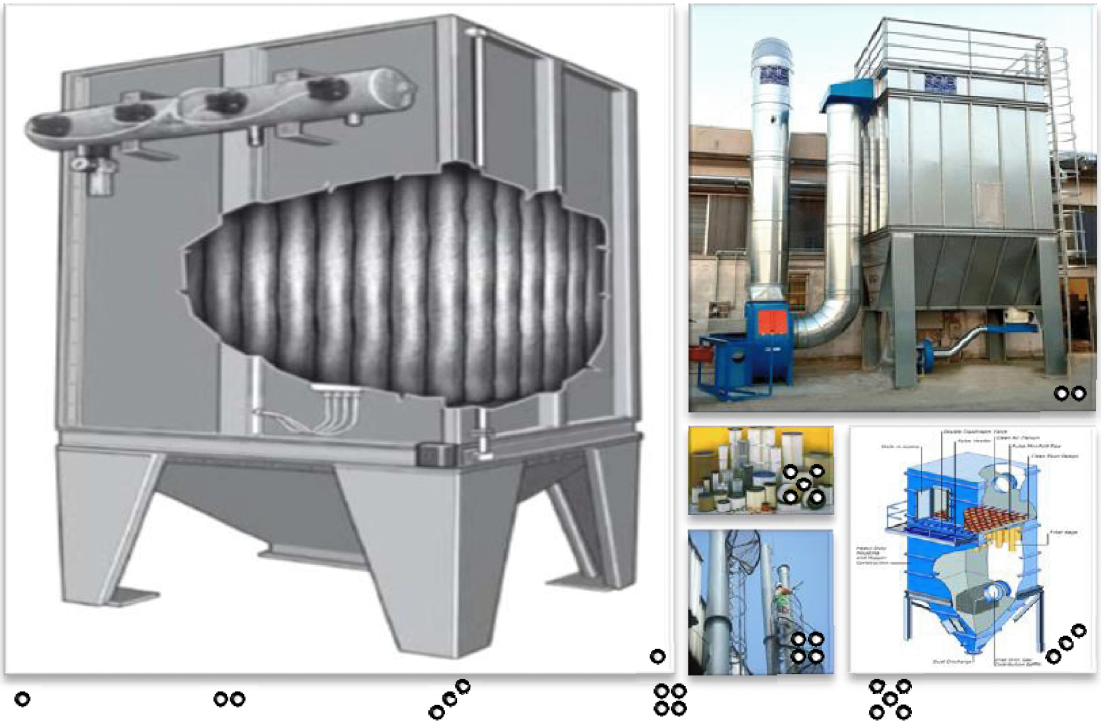
A GUIDEBOOK ON PERFORMANCE MONITORING OF BAG FILTER DUST COLLECTOR



ENVIRONMENT INSTITUTE OF MALAYSIA
(EiMAS)
DEPARTMENT OF ENVIRONMENT

A GUIDEBOOK ON
PERFORMANCE MONITORING OF
BAG FILTER DUST COLLECTOR

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FOREWORD

Performance monitoring (PM) on air pollution control system (APCS) is a legal requirement under Regulation 9(b), of the Clean Air Regulations 2014 or in short, CAR. The PM is intended to ensure that the APCS are monitored in a systematic manner so that its function is always effective. In this regards, emphasis on preventive and corrective action of the APCS hardware will warrant the emission from APCS comply with emission standards of the regulations on a continuous basis.

The practices of performance monitoring by industry will mainstream environmental agenda into day to day tasks of the industry management and instil self-regulation culture and pride of environmental excellence and subsequently improves the industry's corporate image.

Thus, it is important for industry to have a good understanding on the overall processes of the APCS. With this understanding, the industry will also inculcate a sense of ownership and "do it right" in maintaining the APCS operation by conducting monitoring of process parameters at appropriate sampling locations and frequency. Hence, this guidebook is useful as quick reference guide for conducting **performance monitoring of bag filter dust collector**.

(DATO' HALIMAH HASSAN)
Director General
Department of Environment, Malaysia
October 2015

IMPORTANT NOTICE

This document is intended only as a **quick reference/guide** for conducting performance monitoring of bag filters by the industries. The Department of Environment assumes no responsibility for the accuracy, adequacy, or completeness of the concepts, methodologies, or protocols described in **this quick reference/guide book.** Compliance with the regulatory requirements and standards is solely the responsibility of the industries

CHAPTER 1 – INTRODUCTION

1. PURPOSE OF GUIDEBOOK

The main objectives of this guide book are:

a) As a quick reference/guide to interested parties/industries **in carrying out requirements of conducting** performance monitoring and preventive maintenance requirement of a pollution control system (bag filter) **under the Environmental Quality (Clean Air)** Regulations 2014 (CAR 2014); and

b) To standardize **procedures of performance** monitoring and preventive maintenance requirement of a pollution control system (bag filter dust collector) for easy inspection and reporting.

2. ADVANTAGES OF PERFORMANCE MONITORING (PM)

a) Helps detect early onset of deteriorating performance of the control system hence avoids unnecessary **plant shutdowns** and costly **enforcement penalties**;

b) Preventive maintenance procedure can specify action levels at which corrective actions are to be initiated; and

c) Act as acceptable surrogate to **stack emission testing** to gage compliance with emission standards.

2.1 Why PM?

a) Required by Regulation 9(b), of CAR (2014); and

b) All records shall be documented in standard format and kept for inspection for 3 years.

2.2 PM on Bag Filter Dust Collector

a) For this guidance, discussion would focus more on **bag filter dust collector (type pulse jet)**.

b) For other type of bag filter dust collector the operator/owner of the industries is responsible to develop their own PM procedures with reference to:

(i) Key performance monitoring parameter for the types of bag filter dust collectors

(ii) Sampling and monitoring frequency and location of performance parameter.

(iii) Acceptable range of values for the parameter for optimal bag filter dust collector operation.

3 WHO IS RESPONSIBLE FOR CONDUCTING PM IN INDUSTRIES

Each factories/premises is required under Section 49AA, the Environmental Quality Act, 1974 to have a competent person in charge of each air pollution control system. The responsibilities of a competent person is given as below:

a) Conduct and submit timely reports to DOE and PMC as schedule/planned on:
   i. performance monitoring (PM);
   ii. preventive inspections; and
   iii. changes to systems,

b) Maintain records of activities as above for a minimum period of 3 years.

c) Activate and supervise the running of Performance Monitoring Committee (PMS).

d) Maintaining good working ethics and yearly status level of Continuous Professional Development (CDP).

CHAPTER 2 – BAG FILTER DUST COLLECTOR

4 WHAT IS BAG FILTER DUST COLLECTOR ?

a) A bag filter dust collector unit generally consists of one or more isolated compartments containing rows of fabric bags in the form of round, flat, or shaped tubes, or pleated cartridge.

b) These collectors use porous media to separate fine dust particles from the airstream at efficiencies up to 99.99 percent.

c) **Table 1** lists those characteristics for some common filter fabrics.

