



THE EUROPEAN UNION'S LARGE COMBUSTION PLANT BREF - MONITORING AND COMPLIANCE REQUIREMENTS

The Large Combustion Plant BREF requires existing plants to comply with tougher restrictions on emissions to air that are associated with the application of Best Available Techniques. The BREF also introduces new compliance and monitoring requirements for a wider range of pollutants than considered previously.

The European Union's Industrial Emissions Directive (IED) came into force for existing plant on 1 January 2016 [1]. All combustion plant with an aggregated thermal input $\geq 50 \text{ MW}_{\text{th}}$ must comply with the specified general permitting requirements within the IED and are required to implement Best Available Techniques (BAT) for controlling emissions to air. Medium Combustion Plant ($< 50 \text{ MW}_{\text{th}}$) are considered in previous IET articles [2], [3].

Under the IED, Large Combustion Plant (LCP) must comply with specific additional provisions, noting that Emission Limit Values (ELVs) are defined, as a minimum standard, for NO_x , SO_2 , dust and CO (gas fired plant only) and these pollutants are generally measured using Continuous Emission Monitoring Systems (CEMS). Start-up and shut-down requirements for LCP are defined in a separate EU Implementing Decision [4].

The IED also requires permit conditions and ELVs to be based upon more stringent Associated Emission Levels (BAT-AELs) which are defined in BAT Reference documents (BREFs) for various industrial sectors. The National Competent Authority sets the ELVs based on the BAT-AEL concentration ranges given in the BREF. When a new BREF is published, ELVs defined in the IED are superseded by the BREF but these ELVs are retained as a minimum standard should derogations from the BREF be granted by the National Competent Authority based upon plant specific circumstances.

The BREF requirements are summarised within mandatory BAT Conclusions, published separately, with compliance required within four years of publication. The Large Combustion Plant BAT Conclusions were published in 2017 with compliance for existing plant required by 17 August 2021 [5]. The BAT Conclusions were published in advance of the full LCP BREF [6].

Compliance assessment

The IED compliance approach specifies 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 time limits. For gas turbines, ELVs apply when operating above 70% of ISO Base Load.

For a given calendar year:

- No validated monthly average exceeds ELV
 - No validated daily average exceeds 110% ELV
 - 95% of all validated hourly averages do not exceed 200% of the ELV
- In order to allow for measurement uncertainty, the validated hourly average is obtained by subtracting a confidence interval from the reportable reading having already corrected to reference conditions (dry gas, 273K, 101.3 kPa at the reference dry oxygen value for the process). The 95% confidence intervals used for validation are given in Table 1. However, data validation practices vary somewhat between Member States.

Table 1: IED confidence intervals

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

The LCP BREF specifies BAT-AELs for both annual and daily averaging periods so there is a difference in approach between the IED and the LCP BREF which is addressed in national legislation, e.g., the IED averaging periods may be retained with the addition of an annual ELV (UK). The monthly ELV may also be adapted to give the same environmental benefit as achieved with the annual ELV, for example, as demonstrated in The Netherlands. For gas turbines, BAT-AELs apply when the Dry Low NO_x (DLN) system is 'effective' rather than above 70% load and this is again subject to national interpretation.

The Data Acquisition and Handling Systems (DAHS) used for emissions reporting are subject to EN 17255.

European monitoring standards

The IED requires the implementation of CEN standards, especially EN 14181 which is supplemented by EN 13284-2 for dust, EN 14884 for mercury and EN ISO 16911-2 for flue gas flow rate. CEMS are referred to as Automated Measuring Systems (AMS) within EN 14181 which specifies three Quality Assurance Levels relating to instrument certification (QAL1), on-site calibration using an accredited test laboratory (QAL2) and on-going control of the AMS (QAL3), which requires regular zero and span drift checks. The on-site calibration is checked annually by an accredited test laboratory by means of an Annual Surveillance Test (AST).

Quality Assurance (QA) requirements are based on the daily ELV. As the daily ELV is reduced under the LCP BREF, the QA requirements become more difficult to pass.

QAL1 requires an assessment of the suitability of the AMS. New analysers should be type tested, at a suitable certification range, under an appropriate certification scheme. For example, they should meet the minimum standards set out by schemes such as the Technischer Überwachungsverein (TÜV) in Germany or the UK Environment Agency's Monitoring Certification Scheme (MCERTS), to the requirements of EN 15267 parts 1, 2 and 3. The certification range must be less than $2.5 \times \text{daily ELV}$ for combustion plant and less than $1.5 \times \text{daily ELV}$ for incineration plant. The monitoring equipment must also be located so that a representative reading can be obtained, as demonstrated by duct surveys performed according to EN 15259.

