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GUIDANCE DOCUMENT ON PERFORMANCE MONITORING OF INDUSTRIAL EFFLUENT TREATMENT SYSTEMS

Specified in Regulation 9 (a) Environmental Quality (Industrial Effluent) Regulations, 2009

DOE Headquarters
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FOR THE USE OF THE INDUSTRIES AND CONSULTANTS

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TABLE OF CONTENTS

FOREWORD

Performance monitoring of an industrial effluent treatment system (IETS) is a **proactive and preventive procedure** aimed at ensuring the IETS is optimally operated thus producing **quality effluent** at all times. If practiced vigorously by the industries, performance monitoring will enhance **regulatory compliance** and consequently result in enhancement of the **water quality** of our rivers.

This **Technical Guidance Document** fulfills the requirement on performance monitoring as stipulated in Regulation 9 (a) of the Industrial Effluent Regulations, 2009 (to be referred to as IERs). The procedure and specifications on performance monitoring of IETS (to be referred to as "criteria") described in this Guidance Document represent the **minimum criteria** that an owner of an industrial premise shall comply with. The owner of the industrial premise shall conduct monitoring of **additional process parameters** wherever deemed appropriate, to further assure all **unit operations** and **unit processes** are optimally operated and maintained, in order to produce compliant effluent on a continuous basis. The Guidance Document will be reviewed and updated from time to time.

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2009

LIST OF ABBREVIATIONS

BOD	Biochemical oxygen demand
COD	Chemical oxygen demand
DO	Dissolved oxygen
DOE	Department of Environment
F/M Ratio	Food to microorganism ratio
IETS	Industrial effluent treatment system
IERs	Industrial Effluent Regulations, 2009
MLSS	Mixed liquor suspended solids
MLVSS	Mixed liquor volatile suspended solids
OUR	Oxygen uptake rate
RAS	Return activated sludge
SOUR	Specific oxygen uptake rate
SS	Suspended solids
SVI	Sludge volume index
TIN	Total inorganic nitrogen
WAS	Waste activated sludge

LIST OF TABLES

LIST OF FIGURES

CHAPTER I - INTRODUCTION

Industrial effluents vary significantly in pollution characteristics, hence effluents from different industries require different **unit processes** and **unit operations** to treat them. It is in everyone's interest that the unit processes and unit operations in an industrial effluent treatment system (IETS) function optimally to achieve an effluent quality that continuously complies with the **discharge standards**. However, how does one monitor, maintain and ensure that the unit processes and unit operations of the IETS are occurring in an optimal condition and the IETS is optimally operated? Performance monitoring of IETS is the answer to the above question. Performance monitoring is the practical implementation of the "**maintenance culture**" that would assure the "**first class facility**" (i.e. the state of the art IETS) will always function effectively and efficiently. Consequently, the performance of the IETS is ensured on a **sustained basis** resulting in **improved corporate image** of the industries, **enhancement in water quality** and regulatory compliance. Since it was introduced in 2006 as a new requirement, industries which have implemented IETS perfomance monitoring have found it to be an effective tool for ensuring optimal perfomance of the IETS.

This document presents general considerations and procedure on performance monitoring so that effective monitoring program can be established for the various types of unit processes and operations found in an industrial effluent treatment system (IETS).

CHAPTER II - PURPOSE OF GUIDANCE DOCUMENT

In general, the Guidance Document is intended to promote the practice of **performance monitoring** as a routine activity and an integral part of the operation of an industrial effluent treatment system (IETS).

Specifically, the purpose of this Guidance Document is to stipulate:

- The **performance monitoring parameters** for major categories of IETS unit operations and unit processes commonly being employed to treat industrial effluents in Malaysia.
- The **sampling location, frequency of sampling and analysis** of the performance monitoring parameters.
- The **optimal range of values** for major performance monitoring parameters to be maintained for various unit operations and unit processes by the IETS operator or supervisor to ensure optimal operation of the IETS.
- The **record keeping requirements**.

Monitoring and recording of the IETS performance are required to demonstrate that the IETS is **functioning correctly** and the effluent standards are being **complied** with. Additionally, the Guidance Document also recommends useful practical procedure for performing **data analysis** and IETS **performance reporting format** that can be used by the IETS operator/supervisor to communicate with the factory management on IETS performance status. There is an urgent need to **mainstream** the environmental concern in general, and the monitoring of IETS performance status in particular, into the **factory management** and **decision making process**.

The procedure and specifications mentioned in the Guidance Documents represent the minimum that an industry shall comply with. In a particular situation, if deemed appropriate, the industry may monitor **additional parameters** in order to ensure closer monitoring of the IETS processes to achieve the desired effluent quality.

CHAPTER III - WHAT IS PERFORMANCE MONITORING?

Eventhough some industries are routinely conducting various tests to monitor the performance of the unit operations and unit processes which make up the effluent treatment system in their premises, by en large, the practice of **performance monitoring** of industrial effluent treatment system in many industries is an exception rather than the norm. Performance monitoring of an IETS can be understood to mean the **proactive and preventive monitoring** of all the major IETS components to ensure that each component is working properly and optimally operated as designed. This requires one to monitor certain **key process parameters** characteristic of the unit process or unit operation of the IETS on a **scheduled basis** to provide a diagnostic indication of the "health status" of the treatment processes.

Over the years, experience gained in different parts of the world shows that treatment processes within the IETS can be optimally controlled by maintaining certain key parameters within **certain ranges**. Performance monitoring concentrates on the processes within the IETS itself, not on the final effluent hence can be viewed as an "**upstream activity**" as opposed to compliance monitoring, focusing on the final effluent, which is a "**downstream activity**". Although performance monitoring includes the monitoring of the final effluent, it is not only the monitoring of the final effluent as misunderstood by some industries. Focusing only on the final effluent may lead to a "**too-late situation**" where things have gone out of hand and consequently difficult to control or get back on track.

In summary, IETS performance monitoring enforced through the Industrial Effluent Regulations, 2009 (IERs) is the "**maintenance culture in action**" in the field of industrial effluent treatment. It will develop **ownership** of the IETS among the IETS operating/ supervising team as well as ability to have a **control over the processes** occurring within the IETS. As a result, IETS performance will be enhanced and effluent quality ensured on a sustained basis.

CHAPTER IV - REGULATORY REQUIREMENTS ON PERFORMANCE MONITORING

The requirement on performance monitoring is stipulated in regulation **9 (a)** of the Industrial Effluent Regulations, 2009 (IERs). The industries are required to adhere to the procedure and specifications on performance monitoring stipulated in this document.

4.1 Deviation from Specified Procedure

Deviations from the procedure and specifications stipulated in this Guidance Document shall be allowed only if **documented evidence** can be substantiated to justify the use of more relaxed procedure without compromising the desired degree of **control** of the IETS unit operations or unit processes. The evidence shall be documented and kept for inspection by the DOE inspectors.

4.2 Performance Monitoring of Unit Operations and Unit Processes not Discussed in Guidance Document

The types of unit operations and unit processes of IETS discussed in this Guidance Document are not exhaustive. For those unit operations and unit processes which are not discussed, the IETS engineer/consultant shall decide on the following: the **key performance monitoring parameters** for the IETS treatment processes in question; the **sampling and monitoring frequency** of the parameters; and the **acceptable range of values** for the parameters for optimal IETS operation. In deciding the above details, the owner and the IETS process consultant shall be guided by the **industry standard best practices** for the treatment process, which shall be documented for the inspection by the DOE inspectors.

