
ABB MEASUREMENT & ANALYTICS | TECHNICAL DESCRIPTION

Customer information guide

Continuous Emission Monitoring Systems (CEMS)



This document is intended to be a guide from requirement to solution for your Continuous Emission Monitoring System (CEMS) needs. Its goal is to share insights and experience in order to understand all of the major considerations that should be made when selecting and purchasing a CEMS solution.

Contents

| | |
|----------------|--|
| 004 | 1. Foreword |
| 005 | 2. Contents |
| 005–008 | 3. Introduction |
| 009–011 | 4. What to expect from your CEMS vendor? |
| 012 | 5. ABB's unrivaled experience |
| 012–014 | 6. How to make the right choice? |
| 015–027 | 7. Your quality solution provider |
| 028 | 8. System integration |
| 029–031 | 9. Field-testing, certifications and references |
| 032–035 | 10. Your dependable service partner |
| 035–043 | 11. Digital software solutions |
| 043–045 | 12. Lowering your cost of ownership |
| 046–047 | 13. Exceeding your expectations |
| 048–049 | Detailed overviews |
| 050 | Notes |

1. Foreword

The world is changing at a rapid pace and so is the focus on global emissions. The growing demand for Continuous Emission Monitoring Systems, commonly referred to as CEMS, is largely de-coupled from the general economy, driven by increasing regulation and stricter enforcement, but also the public pressure on corporations to operate sustainably and protect their brand image.

At plant level, there is often the tendency to focus on initial cost of CEMS rather than the total cost of ownership, but this is changing as organizations realize that compliance, or non-compliance, can have a big impact on plant availability and profitability. Site maintenance resources are reducing, and it is more challenging to develop and retain good instrument technicians. This increases the demand for contracted services and digital software solutions that ease the burden on plant resources while managing costs.

The ever-growing focus on global emissions and rapidly developing industrial internet of things are driving a significant shift in the way continuous emission monitoring systems are delivered and maintained and ABB is leading the way.

Building on the firm foundation of 90 years rich heritage in continuous gas analysis and emission monitoring and a global force of more than 600 factory certified service engineers, ABB is the pioneer in digital software solutions that are paving the way for true predictive maintenance.

The ABB value proposition is this unique combination of market leading products, locally available and highly skilled service professionals, enhanced by cyber secure remote assistance and condition monitoring services.

All this adds up to market leading CEMS solutions delivering unrivalled value for money.



Products

Technology leader setting benchmark for performance and reliability with cost saving calibration options

Service

Over 600 certified service engineers worldwide delivering consistent quality where and when you need us

Digital

Pioneer in digital software solutions leading shift from preventative to predictive maintenance

2. Contents

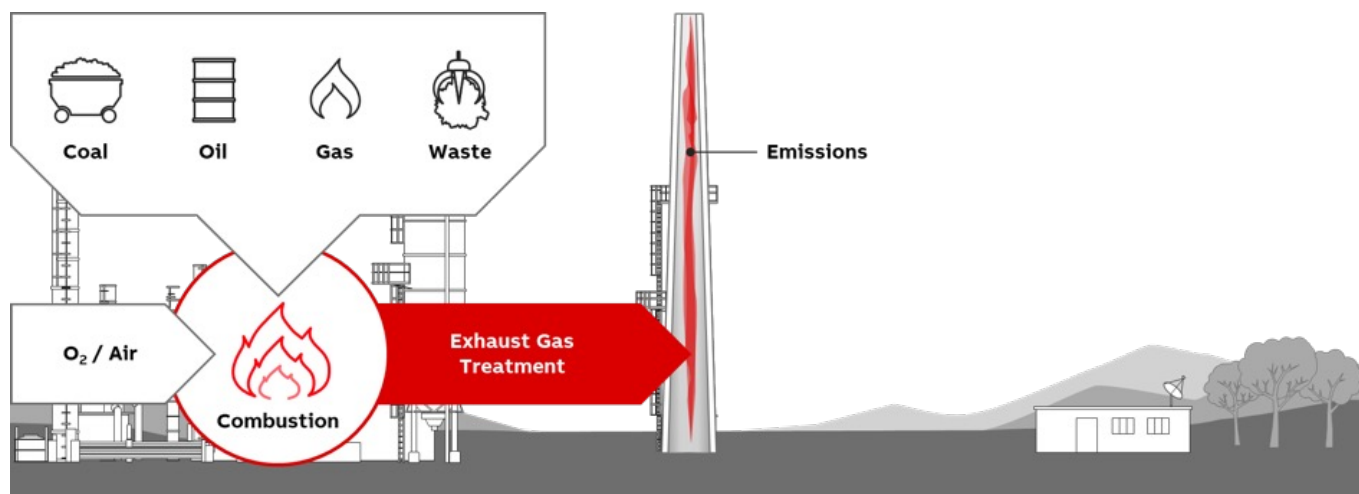
The goal of this guide is to provide helpful information for companies planning for installation and maintenance of CEMS, whatever stage of the purchasing process or experience with this topic. It addresses the global market and tries to present the information in an impartial manner, for example with pros and cons of different approaches, while also explaining how ABB products and services can help meet various compliance requirements and lower cost of ownership.

For the newcomer or those wishing to strengthen the foundation of their knowledge, we begin with some background information and the regulatory

framework that is the main driver behind the growing global demand for CEMS. Then we will attempt to jump into the shoes of our customers with tips to help ease the decision-making process, including criteria to assess potential suppliers on. We will then explain ABB's CEMS offering of products, traditional services, and digital software solutions.

And reflecting on the complete value chain, with the help of real-life case studies, we demonstrate how ABB lowers the overall cost of ownership and goes above and beyond to exceed the expectations of our customers and make compliance easy.

3. Introduction

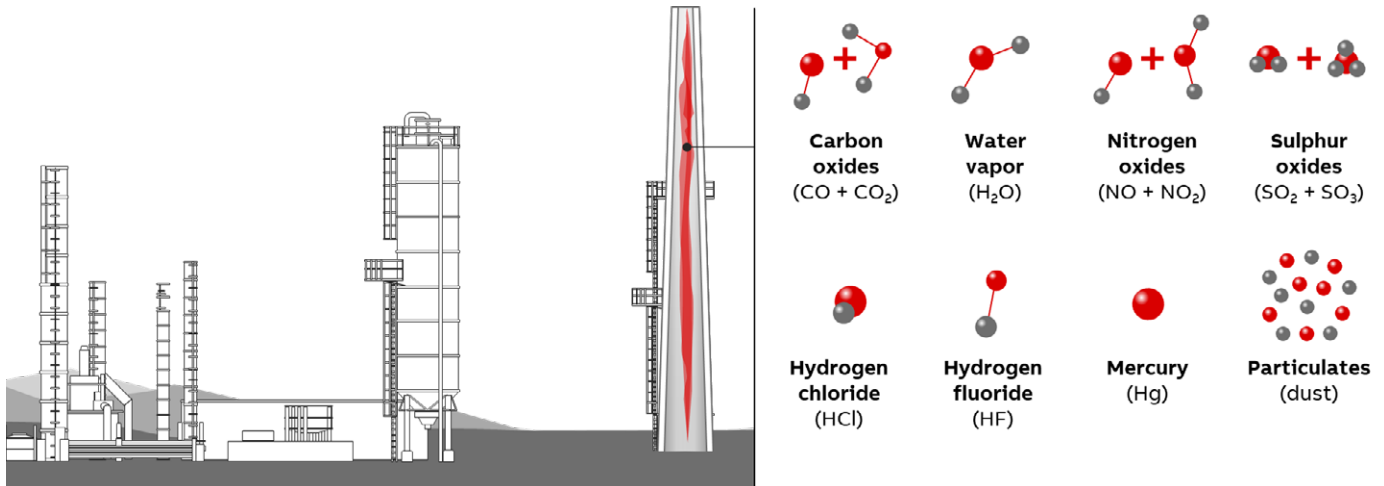


It's important to be aware of what is released into the atmosphere from any combustion process.

The fuel source plays a major role in determining the plant emissions, whether it be coal, oil, gas or any kind of waste. However, the raw material composition can also be a factor.

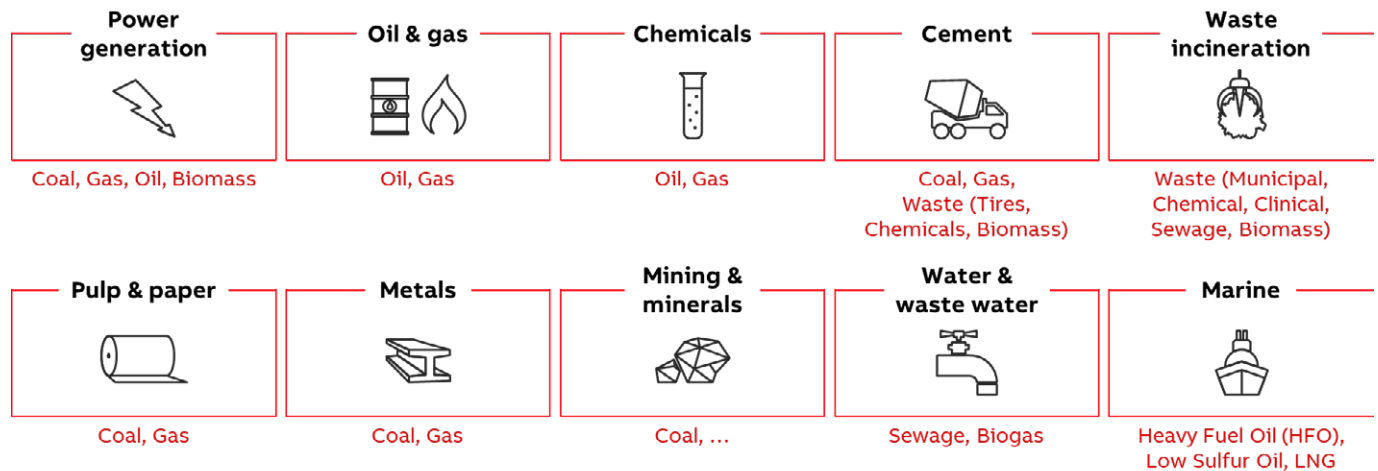
Exhaust gas treatment can be very effective at reducing emissions below regulated limits, but they cannot be eliminated completely.

3.1 Typical products of combustion



- **Carbon monoxide and dioxide:** Excess CO emissions is a strong indicator for incomplete combustion and therefore release of other potentially toxic pollutants. CO₂ is a major contributor to greenhouse gas emissions that trap heat in the atmosphere and cause global warming.
- **Water**, in the form of steam, could give the impression your company is generating significant pollution and the concentrations need to be considered in relation to measurements of other pollutants.
- **Oxides of nitrogen** are a major pollutant and are usually high in focus for the authorities as they increase the greenhouse effect, create acid rain and are damaging for the environment.
- **Sulfur dioxide** is often of interest as well due to its toxicity and direct impact on health. **Sulfur trioxide** emissions are a key component of plume opacity and acid deposition but are currently challenging to measure continuously as they quickly react with water in the air to form sulfuric acid.
- **Hydrogen chloride and fluoride** emissions are acid gases that are often produced during the combustion of waste but can also originate from coal that is high in chlorides.
- Exposure to **Mercury** threatens our health, with many irreversible toxic effects, and harms wildlife and ecosystems.
- And **Particulate** emissions are formed from three main sources: ash contained in liquid fuels, unburned carbon in gas or oil, and SO₃. Fine particles (haze) are the main cause of reduced visibility but they can also get deep into your lungs and some may even get into your bloodstream.

3.2 Industries impacted by environmental regulations and their typical emission sources



- The **automotive** and **aerospace** industries are major emitters but are regulated in different ways to stationary sources:
- **Power generation** can be fueled by coal, gas, oil or even biomass.
- **Oil, gas and chemicals** are in the business of extracting and refining oil and gas into a wide variety of products.
- **Cement** production uses a lot of fuel and is also able to handle various waste products such as tires, chemical waste and biomass due to the high temperatures in the kiln.
- **Incineration** has proven to be a very effective method for disposing of a range of waste sources but also emits the widest variety of pollutants.
- **Pulp and paper** production utilizes a large amount of steam and makes use of coal and gas to fire on site boilers.
- The different furnaces used in **metals** production are also usually fired by coal or gas.
- **Smelting** is a process for the extraction of base metals from mined materials and often uses coal as a fuel source.
- **Sewage** itself and the biogas given off from it are both sources of fuel used to generate energy.
- The **marine** industry is coming under increasing pressure to reduce emissions and is a heavy user of fuel oils and more recently liquefied natural gas.



3.3 International treaties

| International Treaties / Agreements | | | | |
|-------------------------------------|----------------|--------------------------|---------------------|-----------------|
| Kyoto Protocol | Sofia Protocol | Asia Pacific Partnership | Minamata Convention | Paris Agreement |

Emission regulations stem from international treaties such as the Kyoto Protocol, adopted in 1997, and the Sofia Protocol, which was signed in 1988 with the aim to control the emissions of Nitrogen Oxides.

The Asia-Pacific Partnership on Clean Development and Climate, also known as APP, was an international, voluntary, public-private partnership among Australia, Canada, India, Japan, the People's Republic of China, South Korea, and the United States announced in 2005 at an Association of South East Asian Nations.

As mentioned, the UN Minamata Convention signed in 2013 significantly elevated the global focus on reducing Mercury emissions.

And most recently, the Paris Agreement, which entered into force on 4 November 2016, brings together almost 200 parties into a commitment to making their best efforts to lower greenhouse gas emissions. This includes requirements that all Parties report regularly on their emissions and on their implementation efforts.

3.4 Global emission regulations

| National Directives | | |
|---|---|--|
|  EU Legislation EC Directives & Standards 2010/75/EU (IED) EN14181 & EN15267 |  USA & Canada Legislation EPA Regulations Clean Air Act Rules CSAPR, NAAQS, NESHAP 40 CFR Part 60, 63, 75 |  Asia & other regions Different standards Most of regulations follow EU and/or USA legislation |
| Country legislation | Country legislation | |
| Regional & local legislation | Regional & local legislation | |

EU and North American regulations for emission control and monitoring have been in place for many years and have now reached a high level of maturity.

There are many similarities between the regulatory systems introduced in both regions, for example independent stack testing to verify the accuracy of continuous measurements.

The main differences are the certification scheme in the EU for analyzer systems and the requirement for daily calibration in the United States.

Regulations in Asia are quite mixed with China, Japan and Korea having their own systems and other regions around the world adopting either the US EPA or EU standards or a mixture of the two.

ABB has extensive experience of both European and US EPA emission regulations as well as many

of the local rules and guidelines implemented in Asia and other regions of the world.

Understanding and interpreting complex emission regulations has become a major challenge for many industrial plant operators, but help is at hand...

ABB is happy to share our experiences of successfully implementing our CEMS solutions according to US EPA, EU and many other local regulations. Over the years we have often supported to digest and advise on how best to comply with local emission standards.

And we have also shared best practices for the development and implementation of quality control schemes for CEMS at plant or even fleet level for major corporations around the world.

4. What to expect from your CEMS vendor?

When faced with installing new or replacement CEMS it's very important that vendors are challenged to demonstrate their capabilities in order to avoid unwanted surprises later.

After all, this is a purchase decision that should ensure compliance with environmental regulations for the 10 to 15 year lifetime of the CEMS, so it is not a decision to be taken lightly considering how rapidly the regulations and strength of enforcement are developing all over the world.

Facing this challenge for the first or second time can bring up different questions or concerns so both scenarios will be covered, highlighting the most important considerations for making the right choice.

The stakeholders in the decision-making process also have different interests that all need to be considered and addressed.

4.1. Decision-making stakeholders



Site manager

"Ensure compliant with freedom to operate with fixed investments and known costs"



Environmental manager

"I need to meet the requirement for accuracy and availability, ensuring all reports and document meet scrutiny"



Operations

"I need my team to be able to run the plant without issue and drive improvements that add value to the operation"



Maintenance engineer

"I need the skills to perform the maintenance and the peace of mind to understand annual ownership costs"



CEMS management

Emission monitoring and sustainability are a key part of running many successful businesses globally and CEMS management impacts many functions within an organization:

- The Site manager requires 100% compliance with known costs.
- The Environmental manager needs to understand and trust the performance of the CEMS equipment, ensure the data is below emission regulations and demonstrate to local government auditors that they are compliant.
- Maintenance engineers worry about resourcing, especially at weekends and need to avoid budget overruns.

