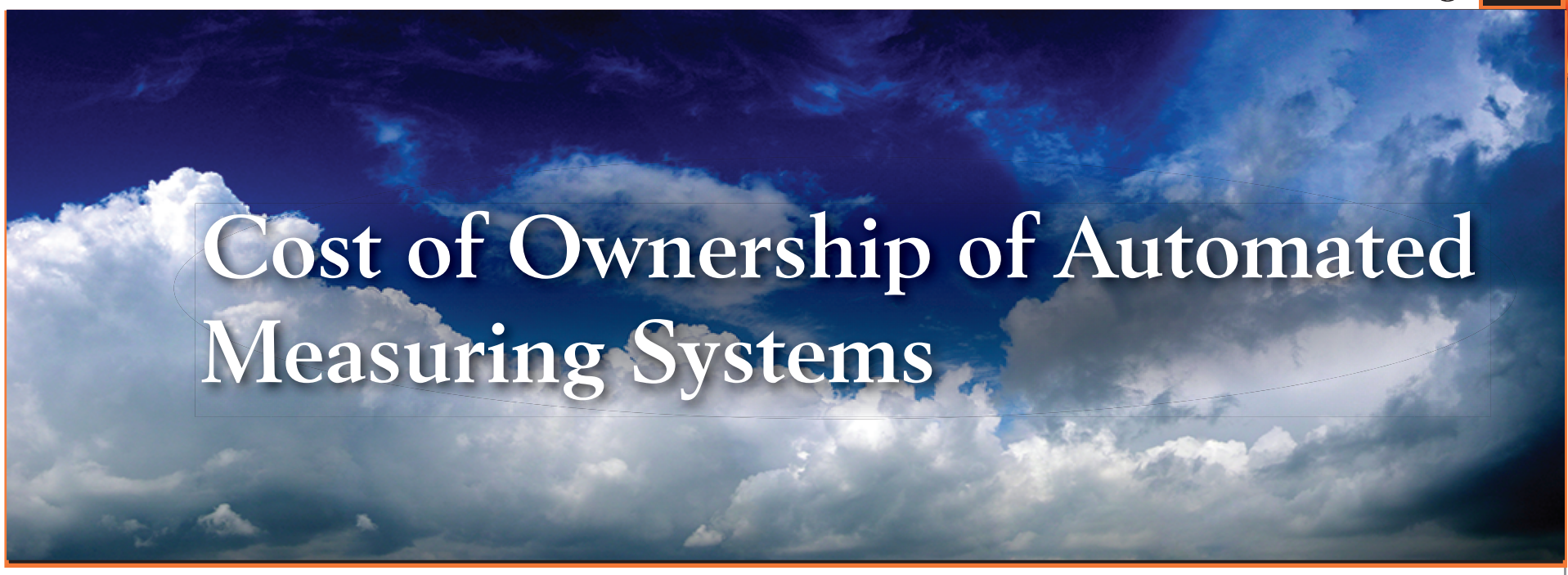

Cost of Ownership of Automated Measuring Systems

Industrial plants with the most potential to pollute to air, water and waste in the EU tend to fall under the scope of EU directives. The recently adopted Industrial Emissions Directive (IED), harmonises requirements across the EU (with more prescriptive BREF guidance) and integrates and supersedes the requirements of the Integrated Pollution Prevention Control (IPPC) Directive, Large Combustion Plant Directive (LCPD) and Waste Incineration Directive (WID). The IED continues to adopt many of the philosophies used in the UK such as permits which consider emission limits and monitoring requirements in light of Best Available Techniques (BAT) with central guidance on what should be considered as industry specific BAT.

"To continue to meet BS EN 14181 requirements it is necessary for the AMS installation to undergo an Annual Surveillance Test (AST) by an accredited test laboratory"

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One aspect of the IED and BREF guidance is the increasing use of Automatic Measuring Systems (AMS) sometimes referred to as CEMs (Continuous Emissions Monitoring).

A question that is frequently asked is "what is the cost of fitting an AMS to a plant?" Below is a detailed case study supplied by EPRL on a plant they recently fitted out with a new AMS.

Later in the article we have shown costs of an AMS on a Cement Plant run by LaFarge Tarmac in the UK.

Case Study

The Process

Energy Power Resources Limited (EPRL) operates a mix of Large Combustion Plants and waste co-incinerators that burn renewable fuels at electrical power stations. Within England the EPRL stations fall within A1 sections of the Environmental Permitting Regulations and are therefore subject to control by the Environment Agency (EA). The EA issues operating permits that require the stations to continuously measure stack emissions by using approved equipment, MCERTS instruments, and to satisfy the requirements of BS EN14181 Stationary Source Emissions — Quality Assurance of Automated Measuring Systems (AMS) to ensure the performance of those instruments.

