EUROPEAN COMMISSION
DIRECTORATE-GENERAL JRC
JOINT RESEARCH CENTRE
Institute for Prospective Technological Studies
Sustainability in Industry, Energy and Transport
European IPPC Bureau

Integrated Pollution Prevention and Control

Executive Summary
Reference Document on
Best Available Techniques on Emissions from Storage

January 2005

Edificio EXPO, c/Inca Garcilaso s/n, E-41092 Sevilla - Spain
Telephone: direct line (+34-95) 4488-284, switchboard 4488-318. Fax: 4488-426.
Internet: http://eippcb.jrc.es; Email: JRC-IPTS-EIPPCB@ cec.eu.int

EXECUTIVE SUMMARY

The horizontal BAT (Best Available Techniques) Reference Document (BREF), entitled 'Emissions from storage' reflects an information exchange carried out under Article 16(2) of Council Directive 96/61/EC (IPPC Directive). This executive summary – which is intended to be read in conjunction with the BREF preface's explanation of objectives, usage and legal terms – describes the main findings, a summary of the principal BAT conclusions and the associated emission/consumption levels. It can be read and understood as a stand alone document but, as a summary, it does not present all the complexities of the full BREF text. It is therefore not intended as a substitute for the full BREF text as a tool in BAT decision making.

Scope

The issue 'emissions from storage of bulk or dangerous materials' has been identified as a horizontal issue for all activities described in Annex I of the IPPC Directive. It means that this document covers the storage, transfer and handling of liquids, liquefied gases and solids, regardless of the sector or industry. It addresses emissions to air, soil and water, however, most attention is given to emissions to air. Information about air emissions from the storage and handling/transfer of solids focuses on dust.

General information, substances and classifications

Chapter 1, General information, provides general information on the environmental relevance of storage and handling of bulk and dangerous substances and the emission situation at storage installations by identifying, in general, the most important sources of emission to air and water and waste. Chapter 2, Substances and classifications, addresses the different classification systems of substances and the different categories of substances such as toxicity, flammability and harmfulness for the environment. For solids in bulk, it also addresses the dispersiveness class.

Applied storage, transfer and handling techniques, and techniques to be considered in the determination of BAT

Chapter 3, Applied storage, transfer and handling techniques, describes the techniques applied in the storage, transfer and handling of liquids, liquefied gases and solids. Chapter 4 describes techniques to be considered in the determination of BAT, again related to liquids, liquefied gases and solids. First, the liquids and liquefied gases related topics will be summarised, followed by the solids related topics.

Liquids and liquefied gases

For the storage of liquids and liquefied gases, the following modes are described in Chapter 3:

- open top storage tanks
- external floating roof tanks
- (vertical) fixed roof tanks
- aboveground horizontal storage tanks (atmospheric)
- horizontal storage tanks (pressurised)
- vertical storage tanks (pressurised)
- spheres (pressurised)
- mounded storage (pressurised)
- lifter roof (variable vapour space) tanks
- refrigerated storage tanks
- underground horizontal storage tanks
- containers and the storage of containers
- basins and lagoons
- mined caverns (atmospheric)
- mined caverns (pressurised)
- salt leached caverns, and
- floating storage.

Equipment such as vents; gauging, sample and access hatches; still wells and guide poles; drains; sealing elements and valves, and common issues are addresssed for tanks and other storage modes, together with issues such as design, commissioning and decommissioning, economics, management and operation are also addressed.

For the transfer and handling of liquids and liquefied gases equipment, such as vents, drains, sealing elements and pressure relief devices and the following techniques or operations are described:

- aboveground open and closed piping transfer systems
- underground piping transfer systems
- loading and unloading of transporters
- gravity flow
- pumps and compressors
- inert gases
- flanges and gaskets, and
- valves and fittings.

For each storage mode and for each transfer and handling operation, the relevant operational activities, such as filling, emptying, breathing, cleaning, draining, pigging, purging, connecting/disconnecting, and possible events/incidents, such as overfill and leakages, which potentially result in an emission, are listed. This forms the basis for describing the possible emissions by mode and activity. In particular, the potential emission sources from storage modes and transfer and handling operations, are selected for further analyses using a risk matrix approach. In this approach a scoring system is applied, calculating emission scores from operational sources by multiplying emission frequency by emission volume for each single storage mode and transfer and handling operation. All potential emission sources with a score of 3 or more are considered relevant and therefore emission control measures, further called ECM, to prevent or reduce the potential emissions from these sources are discussed in Chapter 4, Techniques to be considered in the determination of BAT.

