposed EfW facility, and measures to control the risks associated with such events should also be considered. This will be considered further in Phase 2 of the study.

5.4.3 Minimising Population at Risk

One way to reduce the societal risks associated with potential VCE events is to minimise the number of people present during the most hazardous activities, such as during transfers from refuelling ships.

It has been suggested that it may be possible, when a tanker is at the jetty, to restrict the number of people at the proposed EfW facility to occupation levels prevailing over the weekend, i.e. the proposed EfW facility would not accept waste during deliveries of fuel.

It is understood that, on average, a tanker is in each week and is at the jetty for approximately 8 hours during the visit (which may be day or night).
If it is assumed that half of all VCE events occur during ship transfer operations (a not unreasonable assumption), then the procedure above would almost halve the societal risks (i.e. shift the FN curve down by nearly a factor of two). The maximum individual risks (for those persons who might be present at the proposed EfW facility during ship transfers) would be essentially unchanged.

Given that the societal risks are already low, such a procedure is probably not a worthwhile risk reduction measure on a cost benefit basis, unless it could be implemented and operated very easily.
6 DISCUSSION OF ISSUES

This section discusses some of the issues relating to the nature of HSE’s advice under the PADHI approach, and the degree of acceptability of the predicted levels of risk.

6.1 LEVELS OF RISK AND THEIR ACCEPTABILITY

Based on the results in Section 5.3.1, it is estimated that the total level of individual risk of fatality for a worker at the proposed EfW facility lies in the range 10 to 25 cpm. The average individual risk at the facility is probably about 20 cpm.

In order to set this level of risk in context, it can usefully be compared with standard risk tolerability criteria. The HSE’s framework for judging the tolerability of risk is represented in Figure 6.1, and described in paragraphs 122 to 124 of HSE’s ‘Reducing Risks, Protecting People’ (R2P2) document (HSE, 2001) as follows:

The triangle represents increasing level of ‘risk’ for a particular hazardous activity (measured by the individual risk and societal concerns it engenders) as we move from the bottom of the triangle towards the top. The dark zone at the top represents an unacceptable region. For practical purposes, a particular risk falling into that region is regarded as unacceptable whatever the level of benefits associated with the activity. Any activity or practice giving rise to risks falling in that region would, as a matter of principle, be ruled out unless the activity or practice can be modified to reduce the degree of risk so that it falls in one of the regions below, or there are exceptional reasons for the activity or practice to be retained.

The light zone at the bottom, on the other hand, represents a broadly acceptable region. Risks falling into this region are generally regarded as insignificant and adequately controlled. We, as regulators, would not usually require further action to reduce risks unless reasonably practicable measures are available. The levels of risk characterising this region are comparable to those that people regard as insignificant or trivial in their daily lives. They are typical of the risk from activities that are inherently not very hazardous or from hazardous activities that can be, and are, readily controlled to produce very low risks. Nonetheless, we would take into account that duty holders must reduce risks wherever it is reasonably practicable to do so or where the law so requires it.

The zone between the unacceptable and broadly acceptable regions is the tolerable region. Risks in that region are typical of the risks from activities that people are prepared to tolerate in order to secure benefits, in the expectation that:

- the nature and level of the risks are properly assessed and the results used properly to determine control measures. The assessment of the risks needs to be based on the best available scientific evidence and, where evidence is lacking, on the best available scientific advice;

- the residual risks are not unduly high and kept as low as reasonably practicable (the ALARP principle – see Appendix 3 [of R2P2]); and

- the risks are periodically reviewed to ensure that they still meet the ALARP criteria, for example, by ascertaining whether further or new control measures need to be introduced to take into account changes
over time, such as new knowledge about the risk or the availability of new techniques for reducing or eliminating risks.

In terms of providing quantitative criteria to define these regions, paragraph 130 of R2P2 states that:

“HSE believes that an individual risk of death of one in a million per annum for both workers and the public corresponds to a very low level of risk and should be used as a guideline for the boundary between the broadly acceptable and tolerable regions.”

Paragraph 132 of R2P2 goes on to consider the boundary between the ‘tolerable’ and ‘unacceptable’ or intolerable region and concludes:

“For members of the public who have a risk imposed upon them ‘in the wider interests of society’ this limit is judged to be … 1 in 10,000 per annum”.

