OSCAR Bioenergy JV
Room 702, 7/F, Lee Garden Two,
28 Yun Ping Road,
Causeway Bay, HONG KONG
Tel : 2563 0661
Fax : 2565 8336

OSCAR Bioenergy Joint Venture

Your Ref: Nil
Our Ref: EPSP6110/LT/6519

11 February 2019

By Email & By Hand
(Ingo@epd.gov.hk)

Environmental Protection Department
The EIA Ordinance Register Office
27/F, Southern Centre,,
130 Hennessy Road,
Wanchai,,
HONG KONG

Attention: Mr. Lawrence Ngo

Dear Sirs,

Contract No EP/SP/61/10
Organic Resources Recovery Centre (Phase 1)
EM&A Manual (Rev.E)

The EM&A Manual was finalized for submission to EPD with IEC verification and ET Leader approval, and, an ET Leader approved Technical Note as support. This submission supersedes the draft submission covered by our letter (Our Ref.: EPSP6100/LT/6514 issued on 4 February 2019).

We are pleased to submit 3 copies of the revised EM&A Manual together with CD ROM for your approval.

The changes are updated NMVOCs and VOCs (including methane) limits in Table 2.3; update parameter descriptions of VOCs as VOCs (including methane) in Table 2.2, 2.3, 2.4 and 2.5.

Please do not hesitate to contact our Edwin Wong at 9388 8482 if further information is required.

Yours faithfully,
For and on behalf of
OSCAR Bioenergy Joint Venture

Laurent BICKERT
Project Manager

Our Ref: EPSP6110/LT/6519 (cont'd) Date : 11 February 2019

Encl. CE-OSC-00-0-PM-0184-E : 3 copies of EM&A Manual Rev. E

Technical Note : 3 copies of Assessment for the proposed Change of VOC Emission Limit for Cogeneration Units
: 3 copies pf ET Leader Check Certificate
: 3 copies 0f IEC Verification Certificate
: 1 CD ROM

cc.	EPD	– Ms. Theresa WU	(By Email)
	AECOM	– Mr. Tim LEE	(By Email)
	MEINHARDT	- Mr. Alan Wan	(By Email)
	ERM	- Mr. Frank Wan	(By Email)

LBI/MTS/EWO/lykw

OSCAR Bioenergy Joint Venture

Contract Number: EP/SP/61/10
Organic Waste Treatment Facilities Phase 1

Proposed update on

Environmental Monitoring & Audit Manual

According to the updated Environmental Review Report (November 2015) and Environmental Permit: FEP-01/395/2010/C

February 2019
Revision E

Contract No. EP/SP/61/10	Signature	
	Prepared and Checked by	Reviewed & Approved by
Revision **E**		
Date **4 February 2019**	**KH TANG** **Environmental Officer**	**Marshall TSOI** **Deputy Project Manager**

ENVIRONMENTAL MONITORING REPORT CHECK CERTIFICATE

ENVIRONMENTAL PROTECTION DEPARTMENT
THE HONG KONG SAR GOVERNMENT

CONTRACT NO. EP/SP/61/10
ORGANIC WASTE TREATMENT FACILITIES PHASE 1

Environmental Monitoring Report Check Certificate : CE-OSC-00-0-PM-0184-E

Report No. & Rev. : NIL

Report Title: EM&A Manual

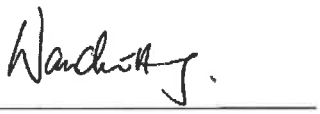
Documents subject to this certification:

ENVIRONMENTAL MONITORING : We warrant, in accordance with Clause 50 of the Conditions of Contract, the environmental monitoring has been carried out as set out in the Specification:

Attachments

Ref:

Any departures from the above and/or the Employer's Directives are attached.

Signed		Signed	
Name	Frank Wan	Name	Laurent BICKERT
Position	Environmental Team Leader (Director/Partner)	Position	Project Manager (Director)
Organisation	ERM Hong Kong Limited (Environmental Team)	Organisation	OSCAR Bioenergy Joint Venture (Contractor)
Date	4 February 2019	Date	4 February 2019

CHECK : We certify in accordance with Clause 50 of the Conditions of Contract.

Attachments

Ref:

Signed		Signed	
Name		Name	
Position	(Director/Partner)	Position	(Director/Partner)
Organisation	(Sub-Consultant to Independent Consultants)	Organisation	(Independent Environmental Checker)
Date		Date	

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Amendment History

Date:	Rev.	Description
05/2016	A	The EM&A Manual was updated based on the findings in the Environmental Review Report (November 2015) submitted to EPD to support the application for Variation for and Environmental Permit (VEP-487/2015) and matched with the current Environmental Permit (FEP-01/395/2010/C) i. Update programme in Table 1.1 ii. Add ammonia stripping plant in section 2.3, 2.7 & 2.10 iii. Add ammonia stripping plant in Table 2.1 iv. Insert Table 2.5 Emission Limit for ASP v. New layout plan This update also based on the comments from ET leader and IEC.
01/2017	B	The “Ammonia” was been inserted in Table 2.1
02/2017	C	Add ammonia stripping plant to all parameters in Table 2.1
07/2017	D	Table 2.2 was updated
02/2019	E	Table 2.2, 2.3, 2.4 and 2.5 were updated regarding changes in VOCs discharge limits and descriptions substantiated by the *Technical Note – ORRC1 Review of Air Quality Impact Assessment for the Proposed Change of VOC Emission Limit for Cogeneration Units*

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ENVIRONMENTAL MONITORING AND AUDIT MANUAL

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1. INTRODUCTION

Purpose of Manual

1.1 The Environmental Monitoring and Audit (EM&A) Manual was updated based on findings in Environmental Review Report (November 2015) submitted to EPD to support the Application for Variation for Environmental Permit (VEP-487/2015) and matched with the current Environmental Permit (FEP-01395/2010/C).

1.2 The purpose of this Environmental Monitoring and Audit (EM&A) Manual is to guide the setup of an EM&A programme for the implementation of the Environmental Impact Assessment (EIA) Study recommendations, to evaluate the effectiveness of the recommended mitigation measures and to identify any further need for additional mitigation measures or remedial action. This Manual outlines the EM&A programme for the construction and operation phases of the proposed Project, namely "Organic Waste Treatment Facilities Phase I" (hereinafter referred to as "the Project"). It aims to provide systematic procedures for monitoring, auditing and minimising environmental impacts associated with construction works and operational activities.

1.3 Hong Kong environmental regulations and the Hong Kong Planning Standards and Guidelines have served as environmental standards and guidelines in the preparation of this Manual. In addition, the EM&A Manual has been prepared in accordance with the requirements stipulated in Annex 21 of the Technical Memorandum on the EIA Process (EIAO-TM).

1.4 This Manual contains the following information:

- Responsibilities of the Contractor, the Supervising Officer (SO)[1], Supervising Officer's representative (SOR)[1], Environmental Team (ET)[2], the Independent Environmental Checker (IEC), Environmental Protection Department (EPD) and Monitoring Team (MT) with respect to the EM&A requirements during the course of the Project;
- project organization for the Project;
- the basis for, and description of the broad approach underlying the EM&A programme;
- requirements with respect to the construction programme and the necessary EM&A programme to track the varying environmental impact;
- methodologies to be adopted, including all field, laboratories and analytical procedures, and quality assurance and quality control programme (e.g. calibration of monitoring equipment);
- definition of Action and Limit levels;
- establishment of Event and Action plans;

- procedures for environmental complaints handling;
- requirements for reviewing pollution sources and working procedures required in the event of non-compliance with the environmental criteria and complaints;
- requirements for presentation of EM&A data and appropriate reporting procedures; and
- requirements for review of EIA predictions and the effectiveness of the mitigation measures / environmental management system and the EM&A programme.

1.5 For the purpose of this manual, the ET leader, who shall be responsible for and in charge of the ET, shall refer to the person delegated the role of executing the EM&A requirements.

Project Description

Introduction

1.6 The proposed Organic Waste Treatment Facilities (OWTF) Phase I development is to construct and build a biological treatment facility with a capacity of about 200 tonnes per day and convert the source-separated organic waste into compost and biogas through proven biological treatment technologies.

1.7 The OWTF Phase I development is proposed to be located in the Siu Ho Wan, North Lantau. The location plan of the Project is shown in **Figure 1.1**. The total area of the Project site is approximately 2 hectares and it is bounded northeast by North Lantau Highway and southeast by Siu Ho Wan Water Treatment Works (SHWWTW) located. The project area boundary of the OWTF Phase I development is shown in **Figure 1.2**.

Project Scope

1.8 The Project is planned to be implemented through a Design, Build and Operate (DBO) contract. A reference design for the OWTF Phase I development has been prepared, and the Contractor will be responsible for the detailed design of the facilities; provision and installation of the facilities; testing and commissioning of equipment; operation of the facilities; and monitoring of operation.

1.9 The preliminary layout plan of the proposed buildings and facilities in the Project site is shown in **Figure 1.3**. The key elements of OWTF Phase I developments include:

- Pre-treatment facilities;
- Anaerobic digestion process;
- Post-treatment of digestate;
- Energy recovery system; and
- Air and wastewater treatment facilities.

1.10 The OWTF Phase I development will be operated in 24-hour basis daily, while the reception of organic waste would be 14 hours per day, tentatively.

Project Programme

1.11 The construction of OWTF Phase I was commenced in 2014. The OWTF is tentatively scheduled for commissioning by early 2017. The tentative project programme is shown in **Table 1.1**.

Table 1.1 Construction Program

Description	Tentative Date
Site Handover to EPD	May 2011
Award of Contract	December 2014
Site Establishment and Temporary Works Preparation	December 2014– May 2015
Construction of OWTF Phase I and Ancillary Facilities	May 2015 – Sept 2017
Testing and Commissioning	April – November 2017

Project Organization

Introduction

1.12 The roles and responsibilities of the various parties involved in the construction phase and operation phase EM&A process and the implementation of the EM&A programme are outlined below. The proposed project organization and lines of communication during construction and operation phases with respect to environmental protection works are shown in **Figure 1.4** and **Figure 1.5** respectively.

Construction Phase

Supervising Officer (SO) and Supervising Officer's Representative (SOR)

1.13 The term SO and SOR refers to the organization responsible for overseeing the construction works of the Project undertaken by the Contractor, and for ensuring that they are undertaken by the Contractor in accordance with the specification and contractual requirements. The responsibilities for SO and SOR include the following:

- Monitor the Contractor's compliance with contract specifications, including the implementation and operation of the environmental mitigation measures and ensure their effectiveness, and other aspects of the EM&A programme;
- Monitor the Contractor's, the ET's and the IEC's compliance and ensure that the requirements in the Environmental Permit (EP) and EM&A Manual are fully complied with;
- Provide assistance to the ET as necessary in the implementation of the M&A programme;
- Participate in joint site inspection undertaken by the ET and the IEC;
- Comply with the agreed Event / Action Plan in the event of any exceedance; and

- Adhere to the procedures for carrying out complaint investigation.

Contractor

1.14 The term "Contractor" should be taken to mean all construction contractors and sub- contractors, working on site at any one time. Besides reporting to the SOR, the Contractor should also be responsible for the following tasks:

- Work within the scope of the relevant contract and other tender conditions;
- Provide assistance to the ET in carrying out monitoring;
- Participate in the site inspections undertaken by the ET as required, and undertake any corrective actions;
- Provide information / advice to the ET regarding works activities which may contribute, or be continuing to the generation of adverse environmental conditions;
- Submit proposals on mitigation measures in case of exceedances of Action or Limit levels in accordance with the Event / Action plans;
- Implement measures to reduce impact where Action or Limit levels are exceeded; and
- Adhere to the procedures for carrying out complaint investigation.

Independent Environmental Checker (IEC)

1.15 The IEC should not be in any way an associated body of the Contractor for the Project. The responsibilities for IEC should include the following:

- Advise the SOR on environmental issues related to the Project, independent from the management of construction works, but empowered to audit the environmental performance of construction and operation;
- Provide proactive advice to the SOR and the Employer of the Project on environmental matters;
- Review and audit all aspects of the EM&A programme, including the implementation of environmental mitigation measures, submission relating to the EP and EM&A, and any other submission required under the EP and EM&A Manual;
- Review and verify the monitoring data and all submissions relating to or under the EP and EM&A Manual submitted by the ET, including but not limited to the EM&A reports;
- Monitor the implementation of the EM&A programme and the overall level of environmental performance being achieved;
- Arrange and conduct regular, at least monthly site inspections of the works during

construction phase, and ad hoc inspections if significant environmental problems are identified;

- Comply with the agreed Event / Action Plan in the event of any exceedance;
- Check and ensure the procedures for carrying out complaint investigation being followed and check the effectiveness of corrective measures;
- Feedback audit results to ET by signing off relevant EM&A proforma;
- Ensure the impact monitoring is conducted at the correct locations at the frequency identified in the EM&A Manual;
- Check that the mitigation measures are effectively implemented; and
- Report the works conducted, the findings, recommendation and improvement of the site inspections, the findings, recommendation, and improvement after reviewing the ET's and the Contractor's wor.ks, and any advices to the SOR and the Employer of the Project on a monthly basis.

Environmental Team

1.16 The ET shall not be in any way an associated body of the Contractor, and shall be responsible to conduct the EM&A programme. The ET should be managed by the ET Leader. The ET Leader shall be a person who has at least 7 years' experience in EM&A and have relevant professional qualifications. Suitably qualified staff should be included in the ET, and resources for the implementation of the EM&A programme should be allocated in time under the Contract, to enable fulfilment of the Project's EM&A requirements as specified in the EM&A Manual during construction of the Project. The ET shall report to the SOR and the duties of ET shall include the following:

- Monitor and audit various environmental parameters as required in this EM&A Manual;
- Analyse the EM&A data and review the success of EM&A programme to cost- effectively confirm the adequacy of mitigation measures implemented and the validity of the EIA predictions and to identify any adverse environmental impacts arising;
- Carry out regular site inspection to investigate and audit the Contractor's site practice, equipment and work methodologies with respect to pollution control and environmental mitigation, and effect proactive action to pre-empt problems;
- Monitor compliance with conditions in the EP, environmental protection, pollution prevention and control regulations and contract specifications;
- Audit environmental monitoring data and site environmental conditions;
- Report on the environmental monitoring and audit results to EPD, the SOR, the IEC and

Contractor or their delegated representative;

- Recommend suitable mitigation measures to the Contractor in the case of exceedance of Action or Limit levels in accordance with the event and action plans;
- Liaise with the IEC on all environmental performance matters and timely submit all relevant EM&A proforma for approval by the IEC;
- Advise the Contractor on environmental improvement, awareness, enhancement matters, etc., on site;
- Adhere to the procedures for carrying out complaint investigation; and
- Timely submit the EM&A Reports to the EPD.

1.17 Sufficient and suitably qualified professional and technical staff should be employed to ensure full compliance with their duties and responsibilities, as required under the EM&A programme during the construction phase of the Project.

Operation Phase

1.18 Under the DBO contract, the Contractor will be responsible for the operation of the OWTF. The Contractor shall ensure full compliance with the conditions of the EP during its operation. A Monitoring Team (MT) should be employed by the Contractor to carry out the monitoring works during the operation phase as required in this EM&A Manual.

1.19 The MT shall be managed by the MT Leader to analyze the monitoring results. The MT Leader shall be a person who has at least 7 years' experience in EM&A and have relevant professional qualifications. Suitably qualified staff should be included in the MT, and resources for the implementation of the monitoring programme should be allocated in time under the Contract, to enable fulfilment of the Project's monitoring requirements as specified in the EM&A Manual during operation of the Project. The responsibilities for MT should include the following:

- Monitor various environmental parameters as required in this EM&A Manual;
- Report on the environmental monitoring results to the Contractor, the SOR, and the IEC;
- Analyze monitoring results collected from the monitoring works;
- Prepare monitoring reports to provide the impact evaluation results to the Contractor, the SOR and the IEC; and
- Recommend suitable actions to the Contractor and SOR in case of exceedance of any assessment criteria.

Structure of this Manual

1.20 Following this introductory section, the structure of the EM&A Manual is set out below:-

- Section 2 details the requirement for impact monitoring for dust during the construction phase and for air emission from OWTF and odour during the operation phase.
- Section 3 details the audit requirements with regard to hazard to life issues.
- Section 4details the requirements for baseline and impact monitoring for water quality during the construction phase.
- Section 5 details the audit requirements with regard to waste management issues as well as the waste control and mitigation measures recommended in the EIA.
- Section 6details the requirements with regard to landscape and visual issues.
- Section 7details the requirements with regard to noise issues
- Section 8 details the requirements on site environmental audit and the environmental complaints handling procedure.
- Section 9 details the EM&A reporting requirements.

2 AIR QUALITY

Introduction

2.1 This section presents the requirements, methodology, equipment, criteria and protocols for the monitoring and audit of air quality impacts during the construction and operational phases of the Project.

2.2 The objectives of the air quality monitoring include the following:-

- to identify the extent of construction dust and operational odour impacts;
- to determine the effectiveness of mitigation measures to control dust emission from activities during construction phase and odour control measures during operational phase;
- to audit the compliance of the Contractor with regard to dust control, contract conditions and the relevant dust impact criteria;
- to recommend further mitigation measures if found to be necessary; and
- to comply with action and limit levels for air quality as defined in this Manual.

2.3 During construction phase of the Project, dust impacts would be the major air quality impacts. While during operation phase of the Project, stack emissions from the centralized air pollution control unit (CAPC), the cogeneration units, the ammonia stripping plant (ASP) and the standby flare would be the key environmental issue. Odour emission from the operation of OWTF would be another environmental issue.

Monitoring during Construction Phase

2.4 With the implementation of practicable dust suppression measures stipulated in the Air Pollution Control (Construction Dust) Regulation, adverse construction dust impact at the Air Sensitive Receiver (ASR) is not expected during construction of the Project. Yet, regular site environmental audits during the construction phase of the Project as described in **Section 8** of this Manual should be conducted to ensure that the recommended dust suppression measures are implemented properly.

2.5 Mitigation measures for dust control have been recommended in the EIA Report and are listed below:

- Use of regular watering, with complete coverage, to reduce dust emissions from exposed site surfaces and unpaved roads, particularly during dry weather;
- Use of frequent watering for particularly dusty construction areas and areas close to ASRs;
- Side enclosure and covering of any aggregate or dusty material storage piles to reduce emissions. Where this is not practicable owing to frequent usage, watering should be applied

to aggregate fines;

- Open stockpiles should be avoided or covered. Where possible, prevent placing dusty material storage piles near ASRs;
- Tarpaulin covering of all dusty vehicle loads transported to, from and between site locations;
- Establishment and use of vehicle wheel and body washing facilities at the exit points of the site;
- Provision of wind shield and dust extraction units or similar dust mitigation measures at the loading points, and use of water sprinklers at the loading area where dust generation is likely during the loading process of loose material, particularly in dry seasons/ periods;
- Imposition of speed controls for vehicles on unpaved site roads. 8 kilometers per hour is the recommended limit;
- Where possible, routing of vehicles and positioning of construction plant should be at the maximum possible distance from ASRs;
- Every stock of more than 20 bags of cement or dry pulverised fuel ash (PFA) should be covered entirely by impervious sheeting or placed in an area sheltered on the top and the 3 sides;
- Cement or dry PFA delivered in bulk should be stored in a closed silo fitted with an audible high level alarm which is interlocked with the material filling line and no overfilling is allowed; and
- Loading, unloading, transfer, handling or storage of bulk cement or dry PFA should be carried out in a totally enclosed system or facility, and any vent or exhaust should be fitted with an effective fabric filter or equivalent air pollution control system.

2.6 The Contractor shall be responsible for the design and implementation of these measures.

Monitoring during Commissioning Stage and Operation Phase

Stack Monitoring

2.7 Monitoring of air quality parameters of concern due to stack emissions from centralized air pollution control unit, the ammonia stripping plant, the cogeneration units and the standby flaring gas unit should be conducted during commissioning stage. During the operation phase of the Project, stack monitoring shall be installed for the centralized air pollution control unit, the ammonia stripping plant and the cogeneration units of OWTF.

2.8 The parameters for measurement and the analytical methods are listed in **Table 2.1**. It should be noted

that the proposed sampling methods below are for reference only and should be subject to the approval of EPD.

Table 2.1 Analytical Parameters and Methodology

Parameters	Method	Stacks to be Monitored
Gaseous and vaporous organic substances	USEPA Method 18 USEPA Method 0031	• Centralized Air Pollution Control Unit • Cogeneration Units • Standby Flaring Gas • Ammonia Stripping Plant
Particulate	ISO 9096, ASTM D3685-98, USEPA Method 17	• Centralized Air Pollution Control Unit • Cogeneration Units • Standby Flaring Gas Unit • Ammonia Stripping Plant
Carbon monoxide	Combustion Gas Analyser	• Cogeneration Units • Standby Flaring Gas Unit • Ammonia Stripping Plant
NOx	USEPA Reference methods USEPA Method 7 and associated methods	• Cogeneration Units • Standby Flaring Gas Unit • Ammonia Stripping Plant
SO2	USEPA Method 8	• Cogeneration Units • Standby Flaring Gas Unit • Ammonia Stripping Plant

Parameters	Method	Stacks to be Monitored
HCl and HF	USEPA Method 26 A USEPA Method 13B sampling train	• Cogeneration Units • Standby Flaring Gas Unit • Ammonia Stripping Plant
Oxygen	Combustion Gas Analyser (chemical cell and paramagnetic)	• Centralized Air Pollution Control Unit • Cogeneration Units • Standby Flaring Gas Unit • Ammonia Stripping Plant
Velocity and Volumetric Flow	ISO 10780 and ISO 9096	• Centralized Air Pollution Control Unit • Cogeneration Units • Standby Flaring Gas Unit • Ammonia Stripping Plant
Water Vapour Content and Temperature	USEPA Method 4	• Centralized Air Pollution Control Unit • Cogeneration Units • Standby Flaring Gas Unit • Ammonia Stripping Plant

Parameters	Method	Stacks to be Monitored
Ammonia	USEPA CTM 027	• Ammonia Stripping Plant

2.9 Necessary monitoring equipment and techniques should be provided and used to demonstrate that the process is properly operated and the emissions can be minimized to meet the air pollution control requirements as tabulated in **Tables 2.2, 2.3, 2.4** and **2.5** below.

Table 2.2 Emission Limit for Centralized Air Pollution Control Unit

Parameter	Emission Level (mg/Nm^3)
VOCs (including methane)	680
Dust (or Total Suspended Particulates)	6
Odour (including NH3 & H2S)	220 [(1)]

Note:[(1)] The odour unit is ou/Nm^3.

Table 2.3 Emission Limit for Cogeneration Units

Parameter	Maximum Emission Level (mg/Nm^3) [(1)]
Dust (or Total Suspended Particulates)	15
Carbon Monoxide	650
NO_x	300
SO_2	50
NMVOCs	150
VOCs (including methane) [(2)]	1,500
HCl	10
HF	1

Note: [(1)] All values refer to an oxygen content in the exhaust gas of 6% and dry basis.
[(2)] The VOCs emission limit include methane as biogas is adopted as fuel in the combustion process.

Table 2.4 Emission Limit for Standby Flaring Gas Unit

Parameter	Maximum Emission Level (mg/Nm^3) (1)
Dust (or Total Suspended Particulates)	5
Carbon Monoxide	100
NO_x	200
SO_2	50
VOCs (including methane) (2)	20
HCl	10
HF	1

Note: (1) All values refer to an oxygen content in the exhaust gas of 11% and dry basis.
(2) The VOCs emission limit include methane as biogas is adopted as fuel in the combustion process.

Table 2.5 Emission Limit for ASP

Parameter	Maximum Emission Level (mg/Nm^3) (1)
Dust (or Total Suspended Particulates)	5
Carbon Monoxide	100
NOx	200
SO_2	50
VOCs (including methane) (2)	20
NH_3	35
HCl	10
HF	1

Note: (1) All values refer to an oxygen content in the exhaust gas of 11% and dry basis.
(2) The VOCs emission limit include methane as biogas is adopted as fuel in the combustion process.

2.10 On-line monitoring should be carried out for centralized air pollution control unit, cogeneration and ASP units during the operation phase of the OWTF. The continuous monitoring data should be transmitted instantaneously to EPD by telemetry system in such manner and the format to be agreed with EPD. The record should be retained at the premises for a minimum of two years, or other period specified by EPD, after the date of last entry and be made available for examination as and when required by EPD.

2.11 Evidence should be provided to demonstrate quality assurance procedures are in place to ensure all monitoring results are sufficiently accurate and reliable. Calibration on the monitoring equipment has to be done by means of parallel measurements with the reference methods as agreed by EPD.

2.12 The on-line monitoring of the in-stack exhaust gas shall be carried out. The continuous monitoring data should be transmitted instantaneously to EPD by telemetry system in such manner and format agreed with EPD. The parameters to be continuously monitored are listed below:

- nitrogen oxides
- hydrogen chloride
- hydrogen fluoride
- sulphur dioxide
- ammonia
- gaseous and vaporous organic substances
- carbon monoxide
- oxygen
- pressure
- temperature
- water vapour content (continuous measurement of the water vapour content should not be required if the sample exhaust gas is dried before the emissions are analysed.)

Odour Monitoring

Commissioning Stage

2.13 Odour sampling works should be conducted weekly in the first month of the commissioning stage of the Project. The air samples at the stack of Centralized Air Pollution Control Unit under full capacity of operation should be collected for olfactometry analysis. Duplicate samples should be collected for each sampling exercise.

2.14 The following items should be recorded during sampling:

- the prevailing weather condition;
- the wind direction;
- any odour detected during sampling and the flavours of odour with detailed description

of characteristics (e.g. sewage or rotten-egg smell, decayed vegetables, ammonical, dischargeable odour, putrefaction, sharp, pungent, fish, irritating, fruit, vinegar, etc);

- downwind or upwind direction from the odour source;
- duration of odour (intermittent or continuous) during sampling; and
- photo showing the sampling locations relative to existing land features The relevant meteorological data (e.g. ambient temperature, wind speed and direction, etc.) from the nearest Hong Kong Observatory station during the sampling period should also be recorded for reference.

2.15 The collected air samples should be delivered to the laboratory for olfactometry analysis within 24 hours.

2.16 The odour concentration of the collected air samples should be determined by a forced- choice dynamic olfactometer with a panel of human assessors being the sensor in accordance with the European Standard Method: Air Quality – Determination of Odour Concentration by Dynamic Olfactometry (EN13725) within 24 hours after collection.

2.17 The odour laboratory should be ventilated to maintain an odour-free environment and to provide fresh air to the panel members. Each odour testing session should comprise at least five qualified panellists. All of the panellists should be screened beforehand by using 50 ppm solution/mixture of certified n-butanol standard gas.

2.18 During each odour sampling day, one blank sample should be collected for quality control. The sample should be taken by purging pure nitrogen gas into the odour bag directly on site as a blank sample.

2.19 The olfactometry analysis should be conducted by the testing laboratories complying with the European Standard EN13725:2003. The laboratories should provide the QA/QC results in the laboratory analysis report.

Operation Phase

2.20 To determine the effectiveness of the proposed odour mitigation measures and to ensure the odour impacts arising from operation of the OWTF and the on-site wastewater treatment unit meeting the air pollution control requirements, odour patrol shall be conducted.

2.21 The odour patrols shall be conducted by an odour patrol team. The odour patrol team will patrol and sniff along an odour patrol route at the OWTF site boundary as shown in **Figure 1.2**. The implementation of the odour patrol shall be subject to the prevailing weather forecast condition and no odour patrol should be carried out during rainy day. The odour patrol team should be comprised

of at least two independent trained personnel / competent persons, who should pass a set of screening tests and fulfil the following requirements:

- have their individual odour threshold of n-butanol in nitrogen gas in the range of 20 to 80 ppb/v required by the European Standard Method (EN 13725);
- be at least 16 years of age and willing and able to follow instructions;
- be free from any respiratory illnesses;
- be engaged for a sufficient period to build up and monitor/detect at several monitoring location;
- not be allowed to smoke, eat, drink (except water) or use chewing gum or sweets 30 min before and during odour patrol;
- take great care not to cause any interference with their own perception or that of others by lack of personal hygiene or the use of perfumes, deodorants, body lotions or cosmetics; and
- not communicate with each other about the results of their choices.

2.22 The independent trained personnel / competent persons should use their noses (olfactory sensors) to sniff odours at different locations. The main odour emission sources and the areas to be affected by the odour nuisance shall be identified. During the patrol, the sequence should start from less odorous locations to stronger odorous locations.

2.23 The perceived odour intensity is divided into 5 levels. **Table 2.6** describes the odour intensity for different levels.

Table 2.6 Odour Intensity Level

Level	Odour Intensity
0	Not detected. No odour perceived or an odour so weak that it cannot be easily characterised or described
1	Slight identifiable odour, and slight chance to have odour nuisance
2	Moderate identifiable odour, and moderate chance to have odour nuisance
3	Strong identifiable, likely to have odour nuisance
4	Extreme severe odour, and unacceptable odour level

2.24 The independent trained personnel / competent persons should record the findings including date and time, weather condition (e.g. sunny, fine, cloudy, and rainy), odour intensity, odour nature and possible odour sources, local wind speed, and wind direction at each location. In addition, some

relevant meteorological data such as daily average temperature, and daily average humidity, on the day of odour patrol should be obtained from the nearest Hong Kong Observatory stations including Siu Ho Wan Weather Station and Chek Lap Kok Airport Weather Station for reference.

2.25 Odour patrols should be conducted in summer (i.e. from July to September). In the first 2 operational years of the OWTF, monthly odour patrols should be conducted. Odour patrols should be carried out during daytime and evening / night time when the OWTF and its on-site wastewater treatment plant are operated under the normal operating condition.

2.26 The need to continue the odour patrol after the end of the 2-year monitoring period would depend on the monitoring results and should be agreed with EPD. If the level of odour intensity at any sniffing location is higher than 1 due to potential odour emission from the OWTF and its on-site wastewater treatment unit in two consecutive months, the odour patrol programme would be extended until the level of odour intensity (that is determined to be due to potential odour emission from the OWTF and its on-site wastewater treatment unit) at all the sniffing locations have dropped to 0 in three consecutive months.

2.27 **Table 2.7** shows the action level and limit level to be used for odour patrol. Should any exceedance of the action and limit levels occurs, actions in accordance with the event and action plan in **Table 2.8** should be carried out.

Table 2.7 Action and Limit Levels for Odour Nuisance

Parameter	**Action Level**	**Limit Level**
Odour Nuisance (from odour patrol)	When one documented compliant is received(1), or Odour Intensity of 2 is measured from odour patrol.	Two or more documented complaints are received(1) within a week; or Odour intensity of 3 or above is measured from odour patrol.

Note:

(1) Once the compliant is received by the Project Proponent (EPD), the Project Proponent would investigate and verify the complaint whether it is related to the potential odour emission from the OWTF and its on-site wastewater treatment unit.

Table 2.8 Event and Action Plan for Odour Monitoring

EVENT	ACTION	
	Person-in-charge of Odour Monitoring	**Project Proponent**[(1)]
ACTION LEVEL		
Exceedance of action level (Odour Patrol)	1. Identify source/reason of exceedance; 2. Repeat odour patrol to confirm finding.	1. Carry out investigation to identify the source/reason of exceedance. Investigation should be completed within 2 weeks; 2. Rectify any unacceptable practice; 3. Implement more mitigation measures if necessary; 4. Inform DSD or the operator of the Siu Ho Wan Sewage Treatment Works (SHWSTW) if exceedance is considered to be caused by the operation of the SHWSTW. 5. Inform North Lantau Refuse Transfer Station (NLTS) operator if exceedance is considered to be caused by the operation of NLTS.

EVENT	ACTION	
	Person-in-charge of Odour Monitoring	**Project Proponent**[(1)]
Exceedance of action level (Odour Complaints)	1. Identify source/reason of exceedance; 2. Carry out odour patrol to determinate odour intensity.	1. Carry out investigation and verify the complaint whether it is related to potential odour emission from the nearby SHWSTW; 2. Carry out investigation to identify the source/reason of exceedance. Investigation should be completed within 2 weeks; 3. Rectify any unacceptable practice; 4. Implement more mitigation measures if necessary; 5. Inform DSD or the operator of the SHWSTW if exceedance is considered to be caused by the operation of the SHWSTW. 6. Inform North Lantau Refuse Transfer Station (NLTS) operator if exceedance is considered to be caused by the operation of NLTS.

EVENT	ACTION	
	Person-in-charge of Odour Monitoring	**Project Proponent**(1)
LIMIT LEVEL		
Exceedance of Limit level	1. Identify source/reason of exceedance; 2. Inform EPD; 3. Repeat odour patrol to confirm findings; 4. Increase odour patrol frequency to bi-weekly; 5. Assess effectiveness of remedial action and keep EPD informed of the results; 6. If exceedance stops, cease additional odour patrol.	1. Carry out investigation to identify the source/reason of exceedance. Investigation should be completed within 2 week; 2. Rectify any unacceptable practice; 3. Formulate remedial actions; 4. Ensure remedial actions properly implemented; 5. If exceedance continues, consider what more/enhanced mitigation measures should be implemented; 6. Inform DSD or the operator of the SHWSTW if exceedance is considered to be caused by the operation of the SHWSTW.

Note: (1) Project Proponent shall identify an implementation agent.

2.28 In the event when an odour compliant is received, Project Proponent should liaise with the complainant and register the complaint. The compliant register is to record detailed information regarding the odour compliant and hence, facilities efficient investigation work. The registration should contain, but not be limited to the following information:

- Location of where the odour nuisance occurred;
- Date and time of the complaint and the nuisance event;
- Description of the complaint, i.e. the type and characteristics of the odour; and an indication of the odour strength (highly offensive / offensive / slightly offensive / just continuously detectable / intermittently detectable);
- Meteorological conditions from the nearest HK Observatory station at the time of complaint; and

- Name and contact information of the complainant.

3 HAZARD TO LIFE

Introduction

3.1 A hazard assessment has been conducted in this EIA study and it is concluded that construction and operation of the OWTF would not increase the risk of chlorine release at the Siu Ho Wan Water Treatment Works (SHWWTW). Impact of chlorine store and chlorine delivery operation at SHWWTW on construction workers and on-site personnel could be reduced with all the recommended practicable mitigation measures.

3.2 Mitigation/safety measures for hazard to life have been recommended in the EIA Report and are presented below.

Mitigation Measures

3.3 Construction Phase

- The number of workers on site during construction stage should be kept at the same level as the assessment.
- Construction works should be suspended when delivery of chlorine takes place.
- 3m high fence should be constructed along the boundary facing the SHWWTW.
- Emergency evacuation procedures should be formulated and the Contractor should ensure all workers on site should be familiar with these procedures as well as the route to escape in case of gas release incident. Relevant Departments, such as Fire Services Department (FSD), should be consulted during the development of Emergency procedures. Diagram showing the escape routes to a safe place should be posted in the site notice boards and at the entrance/exit of site. A copy of the latest version emergency procedures should be dispatched to Tung Chung Fire Station for reference once available.
- The emergency procedures should specify means of providing a rapid and direct warning (e.g. Siren and Flashing Light) to construction workers in the event of chlorine gas release in the SHWWTW.
- The Contactor should establish a communication channel with the SHWWTW operation personnel and FSD during construction stage. In case of any hazardous incidents in the treatment works, operation personnel of SHWWTW should advise the Contractor to inform construction workers to proceed with emergency procedure. The Contractor should appoint a Liaison Officer to communicate with FSD Incident Commander on site in case of emergency.
- Introduction training should be provided to any staff before carryout construction works at the Project site.
- Periodic drills should be coordinated and conducted to ensure all construction personnel are familiar with the emergency procedures. Upon completion of the drills, a review on every step taken should be conducted to identify area of improvement. Prior notice of periodic drills should be given to Station Commander of Tung Chung Fire Station. Joint operational exercise with FSD and SHWWTW is recommended.

3.4 Operation Phase

- The site office should be close to the western boundary of the Project site and away from the SHWWTW's chlorine store as far as possible.
- 3m high fence should be constructed along the boundary facing the SHWWTW.

- Emergency evacuation procedures should be formulated and the Contractor should ensure on site staff should be familiar with these procedures. Diagram showing the escape routes to a safe place should be posted in the site notice boards and at the entrance/exit of site. A copy of the latest version emergency procedures should be dispatched to Tung Chung Fire Station for reference once available.

- The emergency procedures should specify means of providing a rapid and direct warning (e.g. Siren and Flashing Light) to personnel on site in the event of chlorine gas release in the SHWWTW.

- The Contractor should establish a communication channel with the SHWWTW operation personnel and FSD. In case of any hazardous incidents in the treatment works, operation personnel of SHWWTW should advise the Contractor to inform personnel on site to proceed with emergency procedure. The Contractor should appoint a Liaison Officer to communicate with FSD Incident Commander on site in case of emergency.

- Periodic drills should be coordinated and conducted to ensure all on site personnel are familiar with the emergency procedures. Upon completion of the drills, a review on every step taken should be conducted to identify area of improvement. Prior notice of periodic drills should be given to Station Commander of Tung Chung Fire Station. Joint operational exercise with FSD and SHWWTW is recommended.

4 WATER QUALITY

Introduction

4.1 The water quality impact assessment indicated that no adverse water quality impact would be expected associated with the construction and operation of the Project, with implementation of recommended mitigation measures. No unacceptable residual water quality impact was expected. Water quality monitoring is therefore not considered necessary. Regular site inspection shall be undertaken to inspect the construction activities and works areas in order to ensure that the recommended mitigation measures are properly implemented.

Construction Site Audits

4.2 Regular site audits will help to ensure that the recommended mitigation measures are properly implemented during the construction works. It can also provide an effective means of control of any malpractices, and therefore achieve continual improvement of environmental performance on site.

Site Inspection

4.3 Site inspections should be carried out by the ET and should be based on the recommended mitigation measures for water pollution control. In the event that the recommended mitigation measures are not fully or properly implemented, deficiency should be recorded and reported to the site management. Suitable actions are to be carried out to:

- Record the problems and investigate the causes;
- Issue action notes to the Contractor who is responsible for the works;
- Implement remedial and corrective actions immediately;
- Re-inspect the site conditions upon completion of the remedial and corrective actions; and
- Record the event and discuss with the Contractor for preventive actions.

Compliance Audits

4.4 Compliance audits are to be undertaken to ensure that a valid discharge licence has been issued by EPD prior to the discharge of effluent from the Project site. If monitoring of the treated effluent quality from the works areas is required during the construction phase of the Project, the monitoring should be carried out in accordance with the Water Pollution Control Ordinance (WPCO) licence which is under the ambit of the relevant Regional Office (RO) of EPD. The audit results reflect whether the effluent quality is in compliance with the discharge licence requirements. In the event of non-compliance, suitable actions by the relevant parties should be undertaken to:

- Notify the site management on the non-compliance;
- Identify the sources of pollution;
- Check the implementation status of the recommended mitigation measures;
- Investigate the operating conditions of the on-site treatment systems;
- Implement corrective and remedial actions to improve the effluent quality;
- Increase monitoring frequency until the effluent quality is in compliance with the discharge licence requirements; and
- Record the non-compliance and propose preventive measures.

Mitigation Measures

4.5 Mitigation measures for water quality control have been recommended in the EIA Report and listed in the implementation schedule given in **Appendix A**.

4.6 In the event of complaints or non-compliance / area of improvement being observed, the ET and the Contractor should review the effectiveness of these mitigation measures, design alternative or additional mitigation measures as appropriate and propose to the IEC for approval and implement these alternative or additional measures.

5 WASTE MANAGEMENT

Introduction

5.1 Waste management would be the Contractor's responsibility to ensure that all wastes produced during the construction of the Project are handled, stored and disposed of in accordance with the recommended good waste management practices and EPD's regulations and requirements.

