European Union Network for the Implementation and Enforcement of Environmental Law

STRATEGIES FOR VERIFICATION OF SELF-MONITORING AND REPORTING ON AIR EMISSIONS WORKSHOP

Verifying the reliability of continuous atmospheric emission monitoring systems

Nobody made a greater mistake than he who did nothing because he could do only a little
Edmund Burke

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Introduction

- The monitoring of emissions to air represents an important element in preventing and reducing pollution from industrial installations and in ensuring a high level of protection of the environment taken as a whole.
- It is best practice to assess the overall risk posed by the potential emissions from an installation to the environment and to match the frequency and scope of the monitoring regime to this risk.
- Examples of the risk factors to be considered:
  - Size of installation and the complexity of the process;
  - Frequency of process switching, particularly at multi-purpose chemical plants;
  - Possible hazards posed by the type and amount of input feedstock and fuel materials;
  - Possible environmental and human health effects resulting from emissions, taking into account the pollutant types and their rates of release, and including the potential failure of abatement equipment;
  - Proximity of the emission source to sensitive environmental receptors and the presence of natural hazards, such as geological, hydrological, meteorological or marine factors.
- There are several approaches that can be taken to monitor a specific parameter:
  - direct measurements: continuous, periodic and campaign;
  - Indirect methods: surrogate parameters, mass balances, emission factors and other calculations.

Continuous vs Periodic Measurements

Characteristics	Continuous Measurement	Periodic Measurement
Sampling Period	Measurement covers all or most of sampling period the time during which substances are emitted	Snapshots of the long-term emission pattern
Speed	Real-time results	Real-time results (instrumental analysers are used) Delayed results (manual method with a laboratory end-method is used)
Averaging of Results	Results continuously gathered and can be averaged over a given period (30 minutes, 1 hour or 24 hours)	Results over the sampling period (30 minutes to several hours)
Calibration and Traceability	Require calibration against a standard reference method and adjustment with certified reference materials in the maintenance interval	Standard reference methods (manual or automated) can be used for periodic measurements
Accreditation	Quality assurance of the calibration and maintenance according to EN 14181:2014 and EN ISO/IEC 17025:2017 [1, CEN 2017]	Quality assurance for periodic measurements according to EN ISO/IEC 17025:2017
Certification of Equipment	Available	
Investment Costs	Higher	Lower
Operating Costs	Normally higher	Normally lower

Legal Framework

Emission Monitoring

Decree-Law n.º 39/2018, of 11 July: defines the regime for the prevention and control of pollutant emissions into the air and transposes Directive (EU) 2015/2193

Measurement's frequency (continuous or periodic) defined accordingly mass flow threshold

Pollutant	Minimum Mass Flow (kg/h)	Medium Mass Flow (kg/h)	Maximum Mass Flow (kg/h)
Sulphur dioxide (SO_2)	0,5	2	50
The sum of nitrogen monoxide (NO) and nitrogen dioxide (NO_2) (NOx), expressed as NO_2	0,5	2	30
Total particulate matter (in air)	0,1	0,5	5
Carbon monoxide (CO)	1	5	100
Volatile organic carbon, expressed as total carbon (VOC)	1	2	30

Continous measurement of SO_2 is mandatory to installations that burn petroleum coke

Article 13.º Measurement and Methods

- Measurements of air pollutants and process operating parameter conditions must be carried out in normal and representative conditions of the functioning of the installations, excluding start-up and shut-down periods.
- Sampling must take into account aim of the monitoring, specified period in the applicable standards, period associated to emission limit value (ELV), detection and quantification limits of measurement methods, response time of the equipment and production process´s variations.
- Sampling and analysis of relevant polluting substances and measurements of process parameters as well as the quality assurance of automated measuring systems (AMS) and the reference measurement methods to calibrate those systems shall be carried out in accordance with CEN standards or, if CEN standards are not available, ISO, national or other international.