As the risk of fatality for the most exposed people at the proposed EfW facility is considered to be up to about 25 cpm, or once in 40,000 years, it is reasonable to conclude that the maximum risks at the proposed development are about a factor of 25 times the level which would be regarded as insignificant (broadly acceptable), but a factor of 4 below the level at which they would be regarded as becoming intolerable.
6.2 HSE’S CALL-IN POLICY AND PROCEDURE

The HSE’s current call-in policy and procedure is set out in full in Annex 2. This may be less relevant for the situation in Jersey, but it provides useful background in terms of the factors which HSE would consider in order to decide whether the risks associated with a proposed development are intolerable, regardless of any socioeconomic benefit.

In general, Annex 2 indicates that HSE only normally consider call-in if a proposed development fails to meet the Table 4.1 criteria matrix by ‘more than one cell’. i.e. if developments only just fail to meet the LUP criteria, then HSE would not normally call it in, provided that the Local Planning Authority understands the reasons for HSE’s advice and were making an informed decision, balancing the residual risks against other benefits.

6.3 IMPLICATIONS OF CURRENT HSE CONSULTATION

One of the key concerns arising from the current consultations (CD211) is that HSE may in future wish to advise against any normally occupied buildings within a Development Proximity Zone of about 150 m, which would include the proposed EfW facility.

If there were clear evidence that the likelihood or severity of VCEs at the La Collette fuel storage depot was significantly less than that considered generically applicable for such sites in RR512, then it might be possible to recommend a smaller DPZ. However, whilst this might be the case, Atkins does not believe that there is currently sufficient understanding of all the factors involved to make this judgement for the La Collette site.

However, Atkins would emphasise that HSE’s planning zones (including possible future DPZs) and PADHI advice should only be regarded as suitable for initial screening; identifying all those cases where the risks are sufficiently significant for concern, but not necessarily unacceptable if there are socioeconomic and other planning benefits which outweigh the residual risks.

Atkins would normally recommend that, in cases where HSE’s LUP criteria are not strictly met, and a planning authority is still minded to grant planning permission, then the precise levels of individual and societal risk should be quantified and compared with standard criteria in order to gain an understanding of the significance of the risks. If the risks are not so high as to be intolerable, then an informed judgement can be made by decision makers comparing the risks with the benefits. The provision of this information to decision-makers is the primary purpose of this current study.

In summary, the fact that the proposed EfW facility lies within the possible 150 m DPZ is not a critical deciding factor, provided it can be demonstrated in a site specific analysis (as has been undertaken in this report) that the risks are not unreasonable.
### 6.4 COMPARISON WITH OTHER RISKS

In order to help understand the level of risk at the proposed EfW facility, it is worthwhile to compare it with historical data on the other risks to which people are typically exposed.

HSE’s R2P2 provides some data on the risks to which people are routinely exposed. Some of this information is reproduced below, in terms of risk of fatality as annual experience per million, or chances per million years (cpm).

<table>
<thead>
<tr>
<th>Risk Description</th>
<th>Annual Risk</th>
<th>1 in (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual risk of death (entire population)</td>
<td>10,309 cpm</td>
<td>(1 in 97)</td>
</tr>
<tr>
<td>Annual risk of cancer</td>
<td>2,584 cpm</td>
<td>(1 in 387)</td>
</tr>
<tr>
<td>Annual risk from all types of accident</td>
<td>246 cpm</td>
<td>(1 in 4,064)</td>
</tr>
<tr>
<td>Annual risk from all forms of road accident</td>
<td>60 cpm</td>
<td>(1 in 16,800)</td>
</tr>
<tr>
<td>Construction</td>
<td>59 cpm</td>
<td>(1 in 17,000)</td>
</tr>
<tr>
<td>Agriculture, hunting, forestry and fishing</td>
<td>58 cpm</td>
<td>(1 in 17,200)</td>
</tr>
<tr>
<td>Manufacturing industry</td>
<td>13 cpm</td>
<td>(1 in 77,000)</td>
</tr>
</tbody>
</table>

These risks can be compared with the additional annual risk for the most exposed people at the proposed EfW facility of up to about 25 cpm (1 in 40,000) due to major accidents. For example, the annual risk of death for the most exposed person would increase by about 0.25% (from 10,309 to 10,334 cpm), and this increase would be about a tenth of the risk of dying in all types of accident.
6.5 RISK OF MULTIPLE FATALITY EVENTS

Whilst the above individual risks may not be regarded as significant, it should be remembered that the worst case accident, involving a major VCE, could theoretically result in large numbers of people being affected in a single incident (including many people not in the proposed EfW development). The likelihood of such a very severe event is very low (probably of the order of less than once in 10,000 years). This possibility of multiple fatalities may be regarded as a greater concern than the individual risks of up to 25 cpm. There are few generally accepted criteria for judging the acceptability of such risks to groups of people, although paragraph 136 of R2P2 states that:

“HSE proposes that the risk of an accident causing the death of 50 people or more in a single event should be regarded as intolerable if the frequency is estimated to be more than one in five thousand per annum.”

