Task Force Report on

CEMS Training-Cum-Exposure visit to Germany

3–12 August 2016

EXECUTIVE SUMMARY

Continuous emission monitoring systems (CEMS) is an important tool to improve compliance and enforcement of environmental regulation. Developed countries, such as Germany, Great Britain and USA, and developing countries, such as China and South Africa, have experienced the benefits of CEMS implementation.

All these countries, however, faced challenges in implementing CEMS that they eventually overcame. India is in the initial phase of implementation and struggling with the issues such as absence of guidelines and protocols on technology selection, installation, and operation and maintenance; absence of quality assurance, verification, mechanism for compliance checking; and lack of required knowledge and skill among stakeholders. Centre for Science and Environment (CSE) is working to improve the implementation of the CEMS programme, including capacity building of regulators on CEMS.

The Ministry of Environment Forest and Climate Change (MoEF&CC), CSE and Central Pollution Control Board (CPCB) has had a tripartite agreement since 22 September 2010 to train the officials of state and CPCBs on various environmental issues. As part of this initiative, a training-cum-exposure visit to Germany was organized from 3 to 12 September 2016 to build the capacity of state and central pollution control boards on best practices, technology and policy framework needed for proper implementation of CEMS in India.

The key learnings from the programme were as follows:

- Selection of suitable CEMS devices (analysers and accessories) in Germany is based on the requirement of a specific industry and process. A generalized approach of technology selection is not effective. In fact, great effort goes into selecting the right devices based on the type of industry, process and flue gas characterization.
- Sector-specific directives on various aspects of CEMS are necessary for successful implementation. In Germany, CEMS implementation is carried under defined directives, mainly the Directives of Waste Incinerator Plants (Directive 2000/76/EC) and the Directives for Large Combustion Plants (Directive 2001/80/EC). Both directives have now been merged with five other directives and called Industrial Emission Directive (Directives 2010/75/EU).
- Clear standards/regulations for CEMS implementation are vital. Some key standards in Germany include DIN EN14181, which details the procedure of performance and quality assurance of CEMS; DIN EN15267 details about CEMS certification system and DIN EN 15259 explains measurement sites and installation of CEMS. These standards have clear guidelines and protocols for respective processes.
- Certification and quality assurance of a CEMS device by a competent agency is mandatory in Germany. The complete CEMS device (including the accessories) is tested and certified.

Software for data acquisition is also certified. It takes around one and a half years to process testing and certification of a new technology/CEMS device. TUV Rheinland and TUV SUD are assigned to certify devices, test performance, calibrate, check regularly, inspect and verify the performance of CEMS. These agencies are equipped with state-of-the-art facilities and have an excellent knowledge base to carry out their job.

- Industries are required to instal CEMS devices before as well as after pollution control equipments. CEMS analysers installed before treatment check for any malfunctioning in plant processes and level of emission control required.
- In Germany, CEMS data is collected at the plant level and sent online both on a short-term (half-hourly average) and long-term (hourly average) basis for compliance check to a common server installed in the regional environmental agency.
- The data acquisition and handling software is provided with the device as a package. Suppliers may choose to tie up with software firms to provide software as a package with CEMS device. The data acquisition system software installed has a defined format required by industries and compatible to the server installed at regulators. The data acquisition and handling server presents every monitoring-cycle data, half-hourly average and hourly-average data against the respective norms and flags in case any noncompliance is noted.
- The regional regulators in Germany access the CEMS data in conjugation with plant's key operational data, such as plant load, production efficiency, fuel rate, air intake and efficiency of pollution control equipments. Operational data correlates plant's performance with pollution levels and validates them for compliance check. In case of noncompliance, an alarm is sent to the industry. The server installed at regional agencies automatically checks compliance of the data and also sends an alert to industry in case of any noncompliance.
- German industries consider CEMS data complementary to a plant's operational data as it helps in optimization of the process. The CEMS server (data collection and handling server) is installed in the control room where plant operations are handled and the monitoring screens for CEMS data and operational data are installed side by side.
- Roles and responsibilities of all the involved parties, viz. regulators, manufacturers, industry and laboratories, are clearly defined. The CEMS manufacturer remains responsible for the quality of the product and certification. Installation, operation and regular maintenance is the responsibility of both the supplier and industry while compliance is the responsibility of industry alone. Compliance check is the responsibility of the regional environmental agency.
- Environment, health and safety are prime concerns for German industries. This was apparent from the clean and well-maintained plants. High-quality CEMS equipments were installed on well-designed and safe monitoring platforms, which helps in operation and maintenance of CEMS devices.

The best practices and framework for CEMS noted in Germany suggest that there is a need to take corrective measures and develop necessary systems for successful implementation of CEMS in India. India can learn from experiences of countries such as Germany and improve implementation of CEMS. Some key measures that should be quickly developed in India are as follows:

- A set of guidelines and protocols for selection of right device, correct installation, regular maintenance, reporting and compliance check is needed to support CEMS implementation in India. It will help the industry in proper implementation of CEMS.
- Quality and performance assurance of the CEMS device is crucial for data accuracy and credibility of the system. Therefore, it should be made mandatory to use certified devices or, as an alternative, the devices must be checked for performance assurance during installation. A performance assurance guideline for installation needs to be developed.
- India should start a process for indigenous certification of CEMS devices. Expert agencies such as TUV and BIS should be consulted to support this initiative.
- Performance check, calibration and verification of CEMS should be done by authorized third-party laboratories. India must initiate the process to set up a self-sustainable system for this. Expert agencies such as TUV and NABL can be consulted for development of laboratory accreditation and empanelment system. Until the system is set up, NABL-accredited laboratories can be trained and authorized to carry out tasks such as performance check, calibration and verification of CEMS.
- The data-reporting system in India has been similar to practices followed in Europe. However, a uniform and foolproof data-transfer and validation process is required before the data is used for compliance. The CEMS data should be seen with some relevant operational parameters to bring credibility to it.
- The roles and responsibilities of regulators, industries, suppliers and service providers should be clearly defined. In case of noncompliance, provisions for strict actions should be laid down. The state boards should be given adequate responsibilities for CEMS implementation in their respective territories.
- Skill and capacity-building is essential for all the stakeholder groups. Trainings and hands-on experience must be assured for success of this initiative.

