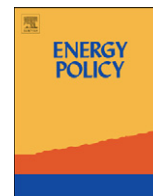




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Continuous emission monitoring systems at power plants in China: Improving SO₂ emission measurement

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ABSTRACT

The Chinese Government recently mandated the installation of continuous emission monitoring systems (CEMS) at state-controlled key polluting facilities in order to provide direct, real-time, continuous measurements of sulfur dioxide (SO₂) emissions. By 2010, most coal-fired power plants in China have installed and are operating SO₂ CEMS. As China's Central Government strengthens the SO₂ control program and implements new nitrogen oxides (NO_x) and carbon dioxide (CO₂) control programs, the quality of and confidence in CEMS data will become more important. This study utilizes field surveys and existing literature on Chinese CEMS to analyze their operation and management. Our study found that the Chinese government has issued a set of regulations and technical guidance documents to standardize CEMS operation, management, and supervision, and to improve the quality of CEMS data. Many power plants have followed key parts of the national CEMS rules and guidance and are periodically inspected by local environmental authorities. This study suggests several options for addressing some of the gaps and problems with the CEMS operation and supervision and thus enhancing China's CEMS program.

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1. Introduction

Coal-fired power plants are a major source of sulfur dioxide (SO₂) emissions affecting air quality in China's major cities (Hao et al., 2007a; Hao et al., 2007b; Yi et al., 2007; Zhao et al., 2008). During the past decade, in an effort to address the high emission levels that led to deteriorating air quality and acid rain problems, the Chinese Central, provincial, and local governments implemented a number of policies targeting SO₂ emissions from coal-fired power plants. In the tenth five-year plan period (2001–2005), the Chinese Central Government established a nationwide goal of reducing SO₂ emissions by 10 percent and 20 percent in the two-control zones—regions with high SO₂ concentrations, acid rain, or both (SEPA, 2002). By the end of 2005, SO₂ emissions had not declined to the target levels, but had increased by 34 percent while power sector SO₂ emissions increased by 65 percent (NBS, 2001; NBS, 2006). In the eleventh five-year plan period (2006–2010), the Chinese Central Government established another nationwide goal—reduce SO₂ emissions by ten percent (SEPA, 2007a). This time, however, the Government included a suite of policies and

incentives designed to achieve the emission goals. To measure compliance with these policies the Government mandated the installation of continuous emission monitoring systems (CEMS) on key coal-fired power plants and large industrial boilers as well as coal-fired power plants with SO₂ control technologies. By the end of 2010, SO₂ emissions had declined by 14.3 percent nationwide (Wen, 2011) and by 31.8 percent in the power sector.

A CEMS is a system of sampling, conditioning, and analytical components and software that is designed to provide direct, real-time, continuous measurements of pollutant concentration by analyzing representative samples of the flue gas. Experience in the United States has shown that CEMS can provide the most accurate and consistent data necessary to assess compliance with emission control requirements, but they must be properly designed, installed, operated, maintained, quality assured, and inspected to ensure compliance (Schakenbach et al., 2006; Jahnke, 2000; US EPA, 2003).

In 1986, a power plant in Guangdong Province was the first major emission source to install a CEMS in China (Zhu et al., 2000). Since that first CEMS, power plants and industrial facilities in China have installed thousands of CEMS through the 1990s and 2000s, though most of the installations took place in the 2000s. Until 2004, most SO₂ CEMS were installed as a component of an SO₂ control system (e.g., flue gas desulfurization (FGD) units or “scrubbers”). In 2004, the Central Government established a requirement

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for most coal-fired power plants to install CEMS for SO₂ emissions. In 2007, the government expanded the scope of the policy by requiring all state-controlled key polluting facilities to install CEMS by the end of 2008 (SEPA, 2007b). Defining key sources as those whose aggregate emissions total at least 85 percent of national industrial emissions. As of March 2009, approximately 85.5 percent of those facilities had installed CEMS, a total of 5472 monitors for air emissions (China News Agency, 2009). A 2010 Chinese study on CEMS reported that a total of over 10,000 CEMS, measuring various air emissions and operating parameters, were installed at power plants (including state-controlled key power plants) throughout the nation (Zhu et al., 2010).

