

The Buncefield Investigation

Progress report



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Photographs are courtesy of the Chiltern Air Support Unit and Hertfordshire County Council

Foreword

At the first meeting of the Major Incident Investigation Board (MIIB) on 24 January I was asked to prepare, for the second (10 February) meeting, a progress report on the Buncefield Major Incident Investigation by the Health and Safety Executive (HSE) and the Environment Agency (EA). This was to bring together relevant background material and to cover progress with the investigation and such facts as have been established to this point.

The MIIB said that this progress report would not constitute the 'initial report' required by Terms of Reference 6, since some of the main facts have yet to be established. This progress report is a stepping stone towards the initial report.

The report describes the incident and the nature of the site and surrounding communities and the initial responses by EA and HSE. Importantly, the report describes the most likely nature of the explosion and fires that have so far been ascertained from eyewitness statements and CCTV records. The explanation of what the investigation team believes is most likely to have led to the devastation of the area is not yet verified by scientific modelling and other evidence but I have sufficient confidence in the evidence to believe on balance it should be made public.

The report does not describe how what happened occurred. This is because I am not in a position to say anything with sufficient confidence for it to be other than a line of inquiry amongst others. Speculating publicly on causation would be undesirable because I am not in a position to confirm the likelihood of the theory, nor to deal authoritatively with the implications arising out of the theory. It may also lead to nugatory remedial actions by depot operators. I believe verification is required from records of fuel movement and storage to confirm any theory related to loss of containment, not least of all because this may alter the balance between system and mechanical failure, and this knowledge is vital in formulating a competent response to the Buncefield incident.



Taf Powell

Buncefield Investigation Manager and Member of Buncefield Major Incident Investigation Board

Part 1 The Investigation so far

1.1 The incident

1 At around 06.00¹ on 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 over 20 large fuel storage tanks over a high proportion of the site.² There were 43 people injured in the incident, none seriously. 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. About 2000 people were evacuated. Sections of the M1 motorway were closed.

Figure 1 This photograph shows the Buncefield site on the first day of the fire. The Northgate building can be seen burning towards the lower left corner of the photograph.

¹ Preliminary analysis of seismic records published by the British Geological Survey indicates that the initial explosion event occurred at 06:01 GMT.

² Figure 5 on page 8 shows the damaged area. For a description of the site see Part 2.1 of this report.



2 The fire burned for several days, destroying most of the site and emitting large clouds of black smoke into the atmosphere, dispersing over southern England and beyond. Large quantities of foam and water were used to control the fire, with risks of contaminating water courses and ground water (see Figure 2).

Emergency response

3 The emergency services (primarily the Fire and Rescue Service and the police) led the initial response to the incident and its immediate aftermath. As a Category 1 responder under the Civil Contingencies Act, EA worked closely with the Fire and Rescue Service, the police, the Health Protection Agency (HPA) and the Strategic Health Authority, including advising on the water pollution aspects of the fire-fighting activities. HSE is a Category 2 responder, so during the early phase of the incident stood ready to provide advice and expertise on request in support of the emergency services and EA.

Figure 2 This photograph shows the fire-fighting operation in progress with the appliance in the avenue between bunds 'A' and 'B'

4 Hertfordshire Police co-ordinated the emergency response and worked closely with other responders including the Hertfordshire Fire and Rescue Service, Hertfordshire County Council, Dacorum Borough Council, EA and HPA. The police



set up an exclusion zone around the site which remained in position for several days. The Hertfordshire Fire and Rescue Service was supported by staff drafted in from many other brigades and used equipment and foam brought in from around the country. Shortly before Christmas the police were able to hand back the security of the site to the depot operators but the fire service retained a presence on site until the New Year as quantities of uncontained fuel remained on site.

5 At the peak of the incident – on Monday lunchtime, 12 December – there were 26 Hertfordshire pumps on site, 20 support vehicles and 180 firefighters. More than 250 000 litres of foam concentrate were used, together with 25 million litres of water and 30 km of high-volume hose.

6 The investigation team wishes to acknowledge the work of the emergency services and especially the invaluable support given to HSE and EA in securing vital evidence in the initial period when the site was dangerous and under the control of the emergency services.

Securing the site

7 Once the Buncefield fire had been extinguished, HSE issued formal notices on the two operators of the part of the depot that had suffered the greatest damage. Prohibition Notices were served on both Hertfordshire Oil Storage Ltd (HOSL)³ and British Pipeline Agency Ltd (BPA) on 16 December 2005 prohibiting operations on site under their control unless appropriate risk assessments had been agreed with HSE. Each of these operators were also served with Notices requiring that the parts of the depot under their control were left undisturbed. The Notices were issued to ensure that key pieces of evidence remained in place for examination by the investigation team and that the clear up operations were carried out in a safe manner. The operators have co-operated with HSE and EA to achieve these goals.

Water pollution

8 EA worked with the Fire and Rescue Service to develop a plan that minimised the potential for firewater run-off. This included recirculating cooling water. The main concern was the containment of liquid on site due to the presence of a drinking water aquifer nearby. Some material did leave the site into Three Cherry Trees Lane. EA believe most of this was contained by the natural contours of the land, which prevented it reaching surface waters. Pollution of the River Ver is low and no impact on its fish and animal life has been seen.

9 From the start of the incident both the Meteorological Office (using a long-range pollution dispersion model) and EA (using a short-range model) worked to model the plume and provided data to HPA on likely plume direction and ground level concentrations. On the advice of HPA a number of schools were closed as a precaution.

10 Air pollution in London and the Home Counties was measured by four regional air quality monitoring networks managed by King's College, London, and comprising over 130 local authority monitoring sites. A number of parameters were measured including particulates. Air samples were sent for particulate analysis and the results are awaited.

³ For more details of the HOSL and BPA sites see Part 2.1 of this report.

Social and economic impact

11 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.

Figure 3 The smoke plume rising and spreading above the Buncefield site.





