Impact of the Industrial Emissions Directive on the European Power Industry

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Abstract

The Industrial Emissions Directive (IED), published in December 2010, replaces numerous European Directives that govern the environmental regulation of process plant; for example, the Large Combustion Plant Directive, the Waste Incineration Directive and the Integrated Pollution Prevention and Control Directive. The IED applies to new combustion plant permitted from 7 Jan 2013 and existing plant from 1 Jan 2016. The emphasis is placed on power plant, in this paper, including large coal fired boilers and gas turbines.

This paper summarises the key requirements of the IED in relation to both environmental control and emissions monitoring. The concept of Best Available Techniques (BAT) has been strengthened and in some cases the mandatory emission limit values for existing plant, in particular, are more stringent. The monitoring requirements are broadly similar to before but there has been a harmonisation of approach that will make it easier to apply CEMs Quality Assurance standards overall. However, the IED also provides for transitional arrangements for older plant and contains various derogations for plant with low load factors and limited lifetimes. These provisions also need to be addressed when considering the monitoring arrangements.

1 Overall Scope and Structure of the Directive

The over-arching objectives of the Industrial Emissions Directive (IED) [1] are the protection of human health and the environment, and the improvement of environmental quality, by controlling the emissions from industrial activities. The IED takes an integrated approach to the prevention and control of emissions to air, water and land in addition to waste management, energy efficiency and accident prevention.

The IED supersedes and harmonises the requirements of the Integrated Pollution Prevention and Control (IPPC) Directive and those of six other Directives related to industrial emissions, including the Large Combustion Plant Directive (LCPD) [3] and the Waste Incineration Directive (WID) [4]. The other Directives are related to the solvents and the titanium dioxide industries [5, 6].

The structure of the IED is shown in Table 1 which gives a breakdown of the chapters with reference to the individual Articles and the page numbers in the Official Journal of the European Union. The IED does not preclude Member States from applying more stringent controls including, for example, requirements for controlling greenhouse gases

which are excluded from the scope of the IED in relation to the EU Emissions Trading Scheme. The IED does not apply to Research & Development activities or the testing of new products and processes within specified time constraints.

Chapter	Content	Articles	OJ 334/
	PREAMBLE	(1 - 48)	17 - 22
I	Common Provisions	1 - 9	22 - 27
II	Provisions for activities listed in Annex I	10 - 27	27 - 34
III	Special provisions for Combustion Plants	28 - 41	34 -39
IV	Special provisions for waste incineration plants and waste co-incineration plants	42 - 55	39 - 43
V	Special provisions for installations and activities using organic solvents	56 - 65	43 - 46
VI	Special provisions for installations producing titanium dioxide	66 - 70	46 - 46
VII	Committee, transitional and final provisions	71 - 83	47 - 50

Table 1 IED main structure

The Preamble alone contains forty-eight individual points that explain the background to the Directive and provide a summary of the guiding principles and major provisions which include: the permitting of installations; the setting and updating of emission limit values (ELVs) to be based on Best Available Techniques (BAT); the establishment of BAT reference documents (BREFs) that define BAT, and related BAT ELV ranges, for each industrial activity, and the transposition of the IED into national law.

There is some flexibility with regards to the setting of ELVs and averaging periods that differ from BAT, provided that the overall performance is equivalent to BAT. However, in circumstances where the application of BAT would result in disproportionately high costs, when compared with the environmental benefit, deviations from BAT are allowed provided that the mandatory ELVs, where already defined in the IED, are not exceeded.

Chapter I contains common definitions, including those related to permitting and BAT but also defining various categories of combustion plant, fuels and pollutants, noting that radioactive substances and genetically modified organisms are excluded from the scope. This chapter also describes the granting and holding of permits and the actions to be taken when breaching permit conditions or following an accidental release that affects the environment. A plant must not continue to operate if there is a significant negative impact on the environment or an immediate danger to human health. The Commission also has implementing powers to adopt BAT Conclusions, drawn from the BREFs, and to establish detailed rules on the establishment of start-up and shut-down periods and for transitional national plans for large combustion plant (Sections 2.5and 2.6 below).

