5. BEST AVAILABLE TECHNIQUES

In understanding this chapter and its contents, the attention of the reader is drawn back to the preface of this document and in particular the fifth section of the preface: 'How to understand and use this document'. The techniques and associated emission and/or consumption levels, or ranges of levels, presented in this chapter have been assessed through an iterative process involving the following steps:

- identification of the key environmental issues for the sector; emissions to air and soil from the storage, transfer and handling of liquids and liquefied gases and of dust from the storage and handling of solids. Also safety issues are addressed
- examination of the techniques most relevant to address these key issues
- identification of the best environmental performance levels, on the basis of the available data in the European Union and worldwide
- examination of the conditions under which these performance levels were achieved; such as costs, cross-media effects, main driving forces involved in implementation of the techniques
- selection of the best available techniques (BAT) and the associated emission and/or consumption levels in a general sense, all according to Article 2(11) and Annex IV of the Directive.

Expert judgement by the European IPPC Bureau and the storage Technical Working Group (TWG) has played a key role in each of these steps and in the way in which the information is presented here.

On the basis of this assessment, techniques, and as far as possible emission and consumption levels associated with the use of BAT, are presented in this chapter that are considered to be appropriate to the relevant storage, transfer and handling systems and in many cases reflect current performance of some installations applied. Where emission or consumption levels 'associated with best available techniques' are presented, this is to be understood as meaning that those levels represent the environmental performance that could be anticipated as a result of the application of the techniques described, bearing in mind the balance of costs and advantages inherent within the definition of BAT. However, they are neither emission nor consumption limit values and should not be understood as such. In some cases it may be technically possible to achieve better emission or consumption levels but due to the costs involved or cross-media considerations, they are not considered to be appropriate as BAT for the relevant storage or transfer and handling system. However, such levels may be considered to be justified in more specific cases where there are special driving forces.

The emission and consumption levels associated with the use of BAT have to be seen together with any specified reference conditions (e.g. averaging periods).

The concept of 'levels associated with BAT' described above is to be distinguished from the term 'achievable level' used elsewhere in this document. Where a level is described as 'achievable' using a particular technique or combination of techniques, this should be understood to mean that the level may be expected to be achieved over a substantial period of time in a well maintained and operated installation using those techniques.

Where available, data concerning costs have been given together with the description of the techniques presented in the previous chapter. These give a rough indication about the magnitude of costs involved. However, the actual cost of applying a technique will depend strongly on the specific situation regarding, for example, taxes, fees, and the technical characteristics of the installation concerned. It is not possible to evaluate such site-specific factors fully in this document. In the absence of data concerning costs, conclusions on economic viability of techniques are drawn from observations on existing installations.

It is intended that the general BAT in this chapter are a reference point against which to judge the current performance of an existing installation or to judge a proposal for a new installation. In this way they will assist in the determination of appropriate 'BAT-based' conditions for the installation or in the establishment of general binding rules under Article 9(8). It is foreseen that new installations can be designed to perform at or even better than the general BAT levels presented here. It is also considered that existing installations could move towards the general BAT levels or do better, subject to the technical and economic applicability of the techniques in each case.

While the BAT reference documents do not set legally binding standards, they are meant to give information for the guidance of industry, Member States and the public on achievable emission and consumption levels when using specified techniques. The appropriate limit values for any specific case will need to be determined taking into account the objectives of the IPPC Directive and the local considerations.

In a horizontal approach it is assumed that the environmental aspects of the applied techniques and the associated reduction measures can be assessed and that generic BAT can be identified that are independent of the industry in which these techniques are applied.

However, it is recognised that tanks differ due to design, product stored, location etc., and therefore a methodology has been developed for assessing the emission control measures (ECM) described in Chapter 4. This methodology is a tool that can be used by the permit writer and the operator in order to define which ECM, or combination of ECM, that meet the generic BAT levels or do better, performs best in the storage of liquid and liquefied gas in a specific situation, and is described in Section 4.1.1.

There is a split view from some Member States, that the ECM methodology is neither practical nor suitable for determining BAT in their view (see Section 4.1.1). Specifically, the methodology:

- is not BAT and this was agreed upon in the TWG. Furthermore, the methodology does not conform with the requirements on BAT according the BREF Outline and Guide
- has not been practically tested in practice by the permitting authorities
- does not allow any European or sectoral conclusions on BAT for substances with certain properties, and
- does not offer a possibility for the harmonisation of BAT techniques in Europe.

A few Member States do not agree with the BAT conclusions in Chapter 5 because, in their view, there is too much emphasis on the determination of BAT on a case by case basis at a local level. In their view, the BREF does not contain clear European BAT conclusions which would contribute more to harmonisation of standards at the European level. They would prefer, in particular, that such standards are based upon the hazardous potential and the amount of materials being handled.

5.1. Storage of liquids and liquefied gases

5.1.1. Tanks

5.1.1.1. General principles to prevent and reduce emissions

Tank design

BAT for a proper design is to take into account at least the following:

- the physico-chemical properties of the substance being stored
- how the storage is operated, what level of instrumentation is needed, how many operators are required, and what their workload will be
- how the operators are informed of deviations from normal process conditions (alarms)
- how the storage is protected against deviations from normal process conditions (safety instructions, interlock systems, pressure relief devices, leak detection and containment, etc.)
- what equipment has to be installed, largely taking account of past experiences of the product (construction materials, valve quality, etc.)
- which maintenance and inspection plan needs to be implemented and how to ease the maintenance and inspection work (access, layout, etc.)
- how to deal with emergency situations (distances to other tanks, facilities and to the boundary, fire protection, access for emergency services such as the fire brigade, etc.).

See Annex 8.19 for a typical checklist.

