Chapter 4

Monitoring Exhausted Gas from CPPs: A Review

October 2017

This chapter should be cited as

ERIA (2017), 'Monitoring Exhausted Gas from CPPs: A Review, in Murakami, T. (ed.), *Creating Better Social Acceptance for Electric Power Infrastructure*. ERIA Research Project Report 2016-05, Jakarta: ERIA, pp.101-113.

Chapter 4

Monitoring Emissions from CPPs: A Review

4.1 Japan

The national legislation that regulates air pollutant emission is the Air Pollution Control Act, which includes relevant Cabinet orders and ordinances on the environment. To avoid redundant regulations, CPPs, which have an authorization under the Electricity Business Act (Ministry of Economy, Trade and Industry), are partly exempted from the Air Pollution Control Act. However, the same level of emission standard is required.

The Air Pollution Control Act allows local governments to set their own emission standards (which are, in general, more stringent than that of the central government) and establish necessary regulations relating to air pollutant emissions. Local governments can establish their own ordinance. Thus, while they do not have any direct regulatory control over CPPs, such laws can potentially limit air emission levels from CPPs. For instance, Yokohama City, where the Isogo coal plant is located, establishes ordinances on the living environment in the city.

Regulated pollutants relating to coal-fired power plants under the Air Pollution Control Act are sulphur dioxide (SO_2), nitrogen oxides (NOx), and particulate matter (PM). In addition, Yokohama City ordinance relating to the living environment regulates the following pollutants:

- Cadmium/ Cadmium compound
- Chlorine/ Hydrogen Chloride
- Fluorine/ Hydrogen Fluoride/ Silicon Fluoride
- Lead/ Lead compound
- Ammonia
- Cyanogen compound
- NO_2
- SO_2
- Hydrogen Sulfide

The legally mandated emission standards for major pollutants are:

- SOx

  [Air Pollution Control Act]

  $q = K * 10^{-3} * He^2$

  q: Maximum permissible limit of SOx (Nm^3/h)

  He: Adjusted height of the Outlet (m)

  He = Ho+0.65 (Hm+Ht)

  Hm = 0.795√($Q*V$) /{1+(2.58/V)}

  Ht = $2.01*10^{-3}*Q*(T-288))*\{2.30\log J+(1/J)-1\}$

  J = (1/√($Q*V$))[1460-296*{V/(T-288)}]+1

  He: Adjusted height of the Outlet (m)

  Ho: Actual height of the Outlet (m)

  Q: Quantity of emission at 15 Celsius degree (m^3/s)

  V: Discharge rate of emission (m/s)

  T: Temperature of emission (absolute temperature)

  K: Area of classification

  General regulation K: from 3.0 to 17.5

  Special regulation (new construction, specified area) K: from 1.17 to 2.34

  [Ordinance on Conservation of Living Environment (Yokohama City)]

Sulphur content in emission: 4 SO_2 equivalent grams/1 fuel oil equivalent kg combustion

- NOx

  [Air Pollution Control Act]

  200ppm (O_2: 6%)

[Ordinance on Conservation of Living Environment (Yokohama City)]

NO_2: 100ppm

NOx: 200ppm

- PM

[Air Pollution Control Act]

100mg/ Nm^3 (O_2: 6%)

[Ordinance on Conservation of Living Environment (Yokohama City)]

0.05g/Nm^3

There are also more stringent agreements signed voluntarily by local governments and power plant operators. Moreover, power plants' own operational standards set more stringent internal targets.

The Air Pollution Control Act stipulates that prefectural governors shall set standards for controlling the total emissions in an area where there is a concentration of factories or workplaces.

Coal-fired power plants shall share the following information with the prefectural governor:

- Name and address
- Location
- Type of air pollutant
- Structure of facilities
- Way of disposing of air pollutants, etc.

The prefectural governor has the power to order emitters to temporarily suspend their facilities' operation when they violate the regulations and to order improvements if the CPP continuously emits more than the regulated limit. Based on an agreement between the local government and the CPP operator, once the CPP has been found to commit violations, the local government can

delay the lift on the suspension until the CPP has made satisfactory improvements. This mechanism obligates the CPP operator to comply with the voluntary targets to avoid receiving orders for improvement from the local government.