Chapter II applies integrated pollution control to a wide range of industries previously covered by the IPPC Directive:

- Energy industries (combustion and gasification)
- Production and processing of metals (production and processing of metals)
- Mineral industry (production of cement, lime, glass, ceramics)
- Chemical industry (production of organic and inorganic chemicals)
- Waste management (disposal or recovery of waste)
- Other activities (pulp, paper, fibre-board, slaughter-houses, poultry farming…)

Further details of the individual activities are given in Annex I of the IED (Table 2 below). It should be noted that Carbon Capture and Storage is included in 'Other activities'. A non-exhaustive list of polluting substances to be considered is given in Annex II.

Chapter II lists the basic obligations of operators and further details the permitting process, including revisions due to process changes, and the development of BAT Reference documents. The criteria for determining BAT are given in Annex III of the IED. Permits and, in particular, ELVs must be reviewed within four years of the adoption of the BAT Conclusions drawn from the BREFs.

Annex	Description	OJ 334/
I	Categories of activities referred to in Article 10	51 - 55
II	List of polluting substances	56 - 56
III	Criteria for determining best available techniques	57 - 57
IV	Public participation in decision-making	58 - 58
V	Technical provisions relating to combustion plants	59 - 66
VI	Technical provisions relating to waste incineration plants and waste co-incineration plants	67 - 76
VII	Technical provisions relating to installations and activities using organic solvents	77 - 88
VIII	Technical provisions relating to installations producing titanium dioxide	89 - 89
IX	Repealed directives and time limits for transposition into national law	90 - 91
X	Correlation table	92 - 119

Table 2 IED Annexes

With regards to combustion plant, the IED applies to installations with a total (combined) rated thermal input ≥ 50MW as noted in Annex I. All combustion activities are included in this general aggregation with no lower limit specified for individual units, in line with the IPPC Directive. The general requirements for permitting and BAT then apply to the whole installation.

Chapters III defines special provisions for large combustion plant and this is considered in detail below since combustion processes are the focus of this paper. Chapter IV defines special provisions for waste incineration plant. Chapters V and VI apply to the solvents and titanium dioxide industries and these will not be considered further.

Chapter VII requires each Member State to regularly report on the effectiveness of the IED implementation in relation to BAT and the setting of ELVs. IED inventory reporting for large combustion plant is also required as described in Section 2.7 below.

Every three years, starting from 7 Jan 2016, the Commission will review the need to establish or update the minimum requirements for ELVs, and the monitoring and compliance rules, for the different industrial sectors based on the BAT Conclusions adopted within that previous three year period. This will take account of environmental impacts and the state of implementation of BAT within each sector. In the case of large combustion plant, these minimum requirements are already initially defined in Chapter III and Annex V as discussed below. However, by 31 Dec 2012, the Commission will also review the need to control emissions from smaller combustion installations with an aggregated thermal input below 50MW.

Chapter VII allows for revision of the monitoring and compliance requirements laid down in Annexes V and VI for combustion and incineration plant respectively.

Timetables for the implementation of the IED and transposition into National Law are also specified in Chapter VII. The Large Combustion Plant Directive is repealed from 1 Jan 2016 and is no longer applied from 7 Jan 2013 for new plant. The remaining Directives, including the IPPC Directive and the Waste Incineration Directive, are repealed from 7 Jan 2014.

2 Provisions for Large Combustion Plant

2.1 Scope

The requirements of Chapter III of the IED, and the mandatory minimum ELVs defined in Annex V, apply to individual large combustion plant with a rated thermal input ≥ 50MW, subject to the aggregation rules described below. A combustion plant is any plant in which any fuel is oxidised in order to generate useful heat (including power plant). However, Chapter III does not apply to road, marine or aviation transport or stationary combustion plant of the following types: direct heating, drying or heat treatment processes; integrated post-combustion waste gas treatment units; the regeneration of catalytic cracking catalysts; conversion of H_2S to S; reactors used in the chemical industry; coke battery furnaces; cowpers (air pre-heat stoves used in the steel industry); gas turbines and engines used on offshore platforms and waste incineration plant (other than for uncontaminated biomass which remains subject to Chapter III).

2.2 Aggregation Rules

A single large combustion plant (LCP) of ≥ 50MW thermal input may be comprised of more than one combustion unit if the waste gases are discharged through a common stack. A stack may contain multiple flues.

