

**Technical Guidance Document Series Number: DOE-APCS-5**

:

**TECHNICAL GUIDANCE ON  
PERFORMANCE MONITORING OF  
AIR POLLUTION CONTROL SYSTEMS**

**FOR THE USE OF THE INDUSTRIES AND CONSULTANTS**

**DOE Malaysia**

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# PERFORMANCE MONITORING OF AIR POLLUTION CONTROL SYSTEMS

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# PERFORMANCE MONITORING OF AIR POLLUTION CONTROL SYSTEMS

## 1. INTRODUCTION

**Preventive maintenance** and **performance monitoring** of a pollution control system, be it an effluent treatment system to treat an industrial effluent, or an air pollution control system to abate the release of air contaminants into the atmosphere, is a **prerequisite** for an uninterrupted and efficient operation of the control system. Experience of the officers of the Department of Environment (D.O.E) during **enforcement and site inspections** attests to the undisputable fact that preventive maintenance and performance monitoring of pollution control systems is not given due importance by the industrial operators. With regard to air pollution control systems, broken and corroded ducting, corroded cyclones, broken filter bags, malfunctioned compressed air system, non functioning pressure gages, etc are common observations made during enforcement rounds. This subsequently leads to inefficient operation of the control system which may result in violation of **emission standards** as well as **work place air quality standards**. If performance monitoring had been put in place and strictly adhered to, this unacceptable state of affairs would never happen. Continual and efficient functioning of air pollution control systems is dependent on effective preventive maintenance and performance monitoring program.

## 2. OBJECTIVE OF THE GUIDANCE DOCUMENT

The objectives of the guidance document are:

- (i) To standardize the **performance monitoring procedure** to be conducted by the industries to ensure proper working conditions of air pollution control equipment. Regulation 40 of the Clean Air Regulations, 1978 requires that control system be maintained in **proper working condition**. This guidance

document has been prepared to satisfy the intent of the above regulatory provision (regulation 40).

- (ii) To standardize **performance monitoring requirements** as spelt out in the approval conditions of new installations of air pollution control system. The control equipment covered in this guideline falls under the broad definition of control equipment as used in the **Environmental Quality Act, 1974**.

### **3. IMPORTANCE OF PERFORMANCE MONITORING**

Performance monitoring typically forms an integral part of **preventive maintenance procedure** adopted in an industry to ensure smooth and uninterrupted operation of air pollution control system. Additionally, preventive maintenance helps detect early onset of deteriorating performance of the control system hence avoids unnecessary **plant shutdowns** and costly **enforcement penalties**. Preventive maintenance procedure can specify action levels at which corrective actions are to be initiated.

From the enforcement viewpoint, performance monitoring of air pollution control equipment is an acceptable surrogate to **stack emission testing** to gage compliance with emission standards. As we all know, stack emission testing is not commonly conducted on a routine basis due to cost and other constraints. Data kept in preventive maintenance procedures and performance monitoring is typically used by environmental agencies worldwide as an **additional enforcement tool** apart from actual stack emission testing.

### **4. PERFORMANCE MONITORING REQUIREMENT**

All air pollution control equipment must be maintained and operated in such a manner that they are in **good working condition** as required by Regulation 40 of the Clean Air Regulations. In order to ensure compliance with this requirement a set of activities need to be conducted on a **routine basis** typically by the operator of the pollution control equipment. These activities commonly referred to as **operation and maintenance**

(O&M) or more appropriately **preventive maintenance and performance monitoring** are routine duties of the operator.

#### **4.1 Written permission conditions for new sources**

Approval of new installations of control equipment will invariably incorporate some conditions on **performance monitoring requirements**. These may include **reporting** and **record keeping requirements**. Typical **forms/log sheets** to be used to record the performance data may be prescribed or recommended.

