Differences between CEN/TS 17337:2019 and TGN M22: Stationary Source Emissions Monitoring using Portable Fourier Transform Infrared (FTIR) Spectroscopy

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Scope

This document discusses measurement method CEN/TS 17337:2019 'Stationary source emissions - Determination of mass concentration of multiple gaseous species - Fourier transform infrared spectroscopy'. Significant differences of CEN/TS 17337 compared to TGN M22 'Measuring stack gas emissions using FTIR instruments' are highlighted, along with an itemised list of all differences. Also discussed are: the background to the elaboration of CEN/TS 17337; the document's positioning in the overall CEN/TC 264 'Air Quality' standardisation framework; the document's relationship with EN 16429:2021 'Stationary source emissions — Reference method for the determination of the concentration of gaseous hydrogen chloride (HCl) in waste gases emitted by industrial installations into the atmosphere'. Lastly, details are provided for selecting test gases for the Check Gas Approach found in CEN/TS 17337 for Protea's atmosFIRt.

Standardisation Framework Background

Elaboration of CEN/TS 17337

CEN/TS 17337 [1] provides a method for the measurement of various species emitted from stationary sources measured using portable automated measuring systems (P-AMSs) based on Fourier transform infrared (FTIR) technology. [Nb. in the UK P-AMS are referred to as transportable continuous emission monitoring systems (T-CEMS)]. Whilst the UK was a key driver in the elaboration of this method - due to the desire to replace TGN M22 [2] with a more widely accepted European document - there was another driver in terms of the EC's Directorate-General Environment and the request of CEN/TC 264 'Air Quality' to produce more 'horizontal' standards. Whilst there are well known horizontal standards concerning flow (EN ISO 16911-1 [3]) and sampling (EN 15259 [4]), with regards to pollutant concentration measurands standards have tended to be 'vertical' i.e. species specific. CEN/TS 17337 is a rare example of a measurement method that is technology specific and not species specific.

CEN/TS 17337 and EN 16429 for HCl monitoring

The recently published EN 16429 [5] is higher in the CEN hierarchy than CEN/TS 17337 and is the defacto Standard Reference Method (SRM) for HCl monitoring by P-AMS. The EC Mandate (M/513 [6]) formerly requesting that CEN produce EN 16429 stated that, "…the IED [Industrial Emissions Directive] (Annex VI) is targeting specifically gaseous hydrogen chloride (HCl) and not the other inorganic chlorides" and went onto say that as a "necessary condition for the efficient implementation of the Directive" a new standard is needed to specifically monitor HCl emissions and provide calibration of AMSs (referred to as continuous emission monitoring systems (CEMS) in the UK). Consequently, EN 16429 is not considered an Alternative Method (AM) to EN 1911:2010 'Stationary source emissions — Determination of mass concentration of gaseous chlorides expressed as HCl — Standard reference method' as they provide a method for different measurands (HCl vs total chlorides) [7]. Hence, during the validation of EN 16429 there was no requirement to compare (in accordance with EN 14793 [8]) equivalency between the two methods. However, the IED does not specify what is the SRM for HCl (it only stipulates that CEN standards shall be used if available), CEN/TC 264 don't have the authority to stipulate which methods are SRMs and which are AMs (they can only recommend), therefore, it rests with the local competent authority to designate which method is the SRM for a given measurand. Hence, it seems likely that most, if not all, local competent authorities will continue to consider that EN 1911 is the SRM for HCl (despite the measurand being total chlorides) for the moment. What also complicates this is that whilst emission limits in the IED are expressed in terms of HCl, in some BAT Conclusions (but not all) associated emissions levels (AELs) are expressed in terms of total chloride. For example, the Large Combustion Plant BAT Conclusions [9] defines the measurand as “all inorganic gaseous chloride compounds, expressed as HCl” whilst the Waste Incineration BAT Conclusions [10] is in-line with the IED measurand definition (i.e. HCl only). So, the legislation is not self-consistent.

