

Proposals for revised policies for HSE advice on development control around large-scale petrol storage sites

This consultative document is issued by the Health and Safety Executive.

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to reach there no later than **22 May 2007**

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Responses to this consultative document are invited on the basis that anyone submitting them agrees to their response being dealt with in this way. Responses, or part of them, will be withheld from the Information Centres only at the express request of the person making them. In such cases, a note will be put in the index to the responses identifying those who have commented and have asked that their views, or part of them, be treated as confidential.

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Consultative document on proposals for revised policies for HSE advice on development control around large-scale petrol storage sites

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PREFACE

This Consultative Document sets out the Health and Safety Executive (HSE)'s proposals for revised policies on the advice it gives to Local Planning Authorities (LPAs) on development control in the vicinity of large-scale petrol storage sites, in the light of the explosion and fire at the Buncefield Depot. It also contains a Regulatory Impact Assessment of the proposals.

Acknowledgements

HSE wishes to thank those who have assisted it with the development of the proposals, particularly the Department for Communities and Local Government, Department of Trade and Industry, Welsh Assembly and Scottish Executive who have commented on these proposals and are content with their presentation in this document. The Buncefield Major Incident Investigation Board (see paragraph 1.4 below) have asked HSE to review its land use planning policies in the vicinity of sites like Buncefield and they have provided helpful advice to us.

Who should read this

The proposals will be of particular interest to operators of large-scale petrol storage sites, local authority planners, the emergency services, surveyors, and property developers.

Why we are consulting you

Although the HSE does not have a statutory duty to seek stakeholders' views on proposed changes to its policies for giving advice to LPAs on developments near major hazard sites, we believe that this is a matter of sufficient importance and public interest that we should hold a public consultation on it. We believe that this enables an open and transparent approach to decision-making, which is essential if policies and decisions are to have widespread ownership and reflect the needs and aspirations of the people they will affect. We will then decide on the best way forward based on an interpretation and analysis of the results of the exercise.

What we would like you to do

We would like you to respond to these proposals by 22 May 2007.

Online responses

Please register and visit the 'revised siting policy' consultation pages using the links at <http://consultations.hse.gov.uk>

Word Format Responses

A downloadable version of the questionnaire in Word format is available from <http://consultations.hse.gov.uk/>

Once completed offline, your response should be returned via the website.

By post

Please send your response to:

Consultation Administrator
Health and Safety Executive
Policy Group
5S.1 Redgrave Court
Merton Road
Bootle
Merseyside L20 7HS

Fax: 0151 951 3418, E-mail: sandra.ashcroft.lupqueries@hse.gsi.gov.uk

Responses to CDs are normally made publicly available unless respondents request confidentiality. If you reply to this consultative document in a personal capacity, rather than as a post holder of an organisation, you should be aware that the information you provide may constitute "personal data" in terms of the Data Protection Act 1998. For the purposes of this Act, HSE is the "data controller" and will process the data for health, safety and environmental purposes. HSE may disclose this data to any person or organisation for the purposes for which it was collected, or where the Act allows disclosure. You have the right to ask for a copy of the data and to ask for inaccurate data to be corrected.

We have included a reply form summarising the areas where we would welcome your views; it will also help to analyse responses. It is not intended to restrict the scope of comments: we would welcome any comments you wish to make on these proposals.

What happens next

We will acknowledge all responses and give full consideration to the substance of arguments in the development of proposals; we may also contact you again if, for example, we have a query. When we have made a decision we will publish on our website how the work will proceed and how the decision reached reflects the results of the consultation. We will not normally be giving individual responses. We will then revise our operational practices as necessary after which we expect to publish the revision on the HSE website.

Making responses public

To make our consultation process as thorough as possible we make the comments we receive available to the public at our Information Centre in Bootle. Copies will be made available at a small charge to cover our costs from the following addresses:

Health and Safety Executive
Information Centre
Redgrave Court
Merton Road
Bootle
Merseyside L20 7HS

If you do not want your views to be made public, please make this clear in your response, and we will respect your wishes.

Questions and complaints

If you have any questions about this consultation please contact:

Infoline on 0845 345 0055 or

e-mail: sandra.ashcroft.lupqueries@hse.gsi.gov.uk

e-mail: shaun.welsh.lupqueries@hse.gsi.gov.uk.

If you have specific enquiries about the Regulatory Impact Assessment please contact:

Chris Milne e-mail chris.milne@hse.gsi.gov.uk

If you are not satisfied with the way in which this consultation exercise has been conducted you can complain by contacting Gwyneth Deakins, Health and Safety Executive, Policy Group, Specific Interventions Division, 7NW, Rose Court, 2 Southwark Bridge, London SE1 9HS.

We aim to reply to all complaints within 10 working days. If you are not satisfied with the outcome of your complaint, you can raise the matter with the Chief Executive at the Health and Safety Executive, Rose Court, 2 Southwark Bridge, London SE1 9HS. You can also write to ask your MP to take up the case with us. Your MP may refer the matter to the Parliamentary Commissioner for Administration (the Ombudsman) who will investigate your complaint.

EXECUTIVE SUMMARY

Introduction

The explosion and fire at Buncefield Oil Storage Depot in December 2005 has challenged worldwide perception about the scale and nature of risks presented by sites storing large quantities of petrol. A large vapour cloud explosion (VCE), as occurred at Buncefield, was not considered to be credible - a large petrol fire was considered the most likely 'worst-case scenario'.

One of the ways in which the risks from such sites are controlled is restricting development around them through the land use planning (LUP) system. This Document reviews the current arrangements for HSE's advice to local planning authorities (LPAs) about proposed development around similar sites in the light of the Buncefield incident, and seeks views on possible changes.

This follows from the Buncefield Major Incident Investigation Board (MIIB)'s statement (see <http://www.buncefieldinvestigation.gov.uk>.) in May 2006 which referred to 'the importance we attach to HSE reviewing the advice it gives to planning authorities in relation to sites such as Buncefield . . . enough information has now emerged to enable HSE to undertake this review.' This consultation will help HSE to respond to the Board's request.

It is the first of two public consultations on related issues. The Government is to publish a separate document examining whether the concept of 'societal risk' should be brought into the LUP process around major hazard sites, including some petrol storage depots. Currently HSE gives advice to LPAs based on assessment of the risk to **individuals** (i.e. people at a particular location) around these sites. 'Societal risk' is the term used to describe the chances that major accidents at such sites could result in harm to a significant **number** of people. At present societal risk is taken into account only to a limited extent in HSE's advice to LPAs about each proposed development near these sites.

The LUP system around major hazard sites

Sites holding certain hazardous substances above defined limits to have consent from the Hazardous Substances Authority (HSA), which is usually the local planning authority (LPA). By law the HSA must consult HSE when it considers Consents applications. If consent is granted HSE notifies the LPA of a 'consultation distance' (CD) around the site and produces a map dividing the CD into three zones in the CD, defining levels of likely risk or harm to any individual within each zone. The nearer the individual is to the site, the greater the level of harm or risk would be. HSE must by law be consulted by the LPA on any future applications for planning permission for specified development within these zones.

HSE's advice has to be taken into account by LPAs in deciding on planning applications for developments within the CD. In the majority of cases the LPA follows HSE's advice.

The principles on which HSE's advice is based

HSE has developed principles to enable it to respond to consultations by LPAs. Its principles are based on the findings of the Advisory Committee on Major Hazards (ACMH), and include 'Mitigation' of consequences (lessening the effects) of major accidents that may occur after the loss of 'prevention' and 'control'. This is done through measures such as land use planning controls and emergency planning.

HSE's policy objectives and principles on LUP were recently reviewed as part of a fundamental review of HSE's role in land use planning and were revised in conjunction with a group of external stakeholders including industry and LPAs. However they may now need to be reconsidered to some extent in the light of the Buncefield incident and the forthcoming Government consultation on societal risk.

Question

- **Do you think that in the light of the Buncefield incident, the Objectives and Principles (in Annex 1) remain a sound basis for HSE's land use planning advice to planning authorities?**

Previous assumptions about people's ability to respond to a similar incident to Buncefield, and their safety at given distances from it, may now be open to challenge. The rate of release of dangerous substance, and subsequent effects such as fire and or explosion, could be such that people might have difficulty in escaping to safer locations or shelters. This suggests the need for a review of previous HSE policy on advice on developments in the inner zone.

The Buncefield incident and its implications for Land Use Planning

Had the buildings surrounding the Buncefield site been occupied, significant numbers of people could have been killed or injured by the explosion, though the precise consequences are uncertain. HSE's criteria for setting CDs and zones recognise that people within these zones **could** be harmed, but even so it is not clear that the zones around Buncefield provided enough protection.

Buncefield proved that a major release of unleaded petrol can result in a violent explosion. Further scientific research is required to investigate this VCE phenomenon - without it there will continue to be uncertainty about how VCEs might occur and what effects they may have. However it would take a number of years to do all the necessary work and clearly it would be imprudent to delay making changes to HSE's advice on LUP pending the outcome of the research.

HSE uses the 'protection-based' approach to determining CDs and zone boundaries for some sites, rather than a 'Quantified Risk Assessment'. HSE believes the benefits of the protection concept are particularly relevant to this case because of the uncertainty around the likely frequency of such incidents in future, which makes assessment of risk especially difficult.

HSE seeks to achieve a sensible and practicable balance between risk and development. This currently allows a limited amount of less 'sensitive' industrial and commercial development and small scale housing close to large scale petrol storage

depots. However, it is now appropriate to consider changes to the nature of the developments that may be allowed/not 'advised against' within each of the three zones in the CD. We therefore commissioned two studies to assess our current policies and examine options for change. HSE has used the two reports combined with expert judgment to propose options that are precautionary given the continuing uncertainties and gaps in knowledge following the events at Buncefield.

The Options

The possible options include combinations of changes to the consultation distances, zone boundaries and the advice that is given within them. Any changed LUP advice policy will affect only future developments around petrol storage depots – it is not intended, nor would it be practicable, to impose a new policy retrospectively on developments around existing sites.

At present the consultation distances/zones around large-scale petrol storage sites are 185 m for the consultation distance/outer zone, 135 m for the middle zone and 120 m for the inner zone.

Option 1 – No change to LUP advice

No change to HSE's LUP advice system - HSE would assume that improvements to on-site safety arrangements at petrol storage depots would reduce the risk of such an incident happening again to such an extent that the offsite risks could be considered acceptable without further planning restrictions.

This would be simple and avoid further restrictions on development, but we do not know the extent to which improved safety measures would reduce the likelihood of another such incident (because we do not fully understand the causes of the Buncefield explosion), and it might not meet our legal obligations to limit the consequences of a major accident.

Option 2 – Change size of CD and zones, based on hazard

Extend the current CD and planning zones around petrol storage depots, based on the observed building damage from the VCE at Buncefield. However the 'sensitivity levels' of developments HSE would advise to be permitted within the zones would not change.

This would be relatively simple, the increase in zone sizes is clearly based on the evidence from Buncefield and would better control risks, and control increases in the number of people within a larger area. It would provide greater public reassurance. On the other hand it would not control risks for workplaces or control any increase in the number of people in workplaces in the Inner Zone because medium-sized workplaces would still be permitted.

Option 3 – Change size of CD (as Option 2) and development sensitivity levels

Extend the CD and zones around petrol storage depots, and limit development in the Inner Zone more than at present, i.e. allow only buildings that are 'not normally occupied'.

This would better control risks to individuals, and prevent incremental build-up of new occupied workplaces in the Inner Zone. It would minimise economic disruption after an incident, and provide greater public reassurance. On the other hand it would be more difficult for HSE and planning authorities to administer and would place significant limitations on development.

Option 4 – Change size of CD informed by risk, and adopt new Development Proximity Zone to give more restrictive advice

Extend the CD and planning zones as in Options 2 and 3, and introduce a new development proximity zone (DPZ) at a radius of 150m from the site. Within the DPZ HSE would advise against development other than that involving buildings that are 'not normally occupied'.

Risks to individuals would be better controlled, and there would be greater reassurance to the public than Option 2 (though maybe not Option 3). Incremental build-up of new workplaces up to 150 m from the site would be avoided, and development restriction is less onerous than Option 3. On the other hand, development restriction is more onerous than Option 2, it would be more complex to administer, and new buildings within the Inner Zone could be subject to significant damage from an incident similar to Buncefield.

If it is considered that some extension of the CD is appropriate, the advantages and disadvantages of options 2 to 4 are finely balanced. However the arguments suggest that the option which best combines and increase in public protection with a relatively less onerous restriction of new economic and social development is Option 4.

Questions

- **Is it right to extend the consultation distances to the area of damage observed in the Buncefield explosion?**
- **Should we change our assumptions about the vulnerability of individuals likely to be affected by such an incident?**
- **Which option best strikes the right balance between reducing the risk of harm to individuals and allowing economic and social development in the vicinity of these sites?**
- **We would particularly like views on Option 3, which gives the greatest level of protection to individuals and the greatest amount of land use control; and Option 4, which gives greater public safety protection than at present but allows more development than Option 3.**

Conclusion

The information gathered following the Buncefield incident enables HSE to propose options for change to its LUP advice to LPAs based upon the best evidence currently available. On the basis of this information, it seems sensible to make some change. But whether to do so and the extent of any change is the subject of this consultation exercise. In addition to consulting on the four options set out above, we are also

taking the opportunity to confirm the principles on which we base our advice, and are seeking comments on them.