Inspection and maintenance

BAT is to apply a tool to determine proactive maintenance plans and to develop risk-based inspection plans such as the risk and reliability based maintenance approach; see Section 4.1.2.2.1.

Inspection work can be divided into routine inspections, in-service external inspections and out-of-service internal inspections and are described in detail in Section 4.1.2.2.2.

Location and layout

For building new tanks it is important to select the location and the layout with care, e.g. water protection areas and water catchment areas should be avoided whenever possible. See Section 4.1.2.3.

BAT is to locate a tank operating at, or close to, atmospheric pressure aboveground. However, for storing flammable liquids on a site with restricted space, underground tanks can also be considered. For liquefied gases, underground, mounded storage or spheres can be considered, depending on the storage volume.

Tank colour

BAT is to apply either a tank colour with a reflectivity of thermal or light radiation of at least 70 %, or a solar shield on aboveground tanks which contain volatile substances, see Section 4.1.3.6 and 4.1.3.7 respectively.

Emissions minimisation principle in tank storage

BAT is to abate emissions from tank storage, transfer and handling that have a significant negative environmental effect, as described in Section 4.1.3.1.

This is applicable to large storage facilities allowing a certain time frame for implementation.

Monitoring of VOC

On sites where significant VOC emissions are to be expected, BAT includes calculating the VOC emissions regularly. The calculation model may occasionally need to be validated by applying a measurement method. See Section 4.1.2.2.3.

There is a split view from three Member States, because in their view, on sites where significant VOC emissions are to be expected (e.g. refineries, petrochemical plants and oil terminals), BAT is to calculate the VOC emissions regularly with validated calculation methods, and because of uncertainties in the calculation methods, emissions from the plants should be monitored occasionally in order to quantify the emissions and to give basic data for refining calculation methods. This can be carried out by using DIAL techniques. The necessity and frequency of emission monitoring needs to be decided on a case-by-case basis.

Dedicated systems

BAT is to apply dedicated systems; see Section 4.1.4.4.

Dedicated systems are generally not applicable on sites where tanks are used for short to medium-term storage of different products.

5.1.1.2. Tank specific considerations

Open top tanks

Open top tanks are used for the storage of, e.g. manure slurry in agricultural premises and water and other non-flammable or non-volatile liquids in industrial facilities, see Section 3.1.1.

If emissions to air occur, BAT is to cover the tank by applying:

- a floating cover, see Section 4.1.3.2
- a flexible or tent cover, see Section 4.1.3.3, or
- a rigid cover, see Section 4.1.3.4.

Additionally, with an open top tank covered with a flexible, tent or a rigid cover, a vapour treatment installation can be applied to achieve an additional emission reduction, see Section 4.1.3.15. The type of cover and the necessity for applying the vapour treatment system depend on the substances stored and must be decided on a case-by-case basis.

To prevent deposition that would call for an additional cleaning step, BAT is to mix the stored substance (e.g. slurry), see Section 4.1.5.1.

External floating roof tank

External floating roof tanks are used for the storage of, e.g. crude oil; see Section 3.1.2.

The BAT associated emission reduction level for a large tank is at least 97 % (compared to a fixed roof tank without measures), which can be achieved when over at least 95 % of the circumference the gap between the roof and the wall is less than 3.2 mm and the seals are liquid mounted, mechanical shoe seals. By installing liquid mounted primary seals and rim mounted secondary seals, a reduction in air emissions of up to 99.5 % (compared to a fixed roof tank without measures) can be achieved. However, the choice of seal is related to reliability, e.g. shoe seals are preferred for longevity and, therefore, for high turnovers. See Section 4.1.3.9.

BAT is to apply direct contact floating roofs (double-deck), however, existing non-contact floating roofs (pontoon) are also BAT. See Section 3.1.2.

Additional measures to reduce emissions are (see Section 4.1.3.9.2):

- applying a float in the slotted guide pole
- applying a sleeve over the slotted guide pole, and/or
- applying 'socks' over the roof legs.

A dome can be BAT for adverse weather conditions, such as high winds, rain or snowfall. See Section 4.1.3.5.

For liquids containing a high level of particles (e.g. crude oil), BAT is to mix the stored substance to prevent deposition that would call for an additional cleaning step, see Section 4.1.5.1.

Fixed roof tanks

Fixed roof tanks are used for the storage of flammable and other liquids, such as oil products and chemicals with all levels of toxicity, see Section 3.1.3.

For the storage of volatile substances which are toxic (T), very toxic (T+), or carcinogenic, mutagenic and reproductive toxic (CMR) categories 1 and 2 in a fixed roof tank, BAT is to apply a vapour treatment installation.

There is a split view from industry, that this technique is not BAT because in their view:

a) there is no definition of ' volatile' in this BREF
b) there is no test of environmental significance
c) products which may be dangerous to the environment, but not classed as toxic, are not captured
d) it can be demonstrated that other emission control measures may provide a higher level of environmental protection taking into account the costs and advantages of the various techniques
e) there are no commonly understood performance criteria for a vapour treatment installation
f) this does not take into account the cost, or advantages of other techniques
g) this does not provide the flexibility to take into account the technical characteristics of the installation concerned, its geographical location and the local environmental conditions
h) there is no proportionality in this conclusion.

For other substances, BAT is to apply a vapour treatment installation, or to install an internal floating roof (see Sections 4.1.3.15 and 4.1.3.10 respectively). Direct contact floating roofs and non-contact floating roofs are BAT. In the Netherlands, the condition for when to apply these BAT is when the substance has a vapour pressure (at 20 ºC) of 1 kPa and the tank has a volume of $\geq 50\ m^3$. In Germany, the condition for when to apply these BAT is when the substance has a vapour pressure (at 20 ºC) of 1.3 kPa and the tank has a volume of $\geq 300\ m^3$.