CHAPTER V – GENERAL CONSIDERATIONS ON PERFORMANCE MONITORING OF INDUSTRIAL EFFLUENT TREATMENT PROCESSES

A successful effluent treatment is dependent upon **all components** of the industrial effluent treatment system (IETS) being operational in optimal condition. Problems with any one of the system components will affect the overall efficiency of the IETS resulting in **poor effluent quality**. To ensure successful treatment and regulatory compliance, each of the treatment processes (i.e. **unit processes** and **unit operations**) shall be **closely monitored** on a regular basis.

5.1 Influent Monitoring

For successful IETS operation, routine **influent monitoring** is usually performed. At the minimum, the incoming raw effluent (i.e the influent to the IETS) shall be monitored for its **flow and quality**. Additionally, raw effluents from various major process/waste streams may also be monitored at several points within the factory. Influents are preferably sampled at points of highly **turbulent flow** in order to ensure good mixing.

5.2 Effluent Monitoring

The net result of the effectiveness of the all the unit operations and unit processes within the IETS is reflected in the quality of the **final effluent**. For performance monitoring, **flow measurement** shall be made and **effluent samples** at the final discharge point shall be collected for analysis. The quality of the final effluent shall comply with the discharge standards all the time. The requirements on final effluent monitoring are discussed in detail in chapter VIII.

5.3 Sampling Criteria

To assure smooth operation of an IETS, a **sampling and analysis plan** shall be established and adhered to. Among the criteria to be considered in sampling are:

(i) Samples taken must be **representative**
(ii) Location of sampling points must be **safe and easily accessible**
(iii) To minimize cost of analysis, the number of samples sent for laboratory analysis should be **kept to the minimum** without compromising the need for representativeness
(iv) Whenever possible and where it is not burdensome economically, **on-line continuous measurement** should be implemented.

For some parameters such as biochemical oxygen demand (BOD) and suspended solids (SS), instead of grab sampling, composite sampling may be used. A **grab sample** may be defined as an individual discrete sampling over a period of time not exceeding 15 minutes. It can be taken manually using a pump, scoop, pail, or automatically by using an automatic sampler. **Composite samples** from ponds with long detention times may not be representative. Convenience, accessibility and practicability are important factors but they must not be compromised with the need for **representativeness** of sampling. Preferably, samples shall be analyzed as soon as possible. If necessary, **preservation** protocols recommended in the Standard Methods shall be adhered to. Parameters such as pH, D.O. and temperature shall be measured **in-situ**.

5.4 Sampling Type, Location and Frequency

Table 5.1 summarizes the recommended sampling requirements for performance monitoring of an activated sludge system assuming that typically, for industrial effluent treatment, the IETS has an **equalization tank** but does not have a **primary clarifier**. **Secondary clarifier monitoring** includes the monitoring of the **clarifier effluent** (i.e., the final effluent) and "**the solids level**". There are several methods/equipment being used in practice for monitoring the clarifier sludge level, which include the sludge gun, core sampler and portable MLSS meter. Figure 5.1 illustrates a schematic diagram of a typical activated sludge system while Fig. 5.2 to 5.4 show the recommended sampling locations for the equalization tank, the aeration tank and the secondary clarifier, respectively.

Table 5.1: Recommended sampling requirements for an activated sludge system

Parameter	Sample location	Sampling station	Sample type	Sampling frequency
Equalization tank *				
Flow	Effluent	P1	Totalizer	Daily
BOD_5	Effluent	P1	Preferably composite	Weekly
COD	Effluent	P1	Preferably composite	Daily
pH	Effluent	P1	In-situ	Daily
TIN	Effluent	P1	Grab	Monthly
Aeration tank				
DO	Aeration tank, preferably at three locations	P2, P3, P4	In-situ	Daily
MLSS	Effluent**	P5	Grab	Daily
MLVSS (from MLSS analysis)	Effluent	P5	Grab	Weekly
SVI	Effluent	P5	Grab	Daily

Table 5.1 continued

pH	Aeration tank	Around P2	In-situ	Daily
SS of RAS	RAS line	P6	Grab	Daily
SS of WAS	WAS line	P7	Grab	Daily
Q_{RAS}	RAS line	P6	Totalizer	Daily
Q_{WAS}	WAS line	P7	Totalizer	Daily
F/M ratio***	-	-	-	Weekly
SOUR	Aeration tank at the effluent end	Around P4	Grab	Weekly
Microscopic examination	Effluent	P5	Grab	Weekly
Secondary clarifier******				
Sludge level/ blanket	Middle of clarifier	P8	Grab	Daily or several times daily
BOD_5	Effluent	P9	Preferably composite	Weekly
COD	Effluent	P9	Preferably composite	Daily
SS	Effluent	P9	Preferably composite	Daily
pH	Effluent	P9	In-situ	Daily
TIN	Effluent	P9	Grab	Monthly

Note:

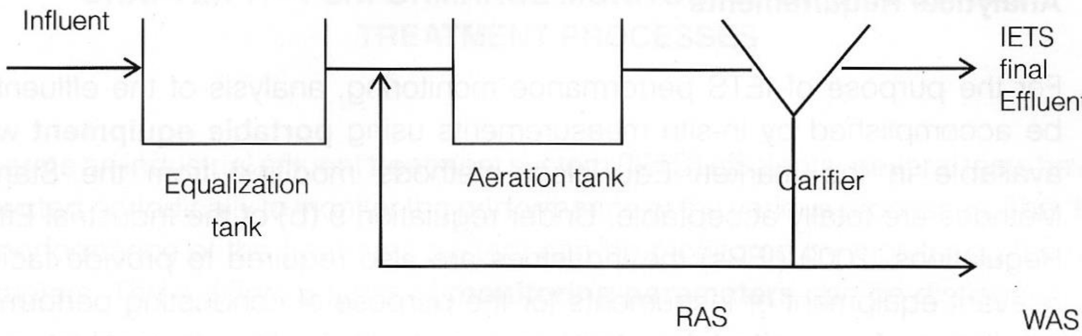
* If there is no equalization tank, take the samples of the influent (i.e. raw effluent).

** More than one sample and sampling from the aeration tank itself may be required if the aeration tank is long and narrow.

***F/M ratio is computed from BOD/COD influent and MLVSS data.

**** If there is no advanced treatment process, the clarifier effluent is the final effluent.

DO = dissolved oxygen; BOD = biochemical oxygen demand; COD = chemical oxygen demand; MLSS = mixed liquor suspended solids; MLVSS = mixed liquor volatile suspended solids; SVI = sludge volume index; RAS = return activated sludge; WAS = waste activated sludge, F/M ratio = food to microorganism ratio; SS = suspended solids; TIN = AN + nitrite + nitrate;



(Note: assume no primary clarifier and advanced treatment)
Fig 5.1: Schematic Diagram of a Typical Activated Sludge Process

