Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

Draft BAT Guidance Note on Best Available Techniques for the Energy Sector (Large Combustion Plant Sector)

Draft 9

Contents

Acknowledgements

The Environmental Protection Agency would like to acknowledge the assistance provided by Byrne Ó Cleirigh in preparing the consultation draft document.

1. INTRODUCTION

1.1 GENERAL

This Guidance Note is one of a series issued by the Environmental Protection Agency (EPA) which provide guidance on the determination of Best Available Techniques (BAT) in relation to:

- applicants seeking Integrated Pollution Prevention and Control (IPPC) licences under Part IV of the Environmental Protection Agency Acts, 1992 and 2003,
- existing Integrated Pollution Control (IPC) licensees whose licence is to be reviewed under the Environmental Protection Agency Acts, 1992 and 2003,
- applicants seeking Waste licences under Part V of the Waste Management Acts 1996 to 2005,
- existing Waste licensees whose licence is to be reviewed under the Waste Management Acts 1996 to 2005.

This Guidance Note shall not be construed as negating the installation/facility statutory obligations or requirements under any other enactments or regulations.

1.2 BAT GUIDANCE NOTE STRUCTURE

This Guidance Note has been structured as follows:

Section	Details
1	Introduction
2	Interpretation of BAT
3	Sector Covered by this Guidance Note
4	Process Description, Risk to the Environment, and Control Techniques
5	Best Available Techniques for the Slaughtering Sector
6	BAT-Associated Emission Levels
7	Compliance Monitoring

Where relevant, references are made to other detailed guidance; such as the reference documents (BREF) published by the European Commission, Agency Guidance Notes for Noise in Relation to Scheduled Activities, and the determination of BAT should be made giving regard to these.

The information contained in this Guidance Note is intended for use as a tool to assist in determining BAT for the specified activities.

2. INTERPRETATION OF BAT

2.1 STATUS OF THIS GUIDANCE NOTE

This Guidance Note will be periodically reviewed and updated as required to reflect any changes in legislation and in order to incorporate advances as they arise.

Techniques identified in these Guidance Notes are considered to be current best practice at the time of writing. The EPA encourages the development and introduction of new and innovative technologies and techniques, which meet BAT criteria and look for continuous improvement in the overall environmental performance of the sectors activities as part of sustainable development.

2.2 INTERPRETATION OF BAT

BAT was introduced as a key principle in the IPPC Directive, 96/61/EC. This Directive has been incorporated into Irish law by the Protection of the Environment Act 2003. To meet the requirements of this Directive, relevant Sections of the Environmental Protection Agency Act 1992 and the Waste Management Act 1996 have been amended to replace BATNEEC (Best Available Technology not Entailing Excessive Costs) with BAT.

Best available techniques (BAT) is defined in Section 5 of the Environmental Protection Agency Acts 1992 and 2003 and Section 5(2) of the Waste Management Acts 1996 to 2003 as the "most effective and advanced stage in the development of an activity and its methods of operation, which indicate the practical suitability of particular techniques for providing, in principle, the basis for emission values designed to prevent or eliminate or where that is not practicable, generally to reduce an emission and its impacts on the environment as a whole" where:

B 'best' in relation to techniques means the most effective in achieving a high general level of protection of the environment as a whole.

A 'available techniques' means those techniques developed on a scale which allows implementation in the relevant class of activity under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced within the State, as long as they are reasonably accessible to the person carrying on the activity.

T 'techniques' includes both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned.

The range of BAT associated emission level values specified in Section 6 indicate those that are achievable through the use of a combination of the process techniques and abatement technologies specified as BAT in Section 5. The licensee must demonstrate to the satisfaction of the Agency, during the licensing process, that the installation/facility will be operated in such a way that all the appropriate preventative measures are taken against pollution through the application of BAT and justify the application of other than the most stringent ELV in the range.

At the installation/facility level the most appropriate techniques will depend on local factors. A local assessment of the costs and benefits of available options may be needed to establish the best option. The choice may be justified on:

– technical characteristics of the installation/facility;

– its geographical location;

– local environmental considerations;

– the economic and technical viability of upgrading existing installation/facility;

The overall objective of ensuring a high level of protection for the environment as a whole will often involve making a judgment between different types of environmental impact, and these judgements will often be influenced by local considerations. On the other hand, the obligation to ensure a high level of environmental protection including the minimization of long-distance or transboundary pollution implies that the most appropriate techniques cannot be set on the basis of purely local considerations.

In the case of LCP regard shall be had to the National Emissions Reduction Plan (NERP) as provided for in the LCP Directive (2001/80/EC).

The guidance issued in this Note in respect of the use of any technology, technique or standard does not preclude the use of any other similar technology, technique or standard that may achieve the required emission standards and is demonstrated to the Agency to satisfy the requirement of BAT.

2.3 BAT HIERARCHY

In the identification of BAT, emphasis is placed on pollution prevention techniques rather than end-of-pipe treatment.

The IPPC Directive 96/61/EC and the Environmental Protection Agency Acts 1992 and 2003 (section 5(3)), require the determination of BAT to consider in particular the following, giving regard to the likely costs and advantages of measures and to the principles of precaution and prevention:

(i) the use of low-waste technology.

(ii) the use of less hazardous substances,

(iii) the furthering of recovery and recycling of substances generated and used in the process and of waste, where appropriate,

(iv) comparable processes, facilities or methods of operation, which have been tried with success on an industrial scale,

(v) technological advances and changes in scientific knowledge and understanding,

(vi) the nature, effects and volume of the emissions concerned,

(vii) the commissioning dates for new or existing activities,

(viii) the length of time needed to introduce the best available techniques,

(ix) the consumption and nature of raw materials (including water) used in the process and their energy efficiency,

(x) the need to prevent or reduce to a minimum the overall impact of the emissions on the environment and the risks to it,

(xi) the need to prevent accidents and to minimize the consequences for the environment, and

(xii) the information published by the Commission of the European Communities pursuant to any exchange of information between Member States and the industries concerned on best available techniques, associated monitoring, and developments in them, or by international organisations, and such other matters as may be prescribed.

