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**Hong Kong Special Administrative Region**
**Environmental Protection Department**
**Agreement No. CE 1/2007 (EP)**

# Study of Major Industrial Air Pollution Sources in the Pearl River Delta Region - Feasibility Study

## Summary Report

**January 2014**

Hong Kong Special Administrative Region
Environmental Protection Department

**Agreement No. CE 2/2007 (EP)**

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## Acknowledgement

We are thankful for the project team’s concerted efforts in completing this study, and especially, Guangdong Provincial Environmental Monitoring Center’s support and expertise. Also, participation of various enterprises in this study is gratefully acknowledged.

## Remarks

This report summarized the results found in Hong Kong SAR. Detailed results of the Pearl River Delta Economic Zone are not contained based on the agreement with Guangdong government.

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# 1 INTRODUCTION

## 1.1 Background

1.1.1 In the past two or three decades, the Pearl River Delta Economic Zone and the Hong Kong Special Administrative Region (hereafter referred to as “PRD region”) has experienced a rapid economical development resulting in wide-spread industrialization and urbanization. With the rapid growth of per capita GDP, the air pollutants emitted in the PRD region has significantly increased, which has a profound impact on the regional air quality. Meanwhile, the promulgation and implementation of Guangdong "double transfer (雙轉移)" policy (industry transfer and labour force transfer), not only contributes to the upgrading and optimization of both economic and industrial structure in the PRD region, but also brings opportunities to improve environment and air quality in the PRD region.

1.1.2 Regional and urban monitoring data show that the air pollution index of the PRD region was significantly higher than that of the surrounding areas in recent years. Respirable particulate matter ($PM_{10}$) and ozone concentrations remain at high level. This couples with very serious acid rain pollution and regional haze shows a deteriorating trend in the entire Pearl River Delta Region.

1.1.3 Recent study reports showed that power generation and other industrial sectors are the main contributors of sulfur dioxide ($SO_2$), nitrogen oxides (NOx) and respirable particulate matter (RSP/$PM_{10}$) emissions of all the air pollution sources, while volatile organic compounds (VOC) emission is one of the precursors causing photochemical pollution. VOC is mainly emitted from mobile source, industrial production activities and natural source.

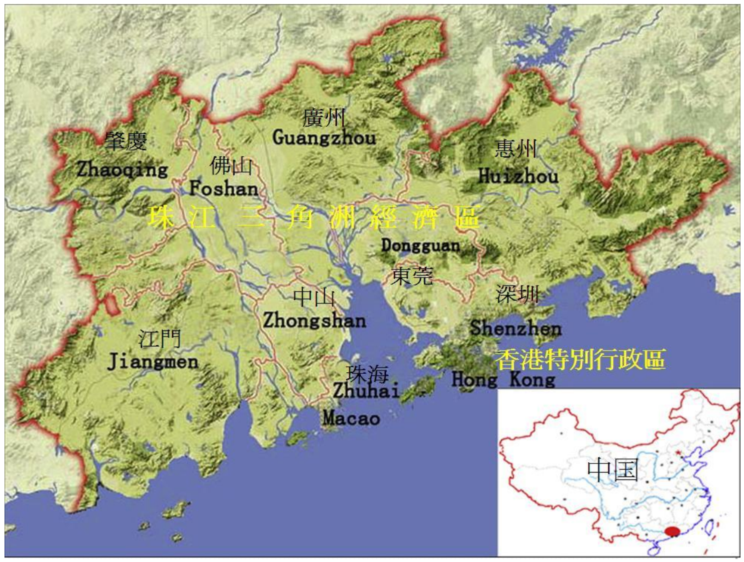
1.1.4 The Environmental Protection Department of the Hong Kong Special Administrative Region Government and the Guangdong Provincial Environmental Protection Department (formerly Guangdong Environmental Protection Bureau) have agreed to carry out study of major industrial air pollution sources in the Pearl River Delta Region, designed to help the two governments to introduce further measures to improve regional air quality. On 18 October 2007, the Hong Kong Environmental Protection Department (HKEPD) commissioned AECOM Asia Co. Ltd. (AECOM, formerly ENSR Asia (HK) Ltd (ENSR)) to conduct Study of Major Industrial Air Pollution Sources in the Pearl River Delta Region – Feasibility Study (Agreement No. CE 1/2007 (EP), hereinafter called “the study”). The team members and technical experts included Guangdong Provincial Environmental Monitoring Centre, College of Environmental Sciences and Engineering of Peking University and Professor Junyu ZHENG (School of Environmental Science and Engineering of South China University of Technology). Professor Tao WANG (The Hong Kong Polytechnic University) was appointed as an independent specialist.