Units with individual stacks, permitted from 1 Jul 1987, may also be considered to comprise a single LCP, if they could have been flued through a common stack, taking into account technical and economic factors (determined by the competent authority in each Member State).

Emission Limit Values for an LCP depend on the size of the plant (Section 2.3 below) and these are based on the aggregated thermal input of the LCP.

Individual units of less than 15 MW thermal input are not counted when defining these individual LCPs and their rated thermal input. However, smaller units are included when aggregating combustion activities with regards to the general permitting requirements and the application of BAT, as noted above. That is, an installation of more than 50MW thermal input may be comprised of smaller combustion plant.

2.3 Emission Limit Values

With regards to the pollutants listed in Annex II, Emission Limit Values (ELVs) are defined for SO_2, NOx and Dust for plant fired by solid and liquid fuels. For gas fired plant, ELVs are also defined for CO. For gas turbines, ELVs are specified for NOx and

CO only. ELVs apply during normal operation only (excluding start-up and shut-down periods). This point is typically between 50 and 70% of base load for power plant depending on the technical characteristics of the plant. ELVs are set based on the total thermal input of the Large Combustion Plant, regardless of the number of individual units.

Existing plant should not exceed the limit values defined in Part 1 of Annex V from 1 Jan 2016. Existing plant are those permitted before 7 Jan 2013 - or those for which the complete permit application has been submitted before that date and which commence operations by 7 Jan 2014. This does not include plant previously opted-out of the LCPD, with limited running to the end of 2015, which are subject to the more stringent new plant limits described below if they are upgraded and re-open beyond 1 Jan 2016.

New plant, permitted from 7 Jan 2013, should not exceed the more stringent limit values defined in Part 2 of Annex V.

IED Limits (> 300 MW thermal input)

	Existing Plant (Part 1)			New Plant (Part 2)		
	Solid fuel	**Liquid fuel**	**Natural gas**	**Solid fuel**	**Liquid fuel**	**Natural gas**
SO_2	200	200	35 [1]	150 [8]	150	35 [1]
NO_x	200	150 [2]	100 [3,4]	150 [9]	100	100
CO	-	-	100 [5]	-	-	100
Dust	20	20 [6]	5 [7]	10 [10]	10	5 [7]
Ref. $O_{2\ dry}$	6%	3%	3%	6%	3%	3%

Notes to this table

1	Liquefied gas: 5 mg/m^3; Coke oven gas (low CV): 400 mg/m^3; Blast furnace gas (low CV): 200 mg/m^3
2	450 mg/m^3 for distillation and conversion residues from the refining of crude-oil for own consumption in combustion plants with a total rated thermal input ≤ 500 MW which were granted a permit before 27 Nov 2002 or the operators of which had submitted a complete application for a permit before that date, provided that the plant was put into operation no later than 27 Nov 2003
3	200 mg/m^3 for Coke oven gas, Blast furnace gas, low CV gas ex gasification of refinery residues and other gas
4	300 mg/m^3 for combustion plants with a total rated thermal input ≤ 500 MW which were granted a permit before 27 Nov 2002 or the operators of which had submitted a complete application for a permit before that date, provided that the plant was put into operation no later than 27 Nov 2003
5	Specified for natural gas firing only
6	50 mg/m^3 for distillation and conversion residues from the refining of crude-oil for own consumption in combustion plants with a total rated thermal input ≤ 500 MW which were granted a permit before 27 Nov 2002 or the operators of which had submitted a complete application for a permit before that date, provided that the plant was put into operation no later than 27 Nov 2003
7	Blast furnace gas: 10 mg/m^3; Gases produced by the steel industry which can be used elsewhere: 30 mg/m^3
8	200 mg/m^3 for CFBC - all fuels except biomass
9	Pulverised lignite combustion : 200 mg/m^3
10	Biomass and Peat: 20 mg/m^3

Table 3 IED limits for combustion plant > 300 MW thermal input

Annex V defines limit values for different sizes of LCP, based on aggregated thermal input, by pollutant type. For illustrative purposes, the combined ELVs for new and existing plant greater than 300 MW thermal input, e.g., large utility boilers, are given in Table 3. It can be seen that there is some variation of ELV with fuel and technology type. There are additional derogations for plant that operate for less than 1500 hours per year as a five year rolling average.