The basic event frequency for Buncefield type VCEs is estimated (see Section 5.1) to be about once in 10,000 years, and the maximum additional number of people that might suffer fatality due to the introduction of the proposed EfW facility is about 29. This appears to indicate that the additional societal risk associated with the proposed EfW facility and VCE events is probably not significant. This is illustrated rather better by comparison of the FN curve with the R2P2 point on Figure 5.3.

It is noted that HSE sometimes calculate another measure of societal risk known as the Scaled Risk Integral (SRI), as noted in Paragraphs 3c and 9 of Annex 2, which provides a simple approach which takes account of the most relevant factors. The methodology for calculating the SRI is described by Carter (1995) and Hirst and Carter (2000) as follows:

\[ SRI = \frac{P \times R \times T}{A} \]

Where,
- \( P \) = 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

Carter (1995) recommends an occupancy factor \( T = 0.3 \) for offices, and so taking \( n = 23 \) people (based on an average number of people present during weekdays from Appendix 1), \( R = 80 \) cpm (for someone present 100% of the time) and \( A = 3 \) ha (approximate area), gives:

\[ SRI = \frac{(23 + 23^2) / 2 \times 80 \times 0.3}{3} = 2,208 \]

This is only an indicative calculation, using an average number of people present, to illustrate the methodology. However, a more sophisticated calculation based on the population numbers present in each individual hour of the week (see Appendix 1) leads to a similar SRI value of 2,186 (disregarding school parties). It is worth noting that this result is below the ‘lower comparison value’ of 2,500 referred to by Carter (1995), below which HSE would normally regard the societal risk as being sufficiently low that they would not ‘Advise Against’. The SRI value of 2,186 is below the range of 2,500 to 35,000 which is regarded by HSE as the ‘significant risk region’, and it is far below the value of 500,000 above which HSE would consider recommending call-in (see Annex 2, paragraph 3c).
6.6  HSE’S ROLE IN LAND USE PLANNING

The HSE has published their current approach to land use planning on its web site (HSE, 2006). Paragraph 3 of that document states:

It is important to note that HSE’s role in the land use planning system is advisory. It has no power to refuse consent or a planning application. It is the responsibility of the HSA or LPA to make the decision, weighing local needs and benefits and other planning considerations alongside HSE advice, in which case they should give HSE advance notice of that intention. LPAs may be minded to grant permission against HSE’s advice. In such cases HSE will not pursue the matter further as long as the LPA understands and has considered the reasons for our advice. However HSE has the option, if it believes for example that the risks are sufficiently high, to request the decision is ‘called in’ for consideration by the Secretary of State, in England and Wales (a very rare situation). In Scotland, if the planning authority is minded to grant permission they have to notify the Scottish Ministers who can decide to call-in the application.

It is noted that the outcome of the current consultation CD211 regarding Buncefield type sites (see Section 4.5) is uncertain, and it is not yet clear whether HSE would consider occupied buildings within the DPZ to warrant call-in. Atkins would be of the view that some developments might be permitted within the DPZ, provided that the risks are low, and therefore a case such as the proposed EfW facility would not necessarily warrant call-in, and would be the sort of situation where a Local Planning Authority might consider granting planning permission despite HSE’s formal PADHI based advice. However, DETR Circular 04/2000 emphasises that:

In view of their acknowledged expertise in assessing the off-site risks presented by the use of hazardous substances, any advice from HSE that planning permission should be refused for development for, at or near to a hazardous installation or pipeline,… should not be overridden without the most careful consideration.

It is intended that the additional information in this report should enable all parties not only to understand the reasons for HSE’s advice, but also to begin to have an appreciation of the actual levels of risk and their degree of acceptability compared with typical criteria.
7 REVIEW AGAINST INITIAL SCOPE

This section provides a brief summary against the initial scope defined by the States of Jersey.