1.1.5 The main objective of the study is to identify and characterise the emission characteristics of typical major industrial air pollution sources in the Pearl River Delta Region. Results from this study have served as an important source of reference in supporting the formulation of short- and long-term air pollution control strategies in the PRD region (in particular the regional smog control strategy). This study also facilitates the technical exchange and corporation with the mainland academia in air pollution control. The study included extensive site survey and source measurement, and data were analyzed using bottom-up approach from sub-sectors of industrial air pollution sources in the PRD region. This study also resembled the first comprehensive review on major industrial air pollution control technology and typical industrial VOC sources research. The results of this study not only fill gaps in the regional industrial air pollution sources, but also provide technical information for governments to develop air quality improvement programme. In addition, the study also further promotes the academic exchanges among the community of the Pearl River Delta Regional Air Quality Research.

## 1.2 Study Area

1.2.1 The study area covers the Pearl River Delta Economic Zone and the Hong Kong Special Administrative Region, collectively referred to as the Pearl River Delta region. The study area of the Pearl River Delta Economic Zone includes Guangzhou, Shenzhen, Zhuhai, Dongguan, Zhongshan, Jiangmen, Foshan, Huizhou and Zhaoqing (See Figure 1).

**Figure 1 Study Area**




(source: Zheng et al., 2009[1])

## 1.3 Objectives

1.3.1 The targets of the study are major industrial air pollution sources, i.e. major industrial processes and facilities which would emit $SO_2$, $NO_x$, $PM_{10}$ and VOC during the industrial activities in the PRD region. These major industrial air pollution sources not only include the combustion processes and operational processes of the industrial activities, but also include solvent usage and oil storage and other emission sources, etc. Fugitive emissions, however, may not be fully addressed. While this study would examine the industrial activity data and emission factors etc. for major industrial sources, the scope of work does not cover the compilation of regional emission inventory.

# 2 STUDY TASKS AND METHODOLOGY

## 2.1 Methodology

2.1.1 The study tasks and related methodology included (1) Literature Review such as relevant policies, regulations and research reports on air pollution in the PRD region. (2) Identify major industrial pollution sources in the PRD region making reference to the Guangdong Provincial Environmental Statistics and datasets of

[1]Zheng, J., Zhang, L., Che, W., Zheng, Z., and Yin S., 2009. A highly resolved temporal and spatial air pollutant emission inventory for the Pearl River Delta region, China and its uncertainty assessment. Atmospheric Environment 43: 5112–5122.

Hong Kong Specified Process in 2006 and compiled an initial list of industrial pollution sources (facilities) of the PRD region with respect to the emissions of $SO_2$, NOx and $PM_{10}$. (3) Characterize $SO_2$, NOx and $PM_{10}$ emissions from these pollution sources were estimated. In addition, with reference to the quality assurance / quality control (QA/QC) manuals for emission inventory edited by US EPA (AP42), QA/QC procedures were established. The base year of the study is 2006, and supplemented with the latest information.

2.1.2 In addition, this study included an investigation of typical industrial VOC sources in the PRD region to help identify and characterize the sources of regional photochemical ozone formation.

## 2.2 Characterisation of major industrial pollution sources and application of control technology

2.2.1 From the review of major industrial air pollution sources and nine typical industrial VOC pollution sources in the PRD region in 2006, representative enterprises were selected after consideration of industry type, production scale, operating procedures, control technologies applied and geographical distribution, etc. Some industrial sectors with rapid development in recent years were also selected, such as waste incineration power generation and container manufacturing. According to the contract requirements, a total of more than 150 enterprises have been selected for survey. The data from these enterprises, such as the main industrial activity in 2007, production and operational processes, air emissions, were collected to calculate the air emissions ($SO_{2,}$ $NO_X$, and $PM_{10}$) with respect to the production or fuel consumption. Comparison of the calculation results to the domestic and international authoritative reference (such as the handbook for first census on national pollution sources in China and U.S. AP42) and analysis of applied control technology were made to characterize the major industrial pollution sources and application of control technology.