BACKGROUND OF THE PROGRAMME

The Ministry of Environment, Forest and Climate Change (MoEF&CC) and Central Pollution Control Board (CPCB) had mandated installation of CEMS in 17 categories of highly polluting industries and common pollution treatment facilities in February 2014. Centre for Science and Environment (CSE) believes that CEMS is an important tool to improve compliance and enforcement in India and therefore supports this initiative. CSE is working with MoEF&CC, CPCB, state pollution control boards (SPCBs), industries, device manufacturers and other stakeholders to improve implementation of CEMS.

So far, CSE has organized a series of meetings/roundtables/conferences and has carried industrial surveys to understand the challenges and find the solutions for CEMS implementation.

CSE's overall assessment is that there are gaps in the CEMS implementation programme that must be bridged. To bridge the gaps, CSE has started a process to develop guidelines and protocols for CEMS. It has also started training programmes to build capacity of regulators on best practices in CEMS. These programmes to train the officers of state and central pollution control boards are being conducted under the MoEF&CC-CSE-CPCB tripartite agreement.

Absence of guidance manual and inadequate knowledge base and skills are critical issues that affect the implementation of CEMS on the ground. To bridge the gaps, the initiatives of development of CEMS guidelines and protocols and trainings for regulators have been started by CSE. The draft guidelines and protocols are being developed by CSE in consultation with European experts, while trainings have been initiated for capacity building of regulators. The 'regulators' training-cum-exposure visit to Germany' was also an important activity in this direction that was intended to provide experience and knowledge on best practices, technologies and policy framework needed for CEMS implementation in India

VISITING TEAM

The training-cum-exposure visit on CEMS had the objective of training key officials from selected state and central regulators. Initially, eleven participants were shortlisted, including three from CPCB and one each from eight state pollution control boards and one person from CSE. Unfortunately, CPCB didn't come forward while some of the SPCBs failed to obtain required clearance for its nominated officials till the last moment. Finally, a team of the following seven persons continued on this training-cum-exposure visit:

1. R. Kumar, ACEE, Tamil Nadu Pollution Control Board (TNPCB)
2. R. Dhanasekharan, Dy. Director, Air Care Lab, Tamil Nadu Pollution Control Board (TNPCB)
3. Rajendra Chaturvedi, Scientist, Madhya Pradesh Pollution Control Board (MPPCB)
4. Dillip Kumar Dash, Environmental Engineer, Odisha Pollution Control Board (OSPCB)

5. Tejbir Singh, Vice President, Analytical Product Management, ABB India Pvt. Ltd
6. Sankar Kannan, National Manager, Process Automation, SICK India Pvt. Ltd
7. Sanjeev K. Kanchan, Programme Manager, CSE

CSE had managed the logistics and other arrangements for one participant from each board and one participant from CSE. The second participant from TNPCB and the participants from CEMS manufacturer ABB and SICK were self-funded. Representatives from manufacturing companies were coordinators for the programme on behalf of their companies. Since they are also CSE's resource persons for CEMS work in India, they also attended the programme as participants.

SUPPORTING ORGANIZATIONS

CSE extends thanks to the organizations for supporting this training-cum-exposure visit.

The following organizations cooperated and provided support to make this programme successful:

1. TUV Rheinland, Cologne (Germany)
2. Federal Environment Agency (UBA), Germany
3. TUV SUD, Munich (Germany)
4. ABB, Frankfurt (Germany) and ABB, New Delhi (India)
5. SICK Freiburg (Germany) and SICK, Mumbai (India)

SUMMARY OF THE PROGRAMME

The programme was organized from 3 to 12 September 2016. It included an introduction and discussion of the programme at CSE in New Delhi (3 September 2016), travel from New Delhi to Frankfurt on 4 September 2016, training programme during 5–11 September 2016, return to Delhi and concluding and briefing meeting at CSE on 12 September.

To enable an understanding of the complete CEMS framework and all the aspects of CEMS, the programme was designed so that the participants can interact with all kinds of relevant stakeholders. Presentations and discussions were organized with CEMS manufacturing facilities, certifying, testing and verifying agencies, operating industries as well as the Federal Environmental Agency.

Preparatory sessions and programme in Delhi (3–4 September 2016)

The introductory meeting with the participants was organized in CSE to discuss the objective of the training-cum-exposure visit to Germany, focus areas of learning, code of conduct and plan for future action on CEMS implementation. The team took off from New Delhi in the afternoon on 4 September and reached to Frankfurt (Germany) at night.

Programme sessions in Germany (5–11 September 2016)

5 September 2016: The programme in Germany started with an interaction with CEMS experts from ABB (a CEMS-device manufacturer). CSE, on behalf of the team, presented the status of CEMS implementation in India and shared the objective of this programme. Experts from ABB shared their experience on key issues, including various technologies and their suitability, data-acquisition and handling system and regulatory requirements related to CEMS in Germany.