Wider Implications for other major hazard sites

The implications of these changes for major hazard sites other than large scale petrol storage need to be considered, but those are not an issue for this consultation exercise. Installations storing substances other than petrol could present this type of hazard, and assumptions about possible means of and time available for emergency action are equally applicable to such sites. More research should be undertaken to clarify our understanding of the conditions under which such explosions may occur, and thence how the risks from them may be controlled. Also, HSE needs to review some of the assumptions used in its risk assessments to rationalise issues such as, for example the level of protection given to people from fire and toxic hazards, as well as from explosions; and the varying capabilities of people to escape from a 'developing' major incident.

1. INTRODUCTION

1.1 The explosion and fire at Buncefield Oil Storage Depot in December 2005 has challenged worldwide perception about the scale and nature of risks presented by sites storing large quantities of petrol such as Buncefield. In the UK such sites have generally been designed and operated to goal-setting standards that were designed to cover a wide range of risks. However they did not consider a large vapour cloud explosion (VCE), as occurred at Buncefield, to be credible - a large petrol fire was considered the most likely 'worst-case scenario'.

1.2 One of the ways in which the risks from such sites are controlled in this country is restricting, to some extent, development in the areas around them through the land use planning system. This Consultative Document reviews the current arrangements for HSE's land use planning advice to local planning authorities (LPAs) about proposed development around similar sites in the light of the Buncefield incident, and seeks views on possible changes. It also takes the opportunity to seek views on the implications of the Buncefield incident for the objectives and principles on which HSE's Land Use Planning (LUP) advice policy is based. It is issued by the Health and Safety Executive who have responsibility for advising local planning authorities on development around major hazard sites.

The Incident

1.3 'In the early hours of Sunday 11 December 2005, a number of explosions occurred at Buncefield Oil Storage Depot, Hemel Hempstead, Hertfordshire. At least one of the initial explosions was of massive proportions and there was a large fire, which engulfed a high proportion of the site. Over 40 people were injured; fortunately there were no fatalities. Significant damage occurred to both commercial and residential properties in the vicinity and a large area around the site was evacuated on emergency service advice. The fire burned for several days, destroying most of the site and emitting large clouds of black smoke into the atmosphere.' (Extract from Buncefield Investigation Homepage, www.buncefieldinvestigation.gov.uk.)

The Major Incident Investigation Board

1.4 On 12 January 2006 the Health and Safety Commission appointed a six-person Major Incident Investigation Board (MIIB) to oversee the formal investigation being carried out jointly by the HSE and the Environment Agency (see <http://www.buncefieldinvestigation.gov.uk>). In a statement to accompany the Board's third progress report on 9 May 2006 it said - 'In relation to land use planning the Board's statement of 21 February, on publishing the first progress report, emphasized the importance we attach to HSE reviewing the advice it gives to planning authorities in relation to sites such as Buncefield, as information emerges from the investigation. While we still do not fully understand why the explosion was so violent, enough information has now emerged to enable HSE to undertake this review.' The consultation carried out via this document is a key element in formulating HSE's response to the Board's request.

Review of 'Societal risk'

1.5 This is the first of two public consultations on related issues. This document suggests some possible options for specific changes to the LUP system in the light of the lessons learned from the Buncefield incident. In addition work has been under way since before this incident to consider the implications of new information about major hazard sites which HSE has gathered. Lord Hunt, the then Minister for Work and Pensions, said in a statement in May 2006 that this process, coordinated by the Cabinet Office, would be the subject of consultation as soon as clear conclusions emerged. This second consultation document will examine whether the concept of 'societal risk' should be brought into the land use planning process around major hazard sites, including, but not limited to, petrol storage depots like Buncefield.

1.6 As will be explained in more detail below, HSE gives advice to LPAs based on assessment of the risk to **individuals** (i.e. people at a particular location) in the immediate area around major hazard sites. The possible changes to its advice that are set out in this document would be based on views on risk and harm to individuals who might occupy future developments around petrol storage depots. Societal risk is the term used to describe the chances that major accidents at major hazard sites (including depots like Buncefield) could result in harm to a significant **number** of people, either on-site or living or working nearby. At present societal risk is taken into account only to a limited extent in the advice that HSE gives to LPAs about each proposed development near major hazard sites.

1.7 'Risk' can be described in simple terms as the chance or probability of a particular thing happening. Both 'individual' and 'societal' risk are a combination of the probability of events happening (e.g. an accident at a major hazard installation) and the possible consequences of those events. The key factor in societal risk estimates is the total population around sites. If there is more population around a site, it is more likely that a major incident would harm a significant number of people. The more people and the closer they are to the hazard, the higher, generally, is the societal risk. Also, if the population density in a particular location goes up, more people will be harmed if, for example, a gas cloud goes towards that area. This is of concern to 'society' as a whole, because of public concern about large numbers of casualties from a single event, and the wider economic implications of such an incident. For each of the individuals around a site, however, the (very low) risk of harm from an incident is unaffected by societal risk considerations.

1.8 In its Initial Report the Buncefield MIIB noted that possibly 'in future more attention should be paid to the total population at risk from major hazard sites.' The Board looked forward to the consultation with stakeholders that the Government is to undertake. The response to that exercise, together with this consultation on LUP around petrol storage depots, should help to address the Board's concerns about LUP around major hazard sites.

1.9 The results of both consultations will help HSE, other Government Departments and agencies, and LPAs more effectively to ensure public safety whilst maintaining an appropriate balance with the need for economic and social development around major hazard sites.

2. BACKGROUND – THE LUP SYSTEM AROUND MAJOR HAZARD SITES

The Present System

2.1 The MIIB said in its Initial Report (Executive Summary): ‘The Buncefield incident poses fundamental questions about residential and commercial development around sites like Buncefield. Continuing uncertainty in this area creates serious problems for local communities, particularly those directly affected by the Buncefield incident. This is a complex issue requiring a balance to be made between the risks and benefits of development.’

2.2. The risks posed by sites using and storing large quantities of hazardous substances are regulated and managed in a number of ways including land use planning. Operators of major hazard sites are required by the Health and Safety at Work Act (HSWA) 1974 and the Management Health and Safety at Work Regulations 1999 to produce safety policies and risk assessments covering the whole range of health and safety risks from their activities. Further duties under the Control of Major Accident Hazard (COMAH) Regulations are aimed at preventing and mitigating the effects of major accidents involving dangerous flammable and toxic substances that can cause serious harm to people and the environment. This document does not cover the issues of health and safety within these sites, nor with the arrangements which by law have to be made to deal with emergency plans for major accidents.

2.3 Land use planning controls have been a feature of the UK’s strategy for managing major hazards for over 30 years. (The 1996 Seveso II Directive introduced these principles across all of the European Union – some Member States also already had similar arrangements.) Current legislation includes the Planning (Hazardous Substances) Act 1990 and the associated Planning (Hazardous Substances) Regulations 1992 as amended, which require sites holding certain hazardous substances above defined limits to have consent from the Hazardous Substances Authority (HSA), which is usually the local planning authority (LPA). By law the HSA must consult HSE when it considers applications for these Hazardous Substances Consents. HSE advises the HSA on whether consent should be granted, based on its view of the hazards and risks posed by the hazardous substances to people in the surrounding area and taking account of existing and potential developments. HSE bases its land use planning advice on historical data and the presumption that site operators are complying with the law.

2.4 If consent is granted HSE notifies the LPA of a ‘consultation distance’ (CD) around the site, which is divided into three zones. When dividing the CD into zones, HSE uses the information given by the site operator in the Hazardous Substances Consent application. HSE produces a map with the three zones around the site, defining levels of likely risk or harm to any individual within each zone. The nearer the individual is to the major hazard site, the greater the level of harm or risk would be. In each case the risk relates to an individual sustaining a specific level of harm - the so-called ‘dangerous dose’ or worse. (The three zones represent either defined levels of harm; or levels of individual risk of 10 cpm (chances per million) in the inner zone, 1 cpm in the middle zone and 0.3 cpm in the outer zone per year respectively of receiving a dangerous dose or worse.) The outer edge of the third zone represents the edge of the consultation distance. HSE must by law be consulted by

the LPA on any future applications for planning permission for specified development within these zones.

2.5 It should be noted that risk or harm considered in this context does not include damage to property except insofar as this may impact directly on the health and safety of people.

2.6 The proposed development is assigned to one of four 'sensitivity levels', depending on its intended use, the number of people at the development, the intensity of the development and whether it is intended for 'vulnerable' people such as schoolchildren.

2.7 HSE's advice has to be taken into account by LPAs in deciding on applications for planning permission for proposed developments within the consultation distance. In the majority of cases the LPA follows HSE's advice. In those (rare) cases where the planning authority is minded to grant planning permission against HSE's advice, it must give HSE notice and allow twenty-one days to pass before making a decision. In these cases, HSE further reviews the application and if it considers the risk to people is of major significance, it may request that the application be 'called-in' for determination by, in England, the Secretary of State for the Department of Communities and Local Government and, in Wales, the National Assembly for Wales. In Scotland, if a planning authority is minded to approve an application contrary to HSE's advice, it has to notify the Scottish Ministers who may decide to call in the case for their own determination¹.

2.8 During 2006 and 2007, HSE has been giving all planning authorities in England, Scotland and Wales on-line access to HSE's land use planning decision tool, PADHI+ (Planning Advice for Developments near Hazardous Installations). The PADHI+ system consists of the consultation zone library (CZL) for all hazardous installations and pipelines together with the PADHI+ advice generator.

2.9 The PADHI+ system was based on a codification of over 25 years' experience of HSE giving advice to LPAs on developments. Planning Authority staff enter information about the development on which they are seeking advice, together with its location in the zones around the site in question. The zones are based on detailed assessments by HSE technical staff of the hazards and risk posed by what is contained in each of the sites' Hazardous Substances Consent. The software then uses the inputs and the matrix illustrated in the box below (Table 1) to generate HSE's advice for or against the granting of planning permission. A detailed description of how PADHI decision tool works is on the HSE website (<http://www.hse.gov.uk/lanuseplanning/padhi.pdf>).

¹ The call-in arrangements are on HSE's website at <http://www.hse.gov.uk/foi/internalops/hid/spc/spctg22.pdf>.

Table 1 Matrix for generating HSE advice on planning applications around major hazard sites

Level of Sensitivity	Development in Inner Zone	Development in Middle zone	Development in Outer Zone
1	DAA	DAA	DAA
2	AA	DAA	DAA
3	AA	AA	DAA
4	AA	AA	AA

Sensitivity Level 1 - Example: Factories

Sensitivity Level 2 - Example: Houses

Sensitivity Level 3 - Example: Vulnerable members of society e.g. primary schools, old people's homes

Sensitivity Level 4 - Example: Football ground/ large hospital

DAA means **Do Not Advise Against Development**

AA means **Advise Against the Development**

The principles on which HSE's advice is based

2.10 HSE has developed principles to enable it to respond to consultations by LPAs. Its principles are based on the findings of the Advisory Committee on Major Hazards (ACMH) which was appointed by the Health and Safety Commission to help to develop regulation on major hazards in the wake of the Flixborough explosion in 1974 and produced 3 reports between 1976 and 1984. A three-strand approach to 'risk' control for major hazards was developed, and is reflected in legislation:

- Identification of the major hazards – for example the Planning (Hazardous Substances legislation)
- Assessment and Control (COMAH) – measures taken by operators both to a) prevent, so far as is reasonably practicable, major accidents and b) reduce the chances of any incident that does occur escalating to more serious consequences e.g. one explosion leading to another
- Mitigation – of consequences (lessening the effects) of major accidents that occur after the loss of 'prevention' and control. This is done through measures such as land use planning controls and emergency planning.

2.11 In relation to 'mitigation' ACMH acknowledged that

“absolute safety in any sphere of human endeavour is impossible and it would be imprudent not to take account of the possibility of a major accident, however remote.”

So despite health and safety legislation to control risks as far as is reasonably practicable, there remains a chance of a major accident, whose impact upon people outside the installation could be lessened by mitigating measures such as keeping major hazard plants 'away from centres of population' and 'similarly it is wise to avoid substantial growth in population near an existing installation. . . Ideally the separation should be such that the population would be unaffected whatever accident occurs. For hazardous installations, however, such a policy is not

reasonably practicable. It seems reasonable to aim for a separation which gives almost complete protection for lesser and more probable accidents, and worthwhile protection for major but less probable accidents. . . Different activities also involve different people of varying degrees of vulnerability. A relatively active and disciplined factory work force for example could reasonably be expected to take cover or evacuate a danger area in an orderly fashion. It would not be reasonable to expect the same response from an old people's home, an infant school or a crowd of shoppers at a supermarket.' (Extracts from the third ACMH Report, paragraphs 80-86)

2.12 These policy objectives and principles were reviewed as part of a fundamental review of HSE's role in land use planning in 2002. As part of the review, HSE revisited the ACMH principles upon which it provided land use planning advice. This was mainly to bring them together in a single place and to give greater clarity to the way the principles themselves were presented. The review also aimed to ensure that the principles remained fit for purpose and were up to date. A new set of Objectives and Principles to govern HSE's involvement in land use planning was drawn up in 2004-05 in consultation with planning authorities, industry and other stakeholders who endorsed them. Their publication was placed on hold by HSE as it entered in to discussions with other Departments on societal risk, and therefore they have not been entirely implemented in their updated form. HSE believes that they remain basically sound, particularly because of the relatively recent stakeholder involvement in their review and public consultation. However they may now need to be reconsidered to some extent in the light of the Buncefield incident and the forthcoming Government consultation on societal risk (see paragraphs 1.5 – 1.9 above). (The societal risk consultation will cover all major hazard sites, including large scale petrol storage depots, so that issue is not covered in this exercise.) The full set of these Objectives and Principles has not been published since the 2004-05 review and, for completeness, are included here at Annex 1.