Article 15.º Automated Mesuring Systems

- Automated measuring systems (AMS) are subject to metrological control which minimal periodicity is 1 year, using accredited laboratories, for each test. They must be accompanied by an updated technical sheet relating to verification or calibration operations. These technical sheet must contain indication of the procedures used to ensure the traceability and accuracy of the measurement results.
- AMS must be appropriated to the range of measured values, the uncertainty associated and performance parameters.
- Data acquisition systems associated with AMS should ensure a query interval equal to or less than one minute.

Decree-Law n.º 127/2013, of 30 August: defines industrial emissions regime applicable to the integrated prevention and control of pollution, as well as the rules aimed at preventing and/or reducing emissions to air, water and soil and the production of waste, transposing Directive 2010/75/EU, of the European Parliament and of the Council

Annex V (Technical provisions relating to combustion plants), Part 3

- Concentrations of SO_2, NOx and dust in waste gases from each combustion plant with a total rated thermal input of 100 MW or more shall be measured continuously.
- Concentration of CO in waste gases from each combustion plant firing gaseous fuels with a total rated thermal input of 100 MW or more shall be measured continuously.
- Concentrations of SO_2, NOX and dust in waste gases from each combustion plant with a total rated thermal greater than 50 MW and less than 100 MW, as well as concentrations of other pollutants that may be present in waste gases are measured in accordance with provided in Decree-Law n.º 39/2018.
- Continuous measurements include the measurement of the oxygen content, temperature, pressure and water vapour content of the waste gases. The continuous measurement of the water vapour content of the waste gases shall not be necessary, provided that the sampled waste gas is dried before the emissions are analysed.
- Agência Portuguesa do Ambiente, IP may decide not to require the continuous measurements in the following cases:
  - combustion plants with a life span of less than 10 000 operational hours;
  - SO_2 and dust from combustion plants firing natural gas;
  - SO_2 from combustion plants firing oil with known sulphur content in cases where there is no waste gas desulphurisation equipment;
  - SO_2 from combustion plants firing biomass if the operator can prove that the SO_2 emissions can under no circumstances be higher than the prescribed emission limit values.

Annex VI (Technical provisions relating to waste incineration plants and waste co-incineration plants), Part 4

- Concentrations of NOx, provided that ELV are defined, CO, dust, total organic carbon (TOC), hydrogen chloride (HCl), hydrogen fluoride (HF) and SO_2 in waste gases from waste incineration plants and waste co-incineration plants shall be measured continuously.
- Continuous measurements include the following process operation parameters: temperature near the inner wall or at another representative point of the combustion chamber as authorized by APA, IP concentration of oxygen, pressure, temperature and water vapour content of the waste gas.
- APA, IP may decide not to require the continuous measurements of HCl, HF, SO_2 and water vapour, provided that the sampled waste gas is dried before the emissions are analyzed.

Measurement and Methods

- Sampling and analysis of relevant polluting substances and measurements of process parameters as well as the quality assurance of AMS and the reference measurement methods to calibrate those systems shall be carried out in accordance with CEN standards or, If CEN standards are not available, ISO, national or other international standards.
- AMS shall be subject to control by means of parallel measurements with the reference methods at least once per year.

Data Validation and Legislation's Compliance

Decree-Law n.º 39/2018, of 11 July

- A valid daily average value has no more than three hourly average values excluded on the same day due to measuring system malfunction or maintenance, and no more than 10 days in a year.
- Compliance with ELV
  - No validated monthly average value exceeds ELV;
  - No validated daily average value exceeds more than 30 % of ELV and for medium combustion plant (MCP) exceeds more than 10 % of ELV;
  - 95% of all the validated hourly average values over the year do not exceed 200% of ELV.

Decree-Law n.º 127/2013, of 30 August

Annex V (Technical provisions relating to combustion plants), Part 3 and 4

- Any day in which more than three hourly average values are invalid due to malfunction or maintenance of the AMS shall be invalidated. If more than 10 days over a year are invalidated for such situations the competent authority shall require the operator to take adequate measures to improve the reliability of the AMS.
- Compliance with ELV
  - No validated monthly average value exceeds ELV;
  - No validated daily average value exceeds 110 % of ELV;
  - In cases of combustion plants composed only of boilers using coal with a total rated thermal input below 50 MW, no validated daily average value exceeds 150 % of ELV;
  - 95% of all the validated hourly average values over the year do not exceed 200% of ELV.

