A GUIDANCE NOTE ON THE BEST PRACTICABLE MEANS

FOR

PETROCHEMICAL WORKS

(POLYMERISATION OF OLEFINS)

BPM 13/1 (99)

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 the specified process and associated processes in which any olefins, derivatives of olefins or mixtures of thereof are polymerised, described as "Petrochemical Works" in Schedule 1 to the Ordinance. "Petrochemical Works" are works in which the processing capacity exceeds 100 tonnes per annum (expressed as total chemical products), and in which

(a) any hydrocarbons are used for the production of olefins or derivatives of olefins; or

(b) any olefins, derivatives of olefins or mixture of thereof are used in any chemical manufacturing process, not being any works described in any other specified process; or

(c) any olefins, derivatives of olefins or mixtures of thereof are polymerised.

2. EMISSION LIMITS

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

2.2 Emissions from the specified process and associated processes as covered by this Note shall not:

(a) exceed the concentration limits set out in Annex I.

(b) appear to be as dark as or darker than Shade 1 on the Ringelmann Chart when compared in the appropriate manner with the Ringelmann Chart or an approved device.

3. FUEL RESTRICTION

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

4. CONTROL ON EMISSIONS

4.1 Emission of air pollutants shall be minimized to prevent:

(a) harm to the environment, adverse effects to human health, or creation of any nuisance situation;

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

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

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

4.2 To satisfy the emission limits set out in Section 2 of this Note, prevention or reduction of emissions at source is the choice. Where the emission is not able to be prevented or reduced at sources to sufficient extents to meet these requirements, air pollution control equipment shall be provided.

4.3 Clean energy sources and fuels with proven benefits to air pollution reduction shall be used whenever possible in the relevant specified process and associated operations. The use of electricity or gaseous fuel for process heating or production of goods is always recommended.

Design of chimney

4.4 Chimney includes vents, structures and openings of any kind from or through which air pollutants may be emitted. The applicant will need to demonstrate that the proposed chimney will provide sufficient dispersion of air pollutants.

4.5 As a general rule, a chimney shall be at least 3 metres above the roof of any building to which it attaches, and any adjacent or attached buildings. However, discrete consideration may be given to some process vents or openings if with well justification.

4.6 Releases to air from chimney shall be directed vertically upwards and not be restricted or deflected by the use of, for example, plates or caps. These include the use of properly designed flame arresters where they are required for operational safety reasons.

4.7 Chimney shall normally be designed for an efflux velocity of not less than 15 m/s at full load condition. If the chimney is coned to obtain the minimum velocity, care is needed to avoid generating excessive positive pressure zones within the chimney unless the chimney wall is impervious or lined. The cones shall be well maintained.

4.8 Chimney flues and ductwork leading to the chimney shall be adequately insulated by materials free of asbestos to minimize the cooling of waste gases and prevent liquid condensation on internal surfaces, and the design should allow for the regular internal cleaning of the chimney flues and ductwork. Where a wet method of arrestment is used to treat process gases, the mean velocity should not exceed 9 m/s within the barrel of the stack with the design of the flue such that the final velocity exceeds 15 m/s.

4.9 Wherever practicable, hot releases should take place from the minimum number of vents in order to obtain maximum advantage from thermal buoyancy, and multiplicity of discharge points should be avoided.

4.10 Emissions from chimney shall be hot enough to avoid visible plume formation in its vicinity. This is to prevent the condensation or absorption of environmentally harmful substances by the condensing water vapour. Exhaust gas from a wet scrubber can be heated by the use of waste process heat to raise the exit temperature of the exhaust gases and prevent immediate condensation on exit from the chimney. This procedure also assists the thermal buoyancy of the plume. Unless there is no available waste heat and the emission contains no significant environmentally harmful substances, this guideline shall be followed for all situations.

Control of process and fugitive emissions

4.11 Means for dealing with polluting emissions from pressure relief systems shall be provided. Such means normally include phase separation where two phase flow is possible, and may include venting to scrubber systems; to flare; to vent; or to an enclosed dump tank. Procedures shall be in place to reduce to a minimum the likely frequency of such emissions. It may be appropriate to have two relief devices in parallel set at different relief pressures. The lower set pressure can allow low emission rates capable of being scrubbed in emergency equipment, whilst the higher set pressure deals with the low probability high flow rate event that cannot be abated and must be released at a sufficient height to promote dispersion and prevent hazardous concentrations at ground level or in buildings and plant structures. Processes must be operated in such a way as to protect the environment as well as persons at work.