For tanks $< 50\ m^3$, BAT is to apply a pressure relief valve set at the highest possible value consistent with the tank design criteria.

The selection of the vapour treatment technology is based on criteria such as cost, toxicity of the product, abatement efficiency, quantities of rest-emissions and possibilities for product or energy recovery, and has to be decided case-by-case. The BAT associated emission reduction is at least 98 % (compared to a fixed roof tank without measures). See Section 4.1.3.15.

The achievable emission reduction for a large tank using an internal floating roof is at least 97 % (compared to a fixed roof tank without measures), which can be achieved when over at least 95 % of the circumference of the gap between the roof and wall is less than 3.2 mm and the seals are liquid mounted, mechanical shoe seals. By applying liquid mounted primary seals and rim mounted secondary seals, even higher emission reductions can be achieved. However, the smaller the tank and the smaller the number of turnovers the less effective the floating roof is, see Annex 8.22 and Annex 8.23 respectively.

Also the case studies in Annex 8.13 show that achievable emission reductions depend on several issues such as the substance that is actually stored, meteorological circumstances, number of turnovers and diameter of the tank. The calculations show that with an internal floating roof an emission reduction in the range 62.9 – 97.6 % can be achieved (compared to a fixed roof tank without measures); where 62.9 % refers to a tank of 100 m^3 equipped with only primary seals and 97.6 % refers to a tank of 10263 m^3 equipped with primary and secondary seals.

For liquids containing a high level of particles (e.g. crude oil) BAT is to mix the stored substance to prevent deposition that would call for an additional cleaning step, see Section 4.1.5.1.

Atmospheric horizontal tanks

Atmospheric horizontal tanks are used for the storage of flammable and other liquids, such as oil products and chemicals in all levels of flammability and toxicity, see Section 3.1.4. Horizontal tanks are different to vertical tanks, e.g. since they can inherently operate under higher pressures.

For the storage of volatile substances which are toxic (T), very toxic (T+), or CMR categories 1 and 2 in an atmospheric horizontal tank, BAT is to apply a vapour treatment installation.

There is a split view from industry, that this technique is not BAT because in their view:

a) *there is no definition of 'volatile' in this BREF*
b) *there is no test of environmental significance*
c) *products which may be dangerous to the environment, but not classed as toxic, are not captured*
d) *it can be demonstrated that other emission control measures may provide a higher level of environmental protection taking into account the costs and advantages of the various techniques*
e) *there are no commonly understood performance criteria for a vapour treatment installation*
f) *this does not take into account the costs or advantages of other techniques*
g) *this does not provide the flexibility to take into account the technical characteristics of the installation concerned, its geographical location and the local environmental conditions*
h) *there is no proportionality in this conclusion.*

For other substances, BAT is to do all, or a combination, of the following techniques, depending on the substances stored:

- apply pressure vacuum relief valves; see Section 4.1.3.11
- up rate to 56 mbar; see Section 4.1.3.11
- apply vapour balancing; see Section 4.1.3.13
- apply a vapour holding tank, see Section 4.1.3.14, or
- apply vapour treatment; see Section 4.1.3.15.

The selection of the vapour treatment technology has to be decided on a case-by-case basis.

Pressurised storage

Pressurised storage is used for storing all categories of liquefied gases, from non-flammable up to flammable and highly toxic. The only significant emissions to air from normal operation are from draining.

BAT for draining depends on the tank type, but may be the application of a closed drain system connected to a vapour treatment installation, see Section 4.1.4.

The selection of the vapour treatment technology has to be decided on a case-by-case basis.

Lifter roof tanks

For emissions to air, BAT is to (see Sections 3.1.9 and 4.1.3.14):

- apply a flexible diaphragm tank equipped with pressure/vacuum relief valves, or
- apply a lifter roof tank equipped with pressure/vacuum relief valves and connected to a vapour treatment installation.

The selection of the vapour treatment technology has to be decided on a case-by-case basis.

Refrigerated tanks

There are no significant emissions from normal operation, see Section 3.1.10.

Underground and mounded tanks

Underground and mounded tanks are used especially for flammable products, see Sections 3.1.11 and 3.1.8 respectively.

For the storage of volatile substances which are toxic (T), very toxic (T+), or CMR categories 1 and 2 in an underground or mounded tank, BAT is to apply a vapour treatment installation.

There is a split view from industry, that this technique is not BAT because in their view:

a) *there is no definition of 'volatile' in this BREF*
b) *there is no test of environmental significance*
c) *products which may be dangerous to the environment, but not classed as toxic, are not captured*
d) *it can be demonstrated that other emission control measures may provide a higher level of environmental protection taking into account the costs and advantages of the various techniques*
e) *there are no commonly understood performance criteria for a vapour treatment installation*
f) *this does not take into account the costs or advantages of other techniques*
g) *this does not provide the flexibility to take into account the technical characteristics of the installation concerned, its geographical location and the local environmental conditions*
h) *there is no proportionality in this conclusion.*

For other substances, BAT is to do all, or a combination, of the following techniques, depending on the substances stored:

- apply pressure vacuum relief valves; see Section 4.1.3.11
- apply vapour balancing; see Section 4.1.3.13
- apply a vapour holding tank, see Section 4.1.3.14, or
- apply vapour treatment; see Section 4.1.3.15.

The selection of the vapour treatment technology has to be decided on a case-by-case basis.

5.1.1.3. Preventing incidents and (major) accidents

Safety and risk management

The Seveso II Directive (Council Directive 96/82/EC of 9 December 1996 on the control of major accident hazards involving dangerous substances) requires companies to take all measures necessary to prevent and limit the consequences of major accidents. They must, in any case, have a major accident prevention policy (MAPP) and a safety management system to implement the MAPP. Companies holding large quantities of dangerous substances, the so-called upper tiered establishments, must also draw up a safety report and an on-site emergency plan and maintain an up-to-date list of substances. However, plants that do not fall under the scope of the Seveso II Directive can also cause emissions from incidents and accidents. Applying a similar, maybe less detailed, safety management system is the first step in preventing and limiting these.