Figure 4 Depot and surroundings prior to incident

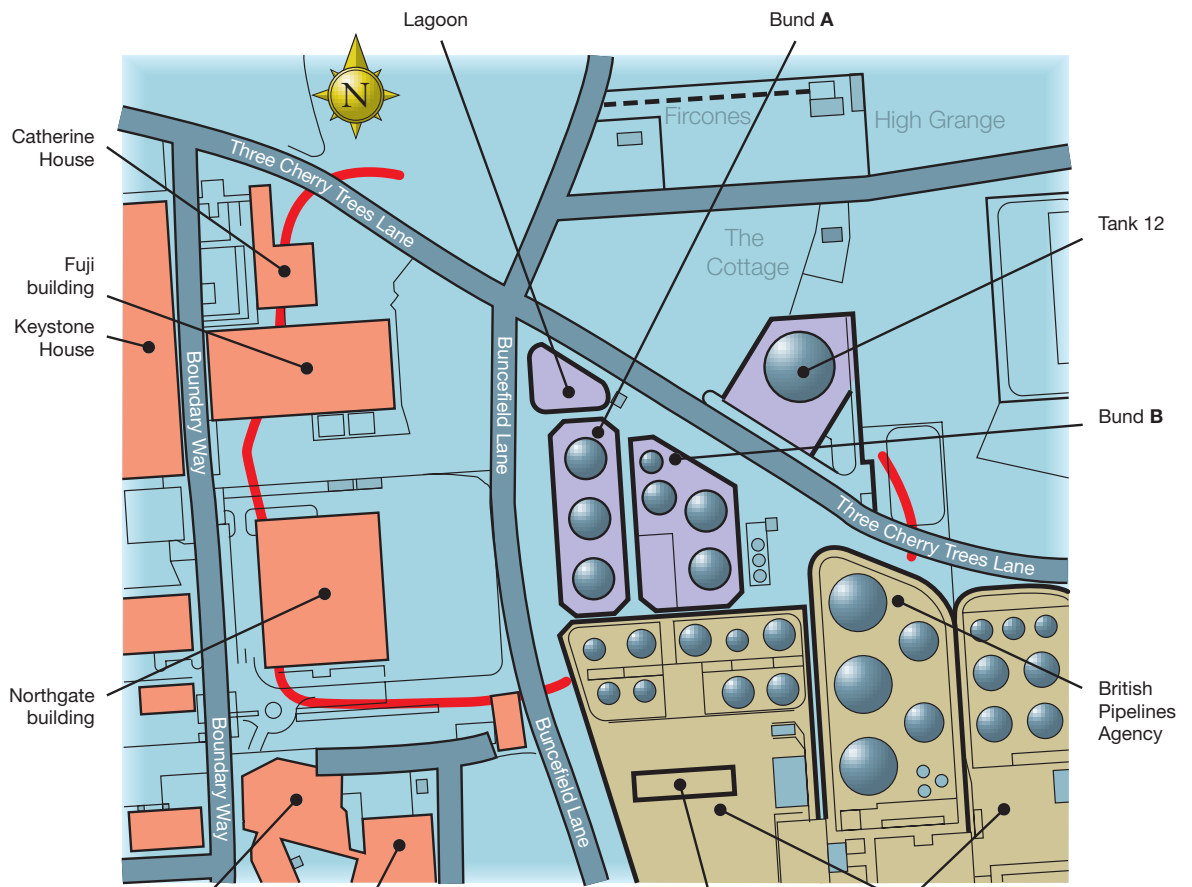


Figure 5 Layout of Depot and surroundings also showing limit of flammable mixture indicated by burned material



12 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.

13 The incident disrupted fuel supply to London and South-East England. Remedial measures by the industry have restored supplies of road transport, commercial and domestic fuels generally back or close to pre-incident levels. However, supplies to Heathrow remain disrupted. This has required fuel rationing by the BAA to allow the airport to function normally, with no flight cancellations. For all supplies the industry is trying to find permanent solutions to replace the current transitional arrangements.

1.2 What is known about the explosions and fire

14 Evidence obtained so far points to the formation of a flammable mixture of petrol, or similar spirit, and air that ignited, leading to the explosions and fire. The flammable mixture appears associated with a visible mist. This evidence includes reports from eyewitnesses, CCTV records and forensic material, as briefly summarised below.

Eyewitness reports

15 On-site at the west side of the tanker loading gantry on HOSL West site:

- Witnesses describe seeing mist at about 05:50 GMT in the vicinity of one of the tanks in bund A⁴ (see Figure 4). They also describe a mist variously between one and three feet in height rolling from bund A towards the tanker loading gantry. Witnesses also report a moving mist near the trees (along Buncefield Lane to the west of the site) about one and a half feet high and wisps of vapour on the ground near the end of the loading bay.
- These witnesses mention a strong smell at this time, variously described as petrol or aviation gasoline.
- None of the witnesses describe the flames reaching them as they moved from the tanker loading gantry towards the site exit. None of them report having suffered burn injuries.

16 Off-site in the vicinity of the Fuji building carpark to the west of the site:

- Witnesses describe a thick fog 'above head height' or 'between 15 and 20 feet high' between 05:50 and 06:00 GMT. This was first seen near the junction where Three Cherry Trees Lane meets Buncefield Lane. The fog continued to spread to the west towards Catherine House.
- These witnesses noticed a strong smell, but were not certain of its nature and in general there is a degree of disagreement among witnesses as to the nature of the smell. These witnesses also describe various responses from their car engines including 'revving uncontrollably', 'running rough' and 'stalling'.
- From the witness statements and lack of burn injuries, the flame does not appear to have travelled as far as Boundary Way.

CCTV records

17 Examination of CCTV images for the HOSL site and for the RO building off-site has provided the following evidence.

⁴ A bund is an enclosure designed to contain fluids should they escape from the tank or vessel inside the bund.

18 HOSL West

- Before the event there was no evidence of mist or fog at ground level showing on any of the camera images. This includes the surface of the fire water lagoon in the north-west corner of the HOSL West site.
- The first unusual indication was at 05:38 GMT, 23 minutes before the explosion. At the north-west corner of bund A, a light mist is seen flowing from inside bund A towards the west. This is at the north-west corner of bund A. The mist is low-lying and about one metre deep. Its appearance is consistent with a mist that is denser than the surrounding air.
- During the next few minutes mist is seen flowing towards Three Cherry Trees Lane via the lagoon and flowing out of bund B at the north-east edge of the site, along the roadway on-site.
- Cameras at the eastern edge of the HOSL site adjacent to the BPA site first show the mist eight minutes after its first appearance crossing the wall of bund A.
- By this time, the cameras along the western edge of the site, along Buncefield Lane, show that the mist has thickened to about two metres deep. It is now so dense that it is not possible to see through it. It appears to flow away from bund A in all directions.
- There is no indication on the cameras that the visible mist has spread as far south as the tanker filling gantry.
- All the cameras stopped recording at the time of the explosion.

19 HOSL East

- There is no evidence of the mist seen on the HOSL West site having reached as far as any of the cameras on the HOSL East site. The cameras show evidence of the fire, but it is not possible to learn anything of significance.

20 RO building

- This building is to the south of the Northgate building, approximately level with the tanker loading gantry on the HOSL West site. There is no evidence of the mist having reached as far as any of the cameras at this building. The images show a flash of light at the time of the explosion, followed by evidence of explosion damage.

Figure 6 HOSL West gates



Initial forensic examination

21 Initial examination of the evidence of damage around the site by the Health and Safety Laboratory (HSL) allows the approximate extent of the flammable mixture to be judged from the effects of the flash fire on vulnerable surfaces:

- Scorched vegetation on a row of trees between the Northgate building and the 3-Com building.
- Scorched leaves underneath these trees.
- Scorched upholstery to unignited cars at this location.

22 In addition the north-east corner of the Northgate building has been on fire. There are burnt cars and trees between the Northgate building and the Fuji building.

23 Cars on Three Cherry Trees Lane near to Catherine House were set on fire and vegetation along the side of Three Cherry Trees Lane was scorched at this location.

24 Evidence of the extent of any flammable mixture over the HOSL site is masked by damage from the resulting tank and bund fires.

Initial conclusions regarding the extent of the flammable mixture.

25 The explosion(s) that caused the extensive damage on and off site, and the early fires, can probably be ascribed to the ignition of a flammable mixture that is thought to have been associated with the visible mist reported by eyewitnesses and visible on CCTV records.