4.12 Releases to air from process and cooling water systems and associated treatment plant shall be minimized. Techniques include ensuring that initial contamination is minimized by provision of adequate phase separation facilities, that any intermediate stripping is efficient and enclosed drainage to treatment plant is used.

4.13 The aim shall be to prevent organic and particulate matter emissions to air during plant cleaning, equipment decoking, catalyst regeneration, catalyst discharging and charging operations, and catalyst and sludge disposal. Techniques available include venting and steaming vessels to flare, discharge of vessel contents to enclosed vessels with suitable treatment.

4.14 Vent systems shall be chosen to minimize breathing releases and, where relevant, should be fitted with knock-out pots and appropriate abatement equipment.

4.15 Secondary emissions resulted from the collection and open treatment of wastewater containing volatile organic compounds shall be minimized. Consideration should be given to pre-stripping of the wastewater or use of an enclosed treatment method. Vented vapours should be passed to the fuel gas system, treatment plant or flare.

4.16 All practicable steps shall be taken to prevent the occurrence of a runaway reaction. On the basis that in most cases, one reactant is added at a controlled rate to the full charge of the second reactant, important considerations include:

(a) Operating procedures which ensure that the reaction is properly initiated and under control before the main reactant addition stage, which is often on automatic control, commences.

(b) If initiation of the reaction is known to be a problem, impurities in the feed materials should be minimized.

(c) Limitation of the flow of the input reactant such that the heat of reaction evolved cannot exceed the capacity of the reactor cooling system.

4.17 Safety relief systems shall generally be isolated from routine emission collection systems. In such cases, consideration should be given to the application of appropriate abatement techniques.

4.18 For emergency vent emissions which could have a significant environmental impact, total containment relief systems should be considered. This would require a vent receiver which does not discharge directly to atmosphere and is capable of receiving the complete process gaseous, liquid and solid inventory, taking account of all decomposition products, without itself being overpressurised.

4.19 Emergency relief systems which deal with pyrophoric materials may require a total containment vent receiver maintained under an inert atmosphere. For less significant pyrophoric emergency emissions it may be acceptable to allow discharge to atmosphere directly so long as:

(a) combustion is contained;

(b) combustion products are vented to a safe location; and

(c) emission of combustion products does not have a significant environmental impact.

<u>Thermal incinerator used for the control of waste gases containing organic vapours or for the disposal of organic liquid wastes arising from the specified processes</u>

4.20 The incineration plant shall be capable to destroy waste chemicals at a destruction and removal efficiency of not less than 99.99% and shall achieve a combustion efficiency of not less than 99.9%. Emission from the incineration plant shall be vented to suitable arrestment plant where necessary to meet the emission limits set out in Section 2 of this Note.

4.21 The waste charging system shall be interlocked with the process control system of the incineration plant in order to prevent the addition of waste material to the incinerator if the incinerator is working outside the normal operation regime.

5. OPERATION AND MAINTENANCE

5.1 Best practicable means requirements include not only the provision of the appliances, but the proper operation and maintenance of equipment, its supervision when in use, and the training and supervision of properly qualified staff.

5.2 Equipment shall be repaired as soon as practicable. Specific operation and maintenance requirements shall be specified for individual pieces of equipment used in the specified process.

5.3 Without prejudice to the generality of clause 5.2 of this Note, the licensee shall implement the leak detection and repair programme specified in Appendix 1 to prevent diffuse emissions resulting from equipment leaks.

5.4 Malfunction, breakdown or failure of any process or air pollution control equipment that may result in abnormal emission of air pollutants shall be reported to the Authority by telephone or facsimile as soon as possible, followed by a written report within 3 working days after the incident.

6. MONITORING REQUIREMENTS

6.1 The applicant shall satisfy the Authority that

(a) he will provide the necessary instrumentation, process controls and monitors to demonstrate that the process is being properly controlled;

(b) the scope, manner and monitoring frequency will be sufficient to demonstrate compliance with the terms and conditions imposed to the licence at all times; and

(c) he will have sufficient staff to service these requirements.