- Operations wants to continuously drive improvements to save costs and increase productivity.
- Ultimately it is ABB's vision to increase customer productivity by reducing the burden of CEMS across organizations.
- We deliver extremely accurate and reliable CEMS equipment providing an attractive total cost of ownership with reduced burden of knowledge for our customers.

4.2. First time buyer

Faced with the prospect of installing CEMS for the first time, our customers may be thinking one or more of the following:

- What's in it for me? The most common concern is that CEMS doesn't deliver any significant process benefit.
- Secondly, that the regulations or requirements are written in such a way that they are very difficult to understand.
- The pressure to maximize the efficiency and output from each plant is continually increasing and emission monitoring is often seen as an unwanted distraction.
- There can also be a lot of confusion related to the different approaches and technologies offered for emission monitoring.

Unfortunately, many first-time buyers only realize after they've made a purchase decision that there are consequences of making the wrong choice that will result in even more stress and unforeseen costs.

So, let's look at the most common pitfalls and the risks associated with each one.

1. Buying the cheapest equipment available because there is not perceived to be any process benefit will often result in much higher costs because of the low accuracy and poor reliability of the equipment.
2. Regulations might still be developing in some countries so there can be a temptation to think that the authorities will not pay attention to the performance of the CEMS. Following the trend in other countries, regulations are only ever going to get stricter, meaning that someone will check the performance of the analyzers at some point in time.

3. Suppliers can make a variety of claims about the performance and reliability of their equipment. It is tempting to trust their word but a word of caution – it is wise to ask for evidence to back up such claims because the costs for non-compliance can be much more expensive when considering fines and enforced corrective actions.

4. The level of maintenance required by a CEMS can vary significantly, leading to unwelcome surprises in terms of cost of ownership. It pays to investigate the level of maintenance required including calibration frequency, consumable parts costs and suggested maintenance schedules.

5. It's quite normal for CEMS to run for long periods of time without failures but, considering these systems should run 24/7 all year round, there will be a few instances during the 10 to 15 year life when supplier intervention is needed. In these instances, being in the situation that an engineer or the necessary replacement parts are not available in a short time would be very frustrating.

To avoid these pitfalls, it is strongly recommended to pay close attention to each supplier's certifications, references, capabilities, commitments.

4.3. Second time buyer

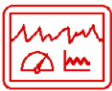



Going through this process before and already experiencing installing and operating CEMS raises other possible concerns such as:

- Higher costs than expected, either to directly maintain the CEMS or in other ways like cost of lost production or fines from the authorities.
- Excessive failures that impacted the CEMS availability and possibly also the plant.
- More maintenance than promised, specialist training required for staff and consuming resources that are already stretched.
- And having to wait longer than expected for support either remotely or physically on site.

4.4. Criteria for selecting your CEMS vendor

It's vitally important to look further into the details in order to assess potential supplier's capabilities

to provide a high quality CEMS solution with the right level of support

| Uncertainty | Availability | Maintenance | Service |
|---|---|--|---|
|  |  |  |  |
| How low? | How high? | How much? | How fast? |
| <ul style="list-style-type: none"> – measuring ranges – cross sensitivities – zero/span drift – external influences | <ul style="list-style-type: none"> – inspection – calibration – maintenance – breakdown | <ul style="list-style-type: none"> – per day – per week – per month – per year | <ul style="list-style-type: none"> – by phone/remote – fault diagnosis – parts delivery – to site |

- **Uncertainty** is the total potential error in a measurement device considering both internal and external factors. Lowest certified measuring ranges give the best indication of required sensitivity at low ppm concentrations. Low cross sensitivities mean the measurement is not influenced by other gases in the sample. Zero and span drift occur when an analyzer's performance is not stable, so low drift equals high quality. And external factors such as changing ambient temperature and pressure can influence the measurement, but they can also be compensated for so looking into this data can be very helpful.

- **Availability or up-time** should be as high as possible to avoid unnecessary shutdowns so looking into certifications or talking to references who can share their experiences with the equipment being considered makes a lot of sense. Also, potential suppliers or users of the equipment should clearly explain the calibration and **maintenance** requirements and how long these are likely to take, because these will all reduce the overall availability of the system significantly.

- Each supplier should be able to advise how much maintenance and how many spare parts will be needed per day, week, month and year. And this can have a significant influence on the overall cost of ownership. Ideally the supplier will have a clear digital strategy targeted at reducing on-site maintenance requirements and increasing availability to reduce costs and downtime.

- And if **support** is needed, it is important to know how fast the service provider can respond by phone or remotely, how long it typically takes to diagnose a fault and then how quickly parts can be delivered, or an engineer mobilized to site.

The key message here is to emphasize how important the CEMS selection process is. There are ways to challenge vendors and get the decision right the first time, or at the very least the second time.

5. ABB's unrivaled experience

ABB is a global leader in emission control having installed over 70,000 systems in more than 50 countries worldwide. The center of excellence in Frankfurt, Germany has over 90 years of rich heritage in continuous gas analysis and we're proud to serve 15% of the global market with our products and services.

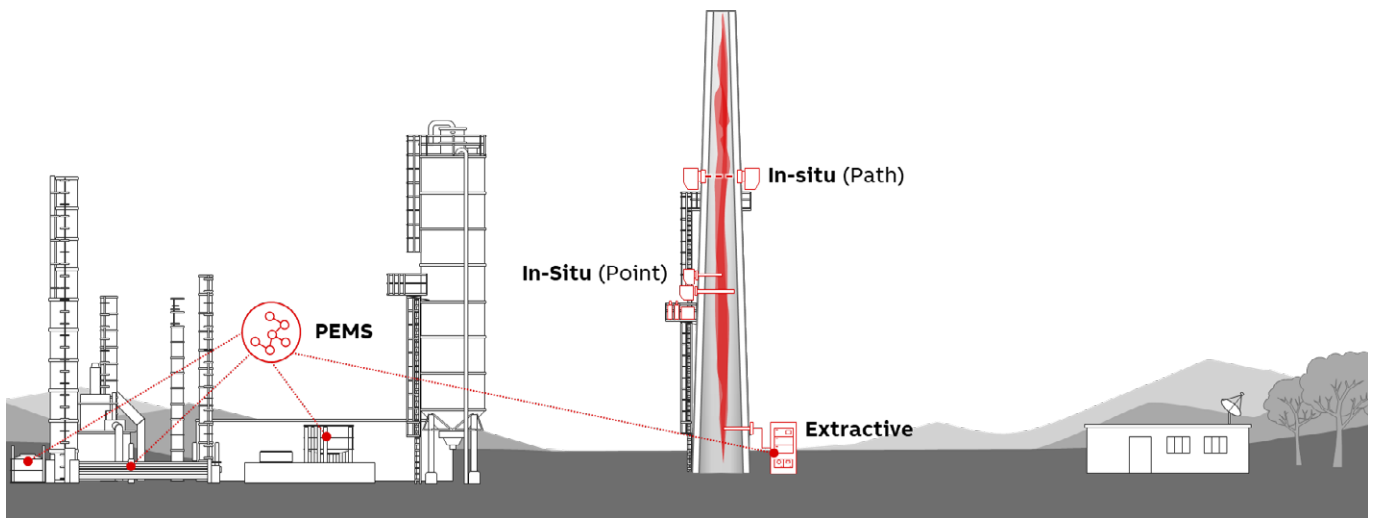
In recent years, ABB has been very active in developing advanced digital solutions that put specialist support at our customers' fingertips and save valuable time and money while increasing CEMS and therefore plant availability.

On top of that, we have more than 600 engineers around the world who are factory certified to maintain the equipment that we supply.

6. How to make the right choice?

One of the challenges for the first-time buyer is how to choose between the different solutions

being proposed but this is equally relevant for a second time buyer.



The installation methods for CEMS can be broken down into three main categories:

- **In-situ** where the device is mounted directly on the stack, either as a point measurement where a probe or measuring cell sits inside the stack, or path where light is sent from one side of the stack to the other.
- **Extractive** is where a sample is continuously taken from the stack, transported, conditioned and presented to the analyzer for measurement. Source level extractive systems measure the gases at the concentrations at which they are in the stack and dilution extractive systems mix the sample with very dry instrument air either in the stack or at the probe by factors of up to 150:1.

- **Predictive** is not widely used today but is growing in popularity in some regions and for certain applications. A model predicts the emission concentrations rather than measuring them directly using historic emissions data and/or process measurements. ABB is one of only a few suppliers who offer both CEMS and PEMS solutions and can advise without bias on where each system will work best or even in combination.

6.1. In-situ method

Let's have a closer look on the advantages and disadvantages of the in-situ method:

- As explained previously continuous gas analyzers that are based on the in-situ method are directly mounted on the process. They do not require a sample handling system which is a benefit as the main source for failures in an analytical system is the sample handling. Being directly installed into the process, in-situ based analyzers can detect changing concentrations within two seconds which makes them ideally suited for applications where a short response time is critical.
- Even though the analyzer is designed for various applications, it is important to consider that the detector is directly exposed to temperature and pressure of the process. On top of that there is almost no protection of the equipment for dust and harsh process conditions. Since many in-situ analyzers use tunable diode lasers with a specific wavelength, it is often only possible to measure one or two components with an in-situ based analyzer. Please also bear in mind that the installation of such analyzers can be difficult depending on the location and its accessibility. In case you want to perform maintenance or repair activities, you will always need to dis-mount the analyzer, which costs you additional time and unavailability of the measurement.

6.2. Extractive method

An alternative to perform the measurement would be the extractive method.

- In this case a sample is taken from the process and transported via a sample handling system to the analyzer, which is usually located in a nearby cabinet or shelter. The sampling itself is completely automated and there is no manual effort required. One of the main advantages of extractive based analyzers is the possibility to measure more than one component at the same time. Since those analyzers are built in an easily accessible cabinet or shelter, any kind of activities related to maintenance and calibration can be conducted without difficulties.
- Despite the mentioned advantages, following the extractive method also has some drawbacks. As this method uses a sample handling system which consists of parts like probe, sample gas line, pump and cooler any additional part creates additional effort and poses a risk for potential failures. Besides the fact that leakages in the sample system could lead to mis-readings, the sample gas also needs to be disposed of. Finally, extractive based analyzers can have longer response times depending on the length of the sample gas line.

6.3. Dilution-extractive method

As opposed to source-level extractive CEMS, one technology that was widely used in the past, and still is today in some countries like the USA, is the "dilution extractive method". In this method, a special probe is used in conjunction with compressed air to dilute the sample gas at the intake point. A steady flow of compressed air is generated by means of a critical orifice, providing this way a stable dilution ratio.

- This method has the advantage that corrosive gases like sulfur dioxide and nitrogen oxides can be diluted to ppm concentrations, avoiding damage to otherwise sensitive analyzers. Additionally, it is not necessary to remove water vapor using a sample gas cooler, which reduces initial investment in the sample conditioning system.
- Nevertheless, these kinds of probes require the constant supply of good-quality, clean, dry compressed air, which in turn requires the installation of a dedicated compressor, carbon dioxide scrubber and air dryer. If oxygen measurement is also required by the environmental authority, it often must be measured in-situ with a Zirconia probe to avoid false readings, while carbon dioxide must always be measured to verify that the dilution ratio is properly set. All these additional requirements can create higher maintenance and operation costs compared to a source-level extractive CEMS.

6.4. Predictive method

Predictive Emission Measurement Systems, or PEMS, are an emerging technology for emission control. These systems consist of a software suite installed in a dedicated computer, which uses empirical, calculated and statistical data to predict the emission of certain gases from a specific industrial process.

- This kind of system has the clear advantage that theoretically no analyzer installation is needed at the plant, which significantly reduces the operating and maintenance cost. Additionally, in cases where a PEMS is used in conjunction with a CEMS, the availability of the complete emission monitoring solution can be maximized.

- The main disadvantage is that these systems are only suitable where a stable and consistent source of fuel is used, which leaves many emission sources like waste incinerators and cement plants out of the scope of use. Additionally, the calculation model must be established by empirical observations and sometimes years of statistical data, which implies a continuous effort for the plant owner. Some emission directives and regulations also allow PEMS to be used only in conjunction with analyzer based CEMS, which represents higher initial investment.

6.5. Tips to aid the decision-making process

Faced with all these options, here are some helpful tips to aid the decision-making process:

Initially in-situ seems attractive because it can be installed directly on the stack with no sample handling. However, approximately 80-90% of plants around the world have a strong preference for the extractive method. But why is that? Well, there are some very good reasons:

- Extracting a sample means only the probe is in contact with the gas and not any delicate optical components. After conditioning, a clean and dry sample is presented to the analyzer.
- The system can then be installed in an air-conditioned cabinet or shelter and protected from sometimes harsh ambient conditions.
- Where in-situ devices are usually limited to one or two components, multiple components can be measured simultaneously using a sequence of sensors in an extractive system and therefore less holes in the stack are required.

- As the analyzer system is installed usually at ground level in a nice, clean environment, maintenance is much more convenient and test gas cylinders are available nearby to easily calibrate the devices.
- If repairs are necessary, components can comfortably be removed and worked on and, because the analyzers are not tightly packed into in-situ housings, they can usually be repaired in the field without having to return them to the factory.
- Considering all the above points it's widely accepted that the overall cost of ownership for an extractive system is lower in the end.

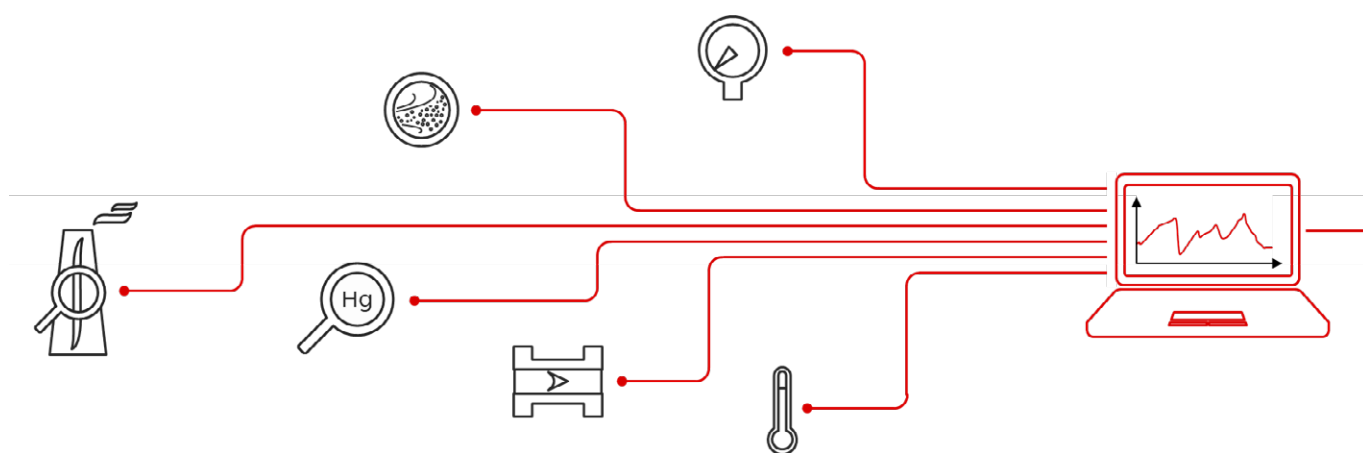
7. Your quality solution provider

ABB is not just about offering high quality products. We understand that a complete solution is needed to address the full requirements of each operating permit. Our portfolio is comprehensive and designed around the needs of our customers.

As we begin to look at the different components of a CEMS solution, it's important to keep in mind the complete scope of supply and what a CEMS vendor must supply in order to comply with the requirements in the plant's operating permit.

The gas analyzer system is a very important component but so too are ancillary devices for Mercury, Particulate, Flow, Pressure and Temperature.

The Data Acquisition and Handling System is also a very critical element of the solution as this software takes care of all reporting requirements to the local authorities.



