2nd Interim Report (3rd update September 2007) by the Working Group on Fuel Storage Sites (Arbeitskreis Tanklager, AK-TL) of the German Commission on Process Safety (Kommission für Anlagensicherheit, KAS)

Note on the 3rd update of September 2007

The second interim report as of November 2006 was discussed in detail and approved by the German Commission on Process Safety at the meeting on 7–8 November 2006. Considering the further investigations carried out in Great Britain by the Buncefield Major Incident Investigation Board (MIIB) together with the "Initial report – recommendations requiring immediate actions" of the "Buncefield Standards Task Group" of 12th October 2006, the Working Group on Fuel Storage Sites (henceforth referred to as the Working Group) updated this interim report for the first time at its meeting on 22nd January 2007. The 2nd update of June 2007 considers primarily the 5th report of the MIIB "Recommendations on the design and operation of fuel storage sites" of 29th March 2007. The 3rd update presented here additionally takes into consideration the Buncefield MIIB "Recommendations on the emergency preparedness for, response to and recovery from incidents" of 17th July 2007. Alterations to the June 2007 version of the interim report were unanimously discussed at the Working Group meeting on 29th August 2007 and approved by the German Commission on Process Safety at its meeting on 5th/6th November 2007. They relate to sections 3.5 and 4 and are marked in the margin.

Provisional evaluation of the Buncefield fuel storage site fire on 11 December 2005 and recommendations arising from this for German petroleum storage depots

1 Initial position and current status in Germany

1.1 Remit and scope of the investigation by the Working Group

On 13 December 2005 Siegmar Gabriel, the German Environment Minister, asked the Commission on Process Safety for a statement as to whether the sequence of events during the major fire at the Buncefield fuel storage site near London on 11 December 2005 indicated a need for action in relation to German fuel storage sites. In particular, checks were to be carried out as to whether the statutory provisions and technical regulations for the safe operation of fuel storage sites in Germany are adequate or need to be updated.

In line with the Minister's directions, the Working Group concentrated on storage sites for highly flammable liquids (e.g. petroleum) which are subject to the extended obligations of the Major Accident Ordinance (StörfallV) (establishments with over 25,000 t of petroleum). Operators of smaller fuel storage sites and those with other highly flammable materials as well as the competent authorities are recommended to check in individual cases as to what degree the recommendations of this interim report could be applicable.

1.2 Approach

The Commission on Process Safety (Kommission für Anlagensicherheit, KAS) immediately formed a Working Group, which has held nine meetings to date, the last being on 29 August 2007. Members of the Working Group are listed in **Annex 1**. An important basis for the Working Group discussions was provided by the reports from the Buncefield Major Incident Investigation Board which were available up to this date (see Section 2). In addition, information on the number, kind and mode of operation of fuel storage sites in Germany was collected (see Sections 1.4 and 1.5). Furthermore, an initial examination was made of the relevant German and British legal provisions and technical regulations (see Section 1.3) and a list of possible causes of damage compiled. The results of investigations by the environment ministries of Baden-Württemberg and North Rhine-Westphalia after the Buncefield incident have also been incorporated in the Working Group's deliberations.

At its meeting on 22–23 June 2006 the Commission on Process Safety approved a first interim report which is updated and replaced by this second interim report.

1.3 Statutory provisions

Fuel storage sites for combustible (highly flammable) liquids which are above a certain capacity must be licensed according to the Federal Pollution Control Act (Bundes-Immissionsschutzgesetz, BImSchG). In addition, they are subject to the requirements of the Operating Safety Ordinance (Betriebssicherheitsverordnung, BetrSichV), the Ordinance on Facilities for Handling Substances Hazardous to Water (Verordnung über Anlagen für wassergefährdende Stoffe, VawS), the building regulations of the German Länder (Landesbauordnungen, LBO) as well as the Major Accident Ordinance (StörfallV) where applicable. Compliance with these regulations should be verified in the licence (or permit) application as well as, in the case of establishments with extended obligations under the Major Accident Ordinance, in the safety report. In addition to general inspection by the competent authorities, comprehensive testing by third party independent experts (including authorised inspection bodies) is mandatory.

A preliminary overview of the statutory instruments which are applicable to fuel storage sites is attached in **Annex 2**. The technical regulations which are of particular importance for the remit of the Working Group are listed in **Annex 3**. In addition, reference is also made to the report by the Technical Committee for Plant Safety (Technischer Ausschuss für Anlagensicherheit, TAA), TAA-GS-04, of April 1994.

1.4 Current status and safety strategy for storage sites for petroleum fuel in Germany

The tank storage facilities considered here are an important link in the transportation chain between the producer (refinery or import terminal) and the end consumer (filling station or household heating fuel tank). The extensive supply of tank storage facilities via inland shipping, railway tank-cars and in particular pipelines minimises the transportation of mineral oil products on the road.