4.1 Types of Bag Filter Dust Collector

a) Three (3) most common types of Bag Filter Dust Collector based on cleaning mechanism of filter bags:
   - Shaker Cleaning
   - Reverse-air Cleaning
   - Pulse-jet Cleaning

b) **Table 2** lists the advantages and disadvantages comparison of bag filter dust collector cleaning types.

c) **Table 3** summarizes typical design criteria for each type of bag filter dust collector

Table 1 : Characteristics of Filter Fabrics

Generic Names	Example Trade Name Fabrics**	Max. Temp. F		Resistance to Physical Action					Resistance to Chemicals				
		Continuous	Intermittent	Dry Heat	Moist Heat	Abrasion	Shaking	Flexing	Mineral Acid	Organic Acid	Alkalies	Oxidizing	Solvents
Cotton	Cotton	180	—	G	G	F	G	G	P	G	F	F	E
Polyester	Dacron[1] Fortre[2] Vycron[3] Kodel[4] Enka Polyester[3]	275	—	G	F	G	E	E	G	G	F	G	E
Acrylic	Orlon[1] Acrilan[6] Creslan[7] Dralon T[8] Zefran	275	285	G	G	G	G	E	G	G	F	G	E
Modacrylic	Dynel[10] Verel[4]	160	—	F	F	F	P-F	G	G	G	G	G	G
Nylon (Polyamide)	Nylon 6,6[1,2,6]	225	—	G	G	E	E	E	P	F	G	F	E
	Nylon 6[5,11,12]	400	450	E	E	E	E	E	P-F	E	G	G	E
	Nomex[11]	500	580	E	P	G	G	E	P-F	G	F	G	E
Polymide	P-84[18]	200	250	G	F	E	E	G	E	E	E	G	G
Polypropylene	Herculon[13] Reevon[14] Vectra[15]	500	550	E	E	P-F	G	G	E	E	E	E	E
Teflon (flurocarbon)	Teflon TFE[1]	450	—	E	E	P-F	G	G	E	E	E	E	E
	Teflon FEP[1]	500	550	E	E	P-F	G	G	E	E	E	E	E
Expanded PFTE	Rastex	350	—	F	F	F	G	G	E	E	G	G	P
Vinyon	Vinyon[16] Clevylt[17]	500	600	E	E	P	P	F	E	E	F	E	E
Glass	Glass	550	550	E	E	P	P	G	G	G	G	E	G
Fiberglass	Fiberglass[19]												

*E - excellent; G = good; F = fair; P = poor

** Registered Trademarks

(1) Du Pont; (2) Celanese; (3) Beaunit; (4) Eastman; (5) American Enka; (6) Chemstrand; (7) American Cyanamid; (8) Farbenfabriken Bayer AG; (9) Dow Chemical; (10) Union Carbide; (11) Allied Chemical; (12) Firestone; (13) Hercules; (14) Alamo Polymer; (15) National Plastic; (16) FMC; (17) Societe Rhovyl; (18) Lenzing; (19) Huyglas

Table 2 : Comparison of Bag Filter Dust Collector Cleaning Types

<table>
<tr><th colspan="2">Types: Reverse-air baghouses</th></tr>
<tr><td colspan="2">  </td></tr>
<tr><th>Advantages</th><th>Disadvantages</th></tr>
<tr><td>• Have high collection efficiency for respirable dust
• Are preferred for high temperatures due to gentle cleaning action
• Have low pressure drop for equivalent collection efficiencies</td><td>• Have low air-to-cloth ratio
• Require frequent cleaning because of gentle cleaning action
• Have no effective way to remove residual dust buildup
• Cleaning air must be filtered
• Require personnel to enter baghouse to replace bags, which creates potential for toxic dust exposure</td></tr>
</table>

Types: Mechanical-shaker baghouses

Advantages	Disadvantages
• Have high collection efficiency for respirable dust • Can use strong woven bags, which can withstand intensified cleaning cycle to reduce residual dust buildup • Simple to operate • Have low pressure drop for equivalent collection efficiencies	• Have low air-to-cloth ratio • Cannot be used in high temperatures • Require large amounts of space • Need large numbers of filter bags • Consist of many moving parts and require frequent maintenance • Personnel must enter baghouse to replace bags, creating potential for exposure to toxic dust • Can result in reduced cleaning efficiency if even a slight positive pressure exists inside bag

Types: Pulse-jet baghouses

Advantages	Disadvantages
• Have a high collection efficiency for respirable dust • Have increased efficiency and minimal residual dust buildup due to aggressive cleaning action • Can clean continuously • Can use strong woven bags • Have lower bag wear • Have small size and fewer bags because of hgih air-to-cloth ratio • Some designs allow bag changing without entering baghouse • Have low pressure drop for equivalent collection efficiencies	• Require use of dry compresses air • May not be used readily in high temperatures unless special fabrics are used • Cannot be used if high moisture content or humidity levels are present in the exhaust gases

Table 3 : Typical design criteria of bag filter

Type of bag filter	Design variable	Notes
Mechanical Shaker	Air to cloth ratio : 0.3 to 2.4 m/min (optimum)	Filtration velocity (A/C ratio) may refer to **Appendix 1**
	Pressure Drop : 2 – 6 in water (0.5 – 1.5 kP_a)	
Reverse Air	Air to cloth ratio : 0.4 – 0.6 m min^{-1}	
	Pressure Drop : 2 – 6 in water (0.5 – 1.5 kP_a)	
Pulse Jet	Air to cloth ratio : 0.9 – 4.6 m min^{-1}	
	Pressure Drop : 4 – 6 in water (0.5 – 1.5 kP_a)	

4.2 Components of Bag Filter Dust Control System

a) A bag filter dust control system (**Figure 1**) usually includes:-

- ✓ **Hoods** or enclosure to capture the air contaminant
- ✓ **Ductwork** leading to an exhaust fan to transport the contaminant
- ✓ A **bag filter dust collector unit**, for removing the dust particle contaminants from the air stream
- ✓ **Fan** to create air flow in the system
- ✓ **Stack** to discharge the clean air outside the workplace or to the atmosphere