7.1. The measuring principles

The heart that beats continuously 24 hours a day, 7 days a week in ABB's gas analyzers are the core measuring technologies that have been developed and optimized over many decades.

Optical technologies, including Infrared, UV, FTIR and laser technology, cover the widest range of components. Flame ionization for measurement of

total hydrocarbons and various approaches for oxygen measurement complete the offering.

With such a comprehensive portfolio of in-house technologies, ABB is well equipped to tailor the emission monitoring solution to meet any measurement requirements.

| Measuring principle | CO | NO | NO ₂ | NOx | N ₂ O | SO ₂ | CO ₂ | H ₂ O | HCl | HF | NH ₃ | CH ₂ O | CH ₄ | THC ² | O ₂ |
|---------------------|----|----|-----------------|-----|------------------|-----------------|-----------------|------------------|-----|----|-----------------|-------------------|-------------------|------------------|----------------|
| Infrared | | | | | | | | | | | | | | | |
| Ultra Violet | | | | | | | | | | | | | | | |
| FTIR ¹ | | | | | | | | | | | | | | Non-certified | |
| Laser | | | | | | | | | | | | | | | |
| Flame ionization | | | | | | | | | | | | | NMHC ³ | | |
| Paramagnetic | | | | | | | | | | | | | | | |
| Zirconia | | | | | | | | | | | | | | | |
| Electrochemical | | | | | | | | | | | | | | | |

¹ Fourier-transform infrared spectroscopy

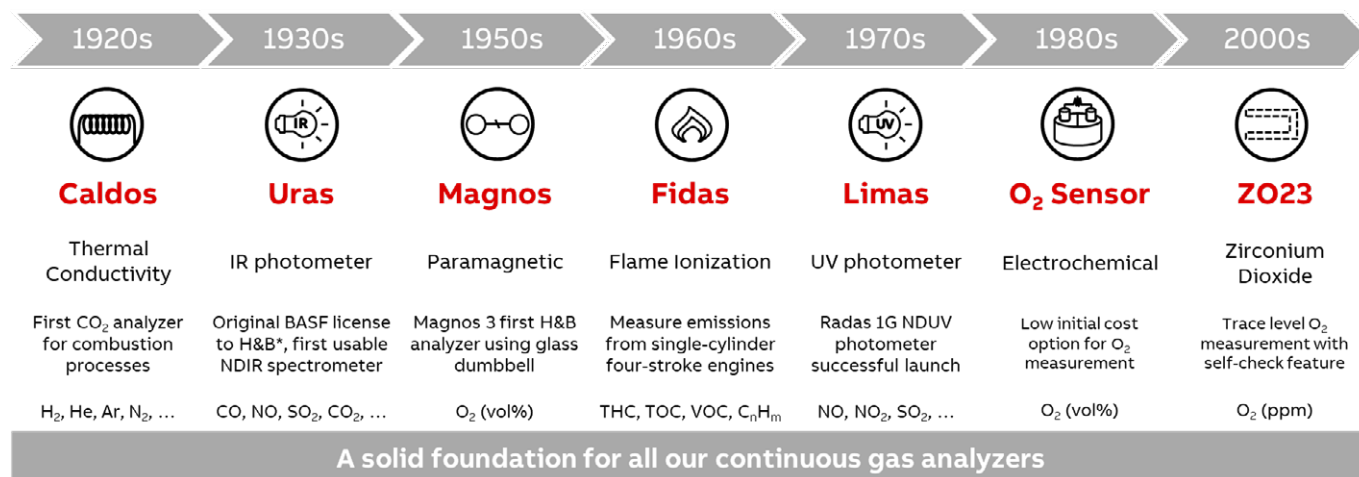
² Total Hydrocarbons – also known as TOC, VOC, Total C or CnHm

³ Non-Methane Hydrocarbons – catalyst used to remove CH₄

7.2. The analyzer modules

These different measuring technologies are incorporated as modules into ABB's range of continuous gas analyzers:

- Our 90 years of rich heritage can be traced back to the first CO₂ analyzer for combustion processes, the **Caldos**, based on the thermal conductivity principle introduced in the 1920's.
- Our flagship product, the **Uras**, is based on over 80 years of experience gained with non-dispersive infrared technology and measures up to four components simultaneously such as CO, NO, SO₂ and CO₂.
- Paramagnetic oxygen measurement experience dates back to the 1950's and the latest **Magnos28** now incorporates ABB's revolutionary microwaving technology and semi-automatic manufacturing for highest precision and repeatability.
- The **Fidas** uses the flame ionization principle for measurement of total hydrocarbons and is world-renowned and appreciated for its robustness and reliability.
- UV measuring technology was introduced in the 1970's and the **Limas** is our workhorse, unaffected by either water or CO₂ and measuring both NO and NO₂ simultaneously as well as SO₂ if required.
- Electrochemical and zirconia oxygen sensors are also available if you prefer to optimize the initial cost of purchase, but these will need to be replaced periodically.
- This broad range of measuring technologies are the foundation for all of ABB's gas analyzer solutions. We are also market leaders in FTIR based emission monitoring – more on that later.



7.3. Continuous gas analyzers

Following this modular approach provides a great deal of flexibility to customize a solution to meet specific application requirements:

7.3.1. Advance Optima series (AO2000)

These analyzer modules form the basis for the Advance Optima or AO2000 series, which is an integrated system concept.

- Up to four of these modules can be combined with one central control unit measuring up to six components simultaneously.
- Both rack and wall mount configurations are available, and the modules can be installed up to 350 meters away from the central unit using a digital bus architecture.
- Even the ABB sample handling components and the LS25 laser gas analyzer can be integrated to the system via a single cable and data made available on the AO2000 display.
- Modern and cyber secure options for remote assistance and condition monitoring are also available.

- Powerful internal electronics offer PLC functionality that adds another level of flexibility to adapt the solution to custom requirements.



7.3.2. EasyLine series (EL3000)

The EasyLine series was introduced some years ago to address the need for high quality measurement at a slightly lower price.

- It is a single housing solution using the same high-quality analyzer modules from the Advance Optima series but packaged with a simpler yet very intuitive user interface and a compact three height unit box in either a rack or wall mount configuration.
- Up to five components can be measured simultaneously by combining two analyzer modules in a single enclosure because the Uras and Limas are both capable of multi-component measurement.
- The Uras NDIR sensor can be combined with up to two electrochemical oxygen sensors or with one paramagnetic O₂ sensor, the Magnos.
- The Limas UV sensor can also be combined with the Magnos.

- Finally, the Fidas FID sensor is available as a standalone unit to complete the line-up.
- Operation of the EasyLine series is made simple via the well thought out 4-way navigation system
- And modern and cyber secure options for remote assistance and condition monitoring are also available.



7.3.3. CL3020 Chemiluminescence NOx analyzer

For the U.S. CEMS market, there is a particularly strong preference for using chemiluminescence detection for single digit ppm NOx measurement.

Therefore, ABB worked with a local company to bring their novel, solid-state detection technology into the same look-and-feel as our EasyLine series.

This product is exclusively for the U.S. market and there is no current plan to make this available in

other countries where we already offer a very good alternative in the Limas UV analyzer, which is capable to measure NO and NO2 simultaneously in combination with SO₂.



7.3.4. In-situ laser gas analyzers

Supplementing our two extractive product lines is the in-situ laser gas analyzer – the LS25, which is part of the Advance Optima series.

The LS25 is ideally suited to challenging process and emission control applications with high temperatures, high pressures and high dust loads.

It can be adapted to measure a wide variety of components, sometimes two simultaneously.



7.3.5. AZ series combustion analyzers

Combustion optimization is where zirconia-based oxygen analyzers are used but they also sometimes find their place in emission monitoring applications.

ABB offers a complete line-up of products under the brand name Endura AZ series.

The AZ20 is our biggest selling product and also carries TÜV and MCerts CEMS approvals for the European market.



7.3.6 Attractive solutions for hazardous areas

If the CEMS must be installed in a zone 2 hazardous area, then the most common approach is to purge the cabinet or shelter. The problem with this is that the system must be isolated before any maintenance or repairs can be performed, which significantly increases the time spent and therefore the cost of ownership.

The AO2000 series in both rack and wall mount are ATEX 3G and CSA Class 1 Division 2 by design, and the EL3000 wall mount analyzers are ATEX 3G by design. This means that the complete system can be designed without a purge, allowing maintenance or repairs at any time.

As a result, time and cost savings can be realized as well as an increase in system availability.

AO2000 series



ATEX 3G non-flammable gases by design



CSA Class1 Div2 by design

EL3000 (wall mount version only)

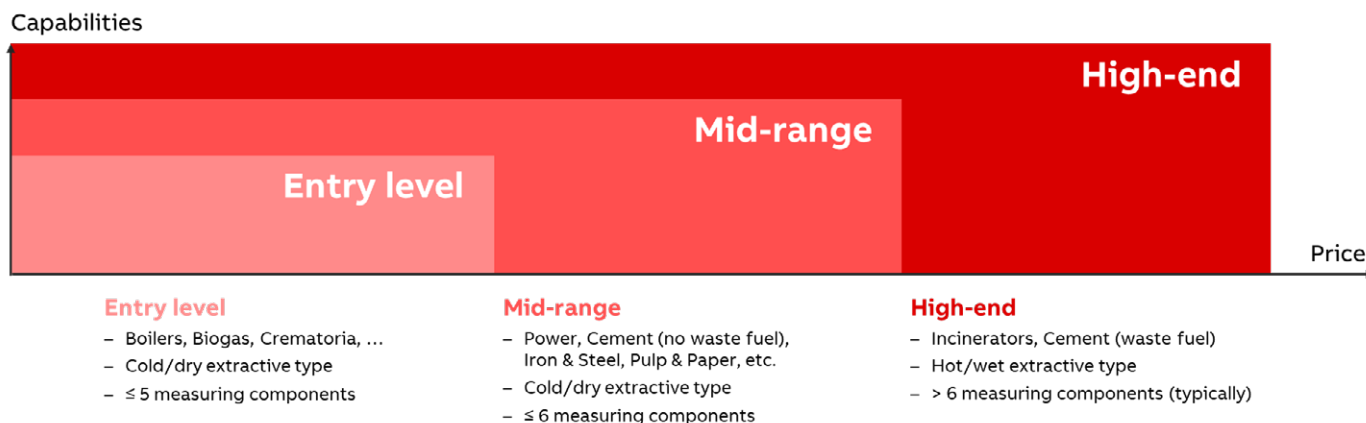


ATEX 3G non-flammable gases by design

7.4. System solutions

Emission regulations vary by industry sector and geographical location and this creates demand for a tiered approach for system solutions.

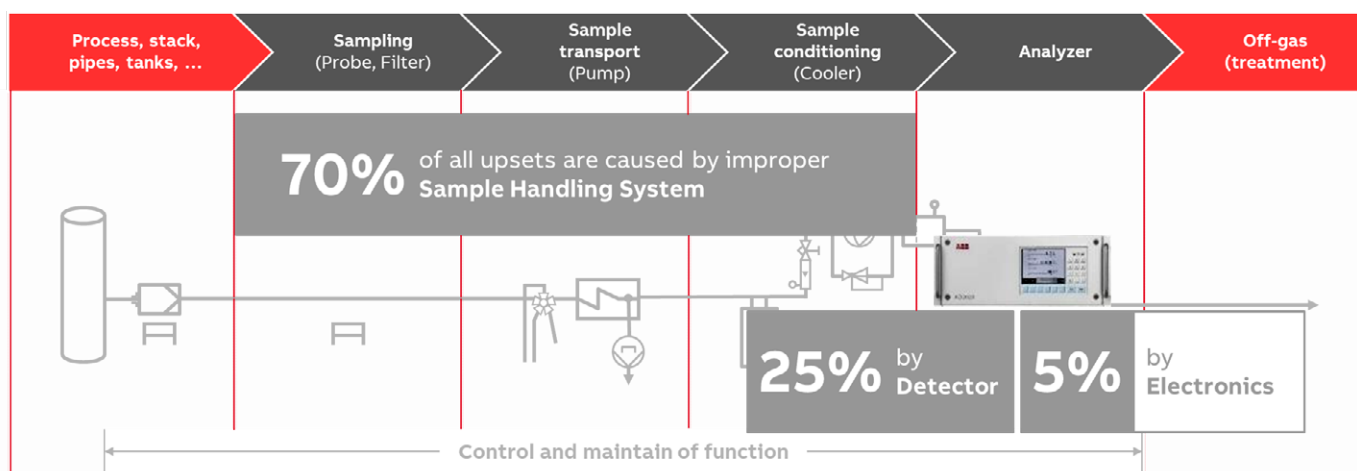
ABB has decades of experience producing standardized system solutions with application-specific flexibility that reduce the up-front design and engineering costs significantly.



- **Entry level:** Smaller and more widespread applications such as boilers, biogas plants and crematoria are also more price sensitive so a simplified cold/dry extractive system measuring up to 5 components is needed.
- **Mid-range:** Larger plants burning only fossil fuels can also be served with cold/dry extractive technology measuring up to 6 components. The technical solution requires more features as the regulatory requirements increase in complexity.
- **High end:** And waste burning processes, that emit a wider variety of gases and are therefore

regulated more tightly, require a hot/wet extractive solution sometimes measuring 12 components or more.

Analyzing the root cause of system failures, you may be surprised to hear that 70% of all upsets are caused by improper sample handling, either how it was designed from the beginning or caused by a lack of maintenance. Beyond that 25% of upsets are caused by the measurement detector and only 5% are caused by electronics.















So, first things first, it's important that the complete system is engineered by an experienced supplier.

For all extractive systems, a probe, heated filter unit and sample line are required to extract and transport the sample to the analyzer system. Typically, manual or solenoid valves are included for calibration, a gas cooler to drop out most of the water, perhaps some additional protection from acid mist or moisture carry-over, and a pump to pull the sample through the system at a steady flow rate to the analyzer.

It is beneficial to have some diagnostics of the sample handling system to ensure smooth operation and this is available within ABB systems.

- ABB is one of very few suppliers who offer a comprehensive range of sample handling components from our portfolio.
- A range of unheated, self-regulated and regulated heating probes, filter units and sample lines are available.
- ABB's unique SCC-C cooler and SCC-F feed unit with optional I/O card are a popular choice while the SCC-S offers a combined cooler and feed unit for less challenging applications.
- Additional components for NO_x conversion, electrical distribution and protection devices complete ABB's offering for sample handling components.

| Probes | Filter Units | Heated Lines | Sample Conditioning | and more... |
|---|---|---|---|--|
|  <p>Unheated Probe 40</p>  <p>Heated Probe 42</p> |  <p>FE2</p>  <p>PFE2 regulated</p>  <p>PFE3 self-regulated</p> |  <p>CGWB13</p> <p>– Self regulated heater – Regulated heater</p>  <p>TBL01</p> <p>– Self regulated heater – Fixed resistor heater – Typical for Fidas24</p> |  <p>SCC-C Cooler</p>  <p>SCC-F Feed Unit</p>  <p>SCC-S Conditioning Unit</p> |  <p>SCC-K Converter</p>  <p>SCC-U Utility Unit</p> <p>Acid filter</p> <p>Condensate trap ...</p> |

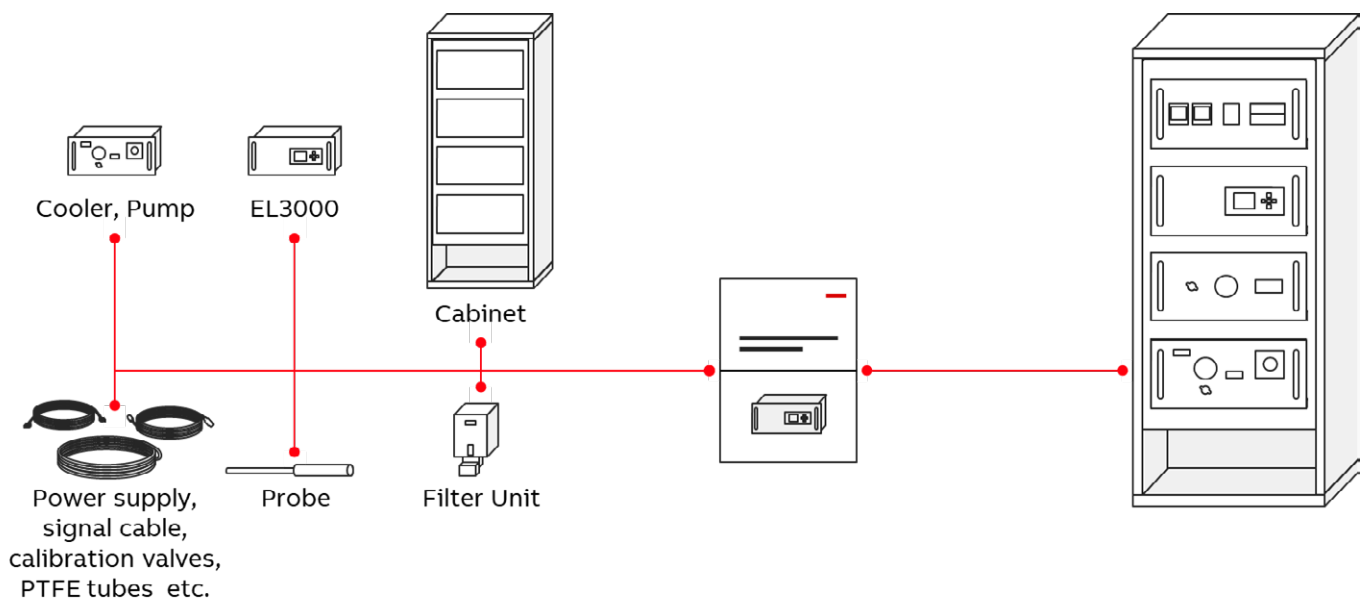
7.4.1. Easy System cold/dry extractive solution

The Easy System is a plug & play, building block concept for system integration, designed for entry level applications.