## 2.3 Characterisation of emissions from major industrial polluting facilities and operation processes

2.3.1 Based on the selected and ascertained enterprises, with consideration of representativeness of type of industry, production scale, operational procedures and control technology, technical guidelines issued by the State General Administration of Quality Supervision, Inspection and Quarantine and the Ministry of Environmental Protection of China, $SO_2$, NOx and particulate matter monitoring were conducted. Comparative analyses on the measurement results were conducted to characterise emissions from major industrial polluting facilities and operation processes.

## 2.4 Review of industrial air pollution control technology

2.4.1 Through review on the latest development of air pollution control technology in the Mainland and overseas to identify the available control technologies suitable for major industrial air pollution facilities and operating processes in the PRD region.

## 2.5 Identification of available options for control technology and technical guideline

2.5.1 Based on the identified control technologies applicable to major industrial air pollution sources in the PRD region, with reference to air emission standards and technical code issued by governments and with consideration of new and existing polluting facilities, Analytic Hierarchy Process was employed, along with consultation with representatives from power plant, cement and printing industries, to identify the available control technologies for different major industries. Meanwhile, according to the industrial air pollution control policies and regulations issued by governments and relevant technology authorities, the options for available control technology and technical guideline were consolidated for reference.

# 3 KEY FINDINGS OF THE STUDY

## 3.1 Major industrial pollution sources

3.1.1 Based on the information found in 2006, 16 types of industrial sectors could be classified, including power plants. This list did not include VOC industrial emission sources, nor solvent use in typical VOC industrial emission sources, such as printing and spray painting.

3.1.2 Based on the information, power industry topped $SO_2$ and $NO_x$ emissions (about 60% and 75% respectively), followed by non-metallic mineral product manufacturing, paper and pulps industry and light industry manufacturing (comprised of about 10% each for $SO_2$ and 15% in total for NOx). The industrial sector with the highest $PM_{10}$ emission in 2006 was non-metallic mineral product manufacturing (about 40%), followed by power industry (about 30%), paper and pulps industry and light industry manufacturing.

3.1.3 When comparing the emission inventory of Guangdong and Hong Kong between year 2003 and year 2006, the major industrial sectors of air pollution emissions in the PRD region did not change much, only the contribution of emission from these major industrial sectors has changed. For example, the percentage of $SO_2$ emission from power industry has declined, and percentage of $PM_{10}$ emission from non-metallic mineral product manufacturing industry has also decreased significantly. This could be attributed to the implementation of air pollution control policies to related industries and adjustment of industrial structure by the Government.

3.1.4 According to the selection criteria of major industrial air pollution sources, there were slightly over one thousand major industrial air pollution sources identified in the PRD region in 2006. The top five industrial sectors with large $SO_2$, NOx and $PM_{10}$ emissions included power industry, paper and pulps industry, light industry manufacturing, non-metallic mineral product manufacturing and oil refining industry.

## 3.2 Typical industrial VOC pollution sources

3.2.1 Typical industrial VOC pollution industries include automobile manufacturing (mainly car production), printing, furniture manufacturing (mainly wooden furniture production industry), footwear manufacturing, electronics manufacturing (mainly printed circuit board industry), oil transportation and storage (oil depots and gas stations), toy manufacturing, paint manufacturing and petrochemical and refining industries. Observations are briefly summarized below.

3.2.2 The major VOC emission sources from nine typical industrial sectors included coating / painting, usage and cleaning of organic solvents, handling and storage of oil products, operational process and fugitive emission of pipelines and so on.

3.2.3 In order to control VOC emissions, Hong Kong, Mainland China (e.g. Guangdong) and overseas have established local or national VOC content limits on coatings of automotive manufacturing industry, printing inks, adhesives and coatings of furniture industry, adhesives of footwear manufacturing, paints of toy manufacturing, exterior and interior wall coatings produced by coatings industry respectively.

3.2.4 Standards are also set up to control VOC emissions from operational processes in these typical industrial sectors, including printing, automotive, footwear manufacturing and furniture industry in Guangdong and other Mainland provinces.

3.2.5 Both cleaner production and end-of-pipe technology are effective ways to control VOC emissions. It was observed during on-site visit that the end-of-pipe control technology are effectively installed in large-scale plants, such as petrochemical factories, while cleaner production measures would be a more efficient approach to prevent VOC emission from small-scale factories, including printing company and furniture factory.