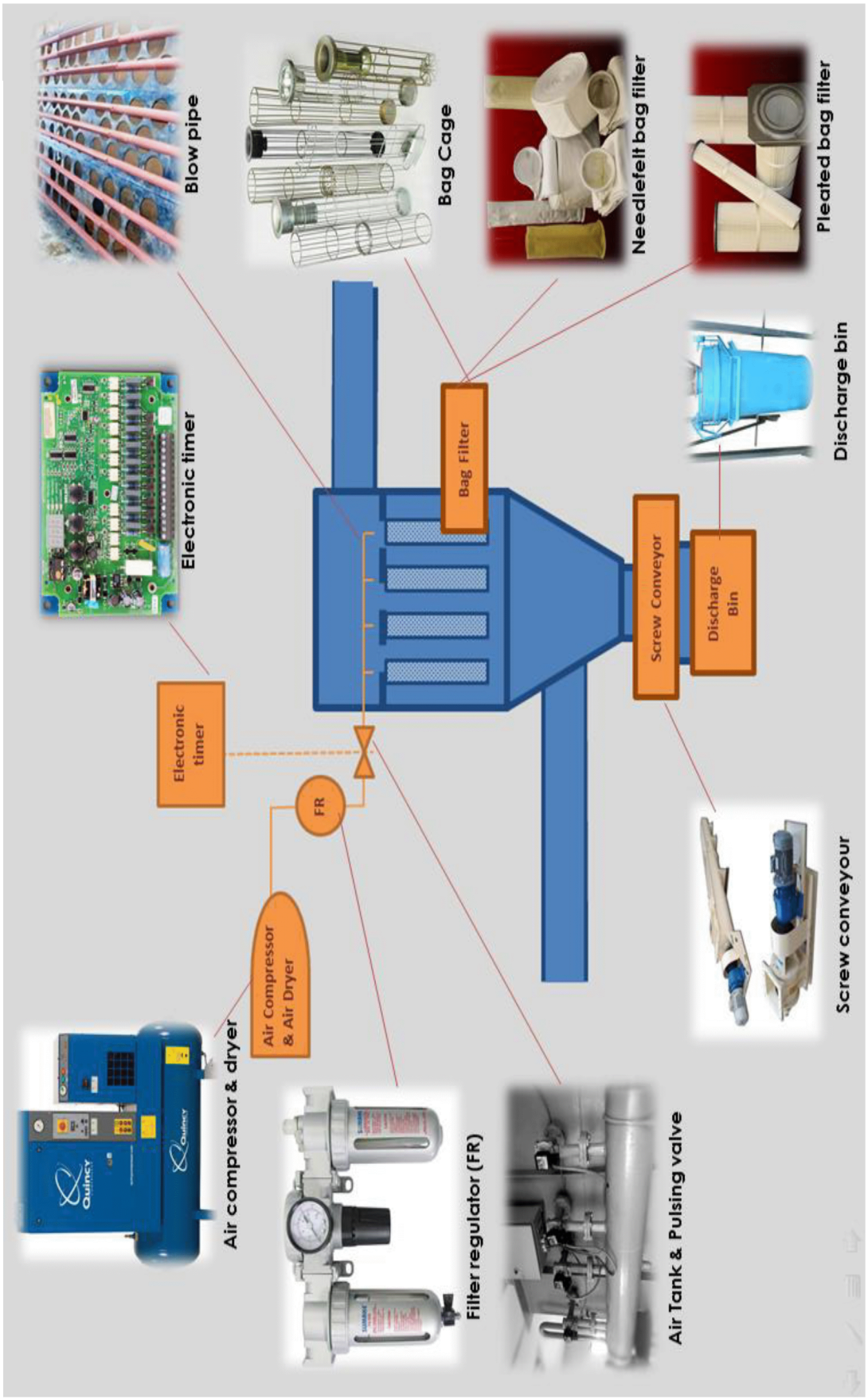
Figure 1 : Main components of bag filter dust control system

5 EQUIPMENT ASSOCIATED WITH BAG FILTER DUST COLLECTOR (PULSE JET)

a) Important equipment associated with bag filter dust collector (pulse jet):-

- ✓ Air Compressor & dryer
- ✓ Filter regulator
- ✓ Air Tank
- ✓ Pulsing valve
- ✓ Electronic timer
- ✓ Bag cage
- ✓ Needlefelt or pleated bag filter
- ✓ Dust Bin
- ✓ Conveyour
- ✓ Blow pipe

Figure 2 : Equipment associated with bag filter dust collector (pulse jet)



6. GENERAL OPERATIONAL PROCEDURE OF BAG FILTER DUST COLLECTOR

A typical procedure for initial start up, normal start up and shutdown of bag filter dust collector system are given in **Appendix 2.**

CHAPTER 3 – PERFORMANCE MONITORING

7. PERFORMANCE MONITORING OF BAG FILTER DUST COLLECTOR

7.1 Performance Monitoring Of Bag Filter Dust Collector

At the minimum the parameter stated in **Table 4** must be monitored and kept in log book and made available to the DOE officers for inspection. Typical forms to record performance data on bag filter dust collectors are depicted in **Appendix 3.**

Table 4 : Records of Performance Data

Performance Data	Comments
Pressure drop	Pressure drop across the filter must be monitored as an indication of resistance to flow and cleaning effectiveness
Flow rate	Pressure drop information cannot be interpreted properly unless flow rate information is known. Flow rate record is useful in identifying a developing leak in ducting or in the baghouse itself
Opacity	Whether a continuous transmissometer/ smoke meter/ opacity meter is incorporated into the system or not, the output on opacity / stack observation should be recorded. The cause of abnormal change in opacity level should be pursued and understood
Temperature	In some applications, temperature data is also important to evaluate high temperature excursion

Performance Data	Comments
	condensation. At least the inlet gas temperature of the baghouse must be monitored.
Dust	Additionally, at least one parameter indicating the quantity of dust removed (e.g. weight or volume) from each compartment of the baghouse must be monitored. Significant change in dust quantity may be indicative of baghouse failure or of process change
Compressed air pressure	Where cleaning is effected by using compressed air pressure should be monitored to ensure effective cleaning operation

- *There are also other monitored data should be considered to ensure effective dust collector system such as fan current, fan rpm*

7.2 Preventive Maintenance Of Bag Filter Dust Collector

Table 5 summarizes frequency of preventive maintenance of bag filter dust collector. The industry should abide to this procedure on preventive maintenance of the bag filter dust collector. The record keeping of preventive maintenance on bag filter dust collector is given **Appendix 4**

Table 5 : Preventive maintenance of bag filter dust collector

Frequency	Procedure
Daily	✓ Check pressure drop ✓ Observe stack (visually or with opacity meter) ✓ Walk through system, listening for proper operation ✓ Check for unusual occurrences in process ✓ Observe control panel indicators ✓ Check compressed-air pressure ✓ Assure that dust is being removed from system

Frequency	Procedure
Weekly	✓ Inspect screw-conveyor bearings for lubrication ✓ Check packing glands ✓ Operate damper valves ✓ Check compressed-air lines, including line filters and dryers ✓ Check that valves are opening and closing properly in bag-cleaning sequence. ✓ Verify accuracy of temperature-indicating equipment ✓ Check pressure-drop-indicating equipment for plugged lines

Frequency	Procedure
Monthly	✓ Check all moving parts in shaker mechanism ✓ Inspect fans for corrosion and material buildup ✓ Check drive belts for wear and tension ✓ Inspect and lubricate appropriate items ✓ Spot-check bag tension ✓ Spot check for bag leaks ✓ Check hoses and clamps ✓ Check accuracy of indicating equipment ✓ Inspect housing for corrosion

Frequency	Procedure
Quaterly	✓ Inspect baffle plate for wear ✓ Inspect bags thoroughly ✓ Check duct for dust buildup ✓ Observe damper valves for proper seating ✓ Check gaskets on doors ✓ Inspect paint, insulation, etc. ✓ Check screw conveyor for wear or abrasion ✓ Check fan belts
Annually	✓ Check welds ✓ Inspect hopper for wear

8. MEASURING INSTRUMENTS USED TO MONITOR BAG FILTER DUST COLLECTOR PERFORMANCE

a) A monitoring system must be properly installed and maintained to provide reliable data.

b) **Figure 3** illustrate the location of measuring instruments to monitor bag filter performance.

c) In the majority of bag filter operation, measuring instruments is installed directly on the air pollution control equipment, and there are also a premise had installing and connecting directly to a programmable logic controller (PLC). However there is a need to provide portable measuring instruments for the purpose of verifying the data recorded by automatic system.

d) **Table 6** summarise the measuring instruments to monitor bag filter dust collector performance variables.

