Technical Guidance Note (Monitoring)

M5

Medium Combustion Plant Directive and Generator Controls: monitoring point source emissions

Environment Agency
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Version X
Draft for consultation

Foreword

This technical guidance note is one of a series providing guidance on monitoring to regulators, process operators and those with interests in monitoring.

It provides information on how to monitor emissions to meet the requirements of the Medium Combustion Pant Directive and Generator Controls.

Feedback

Any comments or suggested improvements to this technical guidance note should be emailed to MCPDHelp@environment-agency.gov.uk

Status of this technical note

This technical note may be subject to review and amendment following its publication. The latest version can be found on our website at: www.mcerts.net.

Contents

1. Medium Combustion Plant Directive and Generator Controls

This technical guidance note has been produced to provide a standardised approach to monitoring point source emissions from plants regulated under the Medium Combustion Plant Directive and for other specified Generators.

Medium-sized combustion plants (MCPs) were a largely unregulated but significant source of emissions of air pollutants. Implementation of the MCP Directive makes an important contribution to improving air quality by providing a means to reduce emissions of SO_2, particulates and NO_2.

MCPs are used to generate heat for large buildings (such as, offices, hotels, hospitals and prisons) and industrial processes, as well as for power generation. Implementing the MCPD[1] will help to reduce air pollution by bringing in emission controls for these combustion plants in the 1-50 MWth range. The Directive requires all plants in scope to be registered or permitted and sets limits on the levels of pollutants that these plants can emit. It also requires operators to test emissions from their plants to demonstrate compliance with emission limits.

Within the UK, there has been rapid growth in the use of low-cost, small scale flexible power (mainly diesel) generators. The MCPD requirements are not sufficient to tackle emissions from the increased use of these generators, so our generator emissions controls mean that these generators are subject to regulations. These regulations apply controls to combustion plant used to generate electricity (‘Specified Generators’) between 1 and 50MWth.

2. Monitoring requirements of the MCPD

The MCPD specifies emission limit values (ELV) that operators must comply with. Measurements are also required for CO at all plants, even though an ELV is not specified. This is because measurement of CO is important for demonstrating combustion efficiency.

All emissions monitoring results for MCPs are standardised to a dry gas, at standard temperature and pressure (273k and 101.3kPa). They are also reported to a reference O_2 concentration of 3% for liquid or gaseous fuels, 6% for solid fuels and 15% for all engines and gas turbines (further information on reference conditions used in stack emissions monitoring is available in EA TGN M2).

Periodic (short term) measurements are required at least every 3 years for plants with a rated thermal input of 1 - 20 MW, and every year for plants with a rated thermal input greater than 20 MWs.

For SO_2 emissions reporting, the MCPD allows other procedures, such as sulphur in fuel analysis, to be used as an alternative to periodic measurements, provided they are verified and approved by the competent authority.

The MCPD states that sampling and analysis of polluting substances and measurements of process parameters, as well as any alternatives must based on methods enabling reliable, representative and comparable results. This TGN provides our approach for meeting this requirement. Where available and practical to do so, methods complying with European standards have been specified in this TGN.

During each measurement, the plant shall be operating under stable conditions, at a representative even load, with start-up and shutdown periods excluded.

For periodic measurements, the ELVs are regarded as having been complied with, if the results of each of the series of measurements do not exceed the relevant ELV.
For larger MCPs, continuous measurements, using continuous emissions monitoring systems (CEMs), may be used as an alternative to periodic measurements. In these cases, the automated measuring systems must be calibrated according to the requirements of BS EN 14181: *Quality assurance of automated measuring systems*[2]. This involves using an appropriately certified CEM, which is calibrated against parallel periodic measurements, which are carried out by an organisation with accreditation for these measurements. Further information is provided in Environment Agency Technical Guidance Note M20[3].

A summary of monitoring requirements are provided in Annex 1.

