How to comply with your environmental permit
Additional guidance for:

The Incineration of Waste (EPR 5.01)

We are the Environment Agency. It's our job to look after your environment and make it a better place – for you, and for future generations.

Your environment is the air you breathe, the water you drink and the ground you walk on. Working with business, Government and society as a whole, we are making your environment cleaner and healthier.

The Environment Agency. Out there, making your environment a better place.

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Introduction

In *"Getting the basics right – how to comply with your environmental permit"* (GTBR) we described the standards and measures that we expect businesses to take in order to control the risk of pollution from the most frequent situations in the waste management and process industries.

This sector guidance note (SGN) is one of a series of additional guidance for Part A(1) activities listed in Schedule 1 of the Environmental Permitting Regulations (the Regulations). We expect you to use the standards and measures in this note **in addition** to those in GTBR to meet the objectives in your permit.

Sometimes, particularly difficult issues arise such as problems with odour or noise. You may then need to consult the "horizontal" guidance that gives in depth information on particular topics. Annex 1 of GTBR lists these.

The IPPC Directive requires that the Best Available Techniques (BAT) are used. When making an application, explain how you will comply with each of the indicative BATs in this sector guidance note. Where indicative BAT is not included, where you propose to use an alternative measure or where there is a choice of options you should explain your choice on the basis of costs and benefits. Part 2 of Horizontal Guidance Note H1 Environmental Risk Assessment (see GTBR Annex 1) gives a formal method of assessing options which you should use where major decisions are to be made.

We will consider the relevance and relative importance of the information to the installation concerned when making technical judgments about the installation and when setting conditions in the permit.

Modern permits describe the objectives (or outcomes) that we want you to achieve. They do not normally tell you how to achieve them. They give you a degree of flexibility.

Where a condition requires you to take appropriate measures to secure a particular objective, we will expect you to use, at least, the measures described which are appropriate for meeting the objective. You may have described the measures you propose in your application or in a relevant management plan but further measures will be necessary if the objectives are not met.

The measures set out in this note may not all be appropriate for a particular circumstance and you may implement equivalent measures that achieve the same objective. In cases where the measures are mandatory this is stated.

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In response to the application form question on Operating Techniques, you should address each of the measures described as indicative BAT in this note as well as the key issues identified in GTBR.

Unless otherwise specified, the measures and benchmarks described in this note reflect those of the previous Sector Guidance Note. They will be reviewed in the light of future BREF note revisions. In the meantime we will take account of advances in BAT when considering any changes to your process.

Installations Covered

This note applies to activities regulated under the following section of schedule 1 of the Regulations:

Section 5.1, Incineration and co-incineration of waste, Part A(1)

(a) The incineration of hazardous waste in an incineration plant.

(c) The incineration of non-hazardous waste in an incineration plant with a capacity of 1 tonne or more per hour.

Definition and exclusions

An incineration plant is plant whose primary purpose is the burning of waste or its thermal treatment for the purpose of disposal. Although a new plant will usually reclaim energy from the combustion of the waste, the reason for its operation is not primarily the generation of energy but the disposal of waste.

A co-incineration plant is any plant whose primary purpose is the generation of energy or the production of material products which burns or thermally treats waste as a fuel or for disposal. Even if the plant is completely fired by waste or waste derived fuel, it is a co-incinerator if its primary purpose is a production or energy generation activity. A typical co-incineration plant could be a boiler burning waste from a chemical process to raise steam for use in the process. The boiler would be required whether or not it burns the waste, and therefore the primary purpose is raising steam. Disposal of the process waste or recovering energy from it is secondary.

The definition of incineration plant covers the entire plant including all incineration lines, waste reception, storage, on site pre-treatment facilities, waste-, fuel- and air-supply systems, boiler, facilities for the treatment of exhaust gases, on-site facilities for treatment or storage of residues and waste water, stack devices and systems for controlling incineration operations, recording and monitoring incineration conditions. Because of this definition, most incineration plants do not have directly associated activities.

All incineration and co-incineration plants must comply with the Waste Incineration Directive (WID) with the following exclusions.

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(a) plant treating only the following wastes—
  - (i) vegetable waste from agriculture and forestry,
  - (ii) vegetable waste from the food processing industry, if the heat generated is recovered,
  - (iii) fibrous vegetable waste from virgin pulp production and from production of paper from pulp, if it is co-incinerated at the place of production and the heat generated is recovered,
  - (iv) wood waste with the exception of wood waste which may contain halogenated organic compounds or heavy metals as a result of treatment with wood-preservatives or coating, and which includes in particular such wood waste originating from construction and demolition waste,
  - (v) cork waste,
  - (vi) radioactive waste,
  - (vii) animal carcasses as regulated by Regulation (EC) No 1774/2002 of the European Parliament and of the Council of 3 October 2002 laying down health rules concerning animal by-products not intended for human consumption, or
  - (viii) waste resulting from the exploration for, and the exploitation of, oil and gas resources from off-shore installations and incinerated on board the installation; and

(b) an experimental plant used for research, development and testing in order to improve the incineration process and which treats less than 50 tonnes of waste per year;

This guidance is intended for incineration processes, whose primary purpose is the burning of waste.

If you operate a co-incineration process whose primary purpose is the generation of energy or production of material products, some of the information in this guidance may also be applicable. However, BAT for your process is defined in the sector specific guidance applicable to the primary purpose of it, and you should compare your techniques against those described in that sector guidance.

Guidance produced by Defra, "Environmental Permitting Guidance. The Directive on the Incineration of Waste", may be useful to you in understanding how WID applies in such situations (See http://www.defra.gov.uk/environment/epp/documents/wid-guidance.pdf). The Agency has also produced a Supplemental Technical Guidance Note on the requirements of WID for co-incineration plant, including combustion plant and cement and lime kilns. Link reference to web.

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Key Issues

The key issues are:

Environmental impact

Unless your installation is an excluded plant or a plant which burns only halogenated gases, you must comply with the requirements of the Waste Incineration Directive.

The most significant environmental impacts are likely to be on ground level air quality and global warming, which you should address particularly in your assessment of environmental impact.

Planning issues

The siting of Waste Incinerators is controlled under the Land Use Planning regime by the Planning Authorities (Local Authorities). The Planning Authorities are likely to give permission for new incinerators only as part of a wider scheme which is consistent with the Government's Strategy for Waste Disposal, which includes among its objectives the recovery of materials in preference to incineration. Schemes could include, as appropriate, kerbside recycle collection, municipal recycling facilities and composting. While the siting issue is not directly relevant to the determination of an environmental permit Application or the issue of a Permit, the Regulator and Local Authority are both Statutory Consultees on each other's determination process, and information is exchanged between the two Competent Authorities. You should provide information under both regimes as early as possible and, where possible, over the same time frame. This will ease both of the determination processes in many cases.

One of the objectives of the Waste Incineration Directive (Article 4.2.(b)) is that "the heat generated during the incineration and co-incineration process is recovered as far as practicable e.g. through combined heat and power, the generation of process steam or district heating". As part of its consultation response to the Planning Application, the Agency will consider whether all opportunities to maximise energy recovery in the proposed location have been adequately considered.

Unlike many waste disposal facilities, it is not a requirement for the determination of an environmental permit Application for a Waste Incinerator that Planning Permission has been obtained from the Planning Authority.

Feedstock composition

Many wastes vary in terms of physical and chemical composition. The nature of the waste to be treated is an important factor in determining what is BAT for an individual installation. In some cases it may be necessary for you to restrict the wastes types burned or pre-treat the waste feed in order to prevent short-term breaches of emission limits.

Residues handling and disposal

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The purpose of an incinerator is to maximise the safe destruction of waste and to minimise the production of residues in terms of their quantity and harmfulness. The nature of the wastes treated and the throughput dictate the quantities of residues produced. Residues are typically in the form of grate or bottom ash, fly ash, and residues from the air pollution control (APC) equipment. In some plants the fly ash and APC residues are combined. All of these ashes have the potential to be difficult to handle on account of their physical characteristics and some may be classed as hazardous wastes (e.g. APC residues). You must make adequate provision for the on-site management of these residues.

European legislation

The Waste Incineration Directive (WID, 2000/76/EC) implemented by the Waste Incineration Regulations (S.I. 2002 No. 2980), applies to the majority of Installations. Defra has produced "Guidance on: Directive 2000/76/EC on the Incineration of Waste" which describes the scope of the Waste Incineration Directive, how it is implemented in England and Wales and what the main duties of the operator and the regulator are. The standards set out in this guidance take direct account of the Directive and the Defra Guidance (as well as other relevant legislation). Interpretation of the Directive is complex and we recommend that you discuss this with us well before an application is submitted.

You will need to comply with WID when thinking about the following aspects of your installation:

- waste reception
- feedstock composition
- waste charging
- furnace types and requirements
- combustion conditions
- dump stacks and bypasses
- cooling systems
- boiler design
- emissions to air, waster, sewer, groundwater and land
- odour
- monitoring and reporting of emissions
- emissions benchmarks
- residues handling and disposal.

Information you must include in your application for a permit

When you make an application for a permit, you must include explicit answers to the following questions in addition to the information required to demonstrate BAT etc.

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Describe how the plant is designed, equipped and will be operated to ensure that the requirements of Council Directive 2000/76/EC on the incineration of waste are met, taking into account the categories of waste to be incinerated

1. Does the installation contain more than one incineration line? Identify with a brief reference (e.g. L1, L2 etc) and provide a brief description (e.g. fixed hearth, chain grate) of each line.
2. State the maximum design capacity (in tonnes/hour) for waste incineration for each line, and the maximum total incineration capacity (in tonnes/hour) of the plant.
3. Are any of the wastes you treat hazardous waste for WID purposes?

   (For the purposes of WID, Hazardous Waste means any solid or liquid waste as defined in Article 1(4) of Council Directive 91/689/EEC of 12 December 1991 on Hazardous Waste, with the exception of:

   - Combustible liquid wastes including waste oils as defined in Article 1 of Council Directive 75/439/EEC of 16th June 1975 on the disposal of waste oils provided that they meet the following criteria:
     - the mass content of polychlorinated aromatic hydrocarbons (e.g. PCB, PCP) amounts to concentrations not higher than those set out in relevant Community legislation
     - the wastes are not rendered hazardous by virtue of containing other constituents listed in Annex II to Directive 91/689/EEC in quantities or in concentrations which are inconsistent with the achievement of the objectives set out in Article 4 of Directive 75/442/EEC, and
     - the net calorific value amounts to at least 30MJ per kilogram.
   - Any combustible liquid wastes which cannot cause, in the flue gas directly resulting from their combustion, emissions other than those from gasoil as defined in Article 1(1) of Directive 93/12/EEC or a higher concentration of emissions than those resulting from the combustion of gasoil as so defined.)
4. For each line, provide the following information:

   a. Is the operating temperature of the plant, after the last injection of combustion air, 1100°C for hazardous waste with greater than 1% halogenated hydrocarbons expressed as chlorine, or 850°C for all other wastes?

   b. If the operating temperature is below 1100°C for incineration of hazardous waste with greater than 1% halogenated hydrocarbons

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expressed as chlorine, or below 850°C for all other wastes, you must request a derogation under WID Article 6(4) with a justification that the operation will not lead to the production of more residues or residues with a higher content of organic pollutants than could be expected if operation was according to WID conditions.

c. State the residence time of gas at the operating temperature given above. Is it less than 2 seconds?

d. Where the residence time is less than 2 seconds, you must request a derogation under WID Article 6(4) with a justification that the operation will not lead to the production of more residues or residues with a higher content of organic pollutants than could be expected if operation was according to WID conditions.

e. Describe the technique that will be used to verify the gas residence time and the minimum operating temperature given, both under normal operation and under the most unfavourable operating conditions anticipated, in accordance with WID Article 6 (4).

f. Describe where the temperature in the combustion chamber will be measured with a demonstration that it is representative in accordance with WID Article 6(1).

5. For each line, describe the automatic system to prevent waste feed under the following circumstances:

   a. during start-up;

   b. when continuous emission monitors show that an emission limit value (ELV) is exceeded due to disturbances or failures of the abatement equipment;

   c. whenever the combustion chamber temperature has fallen below a set value.

   You must show that you comply with WID Article 6 (3) and 6 (4).

6. State the temperature set point at which waste feed is prevented. It must be at least the temperature specified in WID (1100°C for hazardous waste with greater than 1% halogenated hydrocarbons expressed as chlorine, or 850°C for all other wastes) or an alternative temperature as allowed by WID Article 6(4) in which case the applicant should demonstrate how WID Article 6(4)'s requirements are met.

7. Does the plant use oxygen enrichment in the incineration combustion gas? If it does, specify the oxygen concentration in the primary air and secondary air (% oxygen). This is required to enable us to specify standards for measurement as required in Article 11 (8)

8. Does each line of the plant have at least one auxiliary burner controlled to

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switch on automatically whenever the furnace temperature drops below a set value in accordance with the requirements of WID Article 6 (1)? If the set value is not at least the temperature specified in WID (1100°C for hazardous waste with greater than 1% halogenated hydrocarbons expressed as chlorine, or 850°C for all other wastes), justify how operating at this lower temperature will not lead to the production or more residues or residues with a higher organic pollutant content as required by WID Article 6 (4)?

9. Which fuel type is used during start-up/shut-down? If it is not natural gas, LPG or light fuel oil/gasoil, provide evidence that it will not give rise to higher emissions than burning one of those fuels, as specified by WID Article 6 (1)

10. Are pre-treatment methods required to ensure that the quality standard for Total Organic Carbon (TOC) content or Loss on Ignition (LOI) of the bottom ash or slag is achieved? If they are, describe them. (WID Article 6 (1))

11. If any line of the plant uses fluidised bed technology, do you wish to request a derogation of the CO WID ELV to a maximum of 100 mg/m^3 as an hourly average, as provided for in WID Annex V (e)? If you do, you must provide a justification.

12. For each type of waste to be burned, provide the following information
    a. Waste reference (e.g. WT1, WT2 etc)
    b. Waste description (e.g. chemical/physical description, trade name and firing locations)
    c. EWC classification number
    d. Maximum and minimum annual disposal in tonnes
    e. State whether it is hazardous waste for the purposes of WID and if it is, provide the following information:
        i. the hazardous waste category (H1 – 14);
        ii. the names and maximum concentrations in grams/tonne of the specified substances that cause it to be hazardous. This should include at least PCB, PCP, chlorine, fluorine, sulphur and heavy metals if these are present;
        iii. whether it is waste oil, as defined in Article 1 of Council Directive 75/439/EEC (WID Article 3 (2));
        iv. The waste composition, expressed as tabulated below

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Substance	% by weight of the waste (dry basis)
Carbon	
Hydrogen	
Nitrogen	
Sulphur	
Oxygen	
Balance	

v. Is the balance of the waste composition more than 10%? If it is, give details of the waste components and quantities likely to be present in the balance.

vi. Provide calorific value (CV) and feed rate details for the waste (WID Article 4)

Minimum CV (MJ/kg)		Maximum CV (MJ/kg)		Design feed rate (kg/hr)	
Net	Gross	Net	Gross	Min.	Max.

Hazardous wastes incineration

13. Is any fraction of the hazardous waste generated by the installation of which the incinerator is a part? For hazardous wastes which fall into this category, you may request a derogation from the requirement to comply with the requirements in sections 14) - 16) below by virtue of Article 5(5) of the Directive.

14. Describe how you ensure that information about the mass of waste (as categorised by the European Waste Catalogue (EWC)) to be delivered, is available before it is received? (WID Article 5 (2))

15. How do you ensure that the requirements of WID Article 5(3) as listed below are satisfied before the hazardous waste streams identified are delivered?

    - hazardous waste consignment notes have been provided
    - the physical and chemical characterisation of the waste show that the waste is suitable for treatment at the plant
    - the hazardous characteristics of the waste are sufficiently known to enable safe handling and safe blending/mixing where appropriate.

16. Do you take representative samples from the hazardous waste streams? If not, provide justification or alternatives (e.g. for clinical waste safety hazards may limit access to the waste stream however the waste acceptance/pre-acceptance procedures from EPR SGN S5.07 on Clinical Waste Management provide robust alternatives). (WID Article 5(4) (b))

17. What is the retention period of samples after incineration of the batch

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has been completed? Minimum is 1 month. (WID Article 5(4) (b))

18. Do you incinerate H9 (as defined in Annex III of the Hazardous Waste Directive) infectious clinical waste?

19. If you incinerate H9 infectious clinical waste, will the material go straight from storage into the furnace without being mixed with other categories of waste and without direct handling during loading of the furnace as required by WID (Article 6 (7))?

Emissions to surface water and sewer

20. If the technique by which you clean the exhaust gas from the incinerator generates waste water, you must give details of the waste water treatment process and demonstrate that you comply with the requirements of WID Annex IV and Articles 8(4) and 8(5). In particular, if you mix waste waters from your exhaust gas treatment with other waste waters prior to treatment, monitoring or discharge, you must demonstrate how you apply the mass balance requirements referred to in Articles 8(4) and 8(5) to ensure that you derive a valid measurement of the emission in the waste water.