Figure 3 : Location Of Measuring Instruments To Monitor Bag Filter Dust Collector

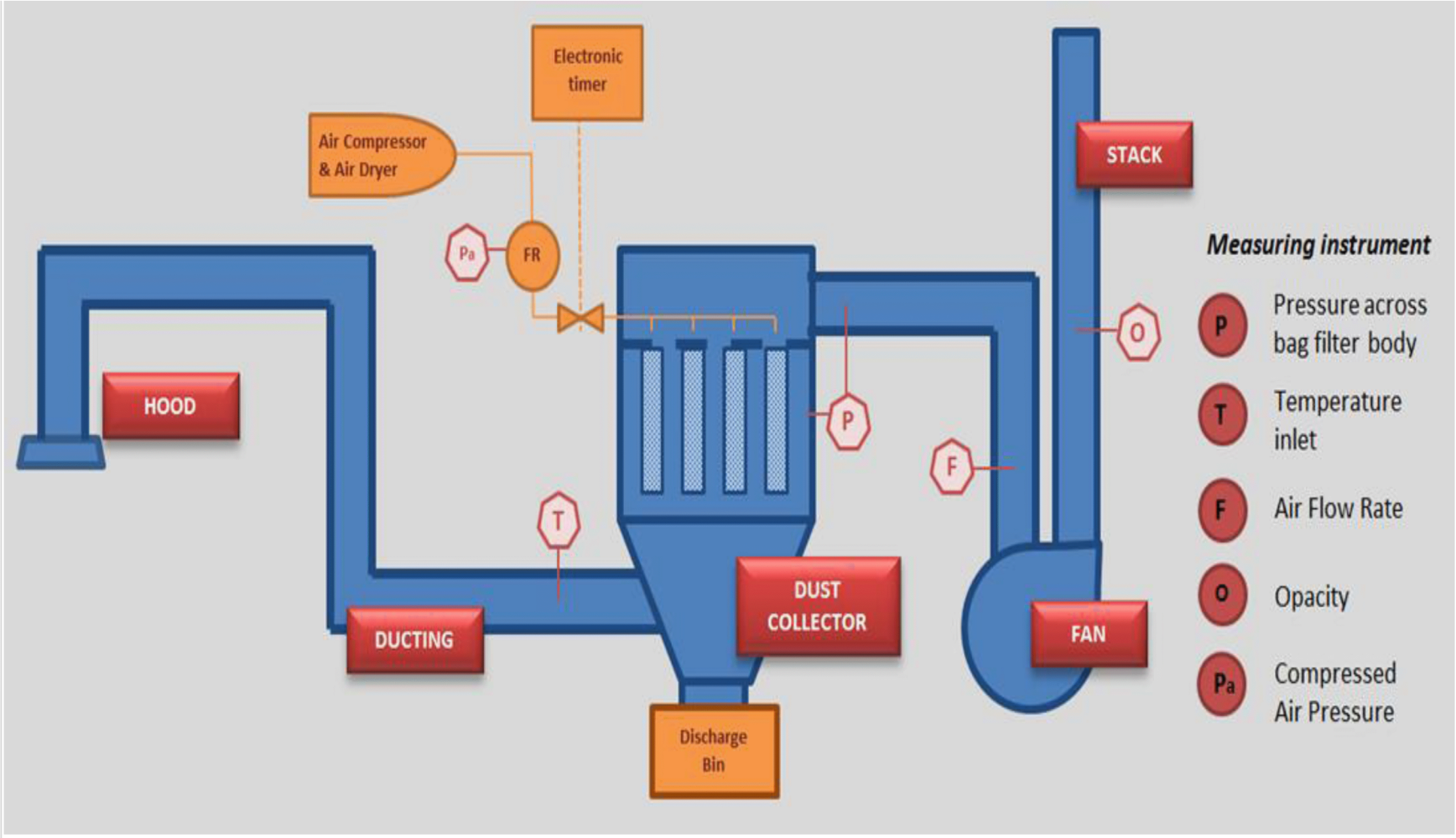
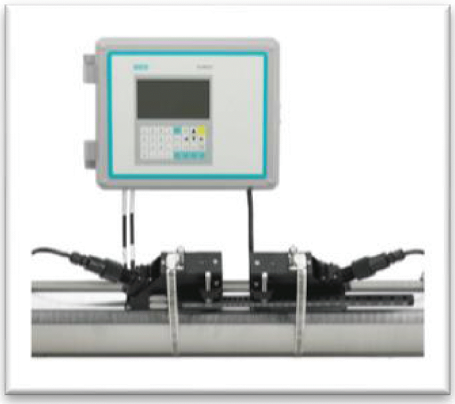


Table 6 : Performance Data and Measuring Instrument

Label (measuring location refer to Figure 3)	Performance Data (Unit)	Example of Measuring Equipment
P	Pressure drop across bag filter body (mm WG or inch WG)	 Magnehelic gauge  U tube manometer

Label (measuring location refer to Figure 3)	Performance Data (Unit)	Example of Measuring Equipment
F	Air flow rate *(m^3/hour)*	 Pitot tube and flow meter (portable)  Flow meter

Label (measuring location refer to Figure 3)	Performance Data (Unit)	Example of Measuring Equipment
T	Temperature *(Degree C)*	 Thermometer
O	Opacity	 Opacity Meter

Label (measuring location refer to Figure 3)	Performance Data (Unit)	Example of Measuring Equipment
Pa	Compress air pressure (bar)	 Filter regulator
	Fan Running Ampere (A)	 Clamp meter (portable)  Ammeter for fan at control panel

CHAPTER 4 – MAINSTREAMING OF BAG FILTER PERFORMANCE MONITORING AGENDA

9. RECORD KEEPING REQUIREMENT

a) Regulation 10, of the Clean Air Regulations (2014) requires premises to maintain a record of production process, preventive maintenance and performance monitoring of air pollution control system.

b) A record should be kept at least 3 years and be made available for inspection.