3. SECTOR COVERED BY THIS GUIDANCE NOTE

This Guidance Note covers the following activities under the First Schedule to the Environmental Protection Agency Acts 1992 and 2003:

2.1 The operation of combustion installations with a rated thermal input equal to or greater than 50 MW.

4. PROCESS DESCRIPTION, RISK TO THE ENVIRONMENT AND CONTROL TECHNIQUES

4.1 DESCRIPTION OF PROCESS

The Energy Sector covers a range of different combustion systems, techniques and fuels. This Guidance Note relates to installations with a capacity in excess of 50 MWth.

The list of technologies covered by this Note includes:

- Combustion of solid fuels in grate systems, pulverised fuel boilers, and fluidised bed systems,
- Combustion of liquid and gaseous fuels in boilers,
- Combustion of liquid and gaseous fuels in gas turbines and
- Integrated systems for solid, liquid and gaseous fuels

The majority of plants covered by this note are plant for conversion of fuels into energy and the generation of electricity. The basic principle behind power plant is the use of heat energy in a thermodynamic cycle to produce kinetic energy and finally electricity. These thermodynamic cycles necessarily entail a loss of energy as low-grade heat, and all power plants can be rated according to their efficiency or the ratio of useful energy produced to heat input.

There are broadly two categories of plant: direct conversion cycles and steam cycles.

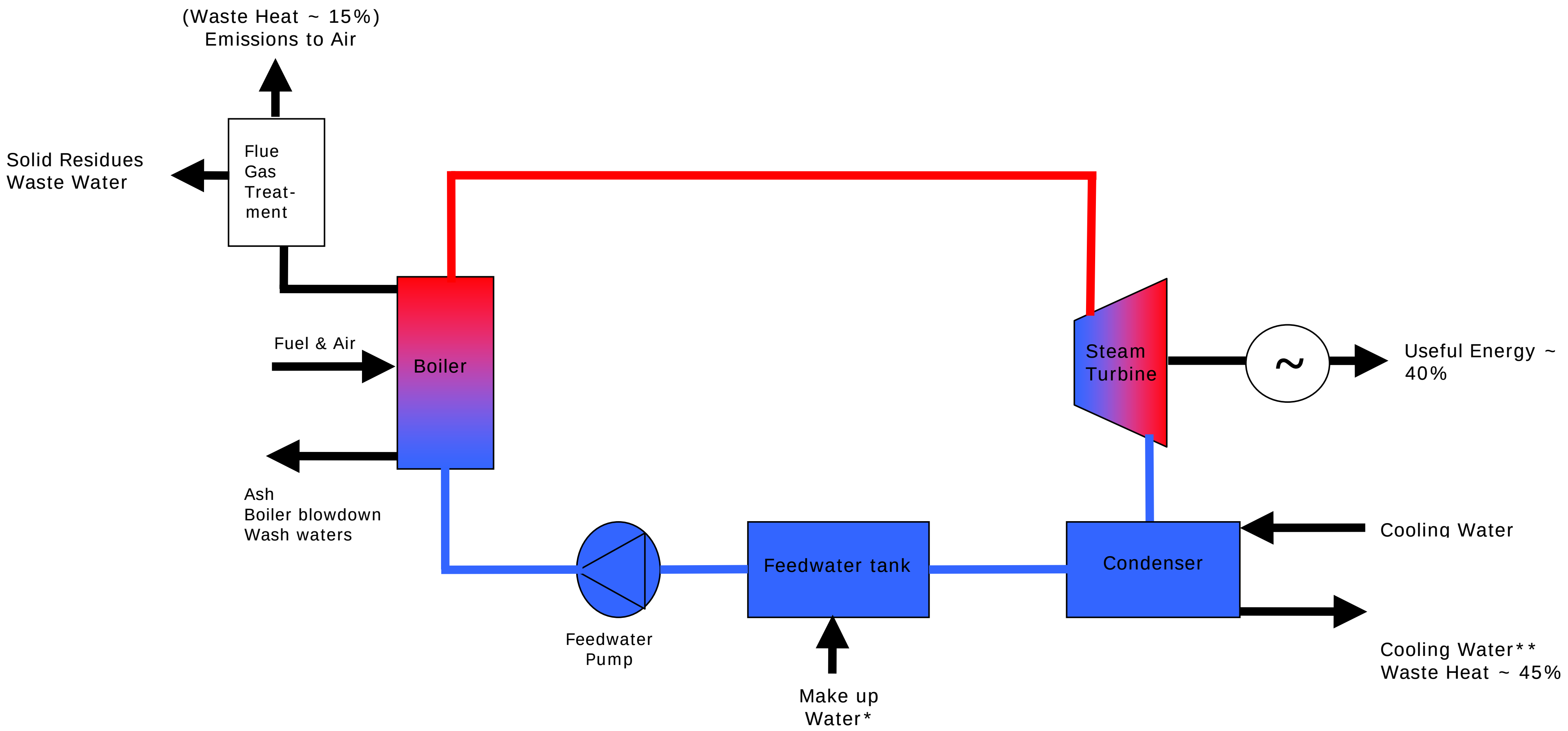
Direct Conversion Plant

In direct conversion plant the hot combustion gases are expanded directly to produce motive power, as in the internal combustion engine or the gas turbine. These types of plant generally reject waste heat directly to the atmosphere in the hot combustion gases.

Steam Cycle

In a steam cycle plant the heat generated from the combustion of fuel is used to produce steam, which is then expanded in a steam turbine and condensed in a condenser. This basic form of a steam cycle is shown in Figure 1. In practice steam cycles are more complex than this basic cycle and include various energy recovery and reheat stages to maximise energy efficiency (LCP BREF Section 2.6). In general, the complexity of the cycle increases as the size of the plant increases. The steam cycle design is dependant on the size of the plant and the extent of the measures taken to improve energy efficiency, and is independent of the fuel used or boiler design.