21. Describe your storage arrangements for contaminated rainwater run-off, water contaminated through spillages and water arising from fire-fighting operations. Demonstrate that the storage capacity is adequate to ensure that such waters can be tested and, if necessary, treated before discharge. (WID Article 8 (7))

22. For each emission point, give benchmark data for the main chemical constituents of the emissions under both normal operating conditions and the effect of possible emergency conditions. In this section we require further information on how you monitor the pollutants in these emissions. You must provide information for flow rate, pH, and temperature. Article 8 of WID requires that wastewater from the cleaning of exhaust gases from incineration plant shall meet the ELVs for the metals and dioxins and furans referred to in Annex IV of WID. Where the waste water from the cleaning of exhaust gases in mixed with other waters either on or offsite the ELVs in Annex IV must be applied to the waste water from the cleaning of exhaust gases proportion of the total flow by carrying out a mass balance. Monitoring for other pollutants is dependant on the process and the pollutants you have identified in response to the question.

23. For each parameter you must define

- the emission point
- the monitoring frequency
- the monitoring method
- whether the equipment/sampling/lab is MCERTS certified

- the measurement uncertainty of the proposed methods and the resultant overall uncertainty
- procedures in place to monitor drift correction
- calibration intervals and methods
- accreditation held by samplers or details of the people used and their training/competencies

24. Describe any different monitoring that you will carry out during commissioning of new plant.

25. Describe any different arrangements during start-up and shut-down.

26. Provide any additional information on monitoring and reporting of emissions to water or sewer.

Waste recovery/disposal

27. How do you deal with the residue from the incineration plant? Explain how you minimise, recover, recycle and dispose of it.

Continuous emission monitor performance

28. How do you intend to manage the continuous measurement system to satisfy WID Article 11 (11)? WID Article 11 allows a valid daily average to be obtained only if no more than

    - 5 half-hourly averages, and
    - 10 daily averages per calendar year

    during the day are discarded due to malfunction or maintenance of the continuous measurement system. Give details of how calibration, maintenance and failure of the continuous measurement system will be managed in order to satisfy these limitations. If necessary distinguish between different incineration lines.

29. Give details of how you define when start-up ends and shut-down begins. Describe any different arrangements for monitoring during start up or shut down. Note that the emission limit values specified for compliance with WID do not apply during start-up or shut-down when no waste is being burned. Explain how you will integrate these periods into the emissions monitoring system in such a way that the reportable averages are calculated between these times, but the raw monitoring data remains available for inspection. (WID Article 11(11)). If necessary distinguish between different incineration lines.

30. Describe each type of unavoidable stoppage, disturbance or failure of the abatement plant or continuous emission monitoring system during which plant operation will continue. State the maximum time anticipated before shut-down is initiated for each of these types of unavoidable stoppage.

31. Will the values of the 95% confidence intervals of a single measured value of the daily emission limit value, exceed the percentages of the emission limit values required by WID Article 11(11)

and Annex III. point 3, as tabulated below? (We will accept that MCERTS certified instruments satisfy these quality requirements)

Substance	Percentage of the emission limit value required by WID
Carbon monoxide	10%
Sulphur dioxide	20%
Nitrogen dioxide	20%
Total particulate	30%
Total organic carbon	30%
Hydrogen chloride	40%
Hydrogen fluoride	40%

32. Describe the monitoring of process variables, using the format tabulated below. For emissions to air, include at least the arrangements for monitoring oxygen content, temperature, pressure and water vapour content at the points where emissions to air will be monitored (WID Article 11 (7)). For emissions of waste water from the cleaning of exhaust gases include at least the arrangements for monitoring pH, temperature and flow rate (WID Article 8 (6)).

Incineration line	Process variable	Describe the monitoring that is proposed

Describe how the heat generated during the incineration and co-incineration process is recovered as far as practicable, for example through combined heat and power, the generating of process steam or district heating.

33. You must assess the potential for heat recovery from each line, using the guidance in this Sector Guidance Note. You must justify any failure to recover the maximum amount of heat.

34. ***Describe how you will minimise the amount and harmfulness of residues and describe how they will be recycled where this is appropriate.***

35. For each significant waste that you dispose of, provide the following information

- incineration line identifier
- residue type reference (e.g. RT1, RT2 etc)
- source of the residue

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- description of the residue
- details of transport and intermediate storage of dry residues in the form of dust (e.g. boiler ash or dry residues from the treatment of combustion gases from the incineration of waste). Article 9 of WID requires operators of incineration plant to prevent the dispersal in the environment in the form of dust.
- details of the total soluble fraction, and soluble heavy metal fraction of the residues. Article 9 of WID requires operators of incineration plant to establish the physical and chemical characteristics and polluting potential of incineration residues.
- the route by which the residue will leave the installation – e.g. recycling, recovery, disposal to landfill, other.

36. Article 6(1) of WID requires incinerators to be operated in order to achieve a level of incineration such that the slag and bottom ashes have a total organic carbon (TOC) content of less than 3%, or their loss on ignition (LOI) is less than 5% of the dry weight of the material.

Where the incinerator includes a pyrolysis stage or other stage in which part of the organic content is converted to elemental carbon, the portion of TOC which is elemental carbon may be subtracted from the measured TOC value before comparison with the 3% maximum, as specified in the Defra Guidance on the Waste Incineration Directive. Note that WID Article 6(1) requirements are complied with if either TOC or the LOI measurement referred to below is achieved.

TOC: for waste incinerators, 3% as maximum as specified by WID Article 6(1).

LOI: for waste incinerators, 5% maximum as specified by WID Article 6(1).

Specify whether you intend to use total organic carbon (TOC) or loss on ignition (LOI) monitoring of your bottom ash or slag.

1

Managing your activities

Accident management

1. Managing your activities

1.1 Accident management

Table 1.1 below lists some of the possible accidents that you should consider, although you should not limit yourself to this list.

Table 1.1

Aspect	Consequence of release	Controls
Waste storage failure	Litter Contaminated land	Secure storage Containment e.g. sealed floors
Incoming waste or raw material handling/storage failure	Spillage Overfilling Putrefaction, leading to odours and/or fire risk	Bund storage tanks correctly Use high level alarms Incoming waste mixing and rapid processing, and a fire detection and sprinkler system.
Waste charging failure	Combustion conditions upset Releases to air (e.g. CO)	Charging design/maintenance Waste inspection
Furnace control failure	Combustion conditions upset Possible release to air Possible plant shut down	Waste feed quality control Maintenance of air systems Effective use of monitoring to control combustion conditions
Residues handling/storage failure	Contaminated land Damage to aquatic systems Possible releases to air	Secure storage Controlled or contained drainage
Air pollution control equipment failure caused by e.g. • power failure • reagent shortage • blockage • damage to equipment	Release of untreated combustion gases to air, and plant shutdown.	Waste feed quality control Emergency power for fans / pumps Low level reagent alarms Pump maintenance Standby equipment provision (e.g. multiple smaller feed systems) Key parameter monitoring e.g. filter pressure drop

Accident management
Energy efficiency

Indicative BAT

Within this sector, particular care should be given to the following:

Abnormal operating conditions

1. Abnormal releases are covered by Article 13 of WID.
2. Standard permit conditions ensure that these requirements are implemented and that they reflect BAT.

1.2 Energy efficiency

Indicative BAT

The following should be used in this sector:

Energy efficiency techniques

1. The following techniques may reduce energy consumption or increase energy recovery and thereby reduce both direct (heat and emissions from on-site generation) and indirect (emissions from a remote power station) emissions. The extent of their use should be justified in your application.
    - use of the heat generated for electricity generation for on-site or off-site use is expected for the majority of new installations. At existing plant the capital expenditure and logistics (e.g. availability of an outlet for the electricity generated) may remain prohibitive
    - use of higher efficiency electrical generation technology e.g. gas turbines or engines
    - use of steam from boilers in on-site or off-site applications
    - use of waste heat for CHP or district heating (potential to increase overall thermal efficiencies from approx. 20% to 75%)
    - use of waste heat for preheating combustion air, boiler feed water or plume reheat
    - effective furnace insulation and construction to retain heat e.g. refractory linings
    - maintaining steady plant capacity to prevent downtime e.g. through provision of supplementary firing with primary fuel, or waste pre-treatment
    - the use of flue gas re-circulation (primarily for NOx reduction) may have the additional benefit of increasing plant energy efficiency
    - effective maintenance of heat exchangers to maintain high heat transfer
    - prevention of uncontrolled air ingress by providing and maintaining seals
    - ensuring plant layout avoids pumping and heavy transfer where possible
    - use of ion exchange instead of high pressure membrane filtration for boiler (and other water) treatment.

Energy efficiency

2. Irrespective of whether a Climate Change Agreement or Trading Agreement is in place, where there are other BAT considerations involved, such as:
    - the choice of fuel impacts upon emissions other than carbon e.g. sulphur in fuel
    - where the potential minimisation of waste emissions by recovery of energy from waste conflicts with energy efficiency requirements
    - where the nature of the waste is such that the primary concern of safe waste disposal may be jeopardised by additional energy recovery (e.g. the need for rapid cooling to prevent *de novo* dioxin generation)
3. You should provide justification that the proposed or current situation represents BAT.

Sub-sector specific issues

4. **Municipal waste incineration**
    - Steam should be generated either for direct use or for electricity generation.
    - Where electricity only is generated, 5-9MW of electricity should be recoverable per 100,000 tonnes of annual waste throughput depending on waste composition.
    - Waste heat should be recovered unless to do so can be demonstrated not to represent BAT (this will require cost justification). All opportunities for CHP and district heating should be explored.
    - The siting of plant near to potential or actual energy users will aid the maximisation of recovery potential. Consideration should be given to joint venture projects wherever possible.
    - If waste heat is not recovered, provision should be made for future installation e.g. the provision of tie-ins.
5. **Hazardous waste incineration**
    - There are likely to be opportunities for internal energy saving using combustion generated heat via exchange systems e.g. to re-heat gases.
    - The incineration of higher concentrations of halogenated or highly thermally stable wastes or highly variable waste streams will be able to justify lower levels of energy recovery on the grounds that safe incineration is the primary purpose. Indeed proposals to recover energy from such wastes will need to demonstrate that this will not give rise to higher levels of polluting emissions by compromising the use of the correct temperature windows.
    - Consistent high CV waste streams offer significant energy recovery potential that should be maximised. This may involve steam or electricity generation and is particularly likely to be worthy of consideration where high quantities are incinerated.
    - Where the installation is situated on or near other potential energy users there may be possibilities for provision of process steam or heating.

Energy efficiency

6. **Clinical waste incineration**
   - Installations will generally be expected to generate steam for local use or electricity generation.
   - Lack of 24 hour operation in some cases may mean the revenues for export schemes will be less favourable.
   - Where hazardous wastes are incinerated, the issues relating to safe destruction made above for hazardous waste incinerators (HWIs) should be considered.
7. **Sewage sludge incineration**
   - There appears to be considerable scope for energy recovery by means of electricity generation and heat provision at sewage sludge incineration sites owing to:
     – the high CV of some (dried) sewage sludges
     – the likelihood in many cases of a consistent feedstock
     – high demand for electrical power for pumping operations at the treatment works
     – potential use of heat for process heating
     – land availability for integrated systems and CHP (e.g. gas from anaerobic digesters may be used as a fuel, balanced with natural gas integrating with post steam turbine incinerator waste heat)
   - There may be energy recovery gains to be made from using pyrolysis or gasification if high efficiency electricity generating equipment can be utilised (and emission limits met).
8. **Animal remains and animal carcass incineration**
   - Lack of 24 hour operation in some cases may mean the revenues for exportation schemes will be less favourable and energy recovery may not be economic.
   - Rural locations may make it more difficult to find energy outlets.
9. **Refuse derived fuel installations**
   - Levels of energy efficiency are expected to be the high for the sector because the relatively consistent fuel should provide stable operational conditions.
   - Electricity generation is anticipated in all cases (and / or steam raising).
   - Integration with other energy users is expected for all new installations.
10. **Pyrolysis and gasification installations**
    - Installations may be able to increase electrical generation through the use of gas turbine or engine generation technology (provided emission limits can be met):
      – All products (solid chars, oils and fuel gas), which will not be used as a primary product (rather than a fuel) should have their energy potential maximised by combustion.

Efficient use of raw materials and water

1.3 Efficient use of raw materials and water

Raw materials

The choice of raw materials is an opportunity to control emissions at source. In this regard we suggest that you closely examine the whole range of possible raw materials that you might use.

The principal raw materials that may be consumed (excluding waste feed) in the incineration sector are:

- Lime – calcium hydroxide ($Ca(OH)_2$) – reagent for gas treatment
- Limestone, dolomite, calcium oxide, spongiacal lime – reagents for gas treatment
- Sodium bicarbonate ($NaHCO_3$) – reagent for gas treatment
- Sodium hydroxide (NaOH) – reagent for gas treatment
- Water- make up for neutralisation reagents / boiler water / cooling towers;
- Urea or ammonia – reagent for NOx reduction
- Activated carbon, carbon filters, lignite and clays to adsorb dioxins and heavy metals.
- Catalysts –- where SCR is used; or in catalytic bag filters
- Water treatment chemicals – for boiler water conditioning
- Effluent treatment plant chemicals – mainly acids and alkalis for pH balancing and precipitation;
- Fuels – either gas or fuel oil for start up and temperature stabilisation
- Biocides – to reduce fouling in direct cooling systems and for biological safety in cooling water.
- MgSi – additive to reduce corrosion

Efficient use of raw materials and water

Some considerations for raw material choice are listed below in Table 1.2

Table 1.2 Considerations when choosing raw materials

Raw material	Selection criteria
Alkaline reagents	• Low concentrations of persistent pollutants in the reagent itself e.g. metals. • High pollutant absorption efficiency is required. • Low waste production i.e. low concentrations of unused reagent in waste. • Possibility to recycle to decrease waste production.
Activated carbon	• Low concentrations of persistent pollutants e.g. metals. • High porosity to enhance absorption efficiency. • Care required when changing supplier / source is required as absorption characteristics may change.
Sodium hydroxide	• Only "low mercury" NaOH should be used.
Support fuels	• Support fuels shall not give rise to higher emissions than burning gas oil, liquefied gas or natural gas. • All uses of support fuel other than natural gas will require justification.
Dispersants/surfactants	• Only chemicals with high biodegradability and known degradation products should be used. • Alkylphenolethoxylates should be avoided.
Biocides	• Only chemicals with high biodegradability and known degradation products should be used. • Environmental assessment should consider site specific nature of receiving waters before deciding on material suitability e.g. saline or freshwater environments.

Efficient use of raw materials and water

Indicative BAT

1. You must identify and consider how the waste that you burn may vary, in terms of likely composition, handling and combustion characteristics. You will need to define the issues covered by Article 5 of WID unless we have granted you an exemption because you are burning your own waste at the place where that waste was generated.
2. You should demonstrate that your plant has been designed and will be managed and operated so that you account for the heterogeneity of the waste. Operational plant will be able to demonstrate this by reference to actual plant data for emissions and other operational parameters. New plant may be able to make reference to the performance of other operational plant of the same design but must consider the possibility of local variations in waste character, plant modifications and management.

Feedstock homogeneity

3. Improving feedstock homogeneity can minimise residues by improving operational stability throughout the installation. This will in turn lead to improved ability to optimise operational and environmental performance and reduce the amount of reagents used and wastes produced.
4. You should consider the following techniques for improving feedstock heterogeneity:
    - upstream waste management
    - procedures for removal of problem wastes
    - on or off site waste treatment/mixing

Furnace conditions

5. The prime purpose of incineration is to thermally treat wastes in order to minimise the amount and harmfulness of the residues arising for further disposal. Good combustion conditions with the correct temperature, residence time and sufficient turbulence are the key to securing this.
6. You should consider at least the following key techniques to minimise residue production:
    - burnout in the furnace should achieve less than 3% TOC (e.g. by improving waste agitation on the bed / burnout time and temperature exposure)
    - SNCR reagent dosing should be optimised to prevent ammonia slip to ash

Gas treatment conditions

7. Optimising alkaline (and other) reagent use will prevent the production of wastes (unused or contaminated) reagent.
8. You should consider at least the following techniques:
    - alkaline reagent recycle
    - wet scrubbing
    - optimisation of reagent dosing and reaction conditions

Efficient use of raw materials and water

Waste management

9. Mixing of wastes produced on site can cause contamination of a large amount of waste with a smaller amount such that it cannot be recovered or easily disposed of. You must ensure that the plant is designed to keep separate waste streams apart in order to facilitate their recovery or disposal. This must include at least:
   - storing air pollution control residues separately from bottom ash
   - considering whether to keep air pollution control residues separate from other fly ash residues collected in particulate abatement plant.

Water

Incinerators are not generally considered to be major users of water. Water use is not therefore a primary environmental concern although it is important to recognise that wet scrubbing and some cooling systems can consume more water. The minimisation of water consumption will however make a contribution to improving environmental performance of the installation, but should be considered on a case by case basis.