#### **4.2 Existing sources**

Although some existing sources have instituted regular activities to monitor the performance of air pollution control equipment on their premises, by en large most sources are still oblivious to the need to have such regular monitoring. A **directive** may be issued to these sources to instruct them to put in place a performance monitoring program and a reasonable time frame of **six months** is recommended for compliance with the directive. Within this time period the industries are expected to be able to undertake the necessary actions such as minor **retrofitting** work to install the required **monitoring instruments**, if necessary.

### **5. PERFROMANCE MONITORING OF CENTRIFUGAL COLLECTORS**

Centrifugal collectors/separators are the most widely used **inertial separators** today. Centrifugal collectors are commonly used as **precleaners** to remove coarser particulates and reduce load on more efficient dust collectors. New generation high efficiency axial flow vortex tubes are also used as filters on solid-fuelled burning equipment. The most common types of centrifugal collectors in use today are:

- (i) Single-cyclone separators
- (ii) Multiple-cyclone separators or multiclones/multicyclones.

Table 1 below summarizes typical preventive maintenance procedure and performance monitoring for single cyclones and multicyclones .

**Table 1: Preventive maintenance procedures for cyclones and multicyclones**

<b>Type of cyclone</b>	<b>Frequency</b>	<b>Procedure/ task</b>
Single Cyclones	<b>Daily</b>	Record <b>cyclone pressure drops</b> . Check <b>stack</b> (if cyclone is the only collector). Record <b>fan motor amperage</b> . Inspect <b>dust discharge hopper</b> to assure dust is removed.
	<b>Weekly</b>	Check <b>fan bearings</b> . Check gaskets, valves, and other opening for <b>leakage</b> .
	<b>Monthly</b>	Check for sign of corrosion and other signs of deterioration. Inspect inlet and outlet for dust-build up
	<b>Daily</b>	Same as cyclones.
Multicyclones	<b>Weekly</b>	Same as cyclones.
	<b>Monthly</b>	Same as cyclones

(Source: Adapted from Bureau of Mines, 1987)

### 5.1 Regulatory record keeping requirements

At A minimum the mandatory performance monitoring data specified in Table 2 must be kept and made available to DOE officers for inspection. Typical forms to record performance data of mechanical separators are given in Appendix I

**Table 2: Records of performance data of cyclones**

<b>Parameter</b>	<b>Comments</b>
<b>Pressure drop</b>	Pressure drop information can indicate if <b>blockage</b> has occurred
<b>Flowrate</b>	Pressure drop information cannot be <b>interpreted</b> properly unless flowrate information is known

<b>Opacity</b>	Whether a continuous transmissometer/smoke meter/opacity meter is incorporated into the system or not, the output on <b>opacity/stack observation</b> should be recorded. The cause of abnormal change in opacity level should be identified and corrective action taken. If operator is not trained to conduct smoke observation, a descriptive statement on the condition of stack emission is sufficient
<b>Dust</b>	At least one parameter indicating the <b>quantity</b> of dust removed (e.g. weight or volume) from cyclone hopper must be monitored. Significant change in dust quantity may be indicative of cyclone <b>failure</b> or of <b>process changes</b> .

## 6. PERFORMANCE MONITORING OF BAGFILTERS

Commonly known as **baghouses**, bagfilters are one of the most efficient and cost effective types of dust collectors available and can achieve a collection efficiency of more than 99% for very fine particulates.

Classified on the basis of cleaning method, four common types of baghouses are:

- (i) Mechanical shaker
- (ii) Reverse air
- (iii) Reverse/Pulse jet
- (iv) Sonic cleaning

Table 3 summarizes typical preventive maintenance procedure and performance monitoring for bagfilters.