Figure 1 – Block diagram for basic steam cycle



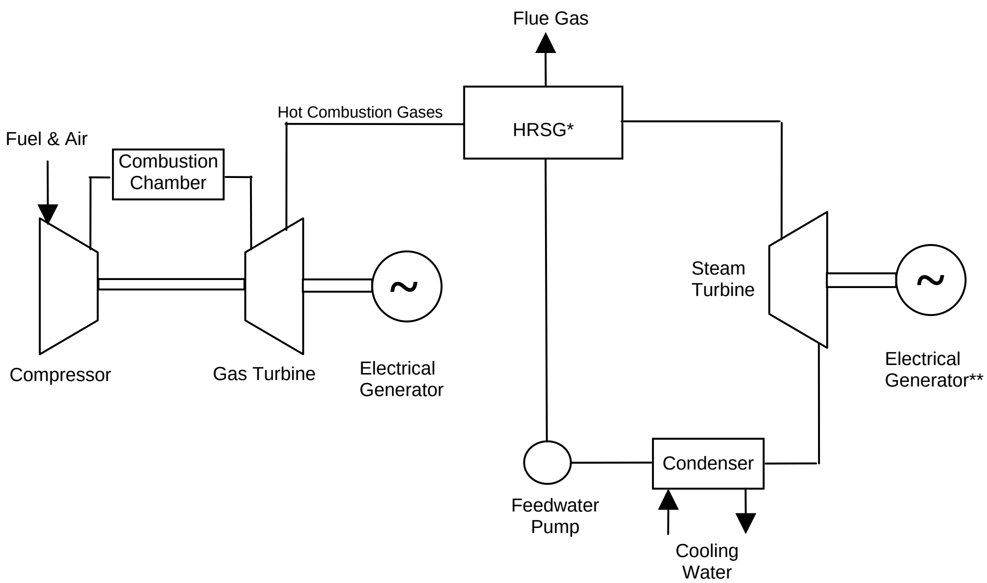
* There is a wastewater stream from the boiler water treatment plant and there may be solid residues depending on the quality of the raw water
** There is a liquid effluent from the cooling system, either as a direct discharge for once through cooling or a blowdown from circulating cooling tower systems.

Combined Cycle Gas Turbine

In integrated systems a combination of energy conversion technologies are used to increase energy efficiency. The most common integrated systems are combined cycle gas turbines (CCGT). In CCGT plant, the waste heat in the hot combustion gases leaving the gas turbine are used to generate steam in a heat recovery steam generator (HRSG), which is effectively a boiler.

This steam is then expanded in a steam turbine to produce additional motive power. A schematic diagram of a CCGT plant is shown in Figure 2.

Figure 2 – Block diagram for CCGT



* Heat Recovery Steam Generator
** CCGT can be configured as either single shaft systems with one electrical generator or as dual shaft systems with two electrical generators.

Boiler Types

The greatest variation in large combustion plant therefore tends to be according to the type of fuel used, the type of boiler and the scale of the plant. In particular, there are a number of different boiler types for solid fuels, which may be appropriate for individual applications depending on fuel type and quality, and the scale of the plant. For smaller solid fuel boilers a grate furnace may be appropriate, whereas for larger boilers, greater than 100 MW_{th}, pulverised combustion (PC) or fluidised bed combustion is preferred. In pulverised combustion the solid fuel is pulverised and is forced through nozzles in burners and is combusted in a manner similar to liquid or gaseous fuels.

In fluidised bed systems, the fuel is injected into a hot turbulent bed of sand with air being blown through the bed from the bottom. The fluidised bed has a large thermal mass, leading to more even and controlled combustion. They are particularly suitable for fuels with a high ash content or low or varying heating values. Fluidised bed combustors also produce lower NO_x emissions than grate or PC systems and allow for simple desulphurisation through the use of sorbent materials in the bed to retain sulphur.

There are three principal types of fluidised bed systems: bubbling fluidised bed combustion (BFBC), circulating fluidised bed combustion (CFBC) and pressurised fluidised bed combustion (PFBC). In bubbling fluidised bed systems sufficient air is blown through the bed to fluidise the bed, but not to entrain any particles from the bed in the air. In a circulating system more air is blown through the bed, which results in particles being entrained in the hot gases. These particles are removed in a cyclone and a portion of the gases is recirculated through the boiler. The pressurised fluidised bed system is an integrated system, where combustion takes place under pressure in the boiler and the hot combustion gases are expanded in a gas turbine before being used to generate steam for the steam cycle.

Other Energy Conversion Techniques

Other energy conversion techniques such as gasification and pyrolysis are more developmental and less widely used. For a description of these processes the reader is referred to the LCP BREF. Likewise, descriptions of internal combustion engines and associated emissions are not included in this document, as their use in Ireland on a scale of over 50 MW_{th} is considered unlikely.

4.2 RISK TO THE ENVIRONMENT

4.2.1 Emissions to Air

Emissions to air are one of the more significant risks to the environment presented by the energy sector and a broad range of substances with the potential to harm the environment are emitted as a result of combustion activities. These substances can have impacts at global, regional and local levels.

The energy sector is one of the largest contributors to greenhouse gas emissions through CO2 and to a lesser extent N2O emissions which pose a significant threat to the global environment.

On a regional level the emission of transboundary air pollutants is a significant risk posed by combustion installations. These emissions are primarily those with the potential to cause acidification: oxides of nitrogen (NOx) and oxides of sulphur (SOx).

Emissions to air from combustion installations also have the potential to cause significant impacts on local air quality. There are a range of emissions and emission sources ranging from dust from solid fuel and ash storage and handling to NOx, SOx CO, hydrocarbons, particulates and heavy metals from combustion plant. All these emissions have the potential to adversely affect air quality.

4.2.2 Emissions to Water

There are a number of aqueous effluent sources from power generation plant. In thermal power generation plant one of the most significant effluents is discharge of cooling water, either from once-through cooling or from cooling tower blowdown. Other effluents include boiler blowdown, effluent from regeneration of ion exchange resins, effluent from reverse osmosis plant, waste wash water, waste water from desulphurisation plant and waste water from slag flushing and ash transport. The list of possible water pollutants from large combustion plant is contained in Table 1.