26 Initial indications are that the flammable mixture of fuel and air extended to the west almost as far as Boundary Way in the gaps between the 3-Com, Northgate and Fuji buildings. To the north-west it extended as far as the nearest corner of Catherine House.

27 It may have extended to the north of the HOSL site as far as BPA tank 12. It may have extended across part of the HOSL site, but there is no evidence of it having spread as far south as the tanker filling gantry, although the visible mist had just started to reach this point. Figure 5 shows the most likely extent of the flammable mixture based on the investigation so far.

28 The visible mist seen in the CCTV records and described by witnesses is assumed to arise from the evaporation of the more volatile fractions of an escape of fuel. This evaporating fuel would be cold compared to the surrounding air, which is known from weather records to have had high humidity. The cooling would result in the condensation of water in the air. The visible mist thus indicates the approximate extent of the fuel air mixture.

29 The source of the fuel release is not yet known, although the CCTV records indicate that it was in the vicinity of bund A on the HOSL West site. The most plausible scenarios involve large-scale loss of containment of vessels or pipework within bund A. Resources are being directed to clarify these early indications and to find out what underlying causes there may have been.

Initial findings regarding the explosion

30 It is clear from the witness accounts and the evidence of damage both on and off site that there was a massive explosion early in the developing incident. There appear to have been several explosions, but the exact sequence of events has not yet been established. Initial indications from examination of the explosion damage are that the main explosion event appears to have been located in the area of the car parks between the HOSL West site and the Fuji and Northgate buildings. The heaviest damage can be seen in this area. This does not necessarily mean that the ignition of the flammable mixture occurred here, but that the highest flame speeds were in this location. The mechanism for this is not yet understood. This forms part of the ongoing investigation.

Initial advice to duty holders

31 In response to the incident HSE will advise duty holders what steps to take in the light of what is known so far about the nature of the Buncefield explosion. The advice will be systematically followed up with duty holders by HSE inspectors.

1.3 The continuing Investigation

32 Immediately after the incident HSE and EA set up a joint investigation team under the leadership of HSE. The Investigation team was tasked with finding out what had happened, including the factors leading up to it and the root causes. The full terms of reference are at Annex 3.

33 The team divided the Investigation into a number of strands and assigned specialist staff to take each one forward. The Investigation is led by specialists in inspection and investigation. The main technical strands are in mechanical engineering, process engineering, fire and explosion engineering, control and instrumentation, and environmental impact assessment. Human factors experts will be increasingly involved as more evidence becomes available concerning the operation of the site. The site has been segmented into areas to assist the early Investigation.

34 The team commissioned staff from the HSL to assess the damage caused by the explosion. This assessment has enabled the team to determine the approximate location and extent of the flammable mixture that had formed, and the probable sources of ignition that led to both the fire and the explosion.

35 Work is continuing to find out the exact nature and composition of the flammable mixture and to determine the precise mechanism which led to such a violent explosion. This includes establishing the nature and composition of the fuel from which the mixture was formed. Priority is being given to this work so that HSE's advice to local planning authorities about developments adjacent to Buncefield and other fuel storage sites can be reviewed and, if necessary, amended. Site surveys have been carried out to enable the team to determine the volume and physical and chemical properties of the flammable mixture; this important work is continuing.

36 Inspectors are continuing painstaking work to restore and view CCTV evidence from the site and adjacent premises. There is a large amount of electronic evidence relevant to the operation of the depot and much of this was contained in buildings severely damaged by the blast. As much of this as possible has now been secured and work continues to restore and then examine these highly specialist electronic records to determine the operating conditions before and at the time of the incident.

37 The Investigation team is also examining the detailed technical documentary records relating to plant design and operation. Examination of the damage to plant on site and forensic examination of key parts of tanks and pipework is only just commencing. Following the extensive damage and contamination of bunds with fuel products and run-off fire water, access to many parts of the site has been restricted. Priority has been given to making these areas safe and only recently have inspectors been able to turn their attention to this aspect of the investigation.

38 On environmental issues the team has focused on containment of products and fire-fighting materials on site and releases to the environment. It is working to identify pathways of pollutants into the environment and to quantify the scale of impact to the environment both on and off site with regard to land and water. As the clean-up operation has progressed samples have been taken from lagoons, boreholes and surrounding watercourses and gaining photographic evidence of the developing situation both on and off site. Staff are also obtaining documentary evidence of how containment was designed, constructed and maintained on site, including the provision for containing fire-fighting water.

39 The Investigation team continues to investigate the scale of environmental impact from the liquids released from the site, as well as closely monitoring the clean-up work. Team members are working to identify the root causes of any containment failings as well as identifying where measures on site have prevented greater impact.

Ongoing objectives

40 The Investigation is at a very early stage. The team has yet to start examining previous inspection reports and assessments of safety reports. This will be necessary to identify whether any issues linked to the root causes of this incident had been raised previously with the operators and if so what the operators had done about them. The investigation will also examine the on- and off-site emergency plans.

41 A critically important focus for the site Investigation is to find out why and where there was a release of hydrocarbons. It is therefore vital to continue work on the examination of pipework and storage tanks to ascertain the precise source of the release and the mechanism of formation of the flammable mixture and why preventive control measures were inadequate.

42 The Investigation still needs to establish whether the incident has caused serious danger to the environment, as set out in the definition of a 'major accident' affecting the environment in the Control of Major Accident Hazards Regulations 1999 (COMAH).

43 Work on all strands of the Investigation is continuing. Further work is needed before a clear and definitive picture will emerge, both of how and why there was a release of fuels on 11 December 2005 and of the underlying reasons for it.

44 As part of the Investigation, the team will also examine all this collective evidence against the standards required by the COMAH Regulations and other health, safety and environmental legislation.

Emergency plans

45 The COMAH Regulations require on- and off-site emergency plans for the Depot (see Part 2.2). HSE and EA are examining the adequacy of these plans in conjunction with the operators and the emergency services. The plans will be compared to the operational response and lessons drawn for the future.



Figure 7 The area prior to incident

Developments around the Buncefield Site

46 COMAH sites are subject to a special planning regime which is described in Part 2.2. At Buncefield this resulted in zones being drawn around the site within which HSE was consulted on developments by the local planning authorities. The outer zone (the ‘consultation distance’) was set at approximately 190 metres from the perimeter of the site. The investigation will examine the history of planning applications within the vicinity of the site and in particular, when the precise nature of the explosion and fire has been determined, will address the question of whether or not advice to local planning authorities at Buncefield and similar sites should be changed.

1.4 Review of HSE/EA roles in regulating activities at Buncefield

47 Point 3 of the Buncefield Investigation terms of reference (Annex 3) requires the Investigation to examine HSE’s and EA’s role in regulating the activities on this site under the COMAH Regulations, considering relevant policy guidance and intervention activity. HSE and EA together form the Joint Competent Authority for the regulation of major hazard sites (such as Buncefield) under the COMAH Regulations.

48 This review will address both the nature of the compliance with policy and procedures for regulating health, safety and environmental matters, and the efficacy of the policy and procedures.