5.2 Waste materials generated from construction activities, such as excavated materials, C&D materials and general refuse, are recommended to be audited at regular intervals (at least once per week as part of the regular site inspections) to ensure that proper storage, transportation and disposal practices are being implemented. The Contractor would be responsible for the implementation of mitigation easures to minimise waste or redress problems arising from the waste materials.

5.3 Mitigation measures for waste management as recommended in the EIA Report are summarised below. With proper handling, storage and disposal of waste arisings during the construction phase of the Project, the potential to cause adverse environmental impacts would be minimized.

Waste Management and Control During Construction Phase

Good Site Practices

5.4 Adverse environmental impacts in related to waste management are not expected, provided that good site practices are strictly followed. Recommendations for good site practices during the construction phase would include:

- Obtain relevant waste disposal permits from appropriate authorities, in accordance with the Waste Disposal Ordinance (Cap. 354) and subsidiary Regulations and the Land (Miscellaneous Provisions) Ordinance (Cap. 28);
- Provide staff training for proper waste management and chemical handling procedures;
- Provide sufficient waste disposal points and regular waste collection;
- Provide appropriate measures to minimize windblown litter and dust during transportation of waste by either covering trucks or by transporting wastes in enclosed containers;
- Carry out regular cleaning and maintenance programme for drainage systems, sumps and oil interceptors;
- Separate chemical wastes for special handling and disposed of to licensed facility for treatment; and
- Employ licensed waste collector to collect waste.

Waste Reduction Measures

5.5 Good management and control can prevent the generation of a significant amount of waste. Waste reduction is best achieved at the planning and design stage, as well as by ensuring the implementation of good site practices. Recommendations to achieve waste reduction include:

- Design foundation works that could minimise the amount of excavated material to be generated;
- Provide training to workers on the importance of site cleanliness and appropriate waste management procedures, including waste reduction, reuse and recycling;
- Sort out demolition debris and excavated materials from demolition works to recover reusable/ recyclable portions (i.e. soil, broken concrete, metal etc.);
- Segregate and store different types of waste in different containers, skips or stockpiles to enhance reuse or recycling of materials and their proper disposal;
- Encourage the collection of aluminum cans by providing separate labelled bins to enable this waste to be segregated from other general refuse generated by the workforce; and

- Plan and stock construction materials carefully to minimize the amount of waste to be generated and to avoid unnecessary generation of waste.

5.6 In addition to the above measures, specific mitigation measures are recommended below for the identified waste so as to minimise environmental impacts during handling, transportation and disposal of waste.

Construction & Demolition Materials

5.7 In order to minimise the impact resulting from collection and transportation of C&D material for off-site disposal, the excavated material arising from site formation and foundation works should be reused on-site as backfilling material and for landscaping works as far as practicable. Other mitigation requirements are listed below:

- A WMP, which becomes part of the Environmental Management Plan (EMP), should be prepared in accordance with ETWB TCW No.19/2005;
- A recording system for the amount of wastes generated, recycled and disposed of (including the disposal sites) should be adopted for easy tracking; and
- In order to monitor the disposal of excavated and C&D material at public filling facilities and landfills and to control fly-tipping, a trip-ticket system should be adopted (refer to ETWB TCW No. 31/2004).

5.8 The Contractor should prepare and implement an EMP in accordance with ETWB TCW No. 19/2005 which describes the arrangements for avoidance, reuse, recovery, recycling, storage, collection, treatment and disposal of different categories of waste to be generated from construction activities. Such a management plan should incorporate site specific factors, such as the designation of areas for segregation and temporary storage of reusable and recyclable materials. The EMP should be submitted to the Supervising Officer (SO) and Supervising Officer's Representative (SOR) for approval. The Contractor should implement waste management practices in the EMP throughout the construction stage of the Project. The EMP should be reviewed regularly and updated by the Contractor, preferably on a monthly basis.

5.9 All surplus excavated and C&D materials arising from or in connection with works should become the property of the Contractor when it is removed unless otherwise stated. The Contractor would be responsible for devising a system to work for on-site sorting of excavated and C&D materials and promptly removing all sorted and process materials arising from the construction activities to minimize temporary stockpiling on- site. The system should be included in the EMP identifying the source of generation, estimated quantity, arrangement for on-site sorting, collection, temporary storage areas and frequency of collection by recycling Contractors or frequency of removal off-site.

Chemical Waste

5.10 Should chemical wastes be produced at the construction site, the Contractor would be required to register with EPD as a Chemical Waste Producer and to follow the guidelines stated in the Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes. Good quality containers compatible with the chemical wastes should be used, and incompatible chemicals should be stored separately. Appropriate labels should be securely attached on each chemical waste container indicating the corresponding chemical characteristics of the chemical waste (such as explosive, flammable, oxidizing, irritant, toxic, harmful, or corrosive). The Contractor should employ a licensed collector to transport and dispose of the chemical wastes, to either the CWTC in Tsing Yi, or any other licensed facilities, in accordance with the Waste Disposal (Chemical Waste) (General) Regulation.

General Refuse

5.11 General refuse should be stored in enclosed bins or compaction units separated from C&D material. A licensed waste collector should be employed by the contractor to remove general refuse from the site,

separately from C&D material. Preferably an enclosed and covered area should be provided to reduce the occurrence of 'windblown' light material.

Waste Management and Control During Operation Phase

Good Site Practices

5.12 It is recommended that the following good operational practices should be adopted to minimise waste management impacts:

- Obtain the necessary waste disposal permits from the appropriate authorities, in accordance with the Waste Disposal Ordinance (Cap. 354), Waste Disposal (Chemical Waste) (General) Regulation and the Land (Miscellaneous Provision) Ordinance (Cap. 28);
- Nomination of an approved person to be responsible for good site practice, arrangements for collection and effective disposal to an appropriate facility of all wastes generated at the site;
- Use of a waste haulier licensed to collect specific category of waste;
- A trip-ticket system should be included as one of the contractual requirements and implemented by the Environmental Team to monitor the disposal of solid wastes at public filling facilities and landfills, and to control fly tipping. Reference should be made to ETWB TCW No. 31/2004.
- Training of site personnel in proper waste management and chemical waste handling procedures;
- Separation of chemical wastes for special handling and appropriate treatment at a licensed facility;
- Routine cleaning and maintenance programme for drainage systems, sumps and oil interceptors;
- Provision of sufficient waste disposal points and regular collection for disposal;
- Adoption of appropriate measures to minimize windblown litter and dust during transportation of waste, such as covering trucks or transporting wastes in enclosed containers; and
- Implementation of a recording system for the amount of wastes generated, recycled and disposed of (including the disposal sites).

Waste Reduction Measures

5.13 Good management and control can prevent the generation of significant amounts of waste. It is recommended that the following good operational practices should be adopted to ensure waste reduction:

- Segregation and storage of different types of waste in different containers, skips or stockpiles to enhance reuse or recycling of materials and their proper disposal;
- Encourage collection of aluminum cans, plastic bottles and packaging material (e.g. carton boxes) and office paper by individual collectors. Separate labelled bins should be provided to help segregate this waste from other general refuse generated by the work force; and
- Any unused chemicals or those with remaining functional capacity should be reused as far as practicable.

Wastes Generated from Pre-Treatment Process

5.14 Wastes generated from pre-treatment process should be recycled as far as possible. Wastes generated from pre-treatment process should also be separated from any chemical waste and stored in covered skips. The recyclables should be collected by licensed collectors, while the rest of the waste should be removed from the site on a daily basis to minimise odour, pest and litter impacts. Open burning must be strictly prohibited.

Chemical Wastes

5.15 Chemical waste generated from machinery maintenance and servicing should be managed in accordance with Code of Practice on the Packaging, Labelling and storage of Chemical Wastes under the provisions

of Waste Disposal (Chemical Waste) (General) Regulation. The chemical waste should be collected by drum-type containers and removed by licensed chemical waste contractors.

5.16 Plant / equipment maintenance schedules should be planned in order to minimize the generation of chemical waste.

5.17 Non-recyclable chemical wastes and lubricants should be disposed of at appropriate facilities, such as CWTC. Copies or counterfoils from collection receipts issued by the licensed waste collector should be kept for recording purpose.

5.18 Recyclable chemical waste will be transported off-site for treatment by a licensed collector. The Contractor will need to register with EPD as a chemical waste producer. Where possible, chemical wastes (e.g. waste lubricants) would be recycled at appropriate facilities, such as Dunwell's oil re-refinery.

General Refuse

5.19 Waste generated in offices should be reduced through segregation and collection of recyclables. To promote the recycling of wastes such as used paper, aluminium cans and plastic bottles, it is recommended that recycling bins should be clearly labelled and placed at locations with easy access. For the collection of recyclable materials, they should be collected by licensed collectors.

5.20 General refuse, other than segregated recyclable wastes, should be separated from any chemical waste and stored in covered skips. The general refuse should be removed from the site on a daily basis to minimise odour, pest and litter impacts. Also, open burning of refuse must be strictly prohibited.

Approaches to Prevent Land Contamination

Fuel Oil Spillage Prevention

5.21 Precautionary measures to prevent fuel oil spillage are as follows:

(i) Fuel Oil Containers

- Fuel oil should be stored in suitable containers.
- All fuel oil containers should be securely closed.
- Appropriate labels showing the name of fuel oil should be posted on the containers.
- Drip trays should be provided for all containers.

(ii) Storage Area

- Distance between the fuel oil refuelling points and the fuel oil containers should be minimized.
- The storage area should be used for fuel oil storage only.
- No surface water drains or foul sewers should be connected to the storage area.
- The storage area should be enclosed by three sides by a wall and have an impermeable floor or surface.

(iii) Fuel Oil Spillage Response

- An Oil Spill Response Plan should be prepared by the operator to document the appropriate response procedures for oil spillage incidents in detail. General procedures to be taken in case of fuel oil spillage are presented below.

  - <u>Training</u>

    Training on oil spill response actions should be given to relevant staff. The training should cover the followings:

- Tools & resources to combat oil spillage and fire, e.g. locations of oil spill handling equipment and firefighting equipment;
- General methods to deal with oil spillage and fire incidents;
- Procedures for emergency drills in the event of oil spills and fire; and
- Regular drills should be carried out.

- Communication

Establish communication channel with the Fire Services Department (FSD) and EPD to report any oil spillage incident so that necessary assistance from relevant department could be quickly sought.

- Response Procedures

Any fuel oil spillage within the Project Site should be immediately reported to the Site Manager with necessary details including location, source, possible cause and extent of the spillage.

Site Manager should immediately attend to the spillage and initiate any appropriate action to confine and clean up the spillage. The response procedures should include the following:

- Identify and isolate the source of spillage as soon as possible.
- Contain the oil spillage and avoid infiltration into soil/ groundwater and discharge to storm water channels.
- Remove the oil spillage.
- Clean up the contaminated area.
- If the oil spillage occurs during refuelling, the refuelling operation should immediately be stopped.
- Recovered contaminated fuel oil and the associated material to remove the spilled oil should be considered as chemical waste. The handling and disposal procedures for chemical wastes are discussed in the following paragraphs.

Chemicals and Chemical Wastes Handling & Spillage Prevention

5.22 The precautionary measures to prevent improper handling / use of chemicals and chemical waste spillage are presented below:

(i) Chemicals and Chemical Wastes Handling & Storage

- Chemicals and chemical wastes should only be stored in suitable containers in purpose-built areas.
- The storage of chemical wastes should comply with the requirements of the Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes.
- The storage areas for chemicals and chemical wastes should have an impermeable floor or surface. The impermeable floor / surface should possess the following properties:
  - Not liable to chemically react with the materials and their containers to be stored.
  - Able to withstand normal loading and physical damage caused by container handling
  - The integrity and condition of the impermeable floor or surface should be inspected at regular intervals to ensure that it is satisfactorily maintained
- For liquid chemicals and chemical wastes storage, the storage area should be bunded to contain at least 110% of the storage capacity of the largest containers or 20% of the total quantity of the chemicals/chemical wastes stored, whichever is the greater.
- Storage containers should be checked at regular intervals for their structural integrity and to ensure that the caps or fill points are tightly closed.
- Chemical handling should be conducted by trained workers under supervision.

(ii) Chemicals and Chemical Wastes Spillage Response

- A Chemicals and / or Chemical Wastes Spillage Response Plan should be prepared by the operator to document in detail the appropriate response procedures for chemicals or chemical wastes spillage incidents. General procedures to be undertaken in case of chemicals / chemical waste spillages are presented below:

  - Training

    Training on spill response actions should be given to relevant staff. The training should cover the followings:

    - Tools & resources to handle spillage, e.g. locations of spill handling equipment;
    - General methods to deal with spillage; and
    - Procedures for emergency drills in the event of spills.

  - Communication

    Establish communication channel with Fire Services Department (FSD) and EPD to report the spillage incident so that necessary assistance from relevant department could be quickly sought.

  - Response Procedures

    Any spillage within OWTF site should be reported to the Site Manager.

    Site Manager shall attend to the spillage and initiate any appropriate actions needed to confine and clean up the spillage. The response procedures should include the followings:

    - Identify and isolate the source of spillage as soon as possible;
    - Contain the spillage and avoid infiltration into soil / groundwater and discharge to storm water channels (in case the spillage occurs at locations out of the designated storage areas);
    - Remove the spillage; the removal method / procedures documented in the Material Safety Data Sheet (MSDS) of the chemicals spilled should be observed;
    - Clean up the contaminated area (in case the spillage occurs at locations out of the designated storage areas); and
    - The waste arising from the cleanup operation should be considered as chemical wastes.

Incident Record

5.23 After any spillage, an incident report should be prepared by the Site Manager. The incident report should contain details of the incident including the cause of the incident, the material spilled and estimated spillage amount, and also the response actions undertaken. The incident record should be kept carefully and able to be retrieved when necessary.

5.24 The incident report should provide sufficient details for the evaluation of any environmental impacts due to the spillage and assessment of the effectiveness of measures taken.

5.25 In case any spillage or accidents results in significant land contamination, EPD should be informed immediately and the Project operator should be responsible for the cleanup of the affected area. The responses procedures described in Sections 6.65 - 6.66 of the EIA Report should be followed accordingly together with the land contamination assessment and remediation guidelines stipulated in the Guidance Manual for Use of Risk-based Remediation Goals for Contaminated Land Management and the Guidance Note for Contaminated Land Assessment and Remediation.

6. LANDSCAPE AND VISUAL

Introduction

6.1 EM&A for landscape and visual resources shall be undertaken by the Contractor during the design, construction and operation phases of the Project. This section presents the requirements of the baseline review, and the monitoring of the design, implementation and maintenance of the landscape and visual mitigation measures during the design, construction and operation phases of the Project.

Baseline Review

6.2 A baseline review shall be undertaken prior to the commencement of the construction works. The purposes of the review are as follows:-

- To check the status and any changes of the baseline Landscape Resources, Landscape Character areas and Visually Sensitive Receivers (VSRS) within and immediately adjacent to the works areas;
- To determine whether amendments in the design of the landscape and visual mitigation measures are required; and
- To recommend any necessary amendments to the design of the landscape and visual mitigation measures due to the above changes, if any.

6.3 Any changes to the mitigation measures that may be recommended as a result of the baseline review shall be taken into account.

Mitigation Measures

6.4 The landscape and visual impact assessment of the EIA Study recommended a series of mitigation measures to ameliorate the potential landscape and visual impacts of the Project. The measures for both the construction and operation phases as recommended in the EIA Report are summarised in **Table 6.1** and **Table 6.2**.

Table 6.1 Proposed Landscape and Visual Mitigation Measures for Construction Phase

ID No.	Landscape and Visual Mitigation Measures	Funding Agency	Implementation	Maintenance/ Management Agency
CM1	Topsoil, where identified, should be stripped and stored for re-use in the construction of the soft landscape works, where practical.	EPD	EPD (via Contractor)	EPD (via Contractor)
CM2	Compensatory tree planting should be provided to compensate for felled trees.	EPD	EPD (via Contractor)	EPD (via Contractor)
CM3	Control of night-time lighting.	EPD	EPD (via Contractor)	EPD (via Contractor)
CM4	Erection of decorative screen hoarding compatible with the surrounding setting.	EPD	EPD (via Contractor)	EPD (via Contractor)

Table 6.2 Proposed Landscape and Visual Mitigation Measures for Operation Phase

ID No.	Landscape and Visual Mitigation Measures	Funding Agency	Implementation	Maintenance / Management
OM1	Aesthetic design of the façade, including its colour theme, pattern, texture, materials, finishing, and associated structures to harmonize with the surrounding settings.	EPD	EPD (via Contractor)	EPD (via Contractor)
OM2	Grass/ groundcover planting to soften the roof.	EPD	EPD (via Contractor)	EPD (via Contractor)
OM3	Heavy standard tree planting to screen proposed associated structures.	EPD	EPD (via Contractor)	EPD (via Contractor)
OM4	Grasscrete paving to soften the harshness of large paved surface areas wherever possible.	EPD	EPD (via Contractor)	EPD (via Contractor)

Design Phase Audit

6.5 The Contractor shall incorporate the recommended mitigation measures, including the design theme and urban design concept, master layout, building form, massing, façade, overall design and landscape treatment, in the detailed design and shall ensure the potential conflicts of the mitigation measures with the works under the Project and other interfacing projects are resolved prior to construction.

6.6 Audits of the detailed design against the recommendations of the landscape and visual impact assessments within the EIA should be undertaken by a Registered Landscape Architect (RLA) to ensure that they fulfil the intentions of mitigation measures.

Construction and Operational Phase Audits

6.7 A specialist Landscape Sub-Contractor (on the approved Government list) shall be employed by the Contractor for the implementation of landscape establishment works and the compensatory planting, as well as the subsequent maintenance operations during the one-year maintenance period which will be the first operational year of the Project.

6.8 All measures, including compensatory planting, undertaken by both the Contractor and the specialist Landscape Sub-Contractor during the construction phase and the first year of the operation phase shall be audited by a Registered Landscape Architect on a regular basis to ensure compliance with the intended aims of the measures and the effectiveness of the mitigation measures.

6.9 Site inspections should be undertaken at least once every two weeks throughout the construction period, and once every month during the first operational year. After the one-year maintenance period, the landscape maintenance and monitoring shall be carried out by the Contractor.

6.10 If there is repeated non-compliance of the landscape and visual mitigation measures, EPD shall be notified as necessary.

7. NOISE

Introduction

7.1 As the noise sensitive receivers identified in this EIA study are located more than 1km away from the Project boundary and substantially screened by natural terrain, no adverse construction and operation noise impact would be anticipated. In this regard, EM&A programme for both construction and operation phases of the Project would not be considered necessary. Notwithstanding this, the Contractor shall be responsible for implementation of good site practices to minimize the noise nuisance as far as practicable.

Good Site Practices

7.2 Good site practices during construction phase are suggested as below:

- Only well-maintained plant should be operated on-site and plant should be serviced regularly during the construction program;
- Mobile plant, if any, should be sited as far from NSRs as possible;
- Machines and plant (such as trucks) that may be in intermittent use should be shut down between work periods or should be throttled down to a minimum;
- Plant known to emit noise strongly in one direction should, wherever possible, be orientated so that the noise is directed away from the nearby NSRs; and
- Material stockpiles and other structures should be effectively utilized, wherever practicable, in screening noise from on-site construction activities.

7.3 The implementation schedule for the recommended mitigation measures is presented in **Appendix A**.

8 ENVIRONMENTAL AUDITING

Site Inspection

8.1 Site inspection provides a direct means to initiate and enforce specified environmental protection and pollution control measures. These should be undertaken routinely to inspect construction activities in order to ensure that appropriate environmental protection and pollution control mitigation measures are properly implemented. The site inspection is one of the most effective tools to enforce the environmental protection requirements at the works area.

8.2 The ET Leader should be responsible for formulating the environmental site inspection, the deficiency and action reporting system, and for carrying out the site inspection works. He / she should submit a proposal for site inspection and deficiency and action reporting procedures to the Contractor for agreement, and to the SOR for approval. The ET's proposal for rectification would be made known to the IEC.

8.3 Regular site inspections should be carried out at least once per week. The areas of inspection should not be limited to the environmental situation, pollution control and mitigation measures within the site, the site inspections should also review the environmental situation outside the works area which is likely to be affected, directly or indirectly, by the site activities. The ET Leader should make reference to the following information in conducting the inspection:

(i) The EIA and EM&A recommendations on environmental protection and pollution control mitigation measures;

(ii) Ongoing results of the EM&A programme;

(iii) Work progress and programme;

(iv) Individual work methodology proposals (which shall include proposal on associated pollution control measures);

(v) Contract specifications on environmental protection;

(vi) Relevant environmental protection and pollution control laws; and

(vii) Previous site inspection results undertaken by the ET and others.

8.4 The Contractor should keep the ET Leader updated with all relevant information on the construction contract necessary for him / her to carry out the site inspections. Inspection results and associated

recommendations for improvements to the environmental protection and pollution control works should be submitted to the IEC and the Contractor within 24 hours for reference and for taking immediate action. The Contractor should follow the procedures and time-frame as stipulated in the deficiency and action reporting system formulated by the ET Leader to report on any remedial measures subsequent to the site inspections.

8.5 The ET should also carry out ad hoc site inspections if significant environmental problems are identified. Inspections may also be required subsequent to receipt of environmental complaint, or as part of the investigation work, as specified in the Action Plan for EM&A.

Compliance with Legal and Contractual Requirements

8.6 There are contractual environmental protection and pollution control requirements as well as environmental protection and pollution control laws in Hong Kong with which construction activities must comply.

8.7 In order to ensure that the works are undertaken in compliance with the contractual requirements on environmental aspects, all works method statements submitted by the Contractor to the SOR for approval should be sent to the ET Leader for vetting to see whether sufficient environmental protection and pollution control measures have been included. The implementation schedule of mitigation measures is summarised in Appendix A.

8.8 The ET Leader should also review the progress and programme of the works to check that relevant environmental laws have not been violated, and that any foreseeable potential for violating laws could be prevented.

8.9 The Contractor should regularly copy relevant documents to the ET Leader so that works checking could be carried out. The document should at least include the updated Works Progress Reports, updated Works Programme, any application letters for different licence / permits under the environmental protection laws, and copies of all valid licences/ permits. The site diary should also be available for the ET Leader's inspection upon his / her request.

8.10 After reviewing the documentation, the ET Leader should advise the IEC and the Contractor of any non-compliance with contractual and legislative requirements on environmental protection and pollution control for them to take follow-up actions. If the ET Leader's review concludes that the current status on licence / permit application and any environmental protection and pollution control preparation works may result in potential violation of environmental protection and pollution control requirements, he / she should also advise the Contractor and the SOR accordingly.

8.11 Upon receipt of the advice, the Contractor should undertake immediate action to correct the situation. The SOR should follow up to ensure that appropriate action has been taken to satisfy contractual and legal requirements.

Environmental Complaints

8.12 Complaints should be referred to the ET Leader for action. The ET Leader should undertake the following procedures upon receipt of any complaint:

(i) log complaint and date of receipt onto the complaint database and inform the IEC immediately;

(ii) investigate the complaint to determine its validity, and assess whether the source of the problem is due to works activities;

(iii) identify mitigation measures in consultation with the IEC if a complaint is valid and due to works;

(iv) advise the Contractor if mitigation measures are required;

(v) review the Contractor's response on the identified mitigation measure(s) and the updated situation;

(vi) if the complaint is transferred from the EPD, submit interim report to the EPD on status of the complaint investigation and follow-up action within the time frame assigned by the EPD;

(vii) undertake additional monitoring and audit to verify the situation if necessary, and review that circumstances leading to the complaint do not recur;

(viii) report investigation results and subsequent actions to complainant (if the source of complaint is EPD, the results should be reported within the timeframe assigned by the EPD); and

(ix) record the complaint, investigation, the subsequent actions and the results in the monthly EM&A reports.

8.13 A flowchart indicating the complaint handling procedures is presented in **Figure 1.6**

9. REPORTING

General

9.1 The EM&A reporting shall be carried out in paper based plus electronic submission upon agreeing the format with the SOR and EPD. All the monitoring data (baseline and impact) shall also be submitted in CD-ROM.

9.2 Types of reports that the ET Leader should prepare and submit include baseline monitoring report, monthly EM&A report, quarterly EM&A summary report and final EM&A review report. In accordance with Annex 21 of the EIAO-TM, a copy of the monthly, quarterly summary and final review EM&A reports should be made available to the Director of Environmental Protection.

Baseline Monitoring Report

9.3 The ET Leader should prepare and submit a Baseline Environmental Monitoring Report within 10 working days of completion of the baseline monitoring. Copies of the Baseline Environmental Monitoring Report should be submitted to the Contractor, the IEC, the SOR and the EPD. The ET Leader should liaise with the relevant parties on the exact number of copies they require. The report format and baseline monitoring data format should be agreed with the EPD prior to submission.

9.4 The baseline monitoring report should include at least the followings:

(i) up to half a page executive summary;

(ii) brief project background information;

(iii) drawings showing locations of the baseline monitoring stations;

(iv) monitoring results (in both hard and soft copies) together with the following information:

- monitoring methodology;
- types of equipment used and calibration details;
- parameters monitored;
- monitoring locations;
- monitoring date, time, frequency and duration; and
- quality assurance (QA) / quality control (QC) results and detection limits;

(v) details of influencing factors, including:

- major activities, if any, being carried out on the site during the period;
- weather conditions during the period; and
- other factors which might affect results;

(vi) determination of the action and limit levels for each monitoring parameter and statistical analysis of the baseline data, the analysis should conclude if there is any significant difference between control and impact stations for the parameters monitored;

(vii) revisions for inclusion in the EM&A Manual; and

(viii) comments, recommendations and conclusions.

Monthly EM&A Report

9.5 The results and findings of all EM&A work required in the Manual should be recorded in the monthly EM&A reports prepared by the ET Leader. The EM&A report should be prepared and submitted within 10 working days of the end of each reporting month, with the first report due the month after construction commences. Each monthly EM&A report should be submitted to the following parties: the Contractor, the IEC, the SOR and the EPD. Before submission of the first EM&A report, the ET Leader should liaise with the parties on the required number of copies and format of the monthly reports in both hard copy and electronic medium.

9.6 The ET leader should review the number and location of monitoring stations and parameters every six months, or on as needed basis, in order to cater for any changes in the surrounding environment and the nature of works in progress.

First Monthly EM&A Report

9.7 The first monthly EM&A report should include at least the following:

(i) executive summary (1-2 pages):

- breaches of Action and Limit levels;
- complaint log;
- notifications of any summons and successful prosecutions;
- reporting changes; and
- future key issues.

(ii) basic project information:

- project organisation including key personnel contact names and telephone numbers;
- construction programme;

- management structure, and
- works undertaken during the month;

(iii) environmental status:

- works undertaken during the month with illustrations (such as location of works); and
- drawings showing the project area, any environmental sensitive receivers and the locations of the monitoring and control stations (with co-ordinates of the monitoring locations);

(iv) a brief summary of EM&A requirements including:

- all monitoring parameters;
- environmental quality performance limits (Action and Limit levels);
- Event-Action Plans;
- environmental mitigation measures, as recommended in the project EIA Final Report; and
- environmental requirements in contract documents;

(v) implementation status:

- advice on the implementation status of environmental protection and pollution control / mitigation measures, as recommended in the project EIA Final Report;

(vi) monitoring results (in both hard and soft copies) together with the following information:

- monitoring methodology;
- name of types of equipment used and calibration details;
- parameters monitored;
- monitoring locations;
- monitoring date, time, frequency, and duration;
- weather conditions during the period;
- any other factors which might affect the monitoring results; and
- QA/QC results and detection limits;

(vii) report on non-compliance, complaints, and notifications of summons and successful prosecutions:

- record of all non-compliance (exceedances) of the environmental quality performance limits (Action and Limit levels);
- record of all complaints received (written or verbal) for each media, including locations and nature of complaints investigation, liaison and consultation undertaken, actions and follow-up procedures taken, results and summary;
- record of all notification of summons and successful prosecutions for breaches of current environmental protection / pollution control legislation, including locations and nature of

the breaches, investigation, follow-up actions taken, results and summary;

- review of the reasons for and the implications of non-compliance, complaints, summons and prosecutions including review of pollution sources and working procedures; and
- description of the actions taken in the event of non-compliance and deficiency reporting and any follow-up procedures related to earlier non-compliance;

(viii) others

- an account of the future key issues as reviewed from the works programme and work method statements;
- advice on the solid and liquid waste management status; and
- comments (for examples, effectiveness and efficiency of the mitigation measures), recommendations (for example, any improvement in the EM&A programme) and conclusions.

Subsequent Monthly EM&A Reports

9.8 Subsequent monthly EM&A reports should include the following:

(i) executive summary (1 - 2 pages):

- breaches of Action and Limit levels;
- complaints log;
- notifications of any summons and successful prosecutions;
- reporting changes; and
- future key issues.

(ii) environmental status:

- works undertaken during the month with illustrations (such as location of works etc.); and
- drawing showing the project area, any environmental sensitive receivers and the locations of the monitoring and control stations.

(iii) implementation status:

- advice on the implementation status of environmental protection and pollution control / mitigation measures, as recommended in the project EIA;

(iv) monitoring results (in both hard and soft copies) together with the following information:

- monitoring methodology;
- name of types of equipment used and calibration details;
- parameters monitored;
- monitoring locations;
- monitoring date, time, frequency, and duration;
- weather conditions during the period;
- any other factors which might affect the monitoring results; and
- QA / QC results and detection limits.

(v) report on non-compliance, complaints, and notifications of summons and successful prosecutions:

- record of all non-compliance (exceedances) of the environmental quality performance limits (action and limit levels);
- record of all complaints received (written or verbal) for each media, including locations and nature of complaints investigation, liaison and consultation undertaken, actions and follow-up procedures taken, results and summary;
- record of all notification of summons and successful prosecutions for breaches of current environmental protection / pollution control legislation, including locations and nature of the breaches, investigation, follow-up actions taken, results and summary;
- review of the reasons for and the implications of non-compliance, complaints, summons and prosecutions including review of pollution sources and working procedures; and
- description of the actions taken in the event of non-compliance and deficiency reporting and any follow-up procedures related to earlier non-compliance.

(vi) others

- an account of the future key issues as reviewed from the works programme and work method statements;
- advice on the solid and liquid waste management status; and
- comments (for examples, effectiveness and efficiency of the mitigation measures), recommendations (for example, any improvement in the EM&A programme) and conclusions.

(vii) appendix

- action and limit levels;
- graphical plots of trends of monitored parameters at key stations over the past four reporting periods for representative monitoring stations annotated against the following:
- major activities being carried out on site during the period;
- weather conditions during the period; and
- any other factors that might affect the monitoring results.

- monitoring schedule for the present and next reporting period;
- cumulative statistics on complaints, notifications of summons and successful prosecutions; and
- outstanding issues and deficiencies.

Quarterly EM&A Summary Reports

9.9 A quarterly EM&A summary report of around five pages should be produced and should contain at least the following information.

(i) up to half a page executive summary;

(ii) basic project information including a synopsis of the project organisation, programme, contacts of key management, and a synopsis of works undertaken during the quarter;

(iii) a brief summary of EM&A requirements including:

- monitoring parameters;
- environmental quality performance limits (action and limit levels); and
- environmental mitigation measures, as recommended in the project EIA Final Report;

(iv) advice on the implementation status of environmental protection and pollution control / mitigation measures, as recommended in the project EIA Final Report, summarised in the updated implementation schedule;

(v) drawings showing the project area, any environmental sensitive receivers and the locations of the monitoring and control stations;

(vi) graphical plots of any trends in monitored parameters over the past four months (the last month of the previous quarter and the present quarter) for representative monitoring stations annotated against:

- the major activities being carried out on site during the period;
- weather conditions during the period; and
- any other factors which might affect the monitoring results;

(vii) advice on the solid and liquid waste management status;

(viii) a summary of non-compliance (exceedances) of the environmental quality performance limits (action and limit levels);

(ix) a brief review of the reasons for and the implications of any non-compliance, including a review of pollution sources and working procedures;

(x) a summary description of actions taken in the event of non-compliance and any follow-up procedures related to any earlier non-compliance;

(xi) a summarised record of all complaints received (written or verbal) for each media, liaison and consultation undertaken, actions and follow-up procedures taken;

(xii) comments (for examples, a review of the effectiveness and efficiency of the mitigation measures); recommendations (for example, any improvement in the EM&A programme) and conclusions for the quarter; and

(xiii) proponents' contacts and any hotline telephone number for the public to make enquiries.

Final EM&A Review Report

9.10 The final EM&A report should include, inter alia, the following information:

(i) an executive summary;

(ii) drawings showing the project area, any environmental sensitive receivers and the locations of the monitoring and control stations;

(iii) basic project information including a synopsis of the project organisation, contacts of key management, and a synopsis of work undertaken during the entire construction period;

(iv) a brief summary of EM&A requirements including:

- monitoring parameters;
- environmental quality performance limits (action and limit levels); and
- environmental mitigation measures, as recommended in the project EIA Final Report;
- Event-Action Plans.

(v) a summary of the implementation status of environmental protection and pollution control/mitigation measures, as recommended in the project EIA Report, summarised in the updated implementation schedule;

(vi) graphical plots of the trends of monitored parameters over the construction period for

representative monitoring stations, including the post-project monitoring annotated against:

- the major activities being carried out on site during the period;
- weather conditions during the period; and
- any other factors which might affect the monitoring results.

(vii) a summary of non-compliance (exceedances) of the environmental quality performance limits (action and limit levels);

(viii) a brief review of the reasons for and the implications of non-compliance including review of pollution sources and working procedures as appropriate;

(ix) a summary description of the actions taken in the event of non-compliance and any follow-up procedures related to earlier non-compliance;

(x) a summary record of all complaints received (written or verbal) for each media, liaison and consultation undertaken, actions and follow-up procedures taken;

(xi) a summary record of notifications of summons and successful prosecutions for breaches of the current environmental protection/pollution control legislations, locations and nature of the breaches, investigation, follow-up actions taken and results;

(xii) a review of the validity of EIA predictions and identification of shortcomings in EIA recommendations; and

(xiii) comments (for examples, a review of the effectiveness and efficiency of the mitigation measures and of the performance of the environmental management system, that is, of the overall EM&A programme);

(xiv) recommendations and conclusions (for example, a review of success of the overall EM&A programme to cost-effectively identify deterioration and to initiate prompt effective mitigation action when necessary).

Data Keeping

9.11 No site-based documents (such as monitoring field records, laboratory analysis records, site inspection forms, etc.) are required to be included in the monthly EM&A reports. However, any such document should be well kept by the ET Leader and be ready for inspection upon request. All relevant information should be clearly and systematically recorded in the document. Monitoring data should also be recorded in magnetic media form, and the software copy must be available upon request. Data format should be agreed with EPD. All documents and data should be kept for at least one year following completion of the construction contract.

Interim Notifications of Environmental Quality Limit Exceedances

9.12 With reference to the Event and Action Plan, when the environmental quality performance limits are exceeded, the ET Leader should immediately notify the IEC and EPD, as appropriate. The notification should be followed up with advice to IEC and EPD on the results of the investigation, proposed actions and success of the actions taken, with any necessary follow-up proposals. A sample template for the interim notifications is presented in **Appendix B**.

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[1] The OWTF Phase I Development will be procured using a design-build-operate (DBO) contract form. Under such type of contract, the contract administration and site supervision works are to be undertaken by the Supervising Officer (SO) and the Supervising Officer's Representative (SOR), which are equivalent to the roles of the Engineer and the Engineer's Representative respectively in traditional form of construction contracts.

[2] The Environmental Team, i.e. the Team Leader and his supporting staff, will be employed by the Employer of the Project, i.e. the Environmental Protection Department (EPD).