The CPP operator shall measure the quantity or concentration of air pollutants, and keep records.

- Frequency of measuring:

  SOx, NOx: more than every two months (Total emission controlling area: continuously)

  PM: more than every two months

- Measuring methods are stipulated in Law.

The CPPs set observation stations—for example, 10 kilometres, 20 kilometres, 30 kilometres away from the CPP—to monitor the emission continuously. Data is automatically transmitted to the local government through a telemeter.

The Ministry of Environment or prefecture governor may require the CPP operator to report the status of air pollutant emissions. The Ministry conducts integrated surveys of the quantity of air pollutant emission every three years. According to an agreement between the CPP operator and the local government, an operator submits the report to the local government every month generally, although the CPP automatically and continuously sends data through a telemeter.

The Ministry of Environment or a prefectural governor may conduct an official inspection.

- On-site inspection by METI: On an irregular basis, every five or six years
- On-site inspection by local government: Depends on the agreement between the CPP operator and the local government: once a year generally, typically during Environment Month.

Although the archive requirement is three years, most CPP operators keep data permanently.

Prefectural governors shall make the status of air pollution within the prefecture available to the public. Local governments collect environmental data from various facilities and publish the status of air pollution on a screen monitor in their city hall. Everyone can see the situation at any given time. Local governments also publish environmental reports periodically. In case of an accident, CPP operators publish the status of air pollutant emissions through press releases.

If a CPP operator violates the Air Pollution Control Act, the name of the operator is disclosed.

Punishment includes imprisonment and fines. Operators have strict liability to compensate for damage and losses.

The Air Pollution Control Act stipulates that the central government shall endeavour to provide financial assistance, technical advice, and other assistance. The Ministry of Environment, in collaboration with the Ministry of Economy, Trade and Industry in some cases, convenes explanatory meetings for CPP operators when the law is amended. Likewise, local governments convene their own explanatory meetings. The Ministry of Environment and local governments post explanatory documents and application/report forms on their website and allow these to be downloaded from the site.

The technical capability of officers in local governments is high. Measurement experts are based in local governments. The Air Pollution Control Act does not require an independent inspector. If a CPP has ISO 14001 certification, the plant is audited every year.

The Air Pollution Control Act does not require periodical meetings with the local community. Another law requires companies to hold a meeting with residents and explain and discuss issues when they apply for an EIA for the construction of a new CPP.

4.2 Australia

The national environment legislations in Australia are the National Environment Protection (National Pollutant Inventory) Measure 1998 and National Environment Protection (Ambient Air Quality) Measure. In addition, each state establishes environmental legislation. Procedures vary from state to state.

Regulated pollutants relating to CPPs are SO_2, NO_2, PM10, and PM2.5. Emission standards are presented in Table 4-1.

Table 4-1. Standards for Pollutants

Pollutant	Averaging period	Maximum concentration standard	Maximum allowable exceedances
NO_2	1 hour	0.12 ppm	1 day a year
	1 year	0.03 ppm	None
SO_2	1 hour	0.20 ppm	1 day a year
	1 day	0.08 ppm	1 day a year
	1 year	0.02 ppm	None
PM10	1 day	50 μg/m^3	None
	1 year	25 μg/m^3	None
PM2.5	1 day	25 μg/m^3	None
	1 year	8 μg/m^3	None

Source: National Environment Protection (Ambient Air Quality) Measure.

Table 4-2. Goal for Particles as PM2.5 by 2025

Pollutant	Averaging period	Maximum concentration
NO2.5	1 day	20 μg/m^3 by 2025
	1 year	7 μg/m^3 by 2025

Source: National Environment Protection (Ambient Air Quality) Measure.

The individual who is in occupation or control of the facility, whether or not the owner of the facility, is required to provide information. Under the Protection of the Environment Operations Act 1997 in New South Wales, for example, clean-up notices, prevention notices, and prohibition notices are the environment protection notices provided for under the legislation. Only the minister can issue a prohibition notice, on the recommendation of the Environment Protection Authority (EPA).