BAT in preventing incidents and accidents is to apply a safety management system as described in Section 4.1.6.1.

Operational procedures and training

BAT is to implement and follow adequate organisational measures and to enable training and instruction of employees for safe and responsible operation of the installation as described in Section 4.1.6.1.1.

Leakage due to corrosion and/or erosion

Corrosion is one of the main causes of equipment failure and can occur both internally and externally on any metal surface, see Section 4.1.6.1.4. BAT is to prevent corrosion by:

- selecting construction material that is resistant to the product stored
- applying proper construction methods
- preventing rainwater or groundwater entering the tank and if necessary, removing water that has accumulated in the tank
- applying rainwater management to bund drainage
- applying preventive maintenance, and
- where applicable, adding corrosion inhibitors, or applying cathodic protection on the inside of the tank.

Additionally for an underground tank, BAT is to apply to the outside of the tank:

- a corrosion-resistant coating
- plating, and/or
- a cathodic protection system.

Stress corrosion cracking (SCC) is a specific problem for spheres, semi-refrigerated tanks and some fully refrigerated tanks containing ammonia. BAT is to prevent SCC by:

- stress relieving by post-weld heat treatment, see Section 4.1.6.1.4, and
- applying a risk based inspection as described in Section 4.1.2.2.1.

Operational procedures and instrumentation to prevent overfill

BAT is to implement and maintain operational procedures – e.g. by means of a management system – as described in Section 4.1.6.1.5, to ensure that:

- high level or high pressure instrumentation with alarm settings and/or auto closing of valves is installed
- proper operating instructions are applied to prevent overfill during a tank filling operation, and
- sufficient ullage is available to receive a batch filling.

A standalone alarm requires manual intervention and appropriate procedures, and automatic valves need to be integrated into the upstream process design to ensure no consequential effects of closure. The type of alarm to be applied has to be decided for every single tank. See Section 4.1.6.1.6.

Instrumentation and automation to detect leakage

The four different basic techniques that can be used to detect leaks are:

- release prevention barrier system
- inventory checks
- acoustic emission method
- soil vapour monitoring.

BAT is to apply leak detection on storage tanks containing liquids that can potentially cause soil pollution. The applicability of the different techniques depends on the tank type and is discussed in detail in Section 4.1.6.1.7.

Risk-based approach to emissions to soil below tanks

The risk-based approach to emissions to soil from an aboveground flat-bottom and vertical, storage tank containing liquids with a potency to pollute soil, is that soil protection measures are applied at such a level that there is a 'negligible risk' for soil pollution because of leakage from the tank bottom or from the seal where the bottom and the wall are connected. See Section 4.1.6.1.8 where the approach and the risk levels are explained.

BAT is to achieve a 'negligible risk level' of soil pollution from bottom and bottom-wall connections of aboveground storage tanks. However, on a case-by-case basis, situations might be identified where an 'acceptable risk level' is sufficient.

Soil protection around tanks – containment

BAT for aboveground tanks containing flammable liquids or liquids that pose a risk for significant soil pollution or a significant pollution of adjacent watercourses is to provide secondary containment, such as:

- tank bunds around single wall tanks; see Section 4.1.6.1.11
- double wall tanks; see Section 4.1.6.1.13
- cup-tanks; see Section 4.1.6.1.14
- double wall tanks with monitored bottom discharge; see Section 4.1.6.1.15.

For building new single walled tanks containing liquids that pose a risk for significant soil pollution or a significant pollution of adjacent watercourses, BAT is to apply a full, impervious, barrier in the bund, see Section 4.1.6.1.10.

For existing tanks within a bund, BAT is to apply a risk-based approach, considering the significance of risk from product spillage to the soil, to determine if and which barrier is best applicable. This risk-based approach can also be applied to determine if a partial impervious barrier in a tank bund is sufficient or if the whole bund needs to be equipped with an impervious barrier. See Section 4.1.6.1.11.

Impervious barriers include:

- a flexible membrane, such as HDPE
- a clay mat
- an asphalt surface
- a concrete surface.

For chlorinated hydrocarbon solvents (CHC) in single walled tanks, BAT is to apply CHC-proof laminates to concrete barriers (and containments), based on phenolic or furan resins. One form of epoxy resin is also CHC-proof. See Section 4.1.6.1.12.

BAT for underground and mounded tanks containing products that can potentially cause soil pollution is to:

- apply a double walled tank with leak detection, see Section 4.1.6.1.16, or
- to apply a single walled tank with secondary containment and leak detection, see Section 4.1.6.1.17.

<u>Flammable areas and ignition sources</u>

See Section 4.1.6.2.1 together with ATEX Directive 1999/92/EC.

<u>Fire protection</u>

The necessity for implementing fire protection measures has to be decided on a case-by-case basis. Fire protection measures can be provided by applying, e.g. (see Section 4.1.6.2.2):

- fire resistant claddings or coatings
- firewalls (only for smaller tanks), and/or
- water cooling systems.

<u>Fire-fighting equipment</u>

The necessity for implementing fire-fighting equipment and the decision on which equipment to apply has to be taken on a case-by-case basis in agreement with the local fire brigade. Some examples are given in Section 4.1.6.2.3.

<u>Containment of contaminated extinguishant</u>

The capacity for containing contaminated extinguishant depends on the local circumstances, such as which substances are stored and whether the storage is close to watercourses and/or situated in a water catchment area. The applied containment therefore has to be decided on a case-by-case basis, see Section 4.1.6.2.4.