Major water uses in incineration plants are:

- gas scrubbing – particularly wet scrubbing
- ash discharge quench baths
- evaporation from wet cooling towers

Other uses include boiler water make up and wash down operations.

Indicative BAT

Water use

1. Dry scrubbing systems do not consume significant quantities of water, with only a little required for ash quench and conditioning.
2. Semi dry gas scrubbing typically consume 250-350Kg / tonne of waste incinerated.
3. Municipal waste incinerators (MWIs) using wet scrubbing can consume up to 850Kg / tonne of waste incinerated, although this should be reduced by scrubber liquor re-circulation. Where this is done, the clean water input must be made at the final (polishing) scrubber to prevent higher emissions to air. Systems with liquor treatment to remove pollutants use less water than simple bleed and top up systems.

Efficient use of raw materials and water

4. The nature of the wastes treated in HWIs means that higher levels of water consumption (up to 1100 Kg/tonne of waste) may be justified to ensure emissions to air are controlled. Multi-stage wet scrubbing systems provide lower water consumption by re-circulating the used stack end scrubber water to earlier scrubbing/quench stages. You can reduce evaporative water losses by cooling the final stage clean scrubber water, but you should ensure that stack exit temperatures are high enough to prevent a visible plume.
5. Most chemical waste incinerators (CWIs) employ dry scrubbing and therefore consume relatively little water.
6. There is little data available for other incineration plant types. In general the more variable the waste feed (e.g. drum incineration) the greater the justification for the use of wet scrubbing techniques that have higher levels of water consumption if they are not of the closed loop type.
7. In justifying any departures from these benchmarks the techniques described below should be taken into account. You should identify the constraints on reducing water use as this is usually installation-specific. With the majority of fresh water being used for gas scrubbing it will be important that you justify your choice of technique. In general the following may represent BAT with regard to water consumption (provided reagent use is similar and closed loop wet systems are not practicable):
   - MWIs –- dry or semi-dry scrubbing
   - HWIs –- wet scrubbing
   - CWIs –- dry or semi-dry scrubbing
8. Other incinerators will be assessed on a case by case basis and you are required to justify why lower water consumption techniques cannot be used (in order to minimise water consumption). The nature of the waste feed in terms of its composition and heterogeneity, the need to ensure emissions to air are controlled within emission limit values and the quantities of waste produced from the gas treatment are all factors that may justify the use of greater quantities of water. Closed loop effluent recycle systems may meet all of these criteria providing there is sufficient space and wet plumes are not an issue. Other prevention options such as waste pre-treatment (to improve homogeneity) or feed management (to remove or dilute high pollutant load items) should also be considered as these may reduce the need for water scrubbing systems.

Other techniques for reducing gross water use

9. Other techniques include:
   - In wet systems, the provision of multi-stage scrubbers in series:
     - with the effluents from the clean scrubbers used as feed for the dirty scrubber/ quench

Efficient use of raw materials and water

  - clean water feeds to final polishing/clean end scrubbers
  - dirty water bleeds only or primarily from dirty end scrubbing/quench stages
  - consider the possibility of scrubber liquor treatment and re-circulation
- In semi-dry systems, the quantity of water should be measured and minimised, but without compromising the ability of the abatement plant to treat stack gases effectively and meet emission limit values. The use of BAT requires you to demonstrate that you do not use too much water but you should not make reductions that could result in reagent handling (pumping) difficulties, or poor reagent reaction conditions (e.g. moisture, temperature or contact time).
- You can minimise both water and reagent use by using fast response monitors and feedback controls to link dose rates to up-stream HCl concentrations. You may also be able to reduce water consumption through the alteration of alkaline reagent concentration (rather than volumetric pumping rate changes). This will require very small mixing tanks in order to effect a sufficiently fast concentration change. Computer software will be required to automatically manage such systems.
- Water used in cleaning and washing down should be minimised by:
  - evaluating the scope for reusing washwater
  - trigger controls on all hoses, hand lances and washing equipment
- Fresh water should only be used for:
  - dilution of chemicals (e.g. for gas scrubbing media)
  - vacuum pump sealing (note, below, that this can be much reduced or even eliminated)
  - to make up for evaporative losses or for demineralisation plants

- Fresh water consumption should be directly measured and recorded regularly, typically on a daily basis.
- Specific points of fresh water use, circuit overflows and recycled water quality should be monitored, particularly the discharge to the effluent treatment plant (ETP).
- Water-sealed vacuum pumps may account for considerable water use and arrangements should be reviewed by considering improvements such as:
  - cascading seal water through high to low pressure pumps
  - by using modern designs with improved internal recirculation of water within the pump casing (up to 50% reduction)

PLUS

  - filtering and cooling seal water with a heat exchanger prior to re-use in the pumps (90% reduction potential), or

Efficient use of raw materials and water

- – filtering and cooling seal water with a cooling tower prior to re-use in the pumps (95% reduction potential), or
- – filtering and cooling seal water with injected fresh water prior to re-use in the pumps (65% reduction potential)

OR

- – recycling the hot seal water

- Any other cooling waters should be separated from contaminated process waters and reused wherever practicable, possibly after some form of treatment, e.g. re-cooling and screening.

Recycling of water

10. Consideration should be given to multiple uses of water to minimise consumption. This includes the re-use of scrubber effluents as a quench media (in HWIs) and the treatment of scrubber liquors for re-use.
11. Site drainage or roof water may be suitable for a wide variety of uses after even rudimentary treatment. Such uses range from on-site feed to toilet facilities, wash down water, quench or scrubber feed. You should demonstrate that such uses have been considered and justify the techniques selected and rejected.
12. In some cases effluent treatment produces good quality water which may be usable in the process directly or in a mixture with fresh water. When treated effluent quality can vary it can be recycled selectively, being used when the quality is adequate and discharged when the quality falls below that which the system can tolerate. You should confirm where you will use treated water from the ETP or justify why you do not.

Avoidance, recovery and disposal of wastes

1.4 Avoidance, recovery and disposal of wastes

In general the waste streams produced comprise:

- bottom ash (approx. 25% by weight and 10% by volume of input for a modern MWI)
- fly ash
- air pollution control residues (commonly combined with fly ash and then approx. 2.5% by weight of waste input for a modern MWI)
- rejected feedstock wastes (chemical or physical incompatibility e.g. large objects)
- recovered waste fractions e.g. steel and aluminium extracted from ash, or MRF recyclable materials

Indicative BAT

Bottom ash handling:

1. Where ash is handled dry, you must ensure that dust does not become airborne. This may be done by the quality of the containment and/or by dust suppression sprays. Dust suppression sprays should be limited to ensure they moisten and agglomerate the surface of the ash without leading to run-off or a leachate problem, and they should use recovered water where available.
2. Where handled wet, the ash should be held at an intermediate point to ensure that it is fully drained before it is transferred to skips or otherwise leaves the site, so that water will not drain off the ash either during transport or at final disposal. All water drained should be returned to the quench tank. Where installations have an ash hopper, the water should be pumped back. (This is less important where the ash is harmless enough to allow disposal on to the surface of land).
3. All ash transport containers should be covered.
4. Adequate cleaning equipment, such as a vacuum cleaner, should be provided and maintained, to clean up promptly any spilled ash. With clinical waste ash in particular any such vacuum cleaner should be fitted with an absolute filter. The dry sweeping of spillages is not acceptable.

Fly ash and APC residues:

5. These two wastes are commonly combined within the process and produced as a single stream. Segregation of these streams may allow the individual streams to be reused or recycled. Both present potential hazards that may be minimised through careful storage, handling and transportation, whether alone or in combination.

Avoidance, recovery and disposal of wastes

6. Fly ash should be stored and transported in a manner that prevents fugitive dust releases. During silo and container filling, displaced air should be ducted to suitable dust arrestment equipment. Apart from the minor use of dust suppression sprays (using recovered water where available), dry materials should be kept dry to avoid the formation of leachates. Dry residues for disposal should be handled in sealed containers such as tankers for large quantities, or FIBCs or "big-bags" (1 m^3) for smaller installations.
7. Ash recovered from the boiler ("boiler ash") will, depending on the design, have properties similar to either the bottom ash or fly ash. In most installations, a BAT judgement (taking into account ash properties and the layout of the installation) will be made as to whether the boiler ash should be combined with the bottom ash or fly ash.

Rejected feedstock

8. You should minimise the delivery of waste that cannot be processed at the facility (unless you have an appropriate license to permit the transfer of the waste). This will include up-stream waste management, provision of information regarding the types of waste acceptable and in some cases audit of waste suppliers' procedures.
9. Despite these efforts some unsuitable wastes will still be included and delivered to the installation. Techniques should therefore be adopted for the inspection of the waste. These techniques should reflect
   - the nature of the waste (including any potential additional hazards that might arise from waste inspection that may limit or prevent inspection)
   - the history of the particular installation in respect of loads and sources of loads which may require special attention
   - the ability of the installation to treat the waste and its operational design envelope (including any pre-treatment/waste mixing carried out)
10. Provision should be made for the safe storage of rejected loads in a designated area with contained drainage, preferably under cover. Procedures should be in place for dealing with such loads to ensure that they are safely stored and despatched for onward disposal. Storage times should be minimised.
11. Examples of loads which have caused difficulties at some plants have included:
    - large quantities of PVC window frames (high HCl loading)
    - large quantities of plaster board (high sulphur loading)
    - large quantities of excessively wet waste (high moisture, low CV)
    - large quantities of iodine or mercury (particularly at HWIs)
    - some wastes containing wire which may jam loading systems or grates e.g. whole tyres, sprung mattresses or sofas
    - large wastes that are not suited to incineration e.g. engine blocks

Avoidance, recovery and disposal of wastes

Recovered waste fractions

12. Provision should be made for the storage of all recovered fractions. The storage provided should take account of the general guidance given in this section.
13. Because ash will often be the major waste produced, you should consider potential uses e.g.
    - opportunities for bottom ash recycling e.g. bottom ash use as aggregate
    - opportunities for fly ash re-use e.g. as a neutralising agent (great care must be taken to avoid remobilisation of pollutants)
14. You must regularly audit your waste disposal/recovery routes to ensure your waste is being properly dealt with.
15. Where disposal occurs, you should justify why recovery is technically or economically not feasible.
16. Where waste must be disposed of, you should provide a detailed assessment identifying the best environmental options for waste disposal - unless we agree that this is unnecessary. For existing disposal activities, this assessment may be carried out as an improvement condition to a timescale to be approved by us.

2

Operations

Incoming waste and raw material management

2. Operations

2.1 Incoming waste and raw material management

This section deals with the techniques required to manage incoming waste effectively. This includes:

- securing the suitability of the waste to be accepted before it is delivered
- management of the waste on the site
- the use of pre-treatment

Indicative BAT

All installations

1. Pre-treat waste to the degree necessary to reduce variations in feed composition and to control emissions within ELVs and to prevent unnecessary waste production.
2. Maintain a high standard of housekeeping in all areas and provide and maintain suitable equipment to clean up spilled materials.
3. You should only load and unload vehicles in designated areas provided with proper hard standing. Such areas should have appropriate falls to an adequate drainage system.
4. Store uncontained or potentially odorous waste inside buildings with suitable odour control e.g. negative pressure created by feeding combustion air, automatic or restricted size doorways.
5. Provide fire fighting in accordance with the requirements of Local Fire Officers, especially for MWI reception bunkers, CWI storage and for chemical wastes.
6. You should store fuels and treatment chemicals in tanks or silos, unless they are supplied in drums. If there is any risk of fugitive emissions the tanks/silos should be provided with closed loop vapour systems and or scrubbers (for liquids), or fabric filters (for powders or materials that may give rise to dust).
7. Provide roofing and drainage segregation to minimise contamination of rainwater. Provide storage capacity for contaminated rainwater to allow for sampling and testing prior to release (see also WID article 8(7)).

Municipal

8. We will regard your techniques for the delivery and reception of waste as BAT if you comply with all legislative requirements. There are specific requirements in respect of checking statutory documentation and a general duty to "take all necessary precautions". Your procedures and management system must enable you identify and manage the risks associated with the reception of wastes.

Incoming waste and raw material management

9. Incoming municipal waste should be:
    - in covered vehicles or containers
    - unloaded into enclosed reception bunkers or sorting areas with odour control (see below).
10. Use design and handling procedures to avoid any dispersal of litter.
11. Use techniques to maximise the homogeneity of waste fed to the incinerator.
12. Your inspection procedures must ensure that any wastes which would prevent the incinerator from operating in compliance with its permit are segregated and placed in a designated storage area pending removal.
13. Waste may then be transferred to the feed chute e.g. by a grab crane.
14. Where the waste is not pre-treated or sorted, use smaller grab sizes on a more frequent basis to allow for greater waste inspection.
15. Operate low volume water fog sprays above the storage bunkers if you need to control dust emission. Minimise liquid run-off and wash down from the storage and handling areas and use them in the process, such as in the ash quench, wherever possible.
16. To minimise odour:
    - provide self-closing doors for any potentially odorous indoor areas
    - ventilate bunkers and use the extracted air as a source of furnace combustion air
    - during shutdown, particularly where there is only one furnace, doors will limit odour spread while still allowing vehicle access. Air should be extracted via a separate system
    - treat extracted air which is not incinerated if odours cause local complaints
    - where there is a recycling facility before the incinerator, you should give careful attention to building sealing arrangements at the design stage, so that the volume of odorous air needing extraction will not exceed the furnace requirements
    - employ bunker management procedures (mixing and periodic emptying and cleaning) to avoid the development of anaerobic conditions
    - remove wastes on a first in, first out basis so as not to exceed a specified maximum storage time (e.g. 4 days or less if problems arise)
    - divert waste away from the site during shut downs if odour management is not effective
    - generally, multiple stream plants are preferred to large single stream plants to provide continuity of odour control and waste movement
    - the quantity of incoming waste being stored should be limited to the permitted limit, and must be confined to the designated areas.

Incoming waste and raw material management

Pre-treatment

17. Remove large bulky items. The extraction of recyclable material and shredding of the remaining waste might be justified although this may be carried out prior to delivery to the installation. Such pre-treatment can help ensure a more consistent feed to the furnace aiding good process control and preventing emissions.
18. A particle size reduction system may be essential for controlled operation of **fluidised bed incinerators**. However, there have been reports of significant operational problems (including high maintenance costs and fires) with front-end **materials recycling facilities** (MRFs) handling raw mixed municipal waste. You will be need to demonstrate that the proposed pre-treatment system represents BAT for the particular installation.
19. Decisions regarding the need for and extent of waste treatment at municipal waste incinerators should take account of the wider waste strategy adopted in the locality as this will influence the composition of the waste delivered. For example, where removal of recyclable materials is being carried out within the waste catchment area (as demonstrated by recycling performance or facility provision) incineration without further front end MRF or shredding may be justifiable as BAT for the remaining waste, provided statutory emission limit values can be secured and the additional environmental gains are outweighed by the costs.

Chemical

20. Article 5 of the Waste Incineration Directive imposes both specific requirements for the delivery and reception of waste, and a general duty to “take all necessary precautions”. You must have procedures and a management system that satisfy these requirements.
21. In particular, you must have sufficient information prior to receiving the waste to ensure that it can be either
    - safely offloaded for safe storage and further characterisation prior to incineration or pre-treatment, or
    - incinerated without need for further characterisation (i.e. the description is already sufficiently detailed given the nature and source of the waste and the intended treatment)
22. You should consider odour risks (e.g. mercaptans, thiols, amines) and, where appropriate, use dedicated “high odour” routes with closed loop or vents fitted with odour abatement.
23. You should hold liquids or sludges in a buffer store until you have analysed them. The checks should ensure that they are compatible with waste already in any bulk storage tanks where it will be stored.

Incoming waste and raw material management

24. If you operate a **merchant incinerator**, you should have systems that:
    - ensure that waste arrives with information covering:
        - its physical and chemical composition
        - any other information necessary to assess its suitability for incineration
        - its hazard characteristics
        - substances with which it cannot be mixed, and
        - handling precautions
    - confirm the information by:
        - checking that the quantity is as declared by the consignor
        - documentation checks, and
        - sampling where appropriate. Samples should be kept for at least 1 month after incineration. Small scale compatibility tests are normally carried out with a sample of the contents of the receiving tank to ensure that there are no reactions which lead to heat release, gassing or other undesirable consequences.
25. If you operate an **in-house incinerator** you should have procedures that give the same level of protection. In particular, where non hazardous waste is being burned, your procedures must ensure that only the permitted wastes are burned.
26. Some hazardous wastes are very heterogeneous and blending or pre-treatment may be necessary. You should operate procedures to ensure that waste is treated / blended to give the most constant combustion conditions possible.
27. Storage and handling must meet the BAT requirements for avoiding fugitive emissions.
28. Drummed waste should:
    - be stored in areas protected from heat and direct sunlight, preferably under cover
    - be stored on an impervious surface which has an adequate fall to a collection sump
    - not be stored more than 2 rows high
    - be analysed and emptied as soon as practicable
    - be subject to routine procedures for checking the condition of drums and pallets
    - air from drum storage opening/transfer points should be treated as for tank vapours above
    - containers which have been emptied should be stored and disposed of without giving rise to emissions to atmosphere and odours.
29. The site preventative maintenance programme should include assessment of all waste handling equipment to prevent fugitive odour (or other) releases; e.g. seals on pumps, valves and flanges etc.