10. PERFORMANCE MONITORING DATA ANALYSIS AND INTERPRETATION

a) Advantages of data analysis:-

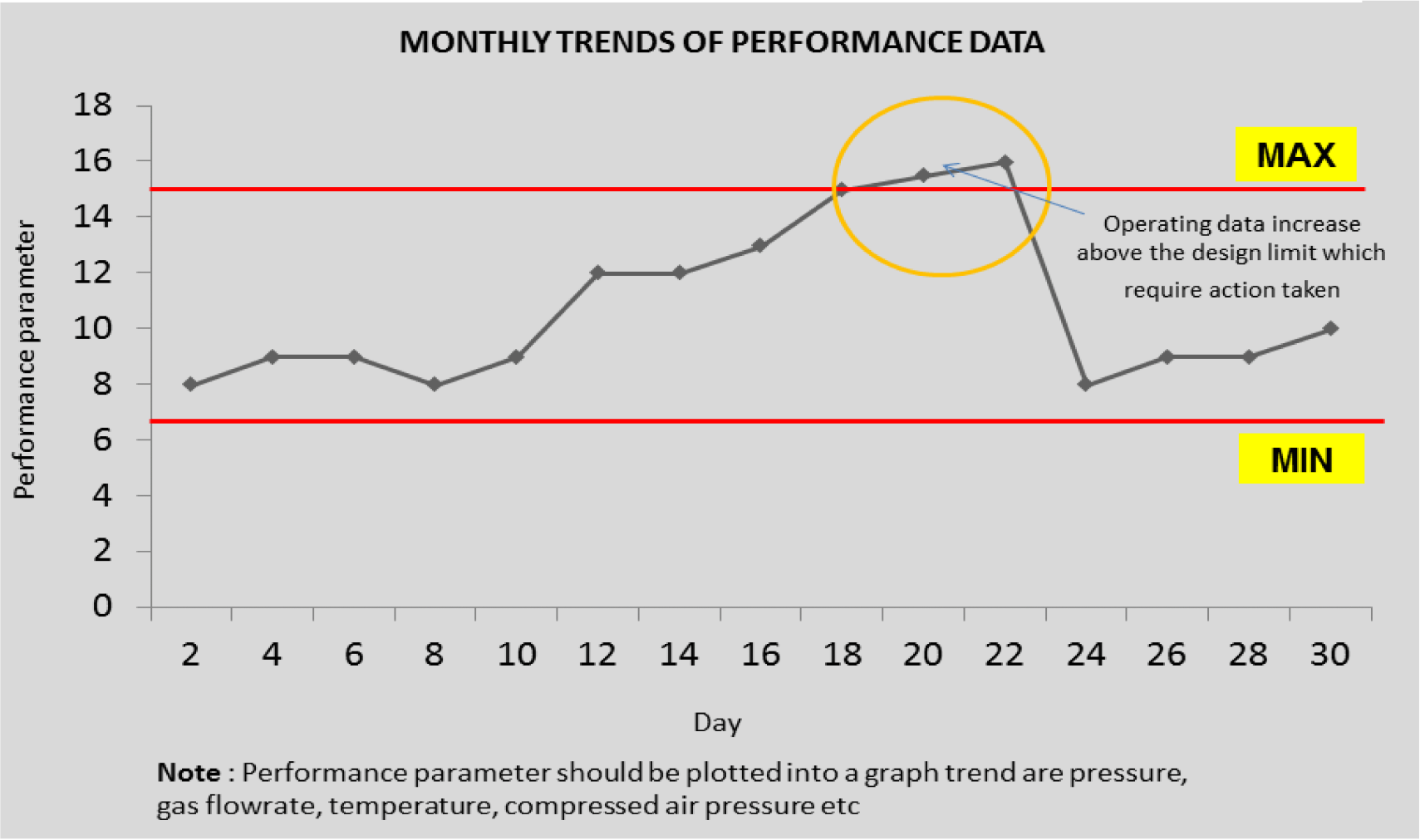
- ✓ able to provide a very good indication of the performance of a dust collector.

- ✓ able to aid in the detection of component deterioration in the bag filter system.

b) The performance daily data (pressure, temperature, air flow rate, compressed air pressure, opacity etc.) must be plotted into a graph trends and compare with the maximum and minimum operating limits for dust collector.

c) The analysis information must be provided on a monthly basis and reported to the Performance Monitoring Committee.

Figure 4 : Example of Monthly Trends of Performance Data



Note : Performance parameter should be plotted into a graph trend are pressure, gas flowrate, temperature, compressed air pressure etc

11. ADDRESSING UPSET CONDITIONS

a) Any upset situation based on the daily performance monitoring data recorded or malfunction 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 5.**

b) For reference **Table 7** indicates the common troubleshooting problem associated with the operation condition of the bag filter dust collector.

Table 7 : Troubleshooting - List of problems, possible causes, possible solution

PROBLEM	POSSIBLE CAUSE	POSSIBLE SOLUTION
1. High Pressure Drop	**a) In-appropriate air-to-cloth ratio**	Check table of representative air-to-cloth ratio values and for the recommendations of the dust collector or filter manufacturer
		Close some branches of the ducting system, remove part of the attached load
		Improve hood designs to allow lowering flow requirements
		Adjust fan/blower damper or slide gates
	b) Plugged filter media	End of filter life – replace
		Excess loading – add pre-cleaner, operate filter cleaning system with reduced or no airflow (downtime cleaning)

PROBLEM	POSSIBLE CAUSE	POSSIBLE SOLUTION
		Wet, agglomerative, sticky, hygroscopic dusts – change filter to appropriate design and material
		Oily air stream – difficult to remedy; pre-coating absorbent material such as lime powder may extend life
		Wet or oil compressed air – see below
	c) Incorrect choice of filter media or surface treatment	Work with collector or filter supplier to determine best choices of filter media to meet system needs
	d) Wet filter media	Eliminate source of water, check for dust collector body rain leaks, check spark extinguishing system, check for water in compressed air

PROBLEM	POSSIBLE CAUSE	POSSIBLE SOLUTION
		Eliminate dew point excursions, and use start-up and shutdown procedures to dry filter media
	e) Cleaning mechanism not working	Check electrical, mechanical and/or pneumatic systems for correct operation and replace or repair as needed
	f) Loss of compressed air and/or low pressure	Monitor compressed air and ensure adequate volume and pressure for all shifts the dust collector operates. Increase compressed air line size or install dedicated compressor
		Malfunction of solenoid or diaphragm valve may be allowing continuous air loss

PROBLEM	POSSIBLE CAUSE	POSSIBLE SOLUTION
	g) **Wet or oily compressed air**	Add filter or dryer to system, or service existing system
		Reduce dew point to less than lowest expected operating temperature
	h) **Pulse pipes missing, installed upside down, or not properly aligned with filters**	Check mechanical system for proper installation and alignment
	i) **Dust storage full or plugged**	Service dust storage or take-away system on regular schedule. Do not use dust collector hopper for dust storage
	j) **Instrument error**	Check for dust-filled, plugged, kinked, cracked, crushed or missing pneumatic lines

PROBLEM	POSSIBLE CAUSE	POSSIBLE SOLUTION
		Check all fittings for leaks
		Check gauge for evidence of dust contamination
		Check for mechanical or electrical instrument failure
		Check gauge calibration
2. Low Efficiency	**a) Air-to-cloth ratio too high**	Check table of representative air-to-cloth ratio values and for the recommendation of the dust collector or filter manufacturer
		Close some branches of the ducting system
		Improve hood designs to allow lowering flow requirements
		Adjust fan/blower damper or slide gates

PROBLEM	POSSIBLE CAUSE	POSSIBLE SOLUTION
	b) Damaged filter media	Check for mechanical damage of filters, tears, split seams, damage due to bag away impact with other bags or dust collector body, installation damage, bend or dented end caps or liners
		Test with fluorescent powder & light and replace if filter damaged
	c) Improper filter installation	Check installation information. Look for airflow directional arrows on filters. Look for gasketed filters installed backwards
	d) Loose filter retention	Check band clamps, cranks, hand knobs, bolt downs, snap bands, or other filter mechanisms for proper tightness. Tighten as directed by installation instructions

PROBLEM	POSSIBLE CAUSE	POSSIBLE SOLUTION
		Test with fluorescent powder & light (repair)
	e) Damaged or missing filter gaskets	Check for gaskets that are torn or detached
	f) Tube sheet leaks	Check for cracks, broken welds, or missing fasteners
		Test with fluorescent powder & light
	g) Warped tube sheets	Test flatness of tube sheet; look for leaks at filter gasket areas. Common problem after fires
		Test with fluorescent powder & light
	h) Missing filters	Check all filters. Install any that are missing

PROBLEM	POSSIBLE CAUSE	POSSIBLE SOLUTION
	i) Abrasion of filter media	High velocity inside dust collector, unequal air distribution, duct directional changes close to dust collector inlet, high solids loading, solids collection container full or plugged
		Add pre-cleaner or abrasion reduction inlet box. Redesign inlets to lower velocities. Remove elbows too close to dust collector inlet. Service solids collection containers on regular schedule
	j) Fire-damaged filters	Look for filters with burn holes or for missing filter media.
		Replace any damaged filters. Eliminate all sources of ignition or burning embers. Add spark and fire suppression system