The team got opportunity to tour ABB's CEMS manufacturing facility and saw the CEMS device being manufactured based on the need of particular process/industry. The team also saw ABB's sophisticated calibration laboratory that is accredited by the German national accreditation body Deutsche Akkreditierungsstelle (DAkkS). This laboratory is ISO 17025 certified, which means it is authorized to carry CEMS calibration and testing tasks.

The visiting team with experts from the ABB (left); the team at the calibration lab of ABB, Frankfurt (right)

6 September 2016: The team visited EGK (Entsorgungsgesellschaft Krefeld GmbH & Co.), a waste-to-energy facility at Krefeld that is required to instal CEMS for a number of pollution parameters. This facility utilizes combustible municipal and industrial solid wastes and sewage generated by 1.2 million populations across three adjoining districts and produces electricity up to 175 MW capacity. Air pollution control equipments such as electrostatic precipitator (ESP), wet scrubber, DeSOx and DeNOx are installed for flue gas treatment. High-end CEMS equipments are installed before as well as after flue gas treatment to monitor pollutants such as NOx, SO_2, HCl, CO, O_2, Hydrocarbons, H_2O, NH_3, Hg and HF.

The team had the chance to observe how new technologies are tested for certification. At the site, TUV Rheinland was testing two new CEMS analysers of ABB (cold dry O_2 analyser and FTIR VOC analyser) in order to grant the certificate. It was noted that the process of certification takes around one to and a half years but once certified, it is accepted as quality device.

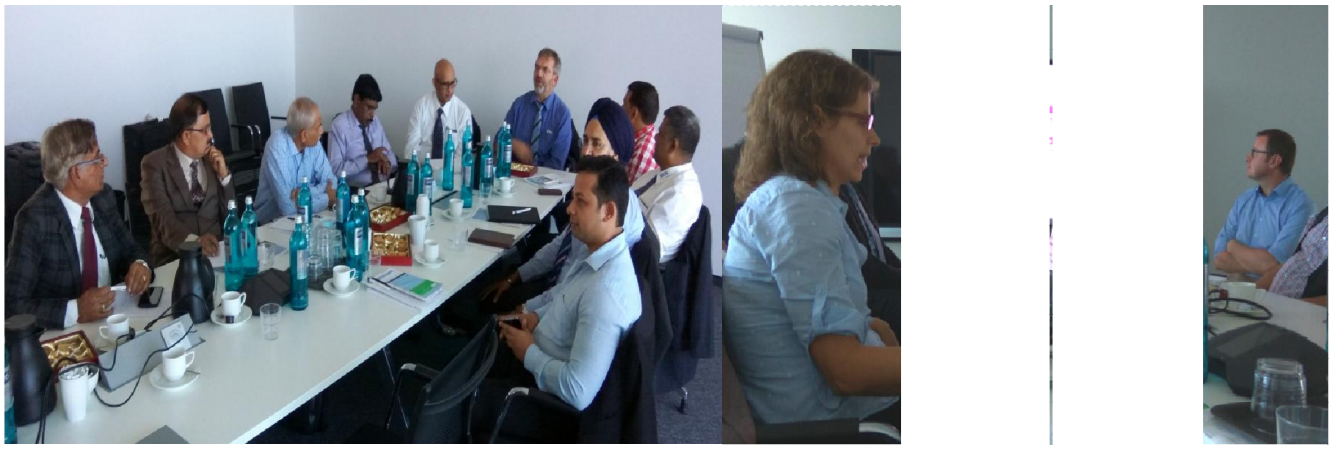
Probes installed in duct before flue gas treatment (left); the team visiting CEMS house (right) at EGK, Krefeld

The team got the opportunity to observe the data acquisition system installed in the plant. The data acquisition of CEMS was installed in the plant's operation control room and data were closely viewed in conjugation with the operational data. The plants in Germany consider CEMS data as complementary for optimization of plant's process.

Team checking CEMS data in plant's operation control room at EGK, Krefeld

7 September 2016: The visiting team participated in interaction and discussion with experts from TUV Rheinland and the Federal Environment Agency (Umweltbundesamt-UBA), Germany. The meeting was also attended by two officials from CPCB, New Delhi and one official from the regional environmental agency from Germany. TUV Rheinland is accredited (EN/ ISO 17025) for CEMS testing/certifications of type approval, emission measurement and declarations, functional tests, calibration services etc. in Germany. The visiting team learnt about the requirement and process of CEMS quality assurance/certification system (under Quality Assurance Levels [QAL] 1, installation and calibration [under QAL 2] and device check during operation [under QAL 3]), Annual Surveillance Test (AST) and standards such as EN 14181 and EN 15267 that are mandatory and to be followed by the manufacturers and industries.