Chapter 4 provides information on the possible ECM for each storage mode discussed in Chapter 3, which includes an assessment of relevant safety, operational aspects and economic considerations. Tanks are used for the storage of a wide range of substances, such as manure,

cooling water, and all sorts of chemicals and petrochemicals. In the petrochemical industry, where large volumes of chemical and oil products are stored in tanks, a lot of experience has been gained on preventing and reducing emissions and, therefore, an important part of the information in this BREF is related to the storage of petrochemical products in tanks.

In respect of emissions from the normal operation of a tank, the following ECM, which are not solely techniques, but also operation and management tools, are discussed and assessed:

- tank design
- inspection, maintenance and monitoring
- emissions minimisation principle
- floating, flexible and fixed covers
- domes
- tank colour
- solar shields
- natural tank cooling
- external and internal floating roofs and the roof seals
- pressure and vacuum relief valves
- draining systems
- vapour balancing and treatment, and
- mixing and sludge removal.

This chapter also provides a general methodology tool for assessing the ECM for tanks for specific cases (specific product, location and storage tank) and provides a number of case studies.

ECM for potential emissions from tanks due to incidents and (major) accidents that are discussed and assessed are:

- safety and risk management
- operational procedures and training
- low level indicator in external floating roof tanks
- leakage and overfill, e.g.:
  - leakage due to corrosion and erosion
  - instrumentation and automation to prevent overfill and detect leakage
  - impervious barriers and tank bunds
  - double wall tanks
- fire protection, fire-fighting equipment and containment.

The storage techniques described in Chapter 3 for packaged dangerous materials are storage cells, storage buildings and storage yards. Operational emissions from packaged materials do not occur; the only possible emissions are from incidents and (major) accidents and ECM discussed and assessed in Chapter 4 are:

- safety and risk management
- construction and ventilation
- segregation and separation policies
- containment of leakage and contaminated extinguishant, and
- fire protection and fire-fighting equipment.

In industry, basins and lagoons are most commonly used to hold cooling water, fire-fighting water and treated and untreated waste water. In agriculture, they are widely used for storing manure. ECM discussed and assessed in Chapter 4 for basins and lagoons are floating and plastic or rigid covers, impervious barriers and protection for overfill due to rainfall.

The types of caverns identified are mined caverns that can be atmospheric, but more often than not are pressurised, and salt leached caverns. Caverns are typically used for the storage of hydrocarbons, such as crude oil, gasoline, diesel fuel, fuel oil and liquefied petroleum gas (LPG). Emissions from normal operations of pressurised mined caverns and from salt leached caverns are considered as not significant and ECM are, therefore, not identified. However, for atmospheric mined caverns, vapour balancing is discussed and assessed as an ECM for emissions from normal operation. ECM for emissions from incidents and (major) accidents that are discussed for the different types of caverns, where appropriate, are:

- safety and risk management
- monitoring
- intrinsic safety properties
- maintaining hydrostatic pressure
- cement injection
- interlock-system, and
- automated overfill protection.

Floating storage, i.e. ships, are sometimes used to provide additional, temporary storage capacity at a marine terminal. These ships are normally ex-trading vessels. Pressure and vacuum relief valves; tank colour; and vapour balancing, collection or treatment are similar to ECM identified for storage tanks. Some ECM for emissions from incidents and (major) accidents are identified, however, further information on these has not been submitted.

For the transfer and handling of liquids and liquefied gases, compared to the storage of these substances, far less ECM are identified and discussed, and the most important are: some management tools, prevention of internal and external corrosion and vapour balancing, and treatment for loading (and unloading) of transporters. For product handling, high performance valve and pump types, such as bellows valves and valves with a diaphragm and seal-less pumps and dual pressurised or unpressurised seals for pumps, are discussed and assessed.