3.2.6 Regarding end-of-pipe control technology, Regenerative Thermal Oxidizer (RTO) was employed in automobile manufacturing industry whereas vapour recovery system could be installed in oil depots and gas stations. Other VOC emission control technologies included activated carbon adsorption, catalytic combustion and regenerative thermal oxidizer technology.

## 3.3 Characteristics of major industrial pollution sources

3.3.1 Site surveys have been carried out including power plants (almost half of them are coal-fired power plants), non-metallic material (e.g. cement, ceramics, glass, brick etc.) production plants, light industry manufacturing plant, large point sources (comprise of steel and iron, refinery and petrochemical plants) and VOC emitting industrial plants. The VOC emitting plants include nine typical VOC pollution industries and two fast-growing industries - household electrical appliances and container manufacturing industry.

3.3.2 Through the survey, air emissions (including $SO_2$, NOx, $PM_{10}$ and VOC) per unit production or fuel consumption in 6 major industries (including 10 sub-industries) covering 19 different kinds of production techniques and 20 different types of polluting facilities (including boilers, industrial furnaces, etc.) are analysed and calculated. From the overall trends of temporal air pollutant emissions, we can find that all these industries always have the lowest emissions in February, while their emission peaks varied.

3.3.3 Overall, in order to control $SO_2$ emissions, in addition to using low sulfur fuels (such as low-sulfur coal or natural gas, etc.), various industrial sectors have generally installed flue gas desulphurization facilities, among which the mainstream technology is limestone-gypsum wet method, whose performance efficiency generally ranged from 80% to 95%; for control of particulate matter emissions, electrostatic precipitation technology is often used in the power plant (with removal efficiency of more than 99%), while fabric filter or bag house are normally applied in cement and ceramic industries, which could achieve removal efficiency of more than 85%. In light industry, wet scrubbing method with more than 90% efficiency is utilized to remove particulate matter. It is found that low NOx combustion technology is already used in power plant in the PRD region, while Selective Catalytic Reduction (SCR) or Selective Noncatalytic Reduction (SNCR) facilities with integrated efficiency up to 80% are installed in a few power plants, petrochemical and gas production plants to control their NOx emission. However in other industry sectors, it is observed from site survey that almost no NOx control measures have been taken.

3.3.4 In the nine typical industrial VOC emission sources in the PRD region, coating and solvent use are major sources of VOC emissions, while petrochemical and chemical industry processes and pipeline transportation, etc., also generated VOC emissions. Some VOC control technologies have been observed in these industrial sources, including activated carbon adsorption, catalytic combustion and regenerative thermal oxidizer technology, with average control efficiency of more than 80%; also cleaner production measures or advanced operational processes have been adopted to reduce VOC emissions.

3.3.5 Air pollutants ($SO_2$, NOx, $PM_{10}$ and VOC) emissions per unit of product or unit fuel consumption in each industry were calculated and compared with domestic and international authoritative references. Comprehensively, it could be found that due to wide adoption of desulphurization in major industrial air pollution sources in the PRD region, $SO_2$ emissions per unit of production or fuel consumption are close to domestic and international reference data, but a small number of oil fired plants have higher $SO_2$ emission data resulted from high sulfur content in fuel or without desulfurization equipment. In ceramic industry, a variety of fuels are utilized to control $SO_2$ emissions, but the emission data are still higher than overseas data because natural gas is commonly used in other countries. Similarly, the widespread installation of the dust removal equipment resulted in $PM_{10}$ emissions per unit of production or fuel consumption relatively close to domestic and international reference data; however, non-metallic products manufacturing industry still has higher $PM_{10}$ emission data than that of U.S. and Europe. In terms of NOx emissions, though control measures are generally not taken in the PRD region, low calorific value of coal and wide employment of circulating fluidized bed boiler characteristic of low-temperature combustion resulted in lower NOx emission data than overseas.

3.3.6 Comparison of air emissions per unit of product and fuel consumption between different industrial sectors and operation processes shows that cement, ceramics and glass industry has presented the typical features of air pollution with high air emission per energy consumption on the whole. $SO_2$ and particulate matter emissions per unit energy consumption in steel and iron industry are relatively higher.

3.3.7 The coal-fired and oil-fired power plants had higher emission of air pollutants per unit of energy consumption than gas-fired units; $SO_2$, NOx and $PM_{10}$ emission per unit energy consumption in oil-fired power plants were significantly higher than that of coal-fired power plants. Since LNG is a kind of clean energy, energy consumption per unit emissions of air pollutants of gas-fired power plant was significantly lower than those of coal-fired and oil-fired power plants.