Question

- **Do you think that in the light of the Buncefield incident, the Objectives and Principles (in Annex 1) remain a sound basis for HSE's land use planning advice to planning authorities?**

2.13 Principles 9 and 10 specifically deal with the separation between categories of 'vulnerable' people and major hazard installations:

Principle 9: HSE's advice will take account of the need to maintain appropriate separation distances between Major Accident Hazard establishments and developments used by people. HSE uses a three-zone approach to decide whether the proposed separation is suitable, on safety grounds, when formulating its advice. The separation depends on the type and size of the proposed development.

Principle 10: HSE advice will depend on the size and type of the proposed development. Vulnerable groups will be afforded greater protection than healthy and mobile people. This reflects society's concern about events causing multiple fatalities and the increased vulnerability of people who, in the event of an incident, cannot easily move away from the source of danger. HSE's approach takes both the vulnerability and number of people potentially involved into account through

its determination of a sensitivity level for a proposed development. It considers 'vulnerable groups' to include children, the sick, the elderly, those with mobility difficulties or those unable to recognise physical danger.

2.14 In the light of the Buncefield incident however, the assumptions previously made about people's ability to respond to a major incident of this type and their safety at given distances from it may now be open to challenge. In any similar major incidents, the rate of release of dangerous substance, and subsequent effects such as fire and or explosion, could be such that people might have difficulty in making their escape to safer locations or shelters away from the effect of the incident. The Buncefield incident suggests the need for a review of previous HSE policy on advice on developments in the inner zone. We now move to explain why the incident cast previous assumptions into doubt.

3. THE BUNCEFIELD INCIDENT AND ITS IMPLICATIONS FOR LAND USE PLANNING

3.1 The first progress report by the Buncefield Incident Investigation Board, February 2006, said:

‘The Buncefield depot is close to the Maylands Industrial Estate, home to some 630 businesses employing about 16,500 people. All businesses were disrupted by the explosions and fire, some severely. The premises of 20 businesses employing 500 people were destroyed; the premises of 60 businesses employing 3500 people are under repair and not yet usable. Most businesses face difficulties in delivering pre-incident levels of service from dispersed and temporary accommodation. Reduced trading and supply disruptions have affected businesses over a wider area. Impact on employment has been limited so far but job losses could become significant over the next few months.

‘The incident also damaged nearby housing, mainly in Dacorum district, but also in St. Albans district. Some houses closest to the site suffered significant structural damage; several families are living in temporary accommodation while their houses are repaired. At least 300 houses suffered lesser damage.’

3.2 Had the surrounding buildings been occupied, significant numbers of people could have been killed or injured, although the precise consequences are uncertain. Because the vapour cloud spread unobtrusively and the explosion happened rapidly there might not have been enough time for organised evacuation. HSE sets consultation distances and zones within these distances to ‘give almost complete protection for lesser and more probable accidents, and worthwhile protection for major but less probable accidents’. (ACMH, see paragraph 2.10 above.) This criterion recognises that people within these zones **could** be harmed, but even within these parameters it is not clear that the zones around Buncefield provided enough protection. (The history of the consultation distance around the Buncefield site is described in Annex 3 of the MIIB’s Initial Report of July 2006. The basis for HSE’s current LUP siting assessment and advice for the Buncefield Oil Storage depot is at Annex 3 of this document.)

3.3 The MIIB said (Initial Report, paragraph 77) ‘Further work is needed to research the actual mechanism for generating the unexpectedly high explosion overpressures seen at Buncefield’. In line with current HSE technical policy (which is kept under review and revised to accommodate the latest scientific thinking and research), the last site-specific assessment at Buncefield limited its consideration of Vapour Cloud Explosion (VCE) events to the possibility of a major loss of containment at the road tanker loading bays. When the VCE was estimated it was shown that the calculated overpressures from the tanker loading area were well within the site boundary, so the zones appeared to be appropriate.

3.4 However, Buncefield proved that a major release of unleaded petrol can result in a violent explosion. Over the years some research has been carried out into the mechanisms of VCEs, largely to investigate the ignition of gas and vapour releases in confined spaces e.g. within buildings and other structures. However further scientific research is required to investigate this VCE phenomenon. Without such work there will continue to be considerable uncertainty about the conditions under

which VCEs might occur, what the scale of impacts may be from the overpressures generated, and the relationship between these impacts and the severity of harm to people. Annex 2 provides HSE's overview of the Theoretical and Experimental Understanding of Unconfined Vapour Cloud Explosions with supporting references to key published papers and research reports (some of which are available on HSE's website).

3.5 It would take a number of years to carry out all the necessary further research to understand completely the VCE phenomenon, and clearly it would be imprudent to delay making changes to HSE's advice on LUP pending the outcome of what would be likely to be extensive and costly research programmes

3.6 There are some 50-60 petrol storage depots similar to Buncefield in Great Britain. This number has been established based on HSE's considered view of the factors that led to the overflow of a tank with petrol supplied through a pipeline, and subsequent generation of the vapour cloud. In other words, it includes all installations storing petrol above a certain quantity (the COMAH threshold). The criteria which would be used to identify sites to which revised land use planning arrangements might be applied are as follows:

'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.'

3.7 These criteria are based upon the best knowledge currently available. However this knowledge may develop in future and so lead to changes. The criteria are precautionary, and so provide what HSE believes to be appropriate additional public protection. Work is under way to identify the characteristics of other substances that may have potential to act in a similar manner to petrol.

A 'protection-based' system or Quantified Risk Assessment (QRA)?

3.8 HSE uses the 'protection-based' approach to determining CDs and zone boundaries for some sites. This method selects a representative 'event'; experience with risk analysis has shown that there is one event that dominates the risk profile. This event is chosen to form the basis of a protection-based assessment from which the consequences are modelled and hence the land use planning zones determined.

3.9 The protection-based approach as employed by HSE is based upon the description in the third report of the Advisory Committee on Major Hazards:

"Ideally, the separation should be such that the population would be unaffected whatever accident occurs. For hazardous installations, however, such a policy is not reasonably practicable. It seems reasonable to aim for a separation which gives almost complete protection for lesser and more probable accidents, and worthwhile protection for major but less probable accidents." (See also para 2.11 above.)

3.10 In its decisions as to when to use the protection-based approach HSE reflects the DETR Circular 04/2000 Para A4 (or WO Circular 20/01), which states:

“where it is beneficial to do so, HSE’s advice takes account of risk as well as hazard – that is the likelihood of an accident as well as its consequences”.

Even where a QRA is considered to be more appropriate (risk based modeling of a range of accident scenarios), a protection-based assessment may be selected until the QRA methodology is developed, tested and implemented. The protection concept has also been reviewed at a public inquiry in 2002 (Portland Port Authority application for Mere Tank Farm), when it was judged fit for purpose by the Enquiry.

3.11 HSE believes that the incident at Buncefield has not changed that position. Indeed the benefits of the protection concept are particularly relevant to this case because of the degree of uncertainty that now exists about the likely frequency of such events in future. In other words, the level of ‘precaution’ that can be incorporated into the protection concept could be seen as an advantage in dealing with similar sites in the present circumstances.

HSE’s consideration of possible changes to assessment and the setting of consultation distances and zones

3.12 When it was assumed that the ‘worst case scenario’ at petrol storage depots would involve a loss of flammable material forming a pool fire, and the anticipated consequences were based on fire hazard to people, it was reasonable to assume that (outside the inner zone) buildings might offer some protection and could allow time to respond to a developing fire emergency. Furthermore, HSE’s approach with planning authorities is based on the need to achieve a sensible and practicable balance between risk and development around major hazard sites, given that in a heavily populated country it is rarely practicable to set up complete exclusion zones. This approach therefore currently allows a limited amount of less ‘sensitive’ industrial and commercial development in close proximity to petrol storage depots.

3.13 However, it is appropriate not only to consider changes to the **extent** of the consultation distance, but also to consider changes to the **nature** of the developments that may be allowed/not ‘advised against’ within each of the three zones in the CD. Events can develop rapidly, giving little time for people to respond and escape from buildings before also being endangered by building collapse. For VCE - which is difficult to predict in risk assessments - to be used as the basis of future land use planning arrangements therefore requires consideration of not only the size of the zones but also the advisability of the type of new ‘normally occupied’ buildings located within them.

3.14 Therefore, in order to be able to respond more quickly to the Buncefield incident, HSE commissioned a number of studies to assess the adequacy of its current policies, and to develop options to revise its advice to planning authorities for future developments. These options are fully described in two HSE Research Reports available from HSE’s website:

- a) Research Report 511 Proposed Revisions to Land Use Planning Arrangements for Large Scale Petroleum Storage Depots, ERM (Environmental Resources Management) 2006 (summary given in Annex 4)

- b) Research Report 512: Review of Significance of Societal Risk for Proposed Revision to Land Use Planning Arrangements for Large Scale Petroleum Storage Depots, Atkins Global 2006 (summary given in Annex 5)

3.15 The two research studies each took a different approach. The first (ERM) noted the absence of our understanding of the VCE explosion that occurred at Buncefield. The outcomes of the study were options that translated damage seen at Buncefield to the levels of harm that HSE uses to set zones for other major hazard sites that have protection-based LUP zones. ERM concluded that for the purposes of land use planning HSE might need to consider advising against new normally occupied development within 250m of the sites.

3.16 The Atkins study took a precautionary risk-based approach founded on a series of expert judgements and assumptions. It showed that the exclusion of new normally occupied buildings from an inner zone of 250m around large petrol storage sites, and the retention of current controls on development in the middle and outer zones would prevent levels of societal risk from increasing to the point where societal risk would need to be explicitly considered. Atkins went on to conclude that a development proximity zone of 150m aligned with the current development controls in the inner, middle and outer zones for large-scale petrol sites might be sufficient to limit any increase in societal risk.

3.17 HSE has used the two reports combined with expert judgement to propose options that are precautionary given the continuing uncertainties and gaps in knowledge following the events at Buncefield.

4. THE OPTIONS

4.1 The possible options for changing HSE's LUP advice system around petrol storage sites include:

- increasing the consultation distance, and changing the relative sizes of the zones
- changing the advice that is given within any or all of the zones
- adding a new 'inner development proximity zone'.

Of course any changed system could incorporate a combination of any of these. There is also the option of leaving the present LUP system around Buncefield-type sites unchanged.

4.2 It is important to make it clear that any changed LUP advice policy will affect only future developments around petrol storage depots – it is not intended, nor would it be practicable, to impose a new policy retrospectively on developments around existing sites.

4.3 Of the many variants for possible changes, for simplicity this document presents four options, which best illustrate the likely benefits and costs of those. At present the consultation distances/zones around large-scale petrol storage sites are 185 m for the consultation distance/outer zone, 135 m for the middle zone and 120 m for the inner zone. (These zones are illustrated in Figure 1 of Annex 3.)

Option 1 – No Change to LUP advice

4.4 There would be no change to HSE's LUP advice system, but HSE would assume that the improvements to on-site safety arrangements at petrol storage depots, agreed by a joint HSE/industry task force, would reduce the risk of such an incident happening again to such an extent that the offsite risks could be considered acceptable without further planning restrictions. Fundamental redesign of tank top structures may offer some scope for risk reduction but this is so far untested and uncosted. It is worth bearing in mind the ACMH report's view that 'absolute safety in any sphere of human activity is impossible and it would be imprudent not to take account of the possibility of a major accident however remote' (see also paragraph 2.11 above).

For

- It would avoid additional restrictions on development
- It would avoid the costs of making and communicating new rules on consultation distances and advice
- It would be founded on established historical data (excluding the Buncefield incident)

Against

- It would rely on the effectiveness of improved safety arrangements, so there would be less of a guarantee that risks would be better controlled. Because the explosion mechanism is not understood, it is not possible to be certain as to the effectiveness of the improved safety measures.
- It could fall short of the duties placed on operators and HSE by the COMAH Regulations and the Seveso II Directive².
- It might not meet public concern.

Option 2 – Change size of CD and zones, based on hazard

4.5 Extend the current consultation distance and planning zones around petrol storage depots (see Fig. 1 below) – the zones proposed here are based on the observed building damage from the VCE at Buncefield. The proposed consultation distance would be doubled and cover approximately four times the area of land covered by the current CD. All of the area covered by the current CD would fall within the new Inner Zone of 250 m. However the ‘sensitivity levels’ of developments HSE would advise to be permitted (i.e. Do not Advise Against – see Table 1) within the zones would not change – as shown in Fig. 2. The Regulatory Impact Assessment (RIA) shows that the 30-year net present value (NPV) opportunity cost of lost development under this option is estimated at £2m.