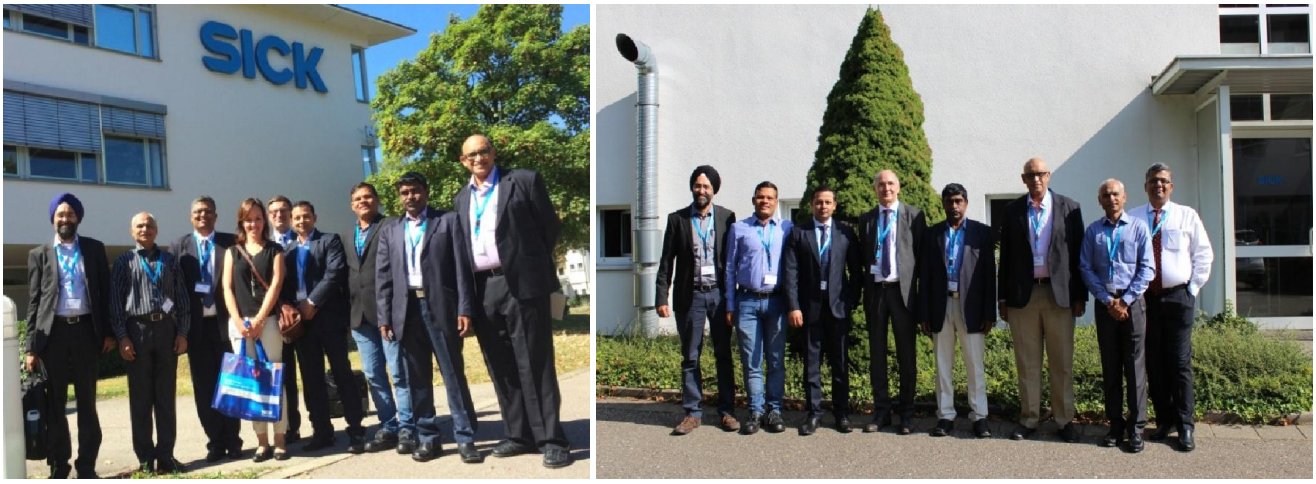
The representative from UBA shared information on German national legislation, best technology and reference documents, European directives for CEMS and system of pollution monitoring, data acquisition and compliance check through CEMS. The fact that implementation of pollution norms/directives are looked after by provincial/regional environmental authority and, as in India, provincial authorities can make the permits more stringent based on their perception was highlighted.



The participants interacting with experts (left); UBA official presenting (right) at TUV Rheinland, Cologne

8 September 2016: In Freiburg, the team participated in the interaction and discussion with experts from SICK, a reputed CEMS analyser manufacturer, and visited their manufacturing and calibration facility. The experts shared information on CEMS technology and their suitability, quality-control process and post-installation services. During factory visit at Reute, Germany, the team visited the analyser manufacturing, integration facility as well as in-house calibration facility of SICK. It was noted that manufacturer prepares the CEMS device based on specific requirement and sends them for series of calibration checks in in-house facility. The integration facility assembles the analyser with other accessories and tests under simulated conditions before dispatch to the customer.

Post the facility tour, the visiting team attended the presentation and discussion with expert from TUV SUD (Munich). The team had good interaction and learnings on crucial topics such as device certification under QAL 1, proper CEMS installation, functional testing and calibration under QAL 2, quality assurance process as per QAL 3 and annual surveillance test (AST). The team also learnt about Integrated Pollution Prevention and Control (IPPC) directives of the European Parliament and Council which, 2010 onwards, is known as Industrial Emissions Directives (IED). The TUV SUD expert also highlighted the details of requirement and process of CEMS framework as per the applicable standards such as EN 14181 (quality assurance), EN 15267 (certification) and EN 15259 (measurement sections and sites).



Participants at SICK, Waldkirch (left); with TUV SUD expert at SICK facility at Reute (right)

9 September 2016: A visit to the waste-to-energy facility TREA at Breisgau, Germany was organized to showcase the installation and functioning of the CEMS. The facility takes care of 1,70,000 tonnes of municipal and industrial combustible wastes and produces approximately 124,000 MWh electricity. The flue gas generated in process is treated with ESP, DeNOx and DeSOx systems and bag filter before it is released. CEMS is used to monitor pollutants before and after flue gas treatment. The facility was found to be well maintained, clean and without any visible emissions.

The plant has installed high-end CEMS devices on a well-designed monitoring house/platform. The monitoring platform was connected to the plant building and was equipped with all safety features and facilities required to maintain CEMS devices on a regular basis (shown below in the picture).


Well designed pollution-monitoring house/platform installed with stack (left); CEMS analyser house below the monitoring house at TREA, Breisgau


CEMS analyser installed inside the monitoring house/platform (L) and the team checking CEMS installation inside the monitoring house at TREA, Breisgau

End of programme and concluding sessions (10–12 September 2016)

One day, 10 September 2016, was allotted for an excursion. The team took the return flight from Frankfurt on 11 September and returned to New Delhi on 12 September 2016.

Initially, the visiting team had planned to meet senior officials from MoEF&CC and CPCB to brief about the programme and learnings, but that couldn't happen. The team had a brief meeting with senior management at CSE and discussed learnings and outcome from the exposure visit. The participants conveyed that the exposure visit was very useful and the learnings could be used for improvement in the CEMS initiative. The team decided to document the learnings from this programme and come up with recommendations for the proper implementation of CEMS initiatives in India.

LEARNINGS AND RECOMMENDATIONS

The learnings from the training-cum-exposure visit were encouraging. Based on the learnings from the programme, the participants shared brief reports and suggested recommendations for CEMS implementation in India.

A brief of the learnings and recommendations shared by individual participants are the following:

Organization: **Madhya Pradesh Pollution Control Board**
Participant: **Rajendra Chaturvedi, Scientist, Emergency Response Centre**

India is committed to a cleaner environment and has taken various measures to show its commitment, including a rushed move to install CEMS (automated monitoring systems) at industrial installations that have significant pollution threat. Taking a ride on the fast track is appreciable but riding without knowing the destination and leaving the task halfway can be dangerous and lead to a complex compromising situation.