3.3.8 In cement industry, $SO_{2,}$ NOx and $PM_{10}$ emissions of per unit of energy consumption from new dry process were significantly lower than from the traditional vertical kiln, which fully reflected the advance of the operational technology.

3.3.9 Similarly in glass manufacturing process, the new float glass production process has lower $SO_2$ and NOx emissions of per unit of energy consumption than conventional glass production process, but the difference between their $PM_{10}$emissions of per unit of energy consumption is minimal.

3.3.10 In architectural ceramics industry, roller kiln has significantly higher $SO_2$ and NOx emissions per unit of energy consumption than the spray-drying tower; however, their $PM_{10}$emissions per unit of energy consumption are similar.

3.3.11 For the industrial boiler of paper and pulps manufacturing and light manufacturing industry, air emissions per unit of energy consumption from circulating fluidized bed boilers were at a lower level compared to the pulverized coal boilers and grate stoker boilers.

### 3.4 Emission characteristics of major industrial pollution sources

3.4.1 Source measurements have been conducted to characterise the emissions of major industrial pollution sources. The source measurements found that oil-fired and coal-water slurry (CWS) fired power plants had higher air emissions level and emission intensity levels than those of coal-fired and gas-fired power plants. Meanwhile, the greater capacity of the unit, the lower level of $SO_2$ emission, which fully embodied the environmental benefits of relevant national policies implemented in power industry of the PRD region, such as sulfur dioxide emission reduction policy and promotion of the large scale and restrictions on the small scale in terms of generation capacity. However, similar impacts on NOx emission level or intensity from these power plants were not observed associated with such policy.

3.4.2 The measured cement plants had generally adopted control measures for particulate matter; $PM_{10}$ emission concentrations were lower than the national average emission level in 2003, but NOx and $SO_2$ emission levels were a bit higher. In addition, the higher the daily output of the cement enterprise, the lower the concentration of $PM_{10}$ emission.

3.4.3 The concentrations of $SO_2$ and $PM_{10}$ emission measured from the architectural ceramics plants were relatetively low comparing with other mainland plants, while the concentrations of NOx emission were higher than the national average. The measurement results showed that roller kilns using traditional fuels had higher NOx and $PM_{10}$ emission concentration than those using clean fuels.

3.4.4 In the glass manufacturing plants, the concentrations of $PM_{10}$ emission were comparable to the national average, but one of the plants emitted high concentration $SO_2$ which could be due to the malfunction of desulfurization equipment. The concentrations of NOx emission were also in high level.

3.4.5 For boilers in paper and pulps industry, concentrations of $PM_{10}$ emission were relatively low, and the concentrations of NOx emission from different types of coal-fired boilers are similar. The concentrations of $SO_2$ emission however presented larger difference among each other; the $SO_2$ emission concentration of individual pulverized coal boiler is relatively high.

3.4.6 For industrial boilers of light industry manufacturing, the overall air emission level of chain furnace is slightly lower than that of circulating fluidized bed boiler.

3.4.7 Emissions from iron and steel plant were similar to the national average, except the concentrations of $PM_{10}$ emission from sintering machines and refining furnaces were slightly higher, but they were still in the same numerical order.

## 3.5 Available options for control technology and technical guideline

3.5.1 Control technologies suitable for different scales of the power industry and retrofit programs of existing FGD facilities include: limestone - gypsum wet desulphurization, flue gas circulating fluidized bed desulfurization and NID method. Control technologies suitable for different boiler powers of paper industry, textile printing and petrochemical industry include circulating fluidized bed desulfurization and ammonia - ammonium sulphate desulfurization method. Control technology suitable for the cement industry is desulfurization and dust removal integration method. Control technology suitable for the ceramic industry is rotating spray drying method. Control technology suitable for glass industry is ammonia desulfurization method. Control technology suitable for iron and steel industry (sintering machine) is the rotating spray drying method.

3.5.2 NOx control technology suitable for all coal-fired boilers is low NOx burner technology (LNB). NOx control technologies suitable for power industry include SCR technology and combined LNB+SNCR technology. The available NOx control technologies suitable for paper industry and light industry manufacturing are LNB, followed by SNCR technology. The available NOx control technologies for cement, glass and ceramics industry are LNB + SNCR technology, followed by SCR technology.