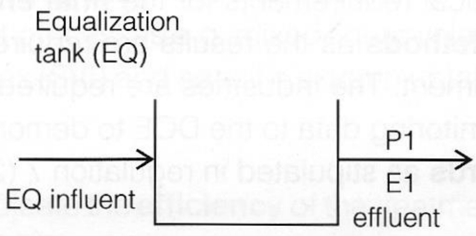


Fig 5.2: Sampling Location for the Equalization Tank

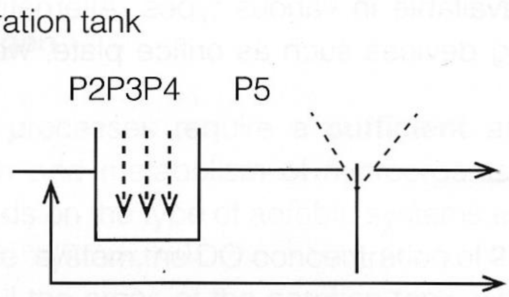


Fig 5.3: Sampling Location for the Aeration Tank

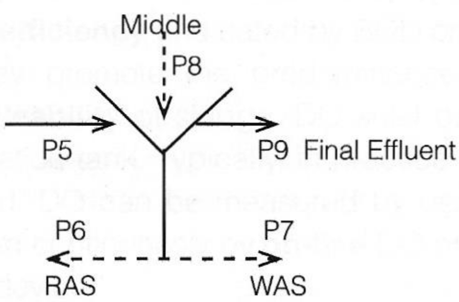


Fig 5.4: Sampling Location for the Secondary Clarifier

5.5 Analytical Requirements

For the purpose of IETS performance monitoring, analysis of the effluent can be accomplished by in-situ measurements using **portable equipment** widely available in the market. Equivalent methods modified from the Standard Methods are totally acceptable. Under regulation 9 (b) of the Industrial Effluent Regulations, 2009 (IERs) the industries are also required to provide facilities, relevant equipment or instruments for the purpose of conducting performance monitoring. An **on-site laboratory** equipped with facilities to conduct routine/ simple measurements and equipment calibration will go a long way to facilitate the conduct of IETS performance activities. Eventhough for the purpose of IETS performance monitoring, portable analytical equipment/equivalent methods are acceptable, the analytical requirements for the **final effluent samples** need to follow the **Standard Methods** as the results are required to be reported to the Department of Environment. The industries are required to maintain and submit monthly discharge monitoring data to the DOE to demonstrate **compliance** with the **discharge standards** as stipulated in regulation 7 (2) of the IERs.

5.6 Flow Measurement

Flowrate measurements of influent and effluent shall be made by the use of **flow meters** which are available in various types. Alternatively, where applicable, other flow measuring devices such as orifice plate, weirs and V notches can also be used.

CHAPTER VI - PERFORMANCE MONITORING OF BIOLOGICAL TREATMENT PROCESSES

To operate an industrial effluent treatment system (IETS) efficiently, several tests have to be conducted periodically to monitor the performance of the various processes. The "**health**" and performance of the treatment system can be monitored by monitoring the relevant parameters. Three different types of **monitoring parameters** can be distinguished:

(i) Parameters that are essential to ensure the biological process are **functioning** optimally such as pH, dissolved oxygen (DO), and nutrients.

(ii) Parameters that provide **diagnostic check** on the "health" status of the various unit operations and unit processes e.g. mixed liquor volatile suspended solids (MLVSS), sludge volume index (SVI) and specific oxygen uptake rate (SOUR) for an activated sludge process,

(iii) Parameters that indicate the **efficiency** of the treatment system such as biochemical oxygen demand (BOD) and chemical oxygen demand (COD).

The importance of the various parameters/tests is discussed briefly below.

6.1 Dissolved Oxygen

Biological unit processes require a **sufficient** amount of dissolved oxygen (DO) for growth and metabolism of microorganisms. The amount of oxygen required depends on the type of aerobic systems employed. For a conventional activated sludge system the DO concentration of **2.0 mg/L to 4.0 mg/L** shall be maintained in all the areas of the aeration tank, while for an extended aeration system, the value to be maintained shall be **4.0 mg/L to 6.0 mg/L**. For every IETS an **optimum DO concentration** depending on the type of microorganism and effluent characteristics can be evaluated by optimizing the DO concentration and the **removal efficiency** (indicated by BOD or COD). Oxygen limited growth environments may promote the predominance of **filamentous organisms** affecting the **settleability** of sludge. DO shall be measured in-situ at **several points** in the aeration tank. Typically, in practice three locations in the aeration tank are identified. DO can be measured by using a **portable** hand-held DO meter or measured continuously by **on-line** DO probe and transmitter equipped with a recording device.

6.2 pH

Monitoring of pH is important from several standpoints. The **optimum biological activity** of the microorganisms for the treatment process is in the pH range from 6.5 to 8.5. Besides that, a pH-value below 6.5 will be detrimental to concrete structures of the IETS and its components. pH shall be monitored preferably on a continuous basis, at the minimum at one location at **the influent end** of the aeration tank.

6.3 Mixed Liquor Suspended Solids and Mixed Liquor Volatile Suspended Solids

The mixed liquor suspended solids (MLSS) and mixed liquor volatile suspended solids (MLVSS) are commonly used to represent the **microorganisms** in biological treatment processes especially the activated sludge process. MLVSS is the **volatile fraction** of the MLSS. Solids analysis is important in the control of biological effluent treatment processes where the solids information is used in calculation of **food to microorganism ratio** (F/M ratio), **sludge volume index** (SVI), **recirculation ratio**, etc. In a long and narrow tank, samples for MLSS/ MLVSS measurements shall be taken from **three points**, namely close to the inlet (i.e. influent end) to the tank, in the middle and at the outlet (i.e. effluent end) of the tank.

Typically, the MLSS concentration shall be maintained within the range of 1500 to 3000 mg/L for a **conventional activated sludge** process and 3000 to 6000 mg/L for an **extended aeration activated sludge** process respectively,

6.4 Sludge Volume Index

The Sludge Volume Index (SVI) is used as an indicator of the **settling characteristics** of the sludge. The SVI values which show a trend towards poor settling can be an indictor for the onset of IETS experiencing upset conditions. SVI measurements also yield information which is used to establish the proper **recirculation ratio** for optimum process efficiency and maximum solids concentration in the waste sludge.

Poor settling sludge will result in the following outcomes: low concentration of solids in the return-activated sludge (RAS) hence a drop in MLSS and MLVSS concentration in the aeration tank. Consequently, the F/M ratio in the aeration tank increases which results in a reduced BOD/COD removal efficiency.

SVI can be computed from the settling test by using the following formula:

$$SVI = \frac{\text{settled sludge volume, mL/L} \times 1000}{\text{MLSS concentration, mg/L}}$$

The settled sludge volume is taken from the 30 min settling test.

SVI shall be measured routinely to monitor **sludge settleability**. A as a guide, typical SVI values indicating the settling characteristics of the sludge are given in Table 6.1 below.

Table 6.1: SVI values and sludge settling characteristics

SVI	Sludge settling characteristics
<50	Excellent
50-100	Good
100-150	Satisfactory
>150	poor-bulking of sludge

6.5 Nutrients

Many industrial effluents are **deficient in nutrients** hence to ensure adequate amounts of nutrients are supplied to the aeration tanks, **nutrient balance** shall be periodically checked. In terms of the basic nutrients of Nitrogen (N) and Phosphorus (P), the rule of thumb for the weight ratio of BOD_5: N: P to be maintained in the **influent** to the aeration tank should be approximately 100: 5: 1. Calculation of **nutrient availability** and **dosage** required shall be based only on **total inorganic nitrogen** (TIN= ammonia + nitrite + nitrate) and **ortho-phosphorus**. A practical method of checking for nutrient deficiency is to assure that at least 1.0 mg/L TIN and 0.5-1.0 mg/L ortho-phosphate remains in the aeration tank effluent at all times. Typical signs of nutrient deficiency are **filamentous growth** and **bulking** of activated sludge.