Annex VI (Technical provisions relating to waste incineration plants and waste co-incineration plants), Part 7

- To obtain a valid daily average value no more than five half-hourly average values in any day shall be discarded due to malfunction or maintenance of the continuous measurement system. No more than ten daily average values per year shall be discarded due to malfunction or maintenance of the continuous measurement system.
- Compliance with ELV
  - None of the daily average values exceeds any of the ELV;
  - For, waste incineration plants, either none of the half-hourly average values exceeds any of the ELV (column A of the table under point 1.2 of Part 2) or, where relevant, 97 % of the half-hourly average values over the year do not exceed any of the ELV (column B of the table under point 1.2 of Part 2);
  - For CO (waste incineration plants)
    - At least 97 % of the daily average values over the year do not exceed the ELV (point 1.5(a) of Part 2; and,
    - At least 95 % of all 10-minute average values taken in any 24-hour period or all of the half-hourly average values taken in the same period do not exceed the ELV (points 1.5(b) and (c) of Part 2. Iin case of waste incineration plants in which the gas resulting from the incineration process is raised to a temperature of at least 1100 °C for at least two seconds, APA, I.P. may apply an evaluation period of 7 days for the 10-minute average values.

Portuguese Installations that Carry Out Continous Measurements

Activity [1]	Number of Installations	Pollutant Measured
Combustion of fuels in installations with a total rated thermal input of 50 MW or more	10	SO_2, CO, NOx, HF, HCl, Dust
Refining of mineral oil and gas	1	SO_2, NOx, VOC, Dust
Production and processing of metals	1	Dust
Production of cement clinker in rotary kilns with a production capacity exceeding 500 t/day or in other kilns with a production capacity exceeding 50/day	6	SO_2, CO, NOx, TOC, Dust, HCl, HF, Ammonia (NH_3), COV
Production of lime in kilns (production capacity exceeding 50 t/day)	3	SO_2
Manufacture of glass including glass fibre with a melting capacity exceeding 20 tonnes per day	4	NOx

(1) Activities included in Annex I of Decree-Law n.º 127/2013 (IPPC installations)

Activity [1]	Number of Installations	Pollutant Measured
Manufacture of ceramic products by firing, in particular roofing tiles, bricks, refractory bricks, tiles, stoneware or porcelain with a production capacity exceeding 75 t/day and/or with a kiln capacity exceeding 4 m^3 and with a setting density per kiln exceeding 300 kg/m^3	6	SO_2
Production of chemicals	6	CO, NOx, TOC, Dust, SO_2, HCl, HF,NH_3
Disposal or recovery of waste in waste incineration plants or in waste co-incineration plants for non-hazardous waste with a capacity exceeding 3 t/h	2	Dust, TOC, HCl, HF, SO_2, NOx, CO, NH_3
Disposal or recovery of waste in waste incineration plants or in waste co-incineration plants for hazardous waste with a capacity exceeding 10 t/day	3	SO_2, CO, NOx, HF, HCl, TOC, Dust
Production in industrial installations of pulp from timber or other fibrous materials	7	SO_2, CO, NOx, Dust, Total Reduced Sulphur (TRS)
Disposal or recycling of animal carcases or animal waste with a treatment capacity exceeding 10 tonnes per day	1	NOx, SO_2, Dust, CO, HCl,