4.2.3 Waste

The combustion of fossil fuels and biomass is associated with the generation of a variety of residues. According to their origin, residues from a combustion plant can be divided into waste directly related to the process of combustion or waste generated by the operation of the plant and its equipment such as coal mills or water treatment facilities. Residues directly related to the process of combustion of fossil fuels are as follows:

- bottom ash and/or boiler slag
- fluidised bed ash
- fly ash
- flue-gas desulphurisation residues and by-products
- gypsum

Besides the waste that is directly related to the combustion process and which arises in large volumes, lower volume wastes are generated as a result of plant and equipment operation. Typical examples of such wastes are:

- residues from boiler cleaning
- rejects from solid fuel milling
- make-up water treatment sludge
- spent ion-exchange resins
- spent catalysts from SCR processes
- waste water treatment sludge

Other residues include those resulting from used oil and equipment containing oil, equipment containing PCBs, and waste from the treatment of fuel (e.g. coal washing).

Most of the above-mentioned residues, from both the combustion process (e.g. ash) and from the desulphurisation process (e.g. gypsum), and any other residue from the combustion plant generally represent a potential environmental risk. Ash from a coal-fired boiler, for instance, contains elements such as silicon, aluminium, iron, calcium, magnesium, potassium, sodium and titanium, as well as heavy metals such as antimony, arsenic, barium, cadmium, chromium, lead, mercury, selenium, strontium, zinc and other metals.

4.2.4 Odour, Vibration and Noise

Odours from combustion plant can arise from the storage and handling of waste and biomass.

Noise and vibration are common issues arising from the operation of large combustion plants, especially gas turbines, which have the potential for high noise emissions.

4.3 Control Techniques

4.3.1 Techniques for Prevention and Minimisation of Resource Consumption

One of the major environmental impacts of the energy sector is the consumption of natural resources and the emission of greenhouse gases. A primary measure to reduce and control environmental impacts is therefore to increase the efficiency of energy transformation, thereby reducing resource consumption and emissions of greenhouse gases from the use of fossil fuels and biomass.

Detailed discussions on techniques to increase energy efficiency are contained in Section 2.7 of the LCP BREF.

4.3.2 Specific Techniques for Particulate Emissions

Particulate matter can arise either as emissions from fuel storage and handling or through emissions from the combustion of solid or liquid fuels. The control of particulate emissions from the combustion of gas is not necessary.

Control techniques for emissions from the combustion of liquid and solid fuels include

- Controlled combustion to prevent soot formation (liquid fuels)
- Cyclones
- Electrostatic precipitators (ESP)
- Fabric filters

Detailed discussions on techniques to control particulate emissions are contained in Section 3.2 of the LCP BREF.

4.3.3 Specific Techniques for NOx Emissions

The principal oxides of nitrogen emitted during the combustion are nitric oxide (NO) and nitrogen dioxide (NO_2), referred to as NO_x. NO_x is formed in the combustion process through two primary mechanisms: conversion of nitrogen contained in fuel and thermal NO_x, or formation of NO_x from nitrogen contained in the air. As liquid and gaseous fuels contain low to negligible amounts of nitrogen, thermal NO_x is the primary mechanism for NO_x formation for these fuels.

The control of NO_x emissions is achieved through a combination of primary and secondary measures. Primary measures generally minimise the formation of thermal NO_x through reduction of excess oxygen or the control of the combustion temperature. They include, for instance, advanced low NO_x burners, flue-gas recirculation, staged combustion, overfire air and fluidised bed combustion (FBC). FBC tends to produce lower levels of NO_x due to the lower, and more controlled, combustion temperature.

Secondary measures include Selective Catalytic reduction (SCR) and Selective Non-Catalytic Reduction (SNCR). The removal efficiency of SCR systems ranges between 80 and 95 %. However, the use of SCR or SNCR has the disadvantage of a possible emission of unreacted ammonia ('ammonia slip').

Detailed discussions on techniques to control NO_x emissions are contained in Section 3.4 of the LCP BREF.

4.3.4 Specific Techniques for SO2 Emissions

Emissions of sulphur oxides arise from the presence of sulphur in the fuel. Different fuels contain varying levels of sulphur and therefore require different degrees of sulphur removal. For example, natural gas is generally considered free from sulphur whereas industrial gases may contain sulphur and desulphurisation techniques may be required.
The techniques for the reduction of SO_2 emissions are the use of low sulphur fuel, the use of techniques to retain sulphur in ash, or flue gas desulphurisation (FGD) techniques. The addition of sorbent material in boilers (e.g. lime or limestome) promotes the retention of sulphur in ash and is particularly effective for fluidised bed combustion.

There are two broad categories of FGD: Dry FGD and wet FGD. Dry FGD entails sorbent injection into the flue gas and can achieve SO_2 reduction rates of 70% - 95%. Wet scrubbers use an aqueous suspension of limestone to absorb SO_2. The wet scrubber has the advantage of also reducing emissions of HCl, HF, dust and heavy metals. A further advantage is that a useful by-product, in the form of gypsum, is produced.

Sea water scrubbing is another technique for SO_2 removal that may be applicable for large combustion plants situated on the coast. It uses the natural presence of carbonates and bicarbonates in the seawater to absorb SO_2. Sulphur dioxide removal efficiencies up to 98% are reportedly possible. However the technique has localised effects from the release of sulphate, chloride and heavy metals to the sea, and the effect of elevated temperature of water discharges. In considering the appropriate techniques for SO_2 abatement the cross media effects (that is, the overall balance between emission to air, water and land) should also be considered.

Detailed discussions on techniques to control SO_2 emissions are contained in Section 3.3 of the LCP BREF.

4.3.5 Specific Techniques for CO Emissions

Carbon monoxide (CO) is naturally formed as an intermediate product in the combustion process and residual traces of CO in the combustion gases are inevitable. The techniques for the minimisation of CO emissions is complete combustion through good furnace and combustion chamber design, the use of high performance monitoring and process control techniques, and maintenance of the combustion system.

4.3.6 Specific Techniques for Emissions to Water

Besides the generation of air pollution, LCP are also a significant source of waste water discharges (cooling and waste water) into rivers, lakes and the marine environment.

There are various sources for the waste waters and the control techniques vary for each different stream. General techniques for the treatment of waste water are discussed in the BREF Note on Common Waste Water and Waste Gas Treatment Systems.