49 HSE and EA will initially conduct separate reviews, sharing findings and aligning outputs as necessary. The final product will be a single report of the regulation of the Buncefield site together with recommendations arising out of the review.

50 Review teams have been set up in both organisations, site visits undertaken and plans for reviewing documentation and previous regulatory involvement have been drawn up.

51 The review findings on the HSE and EA roles will be subject to full scrutiny by the independent members of the Major Incident Investigation Board (see Part 1.5).

1.5 Major Incident Investigation Board

52 On 12 January 2006 HSC appointed a six-person Board to oversee the formal Investigation. This Board comprises an independent non-executive Chairman, two independent experts, one in fire safety, the other in occupational and environmental medicine, and three senior regulatory operations managers, two from HSE and one from EA.

53 In broad terms the purpose of the Board is to oversee the Investigation and ensure that:

- the Investigation is carried out effectively and the best professional advice is used in establishing causation;
- the confidence of the public is maintained in the work and findings of the Investigation;
- the eight points of the terms of reference (Annex 3) are met, even if in some cases delivery is the responsibility of other parties;
- information is made public in a timely way, but subject to legal considerations.

Part 2 Background

2.1 Site description

54 Buncefield Oil Storage Depot is a large strategically important fuel storage site (known as a tank farm) operated by a number of companies. Figure 5 shows the layout of the site and its immediate surroundings.

55 The Depot receives petrol, aviation fuel, diesel and other fuels by pipeline. It stores and then distributes these fuels by pipeline and road tanker to London and South-East England, including to Heathrow Airport. The UK Petroleum Industry Association (UKPIA) reports that, prior to the events of 11 December 2005, Buncefield handled 8% of overall UK oil supplies into the market, including 20% of supply to consumers in the South East. The terminal acted as a main pipeline transit point to meet 40% of Heathrow's demand for aviation fuel. On 11 December the site held over 35 million litres of petrol, diesel and aviation fuel.

56 The Depot contains three sites which are so-called 'top-tier' sites under the COMAH Regulations (see Part 2.2 of this report on regulation of high-hazard sites), although the HOSL and BP sites did not acquire top-tier status until changes were made to the Regulations in July 2002. This required submission of safety reports for these sites by July 2003:

- Hertfordshire Oil Storage Ltd (HOSL) – a joint venture between Total UK Ltd (60%) and Texaco Ltd (40%). This site is in two sections, HOSL East and HOSL West. HOSL West was at the centre of the fire. The site had consent to store 34 000 tonnes of motor spirit and 15 000 tonnes of kerosene. The COMAH safety report assessment process had not been completed.
- British Pipeline Agency Ltd (BPA) – a joint venture between Shell and BP that operates the site and the pipeline system, while the assets are owned by UK Oil Pipelines Ltd (UKOP). This site is split between the 'North' (or 'Cherry Tree Farm') section and the main section. It was substantially damaged by fire. It had consent to store 70 000 tonnes of motor spirit and other fuels. The COMAH safety report assessment process had been completed.
- BP Oil Ltd. The BP facility to the south of the Depot was furthest from the fire and appears to have escaped with superficial damage. It is out of operation while the full extent of damage is assessed. It has consent to store 75 000 tonnes of motor spirit, all product being received from the BPA site pipelines. The COMAH safety report assessment process had been completed.

57 The fuels arrive at the sites in batches through a system of three pipelines, namely:

- One 10" diameter pipeline ('FinaLine') from Lindsey Oil Refinery, Humberside, terminating in the HOSL West site.
- One UKOP 10" diameter pipeline ('Mersey-Buncefield') from Stanlow refinery, Merseyside terminating in the BPA North site
- One UKOP 14" diameter pipeline ('Thames-Buncefield') from Shell Haven and Coryton Refinery terminating in the BPA main site.

58 After separation of the multi-fuel product entering the sites from the pipelines, the fuel is stored in tanks individually dedicated to specific product types. Product then leaves the sites either by road tanker or, in the case of aviation jet fuel, via two dedicated 6" and 8" pipelines from the BPA site into the West London Walton Gatwick pipeline system. Fuel leaving the site by road is loaded by dedicated vehicle loading facilities at HOSL West, BP and to a lesser extent BPA.

59 There are also fire-fighting facilities on site, some of which are shared. The site water treatment is operated by BPA, collecting run-off water from the whole site into a water treatment plant in the north-east corner of the Depot.

60 For land use planning purposes the Depot is surrounded by a consultation distance of 190 metres (see page 22). The local planning authority must consult HSE about developments within that distance, but not those outside it.

Site conditions at the time of the incident

61 Information provided by HOSL indicates that during the hours leading up to the explosion, the HOSL site was importing unleaded petrol through the FinaLine pipeline from the Lindsey Oil Refinery. In addition, unleaded petrol was being imported through the Thames pipeline and diesel through the Mersey line. Unleaded petrol was being exported from the site by filling road tankers at the gantry on the HOSL West site.

Weather conditions

62 Meteorological Office records have been obtained for two sites at Luton Airport (13 km to the east-north-east) and Northolt (24 km to the south). These indicate that during the early morning of 11 December 2005 the weather was calm, cold, stable and humid. Atmospheric stability at Northolt was stable (Pasquill stability category F). The relative humidity was recorded as 99%. The air temperature was -1.7°C at Northolt and 1°C at Luton. There was no wind recorded at Northolt, while Luton recorded an average wind speed of 6 knots (approximately 3 metres per second) during the 10 minutes before 06:00 GMT. The average wind direction was recorded as 280 degrees measured from true north (this is the direction from which the wind was blowing).

63 At Luton there was a light wind west to east. Further south there was no wind.

Geology

64 The Buncefield Depot and the immediate surrounding area are positioned on a variable layer of clay with flints over Upper Chalk. The clay with flints layer is classified as a low permeability surface deposit and is believed to be present at a variable thickness of between 2 m and 10 m. This layer should inhibit the vertical and lateral migration of contaminants and protect the chalk aquifer below where present in sufficient depth.

65 The Upper Chalk is classified as a major aquifer, which provides water supplies regionally. The Depot is located within the catchment of a ground water abstraction point located to the south and east of the Depot. Ground water is present typically at a depth of 45 metres below ground level and flow is generally towards the south-east. Natural holes in the chalk which allow quicker water flow than normal may be present, but none have been positively identified in the immediate area.

66 Within the Depot site boundary a layer of made-ground, comprising a sand clay dominated soil mixture, overlies the clay.

Water

67 A local ground water abstraction point that is used as cooling water is located approximately 500 m south of the Depot.

68 The River Gade is located approximately 3 km to the south-west and the River Ver approximately 3.5 km east of the Depot.

69 During normal operation, surface water from the Depot drains to the Depot effluent treatment plant. It is then pumped into the public surface water system at Pratts Dell to the north-west of the Depot. This in turn drains to the surface water-balancing pond at Redbourne Road and subsequently to the River Red, a tributary of the River Ver.

70 Maylands pond is another surface water-balancing pond situated to the south-west of the Depot. It was used as a source of fire-fighting water during the incident.