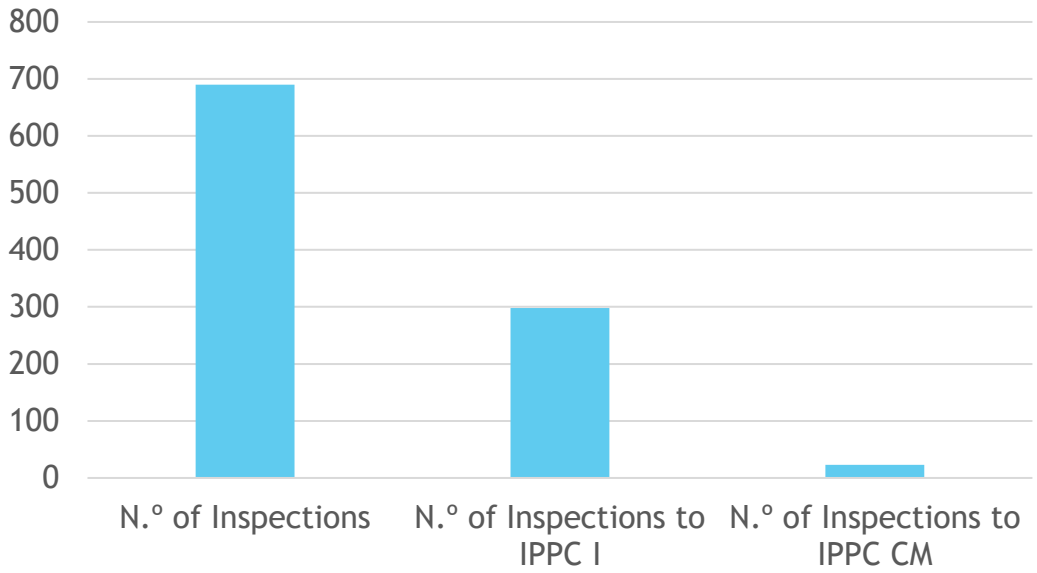
(1) Activities included in Annex I of Decree-Law n.º 127/2013 (IPPC installations)