Incoming waste and raw material management

Clinical

30. Article 5 of the Waste Incineration Directive imposes both specific requirements for the delivery and reception of waste, and a general duty to “take all necessary precautions”. You must have procedures and a management system that satisfy these requirements.
31. Procedures for waste acceptance, pre-acceptance and storage should be implemented in accordance with EPR SGN S5.07 on clinical waste management.
32. Clinical waste is sometimes pre-sorted by a separate waste handling company. You need to be able to identify (without opening any bags) the nature of the waste received, since the calorific value can vary greatly depending on the source of the waste and if a large consignment of a particular type arrives it can upset the incinerator operating conditions. You should minimise this potential variability by providing means to secure a more consistent feed. This may include selective loading/management of identified waste types to blend the feed and/or large pre-charging feed hoppers to facilitate mixing.
33. Avoid using PVC containers wherever possible to minimise HCl emissions.
34. You should have a container wash and disinfectant area. Discharge should be minimised (e.g. by using to quench the bottom ash). Some disinfectants are not broken down fully in sewage treatment works (STW) and could pass to the receiving water after discharge from the STW. You must be able to show that your disinfectants are biodegradable both in the sewage treatment works, and in the receiving water.
35. Process higher risk wastes before lower risk wastes. These might include for example wastes that are either odorous or have a high potential to generate odour, or wastes identified as particularly biohazardous.
36. Procedures should ensure that certain biohazardous clinical wastes are only be accepted in exceptional circumstances. Microbiological cultures, waste from containment level 3 laboratories, and waste contaminated with UN transport Category A or ACDP hazard group 4 organisms are either required or recommended to be treated (e.g. by autoclaving) on the premises of production prior to their collection. An example of exceptional circumstances might be where the producers autoclave has suffered a temporary breakdown.

Animal

37. Installations burning only animal carcasses (or segmented animal carcasses where transport or feeding of whole carcasses is impractical) do not have to comply with WID. However, if the throughput meets the threshold defined in the Regulations the installation must use BAT, and may also be subject to the Animal By-Products Regulation 2002 (ABPR), which is regulated by the State Veterinary Service. All other animal waste incinerators must comply with WID.

Incoming waste and raw material management

38. Store carcasses awaiting incineration in separate, refrigerated storage or in the refrigerated trailers in which they arrive. This should:
    - be totally enclosed with a self-closing door
    - be lockable
    - be bird-, insect- and rodent-proof
    - be cleaned and disinfected each week
    - have effective means of odour control.
39. You can control odours in a variety of ways, with containment and treatment being strongly preferred. Never drag carcasses across the floor. Handle smaller carcasses in plastic wheeled bins with lids to contain the odours.
40. All vehicles, containers, trailers, storage areas, loaders, conveyors and equipment used for the collection, transfer and handling of carcasses should be designed for easy and effective cleansing and disinfection, be constructed of impervious materials and be kept clean.
41. Floors should have a chemical resistant finish to prevent attack by the cleaning and disinfecting materials and should be sloped to a holding pit.
42. Because wash down water may contain pathogens you should inject it into the furnace unless you can treat it on-site in a suitable effluent treatment facility. Check and maintain sumps and transfer equipment integrity.
43. Chose disinfectants and detergents that have the lowest possible environmental impact. You should consider, as a minimum, degradability, bioaccumulation potential and toxicity to relevant species.
44. Do not use PVC packaging, as this will form hydrogen chloride and dioxins during incineration.

Other Animal Waste Incineration (including MBM)

45. Installations that burn any animal wastes other than carcasses are subject to WID and must comply with its requirements.
46. Similar standards to those outlined above for carcass incineration should be adopted. Clinical waste standards may be appropriate in some cases depending upon the nature of the waste and the location of the installation.
47. Security of stored wastes is particularly important in respect of meat arising from culls, to prevent theft.
48. MBM should be handled to prevent dusty emissions. Silo vents should be filtered and loading operations should use closed loop vents to the delivery tanker. Earthing may be required during loading to prevent dust explosions due to static.

Incoming waste and raw material management

49. If MBM (or other waste) is likely to be stored for considerable periods it should be kept in agitated silos to prevent agglomeration.
50. Lumps requiring size reduction before incineration may form on prolonged storage; this is particularly the case where fluidised bed combustors are used. Longer-term storage also increases the risk that the waste will contain pyrolysed fat that may self-combust. Adequate fire detection and control should be provided.
51. Transport MBM from the silo to the combustor using belt or screw conveyors, or by pneumatic means. Screw conveyors may help to break up lumps.
52. All storage and transfer should be carried out such that odour is contained.

Sewage sludge

53. Condition and dewater sewage sludge to produce a sludge cake of sufficiently low moisture content to be incinerated without the use of supplementary fuel (except for start-up). Further drying will not necessarily provide any overall energy advantage, although it may minimise problems of visible plume.
54. Sewage sludge cannot be effectively de-watered without prior conditioning. This is normally done by the addition of polyelectrolyte but thermal conditioning, the addition of ash, or the addition of chemicals such as calcium hydroxide, ferric sulphate, ferric chloride, or aluminium chlorohydrate, are all possible techniques.
55. De-watering systems include plate presses, rotary vacuum filters, centrifuges and filter presses. Where the de-watered sludge will not burn without supplementary fuel, further drying is normally accomplished by means of a sludge dryer, to reduce the water content and minimise the supplementary fuel requirements.
56. The effluent from de-watering cannot be discharged directly to controlled waters without treatment and is usually returned to the sewage treatment works (STW). You should ensure that if you do this, the STW will remain able to meet its statutory obligations in respect of discharges to controlled waters. Treatment prior to release to the STW may allow for more efficient overall reduction in releases, particularly where persistent substances are encountered.
57. Where treatment is required, solids may be removed using flocculants and lamella settlement (or similar) or alternatively by filtration. You should return solids to the incinerator feed. You may need to neutralise the treated effluent and dose it with odour control additives before returning it to the STW.
58. Odour is caused mainly by long dwell times in the sewerage systems before the sewage arrives at the treatment plant. It arises in tank areas, from sludge de-watering; from filtrate treatment, and from conveyor systems. It should be controlled by:
    - providing self-closing doors to all access points

Incoming waste and raw material management

- ventilating all handling and de-watering areas and conveying systems and using the extracted air as a source of furnace combustion air. During shut-down the air should be extracted via another system. Extracted air which is not incinerated should be treated.

Drum incineration

59. Drums should be unloaded to an intermediate reception area where the consignment is verified against the delivery note and the number of drums and their contents recorded. Because most drums are received as part of regular consignments from major chemical companies with little variance in the chemicals being transported in the drums, it is normal practice to place reliance on the quality system of the drum supplier. However, you should carry out spot checks to verify that the delivery note system is being rigorously operated by the drum suppliers.
60. Where the furnace cannot handle halogenated substances, you must identify and reject them. Where the furnace has that capability, you may be able to save money and reduce the use of energy by operating the furnace at the higher temperatures only when burning chlorinated wastes (ensure strict segregation of chlorinated waste from other waste).
61. Where contents cannot be verified the drums must be segregated and analysed to ensure that the plant has the capability and is licensed to burn them.
62. Permits should limit both the quantity of drums to be held and the maximum period for which they can be held prior to incineration.
63. Have rigorous procedures in place to ensure that:
    - caps and lids are kept securely in place
    - drums are stored vertically, and
    - where stored horizontally the fill points are towards the top
    - drainage and water treatment arrangements are adequate.
64. Design new incinerators so that drums can be up-ended on to the conveyor and all of the contents which drain out of the drums to be carried into the incinerator. This will reduce fuel consumption and minimise the need to dispose of drainings to landfill. The design must take into account the drainage apron details, the burner positions and the residence time in both primary and secondary chambers.
65. Where this is not possible, drain drums of excess residual content and transfer the drainings to a purpose-built chemical incinerator. You should justify, any other form of disposal to our satisfaction. You should provide a fixed drainage station, as a loose container may be accidentally knocked over and discharge into the drains. Ensuring good drainage from the drums avoids chemicals dripping on to the floor at the entry to the furnace where conditions for combustion are not ideal.

Incoming waste and raw material management

66. To control odour and release of VOCs you should only open and de-head drums in an enclosed area with extraction to the furnace or to other odour control devices. Minimise the time between opening and incineration, but make sure the drums are adequately drained.

Pyrolysis and gasification

67. The handling required will depend upon the type of waste that is being treated and should follow the appropriate waste type specific guidance outlined in this section.
68. Pyrolysis and gasification installations that subsequently burn the products of these processes are covered by WID and must meet the standards outlined in the Directive.
69. Those processes that are operating have generally required waste to fall within a well-defined specification. It is therefore likely that heterogeneous waste streams (e.g. municipal waste) will need careful selection and/or waste pre-treatment prior to charging to such systems.

Refuse-derived fuel (RDF) incineration

70. This sub-section applies to dedicated RDF installations. The handling required will depend upon the type of RDF and should follow the appropriate waste type specific guidance outlined in this section (e.g. secondary liquid fuel (SLF) has similar hazards to some chemical wastes, municipal RDF has similar hazards to municipal waste). Unless specifically exempted, all RDF plants will be required to meet the standards required by WID.
71. You must ensure that the techniques selected for waste receipt and handling comply with WID and in particular with the following basic principles:
    - you should obtain sufficient information prior to receipt of the waste onto the site to ensure that it can be either:
        – safely offloaded for safe storage and further characterisation prior to incineration or pre-treatment; or
        – incinerated without need for further characterisation (i.e. the description is already sufficiently detailed given the nature and source of the waste and the intended treatment)
    - you should store and transfer the RDF in such a way that it cannot escape from control or give rise to potentially polluting emissions or contamination. You should take into account the physical and chemical nature of the RDF concerned.
    - it will generally be BAT to store RDF under cover, or in purpose built containment in areas of contained or controlled drainage, with suitable fire protection systems.
    - it is BAT to handle and transfer the RDF using sealed systems to prevent its escape.
    - odour control may be important for some RDF types. Guidance on odour control for municipal waste installations should be taken into account.

Incoming waste and raw material management

72. RDF management techniques at co-incineration plants whose prime purpose is the production of energy or material products (e.g. cement works or power stations that are defined as co-incinerators under WID) should take account of the guidance given above and that found in the relevant sector guidance (e.g. cement and lime). The aim should be to handle RDF (or other wastes) at these co-incineration installations in a manner which fulfils the requirements of WID and complements BAT for general raw materials handling in that sector as outlined in the relevant sector guidance.

Co-incineration

73. Specific techniques for waste management at co-incineration plant are not detailed in this guidance. You should consult the sector specific guidance for the particular industry concerned (e.g. cement and lime sector guidance) for guidance on handling incoming raw materials and fuels. The techniques selected must satisfy the requirements of WID.
74. WID treats co-incineration plants differently from incineration plants in some matters. To ensure that the installation is correctly defined and that you use suitable techniques you must consult WID itself, and the associated guidance. We suggest that you discuss the matter with us at an early stage in the application process.

Waste charging

2.2 Waste charging

Indicative BAT

1. Incinerators and co-incinerators should use an automatic system to prevent waste feed:
   - at start-up, until the required temperature has been reached;
   - whenever the required temperature is not maintained;
   - whenever the continuous monitors show that any emission limit value is exceeded due to disturbances or failures of the purification devices.
2. Waste charging must be interlocked with furnace conditions so that charging cannot take place when the temperatures and air-flows are inadequate, when any flue gas cleaning bypasses are open or where the continuous monitors show that the emission limit values are being exceeded for a period of time in excess of the limits set within WID.
3. Make the charging operation as airtight as possible and ensure that the fan control system is capable of responding to changes in furnace pressure during charging, to avoid escape of fumes or excess air flows.
4. In systems that use a waste filled charging chute or hopper to achieve an airtight seal, the mechanism that loads the chute should be interlocked to prevent loading under the conditions outlined by WID.

Charging rates

5. Charging rates outside the installation design capacity seriously undermine environmental performance. The capacity will vary according to the calorific value (CV) of the waste feed. The design should be declared in the application and a firing diagram included. At all installations close attention should be paid to the procedures that are in place to ensure that the designed charging rate is not exceeded. You should record throughput rates and not exceed that declared in the application. You should alter mass throughput rates in order to ensure optimum combustion conditions are achieved, whilst ensuring that waste residence in the chamber is sufficient to secure ash burnout requirements.

Chemical waste

6. Most liquid chemicals are introduced to the furnace by conventional liquid fuel burners. It is essential to ensure good mixing and atomisation. If you use heating to control viscosity you should keep the maximum temperature well below the flash point of the liquid.
7. Where whole drums of waste are fed directly, the incinerator will have to be fitted with a suitable handling mechanism and must be designed to withstand any resulting increase in pressure. While shredding is an option it is more usually found that careful packaging and scheduling of the charges is the key to satisfactory operation. Particular attention should be paid to this aspect.

Waste charging

8. You should operate a well managed storage area with detailed labelling and inventories, so that you can make up loads (e.g. pallets) to be fed to the incinerator without excessive quantities of substances which may be difficult to incinerate (e.g. iodine).

Municipal and clinical waste

9. Use sealed delivery chambers where there is a risk of either waste or products of combustion escaping from the feed mechanism. Positive pressure inert gas blanketing may be necessary to prevent reactions in the feeder system. Feed purge gases to the incinerator.
10. Normal feed mechanisms for solid wastes include ram, gravity and hopper feeds. You should engineer the waste feed to prevent back flow of combustion products through it. You should include a low-level alarm in the feed hopper.
11. The isolation doors that prevent the fire burning back up the chute should be double doors and/or have a cooling system, to prevent ignition of waste in contact with the outside of the door. Water cooled chutes are currently in use.
12. Ensure a consistent feed to ensure steady combustion conditions. Systems in which the grate steadily draws the waste on to it are preferred. You must take particular care in the control of combustion where waste feed is intermittent.
13. For moving grate systems it is particularly important that operating procedures show how overloading of the furnace will be prevented. You should provide automatic means, controlled by measured combustion parameters, to vary the waste feed rate to maintain good combustion conditions.
14. WID requires that infectious clinical waste is placed straight from storage into the furnace, without first being mixed with other categories of waste and without direct handling.

Sewage sludge

15. Because of the homogeneous nature of sludge, its injection to the furnace usually causes few problems. The degree of pre-dewatering will influence the feed mechanism used. Very dry cakes from plate presses may give rise to handling and charging difficulties that lead to less stable combustion conditions.

Drum incineration

16. Feed drums to the furnace as far as possible in sequence, according to their contents, to ensure that the calorific value fed to the incinerator is as constant as possible.
17. Regularly clean the apron to the furnace entry to prevent the build up of combustible material.

Waste charging

18. Because the furnace must be open to allow the drums to pass in (and out), the incinerator has to achieve the required operating temperatures despite considerable ingress of cold air and high excess air levels. Arrangements for feeding the drums should prevent fugitive emissions. Doors and interlocking are not practicable because of the high frequency of drum loading. Water curtains are effective at minimising “puffing” releases from the feed entry and the exit and they also keep dust and ash burning around the entry to a minimum and provide a quench for the drums.
19. Ensure that there are no drums in the furnace on start-up and feed should be stopped when the conditions in the furnace do not meet those given in the Directives.

Animal carcasses

20. Intermittent feed, by front loader vehicle, ram feed or manual, requires the doors to be open to admit the carcasses. As a result, air will be drawn into the furnace during loading, making it difficult to control the temperature of the secondary chamber and the negative pressure of the primary chamber. To comply with BAT, you should macerate and charge carcasses continuously, or use a ram feeder to keep the charging system sealed during loading.

Pyrolysis and gasification

21. Pyrolysis and gasification plants require careful control of air ingress during waste charging operations. Packed rams and screw feeders are suitable for use. Feed throats that reduce in diameter may help to maintain a good seal, as may shredding waste to prevent mechanical blockages. Charging mechanisms must be of appropriate design and materials to resist the reactor back pressures and corrosion that could lead to escape of the gases produced.