**Table 3: Preventive maintenance procedures for baghouses**

Frequency	Procedure
<b>Daily</b>	<ul style="list-style-type: none"> <li>▪ Check pressure drop</li> <li>▪ Observe stack (visually or with opacity meter)</li> <li>▪ Walk through system, listening for proper operation</li> <li>▪ Check for unusual occurrences in process</li> <li>▪ Observe control panel indicators</li> <li>▪ Check compressed-air pressure</li> <li>▪ Assure that dust is being removed from system</li> </ul>
<b>Weekly</b>	<ul style="list-style-type: none"> <li>▪ Inspect screw-conveyor bearings for lubrication</li> <li>▪ Check packing glands</li> <li>▪ Operate damper valves</li> <li>▪ Check compressed-air lines, including line filters and dryers</li> <li>▪ Check that valves are opening and closing properly in bag-cleaning sequence.</li> <li>▪ Verify accuracy of temperature-indicating equipment</li> <li>▪ Check pressure-drop-indicating equipment for plugged lines</li> </ul>
<b>Monthly</b>	<ul style="list-style-type: none"> <li>▪ Check all moving parts in shaker mechanism</li> <li>▪ Inspect fans for corrosion and material buildup</li> <li>▪ Check drive belts for wear and tension</li> <li>▪ Inspect and lubricate appropriate items</li> <li>▪ Spot-check bag tension</li> <li>▪ Spot check for bag leaks</li> <li>▪ Check hoses and clamps</li> <li>▪ Check accuracy of indicating equipment</li> <li>▪ Inspect housing for corrosion</li> </ul>
<b>Quarterly</b>	<ul style="list-style-type: none"> <li>▪ Inspect baffle plate for wear</li> <li>▪ Inspect bags thoroughly</li> <li>▪ Check duct for dust buildup</li> <li>▪ Observe damper valves for proper seating</li> <li>▪ Check gaskets on doors</li> <li>▪ Inspect paint, insulation, etc.</li> <li>▪ Check screw conveyor for wear or abrasion</li> <li>▪ Check fan belts</li> </ul>
<b>Annually</b>	<ul style="list-style-type: none"> <li>▪ Check welds</li> <li>▪ Inspect hopper for wear</li> </ul>

(Source: Adapted from Bureau of Mines, 1987)

### **6.1 Regulatory record keeping requirements**

A record keeping program is essential for the smooth operation of the baghouses and may lengthen its useful life and minimize emission. The program should comprise both



**operating and preventive maintenance records and performance monitoring records.** Record keeping requirements may vary from one industry to another depending on the **type of manufacturing process** being controlled, the **size of operation**, the **size and the location** of the industry. From the regulatory stand point, at the minimum the records specified in Table 4 must be kept and maintained. Typical forms to record performance data on bagfilters are illustrated in Appendix II. This form and other relevant information must be kept in a **logbook** and made available to the DOE officers for inspection. The frequency for **manual collection** of the data on pressure drop and opacity observation should be at the minimum **once per day**.

Table 4: Record of performance data of bagfilters

<b>Data</b>	<b>Comments</b>
<b>Pressure drop</b>	Pressure drop across the filter must be monitored as an indication of resistance to flow and <b>cleaning effectiveness</b>
<b>Flowrate</b>	Proper <b>interpretation of pressure drop information</b> can be made if flowrate information is available. A developing <b>leak</b> in the ducting or in the baghouse itself can be identified by examining flowrate record.
<b>Opacity.</b>	Whether a continuous transmissometer/smoke meter/opacity meter is incorporated into the system or not, the output on <b>opacity/stack observation</b> should be recorded. The cause of abnormal change in opacity level should be identified and corrected
<b>Temperature</b>	In some applications, temperature data are also important to evaluate high <b>temperature excursion</b> condensation. At least the inlet gas temperature of the baghouse must be monitored.
<b>Dust</b>	Additionally, at least one parameter indicating the <b>quantity of dust removed</b> (e.g. weight or volume) from each compartment of the baghouse must be monitored. Significant change in dust quantity may be indicative of <b>baghouse failure</b> or of <b>process changes</b> .
<b>Compressed pressure</b> <b>air</b>	Where cleaning is effected by using compressed air, the pressure should be monitored to ensure <b>effective cleaning operation</b>