In terms of how EN 16429 and CEN/TS 17337 fit into the standardisation framework, there is more than one option for local competent authorities to consider. EN 16429 is the defacto SRM for HCl by P-AMS and as mentioned is species specific but not technology specific. Hence, in principle any optical based P-AMS that has successfully achieved type approval in accordance with EN 15267-4 [11] across the applicable measurement range may be used. One of those technologies is of course FTIR. Clause 6 of EN 16429 stipulates that, “Additional requirements described in method specific standards shall be observed, when they exist (e.g. CEN/TS 17337 for P-AMS based on FTIR technique)”. So, for example, this would require additional QA/QC in terms of the Spectral Residual Test from CEN/TS 17337. In concept, these two methods have been designed to work together, a vertical method providing species specific QA/QC (EN 16429) and a horizontal method providing technique specific QA/QC. Indeed, this has been mirrored for SO_2 in that CEN/TS 17021 [12] in Clause 6.3.1 stipulates that “Additional requirements described in method specific standards shall be observed” (CEN/TS 17337 was published after CEN/TS 17021 so could not be specifically referenced in the latter). Whether in the future we will see more technique specific methods (e.g. for CRDS, TDL) remains to be seen, but if not, technology specific QA/QC will need to be absorbed into future revisions of EN 16429 and CEN/TS 17021 (and indeed other automatic methods, e.g. formaldehyde currently being elaborated by CEN/TC 264/WG 40).

The other option open to local competent authorities is to consider CEN/TS 17337 as an Alternative Method to EN 16429. Consequently, equivalency would then need to be demonstrated in accordance with EN 14793. However, it should be noted that a P-AMS type approved in accordance with EN 15267-4 will have already have had equivalency demonstrated in accordance with EN 14793 as part of the type approval testing (this is a key element of P-AMS type approval under EN 15267-4). In addition, on a domestic level the Environment Agency for England consider any P-AMS with an MCERTS certificate to be equivalent to the applicable SRM across the certified range (see Annex B of [13]).

At the time of writing, the Environment Agency consider that CEN/TS 17337 is an AM to EN 16429 and also EN 1911.

Significant Differences Comparing CEN/TS 17337 to TGN M22

Sampling System

A minimum temperature of at least 180 °C has been defined for all heated components in the sampling system and specifications defined for the sampling flow pump and embedded oxygen sensors. The exception is if this minimum temperature creates a conflict with the temperature used when the P-AMS was type approved, in which case the latter temperature should be used. Sampling using a side stream configuration may be necessary with example setups included in Annex A.

Determination of Performance Characteristics of the Method

In order to use CEN/TS 17337 as an alternative to a SRM, the measuring system shall meet the performance criteria for portable automated measuring systems. Procedures and performance criteria laid out in EN 15267-4 shall be adhered to, which includes demonstrating equivalence to the SRM in accordance to EN 14793, including performing field tests on at least five different process types as well as interference testing. (nb. EN 15267-4:2017 is currently being revised by CEN/TC 264 'Air Quality' so requirements may change).

For species not covered by an SRM the same performance tests outlined in TGN M22 shall be undertaken with the addition of a zero test: with the exception that it is permissible to carry out a Computational Interference test (i.e. as opposed to practical).

T90 Response Time Performance Requirement for Reactive Species (NH_3, HCl and HF)

A T90 response time requirement for the P-AMS of ≤400 s has been included for NH_3, HCl and HF (this requirement cascading down from that in EN 15267-4).

Field Operation

There are several additions and amendments, however, the most significant change is to the on-site validation of the analyser which allows span gases to be used to calibrate the analyser instead of using a check gas. Either the Check Gas Approach or Span Approach may be used. Whichever approach is selected shall be used for all emissions monitoring tests between annual performance checks.

[nb. CEN/TS 17337 provides in an annex guidance for selecting suitable Test Gases for the Check Gas Approach for the Gasmet and Protea 204m portable FTIR's. In an annex at the end of this document analogous information is now provided for the Protea atmosFIR FTIR].

Check Gas Approach for Testing the FTIR Analyser

If the Check Gas Approach is being used (i.e. opposed to the Span Approach) then Check Gases are passed directly into the FTIR analyser and the obtained readings shall not deviate by more than 5.0% from the associated certified values.

Check of Sample Gas Line for Losses and Leakage, and Check of in-field Response Time

The sampling system only needs to be validated with one test gas. This gas shall be the most reactive of all the species under test and the test is done by comparing the results obtained by measuring the gas directly into the analyser and then through the complete sampling system (the latter shall not deviate from the former by more than 2.0%). The same test is applied at the end of the monitoring with drift correction applied to all species under test if required. If the drift test fails (i.e. there is greater than 5% drift) this affects all species under test.

If one of NH_3, HCl or HF is being used as the test gas then it shall be demonstrated that the T90 response time of the P-AMS is ≤400 s.

Environment Agency for England Allowable Deviation

At the time of writing, the EA have stated in [14] that it is permissible to deviate from the above two areas of quality assurance as follows.