Refuse-derived fuels

22. Use sealed charging systems.

Co-incineration

23. Have regard to the sector specific guidance, (e.g. cement and lime) and comply with WID

Furnace types

2.3 Furnace types

Indicative BAT

1. The designs described below should be considered where appropriate for the process.

Table 2.1 Summary of combustion technology application

Combustion Technologies – known to be or have been used in the UK: "UK" – suitable or likely to be: "S"	Waste Type					
	Chemical	Clinical	RDF (note 3)	Municipal	Sewage sludge	Animal carcass
Fixed hearth						UK
Fixed stepped hearth		UK		UK		
Moving grate (normally sloping and stepped)		UK	UK	UK		
Pulsed hearth	S (Note 1)	UK		S		S
Rotary kiln	UK	UK	S	S	S	UK
Fluidised bed (note 2)			UK	UK	UK	
Liquid injection	UK				S	
Semi pyrolytic	UK	UK	S	S		S
Gasification (note 2)	UK	UK	S	S	S	S
Pyrolysis (note 2)	UK	UK	UK	UK	S	S
Cyclonic combustors						
Gas incinerators	UK					
Drum incinerators	UK					

Notes:

1. For mainly solid chemical wastes.
2. May be suitable only for selected / pre-treated waste fractions.
3. RDF may be burned in a variety of plant providing that plant is designed to receive fuels of similar physical, chemical and combustion characteristics e.g. where a high CV liquid RDF replaces a high CV liquid primary fuel.

Furnace types

Fixed hearth incinerators

While these have been used for clinical waste and even chemical waste they are now normally only acceptable for the incineration of consistent wastes whose combustion has a low pollution potential. They are in use for animal carcass incineration where the containment offered by the fixed hearth may help to ensure unburned liquids (e.g. fat) do not leak out.

This design may have difficulty in meeting WID standards, mainly due to the semi-batch nature of the waste travel on the grate and de-ashing operations. A secondary chamber with injection of supplementary fuel and secondary air is essential.

Fixed hearth stepped furnace incinerators

Used, in particular, for **CWI** these comprise a series of steps (typically 3) with embedded primary air channels, down which the waste is moved by a series of rams.

The steps between hearths provide agitation as the waste tumbles down the step; however, this can also produce surges of unburned particulate and hydrocarbons and consequently the provision for good secondary combustion and residence time becomes more important. Gas combustion takes place in the primary chamber and in a subsequent secondary combustion chamber.

Moving grate incinerators

Municipal waste is the main application for these incinerators which can be designed to handle large volumes of waste. In larger furnaces it is possible for the required residence time to be achieved in a single chamber but this may be more difficult to verify.

Pulsed hearth incinerators

The pulsed hearth incinerator uses the pulsed movement of one or more refractory hearths to move the waste and ash through the incinerator. They have been used for municipal, clinical, animal carcasses and other solid wastes.

The smooth hearth can handle difficult wastes with reduced risk of jamming or loss of liquid wastes. The main difficulties, have been in achieving effective and reliable burnout of the solid wastes.

Rotary kiln incinerators

Rotary kilns have wide application and can be of the complete rotation or partial rotation type. They have the benefit of good waste agitation and achieve good burnout provided waste residence time in the furnace is adequate. They can be used in combination with other designs to provide additional ash burnout.

Due to the absence of exposed metal surfaces, rotary kilns are normally able to operate at high temperatures and often operate in a slagging mode. Slagging kilns operate at a temperature high enough to

Furnace types

melt inorganic waste and produce a fused glassy slag which is low in organics and has a low leaching rate. This has made them particularly suitable for **hazardous waste** incineration where whole drums and solid wastes can be completely destroyed.

Careful attention needs to be paid to the seals between the rotating kiln and the end plates to prevent leakage of gases and unburnt waste. Tumbling of the waste may generate fine particles requiring secondary combustion and good particulate abatement. The generation of fine particles can be reduced using a partial rotation (reciprocating) kiln.

Fluidised bed incinerators

Fluidised beds are only suitable for reasonably homogeneous materials and are therefore the main designs for the incineration of **sewage sludge**. Fluidised bed technology may also be used for any waste that has been sufficiently treated, including treated **municipal waste** and **refuse derived fuels**.

The advantages of a fluidised bed incinerator include:

- combustion efficiency is high and temperatures are uniform
- lower temperature leads to low NOx
- simple furnace - no moving parts, and
- the sand provides continuous attrition of the burning material removing the layer of char as it forms and exposing fresh material for combustion. This assists with both the rate of combustion and burnout

An MWI fluidised bed is operational in the UK. The waste is pre-sized by means of a crusher / shredder. There have been operational problems with the waste pre-treatment stages that have led to significant down time.

Starved air (semi-pyrolytic) incinerators

More a method of control than a specific configuration, the concept can be applied to various designs. The primary chamber operates at sub-stoichiometric air levels to produce a gas that is combusted in a secondary zone operating under excess air conditions. A supplementary fuel burner is required in the secondary zone to ensure the required combustion conditions are maintained at all times. The design of the secondary combustion zone and support burner will need to consider the full range of characteristics of the gas evolved to ensure that unburned gas is not released.

The advantages can be a more controlled burn leading to lower releases of NOx, VOCs and CO. The relatively low combustion airflow results in low entrainment of particulate in the flue gas.

Liquid injection incinerators

Liquid injection incinerators, which are usually refractory lined cylindrical chambers, are used for the incineration of chemical waste.

Furnace types

Gas incinerators

The incineration of waste gases (unless the gas arises from the thermal treatment of waste) is not covered by WID. Because of the homogeneous and generally very clean nature of the feedstock it is likely that very low emission levels can be achieved using BAT. Emissions should be below those levels listed in WID.

Drum incinerators

Drum incinerators are all of the same basic design, comprising a conveyor system which takes the inverted drum through a long narrow furnace where the burners, normally gas fired, burn out the residual contents and burn off, or at least loosen, the paint. The gases pass to a secondary chamber where further burners ensure effective combustion.

Gasification installations

Gasification is the conversion of a solid or liquid feedstock into a gas by partial oxidation under the application of heat. Partial oxidation is achieved by restricting the supply of oxidant, normally air. The gas has a relatively low calorific value (CV), typically 4 to 10 MJ/Nm^3, and may be highly corrosive and toxic owing to the partially reduced species present. Particular attention must therefore be paid to ensuring the gas produced in the reactor and passed to the combustion stage is contained.

This should include attention to ensure:

- consistent waste feed characteristics are obtained (pre-treatment is likely to be required for heterogeneous wastes) to ensure even reaction rates and internal plant pressures
- the plant is sealed to contain the gases produced
- the materials of construction are able to withstand the highly corrosive environments to which they will be subjected

For most waste feedstock, the gas produced will contain tars and particulate. Depending upon the combustion technology selected the gas may require cleaning before combustion. Where the gas (or solid or liquid products) produced is subsequently burned, the installation will be required to meet the standards of WID.

Pyrolysis installations

Pyrolysis is the thermal degradation of a material in the complete absence of an oxidising agent. Most pyrolysis plants have an externally heated chamber that is sealed to prevent air ingress. In practice, complete elimination of air is very difficult and some oxidation may occur.

If gas is the principal product, it is likely to have a CV range of 15 to 30 MJ/Nm^3 (cf. CV of natural gas of approx. 39 MJ/Nm^3). This gas can be burned in boilers, engines or gas turbines. The raw gas will contain highly toxic and corrosive reduced species. Similar considerations to those outlined above for gasification plant apply.

Furnace types

Where the char is disposed of (rather than burned as a fuel or used as a product) WID 3% TOC limit will apply. Although the char may consist of primarily elemental carbon (which is not included in the TOC test) , it is still possible that the 3% TOC level will be exceeded. Where this is the case, BAT will require further processing of the char such that the residues ultimately produced for disposal meet the 3% TOC standard. This additional processing may involve the use of a water gas reactor or combustion.

The subsequent combustion of a product of pyrolysis (whether the solid, liquid or gaseous product) will mean that WID will apply to the installation. If you are planning such an installation you are advised to discuss the matter with us to clarify the application of the Directive to your pyrolysis installation.

If the waste feed to the pyrolysis installation is sufficiently heterogeneous, and the gas produced is of good quality, it is theoretically possible that high levels of electricity generation may be achieved through the use of gas engines or gas turbines. At present there is mixed evidence regarding the ability of such systems to meet the stringent requirements of WID in respect of emissions to air. If you are proposing pyrolysis, you should justify your selected power generation technology and explore opportunities to produce clean, high quality fuel gases that may be burned in higher energy efficiency plant (i.e. those that do not depend upon a steam cycle) and can comply with WID emission limit values.

Furnace requirements

2.4 Furnace requirements

Indicative BAT

Legislative requirements under WID

1. The gases resulting from the combustion of non-hazardous wastes must be maintained at above 850 °C for at least 2 seconds.
2. The gases resulting from the combustion of hazardous wastes with halogen content greater than 1% (as chlorine) must be maintained at above 1100 °C for at least 2 seconds.
3. It should be noted that excessive residence times may result in insufficient turbulence in the combustion chamber. WID allows for derogation of requirements 1 and 2 above, where such derogations can be justified as BAT and achieve the overall aims of WID.
4. WID does not specify oxygen concentrations. You should note however that BAT will require sufficiently oxidising conditions at the final combustion stage to provide for good combustion, and that you will need to justify your choice of oxygen concentration. You will also be expected to consider the consequence for releases if the oxygen level were to fall below your proposed minimum.
5. Incinerators must be provided with auxiliary burners to achieve and maintain the required temperatures. This does not apply to co-incineration unless BAT requires them.
6. You must validate the combustion temperature and residence time, and the oxygen content of the stack gases, at least once, and under the most unfavourable operational conditions.
7. You must minimise residues (ash) in their amount and harmfulness.
8. Incinerator slag and bottom ashes shall not exceed 3% total organic carbon (TOC) or 5% loss on ignition (LOI) (dry weight). This does not apply to co-incineration, where BAT for the sector (as defined by the sector specific guidance) will apply.
9. Installations should not give rise to significant ground level air pollution.
10. Whilst it is recognised that these requirements set high technological standards, you will still need to consider the use of techniques that may further reduce releases to demonstrate that your installation uses BAT.

Grates and primary air

11. Ensure residence time of the waste in the furnace is long enough to ensure complete burnout, and is controllable.
12. For gasification and pyrolysis plants, WID 3% TOC requirement applies to the “ash” produced at the subsequent combustion stage rather than the initial reaction stage, which may be set up to deliberately produce a high carbon char for subsequent use as a fuel or other use. Where this char is used as a fuel the 3% TOC will apply to that process (along with other WID requirements). If the char produced is not put to any beneficial use (e.g. it is disposed of to landfill) the pyrolysis / gasification installation will be expected to process the

Furnace requirements

char to meet the 3% TOC requirement and to recover energy from it (e.g. using water gas reactor or combustion stages).

13. Generally, designs which increase turbulence in the primary combustion chamber reduce NOx formation, secondary air requirements and overall flue gas volumes.
14. For most designs of furnace (fluidised beds may be an exception), you should control primary air both to minimise NOx production and minimise velocities and the entrainment of particulate. Starved air systems can be very effective in controlling these while maintaining low levels of CO.
15. Ensure proper distribution of air and fuel, avoiding hot zones, to reduce the amount of inorganic material volatilised.
16. Higher primary airflow through grates may be required to reduce temperatures. The use of water-cooled grates may minimise the airflow requirements.

Combustion chambers, secondary air system designs and supplementary burners

17. You should maintain combustion chambers, casings, ducts and ancillary equipment as gas-tight as practicable. They should be designed to prevent both the release of gases and disturbance of combustion conditions during waste charging, and maintained under slightly reduced pressure. Control of the induced draft fan, primary air and the feed rate should be balanced.
18. Continuously monitor and record the gas temperature in the primary zone and at the entry and exit points from the secondary combustion chamber. Install audible and visual alarms that are triggered when the temperature falls below the minimum specified. Interlock the charging system with the validated combustion temperature to automatically prevent additional waste feed:
    - at start up, until the combustion temperature is reached
    - whenever the relevant combustion temperature is not maintained
    - whenever the continuous emission monitors show breaches of the emission limit values (over the appropriate averaging period).

Supplementary burners and fuels

19. Supplementary burners must be provided at all incineration installations in order to achieve and maintain the required combustion temperatures. Co-incineration plants are not required to include supplementary burners under EC legislation but they may be required by BAT for the particular sector (see relevant sector guidance)
    - the burners must be capable of supporting the combustion temperature under all conditions when there is waste in the furnace
    - the burners may be used for initial start-up, temperature maintenance and final shut-down

Furnace requirements

- in your application you should state the start up and shut down sequence, including the temperatures at which the waste will be introduced, and prevented, and at what temperature the supplementary burners will trigger
- automated systems should be used to trigger the supplementary burners and to prevent additional waste feed until the required temperature is re-established.

20. Use supplementary fuels which produce release levels no worse than those from burning gas oil as defined by Directive 75/716/EEC (as amended).
21. Supplementary fuels may only be wastes if combustion temperatures are greater than those outlined in table 3.2.3B below (or any other temperature specified in the Permit where WID derogation has been invoked); i.e. waste derived fuels cannot be used for start-up, but may be used for maintaining temperatures above the minimum.
22. Use the following techniques to ensure efficient combustion of furnace gases:
    - adequate oxygen content to ensure complete combustion
    - sufficient temperature to promote combustion
    - sufficient time to complete the combustion reactions
    - turbulence to promote mixing.
23. All incineration plant should be equipped and operated in such a way that the temperature of the combustion gas is raised to that specified in Table 2.2, after the last injection of air, in a controlled and homogeneous fashion and even under the most unfavourable conditions anticipated, for at least two seconds.
24. You must maintain these temperatures during operation and at the end of an incineration cycle and for as long as combustible waste is in the combustion chamber. You must maintain oxygen levels at a level demonstrated to be adequate to ensure oxidative combustion and hence destruction of organic species at the final combustion stage. For many installations this will be approximately 6% oxygen by volume. You are expected to justify the minimum oxygen level that you propose. This includes considering the consequence for releases if the oxygen level were to fall below your proposed minimum.

Furnace requirements

Table 2.2 Furnace gas temperatures

Process	Minimum temperature °C
Chemical waste	850 (1100)
Clinical waste	1000 (1100)
Municipal waste	850
Animal carcasses	850
Sewage Sludge	850
Gasification (combustion of products of gasification)	850
Pyrolysis (combustion of products of pyrolysis)	850
Co-incineration	850 (1100)
Refuse Derived Fuels	850 (1100)
Drum recovery	850 (1100)

Notes:

1: Figures in brackets apply where hazardous wastes are to be incinerated.

2: Minimum temperature is normally that measured near the inner wall of the combustion chamber.

3: Where non-clinical offencive/hygiene waste is burned in an MWI or exclusively in a CWI, a temperature of 850°C may be acceptable.

Validation of combustion conditions

2.5 Validation of combustion conditions

Indicative BAT

1. At the **design stage**
   - use a representative Computerised Fluid Dynamics (CFD) model where practical to demonstrate that the residence time and temperature requirements will be met in the chosen design and to identify the ideal (or best practicable) locations for temperature monitoring for the purposes of validation measurements
   - outline the assumptions and inputs used in the CFD modelling and explain how these are representative of the chosen design
   - identify the qualifying zone over which the residence time and temperature will meet the residence time and temperature requirements
   - use a model that is representative of the real flow situation in the qualifying zone (this is most likely to be a combination of plug flow and stirred reactor flow rather than one extreme)
   - taking account of this guidance and BAT report, confirm the details of the method that will be used to validate temperature and residence time modelling, including identification of the worst case conditions under which the test(s) will be carried out including waste type etc.
2. At the **operational stage** use validation techniques in agreement with the Agency that:
   - measure worst case gas residence time using a time of flight method
   - use multiple traverse measurements of gas temperature to identify (or confirm) the lowest gas temperature location at, or shortly after, the qualifying secondary combustion zone
   - confirm that 95% of the one-minute mean temperatures (continuously monitored at the identified lowest temperature location over a period of at least one hour) exceed the stated minimum temperature requirement
   - use suction pyrometers to measure temperatures (acoustic pyrometers or shielded thermocouples may only be used if calibrated against suction pyrometers).
3. The "**qualifying zone**" over which the temperature and residence time shall be required to comply is defined as follows:
   - it should not include areas where primary combustion occurs but relate to the completion of combustion
   - it should commence at a location after the last injection of secondary (or over fire) air and will therefore generally exclude residence time achieved in the primary combustion unit or zone

Validation of combustion conditions

- it would not be reduced where support burners are located within the qualifying zone provided they maintain temperature above the required level
- it would be reduced where tertiary air is added within the qualifying zone.

4. The **test conditions** for validation measurements should be:
    - carried out over a range of operational conditions including the "most unfavourable" and normal operation
    - the "most unfavourable" condition is considered to arise as a consequence of a combination of:
        - waste type being at the boundary of the design envelope in respect of it combustion related parameters (e.g. CV, moisture)
        - the process operating at the limits of its operational range as defined by the plant firing diagram
    - each condition should be tested twice during the validation programme
    - the monitoring within each test period should last at least one hour.
5. For more detailed guidance on validation methodologies refer to BAT report on validation of combustion conditions.

Measuring oxygen levels

6. The oxygen level should be reported on a wet basis, and should be sufficient to ensure adequate combustion. In practice, this is likely to be about 6%.
7. Set the oxygen control point at a level which takes account of the speed with which the control system can introduce more secondary air in response to fluctuations in the rate of combustion on the grate. The larger the fluctuations and slower the rate of response of the control system the larger the margin of excess oxygen must be.

