



**A GUIDANCE NOTE ON  
THE BEST PRACTICABLE MEANS  
FOR  
IRON AND STEEL WORKS  
(ELECTRIC ARC FURNACE)**

**BPM 9/3 (09)**

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 for the melting of a ferrous metal by an electric arc furnace for casting - described as "Iron and Steel Works" in Schedule 1 to the Ordinance. Iron and Steel Works are works in which the installed furnace capacity exceeds 1 tonne, or, if the mode of operation is continuous, 1 tonne per hour, and in which a ferrous metal melting process for casting is carried out.

## **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 OF 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 out; 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 cannot be prevented or reduced at source to a sufficient extent to meet these requirements, air pollution control equipment shall be provided. For effective control of dioxins, one should make reference to the latest emission management technologies for Secondary Steel Production 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 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. They shall be properly located and designed so as to satisfy the requirements set out in paragraph 4.1 above.
- 4.5 For chimney serving the fume control systems of the electric arc furnace(s), their height 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.
- 4.6 A chimney shall be at least 3 metres above the roof of any building to which it attaches and above the roof of any adjacent buildings.
- 4.7 Emissions from chimney shall be directed vertically upwards and not restricted or deflected by the use of, for example, plates or rain caps.

- 4.8 For combustion process, the flue gas exit temperature shall not be less than the acid dew point; and in any case, it shall not be less than 80°C. In order to obtain maximum thermal buoyancy, hot emissions shall as far as practicable be discharged from the minimum number of chimneys, i.e., a multi-flue chimney design shall be used.

Material Handling

- 4.9 Handling and storage of fuel, raw material, products, wastes or by-product shall be carried out in such a manner to prevent the release of:
- (a) visible dust emissions;
  - (b) emissions of organic vapours; and/or
  - (c) other noxious or offensive emissions.
- 4.10 Dusty or potentially dusty materials shall be handled in a totally enclosed system, and the dust laden exhaust shall be treated by properly designed dust collecting equipment such as bag filter. Purpose-built silo shall be used for the storage of dusty materials whenever practicable.

Ferrous Metal Melting

- 4.11 A properly designed and effective fume control system shall be provided, operated and maintained to contain and collect primary<sup>1</sup> and secondary<sup>2</sup> off-gases which are subsequently cleansed by suitable air pollution control equipment to meet the emission limit set out in Section 2 of this Note before discharging. A typical design shall comprise a furnace enclosure in the form of a “doghouse” or other suitable installations with performance demonstrated to be as effective or better than the former in collecting and containing off-gases from the furnace(s), and in combination with effective local exhaust systems to control releases from major emitting sources/processes including, but are not limited to, charging and tapping operations.
- 4.12 Fume control system including furnace enclosures, casting, ductwork and ancillary equipment shall be made and maintained as gas-tight as is practicable. If a “doghouse” is provided, its roof bi-parting doors and all side doors shall be closed during the iron melting/refining, slagging and molten steel tapping processes in such a manner that no visible emission escapes from any leaks or openings. Whenever any roof bi-parting door or side door is not fully closed, air curtain jets shall be provided and activated to seal the opening of the “doghouse” enclosure.

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1 Primary off gases include off gas directly collected from the Electric Arc Furnace and secondary metallurgy processes

2 Secondary off gases from scrap handling and charging, steel tapping, secondary metallurgy with tapping operations and from continuous casting

- 4.13 Emissions from charging operations shall be prevented by careful selection of scrap and its introduction to the furnace. Metallic charge shall be clean, uncontaminated by grease, non-ferrous metals or non-metallic matters.
- 4.14 Suitable energy recovery facilities shall be installed and maintained for preheating the scrap by utilizing part of the sensible heat in the furnace off gas.

## **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 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 when the electric arc furnace or other associated processes are in operation.
- 5.3 Operating staff shall be properly trained in their duties relating to control of the process and emissions to air. 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, all practicable means (including refraining from using the defective furnace(s)) shall be taken to minimize the abnormal emission.

## **6. FUGITIVE EMISSION CONTROL**

### **6.1 Boundary Ambient Standards**

The 24-hour ambient levels of suspended particulates shall not exceed the relevant Hong Kong Air Quality Objectives except the exceedances are caused mainly by other sources (e.g. heavy traffic, nearby construction works, etc.) beyond its premises.

- 6.2 A high standard of housekeeping shall be maintained. Adequate provision shall be made for the containment of liquid and solid spillages. All spillages shall be cleared as soon as possible. Solid materials have to be cleaned by vacuum machines or other appropriate method. Dry sweeping of any sizable spillages shall not be permitted.
- 6.3 Traffic areas, including roads and areas with regular vehicle movements, shall be paved with a suitable roadway covering and be kept clean constantly by means of sweeping machines or other facilities.

- 6.4 External surfaces of the process building, ancillary plant and open yards and storage areas shall be regularly cleaned to prevent the accumulation of dusty material in circumstances where the dust may become wind entrained. Particular attention shall be paid to roofs, guttering, roadways, external storage areas and yards.
- 6.5 Cleaning operations shall be carried out by methods which minimize emissions of particulates to air, for example by vacuum machines, wet mopping or other appropriate techniques.