Check Gas Approach and Losses and Leakage: Instead of passing the Check Gases directly into the analyser and the gas line losses and leakage test gas directly into the analyser and then through the sampling system, the Check Gases may be passed only through the sampling system and a deviation of not more than 5.0% from associated certified values shall be demonstrated.

In-field Response Time: The in-field T90 test may be omitted if instead an annual T90 test is carried out using the longest heated line used and for each analyser used.

Any deviation above would need to be replicated as appropriate in the Tests at the End of the Measurement Period.

Nb. In [14] it does not currently specify a permissible deviation if the Span Approach is being used rather than the Check Gas Approach. If this is the case, then it is proposed that the analogous deviation for Span Approach and Losses and Leakage would be to identify the most reactive Span Gas and use this as the test gas for determining sample line losses and leakage. It would then follow that after Span calibration via Span Approach that this test gas would be passed through the sampling system and it would be demonstrated that the reading did not deviate by more than 5.0% from the certified value.

Ongoing quality checks

The list of required ongoing quality assurance checks have been updated to only those required annually and after maintenance/repair. The most significant change is the additional requirement to carry out annual calibration and validation checks. The analyser shall be calibrated for each species to be tested during the following year, typically at multiple concentrations across each measurement range, however this step is not required if span calibrations (the Span Approach) are used to calibrate the analyser during field operation.

Validation of the calibration is checked for all species to be tested in the following year at five separate points across each measurement range. The deviation between the measured and reference concentrations shall be less than the absolute expanded uncertainty of that reference material at 100% of range. For example, if sulphur dioxide was to be validated over a 0 – 75 mg/m^3 range, and the absolute expanded uncertainty of the reference material was 2%, the deviation between the measured and reference concentrations at each of the five points shall be equal to or less than 1.5 mg/m^3.
An annual T90 response time test is required of all species (TGN M22 stipulated only SRM species), with the possible exception of VOCs dependent on the requirements of the local competent authority. [nb. see Environment Agency for England Allowable Deviation above, which is relevant to the T90 annual testing requirements].

Uncertainty Budget

The informative uncertainty annex aligns with the performance characteristics found in EN 15267-4:2017. Hence, characteristics of influence of vibration, influence of sample gas flow, and losses and leakage in the sample gas line are included in the worked example.

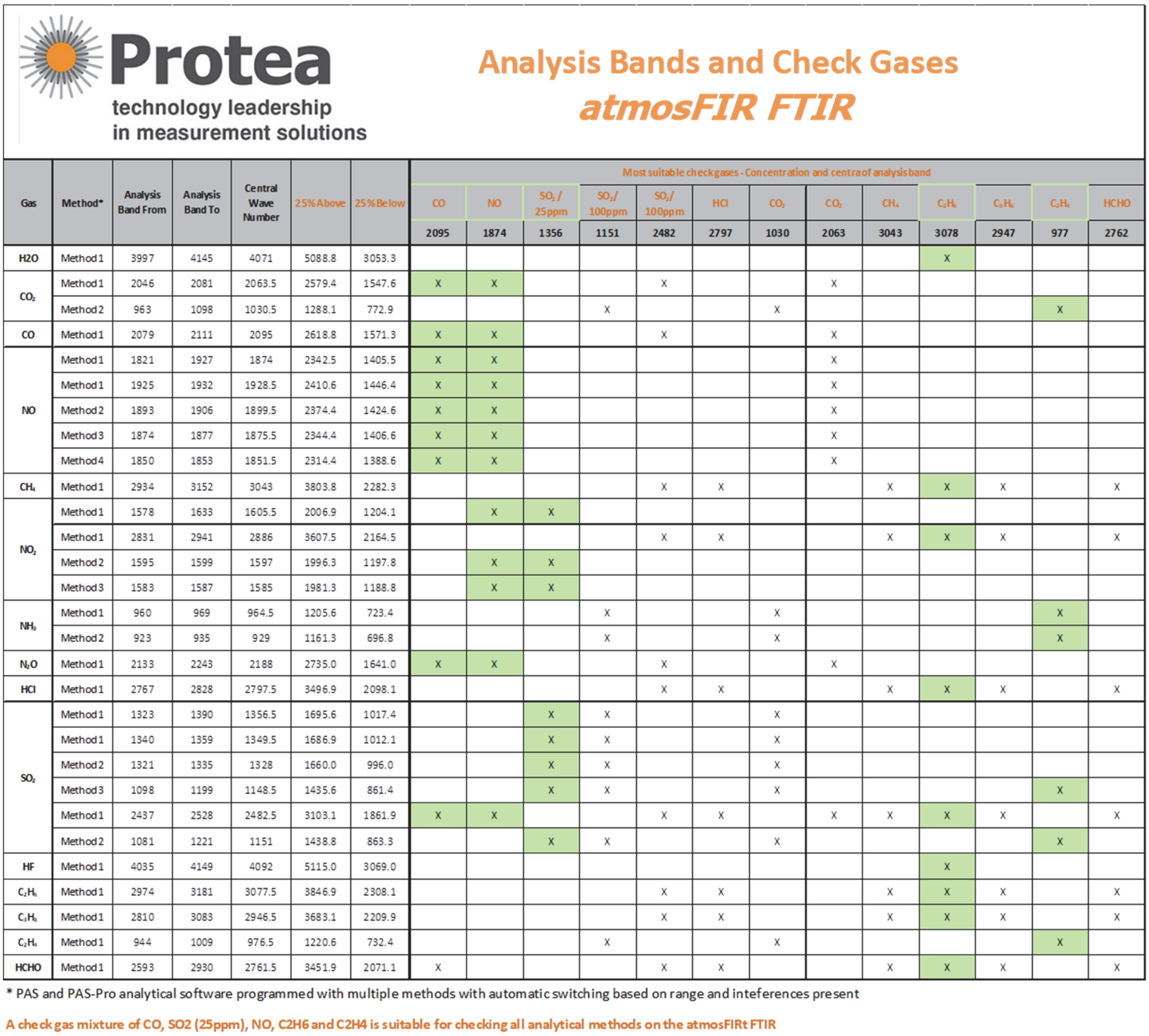
Also, in common with other standards (e.g. EN 15058, EN 16429) there is an informative annex showing how the addition uncertainty attributable to correction to dry and O_2 reference conditions may be estimated.