Combustion control

8. You must maintain optimum control of the combustion process at any instant, especially when burning wastes of very variable moisture content and calorific value and those which cannot be readily charged to the furnace at a steady rate.
9. Ensure that the largest perturbation (e.g. the addition of a single drum to a chemical waste incinerator (ChWI), or the tumbling of a mass of waste in a municipal incinerator (MWI)) is small compared with total mass being burned.
10. Because waste feed rate is a relatively slow acting control parameter, you need to control shorter term fluctuations, especially during stoking, by primary and secondary air flow rates and burner operation.
11. The shortest-term fluctuations are usually caused by sudden conflagrations of the non-homogeneous wastes and take place in the order of seconds. You must use fast response measuring/control systems (such as CO or oxygen sensors) to avoid emission spikes (particularly of CO and unburned hydrocarbons).

Validation of combustion conditions

12. You should demonstrate e.g. by reference to existing plants of the same configuration, how your control system will deal with both:
    - the largest normal perturbation
    - the shortest duration perturbation which is significant in the particular process.
13. Potentially the response time of CO detector systems may be brought down to the microsecond level. Alternatively rapid response can be obtained by taking measurements just above the bed, using acoustic (which can be expensive) or optical/infra-red temperature monitoring. On some plants, this alone has shown significant reductions in CO releases. Better control also improves efficiency and can save fuel where burners are regularly employed. Such techniques can be valuable for improving performance on existing plants.
14. To be effective, rapid monitoring needs to be combined with a secondary air supply arrangement which can also respond rapidly. Techniques to improve air supply response time include:
    - keeping secondary jets clear of slag and operational, particularly in MWIs. Jet performance can be monitored by simple air flow or pressure instrumentation, backed up with viewing windows
    - oxygen injection, via lances. This has been used for merchant ChWI in the US and Germany with significant reductions in the number of high CO events
    - provision of excess capacity in the air supply ductwork upstream of the jets (by use of higher pressure fans) and use of a damper opening behind the jets. On opening of the dampers, there will be an immediate increase in air flow through the jets which may provide a much faster response than that obtained by simply controlling the fan speed.

Combined incineration of different waste types

2.6 Combined incineration of different waste types

This section relates to the combustion of different types of wastes within the same incinerator. It does not deal with the combustion of wastes with, or in the place of, other fuels at installations whose primary purpose is the generation of energy or the production of materials.

Indicative BAT

1. BAT for the incineration of a particular waste is dependent upon the characteristics of that waste. Because of this, to comply with BAT you are likely to need a dedicated charging mechanism, furnace, abatement system and monitoring train for each different type of waste unless you are only going to burn very low proportions of alternative waste types.
2. If you use a single abatement plant to treat emissions from parallel incinerators you must ensure that the reduction in stack efflux velocity when either incineration line is not operating will not adversely affect operation of the abatement plant, and you must provide monitoring at locations that will allow calculation of separate emission limit values for each line. It is not acceptable to combine the flue gases from both lines to achieve dilution to meet emission limits.
3. The incineration of some types of clinical waste (CW) is possible in MWIs or animal carcass incinerators (ACIs), although such mixing would render an ACI otherwise burning only whole carcasses subject to WID. If you plan to burn CW in a MWI, you will need to justify any reduction in your ability to recycle the ash.
4. Place infectious clinical waste straight in the furnace without first mixing it with other waste, and without direct handling.
5. More innocuous waste which is suitable for landfill, may be burned in a well designed and run MWI or ACI, provided:
    - a strict code of quality control is exercised on the source of the waste and its handling into the incinerator and the procedures for these are regularly audited
    - the CW is burned within 24 hrs and records are kept of temperature and quantity of waste fed that procedures are in place to divert and transfer waste already held, should the incinerator be out of action
    - a mass throughput limit is applied which corresponds to a small fraction of the total waste burned.

Flue gas recirculation (FGR)

2.7Flue gas recirculation (FGR)

Indicative BAT

1. Consider using FGR for NOx control. If you propose not to use FGR, you must submit a site specific justification of the alternative NOx control technique by comparing FGR against other alternatives and particularly by addressing the points below.
   - more secondary air is required to provide turbulence than is needed simply for supplying oxygen. The resulting excess oxygen encourages both NOx and dioxin formation. **FGR** replaces 10-20% of secondary air (with N_2 and CO_2) reducing oxygen and peak temperatures thereby reducing NOx generation
   - FGR gives around 20% NOx reduction. In combination with repositioning air inlets (using CFD to optimise locations) and improved control it can give 25-35% reduction
   - higher re-circulation rates may give rise to corrosion. At lower levels we do not expect this to be significant enough to prevent the routine use of this emission reduction technique
   - thermal efficiency of the installation may be increased by re-circulation of the already warmed stack gases. This additional heat retention will need dissipation to prevent increased furnace temperatures altering the thermal profile of the operational plant. In new plant this may be addressed at the design stage (e.g. by providing a larger heat capacity boiler). Existing plants may find increasing heat removal rates highly capital intensive, although this may be recovered through increased heat recovery. Reductions in waste throughput could also reduce thermal load, but this will also be expensive and may be impractical in some situations
   - the costs of retrofitting FGR may be prohibitive for existing plant owing to the space required for the ducting and other factors (heat removal and throughput). Such situations will be assessed on a site specific basis
   - the injection of ammonia or urea (**SNCR**), which converts both NO and NO_2 to nitrogen and water, can further reduce NOx levels (typically by 35-45%). Its use in conjunction with FGR has shown total reductions of up to 80% and may represent BAT in many situations. The use of the two techniques in combination also reduces reagent consumption for SNCR.

Dump stacks and bypasses

2.8 Dump stacks and bypasses

Dump stacks may be included in the design as a safety feature but should only operate for safety reasons or where a heat removal system has failed, and the downstream gas cleaning plant will otherwise be damaged.

Indicative BAT

1. Only operate dump stacks for safety reasons or to prevent damage to gas cleaning plant, and not as part of normal operation or during start up or shut down.
2. Operational frequencies greater than once per year are unlikely to be acceptable.
3. When a dump stack or emergency bypass operates this will be considered to be a period of “abnormal operation” and the process should be reduced or closed down (Ref. WID Article 13).
4. Route dump stacks to the main stack, thus forming a bypass. This will improve dispersion with the additional height and allow monitoring equipment to quantify the release.
5. An abatement system bypass, linking to the main stack may be operated on start-up where this has been authorised and is necessary to prevent damage to abatement plant. Electric heating is an available option for new bag filters to avoid the need for bypass on start-up.
6. Failure of the flue gas cleaning plant should not normally lead to operation of the dump stack.
7. The reliability of heat removal systems, in particular feed pumps and dump condensers, should be demonstrated to be adequate.

Cooling systems

2.9 Cooling systems

Indicative BAT

Discharge of cooling tower water

1. Minimise biocide use (commensurate with meeting health and safety requirements) by:
    - optimising the dosing regime (e.g. intermittent shock dosing or only dosing at critical times of the year)
    - using automatic mechanical cleaning systems for main condensers.
2. Prevent accidental overdoses of biocide being released to the environment by:
    - monitoring of levels in the outgoing water coupled with automatic operation of the final discharge valves
    - bunding of storage vessels
    - adequate operating procedures.

Cooling water intakes

3. Once through cooling systems may be used where:
    - there is adequate provision of water (e.g. coastal sites)
    - CHP or district heating cannot practicably use the waste heat on a closed loop
    - fish (and other aquatic life) kill by the water intake has been assessed and will not be significant
    - thermal and biocide dispersion are such that environmental impacts are not significant
    - the energy and any other environmental benefits can be demonstrated to outweigh alternative technological solutions (e.g. air condensers).

Cooling tower plumes

4. Consider the meteorological conditions under which a visible plume may form. Design and operating procedures for evaporative cooling towers must minimise the formation of condensed plumes. Ground level plumes can contain harmful substances and cause loss of light, poor visibility and icing of roads.

Releases to land

5. Timber used in cooling towers is usually treated with CCA (copper sulphate, potassium dichromate, arsenic pentoxide), most of which remains well bound to the timber over its operating life. However, initial surface residues could lead to significant levels in the purge water. Specifications for treated timber should include the requirement for controlled washing at the treatment site.
6. On final disposal, incineration of the cooling tower timber in the installation may only be carried out if it has been specifically authorised. You must demonstrate that this is BAT.

Boiler design

7. Store wastes (e.g. sludges from effluent treatment plant associated with cooling water treatment and recirculation, and intake screen washings) from the cooling cycle securely pending its transfer for disposal. On site incineration may only be carried out if specifically authorised.

Table 2.3 Cooling system type - advantages and disadvantages

Cooling System Type	Advantages	Disadvantages
Once through	• Greater cooling efficiency may improve energy recovery • Low noise impact • Low visual impact	• Possible fish kill • Possible thermal release effect in water course • Bio-fouling • Biocide discharges
Evaporative cooling	• Good cooling efficiency • Small plot possible	• high visual impact • water consumption • chemical treatments for bio-hazard control
Air cooling	• No water intake or discharge • Unobtrusive design • No water consumption	• Possible noise impacts • Lower cooling efficiency • Power supply costs

2.10 Boiler design

This section deals with boiler design as it relates to the minimisation of local pollution.

Indicative BAT

1. Minimise dioxin production by boiler design and operation:
2. Avoid slow rates of combustion gas cooling to minimise the potential for the *de novo* formation of dioxins and furans.
3. The primary temperature zone of concern is between 450 and 200 °C. However dioxins will still be formed outside this range at a decreasing rate as the temperature moves further away from this core range.
4. Dioxin control should primarily be by preventing formation, rather than by subsequent abatement. As the waste heat boiler is one of the primary sites for formation, its design and operation are important. The main techniques involve maximising the rate of decrease of gas temperature, which is achieved by:

Boiler design

- ensuring that the steam/metal heat transfer surface temperature is a minimum (around 170°C) where the flue gas is in the *de novo* synthesis temperature range, subject to acid dew point considerations
- CFD is used to confirm that there are no pockets of stagnant or low velocity gas
- boiler passes are progressively decreased in volume so that the gas velocity increases through the boiler, and
- boundary layers of slow moving gas are prevented along the boiler surfaces

5. A balance must be maintained, to ensure that these design measures are not made at the expense of a major effect on boiler efficiency.
6. boiler deposits contain substances which catalytically enhance dioxin formation. Municipal waste, in particular, leads to deposits of sodium and potassium sulphates, and to a lesser extent chlorides. Fly ash can then adhere to these deposits to compound the problem. In the initial stages the material is easily removed by an on-line sootblower. As the fouling increases the deposits become fused and can only be removed off-line. Control methods include:
   - design features to maintain critical surface temperatures below the sticking temperature. This includes not only the arrangement of cooling surfaces, but also avoiding peak combustion temperatures by good waste mixing (where relevant) uniform waste feed and good primary and secondary air control
   - additives to prevent sodium and potassium depositing (mixed success), or
   - on-line cleaning by:
     - boiler tube rapping, by striking the tubes (limited success) or lifting and dropping whole banks of tubes (limited experience)
     - continuously allowing steel shot to fall through the tubes (applied successfully to economiser sections)
     - steam or compressed air soot blowing, and
     - off-line cleaning
7. NOx reduction techniques may also help to minimise dioxin emissions.

Minimising releases to water from boilers

8. Boiler blow-down contains small amounts of solids plus water treatment chemicals. These are mainly phosphates with possibly small amounts of alkalis, hydrazine and ammonia used for pH control and de-aeration.
9. Water treatment and de-ionisation plant effluent usually comprises separate acid and alkali streams which are mixed together and pH adjusted for discharge. Soluble and suspended solids content will depend on the original water supply, be it towns water, river or estuary water. Soluble sulphates are also likely to be present from the use of sulphuric

Boiler design

acid for regeneration of the ion exchange material. You should consider the presence of salts in the release.

10. Wash water and cleaning solutions, containing for example citric acid, sodium hydroxide, alkali phosphates, iron oxides in suspension, hydrochloric or hydrofluoric acids, may be generated during maintenance. Complex toxic corrosion inhibitors may be present in these liquors.
11. All these liquors should be neutralised or treated on- or off-site to produce an acceptable waste before discharge or disposal to a licensed facility.

3

Emissions and Monitoring

Emissions to air

3. Emissions and monitoring

3.1 Emissions to air

You must comply with the emission limit requirements of WID **as a minimum**. You must demonstrate that your techniques are BAT as well as meeting the emission limits.

You may achieve the lowest environmental impact by using a combination of several of the techniques described in this section. Furthermore, the selection of one particular abatement system or a particular combustion design (e.g. fluidised bed) may, for valid engineering and environmental reasons, exclude the use of, or undermine the performance of, an alternative abatement system. You should therefore justify your individual equipment selections on the basis of the performance of the installation as a whole i.e. you should set out a number of alternative installation designs and compare the overall performance using the Horizontal Guidance Note H1 Environmental Risk Assessment.

The nature and source of the emissions expected from each activity is given in previous sections and you are required to confirm it in detail in your application.

Abatement techniques are described in this section; if there is doubt, the degree of detail required should be established in pre-application discussions. Information required in a permit application includes:

- a description of the abatement equipment for the activity
- the identification of the main chemical constituents of the emissions and assessment of the fate of these chemicals in the environment using Horizontal Guidance Note H1 Environmental Risk Assessment
- the measures to ensure that there is adequate dispersion of the emission(s). Dispersion should be sufficient to prevent exceeding local ground level pollution thresholds and to limit national and transboundary pollution impacts (based on the most sensitive receptor, be it human health, soil or terrestrial ecosystems).

You must demonstrate that an appropriate assessment of vent and chimney heights has been made. Details are given in Horizontal Guidance Note H1 Environmental Risk Assessment.

You should recognise that the chimney or vent may also be an emergency emission point under certain circumstances. Process upsets or equipment failure giving rise to abnormally high emission levels over short periods should be assessed. Even if you can demonstrate a very low probability of occurrence, the height of the chimney or vent should nevertheless be set to avoid any significant risk to health.

Emissions to air

Wherever possible, the use of abatement bypasses should be avoided. It may be possible to design out their routine use for start-up by providing heated bag houses in order to prevent dew point problems. At new plant any essential major bypasses should be ducted to the main stack to ensure maximum dispersion. At existing plant this is also preferred but costs should be considered in relation to the likely impacts and frequency of use. The impact of fugitive emissions can also be assessed in many cases.

Indicative BAT

1. Unless you are operating an incinerator exempt from the requirements of WID, you must comply with the emission limit requirements of WID **as a minimum**. You must demonstrate that your techniques are BAT which may result in lower emissions than WID emission limits.

Particulate matter

2. **Fabric filters** are proven and when correctly operated and maintained provide reliable abatement of particulate matter to below 5mg/m^3 and are likely to be BAT for many applications. They cannot be used at high temperatures (over approx. 250°C) as this may give rise to fire risk.
3. Use fabric filters with multiple compartments, which can be individually isolated in case of individual bag failures. There should be sufficient of these to allow adequate performance to be maintained when filter bags fail, i.e. design should incorporate capacity for meeting emission limits during on line maintenance.
4. Provide bag burst detectors (e.g. differential pressure type) on each compartment to indicate the need for maintenance when a bag fails. This type of system provides better control of emissions than simple observation of emitted particulate levels.
5. Where **wet scrubbing** is used in combination with fabric filters (e.g. HWI), the cool and wet gases may require reheat (using indirect heat exchange from an otherwise waste heat source where practicable) to prevent dew point and other problems.
6. **Ceramic filters** may be used for high temperature applications, although their use has generally been limited to smaller plant owing to the larger gas volumes at higher temperatures. Fabric filters tend to be less susceptible to “blinding” and are therefore generally considered BAT.
7. **Electrostatic precipitators** (EPs) are not BAT on their own, but they have a low pressure gradient and, by reducing particulate loading on filters, they may reduce the energy consumption of the induced draft fan. However, this energy saving will be minimal where reagents are dosed onto barrier filters as the contribution of the particulate load to the overall pressure drop is itself relatively minor in comparison to that created by the filters themselves and the reagent cake layer formed.

Emissions to air

8. Wet scrubbers on their own are not BAT for particulate abatement as they are not able to meet the same emission levels as other techniques. They can, however, help prevent emissions of soluble acid gases and heavy metals, and may represent BAT in combination with barrier filtration techniques as mentioned above. They give rise to liquid effluent, which, if not recycled into the process, requires treatment and disposal. You must consider this in your environmental assessment.
9. Wet scrubbers are likely to require re-heat to reduce the risk of forming a visible plume. Reheat should use waste heat from the installation. Additional imported energy is unlikely to be BAT.