Results of all monitoring and inspections shall be recorded in such a manner specified by the Authority. This record shall 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 be made available for examination as and when required by the Authority.

6.2 Indication of the satisfactory of air pollution control equipment shall be provided.

6.3 If it can be demonstrated to the satisfaction of the Authority that the emission of any air pollutant will be minimal, for example due to its absence from the feedstock or demonstrated through sampling, then monitoring and regular measurement may not be required for that pollutant.

7. COMMISSIONING

7.1 Commissioning trials, to be witnessed by the Authority whenever appropriate, shall be conducted to demonstrate the performance and capability of the air pollution control measures. A report of the commissioning trial shall be submitted to the Authority within 1 month after completion of the trial.

ANNEX I CONCENTRATION LIMIT FOR EMISSION FROM PETROCHEMICAL WORKS - POLYMERISATION OF OLEFINS

I.1 Air pollutant emissions from the subject specified process and associated processes covered by this Note shall not exceed the concentration limits specified below:

(a) Non-combustion source

The pollutant concentration is expressed at reference conditions of $0^{o}C$ temperature, 101.325 kPa pressure conditions, without correction for water or oxygen content, and compensated for any effect of dilution air to the concentration.

Air Pollutant	Concentration Limit
Particulates	20 mg/m^3
Volatile organic compounds (excluding particulate matter and expressed as toluene)	80 mg/m^3

(Note: The term 'volatile organic compounds' includes all organic compounds released to air in the gas phase and the concentration limit applies where the total mass emission of volatile organic compounds, expressed as toluene, exceeds 5 tonnes/year or 2 kg/hr, whichever is the lower.)

(b) Thermal incinerator for the control of waste gases containing organic vapours or the disposal of organic liquid wastes

The pollutant concentration is expressed at reference conditions of $0^{o}C$ temperature, 101.325 kPa pressure, dry and 11% O_2 content conditions.

Air Pollutant	Concentration Limit
Particulates	20 mg/m^3
Nitrogen oxides (expressed as nitrogen dioxide)	350 mg/m^3
Volatile organic compounds (excluding particulates and expressed as total organic carbon)	20 mg/m^3

Appendix 1 LEAK DETECTION AND REPAIR PROGRAMME FOR THE CONTROL OF FUGITIVE EMISSION OF VOLATILE ORGANIC CHEMICALS FROM PROCESS EQUIPMENT

1. GENERAL

1.1 Equipment that complies with the following requirements can be exempt from the instrumental leak monitoring requirements set out in this appendix:

(a) equipment in vacuum service, that is, at an internal pressure at least 5 kPa below ambient pressure; or

(b) equipment contains or contacts less than 300 hours per calendar year a fluid of organic content greater than 5%.

1.2 The leak detection tests mentioned in this appendix should be conducted in accordance with the methods set out in the United States Environmental Protection Agency Reference Method 21, or other methods accepted by the Authority.

1.3 The instrument used for the conduct of the leak detection tests mentioned in this appendix should conform to the specifications set out in Appendix 2, or other specifications accepted by the Authority.

1.4 The leak definition concentrations specified in this appendix are based on the response of the instrument calibrated by methane or n-hexane in air. The instrument can be calibrated by another compound accepted by the Authority if a conversion factor is determined for that alternative compound so that the resulting meter readings during source measurements can be converted to methane or n-hexane results.

1.5 An equipment is in gas/vapour service if it contains a gas or vapour at operating conditions.

1.6 An equipment is in light liquid service if it contains a liquid that meets the following conditions:

(a) The vapour pressure of one or more of the organic constituents is greater than 0.3 kPa at 20^{o}C;

(b) The total concentration of the pure organic constituents having a vapour pressure greater than 0.3 kPa at 20^{o}C is not less than 20% by weight of the total process stream; and

(a) The fluid is a liquid at operating conditions.

1.7 An equipment is in heavy liquid service if it is not in gas/vapour service or light liquid service.

2. REQUIREMENTS FOR COMPRESSORS

2.1 Each compressor should be checked weekly by visual inspection for liquid dripping from the seal.

2.2 Each compressor should be monitored monthly to detect leak.

2.3 A leak is detected if:

(a) any indication of liquid dripping from the seal; or

(b) the instrument reading exceeds 500 ppmv.