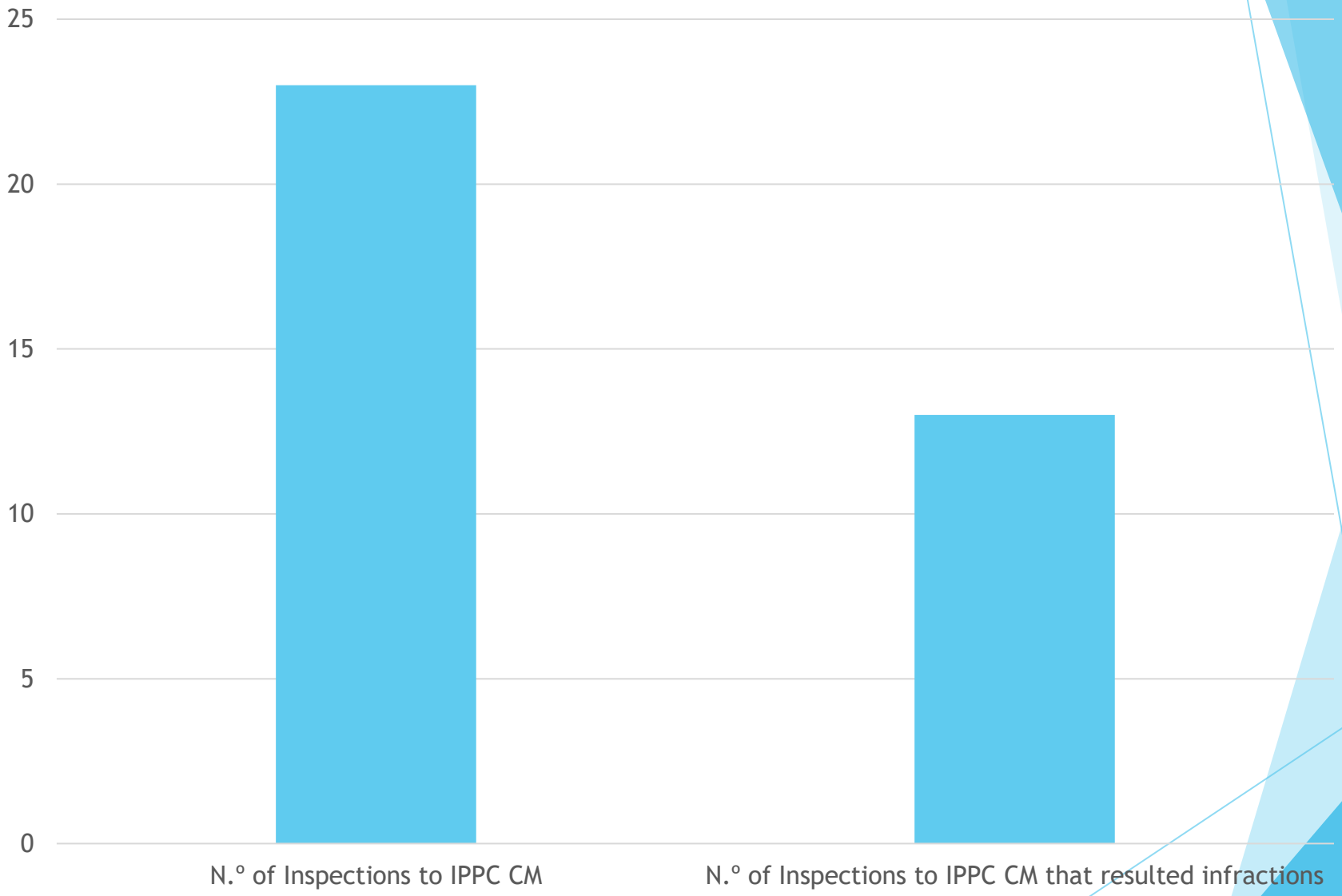
Monitoring Methods

Activity	Monitoring Methods
Combustion of fuels in installations with a total rated thermal input of 50 MW or more	Fourier Transform Infrared Spectometry (FTIR), Non-dispersive Infrared Spectrometry (NDIR), Flame Ionization Detection (FID), Electrochemical Cell, Light Attenuation
Refining of mineral oil and gas	NDIR, Light Attenuation or Scattering
Production and processing of metals	Light Attenuation
Production of cement clinker in rotary kilns with a production capacity exceeding 500 t/day or in other kilns with a production capacity exceeding 50/day	FTIR, FID, Zirconia, Light Attenuation
Manufacture of ceramic products by firing, in particular roofing tiles, bricks, refractory bricks, tiles, stoneware or porcelain with a production capacity exceeding 75 t/day and/or with a kiln capacity exceeding 4 m^3 and with a setting density per kiln exceeding 300 kg/m^3	NDIR
Production of chemicals	Light Attenuation or Scattering, FTIR, Zirconia, FID
Disposal or recovery of waste in waste incineration plants or in waste co-incineration plants for non-hazardous waste with a capacity exceeding 3 t/h	FTIR, Non-dispersive Ultraviolet (spectrometry) (NDUV), Light Scattering
Disposal or recovery of waste in waste incineration plants or in waste co-incineration plants for hazardous waste with a capacity exceeding 10 t/day	FTIR, FID
Production in industrial installations of pulp from timber or other fibrous materials	Light Scattering

Inspections Carry Out by Environmental Inspection Team in 2020

- In 2020, Environmental Inspection Team (EM IA) has carried out:
  - 690 inspections;
  - 278 inspections to IPPC installations (IPPC I);
  - 23 inspections to IPPC installations that carry out continuous measurements (IPPC CM) that belongs to energy, mineral and chemical industries, production and processing of metals, waste management and disposal or recovery of animal by-products.