For toxic, carcinogenic or other hazardous substances, BAT is to apply full containment.

5.1.2. Storage of packaged dangerous substances

Safety and risk management

Operational losses do not occur in storing packaged dangerous materials. The only possible emissions are from incidents and (major) accidents. Companies that fall under the scope of the Seveso II Directive are required to take all measures necessary to prevent and limit the consequences of major accidents. They must, in any, case have a major accident prevention policy (MAPP) and a safety management system to implement the MAPP. Companies in the high risk category (Annex I of the Directive) must also draw up a safety report and an on-site emergency plan and maintain an up-to-date list of substances. However, companies storing dangerous substances not falling under the scope of the Seveso II Directive can also cause emissions from incidents and accidents. Applying a similar, maybe less detailed, safety management system is the first step in preventing and limiting these.

BAT in preventing incidents and accidents is to apply a safety management system as described in Sections 4.1.6.1.

The degree of detail of the system is clearly dependent on various factors such as: the quantities of substances stored, specific hazards of the substances and the location of the storage. However, the minimum level of BAT is to assess the risks of accidents and incidents on the site using the five steps described in Section 4.1.6.1

Training and responsibility

BAT is to appoint a person or persons who is or are responsible for the operation of the store.

BAT is to provide the responsible person(s) with specific training and retraining in emergency procedures as described in Section 4.1.7.1 and to inform other staff on the site of the risks of storing packaged dangerous substances and the precautions necessary to safely store substances that have different hazards.

Storage area

BAT is to apply a storage building and/or an outdoor storage area covered with a roof, as described in Section 4.1.7.2. For storing quantities of less than 2500 litres or kilograms dangerous substances, applying a storage cell as described in Section 4.1.7.2 is also BAT.

Separation and segregation

BAT is to separate the storage area or building of packaged dangerous substances from other storage, from ignition sources and from other buildings on- and off-site by applying a sufficient distance, sometimes in combination with fire-resistant walls. MSs apply different distances between the (outdoor) storage of packaged dangerous substances and other objects on- and off-site; see Section 4.1.7.3 for some examples.

BAT is to separate and/or segregate incompatible substances. For the compatible and incompatible combinations see Annex 8.3. MSs apply different distances and/or physical partitioning between the storage of incompatible substances; see Section 4.1.7.4 for some examples.

Containment of leakage and contaminated extinguishant

BAT is to install a liquid-tight reservoir according to Section 4.1.7.5, that can contain all or a part of the dangerous liquids stored above such a reservoir. The choice whether all or only a part of the leakage needs to be contained depends on the substances stored and on the location of the storage (e.g. in a water catchment area) and can only be decided on a case-by-case basis.

BAT is to install a liquid-tight extinguishant collecting provision in storage buildings and storage areas according to Section 4.1.7.5. The collecting capacity depends on the substances stored, the amount of substances stored, the type of package used and the applied fire-fighting system and can only be decided on a case-by-case basis.

Fire-fighting equipment

BAT is to apply a suitable protection level of fire prevention and fire-fighting measures as described in Section 4.1.7.6. The appropriate protection level has to be decided on a case-by-case basis in agreement with the local fire brigade.

Preventing ignition

BAT is to prevent ignition at source as described in Section 4.1.7.6.1.

5.1.3. Basins and lagoons

Basins and lagoons are used for the storage of, e.g. manure slurry in agricultural premises and water and other non-flammable or volatile liquids in industrial facilities.

Where emissions to air from normal operation are significant, e.g. with the storage of pig slurry, BAT is to cover basins and lagoons using one of the following options:

- a plastic cover; see Section 4.1.8.2
- a floating cover; see Section 4.1.8.1, or
- only small basins, a rigid cover; see Section 4.1.8.2.

Additionally, where a rigid cover is used, a vapour treatment installation can be applied to achieve an extra emission reduction, see Section 4.1.3.15. The need for and type of vapour treatment must be decided on a case-by-case basis.

To prevent overfilling due to rainfall in situations where the basin or lagoon is not covered, BAT is to apply a sufficient freeboard, see Section 4.1.11.1.

Where substances are stored in a basin or lagoon with a risk of soil contamination, BAT is to apply an impervious barrier. This can be a flexible membrane, a sufficient clay layer or concrete, see Section 4.1.9.1.

5.1.4. Atmospheric mined caverns

Emissions to air from normal operation

Where a number of caverns with a fixed waterbed storing liquid hydrocarbons are present, BAT is to apply vapour balancing, see Section 4.1.12.1.

Emissions from incidents and (major) accidents

By their intrinsic nature, caverns are by far the safest way of storing large quantities of hydrocarbon products. BAT for storing large quantities of hydrocarbons is, therefore, to apply caverns wherever the site geology is suitable, see Sections 3.1.15 and 4.1.13.3.

BAT, in preventing incidents and accidents, is to apply a safety management system as described in Section 4.1.6.1.

BAT is to apply, and then regularly evaluate, a monitoring programme which at least includes the following (see Section 4.1.13.2):

- monitoring of the hydraulic flow pattern around the caverns by means of groundwater measurements, piezometers and/or pressure cells, seepage water flowrate metering
- assessment of cavern stability by seismic monitoring
- water quality follow-up procedures by regular sampling and analysis
- corrosion monitoring, including periodic casing evaluation.

For preventing the stored product from escaping out of the cavern, BAT is to design the cavern in such a way that at the depth at which it is situated, the hydrostatic pressure of the groundwater surrounding the cavern is always greater than that of the stored product, see Section 4.1.13.5.

For preventing seepage water entering the cavern, BAT is, apart from a proper design, to additionally apply cement injection, see Section 4.1.13.6.