Learning from the hugely successful Ikea® self-assembled furniture concept, imagine following a similar approach for CEMS with a cabinet, gas analyzer, cooler and pump, filter unit and sample probe, and all necessary cables, valves and tubing. Add some helpful instructions and construction of a complete analyzer system can be made really simple and cost effective. The systems could even be built directly by the end customer. The key building block for plug & play modular analyzer systems is the SCC-U utility unit. The SCC-U brings together the power supply, temperature controllers for the heated sample line and sample probe and solenoid valves for automated calibration.

The advantages of this approach are:

- Compact and cost-effective system can be built which is flexible to meet a wide variety of less challenging applications.
- The SCC-U is designed for plug and play connectivity so that start-up and commissioning is quick and easy.
- No special engineering is required as each of the products can be configured based on the sample gas matrix and plant specific details.
- And a wide variety of applications can be catered for with this system concept, for example boilers, furnaces, biogas plants and crematoria.



7.4.2. AO2000 System cold/dry extractive solution



The AO2000 System is targeted at larger fossil fuel combustion processes and is well established in the market with hundreds of systems delivered around the world since its launch in 2009.

- The system is delivered complete with up to four AO2000 series analyzer modules, measuring up to six components.
- Sample handling components are both physically and digitally integrated via the same bus system used in the AO2000 series.

And the system is available in three different configurations to suit any application:

- Panel mount for installation inside analyzer shelters.
- Painted steel cabinet for indoor installation.
- GRP or fiberglass cabinet for outdoors.

The system is also configurable to suit a wide variety of applications. It's pre-engineered for known applications like emission monitoring and cement process gas analysis but designed in a way that it can be adapted to specific needs as well.

- The system drawings are generated automatically and can be emailed together with our quotation, making it much easier to plan for the installation.
- Finally, the consistency of design is ensured through ISO9001 controlled manufacturing at our center of excellence for continuous gas analyzers in Frankfurt, Germany.
- Because the AO2000 System is standardized and designed with service engineers and instrument technicians in mind, the familiar and open component layout will be a pleasure to work with and can be upgraded at any time if needs change.
- Convenient operation through the front door protects the internal components from the surrounding environment and extends the assets life.
- Modern and cyber secure options for remote assistance and condition monitoring are also available.

7.4.3. ACF5000 hot/wet extractive solution



ACF5000 is the specialist for high-end applications, which are the most challenging emission monitoring applications, predominantly where waste fuels are used in the combustion process.

ABB pioneered the use of FTIR for emission monitoring back in 1993 and the development over the years can be seen here, now with around 2000 installations worldwide we really have unrivalled experience.

And the ACF5000 is at the ideal point in the life-cycle having already been installed and proven on hundreds of plants around the world since its launch in 2014 but still having many years ahead of it in the active phase.

- The ACF5000 is pre-engineered based on more than 25 years of experience and around 2,000 installations worldwide and the complete system is heated above 180degC so that all components remain in the vapor phase for measurement.
- The high resolution FTIR produced by ABB in Quebec, Canada now incorporates an Infrared light source offering more than 5 years lifetime as well as a solid-state laser for continuous alignment that will last more than 20 years in the field.

- All this makes the ACF5000 the ideal choice for measurement of up to 15 components simultaneously including highly soluble and reactive components HCl, HF and NH₃ along with more traditional components like CO, NO_x and SO₂.
- A zirconia oxygen detector is integrated for Oxygen measurement and flame ionization detector for total hydrocarbons. Alternatively, a solution for measuring THC with FTIR is also available.
- Optional validation cells check system drift without the consumption of test gases and full remote access can now be made via a cellular connection if the plant prefers not to integrate the system on the local area network. Automated remote condition monitoring can add further value to maximize the overall availability of the system.

7.4.4. GAA610-M Marine CEMS

The rapidly growing market for Marine emission monitoring is not the focus here but ABB is well prepared with the GAA610-M system, which is a robust, cold/dry extractive system carrying all necessary type approvals. It is particularly notable for low and cost-effective maintenance using internal gas-filled calibration cells and dynamic QR codes for faster fault reporting, diagnosis and repair.



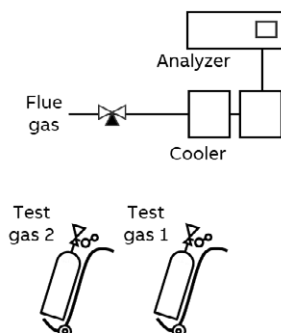
7.5. Calibration concepts

We already mentioned the validation cell option for ACF5000, but ABB is world renowned for innovative calibration concepts for all our continuous gas analyzers that significantly lower the cost ownership.

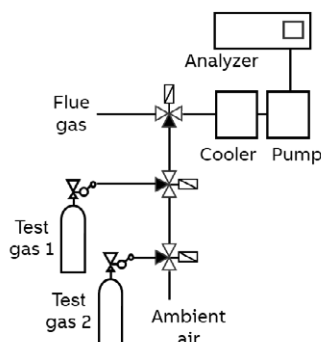
Calibration is necessary for all types of gas analyzers although some require more frequent calibration than others. The effort and costs can vary significantly based on the approach taken towards calibration. Add in the regulatory aspect and it may be necessary to validate the CEMS even more frequently, especially where the US EPA requirements are followed because here daily validation is mandatory. The cost of gas cylinders should not be underestimated and there are significant cost savings to be achieved with the right approach.

- The most basic approach, which is very labor intensive and costly, is to perform manual calibration where the test gases are brought in and connected to a valve in the system for introduction to the analyzers. The one benefit of this approach is that test gases can be shared between multiple systems.
- This process can be automated using solenoid valves and programmable logic, but this adds additional hardware and means the test gases can no longer be easily shared between multiple systems.
- The most cost-effective approach is to automate the process using internal calibration cells for the span point and ambient air for the zero point, thereby eliminating manual work, unnecessary hardware and the high and ongoing cost of test gas cylinders.

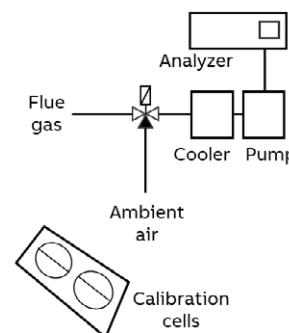
Manual



Automated



Automated with Calibration Cells



7.5.1. Calibration cells

Optionally available in the AO2000 series, EL3000 series and the AO2000 System solution, internal gas-filled calibration cells have proven to be extremely popular with our customers.

- Glass windows are essentially welded to the gold-plated, metal housing using a proprietary sputter and soldering technique, thereby guaranteeing that the gas cannot escape.
- A real test gas with known concentration is connected through the tubes on either end and then sealed inside the cell. ABB has over 30 years of experience with this manufacturing process.

- Calibration cells are an acceptable alternative to flowing test gas for the vast majority of emission monitoring regulations including the European EN14181 and US EPA 40 CFR Part 60.
- Two cells were tested side-by-side by TÜV in Germany for over 10 years and they found that the stability was superior to many cylinder test gases with drift of less than 0.5% per year.
- The calibration cells are specifically mentioned in the AO2000 and EL3000 certifications according to EN15267.

We'll see later that utilizing internal cells can reduce calibration costs by as much as 95%.

Manufacturing



- Gas-filled cell
- Tightness guaranteed by proprietary technique
- > 30 years manufacturing experience

Suitability



- Calibration cells are an alternative to flowing test gas
- Available in both Uras and Limas photometers (AO2000 / EL3000 / AO2000 System)
- Compliant with **EN 14181** and **US EPA 40 CFR Part 60**

Proven technology



- Tested by TÜV for over 10 years
- Stability superior to many test gases
- Drift < 0.5% per year

Certified acc. EN 15267

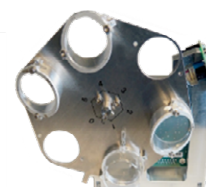
7.5.2. Validation cells

More recently, internal validation cells were introduced to our FTIR based CEMS, the ACF5000.

- These differ to the calibration cells used in the AO2000 and EL3000 because most of them are wide band films which absorb infrared light at multiple frequencies, allowing them to be used to validate more than one component at a time.
- They are approved for validation or checking of the system and not for calibration, but they can be used for automated drift checks required in Europe, the US and other parts of the world.
- FTIR based CEMS are more complex to calibrate than conventional continuous gas analyzers because the gas is measured hot and wet so the benefits for the operator are significant.
- Obviously, there will be a substantial reduction in span gas cylinders required and it's possible for anyone to trigger the validation without any formal training.
- The whole process is completely automated and designed in a way that the validation sequence has no influence on the availability of the CEMS measurements reported to the authorities.

- Once again, this approach potentially saves the operator up to 95% in validation costs.

To see how much can be saved for our customers, ABB has prepared return on investment calculation sheets that can be tailored to each individual situation.

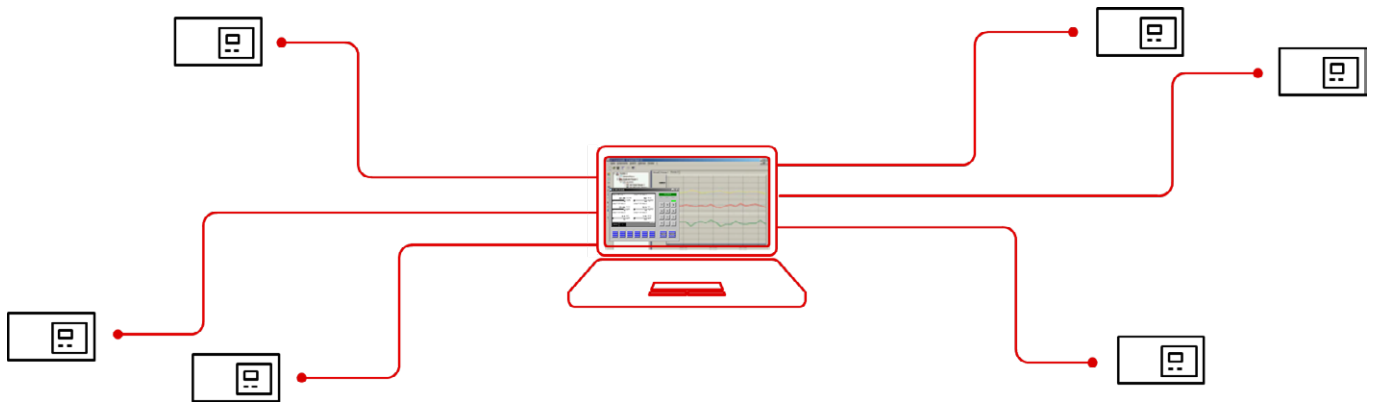


7.6. AnalyzeIT Explorer asset management software

AnalyzeIT Explorer is an asset management software solution that monitors the analyzer and sample handling system status to give an early indication of a change in performance.

- 3rd party sensors can also be integrated and monitored using this tool.
- ABB delivers this software with a basic license free of charge with our AO2000 System and ACF5000 standardized system solutions and otherwise at a very reasonable price level.

- Remote monitoring and full control of the system allows the operator to trigger diagnostic or corrective actions without having to physically move to the analyzer, thereby saving time.
- Investigating logbooks for calibration and status messages, and trending temperatures, flows and pressures are also potential ways to recognize trends or distinguish anomalies.
- If necessary, validation with test gases or calibration cells can be triggered remotely to further analyze the condition of the system.

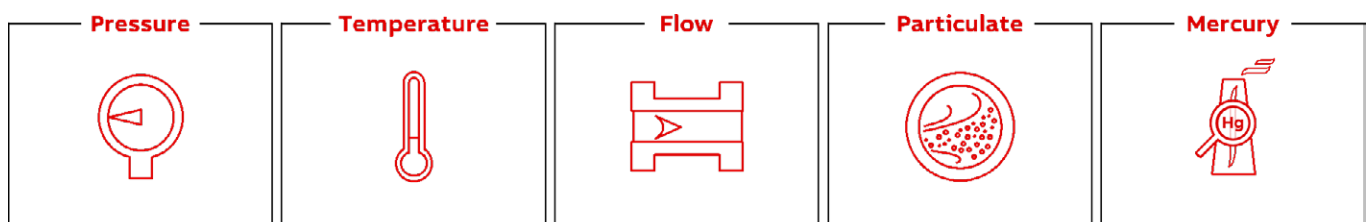


7.7. Additional equipment

Beyond the previously mentioned gas measurement systems, additional devices are often necessary to complete the required scope of supply.

- Most emission regulations require that gas measurements are normalized to standard pressure and temperature and ABB's 266 series and TSx/TTx series transmitters are a good fit here.
- A fixed flow rate can often be used to calculate mass emissions but when a continuous stack flow measurement is needed then the ABB differential pressure StackFlowMaster is a great solution.

- Particulate or Dust measurement is usually one of the first components to be regulated because of the affect it has on the surrounding area of the plant and there are a variety of measuring principles applicable depending on the concentrations, the size of and conditions inside the stack. Here ABB works with different partners but always takes ownership of the complete solution for our customers.
- And that is also the case when Mercury measurement is required. ABB takes responsibility for the complete emission monitoring solution, integrating all necessary devices into a cohesive solution that most effectively addresses the regulatory requirements.



7.8. CEM-DAS data acquisition and handling system

The data acquisition and handling system is a very important component of the entire emission monitoring system and CEM-DAS is ABB's solution for emission reporting in accordance with regional and local regulations and requirements.

- CEM-DAS is TÜV and MCerts certified with more than 99% data availability and designed to meet the upcoming EU standard EN 17255 making it future proof.
- Built-in redundancy and password-protected user management ensure the data remains secure and compliant. It's easy to install and configure especially if the standard Modbus TCP/IP link, available in all ABB gas analyzers, is utilized. This greatly reduces the number of cables needed, minimizes hardware cost and enables much faster setup.
- If troubleshooting is needed later or changes are necessary to comply with new permit requirements, then navigating the Modbus address list is much easier than tracing hard-wired signal cables.

- When ordered together with ABB analyzers, the software comes pre-configured based on the analyzers selected, saving valuable time and therefore cost during commissioning.
- Full remote control provides a cost-effective way to implement small changes and troubleshoot any reported irregularities.
- Due to the browser-based client/server architecture, CEM-DAS can be operated from any mobile device.
- And the software is highly scalable, from simple, single stack installations up to multi-stack solutions with added complexity such as hardware redundancy or switching between systems.