List of changes

- 6.1 – Minimum temperature of the probe filter box and sampling line is now 180 °C instead of at 20 °C above the dew point of the stack gas (unless this conflicts with the temperature when the P-AMS was type approved).
- 6.1 – Sampling using a side stream configuration, if extraction flow rate exceeds the FTIR parameters, has been added.
- 6.2.3 – Heated filters outside the stack must be heated to at least 180 °C, changed from at least 20 °C above the stack gas dew point (unless this conflicts with the temperature when the P-AMS was type approved).
- 6.2.4 – Requirement that the sampling line shall be heated to at least 180 °C added (unless this conflicts with the temperature when the P-AMS was type approved).
- 6.2.5 – Requirements for sampling pump specifications added.

- 6.2.6 – Using built in oxygen sensor requirements added.
- 7.1 – Performance characteristic requirements for using the technical specification as an alternative method to a SRM have been amended. The performance requirements from Table 1 in EN 15267-4 shall be met, as well as demonstrating equivalence in accordance to EN 14793, testing on at least five different process types and interference testing.
- 7.2 – Performance checks carried out on components not covered by a SRM to be done so by a laboratory that is accredited/recognised by the local authority as competent.
- 7.2 – Zero test added.
- 7.2 – Response time test – NH_3/HCl/HF performance criteria of 400 s has been added.
- 7.2 – Option allowing interference testing to be carried out computationally has been added.
- 8.3 – List of interfering components reference changed to EN 15267-4.
- 8.3 – The consideration of droplets in the stack flue gas prior to monitoring has been added.
- 8.3 – If droplets are present in the stack flue gas the recommendation that isokinetic sampling should be undertaken has been added.
- 8.3 – Requirement to record dilution ratio when using this approach has been added.
- 8.4.1 – A Span Approach to carry out on site calibration of the FTIR has been added as an alternative to the Check Gas Approach to validate the analyser.
- 8.4.2.3 – Requirements added for gases to be used if Span Approach selected.
- 8.4.3.1.2 – Check Gas Approach requires gases to be applied directly to the FTIR instead of through the sampling system.
- 8.4.3.1.3 – Span Approach added.
- 8.4.4.3.1 – One test gas is used for the check of sample gas line for losses and leakage. The test gas is passed through the sampling system and directly into the analyser. The difference between the two measured readings must be less than 2%.
- 8.4.4.3.1 – Response time checks applicable for NH_3/HCl/HF (400 s requirement).
- 8.4.3.3.2.2 – Wet gas injection – The test gas is injected directly into the analyser as well as into the analyser through the sampling system, the difference between the measured readings must be less than 2%.
- 8.4.5 – End of measurement sampling system check carried out by passing the test gas through the sampling system and directly into the analyser. The difference between the two measured readings must be less than 2%.
- 8.4.6 – Drift is calculated using the results from the test gas start and end of measurement period sample gas line check and applied to all components if correction is required. If this test fails, the data for all components under test shall be rejected.
- 9.2 – Frequency of QA/QC checks – Table 2 – List of ongoing quality assurance checks does not include measurement period checks. Annual calibration or validation checks and conditioning system checks have been added.
- 9.3 – Annual calibration section added, describing the process for calibrating and validating each component measurement range.
- Annex B – B.2 Response Time – The procedure is included in the annex. Determined by measuring the rise and fall times, with the greater value taken as the response time. TGN M22 only requires one rise time to determine the response time.
- Annex B – B.4 Computational interferent test method added/updated.
- Annex B – B.5 Annual lack of fit method added.
- Annex C – Uncertainty budget worked example aligned to EN 15267-4:2017 performance characteristics.
- Annex F – Worked example for estimating uncertainty associated with correction to dry and O_2 reference conditions.