As far as the Working Group is aware, there are at present around 50 storage sites for mineral oil products in Germany which are governed by the extended obligations under the Major Accident Ordinance on account of the corresponding higher quantities of substances. There are, in addition, 16 comparable fuel storage sites at refineries which are also subject to the extended obligations of the Accident Ordinance.

The Working Group has discussed both matters relating to safety technology as well as

organisational issues on site at a large fuel storage site. Members of the Working Group gave detailed reports on the safety management at a further storage site as well as on issues relating to fire protection.

The safety system at fuel storage sites is always based on several independent technical and organisational components. The Working Group's discussion focussed in particular on the following:

- As is the case in Great Britain, to prevent overfilling there are level gauges and overfill protection systems which are in some cases independent of the gauges. In addition, the tanks are frequently equipped with leakage monitoring systems which would also detect any escape of fuel due to overfilling in good time and trigger counter measures. Particular importance is attached to the regular maintenance and examination of these systems.
- In fuel storage site management, the permissible amount which may be filled is determined each time before filling according to the regulations of Section 19 k of the Water Resources Act (Wasserhaushaltgesetz, WHG). When filling from road tankers, railway tank wagons or inland waterways vessels with a smaller volume than the tank to be filled, the danger of overfilling can be minimised due to the nature of the consignment.
- When filling with petrol takes place from a pipeline (as in Buncefield) – something that is only carried out at 13 fuel storage sites in Germany – then it is essential to have precise arrangements and a reliable form of communication between the supplying and receiving operational units.
- Simultaneous filling of several tanks from the same pipeline, even at different storage sites (as happened at Buncefield), does not occur in Germany to the knowledge of the representatives of the trade associations in the Working Group.
- Fuel storage site monitoring is frequently carried out by a relatively small number of employees (e.g. 2-3 employees). Even though this is understandable against a background of improved technical monitoring equipment, this aspect should be given particular attention looking at the entire safety system, considering that organisational safety measures continue to be of key importance. In this respect, particular attention should be paid to the procedures in case of accident, such as the immediate implementation of fire-fighting and cooling procedures in the case of fire.

2 Findings to date by the British investigation on Buncefield

An important basis for the discussions in the Working Group was provided by the 3 Progress Reports and the summary "Initial Report" dated 11 July 2006 by the Buncefield Major Incident Investigation Board. The investigations of this body and the other British authorities are not yet complete. From current knowledge, the Working Group has obtained the following provisional picture on the causes and course of events of this incident:

- The incident was triggered by the overfilling of a storage tank while it was being filled from a pipeline. This resulted in approx. 300 tonnes of unleaded petroleum being released. The petrol/air mixture which formed exploded and led not only to considerable damage to neighbouring buildings, but also to other tanks at the storage site. This led to additional escape of mineral oil products and hence to a major fire. Forty-three people were injured due to the explosion and fire. Around 2000 residents were evacuated as a precaution.

- The cause of the overfilling was very probably the failure of the level measurement as well as the independent overfill protection. According to what is known so far, the operating staff did not take any action on the evident failure of the level measurement (despite continuous filling, the level measurement did not change over a period of almost 3 hours). There was also no action taken by the operating staff in view of the ongoing escape of petroleum for approx. 40 minutes. Further details on the sequence of events leading to the failure of both the technology and monitoring have not yet been published and will probably not be available in the foreseeable future due to the ensuing criminal investigation.
- The nature of the escape, amongst other things, was crucial in determining the strength of the explosion and therefore the severity of the consequences. The petroleum escaped in large quantities through openings in the tank roof. It then cascaded down from a great height on the outside of the tank through deflector plates and other structures which were intended to improve the distribution of cooling water in the case of fire, turning into spray and therefore achieving an “optimal” mixture of fuel and air.
- Analysis of the damage pattern revealed that the force of the explosion was almost ten times larger than would have been expected according to the assumptions and calculation method normally used. The British authorities have initiated extensive investigations into this effect. When these are complete, it will have to be ascertained to what extent the current calculation methods and therefore where appropriate the safety distances laid down in the technical regulations need to be modified.
- The explosion resulted in the destruction not only of other tanks, but also the fixed fire-fighting equipment. The fires could only be controlled using a huge deployment of mobile high performance fire-fighting equipment which mostly had to be brought in from other sites.
- Part of the sealing on the tank bunds was unable to withstand the long exposure to heat, so that the fire-extinguishing agent and spilled mineral oil products were not effectively contained.
- The effects on the soil and groundwater in particular due to the concentrated fire-fighting efforts and the spilled mineral oil products were so severe, that the competent British authorities reported the event to the EU Commission as a Major Accident to the Environment. In addition there was considerable temporary air pollution due to the huge amount of smoke produced. The British investigations into the environmental effects are ongoing.