1. Carry out an assessment of the risks associated with a Vapour Cloud Explosion (VCE) initiated by a release of petroleum spirits from the La Collette Fuel Farm, as compared with the assessment of VCE risks associated with “Buncefield type sites (large scale petroleum storage sites)” as reported in Research Report 512, using similar methodology as that which informed RR512, i.e. inclusive of application of Atkins RiskTool.

This has been undertaken and is reported in Section 5.

2. Assess the risk associated with a VCE at La Collette, taking into account:
   
   (a) Existing neighbourhood populations and hours of occupation
   
   (b) Potential neighbourhood populations and hours of occupation of development options for La Collette 2 as envisaged in the Jersey Island Plan 2002
   
   (c) Breakdown of maximum Fuel Farm inventories in terms of levels of flammability and tonnages
   
   (d) History of tanker unloading operations, and associated Fuel Farm filling operations, inclusive of tonnages, pumping rates, duration of filling operations, and times of day that filling operations undertaken

This has been undertaken and is reported in Section 5.

Note that this report considers both the proposed EfW facility population and the population data for other existing developments at La Collette. Other future development options may be considered in Phase 2.

The fuel farm inventories are detailed in Section 3.1. The analysis is not sensitive to these values for tanks greater than 175 m$^3$ (and all 11 major tanks have capacities in the range between 513 m$^3$ and 2,649 m$^3$).

Item (d) has not been addressed in detail as such factors would not normally be taken into account by HSE in a land use planning risk assessment, and it is not clear how such factors might affect the likelihood of a VCE. Such factors will probably be more important in Phase 2 of this study, which will consider a more comprehensive set of potential major accident events.

3. Advise as to the maximum time period that is considered reasonably foreseeable for a release of petroleum spirit during filling operations at the Fuel Farm, and thence, the maximum vapour cloud volume that is considered reasonably foreseeable.

The maximum duration for a significant release of petroleum spirit is extremely hard to estimate without a much more detailed investigation. HSE commonly assumes about
30 minutes for such events. Given typical transfer rates of several hundred kg/s, the maximum loss of fuel in 30 minutes due to a leak/overfilling during transfer could be many tonnes. The maximum vapour cloud volume used in the analysis is identical to that adopted in RR512 (HSE, 2007), i.e. 50,000 m$^3$, which only corresponds to a few tonnes of fuel vapour. Hence, it is unlikely that claiming a short maximum time period for release could easily justify a smaller maximum vapour cloud volume. It is known that this is an area where further fundamental research is probably required in order to define maximum cloud volumes in any particular situation, and so at present a precautionary approach is required.

4. **Assess the relative annualised societal risk associated with a VCE at La Collette compared to that reported in RR512.**

This has been done in Section 5.3.2 in terms of the Expectation Value (EV).

5. **Advise as whether the risks are such as to indicate that the size of any Development Proximity Zone, and Consultation Zones around the Fuel Farm, to adequately protect against risks associated with a VCE, might reasonably be set at variance from those recommended in the various options in HSE Consultation Document CD211.**

As discussed in Section 6.3, it is probably not yet possible to set a robust DPZ of less than 150 m for the fuel farm at La Collette. However, the DPZ will probably only be used by HSE for initial screening, and not as an absolute HSE requirement leading to call-in. Hence, the precise extent of the DPZ for the La Collette fuel farm is not a major issue for the proposed EfW facility as the risks are being quantified more comprehensively.

6. **Consider how these risks might be mitigated by onsite plant and procedures, and by offsite measures and procedures.**

It should be ensured that all the lessons learned and advice from HSE following the Buncefield incident has been addressed by the fuel farm operators.

In particular, the fuel farm should be reviewed against published guidance in:

- HSE’s Safety alerts arising from Buncefield as listed at: [http://www.hse.gov.uk/comah/alert.htm](http://www.hse.gov.uk/comah/alert.htm)
If there are any inconsistencies then they should be addressed. It is understood that a study to address these issues is planned.

In terms of off-site measures, there is relatively little that can practicably be done, other than minimising the population at risk. For example, school party visits to the proposed EfW facility may not be advisable (some major hazard sites in the UK have been advised to cease such activities on the grounds of safety). It is probably also worth reviewing the design of the proposed EfW facility against the guidance and recommendations in the Chemical Industries Association ‘Guidance for the Location and Design of Occupied Buildings on Chemical Manufacturing Sites’, Second Edition (CIA, 2003), which includes a number of measures which can help mitigate the risks associated with explosion overpressure. If there are any relatively simple measures which can be adopted then they are worth implementing.