Primary NOx measures

10. If you burn wastes that are nitrogen rich (e.g. sewage sludge), you will need to pay particular attention to the techniques for NOx reduction outlined below.
11. Use **low NOx burners** for burning liquid waste or for supplementary firing.
12. Use **starved air systems** where appropriate to reduce both the oxygen content and the temperature in the area where the NOx is normally formed. They can combine good NOx and good CO performance particularly when used with separate chambers.
13. Methane (natural gas) addition is an emerging technique, although not yet commercially proven, in which the gas is either injected into the bed where it can suppress the formation of NOx or into the secondary combustion area (termed reburn) where it can reduce the NOx which has already formed back to N_2.
14. Fluidised bed combustors (FBC) operate at relatively lower combustion temperatures than other systems. They can therefore produce less thermal NOx than other designs and are commonly used for sewage sludge incineration. They are well suited to wastes of a consistent and small particle size but are not suited to large or heterogeneous waste feeds (e.g. raw municipal waste) unless those are pre-treated. Some waste streams (e.g. mixed raw municipal waste) have been difficult to pre-treat, with breakdowns and fires occurring. The potential NOx reductions of combining FBC and feed preparation must therefore be weighed against these potential difficulties for heterogeneous waste types.
15. Where the emission limit values stated in European Directives can be guaranteed without the need for secondary abatement (e.g. reagent injection), and the waste is suitable, FBC with limited (or no) reagent injection may represent BAT. However, such guarantees are not generally being given. This, and the ability of other non-FBC techniques to meet the required emission levels, and provide optimal reagent reaction conditions (see selective non catalytic reduction below) at slightly higher furnace temperatures means that there is currently little to choose between these technologies. The primary consideration should therefore remain that of waste characteristics.
16. Seal all equipment to prevent fugitive air ingress and maintain it under slight negative pressure to allow control of air input and to prevent combustion gas releases.

Emissions to air

17. Optimise primary and secondary air feed so that conditions in the combustion chamber secure oxidative combustion of gases (and hence destruction of organic species), while not being excessive which would result in higher NOx production.
18. For new plant, or when undertaking upgrade of the combustion chamber you must use computerised fluid dynamics (CFD) to optimise your primary and secondary air input. You should provide alternative (multiple) air injection ports and directional injection nozzles to allow for in-service optimisation.
19. **Pyrolysis and gasification** plants are a special case in that they are specifically designed to operate the initial waste destruction stage at reduced oxygen levels. Pyrolysis itself requires the exclusion of oxygen, and semi-pyrolytic and gasification plant use sub-stoichiometric levels to promote gas evolution. It is important that these "reaction" stages are sealed, and that air flows are well controlled to prevent gas escape and to create optimal conditions. The considerations stated in this section regarding balancing the need for oxidative combustion and NOx prevention are relevant to the subsequent combustion of the products that result from the earlier "reaction" stages.
20. Technical guidance for the combustion of products of these processes in internal combustion engines or gas turbines is provided in other guidance. However, it is important to note that their subsequent combustion will be required to comply with WID standards.
21. Avoid excessive or uneven temperatures as this may lead to higher NOx formation (note, though, that you must comply with any minimum temperature requirements imposed by WID). Water cooled grates may assist with temperature control.
22. Use **Flue Gas Recirculation**, which provides an effective means of NOx prevention by replacing 10 to 20% of secondary air with re-circulated flue gases. It has the additional benefit of reducing the consumption of reagents used for secondary NOx control (see below) and may increase overall energy recovery by retaining heat from stack gases. Retrofits at existing plants may prove expensive or impractical due primarily to the space required for ducting.

Secondary NOx measures

23. Secondary measures should be considered **after** the application of primary NOx reduction measures outlined above. The use of secondary measures without applying the primary measures outlined above (including FGR) is unlikely to represent BAT as the primary techniques will serve to reduce the production of NOx, which in turn will reduce reagent consumption during secondary treatment stages.

Selective non-catalytic reduction (SNCR)

24. **Injection of NH_2 -X compounds** into the furnace reduces the emission of NOx by chemically reducing it to nitrogen and water. It is also reported to inhibit dioxin formation.

Emissions to air

Ammonia and urea injection are suitable and either may represent BAT. When dosing is optimised, ammonia tends to give rise to lower nitrous oxide formation (a potent greenhouse gas); however urea may be effective over a slightly wider temperature window and is easier to handle. SNCR relies on an optimum temperature around 900 °C, and sufficient retention time must be provided for the injected agents to react with NO. Port injection locations must therefore be optimised (CFD modelling may be useful and is likely to be essential for all new plant).

25. Poorly optimised reagent injection may give rise to elevated emissions of ammonia. NOx levels should be monitored and the addition of reagent closely controlled to minimise the possibility of ammonia slippage.
26. It is probable that SNCR will be required to ensure that WID standards are met. In order to comply with WID, daily average NOx standards reagent injection rate set points are typically set so that longer term average releases are in the range of 150 to 180mg/m^3. At higher reagent dosing rates further NOx reductions can be achieved but only with increasing cost – reductions significantly beyond WID compliance therefore appear unlikely to represent BAT. This may not be the case at large plant (over 250K te/yr. waste throughput) or where local environmental conditions justify additional NOx reduction.

Selective catalytic reduction (SCR)

27. SCR reduces NO and NO_2 to N_2 by the addition of NH_3 and a catalyst at a temperature range of about 300-400^oC. SCR technology can also reduce VOCs, CO and dioxin emissions
28. SCR is a proven technology in the waste incineration sector, where NOx emissions of below 70mg/m^3 are achieved.
29. The additional costs of SCR are derived mainly from the energy requirements of achieving the required temperature range after the other abatement plant. Low temperature SCR techniques have been developed that avoid this and it is claimed that the costs are of the same order as SNCR.
30. You should include consideration of the use of SCR in your cost benefit assessment and justify if it is not employed. Similarly use of the technique must also be justified against the alternatives (e.g. SNCR) with particular reference to the possibility of reduced energy efficiency with SCR owing to gas re-heat.

Cost/benefit

31. You must provide a cost/benefit study, using the methodology in Horizontal Guidance Note H1 Environmental Risk Assessment, that demonstrates the relative merits of primary measures, SNCR and SCR for NOx control at the installation. The comparison must show the cost per tonne of NOx abated over the projected life of the plant using the asset lives and typical discount rates given in that document.

Emissions to air

Acid gases and halogens

32. Techniques that may represent BAT to minimise acid gas and halogen releases are summarised below. The technique that represents BAT in one incineration sub-sector may be different from that which provides a solution for another. This will generally relate to the potential of the particular waste stream to give rise to acid gas emissions, their quantity and variability.

Primary acid gas measures

33. Use low sulphur fuels <0.2% w/w for start up and support. During start up, shut down, and to support combustion at a temperature above the minimum specified for the particular waste type, WID prohibits the use of fuels which can cause higher emissions than those of gas oil (as defined by Art 1(1) of Directive 75/716/EEC), liquefied gas or natural gas. In requiring the relevant combustion temperature to be maintained at all times when waste is being burned, WID also effectively prevents the use of wastes as a start up fuel, regardless of specification.
34. Because the primary purpose of incineration is the disposal of waste, there may be few opportunities to influence releases through waste selection. It is fundamental that the installation should be designed to cope with the type of waste it is to receive (see abatement design envelope below). However, sometimes a particular waste stream is known to create particular difficulties or the waste stream has changed. An example of this is large quantities of PVC plastics or plaster board where they are not well mixed with other waste at municipal waste incinerators. Where such problems occur, you are expected to take whatever steps are necessary to ensure compliance.
35. These may include:
    - up stream waste management to prevent the inclusion of problem wastes
    - use of front end waste treatment techniques
    - abatement plant operation trimming
    - abatement plant redesign and rebuild.
36. These options are discussed further below. The chosen options will depend upon the nature of the particular waste stream and decisions regarding the ability to reliably segregate the problematic fractions.
37. Waste selection or segregation techniques may help to prevent releases of acid gases by:
    - allowing the removal of problem wastes
    - homogenising the waste feed to provide for improved process stability.
38. This can give the following benefits:
    - minimising the quantity of reagent required to treat the acid gases
    - minimising the amount if waste reagent requiring re-circulation or disposal.

Emissions to air

Abatement design limits

39. Waste varies in terms of its physical and chemical nature depending upon its source and whether it has undergone any pre-segregation or treatment. You must therefore be clear about the types of wastes you intend to receive and their composition. Your application must very clearly outline the composition of the types of waste that will be incinerated and demonstrate that the installation design takes the full range of likely compositions into account. Existing installations may be able to illustrate this with real data regarding waste types and emissions compliance.
40. In particular the abatement plant design envelope must be wide enough to account for the variation in raw flue acid gas concentrations that will be encountered. Particular care must be taken to ensure that short term fluctuations are considered.
41. The design of the acid gas abatement system must take full account of the flue gas loading and the reaction kinetics of the reagent selected in the conditions that will be encountered in the equipment. In-situ temperatures and moisture contents will have a key role in determining the residence time that is required to ensure effective acid gas neutralisation (and removal). Once you have established the abatement plant design you should provide sufficient over-capacity to allow for maintenance or variation in waste composition.
42. In your application you must pay particular attention in describing how waste will be managed to prevent operation outside the design envelope that could lead to possible breaches of authorised limits. This shall include consideration of:
    - the breadth of waste composition likely to be encountered in the waste types to be received
    - identification of any particular wastes which may cause high acid gas loading; this should make reference to any commonly encountered difficulties within the particular sector
    - measures to be taken to prevent the incineration of the wastes identified, including the upstream management of wastes to prevent their inclusion with other waste;
    - measures to treat or mix wastes to ensure peaks are smoothed out
    - plant detection and control measures included to deal with short term high acid gas loading (see below).

Secondary acid gas measures

43. The advantages of the three main techniques, wet, dry and semi-dry, are shown in Table 3.4 below. You must justify the selected technology by referring to the factors indicated.
44. The advantages of the main reagents are shown in Table 3.5 below. You must justify their selection by referring to the factors indicated.

Emissions to air

45. It may be possible for some waste streams of very consistent composition, that can be demonstrated to be reliably very low in halogens (e.g. well segregated non-halogenated waste solvent streams incinerated on the site of production) to be incinerated without alkaline scrubbing. Indeed, to do so where clearly not necessary is itself unlikely to be BAT owing to the unnecessary consumption of reagent. Water scrubbing only may be acceptable in these circumstances.

Alkaline reagent dosing control

46. BAT requires optimisation of the alkaline reagent dosing system. This is because a well optimised reagent dosing control system will:

- control acid gas emissions within emission limit values
- reduce consumption of reagent
- reduce production of alkaline residues

47. You should optimise the alkaline reagent dosing system, by:

- trimming reagent dosing to acid load using fast response upstream HCl or SO_2 monitoring as a trigger
- ensuring reagent concentration can be rapidly changed through use of variable speed pumps / screw feeders and / or low volume intermediate silos (which will allow for more rapid concentration changes)
- use of small silo load cell systems to provide close control on reagent delivery rates in dry systems
- ensuring good (preventative) maintenance of all reagent handling and delivery equipment
- providing sufficient absorption buffer capacity retained in abatement system to maintain abatement when feed fails
- using multiple or back-up feed systems on standby to maintain reagent feed.

Cost/benefit

48. You must provide an acid gas control cost/benefit study using the methodology in Horizontal Guidance Note H1 Environmental Risk Assessment, to demonstrate the relative merits of primary and secondary measures. The comparison must show the cost per tonne acid abated (as HCl) over the projected life of the plant using the asset lives and typical discount rates given in that document.

49. As some technological options will be mutually exclusive, you can assess the overall viable installation design alternatives in relation to that selected, whilst providing comment regarding the reasons why any apparently better individual process stages are not selected on grounds over overall incompatibility.

Emissions to air

Other releases

Carbon oxides (CO_2, CO) and VOCs

Carbon dioxide:

50. All measures that reduce fuel energy use also reduce the CO_2 emissions. The selection, when possible, of raw materials with low organic matter content and fuels with low ratio of carbon content to calorific value reduces CO_2 emissions. In this sector this is only relevant to the support fuels used. In general natural gas will be the preferred option. If not available low sulphur gas oil provides an alternative.
51. The global warming potential (GWP) of the installation will be derived mainly from the CO_2 releases arising from the waste combustion. As it is the purpose of an incinerator to convert wastes into (primarily) water and CO_2 attention should not focus upon these releases but upon the following:CO_2 equivalent releases resulting from N_2O releases. These can contribute in the order of 10% of the GWP, and may be minimised by appropriate selection and optimisation of SNCR reagent injection;
52. Improving installation energy efficiency (including recovery) will prevent CO_2 release by other installations. This may be demonstrated by providing energy balance (Sankey) diagrams and quoting the net energy production per tonne of waste produced.

Carbon monoxide and volatile organic compounds (VOCs):

53. Elevated CO emissions indicate poorly controlled combustion and may indicate elevated releases of other products of poor combustion.
54. Carbon monoxide emissions are not influenced to any significant extent by the conventionally employed abatement techniques. Reductions in CO may be achieved using catalytic oxidation, pulsed corona or re-burn techniques but these are not known to be used at a commercial scale and would in any event be less preferable to primary techniques for the prevention of CO formation.
55. VOCs may be removed to some extent by means of wet scrubbing but they are liable to be released from solution.
56. Reductions in CO and VOC emissions may be achieved by:
    - ensuring the furnace and combustion requirements outlined earlier in this sector guidance are complied with
    - securing consistent waste feed characteristics (e.g. CV, moisture) and feed rates.
57. Starved air systems such as pyrolysis, semi-pyrolytic and gasification processes by their nature deliberately create combustible gases that will comprise high concentrations of CO and VOCs. These partially oxidised gases will need to be burned before release.

Emissions to air

58. Current evidence concerning the ability of these processes to meet the required standards is contradictory. In all cases you will therefore be required to demonstrate that the chosen combustion stage, either alone or in combination with a secondary combustion stage, will be capable of meeting WID and the relevant emission limit values.

Dioxins and furans

59. Although dioxins can be removed by abatement, the primary method of minimising releases is by careful control of combustion conditions. The gas residence times, temperatures and oxygen contents at the combustion stage must be such that any dioxins/furans should be efficiently destroyed.
60. You should ensure that the conditions for *de novo* synthesis are avoided by ensuring exit gas streams are quickly cooled through the *de novo* temperature region between 450°C and 200°C. This should be considered in the design of the energy recovery boiler.
61. As well as a source of organic materials, dioxin/furan formation needs chlorine and thus limiting chlorine input (where this is possible) may have some effect. Where higher concentrations are unavoidable (e.g. HWIs) the prevention of dioxin releases will become a dominant factor in the plant design to an extent that the recovery of energy from the waste stream may be excluded in favour of rapid quench using water. Such quench systems must be designed to achieve a maximum exit temperature of 200 °C (in practice a temperature of approximately 70 °C is likely).
62. Dioxins tend to adhere to particulate matter and therefore **efficient particulate abatement** will remove dioxin/furans from the gas phase. Bag filters impregnated with catalyst specifically developed for the destruction of dioxins/furans are now commercially available and, where fabric filters are installed, should be used where the benchmarks in Annex 1 cannot be otherwise achieved.
63. **FGR**, **SNCR** and **SCR** are all reported to help to prevent dioxin formation and promote their destruction.
64. **Carbon injection** has a proven record of reducing dioxin emissions at a wide range of facilities for relatively little cost and is therefore BAT. The carbon is commonly injected into the gas stream with the acid gas abatement reagent, prior to retention upon filtration equipment.

Metals

65. In the case of mercury (Hg) there is some scope for control at CWIs as the main sources would appear to be dental amalgam. Up-stream waste segregation should be encouraged where releases approach emission limits. (We note that you are likely to have little control over the metal content of the wastes received.

Emissions to air

66. **Carbon injection** gives reliable and effective mercury reductions if Hg is a problem.
67. For the majority of metals particulate abatement is the main means of ensuring that releases are minimised.

Iodine and Bromine

68. When wet scrubber systems are used and plume colouration from iodine or bromine is a problem, sodium thiosulphate can be added to the scrubber to reduce iodine and bromine to the respective halogen hydride. The resulting effluent stream will require treatment.