## **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 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 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 pollution control system for the foregoing operations shall be monitored and recorded continuously or periodically:
- (a) Continuous Monitoring
    - In-stack particulate levels of process / waste gas or other surrogate parameter(s) acceptable to the authority
  - (b) Periodic Measurement
    - Periodic measurements of particulates, hydrogen fluoride, carbon monoxide, gaseous and vaporous organic substances, heavy metals and dioxins shall be made to confirm the compliance with the emission limits set out in Annex I. The testing frequency shall 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 within reasonable time(s) to be agreed with the Authority after the source sampling(s) as required is/are completed.
- 7.3 Ambient monitoring shall be made for total suspended particulates and/or respirable suspended particulates, if required by the Authority, in such a manner and at such locations and frequency specified by the Authority.

- 7.4 The monitoring equipment to be used shall meet the specifications specified by the Authority. They shall be maintained and calibrated according to the manufacturer's recommendations. Unless otherwise agreed by the Authority, zero and span checks shall be carried out every 24 hours and recorded.
- 7.5 Indication of satisfactory performance of air pollution control equipment shall be provided. Continuous monitoring of essential operating parameter that may significantly affect the emission of air pollutants, such as volumetric flow of fume extraction system(s) or pressure drop across filters, shall be displayed.
- 7.6 Appropriate instrumentation shall be installed to monitor the performance of fume control system(s) including the fume extraction device and dust control equipment. It shall be fitted with audible and visual alarms with trigger levels for activation agreeable to the Authority. Emission events that lead to the alarms being activated shall be properly recorded in such manner and format agreed with the Authority. These instruments shall be checked regularly to ensure that they are functioning correctly in accordance with the manufacturer's instructions.

## **8. COMMISSIONING**

- 8.1 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. Unless otherwise agreed by the Authority, the 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 IRON AND STEEL WORKS – ELECTRIC ARC FURNACE

I.1 Air pollutant emissions from the subject specified process and associated processes covered by this Note shall not exceed the concentration limits tabulated in the tables below. The air pollutant concentration is expressed at reference conditions of 0°C temperature, 101.3 kPa pressure unless specified otherwise. Introduction of diluted air to achieve the emission concentration limits shall not be permitted.

(a) Metal Melting Process

(i) Daily Average Value

| <b>Air Pollutant</b> | <b>Concentration Limit<br/>(mg/m<sup>3</sup>)</b> |
|----------------------|---|
| Carbon monoxide      | 100   |

(ii) Hourly Average Value

| <b>Air Pollutant</b>                 | <b>Concentration Limit<br/>(mg/m<sup>3</sup>)</b> |
|--------------------------------------|---|
| Particulates                         | 10  |
| Carbon monoxide                      | 200   |
| Fluorides as hydrogen fluoride       | 5   |
| Nitrogen oxides as NO <sub>2</sub>   | 50  |
| Volatile organic compounds as carbon | 20  |

- (iii) Average value over the sampling period of standard test method(s) approved by the Authority

| <b>Air Pollutant</b>   | <b>Concentration Limit (mg/m<sup>3</sup>)</b> |
|--|---|
| Cadmium and its compounds as cadmium   | 0.05  |
| Heavy metals <sup>1</sup>  | Total 0.5                                     |
| Mercury and its compounds as mercury   | 0.05  |
| Polychlorinated dibenzodioxins and polychlorinated dibenzofurans<br>(see Annex II for the calculation of equivalent concentration) | 0.1ng I-TEQ/m <sup>3</sup>                    |

(b) Associated Fuel-using Equipment

(i) Daily Average Value

| <b>Air Pollutant</b>               | <b>Concentration Limit (mg/m<sup>3</sup>)</b> |
|------------------------------------|---|
| Nitrogen oxides as NO <sub>2</sub> | 400   |
| Particulates                       | 50  |

*(Note: Concentration of pollutants is expressed at reference conditions of 0°C temperature, 101.3 kPa pressure, 3% O<sub>2</sub> and dry gas.)*

*For controlling NO<sub>x</sub> emission from combustion processes, the use of primary reduction techniques such as low-NO<sub>x</sub> technology in process operation is in preference to secondary treatment techniques.)*

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<sup>1</sup> Total heavy metals include the following metals and their compounds: Antimony (Sb), Arsenic (As), Lead (Pb), Chromium (Cr), Cobalt (Co), Copper (Cu), Manganese (Mn), Nickel (Ni) and Vanadium (V)

(c) Other Processes

(i) Hourly Average Value

| <b>Air Pollutant</b> | <b>Concentration Limit<br/>(mg/m<sup>3</sup>)</b> |
|----------------------|---|
| Particulates         | 10  |

## ANNEX II CALCULATION OF EQUIVALENT CONCENTRATION FOR DIOXINS

II.1 For the determination of the 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:

|                 |                                  | <u>Toxic Equivalence Factor</u> |
|-----------------|----------------------------------|---------------------------------|
| 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                           |