7.9. Predictive Emission Monitoring System (PEMS)

Predictive Emission Monitoring Systems, or PEMS, are growing in popularity in certain parts of the world so let's take a minute to explain what it is, where it can be used, and how ABB is positioned to respond.

- Predictive emission monitoring is a software solution that utilizes a combination of historic emission data and process measurements such as fuel composition, flow, pressure and temperature to accurately predict gas emissions.

- It is subject to the same certification and performance standards as normal hardware based CEMS, for example European EN14181 standards and US EPA regulations.
- PEMS is ideally suited to processes with a very consistent fuel source such as natural gas or oil but not for processes burning waste fuels such as incineration or cement plants.

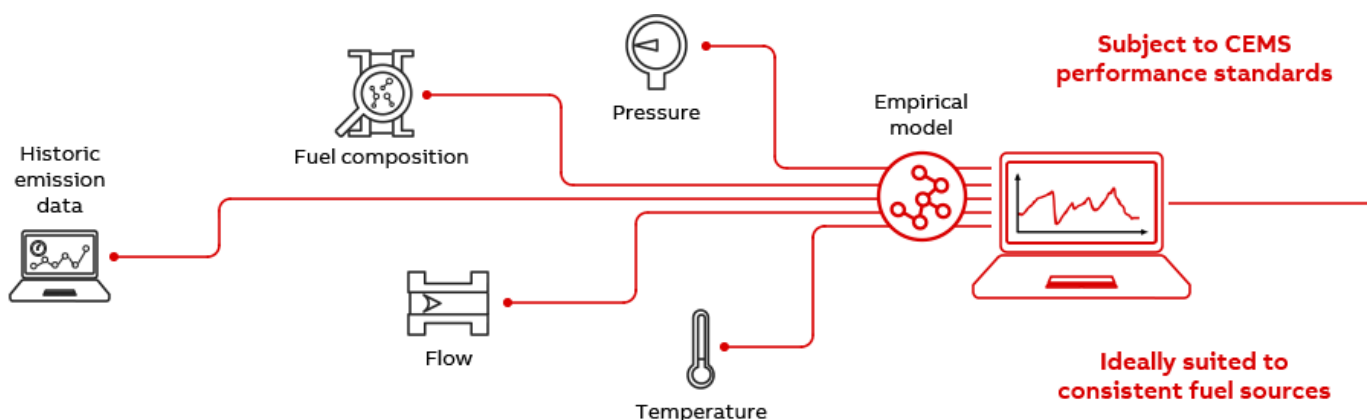
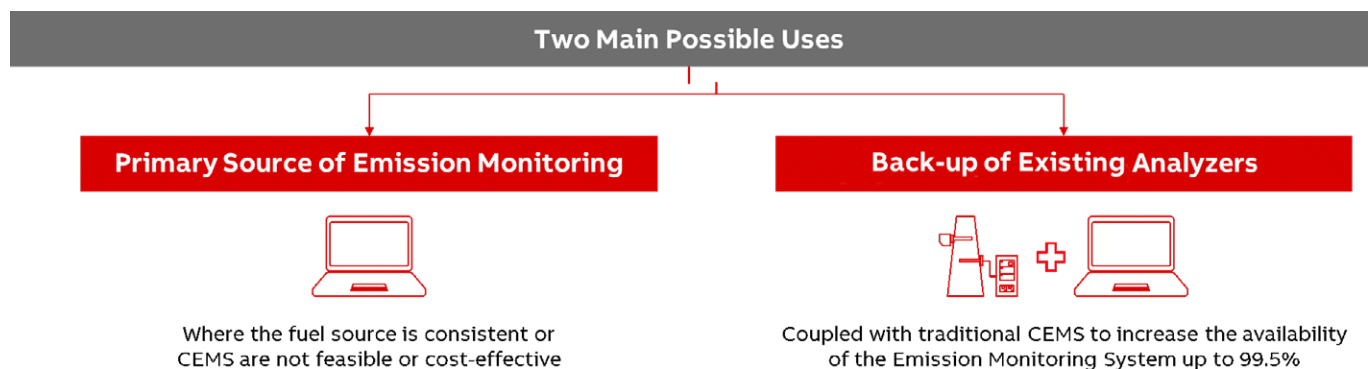


ABB is uniquely positioned as the only major CEMS vendor offering both CEMS and PEMS. We can offer the best solution based on the process and any specific needs, even combining the two where it makes sense.

- ABB is a truly global organization with offices in every major country in the world and we pride ourselves on providing high quality and reliable after-sales services.
- PEMS can be used as the primary source of emission monitoring when the fuel source is consistent or where CEMS is not considered feasible or cost effective – for example, hazardous area installation with challenging sampling requirements.

- It can also be used in addition to hardware-based monitoring to increase the overall availability of the measurement up to 99.5%. In this case, PEMS can maintain a compliant measurement during CEMS calibration and maintenance or provide back-up in case the CEMS fails for any reason.

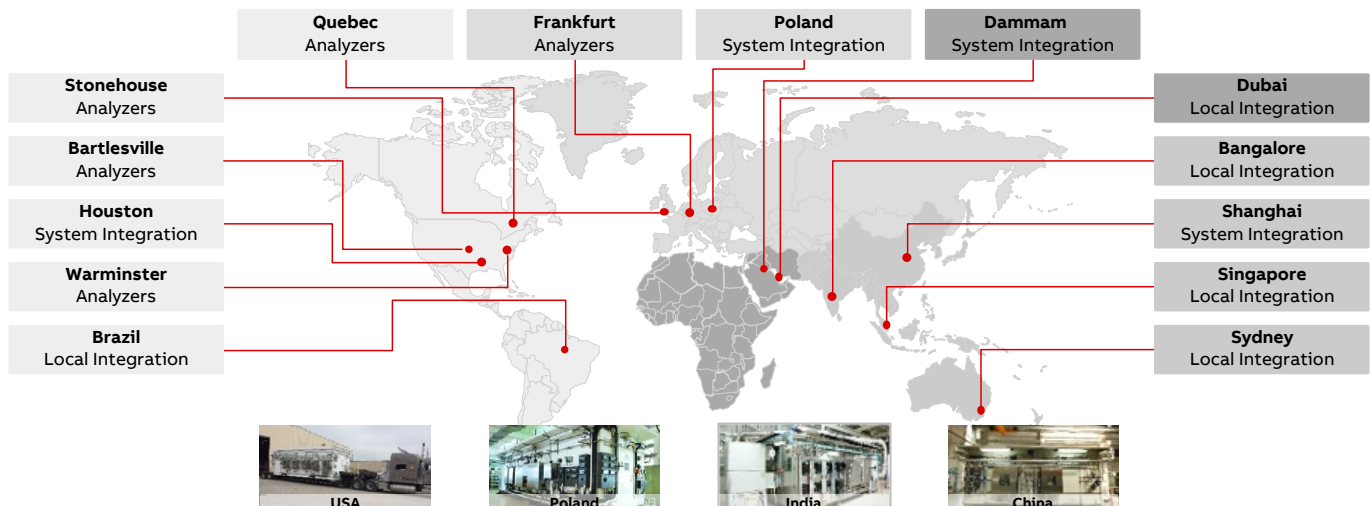
ABB's PEMS solution is built on the Inferential Modeling Platform, which is proprietary software developed over many years and having comprehensive statistical analysis capabilities to build models and deploy them quickly and effectively online.



8. System integration

Bringing all the hardware and software pieces of a CEMS package together is commonly referred to as system integration and, while ABB offers standardized system solutions to minimize the engineering effort required, we are also in the business of providing turn-key solutions that are custom engineered to customer specifications with the quality expected from a global market leader.

We offer this service from many dedicated integration facilities around the world but also work with many regional partners to provide tailored solutions in accordance with local regulations and customs.



9. Field-testing, certifications and references

Referring to the section – what to expect from your CEMS vendor? – we highlighted three main considerations in respect to performance that are especially important.

It can be difficult for our customers to differentiate between the solutions being proposed, so we advise putting trust in independent opinion and hard performance data.

9.1. Independently certified

First, are the suppliers manufacturing processes and safety standards independently certified by internationally recognized and accredited organizations?

- In ABB's case, we operate and are certified in accordance with ISO9001 for quality, OHSAS18001 for health & safety and ISO14001 for environmental.
- All our products are CE marked and many are certified for operation in hazardous areas according ATEX, CSA, IEC as well as localized approvals in China, Japan, Korea and Russia for example.
- SIL becomes an increasingly important topic and ABB is investing heavily to ensure our products are designed and certified in accordance with these safety standards.

- Specific to emission monitoring, TÜV in Germany and MCerts in the UK are independent certifications necessary for the sale of CEMS in Europe.
- While the US EPA does not require any product certification, all manufacturers are required to meet a range of performance specifications and ABB's products are fully compliant with these.
- The tightening of regulations affecting the marine industry are expected to continue and ABB is well prepared with Lloyd's Register, ABS, Bureau Veritas, Nippon Kaiji Kyokai, Korean Register and DNV-GL certifications for onboard CEMS.

Quality, Health & Safety, Environmental



Safety / Explosion Protection



NEPSI (China)
TIIS (Japan)
KCs (Korea)

GOST TR TS (Russia / Eastern Europe)

Emissions



DIN EN ISO/IEC 17025 accredited laboratory

EN 15267 / EN 14181 QAL1

US EPA 40 CFR Part 60 / Part 75

MEPC 184 (59) Marine



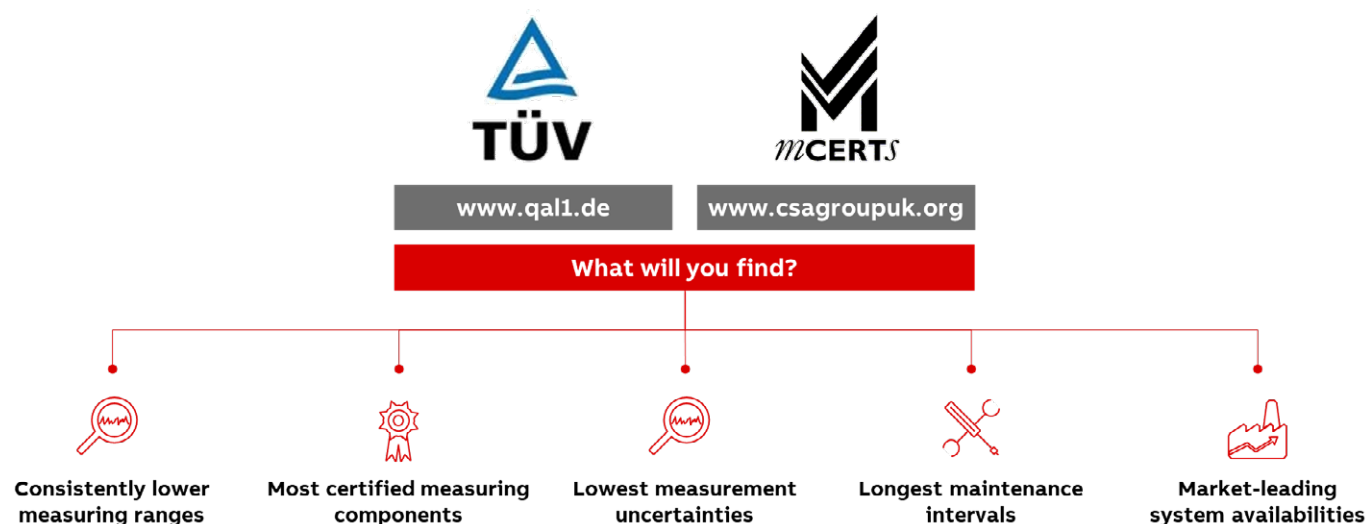
9.2. Independently field-tested and certified

Although originally intended for the European market only, because of the extensive field testing and benchmarking performed during the certification process, both TÜV and MCerts approvals are adopted also in many other parts of the world.

- This makes a lot of sense because before making the decision on which equipment to purchase, customers can review, compare and gain confidence that the CEMS really will deliver all that the supplier is promising.
- So, what can be found for ABB when visiting either of these two websites?
- Well, the good news is that ABB provides consistently lower certified measuring ranges, and this is the best indication of detection limit and sensitivity to accurately measure low concentrations but also a good indication of the overall quality of the device.
- Also, the most certified measuring components, giving confidence that ABB can fulfill the requirements of the operating permit no matter what type of process it is.
- Lowest measurement uncertainties combine all the internal and external influences on the accuracy of the measurement into one number so the lower the number the better the overall performance.

- Certified maintenance intervals demonstrate how often the system will need to be calibrated so the longer the maintenance interval the more robust and stable the CEMS. In fact, each CEMS vendor is required to test two identical systems for two times the certified maintenance interval, so if the CEMS has a 6-month maintenance interval, for example, then these parallel systems were tested for 12 months in the field.
- Finally, system availability, which means the amount of time that the CEMS provided good measurements during the field test. The basic requirement is 95% availability, but ABB consistently achieves 98%+ up-time, which in the end means less maintenance effort, lower cost of ownership and reduced stress and workload caused by non-compliance.

The key message here is that it pays to focus on the details and choose the supplier carefully.



9.3. Extensive references

Reinforcing the independent field testing and certification data available, further confidence can be gained from existing users.

ABB's emission monitoring solutions are trusted by many of the world's leading companies and we are happy to provide a list of references or even put our customers directly in touch with individual users.

This is not just an overview of company names but large, multi-national corporations who have chosen ABB as their vendor for multiple CEMS installations across a wide variety of industry sectors and applications.

Even NASA trusts ABB's analyzer technology for monitoring of greenhouse gases in space.



10. Your dependable service partner

Service is a dedicated product group within ABB's Measurement & Analytics global business line built on a strong foundation of 17 factories with repair centers and 34 local service support centers.

With over 600 engineers operating in more than 50 countries around the world, servicing over 20 million delivered instruments and analyzers and

with a rich heritage of over 100 years, ABB takes our responsibilities as a service provider and partner very seriously.

Tens of thousands of emission monitoring systems have been delivered over the years and we understand the pressures our customers face to remain in compliance and keep plants running.

Over _____

600

Service employees



Services in more than _____

50

countries



Over _____

20m

Instruments and Analyzers delivered



Providing services for over _____

100

years



• Factories with repair centers (17)

• Local service support centers (34)

10.1. Manufacturer Certified Service

When dealing with ABB's service organization customers can also be assured of the quality and capabilities of the engineers providing support. ABB operates a Manufacturer Certified Service program to ensure that all technicians are adequately trained to perform the services. Certification level 1 and 2 are field service certifications,

which are backed up by level 3 technicians coming from the factory team.

Our Manufacturer Certified Service is professional and ensures guaranteed compliance with requirements and specifications as well as a whole host of other advantages.

Competence

- Certified training with manufacturer-approved instructors, documents and exercises
- Certification training for service personnel on new products and technologies
- Three-Tiered Support Concept

01

Certification Level 1

- Well trained and experienced service specialists for on-site support, available in almost all countries around the world

02

Certification Level 2

- The specialists with comprehensive and long time experience for analytical product range
- Manufacturer-approved instructors for service training available in many countries

03

Certification Level 3

- Manufacturer Service Support Group

What you can expect



Adaptable training with standard or in-house programs in a number of languages



A written report after successful technical on-site support for a product



Final acceptance in compliance with the functional specifications and test specifications after test run



Guaranteed compliance with requirements and functional specifications



Direct assistance via phone, e-mail, fax or remote control session



Training, both individual and on site



Consultation and certificates for explosion protection



Tailor-made spare-parts supply



Individual service contracts

10.2. Service Agreements – Measurement Care

ABB Measurement Care is a modular and standardized service agreement framework that can be tailored to customer needs.

Expect consistent service delivery anywhere in the world and simplified interaction with ABB that delivers dedicated solutions that maximize product lifetime and return on investment while delivering highest up-time and accuracy of measurement.