The law requires monitoring stations to be installed in areas with populations greater than 25,000. In New South Wales, the Office of Environment and Heritage operates a comprehensive air quality monitoring network to provide the community with accurate and up-to-date information about air quality. In 2010, it established the Upper Hunter Air Quality Monitoring

Network, in partnership with the Upper Hunter coal and power industries. Data from the monitoring network are presented online as ambient concentrations and air quality index values and updated hourly and stored in a searchable database.

The law in New South Wales does not require licensees to report periodically emission data to EPA. Instead of reporting, the law requires licensees to publish pollution monitoring data.

This goes without saying that the facilities must notify authorities on pollution incidents. The Protection of the Environment Operations Act provides that mandatory audits may be required as a condition for a licence if the EPA reasonably suspects that the licensee is responsible for the pollution. Authorized officers have powers to require information or records, powers of entry and search of premises, powers to question and identify persons, powers to disable intruder alarms, and powers concerning vehicles and vessels.

Pollution monitoring data that must be collected as a pre-condition to a licence must be published by the licensee. Penalties are imposed on such offences as failure to publish monitoring data and publication of false or misleading data. New South Wales' EPA publishes the current situation of air quality on its website.

Meanwhile, the EPA offers a two-day course designed to equip authorized officers in local governments with the necessary competencies to fulfil their responsibilities as outlined in the Protection of the Environment Operations Act 1997. The law in New South Wales does not require a periodical meeting with local community and independent inspectors.

4.3 Germany

Germany is a Federal Republic with 16 federal states whose competent authorities may differ since each federal state has its own laws regulating the administration. As a rule, the mid-level administrative bodies of the federal states (*Landramtsamt* or *Regierungspräsidium*) have permitting authority. The most relevant relation between local and national authorities takes place at the measurement and monitoring stage, which gathers data from local *Länder* and German Federal Environment Agency monitoring networks. Independent inspections are not required.

German regulations on air quality are all aligned with provisions adopted by the European Union (EU) air quality legislation. Current standards are contained in the Directive 2008/50/EC (European Parliament (EP) & Council of European Union (CEU), 11 June 2008) on ambient air quality and cleaner air for Europe, and the Fourth Daughter Directive 2004/107/EC (EP & CEU,

2004), relating to arsenic, cadmium, mercury, nickel, and polycyclic aromatic hydrocarbons in ambient air.

Industrial emissions within the EU are regulated under the Industrial Emissions Directive (Directive 2010/75/EU), which aims to reduce harmful industrial emissions across the EU through application of Best Available Techniques. Enforced on 6 January 2011 (and was supposed to be adopted in member states' national legislations by 7 January 2013), the directive provides an integrated permitting procedure (covering also issues related to water, soil, waste management, energy efficiency, and accident prevention). According to this directive, member states may choose to grant a permit to one responsible operator for each installation or to split the responsibility amongst several operators of different parts of an installation. The provision of emission permits depends on the evaluation of plants based on Best Available Techniques.

The Federal Emission Control Act (*Bundes-Immissionsschutzgesetz* [BImSchG]; Long title: 'Act on Prevention of Harmful Effects on the Environment Caused by Air Pollution' as amended and promulgated on 14 May 1990 and as last amended by Art. 1 of the Act of 3 May 2000) has four strategies to control emissions:

- Laying down environmental quality standards;
- Emission reduction requirements according to the Best Available Techniques;
- Product regulations;
- Laying down emission ceilings.

In addition to the BImSchG, there are also provisions on air quality control at the Federal States' levels, which represent the local enforcement of the BImSchG legal measures.

Regulated pollutants and their target values are also established by Industrial Emissions Directive 2010/75/EU. The directive notes that different approaches of controlling emissions into air, water, or soil separately may encourage the shifting of pollution from one environmental medium to another. Thus, the Industrial Emissions Directive favours an integrated approach to prevent and control pollutants, including substances affecting water.