6.6 Oxygen Uptake Rate

Respirometry measures the **oxygen uptake** of microorganisms. The utilization of oxygen by the microorganisms indicates the **biological activity** occurring in the aeration tank and is interpreted to mean that the effluent is being biodegraded. **Specific Oxygen Uptake Rate** (SOUR) is the amount of oxygen per unit mass of the mixed liquor volatile suspended solids. A sudden rise in SOUR indicates an upsurge of **organic load** while a sudden decrease indicates a **toxic or pH shock**. SOUR shall be measured on a scheduled basis to monitor the biological activity in the aeration tank. SOUR can be computed from OUR by the following relationship:

$$SOUR = OUR/MLVSS$$

SOUR is expressed as mg of O_2 per liter per h per g of MLVSS.

Table 6.2 summarizes **typical SOUR values** and the corresponding **floc settling characteristics**.

Table 6.2: Typical range of SOUR values and corresponding floc properties.

SOUR, mgO_2/h per g. of MLVSS	Floc description, settling characteristic
> 20	dispersed floc; Settling Slow
12-20	Flocs forming; Settling normal
< 12	Pin Floc; Settling too fast

6.7 Food to Microorganism Ratio

Food to microorganism (F/M) ratio expresses the **amount of food** available to the **microorganisms** in the aeration tank. Insufficient amount of food or overdose of it will lead to **settling problems** in the clarifier. Food is represented by the **BOD or COD** while the number of microorganisms by the **MLVSS**. Either BOD or COD can be used to calculate the F/M ratio, but once one of them is chosen, it should be used throughout for comparative purposes. F/M ratio shall be determined on a regular basis for monitoring the activated sludge process. F/M ratio is calculated by using the following formula:

$$F/M = \frac{(COD, mg/L) \times (Q\ m^3/d)}{1{,}000 \times SI, kg}$$

Typical F/M ratios: are given in Table 6.3.

Table 6.3: Typical F/M ratios for different types of activated sludge process

Type of activated sludge system	F/M ratio, kg d^{-1}/kg MLVSS under aeration	
	BOD	COD
Conventional activated sludge	0.1 to 0.5	0.15 to 0.7
Extended aeration activated sludge	0.05 to 0.1	< 0.2

6.8 Microorganisms

There are different groups of microorganisms found in the activated sludge process. Because each of these groups **thrives best** under certain conditions, their presence or absence can be related to the degree of treatment, hence the **efficiency** of an IETS.

The **bacteria** are responsible for stabilization of most of the **organic matter** contained in the effluent and also for **floc formation** which helps in **sludge settling**. **Protozoa** can be used as an **indicator** of the efficiency the treatment process. Although protozoa themselves do not stabilize the organic matter in the effluent, they **feed on the bacteria** and this helps **clarify the effluent**. The presence of ciliated protozoa is indicative of an **efficient treatment process**. **Rotifers** are not commonly found in an activated sludge process. Their presence is indicative of a condition of very **low F/M ratio** or **high sludge age (old sludge)**.

Filamentous organisms are **problem organisms** in an activated sludge which cause problem of **sludge settling** resulting in carry over of solids in the clarifier effluent. The predominance of filamentous organisms which can be either bacteria or fungi, is usually the result of **low pH, low DO, or low nutrient levels**.

Weekly or preferably, **daily observation** of the microorganisms in the activated sludge sample is recommended to help detect the changes in the number of ciliated protozoa or the presence of rotifers.

6.9 Biological Oxygen Demand and Chemical Oxygen Demand

The **overall performance** of a biological treatment process in treating an organic effluent can be best monitored on the basis of either biological oxygen demand (BOD) or chemical oxygen demand (COD) or both. BOD test measures the amount of **biodegradable organic matter** in the effluent while COD measures all components which can be **oxidized** by potassium dichromate, the oxidizing agent used in the test. COD is a better IETS performance monitoring parameter because the test results can be obtained within 3-4 hours, compared to BOD_5 which requires 5 days. If necessary, changes to the operational characteristics of the IETS can then be made promptly, based on the COD test results. However, BOD values can be computed from **correlation relationship** between COD and BOD which can be established for a particular effluent.

6.10 Summary of Performance Monitoring Requirements for Biological Processes

Table 6.1 summarizes the **parameters** which shall be monitored, the **sampling points** and the **sampling frequency** to be complied with, to monitor the performance of the activated sludge process. This has been discussed earlier in chapter V. For other types of biological treatment systems such as the **upflow anaerobic sludge blanket** (UASB), the industry shall decide the details of the performance monitoring procedure to be implemented, based on experience and information in the literature. The procedure shall be documented for the inspection of the DOE inspectors.

CHAPTER VII - PERFORMANCE MONITORING OF PHYSICO-CHEMICAL PROCESSES

7.1 Metals Removal by Precipitation and Coagulation Reactions

Removal of metals by **precipitation** and **coagulation** reaction is heavily dependent on pH of the solution. The solubility of metals is controlled by the solution pH where the point of **minimum solubility** dictates the **narrow pH range** within which the precipitation process needs to be maintained. Once established, the pH shall be monitored and recorded, preferably on a continuous basis. The engineer in charge or supervisor of the coagulation / precipitation process shall determine if more frequent monitoring of the performance monitoring parameters is necessary, based on **industry best practices**.

7.2 Removal of Chromium by Two Stage Redox Reactions

Many of the chemical and the biochemical processes encountered in the treatment of industrial effluents can be described fundamentally as **oxidation-reduction** systems. Measuring and controlling **oxidation reduction potential** (ORP) levels is especially relevant in the treatment of industrial effluents involving an oxidation-reduction reaction such as treatment effluents containing **chromium**. Unit operations involving redox reactions are typically monitored by measuring the ORP level.

ORP is a measurement of the **status** of an oxidation-reduction reaction. Although it can be used to monitor the **degree of treatment** in the reaction tank, ORP values cannot be equated to a specific concentration of the metals such as chrome and therefore are not used as a **final discharge effluent standard**. Additionally, by monitoring pH/ORP, **chemical usage** can be optimized resulting in cost savings.

In the field of industrial effluent treatment ORP measurement has been be utilized successfully to monitor **cyanide oxidation** and **chromate reduction**. The ORP measurement can be made electrometrically using the millivolt mode of a pH meter.

In the treatment of effluents containing chromium, in the first stage, the **hexavalent chromium** is reduced to trivalent chromium by the addition of sodium bisulfate or sulfur dioxide. In the second stage, the **trivalent chromium** is precipitated as **chromium hydroxide**. The conditions to be maintained in both reaction tanks are given in Table 7.1. The pH and ORP in the reaction tanks shall be maintained and their values recorded. The engineer in charge or supervisor of the IETS shall determine if additional monitoring of the performance monitoring parameters is required based on **industry best practices**.

Table 7.1: Conditions to be maintained for two stage chromium removal by oxidation-reduction process

	First Tank	Second Tank
pH	2 – 3	8 - 9
ORP	+ 250 mV to + 300 mV	-

7.3 Treatment of Cyanide Waste by Two Stage Alkaline Chlorination

Dilute cyanide effluent streams are typically treated by a two stage process, commonly known as **alkaline chlorination**. In the first stage, the cyanide is oxidized to **cyanate** by the use of hypochlorite solution. In the second stage, through the addition of additional hypochlorite, the cyanate is oxidized to **carbon dioxide**. The conditions to be maintained in the reaction tanks are given in Table 7.2. The values of pH and ORP shall be monitored and recorded. The actual number of daily measurements of the performance monitoring parameters shall be based on **industry best practices**.