It was decided that one of the EPRL waste co-incinerator sites would have a new suite of AMS, or CEM, instruments installed. To meet permit requirements the site needs to continuously monitor and report emissions of the following species:

- Hydrogen Chloride (HCl)
- Sulphur dioxide (SO_2)
- Carbon monoxide (CO)
- Oxides of nitrogen (NO_x)
- Total Organic Carbon (TOC)
- Particulates

In addition monitoring of peripheral species, oxygen (O_2) and moisture (H_2O), is needed to correct the measured concentrations of the reported species to standard conditions. Processing of the AMS data is typically undertaken by a specialised software programme known as a Data Acquisition and Handling System (DAHS).

Description of the Selected AMS Instruments

During the re-equipment planning the performance and condition of the in-use particulate monitor were good, the unit was therefore retained and its output integrated into the new AMS system.

With the range of gas species that need to be measured at a waste co-incinerator it was decided that a unit using the Fourier Transform Infra Red (FTIR) principle would be used. An FTIR unit has the added advantage of measuring H_2O and the MCERTS certificate for the unit selected also covered an integrated O_2 monitor. MCERTS instruments for measuring TOC emissions use the Flame Ionisation Device (FID) technique and the FTIR supplier was also able to provide a suitable unit.

An upgrade to a new MCERTS version of a commercially available DAHS programme was carried out concurrently with installation of the AMS instruments.

The AMS instruments selected need a considerable electrical power supply as the stack sample is handled 'hot and wet'; it is extracted, transferred and analysed at a temperature of 180°C. The instruments also need to be housed to provide a suitable operating environment, require a high quality instrument air supply, the FID continuously uses fuel gas, the FTIR needs a nitrogen supply and all instruments use test gases to check for drift in measurement. A new cabin was obtained to house the AMS units and all the necessary services were incorporated into that building.

Following installation of an AMS, the system's performance has to be tested by a UKAS accredited and MCERTS certified test laboratory to ensure BS EN 14181 requirements are met, which involves a Quality Assurance Level 2 (QAL2) test. This consists of a structured assessment of the instrument installation work and individual unit performance, followed by parallel testing to produce a calibration function for each species so that monitoring by the AMS in its entirety is proven to be of acceptable accuracy.

Item	Cost £000's(€)
A building to house the AMS units and the related civils	16.0 (19.5)
Electrical power supplies	6.7(8.2)
Installation of stack components	1.0(1.2)
Supply and installation of gas and air services	6.4(7.8)
Update of the DAHS to an MCERTS version and its associated communication system	18.7(22.8)
Supply, installation and commissioning of AMS instruments	106.4(157.7)
Initial QAL2 tests	9.0(11.0)
Total Installation Costs	**164.2(200.0)**

Cost of installation

Ongoing running costs

AMS instruments typically undergo routine maintenance at six monthly intervals to ensure that their performance is consistent, normally undertaken by the company that supplied the units. A support contract is usually put in place so that rapid response is available from AMS supply companies if external support is needed for a system defect.

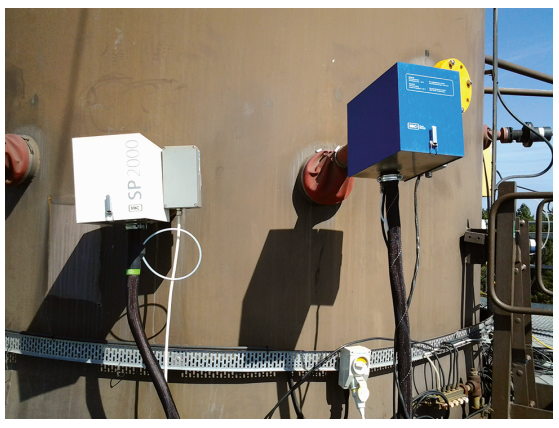
To continue to meet BS EN 14181 requirements it is necessary for the AMS installation to undergo an Annual Surveillance Test (AST) by an accredited test laboratory, which checks for stability of the instrument results and ensures the continued validity of the calibration functions derived during the preceding QAL2. Prior to an AST or QAL2 functional tests are carried out to prove the AMS is operating satisfactorily, those tests may involve the support of the instrument supply company. QAL2 tests are repeated every third year at a waste co-incinerator and at five yearly intervals at large combustion plants.