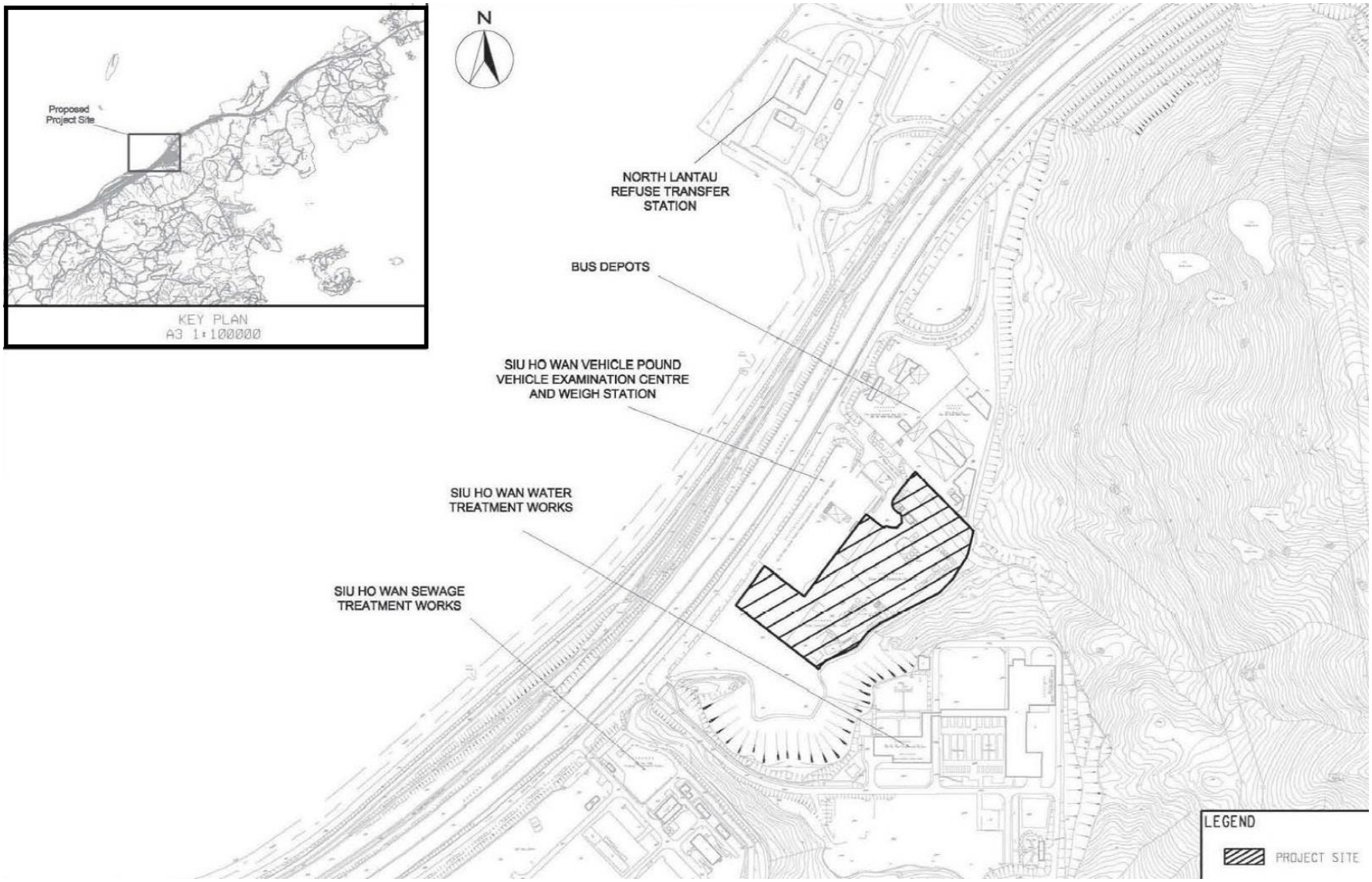

Figure 1.1 Location Plan of Proposed OWTF Phase 1 Development

OSCAR Bioenergy Joint Venture

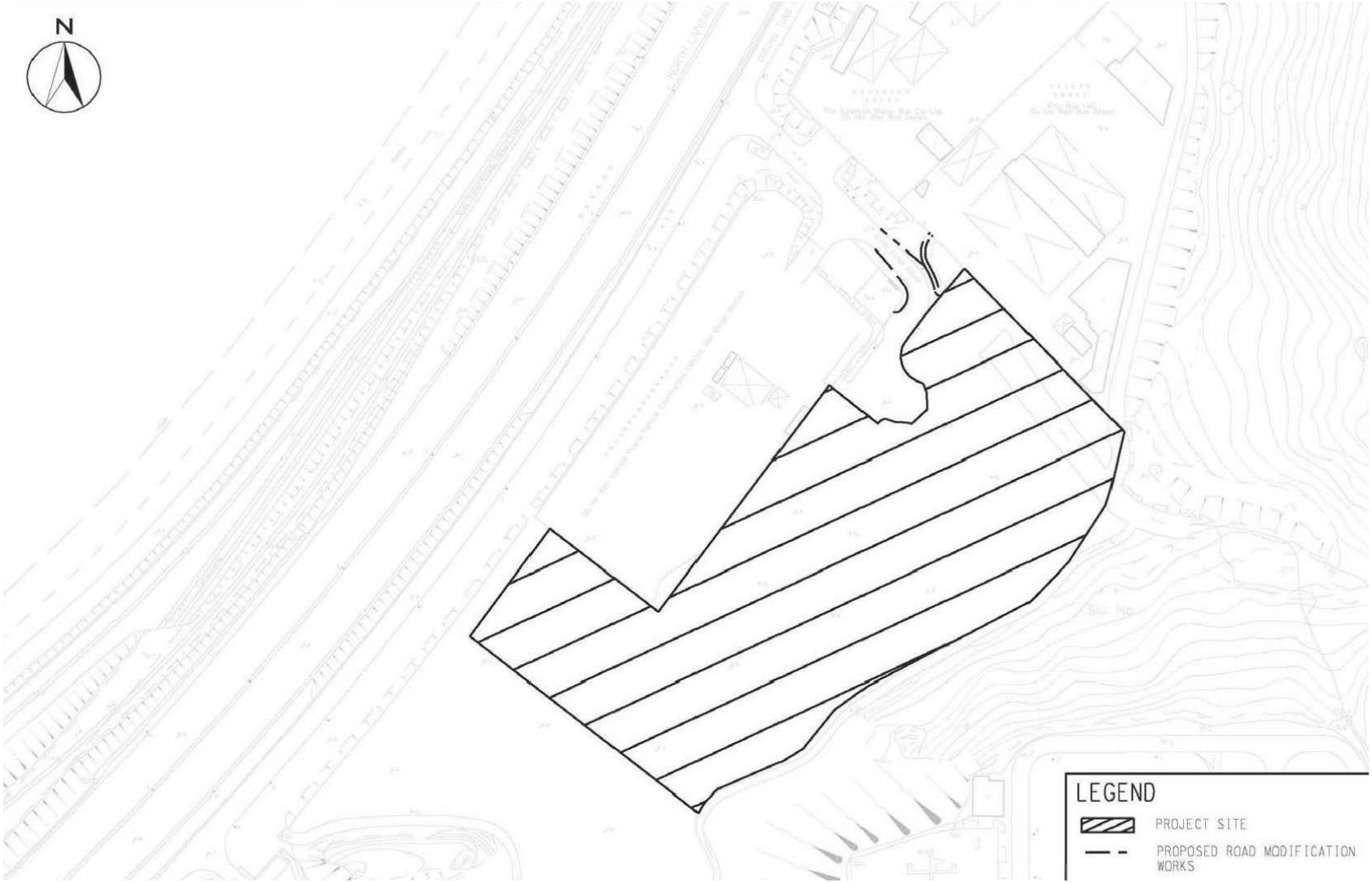

Figure 1.2 Project Area Boundary of Proposed OWTF Phase 1 Development

OSCAR Bioenergy Joint Venture

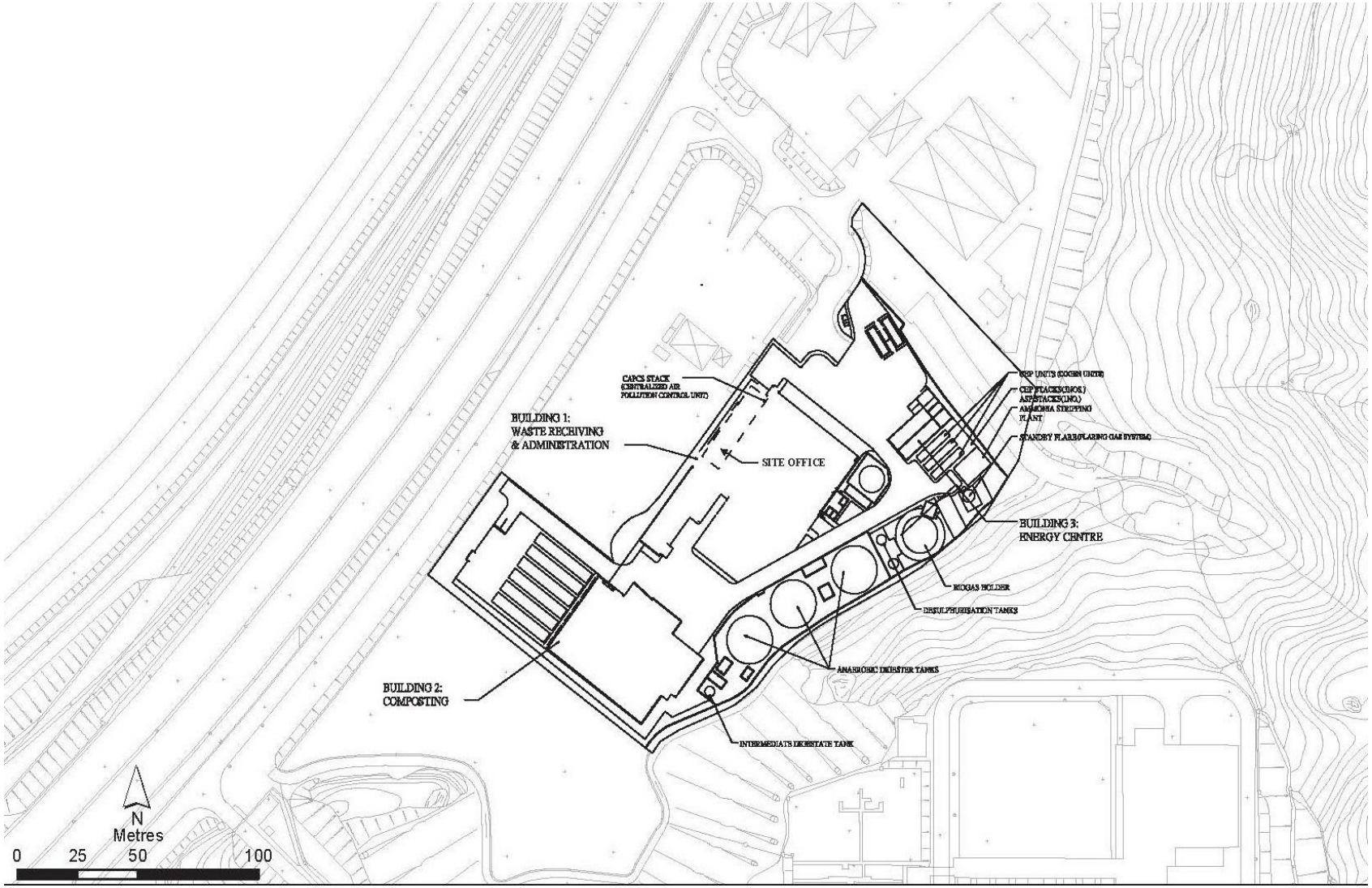

Figure 1.3 Site Layout Plan

OSCAR Bioenergy Joint Venture

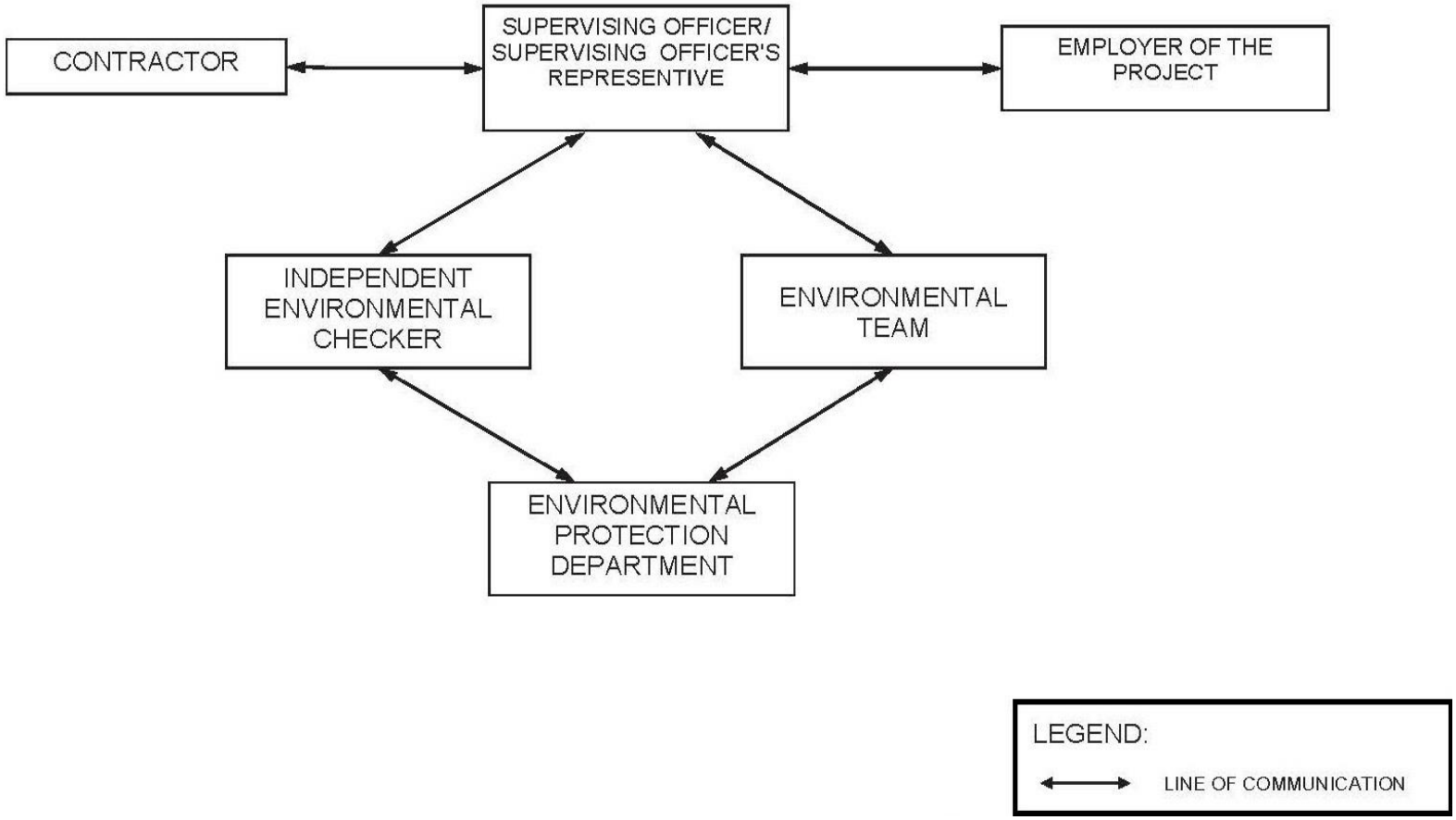

Figure 1.4 Project Organization – EM&A Program For Construction Phase

OSCAR Bioenergy Joint Venture

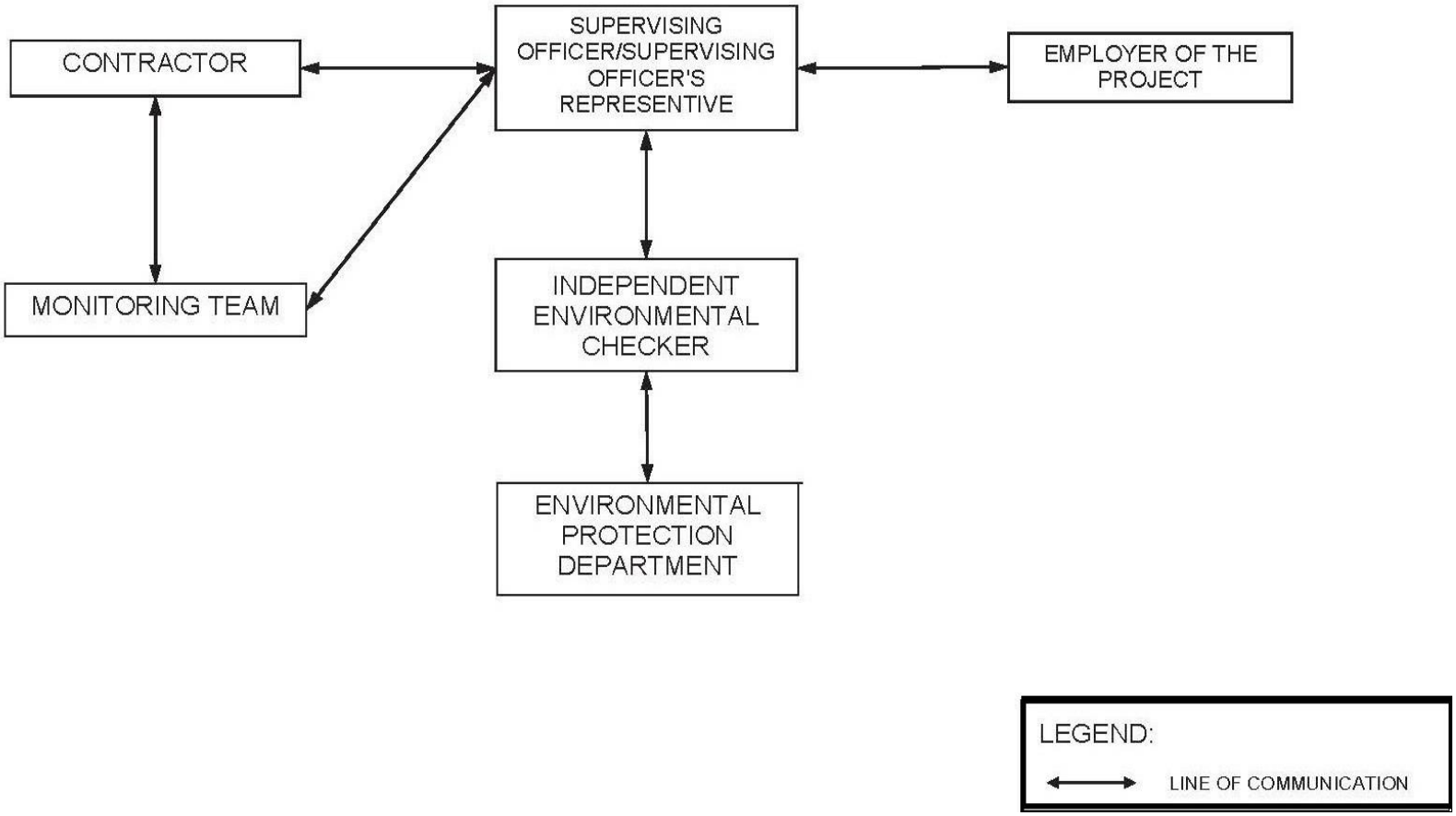

Figure 1.5 Project Organization – EM&A Program for Operation Phase

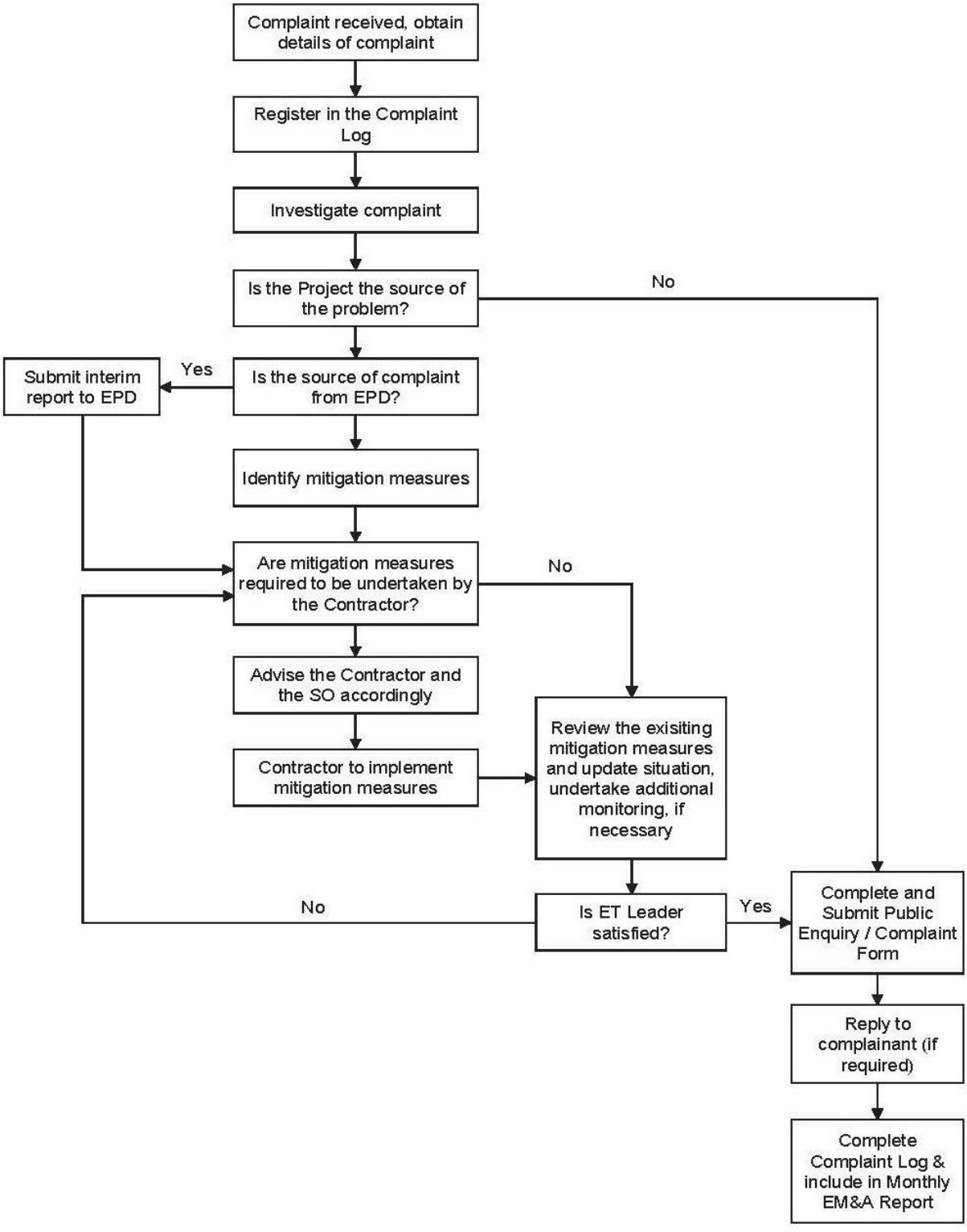

Figure 1.6 Environmental Complaint Flow Diagram

Appendix A
Implementation Schedule of Mitigation Measure

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Appendix A Implementation Schedule of Mitigation Measures

EIA Ref	EM&A Log Ref.	Environmental Protection Measures*	Location /Duration of measures/ Timing of completion of measures	Implementation Agent	Implementation Stages**				Relevant Legislation and Guidelines
					Des	C	O	Dec	
A Air Quality									
3.73	2.5	*Air Pollution Control (Construction Dust) Regulation & Good Site Practices* • Use of regular watering, with complete coverage, to reduce dust emissions from exposed site surfaces and unpaved roads, particularly during dry weather. • Use of frequent watering for particularly dusty construction areas and areas close to ASRs. • Side enclosure and covering of any aggregate or dusty material storage piles to reduce emissions. Where this is not practicable owing to frequent usage, watering should be applied to aggregate fines. • Open stockpiles should be avoided or covered. Where possible, prevent placing dusty material storage piles near ASRs. • Tarpaulin covering of all dusty vehicle loads transported to, from and between site locations. • Establishment and use of vehicle wheel and body washing facilities at the exit points of the site. • Provision of wind shield and dust extraction units or similar dust mitigation measures at the loading points, and use of water sprinklers at the loading area where dust generation is likely during the loading	Construction Site/During Construction Period	Contractor		√			Air Pollution Control (Construction Dust) Regulation

EIA Ref	EM&A Log Ref.	Environmental Protection Measures*	Location /Duration of measures/ Timing of completion of measures	Implementation Agent	Implementation Stages**				Relevant Legislation and Guidelines
					Des	C	O	Dec	
		process of loose material, particularly in dry seasons/ periods. • Imposition of speed controls for vehicles on unpaved site roads. 8 kilometers per hour is the recommended limit. • Where possible, routing of vehicles and positioning of construction plant should be at the maximum possible distance from ASRs. • Every stock of more than 20 bags of cement or dry pulverised fuel ash (PFA) should be covered entirely by impervious sheeting or placed in an area sheltered on the top and the 3 sides. • Cement or dry PFA delivered in bulk should be stored in a closed silo fitted with an audible high level alarm which is interlocked with the material filling line and no overfilling is allowed. • Loading, unloading, transfer, handling or storage of bulk cement or dry PFA should be carried out in a totally enclosed system or facility, and any vent or exhaust should be fitted with an effective fabric filter or equivalent air pollution control system.							
3.78	2.7 & 2.13 – 2.19	• Commissioning tests shall be conducted to confirm the centralized air pollution control unit, the cogen units, the standby flaring unit and ASP against the design emission levels as stated in **Tables 2.2 – 2.5.** • Odour monitoring shall be conducted at the stack exhaust of the centralized air pollution control unit weekly in the first month of the commissioning stage.	OWTF Stacks/ During Design & Commissioning Stage	Contractor	√		√		EIAO-TM

EIA Ref	EM&A Log Ref.	Environmental Protection Measures*	Location /Duration of measures/ Timing of completion of measures	Implementation Agent	Implementation Stages**				Relevant Legislation and Guidelines
					Des	C	O	Dec	
3.78	2.7-2.12	*Air Pollution Control and Stack Monitoring* • Stack monitoring shall be installed for the centralized air pollution control unit, cogen units and ASP of OWTF to ensure that the air emissions from OWTF would meet the design emission limits as well as EPD criteria.	OWTF Stacks/ During design & Operation	OWTF Operator	√		√		EIAO-TM
3.78	2.20-2.28	• Odour Patrol at site boundary of OWTF	OWTF Site Boundary/During Operation (The need to continue the odour patrol after the end of the 2-year monitoring period would depend on the monitoring results and should be agreed with EPD)	OWTF Operator	√		√		EIAO-TM
B Hazard to Life									
4.102	3.3	*Construction Phase* • The number of workers on site during construction stage should be kept at the same level as the assessment. • Construction works should be suspended when delivery of chlorine takes place. • 3m high fence should be constructed along the boundary facing the SHWWTW.	Construction Site/ During Construction Period	Contractor		√			

EIA Ref	EM&A Log Ref.	Environmental Protection Measures*	Location /Duration of measures/ Timing of completion of measures	Implementation Agent	Implementation Stages**				Relevant Legislation and Guidelines
					Des	C	O	Dec	
		• Emergency evacuation procedures should be formulated and the Contractor should ensure all workers on site should be familiar with these procedures as well as the route to escape in case of gas release incident. Relevant Departments, such as Fire Services Department (FSD), should be consulted during the development of Emergency procedures. Diagram showing the escape routes to a safe place should be posted in the site notice boards and at the entrance/exit of site. A copy of the latest version emergency procedures should be dispatched to Tung Chung Fire Station for reference once available. • The emergency procedures should specify means of providing a rapid and direct warning (e.g. Siren and Flashing Light) to construction workers inthe event of chlorine gas release inthe SHWWTW. • The Contractor should establish a communication channel with the SHWWTW operation personnel and FSD during construction stage. In case of any hazardous incidents in the treatment works, operation personnel of SHWWTW should advise the Contractor to inform construction workers to proceed with emergency procedure. The Contractor should appoint a Liaison Officer to communicate with FSD Incident Commander on site in case of emergency. • Introduction training should be provided to any staff before carryout construction works at the Project site. • Periodic drills should be coordinated and conducted to ensure all construction personnel are familiar with the emergency procedures. Upon completion of the drills, a review on every step taken should be conducted to identify area of improvement. Prior								

EIA Ref	EM&A Log Ref.	Environmental Protection Measures*	Location /Duration of measures/ Timing of completion of measures	Implementation Agent	Implementation Stages**				Relevant Legislation and Guidelines
					Des	C	O	Dec	
		notice of periodic drills should be given to Station Commander of Tung Chung Fire Station. Joint operational exercise with FSD and SHWWTW is recommended.							
4.103	3.4	*Design Phase* • The site office should be close to the western boundary of the Project site and away from the SHWWTWs chlorine store as far as possible.	Work Site *I* During Design Period	OWTF operator	√				
4.103	3.4	*Operation Phase* • 3m high fence should be constructed along the boundary facing the SHWWTW • Emergency evacuation procedures should be formulated and the Contractor should ensure on site staff should be familiar with these procedures. Diagram showing the escape routes to a safe place should be posted in the site notice boards and at the entrance/exit of site. A copy of the latest version emergency procedures should be dispatched to Tung Chung Fire Station for reference once available. • The emergency procedures should specify means of providing a rapid and direct warning (e.g. Siren and Flashing Light) to personnel on site in the event of chlorine gas release inthe SHWWTW. • The Contractor should establish a communication channel with the SHWWTW operation personnel and FSD. In case of any hazardous incidents in the treatment works, operation personnel of SHWWTW	Work Site *I* During Operation Period	Contractor			√		

EIA Ref	EM&A Log Ref.	Environmental Protection Measures*	Location /Duration of measures/ Timing of completion of measures	Implementation Agent	Implementation Stages**				Relevant Legislation and Guidelines
					Des	C	O	Dec	
		should advise the Contractor to inform personnel on site to proceed with emergency procedure. The Contractor should appoint a Liaison Officer to communicate with FSD Incident Commander on site in case of emergency. • Periodic drills should be coordinated and conducted to ensure all on site personnel are familiar with the emergency procedures. Upon completion of the drills, a review on every step taken should be conducted to identify area of improvement. Prior notice of periodic drills should be given to Station Commander of Tung Chung Fire Station. Joint operational exercise with FSD and SHWWTW is recommended.							
C	***Water Quality***								
5.44	4.5	*Construction site run-off and general construction activities:* The mitigation measures as outlined in the ProPECC PN 1/94 Construction Site Drainage should be adopted where applicable.	Construction Site/ During Construction Period	Contractor		√			EIAO-TM, ProPECC PN 1/94; WPCO
5.45	4.5	*Excavation of Soil Materials* The construction programme should be properly planned to Minimize soil excavation, if any, in rainy seasons. This prevents soil erosion from exposed soil	Construction Site/ During Construction Period	Contractor		√			EIAO-TM, ProPECC PN 1/94; WPCO

EIA Ref	EM&A Log Ref.	Environmental Protection Measures*	Location /Duration of measures/ Timing of completion of measures	Implementation Agent	Implementation Stages**				Relevant Legislation and Guidelines
					Des	C	O	Dec	
		surfaces. Any exposed soil surfaces should also be properly protected to Minimize dust emission. In areas where a large amount of exposed soils exist, earth bunds or sand bags should be provided. Exposed stockpiles should be covered with tarpaulin or impervious sheets at all times. The stockpiles of materials should be placed at locations away from any stream courses so as to avoid releasing materials into the water bodies. Final surfaces of earthworks should be compacted and protected by permanent work.							
5.46	4.5	*Accidental spillage of Chemicals:* Contractor must register as a chemical waste producer if chemical wastes would be produced from the construction activities. The Waste Disposal Ordinance (Cap 354) and its subsidiary regulations in particular the Waste Disposal (Chemical Waste) (General) Regulation should be observed and complied with for control of chemical wastes.	Construction Site/ During Construction Period	Contractor		√			EIAO-TM, ProPECC PN 1/94; WPCO, WDO
5.47	4.5	Maintenance of vehicles and equipment involving activities with potential for leakage and spillage should only be undertaken within the areas which appropriately equipped to control these discharges.	Construction Site/ During Construction Period	Contractor		√			EIAO-TM, ProPECC PN 1/94; WPCO, WDO
5.48	4.5	Oils and fuels should only be used and stored in designated areas which have pollution prevention facilities. All fuel tanks and storage areas should be sited on sealed areas in order to prevent spillage of fuels and solvents to the nearby watercourses. All waste oils and fuels should be collected in designated tanks prior to disposal.	Construction Site/ During Construction Period	Contractor		√			EIAO-TM, ProPECC PN 1/94; WPCO, WDO

EIA Ref	EM&A Log Ref.	Environmental Protection Measures*	Location /Duration of measures/ Timing of completion of measures	Implementation Agent	Implementation Stages**				Relevant Legislation and Guidelines
					Des	C	O	Dec	
5.49	45	Disposal of chemical wastes should be carried out in compliance with the Waste Disposal Ordinance. The Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes published under the Waste Disposal Ordinance details the requirements to deal with chemical wastes. General requirements are given as follows: • Suitable containers should be used to hold the chemical wastes to avoid leakage or spillage during storage, handling and transport. • Chemical waste containers should be suitably labeled, to notify and warn the personnel who are handling the wastes, to avoid accidents. • Storage area should be selected at a safe location on site and adequate space should be allocated to the storage area.	Construction Site/ During Construction Period	Contractor		√			EIAO-TM, ProPECC PN 1/94; WPCO, WDO
5.50	45	Construction solid waste, debris and rubbish on site should be collected, handled and disposed of properly to avoid entering to the nearby watercourses. Stockpiles of cement and other construction materials should be kept covered when not being used. Rubbish and litter from construction sites should also be collected to prevent spreading of rubbish and litter from the site area. It is recommended to clean the construction sites on a regular basis.	Construction Site/ During Construction Period	Contractor		√			EIAO-TM, ProPECC PN 1/94; WPCO, WDO
5.51	45	<u>Sewage *Effluent*</u> The presence of construction workers generates sewage. It is recommended to provide sufficient chemical toilets in the works areas. The toilet facilities should be more than 30m from any watercourse. A licensed waste collector should be deployed to clean the	Work Site / During Construction Period	Contractor		√			EIAO-TM, WPCO

EIA Ref	EM&A Log Ref.	Environmental Protection Measures*	Location /Duration of measures/ Timing of completion of measures	Implementation Agent	Implementation Stages**				Relevant Legislation and Guidelines
					Des	C	O	Dec	
		chemical toilets on a regular basis.							
5.52	4.5	Notices should be posted at conspicuous locations to remind the workers not to discharge any sewage or wastewater into the nearby environment during the construction phase of the project. Regular environmental audit on the construction site can provide an effective control of any malpractices and can achieve continual improvement of environmental performance on site.	Work Site / During Construction Period	Contractor		√			EIAO-TM, WPCO
5.53	4.5	*Nullah Decking* To minimize the potential water quality impacts from the nullah reconstruction works, the practices outlined below should be adopted where applicable: • The proposed works should be carried out within the dry season between October and March when the flow in the open nullah is low. • The use of less or smaller construction plants may be specified to reduce the disturbance to the nullah bed. • Temporary storage of materials (e.g. equipment, filling materials, chemicals and fuel) and temporary stockpile of construction materials should be located well away from the nullah and any water courses during carrying out of the construction works. • Stockpiling of construction materials and dusty materials should be covered and located away from the nullah any	Work Site / During Construction Period	Contractor		√			EIAO-TM, WPCO

EIA Ref	EM&A Log Ref.	Environmental Protection Measures*	Location /Duration of measures/ Timing of completion of measures	Implementation Agent	Implementation Stages**				Relevant Legislation and Guidelines
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		• Construction debris and spoil should be covered up and/or disposed of as soon as possible to avoid being washed into the nullah and nearby water receivers. • Construction activities, which generate large amount of wastewater, should be carried out in a distance away from the nullah, where practicable. • Construction effluent, site run-off and sewage should be properly collected and/or treated. • Any works site inside the nullah should be temporarily isolated, such as by placing of sandbags or silt curtains with lead edge at bottom and properly supported props to prevent adverse impact on the water quality. • Proper shoring may need to be erected in order to prevent soil/mud from slipping into the nullah and nearby watercourse. • Supervisory staff should be assigned to station on site to closely supervise and monitor the works.							
5.54	4.5	*Wastewater from Organic Waste Treatment Process* The Project site will be equipped with an adequately sized wastewater treatment plant. A high rate type of active sludge system specifically designed for the removal of nitrogen components from the wastewater in combination with conversion of residual BOD and COD would be deployed. The wastewater treatment plant would also be incorporated with SHARON or annamox technology or equivalent to achieve high total overall nitrogen removal. Wastewater generated from the OWTF (including wastewater from dewatering process, leachate from waste reception area, condensate from biogas handling, wastewater from scrubber of air treatment system and any surplus water from truck	Work Site / During Design & Operation Period	OWTF Operator			√		TM-DSS;WPCO;WDO

EIA Ref	EM&A Log Ref.	Environmental Protection Measures*	Location /Duration of measures/ Timing of completion of measures	Implementation Agent	Implementation Stages**				Relevant Legislation and Guidelines
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		washing facility) will be diverted to the wastewater treatment plant. Treated effluent will then be stored temporarily in order to be used as process water within the plants. The storage volume would be around 20 m^3. Overflow from the tank will be discharged to foul sewers. The polluting parameters in effluent shall be in compliance with the requirements specified in the TM- DSS. The design, installation and operation of the wastewater treatment plant shall be licensed under the Waste Disposal Ordinance and subject to the effluent monitoring as required under the WPCO which is under the ambit of regional office (RO) of EPD. To ensure that wastewater can be adequately treated and effluent from treatment plant can meet the standards listed in TM- DSS, the following mitigation measure should be conducted. • Cleaning and maintenance of treatment facilities should be conducted on a regular basis to ensure that removal rate of each treatment facility would not be reduced. • Cleaning and maintenance of pipelines should be carried out on a regular basis to prevent block of pipeline and leaching of wastewater, and therefore prevent overflowed or leached wastewater discharging into nearby drainages and water streams. • Regular site inspection should be conducted to ensure that no wastewater can be directly discharged into nearby water streams.								