## 7. PERFORMANCE MONITORING OF WET PARTICULATE SCRUBBERS

Commonly known as **wet scrubbers**, these particulate/dust collectors use liquid (usually water) as the scrubbing liquid to remove dust particles from a dust-laden gas stream. Wet scrubbers may be categorized by pressure drop (in inches water gauge) as follows:

- **Low-energy scrubbers** (0.5 to 2.5), e.g. gravity-spray-tower scrubber
- **Low- to medium-energy scrubbers** (2.5 to 6), e.g. wet cyclones
- **Medium- to high-energy scrubbers** (6 to 15), e.g. packed-bed scrubbers
- **High-energy scrubbers** (greater than 15), e.g. venturi scrubbers.

Although there are a variety of commercially available scrubbers hence preventive maintenance procedures may differ slightly from one another, Table 5 summarizes the procedures for typical wet scrubbers for particulates control.

## 8. PERFORMANCE MONITORING OF GASEOUS SCRUBBERS

The preventive maintenance procedures recommended for gaseous scrubbers are given in Table 6.

Table 5: Preventive maintenance procedures for wet particulate scrubbers

Frequency	Procedure
<b>Daily</b>	<ul style="list-style-type: none"> <li>▪ Check recycle flow</li> <li>▪ Check bleed flow</li> <li>▪ Measure temperature rise across motor</li> <li>▪ Check fan and pump bearing every 8 hours for grease/oil level, grease/oil color, grease/oil temperature, and vibration</li> <li>▪ Check scrubber pressure drop</li> <li>▪ Check pump discharge pressure</li> <li>▪ Check fan inlet and outlet pressure</li> <li>▪ Check slurry bleed concentration</li> <li>▪ Check vibration of fan for buildup or bleeds</li> <li>▪ Record inlet and saturation temperature of gas stream</li> <li>▪ Use fan motor current readings to detect flow decreases. Use fan motor current to indicate gas flow.</li> </ul>
<b>Weekly</b>	<ul style="list-style-type: none"> <li>▪ Check wet/dry line areas for material buildup. Clean, if necessary</li> <li>▪ Check liquid spray quantity and manifold pressure on mist eliminator automatic wash down</li> </ul>

	<ul style="list-style-type: none"> <li>▪ Inspect fans on dirty applications for corrosion, abrasion, and particulate buildup</li> <li>▪ Check bearings, drive mechanisms, temperature rise, sprocket alignment, sprocket wear, chain tension, oil level, and clarifier rakes</li> <li>▪ Check ductwork for leakage and excessive flexing. Line or replace as necessary</li> <li>▪ Clean and dry pneumatic lines associated with monitoring instrumentation.</li> </ul>
<b>Semiannually</b>	<ul style="list-style-type: none"> <li>▪ Verify accuracy of instruments and calibrate</li> <li>▪ Inspect orifice plates</li> <li>▪ Clean electrical equipment, including contacts, transformer insulation, and cooling fans</li> <li>▪ Check and repair wear zones in scrubbers, valves, piping, and ductwork</li> <li>▪ Lubricate damper drive mechanisms and bearings. Verify proper operation of dampers and inspect for leakage</li> </ul>

(Source: Bureau of Mines, 1987)