In broad terms, the IED ELVs are about 50% of the current LCPD values for existing plant except, noting that the NOx ELV was already scheduled to reduce under the LCPD form the same date. This has implications for the monitoring approaches as discussed in Section 3.3 below. There are obviously large costs associated with the installation of the necessary control technologies such as Selective Catalytic Reduction (SCR) for NOx and Flue Gas desulphurisation (FGD) for SO_2, if not already fitted.

For existing gas turbines, the NOx limits depend on the thermal efficiency of the plant, as shown in Table 4 and Figure 1.

IED Limits Gas Turbines (> 50 MW thermal input)

	Existing Plant (Part 1)		New Plant (Part 2)	
	Natural gas	**Liquid fuel**	**Natural gas**	**Liquid fuel**
NOx	50 [1, 2, 3, 4]	90	50 [2]	50
CO	100 [3]	100	100	100
Ref. $O_{2\ dry}$	15%	15%	15%	15%

Notes for this table

1 NOx limit = 75 mg/m^3 if ISO base load efficiency > 75% (CHP) or > 55% (CCGT) & for mechanical drive

2 NOx limit = 50 η / 35 (mg/m^3) for single cycle gas turbines where the ISO base load efficiency is η %

3 NOx limit = 120 mg/m^3 and there is no CO limit for other fuel gases (natural gas is defined as fuel gas containing more than 80% methane by volume)

4 150 mg/m^3 for natural gas and 200 mg/m^3 for other gases or liquid fuels for gas turbines which were granted a permit before 27 Nov 2002 or the operators of which had submitted a complete application for a permit before that date, provided that the plant was put into operation no later than 27 Nov 2003, and which do not operate for more than 1500 hours per year as a rolling 5 year average.

Table 4 IED limits for gas turbines

For gas turbines, ELVs apply only above 70% load and limit values do not apply to gas turbines for emergency use that operate for less than 500 operating hours per year.

These levels of NOx are low, and challenging from a monitoring point of view, but can generally be achieved using lean premix combustion systems without the need for water or steam injection.

It should be noted that, under the LCPD, emission limit values are not defined for existing gas turbines (permitted before 27 Nov 2002).