Between the annual BS EN 14181 tests the operator undertakes internal QAL3 tests that check for span and zero drift of the AMS instruments. In addition to costs for test materials, such as gases for each monitored species, the QAL3 tests require a skilled technician to carry out the work and assess the results. The need for minor routine maintenance tasks such as replacement of gas cylinders and confidence building system health checks is also likely. Excluding unplanned rectification, this site work might take

Item	Cost £000's(€)
Annual instrument servicing and functional tests plus support contract costs	8.7(10.6)
Completion of annual BS EN 14181 AST test	8.0(9.8)
Test and operating gases for one year	1.0(1.2)
Anticipated in-house man hour costs for one year	3.8(4.6)
Anticipated Annual Running Costs	**21.5(26.2)**

four man hours per week.

Operators are likely to incur a further and less direct cost of AMS ownership. Coordination of AMS installation work, resolution of system errors and control of annual tests will probably be undertaken by an internal or external specialist. Costs for the individual in that post are dependent on several factors but they may be significant in comparison to other more obvious ongoing costs.



The prime AMS sample extraction probe on the right and the extraction probe for a 'hot spare' AMS system on the left

The stack and its gantry at the 30m level

The cabin housing the AMS instruments with the sample extraction line and gas supply systems.

Costs of operation on a cement process

Below is an example of the operating costs of an AMS system fitted to a cement plant in the UK.

CEM system costs (Gaseous)

Item	Remarks
Type of process	Cement
Pollutants monitored	H_2O, O_2, TOC, NO, NO_2, N_2O, NH_3, HCL, CO, SO_2, CO_2
Technology employed	FT-IR, FID, Zirconia Detector
	Cost
System Purchase Cost	£90,000 (€110,000)
Installation and Commissioning Cost	£8,000 (€10,000)
Other significant cost (GRP enclosure e.t.c)	£15,000 (€18,300)
On-going maintenance, service and calibration costs per year, including call out response and 24/7 spare availability.	£14,000 (€17,000) per system

CEM system costs (Particulate)

Item	Remarks
Type of process	Cement
Pollutants monitored	Particulate
Technology employed	Laser scatter
	Cost
1/ System Purchase and installation Cost - forward scatter probe type	£10,000 (€12,200)
2/ System Purchase and installation Cost - back scatter externally mounted type	£15,000 (€18,300)
3/ System Purchase and installation Cost - wet scrubber externally mounted type	£40,000 (€48,800)
On-going maintenance, service and calibration costs per year	1/ £350 (€366), 2/ £450 (€550) and 3/ £550 (€670) per systems detailed above

Compliance monitoring

Item	Remarks
Type of process	Cement
Pollutants monitored	SO_2, NO_x, VOC, CO2, CO, HCL, HF, NH_3, N_2O, Group 1,2,3 metals, PCBs, PAHs,O_2, H_2O, Flow, C6H6, C8H8, CH3Cl, C4H6, CH4, C2H6, C2H4, C3H8, NM VOCs, PCDDs & PCDFs,
Frequency of tests	Bi-annual
	Cost
Cost per set of tests	£6,000 (€7,300)per test
(per kiln line)	
EN14181	
QAL2 costs	£5,500 (€6,700) per test when combined and completed at the same time as routine testing, £8,500 (€10,400) if stand alone QAL2 completed
AST cost	£3,000 (€3,600) per test when combined and completed at the same time as routine testing, £4,500 (€5,500) if stand alone AST completed

Compliance monitoring Continued

Item	Remarks
Type of process	Cement
Pollutants monitored	Particulate
Frequency of tests	Bi-annual
	Cost
Cost per set of tests	£400 (€490) per BS EN 13284-1 test
EN14181	
QAL2 costs	£5,000 (€6,100) per test
AST cost	2500 (€3,050) per test

The Source Testing Association

The Source Testing Association (STA) was established in 1995 the membership comprises representation from process operators, regulators, equipment suppliers and test laboratories. The STA is a non-profit making organisation.

The STA is committed to the advancement of the science and practice of emission monitoring and to develop and maintain a high quality of service to customers.

Its aims and objectives are to:

(i) contribute to the development of industry standards, codes, safety procedures and operating principles;

(ii) encourage the personal and professional development of practicing source testers and students;

(iii) maintain a body of current sampling knowledge;

(iv) assist in maintenance of a high level of ethical conduct;

(v) seek co-operative endeavours with other professional organisations, institutions and regulatory bodies, nationally and internationally, that are engaged in source emissions testing.

The Associations headquarters are based in Hitchin, Hertfordshire with meeting rooms, library and administration offices.

The Association offers a package of benefits to its members which include:

- Technical advice relating to emission monitoring
- Conference and exhibition opportunities
- Seminars and training on a variety of related activities
- Representation on National, European and International standards organisations
- Training in relation to many aspects of emission monitoring
- Liaison with regulators, UK and International, many of whom are members.