3 Conclusions and recommendations by the Working Group

3.1 Introduction

The magnitude of the incident at Buncefield was largely determined by the following factors:

- Prolonged excessive overfilling of a storage tank with highly flammable petroleum at a flow rate of 550 m^3/h up to 890 m^3/h at the end,
- Escape of large quantities of fuel from the tank roof and creation of turbulence/aerosol formation while cascading down the outside of the tank from a great height.

This produced an enormous quantity of explosive vapour/air mixture. Its ignition led to several tanks in various bunds being destroyed or damaged, to the destruction of the fixed fire-fighting appliances at the site, resulting in a major fuel storage site fire of a previously unknown magnitude.

Fuel storage sites for petroleum are not normally designed for the control of a serious explosion of this kind with subsequent fire in several tanks. The measures for damage limitation laid down in the German technical regulations are based on leakage and fire in only one single tank in the entire storage site. Therefore, in accordance with the principles of explosion protection, sources of danger which could lead to an explosion must be prevented as laid down in section 3 para. 1 of the Major Accident Ordinance. In addition, despite this, damage limiting measures (measures in accordance with points 3.2.2 to 3.5 below) should be provided for in accordance with section 3 para. 3 of the Major Accident Ordinance.

Apart from the scenario identified at Buncefield (and terrorist attacks and acts of war not dealt with here) the Working Group knows of no course of events which might lead to similar consequences. The findings and conclusions of the Working Group therefore relate to the lessons which can be learned directly from Buncefield. Should further relevant scenarios come to light, then additional investigations would be required.

The following aspects were investigated by the Working Group in detail:

- the reliable prevention of overfilling through appropriate
  - technical and
  - organisational measures
  - as well as monitoring,
- the prevention of turbulence and other critical dispersion effects when substances escape,
- detection of leaks and retention of substances as well as
- emergency response, fire fighting and emergency planning.

Because of the differing basic conditions at petroleum storage sites (e.g. self-contained fuel storage sites/storage tanks at a refinery) the Working Group considers the laying down of detailed guidance only to be partially feasible. Technical and organisational safety measures complement one another. The following conclusions and recommendations should be examined by the individual operators within the total safety conception. This will result in an individual safety programme for each specific site, in which the proposed measures and considerations can be incorporated. The operator is required to provide proof of this in the safety report in accordance with section 9 of the Major Accident Ordinance. This safety report will be repeatedly referred to in the following sections.

In accordance with the remit of the Working Group (see Section 1), the following conclusions and recommendations are primarily applicable to fuel storage sites for petroleum (as well as other highly flammable liquids) which are subject to the extended obligations of the Major Accident Ordinance and which can therefore be most closely compared with the storage site at Buncefield. It is recommended that the operators of other storage sites as well as the competent authorities examine the extent to which these conclusions and recommendations could be relevant for individual cases.

3.2 Prevention of overfilling

3.2.1 Technical measures

The Commission on Process Safety considers it necessary that operators of fuel storage sites for petroleum which are subject to the extended obligations of the Accident Ordinance should prove the following in the safety report, according to section 9 of the Accident Ordinance:

- Tanks are equipped with level gauges and overfill protection systems to prevent overfilling in accordance with the regulations in force. Overfilling should be safeguarded against using highly reliable safety technology. This can be achieved by
  a) application of the redundancy principle, in which e.g. both level gauges and overfill protection systems are designed to be totally independent devices/ protection systems
  b) the use of a self-monitoring overfill protection system.

  In any case, a preliminary warning must be provided, before the main alarm is triggered. The classification of overfill protection devices as process control protection devices, which is not required by the regulations for flammable-only liquids, is recommended.
- Overfill protection systems interrupt the filling process in good time before the permitted filling level is reached and trigger the alarm, as long as overfilling is not precluded by a connected system (Technical Regulations for Flammable Liquids (TRbF) 20 number 9.7.2). The operation of remote-controlled valves should be ensured using feedback or fail safe mechanisms. Attention should be paid to pressure surges when using quick-closing valves. It must always be ensured that when the inlet valve is closed, the feed-pump is switched off.
- Malfunction of the level gauge, the overfill protection system and the relevant valves needs to be detected quickly, reliably and with certainty. The operating staff should be instructed in such cases not to undertake any filling or to terminate the filling processes.
- In emergency, the operational capability of at least safety relevant part of the process control system should be ensured by means of an uninterruptible energy supply of adequate size, unless safety is guaranteed using fail safe mechanisms.

3.2.2 Organisational measures

Buncefield demonstrates the pre-eminent importance of the “human factor” for the safe operation of a fuel storage site. The Commission on Process Safety therefore considers it necessary, in particular for operators of fuel storage sites for petroleum which fall under the extended obligations of the Major Accident Ordinance, to define procedures for the following points in their safety management system according to Annex III of the Major Accident Ordinance:

- In the context of fuel storage management, the permissible filling capacity should be determined each time before filling. Only such quantities as can be safely held in the tank should be accepted.