25
20
15
10
5
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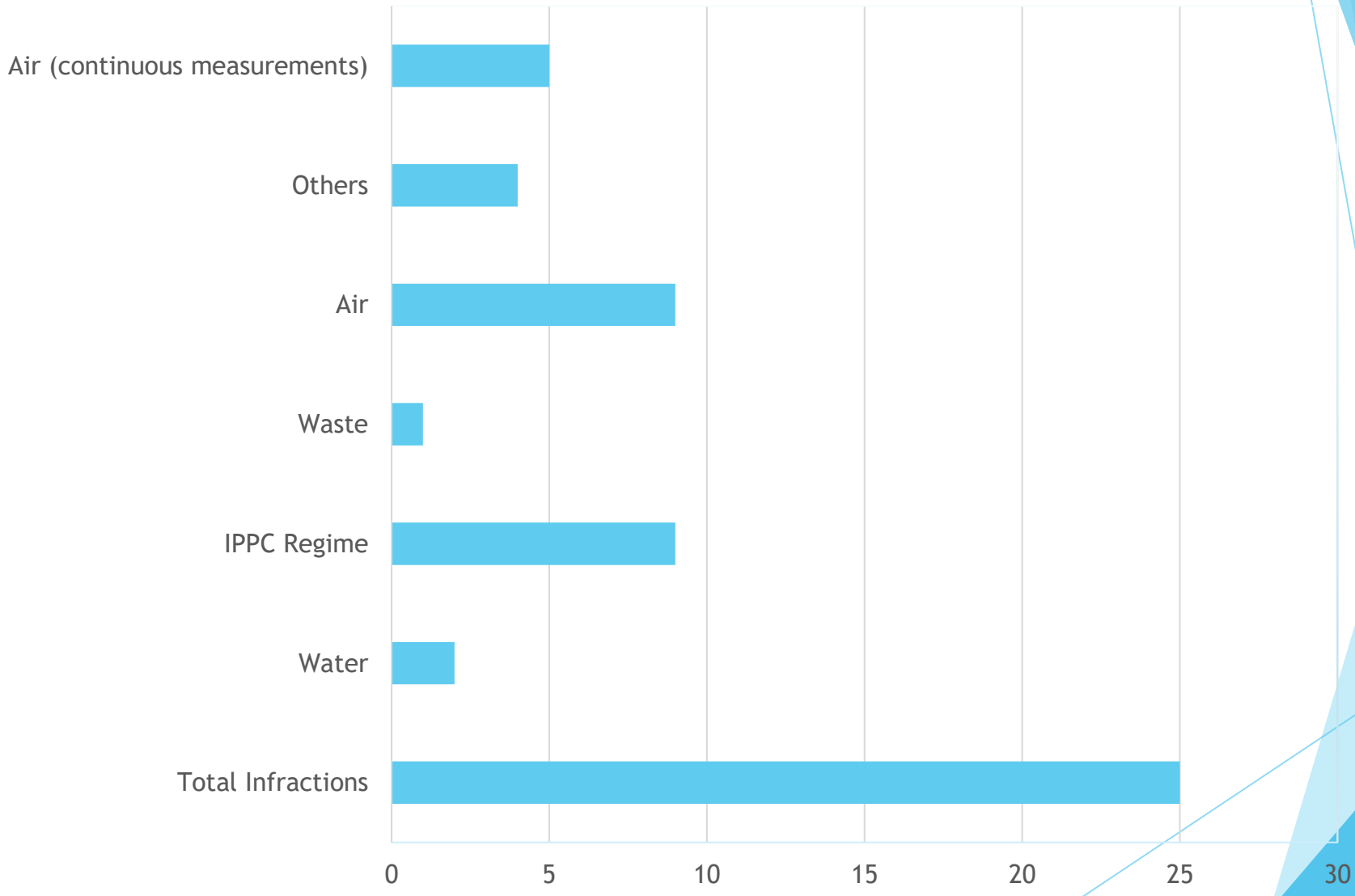
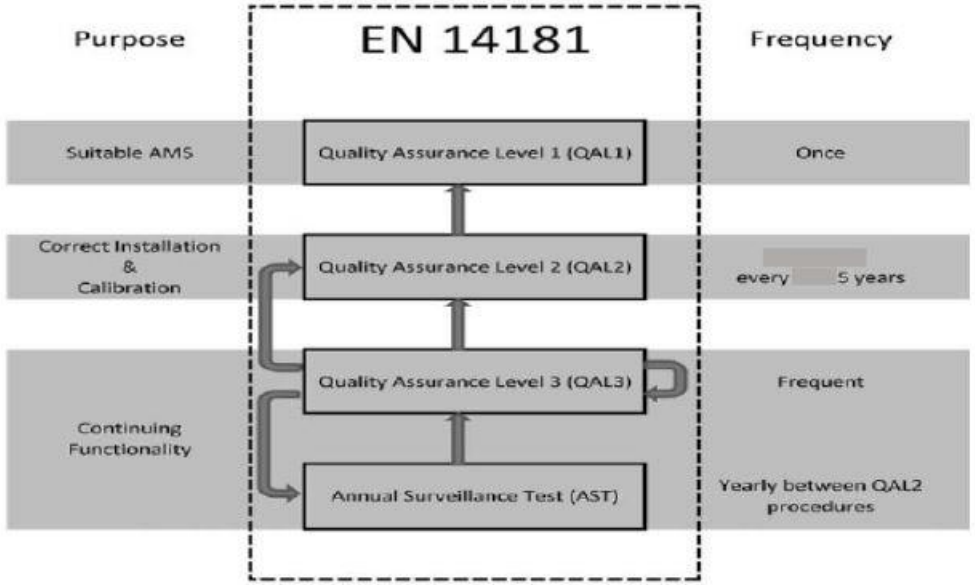
N.º of Inspections to IPPC CM
N.º of Inspections to IPPC CM that resulted infractions