EIA Ref	EM&A Log Ref.	Environmental Protection Measures*	Location /Duration of measures/ Timing of completion of measures	Implementation Agent	Implementation Stages**				Relevant Legislation and Guidelines
					Des	C	O	Dec	
5.55	4.5	In the scrubber, spraying water should be re-circulated to minimize the need for external water. The spraying water would be collected at the bottom of the scrubber. Excess water would be discharged to the wastewater treatment plant as described in Section 5.54.	Work Site/ During Design & Operation Period	OWTF Operator	√		√		TM-DSS; WPCO; WDO
5.56	4.5	The waste reception, treatment facilities and compost storages of OWTF should be located in enclosed buildings to prevent generation of contaminated rain runoff. All surface runoff such as washed water generated in the treatment processes areas should be properly collected and diverted to the on-site wastewater treatment plant as described in Section 5.54.	Work Site/ During Design & Operation Period	OWTF Operator	√		√		TM-DSS; WPCO; WDO
5.57	4.5	All drainage system for collection and transferring wastewater generated in the OWTF to the on-site wastewater treatment plant as described in Section 5.54 should be capable of preventing clogging and easy maintenance and cleaning.	Work Site/During Design & Operation Period	OWTF Operator	√		√		TM-DSS; WPCO; WDO
D.1 Waste Management									
6.41	5.4	<u>Good Site Practices</u> Recommendations for good site practices during the construction phase would include: • Obtain relevant waste disposal permits from appropriate authorities, in accordance with the Waste Disposal Ordinance (Cap. 354) and subsidiary Regulations and the Land (Miscellaneous Provisions)	Work Site/During Construction Period	Contractor		√			WDO; LDO; ETWB TCW No. 19/2005

EIA Ref	EM&A Log Ref.	Environmental Protection Measures*	Location /Duration of measures/ Timing of completion of measures	Implementation Agent	Implementation Stages**				Relevant Legislation and Guidelines
					Des	C	O	Dec	
		Ordinance (Cap. 28); ● Provide staff training for proper waste management and chemical handling procedures; ● Provide sufficient waste disposal points and regular waste collection; ● Provide appropriate measures to minimize windblown litter and dust during transportation of waste by either covering trucks or by transporting wastes in enclosed containers; ● Carry out regular cleaning and maintenance programme for drainage systems, sumps and oil interceptors; ● Separate chemical wastes for special handling and disposed of to licensed facility for treatment; and ● Employ licensed waste collector to collect waste.							
6.42	5.5	<u>Waste Reduction Measures</u> Waste reduction is best achieved at the planning and design stage, as well as by ensuring the implementation of good site practices. Recommendations to achieve waste reduction include: ● Design foundation works that could minimize the amount of excavated material to be generated; ● Provide training to workers on the importance of site cleanliness and appropriate waste management procedures, including waste reduction, reuse and recycling; ● Sort out demolition debris and excavated materials from demolition works to recover reusable/recyclable portions (i.e. soil, broken concrete, metal etc.); ● Segregate and store different types of waste in different containers, skips or stockpiles to enhance	Work Site/During Design & Construction Period	Contractor	√	√			

EIA Ref	EM&A Log Ref.	Environmental Protection Measures*	Location /Duration of measures/ Timing of completion of measures	Implementation Agent	Implementation Stages**				Relevant Legislation and Guidelines
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		reuse or recycling of materials and their proper disposal; • Encourage the collection of aluminum cans by providing separate labelled bins to enable this waste to be segregated from other general refuse generated by the workforce; and • Plan and stock construction materials carefully to minimize the amount of waste to be generated and to avoid unnecessary generation of waste.							
6.44	5.7	Excavated and C&D Materials In order to minimize the impact resulting from collection and transportation of C&D material for off-site disposal, the excavated material arising from site formation and foundation works should be reused on-site as backfilling material and for landscaping works as far as practicable. Other mitigation requirements are listed below • A WMP, which becomes part of the Environmental Management Plan (EMP), should be prepared in accordance with ETWB TCW No.19/2005; • A recording system for the amount of wastes generated, recycled and disposed of (including the disposal sites) should be adopted for easy tracking; and • In order to monitor the disposal of excavated and C&D material at public filling facilities and landfills and to control fly-tipping, a trip-ticket system should be adopted (refer to ETWB TCW No. 31/2004).	Work Site / During Design & Construction Period	Contractor	√	√			ETWB TCW No. 33/2002; ETWB TCW No. 19/2005 ETWB TCW No. 31/2004
6.45-6.46	5.8-5.9	An EMP should be prepared and implemented in accordance with ETWB TCW No. 19/2005 which describes the arrangements for avoidance, reuse, recovery, recycling, storage, collection, treatment and	Work Site/ During Design& Construction Period	Contractor	√	√			ETWB TCW No. 19/2005

EIA Ref	EM&A Log Ref.	Environmental Protection Measures*	Location /Duration of measures/ Timing of completion of measures	Implementation Agent	Implementation Stages**				Relevant Legislation and Guidelines
					Des	C	O	Dec	
		disposal of different categories of waste to be generated from construction activities. The EMP should be submitted to the Supervising Officer (SO) and Supervising Officer's Representative (SOR) for approval. The EMP should be reviewed regularly and updated, preferably on a monthly basis. A system should be devised to work for on-site sorting of excavated and C&D materials and promptly removing all sorted and process materials arising from the construction activities to minimize temporary stockpiling on-site. The system should be included in the EMP identifying the source of generation, estimated quantity, arrangement for on-site sorting, collection, temporary storage areas and frequency of collection by recycling Contractors or frequency of removal off-site.							
6.47	5.10	<u>Chemical Waste</u> Should chemical wastes be produced at the construction site, the Contractor w ould be required to register with EPD as a Chemical Waste Producer and to follow the guidelines stated in the Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes. Good quality containers compatible with the chemical wastes should be used, and incompatible chemicals should be stored separately. Appropriate labels should be securely attached on each chemical waste container indicating the corresponding chemical characteristics of the chemical waste (such as explosive, flammable, oxidizing, irritant, toxic, harmful, or corrosive). The Contractor should employ a licensed collector to transport and dispose of the chemical wastes, to either the CWTC in Tsing Yi, or any other licensed facilities, in accordance with the Waste Disposal (Chemical Waste)	Work Site/During Construction Period	Contractor		√			Waste Disposal (Chemical Waste) (General) Regulation

EIA Ref	EM&A Log Ref.	Environmental Protection Measures*	Location /Duration of measures/ Timing of completion of measures	Implementation Agent	Implementation Stages**				Relevant Legislation and Guidelines
					Des	C	O	Dec	
		(General) Regulation.							
6.48	5.11	General Refuse General refuse should be stored in enclosed bins or compaction units separated from C&D material. A licensed waste collector should be employed by the contractor to remove general refuse from the site, separately from C&D material. Preferably an enclosed and covered area should be provided to reduce the occurrence of 'windblown' light material.	Work Site / During Construction Period	Contractor		√			Public Health and Municipal Services Ordinance
6.50	5.12	Good Site Practices Good operational practices should be adopted to Minimize waste management impacts: ● Obtain the necessary waste disposal permits from the appropriate authorities, in accordance with the Waste Disposal Ordinance (Cap. 354), Waste Disposal (Chemical Waste) (General) Regulation and the Land (Miscellaneous Provision) Ordinance (Cap. 28); ● Nomination of an approved person to be responsible for good site practice, arrangements for collection and effective disposal to an appropriate facility of all wastes generated at the site; ● Use of a waste haulier licensed to collect specific category of waste; ● A trip-ticket system should be included as one of the contractual requirements and implemented by the	During Operation Period	OWTF Operator			√		WDO; Waste Disposal (Chemical Waste) (General) Regulation; Land (Miscellaneous Provision) Ordinance (Cap. 28); ETWB TCW No. 31/2004

EIA Ref	EM&A Log Ref.	Environmental Protection Measures*	Location /Duration of measures/ Timing of completion of measures	Implementation Agent	Implementation Stages**				Relevant Legislation and Guidelines
					Des	C	O	Dec	
		Environmental Team to monitor the disposal of solid wastes at public filling facilities and landfills, and to control fly tipping. Reference should be made to ETWB TCW No. 31/2004. ● Training of site personnel in proper waste management and chemical waste handling procedures; ● Separation of chemical wastes for special handling and appropriate treatment at a licensed facility; ● Routine cleaning and maintenance programme for drainage systems, sumps and oil interceptors; ● Provision of sufficient waste disposal points and regular collection for disposal; ● Adoption of appropriate measures to minimize windblown litter and dust during transportation of waste, such as covering trucks or transporting wastes in enclosed containers; and ● Implementation of a recording system for the amount of wastes generated, recycled and disposed of (including the disposal sites).							
6.51	5.13	Waste Reduction Measures Good management and control can prevent the generation of significant amounts of waste. It is recommended that the following good operational practices should be adopted to ensure waste reduction: ● Segregation and storage of different types of waste in different containers, skips or stockpiles to enhance reuse or recycling of materials and their proper disposal; ● Encourage collection of aluminum cans, plastic bottles and packaging material (e.g. carton boxes) and office paper by individual collectors.	During Operation Period	OWTF Operator			√		

EIA Ref	EM&A Log Ref.	Environmental Protection Measures*	Location /Duration of measures/ Timing of completion of measures	Implementation Agent	Implementation Stages**				Relevant Legislation and Guidelines
					Des	C	O	Dec	
		Separate labelled bins should be provided to help segregate this waste from other general refuse generated by the work force; and ● Any unused chemicals or those with remaining functional capacity should be reused as far as practicable.							
6.52	5.14	Wastes Generated from Pre-Treatment Process Wastes generated from pre-treatment process should be recycled as far as possible. Wastes generated from pre-treatment process should also be separated from any chemical waste and stored in covered skips. The recyclables should be collected by licensed collectors, while the rest of the waste should be removed from the site on a daily basis to minimize odour, pest and litter impacts. Open burning must be strictly prohibited.	Pre-Treatment Process/ During Operation Period	OWTF Operator			√		
6.53-6.56	5.15-5.18	Chemical Wastes ● Chemical waste generated from machinery maintenance and servicing should be managed in accordance with Code of Practice on the Packaging, Labelling and storage of Chemical Wastes under the provisions of Waste Disposal (Chemical Waste) (General) Regulation. The chemical waste should be collected by drum-type containers and removed by licensed chemical waste contractors. ● Plant / equipment maintenance schedules should be planned in order to minimize the generation of chemical waste. ● Non-recyclable chemical wastes and lubricants should be disposed of at appropriate facilities, such	Whole Site / During Operation Period	OWTF Operator			√		Waste Disposal (Chemical Waste) (General) Regulation

EIA Ref	EM&A Log Ref.	Environmental Protection Measures*	Location /Duration of measures/ Timing of completion of measures	Implementation Agent	Implementation Stages**				Relevant Legislation and Guidelines
					Des	C	O	Dec	
		as CWTC. Copies or counterfoils from collection receipts issued by the licensed waste collector should be kept for recording purpose. • Recyclable chemical waste will be transported off-site for treatment by a licensed collector. The Contractor will need to register with EPD as a chemical waste producer. Where possible, chemical wastes (e.g. waste lubricants) would be recycled at appropriate facilities, such as Dunwell's oil re-refinery.							
6.57-6.58	5.19-5.20	<u>General Refuse</u> • Waste generated in offices should be reduced through segregation and collection of recyclables. To promote the recycling of wastes such as used paper, aluminum cans and plastic bottles, it is recommended that recycling bins should be clearly labelled and placed at locations with easy access. For the collection of recyclable materials, they should be collected by licensed collectors. • General refuse, other than segregated recyclable wastes, should be separated from any chemical waste and stored in covered skips. The general refuse should be removed from the site on a daily basis to minimize odour, pest and litter impacts. Also, open burning of refuse must be strictly prohibited.	Whole Site / During Operation Period	OWTF Operator			√		Public Health and Municipal Services Ordinance
D.2 Proposed Land Contamination Preventive Measures									
6.65	5.21 (i)	<u>Fuel Oil Containers</u> • Fuel oil should be stored in suitable containers. • All fuel oil containers should be securely closed. • Appropriate labels showing the name of fuel oil	Fuel Oil Storage Containers /During Operation Period	OWTF Operator			√		

EIA Ref	EM&A Log Ref.	Environmental Protection Measures*	Location /Duration of measures/ Timing of completion of measures	Implementation Agent	Implementation Stages**				Relevant Legislation and Guidelines
					Des	C	O	Dec	
		should be posted on the containers. ● Drip trays should be provided for all containers.							
6.65	5.21 (ii)	Storage Area ● Distance between the fuel oil refuelling points and the fuel oil containers should be minimized. ● The storage area should be used for fuel oil storage only. ● No surface water drains or foul sewers should be connected to the storage area. ● The storage area should be enclosed by three sides by a wall and have an impermeable floor or surface.	Fuel Oil Storage Area /During Operation Period	OWTF Operator			√		
6.65	5.21 (iii)	Fuel Oil Spillage Response An Oil Spill Response Plan should be prepared by the operator to document the appropriate response procedures for oil spillage incident in detail. General procedures to be taken in case of fuel oil spillage are presented below. ● Training Training on oil spill response actions should be given to relevant staff. The training should cover the followings: - Tools & resources to combat oil spillage and fire, e.g. locations of oil spill handling equipment and firefighting equipment; - General methods to deal with oil spillage and fire incidents; - Procedures for emergency drills in the event of	Whole Site / During Operation Phase	OWTF Operator			√		

EIA Ref	EM&A Log Ref.	Environmental Protection Measures*	Location /Duration of measures/ Timing of completion of measures	Implementation Agent	Implementation Stages**				Relevant Legislation and Guidelines
					Des	C	O	Dec	
		oil spills and fire; and - Regular drills should be carried out. • Communication Establish communication channel with the Fire Services Department (FSD) and EPD to report any oil spillage incident so that necessary assistance from relevant department could be quickly sought. • Response Procedures Any fuel oil spillage within the Project Site should be immediately reported to the Site Manager with necessary details including location, source, possible cause and extent of the spillage. Site Manager should immediately attend to the spillage and initiate any appropriate action to confine and clean up the spillage. The response procedures should include the following: - Identify and isolate the source of spillage as soon as possible. - Contain the oil spillage and avoid infiltration into soil / groundwater and discharge to storm water channels. - Remove the oil spillage. - Clean up the contaminated area. - If the oil spillage occurs during refuelling, the refuelling operation should immediately be stopped. - Recovered contaminated fuel oil and the associated material to remove the spilled oil should be considered as chemical waste. The							

EIA Ref	EM&A Log Ref.	Environmental Protection Measures*	Location /Duration of measures/ Timing of completion of measures	Implementation Agent	Implementation Stages**				Relevant Legislation and Guidelines
					Des	C	O	Dec	
		handling and disposal procedures for chemical wastes are discussed in the following paragraphs.							
6.66	5.22 (i)	Chemicals and Chemical Wastes Handling & Storage ● Chemicals and chemical wastes should only be stored in suitable containers in purpose-built areas. ● The storage of chemical wastes should comply with the requirements of the Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes. ● The storage areas for chemicals and chemical wastes should have an impermeable floor or surface. The impermeable floor *I* surface should possess the following properties: - Not liable to chemically react with the materials and their containers to be stored. - Able to withstand normal loading and physical damage caused by container handling - The integrity and condition of the impermeable floor or surface should be inspected at regular intervals to ensure that it is satisfactorily maintained ● For liquid chemicals and chemical wastes storage, the storage area should be bonded to contain at least 110% of the storage capacity of the largest containers or 20% of the total quantity of the chemicals/chemical wastes stored, whichever is the greater. ● Storage container should be checked at regular intervals for their structural integrity and to ensure	Whole Site / During Operation Period	OWTF Operator			√		

EIA Ref	EM&A Log Ref.	Environmental Protection Measures*	Location /Duration of measures/ Timing of completion of measures	Implementation Agent	Implementation Stages**				Relevant Legislation and Guidelines
					Des	C	O	Dec	
		that the caps or fill points are tightly closed. ● Chemical handling should be conducted by trained workers under supervision.							
6.66	5.22 (ii)	Chemicals and Chemical Wastes Spillage Response A Chemicals and / or Chemical Wastes Spillage Response Plan should be prepared by the operator to document in detail the appropriate response procedures for chemicals or chemical wastes spillage incidents. General procedures to be undertaken in case of chemicals *I* chemical waste spillages are presented below ● Training Training on spill response actions should be given to relevant staff. The training should cover the followings: - Tools & resources to handle spillage, e.g. locations of spill handling equipment; - General methods to deal with spillage; and - Procedures for emergency drills in the event of spills. ● Communication Establish communication channel with Fire Services Department (FSD) and EPD to report the spillage incident so that necessary assistance from relevant department could be quickly sought. ● Response Procedures Any spillage within OWTF site should be reported to the Site Manager.	Whole Site / During Operation Period	OWTF Operator			√		

EIA Ref	EM&A Log Ref.	Environmental Protection Measures*	Location /Duration of measures/ Timing of completion of measures	Implementation Agent	Implementation Stages**				Relevant Legislation and Guidelines
					Des	C	O	Dec	
		Site Manager shall attend to the spillage and initiate any appropriate actions needed to confine and clean up the spillage. The response procedures should include the followings: - Identify and isolate the source of spillage as soon as possible; - Contain the spillage and avoid infiltration into soil / groundwater and discharge to storm water channels (in case the spillage occurs at locations out of the designated storage areas); - Remove the spillage; the removal method / procedures documented in the Material Safety Data Sheet (MSDS) of the chemicals spilled should be observed; - Clean up the contaminated area (in case the spillage occurs at locations out of the designated storage areas); and - The waste arising from the cleanup operation should be considered as chemical wastes.							
6.67 – 6.69	5.23-5.25	<u>Incident Record</u> ● After any spillage, an incident report should be prepared by the Site Manager. The incident report should contain details of the incident including the cause of the incident, the material spilled and estimated spillage amount, and also the response actions undertaken. The incident record should be kept carefully and able to be retrieved when necessary. ● The incident report should provide sufficient details for the evaluation of any environmental impacts due	Whole Site / During Operation Period	OWTF Operator			√		

EIA Ref	EM&A Log Ref.	Environmental Protection Measures*	Location /Duration of measures/ Timing of completion of measures	Implementation Agent	Implementation Stages**				Relevant Legislation and Guidelines
					Des	C	O	Dec	
		to the spillage and assessment of the effectiveness of measures taken. ● In case any spillage or accidents results in significant land contamination, EPD should be informed immediately and the Project operator should be responsible for the cleanup of the affected area. The responses procedures described in Sections 6.65 - 6.66 of the EIA Report should be followed accordingly together with the land contamination assessment and remediation guidelines stipulated in the *Guidance Manual for Use of Risk-based Remediation Goals for Contaminated Land Management* and the *Guidance Note for Contaminated Land Assessment and Remediation.*							

EIA Ref	EM&A Log Ref.	Environmental Protection Measures*	Location /Duration of measures/ Timing of completion of measures	Implementation Agent	Implementation Stages**				Relevant Legislation and Guidelines
					Des	C	O	Dec	
E Landscape and Visual									
7.99 & Table 7.7	Table 6.1	*Construction Phase* • Topsoil, where identified, should be stripped and stored for re-use in the construction of the soft landscape works, where practical • Compensatory tree planting should be provided to compensate for felled trees. - Compensation tree species shall be chosen from both indigenous and ornamental species - Compensatory tree planting quantities shall be as per DLO approved requirement. • Control of night-time lighting • Erection of decorative screen hoarding compatible with the surrounding setting	Construction Site/During Design & Construction Stages	Contractor	√	√			
7.98 & Table 7.8	Table 6.2	*Operation Phase* • Aesthetic design of the facade, including its colour theme, pattern, texture, materials, finishing and associated structures to harmonize with the surrounding settings • Grass / groundcover planting to soften the roof • Heavy standard tree planting to screen proposed associated structures • Grasscrete paving to soften the harshness of large paved surface areas wherever possible	Within Project Area / During Design & Operation Stages	OWTF Operator	√		√		

EIA Ref	EM&A Log Ref.	Environmental Protection Measures*	Location /Duration of measures/ Timing of completion of measures	Implementation Agent	Implementation Stages**				Relevant Legislation and Guidelines
					Des	C	O	Dec	
F Noise									
8.25	7.3	Good Site Practice: • Only well-maintained plant should be operated on- site and plant should be serviced regularly during the construction program; • Mobile plant, if any, should be sited as far from noise sensitive receivers (NSRs) as possible; • Machines and plant (such as trucks) that may be in intermittent use should be shut down between work periods or should be throttled down to a minimum; • Plant known to emit noise strongly in one direction should, wherever possible, be orientated so that the noise is directed away from the nearby NSRs; and • Material stockpiles and other structures should be effectively utilized, wherever practicable, in screening noise from on-site construction activities.	Work Site *I* During Construction Period	Contractor		√			EIAO-TM, NCO

* All recommendations and requirements resulted during the course of EIA Process.

* Des=Design; C=Construction; O=Operation; Dec=Decommissioning

Appendix B
Sample of Incident Report on Action Level or Limit Level Non-compliance

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Incident Report on Action Level or Limit Level Non-compliance

Project	
Date	
Time	
Monitoring Location	
Parameter	
Action & Limit Levels	
Measured Level	
Possible reason for Action or Limit Level Non-compliance	
Actions taken / to be taken	
Remarks	

Prepared by: _____

Designation: _____

Signature: _____

Date: _____

Meinhardt Infrastructure and Environment Limited

Organic Waste Treatment Facilities, Phase I

Proposed update on Environmental Monitoring & Audit Manual

(February 2019)

Verified by: Helen Cochrane

Position: Independent Environmental Checker

Date: 11 Feb 2019

TECHNICAL NOTE

OSCAR Bioenergy Joint Venture

Organic Resources Recovery Centre Phase 1

Review of Air Quality Impact Assessment for the Proposed Change of VOC Emission Limit for Cogeneration Units

February 2019

Environmental Resources Management
2507, 25/F, One Harbourfront
18 Tak Fung Street
Hunghom, Kowloon
Hong Kong
Telephone: (852) 2271 3000
Facsimile: (852) 2723 5660
E-mail: post.hk@erm.com
http://www.erm.com

TECHNICAL NOTE

OSCAR Bioenergy Joint Venture

Organic Resources Recovery Centre Phase 1

Review of Air Quality Impact Assessment for the Proposed Change of VOC Emission Limit for Cogeneration Units

February 2019

0491006

For and on behalf of ERM-Hong Kong, Limited	
Approved by:	Frank Wan
Signed:	
Position:	Partner
Date:	08 February 2019

CONTENTS

1 INTRODUCTION

1.1 PROJECT BACKGROUND

The Organic Resources Recovery Centre Phase 1 (ORRC1) is a biological treatment facility with a capacity of about 200 tonnes per day converting source-separated organic waste from the commercial and industrial sectors (mostly food waste) into compost and biogas through proven biological treatment technologies. The facility is located at Siu Ho Wan in North Lantau with a site area of about 2 hectares.

The environmental acceptability of the construction and operation of the Facility had been confirmed an Environmental Impact Assessment (EIA) Study completed in 2009. The EIA Report was approved by the Environmental Protection Department (EPD) (Register No.: AEIAR-149/2010) in February 2010. An Environmental Permit (EP) (No. EP-395/2010) was issued by EPD on 21 June 2010.

The Design, Build and Operate (DBO) Contract for the Facility (Contract No. EP/SP/61/10 Organic Waste Treatment Facilities Phase I) was awarded to a Joint Venture company (OSCAR Bioenergy Joint Venture), consisting of SITA Waste Services Limited, ATAL Engineering Limited and Ros-Roca, Sociedad Anonima (hereinafter referred to as OSCAR).

The EP was most recently varied on 21 December 2015 (No. EP-395/2010/C) due to the change of stack design parameters, site layout plan and on-site population during construction phase, and an Environmental Review Report (2015 ERR) was submitted in support of the variation of EP (VEP). A Further EP (No. FEP-01/395/2010/C) was issued to OSCAR on 21 December 2015.

1.2 BACKGROUND ON THE COGENERATION UNITS AND ITS VOC EMISSION LIMIT

Three Cogeneration Units (CHP) are installed at ORRC1 to generate heat and electricity through burning of biogas. In the approved EIA report (see Appendix A of *Annex A*) and the Environmental Monitoring and Audit (EM&A) Manual (see Appendix C of *Annex A*), the emission limit of volatile organic compound (VOCs) for these CHP is set at 150mg/Nm^3 (at 6% O_2). With reference to the approved EIA report, the VOC emission limit of 150mg/Nm^3 was based on the upper limit of the manufacturing data of Germany plants. Based on the common practices in EU, OSCAR has designed and built the CHP which is capable of meeting the statutory discharge limits set for the EU countries. According to the overseas experts, the VOC emission limit of 150mg/Nm^3 could only be achieved if "methane VOC is excluded", and that in EU "methane emission is normally excluded in setting CHP emission limit".

As in the approved EIA report, the same VOC emission limit for CHP has been adopted in the EM&A Manual and the environmental review reports submitted for subsequent VEP applications (see Appendix B of *Annex A*).

However, whether this VOC emission limit includes or exclude methane has not been clearly specified. In the ORRC1 Contract Specification, the CHP's VOC emission limit of 150mg/Nm^3 refers to "VOCs including NMVOCs"(1) (see Appendix D of *Annex A*).

OSCAR has conducted a desktop review which demonstrates that the CHP's VOC emission limit of 150mg/Nm^3 should exclude methane (i.e. NMVOCs). Relevant supporting documents are provided in *Annex A*.

(1) NMVOCs – Non-methane Volatile Organic Compounds

2 TOTAL VOC EMISSION LIMIT FOR CHP

2.1 TOTAL VOC EMISSION LIMIT FOR CHP

As discussed in *Section 1.2*, it is confirmed that the CHP's VOC emission limit of 150mg/Nm^3 refers to NMVOCs. OSCAR proposes to include the total VOC emission limit for CHP as an additional monitoring parameter during the operation phase of the ORRC1. The total VOC emission limit for CHP (1) is proposed to be 1,500mg/Nm^3. Justifications for the proposed CHP's total VOC emission limit are discussed in *Section 2.2* below.

2.2 JUSTIFICATIONS

A review on the international standards/limits/studies on VOC emissions was undertaken and these references are provided in *Annex B*. The review of the VOC standards of various jurisdictions are summarised and compared in *Table 2.1*.

It can be seen that most of these standards do not specify the VOC emission limit or only specify the limit in terms of NMVOC. According to the current Netherlands standard, the total VOC level is set as 1,500 mg/m^3 at 3% O_2 for engine powered by natural gas, which is equivalent to about 1,250 mg/m^3 at 6% O_2 (see Appendix I and K of *Annex B*). In addition, with reference to the California Energy Commission Interim Report, Section 4.3.1, the average total VOC emissions from natural gas fuelled and biogas fuelled operations are 735ppm and 1,075ppm, respectively (Appendix N of *Annex B*). Therefore, total VOC emissions from biogas fuelled operation may be 30% higher than that from natural gas fuelled operation. Making reference to the Netherlands standard, the total VOC level for engine powered by biogas could be up to 1,625 mg/m^3 at 6% O_2 (i.e. 30% more than 1,250 mg/m^3 at 6% O_2 for engine powered by natural gas).

Based on the above justifications, the proposed total VOC emission limit of 1,500 mg/Nm^3 at 6% O_2 for CHP is considered valid and reasonable.

(1) Total VOC includes methane and measured at 6% O_2 and dry basis

Table 2.1 Summary of VOC Emission Standards

Jurisdictions	Standard Description	Relevant Section	Fuel Used	Reference O_2 (%)	VOC Standard
Netherlands (Appendix I and K)	BEMS 1 April 2010	-	Biogas	3	-
		-	Natural gas	3	1,500 mg/m^3
England and Wales (Appendix L)	Table S3.1 – The Environmental Permitting (England and Wales) Regulations 2016	-	Natural gas	5	1,000 mg/m^3 75 mg/m^3 (for NMVOC)
China (Appendix Q and R)	GB 16297 1996 National Standard – Integrated Emission Standard of Air Pollutants (Appendix Q)	Section 9.3 Table 2	-	-	120 mg/m^3 (for NMVOC)
	DB11/ 1056 2013 Beijing City Local Standard – Emission standard of air pollutants for stationary internal combustion engines (Appendix R)	Section 4.1 Table 1	Biogas	5	-
Austria (Appendix S)	-	-	Sewage/ landfill gas	5	150 mg/m^3 (for NMVOC)
Czech Republic (Appendix S)	Act 415/2012 Sb.	-	Other gases	5	150 mg/m^3 (for NMVOC)
United States (Appendix M)	40 CFR Parts 60, 63, 85 et al. Standards of Performance for Stationary Spark Ignition Internal Combustion Engines and National Emission Standards for Hazardous Air Pollutants for Reciprocating Internal Combustion Engines; Final Rule	Table 4 - Landfill/Digester Gas (HP>=500)	Landfill/ Digester gas	15	1g/HPh or 80 ppmvd (for NMVOC) [(a)]
EU (Appendix O)	Directive (EU) 2015/2193 of the European Parliament and of the Council of 25 November 2015 on the limitation of emission of certain pollutants into the air from medium combustion plants	Part 2 Table 2	Biogas	15	-
Germany (Appendix P)	Technical Instructions on Air Quality Control – TA Luft) of 24 July 2002	Section 5.4.1.4	-	5	-
France (Appendix T)	Arrete du 3 Aout 2018	Section 6.2.5.	Biogas	15	50 mg/m^3 (for NMVOC)

Note:

(a) Refer to Pg. 11/48, Section IV, C - Hydrocarbon Limit disclaimer states that emission limits for VOC effectively do not include ethane, methane, and formaldehyde. When corrected to 6% O_2, it is 107 mg/Nm^3.

3 REVIEW OF AIR QUALITY IMPACT ASSESSMENT FOR VOLATILE ORGANIC COMPOUNDS

3.1 PURPOSE OF THE REVIEW

The purpose of the review is to evaluate whether the total VOC emission limit for CHP will still meet the VOC ambient standard as adopted in the approved EIA report and the 2015 ERR and whether this update will constitute a material change under the EIAO.

3.2 AIR SENSITIVE RECEIVERS

Representative ASRs as identified in the approved EIA report and the 2015 ERR have been reviewed. It is confirmed that the representative ASRs are still valid within no new ASR identified within the Study Area. Details of the representative ASRs are listed in *Table 3.1*.

Table 3.1 Identified Representative ASRs

ASR	Description	Type of Use [(a)]	Separation Distance from the Nearest Project Site Boundary (m above ground)	No. of Storey	Assessment Heights (m above ground)
A1	Siu Ho Wan Water Treatment Works	GIC	90	2	1.5, 4.5
A2	Siu Ho Wan Sewage Treatment Works	GIC	196	2	1.5, 4.5
A3	Siu Ho Wan Vehicle Pound Vehicle Examination Centre and Weight Station	GIC	25	1	1.5
A4	Bus Depot of Kowloon Motor Bus Ltd	Industrial	77	2	1.5, 4.5
A5	Bus Depot of City Bus Ltd	Industrial	15	3	1.5, 4.5, 7.5
A6	North Lantau Transfer Station	GIC	385	3	1.5, 4.5, 7.5

Note:
(a) GIC – Government, institution or community uses.

3.3 ASSESSMENT CRITERION FOR VOCS

The assessment criteria for VOCs remain the same as that adopted in the approved EIA report and the 2015 ERR, i.e. 600,000µg/m^3.

3.4 POTENTIAL VOC IMPACTS BASED ON TOTAL VOC EMISSION LIMIT

With reference to Annex A4 of the 2015 ERR, the predicted VOC concentrations at the representative ASRs under the scenario of CHP operation [(1)] are shown in *Table 3.2*.

Table 3.2 ***Predicted Maximum 1-hour Average VOC Concentrations at the Representative ASRs during CHP Operation (from 2015 ERR)***

ASR	Description	Maximum 1-Hour Average VOC Concentration (μg/m³)		
		Receptor Height (m above ground)		
		1.5	4.5	7.5
ASR1	Siu Ho Wan Water Treatment Works	3,472.7	3,476.6	-
ASR2	Siu Ho Wan Sewage Treatment Works	595.7	610.0	-
ASR3	Siu Ho Wan Vehicle Pound Vehicle Examination Centre and Weight Station	724.3	-	-
ASR4	Bus Depot of Motor Bus Ltd.	361.3	443.6	-
ASR5	Bus Depot of City Bus Ltd.	625.7	728.5	932.9
ASR6	North Lantau Refuse Transfer Station	619.3	637.9	677.5
	VOC Assessment Criterion (μg/m³)	**600,000**	**600,000**	**600,000**

Note:

(a) The predicted VOC concentrations at the ASRs are based on CHP's VOC emission limit of 150mg/Nm³ (NMVOC) as adopted in the 2015 ERR.

As concluded in the 2015 ERR, the predicted VOC impact arising from the operation of the ORRC1 at the representative ASRs is insignificant (i.e. about 0.6% of the assessment criterion at maximum) based on CHP's VOC emission limit of 150 mg/Nm³.

It should be noted that there is no change to the VOC emissions from other facilities within the ORRC1 (i.e. the centralised air pollution control system (CAPCS), ammonia stripping plant (ASP) and standby flaring gas unit) [(2)] as compared with those presented in the 2015 ERR. In addition, all the stack parameters (including stack locations, exit velocity, exit temperature and stack diameter) for the CHP, CAPCS, ASP and the standby flaring gas unit remain the same as those indicated in the 2015 ERR. With the same set of stack parameters and emission characteristics from these stacks, the predicted VOC impact at the representative ASRs under the CHP's total VOC emission limit of 1,500 mg/Nm³ is still expected to be insignificant and well within the assessment criterion. Therefore, adverse VOC impact arising from ORRC1 operation is not anticipated.

(1) "Scenario 1 – With Cogen units" as presented in Table 3.3 of the 2015 ERR.

(2) The VOC emission limit for CHP presented in Table 2.3 of the EM&A Manual is changed to NMVOCs of 150 mg/Nm³ and VOCs (including methane) of 1,500 mg/Nm³, as suggested in Section 3.4. The VOC emission limits for standby flaring gas unit and ASP as presented in Tables 2.4 and 2.5 of the EM&A Manual remain unchanged. The VOC parameter descriptions are updated to "VOCs (including methane)" as methane could be present in the VOCs emitted from these stacks. For CAPCS stack emission, the VOC emission limit remains unchanged and the parameter description is updated to "VOCs (including methane)" as presented in Table 2.2 of the EM&A Manual for the purpose of consistency with other VOC limit descriptions, not necessarily meaning that there is presence of methane in CAPCS air emission stream.

3.5 CONSIDERATION OF MATERIAL CHANGE

It has been demonstrated that with the total VOC emission limit for CHP, no adverse air quality impact at the representative ASRs is anticipated. A review against the criteria in Section 6.1 and 6.2 of the EIAO-TM has concluded that this update is not considered a "material change" as summarised in *Table 3.3*.

Table 3.3 Review against Section 6.1 and 6.2 of EIAO-TM

Item	Requirements	Findings	Material Change?
6.1 (a)	A change to physical alignment, layout or design of the project causing an environmental impact likely to affect existing or planned community, ecologically important areas or sites of cultural heritage	No changes to location or number of stacks.	No
6.1 (b)	A physical change resulting in an increase in the extent of reclamation or dredging affecting water flow or quality likely to affect ecologically important areas, or disrupting sites if cultural heritage	Not applicable.	No
6.1 (c)	An increase in pollution emissions or discharges or waste generation likely to violate guidelines or criteria in this technical memorandum without mitigation measures in place	In addition to the CHP's VOC emission limit (NMVOC) of 150 mg/Nm^3, it is proposed to include the CHP's total VOC emission limit of 1,500 mg/Nm^3 as an additional monitoring parameter to take into account methane emissions from the CHP. There is no stack design changes that cause any actual increase of overall VOC emissions.	No
6.1 (d)	An increase in throughput or scale of the project leading to physical additions or alterations that are likely to violate the guidelines or criteria in this technical memorandum without mitigation measures in place	There is no increase in throughput or scale of the project.	No
6.1 (e)	A change resulting in physical works that are likely to affect rare, endangered or protected species, or an important ecological habitat, or site of cultural heritage.	Not applicable.	No
6.2	The environmental impact of a designated project, for which an environmental permit has been issued, is considered to be materially changed if the environmental performance requirements set out in the EIA report for this project may be exceeded or violated, even with the mitigation measures in place.	The predicted VOC impact at the representative ASRs under the CHP's total VOC emission limit of 1,500 mg/Nm^3 is considered insignificant and well within the relevant assessment criterion. No exceedance or violation of the environmental performance requirements set out in the approved EIA report is anticipated.	No

Annex A

References for VOC and NMVOC Emissions from CHP

Appendix A - Extract from Approved EIA

AECOM

Environmental Protection Department

Agreement No. CE7/2008 (EP)

Organic Waste Treatment Facilities, Phase I – Feasibility Study

Environmental Impact Assessment Report

December 2009

	Name	Signature
Prepared & Checked:	Kenny YIU	
Reviewed & Approved:	Matthew KO	

Version: B	Date: 28 December 2009

AECOM Asia Co. Ltd.
11/F, Grand Central Plaza, Tower 2, 138 Shatin Rural Committee Road, Shatin, NT, Hong Kong
Tel: (852) 2893 1551 Fax: (852) 2891 0305 www.aecom.com

- Minor excavation and materials handling;
- Construction of superstructure for the office and storage; and
- Installation of treatment facilities.

3.14 The area of the Project Site is approximately 2 ha. The total volume of C&D materials to be generated during excavation is estimated to be no more than 7,000 m^3. The construction period for the project is approximately 11 working months (May 2012 – March 2013) on the basis of 26 working days per working month. The maximum amount of excavated/ handled materials per day is about 25 m^3, which is a small amount of excavated materials. With the implementation of practicable dust suppression measures stipulated in the Air Pollution Control (Construction Dust) Regulation, the dust impact from this Project is considered to be minimal.

3.15 As mentioned in Section 2, the HyD's project "Further Landscape Enhancement Works to North Lantau Highway" would be commenced in May 2010 and ended in November 2012. It would have about six months overlapping with this Project. Since the work area for landscape enhancement works would be limited and the excavated materials generated from this Project is in small amount, no adverse cumulative dust impacts would be anticipated. Two WSD's projects "Extension of Siu Ho Wan Water Treatment Works" and "Integration of Siu Ho Wan and Silver Mine Bay Water Treatment Works" may be commenced in early March 2013. Since the overlapping with these Projects would be 1 – 2 months and the construction of OWTF would be almost completed at this stage, cumulative dust impact would not be anticipated.

Operational Phase

Potential Air Quality Impact from Operation of OWTF

Waste Acceptance & Pre-treatment Area

3.16 Organic waste would usually be stored for a period of time prior to its collection. This could allow facultative anaerobic degradation of the organic matters in the waste stream, resulting in the generation of odour. Therefore, the unloading and pre-processing of these wastes at OWTF would likely release odour. The waste reception building will be equipped with unloading bays for bulk waste and will operate under negative pressure. Any air circulating inside will be directed to the centralized air pollution control unit where a biofilter would be installed. Therefore, odour emission is expected to be insignificant.

3.17 As the moisture content of the mixed organic waste would not be low, adverse dust emissions during the unloading process and pre-processing of these wastes are not anticipated. In addition, with dust in the vented air be removed after passing through the scrubber, dust impact from the wastes reception hall and pre-treatment area is anticipated to be insignificant.

Digestion

3.18 Mixed organic waste that has high moisture content would be directed to the digesters for processing. Each digester would be equipped with mixing devices to maintain suitable conditions for microbiological activities. The retention time inside the digester would be approximately 40 days to ensure good degradation and maximize biogas.

3.19 The digestion process would be undertaken in an enclosed system. According to the reference design of OWTF, the produced biogas would be cleaned to remove hydrogen sulphide before converting to energy using gas engine generator sets (cogen units). As provided by the manufacturer, the air pollutant emission levels of cogen units are summarized in **Table 3.5** below.

Table 3.5 Standards to be Applied for the Emission Level of Cogen Units

Parameter	Emission Level (mg//Nm^3) [1]
Dust [2]	<15
Carbon Monoxide	100 – 650
NOx	100 – 300
SO_2	< 50
VOCs	<50 – 150
HCl	< 10
HF	< 1

Note: (1) All values refer to an oxygen content in the exhaust gas of 6% and dry basis.
(2) Dust means Total Suspended Particulates.

3.20 Biogas is being used as a fuel for the cogen units. If there is a failure in the cogen units, biogas (after cleaning) would be flared. To eliminate the production of dioxins by the flare, the flaring temperature and the residence time would be around 900°C and 0.3 seconds and the flaring process will be in a combustion room, not open flaring. The emissions from the flare would be controlled making reference to European Standard and the emissions would include less than 50mg/Nm of SO_2, less than 5 mg/Nm^3 of dust, negligible amount of VOCs and methane. The flare will normally be in operation only if one or more of the cogen units is/are out of operation. Therefore, the emission of the flare will replace the higher emission level of the cogen units. As a result, worst case situation with respect to emissions would occur when all the biogas is utilized by the cogen units and no biogas is used by the flare.

Post-treatment Process

3.21 After the digestion process, residual materials would be passed through a separator to filter out fibrous material from liquid. Wastewater would be re-circulated in the treatment process, while surplus wastewater would be directed to the wastewater treatment unit. Fibrous material (i.e. digestate) would be transported to the composting plant for stabilization. Dewatering process as well as the wastewater treatment unit would be in an enclosed system. The air exhaust from dewatering process area and wastewater treatment unit will also pass through the centralized air pollution control unit to remove the odour before discharging.

Composting

3.22 Digestate would be directed to composting facilities for processing. Supply of air is required by regular aeration to maintain aerobic conditions. The retention time inside the composting process would be about 2 weeks.

3.23 Excluding odour emissions, composting of fibrous materials may emit gaseous pollutants including non-methane volatile organic carbon (NMVOC), VOCs, NH_3 and N_2O, while the composting equipment would be enclosed inside the building. Air circulation in the building will pass through the centralized air pollution control unit which can remove gas pollutants, particles and odour before it is discharged.

Centralized Air Pollution Control Unit

3.24 Referring to the reference design of OWTF, vented air extracting from the main buildings of OWTF, including waste reception and pre-treatment area, temporary storage area for shredded materials and dewatering process area, composting area and storage area, and wastewater treatment unit, will be treated in the centralized air pollution control unit before discharging to the atmosphere. Negative pressure system would be provided for the main buildings of OWTF and wastewater treatment area to avoid escape of odour. The design emission levels of the centralized air pollution control unit are summarized in **Table 3.6** as follows.

PATH model. As mentioned in S3.30, the OWTF is expected to be in full capacity in Year 2015, the adoption of Year 2015 traffic flow for other roads are expected to be reasonable..

(g) Other Emission Sources

3.43 The emissions from other emission sources (e.g. non-road mobile sources, VOC containing sources etc) within HKSAR have also been considered by making reference to 2030 emission inventory (without implementation measure) as mentioned in the AQO Review Report. Year 2030 emission inventory is expected to be higher than in Year 2015 as there is a positive growth factor in the forecast data.

Emission Inventory of OWTF

Emissions from Centralized Air Pollution Control Unit

3.44 Centralized air pollution control unit would be used to remove air pollutants, dust and odorous gas in the air extracted from the main buildings of OWTF and the wastewater treatment unit. The design emission rates of the centralized air pollution control unit as stated in **Table 3.6** are derived from experiences in the similar plants in Europe. Therefore, the specified emission levels are considered practically achievable. As a conservative approach, the dust emissions are all considered as RSP emissions and the maximum concentrations of the air pollutants given in manufacture data are adopted in the assessment. Based on the preliminary design, the stack height of centralized air pollution control unit would be 18m above ground level with a diameter of 1.6m. The discharge temperature of flue gas would be 308K and the efflux velocity would be 18m/s. The emission levels of the air pollutants from the treatment unit considered in the assessment are summarized in **Table 3.7**.

Table 3.7 Emission Level of Centralized Air Pollution Control Unit

Parameter	Emission Level (mg//Nm^3)
VOCs (including NMVOC)	680
RSP [1]	6
Odour(including NH_3 & H_2S)	300 [2]

Note: (1) Dust emission levels are considered as RSP in the assessment.
(2) The odour unit is ou/Nm^3.

Emissions from Cogen Units /Flaring Emission (Biogas)

3.45 The design emission levels for cogen units of OWTF are based on the manufacturing data, which are making reference to the design in Germany plants, are practically achievable. As a conservative approach, the dust emissions are all considered as RSP emissions in the assessment. Based on the preliminary design, the stack height of cogen units would be 8m above ground level with a diameter of 0.5m. The discharge temperature of flue gas would be 733K and the efflux velocity would be 15m/s. The maximum concentration of pollutants from the cogen units (listed in **Table 3.5**) adopted for the assessment are summarized in **Table 3.8** below.

Table 3.8 Emission Level of Cogen Units

Parameter	Maximum Emission Level (mg//Nm^3) [1]
RSP[2]	15
Carbon Monoxide	650
NOx	300
SO_2	50
VOCs	150
HCl	10
HF	1

Note: (1) All values refer to an oxygen content in the exhaust gas of 6% and dry basis.
(2) Dust emission levels are considered as RSP in the assessment.