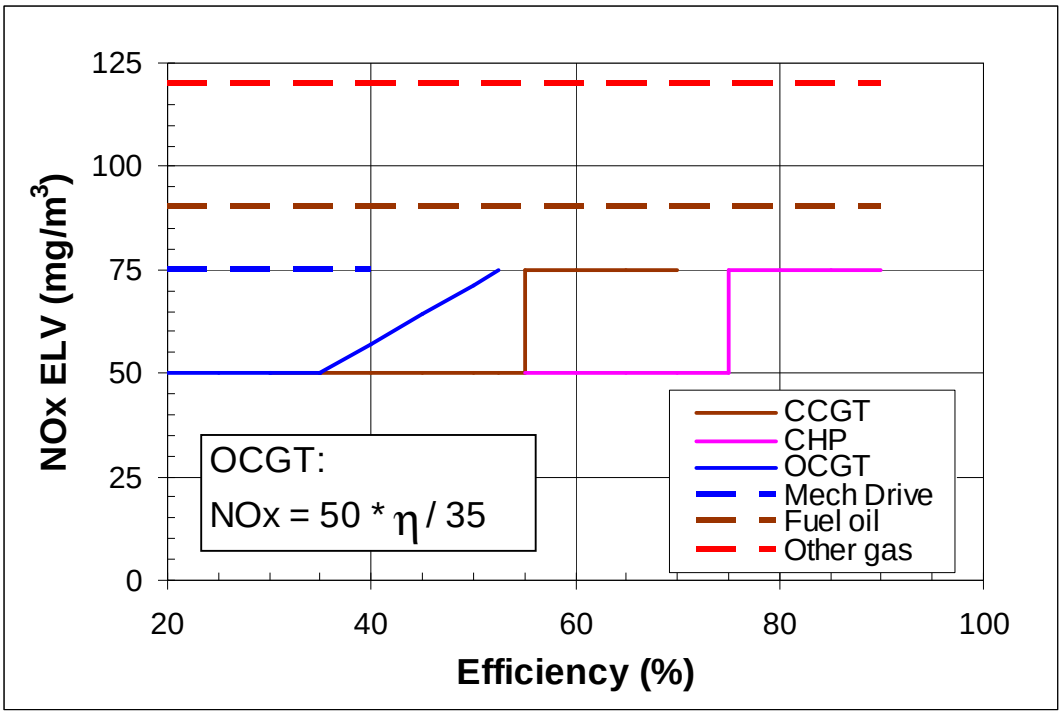

Figure 1 IED NOx limits for existing gas turbines

2.4 Compliance approach

The general compliance approach is given in Part 4 of Annex V noting, again, that ELVs apply during normal operation only (excluding start-up and shut-down and periods of malfunction or breakdown of abatement equipment subject to defined limited time periods). For a given calendar year:

- No validated monthly average exceeds ELV
- No validated daily average exceeds 110% ELV
  (150% ELV for coal fired boilers < 50 MW thermal input)
- 95% of all validated hourly averages do not exceed 200% of the ELV

The validated hourly average is obtained by subtracting a confidence interval (CI) from the CEM reading having already corrected to reference conditions (dry gas, 0°C, 101.325 kPa and the reference dry oxygen value for the process).

The 95% confidence intervals used for this validation process are specified in Annex V Part 3 and are given in Table 5 below.

Species	Confidence interval (95%)
SO_2	20%
NO_x	20%
Dust	30%
CO	10%

Table 5 IED confidence intervals (combustion plant)

2.5 Start-up and shut-down

The Commission is mandated to draw up guidance for the determination of start-up and shut-down periods.

ELVs apply during normal operation only. This excludes start-up and shut-down periods. This end of start-up is typically between 50 and 70% of base load for power plant depending on the technical characteristics of the plant and the fuel type.

During the start-up of gas turbines, it is not possible to combust the fuel with low emissions since the air:fuel ratio is too high to achieve basic flame stability and low emissions simultaneously. Once the combustion system is able to switch into a low emission combustion mode, typically between 50 to 70% of gas turbine load, depending on the turbine model, the acoustic pulsations are then a concern and many parameters are monitored in order to characterise the turbine operation (typically gas and metal temperatures, acoustic pulsations and emissions). It is important to recognise that ambient conditions influence combustion system performance, emissions and acoustics, and fuel quality also has an influence. The end of start-up is therefore typically defined by a load point (the Stable Export Limit) or some other parameter that relates to low emissions operation, e.g., combustion mode.

During the start-up of coal fired plant, the point of Minimum Stable Generation (MSG) is the minimum load point, on the way up in load, at which combustion first becomes stable. When load is dropped the boiler and turbines are 'warmed through' and the point at which stable operation is achieved can be lower, thus defining the Stable Operating Point (SOP). The point at which stable operation is achieved is a function of firing system design and the fuels used. The plant has to accommodate the switch-over from start-up fuel to coal and the bringing into service of the mills and associated ancillary equipment, noting that safety is a primary concern in relation to milling operations. The abatement equipment also needs to be brought into operation for normal running.

The above approaches are well established and ensure that normal operation is achieved as smoothly, reliably and rapidly as possible. There are major difficulties in taking any other approach since compliance with the ELVs set for normal operation is generally not possible during the start-up/shut-down periods and the accuracy of CEMs data is compromised by, for example, the high oxygen levels and related corrections that exist during start-up.

2.6 Transitional National Plans

Individual pollutants (excluding CO) for older Large Combustion Plant, permitted before 27 Nov 2002, may be exempted from ELV compliance in the period 1 Jan 2016 to 30 Jun 2020, subject to at least meeting their existing ELVs, provided that the total tonnage of each pollutant is controlled, at the Member State level, to achieve a specified level of environmental protection overall. The tonnage ceiling for each pollutant is based on a linear interpolation between the tonnage allowed in 2016 and the tonnage allowed in 2019. These ceiling tonnages are based on assumed ELVs for 2016 and 2019 combined with a fixed annual flue gas volume that is derived from a base-line operating period. The base-line operation of each plant is based on the average energy and fuel consumption in the period 2001 to 2010. The national ceilings for each pollutant, for

plant included in the Transitional National Plan, are therefore determined according to a sliding scale between 2016 and 2019, aimed at delivering full ELV compliance by 2019. Plant may be constrained operationally in order to meet the transitional arrangements.