Any surface run-off from solid fuel storage areas should be collected and treated (settling out) before being discharged. The minimisation and control of waste water emissions from storage of solid or liquid fuels is addressed in the BREF document on Emissions from Storage BREF.

Oil separation wells and interceptors should be used to avoid the release of oils via wash waters with minor amounts of oil contamination.

Effluents from water treatment (de-ionisation) plants should be mixed and pH balanced prior to discharge.

The dosing of cooling water with oxygen scavenging, biocide and other chemicals should be carefully controlled and minimised to reduce the impact on surface waters. Detailed discussions on the optimisation of dosing regimes for cooling water are contained in the Industrial Cooling BREF.

Waste waters from wet FGD plant should be treated prior to discharge. The waste water treatment plant consists of different chemical treatments to remove heavy metals and to decrease the amount of solid matter. The treatment plant should also incorporate adjustment of the pH level, precipitation of heavy metals and removal of solid matter.

4.3.7 Other Emissions

The techniques for the minimisation and control of fugitive air emissions from the storage of solid and liquid fuels are contained in the Storage BREF.

4.3.8 Techniques for Recovery and Recycling of Wastes

All solid wastes should be re-used or recycled where possible. There are many different utilisation possibilities for different wastes and by-products such as ashes. For example bottom ash can be used as an aggregate and pulverised fuel ash (PFA) can be used in cement manufacture and for other construction products. Other by-product streams, such as gypsum from FGD can also be used in the construction sector.

For each utilisation option different specific quality criteria will apply. These criteria are so wide ranging that they have not been addressed in any of the referenced documents, including the LCP BREF.

4.3.9 Noise

For guidance on measures in relation to noise have regard to the Guidance Note for Noise in relation to scheduled activities.

5 BEST OF AVAILABLE TECHNIQUES IN THE ENERGY SECTOR

5.1 INTRODUCTION

As explained in Section 2, this Guidance Note identifies BAT but obviously does so in the absence of site-specific information. Accordingly, it represents the requirements expected of any new activity covered by the Note, and ultimately the requirements expected of existing facilities, but excludes additional requirements, which may form part of the granting of a licence for a specific site.

The technical feasibility of the measures listed below has been demonstrated by various sources. Used singly, or in combination, the measures represent BAT solutions when implemented in the appropriate circumstances. These circumstances depend on plant scale, process type, fuels used etc.

5.2 BAT - GENERAL PREVENTIVE MEASURES

5.2.1 Prevention of Environmental Impact

5.2.1.1 Process Selection

The selection of process for LCP will depend on fuel type, the scale of the plant and also on the expected operating regime. As such no particular process is considered BAT, however, the selected process should maximise energy efficiency and minimise emissions as per the following discussions.

5.2.1.2 Energy Efficiency

One of the major environmental impacts of the energy sector is the consumption of natural resources and the emission of greenhouse gases. A primary measure to reduce and control environmental impacts is therefore to increase the efficiency of energy transformation, thereby reducing resource consumption and emissions of greenhouse gases from fossil fuelled generation.

For all LCP, cogeneration or CHP offers the highest efficiency and lowest consumption of natural resources and CO_2 emissions per unit energy delivered. The LCP BREF Note concludes that CHP is BAT for any new power plant, but acknowledges that its application is contingent on the proximity of a suitable large heat demand, the variability of the heat demand and economic considerations.

The general techniques to be considered in determining BAT for thermal power plants are as follows:

- Minimising the heat loss due to unburned gases and elements in solid wastes and residues from combustion

- Optimising steam cycle efficiency through achieving the highest possible steam pressure and temperature and the repeated superheating of the steam.
- Minimising cooling water temperature
- Reducing energy losses via flue gases through preheating feedwater and combustion air.
- Minimising the heat loss through slag and ashes
- Minimising the internal energy consumption by taking appropriate measures (eg high efficiency pumps and fans)
- Preheating the boiler feed-water with steam
- Use of more efficient turbines with improved blade geometry.

For gas turbines and combined cycle gas turbine (CCGT) plant the use of efficient gas turbines and an efficient steam cycle, incorporating the above techniques, is considered BAT.

These techniques can be applied in increasing the efficiency of existing plant and all these techniques should be incorporated into the design of new power plant. The appropriate use of these techniques can achieve the efficiencies shown in Table 1.

Table 1- Energy efficiency associated with BAT

Fuel	Combustion Technique	Thermal Efficiency	
		New Plants	Existing Plants
Coal	PC	43% – 47%	36% - 40%
	Fluidised bed	> 41%	
	PFBC	> 42%	
Gas	Gas turbine	36% -40%	32% - 35%
	Gas boiler	40% - 42%	38% - 40%
	CCGT	54% - 58%	50% - 54%

It should be noted that for electricity network operability and stability reasons a varied mix of different types of electricity generation plant is required. For example Open Cycle Gas Turbines although less efficient than CCGT, are essential for short term peak lopping especially as a standby reserve for wind turbines.

5.3 BAT - Measures for Treatment, Abatement and Disposal

Emissions to air possibly represent the greatest environmental impact of large combustion plant and the application of appropriate techniques to control emissions is therefore very important in determining BAT. As for other emissions, the appropriate emission control technique is dependant on the fuel type, combustion technique and scale of plant.

5.3.1 Minimisation of Emissions to Air – Coal Fired Plant (see BREF-LCP Section 4.5)

BAT for the control of particulate emissions is the use of electro-static precipitators (ESP) or fabric filters (FF).

For coal fired combustion plant Flue Gas Desulphurisation (FGD) and the use of low sulphur fuel are considered to be BAT for the control of SO2 emissions. The use of low sulphur fuel can be a supplementary technique (particularly for plants over 100 MWth), but generally is not itself sufficient to reduce SO2 emissions.

The techniques that are considered to be BAT for pulverised coal fired combustion plants are: wet scrubbers, spray dry scrubbers and, for smaller applications below approximately 250 MWth, dry sorbent injection (i.e. dry FGD with an adjacent fabric filter).

Wet scrubbers also have a high reduction rate for HF and HCl (98- 99 %). Another advantage of the wet scrubber is its contribution to the reduction of particulate matter and heavy metal (such as Hg) emissions. Existing plants that have already installed a wet FGD system can reduce SO2 emissions by optimising the flow pattern in the absorber vessel.