Appendix B - Extract from Environmental Review Report

FINAL REPORT

OSCAR Bioenergy Joint Venture

Contract No. EP/SP/61/10
Organic Waste Treatment Facilities
Phase 1: Proposed Design Change
Environmental Review Report

November 2015

Environmental Resources Management
16/F Berkshire House
25 Westlands Road
Quarry Bay, Hong Kong
Telephone: (852) 2271 3000
Facsimile: (852) 2723 5660
E-mail: post.hk@erm.com
http://www.erm.com

materials to reduce the bulkiness of the building blocks. The height of the roof of Building 1 will be reduced from 18m (in the *2013 Re-assessment Report*) to 15.8m above ground while the top of the stack remains at 25m above ground. The height of the roof of Building 2 will be reduced from 22m (in the *2013 Re-assessment Report*) to 13.5m above ground. Building 3 is newly added. It is a two-storey building with a height of approximately 10m.

2.1.3 *Changes to the Design of the Process Equipment*

The design and the locations of the centralised APCU, Cogen Units and flaring gas system have been changed. In order to effectively remove the ammonia in the wastewater generated from the OWTF, it is proposed to install an ASP to reduce the ammoniacal-nitrogen in the wastewater by stripping and the ammonia gas in the stripped air will be destroyed via a thermal oxidiser prior to discharge to the atmosphere. The ASP will be located next to the Cogen Units.

The proposed changes to the various process equipment are summarised in *Table 2.2*.

Table 2.2 Proposed Change of Design Parameters of APCU, Cogen Units, Flaring Gas System and ASP

Parameter		Approved EIA Report	Updated Scheme
Centralized APCU			
Exit temperature (K)		308	308
Exit velocity (m/s)		18	**15**
Stack diameter (m)		1.6	**1.8**
Stack height (m above ground)		18	**25**
Stack location		817742.5 E, 819452.3 N	**817819.8 E, 819559.3 N**
Emission Limit (mg/Nm^3)	VOCs (including NMVOC)	680	680
	Particulates (in terms of RSP) [(a)]	6	6
	Odour (NH_3 and H_2S) (OU/Nm^3)	300	**220**
Emission Rate (g/s)	VOCs (including NMVOC)	21.8	**23.0**
	Particulates (in terms of RSP) [(a)]	0.192	**0.203**
	Odour (NH_3 and H_2S) (OU/s)	9,600	**7,440**
Cogen Units			
Exit temperature (K)		733	**453**
Exit velocity (m/s)		15	**16.5**
Stack diameter (m)		0.5	0.5
Stack height (m above ground)		8	**12**
Stack location (3 stacks – 1 for each cogen unit)		817821.3 E, 819488.0 N	**817896.7 E, 819550.2 N**
		817824.4 E, 819492.0 N	**817897.1 E, 819545.7 N**
		817827.5 E, 819495.9 N	**817901.8 E, 819544.5 N**
Emission Limit (mg/Nm^3)	Particulates (in terms of RSP) [(a)]	15	15
	CO	650	650
	NO_x	300	300
	SO_2	50	50
	VOCs	150	150
	HCl	10	10

Parameter		Approved EIA Report	Updated Scheme
	HF	1	1
Emission Rate (g/s)	Particulates (in terms of RSP) (a)	0.0129	**0.0292**
	CO	- (c)	**1.27**
	NO_x	0.258	**0.584**
	SO_2	0.0429	**0.0974**
	VOCs	0.129	**0.292**
	HCl	$8.58x10^{-3}$	**0.0195**
	HF	$8.58x10^{-4}$	**$1.95x10^{-3}$**
Flaring Gas System			
Exit temperature (K)		1173	1173
Exit velocity (m/s)		3.5	**13.3**
Stack diameter (m)		2.5	**2.2**
Stack height (m above ground)		8	**18**
Stack location		817784.8 E, 819438.1 N	**817902.9 E, 819521.8 N**
Emission Limit (mg/Nm^3)	Particulates (in terms of RSP) (a)	5	5
	CO	100	100
	NO_x	200	200
	SO_2	50	50
	VOCs	20	20
	HCl	10	10
	HF	1	1
Emission Rate (g/s)	Particulates (in terms of RSP) (a)	0.0121	**0.0587**
	CO	- (c)	**1.17**
	NO_x	0.483	**2.35**
	SO_2	0.121	**0.587**
	VOCs	0.0483	**0.235**
	HCl	0.0242	**0.117**
	HF	$2.42x10^{-3}$	**0.0117**
New ASP			
Exit temperature (K)		-	**413**
Exit velocity (m/s)		-	**9.2**
Stack diameter (m)		-	**0.5**
Stack height (m above ground)		-	**12**
Stack location		-	**817901.8 E, 819540.3 N**
Emission Limit (mg/Nm^3)	Particulates (in terms of RSP) (a)	-	**5**
	CO	-	**100**
	NO_x	-	**200**
	SO_2	-	**50**
	VOCs	-	**20**
	NH_3	-	**35**
	HCl	-	**10**
	HF	-	**1**
Emission Rate (g/s)	Particulates (in terms of RSP) (a)	-	**$5.96x10^{-3}$**
	CO	-	**0.119**
	NO_x	-	**0.238**
	SO_2	-	**0.0596**
	VOCs	-	**0.0238**
	NH_3	-	**0.0417**
	HCl	-	**0.0119**
	HF	-	**$1.19x10^{-3}$**

Parameter	Approved EIA Report	Updated Scheme

Notes:

(a) Particulates emission level is considered as RSP in the assessment.

(b) **Bold** and highlighted data are the proposed changes.

(c) CO was not modelled in the Approved EIA Report

During normal operation, the centralised APCU, Cogen Units (1) and new ASP will be in use. The centralised APCU would be used to remove air pollutants and odorous gas in the air extracted from the main buildings of the OWTF and the wastewater treatment unit. A total of three Cogen units would be installed at the OWTF site. The design emission levels for the Cogen units are obtained from the manufacturer's design specification and it is confirmed by the Design Engineer that they can practically be achieved.

Under the circumstances where there is a failure in the Cogen units, the biogas would be flared by the flaring gas system.

Compared with the emission of the concerned air pollutants, the total emission rates of the concerned air pollutants increased due to an additional emission source (i.e. ASP) and increase of the flowrate of each emission source.

2.2 *KEY ENVIRONMENTAL ISSUES ASSOCIATED WITH THE PROPOSED CHANGES*

Table 2.3 identifies the potential environmental impacts associated with the proposed changes.

Table 2.3 Potential Environmental Issues

Type of Potential Impact	Likelihood of Impact arising from the Proposed Changes (a)
Air Quality Impact - Gaseous emissions	✓
Air Quality Impact - Odour	✓
Air Quality Impact - Dust	×
Airborne Noise Impact - Noisy operation	×
Ground-borne Noise Impact - Noisy operation	×
Water Quality Impact - Liquid effluent, discharge, or contaminated run-off	×
Waste Management Implications - Generation of waste or by-products	×
Hazard to Life	✓
Land Contamination	×
Landscape and Visual Impact	✓
Ecology Impact	×
Cultural heritage	×

Note:

(a) ✓ possible; × not expected

(1) To generate electricity for on-site uses

Annex A1 - Location of Emission Sources and Calculation of Emission Rates for OWTF

Emissions from Centralized Air Pollution Control Unit

Temperature at emission point	=	308
Flow rate at 308K	=	137413.26
Flow rate at 273K	=	121798.12
Exit velocity	=	**15**
Diameter	=	**1.8**
Stack height	=	25
Stack Location (m)	**817819.8 E, 819559.3 N**	

Air Pollutant	Emission Level [2] (mg/Nm3)	Emission Rate (g/s)
VOCs (including NMVOC)	680	**2.30E+01**
RSP [7]	6	**2.03E-01**
Odour (including NH_3 &H_2S)[3]	220	**7.44E+03**

Emission from Cogen Units

Number of unit	=	3
Flow rate per unit	=	7012
Temperture of flue gas at emission point	=	**453**
Exit Velocity	=	**16.5**
Diameter	=	0.5
Stack height	=	**12**
Stack Locations (m)	**817896.7 N, 819550.2 E** **817897.1 N, 819545.7 E** **817901.8 N, 819544.5 E**	

Air Pollutant	Emission Level [2][4] (mg/Nm^3)	Emission Rate (g/s)
RSP [7]	15	**2.92E-02**
CO	650	**1.27E+00**
NO_x	300	**5.84E-01**
SO_2	50	**9.74E-02**
VOCs ←	150	**2.92E-01**
HCl	10	**1.95E-02**
HF	1	**1.95E-03**

Revised parameters are bolded

All the above information are provided by the Engineer of the OWTF Project based on the manufacturer's specification.

Appendix C - Extract from Environmental Monitoring and Audit Manual

AECOM

Environmental Protection Department

Agreement No. CE7/2008 (EP)

Organic Waste Treatment Facilities, Phase I – Feasibility Study

Environmental Monitoring and Audit Manual

December 2009

	Name	Signature
Prepared & Checked:	Kenny YIU	
Reviewed & Approved:	Matthew KO	

Version: B	Date: 28 December 2009

AECOM Asia Co. Ltd.
11/F, Grand Central Plaza, Tower 2, 138 Shatin Rural Committee Road, Shatin, NT, Hong Kong
Tel: (852) 2893 1551 Fax: (852) 2891 0305 www.aecom.com

- Provision of wind shield and dust extraction units or similar dust mitigation measures at the loading points, and use of water sprinklers at the loading area where dust generation is likely during the loading process of loose material, particularly in dry seasons/ periods;

- Imposition of speed controls for vehicles on unpaved site roads. 8 kilometers per hour is the recommended limit;

- Where possible, routing of vehicles and positioning of construction plant should be at the maximum possible distance from ASRs;

- Every stock of more than 20 bags of cement or dry pulverised fuel ash (PFA) should be covered entirely by impervious sheeting or placed in an area sheltered on the top and the 3 sides;

- Cement or dry PFA delivered in bulk should be stored in a closed silo fitted with an audible high level alarm which is interlocked with the material filling line and no overfilling is allowed; and

- Loading, unloading, transfer, handling or storage of bulk cement or dry PFA should be carried out in a totally enclosed system or facility, and any vent or exhaust should be fitted with an effective fabric filter or equivalent air pollution control system.

2.6 The Contractor shall be responsible for the design and implementation of these measures.

Monitoring during Commissioning Stage and Operation Phase

Stack Monitoring

2.7 Monitoring of air quality parameters of concern due to stack emissions from centralized air pollution control unit, the cogeneration units and the standby flaring gas unit should be conducted during commissioning stage. During the operation phase of the Project, stacking monitoring shall be installed for the centralized air pollution control unit and the cogeneration units of OWTF.

2.8 The parameters for measurement and the analytical methods are listed in **Table 2.1**. It should be noted that the proposed sampling methods below are for reference only and should be subject to the approval of EPD.

Table 2.1 Analytical Parameters and Methodology

Parameters	Method	Stacks to be Monitored
Gaseous and vaporous organic substances (including NMVOC)	USEPA Method 18 USEPA Method 0031	• Centralized Air Pollution Control Unit • Cogeneration Units • Standby Flaring Gas Unit
Particulate	ISO 9096, ASTM D3685-98, USEPA Method 17	• Centralized Air Pollution Control Unit • Cogeneration Units • Standby Flaring Gas Unit
Carbon monoxide	Combustion Gas Analyser	• Cogeneration Units • Standby Flaring Gas Unit
NO_x	USEPA Reference methods USEPA Method 7 and associated methods	• Cogeneration Units • Standby Flaring Gas Unit
SO_2	USEPA Method 8	• Cogeneration Units • Standby Flaring Gas Unit
HCl and HF	USEPA Method 26 A USEPA Method 13B sampling train	• Cogeneration Units • Standby Flaring Gas Unit

Oxygen	Combustion Gas Analyser (chemical cell and paramagnetic)	• Centralized Air Pollution Control Unit • Cogeneration Units • Standby Flaring Gas Unit
Velocity and Volumetric Flow	ISO 10780 and ISO 9096	• Centralized Air Pollution Control Unit • Cogeneration Units • Standby Flaring Gas Unit
Water Vapour Content and Temperature	USEPA Method 4	• Centralized Air Pollution Control Unit • Cogeneration Units • Standby Flaring Gas Unit

2.9 Necessary monitoring equipment and techniques should be provided and used to demonstrate that the process is properly operated and the emissions can be minimized to meet the air pollution control requirements as tabulated in **Tables 2.2, 2.3** and **2.4** below.

Table 2.2 Emission Limit for Centralized Air Pollution Control Unit

Parameter	Emission Level (mg//Nm^3)
VOCs (including NMVOC)	680
Dust (or Total Suspended Particulates)	6
Odour (including NH_3 & H_2S)	300 (1)

Note: (1) The odour unit is ou/Nm^3.

Table 2.3 Emission Limit for Cogeneration Units

Parameter	Maximum Emission Level (mg//Nm^3) (1)
Dust (or Total Suspended Particulates)	15
Carbon Monoxide	650
NOx	300
SO_2	50
VOCs	150
HCl	10
HF	1

Note: (1) All values refer to an oxygen content in the exhaust gas of 6% and dry basis.

Table 2.4 Emission Limit for Standby Flaring Gas Unit

Parameter	Maximum Emission Level (mg//Nm^3) (1)
Dust (or Total Suspended Particulates)	5
Carbon Monoxide	100
NOx	200
SO_2	50
VOCs	20
HCl	10
HF	1

Note: (1) All values refer to an oxygen content in the exhaust gas of 11% and dry basis.

2.10 On-line monitoring should be carried out for centralized air pollution control unit and cogeneration units during the operation phase of the OWTF. The continuous monitoring data should be transmitted instantaneously to EPD by telemetry system in such manner and the format to be agreed with EPD. The record should be retained at the premises for a minimum of two years, or other period specified by EPD, after the date of last entry and be made available for examination as and when required by EPD.

2.11 Evidence should be provided to demonstrate quality assurance procedures are in place to ensure all monitoring results are sufficiently accurate and reliable. Calibration on the monitoring equipment has to be done by means of parallel measurements with the reference methods as agreed by EPD.

Specification Part A together with the Design Submissions as specified in Clause 5 of the Specification Part A for the Independent Consultants' certification and Employer's consent.

4.2.1.3 The Contractor shall document the total plant reliability by a Failure Mode, Effects and Criticality Analysis (FMECA) study.

4.2.1.4 The design capacities of all associated and supporting facilities shall be designed by the Contractor to meet the operational need of the Facility.

4.3 Design Life

4.3.1.1 The material of the equipment shall be of durable quality to suit the in-situ operation for a minimum of fifteen (15) years design life.

4.3.1.2 The design life of all buildings, structures and infrastructures shall be a minimum of fifty (50) years counted from the commencement of the Operation.

4.3.1.3 All Plant and Mobile Plant shall have a residual life/remaining service life of 5 years at the expiry of the Operation.

4.3.1.4 All buildings, structures and infrastructures shall have a residual life/remaining service life of 35 years at the expiry of the Operation.

4.4 Environmental Performance Requirements

4.4.1 Air Emission Standards

β α 4.4.1.1 The Design and Operation of the Facility shall comply with the conditions as set out in the latest further Environmental Permit. In the event that the Contractor's Design introduces any changes to the conditions as set out in the latest further Environmental Permit, which may be considered by the Director of Environmental Protection as a material change in the context of the meaning in the EIAO, the Contractor shall, in accordance with Clause 1.8.2 of the Specification Part A, notify the Employer indicating the changes made with the re-assessment results and obtain approval from the Director of Environmental Protection of the proposed changes.

β α 4.4.1.2 The Contractor shall fully comply with the conditions as set out in the latest further Environmental Permit. The air emission standard for the Facility is listed below:

Air Emission Standard for the Facility

Air Pollutant	Emission Limit (mg/Nm^3)
Centralized Air Pollution Control System	
VOCs including non-methane volatile organic compounds (NMVOCs)	680
Dust (or Respirable Suspended Particulates)	6
Odour (including NH_3 and H_2S)	220[(i)]
Combined Heat and Power Generation (CHP) Units[(ii)]	
Dust (or Respirable Suspended Particulates)	15
Carbon Monoxide (CO)	650
Nitrogen Oxides (NO_X)	300

Air Pollutant	Emission Limit (mg/Nm^3)
Sulphur Dioxide (SO_2)	50
VOCs including NMVOCs	150
Hydrogen Chloride (HCl)	10
Hydrogen Fluoride (HF)	1
Standby Flaring Gas Unit[(iii)]	
Dust (or Respirable Suspended Particulates)	5
Carbon Monoxide (CO)	100
Nitrogen Oxides (NO_X)	200
Sulphur Dioxide (SO_2)	50
VOCs including NMVOCs	20
Hydrogen Chloride (HCl)	10
Hydrogen Fluoride (HF)	1

Notes :

β α (i) The emission limit for odour is based on the information included in the Employer's application for variation of the Environmental Permit (Application No. VEP-394/2013). The odour unit is ou/Nm^3.

(ii) All values refer to an oxygen content in the exhaust gas of 6% and dry basis.

(iii) All values refer to an oxygen content in the exhaust gas of 11% and dry basis.

4.4.2 Odour

β α 4.4.2.1 The Contractor shall comply with the odour emission standards and requirement as set out in the latest further Environmental Permit.

4.4.2.2 The Contractor shall note that there are a number of neighborhoods next to the Facility, including the Siu Ho Wan Vehicle Detention Pound, Siu Ho Wan Water Treatment Works, and two bus depots owned by Citybus Limited and Long Win Bus Co. Ltd., that have expressed their concerns regarding potential odour impacts associated with the Operation of the Facility and other interfacing issues as listed in Clause 4.10 of the Specification Part A.

4.4.2.3 The Contractor shall also note that the Facility will be opened to the public for visit regularly. The odour intensity shall be in the non-detectable level (Level 0 as classified in Clause 9.5.3 of Specification Part A) within all public access areas including the Administration Building, and the Visitors and Education Facilities, etc. That means no odour shall be perceived and an odour so weak that it cannot be readily characterised or described.

4.4.2.4 The Contractor shall also pay particular attention and provide necessary provision as per the strategies and guidelines stated in the Guidance Notes for the Management of Indoor Air Quality, published by the Indoor Air Quality Management Group of the Government in order to achieve the "excellent class" indoor air quality.

Appendix E - CHP Systems Extract

MILTON MECKLER, P.E., AND LUCAS B. HYMAN, P.E., EDITORS

SUSTAINABLE ON-SITE CHP SYSTEMS

Design, Construction, and Operations

Ranking of the various fuels in terms of their emissions production potential, in the order of the *least to the highest* emissions is as follows: natural gas, biogas, diesel/fuel oil No. 2, and coal. Similar ranking of the various CHP power generation technologies in terms of their emissions production potential is as follows: fuel cells, combustion turbines, microturbines, natural gas–fired engines, diesel engines, and coal-fired boilers. Therefore, the use of natural gas in fuel cells produces the least emissions, while the use of coal in boilers to produce steam for use in steam turbines to produce power produces the most emissions.

Emissions of Reactive Organic Gases

In addition to the emissions of CO_2, CO, NO_x, and SO_x, environmental permitting process also requires estimates of other criteria pollutants, such as trace organic compounds, as discussed in Chap. 13. The reactive organic gases (ROGs), also known as volatile organic compounds (VOCs), are estimated by the sum of all the speciated organic compounds minus those that are methane and ethane.

Examples of uncontrolled emissions, including ROGs/VOCs, for four-stroke rich and lean burn engines can be found at the following link:[8] http://www.epa.gov/ttn/chief/ap42/ch03/final/c03s02.pdf (see Ref. 8).

Emissions Calculator

The Midwest CHP Application Center has developed a simple spreadsheet-based emissions calculator.[9] The emissions calculator estimates expected emissions from the various classes of power generation technologies (i.e., natural gas–fired reciprocating engines and natural gas–fired turbines) used in CHP systems. The emissions calculator does not provide an estimate of emissions from any specific manufacturer's model of the power generator. For emission estimates for a specific manufacturer model, please refer to the manufacturer's specification sheet for that piece of equipment.

The emissions calculator utilizes the AP-42 emission factors compiled by the U.S. EPA and can be downloaded from the following URL: http://www.chpcentermw.org/pdfs/030123-PermitGuidebook-EmCalc_IL.xls. It allows approximation of the expected emissions from five power generation technology classes:

1. Diesel engine less than 600 hp
2. Diesel engine greater than 600 hp
3. Natural gas–fired engine
4. Gasoline-fired engine less than 250 hp
5. Natural gas–fired turbine

Table 7-3 shows samples of the emissions calculator's results for the above prime movers. The left side of the table shows the information for the case when the prime mover is planned to be located in an attainment area. The various columns display the following:

- The first column shows the pollutants being estimated.
- The second column provides the AP-42 emission factors utilized by this emissions calculator.
- The third column provides the estimated emission levels in tons per year for each pollutant, taking into account the operating hours per year and the fuel input.

Appendix F - USEPA Extract

CHP
EPA COMBINED HEAT AND POWER PARTNERSHIP

Catalog of CHP Technologies

Section 2. Technology Characterization – Reciprocating Internal Combustion Engines

U.S. Environmental Protection Agency
Combined Heat and Power Partnership

CHP
EPA COMBINED HEAT AND POWER PARTNERSHIP

March 2015

2.5.1.3 Unburned Hydrocarbons

Volatile hydrocarbons also called volatile organic compounds (VOCs) can encompass a wide range of compounds, some of which are hazardous air pollutants. These compounds are discharged into the atmosphere when some portion of the fuel remains unburned or just partially burned. Some organics are carried over as unreacted trace constituents of the fuel, while others may be pyrolysis products of the heavier hydrocarbons in the gas. Volatile hydrocarbon emissions from reciprocating engines are normally reported as non-methane hydrocarbons (NMHCs).

2.5.1.4 Carbon Dioxide (CO_2)

While not considered a pollutant in the ordinary sense of directly affecting health, emissions of carbon dioxide (CO_2) are of concern due to its contribution to climate change. The amount of CO_2 emitted is a function of both fuel carbon content and system efficiency. The fuel carbon content of natural gas is 34 lbs carbon/MMBtu; oil is 48 lbs carbon/MMBtu; and (ash-free) coal is 66 lbs carbon/MMBtu. As converted to CO_2 in the exhaust, these values are 117 lb/MMBtu for natural gas, 160 lb/MMBtu for diesel oil, and 205-226 lb/MMBtu for coal.

2.5.2 Emissions Control Options

Emissions from natural gas SI engines have improved significantly in the last decade through better design and control of the combustion process and through the use of exhaust catalysts. Advanced lean burn natural gas engines are available that produce NO_x levels as low 1.8 lb/MWh and CO emissions of 8.1lb/MWh before any exhaust gas treatment. Adding selective catalytic reduction (SCR) and a CO oxidation catalyst can allow lean burn reciprocating engines to meet the very stringent California South Coast emissions standards of 0.07 lb/MWh for NO_x and 1.0 lb/MWh for CO.

NO_x control has been the primary focus of emission control research and development in natural gas engines. The following provides a description of the most prominent emission control approaches.

2.5.2.1 Combustion Process Emissions Control

Control of combustion temperature has been the principal focus of combustion process control in gas engines. Combustion control requires tradeoffs – high temperatures favor complete burn up of the fuel and low residual hydrocarbons and CO, but promote NO_x formation. Lean combustion dilutes the combustion process and reduces combustion temperatures and NO_x formation, and allows a higher compression ratio or peak firing pressures resulting in higher efficiency. However, if the mixture is too lean, misfiring and incomplete combustion occur, increasing CO and VOC emissions.

Lean burn engine technology was developed during the 1980s as a direct response to the need for cleaner burning gas engines. As discussed earlier, thermal NO_x formation is a function of both flame temperature and residence time. The focus of lean burn developments was to lower combustion temperature in the cylinder using lean fuel/air mixtures. Lean combustion decreases the fuel/air ratio in the zones where NO_x is produced so that peak flame temperature is less than the stoichiometric adiabatic flame temperature, therefore suppressing thermal NO_x formation. Most lean burn engines use turbocharging to supply excess air to the engine and produce the homogeneous lean fuel-air mixtures. Lean burn engines generally use 50 to 100 percent excess air (above stoichiometric). The typical uncontrolled emissions rate for lean burn natural gas engines is between 1.5-6.0 lb/MWh.

Catalog of CHP Technologies

Section 6. Technology Characterization – Fuel Cells

U.S. Environmental Protection Agency
Combined Heat and Power Partnership

March 2015

- **Manufactured gases** – typically low- and medium-Btu gas produced as products of gasification or pyrolysis processes.

Factors that impact the operation of a fuel cell system with alternative gaseous fuels include:

- **Volumetric heating value** – Since fuel is initially reformed by the fuel cell's fuel processing subsystem, the lower energy content fuels will simply result in a less concentrated hydrogen-rich gas stream feeding the anode. This will cause some loss in stack performance, which can affect the stack efficiency, stack capacity or both. Increased pressure drops through various flow passages can also decrease the fine balance developed in fully integrated systems.

- Contaminants are the major concern when operating on alternative gaseous fuels. If any additional sulfur and other components (e.g., chlorides) can be removed prior to entering the fuel processing catalyst, there should be no performance or life impact. If not, the compounds can cause decreased fuel processor catalyst life and potentially impact stack life.

6.4.9 System Availability

Fuel cell systems are generally perceived as low maintenance devices. Fuel cells in North America have been recorded achieving more than 90 percent availability. In premium power applications, 100 percent customer power availability, and 95 percent+ fleet availability has been reported during the same time period. Fuel cells can provide high levels of availability, especially in high load factor (i.e. baseload) applications.

6.5 Emissions and Emissions Control Options

As the primary power generation process in fuel cell systems does not involve combustion, very few emissions are generated. In fact, the fuel processing subsystem is the only source of emissions. The anode-off gas that typically consists of 8 to 15 percent hydrogen is combusted in a catalytic or surface burner element to provide heat to the reforming process. The temperature of this very lean combustion can be maintained at less than 1,800° F, which also prevents the formation of oxides of nitrogen (NO_x) but is sufficiently high to ensure oxidation of carbon monoxide (CO) and volatile organic compounds (VOCs – unburned, non-methane hydrocarbons). Other pollutants such as oxides of sulfur (SO_x) are eliminated because they are typically removed in an absorbed bed before the fuel is processed.

6.5.1 Primary Emissions Species

6.5.1.1 Nitrogen Oxides (NO_x)

NO_x is formed by three mechanisms: thermal NO_x, prompt NO_x, and fuel-bound NO_x. Thermal NO_x is the fixation of atmospheric oxygen and nitrogen, which occurs at high combustion temperatures. Flame temperature and residence time are the primary variables that affect thermal NO_x levels. The rate of thermal NO_x formation increases rapidly with flame temperature. Prompt NO_x is formed from early reactions of nitrogen modules in the combustion air and hydrocarbon radicals from the fuel. It forms within the flame and typically is on the order of 1 ppm at 15 percent O_2, and is usually much smaller than the thermal NO_x formation. Fuel-bound NO_x forms when the fuel contains nitrogen as part of the hydrocarbon structure. Natural gas has negligible chemically bound fuel nitrogen. Fuel-bound NO_x can be at significant levels with liquid fuels.

6.5.1.2 Carbon Monoxide (CO)

CO and VOCs both result from incomplete combustion. CO emissions result when there is inadequate oxygen or insufficient residence time at high temperature. Cooling at the combustion chamber walls and reaction quenching in the exhaust process also contribute to incomplete combustion and increased CO emissions. Excessively lean conditions can lead to incomplete and unstable combustion and high CO levels.

6.5.1.3 Unburned Hydrocarbons

Volatile hydrocarbons, also called volatile organic compounds (VOCs), can encompass a wide range of compounds, some of which are hazardous air pollutants. These compounds are discharged into the atmosphere when some portion of the fuel remains unburned or just partially burned. Some organics are carried over as unreacted trace constituents of the fuel, while others may be pyrolysis products of the heavier hydrocarbons in the gas. Volatile hydrocarbon emissions from reciprocating engines are normally reported as non-methane hydrocarbons (NMHCs). Methane is not a significant precursor to ozone creation and smog formation and is not currently regulated. Methane is a greenhouse gas and may come under future regulations.

6.5.1.4 Carbon Dioxide (CO_2)

Carbon dioxide (CO_2) emissions are of concern due to its contribution to global warming. Atmospheric warming occurs since solar radiation readily penetrates to the surface of the planet but infrared (thermal) radiation from the surface is absorbed by the CO_2 (and other polyatomic gases such as methane, unburned hydrocarbons, refrigerants and volatile chemicals) in the atmosphere, with resultant increase in temperature of the atmosphere. The amount of CO_2 emitted is a function of both fuel carbon content and system efficiency. The fuel carbon content of natural gas is 34 lbs carbon/MMBtu; oil is 48 lbs carbon/MMBtu; and (ash-free) coal is 66 lbs carbon/MMBtu.

6.5.2 Fuel Cell Emission Characteristics

Table 6-5 illustrates the emission characteristics of fuel cell systems. Fuel cell systems do not require any emissions control devices to meet current and projected regulations. As previously noted, fuel cells generally have very low emissions.

Table 6-5. Estimated Fuel Cell Emission Characteristics without Additional Controls

Emissions Characteristics	System 1	System 2	System 3	System 4	System 5
Fuel Cell Type	PEMFC	SOFC	MCFC	PAFC	MCFC
Nominal Electricity Capacity (kW)	0.7	1.5	300	400	1,400
NO_x (lb/MWh)	Negligible	Negligible	0.01	0.01	0.01
SO_x (lb/MWh)	Negligible	Negligible	0.0001	Negligible	0.0001
CO (lb/MWh)	Negligible	Negligible	Negligible	0.02	Negligible
VOC (lb/MWh)	Negligible	Negligible	Negligible	0.02	Negligible
CO_2 (lb/MWh)	1,131	734	980	1,049	980
CO_2 with heat recovery (lb/MWh)	415	555	520-680	495	520

Source: ICF Manufacturer Data Collection

Appendix G - UK Example

Environment Agency permitting decisions

Bespoke Variation (Substantial)

We have decided to issue the variation for Lake District Creamery operated by The First Milk Cheese Company Limited.

The variation number is EPR/KP3931MS/V003

We consider in reaching that decision we have taken into account all relevant considerations and legal requirements and that the permit will ensure that the appropriate level of environmental protection is provided.

Purpose of this document

This decision document:

- explains how the application has been determined
- provides a record of the decision-making process
- shows how all relevant factors have been taken into account
- justifies the specific conditions in the permit other than those in our generic permit template.

Unless the decision document specifies otherwise we have accepted the applicant's proposals.

Structure of this document

- Key issues
- Annex 1 the decision checklist
- Annex 2 the consultation and web publicising responses

Key issues of the decision

1 Proposed Changes

Installation of an anaerobic digestion (AD) plant to enable liquid feed stock including waste streams currently generated at the facility to undergo AD treatment with the production of biogas. The biogas will be used to directly power a new Combined Heat & Power (CHP) unit with a thermal input of 1.3MW with the remainder being injected into the National Grid Transmission System.

Changes to the effluent treatment plant (ETP) are also proposed to minimise the phosphorus release into the River Ellen. This reduction in phosphorous will result in a significant improvement in water quality in the River Ellen, helping this water body to achieve the Water Framework Directive objective of Good Ecological Status as identified in the Northwest River Basin Management Plan.

Parameter Concentrations

The concentrations used for the new plant are based on the manufacturer design specification and are tabulated below:

Source	NO_x (mg/m^3)	SO_2 (mg/m^3)	CO (mg/m^3)	H_2S (mg/m^3)	Non methane VOCs(mg/m^3)
New CHP	500	81.7	800	-	75
Emergency Flare	400	10.5	150	5.6	-

Total volatile organic compounds (VOCs) will comprise predominately methane for which there is no Environmental Assessment Level (EAL) and so is excluded from the assessment.

Screening Methodology

PCs are considered **Insignificant** if:

- the **long-term$_{(LT)}$** process contribution is less than **1%** of the relevant EQS/EAL; and
- the **short-term$_{(ST)}$** process contribution is less than **10%** of the relevant EQS/EAL.

EQS – Environmental Quality Standard

EAL – Environmental Assessment Level

For those pollutants which do not screen out as insignificant, we determine whether exceedences of the relevant EQS are likely.

The Process Contributions (PC) and Predicted Environmental Concentrations (PEC) at the **worst case human health receptor** have been compared with the appropriate EQS/EAL.

PEC = PC + background conc. (BC)

Impact Assessment

Assessments were carried out for normal and abnormal operation. Abnormal operation results from emergency operation of the flare which has been assessed for the short term impacts only based on <5% of the total plant availability.

The tables below predict the impacts from both existing and new emissions at the worst case human health receptor, a residential receptor (R12) located 100m north east of the AD & ETP, see below. R13 is a storage container and unoccupied.

Standard rules

Chapter 4, The Environmental Permitting (England and Wales) Regulations 2010

Standard rules SR2010No15
Anaerobic digestion facility including use of the resultant biogas

Introductory note

This introductory note does not form part of these standard rules

When referred to in an environmental permit, these rules will allow the operator to carry out anaerobic digestion of wastes and also use of the biogas in compression and spark ignition engines with an aggregate rated thermal input of up to 3 megawatts. The rules also allow use of standard commercial gas turbines, fuel cells (e.g. Molten Carbonate or Solid Oxide) or treatment followed by injection into the gas grid.

Permitted wastes do not include hazardous wastes. The total quantity of waste that can be accepted at any site under these rules must not exceed 75,000 tonnes per year. Any wastes controlled by the Animal By-Products Regulations[1] must be treated and handled in accordance with any requirements imposed by those Regulations.

The permitted activities must not be carried out within 500 metres of a European Site[2], Ramsar site or a Site of Special Scientific Interest (SSSI) (excluding any SSSI designated solely for geological features). The permitted activities must not be carried out within 250 metres of any off-site building used by the public, including dwelling houses or within a specified Air Quality Management Area (AQMA)[3]. The activities must be outside groundwater Source Protection Zone 1. All storage and treatment of waste solids, liquids and sludges shall also not be within:

- 10 metres of any watercourse
- 50 metres from any spring or well, or from any borehole not used to supply water for domestic or food production purposes, and
- 50 metres from any well, spring or from any borehole used for the supply of water for human consumption. This must include private water supplies
- 250 metres within the presence of Great Crested Newts where it is linked to the breeding ponds of the newts by good habitat
- 50 metres of a National Nature Reserve (NNR), Local Nature Reserves(LNR), Local Wildlife Site (LWS), Ancient woodland or Scheduled Ancient Monument.
- 50 metres of a site that has relevant species or habitats protected under the Biodiversity Action Plan that the Environment Agency considers at risk to this activity .

These standard rules do not allow any emission into surface waters or groundwater except clean water from roofs and parts of the site not used for waste activity including storage of wastes. However, under the emissions of substances not controlled by emission limits rule, biogas condensate, treated digestate and waste waters may be discharged to a sewer subject to a consent issued by the local water company.

[1] The Animal By-Products (Enforcement) (England) Regulations 2011 (SI 2011 No.881) and the Animal By-Products (Enforcement) (Wales) Regulations 2011 (SI 2011 No.600 W.88)

[2] A candidate or Special Area of Conservation (cSAC or SAC) and Proposed or Special Protection Area (pSPA or SPA) in England and Wales.

[3] An Air Quality Management Area which has been designated due to concerns about nitrogen dioxide.

End of Introductory Note

3 – Emissions and monitoring

3.1 Emissions to air, water or land

3.1.1 There shall be no point source emissions to air, water or land, except from the sources and emission points listed in table 3.1

3.1.2 The limits given in table 3.1 shall not be exceeded.

Table 3.1 Point source emissions to air - emission limits and monitoring requirements

Emission Point and Source	Parameter	Limit (including units)	Monitoring Frequency and Standard or Method
Stacks on engines	Oxides of Nitrogen Carbon monoxide Suphur dioxide Total volatile organic compounds including methane Non methane volatile organic compounds	500 mg/m^3 1400 mg/m^3 350 mg/m^3 1000 mg/m^3 75 mg/m^3 Emission levels at Normal Temperature and Pressure and 5%O2, unless otherwise agreed in writing by the Agency Minimum stack exit velocity of 15 m/s to ensure effective plume breakaway	Annual monitoring Monitoring equipment, techniques, personnel and organisations employed for the engine stack emissions monitoring programme (including the measurement of exhaust gas temperature) shall have either MCERTS certification or MCERTS accreditation (as appropriate).
Stacks on boilers burning biogas	Oxides of Nitrogen Carbon monoxide	No limit set No limit set	None specified
Auxiliary flare	Oxides of Nitrogen Carbon monoxide	No limit set No limit set	None specified
Pressure relief valves	Biogas	No limit set	None specified

3.2 Emissions of substances not controlled by emission limits

3.2.1 Emissions of substances not controlled by emission limits (excluding odour) shall not cause pollution. The operator shall not be taken to have breached this rule if appropriate measures, including, but not limited to, those specified in any approved emissions management plan, have been taken to prevent or where that is not practicable, to minimise, those emissions.

3.2.2 The operator shall:

(a) if notified by the Environment Agency that the activities are giving rise to pollution, submit to the Environment Agency for approval within the period specified, an emissions management plan;

(b) implement the approved emissions management plan, from the date of approval, unless otherwise agreed in writing by the Environment Agency.

Annex B

References for VOC Emission Limit for CHP

Appendix I - ECN presentation (Netherlands)

ECN
Your energy. Our passion.

Evaluation of the Dutch Decree on emission limit values for medium-sized combustion installations – five potential restrictions

Nice
October 18th, 2013

www.ecn.nl

Content

- Environmental legislation in the Netherlands
- NO_x: environmental issue in the Netherlands
- Stationary engines – short background
- NO_x and C_xH_y ELV for gas engines
- NO_x and dust ELV for diesel engines
- Conclusions

Environmental legislation in the Netherlands

- In April 2010, the Dutch Decree on emission limit values (ELVs) on medium-sized combustion installations (< 50 MW_{th}) (in Dutch: Bems) entered into force

- The Dutch government aims to simplify environmental legislation
  → Shift several decrees into one Activities Decree
  → Set more common rules for companies
  → Less permits for companies are requested

- Since January 2013, the Bems decree has been incorporated into the Activities decree (§ 3.2.1)

- Evaluation of the Bems decree

Environmental legislation in the Netherlands

- The evaluation of the Bems decree was performed by ECN, Infomil, the Dutch Ministry of Infrastructure and Environment and several stakeholders
- The evaluation tackled various scopes
- Special attention to five potential further restrictions, which were considered at the time of commencement of the Bems decree

Environmental legislation in the Netherlands

Five potential further restrictions

→ NO_x ELV for natural gas and biogas engines (< 1 MW_e/2,5 MW_{th}) at 100 mg/Nm^3 at 3% O_2 (currently: 340)

→ C_xH_y ELV for natural gas engines (≥ 1 MW_e/2,5 MW_{th}) at 1200 mg/Nm^3 at 3% O_2 (currently: 1500) → "methane ELV"

→ Currently no C_xH_y ELV for natural gas and biogas engines (< 1 MW_e/2,5 MW_{th}). The Ministry: are there arguments to set an ELV?