General background

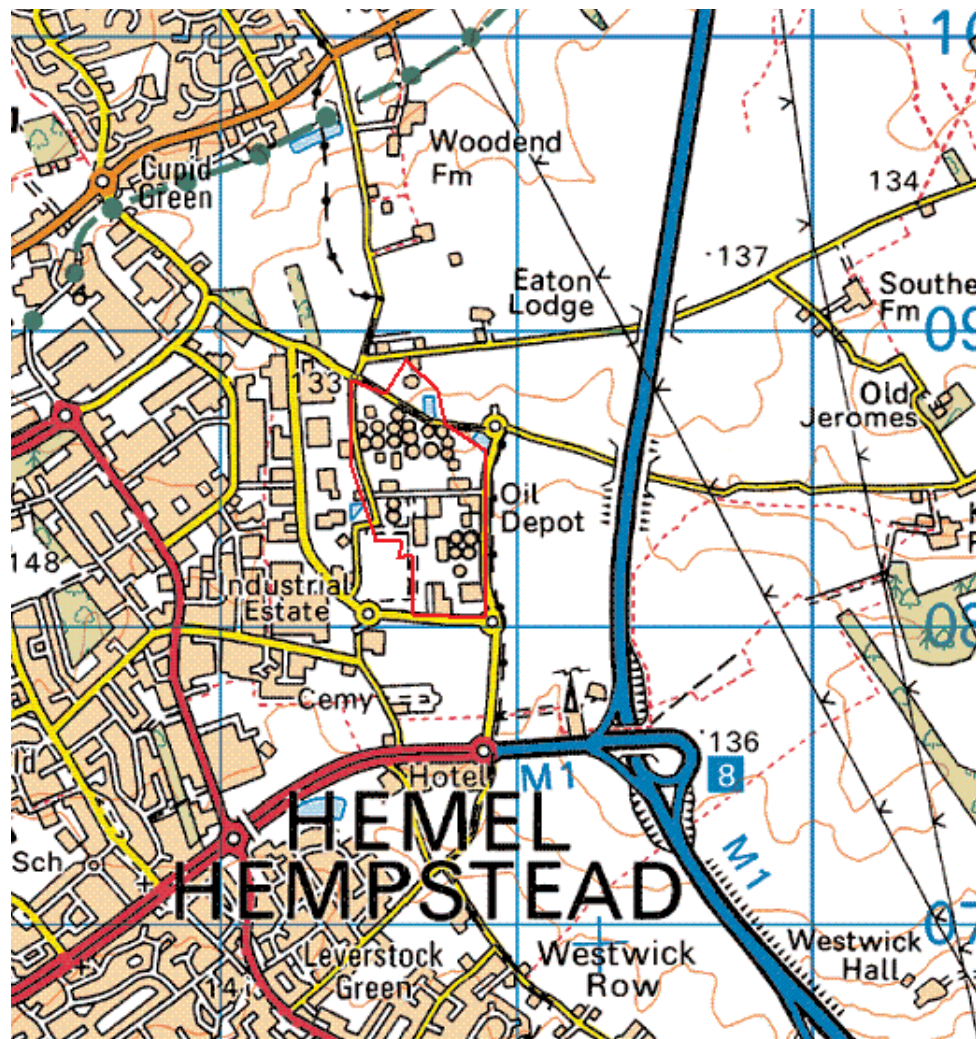
71 Land to the west and north of the Depot is largely used for the growing of arable crops.

72 There are no listed buildings within 1 km of the Depot and no recorded monuments within 500 m of the Depot.

73 The Depot is not located within a 100-year flood plain as defined by the EA flood maps.

74 There are no sites of special scientific interest within 2 km of the Depot and the nearest site designated under the Habitats Directive is Ashridge Common Special Area of Conservation, approximately 8 km north-west of the Depot.

Figure 8 Buncefield Oil terminal - Immediate surroundings of the complex



2.2 Regulation of high-hazard sites

75 The regulatory framework for sites, such as Buncefield, which pose potential major accident hazards comprises requirements imposed on the site operators under both health and safety and environmental legislation, complemented by the requirements of planning law. In particular the COMAH Regulations apply.

Health and safety law

76 Operators in the process industries are subject to the requirements of the Health and Safety at Work etc Act 1974 (HSW Act) and the Management of Health and Safety at Work Regulations 1999 (MHSWR) which require, respectively, safety policies and risk assessments covering the whole range of health and safety risks.

Control of Major Accident Hazards Regulations 1999 (COMAH)

77 COMAH's main aim is to prevent and mitigate the effects of those major accidents involving dangerous substances, such as chlorine, liquefied petroleum gas, and explosives which can cause serious damage/harm to people and/or the environment. The COMAH Regulations treat risks to the environment as seriously as those to people. They apply where threshold quantities of dangerous substances identified in the Regulations are kept or used. There are two thresholds, known as 'lower-tier' and 'top-tier'. Annex 1 gives a brief background to the origins of these Regulations. The requirements of COMAH are fully explained in *A guide to the Control of Major Accident Hazards Regulations 1999 (COMAH). Guidance on Regulations* L111 HSE Books 1999 ISBN 0 7176 1604 5.

78 The COMAH Regulations are enforced by a joint Competent Authority (CA) comprising HSE and EA in England and Wales, and HSE and the Scottish Environment Protection Agency (SEPA) in Scotland. Operators will generally receive a single response from the CA on all matters to do with COMAH. The CA operates to a Memorandum of Understanding which sets out arrangements for joint working.

79 The COMAH Regulations require operators of top-tier sites to submit written safety reports to the CA. Operators of top-tier sites must prepare adequate emergency plans to deal with the on-site consequences of possible major accidents and to assist with off-site mitigation. Local authorities for areas containing top-tier sites must prepare adequate emergency plans to deal with the off-site consequences of possible major accidents, based on information supplied by site operators.

80 The COMAH Regulations place duties on the CA to inspect activities subject to the Regulations and prohibit the operation of an establishment if there is evidence that measures taken for prevention and mitigation of major accidents are seriously deficient. The CA also has to examine safety reports and inform operators about the conclusions of its examinations within a reasonable time period.

Environmental legislation

81 Some of the establishments regulated under the COMAH Regulations are also regulated by EA and SEPA (the Agencies) under the Pollution Prevention and Control Act 1999 (PPC) or Part I of the Environmental Protection Act 1990 (EPA 90). The regime under EPA 90 is gradually being replaced by the PPC regime and will be fully replaced by 2007.

82 While the purpose of the COMAH Regulations (the prevention of major accidents) differs from that of IPC/PPC or LAPC (the prevention of pollution), the means to achieve them are almost identical. They require industry to have good management systems to control risk. PPC includes a specific duty to prevent and mitigate accidents to the environment which is complementary to the main COMAH duty. The Agencies manage this overlap between their different regimes following the principle that accident prevention work on COMAH sites is generally more significant because of the greater risks.

Land use planning

83 The land use planning aspects of the Seveso II Directive are given effect in the UK by the Planning (Hazardous Substances) Regulations 1992. Under these Regulations the presence of hazardous chemicals above specified thresholds requires consents from the Hazardous Substances Authority (HSA), usually the local planning authority. HSE is a statutory consultee on such occasions. The role of HSE is to consider the hazards and risks which would be presented by the hazardous substances to people in the vicinity, and on the basis of this advise the HSA whether or not consent should be granted. HSE will also supply a consultation distance around the site. Any future developments in these zones require HSE to be consulted.

