Book 3

Technical Guidance Document Series Number: DOE-IETS-3

TECHNICAL GUIDANCE ON COMPLIANCE INSPECTION OF INDUSTRIAL EFFLUENT TREATMENT SYSTEMS

DOE Malaysia
First Edition:
December 2006

FOR THE USE OF
THE OFFICERS OF THE DEPARTMENT
OF ENVIRONMENT ONLY

TECHNICAL GUIDANCE ON
COMPLIANCE INSPECTION OF INDUSTRIAL EFFLUENT TREATMENT SYSTEMS

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OVERVIEW

One of the major sources of **water pollution** in Malaysia is **discharges from industries**. The effluents from manufacturing operations are required to be treated to reduce the pollution load before they can be discharged to the watercourses. The engineered system to treat the effluents is commonly known as an **industrial effluent treatment system** (IETS). Industrial effluents vary in **characteristics** and **volume** generated according to **industry type**. Even within similar industry type the **quality** and **quantity** of effluents vary due to **process variation** and **housekeeping practices** adopted in the industry. Likewise, **treatment processes** applicable to treat these varying nature of effluents also differ from industry to industry. Nevertheless, over the years, experience has shown that the various treatment processes that have been developed can be adapted to treatment a wide variety of industrial effluents successfully. A typical IETS may consist of a combination of processes that are usually described as **unit operations** and **unit processes**. All these units would have to be working optimally in unison to bring about overall success to the effluent treatment endeavour.

The Department of Environment (DOE) has established a **Written Permission** procedure for new sources of effluent discharges. Before commencing operation, the industry is required to install an IETS to treat the effluent to comply with the **discharge standards**. Once operational the **DOE inspectors** will conduct inspections to the industry to ensure that the IETS is operated and maintained in good working order. **Operation and maintenance** (O&M) and **performance monitoring** are an integral aspect of good and proactive management practices to ensure continued performance of the IETS. Even a well designed IETS which is poorly operated and maintained will not achieve its objective. A prerequisite for a successful effluent treatment is a well implemented **O&M and performance monitoring program**.

Inspection of an IETS is a task assigned to **Assistant Environmental Control Officers** (***Penolong Pegawai Kawalan-PPK***). It is a thorough, detailed, unit by unit inspection which requires **technical knowledge** and **skills** as well as **hands-on experience**. This document provides a general guidance to the the DOE inspectors on **how to** conduct an effective inspection of IETS. An effective and regular inspection of IETS coupled with performance monitoring and **record keeping requirement** are three inseparable elements of successful enforcement programs that have proven to bring about improvement in **regulatory compliance** and help prevent episodes of **IETS failure**.

Department of Environment (Headquarters)
Putrajaya, Malaysia
December, 2006

COMPLIANCE INSPECTION OF INDUSTRIAL EFFLUENT TREATMENT SYSTEMS

1.0 BASICS OF ENFORCEMENT

The primary objective of conducting enforcement visits is to establish the **compliance status** of manufacturing facilities with the applicable requirements of the **environmental regulations**. It is important to realize that since enforcement visits to a particular source are conducted only a few times a year, the environmental compliance status of the source obtained from those visits represents only a **snapshot** of the real conditions prevailing on the source's premise. So, one would ask: What is the "**state of affairs**" between the visits? This question can be answered satisfactorily only by instituting the following measures:

(i) installing a **continuous monitoring system** (CMS) to monitor air emissions and effluent discharges on a continuous basis or

(ii) measuring relevant treatment process parameters and control equipment **operating parameters** on a regular basis and keeping a record of the measurements for review and inspection.

CMSs are generally more applicable to major industrial sources of air emissions rather than effluent sources. Furthermore, many effluent parameters are not amenable to **on-line measurement**, hence cannot be monitored on a continuous basis. On the other hand, **process and parameter monitoring** can be implemented by all industrial sources, regardless of whether they are air or effluent sources, irrespective of size. **Parameter monitoring** or more commonly referred to as **performance monitoring** is an alternative and indirect way of ensuring compliance with emission or discharge standards. Eventhough effluent discharges are not sampled and analyzed and hence **discharge compliance** status is not absolutely evaluated, performance monitoring provides an effective surrogate to **final effluent monitoring**, which has an inherent delay in information feedback due to time required for **laboratory analysis**.