For:

- Only workplaces, few dwellings and limited public facilities would be allowed (DAA) within 250 m of the site.
- It would be relatively simple to understand and administer
- Risks to individuals within the consultation distances would be better controlled (except in workplaces – see below)
- The potential increase in numbers of people within the consultation distances would be controlled (except in workplaces)
- It would include the consequences of the Buncefield incident in HSE’s land use planning advice using the best scientific evidence currently available

² The operator of an establishment under Seveso II and COMAH has a duty to ‘take all measures necessary to prevent major accidents and to limit their consequences to persons and the environment’, and HSE as competent authority under COMAH has to ensure that the operators fulfil this duty. Furthermore Seveso II/COMAH require that the objectives of preventing major accidents and limiting the consequences of such accidents are taken into account in land use policies inter alia, by ensuring appropriate distances are maintained around such establishments to control development within them. In the light of the consequences of the Buncefield explosion, not to make changes to the planning advice might not be considered ‘appropriate’ in legal terms, although this would depend on the reliability of the additional safety measures imposed on the operators.

- There would be greater reassurance to the public

Against:

- The risk would not be controlled for people in workplaces (who might include some vulnerable individuals)
- Any increase in the numbers of people in the workplaces would not be controlled
- Development would be more restricted than at present, in terms of the increased area of land affected

Option 3 – Change size of CDs (as Option 2) and development sensitivity levels

4.6 Extend the consultation distance and zones around petrol storage depots **and** change the sensitivity levels for these sites (see Fig. 3 below). This means that as well as the area of the CD and the zones being enlarged, the type of development within the inner zone would be more limited than at present. It would be restricted to buildings which are not normally occupied such as warehousing (no offices), outdoor storage, farm buildings and parking areas with no facilities. At present small factories and small offices (less than 100 people), a limited amount of housing and small retail use are permitted within the inner zone. The RIA shows that the 30-year NPV of the opportunity cost of lost development in this option is estimated at £10.7m.

For:

- Risks to individuals are better controlled, in line with the extent of the damage to buildings at Buncefield
- It would prevent incremental build-up of new occupied work places around fuel storage depots up to 250m from the site
- Economic disruption following any incident would be minimised
- There would be a greater level of reassurance to the public

Against:

- The limitations on developments are significantly greater and may be considered onerous
- It would be more difficult for HSE and planning authorities to administer than option 2

Option 4 – Change size of CD informed by risk, and adopt new Development Proximity Zone to give more restrictive advice

4.7 Extend the consultation distance and planning zones around petrol storage depots, as in Options 2 and 3, and introduce a new ‘development proximity zone’

with increased sensitivity levels. The new 'development proximity zone' (DPZ) would be at a radius of 150 m from the site. Within this zone HSE would 'advise against' new development other than that involving 'not normally occupied' structures (analogous to the developments in the inner zone under Option 3 above). In this option the advice given about development in the revised Inner Zone, outside the new DPZ, would be identical to what is given there at present (albeit over a greater area) (see Fig 4 below). The RIA shows that the 30-year NPV of the opportunity cost of lost development under this option is estimated at £10.5m.

For:

- Risks to individuals are better controlled
- Development restriction, in terms of land area, is less onerous than Option 3
- It would prevent the incremental build-up of new occupied work places around fuel storage depots up to 150m from the site
- There would be greater reassurance to the public than Option 2 (though maybe not Option 3)

Against:

- Development restriction, in terms of land area, is less onerous than Option 3 but more so than Option 2
- It would be more complex to administer than Option 2 and, arguably, Option 3. HSE would therefore incur extra costs in applying it
- New buildings within the Inner Zone could be subject to significant damage from an incident similar to Buncefield

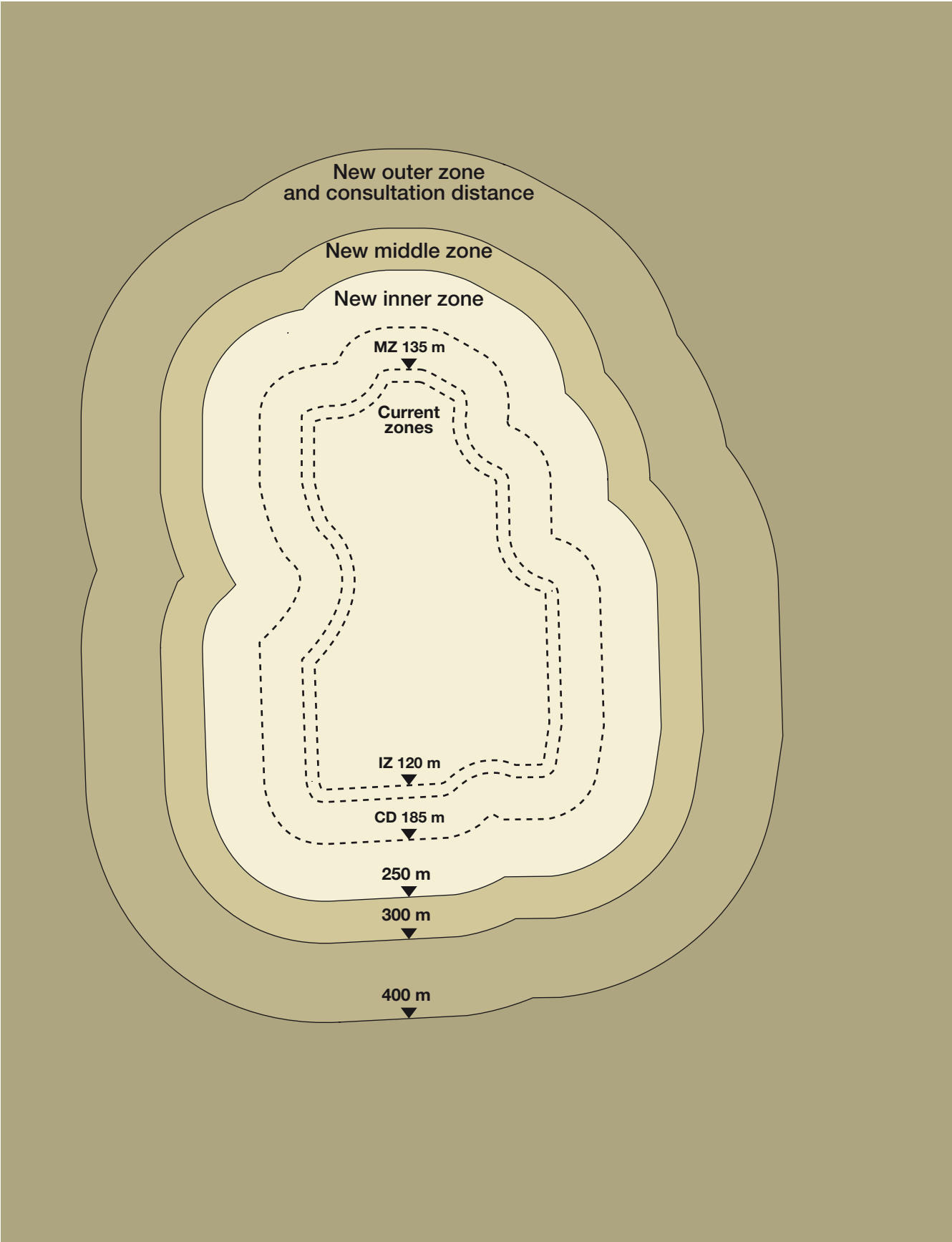


Figure 1: Shows the change from the Current Planning Zones at Buncefield (dashed lines) to new Zones based on building damage seen after the major accident

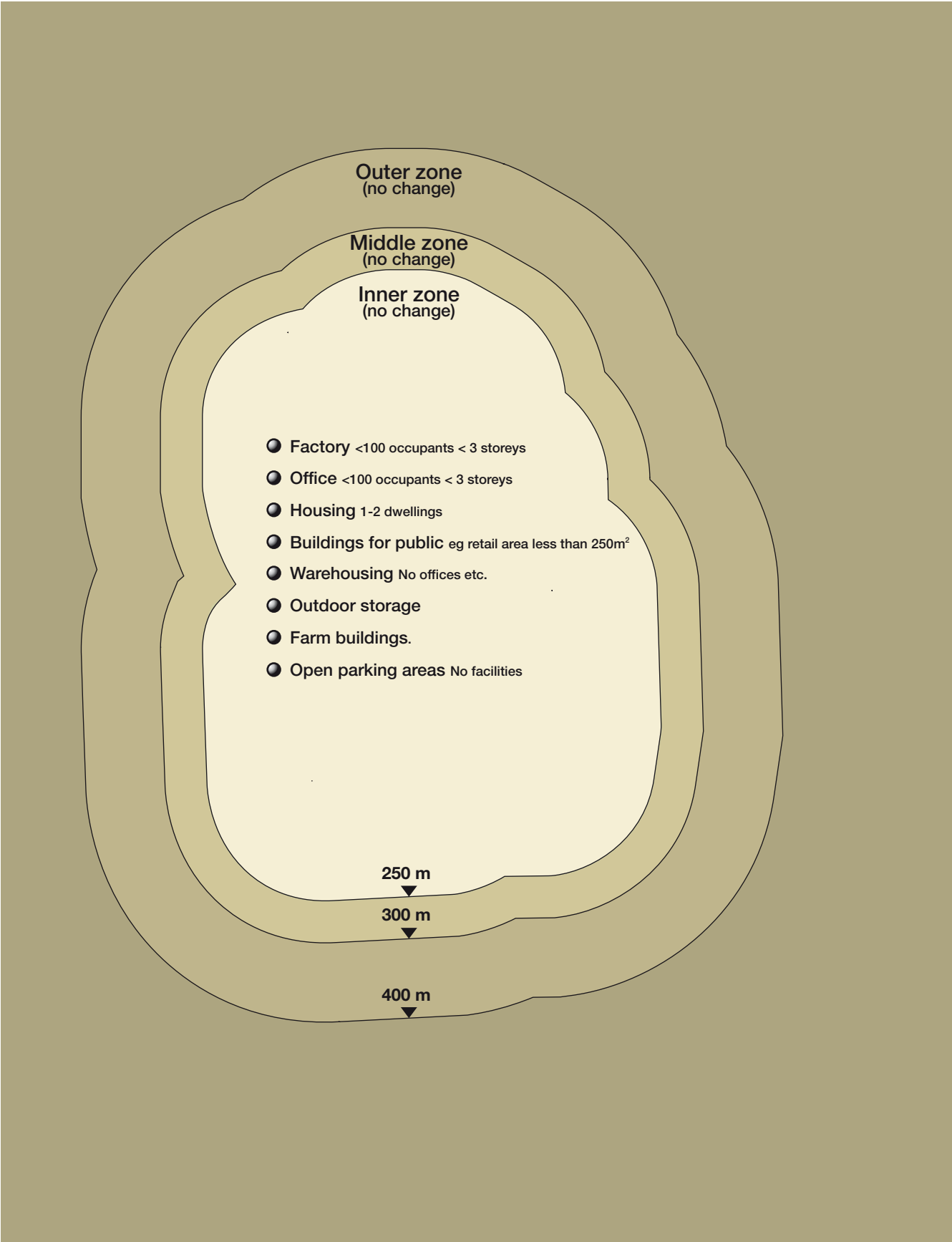


Figure 2: Types of Development that HSE would not 'Advise Against' within the proposed extended zones (referred to in Figure 1)

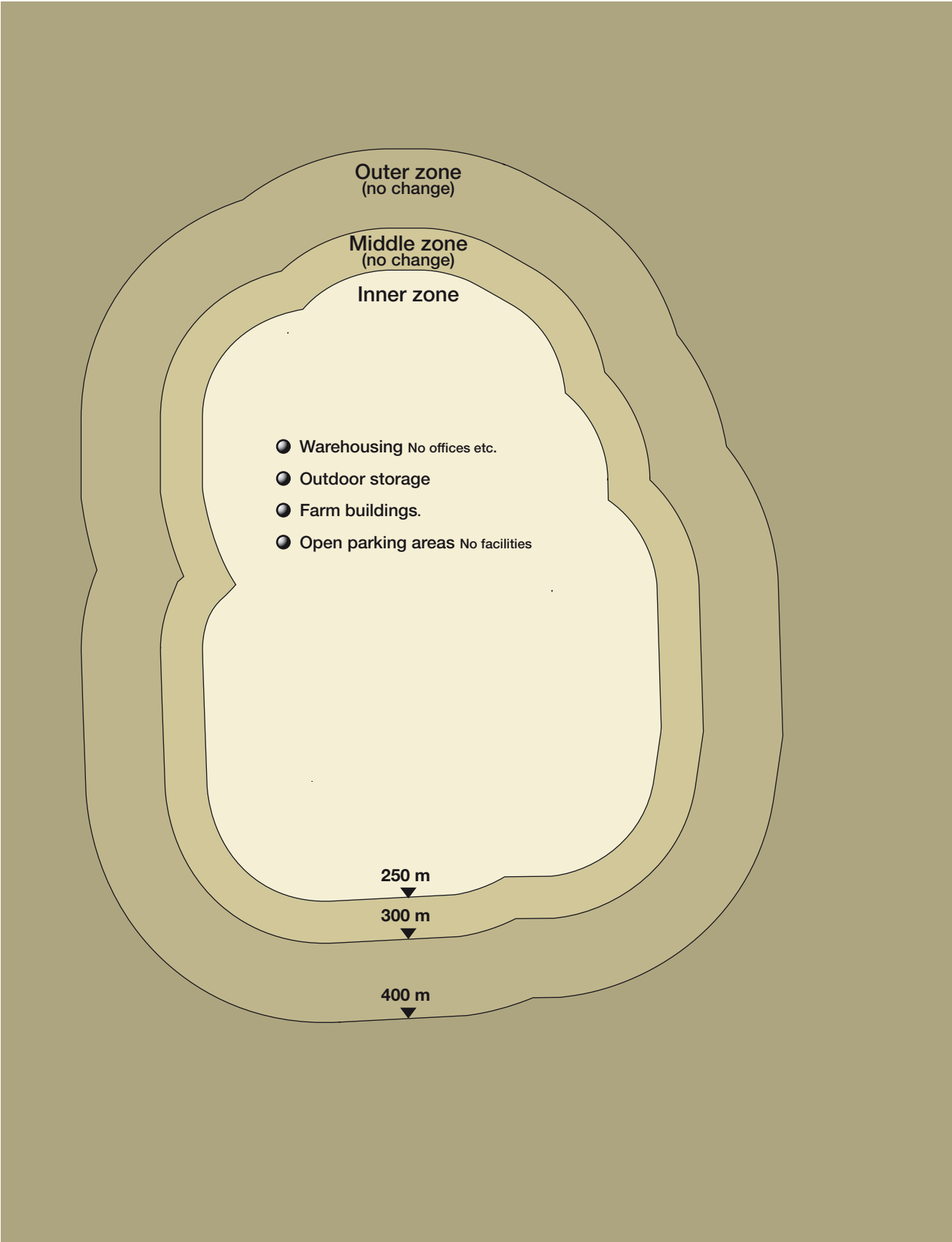


Figure 3: Types of Development that HSE would not 'Advise Against' within the proposed extended zones if changes were made to the sensitivity of certain developments