I understand that the stakeholders feel that the implementation of CEMS in the state/country needs to be structured and properly planned with well-defined path and responsibilities. Having been exposed to the present CEMS scenario in our state and country and the CEMS programme implementation in Germany, I personally feel that the following measures need to be essentially considered in true spirit for effective implementation of Continuous Emission Monitoring programme in target sectors in the State, and the country as a whole, in the larger interest of environment:

- ✓ There is a need to come out with established regulatory framework' for application of CEMS in the country. QAL 1 criteria should be mandatory forprocurement of CEMS and data should be transferred to the regulatory bodies only after verification of CEMS's post-installation functioning by an independent accredited agency.
- ✓ Clear guidelines stating the selection criteria of CEMS for specific sectors and specific process conditions will make the task of procurement easier for the customer.

- ✓ There is genuine need to have an indigenous certification agency. CPCB's guidelines on CEMS require certification of CEMS but there is no agency in the country to certify the 'equipment type' to be used for CEMS purpose.
- ✓ India needs to have a dedicated facility, as in Germany, for performance evaluation and calibration of CEMS. The protocol for performance evaluation for CEMS should be comprehensive and should cover every component of interest from parameters to the processes etc.
- ✓ A well-defined certification policy is essentially needed, not as a guideline but as a rule. This will attract the foreign investment which in turn will help promote the 'Make in India' mission.
- ✓ There is an immediate need to have accredited agency/laboratories for the purpose of CEMS.
- ✓ A mechanism should be defined for a periodic performance audit of the CEMS after installation and the responsibility should also be precisely mentioned.
- ✓ CEMS is a new technology and, therefore, capacity building and skill enhancement of the target groups, regulators and the industries is the primary demand.

Developed countries have taken 50 years to reach to current levels but a few grey areas in CEMS technology persist for which the West has no solution so far. This is where India needs to explore its own solutions and establish our sincere commitment towards the environment.

The effort of CSE in organizing this purposeful technology-exposure trip of regulators from different states is commendable. The learnings from the tour will pave the path towards establishing best CEMS practices in our country, with joint efforts of all the stakeholders, for a cleaner environment.

Organization: **Tamil Nadu Pollution Control Board**
Participants: **1. R. Kumar, ACEE**
2. R. Dhanasekaran, Asst. Director, Care Air Centre

It is learnt from the visit that the CEMS monitoring in India today is simply monitoring of data. Qualified monitoring is the need of the day. A certifying agency or body is required to certify the quality of the data in CEMS.

The European practice in this context is in three stages, namely QAL1, QAL 2 and QAL 3. QAL1 certifies the analyser which generates the monitored data with accepted uncertainties. QAL 2 is the calibration and linearity check of the analyser installed and monitored. QAL 3 is an ongoing process of monitoring to check the analyser drift and validation of data.

The following are some key recommendations:

- ✓ Quality-certified analysers need to be installed and monitored.
- ✓ The formation of a certifying body with calibration infrastructure is needed. The certifying body must have a full-fledged calibration facility to demonstrate the reliability of CEMS. Thus, a certifying mechanism for analyser certifying as quality analyser and fit for monitoring the required parameter is the most important requirement in the present context.
- ✓ Accredited laboratory certified under NABL to conduct QAL 2 Monitoring and Annual Surveillance Testing (AST) certifying the analysers for CEMS monitoring is needed. Third-party monitoring through Standard Reference Methods (SRMs) and declaration of uncertainties in CEMS monitoring is important
- ✓ The operator or the industry must be equipped with inbuilt or external calibration facility with CEMS to check ongoing monitoring process. The operator/Industry shall be qualified enough to maintain the analyser through QAL 3 checks and reporting.
- ✓ Training is also an important missing segment found to be included in induction of CEMS regime in India. It is an important requirement both for Regulators and Industry for a successful CEMS regime.

Organization: **Odisha Pollution Control Board**
Participants: **Dillip Kumar Dash, Environment Engineer**

CEMS have been used in the industrial set-ups of Germany and the European Union for the last 50 years. They have come this far facing technical problems in implementation and management problems in environmental governance. It was opined that the learning of Germany can be used in India so that India's journey can be much faster.

Monitoring of industrial stacks and maintaining emissions below prescribed limits is the responsibility of the industries, while monitoring of ambient air is the responsibility of Federal Agency. The industries do not monitor ambient air quality as is done in India.

Each of the CEMS equipment installed in the factories has been certified QAL1. They are from reputed manufacturers, certified by accredited agencies like TUV in Germany. No CEMS can be installed in the factories without such certification. The sites of industrial stacks, prevailing atmospheric conditions are studied to customize each of the CEMS. The procedure followed during installations is certified under QAL 2 guidelines. QAL 3 guidelines are followed during operation and the life period of the CEMS. Annual surveillance test (AST) is carried out for each of the CEMS. Such AST is conducted by the regulators manually using prescribed standard reference methods (SRM) for each pollutant. Each country in the EU has its own statistical method of handling the online monitoring data. There is no question on the sanctity and reliability of the data in the country level. However, there is no consensus on the uniformity of data analysis in the

level of the European Union as of now. Different agencies are currently working on achieving such goals. The data reporting system adopted in India is similar to those in Germany and monitoring data are transferred alongside to the regulators. The data acquisition system (DAS) is also certified by accredited laboratories. However, unlike in India, most of the DAS are inbuilt along with the set of analysers, making them tamper-proof.