Performance monitoring of IETS is usually enforced through the requirement on **record keeping**. Record keeping requirement has recently been introduced in the **Written Permission** procedure. Although new to the DOE's practice, record keeping concept has been used as a legal requirement in many developed countries and is being used internally in Malaysia by several industries to monitor the performance of their pollution control systems. Inspection of IETS focuses on evaluating how well the IETS is being **operated and maintained** to ensure that it will always perform satisfactorily as it was originally designed. The evaluation is performed through **current on-site observations** and by reviewing **performance monitoring records** kept by the factory management.

2.0 TYPICAL TECHNOLOGIES FOR EFFLUENT TREATMENT USED IN INDUSTRIES IN MALAYSIA

Table 1 summarizes typical effluent **treatment technologies** used in industries in Malaysia to treat different categories of common pollutants. To conduct an objective and professional inspection of industrial effluent treatment systems (IETSs), DOE inspectors will need to be **technically conversant** with the treatment technologies as well as the **unit operations** and **unit processes** employed by the treatment technologies. Knowledge of what constitutes typical **operating ranges** of the unit processes and unit operations and **performance monitoring practices** is a must-have by the DOE inspectors. Skills in **equipment inspection** are a new dimension to the field of factory inspection which need to be acquired by the DOE inspectors.

Table 1: Common Effluent Treatment Technologies Used In Industries In Malaysia to Treat Different Types of Pollutants

Type of pollutant	Type of treatment technology (Unit operations/unit processes)
Suspended solids/Oil and grease	Sedimetation Dissolved air flotation
Degradable organics	Stabilization basins Aerated lagoons Trickling filters Rotationg biological contactors Aerobic treatment (Activated sludge) Anaerobic treatment (Upflow Anaerobic Sludge Blanket)
Heavy metals	Chemical precipitation Ion exchange Membrane technology
Refractory toxic organics	Carbon adsorption Anaerobic treatment Chemical oxidation

3.0 GENERAL CONSIDERATIONS IN THE INSPECTION OF INDUSTRIAL EFFLUENT TREATMENT SYSTEMS

The discussion in this chapter focuses on the general aspects of inspection, regardless of the type of **unit operations** and **unit processes** installed in the factory for the treatment of its effluent.

3.1 Effluent Drainage System

The effluent drainage system may not be a part of the IETS but it is important that this aspect is given due attention by the DOE inspectors. The DOE inspectors should ensure that the effluent drainage system captures the effluents generated from all **effluent generating points** and all effluent streams are routed to the IETS. Additionally, the effluent drainage system should not have any connection with the **storm water drainage system** or **non process effluent streams**.

The area surrounding the factory premise should also be checked for signs indicative of **unauthorized discharges** or **nonoperative** or **malfunctioning** of the IETS. These could be unsual odors, signs of seepage, pipe outlets, or unapproved discharge valves.

3.2 Ask It Right-General Questions

The design of an IETS is based on a predetermined set of factory operating conditions. These may include such factors as: type of industry; type of manufacturing processes; product output; the number of process lines; estimated quantity of effluent generated; type of unit operations and unit processes utilized; specific operational characteristics and parameters by which unit operations and unit processes will be operated; etc. If these **factory manufacturing characteristics** and **pollution control system operational parameters** have been changed, the performance of the system may have been affected. The DOE inspectors should ask relevant questions to find out these changes. Given below is a list of **general questions** an inspector might ask.

(i) has the **rate of production** increased or decreased?
(ii) have **new manufacturing process lines** been added?
(iii) has there been a **change in the product mix**?
(iv) have there been any **changes to the IETS** such as the addition of new aeration system; new unit operation/unit process?
(v) have any **unit operation or process or major equipment** been removed from IETS?
(vi) has the **capacity of IETS** been increased?
(vii) have **new sources of effluent** been added to the IETS?