QAL2 requires calibration of the monitors against analytical methods - Standard Reference Methods (SRM) - as defined in a further suite of European standards and as applied by a test laboratory accredited to ISO 17025. The prescribed linear calibration relationship between the AMS and the SRM test data is established by taking at least 15 pairs of measurements obtained across at least three days of normal plant operation although, for dust, a reduced number of tests may be carried out so long as the total test duration is more ≥ 7.5 hours across three days and, for flue gas flow rate, the minimum time period is five hours across at least one day. Any scatter in the data comparison is assumed to be caused by the AMS and this scatter (variability) must be below a threshold, again based on the daily ELV, in order to pass.

QAL3 is intended to provide an audited check of ongoing AMS performance by conducting regular zero and span checks, usually using reference gases, then comparing the measured drift against pre-defined warning and action limits using a control chart approach. The control chart limits become more onerous when they are based on the daily ELV.



Annual Surveillance Tests are intended to validate the calibration established under QAL2 by, again, employing an accredited test laboratory to take a reduced number of parallel measurements during a single day of plant operation. The tolerance applicable to the data scatter is widened and an additional test compares the mean deviation of the new data from the original calibration line. This validity test is also based on the daily ELV, as are the various functional tests that must be performed prior to either a QAL2 or an AST, for example, through the use of linearity testing using reference gases.

It should be noted that, at the lower end of the BAT-AEL ranges, it may not be possible to meet the specified measurement uncertainty requirements with the existing SRMs. As a result, additional standardisation work would need to be undertaken, or the commercially available AMS may not be suitable for the lowest concentration ranges, requiring further technology development to be undertaken.

For dry gas concentration measurements, the oxygen content of the flue gas sample must be measured, and a QAL2 calibration applied, in order to convert the emissions to standard reference conditions. Similarly, for 'wet' gas concentration measurements, the water vapour content must also be measured for correction to the dry reference conditions. For in-situ or extractive dust measurements, the flue gas temperature and pressure are also required. In order to report mass emissions of pollutants, the flue gas flow rate is needed and this is measured and calibrated according to EN ISO 16911-2. Flow monitoring is not formally required under the IED but this is mandated by the LCP BREF as a process monitoring parameter.

LCP BREF Monitoring Requirements

Monitoring requirements, specific to each regulated industrial activity/sector, are defined within each BREF along with the required monitoring standards. Further general guidance on the monitoring of emissions to both air and water is provided in the Reference Report on Monitoring (ROM), prepared by the Joint Research Centre of the European Commission [7].

The LCP BREF defines more stringent monitoring requirements and addresses a wider range of pollutants from: solid fuel fired plant (CO, HCl, HF, Hg and trace metals); gas or oil fired reciprocating engines (CH₄ and CH₂O or TVOC, respectively); and Selective Catalytic Reduction (SCR) or Selective Non-Catalytic Reduction (SNCR) NO_x abatement processes (NH₃ and SO₂).

Either continuous monitoring using CEMS, or periodic monitoring using SRMs, is required dependent upon the pollutant species and the plant technology, size, age and annual operating hours, as defined in BAT Conclusion Number 4 (BAT 4). The required monitoring frequency is given in Table 2, grouped by pollutant type and fuel category, noting that, in all cases, the 'monitoring frequency does not apply where plant operation would be for the sole purpose of performing an emission measurement', e.g., for plant with limited, intermittent operation. Table 2 includes the provisions for reciprocating engines but excludes gasification and co-incineration plant and process fuels used within the Iron & Steel and Chemicals industries.

Regarding Group I pollutants as set out in Table 2, there are no derogations from continuous monitoring for the largest plant for the existing IED pollutants (NO_x, SO₂, CO and dust). Depending on national interpretation, there may be flexibility with regards to CO which is subject to 'indicative' BAT-AELs only. However, smaller LCP (< 100 MW_{th}) and with limited operation (< 1500 hours/year) may instead be monitored periodically every six months. The exception is SO₂ emissions from oil fired plant without abatement, which need to either be monitored more frequently, every three months, or SO₂ emissions reported based on the fuel sulphur content.

Group II pollutants shown in Table 2, i.e., the acid gases HCl and HF, can reduce their monitoring frequency if the emissions are

