GUIDANCE NOTE ON
THE BEST PRACTICABLE MEANS
FOR

INCINERATORS

(SEWAGE SLUDGE INCINERATION)

BPM 12/3 (10)

Environmental Protection Department
Air Policy Group

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1. INTRODUCTION

1.1 This Note is one of a series issued by the Environmental Protection Department to provide guidance on air pollution management for processes specified under Part IV of the Air Pollution Control Ordinance (the Ordinance). It also serves as a guide for the assessment of an application for Specified Process licence under the Ordinance.

1.2 It should be understood that this Note sets out the basic requirements for the applicant to provide and maintain the best practicable means for the prevention of emission of air pollutants. The applicant should recognize that whether a licence is granted or refused, and on what conditions, will depend on all the circumstances of an individual application besides the requirements set out in this Note. The Authority may devise specific requirements for individual facility carrying out the specified process.

1.3 This Note covers specified and associated processes in relation to the incineration of waste in the form of sludge arisen from sewage treatment facilities, and described as "Incinerators" in Schedule 1 to the Ordinance. Incinerators are works in which the installed capacity exceeds 0.5 tonne per hour and which are used for the destruction by burning of wastes or refuse, and not any works described in other specified process.

2. EMISSION LIMITS

2.1 All emissions to atmosphere, other than steam and water vapour, shall be colourless, free from persisting mist or fume, and free from droplets.

2.2 Smoke emission from incineration process during normal operations (including start-up and shut-down) shall not, when compared in an appropriate manner with the Ringelmann Chart or an approved device, appear to be as dark as or darker than Shade 1 on the Ringelmann Chart.

2.3 Emission from incineration process shall not exceed the concentration limits set out in Annex I. All pollutant concentration limit values are expressed at reference conditions of 0^{o}C temperature and 101.325 kPa pressure, dry and 11% oxygen content conditions.

3. FUEL RESTRICTION

3.1 All fuels to be used shall comply with the Air Pollution Control (Fuel Restriction) Regulation in force.

4. CONTROL OF EMISSIONS

4.1 The incinerator shall be designed, equipped, built and operated in such a way that emission of air pollutants is controlled to prevent:

(a) exceedance of emission limits set out in section 2 of this Note;

(b) threatening the attainment or maintenance of the relevant air quality objectives;

(c) harm to the environment, or risks to human health, or creation of any nuisance situation;

(d) giving rise to an objectionable odour noticeable outside the premises where the process is carried out; and

(e) imposing undue constraint on the existing and future development or land use.

4.2 **Incoming Waste Handling**

4.2.1 To prevent malodorous emissions arisen from sludge receiving, storage, handling and processing from causing air pollution, suitable facilities and management measures shall be provided to contain fully the emissions from sludge incineration works and associated processes as well as deodorizing facilities. Properly designed operation process shall be installed and operated to minimize, contain and treat odorous emissions. Sludge receiving and storage areas, and sludge feeding system shall be of enclosed design to prevent malodorous emission.

4.2.2 A well-designed ventilation system capable of maintaining a suitable negative pressure shall be provided and operated at the plant including, but not limited to, sludge receiving and storage areas to prevent any uncontrolled escape of malodorous air to open atmosphere. Exhaust air from those areas shall be treated by deodorizing facilities before being discharged to open atmosphere.

4.2.3 The sludge feeding system shall be designed and equipped to provide a homogenized and consistent feedstock in terms of uniform size, calorific value, moisture content and throughput as appropriate.

4.3 **Design of Incinerator Furnace**

4.3.1 Fluidized bed technology shall be adopted for sewage sludge incineration.

4.3.2 The incinerator furnace shall be designed to ensure effective destruction of combustible substances in the waste gas. Combustion gas temperature, residence time, air supply and gas turbulence shall be adequate and properly controlled to achieve this requirement. For effective control of dioxins, one should make reference to the latest emission management technologies for Waste Incinerators provided in “Guidelines on Best Available Techniques and Provisional Guidance on Best Environmental Practices relevant to Article 5 and Annex C” of the Stockholm Convention on Persistent Organic Pollutant.