3.3 General Observation of the IETS

The inspector should perform a **walk-through inspection** of the IETS area to observe the general conditions of the IETS. In particular, look for signs indicative of lack of **preventive maintenance** of the system such as corrosion, saging effluent pipes, and presence of leaks. Where effluent flowrate is **big** and IETS is **complex**, the factory management should assign a **dedicated** and **competent operator** to be in charge of the operation and day to day running of the IETS. A small **lab** equipped with the basic facilities to conduct simple **calibrations** and **performance monitoring activities** would be an added asset to have to ensure proper operation and maintenance of the IETS. The inspector should review the **logs** kept by the factory to verify compliance with the **Record Keeping** requirements.

3.4 Common Unit Operations Used in Industries in Malaysia

Typical unit operations and unit processes encountered by the DOE inspectors when conducting factory inspections are listed below:

(i) screens
(iii) equalization basins/tanks
(iv) primary sedimentation tanks/clarifiers
(v) dissolved air flotation units
(vi) precipitation units/tanks
(vii) inclined plate clarifiers
(viii) aeration tanks/basins
(ix) secondary clarifiers
(x) ion exchange columns
(xi) activated carbon columns
(xii) electrowining units
(xiii) oxidation-reduction systems
(xiv) chemical oxidation systems
(xv) sand bed
(xvi) pressure filters.
(xvii) conventional activated sludge process
(xviii) extended aeration activated sludge process
(xix) sequencing batch reactors (SBR)
(xx) trickling filters
(xxi) rotating biological contactors (RBC)
(xxii) membrane processes
(xxiii) upflow anaerobic sludge blanket (UASB)
(xxiv) pond processes

4.0 INSPECTION OF ACTIVATED SLUDGE PROCESSES

The activated sludge process and and its **variants** are the most widely used process for treating **organic effluents**. The overall objective of the activated-sludge process is to remove **oxygen demanding substances** from the effluents. This is accomplished by the **metabolic reactions** of the microorganisms, the **separation of activated-sludge solids** from the aqueous phase, the **return of microorganisms** back into the system and the **removal of excess microorganisms** from the system.

4.1 Components of the Activated Sludge System

In terms of **physical components**, the activated-sludge system contains **five** essential interrelated equipment components (Water Environment Association, 1987). These are described briefly below:

(i) An **aeration tank** or a number of tanks in which air or oxygen is introduced into the system for two purposes; firstly to create an **aerobic environment** for the microorganism to thrive, and secondly to provide **mixing** and to keep the activated sludge in **suspension**. To achieve different **flow patterns** a number of tanks in some specific shape may be used.

(ii) An **aeration source** that will supply **sufficient oxygen** into the tank that will also provide appropriate mixing between the microorganisms and the effluent. This source may be **provided by pure oxygen, compressed air** or **mechanical aeration**. A variety of **aeration systems** is available on the market to deliver air or oxygen into aeration tanks.

(iii) A **secondary clarifier** which follows the aeration tanks. In secondary clarifiers, activated-sludge solids separate out from the aqueous phase and a clarified **supernatant** is produced which can be discharged or sent for further treatment. A concentrated sludge is also produced at the bottom of the clarifier where a portion of it is recycled as **return activated sludge (RAS)** and a portion is taken out of the system as **wasted activated sludge (WAS)**.

(iv) **Return activated sludge** is pumped back to the aeration tank to maintain a certain concentration of microorganism in the aeration tank.

(v) **Waste activated sludge** is pumped out of the system to maintain a certain **food-to-microorganism ratio** in the aeration tank(s).

In terms of **biological component** the activated sludge system is comprised of microorganisms whose composition is 70 to 90 percent **organic matter** and 10 to 30 percent **inorganic matter.**

The DOE inspectors would need to be very conversant with the components of the activated sludge system. During an on site inspection the inspector needs to **locate** where the components are, make **critical observations**, and ask **pertinent questions** about each component to assess and verify that the entire system components are being operated optimally.

4.2 Ask It Right-Questions On Activated Sludge System

Typical questions that an inspector might ask about nonactivated sludge system are:

(i) What is the **volume** of the aeration tank?