→ PM ELV for diesel engines at 15 mg/Nm^3 at 3% O_2 (currently: 50)

→ NO_x ELV for diesel engines at 140 mg/Nm^3 at 3% O_2 (currently: 450)

Environmental legislation in the Netherlands

- Natural gas engines relevant in NL:
  - → ~4250 stationary gas engines
  - → of which, ~3000 (< 1 MW_e/2,5 MW_{th})
    - → of which, ~1650 in Agricultural sector, ~450 in Health care sector, ~450 in Services sector

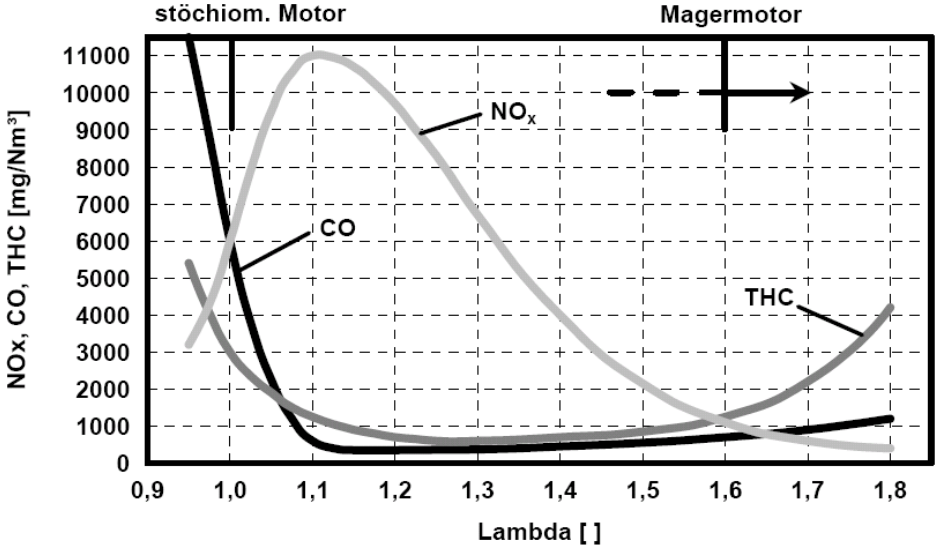
NO_x: environmental issue in the Netherlands

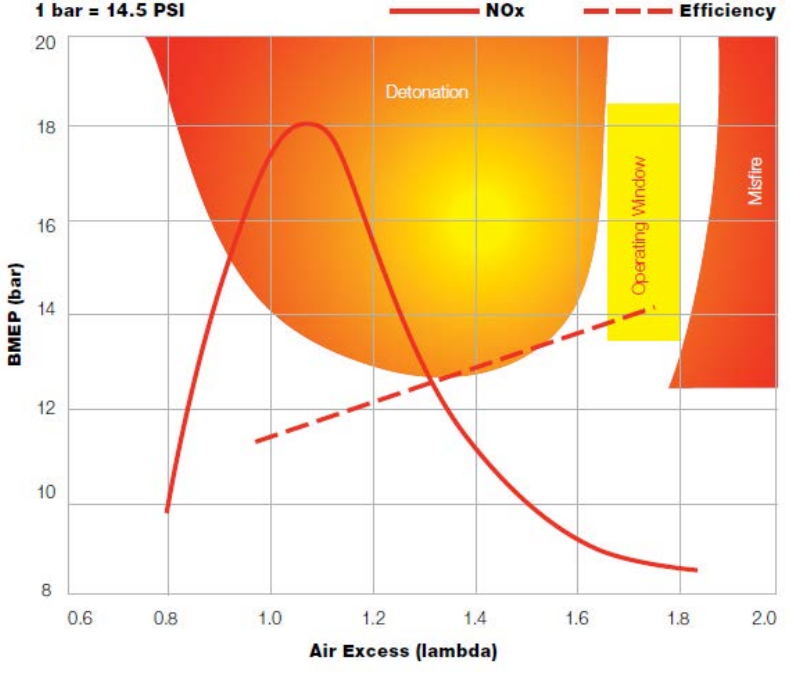
- Dutch NO_x emissions in 2010: 274 kton (NEC definition; source: CBS, ECN & PBL)
  - Of which: 59% due to traffic, 12% and 11% due to Energy and Industry sectors, 4% combustion installations in greenhouse horticulture

- In 2010: Dutch NO_x-emissions were above the NEC ceiling. Other NEC emissions were below NEC ceiling.

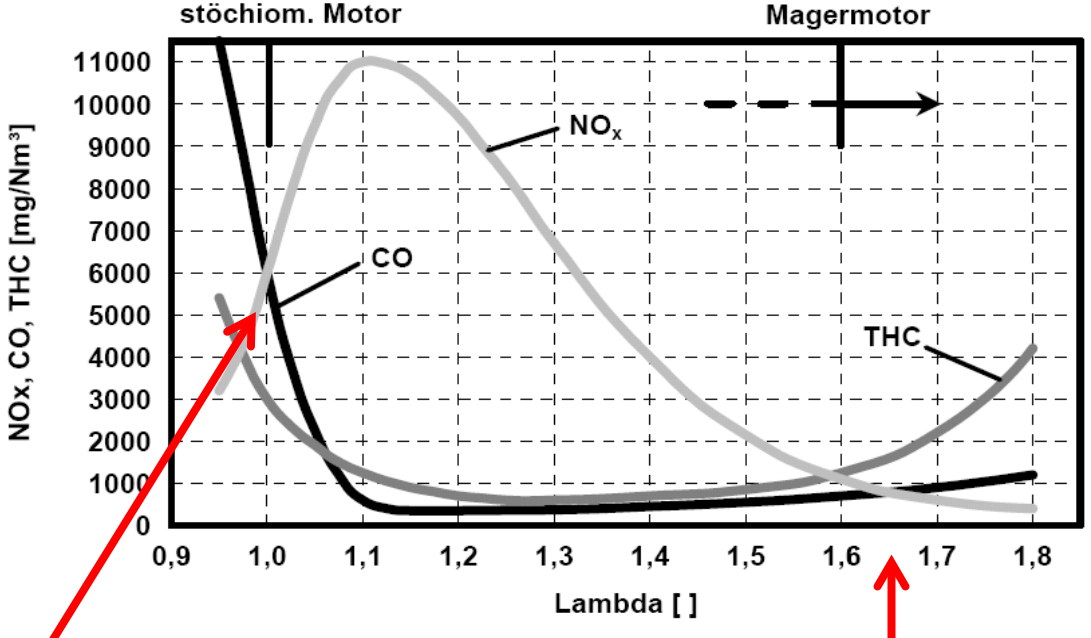
- In 2012: NO_x hotspots in NL above 40 µg/m^3, i.e. above European standards

Stationary engines – short background





NO_x ELV for gas engines



Alternative: run engine stoichiometric:

- 3-way catalyst (cheap!)
- Efficiency improvement via new technology: cooled EGR

Majority of engines at high lambda to increase (mechanical) efficiency. Potential after-treatment: SCR.

→ Not cheap

→ But: applied several times in horticulture

→ Moreover: prices have gone down

NO_x ELV for gas engines

→ Catalytic after-treatment with SCR or 3-way catalysts commercially available

- Proposed further restriction: from 340 to 100 mg NO_x/Nm^3 at 3% O_2
- Already similar ELVs in Californian regions and Swiss regions
- Achieving 100 mg NO_x/Nm^3 technically difficult with 3-way catalyst
- Advise: consider ELV at 140 mg NO_x/Nm^3 at 3% O_2

→ For engines running on particular biogases:

- Contaminants may affect the after-treatment catalysts, e.g. siloxanes in sewage treatment biogas
- Activated carbon filters commercially available
- Advise: consider similar ELVs biogas engines as compared to natural gas engines

C_xH_y ELV for gas engines

- C_xH_y ELV for natural gas engines (≥ 1 MW_e/2,5 MW_{th}) from 1500 to 1200 mg/Nm^3 at 3% O_2 → "methane ELV"
- Currently no C_xH_y ELV for natural gas and biogas engines (< 1 MW_e/2,5 MW_{th}). The Ministry: are there arguments to set an ELV?

→Application of gas engine as CHP saves CO_2 emissions

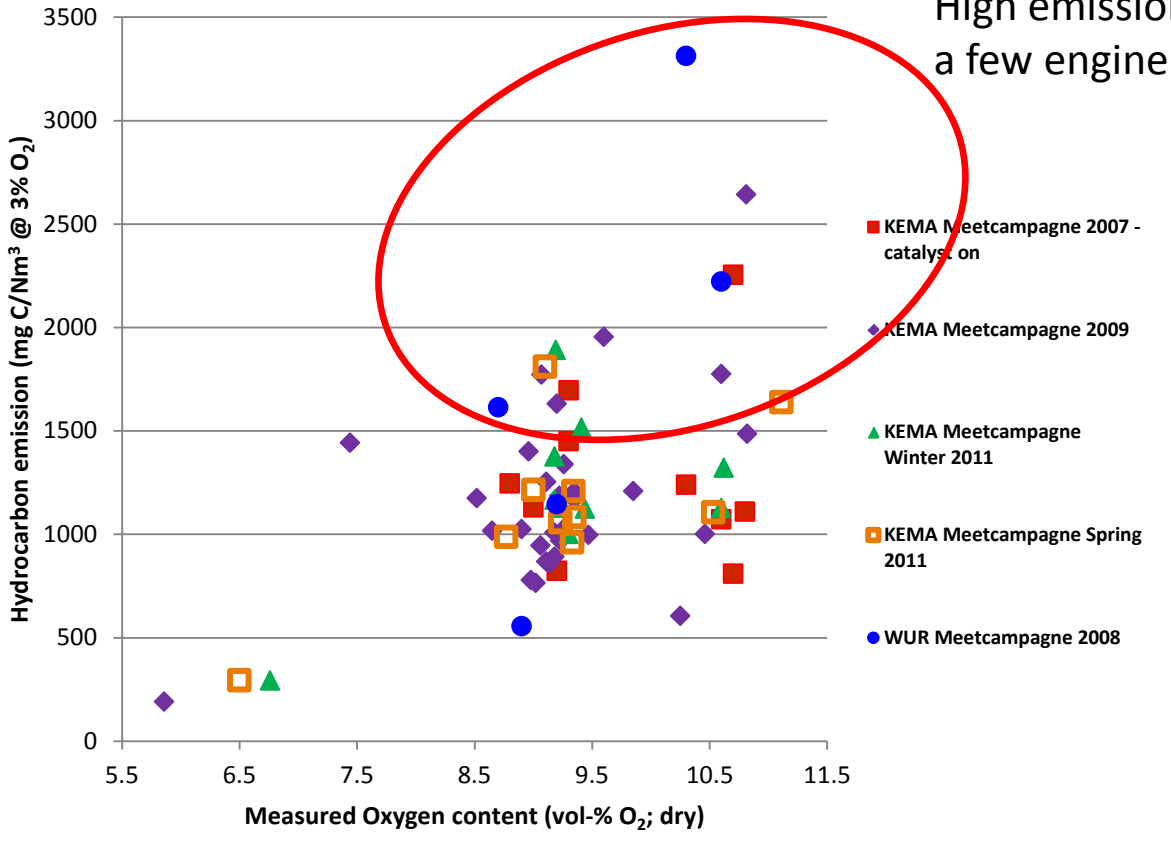
→Methane slip partly counteracts realized CO_2 savings

	CO_2 reduction without methane slip	CO_2 reduction at CH_4 emission of 1200 mg C/Nm^3	CO_2 reduction at CH_4 emission of 1500 mg C/Nm^3
Case large gas engine	26%	15%	12%
Case small gas engine	20%	8%	5%

Case large gas engine: 41% $_{\text{electrical efficiency}}$, 49%$_{\text{thermal efficiency}}$
Case small gas engine: 34% $_{\text{electrical efficiency}}$, 52%$_{\text{thermal efficiency}}$
Reference electrical efficiency: 50.5%
Reference heat efficiency: 90%

C_xH_y ELV for gas engines

High emissions dominated by a few engine manufacturers



C_xH_y ELV for gas engines

- New engines can already meet the proposed ELV
- Some manufacturers: change engine design or cannot sell
- For existing engines aftertreatment is commercially available

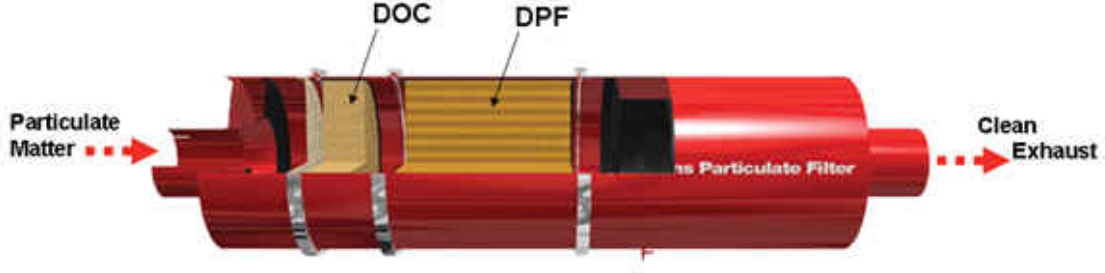
→ Advise: consider the proposed ELV for new engines and consider a transitional arrangement for existing engines

- Small gas engines and biogas engines emit substantial less methane
- Stricter NO_x-ELVs may result in leaner operation of small gas engines

→ Advise: consider the current C_xH_y ELV also for small gas engines to restrict potential increasing methane emissions due to leaner operation

Dust ELV for diesel engines

- Proposed further restriction: from 50 to 15 mg PM/Nm^3 at 3% O_2
- (Commercially available) filter technology needed
- Dust filters require relative high-quality diesel (ULSD)
- Germany has similar ELV as proposal
- In USA, stricter ELVs will phase in from 2015 onwards
- Advise: consider implementation ELV at the same time as USA



NO_x ELV for diesel engines

- Proposed further restriction: from 450 to 140 mg NO_x/Nm^3 at 3% O_2
- Proposed ELV near Euro VI for diesel trucks → SCR commercially available
- Stationary diesel engines often large power capacity
- Low rpm, high cylinder volume → increase of NO_x emissions
- In USA, strict ELVs will phase in from 2015 onwards (variable in power, rpm and cylinder volume) → 150 till 1350 mg NO_x/Nm^3 at 3% O_2
- Advise: consider ELV at 250 mg NO_x/Nm^3 at 3% O_2

  Keep timing in line with introduction USA ELV for diesel engines <10 L per cylinder

Conclusions

- Current ELVs belong to strictest of Europe, but can be restricted further: techniques are commercially available
- It is recommended to restrict the ELVs, but not all original considered levels are recommended for technical reasons:
  - Small gas engines 140 instead of 100 mg NO_x/Nm^3 at 3% O_2
  - Diesel engines 250 instead of 140 mg NO_x/Nm^3 at 3% O_2
- Advise has been reported
- Implementation of stricter ELVs is pending at the Dutch Ministry of Infrastructure and Environment

  → EC considers to regulate medium-sized combustion installations

  → Implementation not opportune yet

Thank you for your attention

Arjan Plomp – ECN, the Netherlands
plomp@ecn.nl

Recalculation of Dutch ELVs to other units

Installation type	Substance	ELV-mg/Nm^3 at 3% O_2	ELV-mg/Nm^3 at 15% O_2	ELV in g/GJ
Gas engine	NO_x	100	33	28 (fuel: natural gas of 31.65 MJ/Nm^3)
Gas engine	NO_x	140	46	40 (fuel: natural gas of 31.65 MJ/Nm^3)
Gas engine	NO_x	340	113	95 (fuel: natural gas of 31.65 MJ/Nm^3)
Gas engine	C_xH_y as C	1200	398	336 (fuel: natural gas of 31.65 MJ/Nm^3)
Gas engine	C_xH_y as C	1500	497	420 (fuel: natural gas of 31.65 MJ/Nm^3)
Diesel engine	PM	15	5	4 (fuel: diesel of 42.7 MJ/kg)
Diesel engine	PM	50	17	14 (fuel: diesel of 42.7 MJ/kg)
Diesel engine	NO_x	140	46	40 (fuel: diesel of 42.7 MJ/kg)
Diesel engine	NO_x	250	83	72 (fuel: diesel of 42.7 MJ/kg)
Diesel engine	NO_x	450	149	129 (fuel: diesel of 42.7 MJ/kg)

Dutch Bems ELVs, since April 2010

Installation	NO_x	Dust	SO_2	C_xH_y
Boiler (s,l) ≥1 $MW_{(n)}$	100	5	200	
Boiler (Biomass) <5 MW_{th}	200	20	200	
Boiler (Biomass) ≥5 MW_{th}	145	5	200	
Boiler (g) ≥1 $MW_{(n)}$	70		200	
Diesel engine (l)	450	50	200	
Gasengine (g)	100		200	1500
Gasengine (biogas or <2,5MW_{th})	340		200	
Gasturbine (l)	140	15	200	
Gasturbine (g)	140		200	

Emission limit values: s:mg/Nm^3 @ 6 vol%O_2; l+g:mg/Nm^3 @ 3 vol% O_2

MW_{th}: Thermal input rate in MW; MW_n: Nominal heat output in MW (source: website Infomil)

Adjustments of Dutch Bems ELVs to Activities decree, since January 2013

Installation	NO_x	Dust	SO_2	C_xH_y
Boiler (l) ≥1 $MW_{(n)}$	120 ~~100~~			
Boiler (l) (>0.4-<1 MW_{th})	120	20	200	
Boiler (Biomass) (>0.4-<1 MW_{th})	300	5	200	
Boiler (g) (>0.4-<1 MW_{th})	70		200	
Boiler (Biomass) (≤0.4 MW_{th})	300	40	200	

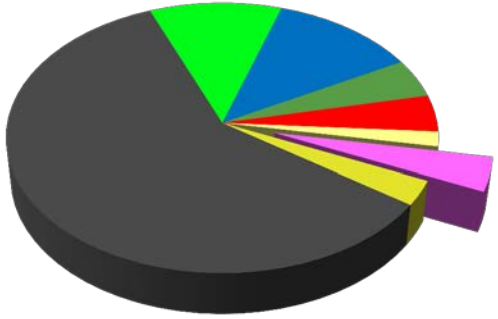
Emission limit values: s:mg/Nm^3 @ 6 vol%O_2; l+g:mg/Nm_3 @ 3 vol% O_2
MW_{th}: Thermal input rate in MW
MW_n: Nominal heat output in MW (source: Dutch Activiteis decree, §3.2.1)

Note: until January 2015, a transitional arrangement is in place for biomass-fired boilers for <1 MW_{th} due to potential EC regulation:
Boiler (Biomass) (>0.4-<1 MW_{th}) →only dust ELV: 75
Boiler (Biomass) (≤0.4 MW_{th}) →only dust ELV: 150

Environmental legislation in the Netherlands

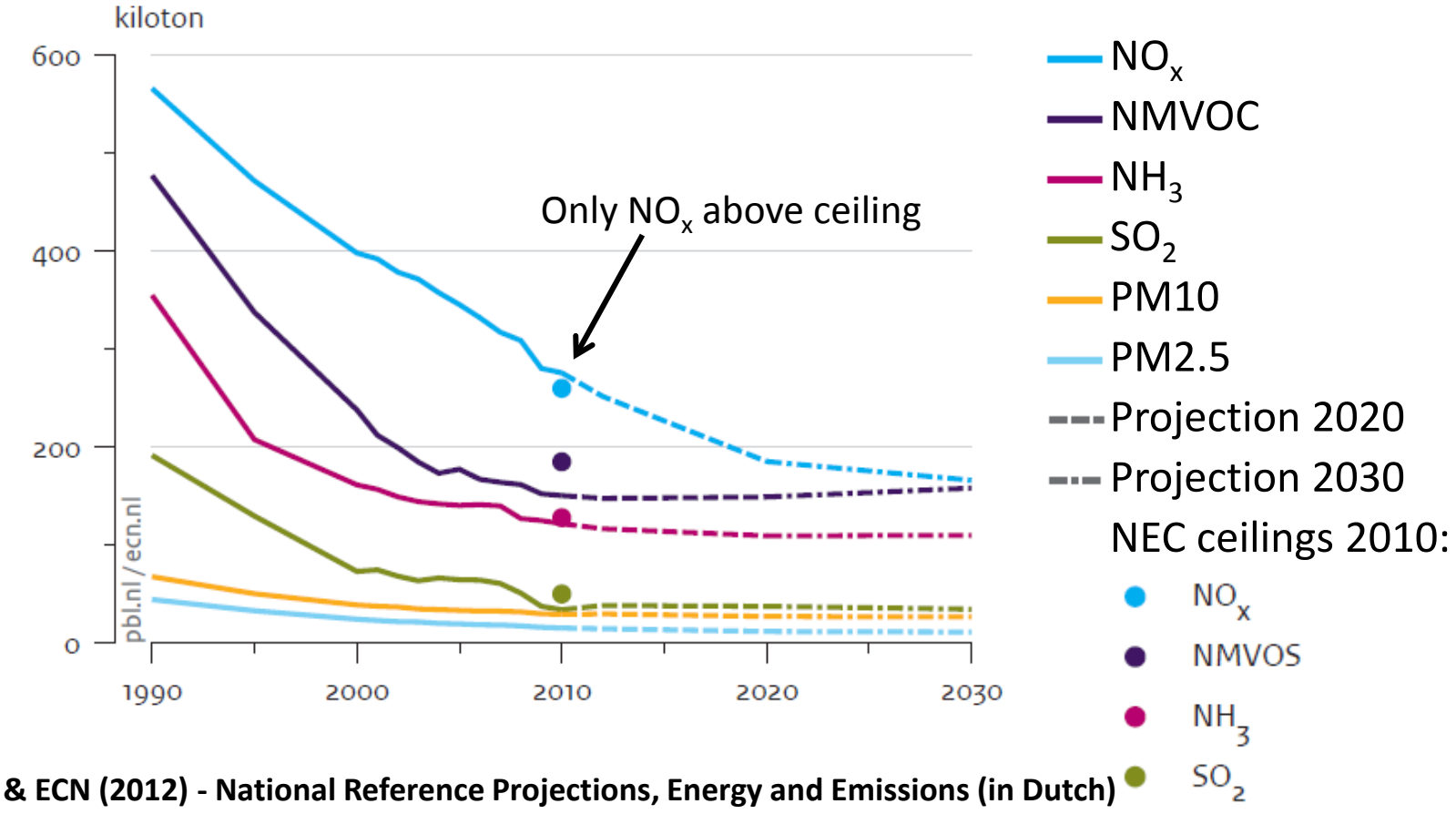
- Natural gas engines relevant in NL:
  - → ~4250 stationary gas engines
  - → of which, ~3000 (< 1 MW_e/2,5 MW_{th})
    - → of which, ~1650 in Agricultural sector, ~450 in Health care sector, ~450 in Services sector

NO_x emissions in 2010: 274 kton **(NEC definition; source: CBS, ECN & PBL)**



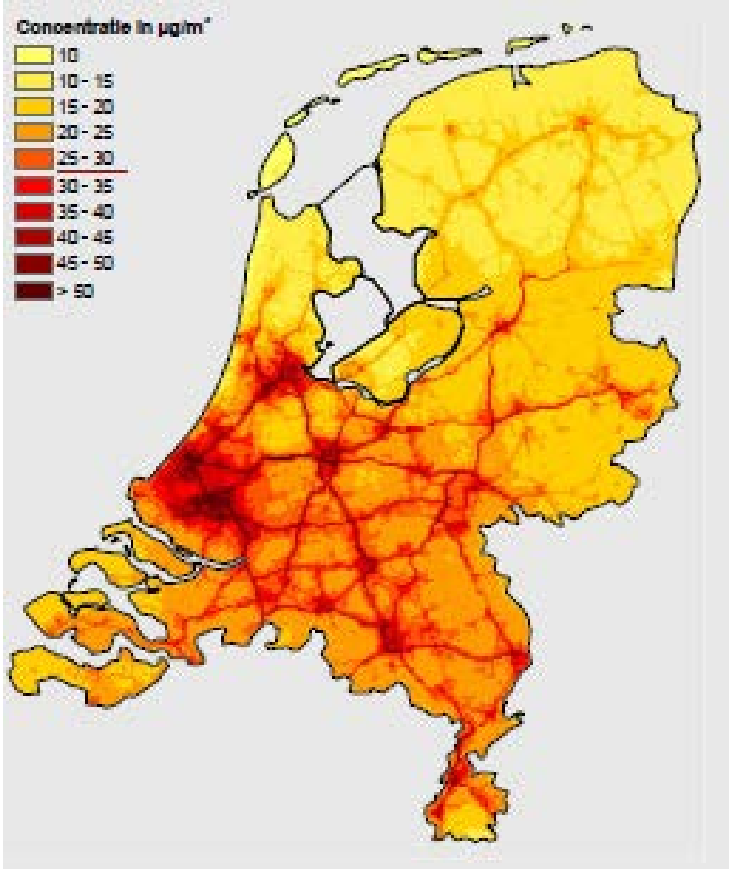
- Agriculture | combustion installations greenhouse horticulture
- Agriculture other activities and other combustion installations
- Traffic total according NEC (without marine traffic)
- Industry total
- Energy total
- Consumers total
- Services total
- Waste incineration total

NO_x: environmental issue in the Netherlands



Source: PBL & ECN (2012) - National Reference Projections, Energy and Emissions (in Dutch)

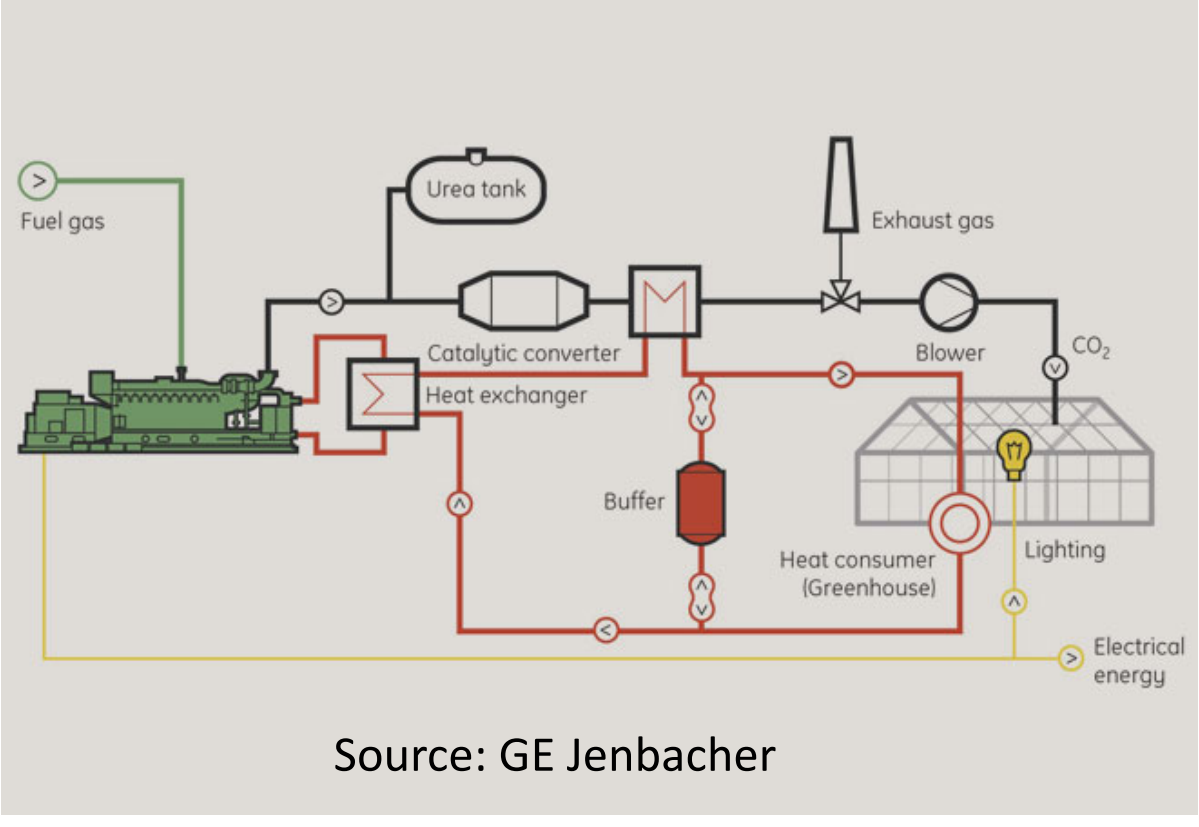
NO_x: environmental issue in the Netherlands



- Annual NO_x concentration in the Netherlands in 2012
- Hotspots
- Substantially traffic induced
- Decrease of background concentration

Source: RIVM (2012) – Annual Report Air Quality (in Dutch)

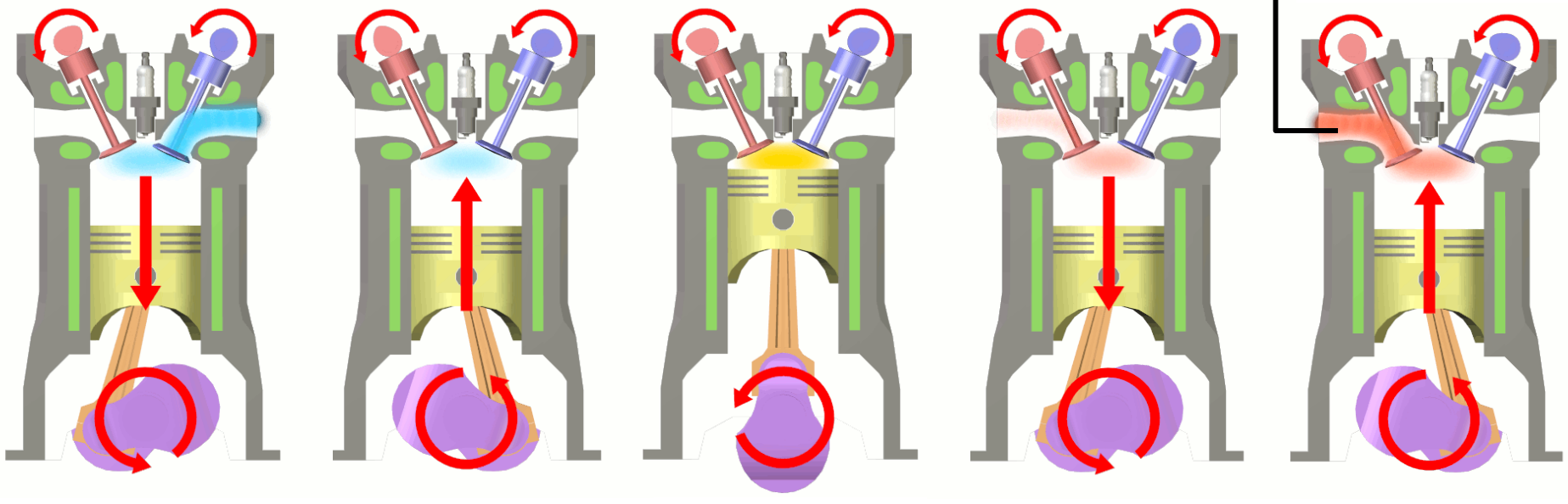
Stationary engines – short background



Source: GE Jenbacher

Stationary engines – short background

CO_2, H_2O, NO_x, C_xH_y, evt PM



Appendix J - CIMAC data on methane emissions - Extract

CIMAC
INTERNATIONAL COUNCIL ON COMBUSTION ENGINES

04 | 2014

CIMAC Position Paper

Methane and Formaldehyde Emissions of Gas Engines

By CIMAC WG 17, Gas Engines

The first edition of this document was approved by the members of the CIMAC WG 17 ‘Gas Engines’ on April 10th, 2014.

(2) *The dilemma of NO^x and CH^4:*

Similar to the dilemma of efficiency and CH^4 there is also a dilemma with regard to NO^x and CH^4. When just focusing on the reduction of unburned CH^4-emissions the enrichment of the combustion mixture would be a very effective measure. By reaching almost stoichiometric conditions this measure alone would reduce the unburned CH^4 emissions well below 1% of the total amount of gas. But reducing the amount of unburned CH^4 by enrichment of the gas/air mixture will result in increased NO^x and CO emission rates (Fig. 1).

(3) *The dilemma of engine bore and CH^4:*

Due to mechanical limitations the engine speed must drop with larger bores. As a direct consequence of the engine's speed the combustion and emission characteristics are different for small, medium and large bore gas engines: With increasing engine speeds the internal combustion process gets faster. This effect helps to reduce the time-dependent formation of NO^x and the risk of knocking events. Within the category of pre-mixed combustion systems large bore gas engines are therefore more affected by the constraints of the chemical reaction kinetics than small bore engines. Consequently large bore engines with pre-mixed combustion must be run under leaner conditions in order to keep the same NO^x emissions and the same margin to the knocking limit as small bore engines. This of course affects the unburned CH^4 emissions.

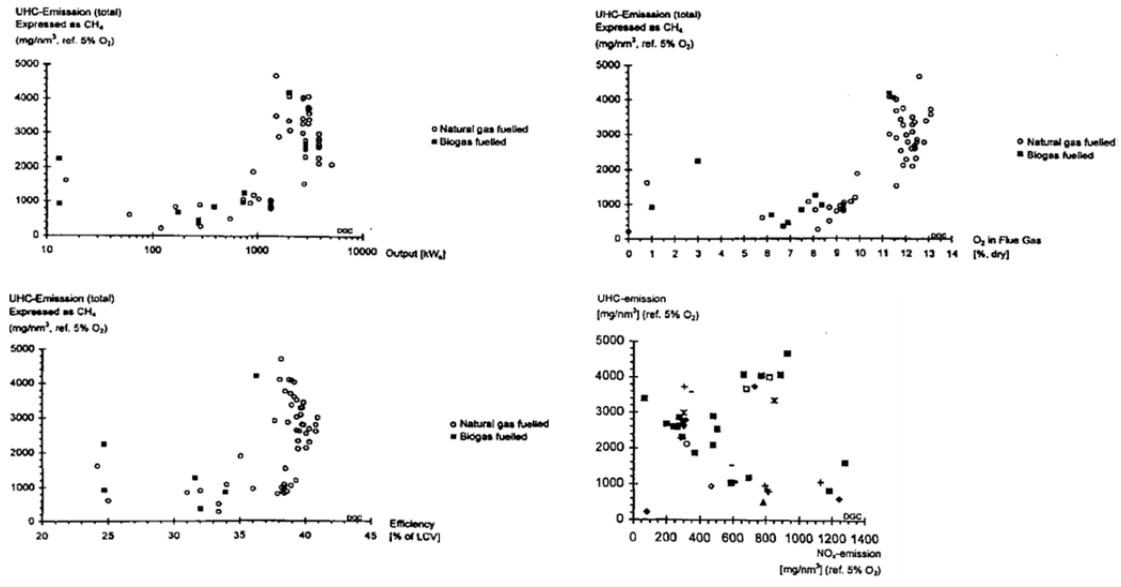


Fig. 4: CH^4-emissions in the context of multi-disciplinary engine optimization [1]

Fig. 5 compares the CH^4-emssions of different gas engine designs and combustion systems from a qualitative point of view. Each source of unburned CH^4-emissions is evaluated with regard to its relative contribution.

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Methane emissions from gas engines driving combined heat and power installations

Michel de Zwart , Gerco van Dijk & Jacob Klimstra

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To link to this article: https://doi.org/10.1080/1943815X.2012.691885

modern gas engines ranges between 8.5 and 11%. Based on the composition and energy content of Groningen-type fuel gas, 1000 mg C/m^3 at 3% O_2 roughly compares with 285 g C/GJ and 380 g CH_4/GJ (Geerssen 1988).

Figure 2 shows the large variation in HC emissions from engine to engine. Engine 29 is a naturally aspirated engine running on bio gas. This engine is not representative for modern turbocharged gas engines. The averaged HC emission of the 30 engines as measured during a time span of 30 min ranges from 605 mg C/m^3 to 2643 mg C/m^3, all converted to an oxygen concentration in the exhaust of 3% (dry). Only two of the five engines with HC emissions exceeding 1500 mg C/m^3 in 2009 were prechamber engines. Therefore, the idea that prechamber engines especially have high HC emissions had to be abandoned.

The reproducibility of the HC emissions of the eight engines that had been tested in 2007 as well as in 2009 deserves special interest. The results are given in Figure 3.

Of the eight engines tested in 2007 as well as in 2009, only one engine had significantly lower HC emissions in 2009 than in 2007. This was engine 8 that had been modified before the second tests: the prechambers were replaced by a low emission type, while the aluminium pistons were replaced by steel ones. This action seemed quite successful, since the HC emissions more than halved, from 1239 to 605 mg C/m^3. Engine 21 showed a lower decrease, from 1445 to 1170 mg C/m^3 at 3% O_2 or almost 20% decrease. Three of the eight engines however showed a significant increase in HC emissions, ranging from 37% to 60%. The observed changes in HC emissions were that closer research into the underlying cause was deemed necessary.

Many references presume that higher HC emissions are directly related with a leaner mixture (Dyer 1985; Klimstra 1990; Hicks et al. 1996; Euromot 2010). Therefore, the HC emission of the engines of the 2009 test series was plotted as a function of the measured oxygen concentration (Figure 4). It is apparent from Figure 4 that the 2009 results combined do not show a significant rise in HC emissions for a higher oxygen concentration in the exhaust gas. The red linear trend line in Figure 4 slightly increases with oxygen concentration, but this is primarily caused by engine 2 which clearly is an outlier. The correlation coefficient is just 0.2, indicating again a poor relationship between HC emissions and oxygen concentration in the exhaust gas. If the high HC emission from engine 2 is omitted, the correlation coefficient is just 0.06.

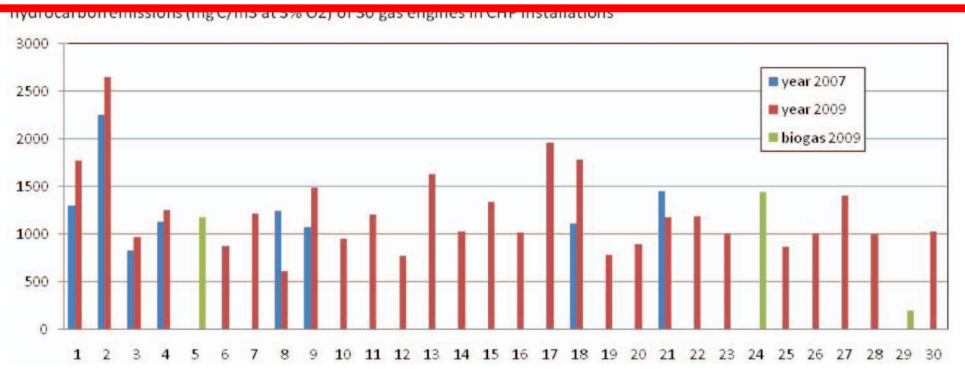

Figure 2. Overview of the total hydrocarbon emissions of 30 different gas engines as measured by KEMA in 2009, in combination with 8 engines measured in 2007 (Olthuis et al. 2009).

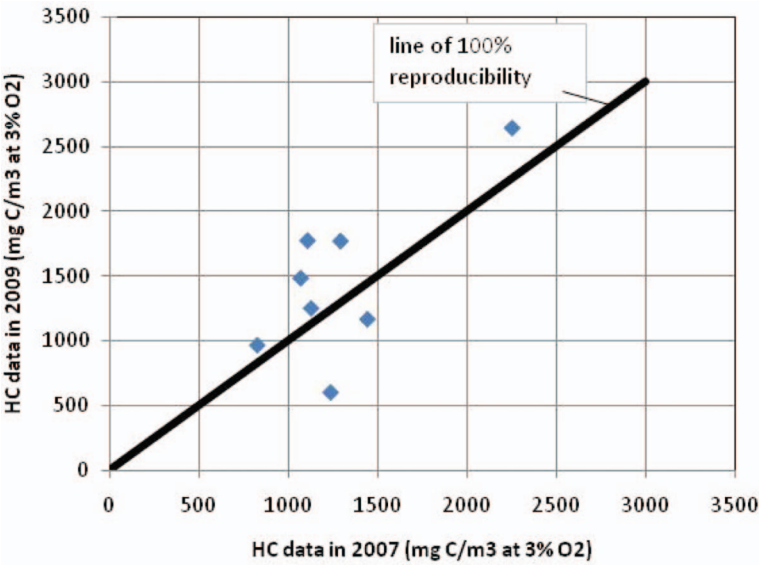

Figure 3. Comparison of the HC emissions of the eight engines measured in 2007 as well as in 2009.

