3.1 What is a continuous emission monitoring system (CEMS)?

A continuous emission monitoring system, or CEMS, consists of all the equipment needed to measure and provide a permanent record of the emissions from an affected unit. Examples of CEMS components include:

• Pollutant concentration monitors (e.g., SO_2 or NO_x monitors).

• Diluent gas monitors, to measure $\%O_2$ or $\%CO_2$

• Stack gas volumetric flow rate monitors

• Sample probes

• Sample ("umbilical") lines

• Sample pumps

• Sample conditioning equipment (e.g., heaters, condensers, gas dilution equipment)

• Data loggers or programmable logic controllers (PLCs)

• DAHS components that electronically record all measurements and automatically calculate and record emissions and heat input in the required units of measure.

The specific components of a CEMS depend upon the parameter being monitored, the measurement principle of the CEMS, and the required units of measure. Some components are common to all systems, while others are specific to a particular monitoring technology. To illustrate:

• The key components of a Part 75 CEMS are the analyzer(s) and the DAHS (see Table 4). Table 4 shows that all Part 75 CEM systems, except for one, have only one component monitor. The exception is the NO_x emission rate, or "NO_x-diluent" monitoring system, which measures NO_x in lb/mmBtu. This system includes both a NO_x monitor and a diluent gas monitor (either CO_2 or O_2).

• PLCs and data loggers are common to all types of CEMS

• Probes, sample lines, vacuum pumps and sample conditioning equipment are associated with "extractive" CEMS, which continuously withdraw a sample of the effluent gas from the stack and send it to an analyzer located in a climate-controlled environment (i.e., a "CEMS shelter").

• "In-situ" CEMS, which analyze the effluent gas at stack conditions, sometimes have probes14, but unlike extractive systems, do not require sample lines, sample conditioning equipment, etc.

• Extractive CEMS that measure on a dry basis require moisture removal systems, whereas wet basis extractive systems15 do not.

The number of required monitors can sometimes be minimized by sharing certain components among two or more monitoring systems. For example, data from a single diluent gas monitor could be used to calculate NO_x emission rate and CO_2 mass emissions.

Table 4: Part 75 CEM Systems

Type of Monitoring System (Units of Measure)	Key Components:						
	SO_2 Monitor	NO_x Monitor	Flow Monitor	Diluent Gas Monitor[a]	Moisture Monitor	Opacity Monitor	DAHS
SO_2 concentration (ppm)	√						√
NO_x emission rate (lb/mmBtu)		√		√			√
NO_x concentration[b] (ppm)		√					√
Stack gas flow rate (scfh)			√				√
CO_2 concentration[c] (% CO_2)				√			√
O_2 concentration[d] (% O_2)				√			√
Moisture[e] (% H_2O)				√[e]	√[e]		√
Opacity[f] (%)						√	√

[a] Diluent gas is either CO_2 or O_2.

[b] This type of system is used only by CAIR NO_x Program sources, in conjunction with a stack flow monitor, to quantify NO_x mass emissions.

[c] Note that CO_2 concentration may be determined indirectly, using an O_2 monitor and Equation F-14a or F-14b. In the Acid Rain Program, this type of system is used with a flow monitor to quantify CO_2 mass emissions. In the CAIR NO_x Program, it is used exclusively for heat input rate determinations.

[d] This type of system is used exclusively for heat input rate determinations. An O_2 monitor is required.

[e] This type of system is used whenever the emissions or heat input calculations require a correction for the stack gas moisture content. It may include a continuous moisture sensor or wet and dry-basis O_2 analyzers.

[f] This type of system is required only for coal-fired and certain oil-fired units in the Acid Rain Program. It is generally referred to as a "continuous opacity monitoring system", or "COMS", rather than a CEMS.