According to the Industrial Emissions Directive, competent authorities in the member states shall review installations and are authorized to grant permits. Such permits must take into account the entire environmental performance of the plant, in accordance with the Industrial Emissions Directive's integrated approach.

Inspections are done at the Federal government level, with the consent of the *Bundesrat*. Each inspection plan shall include a general assessment of relevant significant environmental issues, the geographical area covered by the inspection plan, a register of the installations covered by the plan, procedures for drawing up programs for routine environmental inspections, procedures for non-routine environmental inspections, and provisions on the cooperation between different inspection authorities.

Before starting any operation of an installation, operators are required to submit a baseline report to the competent authority. The report shall contain the information necessary to

determine the state of soil and groundwater contamination. Permit conditions are based on Best Available Techniques as defined by the Best Available Techniques Reference Documents (BREFs). The conclusions reached in the BREFs—which included input from experts from member states, industries, and environmental organizations—have been adopted as implementing decisions and constitute the reference for setting permits conditions.

Meanwhile, existing installations are required by the Industrial Emissions Directive to furnish their competent authority regularly—at least annually—with their emission monitoring results (measurement methodology, frequency and evaluation procedure) in order to enable the authority to verify compliance with permit conditions.

In case of non-compliance with requirements, operators are required to suspend operations. According to BImSchG, Art. 20, the competent authority may decide to suspend activities of a plant in whole or in part. The same authority shall also order the closure of an installation that was built without necessary authorization or cannot guarantee the adequate protection of the neighbouring environment.

Cleanup of soil, water or damaged goods can be requested if there is a causal connection between the air pollution and the damage. If the responsible party is unwilling or unable to execute the cleanup, the authorities can do so at the polluter's cost. Severe cases of non-compliance can result in criminal liability. Criminal sanctions include imprisonment and fines (up to €50,000).

Establishing the emission limit values (mg/ Nm^3) are necessary as it ensures that, under normal conditions, emissions levels do not exceed those associated with the Best Available Techniques. The limit values are determined through standards stipulated in the European air pollution control directives and then transposed into German law. Such values shall apply at the point where the emissions leave the installation, and any dilution prior shall be disregarded. Alternatively, different emission limits, in terms of values, periods of time and reference conditions, can be set.

The Technical Instructions on Air Quality Control (*Technische Anleitung zur Reinhaltung der Luft* [TA Luft]) lay down requirements for calculations, which are based on the Lagrangian particle dispersion model and computed through a computer programme called AUSTAL2000. The analytical methods used are standardized internationally, with air quality data gathered by international data centres and used for computer modelling. The Federal Republic of Germany cooperates with other countries under the Convention on Long-range Trans-boundary Air Pollution framework. The international control instrument under this framework is the European Monitoring and Evaluation Program, which measures trans-boundary air pollution from 25 countries.

If continuous measurements are required, compliance depends on:

- No validated monthly average exceeding limit values;
- No validated daily average exceeding 110% of limit values;

- In case of combustion plants using coal with a total rated thermal input below 50 MW, no validated daily average exceeding 150% of limit values; and
- 95% of all the validated hourly average values over the year not exceeding 200% of limit values.

If continuous measurements are not required, the results of each of the series of measurements shall not exceed the limit values. The concentrations of SO_2, NOx, and dust shall be measured continuously. The German Federal Environment and the Agency German's Länder monitoring networks (Länder) measure data on ambient air quality several times a day.

According to the Industrial Emissions Directive (Part 6), sampling and analyses of all polluting substances, including dioxins and furans, as well as the quality assurance of automated measuring systems and reference measurement methods to calibrate them, shall be carried out according to CEN-standards. If CEN standards are not available, International Standards Organization ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality shall apply. German air monitoring networks are operated by the German Federal Environment Agency (*Umweltbundesamt*) and Länder. The data from the agency and the Länder provide the foundation for the presentation of the country's air quality. They are gathered in the centre of the air monitoring network in Langen (Hesse), near Frankfurt/Main.