Table 7.2: Conditions to be maintained for two stage alkaline chlorination of cyanide

	First Tank	Second Tank
pH	> 10, preferably 11.0 to 11.5	~ 8.5
ORP	+ 325 mV to + 400 mV	+ 600 mV to + 800mV

7.4 Removal of Metals by Ion Exchange

A metal-laden effluent that will undergo an ion exchange process is commonly collected in a buffer tank where **pH adjustment** may be carried out. The subsequent process of ion-exchange operations are usually monitored by monitoring **conductivity**. In practice, more accurate control can be achieved by using **conductivity ratio** measurement. Comparison of **conductivity, pressure difference and metals concentration** at the column's inlet and outlet and within the column will enable one to detect the onset of **breakthrough**, hence the need for **column regeneration**.

pH shall be monitored and recorded if pH adjustment is an integral part of the ion exchange system. The record of other parameters used to detect the breakthrough point shall also be maintained for the inspection of DOE's inspectors. The engineer in charge or supervisor of the IETS shall determine if additional monitoring of the performance monitoring parameters is required based on **industry best practices**.

7.5 Removal of Metals by Electowinning

Electrowinning is an **electrochemical process** that can be employed to remove metallic ions from concentrated **rinse water, spent process solutions**, and **ion exchange regenerant**. An advantage of electrowinning is that the metal removed from the effluent is plated out as a **solid metal**. Sometimes, to enable automated system operation and ensure consistent environmental performance, the electowinner is equipped with an **on-line metal sensor** to provide real-time monitoring of the concentration of the metal to be removed. To monitor the efficiency of the electrowinning process, other parameters monitored may include **current, voltage** and **temperature**. The parameters chosen to monitor the operation of the electrowinner shall be identified and the record of the monitoring of the parameters shall be maintained for the inspection of DOE's inspectors. Based on **industry best practices**, the engineer in charge of the electrowinner shall determine if more frequent monitoring is required.

7.6 Removal of Various Contaminants by Carbon Adsorption

The adsorption process in a carbon column will continue until the capacity of the carbon is reached (the **breakthrough time**). This time should be closely monitored to ensure that the carbon is **replaced** or **regenerated** before the stipulated time. The breakthrough time of carbon beds can be determined via several ways such as:

(i) By sampling of effluent from the column and monitoring the **concentration of pollutants** of interest (e.g. COD)
(ii) By consideration of the **hours of operation** of the column
(iii) By using total **volume of throughput**.

The parameters chosen to monitor the operation of the carbon column shall be identified and the record of the monitoring of the parameters shall be maintained for the inspection of DOE's inspectors. The engineer in charge or supervisor of the adsorption column shall determine whether more frequent monitoring of the performance monitoring parameters is required based on **industry best practices**.

7.7 Summary of Performance Monitoring Requirements for Physico-Chemical Processes

Table 7.3 presents a summary of the performance monitoring parameters which are typically monitored in the operation of common physico-chemical treatment processes.

Table 7.3: Recommended performance monitoring requirements for physico-chemical treatment processes

Process	Test/Check	Frequency	Remarks
Chemical Precipitation	Flowrate	Daily	
	pH	Daily	
	Chemical dosage system	Daily	- To calculate the chemical dosage - To ensure it's working properly
	Metals (If process is for metals removal)	Daily	Influent & effluent
Oxidation/ Reduction	Flowrate	Daily	
	pH	Daily	
	ORP	Daily	
	Chemical dosage system	Daily	- To calculate the chemical dosage - To ensure it's working properly
	Metals	Daily	Influent & effluent
	COD, if relevant	Daily	Influent & effluent
Dissolved Air Flotation (DAF)	Recirculation flowrate	Daily	
	Pressure	Daily	
	Air flowrate	Daily	
Ion Exchange[(a)]	Flowrate	Daily	
	Metals (the relevant ones)	Weekly or daily; more frequent as breakthrough is approached	Influent & effluent
	Pressure difference	Daily	
Electrowinning	Flowrate	Daily	
	Current	Daily	
	Voltage	Daily	
	pH	Daily	
	Temperature	Daily	
	Metal (the relevant one)	Per batch (if batch process)	Influent & effluent

Table 7.3 continued

Carbon Adsorption[(a)]	Flowrate	Daily	Influent & effluent
	Contaminant to be removed (e.g. COD)	Daily; more frequent as breakthrough is approached	
	Pressure difference	Daily	

Note: (a) Additionally, the operator has to be mindful of the **breakthrough time** of the carbon column (based on throughput or hours of operation or contaminant concentration). Processes listed in the Table 7.3 are not exhaustive. This is a minimum sampling guide and is subject to change with plant site, complexity of operation, and problems encountered.

CHAPTER VIII - MONITORING OF FINAL EFFLUENT

Many industries are currently performing sampling and analysis of the final effluent on a **monthly** or **bimonthly basis**. Some industries may conduct more frequent sampling, even on a daily basis. Typically, the whole set of 23 parameters listed in the Third Schedule of the Sewage and Industrial Effluents Regulations (now repealed) are analyzed. This Guidance Document stipulates that industries shall perform **weekly sampling** of the final effluent but only **significant parameters** are required to be analyzed. Significant parameters relevant to the industry's operation shall be determined based on the **raw materials** used and the **manufacturing process** utilized by the industry. Experience from **similar industries** and information from the **literature** will also be useful in identifying the significant parameters. Table 8.1 gives a guide on the significant parameters for different categories of industries.

For **batch discharges**, the effluent to be discharged shall be sampled for **each batch** to ensure **compliance** with the discharge standards before the discharge is allowed. Analysis shall be performed on relevant/significant effluent parameters which can be performed within a relatively short period using rapid measurement techniques. Such parameters typically include pH, COD and metals. The **name of the responsible industry personnel** authorizing the discharge, the **time of discharge** and the **discharge quantity and quality** shall be recorded for the inspection by the inspectors of the Department of Environment.

For ease of reference, the monthly discharge monitoring report as stipulated in the Tenth Schedule to the Industrial Effluent Regulations, 2009 (IERs) is reproduced in Appendix L. The requirement on submission of **monthly discharge data** stipulated in regulation 7 (3) of the IERs is applicable to **continuous discharges** as well as **batch discharges**. As an additional requirement, batch discharges are required to maintain discharge data every time a batch discharge is made as explained in the previous paragraph. Appendix M is a format for recording batch discharges.