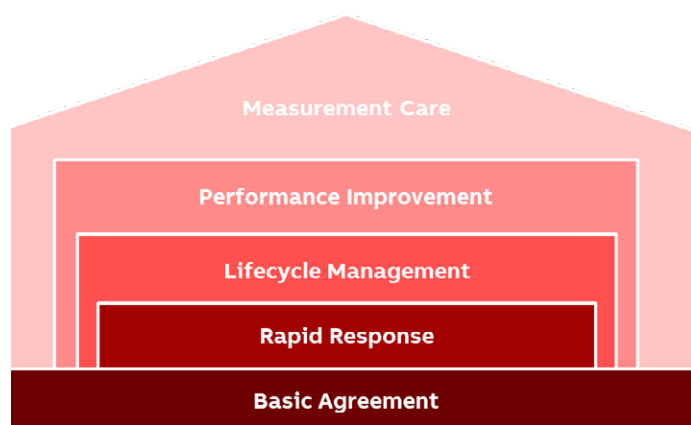
Bundling the specific services needed leads to reduced complexity, more predictable and lower operating costs, and maximized return on capital investment.

Professional and efficient contract management is the foundation for ABB's Measurement Care service agreements.

Speed of response is vitally important for CEMS applications because of the pressure faced to remain in compliance and keep plants operational.

- In most countries ABB offers guaranteed response times in terms of technical support and remote troubleshooting.

- Dynamic QR Codes are a nice innovation that will be covered in more detail shortly and these are all about helping to maximize system availability.
- When needed, both on-site and workshop repairs are offered with most cases being repaired on site, again with the focus on increasing up-time.
- Proactively partnering together throughout the entire equipment lifecycle ensures no unwelcome surprises, predictable costs and extended life.
- ABB can recommend appropriate spare parts stock to be held on site but also put in place further security to make sure that critical parts are available when needed.
- Preventative maintenance is very important to extend the lifetime of assets and we can also visit site to assess the overall condition of the installed base, providing a detailed report and recommendations to aid with future planning.
- Enhancing the performance of assets is achieved by embracing the latest digital technologies and the wealth of experience available in the ABB organization to monitor the CEMS condition and predict and avoid failures before they occur.



Basic Agreement

We cut complexity with professional contract management

Rapid Response

We guarantee fast and flexible response to maximize your equipment uptime

Lifecycle Management

We employ powerful tools and knowledge to optimize and extend your equipment life

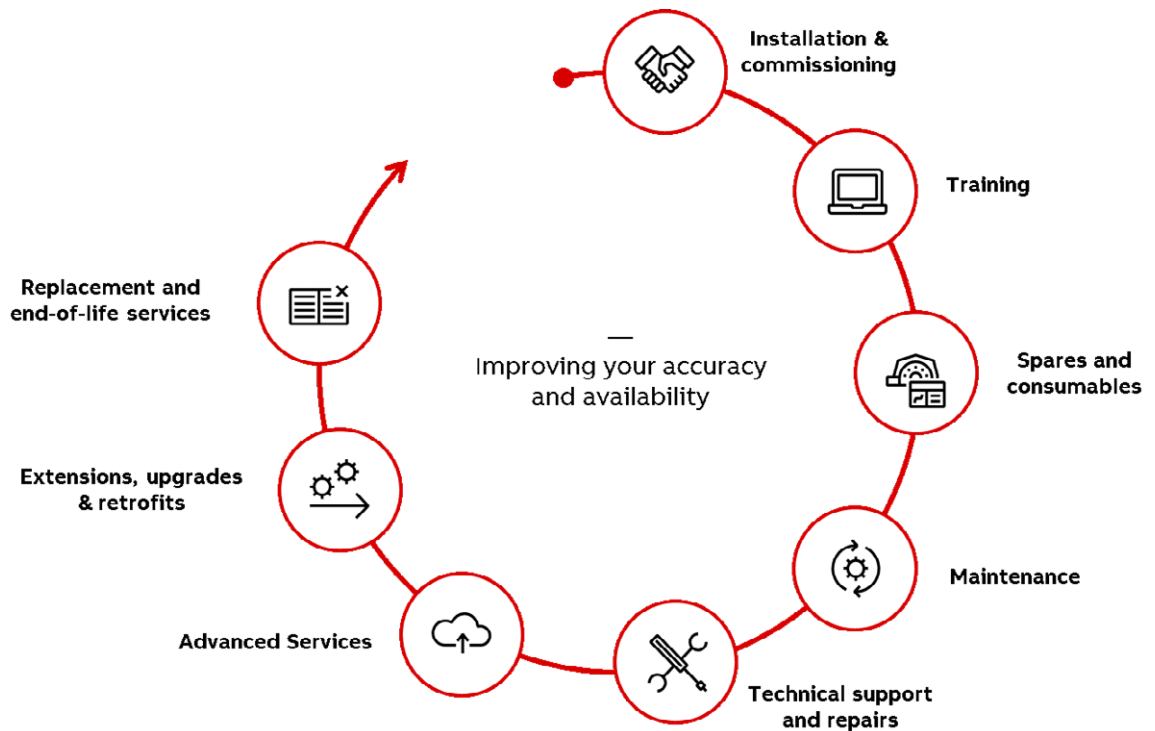
Performance Improvement

We optimize connectivity, reliability and efficiency of your assets to increase speed and yield

10.2.1. Services throughout the lifecycle

ABB provides a full range of services that are fully productized to ensure consistent high standards globally and are always delivered by certified professionals.

- Specific to Analytical Measurement or in this case CEMS, ABB makes sure our customers start quick and easy during installing and commissioning.
- Training is available either remotely through webinars and e-learning, or face-to-face to equip plant personnel to manage the assets effectively.
- Spares and consumables are itemized according to consumption and criticality so that local stocking or access to ABB warehouses is carefully planned.
- Routine maintenance and calibration ensure they remain in optimum working order.
- Should you encounter a problem with your assets, ABB will be on hand to provide technical support and workshop repairs in the unlikely event that it can't be resolved in the field.
- Performance and availability are enhanced through secure remote connectivity and on-premise conditioning monitoring.
- Extensions, upgrades and retrofits are planned together up-front to maximize asset value, minimize downtime and avoid unwelcome surprises.
- And when the end-of-life comes, we'll be there to plan for replacement in good time so that budgets are prepared well in advance.



10.2.2. Customer-oriented lifecycle policy

At the heart of ABB's services is Product Life Cycle Management, a four-phase model based on the know-how and experience acquired by ABB during four decades in local and global markets.

The lifecycle policy is comprehensive and customer-oriented, providing the transparency, predictability and confidence that is expected from a global organization like ABB Measurement & Analytics.

| Active | Classic | Limited | Obsolete |
|--|--|--|--|
| Complete life cycle services | | Limited life cycle services | |
| <ul style="list-style-type: none"> Starts when the product is launched. The end user benefits from different warranty options and other services such as training & technical support including product adjustment for optimum performance. The active phase ends when the volume production of the product ceases. | <ul style="list-style-type: none"> Aligned with ABB's research & development work to provide continuing support for product while developing future generations. New hardware and software development may be required to provide the maintenance techniques and upgrades needed to guarantee that the product continues to operate at its peak performance. | <ul style="list-style-type: none"> Spare parts are available as long as components and materials can be obtained. Towards the end of the limited phase, services gradually become obsolete. In addition to the annual life cycle status reviews, ABB issues a life cycle phase change announcement, half a year prior the product becoming obsolete. | <p>The ABB product is transferred to the obsolete phase when it is no longer possible to provide services at reasonable cost, or when ABB can no longer support the product technically, or the old technology is not available.</p> |

11. Digital software solutions

Quality solutions from a dependable service partner are what ABB's strong global reputation has been built on for many decades but now we are pioneering Digital software solutions that are leading the shift towards market leading remote assistance solutions and predictive maintenance.

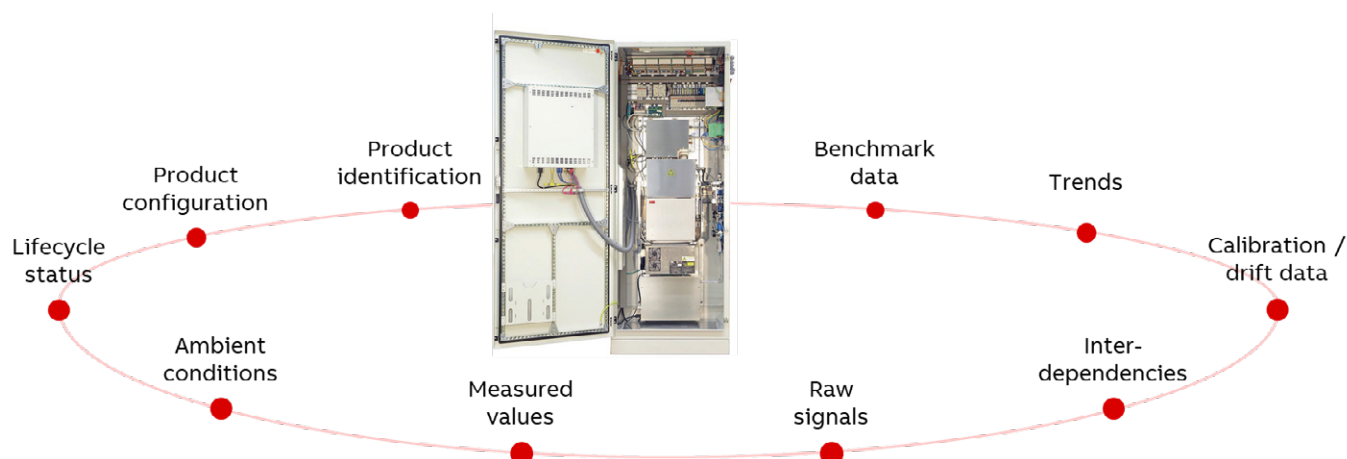
Because of the increasing enforcement of environmental regulations around the world, CEMS availability and performance becomes even more critical.

Digital is all about harnessing the data that exists within the analyzer systems, getting it into the hands of the people who need it in a safe, easy and fast way and delivering intelligent insights to what needs attention and how it should be addressed.

But what is Digital really?

Analyzer systems generate a lot of data and a certain level of intelligence is already built in that trigger helpful warnings and alarms for the user.

Ideally, we want to predict a failure before it occurs so that it can be prevented but, if something does go wrong, we also want to diagnose and fix it as soon as possible.



11.1. Cyber security management within ABB

As Digital is all about harnessing data and providing valuable information whenever and wherever it needs to be, security becomes a key consideration.

Cybersecurity threats evolve daily, making it a journey not an end destination.

- Our long history of delivering critical infrastructure in power and other industries means that security management is part of ABB's DNA, touching every aspect of our business including our people, IS, products, systems and services as well as our extended eco-system which includes vendors, partners and contractors.

- All products have been rigorously tested in ABB's Device security assurance center to ensure they exceed industry practice security measures.
- We continuously monitor new threats that appear and actively work to remove any weaknesses that emerge in a systematic way.
- Cybersecurity is a complex subject and we have experts available to answer specific questions or concerns raised by customer IS departments, additionally we have a range of services and specialists ready to help customers protect their business from the threat of cybercrime.

General security measures



- Cyber security policy
- Mandatory trainings for all ABB staff with annual refreshers
- Data protection
- Security awareness
- Phishing / malware

Information Systems



- Patching
- Network security
- Data handling, back-up & encryption
- Malware scanning
- System hardening

Products and solutions



- Gate model process
- Software Development Improvement Program (SDIP)
- Mandatory cyber security checklists and assessments for all solutions
- Device Security Assurance Center (DSAC)

Services and projects



- Mandatory trainings for all field service technicians
- Protecting own IT
- Working on customer systems / data handling
- Virus checking PC's, USB sticks, CD's
- User account management

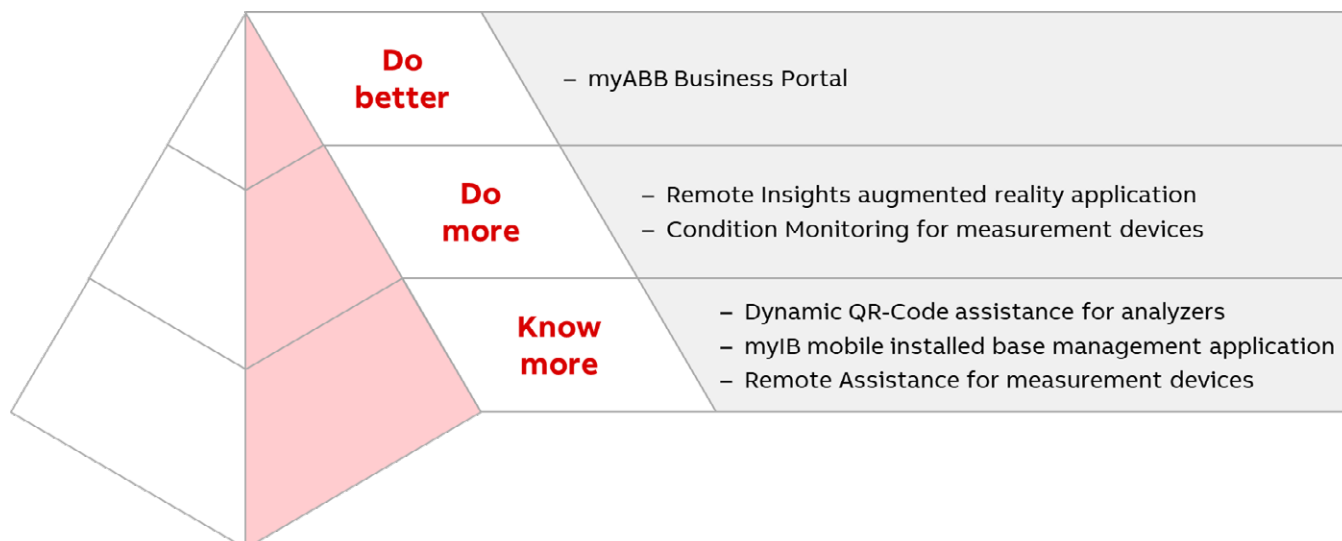
11.2. ABB Ability™ Digital software solutions

Devices, systems, solutions, services and a platform that enable our customer to know more, do more, do better, together.

ABB Measurement & Analytics offers an ever-increasing suite of Digital Solutions on the ABB Ability™ platform, each designed to help our cus-

tomers increase efficiency and lower operational costs.

We will explore each of these solutions and demonstrate the value that they bring to our customers, but before we begin...



11.3. Difference between traditional and digital services

The major difference between traditional services and advanced digital services is that we are now going beyond ensuring availability and avoiding downtime and shifting to measurable increases in up-time through prediction of faults before they occur. As a result, costs are reduced, and plant profitability is increased.

Effective digital solutions must capture and analyze data quickly and deliver actionable insights that improve performance of the assets continuously.

11.4. Dynamic QR Codes

The first of our digital solutions appears simple, and it is so easy to use, but a lot of energy went into bringing Dynamic QR Codes to our analyzer solutions.

Let's start with a common scenario that we call communication 'ping-pong'...

Imagine an analyzer on a plant and it is showing an alarm and support is needed to identify what the problem is.

The plant gets on the phone with the supplier and the following example unfolds:

- Our analyzer is not working, can you help us?
- Of course, we'd be glad to. Can you provide some additional information about the equipment?
- Sure, it's a Uras analyzer. What else do you want to know?
- Ok, please give me the serial number on the type plate.
- Hmm...that's difficult to find as the analyzer is installed in a rack. Is there another way?

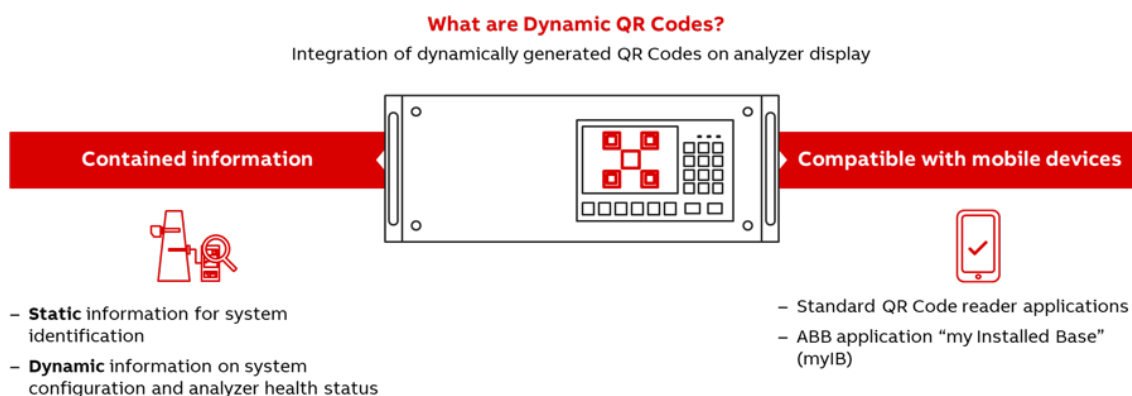
A lot of time can easily be consumed just trying to obtain basic information about the device before even beginning to start diagnosing what the problem is.