3. Sample locations

The sample location requirements for plants that are > 20 MW thermal capacity are the same as those specified for stack emissions monitoring. Information on sampling locations for stack emission monitoring is provided in Environment Agency Technical Guidance Note M1[4].

M1 describes the requirements for sample locations and facilities for measuring particulates and gas concentrations. The requirement for measuring gas concentrations are much simpler than those for measuring particulates. Therefore, where the measurement is of concentrations of gaseous species alone, a sampling location can be chosen that does not have to take into account the requirements to measure flow and particulates. This means requirements on designing a measurement section to measure gas concentrations alone are less stringent than for measuring flow or particulates. Also, provided the gases are well mixed the sampling approach is more straightforward because single point sampling may be carried out rather than grid sampling. These simpler arrangements will exist for most measurements carried out to meet the requirements of the MCPD.

For plants that are below 20 MWth thermal capacity, it is acceptable to install a sample location in the boiler, downstream of the combustion zone, provided the gases are well mixed.

4. Emissions monitoring by organisations that specialise in stack emissions monitoring

For some MCPs we would require monitoring to be carried out by an organisation that has MCERTS accreditation (see Box 2.1) for the measurement methods specified in the operator's permit.

Box 2.1 MCERTS
MCERTS is our Monitoring Certification Scheme for instruments, monitoring and analytical services. The scheme is built on proven international standards and provides industry with a framework for choosing monitoring systems and services that meet our performance specifications. MCERTS reflects the growing requirements for regulatory monitoring to meet European and international standards. It brings together relevant standards into a scheme that can be easily accessed by manufacturers, operators, regulators and test houses. Further information on MCERTS is available at www.mcerts.net.

The following plants would require MCERTS accredited monitoring:

- plants that use heavy fuel oil, coal, biomass or wood as fuel

- landfill gas engines that are covered by Chapter II of the Industrial Emissions directive (IED)[5]
- gas engines using off-gas from sewage treatment
- specified generators.

The emissions monitoring compliance test co-insides with a service of a boiler, the test must be carried out before any adjustments to the boiler take place.

MCERTS accredited organisations are required to report results using a standard report format specified in the MCERTS Performance standard for stack emissions monitoring[6].

5. Emissions monitoring by organisations that service and maintain boilers

5.1 Scope

Organisations that service and maintain boilers that are below 20MWth, may carry out compliance monitoring of emissions for the MCPD, as part of their routine service visits.

Most boilers are serviced every 6 months. During this service, emissions measurements are made by the service engineer. These measurements can be averaged to provide the overall result for the compliance period required by the MCPD. For example, for boilers that have a reporting period of once every 3 years, the operator can report the average of the 6 monthly measurements taken over this period. Alternatively, the operator can report a single compliance test result for the reporting period. If the operator chooses to report a single compliance test result, then that test must be carried out by an organisation that has MCERTS accreditation for the methods used.

Portable monitoring systems must be selected that have met the requirements of MCERTS certification for portable analysers[7] (this includes either the scheme for highly portable hand held battery powered analysers, or the scheme for transportable analysers[8], which are certified to EN 15267-4[9]). As an interim measure, systems that have been assessed against the requirements of EN 50379-2[10] (for small heating appliances) may be used, provided the assessment has been made by an organisation with accreditation for these performance requirements (e.g. TUV). However, when analysers are replaced, they must be replaced by analysers that have MCERTS certification for portable analysers. From the 1 January 2025, all analysers must be MCERTS certified.

This sampling and quality assurance procedures below are applicable to the determination of NO, NO_2, CO, O_2 and, where required, SO_2 emissions from small combustion plants (<20MW).

A gas sample is extracted from a location, where the combustion gases are well mixed. It is transported to a portable analyser for determination of gas concentrations using electrochemical cells.

In order to help ensure consistent results, ongoing routine quality assurance tests specified below must be followed.

5.2 Description of the measuring system

The description below is based on the use of electrochemical cells because these are the most commonly used measurement techniques. Other types of analysers may be used, provided they have MCERTS certification for portable analysers.