Table 8.1: Priority effluent parameters for different industries

Industry Type	Common Priority Parameters
Chlor-Alkali (Mercury Cell)	T, pH, SS, Chlorine, Mercury, Chlorides
Chlor-Alkali (Diaphragm Cell)	T, pH, SS, Chlorine, Chlorides
Metal Finishing and Electroplating	T, pH, SS, O&G, Arsenic, Cadmium, Chromium (trivalent), Chromium (hexavalent), Lead, Nickel, Mercury, Silver, Zinc, Fluorides, Cyanides-depending on the metals involved
Fertilizer (Nitrogenous)	T, pH, SS, Ammoniacal nitrogen, COD
Fertilizer (Phosphate)	T, pH, SS, Ammoniacal Nitrogen, COD, Fluoride

Table 8.1 continued

Pulp and Paper	T, pH, BOD_5, COD, SS, Sulfides
Petroleum Refining	T, pH, BOD_5, COD, SS, O&G, Phenolic compounds
Steel Industry	T, pH, COD, SS, Chromium (trivalent), Iron, O&G, Cadmium, Copper
Synthetic Fiber	T, pH, BOD_5, COD, SS, O&G, Sulfides
Tanning and Leather Finishing	T, pH, BOD_5, COD, SS, Sulfide, O&G, Chromium (trivalent), Chromium (hexavalent), Phenolic compounds
Textile Processing	T, pH, BOD_5, COD, SS, Chromium, Copper
Pigments and Dyes	T, pH, COD, Lead, Copper, Zinc
Thermal Power Plants	T, pH, SS, O&G
Rubber Products	BOD_5, COD, Zinc, Chromium, SS
Paints, Varnishes & Lacquers	pH, SS, COD, Lead, Chromium, Cadmium, Zinc, Barium
Pesticides	COD, Mercury
Printing	COD, Lead
Industrial Chemicals	pH, COD, Phenolic Compounds, Cyanide, Cadmium, Lead, Chromium, Mercury, Nickel, Zinc, Arsenic, pH, SS, Ammoniacal nitrogen,
Oil & Gas Production	T, pH, BOD_5, COD, SS, O&G, Chloride, Phenolic compounds
Petrochemicals	T, pH, BOD_5, COD, SS, O&G, Phenolic compounds
Dairy Industry	T, pH, BOD_5, COD, SS, O&G
Fruit and Vegetable Processing	T, pH, BOD_5, COD, SS
Food and Beverage	T, pH, BOD_5, COD, SS, O&G
Glass Manufacturing	T, pH, COD, SS, Barium, O&G
Sugar	T, pH, BOD_5, COD, SS, O&G
Detergent	pH, COD, O&G, An-ionic Detergent
Photographic	pH, COD, Silver, Cyanide, Fluoride
Glue Manufacture	pH, BOD_5, COD, Phenolic compounds, Formaldehyde
Oil & Gas Exploration	T, pH, COD, SS, O&G, Chloride, BOD_5, Phenolic compounds
Vegetable Oil Mills	T, pH, BOD_5, COD, SS, O&G
Plastic Materials and Products	SS
Wood Products	pH, SS, COD, Phenolic compounds
Pharmaceutical	T, pH, BOD_5, COD, SS

Note: List not exhaustive; AN = Ammoniacal nitrogen; SS = suspended solids; COD = Chemical oxygen demand; BOD = Biochemical oxygen demand O&G = Oil and grease; T = Temperature

CHAPTER IX - RECORD KEEPING FORMATS

Industries are required to maintain the record of **performance monitoring data** and **corrective actions** taken to address **upset conditions** encountered in the daily operation of the industrial effluent treatment systems. Appendices A to J are recommended tables to be used for recording performance monitoring data of the industrial effluent treatment systems while Appendix K is the recommended table for recording corrective actions taken by the industry to address upset situations. The records should be kept in a **log** or in a **dedicated file** and made available for the inspection of the officers of the Department of Environment (DOE) during their enforcement duties.

All the tables can be **modified** to suit individual situations and requirements as long as the data on essential performance monitoring parameters are captured and can be made available for inspection.

In case where performance monitoring parameters are monitored by **on-line sensors**, the records and summaries of the data shall be maintained and made available for inspection by the DOE inspectors.

CHAPTER X - ANALYSIS OF PERFORMANCE MONITORING DATA

This chapter is dedicated to the **analysis of the data** obtained from the performance monitoring activities. The methods of data analysis discussed in this chapter is only a **recommended procedure** to assist the operators or supervisors on how to tabulate, interpret and present data to the factory management in a systematic and technically acceptable fashion. The industry personnel who are in charge of the analysis of the IETS performance data are at liberty to adopt any other methods that suit their requirements and style.

10.1 From raw data to descriptive statistics

The data that have been obtained from the performance monitoring activities fall into two different categories, namely "**direct measurements**" and "**computed data**". Direct measurements include data on flowrate, pH, temperature, DO, MLSS, MLVSS, BOD, COD, SV_{30}, N and P. These data are obtained either from equipment readings, field tests, flow readings or measurements or laboratory tests. Computed data include SVI, OUR, SOUR. F/M, Q_{RAS}, Q_{RAS}/Q, HRT, Solids Inventory, and Waste Sludge.

The next important step is to transform the "**raw data**" that have been collected through IETS performance monitoring activities into some **useful information**. One means for effective interpretation of the raw data is through **statistical analysis**. **Descriptive statistics** help us to simply summarize large amounts of data in a sensible way. Each descriptive statistic reduces lots of data into a simple summary. Descriptive statistics can include **graphical summaries** that show the spread of the data, and **numerical summaries** that either measure the **central tendency** of a data set or that describe the **spread** of the data. Graphical summaries include the **histogram**, **dispersion graphs** and **trend charts** while measures of central tendency are commonly reported as the **mean**, **median**, and **mode**. Today with the advancement in computers, statistical analysis can easily be performed by using **statistical packages** which can produce results quickly and will minimize the chance of errors.

10.2 Comparing the computed statistics with the recommended ranges

The statistics computed earlier must be presented in a suitable format for reference, ease of comparison, and effective communication with the superiors. The recommended table by which the **computed statistics** can be presented is shown in Table 10.1. The **means** of the performance monitoring data which include data on pH, dissolved oxygen, MLSS, MLVSS, BOD, COD, nutrients, SVI, OUR, SOUR SV_{30}, SVI, F/M, Q_R, Q_R/Q, HRT, Solids Inventory, Waste Sludge as well as the **recommended ranges** are tabulated in this table. Any parameter whose means fall outside the recommended ranges is easily noticed, thereby

prompt attention can be given. Sometimes, the situation calls for immediate **corrective action** to be taken. In other situation, it calls for **further investigation** to determine or confirm the cause of the problem. Whatever the circumstances are, for the most part, prompt action is necessary in order to avoid effluent noncompliance problems.

10.3 Trend charts

Trend charts can be easily plotted by using a **statistical package** commonly available on a personal computer. Trend charts of various parameters such as F/M ratio, D.O., MLSS, WAS, RAS, influent BOD or COD, effluent BOD or COD, and sludge age versus time can be plotted to evaluate process control performance.

10.4 Summary reports

It is highly recommended that a **summary report** is prepared to summarize the status of IETS performance based on the descriptive statistics that have been tabulated in Table 10.1. An example of such a report is illustrated in Appendix N, which can be regularly submitted to the IETS performance monitoring committee or to the factory management.

Table 10.1: Daily Performance Monitoring Test Results

Type of process: Conventional Activated Sludge System
Operator's name: ....
Supervisor's name: ....
Shift number: ....
Date sample taken: ....