2.4 When a leak is detected, the compressor concerned should be repaired as soon as practicable and in any case, should not be later than 15 calendar days after the leak is detected.

Exemption from instrumental leak monitoring

2.5 Compressors that comply with the following requirements can be exempt from the instrumental leak monitoring programme:

(a) Compressors that are equipped with seal systems which include a barrier fluid system that satisfies the following requirements:

(i) The compressor seal system is operated with the barrier fluid at a pressure that is at all times greater than the compressor stuffing box pressure; or equipped with a barrier fluid degassing reservoir that is connected by a closed-vent system to a control device of efficiency greater than 95%; or equipped with a closed-loop system that purges the barrier fluid directly into a process stream;
(ii) The barrier fluid is not in light liquid service; and
(iii) The barrier fluid system is equipped with a sensor, which is observed daily or equipped with an alarm, that will detect failure of the seal system and/or the barrier fluid system.

(b) Compressors that are equipped with closed-vent system capable of capturing and transporting any leakage from the seal to a control device of efficiency greater than 95%.

3. REQUIREMENTS FOR PUMPS IN LIGHT LIQUID SERVICE

3.1 Each pump should be checked weekly by visual inspection for liquid dripping from the seal.

3.2 Each pump should be monitored monthly to detect leak.

3.3 A leak is detected if:

(a) any indication of liquid dripping from the seal; or

(b) the instrument reading exceeds 5,000 ppmv for pumps handling styrene monomer and 1,000 ppmv for pumps handling other light liquid.

3.4 When a leak is detected, the pump concerned should be repaired as soon as practicable and in any case, should not be later than 15 calendar days after the leak is detected.

3.5 A quality improvement programme should be implemented if calculated on a six-month rolling average, more than 10% of the pumps or more than three pumps leak.

Exemption from instrumental leak monitoring

3.6 Pumps that comply with the following requirements can be exempt from the instrumental leak monitoring programme:

(a) Pumps that are equipped with dual mechanical seals which include a barrier fluid system that satisfies the following requirements:

(i) The barrier fluid system is operated with the barrier fluid at a pressure that is at all times greater than the pump stuffing box pressure; or equipped with a barrier fluid degassing reservoir that is connected by a closed-vent system to a control device of efficiency greater than 95%; or equipped with a closed-loop system that purges the barrier fluid into a process stream;
(ii) The barrier fluid is not in light liquid service; and
(iii) The barrier fluid system is equipped with a sensor, which should be observed daily or equipped with an alarm, that will detect failure of the seal system and/or the barrier fluid system.

(b) Pumps without externally actuated shaft penetrating the pump housing.

4. REQUIREMENTS FOR VALVES IN GAS/VAPOUR SERVICE AND IN LIGHT LIQUID SERVICE

4.1 Each valve should be monitored for leak at frequencies specified below:

(a) Monthly if the percentage of leaking valves calculated on a monthly rolling basis is greater than 2%;

(b) Quarterly if the percentage of leaking valves calculated on a monthly rolling basis is greater than 1% but less than 2%;

(c) Semiannually if the percentage of leaking valves calculated on a monthly rolling basis is greater than 0.5% but less than 1%;

(d) Annually if the percentage of leaking valves calculated on a monthly rolling basis is less than 0.5%; and

(e) Annually if the valve cannot be monitored without elevating the monitoring personnel more than two metres above a support surface.

4.2 A leak is detected if the instrument reading exceeds 500 ppmv.

4.3 When a leak is detected, the valve concerned should be repaired as soon as practicable and should not be later than 15 calendar days after the leak is detected unless a plant shutdown is necessary. In that case, the repair should be carried out in the next scheduled plant shutdown.

Exemption from instrumental leak monitoring

4.4 Valves that are unsafe to monitor can be exempt from the instrumental leak monitoring programme but should be monitored as frequent as practicable during safe-to-monitor times.

4.5 Valves that are operated at a frequency less than once per week can alternatively be monitored for leak at frequencies specified in section 5 herein.