Member States must submit their Transitional National Plans to the Commission by 1 Jan 2013 and these will be approved by 1 Jan 2014 in the absence of any required revisions. Further consideration of TNPs is beyond the scope of this paper. From a monitoring perspective, the implications of the IED for the quality assurance of CEMs, discussed below, will apply from the point at which new or improved abatement plant is installed.

2.7 Inventory and operating hours reporting

Chapter VII requires the reporting, for individual large combustion plant, to the Member States, of the following parameters:

- total rated thermal input;
- date of the start of operation;
- type of plant - boiler, gas turbine, gas engine, diesel engine, other (specify);
- number of operating hours;
- total net energy input (TJ per year) by fuel type - coal, lignite, biomass, peat, other solid fuels (specify) - liquid fuels - natural gas, other gases (specify)
- annual inventory reporting of SO_2, NOx and dust (tonnes per year)

Starting from 1 Jan 2016, a summary of these national inventories is made available to the Commission every three years with a separation of data for plant within refineries.

Annual reporting of fuel sulphur content and the desulphurisation efficiency is required for plant that cannot meet the required SO_2 limits due to the firing of high sulphur indigenous solid fuel. Annual reporting of operating hours is also required for plant that does not operate for more than 1500 hours per year as a five year rolling average.

3 Monitoring requirements

3.1 General provisions

Emissions monitoring underpins all of the compliance and reporting requirements of the IED and will be considered within BAT Conclusions (Article 3).

Monitoring provisions must be specified in permit applications (Article 12) and must be included in the permit conditions (Article 14). Compliance with ELVs is determined on the basis of monitoring results which must be assessed at least annually (Article 15). Monitoring requirements are to be based on BAT conclusions (Article 16) and permit updates are to be underpinned by historical monitoring results (Article 21) which must be publicly available (Article 24).

For Large Combustion Plant, detailed monitoring provisions for emission to air are specified in Part 3 of Annex V, as required by Article 38, which also states that the competent authority shall determine the location of the sampling or measurement points to be used for the monitoring of emissions. The practical implementation of this requirement may be the approval of monitoring points that are proposed and justified by the operator.

For waste incineration plant, the detailed monitoring provisions for emission to air are specified in Part 6 of Annex VI, as required by Article 48.

Monitoring and compliance requirements are included within the three year IED review process (Article 73) and the relevant sections of Annex V (combustion) and Annex VI (incineration) may be amended from time to time to take account of scientific and technical progress (Article 74).

3.2 Provisions for Large Combustion Plant

The following requirements are specified in Part 3 of Annex V and are broadly in line with previous arrangements under the LCPD.

When and what to monitor
Continuous monitoring is formally required by the IED, for plant with a rated thermal input higher than 100 MW, for SO_2, NOx and Dust. CO is also required for gas fired plant.

In addition to the continuous measurement of the specific pollutants, the peripheral measurements that are required to correct the emission concentration to reference conditions must also be measured continuously: oxygen, temperature and pressure and water vapour (not required if the pollutant is measured on a dry basis).

Continuous monitoring may not be required, by agreement with the competent authority, in the following circumstances:

- for SO_2 and dust when firing natural gas (since these are not significant);
- for SO_2 when firing oil with a known sulphur content on plant without desulphurisation equipment (since the SO_2 can be calculated from the fuel sulphur content);
- for SO_2 when firing biomass provided that it can be demonstrated by the operator that the fuel sulphur content would never give rise to a breach of the ELV;
- for low load factor plant (with a remaining life span of less than 10 000 operating hours).

If continuous monitoring is not required, then six monthly periodic monitoring is specified, noting that mercury shall also be measured at least once per year for coal and lignite fired plant (a new requirement). However, alternative procedures can be proposed in place of periodic monitoring of the main pollutants, e.g., calculation of SO_2 from fuel sulphur content.

The above conditions shall be reassessed by the competent authority if there is a significant change in the fuel type or the mode of operation of the plant.

Additional monitoring of fuel sulphur content is required when compliance is based on desulphurisation efficiency rather than an ELV.