**Table 6: Preventive maintenance of gaseous scrubbers**

	<b>Daily Inspection</b>
<b>Check point</b> <ol style="list-style-type: none"> <li>1. Pump</li> <li>2. Valves</li> <li>3. Piping</li> <li>4. Body</li> <li>5. Pressure gage</li> <li>6. Pressure gage ammeter combination</li> </ol>	<b>What to look for</b> <ol style="list-style-type: none"> <li>a. Leaking</li> <li>b. Increased noise</li> <li>a. Position</li> <li>b. Leaks</li> <li>a. Leaks</li> <li>a. Leaks</li> <li>a. Pressure change from previous day</li> <li>a. Changes in either or both pressure reading and ampere drawn from last clean system check readings.</li> </ol>
<b>Gage Readings</b> <ol style="list-style-type: none"> <li>1. <ol style="list-style-type: none"> <li>a. Water pressure same</li> <li>b. Ampere draw same</li> </ol> </li> <li>2. <ol style="list-style-type: none"> <li>a. Water pressure decrease</li> <li>b. Ampere draw decrease</li> </ol> </li> <li>3. <ol style="list-style-type: none"> <li>a. Water pressure same or increase</li> <li>b. Ampere draw decrease</li> </ol> </li> <li>4. <ol style="list-style-type: none"> <li>a. Water pressure increase</li> <li>b. Ampere draw increase</li> </ol> </li> </ol>	<b>Probable Trouble</b> <p>None</p> <ol style="list-style-type: none"> <li>a. Missing nozzles</li> <li>b. Pump wear or plugging of suction line</li> <li>a. Plugging of nozzles or spray bars</li> <li>a. Holes in spray bar or manifold</li> </ol>

	<b>Weekly Inspection</b>
<p><b>Check point</b></p> <ol style="list-style-type: none"> <li>1. Spray bars</li> <li>2. Pipes and manifolds</li> <li>3. Pressure gage</li> <li>4. Pumps and valves</li> <li>5. Main body of scrubber</li> </ol>	<p><b>What to look for</b></p> <ol style="list-style-type: none"> <li>a. Plug nozzles</li> <li>b. Worn or missing nozzles</li> <li>a. Plugging or leaks</li> <li>a. Check accuracy</li> <li>a. Wear</li> <li>b. Valves operation</li> <li>a. Material feed building</li> <li>b. Abrasion</li> <li>c. Corrosion</li> </ol>

(Source: Hesketh, ed, 1983)

The most important and useful parameter to monitor is **pressure** hence pressure instruments must be installed at strategic locations, namely on the **scrubber, mist eliminator** and **fan** as a minimum.

### **8.1 Regulatory record keeping requirements**

At A minimum the parameters stated in Table 7 must be monitored and data kept in log book and made available to the DOE officers for inspection. Typical forms to record performance data on gaseous scrubbers are depicted in Appendix III.

**Table 7: Records of performance data**

<b>Data</b>	<b>Comment</b>
<b>Temperature-</b>	The scrubber <b>inlet temperature</b> is monitored to prevent high inlet gas temperature. Inlet gas temperature higher than the design value could lead to excessive liquid evaporation resulting in damage to scrubber components. The scrubber <b>outlet temperature</b> is monitored to evaluate scrubber operation and to protect downstream equipment from excessive temperature. High outlet temperature may be indicative of poor liquid distribution or plugging of liquid inlet
<b>Pressure drop</b>	To provide the most useful information, the pressure drop should be monitored across <b>specific scrubber components</b> i.e. scrubber chamber and mist eliminator instead of across the entire scrubber body.
<b>Liquid flowrate</b>	To ensure effective scrubbing, the <b>liquor feed rate</b> as well as the <b>water make up rate</b> should be monitored.
<b>pH</b>	Also for ensuring effective scrubbing, the pH of the chemical and scrubbing liquid <b>feed streams</b> and the <b>recycle liquor</b> systems should be monitored.

## **9. PERFORMANCE MONITORING OF TRANSMISSOMETERS**

Transmissometers are **opacity monitors** which are more commonly known as **smoke meters and recorders** in Malaysia. The instrument is generally installed across a **stack** or a **duct** that leads to the stack. Transmissometers are widely used to monitor the effectiveness of **dust arrestment device** and sometimes directly as a method of determining **compliance** with opacity emission standards.

A transmissometer is not per se an air pollution control equipment whose primary objective is to limit the discharge of contaminants into the atmosphere. Rather, it is an **instrumentation** system, hence a **quality assurance** program is imperative.