The sampling system must maintain the gas sample at a temperature above the dew point up to the moisture removal system.

The sample conditioning system must be designed so that there are no entrained water droplets in the gas sample when it contacts the electrochemical sensors.

The sample probe must be of sufficient length to reach the required sample point. The sample probe will be exposed to gases at high temperatures (e.g. >250°C). Therefore, it must be made of temperature resistant and non-reactive material (for example Inconel).

The sample line is designed to prevent gas coming into contact with condensate. Non-reactive tubing must be used to transport the sample gas to the moisture removal system. A heated sample line may also be used.

A tee fitting is used to attach to the probe tip for introducing calibration gases at ambient pressure during the calibration checks. The vented end of the tee has a flow indicator to ensure sufficient calibration gas flow.

A chilled condenser or similar device (e.g. permeation dryer) is used to remove condensate continuously from the sample gas, while maintaining minimal contact between the condensate and the sample gas.

Filters at the probe or the inlet or outlet of the moisture removal system and inlet of the analyser may be required to prevent accumulation of particulate material in the measurement system. Filters must be made of materials that are non-reactive to the gas being sampled.

A leak-free pump is used to pull the sample gas through the system at a flow rate sufficient to minimize the response time of the measurement system. The pump may be constructed of any material that is non-reactive to the gas being sampled.

A sample flow rate control valve and flow meter, or equivalent is used to maintain a constant sampling rate, within 10% during sampling and calibration checks.

The analyser contains electrochemical sensors to determine the NO, NO_2, CO, SO_2 and O_2 concentrations in the sample gas stream. The minimum detectable limit of the analyser depends on the nominal range of the sensor, calibration drift, and signal-to-noise ratio of the measurement system. For a well-designed system, the minimum detectable limit should be less than 2% of the nominal range.

A digital recorder is used for recording measurement data.

An external interference gas scrubber is used by some analysers to remove interfering compounds upstream of a CO electrochemical sensor. The scrubbing agent should be visible and should have a means of determining when the agent is exhausted (i.e. colour indication).

A NO cell temperature indicator thermocouple, thermistor or other device must be used to monitor the temperature of the NO electrochemical sensor. The temperature may be monitored at the surface or within the cell.

5.3 Analyser performance

The following analyser performance checks must be carried out annually or after a major repair to an analyser (e.g. change of electrochemical sensor). These checks can be carried out by the service organisation or other suitable organisation (e.g. a calibration laboratory or the manufacturer of the portable analyser).

A summary of service work carried out on the analyser and test results for Table 1 performance must be recorded in an annual service report.

Table 1: Analyser performance characteristics and associated performance criteria

Performance characteristic	Performance criteria		
	CO, NO, SO_2	**NO_2**	**O_2**
Response time	≤200s	≤200s	≤200s
Zero check	≤5%[a]	≤3%[a]	≤0.4%[b]
Span check	≤5%[a]	≤5%[a]	≤0.4%[b]
Lack of fit	≤5%[a]	≤3%[a]	≤0.4%[b]
Stability check	≤1%[a,c]	≤1%[a,c]	≤0.1%[b]
Cross sensitivity	≤5%[a,d]	≤3%[a,d]	≤0.4%[b,d]

[a] Percentage value of the ELV or the typical concentration, if an ELV if not specified
[b] Values are given as percentage values of oxygen volume concentration (volume fraction).
[c] The stability check is tested for a minimum time duration of 10 minutes
[d] The cross sensitivity check is tested on each sensor using each span gas

5.4 Ongoing measurement system performance check procedures

If the results are part of a 6 monthly programmed service visit, the following procedures are carried out at a frequency dependant on the proven stability of the analyser (for example weekly tests may be extended to monthly, if evidence of stability is available).

Zero and span gases are used for checking that the instrument has not drifted out of calibration.

The span gases used for the gas analyser checks are CO in nitrogen or CO in nitrogen and O_2, NO in nitrogen, NO_2 in air or nitrogen, and O_2 in nitrogen. The mixtures can be combined e.g. O_2 and CO with balance nitrogen.