Annex: Selecting Test Gases for Check Gas Approach for the Protea atmosFIR FTIR.



Protea
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Analysis Bands and Check Gases
atmosFIR FTIR

Gas	Method*	Analysis Band From	Analysis Band To	Central Wave Number	25% Above	25% Below	Most suitable checkgases - Concentration and centra of analysis band												
							CO	NO	SO_2 / 25ppm	SO_2/ 100ppm	SO_2/ 100ppm	HCl	CO_2	CO_2	CH_4	C_2H_6	C_3H_8	C_2H_4	HCHO
							2095	1874	1356	1151	2482	2797	1030	2063	3043	3078	2947	977	2762
H2O	Method1	3997	4145	4071	5088.8	3053.3										X			
CO_2	Method1	2046	2081	2063.5	2579.4	1547.6	X	X			X			X					
	Method2	963	1098	1030.5	1288.1	772.9				X			X					X	
CO	Method1	2079	2111	2095	2618.8	1571.3	X	X			X			X					
NO	Method1	1821	1927	1874	2342.5	1405.5	X	X						X					
	Method1	1925	1932	1928.5	2410.6	1446.4	X	X						X					
	Method2	1893	1906	1899.5	2374.4	1424.6	X	X						X					
	Method3	1874	1877	1875.5	2344.4	1406.6	X	X						X					
	Method4	1850	1853	1851.5	2314.4	1388.6	X	X						X					
CH_4	Method1	2934	3152	3043	3803.8	2282.3					X	X			X	X	X		X
NO_2	Method1	1578	1633	1605.5	2006.9	1204.1		X	X										
	Method1	2831	2941	2886	3607.5	2164.5					X	X			X	X	X		X
	Method2	1595	1599	1597	1996.3	1197.8		X	X										
	Method3	1583	1587	1585	1981.3	1188.8		X	X										
NH_3	Method1	960	969	964.5	1205.6	723.4				X			X					X	
	Method2	923	935	929	1161.3	696.8				X			X					X	
N_2O	Method1	2133	2243	2188	2735.0	1641.0	X	X			X			X					
HCl	Method1	2767	2828	2797.5	3496.9	2098.1					X	X			X	X	X		X
SO_2	Method1	1323	1390	1356.5	1695.6	1017.4			X	X			X						
	Method1	1340	1359	1349.5	1686.9	1012.1			X	X			X						
	Method2	1321	1335	1328	1660.0	996.0			X	X			X						
	Method3	1098	1199	1148.5	1435.6	861.4			X	X			X					X	
	Method1	2437	2528	2482.5	3103.1	1861.9	X	X			X	X		X	X	X	X		X
	Method2	1081	1221	1151	1438.8	863.3			X	X			X					X	
HF	Method1	4035	4149	4092	5115.0	3069.0										X			
C_2H_6	Method1	2974	3181	3077.5	3846.9	2308.1					X	X			X	X	X		X
C_3H_8	Method1	2810	3083	2946.5	3683.1	2209.9					X	X			X	X	X		X
C_2H_4	Method1	944	1009	976.5	1220.6	732.4				X			X					X	
HCHO	Method1	2593	2930	2761.5	3451.9	2071.1	X				X	X			X	X	X		X

* PAS and PAS-Pro analytical software programmed with multiple methods with automatic switching based on range and inteferences present

A check gas mixture of CO, SO2 (25ppm), NO, C2H6 and C2H4 is suitable for checking all analytical methods on the atmosFIRt FTIR

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