- When filling takes place from a pipeline, then it is essential to have precise arrangements and a reliable form of communication between the supplying and receiving operational units. It is clearly recognised that a pipeline provides the safest transport route for the movement of flammable liquids. However, it must be noted in this case that the potentially available volume for filling is usually considerably larger than when filling from road tankers or railway tank wagons and the distance between the delivering and receiving operational units places particular demands on communication. In particular, it must be ensured that in cases of emergency, the personnel entrusted with supervising the fuel storage site to be filled must be able to terminate the filling operation themselves. The customary practice in Germany as far as current understanding goes, of not filling several storage sites by pipeline simultaneously, should be retained. In case of future changes to this practice, then specific safety measures need to be identified, particularly to ensure communication between all those involved.
- Manning levels at the fuel storage site must guarantee safety both during normal operation and also during serious operational breakdowns to be defined. The operators must, taking into consideration the operating mode of the fuel storage site (e.g. the kind of filling), the process control system and the availability of additional forces in cases of breakdown (e.g. plant fire brigade), define and verify the tasks to be performed, so that the minimal manning level at the fuel storage site defined in this way is sufficient to discharge the required emergency measures and so that the personnel are adequately educated and trained for this.
- At fuel storage sites which are not manned 24 hours per day, the necessary emergency measures must be able to be set in motion by reliable automation and rapid arrival of an adequate number of qualified personnel. Filling processes may only be carried out in the presence of sufficient personnel.
- Personnel must be aware of the particular risks inherent in the filling processes through selection as well as regular training and practice/exercises. They need to be familiar with possible faults and be able to initiate rapid counter measures. Precautionary procedures should be encouraged and not criticised unreasonably. The safety management system must take account of possible hazards (instrument error, machinery breakdown) and provide for appropriate operating instructions and test and maintenance intervals.
- Maintenance, inspection, repair and cleaning procedures on safety technology devices must be undertaken and completed in such a way that no additional risks arise due to these procedures (e.g. using log book entries, tag-in/tag-out procedures, registration chains etc.). After completion of the work, the serviceability of the safety technology devices must be ensured (e.g. using organisational measures or process management and control).

3.2.3 Inspection of overfill protection systems

Fuel storage sites, as installations under an independent inspection regime, are also subject to the regulations of Section 3 of the Operating Safety Ordinance (Betriebssicherheitsverordnung, BetrSichV), in particular with regard to monitoring, maintenance and regular inspection (incl. documentation) by authorised inspection bodies. The requirements for regular inspection of overfill protection systems contained in the technical approval of the German Institute for Building Technology (Deutsches Institut für Bautechnik, DIBt) should also be complied with.

The Commission on Process Safety suggests that, in the context of the required exchange of experience among authorised inspection bodies, appropriate recommendations on the scope and frequency of inspection be developed and that the Committee on Operational Safety (Ausschuss für Betriebssicherheit, ABS) verifies to what degree this factor is already covered in the current technical regulations.

The frequency with which over-fill protection systems are tripped can give an indication of the the reliability of the tank storage facility management system. Therefore this should be documented electronically in a form which may be easily analysed together with the measures that were triggered as a Key Performance Indicator, which is then periodically evaluated. This evaluation should include the immediate and root causes together with the measures necessary for the future prevention.

3.3 Leakage detection and product retention

The Commission on Process Safety recommends that operators of fuel storage sites for petroleum which are subject to the extended obligations of the Major Accident Ordinance should, within the framework of a comprehensive safety concept, look into equipping tanks with additional leakage monitoring devices which will rapidly detect an escape of the product and at the very least give the alarm. Combination with counter measures, such as the termination of filling procedures, should be reviewed where appropriate. In some situations encasing the tanks with secondary containment can be of benefit. The space between the tank and the secondary containment should be fitted with a leakage detector including alarm as well as a (partially) fixed fire-fighting equipment for foam production.

The Commission on Process Safety considers it necessary for the bund to be leakproof (according to the Technical Regulation for Substances Hazardous to Water [Technische Regel wassergefährdender Stoffe, TRwS 788, formerly TRwS 133]) even under fire impingment over an appropriate period. In this connection it recommends that the competent bodies (the German Institute for Building Technology – Deutsches Institut für Bautechnik, DIBt) or Committees (the Committee on Operational Safety, ABS) examine the regulations in view of the experiences at Buncefield. Also the possibilities for the safe collection and channelling of released product should be considered.

3.4 Prevention of turbulence and other critical dispersion effects

The findings of the British investigation into Buncefield to date show that the fuel escaping through ventilation holes in the tank roof became finely dispersed when cascading down over the particular shape of the tank's outer wall. This contributed to the development of a dangerous explosive atmosphere.