How to monitor
Sampling and analysis, and the quality assurance of CEMs, are subject to CEN standards. The major standards of interest are EN 14181 [7] – the quality assurance of Automated Measuring Systems - and EN 15259 [8] – defining measurement locations by the use of duct surveys. The IED also requires annual checking of CEMs using manual reference methods (the Annual Surveillance Test – AST - of EN 14181) and specifies that the competent authority is informed of the results of the checking of the CEMs.

The availability of the CEM systems is expected to be high. Any day with more than three hours of lost data, due to malfunction or maintenance of the CEMs is invalidated. If more than ten invalidated days in a calendar year, the competent authority shall require the operator to take adequate measures to improve the reliability of the CEMs.

3.3 Implications for the Quality Assurance of CEMs

The implications of the IED for the Quality Assurance of CEMs are considered in relation to the Quality Assurance Levels (QALs) specified in EN14181. Power industry experience with the implementation of EN14181 has been considered in a previous paper which makes a number of detailed recommendations [9].

QAL1 (fitness for purpose)
The substantial reduction in ELVs for existing power plant may require replacement of CEMs if they are unsuitable for measuring the lower concentrations. The certified range of the instruments should be less than 2.5*Daily ELV for combustion plant. For the above example of large coal fired utility boilers (> 300 MW thermal), the required certification ranges are shown in Table 6 and Table 7.

Species	**ELV_{24h} (mg/m^3)**	**Required certification range (mg/m^3)**	**Confidence interval (CI)**
NO_x (as NO_2)	220	< 550	± 20%
SO_2	220	< 550	± 20%
Dust	22	< 55	± 30%
O_2	6%	< 15%	± 10%
H_2O	6%	< 15%	± 30%

Table 6 Required certification ranges for large existing coal fired plant (IED)

Species	**ELV_{24h} (mg/m^3)**	**Required certification range (mg/m^3)**	**Confidence interval (CI)**
NO_x (as NO_2)	165	< 412.5	± 20%
SO_2	165	< 412.5	± 20%
Dust	11	< 27.5	± 30%
O_2	6%	< 15%	± 10%
H_2O	6%	< 15%	± 30%

Table 7 Required certification ranges for large new coal fired plant (IED)

Similar information is presented Table 8 for both new and existing gas turbines, subject to the caveats given in Table 4.

Species	**ELV_{24h} (mg/m^3)**	**Required certification range (mg/m^3)**	**Confidence interval (CI)**
NO_x	55	< 137.5	± 20%
CO	110	< 275	± 10%
O_2	10%	< 25%	± 10%
H_2O	6%	< 15%	± 30%

The 'ELV' for O_2 is set at 10%, even though the process reference condition is 15%. The required span value is then close to 21% (air). The importance of the oxygen reading for gas turbines (operating at high excess air levels) needs to be recognised [9].

Table 8 Required certification ranges for existing and new gas turbine plant (IED)

If the certified ranges continue to be acceptable then they can be retained subject to passing the remainder of the QA checks.

If the certified ranges are unacceptable, then new instruments may need to be purchased. Alternatively, the remainder of the QA checks can be done to see if the instruments continue to perform acceptably.

QAL2 and the AST (in- situ calibration)
A QAL2 is required every five years for combustion plant or following a significant change to the process or CEMs.

Coal plant
If SCR is retro-fitted to meet NOx ELVs, the installation of SCR significantly changes the flue gas matrix and a repeat QAL2 is therefore required. This also the case for FGD installation on a coal or oil fired plant.

Gas turbines
Improved NOx control by combustion modification can be regarded as a minor process change since the only impact is a reduced NOx concentration, although it may be prudent to perform an AST to verify the CEMs performance.

CO limits are specified for gas fired systems under the IED. A new CEM for CO measurement may therefore be required if one is not already fitted or if the existing instrument is unsuitable and has not previously been subject to QA requirements. Since CO concentrations are very low, during normal operation, it is often not possible to produce an adequate QAL2 calibration using reference methods. The functional checks are therefore crucially important since it may be necessary to use the linearity data, obtained using test gases, to verify the instrument calibration. The test gases must also be of a high quality if the functional checks are used for these purposes.