7. Report assumptions built in to the Fuel Farm VCE risk assessment, together with any limitations of the RiskTool model, e.g. as regards on or offsite topography and obstructions.

The assumptions and limitations are covered in Section 5.1.

Topography is unlikely to be significant as the La Collette site is relatively flat.

The effects of obstructions on the blast wave from a vapour cloud explosion are extremely complex, and would not normally be considered in a land use planning risk assessment. However, this is not considered to be a major issue at La Collette.

8. Note that it is intended to commission further work to assess the risks associated with potential major accidents arising from causes other than a VCE associated with a release of petroleum spirits from the Fuel Farm, e.g. to include consideration of the risks associated with various interfaces with the sites occupied by Jersey Gas, the Fuel Farm, and Jersey Electricity, but that such risks are outside this specification.

This approach is noted and understood. The work already undertaken for Phase 1 provides a good basis for the work required in Phase 2.
8 SUMMARY AND CONCLUSIONS

This initial report provides an assessment of the health and safety land use planning issues associated with the potential vapour cloud explosion risk associated with the fuel depot at la Collette, and the implications for the proposed EfW facility.

The UK HSE have a well established methodology, known as Planning Advice for Developments near Hazardous Installations (PADHI), which is used to provide advice on potential planning developments. This PADHI methodology takes account of both the sensitivity of the development and its proximity to the hazard. For the proposed EfW facility, the current PADHI methodology and existing HSE 3 zone map would lead to a ‘Don’t Advise Against’, as the proposed EfW facility only constitutes a Sensitivity Level 1 development, which is not advised against in any zone.

It is noted that the existing HSE 3 zone map does not consider the fuel depot, but if the map had been updated using HSE’s standard pre-Buncefield approach then the proposed EfW facility would have fallen within the Inner Zone (and still not advised against). However, it is possible that as a result of Buncefield, HSE might in future advise against the proposed EfW facility on the grounds of safety, as it would lie within the new Development Proximity Zone.

In cases where the HSE methodology leads to an Advise Against response, the HSE are satisfied that the risks are such that they would be prepared to provide evidence to back up a refusal of planning permission by, for example, a Local Planning Authority. If the Local Planning Authority were still minded to grant permission, the HSE would also take a view as to whether the risks are so high as to outweigh all other considerations, and if so they would normally call-in the application. It is unclear whether HSE would consider call-in for a Sensitivity Level 1 development in the DPZ, but Atkins would be of the view, based on the information currently available and the assessment undertaken in this report, that the risks would be insufficiently high to warrant call-in for the proposed EfW facility.

It is noted that the UK HSE’s role is purely advisory, and Planning Authorities are not obliged to follow HSE’s advice. In cases where a Planning Authority is minded to grant permission when HSE has advised against, it is important that the basis of HSE’s advice is well understood, and the Planning Authority should be satisfied that the socio-economic and other local benefits associated with the development should outweigh the residual levels of risk. It is emphasised that HSE’s advice is purely on health and safety grounds, and does not attempt to take into consideration the planning benefits.

In addition to providing an understanding of the basis of HSE’s approach in this type of case, this report provides an initial estimate and assessment of the risks, and identifies a number of relevant issues which are important in appreciating the nature and extent of the risk. The risk at the proposed EfW facility is probably dominated by potential VCE events at the fuel depot, although flash fires and large pool fires may also be significant.

It is estimated that the individual risk of fatality at the proposed EfW facility due to potential VCE events at the fuel depot is between 10 and 18 cpm, depending on the precise location. If the risks from other events (yet to be quantified) are included then the maximum individual risk at the proposed EfW facility may be around 25 cpm. This is not an insignificant level of individual risk, being a factor of 25 above the level that would generally be regarded by HSE as insignificant (broadly acceptable), but is still a factor of 4 below the 100 cpm level which is generally regarded as intolerable for members of the public who have a risk imposed upon them, and where HSE would almost certainly recommend call-in in the UK. However, it is noted that there may be some conservatism in the 25 cpm result.
The presence of people at the proposed EfW facility will also add to the societal risk associated with major accident events at the fuel depot and LPG storage sites. However, the initial calculations indicate that the resulting increment to the societal risk associated with VCEs at the fuel depot (which are probably the most significant events) is relatively small, and if considered in isolation would be comparable with a level that is generally considered to be broadly acceptable.