84 The aim of health and safety advice relating to land use planning is to mitigate the effects of a major accident on the population in the vicinity of hazardous installations, by following a consistent and systematic approach to provide advice on applications for planning permission around such sites.

85 Historically, HSE has based its land use planning advice on the presumption that site operators are in full compliance with the HSW Act. Section 2 of the Act places a duty on an employer to ensure, so far as is reasonably practicable, the health and safety of his employees. There is a corresponding duty in Section 3 to ensure, so far as is reasonably practicable, that others (which includes the public) are not exposed to risks to their health and safety. These duties are goal-setting and operators are expected to determine the most appropriate means to comply with them, without the need for detailed approval from HSE.

86 Annex 2 sets out HSE's current approach to land use planning advice.

87 Under the General Development Procedure Order 1995, both HSE and EA are statutory consultees for:

- the development of a new major accident hazard site; or
- developments on an existing site which could have significant repercussions on major accident hazards; or
- other developments in the vicinity of existing establishments, where the siting or development is such as to increase the risk or consequences of a major accident.

Annex 1

Background to the COMAH Regulations

1 Certain industrial activities involving dangerous substances have the potential to cause accidents that give rise to serious injury to people or damage to the environment both close to and further away from the site of the accident. Such activities are known as major accident hazards.

Flixborough

2 In Great Britain, a disastrous explosion at a chemical plant at Flixborough in 1974 profoundly influenced the approach to regulating major hazards. There were 28 workers killed, the plant was destroyed and there was extensive damage to property off site. Following that accident, a committee of experts, the Advisory Committee on Major Hazards (ACMH), was appointed by the Health and Safety Commission to consider the problems of major accident hazards and make recommendations. They proposed a three-part strategy:

- (a) identification of the sites;
- (b) control measures to prevent major accidents; and
- (c) mitigatory measures to limit the effects of any accidents which do occur.

European Union Directive

3 Other major accidents occurred in Europe during the 1970s, the most significant of which took place in Seveso, Italy in 1976. Here, the accidental production and release of a dioxin as an unwanted by-product from a runaway chemical reaction led to widespread contamination. Such incidents, and the recognition of the differing standards of controls over industrial activities within the European Community, led the European Commission to propose a Directive on the control of major industrial accident hazards. The three-part strategy proposed in the UK was highly influential in shaping the Directive. The Directive on the Major Accident Hazards of Certain Industrial Activities (82/501/EEC) was adopted on 24 June 1982, and is generally known as the Seveso Directive.

4 Following a complete review of the Directive by the European Commission a new one, now known as Seveso II, was adopted in 1996. The Seveso II Directive retained the basic principles of major accident hazard controls set out in the original Seveso Directive but addressed some weaknesses and omissions. The new Directive followed a review carried out by the European Commission in conjunction with the Committee of Competent Authorities for the Seveso Directive (made up of representatives of all Member States' governmental bodies enforcing the Seveso Directive). It came into force on 3 February 1997 and was implemented in Great Britain on 1 April 1999 by the COMAH Regulations, except for land use planning requirements (article 12) which were implemented by changes to planning legislation.

5 An amending Directive in 2003 was implemented by changes to the COMAH Regulations. These came into force on 30 June 2005.

Annex 2

HSE's current approach to land use planning

Policy and practice

1 Under the Planning (Hazardous Substances) Regulations, the presence of hazardous chemicals above specified threshold quantities requires consent from the Hazardous Substances Authority (HSA), which is usually also the local planning authority (LPA). HSE is a statutory consultee on all hazardous substances consent applications. HSE's role is to consider the hazards and risks which would be presented by the hazardous substance(s) to people in the vicinity, and on the basis of this to advise the HSA whether or not consent should be granted.

2 In advising on consent, HSE may specify conditions that should be imposed by the HSA, over and above compliance with statutory health and safety requirements, to limit risks to the public (eg limiting which substances can be stored on site, or requiring tanker delivery rather than on-site storage). HSAs should notify HSE of the outcome of all applications for consent and where consent has been granted should supply copies of the site plans and conditions.

3 HSE uses the information contained in consent applications to establish a consultation distance (CD) around the installation. This usually comprises three zones (or 'risk contour areas') – see paragraph 6. The CD is based on the maximum quantity of hazardous substance(s) that the site is entitled to have under its consent. HSE notifies the LPAs of all CDs in their areas. The General Development Procedure Order 1995 requires the LPA to consult HSE about certain proposed developments (essentially those that would result in an increase in population) within any CD.

4 HSE advises the LPA on the nature and severity of the risks presented by the installation to people in the surrounding area so that those risks are given due weight by the LPA when making its decision. Taking account of the risks, HSE will advise against the proposed development or simply note that it does not advise against it. This advice balances the ACMH principle of stabilising and not increasing the numbers at risk, with a pragmatic awareness of the limited land available for development in the UK.

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

Consultation distances and risk contours

6 Using consent information, HSE undertakes a detailed assessment of the hazards and risks from the installation and produces a map with three risk contours representing defined levels of risk or harm which any individual at that contour

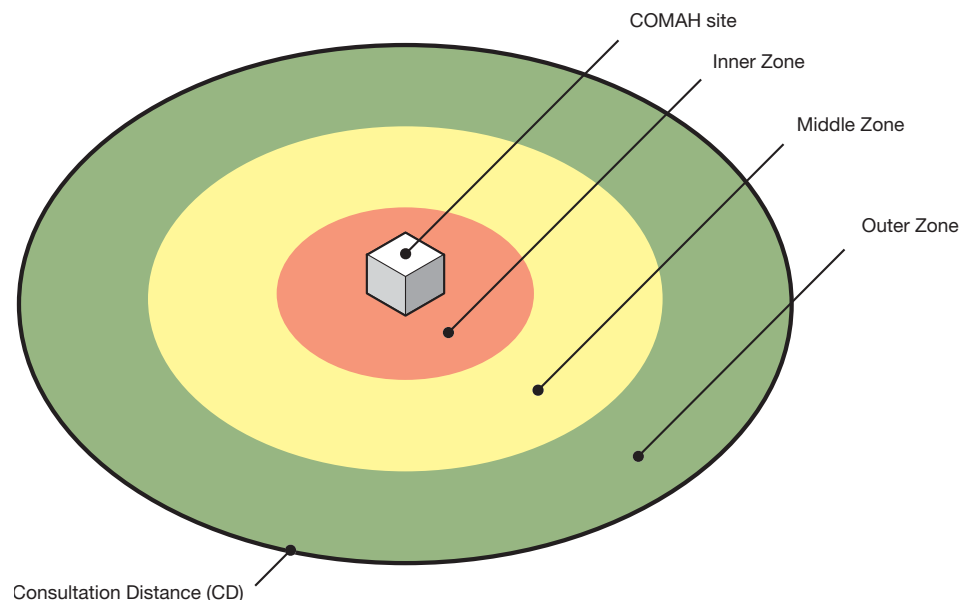
would be subject to. The risk of harm to an individual is greater the closer to the installation. In each case the risk relates to an individual sustaining the so-called 'dangerous dose' (see Figure 9) or specified level of harm. The three contours represent levels of individual risk of 10 cpm (chances per million), 1 cpm and 0.3 cpm per year respectively of receiving a dangerous dose or defined level of harm. The contours form three zones (see left), with the outer contour defining the CD around major hazard sites. The LPA consults HSE on relevant proposed developments within this CD.