According to the information currently available to the Commission on Process Safety, in Germany petroleum is stored in floating roof tanks or in fixed roof tanks with a connection to a hydrocarbon vapour recovery unit. There would therefore not be any openings like those at Buncefield. The Commission on Process Safety recommends, however, that operators of storage sites and the manufacturers of large tanks should check their design for construction features which might contribute to the fine dispersion of overflowing product. Nevertheless, the required cooling effects which are promoted by this kind of design need to be taken into account.

3.5 Damage limitation measures (safe distances, hazard prevention, fire fighting and emergency planning)

For petroleum storage sites, there is a need to look into whether a storage site design can be devised, particularly for the spacing of tanks and groups of tanks, which would permit events like those at Buncefield to be controlled more effectively. For planning measures with importance for the neighbourhood, appropriate distances from the establishment to sensitive objects outside of the establishment should be taken into account in accordance with Section 50 of the Federal Pollution Control Act (BImSchG).

The Commission on Process Safety considers it necessary for operators of fuel storage sites for petroleum which are subject to the extended obligations of the Major Accident Ordinance to demonstrate the following in the safety report according to section 9 of the Major Accident Ordinance:

- An immediate cooling of the tanks must be guaranteed in case of fire. Preference should be given to automatic, semi-fixed or at least remotely operated appliances.
- Suitable fire-fighting appliances should be available. If individual cases are reviewed within the scope of the safety concept, it should in particular be demonstrated how hazard prevention and damage control systems potentially destroyed by fire or explosion can be replaced by alternative systems or measures within acceptable time limits.

  There should be a careful follow-up on future developments regarding the protection of such systems against fire and explosion.

  Particular care should be given to ensuring a reliable supply of fire extinguishing agents (e.g. underground or sufficiently redundant and above all easily accessible systems for the feeding of fire extinguishing agents, if need be by using mobile units). As part of a graded concept it will, however, also be necessary to make provisions for a break-down of the primary supply of fire extinguishing agents (see bullet point 6 below). The corresponding information required in the safety report should also be checked by the authorities responsible for emergency plans.
- Copies of all documents relevant for hazard prevention should be kept in a second safe place. In case of an incident a dispatch centre should be operational at any time by keeping a sufficient distance between the dispatch centre and the operational unit or by maintaining a “back-up dispatch centre” (as a mobile unit, by locating the dispatch centre at a safe place or by using the dispatch centre of the responsible municipal fire brigade).
- The collection and environmentally compatible disposal of larger quantities of fire-fighting media should be guaranteed.
- The internal emergency plans should also include measures for the containment of firewater.
- Adequate material and personnel resources should be available for major fires (e.g. equipment, fire-extinguishing agent[1], transport infrastructure, human resource capacities) or there should be rapid access to these. For this purpose the required network for emergency response must be coordinated with the competent authorities and documented in the external emergency plans. The Commission on Process Safety specifically recommends the use of the new “TUIS service for hazard prevention in case of large fires in fuel storage sites”.

[1] In accordance with DIN 14493 the amount of foam required for extinguishing a fire in the largest tank must be kept in readiness at the storage site.

- When compiling the information for production of the external emergency plans under Section 10 para. 1 no. 2 of the Major Accident Ordinance (hypothetical major accidents), the possibility of explosions and their consequences – i.e. that in quick succession several tanks catch fire and burn simultaneously, with the resultant effects on neighbouring commercial and housing areas, as well as a potential failure of the leak-proofness of the bund due to fire impingement – would have to be investigated and where necessary included in the coordination with the competent authorities responsible for the external emergency plans, according to the Guidance on Coordination of Emergency Planning (SFK-GS-45). The effects of the subsequent use of huge quantities of fire-fighting media should also be taken into account.

It should be pointed out that decontamination and environmental remediation (soil/water) after a major accident are subject to relevant legal provisions and recommendations. In particular soil protection law provides for extensive regulations on how to deal with soils and water bodies damaged by environmentally harmful inputs as defined in the Federal Immission Control Act. A mention should also be made of the new provisions of the Environmental Damage Act of 10th May 2007. It stipulates the requirement to remediate any damage and to restore the environment to its original state to the extent possible after an incident. Emergency plans to be established according to Section 10 of the Major Accident Ordinance should therefore, where required, also set out information on plans for material and organisational resources to be used in the event of decontamination or remediation activities.

4 Implementing the findings from Buncefield

The conclusions and recommendations of this report deal with a *new level of knowledge in relation to safety technology or current findings for hazard evaluation* as described in Section 9 para. 5 no. 3 of the Major Accident Ordinance. Therefore, operators should check and where necessary update existing safety reports and safety management systems without delay.

The Commission on Process Safety recommends that the authorities responsible for inspection of establishments under the Major Accident Ordinance should check this without delay. In addition, it is recommended that the authorities should check the implementation of these recommendations within the scope of on site inspections under Section 16 of the Major Accident Ordinance.

Should for existing tank storage facilities the necessary improvements and alterations due to this new knowledge be disproportionate in the view of the operator, then together with the competent authorities alternative solutions should be investigated which are appropriate to the risks.