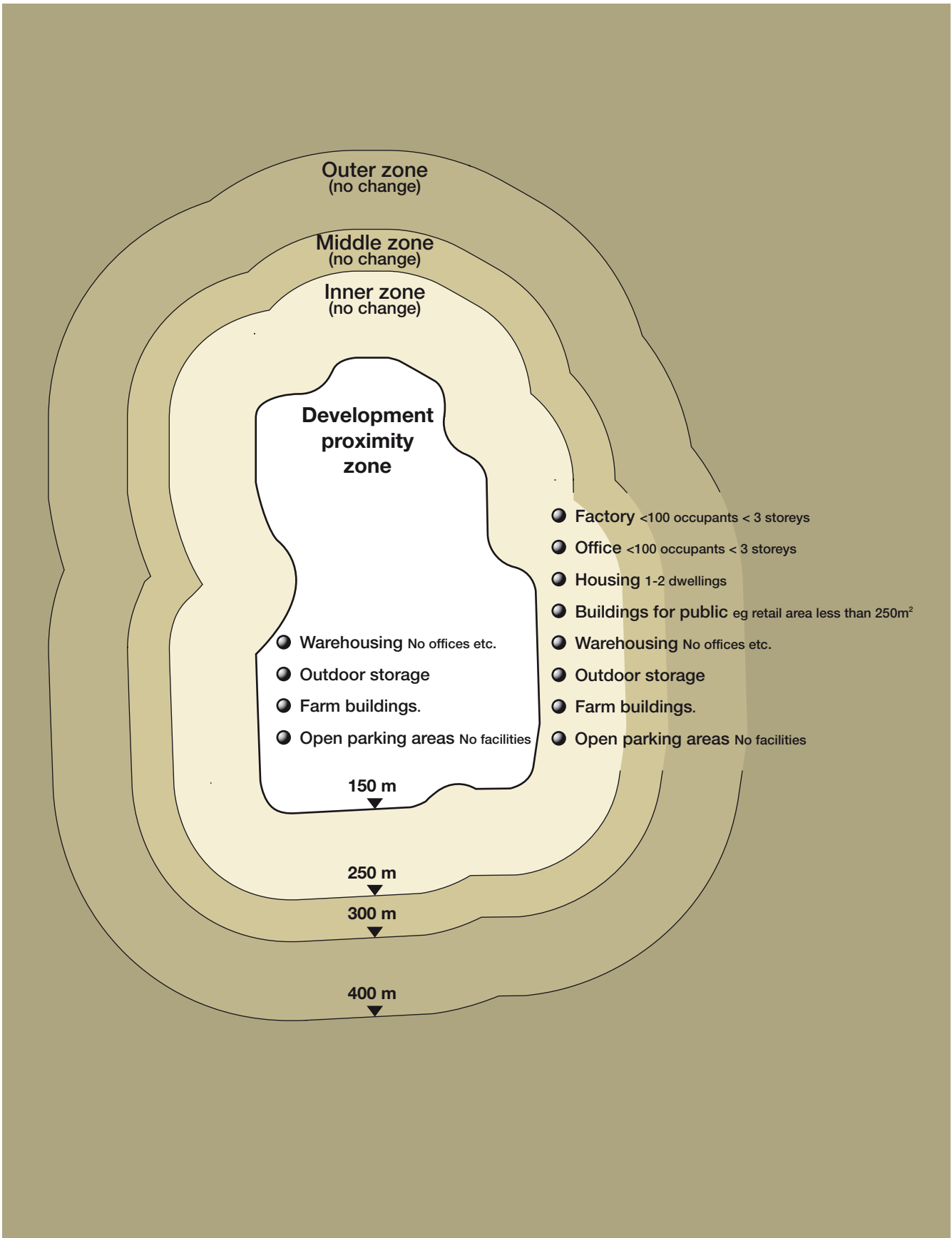


Figure 4: If changes were made to the sensitivity of certain developments, this shows the Types of Development that HSE would not 'Advise Against' within the proposed extended zones and development proximity zone

Comparison between options

4.8 If it is considered that some extension of the CD is appropriate, the advantages and disadvantages of options 2 to 4 are finely balanced. However the arguments suggest that the option which best combines an increase in public protection with a relatively less onerous restriction of new economic and social development is Option 4.

Effect of changes in advice on PADHI

4.9 Any changes to the land use planning consultation distances or to HSE's advice on planning applications around large-scale petrol storage depots would be enabled through the PADHI framework (see paras 2.7-9 above). If, for example, changes to the IZ policy at petrol storage depots were implemented, it would mean that only a small number of planning applications would have to be sent to HSE for its considered advice. This is the way in which applications for developments near nuclear installations, explosive sites, and quarries are currently dealt with, i.e. the application would be initially processed through PADHI+ and the system would generate a letter to direct the application to HSE.

Questions

- **Is it right to extend the consultation distances to the area of damage observed in the Buncefield explosion?**
- **Should we change our assumptions about the vulnerability of individuals likely to be affected by such an incident?**
- **Which option best strikes the right balance between reducing the risk of harm to individuals and allowing economic and social development in the vicinity of these sites?**
- **We would particularly like views on Option 3, which gives the greatest level of protection to individuals and the greatest amount of land use control; and Option 4, which gives greater public safety protection than at present but allows more development than Option 3.**

5. CONCLUSION

5.1 The information gathered following the Buncefield incident enables HSE to propose options for changes to its land use planning advice policy around petrol storage sites, based upon the best evidence currently available. On the basis of this information, it seems sensible to make some change. But whether to make change and if so the extent of the change to HSE's advice to LPAs is the subject of this consultation exercise. In addition to consulting on the four options set out in Chapter 4, we are also taking the opportunity to confirm the principles on which we base our advice, and are seeking comments on them.

6. WIDER IMPLICATIONS FOR OTHER MAJOR HAZARD SITES

6.1 The implications of these changes for major hazard sites other than those like Buncefield need to be considered, but those are not an issue for this consultation exercise. Clearly we have a poor scientific understanding of the mechanisms which led to the vapour cloud explosion at Buncefield, and we accept that installations storing other substances could present this type of hazard, for example bulk LPG storage, and other flammable liquid storage. Assumptions about possible means of and time available for emergency action are equally applicable to such sites as they are to large-scale petrol storage depots. Further scientific research should be undertaken to clarify our understanding of the conditions under which such explosions may occur, and thence how the risks from them may be controlled.

6.2 Furthermore it is necessary to review some of the fundamental assumptions used in HSE's risk assessments to rationalise issues about, for example:

- the building design and construction;
- the level of protection given to people from fire and toxic hazards, as well as from explosions; and
- the varying capabilities of people at home and work to respond effectively and escape from a 'developing' major incident.

6.3 The forthcoming Government consultation on societal risk will examine that issue in relation to all major hazard sites including petrol storage depots, so societal risk has not been covered in this exercise.

ANNEX 1

Objectives and Principles of HSE's involvement in Land Use Planning

1. In 2002, HSE concluded a fundamental review of its role in land use planning. As part of the review's implementation, HSE revisited the Advisory Committee on Major Hazards (ACMH) principles upon which HSE would provide its land use planning advice. ACMH was set up by HSC following the Flixborough explosion in 1974 that killed 28 people on site and caused extensive damage off-site. During the late 1970s and early 1980s the Committee produced a series of principles and recommendations in three Reports, which formed the early basis of HSE's regulation of Major Hazard sites and its approach to the provision of development control advice around major hazard sites and pipelines.

2. One driver for the review of these principles was the amount of time that has elapsed since the principles were first established - the first ACMH Report had been published nearly 30 years earlier and society's views might have changed in this period, and new legislation had been introduced. The second driver was an acknowledgement that the principles set out in the Reports were sometimes not entirely clear in their meaning (and thus were misquoted), were in one instance contradictory and, generally, were not always easy to find in the text of the three Reports.

3. The aim of the review process was to gather together all of the 'principles' contained in the three ACMH reports, and present them in one place in an easily understandable way. Where necessary or appropriate they were to be updated or, where no pre-existing principles existed, new ones were to be developed in line with current HSE practice and/or policy.

4. In order to undertake this process, a group of relevant stakeholders was created. This consisted of representatives from:

- HSE
- Industry
- Local Planning Authorities
- Academia
- The general public (e.g. National Consumer Federation)
- External consultants

5. This group produced a set of Objectives and Principles (O & Ps) governing HSE's involvement in LUP. These O & Ps were then subjected to a limited consultation process that included planning department parent bodies. Subsequently a wider consultation exercise was carried out in 2004/2005. Feedback was received from planning practitioners, industry and trade associations amongst others. HSE gratefully acknowledges the comments it received and has taken account them in formulating the objectives and principles that follow.

HSE Land-Use Planning Objectives

Objective
O1: To provide advice to the decision makers in accordance with published criteria that are based on the following principles and which ensures that the individual risk borne by people living or working in the vicinity of Major Hazard Installations and Major Hazard Pipelines is tolerable ³ and takes due account of society's concerns.
O2: To provide sufficient information to the decision makers to enable them to take into account the safety implications of major accident hazards in decision-making.
O3: To improve understanding amongst all stakeholders of the role of HSE and the approaches used for providing advice on the safety implications of major accident hazards.
O4: To provide generic guidance on controlling development around major accident hazards sites to enable specific statements to be included in development planning policies/guidelines.

³ As defined in the HSE publication Reducing Risks, Protecting People (R2P2), HSE Books, HMSO, 2001 (ISBN 0 7176 2151 0)

HSE Land-Use Planning Principles

Background	Colour code
Policy	
Process	

Principle	Derivation	Supporting Information
<p>P1: Decision-making on applications for planning permission and hazardous substances consent rests with the land-use planning system.</p>	Adapted from ACMH view	Principle P1 recognises the view of the ACMH that decisions on land-use planning associated with hazardous installations should rest with the planning system rather than HSE. In paragraph 72 of its first report ACMH stated that "...the siting of developments should remain a matter for planning authorities to determine, since the safety implications, however important, could not be divorced from other planning considerations". In other words, the socio-economic benefits of sustainable land development have to be balanced against any safety risks and such decision-making can only take place within the planning system.
<p>P2: HSE should continue to have a statutory role of providing advice to the planning system on the safety implications of applications for planning permission, which fall within Consultation Distances of major hazard sites and pipelines, and on hazardous substances consent.</p>	Adapted from ACMH view	ACMH recognized that planning authorities should consult HSE as it had the expertise to formulate advice on the safety implications of major hazard installations. Principle 2 reflects this view and is consistent with the legal requirement of Article 12 of the Seveso II Directive, which requires, among other things, appropriate consultation arrangements between the competent authorities and planning authorities.
<p>P3: HSE will publish its general methodology for providing planning guidance so that this can be understood by all stakeholders.</p>	Adapted from ACMH view to meet the recommendation from the Fundamental Review of Land Use Planning (FRLUP) for more transparency	<p>HSC policy for enforcement of health and safety legislation stresses the need for proportionate, consistent and transparent decisions. One of the main findings of the FRLUP was a lack of transparency in HSE's advice and the approach to formulating it.</p> <p>HSE intends to publish a range of documents on its website, as part of the IFRLUP process, which will detail its current position and approach to providing LUP advice. These will be available to all stakeholders and will include the finalised Objectives and Principles.</p>