If seepage water that enters the cavern is pumped out, BAT is to apply waste water treatment before discharge, see Section 4.1.13.3.

BAT is to apply automated overfill protection, see Section 4.1.13.8.

5.1.5. Pressurised mined caverns

Emissions from incidents and (major) accidents

By their intrinsic nature, caverns are by far the safest way of storing large quantities of hydrocarbon products. BAT for storing large quantities of hydrocarbons is, therefore, to apply caverns wherever the site geology is suitable, see Sections 3.1.16 and 4.1.14.3.

BAT, in preventing incidents and accidents, is to apply a safety management system as described in Section 4.1.6.1.

BAT is to apply, and then regularly evaluate a monitoring programme which at least includes the following (see Section 4.1.14.2):

- monitoring of the hydraulic flow pattern around the caverns by means of groundwater measurements, piezometers and/or pressure cells, seepage water flowrate metering
- assessment of cavern stability by seismic monitoring
- water quality follow-up procedures by regular sampling and analysis
- corrosion monitoring, including periodic casing evaluation.

For preventing the stored product from escaping out of the cavern, BAT is to design the cavern in such a way that at the depth at which it is situated, the hydrostatic pressure of the groundwater surrounding the cavern is always greater than that of the stored product, see Section 4.1.14.5.

For preventing seepage water entering the cavern, BAT is, apart from a proper design, to additionally apply cement injection, see Section 4.1.14.6

If seepage water that enters the cavern is pumped out, BAT is to apply waste water treatment before discharge, see Section 4.1.14.3.

BAT is to apply automated overfill protection, see Section 4.1.14.8.

BAT is to apply fail-safe valves in the event of a surface emergency event, see Section 4.1.14.4.

5.1.6. Salt leached caverns

Emissions from incidents and (major) accidents

By their intrinsic nature, caverns are by far the safest way of storing large quantities of hydrocarbon products. BAT for storing large quantities of hydrocarbons is, therefore, to apply caverns wherever the site geology is suitable. For more detail see Sections 3.1.17 and 4.1.15.3.

BAT, in preventing incidents and accidents, is to apply a safety management system as described in Section 4.1.6.1.

BAT is to apply, and then regularly evaluate a monitoring programme which at least includes the following (see Section 4.1.15.2):

- assessment of cavern stability by seismic monitoring
- corrosion monitoring, including periodic casing evaluation
- carrying out of regular sonar evaluations to monitor eventual shape variations, particularly if undersaturated brine is used.

Small traces of hydrocarbons may be present at the brine/hydrocarbon interface due to filling and emptying the caverns. If this is the case, BAT is to separate these hydrocarbon products in a brine treatment unit and to collect and dispose of them safely.

5.1.7. Floating storage

Floating storage is not BAT, see Section 3.1.18.

5.2. Transfer and handling of liquids and liquefied gases

5.2.1. General principles to prevent and reduce emissions

Inspection and maintenance

BAT is to apply a tool to determine proactive maintenance plans and to develop risk-based inspection plans such as, the risk and reliability based maintenance approach; see Section 4.1.2.2.1.

Leak detection and repair programme

For large storage facilities, according to the properties of the products stored, BAT is to apply a leak detection and repair programme. Focus needs to be on those situations most likely to cause emissions (such as gas/light liquid, under high pressure and/or temperature duties). See Section 4.2.1.3.

Emissions minimisation principle in tank storage

BAT is to abate emissions from tank storage, transfer and handling that have a significant negative environmental effect, as described in Section 4.1.3.1.

This is applicable to large storage facilities, allowing a certain time frame for implementation.

Safety and risk management

BAT in preventing incidents and accidents is to apply a safety management system as described in Section 4.1.6.1.

Operational procedures and training

BAT is to implement and follow adequate organisational measures and to enable the training and instruction of employees for safe and responsible operation of the installation as described in Section 4.1.6.1.1.

5.2.2. Considerations on transfer and handling techniques

5.2.2.1. Piping

BAT is to apply aboveground closed piping in new situations, see Section 4.2.4.1. For existing underground piping it is BAT to apply a risk and reliability based maintenance approach as described in Section 4.1.2.2.1.

Bolted flanges and gasket-sealed joints are an important source of fugitive emissions. BAT is to minimise the number of flanges by replacing them with welded connections, within the limitation of operational requirements for equipment maintenance or transfer system flexibility, see Section 4.2.2.1.

BAT for bolted flange connections (see Section 4.2.2.2.) include:

- fitting blind flanges to infrequently used fittings to prevent accidental opening
- using end caps or plugs on open-ended lines and not valves
- ensuring gaskets are selected appropriate to the process application
- ensuring the gasket is installed correctly
- ensuring the flange joint is assembled and loaded correctly
- where toxic, carcinogenic or other hazardous substances are transferred, fitting high integrity gaskets, such as spiral wound, kammprofile or ring joints.

Internal corrosion may be caused by the corrosive nature of the product being transferred, see Section 4.2.3.1. BAT is to prevent corrosion by:

- selecting construction material that is resistant to the product
- applying proper construction methods
- applying preventive maintenance, and
- where applicable, applying an internal coating or adding corrosion inhibitors.

To prevent the piping from external corrosion, BAT is to apply a one, two, or three layer coating system depending on the site-specific conditions (e.g. close to sea). Coating is normally not applied to plastic or stainless steel pipelines. See Section 4.2.3.2.

5.2.2.2. Vapour treatment

BAT is to apply vapour balancing or treatment on significant emissions from the loading and unloading of volatile substances to (or from) trucks, barges and ships. The significance of the emission depends on the substance and the volume that is emitted, and has to be decided on a case-by-case basis. For more detail see Section 4.2.8.

For example, according to Dutch regulations, the emission of methanol is significant when over 500 kg/yr is emitted.