Reference is made to the recommendations of the Buncefield Major Incident Investigation Board, to investigate in how far over-fill protection devices and level-gauges can be improved beyond the current state of the art. This recommendation is directed towards operators of tank storage facilities and equipment manufacturers. Details are to be found in Recommendation 8 of the Board's 5th report. (www.buncefieldinvestigation.gov.uk).

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Numerous recommendations in the field of public hazard prevention and emergency preparedness are also listed in the "Recommendations on the emergency preparedness for, response to and recovery from incidents" of the Buncefield Major Incident Investigation Board of 17 July 2007. In its decision of 5th /6th June 2007 the Commission on Process Safety asked the Federal Ministry for the Interior to analyse these recommendations for the relevant sectors under its jurisdiction in cooperation with the Länder and municipalities and also to communicate them in an appropriate way and see to it that the required material and staff resources are made available.

5 Unresolved issues, future work

Although the conclusions and recommendations of this interim report have been developed from a well founded knowledge base, the investigations of the British authorities are still ongoing. The Working Group intends to monitor these investigations and further update this interim report if necessary. Thereby the activities for the industry on various topics suggested by the Buncefield Major Incident Board in its 5th report should be considered.

The Working Group will pay particular attention to the progress of the investigations in relation to the unexpected over pressure of the explosion. If this leads to the need to make fundamental changes to the calculation methods used up until now, this will have considerable impacts on the safety distances on which the technical regulations and land use planning are currently based. This would give rise to the need for further action on the part of the Commission on Process Safety.

The Buncefield investigations could also result in further findings or the requirement for research on explosion models, the calculation of heat radiation from major fires (with particular consideration of smoke blocking effects), spreading of the flame front of a major fire at a fuel storage site, the development and spread of smoke plumes from major fires in view of the use and problems resulting from perfluorinated surfactants in foam fire-fighting substances etc. The Working Group will discuss these at an appropriate time and taking into consideration the extensive investigations which have been initiated in Great Britain.

Annex to the Second Interim Report by the Working Group on Fuel Storage Sites of the Commission on Process Safety

Annex 1: Members of the Working Group on Fuel Storage Sites of the Commission on Process Safety

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Annex to the Second Interim Report by the Working Group on Fuel Storage Sites of the Commission on Process Safety

Annex 2: Statutory and regulatory requirements for fuel storage sites

Dated: 06 April 2006

	Legal basis	Material properties	Leakage detection	Operational requirements	Unresolved issues
Pipeline	**Pipeline Ordinance (RohrfernlV)**	**Technical Regulation for Pipelines (Technische Regel für Rohrfernleitungen, TRFL)**	**Technical Regulation for Pipelines (Technische Regel für Rohrfernleitungen, TRFL)**	**Technical Regulation for Pipelines (Technische Regel für Rohrfernleitungen, TRFL)**	
		No. 5.4: Calculations (Berechnung)	No. 11.4: Equipment for limiting the escape volume (Einrichtungen zum Begrenzen der Austrittsmenge)	No. 12: Operation and monitoring (Betrieb und Überwachung)	
		No. 6: Pipes and pipeline components (Rohre und Rohrleitungsteile)	No. 11.5: Equipment for the detection of escaping substances (Einrichtungen zum Feststellen austretender Stoffe)		
		No. 8: Construction and laying (Bau und Verlegung)			
		Part 2: Property requirements (Beschaffenheitsanforderungen)			
Transfer station	**Pipeline Ordinance (RohrfernlV)**	**Technical Regulation for Pipelines (Technische Regel für Rohrfernleitungen, TRFL)**	**Technical Regulation for Pipelines (Technische Regel für Rohrfernleitungen, TRFL)**	**Technical Regulation for Pipelines (Technische Regel für Rohrfernleitungen, TRFL)**	
		No. 5.4: Calculations (Berechnung)	No. 11.4: Equipment for limiting the escape volume (Einrichtungen zum Begrenzen der Austrittsmenge)	No. 12: Operation and monitoring (Betrieb und Überwachung)	

		No. 6: Pipes and pipeline components (Rohre und Rohrleitungsteile)	No. 11.5: Equipment for the detection of escaping substances (Einrichtungen zum Feststellen austretender Stoffe)		
		No. 8: Construction and laying (Bau und Verlegung)	No. 11.6: Containment devices for pipelines for liquids (Auffangvorrichtungen für Rohrfernleitungen Flüssigkeiten)		