- ✓ India should develop one or two accredited laboratories for certifying its CEMS and the DAS. Agencies like TUV, Rhineland and TUV, SUD may be contacted to set up their laboratories in India.
- ✓ Many of the leading modern industries established in India have adopted world-class technologies and have also adopted CEMS in the processes. India is no less in terms of operational efficiencies. However, our environment can achieve world-class cleanliness with a little improvement in the attitude of people and a little focused political willpower.

Organization: **Centre for Science and Environment, New Delhi**
Participants: **Sanjeev K. Kanchan, Programme Manager**

The programme helped to understand the best practices and framework needed for successful CEMS implementation in Germany that can be replicated in India. Interaction with experts and the visit to CEMS manufacturing facilities clearly reflected that CEMS is sophisticated equipment with design based on fine details of the requirement of a particular industry. A generalized approach of technology selection can't work effectively. Suitable and approved technology selection is the first step in CEMS implementation. The technology properly checked by a competent agency assures quality, which is missing in India.

In more than three decades of CEMS implementation, Germany has developed the policy directives, standards and knowledge base in stakeholders. All these policy tools, guidelines and knowledge base are crucial for proper implementation of CEMS which are presently missing in India. India can learn from the decades of experience of these countries rather than reinventing the wheel and making same mistakes.

There have been established regulations, standards and recognized agencies like TUV Rheinland and TUV SUD assigned for the job of device certification, performance testing, calibration, regular checks, inspections and verification jobs on CEMS. These agencies are equipped with state-of-the-art facilities to carry out their job. India needs such systems in place for proper CEMS implementation.

Industries in Germany were found absolutely clean and well maintained and conscious of environment and safety issues. High-end and suitable CEMS equipments were installed both before and after flue gas treatment and all of them were accurately working and maintained.

CEMS data is considered complementary to plant's operational data as it helps in optimization of the process. The CEMS sever (data collection and handling server) was installed in the control room where the plant operations were being handled and the monitoring screens for CEMS data and operational data CEMS data monitors are installed side by side. CEMS software monitors showed three sets of data—every monitoring cycle data, half-hourly average and hourly average data against the respective norms.

Interaction with certifying and verifying agencies and regulators made it clear that the various stakeholder groups have defined and clear responsibilities. Every agency carries out its jobs based on well-defined guidelines and protocol which keeps improving from time to time based on the experience. Federal agency, UBA, has more of a policy-level role where regional environmental agencies take care of environmental regulation in the respective regions.

The best practices and framework for CEMS noted in Germany suggest India must make efforts to make the CEMS initiative successful in India.

Some key measures that can be taken are as follows:

- ✓ A set of guidelines and protocols is needed to support the CEMS implementation in India. It must help the stakeholders—regulators, industries and service providers etc. —to choose the right equipment, instal correctly, operate and maintain properly for compliance to the norms.
- ✓ Selection of quality assured/certified technology is crucial. Therefore, it should be mandatory to use certified devices or, as an alternative, devices must be checked for performance assurance during installation as per the laid guidelines, as in the US.
- ✓ Third-party calibration and verification of the devices brings data credibility and therefore must be done. It will require the development of a system and protocol for empanelment of capable labs for such processes. The expert agencies working in this domain can be consulted to support in this.
- ✓ The data reporting system has been more or less similar to what practices have been followed in Europe or other CEMS implementing countries. However, a uniform and foolproof data-transfer and validation process is required before data is used for compliance.
- ✓ Development of a knowledge base is urgent for all stakeholders group. Trainings and hands-on experience must be assured for success of this initiative.

Successful implementation of CEMS requires the entire stakeholder to play the role. All of them should have defines roles and responsibilities. As in Germany, state agencies should be enabled and given adequate responsibilities for CEMS implementation in their respective territory.

Organization: **ABB India Private Limited, New Delhi**
Participants: **Tejbir Singh, Asst. Vice President, Analytical Product Management**

The training/exposure visit was very well organized and worked like clockwork. The objective was to have practical as well as theoretical exposure by visiting leading CEMS manufacturers (ABB and SICK) and industrial plants (TREA and EGK) to understand their practices, technology adoption, compliance to regulation and lifecycle. The industry visits were an eye-opener as the plants operating for decades had maintained high standards of practices and cleanliness.

The meetings with German environment regulator UBA and EU-certifying agencies TUV Rhineland and SUD were a revelation on the scientific approach of specifying the Best Available Technologies (BAT), certifying process of analysers, surveillance, certifications etc. to ensure a holistic and sustainable approach to environmental compliance. The EU-harmonized standards of QAL 1, QAL 2, QAL 3 and AST quality-assurance levels have been adopted across member states in EU and are fairly successful in ensuring a clear environment.

The monitoring of source emissions from industry is the responsibility of industry while ambient-air monitoring is the responsibility of the regulator. In introspection/observation, there is a long way to go from current scenario in India.

- ✓ Formulation of guidelines benchmarking is needed. The proven practices of EU are a leading reference for many other countries worldwide.
- ✓ Skill-development gaps across the chain need to be bridged. Global leaders in analytical technology, certifications etc. to build capability and competencies in India should be engaged with.
- ✓ Detailed hands-on training on equipment, calibrations, data transfer, etc. would be invaluable for all states and central regulators. Focused intense practical knowledge and knowledge-sharing can be considered.

I am confident that the above experience will help in implementing the Indian environment guidelines in a structured way by systematically implementing best global practices to be in sync with rest of the world.