5. REQUIREMENTS FOR CONNECTORS IN GAS/VAPOUR SERVICE AND IN LIGHT LIQUID SERVICE

5.1 Each connector should be monitored for leak at frequencies specified below:

(a) Annually if the percentage of leaking connectors found from initial checking is greater than 0.5% or if the percentage of leaking connectors found from quadrennial checking is greater than 1%;

(b) Biennially if the percentage of leaking connectors found from initial checking is less than 0.5% or if the percentage of leaking connectors found from quadrennial checking is greater than 0.5% but less than 1 percent; and

(c) Quadrennially if the percentage of leaking connectors found from biennial checking is less than 0.5%.

5.2 A leak is detected if an instrument reading exceeds 500 ppmv.

5.3 When a leak is detected, the connector concerned should be repaired as soon as practicable and should not be later than 15 calendar days after the leak is detected unless a plant shutdown is necessary. In that case, the repair should be carried out in the next scheduled plant shutdown.

Exemption from instrumental leak monitoring

5.4 Connectors that comply with the following requirements can be exempt from the instrumental leak monitoring programme:

(a) Inaccessible connectors that are either:

(i) buried;
(ii) insulated in a manner that prevents access to the connector by a monitor probe;
(iii) obstructed by equipment or piping that prevent access to the connector by a monitor probe; or
(iv) unable to be reached from a 7.6-metre portable scaffold on the ground, and is more than two metres above a support surface.

(b) Glass or glass-lined connectors.

(c) Screwed connectors of 50.8 millimetres or less but they should be monitored for leaks if:

(i) evidence of a potential leak is found; or
(ii) within the first three months after being returned to organic service after having been opened or have the seal broken.

6. REQUIREMENTS FOR PRESSURE RELIEF DEVICES IN GAS/VAPOUR SERVICE

6.1 No emission of volatile organic compounds should be released from any relief device to the atmosphere below the design safety release pressure of the device. Except during pressure release, each pressure relief device in gas/vapour service should be operated without leaks, that is, with an instrument reading of less than 500 ppmv.

6.2 When a leak is detected, the pressure relief device concerned should be repaired as soon as practicable but in any case, should not be later than 15 calendar days after the leak is detected.

6.3 After each pressure release, the pressure relief device concerned should be returned to the condition indicated by an instrument reading of less than 500 ppmv as soon as practicable and in any case, should not be later than 5 calendar days after the pressure release.

7. REQUIREMENTS FOR PUMPS, VALVES AND CONNECTORS IN HEAVY LIQUID SERVICE; AND PRESSURE RELIEF DEVICES IN LIQUID SERVICE

7.1 Pumps, valves and connectors in heavy liquid service, and pressure relief devices in either heavy or light liquid service should be monitored for leak within 5 calendar days if evidence of a potential leak is found.

7.2 A leak is defined if the instrument reading exceeds:

(a) 1,000 ppmv for pumps; and

(b) 500 ppmv for valves, connectors and pressure relief devices.

7.3 When a leak is detected, the equipment concerned should be repaired as soon as practicable and should not be later than 15 calendar days after the leak is detected unless a plant shutdown is necessary. In that case, the repair should be carried out in the next scheduled plant shutdown.

Appendix 2 SPECIFICATIONS FOR THE INSTRUMENT FOR LEAK DETECTION

1. DEFINITIONS

1.1 'Response Factor' means the ratio of the known concentration of a volatile organic compound to the observed meter reading when measured using an instrument calibrated with the specified reference compound.

1.2 'Response Time' means the time interval from a step change in volatile organic compound concentration at the input of the sampling system to the time at which 90% of the corresponding final value is reached as displayed on the instrument readout meter.

1.3 'Calibration Precision' means the degree of agreement between measurements of the same known value, expressed as the relative percentage of the average difference between the meter readings and the known concentration to the known concentration.

2. PERFORMANCE SPECIFICATIONS

2.1 Response factor should be less than 10 unless correction curve is used.

2.2 Response time should be less than 30 seconds.

2.3 Calibration precision should be less than or equal to 10% of the calibration gas value.

3. ADDITIONAL REQUIREMENTS

3.1 The instrument should respond to the compounds being processed, which is determined by the response factor.

3.2 The instrument should be capable of measuring the leak definition as specified.

3.3 The scale of the instrument should be readable to + 5% of the specified leak definition concentration.

3.4 The instrument should be equipped with a pump so that a continuous sample is provided at a nominal flow rate of between 0.0005 and 0.003 cubic metres per minute.

3.5 The instrument should be intrinsically safe for operation in explosive atmospheres.