PROBLEM	POSSIBLE CAUSE	POSSIBLE SOLUTION
	k) Excessive cleaning frequency	Over-cleaning filters reduces efficiency
		Install pressure drop based cleaning control. Reduce frequency of cleaning
	l) Excessive cleaning energy	Check operating instructions, regulate cleaning air pressure at dust collector manufacturer's recommendation value
	m) Chemical attack	Check the chemical compatibility of the solids and entrained vapors with the filter media. May be affected by concentration and temperature. Choose filter media suited to application

PROBLEM	POSSIBLE CAUSE	POSSIBLE SOLUTION
	n) Temperature	Measure air stream temperature and compare to filter media rating. Install filter with proper temperature rating
3. Premature Filter Failure	**a) Air-to-cloth ratio too high**	Check table of representative air-to-cloth ratio values and for the recommendation of the dust collector or filter manufacturer
		Close some branches of the ducting system
		Improve hood designs to allow lowering flow requirements
		Adjust fan/blower damper
	b) Abrasion of filter media	High velocity inside dust collector, unequal air distribution, duct directional changes close to dust collector inlet, high solids loading,

PROBLEM	POSSIBLE CAUSE	POSSIBLE SOLUTION
		solids collection container full or plugged
		Add precleaner or abrasion reduction inlet box. Redesign inlets to lower velocities. Remove elbows too close to dust collector inlet. Service solids collection containers on regular schedule
	c) Chemical attack	Check the chemical compatibility of the solids and entrained vapors with the filter media. May be affected by concentration and temperature. Choose filter media suited to application
	d) Temperature	Measure air stream temperature and compare to filter media rating. Install filter with proper temperature rating

PROBLEM	POSSIBLE CAUSE	POSSIBLE SOLUTION
	e) Incorrect choice of filter media or surface treatment	Work with dust collector or filter supplier to determine best choices of filter media to meet system needs
	f) Wet or oily compressed air	Add filter or dryer to system, or service existing system
		Reduce dew point to less than lowest expected operating temperature
	g) Dust storage full or plugged	Service dust storage or take-away system on regular schedule. Do not use dust collector hopper for dust storage
	h) Oily airstream	Difficult to remedy; precoating with absorbent material such as lime powder may extend life

PROBLEM	POSSIBLE CAUSE	POSSIBLE SOLUTION
4. In-sufficient Air Flow	**a) Blower rotating backward**	Check rotation arrows on blower housing. Change rotation if necessary
	b) Blower malfunction	Eroded fan wheel, misadjusted – adjusted inlet cone, slipping drive belt
		Repair or replace as required
	c) Dust collector or ducting openings not closed	Look for hopper discharges, inspection doors, access doors, unused duct branches open. Close off any unnecessary openings on both clean and dirty side of dust collector and in ductwork
	d) Ducting collapsed or plugged	Check all affected portions of system for plugged ducting
	e) Improper duct design	Have knowledgeable person check duct design for proper static

PROBLEM	POSSIBLE CAUSE	POSSIBLE SOLUTION
		and flow balance and duct design
	f) Excess flexible ducting	Flexible duct requires more static pressure due to irregular interior surface and direction changes. Calculate losses, increase duct diameter, increase static availability, or reduce length of run
	g) Improper transitions or elbows	Check for transitions facing into flow rather than with flow
		Use minimum angle between trunk line and branch inlet
		Use long radius elbows
	h) Blast-gate/Damper settings	Check all blast gates/damper for proper settings
		Re-adjust any set out of tolerance

PROBLEM	POSSIBLE CAUSE	POSSIBLE SOLUTION
	i) Blower system effects	Elbows close to blower inlet, improper inlet box without turning vanes, improperly designed or no-discharge duct, directional change close to elbow discharge, improper rain hood. Consult trained duct designer or blower supplier, correct ducting errors. Speed up blower
	j) Blower inlet or exhaust dampers	Check settings of all flow dampers in system
	k) Blower motor speed	Check with blower supplier to ensure blower and motor speeds are compatible
	l) High pressure drop	Any fault that cause high pressure drop can also cause low airflow

12. REPORTING AND PERFORMANCE MONITORING COMMITTEE (PMC)

a) There must be a formal and permanent committee established wthin the industry to monitor the bag filter performance on a continuous basis. This committee is commonly known as the performance monitoring committee (PMC). The members of PMC should comprise senior management personnel of the industry from various relevant departments.

b) Through this committee the results of the performance monitoring activities are presented, reviewed and discussed. Monthly trends of performance data plotted in graph and corrective action taken should be presented to committee for improvement discussion.

c) Key industrial personnel from relevant departments are directly involved in bag filter operation issues are jointly responsible for ensuring regulatory compliance so that

the company business plans can progress without hitches due to noncompliance issue.

d) The record date of the meeting and the reports presented to the committee **shall be kept** for inspection by DOE. The conduct of PMC meetings is mandatory for CePBFO to maintain their registration with the DOE in the National Registry of Certifed Environmental Professionals (NRCEP).

e) Example of monthly status report of bag filter performance monitoring for PMC meeting is given in **Appendix 6**

REFERENCES

1. Margaret Pernce. 2012. *Handbook of Air Pollution Control Systems and Devices.* Delhi; University Publications
2. American Conference of Governmental Hygienists. 1992. *Industrial Ventilation A Manual of Recommended Practice.* 21st Ed. Cincinnati, OH; ACGHI
3. C. David Cooper & F.C Alley. 2011. Air Pollution Control – A Design Approach. 4th Ed. Long Grove, Illinois; Waveland Press Inc.
4. David S. Beachler, Jerry Joseph, Mick Pomelia 1995. Fabric Filter Operation Review – *APTI Course SI:412A*. 2nd Ed. N. Carolina State University
5. Department of Environment Malaysia. 2006. Technical Guidance On Performance Monitoring Of Air Pollution Control Systems.
6. Department of Environment Malaysia. 2014. Course Module on Certified Environmental Professional In Bag Filter Operation; CePBFO, EiMAS

APPENDIX 1

Typical air to cloth ratios

Dust	Shaker/Woven Reverse Air/Woven	Pulse Jet/Felt
Alumina	1.27	4.07
Asbestos	1.52	5.08
Cocoa, chocolate	1.42	6.10
Cement	1.02	4.07
Coal	1.27	4.07
Enamel frit	1.27	4.57
Feeds, grain	1.78	7.11
Fertilizer	1.52	4.07.
Flour	1.52	6.10
Flyash	1.02	2.54
Graphite	1.02	2.54
Gypsum	1.02	5.08
Iron ore	1.52	5.59
Iron oxide	1.27	3.56
Iron sulphate	1.02	3.05
Leather dust	1.78	6.10
Lime	1.27	5.08
Limestone	1.37	4.07
Paint pigments	1.27	3.56
Paper	1.78	5.08
Rock dust	1.52	4.57
Sand	1.27	5.08
Sand dust	1.78	6.10
Silica	1.27	3.56
Soap	1.02	2.54
Stanch	1.52	4.07
Sugar	1.02	3.56
Talk	1.27	5.08
Tobacco	1.78	6.61
Zinc oxide	1.02	2.59

(Source: Benitez, 1993)

APPENDIX 2

INITIAL START-UP

Visually inspect all equipment and remove all foreign material and trash. Check that all guards and safety equipment are installed. Be sure all electric wiring has been checked out.