For the continued smooth operation of this **continuous opacity emission monitoring** system (COMS), quality control activities should be performed to assure that quality data are generated from the system. A summary of preventive maintenance/quality control procedures for a transmissometer system is given in Table 8.

**Table 8: Preventive and corrective maintenance for transmissometers**

	<b>Task</b>	<b>Frequency</b>
Operation checks (daily check, observations, adjustment)	Check indicator (fault) lights status Record zero value Record span value Examine strip chart	Daily
Routine maintenance	Clean outer surfaces, windows and filters	Monthly
And preventive maintenance	Check alignment, dessicants and blower motor	Monthly
	Check and replace lamps	1-2 years
Performance audit*	Assess the performance of the entire transmissometer system	3 years

\* Performance audit is an involved exercise which should be independently conducted by the company's assurance group or a third party consultant.

### **9.1 Regulatory record keeping requirements**

To comply with regulatory record keeping requirements at a minimum the records summarized in Table 9 should be kept in a logbook and made available to the DOE officers. Typical forms for recording performance data of transmissometers are given in Appendix V.

**Table 9: Performance monitoring record for transmissometers**

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Daily record of **zero and calibration values**  
Record of **window cleanings**  
Record of **part replacements** (lamps, filters, electronic components)  
Record of any **maintenance**  
Summary and results of **audits**

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## **10. ENFORCEMENT OF PERFORMANCE MONITORING REQUIREMENTS**

**Approval conditions** for new installations of chimneys/air pollution systems must include some conditions on performance monitoring requirements. During inspection duties the DOE enforcement officers will examine the **logbooks** kept at the factory premises for completeness of **entries** as specified in the preceding paragraphs entitled “Regulatory record keeping requirements” (paragraphs 5.1, 6.1, 7.1, 8.1, and 9.1) for each control equipment. This represents the minimum requirement. Other activities to be conducted by the officers during the inspection rounds are discussed in a separate document entitled “**Compliance Inspection of Air Pollution Control Systems**”.

## **11. ADDRESSING UPSET CONDITIONS**

Any upset situations such as malfunctioning of air pollution control system must be attended to immediately. The **corrective actions** taken should be recorded in the relevant form as illustrated in Appendix V.

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<p>This document is intended only as a guide. The Department of Environment assumes no responsibility for the accuracy, adequacy, or completeness of the concepts, methodologies, or protocols described in this guideline. Compliance with the regulatory requirements and standards is solely the responsibility of the industries</p>
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Appendix I

Typical forms to record performance monitoring data/activities of cyclones

(A) Daily; Month:.....

Date	Pressure, mm Hg/H <sub>2</sub> O		Flowrate, m <sup>3</sup> /s	Opacity or Stack Condition	Discharge Hopper Condition
	In	Out			
1					
2					
3					
4					
5					
6					
7					
8					
9					
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28					
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30					
31					

Entries made by:  
 Operator's name:  
 Signature:  
 Date:

Checked by: (daily/weekly)  
 Supervisor's name:  
 Signature:  
 Date:

(B) weekly; Month:.....

Date	Procedure	Notes	Operator's signature	Supervisor's signature
WEEK 1	<p>Check <b>fan bearings</b>.</p> <p>Check gaskets, valves, and other opening for <b>leakage</b>.</p>			
WEEK 2	<p>Check <b>fan bearings</b>.</p> <p>Check gaskets, valves, and other opening for <b>leakage</b>.</p>			
WEEK 3	<p>Check <b>fan bearings</b>.</p> <p>Check gaskets, valves, and other opening for <b>leakage</b>.</p>			
WEEK 4	<p>Check <b>fan bearings</b>.</p> <p>Check gaskets, valves, and other opening for <b>leakage</b>.</p>			

(C) Monthly; Month:.....