Organization: **SICK India private Limited, Mumbai**
Participants: **Sankar Kannan, National Manager, Process Automation**

Germany is a pioneer in environmental regulations and has a vast experience in CEMS. Many trial and errors were done before they reached this level of compliance. The standards follow a type approval of the instrument which includes quality of the manufacturing process, design and suitability of the instrument for specific regulations. Type approval is possible with two agencies,

viz. TUV Rhineland and TUV SUD. TUV SUD is the new entrant in this field. TUV and MCERTS (in the UK) have signed an MOU to recognize each other's certificate and test report.

From the visits to plants in Germany, it is understood that the regulations for waste incinerators areas are stringent. If the instruments can meet this regulation, they can be used for most of the applications. It was noted that the arrangements to mount the measuring instruments had the same amount of investment as that of the measuring instruments.

Very few vendors have the whole range of analysers and DAS. DAS is not as developed as it is expected to be in India. Cloud storage is still at conceptual stage. Quality of the measured values is the most important parameter of the legislation. Violators are heavily fined which makes the industries go for the best available techniques (BAT).

India should learn from the experience these countries have and take measures to implement CEMS successfully in India. Some key measures to be taken may include:

- ✓ An indigenous testing lab to be accredited for such tests for accrediting instruments which are manufactured in India.
- ✓ As is done with PESO (Petroleum Explosives Safety Organization) and International Organization of Legal Metrology (OIML), India can enter into an MOU to recognize TUV/MCERTS certificates.
- ✓ A Best Reference (BREF) document should be made for each industry type which can help industries to select the correct type of measuring instrument. This will ensure correct measurement techniques.
- ✓ More interaction with the testing labs, regulators and manufacturers to be arranged on regular basis for capacity building.

CONCLUSION

The CEMS initiative has received wide salutation from all the relevant stakeholders across India. It is an encouraging step towards improving in the environmental regime. Like other countries, India is facing hurdles in CEMS implementation, but it is time to understand the gaps and take corrective measures. India doesn't need to make the same mistakes that other countries have made. It is better for India to learn from the experiences of developed countries during implementation and customization of CEMS. It is priority to have a detailed guidance document to assist stakeholders in suitable technology selection, installation, operation and maintenance and compliance check. Developing systems for lab empanelment and device certification are long-term processes but are essential and must be accelerated. The existing infrastructure can be used to fulfill the current need of quality assurance and verification until a permanent solution is achieved.

It is better to involve the expert agencies that have experience in this field. The initiative is mutually beneficial for them so they are happy to work along. A wide range of stakeholders—state regulators, technology providers, local expert agencies, industries and independent expert groups—are involved in CEMS initiative, and it will be beneficial to take them along. The collaborative work approach would make the task easy and smooth. The roles and responsibility, nevertheless, should be well defined. As far as capacity building and skill development is concerned, it must be prioritized.

CSE supports CEMS initiative and is making efforts to make it successful. The training-cum-exposure visit to Germany has shown us the best practices, technology and policies that India needs to target. There is a need to prepare a time-bound strategy to reach the goal. All that are discussed in the report will be needed to develop a complete policy framework. A well-defined policy framework will also attract interests and investments for setting up sophisticated manufacturing facilities, high end laboratories and developing advance skills and knowledge that fits well with our approach to 'Make in India'.

ANNEXURE

Agenda for

Regulators' Training-Cum-Exposure visit on CEMS

Germany, 3- 12 September 2016

Date/day	Programme	Organization (Location)
3 September 2016 (Saturday)	**Introduction and instructions for the programme**	**CSE (New Delhi)**
	Arrival of participants Accommodation at Hotel	**CSE**
13:00-14:00	**Lunch**	
14:00- 17:00	Objective of the programme Discussion on Agenda	
4 September 2016 (Sunday)	**New Delhi–Frankfurt**	**CSE**
9:00	Pick up from Hotel to IGI Airport drop	**(New Delhi)**
18:40	**Arrival at Frankfurt, Germany** Transfer from airport to Hotel	**(Frankfurt)**
5 September 2016 (Monday)	**Presentation and discussion:** Technology options, quality assurance, calibration **ABB factory visit**	**ABB (Frankfurt)**
9:00-9:15	Welcome	Mr Ralf Hopp, Site Manager Product Line Manager CGA/CEMS Mr Stephen Gibbons, Head of Sales Development and Product Management
9:15- 9:30	ABB Company and Gas Analysis	Mr.Günter Haberzettl, Product and Industry Manager
9:30-9:45	Presentation from Indian Regulators	Mr Sanjeev Kumar Kanchan, CSE India
9:45-10:30	CEMS - Applied methods and solutions Cold and hot measurements in CEMS	Dy. Programme Manager Mr Günter Haberzettl

10:30-10:45	**Coffee / Tea break**	
10:45-11:30	Legislation and directives to be met by manufactures	Dr Bertold Andres, Consultant for Emission and Process Analytics
11:30-12:00	DAHS	Mr Christoph Becker Portfolio Manager
12:00-12:45	**Lunch at ABB**	
12:45-13:15	Laser technology in combustion processes	Mr Marjus Seubert, Global Product Manager
13:15-13:45	Factory quality standards	Mr Carsten Rathke, Factory Quality Manager
13:45-14:00	**Coffee / Tea break**	
14:00-14:30	ABB Analytical Service	Mr Henning von Hörsten, Manager Technical Support and International Field Service
14:30-15:00	Accredited Calibration laboratory	Mrs Svenja Walter, Responsible Laboratory Engineer
15:00-15:15	**Coffee / Tea break**	
15:15-16:00	Factory tour	Mr. Thomas Weyrauch, Manager of Factory Sales
16:00-16:30	Calibration laboratory tour	Svenja Walter
16:30-17:00	Final discussion	All
18:30	**Common dinner**	
6 September 2016 (Tuesday)	**Visit to incineration plant**	**ABB (Frankfurt)**
8:30	**Start at Fleming´s Hotel by bus**	Dr Henrik A. Noss Mr Günter Haberzettl
8:30-11:30	Travelling from Frankfurt to Krefeld	
11:30-13:30	Visting EGK Krefeld , wWaste incinerator plant	
13:30-15:00	**Lunch at a restaurant**	
15:00-16:00	Travelling from Krefeld to Cologne	
16:00	Arrival at Radisson Hotel	