4.3.3 The sewage sludge incinerator shall be designed, equipped, built and operated in such a way that the temperature of the gas from the incineration process is raised to 850°C, after the last injection of combustion air, in a controlled and homogeneous fashion even under the most unfavourable conditions, for at least two seconds in the presence of at least 6% v/v oxygen on dry basis**.** The temperature is to be measured near the inner wall of the combustion chamber or at another representative point of the combustion chamber acceptable to the Authority.

4.3.4 Auxiliary burner(s) shall be incorporated and operated to ensure the temperature specified in paragraph 4.3.3 above be maintained during start-up and at the end of an incineration cycle and for as long as sludge to be burnt or being burnt is in the combustion chamber.

4.3.5 The incinerator shall have and operate an automatic system to prevent waste feed:

(a) at start-up, until the temperature of 850°C referred to in paragraph 4.3.3 above has been reached;

(b) whenever the temperature of 850°C referred to in paragraph 4.3.3 above is not maintained;

(c) whenever the continuous measurements required by this Note show that any of the emission limit values has been exceeded.

4.3.6 Combustion chambers, casings, ducts and ancillary equipment shall be made, and maintained, as gas-tight as practicable. They shall be maintained under slightly reduced pressure and designed to prevent both the release of gas and disturbance of combustion conditions during sludge charging.

4.3.7 Any heat generated by the incineration process shall be recovered as far as practicable.

4.4 **Design of Chimney**

4.4.1 Chimney includes vent, structure and opening of any kind from or through which air pollutants may be emitted. They shall be properly located and designed so as to satisfy the requirements set out in paragraph 4.1 above.

4.4.2 For the chimney of the incineration process, the height of which shall be determined by mathematical or physical dispersion modelling techniques acceptable to the Authority. Moreover, the efflux velocity of the exhaust from the chimney shall not be less than 15 m/s at full load condition.

4.4.3 The exit temperature of the exhaust gas from the chimney of the incineration process shall not be less than 80°C at full load condition.

4.4.4 For hot releases, chimney flues and ductwork leading to the chimney shall be adequately insulated by materials free of asbestos to minimise the cooling of waste gas and prevent liquid condensation on internal surfaces. The design shall allow for regular internal cleaning of the chimney flues and ductwork.

5. OPERATION AND MAINTENANCE

5.1 Best practicable means requirements include the proper operation and maintenance of equipment, its supervision when in use and the training and supervision of properly qualified staff. Specific operation and maintenance requirements may be specified for individual equipment.

5.2 All control and monitoring equipment shall be operational and functioning properly prior to the combustion or ignition of sludge and until all the sludge is incinerated.

5.3 Operating staff shall be properly trained in their duties relating to the control of processes and emissions to open atmosphere. Particular emphasis shall be given to training for start-up, shut-down and abnormal conditions.

5.4 In case of malfunctioning and breakdown of the process or air pollution control equipment which would cause exceedance of the emission limits or breaches of other air pollution control requirements, the incident shall be reported to the Authority without delay. Moreover, the incinerator shall be closed down as soon as practicable until normal operation can be restored.

6. FUGITIVE EMISSION CONTROL

6.1 The control of fugitive emissions of air pollutants shall be agreed with the Authority. As a general guideline, the loading, unloading, handling and storage of sludge, fuel, raw materials, wastes, by-products, ash and other incineration residue shall be carried out in a manner acceptable to the Authority so as to prevent dust, organic vapours and/or odorous emissions being noticeable outside the site boundary.

6.2 The integrity of all plant buildings shall be maintained to prevent any uncontrolled escape of odorous air from the buildings. Doors should have seals and be kept closed other than for the movement of plant, personnel and materials. Self-closing or motorized doors should be provided and fitted with alarms which operate if the doors fail to close within a reasonable period of time.