Principle	Derivation	Supporting Information
<p>P4: To achieve efficiency and effectiveness HSE should provide advice on development plan policies and land-use allocations to help planning authorities develop a more strategic and long-term approach to managing land-use in the vicinity of major accident hazards.</p>	<p>Adapted from ACMH view to meet Article 12 of the Seveso II Directive, and to meet the recommendation in the FRLUP that HSE should provide an input to planning policies.</p>	<p>HSE can only influence the strategic and long term planning policies of the planning system by making its approach to formulating land-use advice transparent. HSE will therefore provide guidance that enables planning authorities to take account of MHIs and MHPs during the preparation of planning policies.</p>
<p>P5: HSE will provide consistent advice about the safety implications of major accident hazards across the whole of Great Britain, subject to changes over time to reflect developments in scientific understanding or public expectations.</p>	<p>New principle to reflect HSC policy on consistency of decisions</p>	<p>This principle means that, for similar circumstances, HSE's advice on proposed development will be the same in England, Scotland or Wales. However, the risk assessment methods used to achieve consistency may need to be updated from time to time to reflect scientific development. This may lead to different (higher or lower) risk estimates, which determine the advice. Similarly, the criteria used to judge the significance of these estimates may need to be updated to reflect changes in public and government expectations of what constitutes tolerable or acceptable levels of risk. Decisions may, therefore, change over time thus making it difficult to achieve consistency over the longer term. Consistent advice will, however, be provided within a given set of circumstances (e.g. policy).</p>

Principle	Derivation	Supporting Information
<p>P6: HSE's land-use planning policies acknowledge that development and Major Hazards must co-exist in Great Britain, but also that this co-existence must be managed to minimise the potential risks to people.</p>	<p>Adapted from ACMH view reflecting that there is no such thing as absolute safety and that risks will need to be balanced against benefits.</p>	<p>In the rare event of a catastrophic accident at a MHI, or MHP, fatalities amongst members of the public could only be averted if there was a sufficiently large unpopulated area around the site that would wholly eliminate the effects of MAHs on people. Such a policy is impracticable in a country the size of Great Britain where land that is available for development is a scarce resource. The criteria used by HSE for judging the safety implications of planning proposals take account of the need to develop land in the vicinity of MHIs and MHPs, but without compromising people's safety.</p>

Principle	Derivation	Supporting Information
<p>P7: Risks to a person at a proposed development from Major Accident Hazards (MAHs) should not be significant when compared to general risks from everyday life</p>	<p>Modified ACMH view.</p>	<p>This principle is important when setting individual risk criteria for land-use planning purposes. ACMH did not state which everyday risks were appropriate, nor what they meant by significant, but the implication is that the risks from MAHs should not exceed the higher everyday risk levels accepted by society. One such example of this is the risk of being killed in a road accident, which is 55 chances per million per year (cpm) or one in 18,000 per year (2004 data England, Scotland & Wales, annual Abstract of Statistics 2006 volume).</p> <p>HSE has consulted on, and published⁴, criteria for fatality risks. For workers, the intolerable level of fatality risk is 1000 chances per million per year (cpm), and for members of the public the corresponding criterion is 100 cpm. Fatality risks of 1cpm are considered broadly acceptable.</p> <p>In land-use planning the chances per million per year of a 'dangerous dose or worse' (DD) are used to determine risk. For highly vulnerable members of society (e.g. the infirm) the two criteria can be considered to be equal i.e. 1cpm DD = 1cpm fatality. For an 'average' person 1 cpm DD corresponds to approximately 0.33 cpm fatality. These are the relationships that give rise to the risk definitions of the three LUP planning zone boundaries and the decision matrix within PADHI, HSE's automated planning advice software tool.</p>
<p>P8: The approaches used by HSE to generate advice will depend on the type of major accident hazard, be 'fit for purpose' and take account of the scale and nature of the hazards, and the associated risks.</p>	<p>New principle to reflect HSC policy on the need for proportionate decisions</p>	<p>This principle commits HSE to adopting approaches for formulating advice that are fit-for-purpose and appropriate to the type and degree of hazard under consideration. This means that the advice may be based on estimates of either the extent of MAHs with limited consideration of their frequency (a hazard-based approach), or on risk levels that do consider their frequency (a risk-based approach).</p>

⁴ Reducing Risks, Protecting People (R2P2), HSE Books, HMSO, 2001 (ISBN 0 7176 2151 0)

Principle	Derivation	Supporting Information
<p>P9: HSE's advice will take account of the need to maintain appropriate separation distances between MAH establishments and developments used by people.</p>	<p>Adapted from ACMH view and to meet Article 12 of the Seveso II Directive.</p>	<p>HSE uses a three-zone approach to decide whether the proposed separation is suitable, on safety grounds, when formulating its advice. The separation depends on the type and size of the proposed development.</p>
<p>P10: HSE advice will depend on the size and type of the proposed development. Vulnerable groups will be afforded greater protection than healthy and mobile people.</p>	<p>New principle to reflect current practice and HSE's approach to societal concern, as outlined in HSE's 'R2P2' publication.</p>	<p>This Principle reflects both society's concern about harm to vulnerable groups and its increased aversion to events causing multiple fatalities. Society's concern increases with the scale of the consequences of a potential incident, and also with the proportion of children and the elderly that may be affected. HSE's approach takes both the vulnerability and number of people potentially involved into account through its determination of a sensitivity level for a proposed development. This principle has been added to both reflect this fact and to maintain consistency with HSE's approach to decision-making.</p> <p>HSE considers 'vulnerable groups' to include children, the sick, the elderly, those with mobility difficulties or those unable to recognise physical danger.</p>
<p>P11: HSE will advise against the granting of planning permission for any development in the vicinity of a major accident hazard, which is at variance with its published policies, even when there are existing developments closer to the hazard.</p>	<p>Adapted from ACMH view</p>	<p>ACMH recognised that much of the industrial development and urbanisation predated land-use planning arrangements. As a result, some centres of population and some MHIs exist in close proximity. These days HSE would advise against such development. ACMH stressed that existing development closer to a MHI than a planning proposal should not be allowed to set precedents.</p>
<p>P12: HSE will advise against the granting of a hazardous substance consent, which is at variance with its published policies, even when there are risks of similar or greater magnitude from pre-existing sites having hazardous substance consent.</p>	<p>Adapted from ACMH view</p>	<p>This is analogous to, and consistent with, the approach in Principle P11. Examples of Major Hazard Installations exist in locations that would be advised against now because they predated planning legislation. Such examples will not be allowed to set precedents when HSE considers applications for hazardous substance consent for the siting of a new Major Hazard Installation.</p>

Principle	Derivation	Supporting Information
<p>P13: In specific circumstances, such as Planning Appeals and Consents applications, HSE will co-operate with all stakeholders in the planning process, to assist them in reaching an acceptable way forward. Such co-operation will be given where HSE's advice for protecting the public from the effects of major accidents is the main contributory factor to that conflict. This will be Local Authority led dialogue.</p>	<p>Adapted from ACMH view recognising the need for co-operation amongst the stakeholders</p>	<p>It is inevitable that some developments will raise very difficult safety issues. These may initially be incompatible with people's perceptions of risk or may need to be modified to reduce safety implications. In order to resolve conflict, reach compromises, or allay fears constructive dialogue between the stakeholders may be needed. This principle commits HSE to co-operating with the Local Planning Authority and other stakeholders where safety is the main issue. For example, HSE will provide support to a Local Planning Authority, upon request, at Planning Appeals where HSE's advice is a primary factor in the Appeal. HSE will also co-operate in Local Authority led dialogue over Consents applications, where safety is of primary concern.</p>

Principle	Derivation	Supporting Information
<p>P14: HSE will request that a planning or hazardous substance consent application is 'called-in' for determination by the Secretary of State or the Scottish Ministers whenever HSE consider that the risks are substantial and due weight is not being given to its advice in the decision making processes.</p>	<p>New principle to reflect current practice</p>	<p>The phrase 'due weight' means that the decision makers have fully understood the advice that HSE has provided on the safety implications of the proposal, and have weighed them impartially against its socio-economic benefits in coming to a decision to override HSE's advice.</p> <p>Under the planning system in England and Wales, where a LPA is minded to approve development against HSE's advice, HSE can object to a planning application decision and make a request to the Secretary of State for Communities and Local Government or Welsh Assembly to have it called-in. The relevant Secretary of State will then decide the outcome. In Scotland there is an automatic requirement to notify such planning applications to the Scottish Ministers, which may result in the call-in of the application. With hazardous substances consent applications it is open to HSE to ask the Scottish Ministers to call-in an application if the Hazardous Substances Authority wishes to proceed contrary to HSE's advice.</p> <p>Planning or consent applications are only called-in if they raise planning issues of more than local importance. In accordance with this policy, HSE will normally consider recommending call-in action only in cases of exceptional concern for safety, or where important policy issues are at stake (e.g. a decision has major implications for enforcement policy on the COMAH regulations).</p>

Glossary

Dangerous Dose Or Worse – This is considered to be the dose of any given chemical, compound, etc that would lead to all of the following effects in an exposed population:

- Severe distress to almost everyone
- A substantial proportion requiring medical attention
- Some people requiring prolonged hospital treatment
- Any highly susceptible people might be killed

MHI – Major Hazard Installation

MHP – Major Hazard Pipeline

MAH – Major Accident Hazard

ANNEX 2

Theoretical and Experimental Understanding of Unconfined Vapour Cloud Explosions

1. The phenomenon of a vapour cloud explosion (VCE), or an unconfined vapour cloud explosion (UVCE) as it is referred to in the older literature, and the destructive power of such an explosion have been recognised for many decades. Analysis of the published summaries (references 1-6, below) of VCE incidents shows they can occur with a wide range of flammable gases and vapours.

2. A considerable amount of effort was devoted, both experimental and theoretical, during the 1980s and 1990s to establish the mechanism by which apparently unconfined clouds of vapour could generate such destructive explosions (references 5-10 below). It was concluded that in order to generate high overpressures, the cloud had to be partially confined, and/or there had to be a high level of congestion, i.e. the presence of obstacles such as structures, pipework, etc, within the cloud. Partial confinement increases the explosion overpressure as it restricts the expansion of the hot gases generated by the explosion. Obstacles within the cloud increase the flame area, as the flame spreads around the obstacles, and generate turbulence in the vapour mixture pushed ahead of the flame front. Both of these effects will increase the rate of combustion of the vapour and thus the rate of spread (flame speed) and resulting overpressure of the explosion. It was found that a single row of obstacles was sufficient to increase the flame speed. However, the flame decelerated once it spread into an uncongested region. A volume of congestion, with closely spaced "rows" of obstacles is, therefore, considered necessary in order to have any significant effect on the explosion overpressure. A strong ignition source, such as a jet of flame venting from a building or process vessel, will also generate a high flame speed at first, but without some other mechanism to maintain the high speed, the flame will soon decelerate (references 5,6).

3. It is generally acknowledged that in the vast majority of VCE incidents the vapour cloud has not detonated, but instead these incidents have involved a fast deflagration (references 5, 6). In a detonation the flame front is propagating at a velocity greater than the speed of sound in the unburnt gas, while for a deflagration the flame speed is subsonic. A detonation would result in higher explosion overpressures and a blast wave similar to that produced by a solid explosive such as TNT. The few incidents where a detonation has been suggested have involved very reactive vapours, e.g. ethylene oxide, or a strong ignition source combined with a geometry, such as long channels, that would promote rapid flame acceleration. A uniform vapour concentration is also thought to be necessary for a detonation wave to spread throughout the vapour cloud

4. One of the surprising aspects of the Buncefield incident, given our current understanding of the overpressure generating mechanisms, is the destructive power of the explosion that occurred. The highest explosion overpressures were generated in the car park areas to the east of the Fuji and Northgate buildings, areas that had negligible confinement and no extensive areas of congestion that would induce high flame speeds. There were two possible strong ignition sources for the explosion, namely the pump house on the HOSL west site and the Northgate building emergency generator cabin, but they by themselves would still not account for the

powerful explosion that resulted. (For layout of Buncefield site and surrounding area, see reports at <http://www.buncefieldinvestigation.gov.uk>.) Further work is required to explore other mechanisms for generating high overpressures.

Modelling of Unconfined Vapour Cloud Explosions

5. Gas explosion models come in three different levels, in order of increasing complexity: empirical correlations, phenomenological or zone models and Computational Fluid Dynamics (CFD) models. Both empirical correlations and zone models are based on experimental data, which limits their range of applicability. The more complex CFD models provide a more realistic representation of the flow physics although they still rely on experimental data for calibration of combustion model constants, etc. Recent reviews of the state of the art in gas explosion modelling have been carried out (references 11,12) and these conclude that the models can only be as good as the current understanding of the underlying physical processes. The models cannot be expected accurately to model physical phenomena which are poorly understood.

6. A significant body of research has been based on explosion scenarios including congestion. For example in the aftermath of the Piper Alpha disaster in 1988 a large Joint Industry Project called Blast and Fire Engineering for Topside Structures (BFETS) (reference 13) was set up to look at explosions in congested and confined offshore platforms. By contrast there has been little development of models for unconfined and uncongested VCEs. This is partly because it is difficult to control large-scale experiments in unconfined scenarios, so there is little or no experimental data against which models can be calibrated and/or validated. However, as it is accepted that such explosions would generally give rise to much lower overpressures, work in this field has been given a lower priority.

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ANNEX 3

The basis of HSE's current Land Use Planning assessment for the Buncefield Oil Storage Depot

Extract from the Buncefield MIIB's Initial Report, Annex 3 – Planning history of the Buncefield site and neighbouring developments (paras. 14–17):

'In 1983 as a result of the Notification of Installations Handling Hazardous Substances Regulations 1982 (NIHHS Regulations) HSE first received notification from Shell Mex and BP of the terminal as a major hazard. HSE's policy at that time was to issue a generic non site-specific consultation distance of 250 m from the boundary of the site for consultation purposes and the relevant local planning authority was notified. This distance assumed that the main hazard was from thermal radiation following a major fire within the bund around the largest storage vessels.