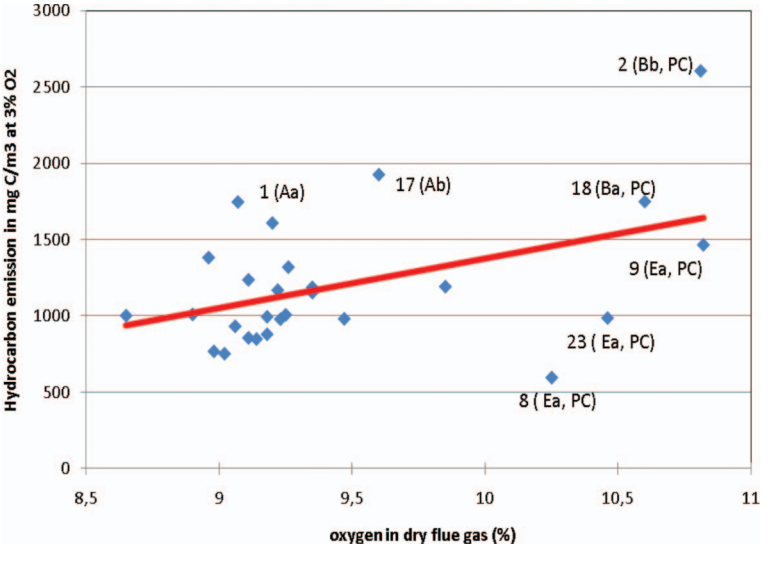

Figure 4. Hydrocarbon emission of the gas engines as measured during the second series of measurements (2009) plotted against the measured oxygen concentration (dry) in the exhaust gas. (engines A, etc. are of the same make; engines Ea are of the same type; PC means prechamber).

However, the three prechamber engines 8, 9 and 23 are of the same make and type. When considering these three engines as identical, a close to linear relationship between the HC emission and the measured oxygen concentration is seen. This might indicate that for an individual engine, a leaner mixture strongly increases the HC

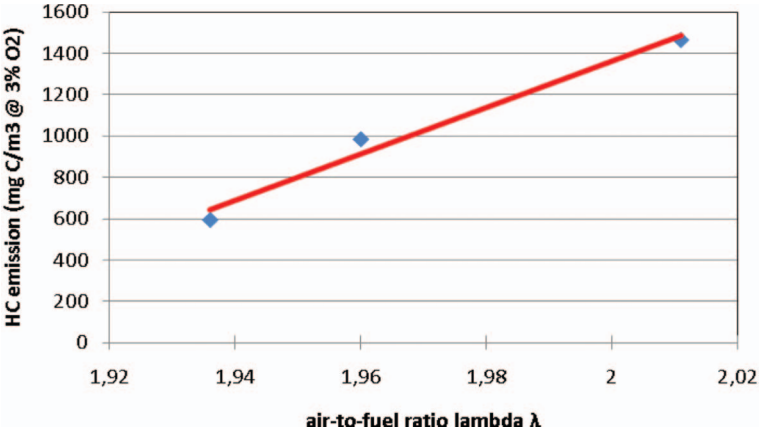

Figure 6. The HC emissions of the prechamber engines 8, 9 and 23 now plotted against the air-to-fuel ratio λ. Note: The unit used to express the HC emission is not influenced by corrections for oxygen not consumed by unburned HC.

programme, 80% of the 30 measured CHP-engines operated within the BEMS emission limit value (ELV) of 1500 mg C/m^3_0 at 3% O_2 for HCs. Some of the CHPs that were compliant to that ELV in the 2007 measurement programme failed to meet the limits in 2009. A first conclusion was that CHP performance and emissions could not yet be guaranteed over time and could even divert relative strongly from the manufacturer's specifications. A workshop was held on 3 January 2010, in which engine specialists and CHP suppliers discussed the results with representatives from the Ministry I&M and NL Agency. It was concluded that the carried out measurement programmes provided a clear overview of the level of HC emissions. However, no solid conclusions could be drawn concerning the causes of the variations due to the large number of unknown process parameters. Explanations for the variations needed to be sought via an additional series of measurements. Such tests should include more engine parameters in order to reveal relationships of the sensitivity of the CHP units to such parameters. Since manufacturers cannot prescribe the typical process parameters as applying to the installations of the users, specific knowledge of the mentioned sensitivities is required prior to further relevant policy-making. It was expected to identify possible emission reduction options from the new test programme.

At the end of 2010, the Ministry I&M and NL Agency launched a new measurement programme to that purpose, which KEMA carried out in 2011. This programme assesses the relevant parameters and process conditions in relation to performance and methane slip of the CHP engines. Important process parameters such as temperature of the combustible mixture in the intake manifold, combustion stability and the occurrence of misfiring will then be measured. Also specific fuel consumption will be measured accurately, since the resulting energy conversion efficiency might explain deviating engine performance. For the 2007 and 2009 programmes, many HC measurements had been taken downstream of the exhaust gas after-treatment system. It has been explained already that such a system has an oxidation catalyst that removes large part of ethene (C_2H_4) and hydrocarbons higher than C_2. Current oxidation catalysts have difficulty in oxidising methane and even

The fraction of methane was generally higher downstream of the exhaust gas after-treatment system than directly in the engine exhaust. This has been explained earlier: the oxidation catalyst of the system appears to remove sometimes 10% of the total hydrocarbons but practically nothing of the methane.

KEMA searched for an explanation for the deviations between the year 2007 fraction of methane and the measured fraction. One explanation might be that in all cases the fuel composition deviated considerably from the standard Groningen composition. Analysis of the fuel gas applied revealed that this was not the case. Closer analyses of the specifications of the FID detector revealed that calibration of such a detector with propane overestimates the concentration of methane by roughly 10%. This is due to different response factors of the FID to ethane and especially to methane compared with propane. Subsequently, the hydrocarbon concentrations as measured with the gas chromatograph were compared with the total HC concentrations as measured with the FID for 16 measurements in 2007. This confirmed that the FID gave on the average 12% higher readings than the combined gas chromatographic HC concentrations. Consequently, with high certainty it can be concluded that the total HC concentrations as reported in 2007 and 2009, and shown in Figures 2–6, are too high. Since methane and not propane is the major constituent of the HC, calibration of the measurement system with methane instead of propane will improve the accuracy. However, in that case an underestimation of the higher HC will occur.

5.2. Further explanation for the variable HC emissions of engine type 8

The level of measured hydrocarbon emissions of engines 8, 9 and 23, all of an identical type, showed a strong dependence upon air-to-fuel ratio during the measurements in 2007 and 2009 (see again Figure 5). Engine 8 was measured again in 2011, and the HC emission had increased from 605 mg C/m^3 at 3% O_2 in 2009 to 1106 mg C/m^3 at 3% O_2 in 2011 as measured after the catalyst. Any misfiring will be clearly revealed by the power stability measurement. This power stability measurement was not used during HC measurements being carried out before 2011. The power stability measurement showed that the engine was not misfiring during the 2011 test. Therefore, misfiring can be excluded as the cause of the increase in HC emissions. Although the aluminium pistons had been replaced by steel ones, the explanation has to probably be found in the increased O_2 percentage. The measured O_2 value, i.e. the value not corrected for incomplete combustion, increased from 10.25% in 2009 to 10.56% in 2011. The HC emission of the latest measurement is close to the same as that of the identical engine number 23 in 2009, which was running with almost 10.5% O_2 in the exhaust (Figure 5). With some precaution, it might be concluded that the HC emission of this prechamber engine type is very sensitive to the air-to-fuel ratio. The underlying mechanism is most probably partial combustion in the main combustion chamber. In this case, the crevices are only responsible for part of the hydrocarbon emissions.

5.3. Power stability measurement results

The measurement of the stability of the power output of the cogeneration installations is an integral part of the 2011 measurements. Variations in power

output reveal misfiring as well as unstable combustion. Of the 10 engines measured in spring 2011, three engines running on natural gas showed severe misfiring, while four ran quite unstable. Misfiring can be caused by improperly functioning spark plugs and by ignition failure due to very lean mixtures. Unstable running without misfiring can be caused by mixtures which are rather lean and by an incorrect ignition timing. The single engine running on bio gas was running very unstable, due to severe misfiring. Misfiring especially can lead to high emissions of hydrocarbons. Proper maintenance in combination with a stability monitor can help to avoid prolonged misfiring.

6. Conclusions

- A general conclusion is that investigations into the emissions of machinery have to be carried out by a team with thorough knowledge in the areas of emission measurement technology and the underlying machinery technology. However, in practice this is often not the case. A simple approach of just registering the output of measurement instruments and reporting these holds a high risk of errors leading to inappropriate conclusions.
- A flame ionisation detector (FID) as used for the hydrocarbon measurements described in the paper has fairly identical response factors for hydrocarbons higher than propane. However, if a FID is used for measuring CH_4 but has been calibrated on propane, a substantial overestimation of the hydrocarbon concentrations occurs.
- The now determined actual methane emissions of the tested spark-ignited gas engines, if corrected for an FID error of 10%, roughly lie between 450 and 2100 mg C/m^3 at 3% O_2. This equals a methane emission range between 125 g/GJ to 600 g/GJ, expressed in gram of CH_4 per GJ of lower heating value of the fuel. This emission level ranges between 0.6 and 3% of the fuel input.
- In general, spark-ignited gas engines designed for running in the leaner air–fuel mixture range around lambda 2.0 do not have higher hydrocarbon emissions than engines designed for running at lambda 1.7.
- For an individual spark-ignited gas engine, an increase in lambda from 1.94 to 2.00 has shown to more than double the hydrocarbon emissions. This is most probably due to the fact that pockets of fuel and air escape the combustion process.

6.1. General remark

The results of the extensive HC emission measurements of gas engines carried out in 2011 on behalf of Ministry I&M and NL Agency will be made available at a later stage. It is expected that the results will provide further insight into possible solutions of abating the HC emissions.

Notes

1. According to the First commitment period of Kyoto 2008–2012, the GWP of CH_4 is 21. For the second commitment period, this GWP will be adjusted to 23.
2. For commercial reasons, the technical details of the engines cannot be revealed in this report.

Appendix L - Wales Example - Extract

Cyfoeth Naturiol Cymru
Natural Resources Wales

Permit with introductory note

The Environmental Permitting (England & Wales) Regulations 2016

Grays Biogas Ltd

Mona Anaerobic Digestion Plant
Mona Industrial Estate
Gwalchmai
Isle of Anglesey
LL65 4RJ

Permit number

EPR/AP3033HY

Schedule 3 – Emissions and monitoring

Table S3.1 Point source emissions to air – emission limits and monitoring requirements

Emission point ref. & location	Source	Parameter	Limit (including unit)	Reference period	Monitoring frequency	Monitoring standard or method
A1	Exhaust stack on CHP Gas Engine	Oxides of Nitrogen (expressed as NO_2)	500 mg/m^3	Hourly Average	Annual	BS EN 14792
		Sulphur Dioxide (SO_2)	350 mg/m^3			BS EN 14791
		Carbon Monoxide (CO)	1400 mg/m^3			BS EN 15058
		Total VOC's	1000 mg/m^3			BS EN 12619:1999 or BS EN 13529:2002 depending on concentration
		nm-VOC's	75 mg/m^3			BS EN 13649:2002
A2	Auxiliary Flare Stack Note 1	Oxides of Nitrogen (expressed as NO_2)	150mg/m^3	Hourly Average	Annual	BS EN 14792
		Total VOC's	10mg/m^3			BS EN 12619:1999 or BS EN 13529:2002
		Carbon Monoxide (CO)	50mg/m^3			BS EN 15058
A3	Odour Control Unit	No Monitoring Required				
A4	Pressure Relief Valves/Vents	No Monitoring Required				

Note 1: Annual monitoring is only required when emergency flare operates in excess of 10% of the time, taken on an annual assessment period.

Table S3.2 Point source emissions to water (other than sewer) and land – emission limits and monitoring requirements

Emission point ref. & location	Source	Parameter	Limit (including unit)	Monitoring frequency	Monitoring standard or method
Surface water balancing facility. Discharge point ref. S1	Surface Water	Visible oil or grease	No Visible Trace	Weekly (discharge and rainfall dependant)	Visual Check
		Visual contamination			
		Ammonia	0.3ppm		Instantaneous Ammonia Reading

Federal Register

Friday,
January 18, 2008

Part III

Environmental Protection Agency

40 CFR Parts 60, 63, 85 et al.

Standards of Performance for Stationary Spark Ignition Internal Combustion Engines and National Emission Standards for Hazardous Air Pollutants for Reciprocating Internal Combustion Engines; Final Rule

Stationary SI engines with a maximum engine power between 100 HP and 500 HP that are natural gas engines or lean burn engines using LPG that are manufactured after January 1, 2011, must limit their exhaust emissions of NO_X to 1.0 g/HP-hr, emissions of CO to 2.0 g/HP-hr, and emissions of VOC to 0.7 g/HP-hr. Again, owners and operators may as an alternative limit their exhaust emissions of NO_X to 82 ppmvd at 15 percent O_2, emissions of CO to 270 ppmvd at 15 percent O_2, and emissions of VOC to 60 ppmvd at 15 percent O_2 instead of the g/HP-hr limits.

Owners and operators who purchase stationary SI engines with a maximum engine power greater than or equal to 500 HP that are natural gas engines or lean burn engines using LPG that are manufactured after July 1, 2007, must limit their exhaust emissions of NO_X to 2.0 g/HP-hr, emissions of CO to 4.0 g/HP-hr, and emissions of VOC to 1.0 g/HP-hr, except that these standards apply to lean burn engines between 500 and 1,350 HP manufactured after January 1, 2008. Instead of complying with limits in terms of g/HP-hr, owners and operators may limit their exhaust emissions of NO_X to 160 ppmvd at 15 percent O_2, emissions of CO to 540 ppmvd at 15 percent O_2, and emissions of VOC to 86 ppmvd at 15 percent O_2.

Stationary SI engines with a maximum engine power greater than or equal to 500 HP that are natural gas engines or lean burn engines using LPG that are manufactured after July 1, 2010, must limit their exhaust emissions of NO_X to 1.0 g/HP-hr, emissions of CO to 2.0 g/HP-hr, and emissions of VOC to 0.7 g/HP-hr. Instead of complying with limits in terms of g/HP-hr, owners and operators may limit their exhaust emissions of NO_X to 82 ppmvd at 15 percent O_2, emissions of CO to 270 ppmvd at 15 percent O_2, and emissions of VOC to 60 ppmvd at 15 percent O_2.

Engine manufacturers may voluntarily certify their stationary non-emergency SI natural gas engines greater than or equal to 100 HP and lean burn LPG engines greater than or equal to 100 HP, but the certification is not required by the rule. Additionally, for natural gas engines below 500 HP manufactured prior to January 1, 2011, and natural gas engines greater than or equal to 500 HP manufactured prior to July 1, 2010, engine manufacturers may choose to certify their engines to the standards for non-severe duty engines in 40 CFR part 1048 (see Table 2 of this preamble).

A summary of the emission standards that apply to stationary non-emergency SI natural gas engines greater than or equal to 100 HP and lean burn LPG engines greater than or equal to 100 HP are shown in Table 4 of this preamble.

For lean burn LPG engines greater than or equal to 100 HP, manufacturers may certify these engines to the certification emission standards in 40 CFR part 1048 instead of the emission standards shown in Table 4 of this preamble.

TABLE 4.—NO_X, CO, AND VOC EMISSION STANDARDS FOR STATIONARY SI ENGINES ≥100 HP (EXCEPT GASOLINE AND RICH BURN LPG), STATIONARY SI LANDFILL/DIGESTER GAS ENGINES, AND STATIONARY EMERGENCY ENGINES >25 HP

Engine type and fuel	Maximum engine power	Manufacture date	Emission standards [a]					
			g/HP-hr			ppmvd at 15% O_2		
			NO_X	CO	VOC	NO_X	CO	VOC
Non-Emergency SI Natural Gas and Non-Emergency SI Lean Burn LPG.	100≤HP<500	7/1/2008	2.0	4.0	1.0	160	540	86
		1/1/2011	1.0	2.0	0.7	82	270	60
Non-Emergency SI Lean Burn Natural Gas and LPG.	500≥HP<1,350	1/1/2008	2.0	4.0	1.0	160	540	86
		7/1/2010	1.0	2.0	0.7	82	270	60
Non-Emergency SI Natural Gas and Non-Emergency SI Lean Burn LPG (except lean burn 500≥HP<1,350).	HP≥500	7/1/2007	2.0	4.0	1.0	160	540	86
	HP≥500	7/1/2010	1.0	2.0	0.7	82	270	60
Landfill/Digester Gas (except lean burn 500≥HP<1,350).	HP<500	7/1/2008	3.0	5.0	1.0	220	610	80
		1/1/2011	2.0	5.0	1.0	150	610	80
	HP≥500	7/1/2007	3.0	5.0	1.0	220	610	80
		7/1/2010	2.0	5.0	1.0	150	610	80
Landfill/Digester Gas lean burn	500≥HP<1,350	1/1/2008	3.0	5.0	1.0	220	610	80
		7/1/2010	2.0	5.0	1.0	150	610	80
Emergency	25>HP<130	1/1/2009	[b] 10	387	N/A	N/A	N/A	N/A
	HP≥130		2.0	4.0	1.0	160	540	86

[a] Owners and operators of stationary non-certified SI engines may choose to comply with the emission standards in units of either g/HP-hr or ppmvd at 15 percent O_2.

[b] The emission standards applicable to emergency engines between 25 HP and 130 HP are in terms of NO_X+HC.

e. Stationary SI Landfill/Digester Gas Engines. Owners and operators who purchase stationary landfill or digester SI engines that are manufactured after July 1, 2007, that are greater than or equal to 500 HP must limit their exhaust emissions of NO_X to 3.0 g/HP-hr, emissions of CO to 5.0 g/HP-hr, and emissions of VOC to 1.0 g/HP-hr, except that these standards apply to lean burn engines between 500 and 1,350 HP manufactured after January 1, 2008. Instead of complying with limits in terms of g/HP-hr, owners and operators may limit their exhaust emissions of NO_X to 220 ppmvd at 15 percent O_2, emissions of CO to 610 ppmvd at 15 percent O_2, and emissions of VOC to 80 ppmvd at 15 percent O_2.

Stationary landfill and digester gas SI engines greater than or equal to 500 HP that are manufactured after July 1, 2010, must limit their exhaust emissions of NO_X to 2.0 g/HP-hr, emissions of CO to 5.0 g/HP-hr, and emissions of VOC to 1.0 g/HP-hr. Instead of complying with limits in terms of g/HP-hr, owners and operators may limit their exhaust emissions of NO_X to 150 ppmvd at 15 percent O_2, emissions of CO to 610 ppmvd at 15 percent O_2, and emissions of VOC to 80 ppmvd at 15 percent O_2.

Appendix N - California Energy Commission Interim Report - Extract

Energy Research and Development Division
INTERIM/FINAL PROJECT REPORT

AIR QUALITY ISSUES RELATED TO USING BIOGAS FROM ANAEROBIC DIGESTION OF FOOD WASTE

Prepared for: California Energy Commission
Prepared by: California State University, Fullerton

MARCH 2015
CEC-500-2015-037

2-propanol, acetone, ethanol

- <65.2 ppb
  methanol

4.3 IC Engine Emissions

The IC engine at the site is a Waukesha Model P48GLD, by GE Power & Water, powering a Kato 750 kW electrical generator.

4.3.1 Historical source test results on IC engine emissions

Since the biogas generated at the site is not sufficient for around-the-clock power generation, the engine is fueled by natural gas when biogas is not available. The IC engine has been source-tested by BAAQMD annually to check for compliance. For each test, the IC engine was fueled by biogas as well as by natural gas. The results from these official source tests provide a valuable opportunity to compare the emissions from the same engine on the same day while using biogas and natural gas.

Table 4.9 provides statistics for the annual source test results from 2008 to 2014 (the raw data can be found in Appendix D). The permit conditions for the exhausts are also listed in the table. The source test results indicate that the IC engine has been in compliance. As shown, the average emissions from natural gas (NG) fueled and biogas fueled operations are: NO_x @ 15% O_2 (38±19 vs. 37±20 ppm); CH_4 (692±83 vs. 1,065±224 ppm); non-methane organic carbon (NMOC) as C_1 (45±33 vs. 18±6 ppm); total organic carbon (TOC) as C_1 (735±65 vs. 1,075±227 ppm); CO_2 (7.5±0.5 vs. 12.8±1.6%); CO @15% O_2 (122±9 vs. 142±14 ppm); O_2 (7.9±0.4 vs. 6.9±0.7%); and SO_2 (4±3 vs. 7±5 ppm).

The NO_x concentrations in the exhausts using NG and biogas are essentially the same (38 vs. 37 ppmv). With regards to emissions of organic compounds, NG-fueled operations emit less CH_4 (692 vs. 1,065 ppmv), but higher NMOC (45 vs. 18 ppmv). The average CO_2 emission from using biogas is higher (12.8 vs. 7.5%), probably due to the higher CO_2 concentration in the biogas. The average CO concentration from biogas-fueled combustion was higher (142 vs. 122 ppmv). The average SO_2 concentration from biogas-fueled combustion was also higher (7 vs. 4 ppmv), probably due to the presence of reduced sulfur compounds in the biogas.

4.3.2 Daily monitoring of IC engine emissions

During the study period, exhausts from the IC engine were surveyed twice per day using the portable emission analyzer, EMCON J2KN Pro Industrial OCNX-IR by ECOM America, Ltd.

Table 4.10 provides statistics for the IC engine emission data from the daily monitoring (the raw data can be found in Appendix E). As shown, the average emissions from natural gas fueled and biogas fueled operations are: NO_2 (30±3 vs. 23±4 ppm); NO (17±4 vs. 10±3 ppm); CH_4 (1,200±170 vs. 1,680±200 ppm); CO_2 (7.2±0.1 vs. 7.7±0.1%); CO (122±9 vs. 142±14 ppm); O_2 (8.0±0.1 vs. 7.2±0.1%); and SO_2 (0±0 vs. 0±0 ppm). The data from daily monitoring are comparable to those from the source tests. For example the NO_x concentrations are in the range of 30 to 50 ppmv. The trends are also valid (i.e., higher methane concentration, high CO

Table 4.9: Statistics of IC Engine Emission Data Using Natural Gas versus Biogas (Official Source Test Results from 2008-2014)

	Natural Gas					Biogas					Permits	
	Max	Min	Median	Avg.	Std. Dev.	Max	Min	Median	Avg.	Std. Dev.	Regulation NG/Biogas	Permit NG/Biogas
Output (kW)	650	538	590	601	42	649	550	620	612	30		
Flow rate (SCFM)	2,140	1,390	1,720	1,717	227	1,810	1,340	1,590	1,583	176		
CO (ppm)	292	246	263	269	17	381	286	329	334	28		
CO (ppm), converted to 15% O_2	138	106	121	122	9	157	114	142	142	14	2,000/2,000	
CO (gm/Hp-hr)	1.56	0.78	1.14	1.14	0.21	1.58	0.87	1.28	1.29	0.21		2.75/2.65
NO (ppm)	129	20	29	49	37	118	11	46	55	42		
NO_2 (ppm)	49	24	33	36	8	43	18	36	33	8		
NO_x (ppm), converted to 15% O_2	77	24	28	38	19	66	13	38	37	20	65/70	
NO_x (gm/Hp-hr)	0.93	0.37	0.45	0.55	0.20	1.02	0.21	0.51	0.54	0.30		1.00/1.25
Methane (ppm)	799	561	686	692	83	1,400	762	1,070	1,065	224		
NMOC as C_1 (ppm)	90	10	34	45	33	26	10	18	18	6		
NMOC as C_1 (gm/Hp-hr)	0.21	0.02	0.08	0.10	0.07	0.07	0.02	0.04	0.04	0.02		1.00/1.00
TOC as C_1 (ppm)	799	639	760	735	65	1,418	778	1,070	1,075	227		
CO_2 (%)	8.3	6.8	7.3	7.5	0.5	15.1	10.7	12.7	12.8	1.6		
Oxygen (%)	8.5	7.2	8	7.9	0.4	8.2	6	6.8	6.9	0.7		
SO_2 (ppm)	11	2	2	4	3	16	2	6	7	5	300/300	
SO_2 (gm/Hp-hr)	0.08	0.01	0.02	0.03	0.03	0.15	0.02	0.05	0.06	0.04		0.30/0.30
Estimated Heat Input (MMBTU/d)						191	191	191	191	0		231/231
Heating Value of Biogas (BTU/scf)						634	424	560	542	65		

Appendix O - EU Directive - Extract

I

(Legislative acts)

DIRECTIVES

DIRECTIVE (EU) 2015/2193 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 25 November 2015

on the limitation of emissions of certain pollutants into the air from medium combustion plants

(Text with EEA relevance)

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty on the Functioning of the European Union, and in particular Article 192(1) thereof,

Having regard to the proposal from the European Commission,

After transmission of the draft legislative act to the national parliaments,

Having regard to the opinion of the European Economic and Social Committee ([1]),

Having regard to the opinion of the Committee of the Regions ([2]),

Acting in accordance with the ordinary legislative procedure ([3]),

Whereas:

(1) Decision No 1386/2013/EU of the European Parliament and of the Council ([4]) ('the Action Programme') recognises that emissions of pollutants to air have been reduced significantly over the past decades, but that at the same time air pollution levels are still problematic in many parts of Europe, and that citizens of the Union continue to be exposed to air-polluting substances, potentially compromising their health and wellbeing. According to the Action Programme, ecosystems continue to suffer from excess nitrogen and sulphur deposition associated with emissions from transport, unsustainable agricultural practices and power generation. In many areas of the Union, air pollution levels are still above the limits that the Union has set, and Union air quality standards are still failing to meet the targets set by the World Health Organisation.

(2) In order to ensure a healthy environment for all, the Action Programme calls for local measures to be complemented with adequate policy at both national and Union level. It requires in particular strengthening efforts to reach full compliance with air quality legislation of the Union and defining strategic targets and actions beyond 2020.

(3) Scientific assessments show that the average lifetime loss for citizens of the Union due to air pollution is eight months.

([1]) OJ C 451, 16.12.2014, p. 134.
([2]) OJ C 415, 20.11.2014, p. 23.
([3]) Position of the European Parliament of 7 October 2015 (not yet published in the Official Journal) and decision of the Council of 10 November 2015.
([4]) Decision No 1386/2013/EU of the European Parliament and of the Council of 20 November 2013 on a General Union Environment Action Programme to 2020 'Living well, within the limits of our planet' (OJ L 354, 28.12.2013, p. 171).

Table 2

Emission limit values (mg/Nm³) for new engines and gas turbines

Pollutant	Type of medium combustion plant	Gas oil	Liquid fuels other than gas oil	Natural gas	Gaseous fuels other than natural gas
SO_2	Engines and gas turbines	—	120 (1)	—	15 (2)
NO_x	Engines (3) (4)	190 (5)	190 (5) (6)	95 (7)	190
	Gas turbines (8)	75	75 (9)	50	75
Dust	Engines and gas turbines	—	10 (10) (11)	—	—

(1) Until 1 January 2025, 590 mg/Nm³ for diesel engines which are part of SIS or MIS.
(2) 40 mg/Nm³ in the case of biogas.
(3) Engines running between 500 and 1 500 hours per year may be exempted from compliance with those emission limit values if they are applying primary measures to limit NO_x emissions and meet the emission limit values set out in footnote (4).
(4) Until 1 January 2025 in SIS and MIS, 1 850 mg/Nm³ for dual fuel engines in liquid mode and 380 mg/Nm³ in gas mode; 1 300 mg/Nm³ for diesel engines with ≤ 1 200 rpm with a total rated thermal input less than or equal to 20 MW and 1 850 mg/Nm³ for diesel engines with a total rated thermal input greater than 20 MW; 750 mg/Nm³ for diesel engines with > 1 200 rpm.
(5) 225 mg/Nm³ for dual fuel engines in liquid mode.
(6) 225 mg/Nm³ for diesel engines with a total rated thermal input less than or equal to 20 MW with ≤ 1 200 rpm.
(7) 190 mg/Nm³ for dual fuel engines in gas mode.
(8) These emission limit values are only applicable above 70 % load.
(9) Until 1 January 2025, 550 mg/Nm³ for plants which are part of SIS or MIS.
(10) Until 1 January 2025, 75 mg/Nm³ for diesel engines which are part of SIS or MIS.
(11) 20 mg/Nm3 in the case of plants with a total rated thermal input equal to or greater than 1 MW and less than or equal to 5 MW.

The following English text of the First General Administrative Regulation Pertaining the Federal Immission Control Act (Technical Instructions on Air Quality Control – TA Luft) is a legally non-binding version. Legally binding is only the German version published in the Joint Ministerial Gazette [Gemeinsames Ministerialblatt] from 30 July 2002 (GMBl. p. 511).

Federal Ministry for Environment, Nature Conservation and Nuclear Safety

First General Administrative Regulation Pertaining the Federal Immission Control Act (Technical Instructions on Air Quality Control – *TA Luft*) of 24 July 2002

(GMBl. [Gemeinsames Ministerialblatt - Joint Ministerial Gazette] p. 511)

(Technische Anleitung zur Reinhaltung der Luft – *TA Luft*)

Pursuant to § 48 of the Federal Immission Control Act as promulgated on 14 May 1990 (BGBl. [*Bundesgesetzblatt* - Federal Law Gazette] I p. 880), as amended by Article 2 of the Act of 27 July 2001 (BGBl. I p. 1950), the Federal Government decrees the following General Administrative Regulation after having heard the parties concerned:

Content:

.../ 2

5.4.1.2.3

NITROGEN OXIDES

Nitrogen monoxide and nitrogen dioxide emissions in waste gas, to be indicated as nitrogen dioxide, shall not exceed the following mass concentrations:

a) when fuel oils from public gas supply are used in boilers with a setting value of the safety device (e.g. safety temperature limiter, safety pressure valve) to protect against an exceedance of
   aa) a temperature lower than 110 °C or an excess pressure lower than 0.05 MPa 0.10 g/m³,
   bb) a temperature of 110 to 210 °C or an excess pressure of 0.05 to 1.8 MPa 0.11 g/m³,
   cc) a temperature higher than 210 °C or an excess pressure higher than 1.8 MPa 0.15 g/m³,
b) when other gases are used, with the exception of process gases containing nitrogen compounds, 0.20 g/m³;
c) when process gases containing nitrogen compounds are used, nitrogen oxides emissions in waste gas shall be reduced using state of the art techniques.

SULPHUR OXIDES

Sulphur dioxide and sulphur trioxide emissions in waste gas, to be indicated as sulphur dioxide, shall not exceed the following mass concentrations:

a) for the use of liquid gas 5 mg/m³,
b) for the use of gases from public gas supply 10 mg/m³,
c) for the use of coke oven gas or refinery gas 50 mg/m³,
d) for the use of biogas or sewage gas 0.35 g/m³,
e) for the use of mineral oil gas used as fuel for steam production during tertiary measures in mineral oil mining, 1.7 g/m³,
f) for the use of fuel gases commonly used by iron and steel plants and coking plants,
   aa) for the use of blast furnace gas 0.20 g/m³,
   bb) for the use of coke oven gas 0.35 g/m³,
g) for the use of other fuels 35 mg/m³.

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MASS FLOWS

The mass flows established in 5.2 shall not apply.

TOTAL DUST, INCLUDING THE CONTENT OF CARCINOGENIC, MUTAGENIC OR REPRODUCTION TOXIC SUBSTANCES

Dust emissions in waste gas from compression ignition engines operated on liquid fuels shall, as a minimum requirement, not exceed the mass concentrations of 20 mg/m³.

Dust emissions in waste gas from stationary internal combustion engines exclusively designed for emergencies or operated for up to 300 hours per year during periods of peak load (e.g. for electricity generation, gas or water supply) shall not exceed, as a minimum requirement, the mass concentration of 80 mg/m³.

The possibilities to further reduce emissions by engine design and other state of the art techniques shall be exhausted.

CARBON MONOXIDE

Carbon monoxide emissions in waste gas shall not exceed the following mass concentrations:

a) for compression ignition engines and spark ignition engines operated on liquid fuels, and for compression ignition engines (jet ignition engines) and spark ignition engines operated on gaseous fuels, with the exceptions of biogas, sewage gas or mine gas, 0.30 g/m³,

b) for spark ignition engines operated on biogas or sewage gas with a rated thermal input of

   aa) 3 MW or more 0.65 g/m³,

   bb) less than 3 MW 1.0 g/m³,

c) for spark ignition engines operated on mine gas, 0.65 g/m³,

d) for jet ignition engines operated on biogas or sewage gas with a rated thermal input of

   aa) 3 MW or more 0.65 g/m³,

   bb) less than 3 MW 2.0 g/m³;

when biogas, sewage gas or mine gas are used, the possibilities to further reduce carbon monoxide emissions by engine design and other state of the art techniques shall be exhausted.

Carbon monoxide emission standards shall not apply to stationary internal combustion engines exclusively designed for emergencies or operated for up to 300 hours per year during periods of peak load (e.g. for electricity generation, gas or water supply); the possibilities of emission reduction by measures of engine design shall be exhausted.

NITROGEN OXIDES

Nitrogen monoxide and nitrogen dioxide emissions in waste gas shall not exceed the following mass concentrations, to be indicated as nitrogen dioxide:

a) for compression ignition engines operated on liquid fuels with a rated thermal input of
   - aa) 3 MW or more 0.50 g/m³,
   - bb) less than 3 MW 1.0 g/m³,

b) for compression ignition engines (jet ignition engines) and spark ignition engines operated on gaseous fuels
   - aa) for jet ignition engines operated on biogas or sewage gas with a rated thermal input of
     - — 3 MW or more 0.50 g/m³,
     - — less than 3 MW 1.0 g/m³,
   - bb) for lean-burn engines and other four-stroke Otto engines operated on biogas or sewage gas, 0.50 g/m³,
   - cc) for jet ignition engines and lean-burn engines operated on other gaseous fuels, 0.50 g/m³,

c) for other four-stroke Otto engines 0.25 g/m³,

d) for two-stroke engines 0.80 g/m³;

when biogas or sewage gas are used in jet ignition engines with a rated thermal input of less than 3 MW, the possibilities to further reduce nitrogen oxides emissions by measures of engine design shall be exhausted.

Nitrogen oxides emission standards shall not apply to stationary internal combustion engines designed exclusively for emergencies or operated for up to 300 hours per year during periods of peak load (e.g. for electricity generation, gas or water supply).

SULPHUR OXIDES

When liquid mineral fuels are used, only fuel oils listed in DIN 51603 Part 1 (March 1998 version) with a sulphur mass content for light fuel oil pursuant to the 3. BImSchV, as currently applicable, or diesel fuels with a sulphur mass content pursuant to the 3. BImSchV, as currently applicable, may be used, or equivalent measures to reduce emissions shall be applied.

When gaseous fuels are used, the requirements under 5.4.1.2.3 shall apply, provided that a conversion to a reference oxygen content in waste gas of 5 per cent is made.

When biogas or sewage gases are used, the possibilities to further reduce emissions by state of the art primary techniques (gas purification) shall be exhausted.

ORGANIC SUBSTANCES

Formaldehyde emissions in waste gas shall not exceed the mass concentration of 60 mg/m^3. The requirements in 5.2.5 shall not apply to emissions of other organic substances.

The possibilities to further reduce organic substances emissions by engine design and other state of the art techniques shall be exhausted.