All data on air quality is published on the internet shortly after being gathered in Langen. In particular, when a decision on permits is made, all data are made available to the public to ensure that the public can participate in the decision-making process and be informed of its consequences by having access to permit applications, permits, and results of the monitoring of releases. Also, there is the EU Pollutant Release and the Transfer Register, which is a public register that provides environmental information on main industrial activities, including data on emissions as reported by member states. It implements for the EU Community the UN/ECE PRTR Protocol to the Aarhus Convention on Access to Information, Public Participation on Decision-making and Access to Justice in Environmental Matters.

4.4 United States

The Unites States' national legislation is the Clean Air Act, which consists of the following stipulations, among others:

- Section 108 (Air quality criteria and control techniques)

  National Ambient Air Quality Standards

  EPA Regulation: 40 CFR part 50

- Section 111 (Standards of performance for new stationary sources)

  New Source Performance Standards

EPA Regulation: 40 CFR part 60 subpart Da

Standards of Performance for Electric Utility Steam Generating Units

- Section 112 (Hazardous air pollutants)

National Emission Standards for Hazardous Air Pollutants

EPA Regulation: 40 CFR part 63

Regulations on pollutants regarding CPPs are described below:

- Section 108

Six 'criteria' of air pollutants: CO, Lead, NO_2, O_3, PM and SO_2.

- Section 111

§60.42Da Standards for PM

§60.43Da Standards for SO_2

§60.44Da Standards for NOx

- Section 112, Clean Air Act

Currently 189 pollutants

EPA's latest regulation: mainly on mercury

Title V of the Clean Air Act requires facilities that are major sources of air pollutants to obtain and operate under a permit. Sources with these 'title V permits' are required to be compliance certified at least annually.

The measurement of emission by an operator is stipulated in one of the Code of Federal Regulations, 40 CFR part 60, subpart Da. The stipulation requires that the owner or operator of an affected facility install, calibrate, maintain, and operate an Opacity Monitoring System; and record the output of the system to measure the opacity of emissions. For instance, an owner or operator of a facility affected with PM must monitor the opacity of its emissions discharged to the atmosphere.

For SO_2, NOX, PM, and NOX plus CO emissions, the performance test data from the initial and subsequent performance tests and the performance evaluation of the continuous monitors (including the transmissometer) must be reported to the administrator. The owner or operator of the affected facility shall submit a signed statement.

The EPA's audit policy entitled, 'Incentives for Self-Policing: Discovery, Disclosure, Correction and Prevention of Violations,' provides several major incentives for regulated facilities to fix voluntarily their violations of federal environmental laws and regulations. Meanwhile, to monitor compliance, EPA's own inspection process may be in the form of on-site visits, civil investigations, record reviews, and information requests. Results of compliance monitoring are announced to the public.

Environmental civil liability is strictly applied when there is an environmental violation. There is liability regardless of whether or not a party knew about the law/regulation they violated. Meanwhile, environmental criminal liability is triggered when there is some level of intent.

If a civil defendant is found liable or agrees to a settlement, the consequences can be in the form of:

- a monetary penalty;
- injunctive relief (actions required to correct the violation and come into compliance, e.g., install pollution control equipment); and/or
- additional actions taken to improve the state of the environment.

If a criminal defendant is convicted or pleads guilty, the consequences can be:

- a monetary fine paid to the US Treasury; and/or
- restitution (reimbursing the government for the cost of cleanup or response; compensating for the harm caused by the violation, e.g. paying for medical testing for people exposed to asbestos);
- incarceration.

The New Source Review and Prevention of Significant Deterioration, both of which are permitting processes, require large industrial facilities to install state-of-the-art air pollution controls when they build new facilities or make modifications to existing facilities. On the EPA

homepage, investigations of the CPP sector have identified a high rate of non-compliance with the New Source Review or Prevention of Significant Deterioration when old plants are renovated or upgraded. The Clean Air Act (Section 108) requires EPA to develop information on pollution control techniques.

The EPA regulation does not require periodical meetings with the local community and independent inspectors.