Wet scrubbers are expensive for smaller plants and are not, therefore, considered as BAT for plants with a capacity of less than 100 MWth. However, unlike other FGD systems, wet scrubbers produce gypsum, which may be a saleable product, used by the cement or construction industries.

For Pulverised Combustion, the use of primary measures such as low NOx burners and Overfire Air (OFA) in conjunction with secondary measures, ie Selective Catalytic reduction (SCR) or Selective Non-Catalytic Reduction (SNCR) is BAT for the control of NOx.

For fluidized bed combustion, staged combustion and effective combustion control is considered BAT for NOx abatement.

Effective combustion control is BAT for CO emission control.

Detailed discussions on BAT for air emissions control from coal fired plant are contained in Section 4.5 of the LCP BREF.

5.3.2 Minimisation of Emissions to Air – Peat Fired Plant (see BREF-LCP Section 5.5)

BAT for the control of particulate emissions is the use of electro-static precipitators (ESP) or fabric filters (FF) (see BREF section 5.5.5)

As for coal fired plant, BAT for SO2 control depends on the type of plant. For grate or pulverised combustion a combination of low sulphur fuel and FGD is BAT.

For fluidised bed combustion, the use of in bed desulphurisation through limestone injection is BAT for plants less than 300 MWth. For larger plants the use of FGD should be considered in determining BAT, dependant on the sulphur content of the fuel and the reduction potential using in bed techniques.

For fluidized bed combustion, staged combustion and effective combustion control is considered BAT for NOx abatement.

Detailed discussions on BAT for air emissions control from peat-fired plant are contained in Section 5.5 of the LCP BREF.

5.3.3 Minimisation of Emissions to Air – Liquid Fuel Fired Plant (see BREF-LCP Section 6.5)

BAT for the reduction of particulate and heavy metal emissions is the use of high efficiency ESPs or fabric filters. For larger scale plant, nominally greater than 300 MWth, the use of ESP or FF in conjunction with wet FGD is BAT.

For plant smaller plant (nominally <100 MWth) the use of low sulphur fuel, or the co-combustion of liquid fuels with gas is BAT for the reduction of SO2 emissions. Dry sorbent injection (DSI) or wet FGD should be considered in determining BAT for larger plant.

BAT for the control of NOx emissions is the use of primary measures and SCR or SNCR.

For liquid fuel fired gas turbines, water or steam injection is BAT for NOx control.

Detailed discussions on BAT for air emissions control from liquid fuel fired plant are contained in Section 6.5 of the LCP BREF.

5.3.4 Minimisation of Emissions to Air – Gas Fired Plant (see BREF-LCP Section 7.5)

Particulate and SO2 emissions from gas-fired plant are typically very low and control measures are generally not required.

BAT for the control of NOx emissions in gas boilers is the use of primary measures in conjunction with SCR/SNCR.

For existing gas turbines BAT for the control of NOx is steam or water injection or retrofitting with Dry Low NOx (DLN) combustors. DLN is BAT for new gas turbines.
Detailed discussions on BAT for air emissions control from gas-fired plant are contained in Section 7.5 of the LCP BREF.

5.3.5 Minimisation of Waste Water Emissions (see BREF-LCP Section 4.3)

The LCP BREF has details of available water treatment techniques (see BREF-LCP Section 3.10) and contains recommendations on what might constitute BAT for a variety of treatment techniques for releases to water (see BREF-LCP Section 4.3).

Bat is to provide storage areas and unloading areas with appropriate containment and bunding.

The effluent from wet scrubbing needs chemical treatment, neutralisation and settlement before discharge. The acidity of the water can be adjusted by the addition of lime or other alkali. Treatment methods for removing cadmium and mercury include precipitating the metals either as hydroxides or sulphides followed by appropriate solids separation. Details on these techniques are contained in the LCP BREF and the Waste Water and Waste Gas BREF.

Wastewater from cooling systems should be controlled through primary measures addressing the dosing regime for the cooling water.

6 BAT ASSOCIATED EMISSION LEVEL VALUES

6.1 EMISSION LEVELS FOR DISCHARGES TO AIR

In the following Sections, the range of emissions, from the lowest emissions associated with BAT in the LCP BREF up to the basic requirements of the Large Combustion Plant Directive are given. For existing installations, BAT at a given installation will be somewhere within this range depending on site-specific considerations such as the age and type of plant and the requirements of the National Emissions Reduction Plan.

Table 6.1 – Range of BAT associated emissions for coal fired plant and similar biomass material

Size (MW_{th})	Combustion Technique	NO_x		SO_2		Particulate Matter	
		New	Existing	New	Existing	New	Existing
50-100	Grate	200 – 400	200 – 600	200 - 850[4]	200 – 2000	5 – 50	5 – 100
	PC & Fluidised Bed	90 - 400	90 - 600	150 - 850[4]	150 – 2000	5 – 50	5 – 100
100 – 300	PC	90 – 200*	90 – 600	100 – 200[4]	100 to 400 - 2000[1]	5 – 30	5 – 100
	Fluidised Bed	100 – 200*	100 - 600	100 – 200[4]	100 to 400 - 2000	5 – 30	5 – 100
300 - 500	PC	90 – 200	90 – 600	20 – 200[3]	20 to 400 - 2000	5 – 30	5 – 100
	Fluidised Bed	50 – 200	50 – 600	100 – 200[3]	100 to 400 - 2000	5 – 30	5 – 100
> 500	PC	90 – 200	90 to 200 - 500[2]	20 – 200[3]	20 – 400	5 – 30	5
	Fluidised Bed	50 - 200	50 to 200 - 500[2]	100 – 200[3]	100 – 400	5 – 30	5

***** The upper level may be 300mg/m^3 where biomass is used.

Note 1: Linear reduction from 2,000 mg/m^3 for 100 MW to 400 mg/m^3 for 500 MW

Note 2: 500 mg/m^3 applies until 1st January 2016 after which time the limit of 200 mg/m^3 will apply.

Note 3: In the case of plants with a rated thermal input greater than 300 MWth a rate of desulphurisation of at least 95% together with a maximum permissible emission limit value of 400 mg/Nm3 shall apply.