Solids

Chapter 3 also describes the techniques applied in the storage, transfer and handling of solids in bulk. Different types of open storage, which is an important potential source of dust emissions, are described, and so is storage in sacks and bulk bags, silos and bunkers, and packaged dangerous solids. The actual handling of solid bulk material is another, and compared to storage an even greater potential source of dust emissions, and several loading, unloading and conveying techniques are described, and they are:

- grabs
- discharge hoppers
- tubs
- suction air conveyors
- mobile loading devices
- dump pits
- fill pipes and tubes
- cascade tubes
- chutes
- thrower belts
- belt conveyors
- bucket elevator
- chain and screw conveyors
- pressure air conveyors, and
- feeders.

Chapter 4, Techniques to be considered in the determination of BAT, describes ECM, and their assessment, for preventing dust emissions from the storage, transfer and handling of solids. The three dust preventing approaches that are identified to minimise dust from storage and handling are: pre-primary approaches, primary approaches and secondary approaches. Pre-primary approaches are part of the production or extraction process and, therefore, outside the scope of this document. Primary approaches are approaches to prevent dust formation and they can be divided into organisational, technical and constructional approaches, of which the latter one is only applicable to storage and not to handling. Secondary approaches are abatement techniques to limit the distribution of dust where the formation of dust could not be prevented. For the storage of solids, the approaches and techniques to prevent and limit dust emissions are listed in Table 1.

Approaches and techniques to reduce dust emissions from the storage of solids		
Primary	Organisational	• monitoring
		• layout and operation of storage places (by planning and operating personnel)
		• maintenance (of prevention/reduction techniques)
		• reduction of wind attack areas
	Constructional	• large volume silos
		• sheds or roofs
		• domes
		• self-erecting covers
		• silos and hoppers
		• wind protection mounds, fences and/or plantings
	Technical	• use of wind protection
		• covering of open storage
		• moistening of open storage
Secondary	• water spraying/water curtains and jet spraying	
	• extraction of storage sheds and silos	

Table 1: Approaches and techniques to reduce dust emissions from the storage of solids

All these techniques are described and assessed in Chapter 4. For the handling of solids, the approaches and techniques to prevent and limit dust emissions are listed in Table 2. These techniques are also described and assessed in Chapter 4.

Approaches and techniques to reduce dust emission from the transfer and handling of solids		
Primary	Organisational	Weather conditions
		Measures (for the crane operator) when using a grab: • reduction of the drop height when the material is discharged • total closing of the grab/jaws after material pick-up • leaving the grab in the hoppers for a sufficient time after discharge • stopping of grab operations when the wind is strong.
		Measures (for the operator) when using a belt conveyor: • suitable conveyor speed • avoiding loading the belt up to its edges.
		Measures (for the operator) when using a mechanical shovel: • reducing the drop height when the material is discharged • choosing the right position during discharging into a truck.
		Layout and operation of storage sites (by the planner and the operating personnel) • reduction of transport distances • adjusting the speed of vehicles • roads with hard surfaces • reduction of wind attack areas
	Technical	Optimised grabs
		Use of closed conveyors (e.g. tube belt conveyors, screw conveyors)
		Conveyor belt without support pulleys
		Primary measures on conventional conveyor belts
		Primary measures on transfer chutes
		Minimising speed of descent
		Minimisation of free fall heights (e.g. cascade hoppers)
		Use of dust barriers on dump pits and hoppers
		Low dust bunker
		Chassis of vehicles with round tops
Secondary	Screens for open conveyor belts	
	Housing or covering of the emission sources	
	Applying covers, aprons or cones on fill tubes	
	Extraction systems	
	Filter systems for pneumatic conveyors	
	Dump pits with suction equipment, housing and dust barriers	
	Optimised discharge hoppers (in ports)	
	The techniques of water spraying/water curtains and jet spraying	
	Cleaning conveyor belts	
	Fitting trucks with mechanical/hydraulic flaps	
	Cleaning of roads	
	Cleaning of vehicle tyres	

Table 2: Approaches and techniques to reduce dust emission from transfer and handling of solids

Best available techniques

The following paragraphs summarise Chapter 5, Best available techniques, by describing the techniques, approaches or activities from which conclusions on BAT are achieved. These relate to the most relevant environmental issues, namely emissions from normal operation to air and soil on the storage and handling of liquids and dust emissions from the storage and handling of solids. In some situations BAT conclusions on emissions from incidents and (major) accidents are also reported. These paragraphs should not be read instead of the 'Best available techniques' chapter. Evenso, the BAT chapter should not be read in isolation from the rest of the BREF, and for this reason cross references are made in each BAT conclusion to the relevant sections in other chapters.