5.2.2.3. Valves

BAT for valves include:

- correct selection of the packing material and construction for the process application
- with monitoring, focus on those valves most at risk (such as rising stem control valves in continual operation)
- applying rotating control valves or variable speed pumps instead of rising stem control valves
- where toxic, carcinogenic or other hazardous substances are involved, fit diaphragm, bellows, or double walled valves
- route relief valves back into the transfer or storage system or to a vapour treatment system.

See Sections 3.2.2.6 and 4.2.9.

5.2.2.4. Pumps and compressors

<u>Installation and maintenance of pumps and compressors</u>

The design, installation and operation of the pump or compressor heavily influence the life potential and reliability of the sealing system. The following are some of the main factors which constitute BAT:

- proper fixing of the pump or compressor unit to its base-plate or frame
- having connecting pipe forces within producers' recommendations
- proper design of suction pipework to minimise hydraulic imbalance
- alignment of shaft and casing within producers' recommendations
- alignment of driver/pump or compressor coupling within producers' recommendations when fitted
- correct level of balance of rotating parts
- effective priming of pumps and compressors prior to start-up
- operation of the pump and compressor within producers' recommended performance range (The optimum performance is achieved at its best efficiency point.)
- the level of net positive suction head available should always be in excess of the pump or compressor
- regular monitoring and maintenance of both rotating equipment and seal systems, combined with a repair or replacement programme.

<u>Sealing system in pumps</u>

BAT is to use the correct selection of pump and seal types for the process application, preferably pumps that are technologically designed to be tight such as canned motor pumps, magnetically coupled pumps, pumps with multiple mechanical seals and a quench or buffer system, pumps with multiple mechanical seals and seals dry to the atmosphere, diaphragm pumps or bellow pumps. For more details see Sections 3.2.2.2, 3.2.4.1 and 4.2.9.

<u>Sealing systems in compressors</u>

BAT for compressors transferring non-toxic gases is to apply gas lubricated mechanical seals.

BAT for compressors, transferring toxic gases is to apply double seals with a liquid or gas barrier and to purge the process side of the containment seal with an inert buffer gas.

In very high pressure services, BAT is to apply a triple tandem seal system.

For more detail see Sections 3.2.3 and 4.2.9.13.

5.2.2.5. Sampling connections

BAT, for sample points for volatile products, is to apply a ram type sampling valve or a needle valve and a block valve. Where sampling lines require purging, BAT is to apply closed-loop sampling lines. See Section 4.2.9.14.

5.3. Storage of solids

5.3.1. Open storage

BAT is to apply enclosed storage by using, for example, silos, bunkers, hoppers and containers, to eliminate the influence of wind and to prevent the formation of dust by wind as far as possible by primary measures. See Table 4.12 for these primary measures with cross-references to the relevant sections.

However, although large volume silos and sheds are available, for (very) large quantities of not or only moderately drift sensitive and wettable material, open storage might be the only option. Examples are the long-term strategic storage of coal and the storage of ores and gypsum.

BAT for open storage is to carry out regular or continuous visual inspections to see if dust emissions occur and to check if preventive measures are in good working order. Following the weather forecast by, e.g, using meteorological instruments on site, will help to identify when the moistening of heaps is necessary and will prevent unnecessary use of resources for moistening the open storage. See Section 4.3.3.1.

BAT for long-term open storage are one, or a proper combination, of the following techniques:

- moistening the surface using durable dust-binding substances, see Section 4.3.6.1
- covering the surface, e.g. with tarpaulins, see Section 4.3.4.4
- solidification of the surface, see Table 4.13
- grassing-over of the surface, see Table 4.13.

BAT for short-term open storage are one, or a proper combination, of the following techniques:

- moistening the surface using durable dust-binding substances, see Section 4.3.6.1
- moistening the surface with water, see Sections 4.3.6.1
- covering the surface, e.g. with tarpaulins, see Section 4.3.4.4.

Additional measures to reduce dust emissions from both long and short-term open storage are:

- placing longitudinal axis of the heap parallel with the prevailing wind
- applying protective plantings, windbreak fences or upwind mounds to lower the wind velocity
- applying only one heap instead of several heaps as far as possible; with two heaps storing the same amount as one, the free surface increases with 26 %
- applying storage with retaining walls reduces the free surface, leading to a reduction of diffuse dust emissions; this reduction is maximised if the wall is placed upwind of the heap
- placing retaining walls close together.

See Table 4.13 for more details.

5.3.2. Enclosed storage

BAT is to apply enclosed storage by using, for example, silos, bunkers, hoppers and containers. Where silos are not applicable, storage in sheds can be an alternative. This is, e.g. the case if apart from storage, the mixing of batches is needed.

BAT for silos is to apply a proper design to provide stability and prevent the silo from collapsing. See Sections 4.3.4.1 and 4.3.4.5.

BAT for sheds is to apply proper designed ventilation and filtering systems and to keep the doors closed. See Section 4.3.4.2.

BAT is to apply dust abatement and a BAT associated emission level of 1 – 10 mg/m^3, depending on the nature/type of substance stored. The type of abatement technique has to be decided on a case-by-case basis. See Section 4.3.7.

For a silo containing organic solids, BAT is to apply an explosion resistant silo (see Section 4.3.8.3), equipped with a relief valve that closes rapidly after the explosion to prevent oxygen entering the silo, as described in Section 4.3.8.4.

5.3.3. Storage of packaged dangerous solids

For details regarding BAT for the storage of packaged dangerous solids, see Section 5.1.2.