1. One by one, start up of the fan, discharge valves, and conveyors, and any other accessory equipment. Check each one for proper rotation, speed, and operation. Turn each one off and correct problems if necessary, then recheck.
2. Check that all ductwork connections and support are in place and tight, clean-out ports are closed, every duct is free of debris, hoods are in place and free of contact with machinery, and the fan exhaust is free and clear and aimed correctly.
3. With all equipment turned off, check that all doors and ports are closed on the collector.
4. Turn on the compressed air to the collector cleaning system and check for the leaks. If air is leaking from any blowpipe, there may be a leak in the diaphragm to solenoid valve tubing line. Turn off the compressed air when everything checks out.
5. Turn on the electric power to the timer or control panel. The red power on light should come on. Select

the timer position for cleaning, and turn both the off time and the on time knobs to a fully counterclockwise position. The individual timing lights at the output terminals should blink at 1.5-s intervals, and the corresponding solenoid valves should activate audibly.

6. Turn on the air supply to the air header. Set the air supply pressure regulatory to about 5~6 bar, unless otherwise instructed. Each diaphragm and solenoid valve should operate every 1.5s (exhaust air can be felt and heard exhausting from each valve). Let the collector pulse for about 10 minutes to ensure that all lines are clear. Then set the off time to about 20~30s. These settings may need later adjustment in operation.
7. Turn on all dust discharge equipment.
8. If moisture or condensible vapors are present in the air stream, the operating temperature should be brought up above that dew point. It may take some time to get all the ductwork and collector walls above the dew point.
9. Start the fan with the damper set for about half flow volume and run for about 30 minute; then start introducing a light load of dust or an intended pre

coat filter aid powder or absorbent. This is particularly recommended when the process dust will be a very fine particle size, and some pre coat dust cake is critical.

10. Observe the differential pressure reading on the photohelic or magnehelic gauge. The pressure drop should be very low at start-up. After some 30 minutes of operation with light incoming dust load, the pressure differential should begin to climb as the bags acquire some coating. The filtration efficiency should then be high enough to begin the feeding step below.
11. The fan damper can be opened up, gradually, and then dust fed at normal design operating rates. The differential pressure should then climb for several hours and stabilize at some value between 1 and 6 in Wg. If below 4 in Wg, then gradually increase the off-time until it reaches 4 in Wg. This is a general guide, but use caution on fragile filter media and with very fine dust.
12. Temperature must be controlled to remain below the maximum rating of the filter bags or cartridges.
13. The collector should now ready for regular operation at the design capacity.

APPENDIX 2

NORMAL DUST COLLECTOR START-UP

Subsequent start-ups should begin with all system off (if new filter bags have just been installed, then the initial start-up procedure above should be followed). Normally equipment should be turned on as follows:

1. All ports, doors, and rotating discharge equipment should be closed, and all safety devices should be in place.
2. Turn on the compressed air.
3. After the pressure reaches 5~6 bar or the normal level, turn on the timer.
4. Turn on all dust discharge equipment.
5. Preheat the system if necessary (this may precede the other steps if several hours preheat is required).
6. Turn on the fan and introduce filter aid powder or a low loading of process dust to precoat, then increase dust flow to the normal operating load.
7. If the exhaust is visible, then refer to the troubleshooting guide. A collection efficiency of around 99-95 percent should eliminate any visible plume unless some steam, vapor or SO_2 is present.

APPENDIX 2

NORMAL DUST COLLECTOR SHUT-DOWN

1. For dust collection system, the shutdown generally reverses the start-up. First turn off the process dust feed, then the fan, unless the two operate in an integrate manner. Wait 5 to 10 minutes and then turn off the cleaning timer to allow filter cleaning without input dust. Then turn off the compressed air supply, and finally the discharge equipment can be stopped.
2. Process systems. Process dryers and equipment feeding the collector should be run until empty of dust, and if moisture is present, then the heat and fan flow at a reduced rate should be maintained until the collector metal and filter bags are dry. Then proceed as in step 1.

APPENDIX 2

SAFETY BEFORE ENTERING DUST COLLECTOR

1. Run cleaning system for about 10 minutes with the fan off to clean the filters well.
2. Run solids out of the hopper discharge equipment during this clean out and inspect for amount of dust and condition.
3. Turn off and lock out all electric power to rotating equipment.
4. If toxic gases are present, purge all collector and block off inlet duct or damper, and follow any further safety precautions.
5. Install safety cables and catwalks where needed.
6. Secure access doors in an open position, or remove odors, unless rain or ambient temperature intrusion is undesirable, to prevent trapping anyone inside.
7. Use the buddy system and other safety precautions when people must enter the bag house.
8. Wear respirator if needed in the bag house, especially if carcinogenic dust or toxic vapors are present.
9. Use common sense and any special precautions.

APPENDIX 3

TYPICAL FORM TO RECORD PERFORMANCE DATA/ACTIVITIES OF BAG FILTER DUST COLLECTOR

Operating/Control Setting	Minimum	Maximum
Pressure Drop		
Temperature		
Flow Rate		
Compressed Air Pressure		
Timer	Ontime = Offtime =	

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

Date	Filter Pressure drop (mmWG)	Flow rate (m3/hour)	Opacity or Stack emission condition	Discharge Hopper Condition	Temperature (degC)	Compressed Air Pressure (bar)	Operator Signature	Supervisor Signature
1								
2								
3								
4								
5								
6								
7								
8								
..								
30								

APPENDIX 4

TYPICAL FORM TO RECORD PERFORMANCE DATA OF BAG FILTER DUST COLLECTOR (PREVENTIVE MAINTENANCE)

B) DAILY

Month : _____ Year : _____

Procedure	Notes	Entries by Operator			Checked by Supervisor		
		Name	Sign	Date	Name	Sign	Date
1. Walk through system, listening for proper operation 2. Check for unusual occurrences in process 3. Observe control panel indicators 4. Ensure that dust is being removed from system							

APPENDIX 4

(C) WEEKLY

Month : _____ Year : _____

Procedure	Notes	Entries by Operator			Checked by Supervisor		
		Name	Sign	Date	Name	Sign	Date
1. Inspect screw conveyor bearings for lubrication 2. Check packing glands 3. Check damper / valves for proper setting 4. Check compressed air lines, including line filters and dryers 5. Check the valves are opening and closing properly in bag cleaning sequence 6. Check temperature – indicating equipment 7. Check pressure drop indicating equipment for plugged lines							

APPENDIX 4

(C) MONTHLY

Month : _____ Year : _____

Procedure	Notes	Entries by Operator			Checked by Supervisor		
		Name	Sign	Date	Name	Sign	Date
1. Inspect fan for material build up and corrosion 2. Check drive belts for wear and tension 3. Inspect and lubricate appropriate items 4. Spot check for bag leaks 5. Check hoses and clamps 6. Check accuracy of indicating equipment 7. Inspect housing for corrosion							

APPENDIX 5

GENERAL FORM TO RECORD CORRECTIVE ACTION FOR UPSET CONDITIONS

(Applicable for all types of control equipment)