Each CEMS is required to provide real-time data feeds to the three tiers of the automatic monitoring and control (AMC) system (SEPA, 2007b). The first tier corresponds to the national AMC center established within the environmental supervision bureau of the Ministry of Environmental Protection (MEP) and the six AMC centers within the regional environmental supervision centers of MEP; the second tier refers to the AMC centers established at the provincial environmental protection bureaus (EPBs); the third tier refers to the AMC centers established at municipal EPBs. In some provinces, AMC centers were also established at the county level. Local AMC centers are usually located in either Environmental Monitoring Centers (EMCs) or Environmental Supervision Centers (ESCs), subsidiaries of local EPBs, which are responsible for collecting emission and environmental quality data and onsite inspection of pollution conditions and control facilities. The EMCs or ESCs review and process the CEMS data in real-time, frequently monitoring for unusual or unreasonable data. If problems arise, the EMC or ESC may dispatch inspectors to the power plant to investigate or they may review closed-circuit video of the facility.

The state of CEMS at power plants in China has changed significantly since the first CEMS was installed in Guangdong province. However, there has been little assessment of CEMS at power plants in China in the English-language literature. Therefore, this paper builds on several Chinese studies and findings from the authors' field research to investigate the management of CEMS in China. The paper describes the research and data collection methods used in this study and then summarizes the results of field research and CEMS inspections conducted in China. The paper presents some options for improving the CEMS operation and management in China that are based on international practices and concludes with several key findings.

2. Research methods and data collection

This paper is primarily based on the findings from several field studies conducted by the authors. All field investigations took place in large provinces and municipalities with varying degrees of economic development, institutional capacity, and financial resources for environmental management in general and CEMS in particular.

The first field study was conducted in 2006 to assess CEMS rules, protocols, procedures, and equipment. We interviewed monitoring and environmental staff at local EPBs and EMCs, engineers at several power plants, and a domestic CEMS vendor. The second field study was conducted in 2008 to assess CEMS procurement and installation practices with a domestic CEMS vendor and engineering firm. The third, and most comprehensive, field study was conducted in 2009 to assess current CEMS management and data verification practices. This study involved in-depth interviews with environmental monitoring and supervision staff at local EPBs, EMCs, and ESCs, as well as CEMS operators at facilities and third-parties. Two additional field

studies were conducted in 2010 to observe CEMS field inspections by local EMCs and ESCs.

In addition to the field studies, we reviewed the Chinese-language literature on CEMS operation and management. The number of articles on the subject in 2000–2010 is limited but the articles provide useful insights into the practices and reliability of CEMS in China.

3. Major research results

This section summarizes the key rules and guidelines for CEMS installation, certification, operation, inspection, and reporting. It also discusses major findings regarding the CEMS financing, certification, plant-level operation and maintenance, EPB monitoring and supervision, and use of CEMS data.

3.1. CEMS technical guidance and management rules

MEP (known at the time as the State Environmental Protection Administration (SEPA)) issued several CEMS-related technical guidelines and management rules (see Table 1) over the past ten years. These Technical Specifications and Orders were developed to guide and standardize CEMS installation, certification, operation, maintenance, supervision, data reporting, and auditing. They serve as the foundation of the CEMS program in China.

Although a few localities that are more progressive in promoting the use of CEMS data for regulatory purposes recently began to draft detailed local CEMS rules and/or standards to supplement the national guidelines and rules, most local EPBs have primarily tried to follow the national rules. They generally issued local

Table 1
An overview of CEMS technical guidelines and management rules.

Code	Title	Year
HJ/T 75	Technical Specifications for Continuous Emissions Monitoring of Flue Gas Emitted from Stationary Sources	2001, 2007 (revised)
HJ/T 76	Specification and Test Procedures for Continuous Emissions Monitoring Systems of Flue Gas Emitted from Stationary Sources	2001, 2007 (revised)
HJ/T 212	Data Transformation Standards for Continuous Emission Monitoring of Polluting Sources	2005
Order #28	Management Methods for Automatic Emissions Monitoring of Polluting Sources	2005
HJ/T 352	Technical Specifications of Information Transformation and Transfers for Automatic Emissions Monitoring of Environmental Polluting Sources	2007
Order #241	Development Plans for Automatic Environmental Monitoring Capacity Building Projects at the State-Controlled Key Polluting Sources	2007
Order #6	Management Methods for the Operation of Automatic Emissions Monitoring Facilities of Polluting Sources	2008
Order #88	Audit Methods of the Validity of the Automatic Monitoring Data from State-Controlled Polluting Sources; Supervision and Examination Procedures for the Automatic Monitoring Equipment of State-Monitored Polluting Sources	2009
HJ/T 477	Technical Specifications for Data Collection and Transformation of Continuous Emissions Monitoring of Polluting Sources	2009

Notes: (1) This table lists the guidelines and rules that primarily address the automatic emission monitoring including CEMS. It does not include the environmental regulations and rules that include general provisions indicating the use of CEMS or CEMS data in regulatory programs. (2) HJ/T is a national environmental technical standard.

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