Appendix Q - China GB 16296 - Extract

Z 60

中华人民共和国国家标准

GB 16297—1996

大气污染物综合排放标准

Integrated emission standard of air pollutants

1996-04-12 发布　　1997-01-01 实施

国家环境保护局　发布

表 2　新污染源大气污染物排放限值

序号	污染物	最高允许排放浓度 mg/m³	最高允许排放速率，kg/h			无组织排放监控浓度限值	
			排气筒高度 m	二级	三级	监控点	浓度 mg/m³
1	二氧化硫	960 （硫、二氧化硫、硫酸和其他含硫化合物生产）	15 20 30 40 50 60 70 80 90 100	2.6 4.3 15 25 39 55 77 110 130 170	3.5 6.6 22 38 58 83 120 160 200 270	周界外浓度最高点[1]	0.40
		550 （硫、二氧化硫、硫酸和其他含硫化合物使用）					
2	氮氧化物	1 400 （硝酸、氮肥和火炸药生产）	15 20 30 40 50 60 70 80 90 100	0.77 1.3 4.4 7.5 12 16 23 31 40 52	1.2 2.0 6.6 11 18 25 35 47 61 78	周界外浓度最高点[1]	0.12
		240 （硝酸使用和其他）					
3	颗粒物	18 （碳黑尘、染料尘）	15 20 30 40	0.51 0.85 3.4 5.8	0.74 1.3 5.0 8.5	周界外浓度最高点	肉眼不可见
		60[2] （玻璃棉尘、石英粉尘、矿渣棉尘）	15 20 30 40	1.9 3.1 12 21	2.6 4.5 18 31	周界外浓度最高点	1.0
		120 （其他）	15 20 30 40 50 60	3.5 5.9 23 39 60 85	5.0 8.5 34 59 94 130	周界外浓度最高点	1.0

表 2(续)

序号	污染物	最高允许排放浓度 mg/m³	最高允许排放速率,kg/h			无组织排放监控浓度限值	
			排气筒高度 m	二级	三级	监控点	浓度 mg/m³
4	氯化氢	100	15 20 30 40 50 60 70 80	0.26 0.43 1.4 2.6 3.8 5.4 7.7 10	0.39 0.65 2.2 3.8 5.9 8.3 12 16	周界外浓度最高点	0.20
5	铬酸雾	0.070	15 20 30 40 50 60	0.008 0.013 0.043 0.076 0.12 0.16	0.012 0.020 0.066 0.12 0.18 0.25	周界外浓度最高点	0.006 0
6	硫酸雾	430 (火炸药厂)	15 20 30 40 50 60 70 80	1.5 2.6 8.8 15 23 33 46 63	2.4 3.9 13 23 35 50 70 95	周界外浓度最高点	1.2
		45 (其他)					
7	氯化物	90 (普钙工业)	15 20 30 40 50 60 70 80	0.10 0.17 0.59 1.0 1.5 2.2 3.1 4.2	0.15 0.26 0.88 1.5 2.3 3.3 4.7 6.3	周界外浓度最高点	20 μg/m³
		9.0 (其他)					
8	氯[3)]气	65	25 30 40 50 60 70 80	0.52 0.87 2.9 5.0 7.7 11 15	0.78 1.3 4.4 7.6 12 17 23	周界外浓度最高点	0.40

表 2(续)

序号	污染物	最高允许排放浓度 mg/m³	最高允许排放速率,kg/h			无组织排放监控浓度限值	
			排气筒高度 m	二级	三级	监控点	浓度 mg/m³
9	铅及其化合物	0.70	15	0.004	0.006	周界外浓度最高点	0.006 0
			20	0.006	0.009		
			30	0.027	0.041		
			40	0.047	0.071		
			50	0.072	0.11		
			60	0.10	0.15		
			70	0.15	0.22		
			80	0.20	0.30		
			90	0.26	0.40		
			100	0.33	0.51		
10	汞及其化合物	0.012	15	1.5×10^{-3}	2.4×10^{-3}	周界外浓度最高点	0.001 2
			20	2.6×10^{-3}	3.9×10^{-3}		
			30	7.8×10^{-3}	13×10^{-3}		
			40	15×10^{-3}	23×10^{-3}		
			50	23×10^{-3}	35×10^{-3}		
			60	33×10^{-3}	50×10^{-3}		
11	镉及其化合物	0.85	15	0.050	0.080	周界外浓度最高点	0.040
			20	0.090	0.13		
			30	0.29	0.44		
			40	0.50	0.77		
			50	0.77	1.2		
			60	1.1	1.7		
			70	1.5	2.3		
			80	2.1	3.2		
12	铍及其化合物	0.012	15	1.1×10^{-3}	1.7×10^{-3}	周界外浓度最高点	0.000 8
			20	1.8×10^{-3}	2.8×10^{-3}		
			30	6.2×10^{-3}	9.4×10^{-3}		
			40	11×10^{-3}	16×10^{-3}		
			50	16×10^{-3}	25×10^{-3}		
			60	23×10^{-3}	35×10^{-3}		
			70	33×10^{-3}	50×10^{-3}		
			80	44×10^{-3}	67×10^{-3}		
13	镍及其化合物	4.3	15	0.15	0.24	周界外浓度最高点	0.040
			20	0.26	0.34		
			30	0.88	1.3		
			40	1.5	2.3		
			50	2.3	3.5		
			60	3.3	5.0		
			70	4.6	7.0		
			80	6.3	10		

表 2(续)

序号	污染物	最高允许排放浓度 mg/m³	最高允许排放速率,kg/h			无组织排放监控浓度限值	
			排气筒高度 m	二级	三级	监控点	浓度 mg/m³
14	锡及其化合物	8.5	15 20 30 40 50 60 70 80	0.31 0.52 1.8 3.0 4.6 6.6 9.3 13	0.47 0.79 2.7 4.6 7.0 10 14 19	周界外浓度最高点	0.24
15	苯	12	15 20 30 40	0.50 0.90 2.9 5.6	0.80 1.3 4.4 7.6	周界外浓度最高点	0.40
16	甲苯	40	15 20 30 40	3.1 5.2 18 30	4.7 7.9 27 46	周界外浓度最高点	2.4
17	二甲苯	70	15 20 30 40	1.0 1.7 5.9 10	1.5 2.6 8.8 15	周界外浓度最高点	1.2
18	酚类	100	15 20 30 40 50 60	0.10 0.17 0.58 1.0 1.5 2.2	0.15 0.26 0.88 1.5 2.3 3.3	周界外浓度最高点	0.080
19	甲醛	25	15 20 30 40 50 60	0.26 0.43 1.4 2.6 3.8 5.4	0.39 0.65 2.2 3.8 5.9 8.3	周界外浓度最高点	0.20
20	乙醛	125	15 20 30 40 50 60	0.050 0.090 0.29 0.50 0.77 1.1	0.080 0.13 0.44 0.77 1.2 1.6	周界外浓度最高点	0.040

表 2(续)

序号	污染物	最高允许排放浓度 mg/m³	最高允许排放速率,kg/h			无组织排放监控浓度限值	
			排气筒高度 m	二级	三级	监控点	浓度 mg/m³
21	丙烯腈	22	15 20 30 40 50 60	0.77 1.3 4.4 7.5 12 16	1.2 2.0 6.6 11 18 25	周界外浓度最高点	0.60
22	丙烯醛	16	15 20 30 40 50 60	0.52 0.87 2.9 5.0 7.7 11	0.78 1.3 4.4 7.6 12 17	周界外浓度最高点	0.40
23	氰[4]化氢	1.9	25 30 40 50 60 70 80	0.15 0.26 0.88 1.5 2.3 3.3 4.6	0.24 0.39 1.3 2.3 3.5 5.0 7.0	周界外浓度最高点	0.024
24	甲醇	190	15 20 30 40 50 60	5.1 8.6 29 50 77 100	7.8 13 44 70 120 170	周界外浓度最高点	12
25	苯胺类	20	15 20 30 40 50 60	0.52 0.87 2.9 5.0 7.7 11	0.78 1.3 4.4 7.6 12 17	周界外浓度最高点	0.40

表 2(续)

序号	污染物	最高允许排放浓度 mg/m³	最高允许排放速率,kg/h			无组织排放监控浓度限值	
			排气筒高度 m	二级	三级	监控点	浓度 mg/m³
26	氯苯类	60	15 20 30 40 50 60 70 80 90 100	0.52 0.87 2.5 4.3 6.6 9.3 13 18 23 29	0.78 1.3 3.8 6.5 9.9 14 20 27 35 44	周界外浓度最高点	0.40
27	硝基苯类	16	15 20 30 40 50 60	0.050 0.090 0.29 0.50 0.77 1.1	0.080 0.13 0.44 0.77 1.2 1.7	周界外浓度最高点	0.040
28	氯乙烯	36	15 20 30 40 50 60	0.77 1.3 4.4 7.5 12 16	1.2 2.0 6.6 11 18 25	周界外浓度最高点	0.60
29	苯并〔a〕芘	0.30×10^{-3} (沥青及碳素制品生产和加工)	15 20 30 40 50 60	0.050×10^{-3} 0.085×10^{-3} 0.29×10^{-3} 0.50×10^{-3} 0.77×10^{-3} 1.1×10^{-3}	0.080×10^{-3} 0.13×10^{-3} 0.43×10^{-3} 0.76×10^{-3} 1.2×10^{-3} 1.7×10^{-3}	周界外浓度最高点	0.008 μg/m³
30	光[5]气	3.0	25 30 40 50	0.10 0.17 0.59 1.0	0.15 0.26 0.88 1.5	周界外浓度最高点	0.080

表 2(续)

序号	污染物	最高允许排放浓度 mg/m³	最高允许排放速率,kg/h			无组织排放监控浓度限值	
			排气筒高度 m	二级	三级	监控点	浓度 mg/m³
13	沥青烟	140 (吹制沥青)	15 20 30 40 50 60 70 80	0.18 0.30 1.3 2.3 3.6 5.6 7.4 10	0.27 0.45 2.0 3.5 5.4 7.5 11 15	生产设备不得有明显的无组织排放存在	
		40 (熔炼、浸涂)					
		75 (建筑搅拌)					
32	石棉尘	1 根(纤维)/cm³ 或 10 mg/m³	15 20 30 40 50	0.55 0.93 3.6 6.2 9.4	0.83 1.4 5.4 9.3 14	生产设备不得有明显的无组织排放存在	
33	非甲烷总烃	120 (使用溶剂汽油或其他混合烃类物质)	15 20 30 40	10 17 53 100	16 27 83 150	周界外浓度最高点	4.0

1) 周界外浓度最高点一般应设置于无组织排放源下风向的单位周界外 10 m 范围内,若预计无组织排放的最大落地浓度点越出 10 m 范围,可将监控点移至该预计浓度最高点,详见附录 C。下同。

2) 均指含游离二氧化硅超过 10%以上的各种尘。

3) 排放氯气的排气筒不得低于 25 m。

4) 排放氰化氢的排气筒不得低于 25 m。

5) 排放光气的排气筒不得低于 25 m。

Appendix R - DB11/1056 2013 - Extract

ICS

点击此处添加中国标准文献分类号

DB11

北　京　市　地　方　标　准

DB 11/ 1056—2013

固定式内燃机大气污染物排放标准

Emission standard of air pollutants for stationary internal combustion engines

2013 - 12 - 26 发布　　2014 - 01 - 01 实施

北京市环境保护局

北京市质量技术监督局　　发布

表1 内燃机大气污染物最高允许排放浓度 单位：mg/m^3

燃料类型	颗粒物	氮氧化物	一氧化碳	氨[a]
天然气、人工煤气[b]	5	75	80	25
沼气等其他气体[c]	—	250	1100	—

[a]适用于内燃机烟气脱硝使用含氨还原剂的情况。

[b]燃柴油及其他液体燃料内燃机执行燃天然气内燃机大气污染物排放限值。

[c]沼气等其他气体包括生物沼气、污泥沼气、垃圾填埋气等。

4.2 烟囱高度规定

4.2.1 烟囱最低高度

新建内燃机烟囱高度及距周围居民住宅的距离按批准的环境影响报告书（表）确定，但不应低于15m，且需高出周围200m半径范围内的建筑物3m以上。

4.2.2 烟囱达不到规定高度时的处置

当新建内燃机烟囱高度由于特殊原因达不到4.2.1规定时，其颗粒物、氮氧化物、一氧化碳以及氨的最高允许排放浓度按相应排放限值的50%执行。

4.3 燃料控制要求

4.3.1 天然气、人工燃气应符合 GB 17820-2012 中规定的Ⅱ类及其以上气质标准。

4.3.2 沼气等其他气体燃料质量应与内燃机的运行要求相匹配。

4.3.3 柴油及其他液体燃料中有害物质含量应符合表 2 的规定。

表2 柴油及其他液体燃料有害物质含量要求

序号	项目	限值
1	硫含量（mg/kg）	≤10
2	多环芳烃（%，质量分数）	≤11

4.4 操作规范

脱硝系统运行管理应符合HJ 562的要求，按公式（1）计算的脱硝系统可用率不应小于98%。

$$脱硝系统可用率=\frac{(A-B)}{A}\times 100\% \quad \cdots\cdots (1)$$

式中：

A—内燃机每年总运行时间，h；

B—脱硝系统每年总停运时间，h。

5 污染物监测要求

5.1 烟气监测孔和采样平台

应在污染物排放监控位置设置规范的永久性烟气监测孔、采样平台和排污口标志，并应符合相关规范要求。

Appendix S - Exhaust Emission Legislation by VDMA - Extract

Engines and Systems

VDMA

Exhaust Emission Legislation
Diesel- and Gas engines

Content

Date of issue: January 2017

Austria

The technical reference for the evaluation of emissions of stationary engines has been updated.
The technical reference document is not legally binding, it summarizes the knowledge of authorities and experts regarding exhaust gas emissions and presents possible pollution reduction measures.
Individual circumstances have to be evaluated by the authorities and therefore other measures may be defined.

Emission limit values for engines running on diesel or heating oil[A]

Mechanical power [kW]	Dust [mg/kWh]	CO [mg/kWh]	NO_x [mg/kWh]	HC [mg/kWh]	NO_x+HC [mg/kWh]	NH_3[B] [mg/kWh]
19 ≤ P < 37[C]	600	5500	–	–	7500	–
37 ≤ P < 56	25	5000	–	–	4700	–
56 ≤ P < 75	25	5000	400	190	–	15
75 ≤ P < 130	25	5000	400	190	–	15
130 ≤ P ≤ 560	25	3500	400	190	–	15
P > 560	25	3000	400	190	–	15

[A] Based on the results of a test cycle according to ISO 8178.
[B] Only for SCR.
[C] (Passive) Diesel particle filter are available for retro-fitting and also reduce CO and HC-emissions.

Emission limit values for engines running on diesel or heating oil and which are operated less than 50 hours per year[A]

Mechanical power [kW]	Dust [mg/kWh]	CO [mg/kWh]	NO_x [mg/kWh]
19 ≤ P < 37C	5500	7500	5500
37 ≤ P < 56	5000	4700	5000
56 ≤ P < 75	5000	4700	5000
75 ≤ P < 130	5000	4000	5000
130 ≤ P ≤ 560	3500	4000	3500
P > 560	3500	4000	3500

[A] Based on the results of a test cycle according to ISO 8178.
[B] (Passive) Diesel particle filter are available for retro-fitting and also reduce CO and HC-emissions.

Emission limit values for gas engines

Fuel type	Mechanical power	CO	NO_x	NMHC
Natural gas, Liquefied gas	[kW]	[mg/kWh]	[mg/kWh]	[mg/kWh]
	P < 1000	600	700	425
	P ≥ 1000	600	425	140
Sewage gas, Landfill gas	[kW]	[mg/m_n^3]	[mg/m_n^3]	[mg/m_n^3]
	P < 100	650	–	–
	P ≥ 100	400	500	150

Czech Republic

The Czech regulation of stationary engines has been updated by the act 415/2012 Sb. The new emission limit values become effective from December 1st, 2012.
The regulation makes provisions for existing plants, which were developed before May 17th 2006 and new plants, which have been developed and constructed after May 17th 2006.
The regulations apply to plants with a power levels of $0.3 \leq P_n < 50\ MW_{th}$ or $P \geq 50\ MW_{th}$. The reference oxygen is set to 5% in the former case and set to 15% in the latter case.

Emission limit values for existing plants for which construction was started before May 17th 2006.

Engine category / Power	Fuel type	SO_2 [mg/m_n^3]	NO_x [mg/m_n^3]	PM [mg/m_n^3]	ΣC^A [mg/m_n^3]	CO [mg/m_n^3]
SI $0.3 \leq P_n < 1\ MW_{th}$	liquid	B	500	–	–	650
	Natural gas	B	500	–	–	650
	Other gases	B	1000	–	–	1300
CI $0.3 \leq P_n < 1\ MW_{th}$	Heavy fuel oil	B	4000	–	–	650
	Gas oil	B	4000	–	–	650
	Natural gas, mine gas C	B	4000	–	–	650
SI $1 \leq P_n \leq 5\ MW_{th}$	liquid	B	500	130	150	650
	Natural gas	B	500	–	150	650
	Other gases	B	1000	130	150	1300
CI $1 \leq P_n \leq 5\ MW_{th}$	Heavy fuel oil	B	4000	130	150	650
	Gas oil	B	4000	130	150	650
	Natural gas, mine gas C	B	4000	–	150	650
SI $P_n > 5\ MW_{th}$	liquid	B	500	130	150	650
	Natural gas	B	500	–	150	650
	Other gases	B	500	130	150	650
CI $P_n > 5\ MW_{th}$	Heavy fuel oil	B	2000	130	150	650
	Gas oil	B	2000	130	150	650
	Natural gas, mine gas C	B	2000	–	150	650

A Total concentration of all organic substances except methane with a mass flow > 3 kg/h.
B The amount of sulfur in the fuel may not exceed the limit value stipulated by separate regulations. For Spark Ignited Engines the amount of sulfur may not exceed 0.05 % of the mass.
C With pilot fuel.

Emission limit values for existing plants for which construction was started before May 17th 2006. Emission limit values for new plants are valid until December 31st 2017.

Engine category / Power	Fuel type	SO_2 [mg/m_n^3]	NO_x [mg/m_n^3]	PM [mg/m_n^3]	ΣC^A [mg/m_n^3]	CO [mg/m_n^3]
SI $0.3 \le P_n < 1\ MW_{th}$	liquid	[B]	500	–	–	650
	Natural gas	[B]	500	–	–	650
	Other gases	[B]	1000	–	–	1300
CI $0.3 \le P_n < 1\ MW_{th}$	Heavy fuel oil	[B]	4000	–	–	650
	Gas oil	[B]	4000	–	–	650
	Natural gas, mine gas[C]	[B]	4000	–	–	650
SI $1 \le P_n \le 5\ MW_{th}$	liquid	[B]	500[D]	130	150	650
	Natural gas	[B]	500[D]	–	150	650
	Other gases	[B]	500[D]	130	150	1300
CI $1 \le P_n \le 5\ MW_{th}$	Heavy fuel oil	[B]	600[D]	130	150	650
	Gas oil	[B]	500[D]	130	150	650
	Natural gas, mine gas[C]	[B]	500[D]	–	150	650
SI $P_n > 5\ MW_{th}$	liquid	[B]	500[D]	130	150	650
	Natural gas	[B]	500[D]	–	150	650
	Other gases	[B]	500[D]	130	150	650
CI $P_n > 5\ MW_{th}$	Heavy fuel oil	[B]	600[D]	130	150	650
	Gas oil	[B]	500[D]	130	150	650
	Natural gas, mine gas[C]	[B]	500[D]	–	150	650

[A] Total concentration of all organic substances except methane with a mass flow > 3 kg/h.

[B] The amount of sulfur in the fuel may not exceed the limit value stipulated by separate regulations. For Spark Ignited Engines the amount of sulfur may not exceed 0.05 % of the mass.

[C] With pilot fuel.

[D] The emission limit value for NO_x is valid since January 1st, 2008. This emission limit value is not to be applied for engines which operate less than 300 hours per year.

Emission limit values for new plants (valid from January 1st 2018) with P_n < 50 MW_{th}:

Power [MW_{th}]	Fuel type	SO_2 [mg/m_n^3]	NO_x [mg/m_n^3]	PM [mg/m_n^3]	ΣC^A [mg/m_n^3]	CO [mg/m_n^3]
0.3 ≤ P_n < 1	liquid	[B]	400	–	–	450
	gaseous. and liquefied gas	[B]	500	–	–	650
1 ≤ P_n < 5	liquid	[B]	400	50	150	450
	gaseous. and liquefied gas	[B]	500	–	150	650
5 ≤ P_n < 50	liquid	[B]	400	20	150	450
	gaseous. and liquefied gas	[B]	500	–	150	650

[A] Total concentration of all organic substances except methane with a mass flow > 3 kg/h.

[B] The amount of sulfur in the fuel may not exceed the limit value stipulated by separate regulations. For Spark Ignited Engines the amount of sulfur may not exceed 0.05 % of the mass.

Limit values for new build plants with P_n ≥ 50 MW_{th}:

Power [MW_{th}]	Fuel type	SO_2 [mg/m_n^3]	NO_x [mg/m_n^3]	PM [mg/m_n^3]	ΣC [mg/m_n^3]	CO [mg/m_n^3]
50 ≤ P_n < 100	liquid	350	300	20	150	175
	Liquefied gas	5	300	5	150	175
	Other gases	35	75	5	150	100
	Natural gas	35	75	5	150	100
100 ≤ P_n ≤ 300	liquid	200	150	20	150	175
	Liquefied gas	5	150	5	150	175
	Other gases	35	75	5	150	100
	Natural gas	35	75	5	150	100
P_n > 300	liquid	150	100	10	150	175
	Liquefied gas	5	150	5	150	175
	Other gases	35	75	5	150	100
	Natural gas	35	75	5	150	100

The emission limit values are not applied to engines operating less than 300 hours per year.

CONVERSION FORMULAS

For sulfur free diesel fuel (10 ppm sulfur) corresponding to EN 590 with a density of ρ = 830 kg/m³ (15° C), the following applies approximately:

Conversion of g/m_n^3 (5 % O_2) to g/kWh:

$$EP_i = EA_i \bullet b_{eff} \bullet \frac{m_N^3}{73g} \qquad EA_i = EP_i \bullet \frac{73g}{m_N^3 \bullet b_{eff}}$$

Conversion with differing residual oxygen content (as per “TA Luft”):

$$EA_i = EX_i \bullet \frac{21-5}{21-X}$$

Conversion of ppm to g/kWh:

$$EP_i = EV_{i,d} \bullet \frac{M_i}{M_{Exh,d}} \bullet \frac{\dot{m}_{Exh,d}}{P_{eff}} = EV_{i,w} \bullet \frac{M_i}{M_{Exh,w}} \bullet \frac{\dot{m}_{Exh,w}}{P_{eff}}$$

EP_i Pollutant mass, i, referenced to P_{eff} (g/kWh)
EA_i Pollutant mass, i, referenced to exhaust volumes based on dry exhaust with 5 % residual oxygen under standardized conditions (g/m_n^3)
EX_i Pollutant mass, i, referenced to exhaust volumes based on dry exhaust with X % residual oxygen under standardized conditions (g/m_n^3)
EV_i Exhaust emission value of components, i, as volume share (ppm)
M_i Mol mass of the components, i, (kg/kmol)
M_{Exh} Mol mass of the exhaust (kg/kmol)
$\dot{m}_{Exh}$ Exhaust mass flow (kg/h)
P_{eff} Power output (kW)
b_{eff} Specific fuel consumption (g/kWh)
Index d: dry
Index w: wet

Component	Mol mass kg/kmol	Remarks
NO_2	46.006	NO_x treated as NO_2
CO	28.0104	
HC	13.876	HC 1
SO_2	64.061	
Exhaust dry	30.21 / 29.84	5 % O_2 / 9.6 % O_2
Exhaust wet	28.84 / 28.82	5 % O_2 / 9.6 % O_2

- At 5 % residual oxygen (corresponding to an excess air ratio of 1.3 : 1) and b_{eff} = 210 g/kWh, the following applies approximately:

$$\frac{\dot{m}_{Exh,d}}{P_{eff}} = 3873\,g/kWh \qquad \frac{\dot{m}_{Exh,w}}{P_{eff}} = 4160\,g/kWh$$

- 1000 ppm NO_x,
  measured wet, corresponds to 2310 mg/m_n^3, d, 5 % (6.60 g/kWh)
- 100 ppm HC,
  measured wet, corresponds to 70 mg/m_n^3, d, 5 % (0.20 g/kWh)
- 100 ppm CO,
  measured dry, corresponds to 125 mg/m_n^3, d, 5 % (0.36 g/kWh)

- At an excess air ratio of 1.8 : 1 (residual oxygen content corresponding to 9.6 %) and b_{eff} = 210 g/kWh the following applies approximately:

$$\frac{\dot{m}_{Exh,d}}{P_{eff}} = 5400\,g/kWh \qquad \frac{\dot{m}_{Exh,w}}{P_{eff}} = 5710\,g/kWh$$

- 1000 ppm NO_x,
  measured wet, corresponds to 9.10 g/kWh (3150 mg/m_n^3, d, 5 %)
- 100 ppm HC,
  measured wet, corresponds to 0.27 g/kWh (95 mg/m_n^3, d, 5 %)
- 100 ppm CO, measured dry, corresponds to 0.51 g/kWh (176 mg/mmg/m_n^3, d, 5 %)

Units:

Energy	1 J	= 1 Nm	= 1 Ws	= 1 VAs
	1 Wh	= 3.6 kJ		
	1 kWh	= 3.6 MJ		
Power	1 W	= 1 VA	= 1 J/s	= 1 Nm/s
Force	1 N	= 1 kgm/s^2		
Pressure	1 Pa	= 1 N/m^2		
	1 bar	= 10^5 Pa		

Conversion of non-SI units:

Length

Inch	1 in	= 25.4 mm	
Foot	1 ft	= 304.8 mm	= 12 in
Yard	1 yd	= 914.4 mm	= 3 ft
Statute mile	1 mi	= 1609.34 m	= 1760 yd
Nautical mile	1 nm	= 1852 m	

Surface

Square inch	1 sq in	= 645.16 mm^2

Volume

Cubic inch	1 cu in	= 0.016387 Liter
Gallon (US)	1 gal (US)	= 3.78541 Liter
Gallon (UK)	1 gal (UK)	= 4.54609 Liter
Liquid barrel (US)	1 liq bbl	= 119.24 Liter
Barrel Petroleum	1 bbl	= 158.99 Liter

Mass

Grain	1 gr	= 64.7989 mg		
Ounce	1 oz	= 28.3495 g		
Pound mass	1 lbm	= 0.45359 kg	= 16 oz	= 7000 gr
Hundredweight (US)	1 cwt (US)	= 45.3592 kg	= 1 short cwt	= 100 lbm
Hundredweight (UK)	1 cwt (UK)	= 50.8023 kg	= 1 long cwt	= 112 lbm
Ton (US)	1 ton (US)	= 907.185 kg	= 1 short ton	= 2000 lbm
Ton (UK)	1 ton (UK)	= 1016.05 kg	= 1 long ton	= 2240 lbm

Force

Pound force	1 lbf	= 4.44822 N

Pressure

Atmosphere	1 atm	= 1.01325 bar	
Water column	1 mm WS	= 9.80665 Pa	
Mercury column	1 mm Hg	= 133.322 Pa	= 1 Torr
Psi	1 lbf / in^2	= 6894.76 Pa pound per square inch	

Energy

Calorie	1 kcal	= 4186.8 J	
Foot pound-force	1 ft lbf	= 1.35582 J	
British thermal unit	1 Btu	= 1055.06 J	
Mineral coal unit	1 kg SKE	= 29.3076 MJ	= 8.141 kWh
Oil equivalent	1 kg OE	= 41.868 MJ	= 11.63 kWh

Power

Horsepower (metric)	1 PS	= 735.499 W	
Horsepower, HP	1 bhp	= 745.70 W	= 550 ft • lbf/s

Temperature

T (K)	= t (°C) + 273.15
t (°C)	= 5/9 • (t(°F) – 32)

Glossary

Exhaust emission components

CO	Carbonmonoxide
HC	Hydrocarbons
NO_X	Nitrogen oxides
NMHC	Non-Methane-Hydrocarbons
PM	Particulate matter
SO_X	Sulfur oxide
THC	Total Hydrocarbon
VOC	Volatile organic components (equals HC)

Regulations

BSO	Bodensee Schifffahrtsordnung, Lake Constance Shipping Ordinance
CFR	Code of Federal Register (US regulations)
RheinSchUO	Rhine vessel inspection regulation
TA-Luft	Technische Anleitung zur Reinhaltung der Luft (German clean-air standard for approval authorities)

Authorities and organizations

EC	European Commission
ECE	Economic Commission for Europe (UN economic commission for Europe)
EEU	Eurasian Economic Union
EPA	Environmental Protection Agency (US environmental authority)
EU	European Union
CARB	California Air Resources Board
IMO	International Maritime Organization
CCNR	Central Commission for the Navigation on the Rhine
UIC	Union International des Chemins de Fer (International Union of Railways)

Engine parameters and technologies

CI	Compression Ignition
DF	Dual-Fuel
m_n^3	standard cubic meter
MW_{th}	Megawatt thermal
n_n	Engine rated speed [rpm]
P_n	Engine rated power [kW]
SI	Spark Ignition
V_h	Swept volume (displacement) [liter]
$V_{h,z}$	Swept volume per cylinder (cyl. displacement) [liter]

VDMA
Engines and Systems

Lyoner Str. 18
60528 Frankfurt am Main
Germany
Telefon +49 69 6603-1378
Fax +49 69 6603-2378
E-Mail mus@vdma.org
Internet mus.vdma.org

Editors
Dr. Tobias Ehrhard
Dr. Alexander Widmann

mus.vdma.org

Appendix T - France - arrete d biogaz - Extract

RÉPUBLIQUE FRANÇAISE

Ministère de la transition écologique et solidaire

Arrêté du [ ]

Relatif aux prescriptions générales applicables aux appareils de combustion, consommant du biogaz produit par des installations de méthanisation classées sous la rubrique n° 2781-1, inclus dans une installation de combustion classée pour la protection de l'environnement soumise à déclaration sous la rubrique n°2910

NOR : TREP1726505A

Rules dated [ ]
Relative to general prescriptions applicable to combustion of biogas from methane producing plants.....

Public : *Exploitants d'appareils de combustion consommant du biogaz produit par des installations de méthanisation classées* ***sous la rubrique n° 2781-1*** *de puissance comprise entre 1 et 20 MW*

Objet : *Fixer des prescriptions générales pour les appareils consommant du biogaz issu de la méthanisation de matière végétale brute, d'effluents d'élevage, de matières stercoraires, lactoserum et déchets végétaux d'industries agroalimentaires*

Entrée en vigueur : *20 décembre 2018*

Notice **:** La modification de la rubrique 2910 de la nomenclature des ICPE modifie le classement des appareils de combustion consommant du biogaz produit par des installations de méthanisation classées sous rubrique 2781-1. Ces installations sont désormais classées à la sous-rubrique 2910 A et le régime de l'installation ne dépend plus du régime de l'installation de méthanisation à l'origine de la formation du biogaz. La plupart de ces installations reclassées en 2910 A seront soumises à déclaration. Le présent arrêté reprend les dispositions de l'arrêté du 8 décembre 2011 en y incluant les nouvelles contraintes liées à la directive (UE) 2015/2193.
Références : *le présent arrêté peut être consulté sur le site Légifrance (http://www.legifrance.gouv.fr).*

Le ministre d'État, ministre de la transition écologique et solidaire**,**

Des dispositions sont prises pour qu'il ne puisse pas y avoir, en cas d'accident (rupture de récipient, cuvette, etc.), déversement de matières dangereuses dans les égouts publics ou le milieu naturel.

L'évacuation des effluents recueillis selon les dispositions du point 2.11 se fait soit dans les conditions prévues au point 5.5 ci-dessus, soit comme des déchets, dans les conditions prévues au point 7 ci-après.

5.8. Épandage

L'épandage des boues, déchets, effluents et sous-produits issus de l'activité de combustion est interdit.

5.9. Surveillance par l'exploitant de la pollution rejetée

Une mesure des concentrations des différents polluants visés au point 5.5 est effectuée au moins tous les trois ans par un organisme agréé par le ministre chargé de l'environnement. Ces mesures sont effectuées sur un échantillon représentatif du fonctionnement sur une journée de l'installation et constitué soit par un prélèvement continu d'une demi-heure, soit par au moins deux prélèvements instantanés espacés d'une demi-heure. En cas d'impossibilité d'obtenir un tel échantillon, une évaluation des capacités des équipements d'épuration à respecter les valeurs limites est réalisée. Une mesure du débit est également réalisée, ou estimée à partir des consommations.

Objet du contrôle :

- présence des résultats des mesures selon la fréquence définie, des paramètres décrits ci-dessus ;

- vérification de la présence d'agrément de l'organisme qui a fait les mesures ;

- vérifier la conformité des résultats de mesure avec les valeurs limites d'émission applicables ;

6. Air - odeurs Air - Odours

6.1. Captage et épuration des rejets à l'atmosphère

Les installations susceptibles de dégager des fumées, gaz, poussières ou odeurs sont munies de dispositifs permettant de collecter et canaliser, autant que possible, les émissions. Ces dispositifs, après épuration des gaz collectés en tant que de besoin, sont munis d'orifices obturables et accessibles. Le débouché des cheminées est éloigné au maximum des immeubles habités ou occupés par des tiers et des bouches d'aspiration d'air frais et ne comporte pas d'obstacles à la diffusion des gaz (chapeaux chinois...). Les points de rejet sont en nombre aussi réduit que possible.

La dilution des effluents est interdite, sauf autorisation explicite de l'inspection des installations classées. Elle ne peut être autorisée aux seules fins de respecter les valeurs limites exprimées en concentration.

Objet du contrôle :

- présence de dispositifs permettant de collecter et canaliser les émissions de fumées, gaz, poussières ou odeurs ;
- présence d'orifices obturables et accessibles ;
- absence d'obstacles à la diffusion des gaz.

6.2. Valeurs limites et conditions de rejet Limits and Normal conditions

6.2.1. Conditions de rejet Normal conditions

Les effluents gazeux respectent les valeurs limites définies ci-après, exprimées dans les conditions normalisées de température (273,15 kelvins) et de pression (101,3 kilopascals) après déduction de la vapeur d'eau (gaz sec) et mesurées selon les méthodes définies au point 6.3.

Les valeurs limites d'émission exprimées en concentration se rapportent à une quantité d'effluents gazeux n'ayant pas subi de dilution autre que celle éventuellement nécessitée par les procédés utilisés. Pour les métaux, les valeurs limites s'appliquent à la masse totale d'une substance émise, y compris la part sous forme de gaz ou de vapeur contenue dans les effluents gazeux.

6.2.2. Combustibles utilisés Fuels

Les combustibles à employer doivent correspondre à ceux figurant dans le dossier de déclaration et aux caractéristiques préconisées par le constructeur des appareils de combustion.

Le combustible est considéré dans l'état physique où il se trouve lors de son introduction dans la chambre de combustion.

L'exploitant tient à jour un relevé du type et des quantités de combustible utilisé dans l'installation.

Objet du contrôle :

- conformité des combustibles utilisés avec ceux figurant dans le dossier de déclaration (le non-respect de ce point relève d'une non-conformité majeure) ;
- présence d'un relevé du type et des quantités de combustible utilisé dans l'installation.

6.2.3. Hauteur des cheminées Stack heights

Toutes les dispositions sont prises pour que les gaz de combustion soient collectés et évacués par un nombre aussi réduit que possible de cheminées, qui débouchent à une hauteur permettant une bonne dispersion des polluants.

La hauteur hp de la cheminée (différence entre l'altitude du débouché à l'air libre et l'altitude moyenne au sol à l'endroit considéré exprimée en mètres) d'un appareil est déterminé en fonction de la puissance thermique nominale totale de l'installation de combustion dans laquelle l'appareil de combustion est inclus et en fonction du combustible consommé par l'appareil.

Si plusieurs conduits sont regroupés dans la même cheminée, la hauteur de cette dernière sera déterminée en se référant au combustible et au type d'appareil donnant la hauteur de cheminée la plus élevée.

Les hauteurs indiquées entre parenthèses correspondent aux hauteurs minimales des cheminées associées aux installations implantées dans les agglomérations et zones mentionnées à l'article L. 222-4 du code de l'environnement.

A. Cas des installations comportant des turbines ou des moteurs Installations with turbines or engines

La hauteur de la ou des cheminées est déterminée en se référant, dans le tableau suivant, à la puissance totale de chaque catégorie d'appareils (moteurs ou turbines) prise séparément.

Puissance totale	> 2 MWth et < 4 MWth	≥4 MWth et < 6 MWth	≥6 MWth et < 10 MWth	≥10 MWth et < 15 MWth	≥ 15 MWth
Hauteur	5 m	6 m	7 m	9 m (13 m)	10 m (15 m)

Dans le cas d'un appareil de combustion isolé ou d'un groupe d'appareils raccordé à une même cheminée et dont la puissance est inférieure ou égale à 2 MWth, la hauteur minimale du débouché à l'air libre de la cheminée d'évacuation des gaz de combustion dépasse d'au moins 3 mètres le point le plus haut de la toiture surmontant l'installation.

Dans le cas des moteurs dual-fioul, la hauteur de la cheminée est majorée de 20 % par rapport à la hauteur donnée dans le tableau ci-dessus pour la puissance correspondante (valeur arrondie à l'unité supérieure).

Pour les turbines et moteurs, si la vitesse d'éjection des gaz de combustion dépasse la valeur indiquée à l'article 6.2.4 (A), la formule suivante pourra être utilisée pour déterminer la hauteur minimale hp de la cheminée sans que celle-ci puisse être inférieure à 3 mètres :

$hp = hA\ [1 – (V – 25)/(V – 5)]$,

où hA est la valeur indiquée dans les tableaux ci-dessus pour la puissance concernée et V la vitesse effective d'éjection des gaz de combustion (en m/s).

B. Autres installations Other installations

Puissance totale	>2 MWth et < 4 MWth	≥4 MWth et < 10 MWth	≥ 10 MWth
Hauteur	6 m	8 m	9 m (14 m)

Dans le cas d'un appareil de combustion isolé ou d'un groupe d'appareils raccordé à une même cheminée et dont la puissance est inférieure ou égale à 2 MWth, la hauteur minimale du débouché à l'air libre de la cheminée d'évacuation des gaz de combustion dépasse d'au moins 3 mètres le point le plus haut de la toiture surmontant l'installation.

C. Prise en compte des obstacles Account for barriers

S'il y a dans le voisinage des obstacles naturels ou artificiels de nature à perturber la dispersion des gaz de combustion (obstacles vus de la cheminée considérée sous un angle supérieur à 15 degrés dans le plan horizontal), la hauteur de la ou des cheminées est déterminée de la manière suivante :

- si l'obstacle considéré est situé à une distance inférieure à D de l'axe de la cheminée :

$Hi = hi + 5$;

- si l'obstacle considéré est situé à une distance comprise entre D et 5 D de l'axe de la cheminée :

$Hi = 5/4(hi + 5)(1 – d/5\ D)$.

hi est l'altitude d'un point de l'obstacle situé à une distance d de l'axe de la cheminée. Soit Hp la plus grande des valeurs de Hi, la hauteur de la cheminée est supérieure ou égale à la plus grande des valeurs Hp et hp.

D est pris égal à 25 m si la puissance est inférieure à 10 MWth et à 40 m si la puissance est supérieure ou égale à 10 MWth.

Objet du contrôle :

– vérification du calcul de la hauteur de cheminée présent dans le dossier de déclaration, sur la base des hypothèses prises par l'exploitant (le non-respect de ce point relève d'une non-conformité majeure) ;

– vérification de l'adéquation entre hauteur de cheminée réelle (mesurée par système optique) et hauteur de cheminée calculée par l'organisme de contrôle (le non-respect de ce point relève d'une non-conformité majeure).

6.2.4. Vitesse d'éjection des gaz Speed of gas ejection

A. Turbines et moteurs Turbines and engines

La vitesse d'éjection des gaz de combustion en marche nominale est au moins égale à 25 m/s si la puissance de l'appareil de combustion est supérieure à 2 MWth, et à 15 m/s sinon.

B. Autres appareils de combustion

La vitesse d'éjection des gaz de combustion en marche nominale est au moins égale à 5 m/s.

Objet du contrôle :

- vérification de la vitesse d'éjection mesurée lors de la mesure périodique de la pollution rejetée ou calculée grâce au débit mesuré lors de la mesure périodique de la pollution rejetée et à la section de la cheminée.

6.2.5. Valeurs limites d'émission Emission limit values

I. Le débit des gaz de combustion est exprimé en mètres cubes par heure rapportés dans les conditions normales de température et de pression (273,15 kelvins et 101,3 kilopascals) après déduction de la vapeur d'eau (gaz sec). Les limites de rejet en concentration sont exprimées en milligrammes par mètre cube (mg/m^3) rapporté dans les mêmes conditions normalisées, la teneur en oxygène étant ramenée à 15 % en volume pour les moteurs et les turbines et à 3 % dans tous les autres cas. Elles s'appliquent à la mesure des gaz, vésicules et particules, le cas échéant.

Dans le cas des turbines et des moteurs, les valeurs limites doivent être respectées dans les conditions de marche des installations à pleine charge.

II. Les valeurs limites d'émission suivantes s'appliquent sous réserve des renvois entre parenthèses :

Engines (mg/Nm^3 at 15% of O2)

	Chaudières ou autres (mg/Nm^3 à 3% d'O2)	Moteurs (mg/Nm^3 à 15% d'O2)	Turbines (mg/Nm^3 à 15% d'O2)
Monoxyde de carbone	250	450	300

Oxydes de soufre (exprimés en dioxyde de soufre)	100 (1)	40 (2)	40 (2)
Oxydes d'azote (exprimés en dioxyde d'azote)	[illegible]	190	75 (3)
Chlorure d'hydrogène inorganiques gazeux HCl)		10	
Fluor et composés inorganiques du fluor (exprimés en HF)	5	5	5
Composés organiques volatils non méthaniques (en carbone total de la concentration globale de l'ensemble des composés)	50	50	50
Formaldhéhyde, si le flux horaire maximal de l'ensemble de l'installation supérieur ou égal à 100 g/h	40	40	40
Ammoniac (lorsque l'installation est équipée d'un dispositif de traitement des oxydes d'azote à l'ammoniac ou ses promoteurs)	20	20	20

"Non Methane Volatile Organic Compounds (measured as total carbone of overall concentration of all compounds)"

Equivalent to 50*(21-6)/(21-15) = 125 at 6% O2

Renvoi	Conditions	Valeur limite d'émission (mg/Nm³)
(1)	Installation mise en service avant le 20 décembre 2018	SO_2 : 170
(2)	Installation mise en service avant le 20 décembre 2018	SO_2 : 60
(3)	Installation mise en service avant le 20 décembre 2018	NOx : 150

6.2.6. Odeurs Odours

Toutes les dispositions nécessaires sont prises pour limiter les odeurs provenant de l'installation.

En particulier, les installations de stockage, de manipulation et de transport des combustibles et des produits susceptibles d'être à l'origine d'émissions d'odeurs sont canalisées ou aménagées dans des locaux confinés et, si besoin, ventilés. Les effluents gazeux canalisés odorants sont, le cas échéant, récupérés et acheminés vers une installation d'épuration des gaz.

6.2.7. Conformité aux VLE Conformance to emission limits

En cas de non-respect des valeurs limites d'émission prévues au point 6.2 du présent arrêté, l'exploitant prend les mesures nécessaires pour assurer le rétablissement de la conformité dans les plus brefs délais. L'exploitant conserve un relevé des mesures prises pour rétablir la conformité

6.3. Surveillance par l'exploitant de la pollution rejetée

6.3.1. Cas général Control of pollution by plant operator