Emissions to air

Table 3.4: Abatement type – advantages and disadvantages for acid gas control

Abatement type	Advantages	Disadvantages
Wet	High reaction rates Good performance over range of loadings Low reagent consumption Low solid residues production Reagent delivery may be varied by concentration and flow rate Condensation effect may assist with metals abatement	Large effluent disposal and water consumption if not fully treated for re-cycle Effluent treatment plant required May result in wet plume Energy required for effluent treatment and plume reheat Wet systems may experience higher corrosion Pre-scrubbing particulate removal may be required
Dry	Low water use Reagent consumption may be reduced by recycling in plant	Reaction rates low therefore larger residence time required Higher solid residue production with lime based systems Reagent delivery only by input rate
Semi-dry	Medium reaction rates Medium water use Reagent delivery may be varied by concentration and input rate	Higher solid waste residues In process reagent recycle not proven

Emissions to surface water and sewer

Table 3.5 Reagent selection – advantages and disadvantages for acid gas control

Reagent	Advantages	Disadvantages	Comments
Sodium Hydroxide	Highest removal rates Copes well with high acid load Low solid waste production	Effluent requires treatment Corrosive material ETP sludge for disposal	Suitable for HWIs and DIs
Lime	Very good removal rates Low leaching solid residue Copes well with medium acid loads Temperature of reaction well suited to use with bag filters Wet, dry and semi dry systems available	Corrosive material Some handling / pumping difficulties May give greater residue volume if no in-plant recycle	Wide range of uses
Sodium Bicarbonate	Good removal rates Easiest to handle Dry recycle systems proven	Efficient temperature range may be at upper end for use with bag filters – Leachable solid residues Bicarbonate more expensive	Often used at CWIs Not proven at large plant

3.2 Emissions to surface water and sewer

The Waste Incineration Directive sets requirements in respect of:

- the design criteria for prevention of waste water releases
- maximum emission limits for releases to water **arising from air pollution control devices**

Following the use of techniques to reduce the production of pollutants it will be necessary for abatement techniques to be employed that will meet the emission limit value requirements of European Directives, **as a minimum**. You are required to demonstrate in your application that BAT has been employed. It is probable that the use of BAT will result in emissions considerably lower than those specified by the legislation.

Recycling of effluents to ash quench baths can eliminate any need for routine discharges of waste water (other than rain water) from the site. At the same time this helps to prevent fugitive dust releases from ash storage and handling.

Emissions to surface water and sewer

Indicative BAT

Techniques for Treatment of Scrubber Liquors

1. Whether scrubber liquors are to be re-used in the process or discharged, you will normally need to separate out the pollutants captured. If this is not done, and the water is re-injected into the incinerator, the indestructible ones will simply build up in the circuit as they are repeatedly recycled.
2. Treatment is typically as follows:
   - Basic treatment normally comprises neutralisation, flocculation, coagulation and settling. Settling is much more effective when techniques such as lamella plates are used. Filtration may be necessary for separation of fine precipitates.
   - For cadmium, mercury and other heavy metals, precipitating the metals either as hydroxides or sulphides followed by appropriate solids separation can remove up to 90% or more of most heavy metals but probably less than 70% of cadmium and nickel.
   - The use of specialist complexing precipitation agents, such as TMT (trimercapto-s-triazine tri-sodium salt) can settle similar percentages and has the advantage of forming stronger bonds with the metals and therefore results in lower leaching. It is, however, more expensive.
   - The settled solids should then be de-watered by filter, centrifuge or evaporation, to make them easier to handle and subsequently stabilise, prior to landfilling.
   - Organics, including dioxins, furans and PAHs should be measured in the treated effluent and, if present, are best removed by activated carbon which can be returned to the incinerator for destruction. Alternatively if the heavy metals have been removed the treated water itself could be returned to the incinerator, where salt concentration does not prevent it.
   - The liquor will, however, still contain salts, in particular chlorides and sulphates. If the receiving water can support this level of salinity the treated water may be discharged. If not, then ion exchange resins, microfiltration and evaporation techniques could be used. Once treated to this degree, the water may be recycled.
   - Where salts need to be removed, because of the nature of the receiving water, evaporation and reverse osmosis are established techniques.

Odour

3.3 Odour

Indicative BAT

1. You should minimise odour by:
   - enclosing odorous waste all the way to the furnace (ACI, CWI)
   - confining waste to designated areas (all)
   - ensuring that putrescible waste is incinerated within an appropriate timescale (MWI, CWI, ACI, SSI)
   - refrigeration of such waste which is to be stored for longer than an appropriate timescale (CWI, ACI)
   - regular cleaning and (for putrescible wastes) disinfection of waste handling areas (all);
   - design of areas to facilitate cleaning (all)
   - ensuring that the transport of waste and ash is in covered vehicles, where appropriate (all)
   - ensuring good dispersion at all times from any release points (all)
   - preventing anaerobic conditions by aeration, turning of waste and short timescales (SSI, MWI)
   - chlorination of waters being returned to STW or in storage (SSI)
   - drawing air from odorous areas at a rate which will ensure that odour is captured (all); and
   - treating such extracted air prior to release to destroy the odours - see below:

     i) The use of these techniques should obviate the need for odour masking or counteractants.

     ii) You should, as far as possible, feed odorous air into the combustion process.

     iii) Where further treatment is required, you should consider the following:

     – scrubbing for odour control typically would use counter current columns with acids or oxidising agents such as potassium permanganate. A 3-stage scrubbing sequence using sulphuric acid, sodium hydroxide/hydrogen peroxide and sodium hydroxide may be effective;

     – carbon filters are effective, especially where the total quantity of organic compounds is small. Otherwise they can be expensive to run and lead to a significant waste that needs to be treated or disposed of. If it cannot be recovered then preferably spent odour abatement carbon should be fed to the furnace, to destroy the odorous compounds, recover the energy content of the carbon and minimise waste arisings.

Noise and vibration Monitoring and reporting of emissions

3.4 Noise and vibration

Principal sources of noise on incineration plant are:

- induced draft fans
- harmonics between induced draft fans and the chimney
- primary and secondary air fans
- vehicle noise
- waste heat boiler safety relief valves
- transformers
- cooling towers - mainly noise from falling water but also fan noise
- general mechanical handling such as dragging rather than lifting skips

3.5 Monitoring and reporting of emissions (to water, sewer and air)

Indicative BAT

1. If you operate a WID installation, you must comply with the requirements of WID as a minimum.
2. In addition, the Secretary of State's direction to the Agency requires that you monitor for polycyclic aromatic hydrocarbons (PAHs) and dioxin-like polychlorinated biphenyls (PCBs) whenever your permit requires you to monitor for dioxins and furans.
3. The PAHs to be monitored are:
    - Anthanthrene;
    - Benzo[a]anthracene;
    - Benzo[b]fluoranthene;
    - Benzo[k]fluoranthene;
    - Benzo(b)naph(2,1-d)thiophene;
    - Benzo(c)phenanthrene;
    - Benzo[ghi]perylene;
    - Benzo[a]pyrene;
    - Cholanthrene;
    - Chrysene;
    - Cyclopenta(c,d)pyrene;
    - Dibenzo[ah]anthracene;
    - Fluroranthene
    - Indo[1,2,3-cd]pyrene;
    - Naphthalene.

4

Annexes

Annex 1 Emission benchmarks

Annex 2 Other relevant guidance and abbreviations

Annex 1-Emission benchmarks

4. Annexes

Annex 1- Emission benchmarks

Emissions to air

The emissions quoted below are daily averages based upon continuous monitoring during the period of operation. You should take care to convert benchmark and proposed releases to the same reference conditions for comparison. To convert measured values to reference conditions, see the **Monitoring Guidance** for more information. The benchmarks given do not take sampling, analytical errors, or uncertainties into account. These will be considered when setting an ELV for a Permit.

Reference conditions for releases to air

The reference conditions of substances in releases to air from point-sources are:

Incinerators:

- temperature 0 °C (273K);
- pressure 101.3 kPa;
- 11% oxygen, dry gas;

Waste oil incinerators:

- temperature 0 °C (273K);
- pressure 101.3 kPa;
- 3% oxygen, dry gas;

To convert measured values to reference conditions, see the **Monitoring Guidance**[1] for more information.

[1] • MCERTS approved equipment link via http://www.sira.co.uk/services_mcerts.html

Guidance on monitoring can be downloaded free from http://www.environment-agency.gov.uk/business/1745440/444671/466158/

Information about direct toxicity testing of effluent can be downloaded free from http://www.environment-agency.gov.uk/business/1745440/444671/466158/1208802/1222740/?version=1&lang=_e

Annex 1-Emission benchmarks

Table 4.1 Benchmark emission limit values for releases to air

Parameters	Parameters				Frequency requirements
	Units	½ Hour average –100% compliance (figure in brackets is ½ hour average – 97% compliance over a year, unless otherwise specified)	Average of ½ Hour averages over a 24-hour day (100% compliance unless specified)	Periodic	
Particulate matter	mg/m^3	30 (10)	10	N/A	CEM[Note1] and bi-annual spot
VOCs (as total organic carbon, TOC)	mg/m^3	20 (10)	10	N/A	CEM and bi-annual spot
Hydrogen chloride	mg/m^3	60 (10)	10	N/A	CEM and bi-annual spot
Hydrogen fluoride	mg/m^3	4 (2)	1 (or N/A)	N/A (or 4)	CEM and bi-annual spot (or, if HCl is abated and the plant is compliant for HCl: 6 monthly sampling [3 monthly in first 12 months of operation]. Average value over sample period of ½ - 8 hours.
Carbon monoxide	mg/m^3	100 (150 for 95% of all 10 minute averages)	50 (97% over a year)	N/A	CEM and bi-annual spot
Sulphur dioxide	mg/m^3	200 (50)	50	N/A	CEM and bi-annual spot
NOx (NO and NO_2 expressed as NO_2) – existing plant > 6 t/h or new plant	mg/m^3	400 (200)	200	N/A	CEM and bi-annual spot
NOx (NO and NO_2 expressed as NO_2) – existing plant > 6 t/h or new plant	mg/m^3	N/A	400	N/A	CEM and bi-annual spot
Nitrous oxide [Note 2]	mg/m^3	Note 3	Note 3	Note 3	CEM and bi-annual spot
Ammonia [Note 2]	mg/m^3	Note 3	Note 3	Note 3	CEM and bi-annual spot
Cadmium and thallium and their compounds (total)	mg/m^3	N/A	N/A	0.05	6 monthly sampling [3 monthly in first 12 months of operation]. Average value over sample period of ½ - 8 hours
Mercury and its compounds	mg/m^3	N/A	N/A	0.05	6 monthly sampling [3 monthly in first 12 months of operation]. Average value over sample period of ½ - 8 hours

Annex 1-Emission benchmarks

Sb, As, Pb, Cr, Co, Cu, Mn, Ni and V and their compounds (total)	mg/m³	N/A	N/A	0.5	6 monthly sampling [3 monthly in first 12 months of operation]. Average value over sample period of ½ - 8 hours
Dioxins and furans (I-TEQ)	ng/m³	N/A	N/A	0.1	6 monthly sampling [3 monthly in first 12 months of operation]. Average value over sample period of ½ - 8 hours
Dioxins and furans (WHO-TEQ)	ng/m³	N/A	N/A	Note 3	6 monthly sampling [3 monthly in first 12 months of operation]. Average value over sample period of ½ - 8 hours
Reference conditions: temperature 273K, pressure101.3kPa, 11% O_2 (except when burning waste oil only – 3%), dry gas. Note 1: CEM is Continuous Emission Monitoring Note 2: Applies to plants using SCR or SNCR to limit NOx releases Note 3: Monitoring results to be reported for the first year of operation, and an ELV set on the basis of the results					

Emissions to Water and Sewer

- Where automatic sampling systems are employed, not more than 5% of samples shall exceed the benchmark value.
- Where spot samples are taken, no spot sample shall exceed the benchmark value by more than 50%.

Annex 1-Emission benchmarks

Table 4.2 Benchmark emission limit values for releases to water

Parameters	Units	Emission Limit Values	Frequency requirements
Total suspended solids (from APC effluents) as defined in Directive 91/271/EEC	mg/l	<30 (95% of measurements) <45 (100% of measurement)	Spot daily sample or 24-hour flow proportional on a daily basis
Mercury and its compounds expressed as mercury (from APC effluents)*	mg/l	0.03	24-hour flow proportional sample on a daily basis
Cadmium and its compounds expressed as cadmium (from APC effluents)*	mg/l	0.05	24-hour flow proportional sample on a daily basis
Thallium and its compounds expressed as thallium (from APC effluents)*	mg/l	0.05	24-hour flow proportional sample on a daily basis
Arsenic and its compounds expressed as arsenic (from APC effluents)*	mg/l	0.15	24-hour flow proportional sample on a daily basis
Lead and its compounds expressed as lead (from APC effluents)*	mg/l	0.2	24-hour flow proportional sample on a daily basis
Chromium and its compounds expressed as chromium (from APC effluents)*	mg/l	0.5	24-hour flow proportional sample on a daily basis
Copper and its compounds expressed as copper (from APC effluents)*	mg/l	0.5	24-hour flow proportional sample on a daily basis
Nickel and its compounds expressed as nickel (from APC effluents)*	mg/l	0.5	24-hour flow proportional sample on a daily basis
Zinc and its compounds expressed as zinc (from APC effluents)*	mg/l	1.5	24-hour flow proportional sample on a daily basis
Total dioxins and furans (as I-TEQ) (from APC effluents)	ng/l	0.3	24-hour flow proportional sample on a daily basis
Total dioxins and furans (as WHO-TEQ) (from APC effluents)	ng/l	^	24-hour flow proportional sample on a daily basis
pH range #		Site specific	Continuous
Temperature #	°C	Site specific	Continuous
Flow #	l/s	Site specific	Continuous

* Limits for metals apply as 24-hour proportional flow samples. Only 1 sample per year or 5% of annual samples (where more than 20 are taken) may exceed the stated limits.
# Parameters to be measured and limits to be applied continuously.
^ Monitoring results to be reported for first year of operation – ELV to be set based on results

Annex 2-Other relevant guidance and abbreviations

Annex 2- Other relevant guidance and abbreviations

For a full list of available Technical Guidance and other relevant guidance see Appendix A of GTBR (see http://publications.environment-agency.gov.uk/pdf/GEHO0908BOTD-e-e.pdf?lang=_e).

In addition to the guidance in GTBR the following guidance is relevant to this sector:

1. IPPC Reference Document on Best Available Techniques for various sectors European Commission http://eippcb.jrc.es

2. Directives

- Hazardous waste incineration Directive (1994/67/EC)

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- Waste incineration Directive (2000/76/EC)
- Large Combustion Plant Directives (1988/609/EEC)
- Habitats Directive (92/43/EC)
- Landfill Directive 1999/31/EC O. J. L182 16.07.1999
- Urban Waste Water Directive 1999/271/EEC O. J. L182 30.05.1991

3. Incineration

- Guidance on Directive 2000/76/EC On The Incineration of Waste Defra www.defra.gov.uk

4. BAT Review

- Review of BAT for New Waste Incineration Issues. Technical Report P4-100/TR - AEA Technology report for the Environment Agency:

Part 1: Waste Pyrolysis and Gasification Issues

Part 2: Validation of Combustion Conditions

Part 3: New IPPC Considerations.

Environment Agency R&D Dissemination Centre, WRc, Frankland Rd., Swindon WILTS SN5 8YF - e-mail:publications@wrcplc.co.uk

Annex 2-Other guidance available and abbreviations

Abbreviations

ACI Animal Carcass Incinerator

APC Air Pollution Control

BAT Best Available Techniques

BATNEEC Best Available Techniques not entailing excessive costs

BFB Bubbling Fluidised Bed

BOD Biochemical Oxygen Demand

BPEO Best Practicable Environmental Option

BSE Bovine Spongiform Encephalitis

BSI British Standards Institute

CAM Ambient Air Quality Monitoring System

CCA Climate Change Agreement

CCTV Closed Circuit Television

CFB Circulating Fluidised Bed

CFD Computerised Fluid Dynamics

ChWI Chemical Waste Incinerator

COD Chemical Oxygen Demand

CV Calorific Value

CWI Clinical Waste Incinerator

DI Drum Incinerator

DPA Direct Participant Agreement

EC European Community

ELV Emission Limit Value

EMAS EC Eco-Management and Audit Scheme

EMS Environmental Management System

EP Electrostatic Precipitator

EQS Environmental Quality Standard

ETP Effluent treatment plant

FBC Fluidised Bed Combustor

FGR Flue Gas Recirculation

GWP Global Warming Potential

HSE Health and Safety Executive

HWI Hazardous Waste Incinerator

HWID Hazardous Waste Incineration Directive

IEMA Institute of Environmental Management and Assessment

IPPC Integrated Pollution Prevention and Control

ISO International Standards Organisation

ITEQ International Toxicity Equivalents

LOI Loss On Ignition

MBM Meat and Bone Meal

MCERTS Monitoring Certification Scheme

MRF Materials Recycling Facility

MWI Municipal Waste Incinerator

PAH Poly Aromatic Hydrocarbon

PPC Pollution Prevention and Control

PVC PolyVinyl Chloride

RDF Refuse Derived Fuel

SCR Selective Catalytic Reduction

SEC Specific Energy Consumption

SEPA Scottish Environment Protection Agency

SLF Secondary Liquid Fuel

Annex 2-Other guidance available and abbreviations

SNCR Selective Non-Catalytic Reduction

SPA Special Protection Area

SSI Sewage Sludge Incinerator

SSSI Site of Special Scientific Interest

STW Sewage Treatment Works

TMT Trimercapto-s-triazine tri-sodium salt

TOC Total Organic Carbon

TSS Suspended solids

VOC Volatile organic compounds

WAMITAB Waste Management Industry Training and Advisory Board

WHB Waste Heat Boiler

WID Waste Incineration Directive

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