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TECHNICAL GUIDANCE ON INDUSTRIAL EFFLUENT CHARACTERIZATION STUDY

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FOR THE USE OF
THE INDUSTRIES AND
CONSULTANTS

TECHNICAL GUIDANCE ON
INDUSTRIAL EFFLUENT CHARACTERIZATION STUDY

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FOREWORD

Characterization of industrial effluents is an important aspect in the management of industrial pollution. The characteristics of effluents are a determinant in the selection of **management option** and **appropriate treatment technology**, in the identification of **possible causes of non compliance** with discharge standards, and in the investigation of **cleaner production opportunities**.

Standardization of **reporting format** for industrial effluent characterization study (IECSs) is also important to stipulate the **minimum criteria** for report preparation to be complied with by the consultants who have been engaged to conduct the IECS. A well planned and properly executed IECS will provide meaningful information to the management of the industry as well as to the regulatory agency. Important **management decisions** can be made based the information. IECS is a useful tool whose potential needs to be harnessed fully to address non compliance problems and evaluate cleaner production options.

Dato' Hajah Rosnani Ibarahim
Director General of the Environment, Malaysia
21 December, 2006

INDUSTRIAL EFFLUENT CHARACTERIZATION STUDY

1. INTRODUCTION

Industrial effluent characterization studies (IECSs) typically form an integral part of any efforts to address effluent **non compliance problems.** The studies precede other steps that are normally taken to fully understand and identify the causes contributing to the non compliance. Industrial effluent characterization studies are also conducted for other purposes, such as:

(i) to determine the physical, biological, and chemical **characteristics** and the **concentrations** of constituents in the effluent,

(ii) to determine the best **methods of treatment** to reduce the pollutant concentrations to comply with the standards stipulated under the Environmental Quality (Sewage and Industrial Effluents) Regulations 1979,

(iii) to explore opportunities for implementing **cleaner production** activities (such as effluent segregation; effluent recycling, etc.) and

(iv) to determine the effluent characteristics of an industry which has just **commenced operation** and compare them with the estimated or assumed characteristics at the design stage.

The **complexity** of the IECS is dependent upon the nature and size of the manufacturing facility and upon the type and extent of the non compliance problem. The IECS will identify contaminants that are present in the various effluent streams and the IECS results will form the basis for making important **follow-up decisions** or **further investigation**, if necessary.

2. OBJECTIVE OF INDUSTRIAL EFFLUENT CHARACTERIZATION STUDY

The objective of this guidance document is to standardize:

(i) the **procedure** for conducting IECS by the industries or industrial effluent consultants. The latter are typically engaged by the industries to conduct the studies and submit **IECS reports** to the Department of Environment (DOE). The reports subsequently form the basis for follow-up **corrective actions** to be taken by the industries to address non compliance problems; and

(ii) the **format** of IECS reports submitted to the DOE.

It should be understood and borne in mind that an IECS would not reveal **all the causes** contributing to the non compliance. The study only focuses on the **effluent streams**. However, non compliance could also be the result of improper **operation and maintenance** of the **industrial effluent treatment system** (IETS). Hence, in certain circumstances, a follow-up investigation on the **operational aspects** of the treatment system may be warranted. Alternatively, a study on the operational and maintenance aspects of the effluent treatment system could be conducted in conjunction or concurrently with the IECS.

IECS should be conducted by **qualified professionals** where the **analytical work** on the effluent samples is to be performed by **SAMM[1] accredited laboratories**. The analytical techniques accepted by the DOE are those listed in the Standard Methods, or the United States Code of Federal Regulations (CFR), or accepted by the United States Environmental Protection Agency (EPA).

3. SAMPLING PROGRAM

The prerequisites for obtaining reliable results in an IECS are namely: **representativeness** of the effluent samples taken and proper **sample preservation** before analysis. Representativeness of the samples is influenced by the choice of **sampling locations** and use of **sampling techniques**. The importance of obtaining representative samples is self evident because the data from the analysis of the samples will ultimately serve as a basis for making important decisions regarding: effluent water recycling, effluent water segregation, and treatment process design. The sampling program is **industry-specific** and must be individually tailored to fit each situation. Special procedures are necessary to handle problems when sampling waste streams that exhibit **considerable variability** in flowrate and composition.

3.1 Sampling Location

Examination of drawings that show **effluent piping/drainage system** and **manholes** will help to determine the appropriate sampling locations. Additionally, a **walk-through survey** may be useful for small industries. The following are some general considerations to be borne in mind in selecting the sampling locations.

(i) The flow conditions at the location encourage a **homogeneous** mixture,

(ii) The **velocity** of flow at the sampling point should be sufficient to prevent deposition of solids. The samples should be taken in the **center** of the effluent channel. In deep, narrow drains, samples should be taken from a point **one - third** the water depth from the bottom,

(iii) This site should be **easily accessible** by and should be **safe** for the sampling personnel, and

(iv) The effluent at sampling site should not be mixed with **sewage**, any **non process** waste streams, or **storm water**.

3.2 Sampling Technique

After suitable sampling locations have been selected, the **type of samples** to be collected must be carefully determined. There are two main methods of effluent sampling: **grab** or **composite** sampling. Grab samples are single, instantaneous collections of effluent that represent the composition of the effluent at a particular sampling location and time. Grab sampling is appropriate if:

(i) the effluents **vary little in composition** throughout the manufacturing period. This is normally the case where industries have a large effluent storage capacity (e.g. holding pond or lagoon) with a long retention time.

(ii) the effluent is **discharged on an intermittent basis**, such as a batch dump from a contaminated process tank.

(iii) the effluent is **highly variable**, grab sampling may be applicable to accurately characterize the changing effluent composition, if necessary.