<b>Date</b>	<b>Procedure</b>	<b>Notes</b>	<b>Operator's signature</b>	<b>Super- visor's signature</b>
	Check for sign of <b>corrosion</b> and other signs of <b>deterioration</b> .  Inspect inlet and outlet for <b>dust-build up</b>			

Appendix II

Typical forms to record performance monitoring data/activities of **bagfilters**

(A) Daily; Month: .....

Date	Pressure, mm Hg/H <sub>2</sub> O		Flowrate, m <sup>3</sup> /s	Notes on Opacity or Stack Condition	Notes on Discharge Hopper Condition	Operator's signature	Supervisor's signature
	In	Out					
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
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22							
23							
24							
25							
26							
27							
28							
29							
30							
31							

(B) Daily; Month:.....

Date	Procedure	Notes	Operator's signature	Supervisor's signature
	<ul style="list-style-type: none"> <li>▪ Walk through system, listening for proper operation</li> <li>▪ Check for unusual occurrences in process</li> <li>▪ Observe control panel indicators</li> <li>▪ Check compressed-air pressure</li> <li>▪ Ensure that dust is being removed from system</li> </ul>	<p>Pressure: ...mmHg/H<sub>2</sub>O</p>		
	<ul style="list-style-type: none"> <li>▪ Walk through system, listening for proper operation</li> <li>▪ Check for unusual occurrences in process</li> <li>▪ Observe control panel indicators</li> <li>▪ Check compressed-air pressure</li> <li>▪ Ensure that dust is being removed from system</li> </ul>	<p>Pressure: ...mmHg/H<sub>2</sub>O</p>		

© Weekly; Month:.....

Date	Procedure	Notes	Operator's signature	Supervisor's signature
	<ul style="list-style-type: none"> <li>▪ Inspect screw-conveyor bearings for lubrication</li> <li>▪ Check packing glands</li> <li>▪ Operate damper valves</li> <li>▪ Check compressed-air lines, including line filters and dryers</li> <li>▪ Check that valves are opening and closing properly in bag-cleaning sequence.</li> <li>▪ Verify accuracy of temperature-indicating equipment</li> <li>▪ Check pressure-drop-indicating equipment for plugged lines</li> </ul>			
	<ul style="list-style-type: none"> <li>▪ Inspect screw-conveyor bearings for lubrication</li> <li>▪ Check packing glands</li> <li>▪ Operate damper valves</li> <li>▪ Check compressed-air lines, including line filters and dryers</li> <li>▪ Check that valves are opening and closing properly in bag-cleaning sequence.</li> <li>▪ Verify accuracy of temperature-indicating equipment</li> <li>▪ Check pressure-drop-indicating equipment for plugged lines</li> </ul>			

(D) Monthly; Month:.....

Date	Procedure	Notes	Operator's signature	Supervisor's signature
	<ul style="list-style-type: none"> <li>▪ Check all moving parts in shaker mechanism</li> <li>▪ Inspect fans for corrosion and material buildup</li> <li>▪ Check drive belts for wear and tension</li> <li>▪ Inspect and lubricate appropriate items</li> <li>▪ Spot-check bag tension</li> <li>▪ Spot check for bag leaks</li> <li>▪ Check hoses and clamps</li> <li>▪ Check accuracy of indicating equipment</li> <li>▪ Inspect housing for corrosion</li> </ul>			

Appendix III

Typical form to record performance data/activities of **gaseous scrubbers**

(A) Daily; Month: .....

Date	Gas flow measurement		Pressure of mist eliminator, mm WG		Pressure scrubber mm WG	of body,	Temperature, of gas, °C		pH of liquor		Liquid flowrate, m <sup>3</sup> /s (or in terms of pressure)	
	Fan motor current, amp	Flow, m <sup>3</sup> /s	In	Out			In	Out	In	Out	Feed	Recycle
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
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28												
29												
30												
31												

Entries made by:  
 Operator's name:  
 Signature:  
 Date:

Checked by: (daily/weekly)  
 Supervisor's name:  
 Signature:  
 Date:

Notes:



(B) Weekly; Month:.....