11.4.1. What are Dynamic QR Codes?

QR Codes are seen everywhere these days but dynamically generated QR codes embedded on the display of the analyzer is something different.

These QR codes are automatically generated by the device based on the current status of the analyzer and not only contain static information like the serial number, fabrication date and software version, but also dynamic or changing information such as current measured values, temperature, pressure, flow and drift values.

A photo can simply be taken of the QR code and sent to ABB. Alternatively, any standard code reader or the ABB my Installed Base app can be used and, in a matter of seconds, provide all the relevant information about the device in one communication to the ABB service organization enabling us to immediately start advising how to go about fixing the problem.



11.4.2. What are the benefits?

In summary, Dynamic QR Codes are simple to use and platform independent, provide case specific information which allows for individual support.

Faster fault reporting allows us to diagnose the failure and suggest corrective actions much

quicker, which results in a faster repair and ultimately increased availability.

Tight integration with the myIB app, which we will cover further on, also improves installed base management.

11.5. myIB mobile installed base management

myIB is ABB's mobile installed base management application. It's free to download from either the App Store or Google Play and allows you to register your device, or even a whole fleet of devices,

using the Dynamic QR Codes or keying in the serial number, report a problem in different ways, request for a service engineer to visit your site and view relevant product literature.



Register your device

Report a problem
QR code, photo or text

Request for service

Read product info
manuals | literature

11.6. ABB Ability™ Remote Assistance

CEMS are engineered products with extremely high availability requirements, so remote connectivity solutions are critical for connecting our customers with ABB experts as quickly as possible.

ABB have provided remote connectivity solutions for more than a decade, enabling our experts to interact with customer systems.





As technology and cybersecurity threats have evolved, so have our solutions, and we deliver a modern and robust solution that offers flexibility, reliability and heightened security to ensure a reliable service.

ABB Ability Remote Assistance is a secure, managed, cloud connection between our ABB experts and the customer analyzer. Connection to the analyzer is through a micro-PC that includes features such as a hardened, patched system with hardware-based encryption technology. With the permission of the customer, our factory certified experts can securely connect to the micro-PC and diagnose problems with the analyzer via a cloud connection. Very often the issue can be fixed remotely, but if not then a field technician will be dispatched armed with the right parts and knowledge of the issue ready to fix it as soon as they arrive on-site. This solution reduces downtime and removes the need for customer skilled resources...

What is it?

-  Collaborative operations solution
-  Software & hardware based remote troubleshooting
-  Access to on-line data via secure cloud connection
-  Possible remote fault resolution

What are the benefits?

-  Immediate action
-  Reduced training need for own staff
-  Easy access
-  No mistakes in troubleshooting



11.7. ABB Ability™ Visual Remote Support

Re-imagining how we address field maintenance; we are pleased to introduce our state-of-the-art augmented reality remote support solution released in 2020.



ABB is embracing the power of augmented reality to bring significant improvements to field service.

ABB Ability Visual Remote Support is a mobile application that allows two-way video and voice exchange between ABB experts and plant personnel. Instructions can be overlaid on the images and appear directly in the customer's view, remaining in the right place even as the user moves around.

Site operators can share what they are seeing via their existing mobile device or using Microsoft HoloLens or RealWear HMT glasses for a hands-free experience. This new solution simplifies maintenance, reduces downtime, increases analyzer effectiveness and improves safety.

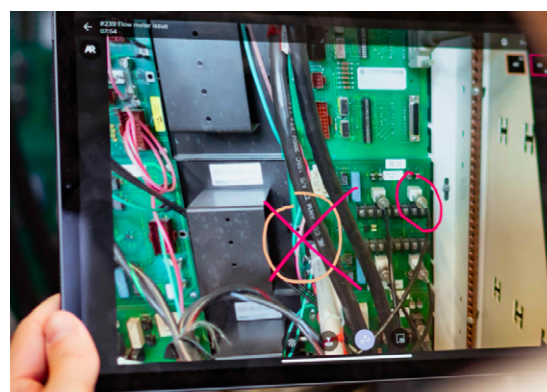
Augmented reality support allows our customers to focus on their business instead of expanding the technical knowledge of their workforce. Additionally, it is no longer necessary to wait for one of ABB's global experts to arrive on site and go through the site permit process before starting to identify the problem.

What is it?

-  Mobile application allowing 2-way video and voice exchange with ABB experts
-  Ability to overlay instructions for site personnel

What are the benefits?

-  Reduced down-time costs by resolving issues quickly
-  Instantly connects to the right expert and information
-  Improves safety and increases awareness
-  Extends asset life and improves quality of repairs
-  Facilitates faster employee enablement through increased access to knowledge



11.8. ABB Ability™ Condition Monitoring

We now move away from ABB's extensive reactive remote support solutions towards a pro-active tool, Condition Monitoring. This is an exciting

automated asset health monitor that can identify issues before they cause downtime.

11.8.1. Maintenance strategies

The ARC Advisory Group assessed the adoption of different approaches taken towards maintenance.

They found that, on average, 65% of maintenance takes place after the problem occurred, which obviously has a direct impact on CEMS availability, potentially the plant operation, the environment and staff.

30% is typically preventative maintenance, performed according to schedule, whether necessary or not, and statistically a massive 60% is unnecessary.

The ideal scenario would be to predict a failure before it occurs but today this constitutes only 5% of maintenance strategies implemented today.

It's clear that increasing the use of condition monitoring can significantly reduce both downtime and operating costs.

65% corrective

- Occurs after the problem
- Influence on operation, plant, environment, staff

30% preventative

- According to schedule, whether necessary or not
- 60% unnecessary
- Influence on availability

5% predictive

- Conditioning monitoring warns user before failure occurs
- Ideal

Types of maintenance

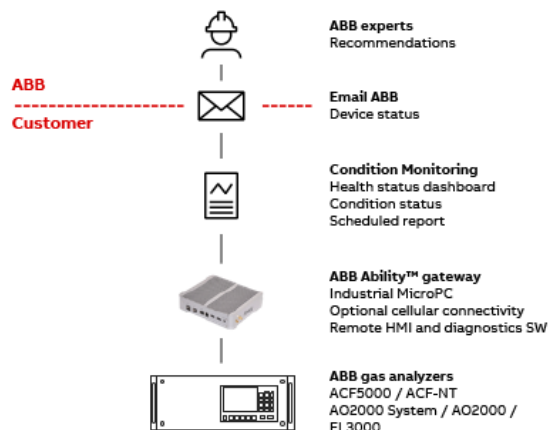
11.8.2. What is Condition Monitoring?

Conditioning Monitoring for measurement devices is a software solution and service that harnesses the expertise and experience ABB has built-up over many decades. Utilizing a robust, industrial-grade MicroPC, data can be periodically gathered from

the ABB gas analyzers and, either processed on site or, transmitted securely to ABB via email, where it is compared against established performance benchmarks in order to identify any indication of a developing fault as early as possible.

What is Condition Monitoring?

- Monitoring a parameter of condition in order to identify a significant change which is indicative of a developing fault.
- Regular system checks and reports provided on-site or utilizing remote connection
- During scheduled sessions, data is downloaded and measured against established performance benchmarks



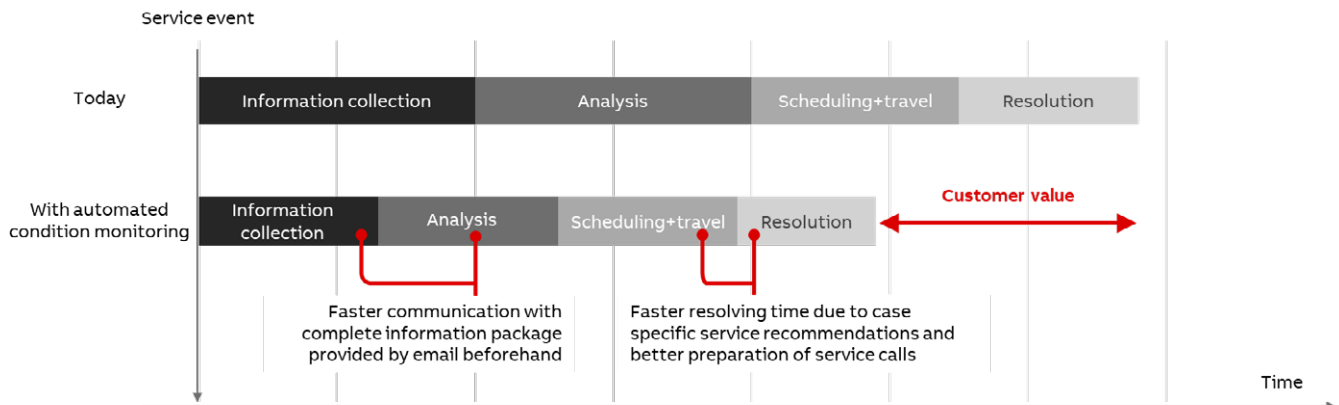
11.8.3. Benefits of Condition Monitoring

Let's assess where we are today and what this service allows ABB to improve for our customers...

By proactively monitoring the asset and benchmarking the data, and ABB experts more regularly assessing the health of the system, we can shorten the time it takes to collect and analyze the information before scheduling a visit to site.

Because we know much more before scheduling occurs, we can arrive at site better prepared with the necessary parts and materials to implement the solution much faster.

Therefore, this new service reduces the burden on plant personnel and increases the overall availability of the asset.

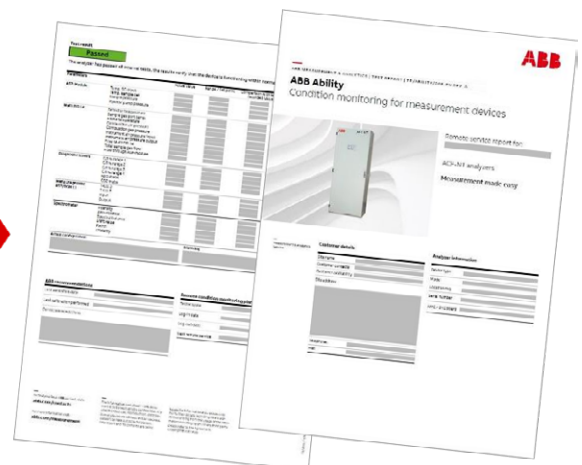


11.8.4. Health check reports

The service is available for the ACF5000, ACF-NT, AO2000 System, AO2000 and EL3000 series. Sessions can be scheduled at any frequency but typically monthly as part of a yearly plan.

Each session will produce a detailed report as per the examples shown using a traffic light system for quick and easy identification of any issues that need to be addressed.

Sessions scheduled according to agreement* between plant and ABB with detailed reports using traffic light system.

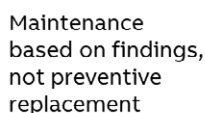
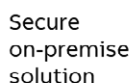
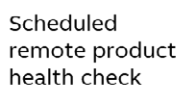


* Typically yearly plan of remote sessions with monthly reports including service recommendations

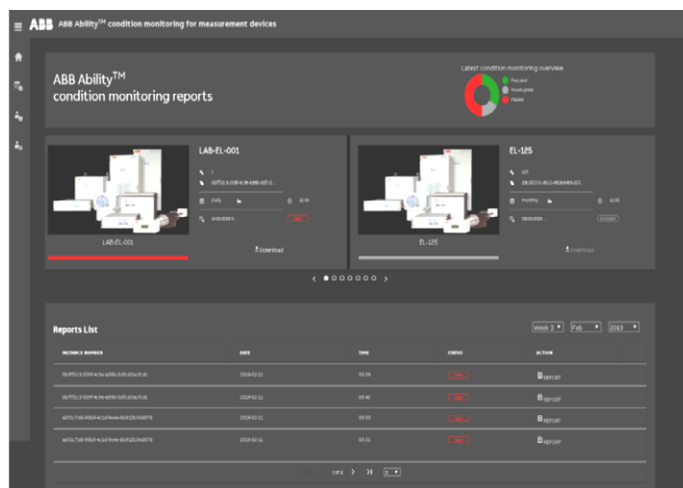
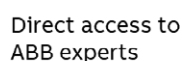
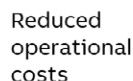
In summary, Condition Monitoring is a simple and effective tool to identify problems with customers CEMS equipment, often before a failure or loss of measurement accuracy occurs.

This solution has been developed as a secure on-premise software application giving the customer the ability to email condition-based reports to ABB experts for remote assessment and predictive analysis.

What is it?



Maximizing accuracy & availability giving higher operational efficiencies



Bringing it all together is myABB, an online customer portal accessed through the ABB website that can be tailored to a wide variety of global and local customer needs.

myABB is an online portal that acts as a gateway to services from ABB. It's available 24/7 and the view can be customized to only see what is relevant for the user.

- View the installed base and lifecycle status across a specific plant or fleet of facilities.
- Download technical documentation such as analyzer data sheets, service reports, standard documentation and system drawings.
- Get an overview of completed or planned service events and receive specific recommendations for each device.
- Spare parts information and pictures can be viewed and, in a future development, also ordered online.



**24/7 access
to ABB**

Find the right
information, saving
time and money



Optimize lifecycle management

Minimize capital outlays and optimize operational budgets



Improve assets performance

Plan maintenance operations and minimize downtime



Boost operational efficiency

Make the right
operational
decisions

11.10. ABB Ability™ Digital software solutions

Putting all these Digital Software Solutions together shows how rapidly things are developing and that ABB is really the trend setter in this area.

ABB provides our customers with a very powerful range of tools that make emission monitoring easy.

With ABB the customer receives early indications of problems through automated condition monitoring. A suite of innovative state-of-the-art remote troubleshooting tools including augmented reality, dynamic QR coding and cloud connected expert support, tools proven to reduce downtime and increase availability. All solutions are closely

tied to the myABB business portal providing the customer 24/7 access to their installed base data and a gateway to online services for all ABB equipment.

Through Digital technologies we harness the data that exists within the analyzer systems, getting it into the hands of the people who need it in a safe, easy and fast way and delivering intelligent insights to what needs attention and how it should be addressed.

It's all about faster fault diagnosis, faster repair, higher availability and lower cost of ownership for our customers.



12. Lowering your cost of ownership

Now that we've introduced ABB's extensive range of products, services and digital software solutions, we will now look at a set of case studies that demonstrate the value that this combination

returns to our customers. These are powerful stories that will certainly resonate with those involved in the field of emission monitoring.

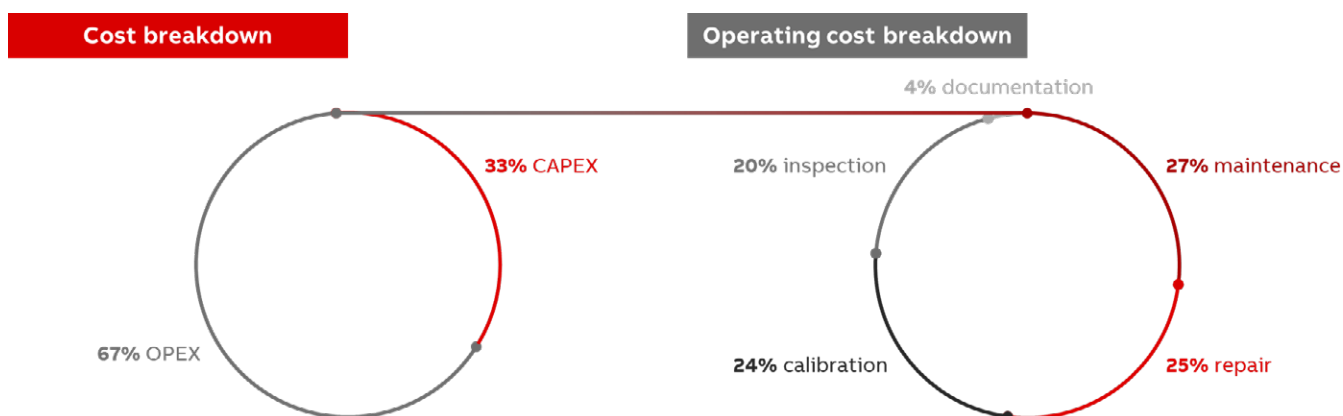


12.1. Cost analysis – CAPEX vs. OPEX

ABB's service organization conducted a study some years ago analyzing the cost breakdown between capital expenditure, or CAPEX, and operational expenditure, or OPEX. A selection of customers also provided useful feedback and confirmed our assessment.