'In 1992 the site expanded and Mobil and Shell sent another notification and application for consent to store certain amounts of flammable material. The existing consultation distance was maintained at a generic 250 m from the site boundary. There are no records of the technical assessments that were performed when the local planning authority sought advice on developments within the vicinity of the site, but early assessments were based then, as now, upon a pool fire following loss of containment of a substantial quantity of flammable liquid. However, for tanks that were banded there was a continuing assumption that any subsequent fire would be within the confines of the bund.

'In 1996 a site specific reassessment was performed based upon consented

amounts of flammable material, and the consultation distance was reduced from 250 m to 190 m. The original 250 m was set in the early days of HSE giving land use planning advice, to ensure that all developments that might be advised against would be subject to consultation. By 1996, technical policy and methodology had been reviewed. In addition, three zone maps were now being produced so that development control advice could be given more quickly and efficiently. The new policy assumed that the bund would not be able to contain the full contents of a tank following a sudden, catastrophic failure. It was assumed that the bund would be overtopped and the resulting pool fire would extend beyond the confines of the bund.

'In July 2001 another consultation distance was calculated due to an extensive reassessment of the hazards from the site following the submission of a batch of new consent applications from the oil companies. The regulations requiring consent to store flammable substances were changed in 1999 to include additional flammable materials. The consultation distance was reduced from 190 m to 185 m. This was unchanged following a further consent application on 8 July 2005 from BP. The presence of the additional material did not alter the main basis of the calculation which assumed the worst-case event was the catastrophic failure of the largest tank containing gasoline. The consultation distance was reduced slightly owing to a slight change to the inputs in the model used to perform the calculations.'

The zones produced by these assessments are given below in Figure 5 which is reproduced from the Major Incident Investigation Board's Initial Report issued on 13 July 2006.

Additional Information regarding the 2001 Assessment

1. For cases where a potential for generation of a large vapour cloud is identified, HSE's current technical policy for assessing vapour cloud explosions is based on the following guiding principles. These principles continue to be underpinned by the interpretation of available scientific understanding of VCEs:

- Under test conditions it is known that some flammable vapour clouds can detonate, although in practice the risk of such a situation occurring is sufficiently remote that HSE does not consider vapour cloud detonation for land-use planning assessments.
- There are no clear cut rules for deciding whether a vapour cloud explosion should be considered in a particular assessment, but HSE has developed some guidance (originally for assessments involving liquefied petroleum gases), to assist in deciding whether or not to consider VCE in an assessment and this is reproduced below:

Factors for Excluding VCE hazards from the assessment	<i>Factors against excluding VCE hazards from the assessment</i>
Less reactive fuel e.g. saturated hydrocarbon	More reactive fuel e.g. unsaturated hydrocarbon
Absence of (semi) confining structures at or near the release point	Presence of (semi) confining structure at or near the release point
Small mass of fuel i.e. less than 10 tonnes entering the vapour cloud	Large mass of fuel i.e. greater than 10 tonnes entering the vapour cloud
No energetic release of fuel e.g. from atmospheric pressure storage	Energetic release of fuel e.g. from pressurised storage
Absence of strong ignition sources	Presence of strong ignition sources e.g. bang box ignition

- Although it is not possible to weight the above factors so that a prescriptive decision can be made, some factors on their own may be used to justify inclusion or exclusion of VCE in an assessment. As an example, where there is no energetic release of the fuel e.g. a release of fully refrigerated Liquefied Natural Gas, exclusion of VCE from the assessment is clearly justified. As a general rule, there should be a presumption that VCE will be included in an assessment with exclusion requiring justification – for example in 2001 Buncefield assessment summarised in paragraph 3 below.
- A model used to determine overpressures from VCEs - the Multi Energy Method (MEM) - calculates, from the initial gas release, the potential total cloud volume (at the Lower/ Upper Flammable Limits - LFL, UFL, or stoichiometric composition) and the lesser of this volume or the available

congested volume is taken as the volume of combusting flammable atmosphere.

Overpressure hazards

2. For assessing the direct effects of overpressure, HSE uses peak overpressures of 600, 140 and 70 mbar. 600 mbar is deemed to produce almost total demolition of buildings and there is a very high probability of death for building occupants. At 140 mbar, which is taken to be a 'dangerous dose', some structural damage will occur which might lead to some fatalities amongst building occupants. At 70 mbar, structural damage is very unlikely although windows will be broken and other minor damage may occur. It is assumed that below 70 mbar, there will be no fatalities even amongst vulnerable populations.

3. The above principles and assumptions about overpressure hazards were used in the 2001 assessment of the Buncefield Oil Storage Depot. Hazards arising from road tanker loading and a VCE assessment were carried out using MEM, but experience has shown that non-flashing liquids such as gasoline (i.e. liquids not under pressure) usually represent a negligible hazard from VCE. To confirm this, MEM was used with n-butane as an exemplar substance for gasoline, and taking the semi-confined volume V to be the product of the whole plan area of the tanker loading bays, and an assumed vapour height H of 1 metre. The largest loading area at Buncefield was in the Shell site, and was used for the scoping assessment. The Shell loading area is approximately 125 m x 50 m, and running MEM for n-butane for a 1 metre high volume, and conservatively assuming a 40-tonne road tanker. The calculated overpressures from the tanker loading area were well within site boundary and these results did not increase the zone boundaries, which were based on inventory loss from a bulk storage tank leading to a pool fire hazard.

FIGURE 5

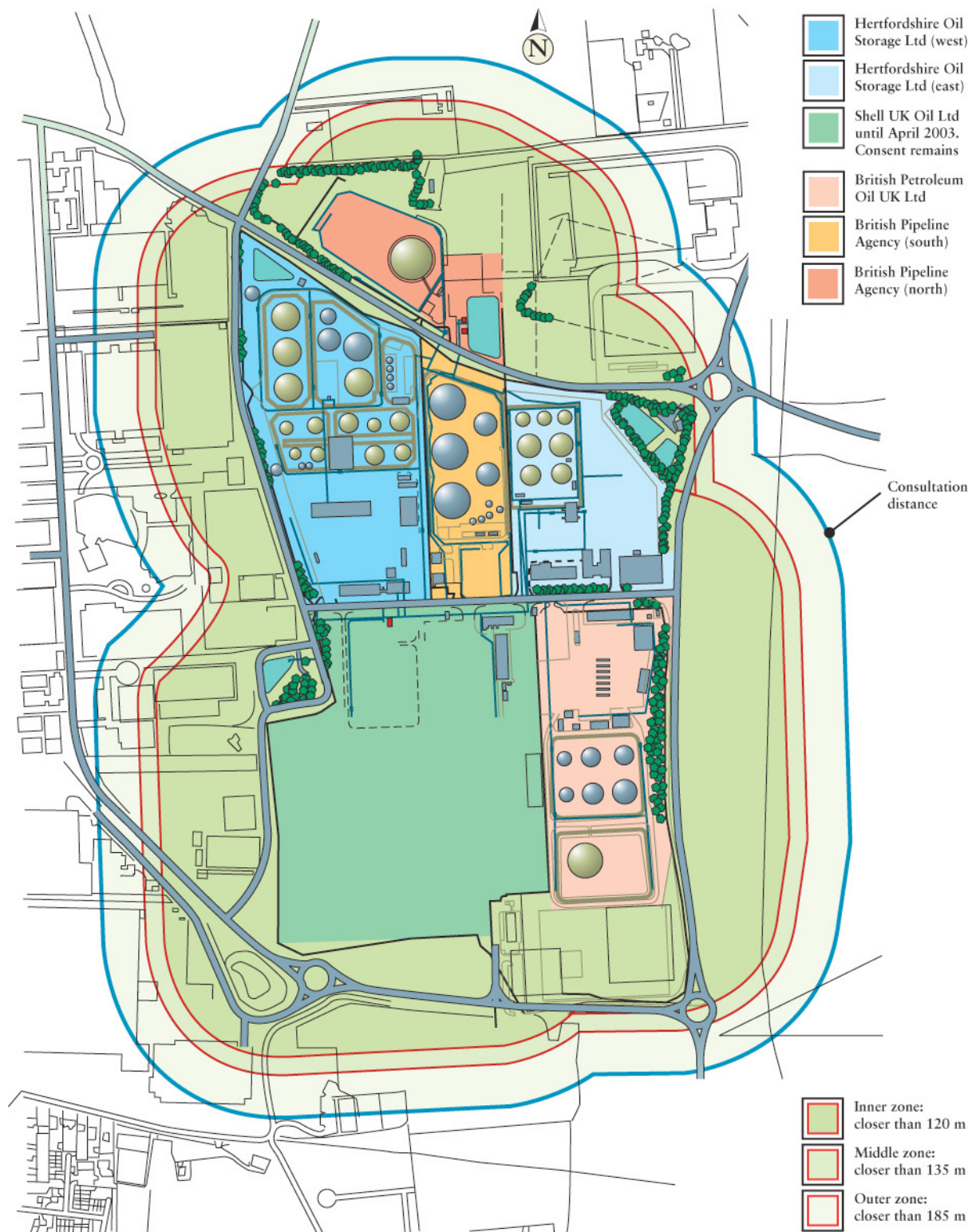


Figure 5 Plan representing the hazardous substances consents and consultation area around the Buncefield depot since July 2001 (for illustration only). Reproduced from the Major Incident Investigation Board's Initial Report issued on 13 July 2006

ANNEX 4

Options for changing LUP arrangements around large scale petroleum storage depots

1. This Annex summarises the published work by ERM (Environmental Resources Management) (Research Report 511: Proposed Revisions to Land Use Planning Arrangements for Large Scale Petroleum Storage Depots) on behalf of HSE. ERM reviewed HSE's current approach to LUP and HSE's initial views on how this might be changed in the light of the Buncefield incident. ERM presented two Options (A and B – note that these are Options 2 and 3 in Chapter 4 - 'Options' - in the main text) which would result in greater restriction on development and derived from a) information on the effect of blast on building occupants, inferred from the observed building damage at the Buncefield and b) the justification underpinning certain aspects of the current policy arrangements.

Scope of Study

2. The study comprised:

- a review of the current LUP arrangements;
- consideration of the various options produced by HSE for revised LUP arrangements in the light of the incident at Buncefield;
- development of the selected options for revised arrangements;
- investigation of the impact of the proposed revised arrangements upon the LUP advice provided by HSE to local authorities; and,
- examination of the sensitivity of the proposed options to a range of factors associated with the features of the major hazard sites of interest.

3. The study followed HSE's 'protection based' approach for major hazard sites that handle flammable substances, which considers the consequences of a selected event, and sets the zone boundaries on different levels of expected harm to people from the event, namely:

- i) the boundary between the inner and middle zones is usually set at the range at which members of a typical population could be subjected to a level of harm corresponding to a significant likelihood of death;
- ii) the boundary between the middle and outer zones is usually set at the range at which a typical, exposed population could experience a dangerous dose;
- iii) the outermost edge of the outer zone is usually set at the range at which a sensitive or vulnerable population could experience a dangerous dose.

Assumptions and Sources of Data used in the Assessment

4. From the MIIB investigations, it was known that:

- a storage tank was filled to overflowing with petrol;
- as the petrol overflowed from the tank a substantial vapour cloud was generated;
- the vapour cloud spread over parts of the site and to areas beyond the site boundary;
- the vapour cloud was ignited, resulting in a vapour cloud explosion (VCE); and
- the VCE caused extensive damage to buildings, particularly those close to the site of the explosion.

5. However, it was not clear why the vapour cloud exploded with such force.

Although such accidents have occurred and the phenomenon subjected to much scientific investigation, the strength of the VCE experienced at Buncefield cannot currently be explained. Protection-based assessments for petroleum storage facilities include the potential for a VCE, but only on the basis of current scientific understanding of the way in which VCEs occur (see Annex 2). However, the assessed potential for a VCE at a site like Buncefield was limited to those work areas which provided sufficient confinement or congestion to generate a VCE, such as the tanker loading bay, which were calculated to give rise relatively small hazard ranges. On HSE's current assumptions, the protection-based assessment of this type of site was therefore likely to be based on other hazards, typically large pool fires.

6. It was not the objective of the new arrangements examined by ERM to provide complete protection for future developments from damage, or for their occupants from harm. Also, it was not within the remit of the study to consider existing land use around petrol storage depots.

7. The Buncefield site currently has inner, middle and outer zone boundaries set at distances of 120 m, 135 m and 185 m respectively (see also Annex 3). ERM's Option A would significantly increase these distances, to 250, 300 and 400 metres respectively. ERM's Option B additionally introduces changes in the development 'sensitivity levels' that would place greater restrictions on the types of development that HSE would 'Advise Against' in the enlarged Inner Zone.

8. The study included sensitivity testing of the size of the proposed LUP zone boundaries to various factors, some of which were strongly site-specific, and which included:

- the rate at which vapour is formed and the conditions under which this occurs (the source term);
- the way in which the cloud moves (the dispersion of the vapour);

- the quantity of fuel involved in the explosion (the explosion size); and,
- the violence of the explosion (the explosion strength).