Table 2: LCP BREF Monitoring Requirements

| Group | Species | Applies to | Frequency | Unless | Then |
|---------------------|-------------------|-----------------------------|----------------|--|--|
| I IED pollutants | NO _x | All fuels | Continuous | Plant < 100 MWth and < 1500 h/yr operation | Periodic (6m) |
| | CO | All fuels | Continuous | Plant < 100 MWth and < 1500 h/yr operation | Periodic (6m) |
| | SO ₂ | Coal, Biomass, HFO, Gas Oil | Continuous | Plant < 100 MWth and < 1500 h/yr operation Oil fired without SO ₂ abatement | Periodic (6m) Periodic (3m) |
| | Dust | Coal, Biomass, HFO, Gas Oil | Continuous | Plant < 100 MWth and < 1500 h/yr operation | Periodic (6m) |
| II Acid gases | HCl | Coal | Periodic (3m) | Emissions are 'sufficiently stable' Plant < 100 MWth and < 1500 h/yr operation | Periodic (12m) Periodic (6m) |
| | | Biomass | Continuous | Emissions are 'sufficiently stable' Plant < 100 MWth and < 1500 h/yr operation Plant < 100 MWth and < 500 h/yr operation | Periodic (6m) Periodic (6m) Periodic (12m) |
| | HF | Coal | Periodic (3m) | Emissions are 'sufficiently stable' Plant < 100 MWth and < 1500 h/yr operation | Periodic (12m) Periodic (6m) |
| | | Biomass | Periodic (12m) | - | - |
| III Metals | Hg | Coal (≥ 300 MWth) | Continuous | Emissions are 'sufficiently stable' | Periodic (6m) |
| | | Biomass | Periodic (12m) | Emissions are 'sufficiently stable' | No monitoring |
| | Trace Metals | Coal, Biomass, HFO, Gas Oil | Periodic (12m) | Emissions are deemed insignificant | Less frequent |
| IV Unburnts | TVOC | HFO, Gas Oil (engines) | Periodic (6m) | Emissions are 'sufficiently stable' | Periodic (12m) |
| | CH ₂ O | NG (engines) | Periodic (12m) | - | - |
| | CH ₄ | NG (engines) | Periodic (12m) | - | - |
| V Abatement | NH ₃ | All fuels with SCR/SNCR | Continuous | Plant < 100 MWth and < 1500 h/yr operation Emissions are 'sufficiently stable' (SCR only) | Periodic (6m) Periodic (12m) |
| | SO ₂ | All fuels with SCR | Periodic (12m) | - | - |

deemed to be 'sufficiently stable' by the National Competent Authority. For example, large biomass fired plant may then monitor HCl every six months, rather than continuously, or large coal fired plant may reduce their periodic HCl monitoring frequency from three monthly to 12 monthly monitoring. Again, there is latitude to reduce the monitoring frequency for small plant with low annual operating hours which have a lower environmental impact.

Group III pollutants include mercury and other trace metals. In the case of mercury, the monitoring frequency can again be reduced if the emissions are deemed to be 'sufficiently stable' by the National Competent Authority. In the case of trace metals, a BAT-AEL is not specified but annual monitoring is required unless the emissions are deemed to be insignificant by the National Competent Authority 'based on an assessment of the relevance of the pollutant releases'.

Group IV pollutants are unburnt fuel species, or partial combustion products, that survive the combustion process and these are monitored periodically in the emissions from reciprocating engines only.

Group V pollutants are monitored when SCR or SNCR processes are used for NO_x abatement. BAT-AELs are specified for ammonia (NH₃) with similar provisions as above for reductions in monitoring frequency. BAT-AELs are not specified for sulphur trioxide (SO₂) emissions but an annual periodic measurement is nevertheless required, noting that an SRM is not defined in BAT 4 for this species.

Summary

The Large Combustion Plant BREF defines the monitoring requirements for emissions to air from a range of combustion processes, fired by a range of fuel types, with the monitoring frequency being dependent upon the plant technology, size, annual operating hours and abatement process. Various provisions allow the monitoring frequency to be reduced, with the approval of the National Competent Authority.

When continuous monitoring is required, this is subject to Quality Assurance (QA) standards that require the CEMS (AMS) to be calibrated by means of on-site testing by an external test laboratory that uses Standard Reference Methods (SRMs). However, as the Emission Limit Values are reduced under the LCP

BREF, it will become more difficult to pass the QA criteria and Operators will need to assess the continuing suitability of their existing CEMS. The accuracy of the SRMs when measuring at low concentrations may also be insufficient.

Further standardisation work is therefore required and the Competent Authority should take these issues into account when specifying ELVs and when assessing compliance.

References

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- [5] Commission Implementing Decision (EU) 2017/1442 of 31 July 2017 establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for large combustion plants, Official Journal of the European Union, L 212/1-82, 17 August 2017.
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Uniper has been directly involved in consultations with the regulators during the development of new legislation both at a European and UK level, for example, the MCPD and the LCP BREF. We also provide technical support to the energy sector and wider industry and can provide a range of supporting services for operators of combustion plant and specified generators, including:

- Interpretation of the legislation and guidance
- All aspects of permit applications
- Air Quality Assessments
- MCERTS accredited emission testing for permit compliance
- BAT and CHP cost-benefit assessments
- Advice on emission reduction and abatement techniques
- Fuel and ash characterisation and related plant impacts

More generally, Uniper can deploy resources on all aspects of power plant construction, operation and decommissioning, including feasibility studies, technical support and outage management and support. Our various consultancy departments provide engineering support across all disciplines: civil; mechanical; electrical; chemical (including combustion); materials (including NDT); data science and environmental science. Uniper has in-depth expertise and knowledge covering all plant types, including utility boilers, gas turbines, steam turbines, incineration plant and renewables.