Figure 9

Dangerous dose would lead to:

- severe distress to all;
- a substantial number requiring medical attention;
- some requiring hospital treatment; and
- some (about 1%) fatalities.

Figure 10



How HSE gives advice

7 When consulted, HSE firstly identifies which of the three defined zones the proposed development is in. Secondly, the proposed development is classified into one of four 'Sensitivity Levels'. The main factors that determine these levels are the number of people at the development, their sensitivity (vulnerable populations such as children, old people) and the intensity of the development. With these two factors known, a simple decision matrix is used to give a clear 'Advise Against' (AA) or 'Do not Advise Against' (DAA) response to the LPA, as shown below:

The 'PADHI' system

8 The decision matrix above was developed taking into account the experience of 30 years of HSE advice on land use planning. It is built into a software tool known as PADHI (Planning Advice for Developments near Hazardous Installations) introduced in late 2002. PADHI deals with the vast majority of consultations and is operated by staff in local HSE field offices, significantly speeding up responses from previous arrangements which required some specialist HSE resource.

Figure 11

Level of sensitivity	Development in Inner zone	Development in Middle zone	Development in Outer zone
1	DAA	DAA	DAA
2	AA	DAA	DAA
2	AA	AA	DAA
4	AA	AA	AA

Sensitivity level 1	<i>Example</i>	Factories
Sensitivity level 2	<i>Example</i>	Houses
Sensitivity level 3	<i>Example</i>	Vulnerable members of society eg primary schools, old people's homes
Sensitivity level 4	<i>Example</i>	Football ground/large hospital

DAA means Do not Advise Against the development
AA means Advise Against the development

Technical assumptions underpinning HSE methodology for land use planning

9 **The installation** The quantities and properties of hazardous substances, and the descriptions of storage and process vessels, are assumed to be in accordance with the 'hazardous substances consent' entitlement for the site since this represents a duty holder's declaration of their entitlement to store such substances which could be introduced at any time. For each type of development HSE's advice to planning authorities will take account of the maximum quantity of a hazardous substance permitted by a hazardous substances consent and any conditions attached to it. Best cautious, but not pessimistic, assumptions concerning substances, locations, operating conditions and surroundings are used. For operations not described in the consent (eg numbers and sizes of road tanker operations, pipework diameters, pumps and other fittings) site-specific values are obtained as necessary.

10 **Hazardous events** All foreseeable major accidents are considered and a representative set of events which describe a set of circumstances which, for that installation, could lead to an accidental release of hazardous substances.

11 **Consequences** The previously described 'dangerous dose' concept is generally used to describe the extent of the impact of any hazardous event on the surrounding population. Protection provided to people by being sheltered within buildings is generally taken into account by the approach, as is the likelihood of people being outdoors at the time of the incident.

12 **Ambient conditions** Local weather data is used to provide wind and stability information around the installation. Further, the surroundings are generally assumed to be flat although ground roughness can be taken into account where circumstances require it.

13 **Risk assessment** The calculations produce contours of the frequency that a typical house resident would be exposed to a dangerous dose or worse. This is generally expressed in terms of 'chances per million per annum' or cpm for short, eg 10 cpm, 3 cpm and 0.3 cpm.

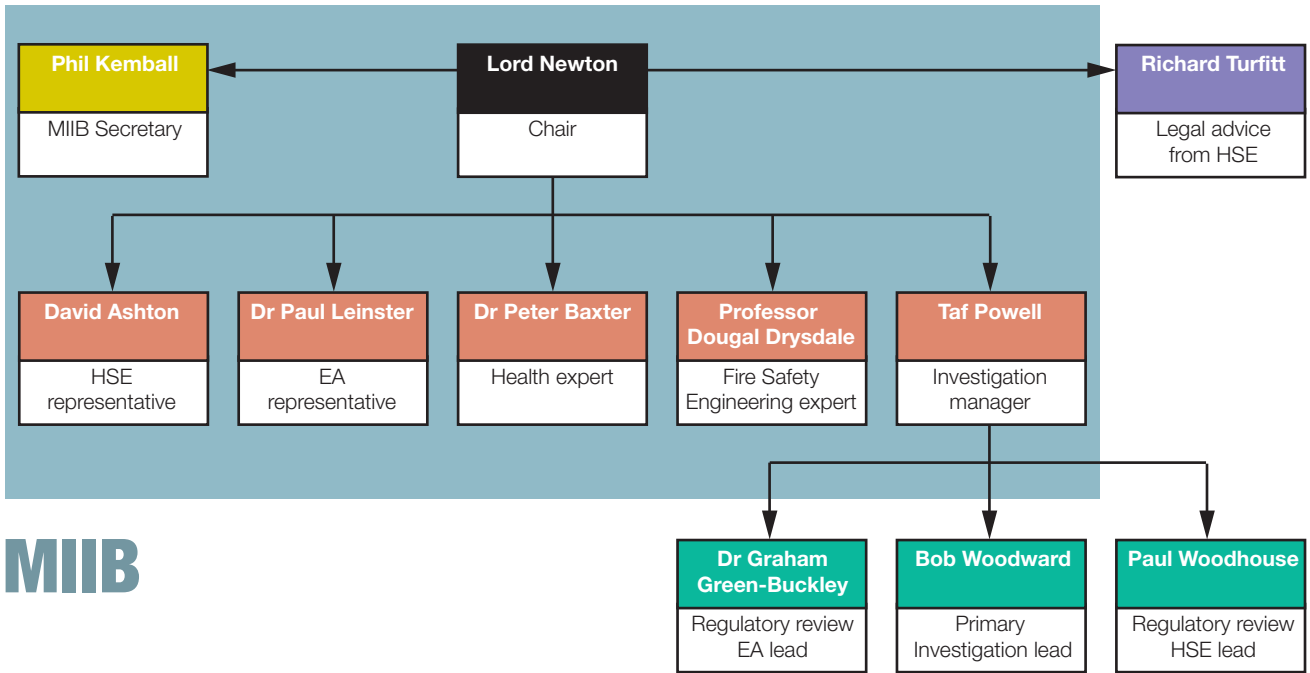
Annex 3

Investigation terms of reference

- 1 To ensure the thorough investigation of the incident, the factors leading up to it, its impact both on and off site, and to establish its causation including root causes.
- 2 To identify and transmit without delay to duty holders and other appropriate recipients any information requiring immediate action to further safety and/or environmental protection in relation to storage and distribution of hydrocarbon fuels.
- 3 To examine the Health and Safety Executive's and the Environment Agency's role in regulating the activities on this site under the COMAH Regulations, considering relevant policy guidance and intervention activity.
- 4 To work closely with all relevant stakeholders, both to keep them informed of progress with the investigation and to contribute relevant expertise to other inquiries that may be established.
- 5 To make recommendations for future action to ensure the effective management and regulation of major accident risk at COMAH sites. This should include consideration of off-site as well as on-site risks and consider prevention of incidents, preparations for response to incidents, and mitigation of their effects.
- 6 To produce an initial report for the Health and Safety Commission and the Environment Agency as soon as the main facts have been established. Subject to legal considerations, this report will be made public.
- 7 To ensure that the relevant notifications are made to the European Commission.
- 8 To make the final report public.