Ideally, CO and NO span gas concentrations should be at the ELV or the typical concentration, an ELV is not specified. Due to practical considerations it may not always be possible to meet this. Therefore, the span gas concentration must not be greater than twice the concentration of the expected average stack gas reading.

NO_2 sensors are generally designed to measure much lower concentrations than NO sensors, so the span gas should be chosen accordingly (NO_2 span gas must not have a greater concentration than the NO span gas). The test is invalid if the concentration results exceeds 1.25 times the span gas at any time during the test.

Dry ambient air (21% O_2) may be used as a span gas for the O_2 sensor. It is also advisable to have an additional O_2 gas between 5% and 10%.

The sampling system is assembled and the analyser and sample interface are warmed up, according to the manufacture’s recommendations.

For analysers that use an external interference gas scrubber tube, the condition of the scrubbing agent should be inspected to ensure that it will not be exhausted during the on-site tests.

Zero and span gases are injected at the probe tip using an assembly that includes a t-piece to prevent the system becoming pressurised. Gases should flow through all parts of the sample interface (including any exhaust lines). During this check, no adjustments are made to the system, except those necessary to achieve the correct gas flow rate to the analyser. The analyser flow rate must be set to the value recommended by the analyser manufacturer. Each reading must be allowed to stabilize before recording the result (see Annex 2 for example reporting form). The time allowed for the span gas to stabilize must be no less than the stability time noted during the annual stability check. After achieving a stable response, the gas is disconnected and the system is purged with ambient air.

The response time is determined by observing the time required to respond to a 95% step change in the analyser's response for both the zero and span gases. The longer of the two times is taken as the response time. For NO_2 span gas, the time required to respond to a 90% step change is recorded.

If the zero and span test results are not within the specifications in Table 1, corrective action is taken and the calibration check is repeated until an acceptable performance is achieved.

If a single compliance test is being submitted for the reporting period, then the pre-test zero and span procedure is repeated after the emissions test(s) have been completed. No changes are made to the sampling system or analyser until all of the zero and span check results have been recorded. If the zero or span calibration check exceeds the specifications in Table 1, then the test data is invalid.

5.5 Emission test procedure

The emissions monitoring compliance test must be carried out before any adjustments to the boiler during the service take place.

The sampling system is assembled and the analyser and sample interface are warmed up, according to the manufacture's recommendations.

If the emissions test is part of a routine service visit, then just before the start of the test, a check at the sampling location (near the sampling port) on the O_2 range, using ambient air is carried out, in line with the manufacturer's recommendations.

The sampling probe is inserted into the sample location. Sample gas extraction must be carried out at the same rate used during the performance check(s). A constant sample rate must be maintained during the test.

Due to the intermittent operation of small boilers, the sample periods can be limited to a few minutes at a time. As a minimum the sample time must be at least 3 times the response time of the analyser.

Monitoring results must be recorded at least once a minute.

If post-test zero and span checks are required, then no seals in the sample handling system should be broken until after they have been completed (this includes opening the moisture removal system to drain condensate).

The temperature of the electrochemical sensors should be monitored regularly (at least once every 5 minutes) during the sample collection period. The analyser should not be used outside the manufacturer's recommended operating temperature range.

At the end of the test, the sample probe is removed from the stack, and the measuring system is purged with ambient air for a minimum of 5 minutes, to clear the system of sample gas.

Test data is recorded on a form the meets the requirements of Annex 3. This form is not submitted to the Environment Agency but is kept as a record of the monitoring for 6 years.

5.6 Quality assurance

For the following reasons, it is recognised that independent third party accreditation (such as MCERTS for stack emissions monitoring organisations) is not required for natural gas boilers of <20 MWth thermal capacity:

- Individually they present little risk to the environment
- They often only operate intermittently, so it is more practical to measure them before a routine service is carried out
- emissions monitoring makes up a small part of the work of service engineers, who maintain boilers, so MCERTS accreditation would not be appropriate
- measurements of gases using electrochemical sensors is a relatively straightforward procedure, so does not need third party verification

To add confidence in the measurements, we require the organisations that carry them out to have monitoring procedures that meet the requirements of this TGN. These procedures should be included in a management system, such as ISO 9001[11], which has been certified by a third party that has been accredited by UKAS.