The BAT conclusions in Chapter 5 are grouped as follows. Firstly, BAT conclusions are listed on the storage of liquids and liquefied gases, addressing the general principles to prevent and reduce emissions, which are:

- inspection and maintenance
- location and layout
- tank colour
- emission minimisation principle in tank storage
- monitoring of VOC, and
- dedicated systems.

This is followed by tank specific BAT conclusions on emissions from normal operation, addressing all the types of tanks that are described in Chapter 4, logically followed with BAT conclusions on (potential) emissions that do not result from normal tank operations, namely on the prevention of incidents and (major) accidents, addressing:

- safety and risk management
- operational procedures and training
- leakage due to corrosion and/or erosion
- operational procedures and instrumentation to prevent overfill
- instrumentation and automation to detect leakage
- risk-based approach to emissions to soil below tanks
- soil protection around tanks (containment)
- flammable areas and ignition sources
- fire protection
- fire-fighting equipment, and
- containment of contaminated extinguishant.

The BAT conclusions on tank storage are followed by the BAT conclusions on the other storage techniques, namely:

- storage of packaged dangerous substances
- basins and lagoons, and
- mined and salt leached caverns.

It is concluded that floating storage is not BAT.

Secondly, BAT conclusions on the transfer and handling of liquids and liquefied gases are listed, also starting with the general principles to prevent and reduce emissions, which in this case are:

- inspection and maintenance
- leak detection and repair programme
- emissions minimisation principle in tank storage
- safety and risk management, and
- operational procedures and training.

BAT conclusions on specific techniques are achieved on piping systems addressing aboveground and underground piping systems, on abatement of emissions from loading and unloading activities, on the joints in the piping systems and the prevention of corrosion, on valves, on pumps and compressors, and on sampling connections.

Thirdly, BAT conclusions on dust emissions from open and enclosed storage and the storage of packaged materials are listed, ending with a BAT conclusion on safety and risk management.

Finally the BAT conclusions on dust emissions from the transfer and handling of solids are listed, starting with conclusions on the following general approaches to minimise dust emissions:

- scheduling the transfer activities
- continuous transport
- reduction measures when applying discontinuous transport, which are:
  - cleaning of roads and vehicle tyres
  - moistening of the product
  - minimising the speed of descent, and
  - minimising the free fall height.

The BAT conclusions on general approaches are followed by conclusions on minimising dust emissions from the transfer techniques grabs and conveyors.

Concluding Remarks

In Chapter 7 – Concluding Remarks – the reader will find information on:

- which pieces of information were submitted by the TWG are the cornerstones of this BREF
- the level of consensus reached on the BAT conclusions
- the recommendations for future work, and
- the topics suggested for future R&D projects.

It is concluded that a high level of consensus was reached, because on the total of 110 BAT conclusions 5 split views were reported. These split views are regarding some BAT conclusions in the sections on storage and handling of liquids and liquefied gases. On the BAT conclusions regarding the storage and handling of solids, no split views were reported. The split views are on the following topics:

- the assessment methodology (ECM methodology)
- the requirement of applying a vapour treatment installation for the storage of certain volatile substances regarding three different tank types, and
- the tool that can be used for quantifying VOC emissions.

At the Information Exchange Forum (IEF) meeting in December 2004, a general split view from a few Member States on the emphasis on determining BAT on a case by case basis was recorded and added to Chapter 5.

Recommendations for the future review of the BREF address the following topics:

- the development of a European classification system for air pollutants
- the separation of the storage and handling of liquids and liquefied gases and the storage and handling of solids which are two completely different areas and, therefore, require different expertise
- the monitoring of VOC emissions and tools to validate the emission calculation methods
- updating the list of techniques to prevent or reduce emissions from tanks to the soil
- collecting data on the loading and unloading of transporters concerning volatile substances, and
- collecting feedback on the assessment methodology.

The EC is launching and supporting, through its RTD programmes, a series of projects dealing with clean technologies, emerging effluent treatment and recycling technologies and management strategies. Potentially these projects could provide a useful contribution to future BREF reviews. Readers are, therefore, invited to inform the EIPPCB of any research results which are relevant to the scope of this document (see also the preface of this document).