Annex 4

Major Incident Investigation organogram



Annex 5

Further information

Useful links

Dacorum Borough Council
www.dacorum.gov.uk
Tel: 01442 228000

St Albans District Council
www.stablans.gov.uk
Tel: 01727 866100

Hertfordshire County Council
www.hertsdirect.org
Tel: 01483 737555

Hertfordshire Chamber of Commerce
www.hertschamber.com
Tel: 01727 813680

Government links

Government Office for the East of England
www.go-east.gov.uk

Environment Agency
www.environment-agency.gov.uk

Department of Trade and Industry – Oil and Gas Directorate
www.og.dti.gov.uk

Health and Safety Executive
www.hse.gov.uk

Industry links

United Kingdom Petroleum Association (UKPIA)
www.ukpia.com
Tel: 020 72400289

Chemical Industries Association
www.cia.org.uk
Tel: 020 78343399

Useful sources of information

Dacorum Borough Council Digest newsletter, available monthly

Dacorum Borough Council Buncefield Update Newsletter

Glossary

The Health and Safety Commission (HSC) is responsible for health and safety regulation in Great Britain. The Health and Safety Executive (HSE) (and local authorities) are the enforcing authorities who work in support of the HSC. Both are statutory bodies, established under the Health and Safety at Work etc Act 1974 (the HSW Act).

HSC's statutory functions include conducting and sponsoring research; promoting training; providing an information and advisory service; and submitting proposals to Ministers for new or revised regulations and approved codes of practice. HSC has a chair plus nine members nominated by organisations representing employers, employees, local authorities and others. They are appointed by the Secretary of State for Work and Pensions.

HSE is a body of three people appointed by HSC with the Secretary of State's approval. HSE advises and assists HSC and has specific statutory responsibilities of its own, notably for enforcing health and safety law. HSE's staff of around 4000 (inspectors, policy advisors, technologists, scientific and medical experts etc) is collectively known as HSE.

HSE regulates health and safety in factories, farms, mines, nuclear installations, offshore installations, hospitals, schools and many other sectors. Local authorities are responsible for enforcement in offices, shops and other services.

The Environment Agency (EA) is the lead regulator in England and Wales with responsibility for protecting and enhancing the environment. It was set up by the Environment Act 1995 and is a non-departmental public body, largely sponsored by the Department for Environment, Food and Rural Affairs (DEFRA) and the National Assembly for Wales (NAW). EA's prime responsibilities include flood risk management, tackling pollution incidents, reducing industry's impact on the environment, restoring and improving rivers, coastal waters, contaminated land, and wildlife habitats.

EA also advises on sustainable drainage, water conservation and management, planning issues, nature conservation and waste management.

The Control of Major Accident Hazards Regulations (COMAH) are enforced by a joint Competent Authority (CA) comprising HSE and EA in England and Wales, and HSE and the Scottish Environment Protection Agency (SEPA) in Scotland.

3-com	A business whose premises were effected by the Buncefield incident
ACMH	Advisory Committee on Major Hazards
Aquifer	A water-bearing stratum of porous rock, gravel or sand
BAA	BAA plc operate airports, including London Heathrow
Boreholes	A cylindrical shaft drilled into the ground, often for geological exploration or extraction of resources
Bund	An enclosure designed to contain fluids should they escape from the tank or vessel inside the bund
Catherine House	A building effected by the Buncefield incident

COMAH Regulations	The Control of Major Accident Hazards Regulations 1999 (COMAH). See annex 1
COMAH sites	A site to which the COMAH Regulations apply
Competent Authority	The COMAH Regulations are enforced by a joint Competent Authority (CA) comprising HSE and EA in England and Wales, and HSE and the Scottish Environment Protection Agency (SEPA) in Scotland. The CA operates to a Memorandum of Understanding which sets out arrangements for joint working
dangerous dose	A dose large enough to lead to: severe distress to all; a substantial number requiring medical attention; some requiring hospital treatment; and some (about 1%) fatalities
dioxin	Toxic chemical by-products of incineration and some industrial processes that use chlorine
duty holder	In the context of this report, any person or organisation holding a legal duty – in particular those placed by the HSW Act, the MHSWR, and the COMAH Regulations
fire water	Water stored for use during, and used during, fire-fighting operations
foam concentrate	In the context of this report, a concentrate used during operations to extinguish hydrocarbon fires
Fuji	A business whose premises were effected by the Buncefield incident
hazard	Anything with the potential to cause harm
human factors	HSE has defined human factors (also known as Ergonomics) as the environmental, organisational and job factors, and human and individual characteristics which influence behaviour at work
hydrocarbon	An organic chemical compound of hydrogen and carbon. There are a wide variety of hydrocarbons such as crude oil (basically a complex mixture of hydrocarbons), methane, propane, butane, etc. They are often used as fuels
Northgate	A business whose premises were effected by the Buncefield incident
on- and off-site and emergency plans	Operators of top-tier COMAH sites must prepare adequate emergency plans to deal with the on-site consequences of possible major accidents and to assist with off-site mitigation. Local authorities for areas containing top-tier COMAH sites must prepare adequate emergency plans to deal with the off-site consequences of possible major accidents, based on information supplied by site operators
particulates	Fine particles (liquid or solid) suspended in the air such as dust, smoke, fumes, and so on

Pasquill stability category	A category within a classification scheme used to describe the degree of atmospheric turbulence
pollution dispersion model	A model used to describe the transport and diffusion of pollutants in the atmosphere
Prohibition Notice	Issuing improvement or prohibition notices are some of the range of means which enforcing authorities use to achieve the broad aim of dealing with serious risks, securing compliance with health and safety law and preventing harm. A prohibition notice stops work in order to prevent serious personal injury
responder	Under the Civil Contingencies Act 2004, EA is a Category 1 responder, and HSE is a Category 2 responder. These categories define the roles played by each body in response to a major incident
risk	The likelihood that a hazard will cause a specified harm to someone or something
RO	A business whose premises were effected by the Buncefield incident
run-off	Uncontained liquid, either deposited on-site as rain, or in the context of the Buncefield incident, fuel and/or fire water not contained as part of the operation to control the incident
safety reports	The COMAH Regulations require operators of top-tier sites to submit written safety reports to the Competent Authority
tier	The COMAH Regulations apply where threshold quantities of dangerous substances identified in the Regulations are kept or used. There are two thresholds, known as 'lower-tier' and 'top-tier'. Annex 1 gives a brief background to the origins of these Regulations
volatile	A substance which evaporates readily, even below its boiling temperature
watercourses	A natural or man-made channel along which water flows