We will also carry out a programme of audits to establish that the procedures in TGN M5 are being met. This will include audits of onsite emissions monitoring and of organisations that carry out the annual service and calibration checks of the measurement system.

6. Particulate monitoring

The method for measuring particulates in stacks is defined by EN 13284:1[12]. This standard along with the supporting standard EN 15259[13], specify the criteria needed to carry out particulate measurements.

Due to the complexity of this type of measurement and the specialist equipment required, it must / recommended be carried out by an organisation with MCERTS accreditation for EN 13284-1.

This measurement must be carried out in a straight section of duct or a stack.

In order to meet the limit of detection requirements in EN 13284-1, a specified volume of gas needs to be sampled, which based on the same flow rate will dictate the sample time duration. This results in a minimum sample time of at least 30 minutes. For gas emissions with low dust levels (<5 mg/m3) the sample time required by the standard may be up to 2 hours.

The long sample time required makes it difficult to apply this method effectively n boilers that have short intermittent operation (e.g. few minutes at a time). A potential option is to carry out cumulative sampling, where the sample equipment is installed for sufficient time to collect a 2 hour sample, based on active sampling during periods of intermittent operation. This would require an automated sampling system, they operated when the boiler is operating and switches off when the boiler is no longer operating.

7. Measurement Uncertainty

Measurement uncertainty quantifies the dispersion around the true value, inherent in a measurement result. The uncertainty assigned to a result represents the range of values about the result in which the true value is expected to lie. Uncertainty should be quantified to show that the measurement is fit for purpose, by demonstrating that the uncertainty of the measurements is within certain criteria. The statement of uncertainty includes a value for the level of confidence. This quantifies the probability that the true value lies within the region defined by the confidence interval. The measurement uncertainty defines the size of the region in which the true value is expected to lie, and the confidence interval defines how likely this is.

Measurement uncertainties result from uncertainties of sampling and analysis. The monitoring organisation have a procedure for determining their measurement uncertainty, which is based on the performance of the equipment they use (the spatial and temporal variability during sampling can be ignored from the determination of the uncertainty). A detailed example of how a measurement uncertainty is determined for stack emissions monitoring is provided in Environment Agency Technical Guidance Note M2[14].

For MCERTS accredited organisations, it is a mandatory requirement for them to calculate their uncertainty using the approach outlined in M2. They must also ensure there maximum uncertainty for each result does not exceed the maximum values specified in Table 2. When an MCERTS accredited monitoring result are reported for MCPs, then measurement uncertainty will be taken into account, when assessing compliance with an ELV.

Table 2: Maximum measurement uncertainties (MU) for periodic monitoring

Determinand	% uncertainty	MU source
Particulates	±30	BS EN 13284-1
CO	±6	BS EN 15058
NOx	±10	BS EN 14792
SO_2	±20	BS EN 14791
O_2	±0.5	BS EN 14789. The standard states ±6%. It was developed for reference conditions of 11%, which gives an absolute value of approximately 0.5%.

For monitoring results on plants that are <20 MWth, there are two approaches to uncertainty, depending on the type of monitoring. If the monitoring results are MCERTS accredited the measurement uncertainty associated with the result is reported to us by the operator (we can then take this into account, when we carry out a compliance assessment). If the measurement made by an organisation that services and maintains boilers, then an uncertainty is not reported with the result or taken account of by the Environment Agency.