6.3 A high standard of housekeeping shall be maintained in all plant areas. Adequate provisions shall be made for the containment of liquid and solid spillages from the sludge incineration operations and associated processes. All spillages shall be cleared as soon as possible and discarded in closed containers for disposal.

6.4 Emissions from the wastewater treatment plant shall be minimized and properly controlled to prevent nuisance.

7. MONITORING REQUIREMENTS

7.1 Necessary monitoring equipment and techniques shall 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. The scope, manner and frequency of the monitoring shall be sufficient for this purpose and will be determined by the Authority. Monitoring results shall be recorded in such manner specified by the Authority. The record should be retained at the premises for a minimum of two years, or other period specified by the Authority, after the date of last entry and made available for examination as and when required by the Authority.

7.2 Without prejudice to the generality of paragraph 7.1 above, the following parameters of the incineration process shall be monitored and recorded continuously or periodically.

7.2.1 In-stack Exhaust Gas Continuous Monitoring

(a) Emission of pollutants
Carbon monoxide, gaseous and vaporous organic substances, hydrogen chloride, hydrogen fluoride, nitrogen oxides, sulphur dioxide and particulates.

(b) Stack emission conditions
Parameters that may be used in assessing the performance of air pollution control measures include, but not limited to, pressure, water vapour and oxygen content of the exhaust gas.
(Note: Continuous measurement of water vapour content shall not be required if the sampled exhaust gas is dried before analysis.)

7.2.2 Process Continuous Monitoring

(a) Temperature and oxygen content of the gas at the appropriate location(s) in the combustion chamber to demonstrate that the requirements set out in paragraphs 4.3.3 to 4.3.4 of this Note can be complied with.

(b) Temperature of the gas at the appropriate location(s) in the chimney to demonstrate that the requirements set out in paragraph 4.4.3 of this Note can be complied with.

7.2.3 On-line Monitoring

The continuous monitoring data referred to in 7.2.1 (a) and (b) above shall be transmitted instantaneously to the Authority by telemetry system in such manner and format agreed with the Authority.

7.2.4 Periodic Measurement

Periodic measurement of dioxins and heavy metals shall be made to confirm that these pollutants continue to be adequately controlled. The testing frequency will be determined by the Authority. All measurement results shall be recorded, processed and presented in a summary report as agreed by the Authority. The report shall be

submitted to the Authority without delay after the source sampling(s) as required is/are completed.

7.3 The system of continuous emission monitoring including instrument specifications, quality control, operation and maintenance to be implemented by the licensee shall meet the protocols set out in the General Requirements of Continuous Emission Monitoring (CEM) System issued by the Authority.

7.4 The licence holder shall publicise emission data on regular interval as required by the Authority.

8. COMMISSIONING

8.1 Commissioning trial (to be witnessed by the Authority whenever appropriate) shall be conducted to demonstrate performance capability of the air pollution control measures and a report of commissioning trial shall be submitted to the Authority within 1 month after completion of the trial.

ANNEX I CONCENTRATION LIMITS FOR EMISSION FROM INCINERATION PROCESS

I.1 Air pollutant emission from sludge incineration process shall not exceed the concentration limits tabulated in the following Tables. All air pollutant concentrations are expressed at reference conditions of 0°C temperature, 101.325 kilopascals pressure, dry and 11% oxygen content conditions.