General comments
If the CEMs do not meet the revised QAL1 certification requirements, a QAL2 would be required since this effectively constitutes a major change to the CEMs (or at least an AST by agreement with the competent authority).

Various functional checks are required prior to conducting the QAL2 or AST, including a span check and a linearity test. For combustion plant, the nominal measuring range of the CEM is usually set at 2.5*ELV, noting that 95% of the hourly averages are expected to lie below 2*ELV and this allows for the normal process variability. The span value used for calibration of the CEMs is usually set at 2*ELV and the points used in the linearity test are 0, 20, 40, 60, 80 and 100% of span. The reduction in ELVs therefore requires a change in gas cylinder concentrations used by both the site and the Test Laboratory performing the QAL2 tests (if these gases are different).

In the analysis of QAL2 data, the test results are plotted against the CEM results and a straight line is fitted to the data. The QAL2 variability test compares the standard deviation of the differences, between the test points and the calibration line, with a theoretical standard deviation, σ_o, where σ_o = CI * ELV / 100. This assesses the scatter in the data about the calibration line and assumes that any bias is corrected by the calibration; a reduced ELV therefore makes it more difficult to pass the variability test. Similar tests are specified for the AST with similar implications.

	NO_x & SO_2 mg/m^3	**Dust mg/m^3**
Emission Limit Value (24h)	220	22
QAL2 Method A zero points must be less than:	11	1.1
QAL2 Method A if concentration range greater than: or QAL2 Method B if concentration range less than:	33	3.3
QAL2 Standard deviation for variability test σ_o	22	3.4
QAL3 Maximum S_{ams} (5% of ELV)	11	1.1
QAL3 Maximum Action Limit (3*Sams)	44	4.4

Table 9 QA parameters for large existing coal fired plant (IED)

Table 9 shows the various QA parameters that are derived from the ELV for QAL2 testing. The data analysis can either employ a straight line fit through all of the data points including zero points (Method A) or a straight line fit through the average of the high level data points and the average zero value (Method B). Method A is used if the concentration range of the measurements is less than about 15% of ELV, as shown in the table. The zero points must be less than 5% of ELV, also as shown. These requirements may change the QAL2 analysis method for a particular plant.

QAL3 (zero and span drift check)

QAL3 is intended to provide an audited check of ongoing performance by conducting regular zero and span checks of the monitors and comparing the measured drift against pre-defined warning and action limits using a control chart approach, e.g., a Shewhart chart. One simple approach is to set control limits based on the ELV as illustrated in Table 9. These become tighter as the ELV is reduced. However, periodic review of these limits is recommended, in any case, in order to check that they are suitable for the actual instrument drift performance and in order to maintain the accuracy of the reported data. There is therefore a limited impact on QAL3 requirements.

4 Concluding remarks

The Industrial Emissions Directive specifies reduced emission limit values for large combustion plant, representing the minimum standard in the context of applying the Best Available Techniques for emission control. In addition to the major cost implications of applying new or enhanced control technologies to the plant, there are several consequential implications for monitoring and compliance. Reduced limit values apply to existing combustion plant from 1 Jan 2016 and to new plant from 7 Jan 2013.

The reporting periods and associated limit values have been harmonised for compliance purposes such that daily and monthly limit values are specified for both new and existing plant, for NOx, SO_2 and Dust, in addition to an annual percentile requirement for hourly averages. Compliance with CO limits is a new, additional requirement for gas fired plant. Mercury emissions must also be measured, at least annually, for coal and lignite fired plant.

The CEMs must be capable of accurately measuring these lower pollutant concentration levels and they may have to be replaced if their certification is inadequate. The CEMs must, in any case, pass the other requirements of the Quality Assurance standard EN 14181, noting that the associated statistical tests are somewhat more difficult to pass at these lower concentration levels. New CEMs for CO measurement may also be required for gas fired plant that do not have certified instruments that comply with EN 14181.

The implementation of the IED is to be reviewed every three years and the European Commission has a mandate to update the monitoring and compliance provisions from time to time.

5 References

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8. EN 15259:2007. Stationary Source Emissions – Requirements for the measurement sections and sites and for the measurement objective, plan and report.
9. Graham, DP et al, VGB Environmental Working Group – Emissions Monitoring, European Power Industry Experience of EN14181, CEM 2009.