7 September 2016, (Wednesday)	**Presentation and Discussion-** Certification and quality assurance, **AMS framework in Germany**	**TUV Rheinland (Cologne)** **UBA**
10:00-10:15	Welcome	G. Baum, M. Meer, P. Wilbring- TUV Rheinland A. Reichart, UBA
10:15- 10:30	Introduction round	
10:30-10:45	Presentation from TUV Rheinland	M. Meer, G. Baum
10:45-11:00	Introduction Umweltbundesamt	A. Reichart
11:00-11:45	European Directives for AMS (IED/BREF)	A. Reichart, UBA
11:45-12:30	Open Discussion	A. Reichart, UBA
12:30-13:30	**Lunch**	
13:30-14:00	EN14181- Quality assurance of AMS in Europe	G. Baum, TUV
14:00-14:15	Open discussion	
14:15-14:45	Type approval of AMS in Europe-QAL1, EN 15267	G. Baum, TUV
14:45-15:00	**Coffee / Tea break**	
15:00-15:30	Certification and auditing process according to EN 15267	G. Baum, TUV
15:30-16:00	Open discussion	
Travel from Cologne Central Station , Arrival at Freiburg Central Station		**CSE (Cologne)**
Pick-up from Station and drop to hotel **Dinner at:** Waldkirch		**SICK (Freiburg)**
8 September 2016 (Thursday)	**Presentation & Discussion-** Technology options, Quality assurance **Visit to SICK factory site**	**SICK (Freiburg)**
8:30	**Transfer from Hotel to SICK, Waldkirch**	
9:00 - 9:10	Welcome at SICK Customer Center Waldkirch	Mr Hehl, Head of SICK , Director of Solution Center - Process Automation, Dr Philippe Balayn, Head of Infrastructure industries

		Mr Ralf Pakulla, Head of Global Product Management SICK Analysers Division
9:10 - 9:30	Presentation SICK	Mr Hehl
9:30 - 9:50	Presentation from Indian regulators	Mr Sanjeev Kumar Kanchan, CSE India
9:50 - 10:10	Process automation /analyzers Division Presentation	Dr Philippe Balayn, Mr Ralf Pakulla
10:10 - 10:30	Presentation from SICK India	Mr S. Kannan
10:30 - 11:00	**Coffee/Tea**	
11:00 - 12:00	Tour Waldirch Production facility	Pia Merkle-Mack
12.00 - 13.00	**Lunch at Waldkirch Canteen**	
13.00 - 13.30	**Transfer from SICK Waldkirch to SICK Reute (Analyzer and System production facility)**	
13.30 - 14.00	Welcome at Reute facility	Mr Klaus Halder, Head of Analyzer Division Ralf Pakulla
14.00 - 15.00	Factor tour analyzer production, analyzer calibration and system integration	Dr Balayn, Mr. Pakulla
15.00 - 15.30	**coffee / tea + snacks**	
15.30 - 17.00	Dust market place SO_2/Nox market place Mercury market place	Product management Dr Balayn, Mr. Pakulla
17.00 - 17:30	Wrap up	Dr. Balayn, Mr. Pakulla
17.30 - 18.00	Transfer to hotel	
18:30	**Dinner at Waldkirch**	
September 9, 2016 (Friday)	**TUV presentation and discussion** CEMS regulation, Installation, Quality assurance, verification, certification, **TUV SUD led industry visit** Waste incinerator	**TUV SUD (Freiburg)**
8:15	Departure from hotel	
08:30 - 10:00	TÜV Süd Presentations in Reute	Mr. Thull, TUV Süd
10:00 - 10:30	**coffee / tea + snacks**	

10:00-12:00	TÜV Süd presentations in Reute	Mr. Thull, TUV Süd
12:00 - 13:00	**Lunch**	
13:00 - 17:00	Visit TREA Breisgau, Waste to Energy plant	Thull, TUV Süd
17:00	Depart from TREA to Freiburg city	
17:30 - 19:00	Walking tour of Freiburg	Balayn, Mr. Pakulla
19:00	**Evening dinner invitation TÜV Süd**	
September 10, 2016 (Saturday)	**Excursion trip**	**Participants**
10 :00- 17:00	Excusrion trip	
	Dinner	
September 11, 2016, (Sunday)	**Return from Germany** Freiburg- Frankfurt- Delhi	**SICK , CSE**
8:30	Hotel to Freiburg train station drop Freiburg station to Frankfurt Airport	**SICK (Freiburg)**
21:00	Departure from Frankfurt Airport	**CSE (Frankfurt)**
September 12, 2016,(Monday)	**Arrival at New Delhi**	**CSE (New Delhi)**
9:30	Pick-up from airport and drop at hotel Accommodation and food at hotel	
14:00	Concluding meeting and briefing of the programme	
	Departure	