(a) Daily Average Value

Air Pollutant	**Concentration Limit (mg/ m3)**
Particulates	10
Gaseous and vaporous organic substances, expressed as total organic carbon	10
Hydrogen chloride (HCl)	10
Hydrogen fluoride (HF) $^{\Delta}$	1
Sulphur dioxide (SO_2)	50
Nitrogen oxides, expressed as nitrogen dioxide (NO_2)	200
Carbon monoxide (CO)*	50

(b) Half-hourly Average Value

Air Pollutant	**Concentration Limit (mg/ m^3)**
Particulates	30
Gaseous and vaporous organic substances, expressed as total organic carbon	20
Hydrogen chloride (HCl)	60
Hydrogen fluoride (HF) $^{\Delta}$	4
Sulphur dioxide (SO_2)	200
Nitrogen oxides, expressed as nitrogen dioxide (NO_2)	400
Carbon monoxide (CO)*	100

[Note: Δ *The continuous measurement of HF may be omitted if treatment stages for HCl are used which ensure that the emission limit value for HCl is not being exceeded. In this case the emissions of HF shall be subject to periodic measurement approved by the Authority.*

* *Excluding the start-up and shut-down phases.]*

(c) Average value over the sampling period of a minimum of 30 minutes and a maximum of 8 hours

Air Pollutant	**Concentration Limit (mg/m^3)**
Cadmium and its compounds, expressed as cadmium (Cd) Thallium and its compounds, expressed as thallium (Tl)	total 0.05
Mercury and its compounds, expressed as mercury (Hg)	0.05
Antimony and its compounds, expressed as antimony (Sb) Arsenic and its compounds, expressed as arsenic (As) Lead and its compounds, expressed as lead (Pb) Chromium and its compounds, expressed as chromium (Cr) Cobalt and its compounds, expressed as cobalt (Co) Copper and its compounds, expressed as copper (Cu) Manganese and its compounds, expressed as manganese (Mn) Nickel and its compounds, expressed as nickel (Ni) Vanadium and its compounds, expressed as vanadium (V)	total 0.5

(d) Average value over the sampling period of a minimum of 6 hours and a maximum of 8 hours

Air Pollutant	**Concentration Limit (ng I-TEQ/m^3)**
Polychlorinated dibenzodioxins and polychlorinated dibenzofurans *(see Annex II for the calculation of equivalent concentration)*	0.1

ANNEX II CALCULATION OF EQUIVALENT CONCENTRATION FOR DIOXINS

II.1 For the determination of total concentration of dioxins and furans, the mass concentrations of the following dibenzodioxins and dibenzofurans shall be multiplied by the following equivalence factors before summing:

		Toxic Equivalence Factor
2,3,7,8 -	Tetrachlorodibenzodioxin (TCDD)	1
1,2,3,7,8 -	Pentachlorodibenzodioxin (PeCDD)	0.5
1,2,3,4,7,8 -	Hexachlorodibenzodioxin (HxCDD)	0.1
1,2,3,6,7,8 -	Hexachlorodibenzodioxin (HxCDD)	0.1
1,2,3,7,8,9 -	Hexachlorodibenzodioxin (HxCDD)	0.1
1,2,3,4,6,7,8 -	Heptachlorodibenzodioxin (HpCDD)	0.01
	Octachlorodibenzodioxin (OCDD)	0.001
2,3,7,8 -	Tetrachlorodibenzofuran (TCDF)	0.1
2,3,4,7,8 -	Pentachlorodibenzofuran (PeCDF)	0.5
1,2,3,7,8 -	Pentachlorodibenzofuran (PeCDF)	0.05
1,2,3,4,7,8 -	Hexachlorodibenzofuran (HxCDF)	0.1
1,2,3,6,7,8 -	Hexachlorodibenzofuran (HxCDF)	0.1
1,2,3,7,8,9 -	Hexachlorodibenzofuran (HxCDF)	0.1
2,3,4,6,7,8 -	Hexachlorodibenzofuran (HxCDF)	0.1
1,2,3,4,6,7,8 -	Heptachlorodibenzofuran (HpCDF)	0.01
1,2,3,4,7,8,9 -	Heptachlorodibenzofuran (HpCDF)	0.01
	Octachlorodibenzofuran (OCDF)	0.001