Key Findings

9. ERM critically reviewed HSE's initial list of options for changes to the LUP arrangements, from which it was evident that any revised approach should take into account the current state of knowledge regarding events at Buncefield, and should be somewhat precautionary in nature. In summary, it was recommended that the focus of any changes would be on the amendment of both the zones and the development sensitivity level definitions.

Changing the Planning Zones (Option A) (Option 2 in Chapter 4 of the main text)

10. It was decided that observations of the damage incurred at Buncefield would be used to estimate maximum ranges of damage levels, and the corresponding distances would be used to establish LUP zone boundaries, so that for example the inner zone distance would correspond to the maximum range of serious structural damage. Establishing zone boundaries on the basis of observed damage rather than an estimate of the overpressure required to cause the observed level of damage avoids the uncertainty inherent in the overpressure estimate. An analytical approach to establishing LUP zones (e.g. by using an explosion model to calculate distances to overpressures of interest) was not considered feasible at present, owing to the lack of understanding of the explosion mechanism involved. Some limited but useful published data were used for correlating levels of building damage to the harm suffered by their occupants.

11. In conjunction with the observations of damage to buildings, the data have been used to form a judgement concerning the likelihood of harm (in broad terms) to the occupants of different buildings. Damaged buildings were assigned to one of four harm categories: high, medium, low and minimal. The first three of these categories correspond to the three harm levels used when performing a protection-based assessment. The 'minimal' category indicates that the potential for harm to occupants arising from damage to the building was such that it would not be of interest for the purposes of setting LUP zone boundaries.

12. The distances to buildings in the different harm categories were measured and used to establish zone boundaries. This resulted in the proposed zone boundary distances. The distances have been calculated by adding the maximum observed flammable cloud extent of 250 m to the distance of the building from the cloud edge.

The **Inner Zone** boundary (250 m) was set at the greater of the distances to the furthest example of 'high' harm potential, or the closest example of 'medium' harm potential. The furthest instance of 'high' is within the cloud; the closest instance of 'medium' is partly inside the cloud. Hence the inner zone is set at the maximum observed flammable cloud extent.

The **Middle zone** boundary (300 m) was set at the greater of the distances to the furthest example of 'medium' harm potential or the closest example of 'low' harm potential.

The **Outer Zone** boundary (400 m) was set at the greater of the distance to the furthest example of 'low' harm potential or the closest example of 'minimal' harm potential

Changes to Zones and the Development Sensitivity Levels (Option B) (Option 3 in Chapter 4 of the main text)

13. In view of the significant damage resulting from the Buncefield incident, ERM felt it appropriate to review HSE's definitions of Sensitivity Level 1 (SL1) developments, which would not be 'Advised Against' within any of the planning zones, even the Inner Zone. SL1 includes small scale residential (1-2 houses), leisure developments and offices factories and workplaces of less than 3 storeys and for less than 100 occupants. Hence such developments could, under existing arrangements, be placed at locations corresponding to relatively high levels of individual risk of fatality. HSE's assess the risk in terms of an individual risk of receiving a dangerous dose or worse (see Glossary in Annex1), but closer to the hazard the proportion of 'or worse' is increased, and tends to be higher with fire and explosion hazards such that the risk is almost entirely a risk of fatality.

14. HSE's arrangements for giving LUP advice are derived from principles & objectives stated in published documents (ACMH reports and the Risk Criteria Document). Two of these principles are:

- i) "The risk from a hazardous installation to an individual employee or member of the public should not be significant when compared with other risks to which he is exposed in everyday life." (Advisory Committee on Major Hazards, 1984) paragraph. 21);

and:

- ii) "The separation of a hazard from a built-up area need not mean... that the intervening land is completely sterilised or available only for agricultural purposes. Depending on the degree of hazard, it may be possible for it to be allocated for other purposes involving low population densities, including some industrial developments." (Advisory Committee on Major Hazards, 1984), paragraph 84.

15. In allowing small housing etc developments within the IZ the second principle is allowed to override the first – a small increase in societal risk is accepted even though the individual risk is relatively high. However, in view of the degree of 'or worse' within the proposed IZs for large scale petroleum storage depots it is proposed that the balance between these two principles is shifted in favour of the first, thus removing small housing etc. developments from SL1 to SL2.

16. With respect to Sensitivity Level 1 (SL1) workplaces, the first part of the justification given for assigning workplaces to Sensitivity Level 1 is that these are 'places where the occupants will be fit and healthy, and could be organised easily for

emergency action'. This appears to suggest that amongst a group of workers, it is likely that the proportion that could be considered particularly sensitive or vulnerable would be lower than in the population at large. Therefore, if this group of workers were exposed to a dangerous dose, the resulting number of fatalities would probably be lower than for a group of the same size but representing a 'typical' cross-section of the general population.

17. However, as with one of the justifications discussed in the previous section, this argument does not consider the proportion of 'or worse' within the 'dangerous dose or worse'. As discussed above, for a VCE like that experienced at Buncefield, the 'or worse' proportion is likely to be high close to the event. Hence, even amongst a 'fit and healthy' group of people, some fatalities could result.

18. The second part of the justification appears to be that the risk to people in a workplace would be significantly reduced as a result of taking emergency action. This assumes that:

- effective emergency action (such as evacuation or sheltering) is possible; and,
- there is sufficient time for this action to be taken.

19. On the first of these points it is not clear what would constitute effective emergency action for occupants of workplaces close to a site presenting a VCE hazard. Evacuation of building occupants could place them in the flammable cloud. However, remaining within a building could place the occupants at greater risk of injury from blast effects. Second, even if some kind of emergency action was possible, a VCE could occur rapidly, with little or no opportunity for raising the alarm.

20. In view of this, it is recommended that consideration is given to alteration of the definition of Sensitivity Level 1 developments within the revised arrangements, as follows:

- all workplaces that are routinely occupied for a significant proportion of the time (i.e. – offices and factories), regardless of size, are re-assigned to Level 2;
- workplaces or areas that are visited intermittently (warehouses, timber yards, outdoor storage areas, haulage depots, farm buildings) with no associated office facilities and car parks with no associated amenities remain in Level 1;
- housing developments of 1 or 2 dwelling units are re-assigned to Level 2;
- smaller hotel/holiday/hostel accommodation is assigned to Level 2; and,
- retail development with less than 250 m² floor space is assigned to Level 2.

Impact of Changes

21. The full ERM Report contains a comprehensive review and explanation of the impacts of introducing Options A or B, including comparison with the current system. The proposed changes would, if implemented, result in:

- significantly larger Consultation Zones and associated zone boundaries for the sites affected (for both Options A and B);
- an increased area within the CD which would result in a larger number of LPA consultations of HSE about proposed developments in the vicinity of the relevant sites (for both Options A and B); and,
- more restrictive advice from HSE on developments in the inner zone (for Option B).

22. Furthermore, it is recognised that there may be significant implications in the proposed arrangements for other types of site where a protection-based approach is applied. These sites include bulk LPG storage, gasholders, other flammable liquid storage and other facilities presenting a VCE hazards. Assumptions about possible means of and time available for emergency action are equally applicable to such sites.

Advantages and Disadvantages of Proposed Options A and B

23. The advantages of these options are assessed as being that they are:

- (a) Precautionary, in the light of current understanding
- (b) Based on accident experience, which is less contentious than using predictive models, particularly in view of current uncertainties
- (c) Provide increased protection to occupants of developments (due to the larger CD), particularly to those in office/factory developments in the inner zone (due to changes in Sensitivity Level definitions)
- (d) Relatively quick and straightforward to implement

And the disadvantages are:

- (a) The system relies on interpretation of damage and historical information, which is open to debate. In particular, the historical data relate to experience with 'conventional explosives' which produce blast with different characteristics to that from a VCE
- (b) The system may not be precautionary enough (i.e. it is possible that a VCE at another comparable site could be worse than that at Buncefield)
- (c) The change gives rise to inconsistency – those sites affected by the proposed system will use the revised set of Sensitivity Level definitions, whereas other sites will use the current definitions
- (d) The increase in CDs and more restrictive advice may generate an adverse reaction from local authorities, developers, etc
- (e) For those sites affected, it will not be possible to use the existing PADHI software to determine the appropriate advice. This is likely to have resource implications for HSE.

24. On balance the report considered that the proposed system reflected the best that could be achieved with the time and information available.

ANNEX 5

Review of Significance of Societal Risk for Proposed Revisions to Land Use Planning Arrangements for Large Scale Petroleum Storage Sites

1. This Annex summarises the published work undertaken by Atkins (Atkins Consultants Ltd) on behalf of HSE (HSE Research Report 512 [[http link](#)]) which considered the significance of societal risk associated with the setting of land use planning zones around large-scale petroleum storage sites. This study critically reviewed HSE's estimation of the societal risk for such sites and considered alternative approaches to help clarify the issues.

Scope of Work

2. HSE commissioned Atkins to examine some internal preliminary work by HSE that considered whether the changes to the land use planning policy for large-scale petroleum storage sites proposed by the ERM study (see Annex 4) might also control increases in societal risk from development that may be authorised within these revised zones. Atkins were also asked to examine how stringent the individual risk-based LUP control in the inner zone for these sites might need to be in order to control risks to the public.

Initial work by HSE

3. The starting point was the revised policy for large-scale petroleum storage depots proposed by the ERM study. The proposed options were to increase the inner, middle and outer zones to 250, 300 and 400 metres respectively and, as another option, change sensitivity levels of development to avoid new normally occupied buildings in the inner zone of 250m.

4. HSE's preliminary work briefly examined the contribution to societal risk of hypothetically distributed population surrounding a site with these revised zones. The initial conclusions were that if stringent individual risk-based LUP control were introduced in the inner zone of 250m, there would be no need for additional land use planning control based on societal risk for these sites.

5. There are two main reasons for this conclusion. First, for events such as VCE, the risk of fatality is highest close into the source of the hazard and then drops markedly beyond this distance. Second, the area of land covered by the inner zone is relatively large compared to the area of the middle and outer zone. Thus the combination of the high risk of fatality close to the source of the hazard and the large area covered by this risk means that it is important to control development in the inner zone in order to manage societal risk for these types of installation.

Atkins risk approach

6. Atkins adopted a risk assessment approach and used a series of expert judgements and assumptions first to characterise the explosion event and then to select an event frequency for a VCE. Next, they used RiskTool (their risk assessment modelling package) to derive risk values from which individual and societal risk measures were determined.

7. Atkins' work on the hypothetical situation supported HSE's initial conclusions. They then carried out work on realistic test cases which again confirmed that population beyond about 250m from large scale petroleum storage sites does not contribute in a significant way to their societal risk. They pointed out that this did not preclude the case for controlling development from the point of view of individual risk beyond 250m.

More stringent control within 150m

8. Atkins also examined how much societal risk control could be achieved by changing the sensitivity level of development (as suggested by the ERM study) to a distance of 150 m (as opposed to ERM's Option A or 250 m in ERM's Option B – these are Options 2 and 3 in the main document). Atkins found that from a risk point of view, if new development within a distance of 150m of a site (a Development Proximity Zone) was strictly controlled, (i.e. no normally occupied developments) and the normal land use controls in the inner, middle and outer zones were followed, any increase in societal risk would be limited.

9. A distance of about 150 m aligns, as it happens, with an approximate risk of fatality as calculated in this study of 10 chances per million per year (cpm) (1 in 100,000 chance of fatality). This figure has been suggested elsewhere as a criterion within which no new normally occupied development should be permitted (Evans et al. 1996, R & D Report 9636, Third Party Risk Near Airports and Public Safety Zone Policy, National Air Traffic Services Ltd, June 1997).

10. Sensitivity studies were also conducted by Atkins, which indicated that a distance of 150 m for the zone with no occupied buildings in an additional option, Option C (Option 4 in the main document), is a reasonable approach. Further sensitivity studies showed that there is probably some conservatism in the risk assessment results presented in the report, but the degree of conservatism was hard to quantify due to our current limited understanding. It therefore seems reasonable at this time to adopt a **precautionary risk-based approach**, such as that represented by Option C.

11. Atkins suggested the following approach to prevent an increase in societal risk around large-scale petroleum storage sites to levels that might be regarded as inadvisable:

'Define a new 'Development Proximity Zone' for large scale petroleum storage sites, set at about 100 to 150 m from the vessel storage area (or site boundary), and advise against all normally occupied buildings within this distance, but allow Sensitivity Level 1 developments beyond this distance in the Inner Zone. This approach (i.e. Option 4 in the main document) should ensure that occupied buildings are not located where levels of individual risk of fatality exceed about 10 cpm, and would also ensure that societal risks are kept to a reasonable level. This essentially risk-based approach would also have less impact than Option B in terms of planning blight.'

Conclusions

12. Overall, Atkins' conclusions were:

- (a) any practicable land use planning approach for large-scale petroleum storage depots must inevitably be risk based, either explicitly or implicitly;
- (b) if stringent individual risk-based Land Use Planning control is introduced in the Inner Zone, there will be no need for any further controls based on societal risk;
- (c) the most appropriate way of controlling the risk within the proposed 250 m Inner Zone would be to introduce a 150 m Development Proximity Zone, within which HSE would advise against all normally occupied buildings;
- (d) whilst there were still many uncertainties regarding the off-site risks associated with large petroleum installations, the adoption of this Development Proximity Zone was considered to represent a precautionary risk-based approach.

Proposals for revised policies for HSE advice on development control around large-scale petrol storage sites

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