	Legal basis	Material properties	Leakage detection	Operational requirements	Unresolved issues
		Part 2: Property requirements (Beschaffenheitsanforderungen)			
On-site pipework	**14. Ordinance to the Equipment and Product Safety Act (Verordnungen zum Geräte- und Produktsicherheitsgesetz GPSGV)**	**14. Ordinance to the Equipment and Product Safety Act (GPSGV), CE labelling for pipes (CE-Kennzeichen für Rohre)**	-	**-**	
		Annex 1 of Directive 97/23/EC			
	Operating Safety Ordinance (BetrSichV)	**Construction Regulations for Pipelines made from Metals (Bauvorschriften für Rohrleitungen aus metallischen Werkstoffen, TRR 100)**	-	**Construction Regulations for Pipelines made from Metals (Bauvorschriften für Rohrleitungen aus metallischen Werkstoffen, TRR 100)**	
		Technical Regulation for Flammable Liquids – Pipelines (TRbF 50)		**Technical Regulation for Flammable Liquids – Pipelines (TRbF 50)**	
		No. 4: Construction Regulations (Bauvorschriften)		No. 14: Operating Instructions, operating regulations (Betriebsanweisung, Betriebsvorschriften)	
		No. 5: Manufacture and laying of pipelines (Herstellung und Verlegung der Rohrleitungen)		No. 15: Cleaning, maintenance and repair (Reinigen, Instandhalten und Instandsetzen)	

		No. 8: Equipment for pipelines (Ausrüstung von Rohrleitungen)		No. 17: Operator checks (Kontrollen durch den Betreiber	
		Annex A: Property regulations (Beschaffenheitsvorschriften)			
	Ordinance on Facilities for Handling Substances Hazardous to Water (VawS)	**Technical Regulation for Substances Hazardous to Water (Technische Regel wassergefährdender Stoffe, TRwS 780)**	**Technical Regulation for Substances Hazardous to Water (Technische Regel wassergefährdender Stoffe, TRwS 780)**	**General Technical Regulations, Technical Regulation for Substances Hazardous to Water 779, 780 (Allgemeine Technische Regelungen, TRwS 779, 780)**	
		Advantages: compliance with TRbF 50/TRR 100	Compliance with TRbF 50/TRR 100 and requirements for connections: limited retention		
	State Building regulations (LBO)	**Building Rules List B Part 2 (Bauregelliste BRL B Teil 2)**	**Building Rules List B Part 2 (Bauregelliste BRL B Teil 2)**	**-, possibly national technical approvals (allgemeine bauaufsichtliche Zulassungen, abZ)**	
		Annex 1 of Directive 97/23/EC, additional requirements if applicable	Supplementary requirements if applicable	According to materials and types of pipe in use	

	Legal basis	Material properties	Leakage detection	Operational requirements	Unresolved issues
Controls and instruments	**14. Ordinance to the Equipment and Product Safety Act (Verordnungen zum Geräte- und Produktsicherheitsgesetz GPSGV)**	**14. Ordinance to the Equipment and Product Safety Act (Verordnungen zum Geräte- und Produktsicherheitsgesetz GPSGV)**	**Technical Regulation for Substances Hazardous to Water (Technische Regel wassergefährdender Stoffe, TRwS 780)**	**Technical Regulation for Substances Hazardous to Water (Technische Regel wassergefährdender Stoffe, TRwS 780)**	
		Annex 1 of Directive 97/23/EC	Compliance with TRbF 50/TRR 100 and requirements for connections: limited retention	Infrastructure measures	
Pumps	**Machine Directive (Masch.Richtlinie)**	**Machine Directive (Masch.Richtlinie)**	**Technical Regulation for Substances Hazardous to Water (Technische Regel wassergefährdender Stoffe, TRwS 780)**	**Technical Regulation for Substances Hazardous to Water (Technische Regel wassergefährdender Stoffe, TRwS 780)**	
			Compliance with TRbF 50/TRR 100 and requirements for connections: limited retention	Infrastructure measures	
Tank	**Operating Safety Ordinance (BetrSichV)**	**Technical Regulation for Flammable Liquids 20 Annex ? (TRbF 20 Anhang ?)**	**Technical Regulation for Flammable Liquids 20 (TRbF 20)**	**Technical Regulation for Flammable Liquids 20 (TRbF 20)**	
		No. 4.1: Transport, foundations, assembly and installation of tanks (Transport, Gründung, Einbau und Aufstellung von Tanks)	Annex 0 No. 1: Interior coating of tanks for storage of flammable liquids (Innenbeschichtungen von Tanks zur Lagerung	No. 15: Operating procedure, operating regulations (Betriebsanweisung, Betriebsvorschriften)	

			brennbarer Flüssigkeiten)		
		No. 4.2: Protection of containers against damage (Schutz der Behälter gegen Beschädigung)		No. 16: Cleaning, maintenance and repair (Reinigen, Instandhalten und Instandsetzen)	
		No. 9: Fitting out tanks (Ausrüstung von Tanks)		No. 18: Operator checks (Kontrollen durch den Betreiber)	
		Annexes A, B, C, M, N: Property requirements (Anhänge A, B, C, M, N: Beschaffenheitsanforderungen)			