Sampling Location	Test Parameter	Unit	Mean	Reference Range
1.Influent/ Equalization tank	Flowrate, Q	m^3/d		Design Value[a]
	BOD_5 or COD	mg/L		Design Value[a]
	pH	-		Actual Condition[b]
	T	°C		Actual Condition[b]
	TIN	mg/L		Actual Condition[b]
	P	mg/L		Actual Condition[b]
	BOD:TIN:P	m		100:5:1
2.Aeration Tank	BOD_5 or COD	mg/L		Design value
	MLSS	mg/L		(1500-3000)[c]
	MLVSS	mg/L		(1200-2400)[d]
	DO	mg/L		(2.0-4.0)[e]
	OUR	mg O_2/(L.h)		
	SOUR	mg O_2 / h per g MLVSS		(8-20)[f]
	pH	-		6.5-8.5
	SV_{30}	mL		
	SVI	mL/g		(50-100)[g]
	F/M	kg/(kg.d)		Based on COD: 0.15-0.7
	Q_{RAS}	m^3/d		
	Q_{RAS}/Q	%		(15-150)[i]
	HRT	h		
	Q_{WAS}	m^3/d		
3.Secondary Clarifier	BOD_5 and COD	mg/L		Standard A or B
	SS	mg/L		Standard A or B
	pH	-		Standard A or B
	Overall BOD_5 Removal	%		
	Sludge level	m		
	TIN	m/gL		1.0
	P	m/gL		0.5 -1.0

Note:
TIN = ammonia + nitrite + nitrate
P as ortho phosphate

a. Considered at design stage of IETS.
b. Depends on the actual condition of the incoming effluent
c. Typical values for conventional activated sludge process;
d. Depends on type of organic effluent. MLVSS is assumed to be 80% of MLSS
e. D.O. typically, 2-4 mg/L for conventional activated sludge and 4-6 mg/L for extended aeration .
f. Compute OUR and SOUR from DO vs Time graph
g. SVI= 50-100: Good
h. Conventional: 15%-100%; Extended aeration: 50%-150%

Discharge standards: [BOD_5: 20,Standard A], [SS: 50,Standard A], [pH: 6-9,Standard A], [Temperature: <40]

CHAPTER XI - MAINSTREAMING OF IETS PERFORMANCE MONITORING

The Department of Environment commends the **exemplary practice** of some industries which pay a serious attention to the monitoring of IETS performance by having established a **permanent committee** or a **management procedure** to oversee and review their IETS performance on a scheduled basis. In these industries, it is a routine ritual where the IETS performance status is reported and discussed on a daily basis or even between shifts. In these industries, IETS operational matters have been integrated into the industry's mainstream operational procedures. In this Guidance Document DOE is encouraging and advocating other industries to follow in the footsteps of these commendable industries to set up permanent procedure or committee to which IETS performance is reported on a routine basis. This will help mainstream monitoring of IETS performance in particular and environmental agenda in general into the industry's **management and decision making process**. When IETS performance has become an integral part of the industry's business process, IETS performance is regularly reported and brought to the attention of the top management thereby ensuring IETS performance and regulatory compliance on a sustained basis. The industry's business plan will not be stalled and corporate image not marred due to poor environmental performance.

CHAPTER XII - CONCLUSION

Performance monitoring is a **proactive and preventive approach** to managing a certain system. The concept of performance monitoring as a part and parcel of preventive maintenance is a logical and easy to understand concept that is being practiced widely in other fields. The practice of performance monitoring of IETS is promoted and enforced through the Industrial Effluent Regulations, 209 (IERs) to assist the industries to develop skills and expertise in **monitoring and controlling the IETS processes** thereby ensuring **compliant effluents** at all times. Rigorous implementation of IETS performance monitoring which is embedded into the day to day operation of the IETS is a win-win strategy for all, resulting in the **improvement in regulatory compliance** and the **enhancement of water quality** of our rivers.

The specifications in this guidance document represent the minimum requirements for conducting performance monitoring of IETS, to be complied with by the industries. However, the DOE assumes no responsibility for the accuracy, adequacy, or completeness of the concepts, methodologies, or protocols described in this document. The owner shall take additional measures where deemed appropriate, to further ensure compliance with the effluent discharge standards stipulated in the IERs. Compliance with the regulatory requirements and standards is solely the responsibility of the industries.

REFERENCES

American Public Health Association. *Standard Methods for the Examination of Water and Wastewater*. 20th Edn. 1998

Associated Water and Air Resource Engineers, Inc. *Handbook for Industrial Wastewater Monitoring*. U.S. Environmental Protection Agency, Technology Transfer, August 1973.

Black, H.H. *Procedure for Sampling and Measuring Industrial Waters*. Industrial Wastes, 24:45, January, 1992.

Drobny, N.L. *Monitoring for Effective Environmental Management*. Proc. ASCE National Water Resources Engineering Meeting. Atlanta, Georgia, January 24-28, 1972.

Gunnerson, C.G. *Optimizing Sampling Intervals*. Proc. IBM Scientific Computing Symposium, Water and Air Resources Management. White Plains New York, 1968.

Harris D.J. and W.J. Keefer. *Wastewater Sampling Methodologies and Flow Measurement Techniques*. EPA 907/9-74-005, U.S. Environmental Protection Agency, Region VII, 1974. 117 pp.

Henderson, F.M. *Open Channel Flow*. MacMillan Co., New York. 1966.

Jenkins, D., Richard, M. G. and Daigger, G. *Causes and Control of Activated Sludge Bulking and Foaming*, 2nd Edn. Lewis Publishers. Boca Raton, FL. 1993

Montgomery, H.A.C. and I.C. Hart. *The Design of Sampling Programs for rivers and Effluents*. Water pollution Control (London, England), 73: 77-98, 1974.

Pakistan Environmental Protection Agency. *Sampling Procedure for Municipal and Industrial Effluent*. No. EPA/Clean/SP1001/Rev 0/98 Central Laboratory for Environmental Analysis

Rabosky, J.G. and D.T. Koraido. *Gaging and Sampling of Industrial Wastewaters*. Chemical Engineering, 80p. 111-120, January 8, 1973

Shamsudin Ab Latif. 2002. *Decolorization of Textile Wastewaters Using Peat-Activated Sludge Process*. Doctoral Dissertation Submitted to Tulane University, New Orleans..

Shelley, P.E. and G.A. Kirkpatrick. *An Assessment of Automatic Sewer Flow Sample*. Prepared for the Office of Research and Monitoring, U.S. Environmental Protection Agency, Washington, D.C. 20460, EPA R2-76-261 June 1973.

Tarazi, D.S. *Comparison of Wastewater Sampling Techniques.* J.W.P.C.F.. 42 pp. 708-732 May 1970.

URS Research Co. *Procedure for Evaluating Performance of Wastewater Treatment Plants.* PB 228 849/6, National Technical Information Services Springfield, Virginia.

Water Monitoring Task Force. R.L. Crim, (ed.), *Model State Water Monitoring Program.* U.S. Environmental Protection Agency, Office of Water and Hazardous Materials, Washington, D.C. EPA-440/9-74-002.

Appendix A

Record of Performance Monitoring Data of Equalization Tank (or influent/raw effluent)

Date:…………; Month:………………..