Number of infractions that result of inspections to installations that carry out continuous measurements



Present and Future Approach

- Continuous atmospheric emission monitoring systems are of crucial importance because they are applied in facilities that have high emission levels and allows more collected data. However, the useful of the collected data is intrinsically associated with their reliability, constituting the calibration one of the key points of this issue.
- In this ways, when inspecting facilities that have AMS, we should check whether the installation has adopted following Quality Assurance Levels (QAL).



CERTIFICATE

on Product Conformity (QAL 1)

Certificate number: 2640853-ts

- There are facilities that only have one emission source which have AMS nonetheless there are others that have several emission sources and, therefore, this type of analysis should focus on the sources that have more significant air emissions, for instance analyzing the form concerning European Pollutant Release and Transfer Register (E-PRTR) for the last 3 years.
- In Portugal there are many activities that have AMS, so it is important to define priority activities, chosen for instance by risk analysis.

In situ **inspection:**

- In control room, checking control screen to identify if there is abrupt breaks in the line concerning to continuous measurements, read the alert messages in order to check if there is messages concerning malfunction or unusual shut-down periods an if they are repeated over time.
- Going to the room where there is the equipment that gives the information about concentrations of pollutants and parameters to check if they are working.
- Checking and demand the delivery of following elements concerning prior day and the day of the inspection: data concerning the minimum integration period (if the minimum is 1 minute) and hourly averages in excel format. On the other hand, as far as monthly averages are obtained from hourly averages, for the prior month to the inspection, request the hourly averages.
- Collecting data concerning changes in the operating regime of the source plus also information about scheduled and unscheduled maintenance periods.

In situ **inspection:**

- Request reports sent to the APA, IP namely the report of the calibration and demonstration that calibration function was placed as a result of its validation and indication the respective date.

- In the aim to understand if AMS is working properly we also subcontract accredited laboratories that do measures in same day of the inspection, and we try to check if the installation is working under normal operational conditions. This information is obtained on control room, checking control screen and questioning maintenance's responsible.

- Check if installations that must only do periodic measurements but belongs to a sector where similar installations have AMS, are effectively not obliged to have AMS. Demand the delivery in the day of the inspection the daily productions for the prior year and the year of the inspection to check if periodic measurements were done under normal operational conditions. Verifying if there is also a screen where the emissions of respective pollutants are controlled.

***Ex situ* inspection:**

- Checking ELV compliance.
- Checking frequency of submission of monitoring results.
- Checking if the reduction in the number of expected monthly hours of operation is correctly explained.
- If abnormal situations occur in operation or equipment failures, verifying if they were communicated to APA, IP taking into account emergency procedure, accompanied by a report with preventive measures adopted.

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