In summary, although there is a residual risk to people at the proposed EfW facility from potential events at the fuel depot, the risks are sufficiently low that it would not be unreasonable for a planning authority to grant permission, provided that they were satisfied that the socio-economic benefits associated with the development outweighed the low levels of residual risk.

Finally, it is noted that if planning permission is granted, there will still be a residual level of risk to the occupants of the proposed EfW facility, and so any reasonably practicable measures to reduce risks to the occupants should be given serious consideration.
9 REFERENCES

Documents Supplied as Part of this Project


‘Fuels Supplies (C.I.) Ltd - La Collette Terminal - Jersey - Oil Spill Emergency Plan’, Revision 0, 18/04/05.


‘La Collette Consortium - Shipping receipts, cargo & flow rates’.


La Collette Regs.doc, ‘La Collette – Hazard review group - Hazard Consultant – Information requirements - Item 2 Regulatory Activities and Procedures - Fire and Rescue Service’

MHAU 1995 report risk assessment of an alternative LPG installation.pdf

MHAU 1999 report proposed development of reclaimed land.pdf

Drawings Supplied as Part of this Project

Jetty - Hazardous area classification.pdf

Office - Hazardous area classification.pdf

Tank compound - hazardous area classification.pdf

La Collette - Hazard Review Group Area.pdf

La Collette 2006 new.jpg

Figure 02 - Island Plan Zoning for La Collette Area - Extract from Town Proposals Map.pdf

E 201 P1 - Planning Application Site Extent.pdf

E 203 P1_Facility plan.pdf

cl2mry45okgsbay5mmfhnt55_1.pdf

871-014-A1.pdf
General References


Consultancy Solutions for the Oil Industry, ‘Fuel Farm, La Collette, St Helier, Jersey - Review of the Current Arrangements for the Importation, Storage and Supply of Petroleum Products to the Distribution and Retail System in Jersey – Final Report’.


Health and Safety Commission, Advisory Committee on Major Hazards:


Health and Safety Executive, ‘Guidance on ‘As Low as Reasonably Practicable’ (ALARP Decisions in Control of Major Accident Hazards (COMAH) – (SPC/Permissioning/12)’, Hazardous Installations Directorate, 2002.


Figure 1.1 The Existing HSE Land Use Planning Zones Calculated in 1999

 jerk island Plan 2002
 TOWN PROPOSALS MAP
 as approved by the States of Jersey, 11 July 2002

 Drawing No. 2-02/A

 Energy from Waste Facility

 Island Plan Zoning For La Collette Area -
 Extract From Town Proposals Map

 Scale: NT6 @ A3
 Drawing No.: A3

 Figure 02
Figure 2.1 Aerial View of La Collette
Figure 2.2 Application Site Extent for Energy From Waste Facility
Figure 2.3 Facility Area Plan for Energy From Waste Facility
Figure 3.1 Site Plan for the Fuel Storage Depot (Showing Hazardous Area Classification)

The classification of areas into Zones 0, 1 and 2 shown on this drawing has been approved for Fuel Supplies (C.I.) Limited by:

For Engineering:

Name: [REDACTED]
Signature: [REDACTED]
Date: [REDACTED]

For Terminal Management:

Name: [REDACTED]
Signature: [REDACTED]
Date: [REDACTED]

Shell Distributor

This drawing is confidential and the information contained herein is a confidential disclosure. It is shown on the understanding that it is not to be revealed to others or used for any other purpose without the written consent of Trident Engineering Consultants.
Figure 4.1 Inner (120m), Middle (135m) and Outer (185m) HSE Land Use Planning Zones for Fuel Depot Based on Pre-Buncefield Approach
Figure 4.2 DPZ (150m), Inner (250m), Middle (300m) and Outer (400m) HSE Land Use Planning Zones for Fuel Depot Based on Possible Post-Buncefield Approach
Figure 5.1a Individual Risk of Fatality Contours for an Industrial Population (25% Occupancy) Scale 1:7,000
Figure 5.2  Individual Risk of Receiving a Dangerous Dose or Worse Contours for an Industrial Population (25% Occupancy) - Scale 1:7,000
Figure 5.3: Societal Risk FN Curve for People at Proposed EfW Facility for Risk of Fatality from Fuel Farm VCEs
Figure 5.4 Societal Risk FN Curve for All People at La Collette for Risk of Fatality from Fuel Farm VCEs
Figure 6.1  HSE Framework for the Tolerability of Risk
(from 'Reducing Risk, Protecting People', HSE, 2001)