(ii) What is the **flowrate** of the effluent? (**HRT** can be computed by using information from(i) and (ii) or just ask question (iii)

(iii) What is the **HRT**?

(iv) is this system operated as a **conventional** or as an **extended aeration** activated sludge?

(v) What is the **F/M ratio**?

(vi) What is the **pH** of the mixed liquor?

(vii) What is the **dissolved oxygen** (D.O) level maintained in the aeration tank?

(viii) At what **sludge age** is the system operated?

(ix) What is the **MLSS** and **MLVSS** concentration?

(x) What is the organic loading?

(xi) What is the **recycle ratio**?

(xii) What is the **BOD:N:P ratio**?

(xiii) What is your **wasting rate**?

(xiv) How often do you need to add **nutrients**?

(xv) In what **form** are the nutrients added?

(xvi) Have you ever experienced **sludge bulking**?

(xvii) Did you identify the **cause** of the problem (sludge bulking)?)If the answewr to question (xv) was YES)

(xviii) What is the **diameter** of the clarifier?

(xix) What is the **surface overflow rate**?

(xx) What is the **weir length**?

(xxi) What is the **weir overflow rate**?

Table 2 gives typical values of some of the operating parameters for different types of activated sludge systems commonly used by the industries in Malaysia.

Table 2: Operating ranges for different activated sludge systems commonly used in Malaysia

Parameter/Type of activated sludge system	Conventional activated sludge	Extended aeration activated sludge	Sequencing batch reactor
F/M ratio, /d	0.25-0.5	0.05-0.1	0.05-0.2
HR, h	6-16	18-24	-
D.O.in tank, mg/L	1.0	2.0	6.5
MLSS, mg/L	1500-3000	3000-5000	1500-5000*
Sludge age	5-10	15-35	NA
Organic loading	0.3-0.7	-	-
Qr/Q	0.25-0.75	0.5-1.5	NA

Note NA-not applicable; * varies with the portion of the operating cycle

4.3 What to Observe?

Look for signs indicative of **malfunctioning** of components or ancillary equipment of the activated sludge system or occurrence of **unsatisfactory conditions** . Examples would be:

(i) Aeration system **out of order**, or one of the surface aerators not turned on
(ii) Presence of **dead zones** in the aeration tanks
(iii) Presence of **unusual odors** from the aeration tanks
(iv) Presence of **foams** in the aeration tanks
(v) Presence of **carry over of solids** in weir overflow

Check that the **ancillary instruments** and **monitors** are in working order. The following monitors listed in Table 3 are usually installed in an activated sludhge system:

Table 3 : Type of meters/sensors commonly installed in an activated sludge system

Type of Meter/sensor	Location installed
Dissolved oxygen monitor	Aeration tank
pH meter	Aeration tank
Solids level sensor	Clarifier

4.4 Review of Performance Monitoring Records

All new written approvals for the installation of IETS contain a requirement on keeping record of **performance monitoring activities**. A separate Technical Guidance document intitled "**Technical Guidance Document Series Number: Guidance Document on Performance Monitoring of Industrial Effluent Treatment Systems"** has been published by the DOE. The inspector should request to see the **performance monitoring log** kept by the factory to evaluate the completeness of entries such as dissolved oxygen monitoring data; nutrient addition, pH measurement, carbon regeneration or replacement, corrective actions taken to address upset conditions, etc, Another requirement of the Written Approval is that **spare parts** are kept on hand. The inspector should check on the compliance with this condition.

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ACKNOWLEDGEMENT

The Department is especially grateful to Ir. Dr. Shamsudin Ab. Latif, Deputy Director General (Development) for taking the initiatitive to write a series of **Technical Guidance Documents**, some for the use of DOE officers and some for the industries. It is our fervent hope that widespread use of these documents will value-add DOE's enforcement work, as well as industries' practices in pollution control. The final goal is to improve **regulatory compliance** and consequently, achieve a better **environmental quality** for all.

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ISBN 983-9119-95-8

9 789839 119954

Printed by:
SASYAZ HOLDINGS SDN. BHD. (219275-V)