Time/Date*	Flow rate, m^3/h	Total flow, m^3/d	BOD_5, mg/L	COD, mg/L	pH	TIN	Remarks	Signature**

Notes:

For frequency of sampling and analysis, refer to Table 5.1

*Choose which ever is applicable

**Signature of operator or supervisor

Appendix B

Record of Performance Monitoring Data of Aeration Tank

Date:…………; Month:…………………

Time/ Date*	MLSS, mg/L	MLVSS, mg/L	SVI mL/mg	pH	SS of RAS, mg/L	SS of WAS, mg/L	Q_{RAS}, m^3/d	Q_{WAS}, m^3/d	F/M, kg d^{-1}/kg	SOUR, mg/(g.h)	Signature**

Notes:

For frequency of sampling and analysis, refer to Table 5.1

*Choose which ever is applicable

**Signature of operator or supervisor

Appendix C

Record of Performance Monitoring Data of Clarifier

Date:…………; Month:…………………

Time/Date*	Sludge level, m	BOD_5, mg/L	COD, mg/L	TSS, mg/L	pH	TIN, mg/L	Signature**

Notes:

For frequency of sampling and analysis, refer to Table 5.1

*Choose which ever is applicable

**Signature of operator or supervisor

Appendix D

Record of Performance Monitoring of Metals Removal via Chemical Precipitation Process

Date:............; Month:...................

Date/Time*	pH	Metal , mg/L		Checking of dosage system and general remarks	Signature**
		In	Out		

Notes:

The engineer in charge shall determine if more intense monitoring is required based on industry best practices. .

*Choose which ever is applicable

**Signature of operator or supervisor

Appendix E

Record of Performance Monitoring of Chromium Treatment via Two Stage Redox Reaction

Date:............; Month:.....................

Date/Time*	First tank		Second Tank	Chromium**, mg/L		Checking of dosage system and general remarks	Signature***
	pH	ORP, mV	pH	In	Out		

Notes:

The engineer in charge shall determine if more intense monitoring is required based on industry best practices.

*Choose which ever is applicable

** If chromium is monitored as a performance monitoring parameter

***Signature of operator or supervisor

Appendix F

Record of Performance Monitoring of Cyanide Treatment via Two Stage Alkaline Chlorination

Date:...........; Month:...................

Date/Time*	First tank		Second Tank		Cyanide**, mg/L		Checking of dosage system and general remarks	Signature***
	pH	ORP, mV	pH	ORP, mV	In	Out		

Notes:

The engineer in charge shall determine if more intense monitoring is required based on industry best practices.

*Choose which ever is applicable

** If cyanide is monitored as a performance monitoring parameter

***Signature of operator or supervisor

Appendix G

Record of Performance Monitoring of Ion Exchange Process

Date:...........; Month:....................

Date/Time*	Flow rate m³/h	Flow throughput, m^3	Pressure difference** psi or kPa	Metals,** mg/L		General remarks	Signature ***
				In	Out		

Notes:

The engineer in charge shall determine if more intense monitoring is required based on industry best practices.

*Choose which ever is applicable

** Depends on the parameters chosen to monitor the process

***Signature of operator or supervisor

Appendix H

Record of Performance Monitoring of Ion Dissolved Air Flotation

Date:............; Month:.....................

Date/Time*	Flow rate** m^3/h	Recirculation Flow** m^3/h	Pressure,** psi or kPa	General remarks	Signature ***

Notes:

The engineer in charge shall determine if more intense monitoring is required based on industry best practices.

*Choose which ever is applicable

** Depends on the parameters chosen to monitor the process

***Signature of operator or supervisor

Appendix I

Record of Performance Monitoring of Carbon Adsorption Column for Removal of COD

Date:...........; Month:...................

Date/Time*	Flow rate** m^3/h	Flow throughput**, m^3	Pressure difference** psi or kPa	COD,** mg/L		General remarks	Signature ***
				In	Out		

Notes:

The engineer in charge shall determine if more intense monitoring is required based on industry best practices.

*Choose which ever is applicable

**Depends on the parameters chosen to monitor the process

***Signature of operator or supervisor

Appendix J

Record of Regeneration of Ion Exchange or Carbon Adsorption Column

Date:…………; Month:……………….

Date	Regeneration Site		If offsite, mention name and address of company conducting regeneration	Signature*
	Onsite	Offsite		

Notes:
*Signature of operator or supervisor

Appendix K

Record of Corrective Actions Taken to Address Upset Conditions

Date:............; Month:...................

Date/Time*	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	Signature**

Notes:

*Choose which ever is applicable

**Signature of operator or supervisor or manager

Appendix L

TENTH SCHEDULE
[Subregulation 7(2)]

MONTHLY INDUSTRIAL EFFLUENT OR MIXED EFFLUENT DISCHARGE MONITORING REPORT

SECTION I

IDENTIFICATION

1. (i) Name and address of premises:............

Telephone number:...................Fax number:............................

(ii) File reference number (if applicable): ....

2. (i) Name and address of accredited analytical laboratory:.............

Telephone number:...................... Fax number:.................................

(ii) Name of analyst: ....

3. (i) Reporting year:..........................

(ii) Reporting month: ....

SECTION II

INFORMATION ON INDUSTRIAL EFFLUENT OR MIXED EFFLUENT

4. (i) Flowrate*

Minimum:...............m^3/d, Maximum :............ m^3/d

(ii) Quality of effluent discharged (unit in mg/L)

Parameter **	First Week Date:.........	Second Week Date:..........	Third Week Date:...........	Fourth Week Date:..........
Temperature				
pH Value				
BOD_5 at 20°C				
Suspended Solids				
Mercury				
Cadmium				
Chromium, Hexavalent				
Arsenic				
Cyanide				
Lead				
Chromium, Trivalent				
Copper				
Manganese				
Nickel				
Tin				
Zinc				
Boron				
Iron				
Silver				
Aluminium				
Selenium				
Barium				
Fluoride				
Formaldehyde				
Phenol				
Free Chlorine				
Sulphide				
Oil and Grease (n-hexane extract)				
Ammoniacal Nitrogen				
Colour***				

*The flowrate and concentration of industrial effluent or mixed effluent at the point of discharge as determined in accordance with the sampling procedure and method of analysis as specified in regulation 8.

**Choose only the significant parameters.

***ADMI unit

SECTION III

DECLARATION

I, ...hereby declare that all information given in this form is to the best of my knowledge and belief true and correct.

Signature of responsible person: ....

Name:.............................

Designation: ....

Date : ....

(Affix official seal or stamp of the company)

Appendix M

RECORD OF DAILY BATCH DISCHARGE

Year:.................Month....................

Date	Time of discharge	Discharge volume, m^3	Significant discharge parameters	Discharge quality*, mg/L	Name and signature of responsible person**

Note

* On-line measurement or via rapid assessment method.

** Responsible person is the person authorizing the discharge.

Appendix N

Example of Summary report

Summary Report:

Findings

Based on the performance monitoring conducted from ....to.........and the data collected which were plotted for trend analysis and statistically analyzed, the following conclusions can be made about the IETS operation:

(a) The IETS was functioning in good operating condition with an overall BOD_5 removal efficiency of ....
(b) The operational parameters of SVI, OUR, SOUR, ...were all within the recommended ranges.
(c) The mean DO level of....... mg/L in the aeration tank was slightly on the low side
(d) The N:P ratio of .... was a little out of range on the low side.
(e) The final effluent BOD_5 complied with the stipulated Standard A except for a period of ..... days which marginally exceeded the Standard.

Recommendations

(a) The cause for the low DO in the aeration tank needs to be investigated and corrected promptly.
(b) The N:P ratio which was out of range needs to be further investigated. Measurements may be repeated to ascertain this finding immediately.

This Guidance Document was authored by Prof. (adj) Dr. Ir. Shamsudin Ab Latif, Deputy Director General (Development), Department of Environment, Malaysia with contribution from Dr. Ahmad Kamarul Najuib Che Ibrahim, Director, Department of Environment (Pahang), Malaysia.

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