5.3.4. Preventing incidents and (major) accidents

Safety and risk management

The Seveso II Directive (Council Directive 96/82/EC of 9 December 1996 on the control of major accident hazards involving dangerous substances) requires companies to take all measures necessary to prevent and limit the consequences of major accidents. They must in any case have a major accident prevention policy (MAPP) and a safety management system to implement the MAPP. Companies holding large quantities of dangerous substances, so-called upper tiered establishments, must also draw up a safety report and an on-site emergency plan and maintain an up-to-date list of substances. However, plants that do not fall under the scope of the Seveso II Directive can also cause emissions from incidents and accidents. Applying a similar, maybe less detailed, safety management system is the first step in preventing and limiting these.

BAT in preventing incidents and accidents is applying a safety management system as described in Section 4.1.7.1.

5.4. Transfer and handling of solids

5.4.1. General approaches to minimise dust from transfer and handling

BAT is to prevent dust dispersion due to loading and unloading activities in the open air, by scheduling the transfer as much as possible when the wind speed is low. However, and taking into account the local situation, this type of measure cannot be generalised to the whole EU and to any situation irrespective of the possible high costs. See Section 4.4.3.1.

Discontinuous transport (e.g. shovel or truck) generally generates more dust emissions than continuous transport such as conveyors. BAT is to make transport distances as short as possible and to apply, whereever possible, continuous transport modes. For existing plants, this might be a very expensive measure. See Section 4.4.3.5.1.

When applying a mechanical shovel, BAT is to reduce the drop height and to choose the best position during discharging into a truck; see Section 4.4.3.4.

While driving, vehicles might swirl up dust from solids spread on the ground. BAT then is to adjust the speed of vehicles on-site to avoid or minimise dust being swirled up; see Section 4.4.3.5.2.

BAT for roads that are used by trucks and cars only, is applying hard surfaces to the roads of, for example, concrete or asphalt, because these can be cleaned easily to avoid dust being swirled up by vehicles, see Section 4.4.3.5.3. However, applying hard surfaces to the roads is not justified when the roads are used just for big shovel vehicles or when a road is temporary.

BAT is to clean roads that are fitted with hard surfaces according to Section 4.4.6.12.

Cleaning of vehicle tyres is BAT. The frequency of cleaning and type of cleaning facility applied (see Section 4.4.6.13) has to be decided on a case-by-case basis.

Where it neither compromises product quality, plant safety, nor water resources, BAT for loading/unloading drift sensitive, wettable products is to moisten the product as described in Sections 4.4.6.8, 4.4.6.9 and 4.3.6.1. Risk of freezing of the product, risk of slippery situations because of ice forming or wet product on the road and shortage of water are examples when this BAT might not be applicable.

For loading/unloading activities, BAT is to minimise the speed of descent and the free fall height of the product; see Sections 4.4.5.6 and 4.4.5.7 respectively. Minimising the speed of descent can be achieved by the following techniques that are BAT:

- installing baffles inside fill pipes
- applying a loading head at the end of the pipe or tube to regulate the output speed
- applying a cascade (e.g. cascade tube or hopper)
- applying a minimum slope angle with, e.g. chutes.

To minimise the free fall height of the product, the outlet of the discharger should reach down onto the bottom of the cargo space or onto the material already piled up. Loading techniques that can achieve this, and that are BAT, are:

- height adjustable fill pipes
- height adjustable fill tubes, and
- height adjustable cascade tubes.

These techniques are BAT, except when loading/unloading non drift sensitive products, for which the free fall height is not that critical.

Optimised discharged hoppers are available and described in Section 4.4.6.7

5.4.2. Considerations on transfer techniques

Grabs

For applying a grab, BAT is to follow the decision diagram as shown in Section 4.4.3.2 and to leave the grab in the hopper for a sufficient time after the material discharge.

BAT for new grabs, is to apply grabs with the following properties (see Section 4.4.5.1):

- geometric shape and optimal load capacity
- the grab volume is always higher than the volume that is given by the grab curve
- the surface is smooth to avoid material adhering, and
- a good closure capacity during permanent operation.

Conveyors and transfer chutes

For all types of substances, BAT is to design conveyor to conveyor transfer chutes in such a way that spillage is reduced to a minimum. A modelling process is available to generate detail designs for new and existing transfer points. For more details see Section 4.4.5.5.

For non or very slightly drift sensitive products (S5) and moderately drift sensitive, wettable products (S4), BAT is to apply an open belt conveyor and additionally, depending on the local circumstances, one or a proper combination of the following techniques:

- lateral wind protection, see Section 4.4.6.1
- spraying water and jet spraying at the transfer points, see Sections 4.4.6.8 and 4.4.6.9, and/or
- belt cleaning, see Section 4.4.6.10.

For highly drift sensitive products (S1 and S2) and moderately drift sensitive, not wettable products (S3) BAT for new situations, is to:

apply closed conveyors, or types where the belt itself or a second belt locks the material (see Section 4.4.5.2), such as:

- pneumatic conveyors
- trough chain conveyors
- screw conveyors
- tube belt conveyor
- loop belt conveyor
- double belt conveyor

or to apply enclosed conveyor belts without support pulleys (see Section 4.4.5.3), such as:

- aerobelt conveyor
- low friction conveyor
- conveyor with diabolos.

The type of conveyor depends on the substance to be transported and on the location and has to be decided on a case-by-case basis.

For existing conventional conveyors, transporting highly drift sensitive products (S1 and S2) and moderately drift sensitive, not wettable products (S3), BAT is to apply housing; see Section 4.4.6.2. When applying an extraction system, BAT is to filter the outgoing air stream; see Section 4.4.6.4.

To reduce energy consumption for conveyor belts (see Section 4.4.5.2), BAT is to apply:

- a good conveyor design, including idlers and idler spacing
- an accurate installation tolerance, and
- a belt with low rolling resistance.

See Annex 8.4 for the disperseveness classes (S1 – S4) of solid bulk materials.