Note 4: where the emission limit values above cannot be met due to the characteristics of the fuel, installations shall achieve 300 mg/Nm^3, or a rate of desulphurisation of at least 92% shall be achieved in the case of plants with a rated thermal input of less than or equal to 300 MWth.

Table 6.2 – Range of BAT associated emissions for peat fired plant and similar biomass material

Size (MW_{th})	Combustion Technique	NO_x		SO_2		Particulate Matter	
		New	Existing	New	Existing	New	Existing
50 – 100	All types	150 – 400	150 – 600	200 – 850*	200 – 2000	5 – 50	5 – 100
100 – 300	PC	150 – 200*	150 – 600	200	200 to 400 - 2000[1]	5 -30	5 – 100
	Fluidised bed	150 – 200*	150 – 600	150 – 200	150 to 400 - 2000[1]	5 - 30	5 – 100
300 - 500	All types	50 - 200	50 – 600	50 – 200	50 to 400 - 2000[1]	5 - 30	5 – 100
> 500	All types	50 - 200	50 to 200 - 500[2]	50 – 200	50 - 400	5 - 30	5 - 50

Note 1: Linear reduction from 2,000 mg/m3 for 100 MW to 400 mg/m3 for 500 MW.

Note 2: 500 mg/m3 applies until 1st January 2016 after which time the limit of 200 mg/m3 will apply.

***** 150 – 300mg/m^3 in the case of biomass.

Table 6.3 – Range of BAT associated emissions for liquid fuel fired plant

Size (MW_{th})	Combustion Technique	NO_x		SO_2		PM		CO
		New	Existing	New	Existing	New	Existing	All Plants
50 – 100	All types (excl GTs)	50 – 400	150 – 450	100 – 850	100 – 1700	5 – 50	5 – 100	30 - 150
100 – 300	All types (excl GTs)	50 – 200	50 – 450	100 to 200 – 400 Note1	100 to 400 – 1700[2]	5 – 30	5 - 100	
300 – 500	All types (excl GTs)	50 - 200	50 – 450	50 – 200	50 to 400 – 1700[2,3]	5 – 30	5 - 100	
> 500	All types (excl GTs)	50 - 200	50 – 400	50 - 200	50 - 400	5 – 30	5 - 50	
All sizes	Gas Turbines (OCGT & CCGT)	120	125	120	120	-	-	100

Note 1: Linear reduction from 400 mg/m3 for 100 MW to 200 mg/m3 for 300 MW.

Note 2: Linear reduction from 1,700 mg/m3 for 100 MW to 400 mg/m3 for 500 MW.

Note 3: Plants, of a rated thermal input equal to or greater than 400 MW, which do not operate more than 2,000 hours per annum until 31 December 2015 and 1,500 hours per annum thereafter are subject to a limit value of 800 mg/Nm3 for sulphur dioxide emissions.

Table 6.4 – Range of BAT associated emissions for gas fired plant

Size (MW_{th})	**Combustion Technique**	**NO_x**		**SO_2**		**Particulate Matter**	
		New	Existing	New	Existing	New	Existing
50 – 100	All types (excl GTs)	50 – 400	50 – 450	10 - 35	10 - 35	5	5
100 – 300	All types (excl GTs)	50 - 200	50 – 450	10 - 35	10 - 35	5	5
300 – 500	All types (excl GTs)	50 - 200	50 – 450	10 - 35	10 - 35	5	5
> 500	All types (excl GTs)	50 - 200	50 – 400	10 - 35	10 - 35	5	5
All Sizes	Gas Turbines (OCGT and CCGT)	50	50 - 120	10 - 35	10 - 35	5	5

6.2 EMISSION LEVELS FOR DISCHARGES TO WATER

The following table sets out emission levels that are achievable using BAT for wastewater treatment. However establishing emission limit values within a licence for direct discharges to surface water from wastewater treatment plant and stormwater discharges must ensure that the quality of the receiving water is not impaired or that the current Environmental Quality Standards (EQS) are not exceeded.

All discharges to sewer are subject to approval from the Sanitary Authority.

Compliance with the Water Framework Directive (2000/60/EC) is required where relevant, in particular Article 16.

Table 6.5 BAT Associated Emission Levels for Discharges to Water *

Constituent Group or Parameter	Emission Levels	Percentage Reduction[3]	Notes
pH	6 –9	-	
Toxicity	5-10 TU		1
BOD_5	20mg/l	>91-99%	
COD	30-250mg/l	>75%	
Suspended Solids	10-35mg/l		
Total Ammonia (as N)	10mg/l		
Total Nitrogen (as N)	5-25mg/l	>80%	2, 4
Total Phosphorus (as P)	2mg/l	>80%	4
Oils Fats and Greases	10mg/l		
Mineral Oil (from interceptor)	20mg/l		
Mineral Oil (from biological treatment)	1.0mg/l		
Phenols			5
Metals			5
Organohalogens			5
Priority Substances (as per Water Framework Directive)			5
Cyanides			5
Other			5, 6

* All values refer to daily averages based on a 24-hour flow proportional composite sample, except where stated to the contrary and for pH, which refers to continuous values. Levels apply to effluent prior to dilution by uncontaminated streams e.g. storm water, cooling water, etc.

* Temperature measured downstream of a point of thermal discharge must not exceed the unaffected temperature by more than 1.5^{o}C in salmonid waters and 3^{o}C in cyprinid waters (Freshwater Fish Directive 79/659/EEC).

Note 1: The number of toxic units (TU) = 100/x hour EC/LC50 in percentage vol/vol so that higher TU values reflect greater levels of toxicity. For test regimes where species death is not easily detected, immobilisation is considered equivalent to death.

Note 2: Total Nitrogen means the sum of Kjeldahl Nitrogen, Nitrate N and Nitrite N.

Note 3: Reduction in relation to influent load.

Note 4: Limits will depend on the sensitivity of the receiving waterbody.

Note 5: BAT associated emissions levels are highly dependent on production process, wastewater matrix and treatment. These parameters shall be considered on a site-specific basis when setting emission limit values.

Note 6: Any relevant polluting substances as specified in Schedule to S.I. No. 394 of 2004: EPA (Licensing)(Amendment) Regulations, 2004.