	Legal basis	Material properties	Leakage detection	Operational requirements	Unresolved issues
	State Building regulations (LBO), Eurocodes	**Standards**	**Standards**	**-, possibly national technical approvals (allgemeine bauaufsichtliche Zulassungen, abZ)**	
Containment area	**Ordinance on Facilities for Handling Substances Hazardous to Water (VawS)**	**Technical Regulation for Substances Hazardous to Water 786 (TRwS 786)**	**Technical Regulation for Substances Hazardous to Water 131 (TRwS 131)**	**Technical Regulation for Substances Hazardous to Water 779 (TRwS 779)**	
		Requirements for sealing surfaces (Anforderungen an Dichtflächen)	Determination of the retention capacity R1 (Bestimmung des Rückhaltevermögens R1)		
	Operating Safety Ordinance (BetrSichV)	**Technical Regulation for Flammable Liquids 20 (TRbF 20)**	**Technical Regulation for Flammable Liquids 20 (TRbF 20)**	**-**	
		No. 4.3: Building regulations for bunds (Bauvorschriften von Auffangräumen)	No. 3.2.1: Containment of escaping flammable liquids (Begrenzung auslaufender brennbarer Flüssigkeiten)		
			No. 3.2.2: Necessity for bunds (Notwendigkeit von Auffangräumen)		
			No. 3.2.3: Capacity of bunds (Fassungsvermögen von Auffangräumen)		
Instrumentation and control systems technology	**Operating Safety Ordinance (BetrSichV)**	**Technical Regulation for Flammable Liquids 20, in part (TRbF 20)**	**Technical Regulation for Flammable Liquids 20 (TRbF 20)**	**Technical Regulation for Flammable Liquids 20, in part (TRbF 20)**	

			9.3 Liquid level indicator and overfill protection (Flüssigkeitsstandanzeige und Überfüllschutz)		
			Annex 0 No. 3: Leakage indication instruments (Leckanzeigegeräte)		
			Annex 0 No. 4: Overfill protection systems, limiting value transmitter, filling protection systems (Überfüllsicherungen, Grenzwertgeber, Abfüllsicherungen)		
	Ordinance on Facilities for Handling Substances Hazardous to Water (VawS)	**Generally acknowledged state of the art (allgemein anerkannte Regeln der Technik, aaRdT)**	**Generally acknowledged state of the art (allgemein anerkannte Regeln der Technik, aaRdT)**	**Generally acknowledged state of the art (allgemein anerkannte Regeln der Technik, aaRdT)**	

	Legal basis	Material properties	Leakage detection	Operational requirements	Unresolved issues
	State Building regulations (LBO)	**Building Rules List B Part 2 (Bauregelliste BRL B Teil 2)**	**Building Rules List B Part 2 (Bauregelliste BRL B Teil 2)**	**-, possibly national technical approvals (allgemeine bauaufsichtliche Zulassungen, abZ)**	
Fuel storage sites	**Operating Safety Ordinance (BetrSichV)**	**Technical Regulation for Flammable Liquids 20 (TRbF 20)**	**-**	**Technical Regulation for Flammable Liquids 20 (TRbF 20)**	
		No. 6: Spacing, protection strips, tank and tank group spacing and weather protection of above-ground storage in the open (Abstände, Schutzstreifen, Tank- und Tankgruppenabstände und Witterungsschutz bei der oberirdischen Lagerung im Freien)		No. 15: Operating procedure, operating regulations (Betriebsanweisung, Betriebsvorschriften)	
				No. 18: Operator checks (Kontrollen durch den Betreiber)	

Annex to the Second Interim Report by the Working Group on Fuel Storage Sites of the Commission on Process Safety

Annex 3: Technical Regulations of relevance for the discussions of the Working Group

(Overview prepared by Dr. Hermann Dinkler, VdTüV)

- Technical Regulation for Flammable Liquids 20 “Storage sites” (TRbF 20 "Läger")
- Technical Regulation for Flammable Liquids 30 “Filling and emptying sites, airfield fuelling sites” (TRbF 30 "Füll- und Entleerstellen, Flugfeldbetankungsstellen")
- Technical Regulation for Flammable Liquids 50 “Pipelines” (TRbF 50 "Rohrleitungen")
    - Regulations for the Construction of Pipelines made from Metals (Bauvorschriften für Rohrleitungen aus metallischen Werkstoffen, TRR 100)
- Technical Regulation for substances hazardous to water 131 “Determination of the retention capacity R1” (TRwS 131 "Bestimmung des Rückhaltevermögens R1")
- Technical Regulation for substances hazardous to water 779 “General Technical Regulations (due to be published shortly) (TRwS 779 "Allgemeine technische Regeln")
- Technical Regulation for substances hazardous to water 780 “Above-ground pipelines”, Part 1 in particular (TRwS 780 "Oberirdische Rohrleitungen", insbesondere Teil 1)
- Technical Regulation for Pipelines (Technische Regel für Fernleitungen TRFL)