Annex 1: Summary of monitoring requirements

Plant type	Sample location	QA regime	Equipment certification	Method used	QA frequency
>20MW & any size plant that is not natural gas fired	Requirements of TGN M1	MCERTS accreditation	MCERTS certified (transportable or EN 15267-4)	Reference methods specified in EA TGN M2	Annual instrument checks and zero and span gas checks before and after each measurement
Specified generators	Requirements of TGN M1	MCERTS accreditation	MCERTS certified (transportable or EN 15267-4)	Reference methods specified in EA TGN M2	Annual instrument checks and zero and span gas checks before and after each measurement
<20 MW (natural gas fired only)	Post combustion zone, where gases are well mixed	MCERTS accreditation or minimum requirements in EA TGN M5	MCERTS certified portables	TGN M5 or reference methods specified in EA TGN M2	Option 1 Annual instrument checks and zero and span gas checks before and after each measurement[1]
					Option 2 Annual instrument checks and zero and span gas at a frequency based on proven instrument stability[2]

[1] If option 2 is used the operator reports a single compliance result for the 3 yearly reporting period
[2] If option 2 is used the operator must report the average of each service check from the 3 yearly reporting period

Annex 2: Zero and span check form

Monitoring organisation / service company____
Date__________________
Analyst__________________________
Analyser Manufacturer/Model No.___________________________________
Analyser Serial Number_____________________________

Zero and span **check results:**

Channel	Zero gas conc.	Zero response	Zero error (%)	Span gas conc.	Span response	Span error (%)
NO						
NO_2						
CO						
O2						
SO_2						

Annex 3: Stack emissions monitoring report form for <20 MW plant

The report below is used by organisations that maintain and service boilers. MCERTS accredited organisations use a report format specified in the MCERTS performance standard for organisations.

Report period: ……………… to............................
Site address …………………………………
Permit number………………………………………..
Monitoring organisation / service company……………………………………….
Operator…………………………………………………………………….
Date issued by operator ………………

Emission point		
Substance		
Summary		
Emission limit (mg/m^3)		
Concentration (mg/m^3)		
Measurement details		
Name & model number of analyser		
Serial number of analyser		
Certification of analytical instrument to MCERTS		
Date of test		
Time test started		
Time test finished		
Process conditions		
Process status		
Supporting information		
Interval between sampling		
Serial number of analyser		
Calibration due date of analyser		
Operating conditions		
Ref. conditions used (273k and 101.3kPa) wet/dry, oxygen		

7. References

1. 2015/2193/EU Directive on the limitation of certain pollutants into the air from Medium Combustion Plants

2. EN 14181, Quality assurance of automated measurement systems

3. Technical Guidance Note (Monitoring) M20, Quality assurance of continuous emission monitoring systems, Environment Agency, available from www.mcerts.net

4. Technical Guidance Note (Monitoring) M1, Sampling and safety requirements for monitoring stack releases to atmosphere, Environment Agency, available from www.mcerts.net.

5. 2010/75/EU, Directive on industrial emissions (integrated pollution prevention and control).

6. MCERTS, Manual stack-emission monitoring: performance standard for organisations, Environment Agency, available from www.mcerts.net.

7. MCERTS performance standard for portable emissions monitoring, Environment Agency, available from www.mcerts.net

8. MCERTS performance standards and test procedures for continuous emissions monitoring procedures – Annex F Transportable systems, Environment Agency, available from www.mcerts.net

9. EN 15267-4, Air quality — Certification of automated measuring systems Part 4: Performance criteria and test procedures for automated measuring systems for periodic measurements of emissions from stationary sources.

10. EN 50379-2 Specification for portable electrical apparatus designed to measure combustion flue gas parameters of heating appliances - Part 2: Performance requirements for apparatus used in statutory inspections and assessment

11. ISO 9001, Quality management systems - Requirements

12. EN 13284-1 Stationary source emissions – Determination of low range mass concentration of dust Part 1: Manual gravimetric method

13. EN 15259, Requirement for measurement sections and sites and for the measurement objective, plan and report.

14. Technical Guidance Note (Monitoring) M2, Monitoring of stack gas emissions to air, Environment Agency, available from www.mcerts.net