We see that only 33% of the total cost is the initial CAPEX with double this amount is to be considered for operating the asset throughout its lifetime.

- So how does this operating cost breakdown?
- Well, 27% is typical for preventative maintenance activities, 25% for repairs, 24% for calibration, 20% for regular visual inspections and 4% for documentation.
- It's clear from this that it is vitally important to consider the total cost of ownership when selecting a CEMS provider.



12.2. Case Study 1: Power plant

The experience using AnalyzeIT Explorer asset management software and internal calibration cells at a power plant is particularly encouraging:

This plant has more than 20 analyzers employed on a single plant.

- By automating the calibrations and documenting the drift, they were able to reduce maintenance efforts by 80%.

- They also saved 95% of calibration costs using calibration cells, reducing the number of test gas cylinders from 100 to just 5.
- By proactively monitoring the analyzer systems remotely, they were also able to reduce downtime.
- As a result, the parent company decided to equip a sister plant in the same way and now both plants are managed from a single location.



Installation

- More than 20 analyzers employed in a single plant



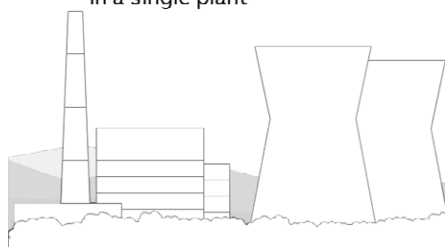
Savings

- 80% reduction in effort due to **automated calibrations** and **automated documentation**
- Over 95% reduction in calibration costs, e.g. through use of calibration cells (100 → 5 gas bottles)
- Less downtime, by **condition monitoring** / AnalyzeIT Explorer



Results

- Sister plant equipped the same way
- Both plants are managed from a single point



12.3. Case Study 2: Waste incineration customer

Waste-to-energy customers operate in a heavily regulated industry with high focus on emissions. Accuracy and availability of CEMS are critical to remain in compliance and operational.

In signing their first service contract with ABB Measurement & Analytics, this customer's isolated location was a major motivator for them to understand the potential benefit of including Condition Monitoring in their contract.

Within 6 months of establishing a Measurement Care agreement, our Service team had an actual use case for remote support. Additional expert analysis was required for one of our service engineers performing a regular maintenance program

as part of the service contract. The client's site is situated 300km from our office.

This was a simple but powerful example how a customer can benefit from connecting the condition monitoring analysis in real time to a product expert. In this case, the expert was able to remotely diagnose the issue and assist the service technician to return the analyzer online with minimal delay and cost.

This remote support saved the customer the costs having an additional product technician travel to site, not to mention delay and possible lost production of at least half a day required if the additional expert travelled to site.

12.4. Case Study 3: Waste water plant

When a long-term ABB end user, wanted to establish a formal agreement for their Measurement & Analytics services they were impressed with the comprehensive coverage available in ABB's Measurement Care agreement.

Customers can tailor the care agreement to ensure the services offered match their needs. A key element for this customer was to ensure regular compliance with their emissions monitoring process. Whilst there are a number of CEMS providers in the

market not all have trained service technicians familiar with the product and regulations. Few if any service providers can then also include remote trouble shooting and support for their analytics devices.

Whilst the existing relationship with the customer was an important first step, ABB's local expert team, remote support and tailored service agreement ensured they signed a 5-year Measurement Care contract.

12.5. Case Study 4: Utilities company

When a utility company needed help meeting clean air regulations, they turned to ABB. The operator was a long-standing ABB customer, but had separate service agreements for each of its 13 facilities. Even though these agreements were effective in providing what they desired, such as 97.5 percent air emission monitoring uptime, managing all these contracts was complex and time-consuming. To keep the operator's sites running without issue, ABB combined all their separate service agreements into a comprehensive ABB Measurement Care agreement.

ABB Ability Condition Monitoring for measurement devices included in the Care agreement ensures the highest level of availability and reliability of equipment and prevents unplanned outages and downtime. This helps the operator avoid serious potential costs and risks, gives them peace of mind since equipment is kept in peak operating condition, and provides a streamlined process since one supplier is responsible for all equipment management and maintenance.

Further, the solution allows ABB to optimize maintenance and enables immediate troubleshooting, which reduces travel expenses and on-site hours for ABB engineers, with savings passed on to the customer. Detailed remote health checks increase the data quality of the analytical systems. These improvements enhance overall maintenance efficiency conditions and can extend the lifecycle of equipment.

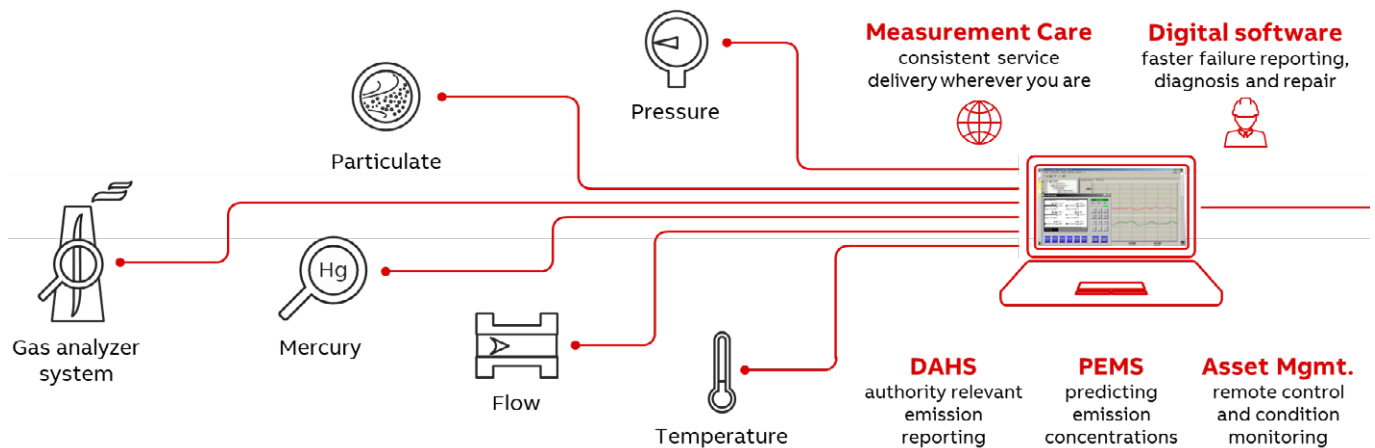
The 'Remote Support' capability of ABB's Condition Monitoring has enabled the Italian team to reduce the number of service engineer hours needed on some sites. In a number of customer facilities this remote support has equated to important savings for the client. This cost is compared to the remote support cases that we traditionally would have required our field service engineers to attend in person. Real evidence of the benefit ABB's expanding digital service capabilities offer our customers.

13. Exceeding your expectations

Summarizing this entire value proposition, we began with what should be expected from a CEMS vendor and have now demonstrated that ABB goes above and beyond and aims to not only meet but exceed our customer's expectations.

ABB is your full-scope solution provider, integrating three different gas analyzer system solutions depending on your application with additional

equipment such as Mercury, Particulate, Flow, Pressure and Temperature, combined with specialized software solutions for environmental reporting, predictive emission monitoring and asset management and supported by standardized but flexible Measurement Care service packages and Digital Software Solutions for increased availability.



13.1. The ABB value proposition

The unique combination of best in class hardware, truly global certified service and pioneering digital solutions sets ABB apart from the rest and

provides our customers with market leading solutions delivering unrivalled value for money.



Products

Technology leader setting benchmark for performance and reliability with cost saving calibration options

Service

Over 600 certified service engineers worldwide delivering consistent quality where and when you need us

Digital

Pioneer in digital software solutions leading shift from preventative to predictive maintenance

13.2. Key features of the ABB solution

Breaking it down one step further, the key features of the ABB solution comprise best in class measuring technology delivering market leading performance and reliability while internal validation or calibration cells significantly reduce gas consumption and therefore cost of ownership. Dynamic QR Codes are also highly appreciated by instrument technicians for quick reporting and diagnosis of faults.

A suite of world leading remote service features including remote connectivity, enhanced by aug-

mented reality, and on-premise condition monitoring help to reduce customer costs and ultimately ensure ABB's highly trained and certified technicians only come to site when absolutely necessary, armed with knowledge of the issue and the right spare parts to rapidly take action. ABB's modular Measurement Care service agreements provide the right level of support to keep our customer's business operating at maximum efficiency.





| | | |
|--|--|---|
| <p>Turn-key CEMS solution</p> <ul style="list-style-type: none"> – Cold/dry and hot/wet extractive solutions – Best in class measuring technology – Market leading performance and reliability <p>Internal validation/calibration cells</p> <ul style="list-style-type: none"> – Significantly reduced gas consumption <p>Dynamic QR Codes</p> <ul style="list-style-type: none"> – Faster fault reporting and diagnosis <p>ABB Ability™ Remote Assistance</p> <ul style="list-style-type: none"> – ABB certified engineers available to support site operations – Secure remote connectivity |  | <p>ABB Ability™ Visual Remote Support</p> <ul style="list-style-type: none"> – Add augmented reality to remote support – Significant improvements to field service <p>ABB Ability™ Condition Monitoring</p> <ul style="list-style-type: none"> – On-premise device health check reports <p>On-site maintenance</p> <ul style="list-style-type: none"> – Factory certified engineers ensure consistent quality <p>Measurement Care fullservice agreement</p> <ul style="list-style-type: none"> – Managing accuracy and availability – Known costs for the life of the agreement |
|--|--|---|

Exceeding your expectations

From lowest uncertainties setting the benchmark in performance, to maximum availability based on the quality you can rely on.

ABB knows what it takes to remain compliant and delivers much more.

Minimal maintenance delivering the lowest cost of ownership and dependable service that is with you where and when you need us.

| | | | |
|--|--|---|--|
| <p>Lowest uncertainty</p>  | <p>Maximum availability</p>  | <p>Minimal maintenance</p>  | <p>Dependable service</p>  |
| <p>The benchmark in performance</p> | <p>Quality you can rely on</p> | <p>Lowest cost of ownership</p> | <p>With you where and when you need us</p> |
| <p>Independently tested and certified with unrivaled references</p> | <p>Consistently delivering more than 98% uptime in the field</p> | <p>Save up to 60% using calibration cells and condition monitoring</p> | <p>Services tailored to your needs throughout the entire lifecycle</p> |

Contents

| | | |
|-------|--------|--|
| 4 | 1. | Foreword |
| 5 | 2. | Contents |
| 5 | 3. | Introduction |
| 6 | 3.1. | Typical products of combustion |
| 7 | 3.2. | Industries impacted by environmental regulations |
| 8 | 3.3. | International treaties |
| 8 | 3.4. | Global emission regulations |
| 9 | 4. | What to expect from your CEMS vendor? |
| 9 | 4.1. | Decision-making stakeholders |
| 10 | 4.2. | First time buyer |
| 10 | 4.3. | Second time buyer |
| 11 | 4.4. | Criteria for selecting your CEMS vendor |
| 12 | 5. | ABB's unrivaled experience |
| 12 | 6. | How to make the right choice? |
| 13 | 6.1. | In-situ method |
| 13 | 6.2. | Extractive method |
| 13 | 6.3. | Dilution-extractive method |
| 14 | 6.4. | Predictive method |
| 14 | 6.5. | Tips to aid the decision-making process |
| 15 | 7. | Your quality solution provider |
| 15 | 7.1. | The measuring principles |
| 16 | 7.2. | The analyzer modules |
| 17 | 7.3. | Continuous gas analyzers |
| 17 | 7.3.1. | Advance Optima series (AO2000) |
| 17 | 7.3.2. | EasyLine series (EL3000) |
| 18 | 7.3.3. | CL3020 Chemiluminescence NOx analyzer |
| 18 | 7.3.4. | In-situ laser gas analyzers |
| 18 | 7.3.5. | AZ series combustion analyzers |
| 19 | 7.3.6. | Attractive solutions for hazardous areas |
| 19–20 | 7.4. | System solutions |
| 21 | 7.4.1. | Easy System cold/dry extractive solution |
| 22 | 7.4.2. | AO2000 cold/dry extractive solution |
| 23 | 7.4.3. | ACF5000 hot/wet extractive solution |
| 24 | 7.4.4. | GAA610-M Marine CEMS |
| 24 | 7.5. | Calibration concepts |
| 25 | 7.5.1. | Calibration cells |
| 25 | 7.5.2. | Validation cells |
| 26 | 7.6. | AnalyzeIT Explorer asset management software |
| 26 | 7.7. | Additional equipment |
| 27 | 7.8. | CEM-DAS data acquisition and handling system |
| 27 | 7.9. | Predictive Emission Monitoring System (PEMS) |

| | |
|-----------|--|
| 28 | 8. System integration |
| 29 | 9. Field-testing, certifications and references |
| 29 | 9.1. Independently certified |
| 30 | 9.2. Independently field-tested and certified |
| 31 | 9.3. Extensive references |
| 32 | 10. Your dependable service partner |
| 32 | 10.1. Manufacturer Certified Service |
| 33 | 10.2. Service Agreements – Measurement Care |
| 34 | 10.2.1. Services throughout the lifecycle |
| 35 | 10.2.2. Customer-oriented lifecycle policy |
| 35 | 11. Digital software solutions |
| 36 | 11.1. Cyber security management within ABB |
| 36 | 11.2. ABB Ability™ Digital software solutions |
| 37 | 11.3. Difference between traditional and digital services |
| 37 | 11.4. Dynamic QR Codes |
| 37 | 11.4.1. What are Dynamic QR Codes? |
| 38 | 11.4.2. What are the benefits? |
| 38 | 11.5. myIB mobile installed base management |
| 39 | 11.6. ABB Ability™ Remote Assistance |
| 39 | 11.7. ABB Ability™ Visual Remote Support |
| 40 | 11.8. ABB Ability™ Condition Monitoring |
| 40 | 11.8.1. Maintenance strategies |
| 40 | 11.8.2. What is Condition Monitoring? |
| 41 | 11.8.3. Benefits of Condition Monitoring |
| 41 | 11.8.4. Health check reports |
| 42 | 11.8.5. Summary – Condition Monitoring |
| 42 | 11.9. ABB Ability™ myABB |
| 43 | 11.10. ABB Ability™ Digital software solutions |
| 43 | 12. Lowering your cost of ownership |
| 44 | 12.1. Cost analysis – CAPEX vs. OPEX |
| 44 | 12.2. Case Study 1: Power plant in Germany |
| 45 | 12.3. Case Study 2: Waste incineration customer in Northern Europe |
| 45 | 12.4. Case Study 3: Waste water plant in Europe |
| 45 | 12.5. Case Study 4: Utilities company in Italy |
| 46 | 13. Exceeding your expectations |
| 46 | 13.1. The ABB value proposition |
| 47 | 13.2. Key features of the ABB solution |
| 47 | 13.3. Exceeding your expectations |
| 48–49 | Detailed overviews |
| 50 | Notes |

ABB Measurement & Analytics

For your local ABB contact, visit:

abb.com/contacts

For your local product information, visit:

abb.com/analytical

We reserve the right to make technical changes or modify the contents of this document without prior notice. With regard to purchase orders, the agreed particulars shall prevail. ABB does not accept any responsibility whatsoever for potential errors or possible lack of information in this document.

We reserve all rights in this document and in the subject matter and illustrations contained therein. Any reproduction, disclosure to third parties or utilization of its contents – in whole or in parts – is forbidden without prior written consent of ABB.