7 Compliance Monitoring

The methods proposed for monitoring the emissions from the sector are set out below. Licence requirements may vary from those stated below due to site-specific considerations, sensitivity of receiving media, and scale of the operations.

7.1 MONITORING OF EMISSIONS TO AIR

7.1.1 Selection of Parameters

Further information on the selection of parameters is given in Section 2.3 of the Monitoring BREF. Information on the timing considerations associated with monitoring is contained in Section 2.5 of the Monitoring BREF.

Continuous monitoring of the following parameters may be required:

- NOx
- SO_2
- Particulate matter (including PM_{10} and $PM_{2.5}$)
- CO

Monitoring of the pressure, temperature and water and oxygen content to allow measured emission concentrations to be adjusted to reference conditions is also required.

Other parameters may need to be monitored, either continuously or as grab samples subject to the detailed monitoring requirements of Annex VIII of the Large Combustion Plant Directive.

7.1.2 Reference Conditions

The standard reference conditions for monitoring emissions to air from combustion plant, as per the LCP Directive and the LCP BREF, for solid, liquid and gaseous fuels used in boilers, and for liquid and gaseous fuels used in gas turbines are:

Solid fuels	Dry gas, 1.013 bar, 273 K, 6% O_2
Liquid and Gaseous fuels	Dry gas, 1.013 bar, 273 K, 3% O_2
Gas turbines	Dry gas, 1.013 bar, 273 K, 15% O_2

7.2 MONITORING OF AQUEOUS EMISSIONS

- For uncontaminated cooling waters, continuous monitoring of temperature and flow.
- Continuous monitoring of flow, volume, pH, temperature and any other relevant parameters deemed necessary by the Agency, taking account of the nature, magnitude and variability of the emissions and the reliability of the control technique.
- Establish existing conditions prior to start-up of key emission constituents and salient flora and fauna.

- Monitoring of influent and effluent for the waste water treatment plant to establish % BOD and COD reduction and early warning of any difficulties in waste water treatment, or unusual loads.
- The potential for the treated effluent to have tainting and toxic effects should be assessed and if necessary measured by established laboratory techniques.
- Periodic biodegradability checks where appropriate on effluents to municipal waste treatment plants, both prior to start-up and thereafter.

7.3 MONITORING OF EMISSIONS TO GROUNDWATER

There should be no direct emissions to groundwater, including during extraction and treatment of groundwater.

7.4 MONITORING OF SOLID WASTE

- The recording in a register of the types, quantities, date and manner of disposal/recovery of all wastes.
- Leachate testing of sludges and other material as appropriate being sent for landfilling.

Annual waste minimisation report showing efforts made to reduce specific consumption together with material balance and fate of all waste materials.

Appendix 1

PRINCIPAL REFERENCES

[1] LCP BREF (Draft BREF on Large Combustion Plants, EIPPCB, May 2005)

[2] WTI BREF (Draft BREF for the Waste Treatment Industries, EIPPCB, January 2004)

[3] Waste Incineration BREF (Draft BREF for the Waste Treatment Industries, EIPPCB, January 2004)

[4] Waste Incineration Directive

[5] LCP Directive (Directive 2001/80/EC of the European Parliament and of the Council of 23 October 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants.)

[6] LCP Directive Review Doc

[7] Storage BREF (Reference Document on Best Available Techniques on Emissions from Storage, EIPPCB, January 2005)

[8] E & CME BREF (Draft BREF on Economics and Cross-Media Effects under IPPC, EIPPCB, September 2003)

[9] Monitoring BREF (BREF on the General Principles of Monitoring, EIPPCB, July 2003)

[10] Cooling Systems BREF (BREF on Industrial Cooling Systems, EIPPCB, December 2001)

[11] Waste Water and Waste Gas Treatment in the Chemical Sector BREF (BREF on Common Waste Water and Waste Gas Treatment/ Management Systems in the Chemical Sector, February 2003)

[12] EPA Guidance Note on Energy Efficiency Auditing (Guidance Note on Energy Efficiency Auditing, Environmental Protection Agency, July 2003)

[13] IPC Technical Guidance: Fuel, power and combustion processes S3 1.01 Combustion Processes: Supplementary Guidance Note Environment Agency (UK), 2000

[14] Integrated Pollution Prevention and Control (IPPC) Sector Guidance for Combustion Activities, Consultation Draft, Environment Agency (UK), March 2005.

[15] US EPA AP-42 (US Environmental Protection Agency, Compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition, Volume I: Stationary Point and Area Sources, January 1995, (updated 2001-2004))

Appendix 2

GLOSSARY OF TERMS AND ABBREVIATIONS

BFBC	bubbling fluidised bed combustion
BOD	biochemical oxygen demand
°C	degree Celsius
CCGT	combined cycle gas turbine
CFBC	circulating fluidised bed combustion
CHP	combined heat and power
CO	carbon monoxide
COD	chemical oxygen demand
CO_2	carbon dioxide
DLN	dry Low NO_x
EA	environment agency
ELV	emission limit value
ESP	electrostatic precipitator
F	Fluorine
FF	fabric filter
HCl	hydrochloric acid
HF	hydrofluoric acid
HFO	heavy fuel oil
K	degree Kelvin (0 °C = 273.15 K)
kPa	kilopascal
LCP	large combustion plant
m^3	cubic metre
mg	milligramme
N_2	nitrogen
NF	nanofiltration
NH_3	ammonia
NH_4	ammonium
NH_4-N	ammonium (calculated as N)
Nm^3	normal cubic metre (101.3 kPa, 273 K)
N_2	nitrogen
N_2O	nitrous oxide
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
O_2	oxygen

PC	pulverised Combustion
PFBC	pressurised fluidised bed combustion
PM_{10}	particles < 10μm in diameter
PO_4-P	phosphate (calculated as P)
SCR	selective catalytic reduction
SNCR	selective non-catalytic reduction
SO_2	sulphur dioxide
SO_x	sulphur oxides
t	tonne (metric)
TDS	total dissolved solids
TSS	total suspended solids
UF	ultrafiltration
VOC	volatile organic compounds