Certain parameters including **pH, oil, and grease (O&G)**, and **temperature** must be taken as grab samples to avoid losses or other changes in sample characteristics. Other relevant parameters include **volatile organics, petroleum hydrocarbons, dissolved gases, residual chlorine**, and **soluble sulfides**.

For the purpose of minimizing cost, **composite sampling** may be employed. Composite sampling is of two types: **time-proportional** composite sampling and **flow-proportional** composite sampling.

(i) time-proportional composite sampling involves the collection of equal volumes of effluent at regular intervals throughout a preset time period,

(ii) flow-proportional composite sampling where samplers collect and composite a fraction of the total effluent flow over a specified time period.

Flow proportional sampling is a collection or "**composite" of individual samples** taken at regular intervals of time or flow during a process day. Composite samples are often collected by an **automatic sampler** programmed to collect individual samples of effluent at selected time intervals. In the absence of an automatic sampler, a composite sample can be obtained by collecting a series of grab samples and measuring the flowrate simultaneously. The individual samples are then **manually mixed** in which the volume of the samples taken is proportional to its flow to obtain a flow-proportional composite sample. Composite sampling is appropriate if:

(i) it is desired to characterize the **toxicity** of an effluent that varies over time,

(ii) effluent composition may vary with **internal activities** of the industry such as changes in production.

Flow proportional sampling is the **preferred method** of composite sample collection, but measurement of flowrate may be a problem because the required flow meters may not be available. In such a situation, some **simple technique of flowrate measurement** can be employed to obtain reliable estimate of flowrate data. Properly taken composite samples are usually considered to adequately represent the **average effluent quality** over the course of a process day.

The appropriate **sampling frequency/sampling interval** also needs careful consideration. The degree of **flowrate variation** dictates the time interval for sampling, which must be short enough to provide a true representation of the flow. Even when flowrates vary only slightly, the concentration of waste products may vary widely. Frequent sampling allows estimation of the average concentration during the sampling period. Typically, samples are composited on **8 to 12 hour basis** when the effluent characteristics are **relatively constant** and on **2 to 4 hour** basis if the effluent characteristics exhibit **significant variation**.

It is best to sample each sampling station on several different days to help identify variations in effluent stream characteristics. Typically, sampling for a period of **three consecutive days** is recommended. Some parameters that are preferably measured using composite samples are: **suspended solids (SS), biochemical oxygen demand (BOD), chemical oxygen demand (COD), sulfates, and heavy metals (total and dissolved), nitrogen** and **phosphorus**.

Batch discharges may require special sampling techniques to obtain representative samples. Typically, a batch discharger collects process effluent over a portion or an entire day in a **holding tank** and treat it on a **batch-wise mode**. The effluent from the treatment system is subsequently discharged to a drain/water course when the results of effluent analysis using **rapid testing**

methods show that the discharge is in compliance with the **discharge standards**. If it is desired to obtain the average effluent quality from the treatment system, grab samples can be taken at the beginning, middle and end of the discharge and can be used to prepare a **manual composite sample** of the treated effluent. Composite sample from the holding tank can also be obtained in a similar manner.

3.3 Sample Preservation

The importance of **sample preservation** cannot be overemphasized. A carefully performed sampling program will be worthless if the physical, chemical, and biological **integrity** of the samples is not maintained during interim periods between **sample collection** and **sample analysis**. Prompt analysis is undoubtedly the most positive assurance against error due to **sample deterioration. Sample preservation** is necessary when analytical and testing conditions dictate a **lag** between collection and analysis, such as when a 24 - hour composite sample is collected. Sample **storage** and **shipping** time to the laboratory should be minimized and **sample preservation** and **holding time** as prescribed in the **Standard Methods** must be strictly adhered to.

3.4 Flowrate Measurements

An integral part of the IECS is the measurement of flowrate of the effluent streams. Information on **flowrates** and **flow variability** is important for composite sampling and for the design of effluent treatment **unit operations** and **unit processes.** Several **flow measuring techniques** and **devices** are available and the choice depends on several factors such as cost, type and accessibility of the conduit, hydraulic head available, and effluent **characteristics**. Some common measuring techniques and devices include: **nozzles and orifices; weirs; flumes;** and **bucket and stop watch.**

4. REPORT FORMAT

At the minimum an industrial effluent characterization study report should contain the following:

(i) Identification

State the name and address of the industry, type of manufacturing process, etc.

(ii) Purpose of the study

Discuss the purpose of the study: ex to determine causes of on compliance or to explore wastewater recycling opportunities; etc.

(iii) Manufacturing process information

Describe the manufacturing process and attach a manufacturing process flowchart showing the points of effluent generation, etc.

(iv) Study methodology

Discuss in this section selection of sampling locations, sampling schedule, type of sampling appropriate for the effluent streams being studied, flowrate measurement, relevant pollution parameters, etc. Provide relevant plans, e.g. plan showing the effluent drainage/sewer map; location of effluent sources and location of sampling stations.

(v) Results and discussion

Report and present a thorough discussion of the results of the study including discussion of the following: based on the flow chart, mass balance for major parameters using 3 day average data; if relevant, nutrient sufficiency/deficiency; toxicity or inhibition; biodegradability; waste segregation; initial assessment of treatment options; water recycling opportunities, etc.

(vi) Conclusions and recommendations

Present conclusions and provide recommendations for further actions based on the study results.

(v) Study team information

List the names of personnel on the study team, their educational background, and professional experience. The study team leader should sign the report and affix his company's official stamp on the report.

(vi) Appendix

Present raw data including lab analytical results.

(viii) References

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NOTES

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