Month : _____

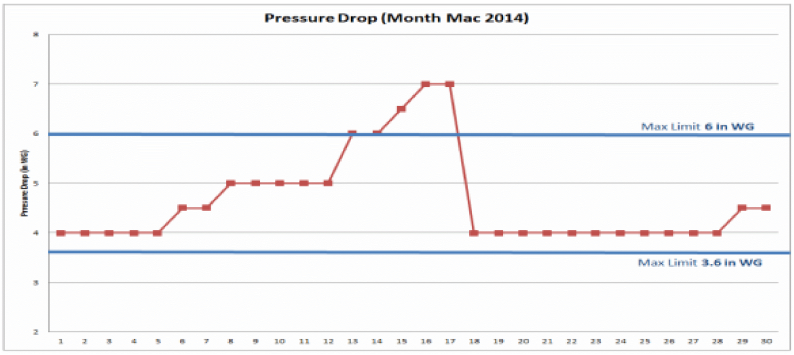
Date	Type of Upset Condition	Diagnosis of Cause of Upset Condition	Any Non Compliance of Discharge Standard Occurred – Give Explanation	Corrective Action Taken	When Condition Returned to Normal	Name and Signature of Reporting Officer	Name and Signature of Supervisor

APPENDIX 6

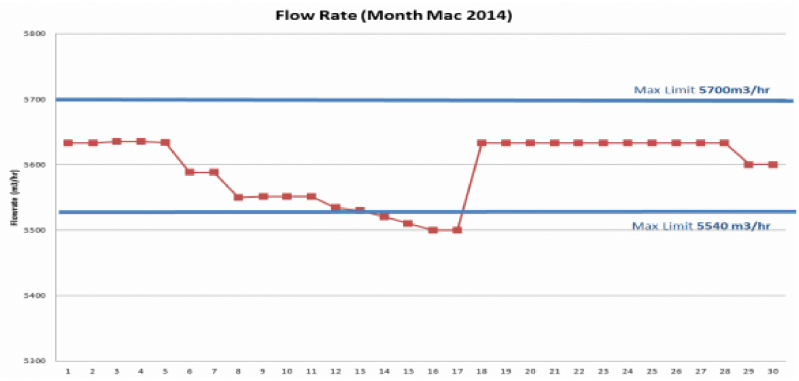
EXAMPLE

BAG FILTER PERFORMANCE MONITORING REPORT

MONTH : MAC 2014
BAG FILTER DUST COLLECTOR ID : BF07



Pressure Drop



Flow Rate

Summary

1) Pressure drop across limit/lower air flow rate start 12/3/2014 – finding filter bag choked. Replacement done on 17/3/2014 and bag filter running back on acceptable ranges.
2) Others corrective action taken for month Mac as per attached

Report prepared by:

Signature :……

Name of Competent Person : …….

CONVERSION FACTORS

Mass	1 kg	2.205 lb
	1 lb	0.4536 kg
	1 tonne	0.9842 tons
	1 ton	1.016 tonnes
Length	1 mm	0.03937 in
	1 in	25.4 mm
	1 m	3.281 ft
	1 ft	0.3048 m
	1 m	1.094 yd
	1 yd	0.9144 m
Area	1 mm^2	0.00153 in^2
	1 in^2	645.2 mm^2
	1 m^2	10.764 ft^2
	1 ft^2	0.0929 m^2
	1 m^2	1.196 yd^2
	1 yd^2	0.8361 m^2
Volume	1 mm^3	0.000061 in^3
	1 in^3	16 390 mm^3
	1 m^3	35.32 ft^3
	1 ft^3	0.0283 m^3
	1 m^3	1.308 yd^3
	1 yd^3	0.7646 m^3
Density	1 kg/m^3	0.06242 lb/ft^3
	1 lb/ft^3	16.02 kg/m^3
	1 $tonne/m^3$	0.7524 ton/yd^3
	1 ton/yd^3	1.329 $tonne/m^3$

Pressure	1mm WG	9.81 Pascal
	1 inch WG	249.17 Pascal
	1 mbar	100 Pascal
	1mbar	0.1 kPa
	1 mm HG	133.3 Pascal
	1 PSI	6894.75 Pascal

USEFUL FORMULA

1) $Q = A \times V \times 3600$

Where
Q = flow rate (m^3/hour)
A = area (m^2)
V = velocity (m/s)

2) $A = \frac{\pi D^2}{4}$

where
A = area (m^2)
$\pi = 3.142$
D = diameter (m)

3) $P = \pi D$,

where
P = perimeter (m)
$\pi = 3.142$
D = diameter *(m)*

DOE STATES

IBU PEJABAT JABATAN ALAM SEKITAR
KEMENTERIAN SUMBER ASLI DAN ALAM SEKITAR
ARAS 1-4, PODIUM 3, WISMA SUMBER ASLI
NO. 25, PERSIARAN PERDANA, PRESINT 4
62574 PUTRAJAYA

JABATAN ALAM SEKITAR NEGERI MELAKA
ARAS 19 MENARA PERSEKUTUAN
JALAN PERSEKUTUAN
BANDAR MITC HANG TUAH JAYA
75450 AYER KEROH

JABATAN ALAM SEKITAR NEGERI PAHANG
ARAS 1, KOMPLEKS MAHKAMAH KUANTAN
BANDAR INDERA MAHKOTA
25200 KUANTAN

JABATAN ALAM SEKITAR NEGERI SEMBILAN
TINGKAT 5, ARAB MALAYSIAN BUSINESS CENTRE
JALAN PASAR
70200 SEREMBAN

JABATAN ALAM SEKITAR W.P. KUALA LUMPUR
TINGKAT 1 & 2, WISMA SCA
NO.3 BATU 2, JALAN SUNGAI BESI
57100 KUALA LUMPUR

JABATAN ALAM SEKITAR NEGERI PERAK
TINGKAT 7 & 9, BANGUNAN SERI KINTA
JALAN SULTAN IDRIS SHAH
30000 IPOH

JABATAN ALAM SEKITAR NEGERI PULAU PINANG
ARAS BAWAH – ZON B
WISMA PERSEKUTUAN
SEBERANG PERAI UTARA
13200 KEPALA BATAS

JABATAN ALAM SEKITAR NEGERI SELANGOR
TINGKAT 12, 13, & 14 SUNWAYMAS
JALAN TENGKU AMPUAN ZABEDAH C 9/C, SEKSYEN 9
40100 SHAH ALAM

JABATAN ALAM SEKITAR NEGERI KEDAH
ARAS 2, MENARA ZAKAT
JALAN TELOK WAN JAH
05200 ALOR SETAR

JABATAN ALAM SEKITAR NEGERI JOHOR
WISMA JAS JOHOR
NO. 46, JALAN PERTAMA, TOWER 2
PUSAT PERDAGANGAN DANGA UTAMA
81300 JOHOR BAHRU

JABATAN ALAM SEKITAR NEGERI KELANTAN
LOT 322 - 324, SEKSYEN 27
JALAN SRI CEMERLANG
15300 KOTA BHARU

JABATAN ALAM SEKITAR NEGERI TERENGGANU
WISMA ALAM SEKITAR
OFF JALAN SULTAN OMAR
20300 KUALA TERENGGANU

JABATAN ALAM SEKITAR NEGERI PERLIS
TINGKAT 2, BANGUNAN KWSP
JALAN BUKIT LAGI
01000 KANGAR

JABATAN ALAM SEKITAR NEGERI SARAWAK
TINGKAT 7-9, WISMA STA NO. 26,
JALAN DATUK ABANG ABDUL RAHIM
93450 KUCHING

JABATAN ALAM SEKITAR NEGERI SABAH
ARAS 4, BLOK A KOMPLEKS PENTADBIRAN KERAJAAN
PERSEKUTUAN SABAH
JALAN UMS-SULAMAN, LIKAS
88450 KOTA KINABALU

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