Date	Procedure- Check point	What to look for	Notes	Opera- tor's signature	Supervi- sor's signature
Week 1	Pump  Valve  Piping  Body  Pressure gage  Pressure gage ammeter combination	Leaking Increased noise  Position Leaks  Leaks  Leaks  Pressure change from previous day  Changes in either or both pressure reading and ampere drawn from last clean system check readings			
Week 2	Pump  Valve  Piping  Body  Pressure gage  Pressure gage ammeter combination	Leaking Increased noise  Position Leaks  Leaks  Leaks  Pressure change from previous day  Changes in either or both pressure reading and ampere drawn from last clean system check readings			
Week 3	Pump  Valve  Piping  Body  Pressure gage	Leaking Increased noise  Position Leaks  Leaks  Leaks  Pressure change			

	Pressure gage ammeter combination	from previous day  Changes in either or both pressure reading and ampere drawn from last clean system check readings			
Week 4	Pump	Leaking Increased noise			
	Valve	Position Leaks			
	Piping	Leaks			
	Body	Leaks			
	Pressure gage	Pressure change from previous day			
	Pressure gage ammeter combination	Changes in either or both pressure reading and ampere drawn from last clean system check readings			

© Monthly; Month:.....

Date	Procedure- Check point	What to look for	Notes	Opera- tor's signature	Superv- isor's signature
	Spray bars	Plug nozzles Worn or missing nozzles			
	Pipes and manifolds	Plugging or leaks			
	Pressure gage	Check accuracy			
	Pumps and valves	Wear Valves operation			
	Main body of scrubber	Material feed building Abrasion Corrosion			

Appendix IV

Typical form to record performance monitoring data/activities of **transmissometers**

(A) Daily; Month:.....

Date	Procedure	Value and notes	Operator's signature	Supervisor's signature
	<p><b><i>Check indicator (fault) lights status</i></b></p>			
1	<p>Record zero value Record span value Examine strip chart</p>			
2	<p>Record zero value Record span value Examine strip chart</p>			
3	<p>Record zero value Record span value Examine strip chart</p>			
4	<p>Record zero value Record span value Examine strip chart</p>			
5	<p>Record zero value Record span value Examine strip chart</p>			
6	<p>Record zero value Record span value Examine strip chart</p>			
7	<p>Record zero value Record span value Examine strip chart</p>			
8	<p>Record zero value Record span value Examine strip chart</p>			
9	<p>Record zero value Record span value Examine strip chart</p>			
10	<p>Record zero value Record span value Examine strip chart</p>			
11	<p>Record zero value Record span value Examine strip chart</p>			
12	<p>Record zero value Record span value</p>			

13	Examine strip chart  Record zero value Record span value Examine strip chart			
14	Record zero value Record span value Examine strip chart  Record zero value Record span value Examine strip chart			

(B) Monthly; Month:.....

<b>Date</b>	<b>Procedure</b>	<b>Notes</b>	<b>Operator's signature</b>	<b>Supervisor's signature</b>
	Clean outer surfaces, windows and filters  Check alignment, dessicants and blower motor			

© Annually; Year:.....

<b>Date</b>	<b>Procedure</b>	<b>Notes</b>	<b>Operator's signature</b>	<b>Supervisor's signature</b>
	Check and replace lamps (1-2 years)			

Appendix V

General form to record corrective actions for **upset conditions**  
 (Applicable for all type of control equipment)

Date	Type of Upset Condition	Diagnosis of Cause of Upset condition	Any Non Compliance Of Discharge Standard Occurred? – Give Explanation	Corrective Actions Taken	When Conditions Returned to Normal	Name and Signature of Reporting Officer	Name and Signature of Supervisor