3.5.3 For particulate matter control technologies, the available control technology for cement industry is bag filter, for glass industry is cartridge filter, for ceramic industry Centrifugal Precipitation (Cyclone) is recommended, while ESP and fabric filter is recommended for power industry, followed by bag filter.

Electrostatic precipitator (ESP) is recommended for Iron and steel industry (sintering).

3.5.4 The cleaner production methods of VOC emission reduction mainly include research of alternative raw materials, product / production process design, process and equipment improvement, and strengthening management of production process. Recommended cleaner production methods are selected from the cleaner production guidelines of PRD and Hong Kong.

3.5.5 For end-of-pipe control of VOC, activated carbon adsorption is recommend for ink / printing industry, coating industry and surface coating industry. Regenerative incineration is recommended in the synthetic resin industry of petrochemical industry, while activated carbon adsorption is recommended for oil tape production industry. Incineration technology is recommended for synthetic leather industry and activated carbon adsorption for refining and oil supply industry, followed by normal temperature / pressure absorption. Fluidized bed adsorption is recommended for electronic manufacturing industry.

3.5.6 The available control technical guidelines of $SO_2$, NOx and $PM_{10}$ are all made reference to the relevant national technical specifications issued by the national/ local governments. There is no national technical specification/standard for industrial VOC control technologies yet, so the draft technical specification produced in this study may be a useful reference in the future.

# 4 CONCLUSION

## 4.1 Results

4.1.1 Guangdong province and HKSAR governments have been continuously taking measures to reduce air pollution emissions and to improve the regional air quality. A series of air control measures has been implemented in the PRD and its surrounding areas and some progress has been made. This study looked into the spatial distribution, characteristics and control technologies for the major industrial sources in the PRD region which provided the scientific data and reference basis for the two governments to devise further control strategies with a view to improving the regional air quality.

4.1.2 This study examined the emissions and control applied in major industrial pollution sources in the PRD region through site surveys and source measurements. Meanwhile, a comprehensive review of air pollution control technologies was carried out. Based on the official emission reduction policies information in the PRD region and the assessment results, the available control technologies were identified for consideration. This study also confirmed the direction of regional air quality strategies.

4.1.3 Since the industrial emissions of VOC have not been regulated and not included in the routine monitoring, VOC data in both the Guangdong provincial environmental statistics database and the datasets of specified process in Hong Kong are limited. Therefore, similar methodology used for other air pollutants cannot be adopted for VOC. In this regard, this study investigated the typical industrial VOC pollution industries in the PRD region identified based on the characteristics of industry in the PRD region and with reference to the relevant literatures, and provide the preliminary information of VOC emissions from the industrial sources in PRD region.

## 4.2 Way Forward

4.2.1 Air emission reduction to improve air quality

- $SO_2$ emission reduction - to fundamentally change the energy structure in the PRD region by reducing the ratio of thermal power, while increasing the contributions of other clean energy, strictly implement the preferential policy for clean energy to gain priority access to electricity grid to increase the clean energy percentage; followed by optimizing thermal power structure and promotion of installation of electricity generation with large generation capacity, if needed.

- NOx emission reduction - NOx reduction programme could be launched in power plants to encourage reduction of NOx emission, promotion of installation of flue gas denitrification facilities, as well as adoption of advanced LNB technology. Such programme could be extended to petrochemical and non-metallic mineral products industry, etc. afterward.

- $PM_{10}$ emission reduction - Hybrid Electrostatic Precipitator-Fabric Filter of particulate matter removal technology is recommended to apply in power plants. Grinding station without kiln process should be encouraged in the PRD region. When retrofitting of existing enterprises, NID technology is promoted to control PM emission.

- VOC emission reduction - Cleaner production shall be put as priority measures in the typical VOC industrial emission sources with solvent use, referred to the published technical guidelines for clean production, or practical guide for industry to implement cleaner production in Cleaner Production Partnership Programme in Guangdong and Hong Kong, oil depots and gas stations shall install vapour recovery system, while in the petrochemical and oil refining and other large factories, end-of-pipe control technologies, such as regenerative combustion technologies could be employed to reduce VOC emission.

4.2.2 Further research

- Based on the experience of this study, a holistic study of regional air pollution could be conducted to cover the Greater Pearl River Delta area (including Hong Kong, Macao and the Pearl River Delta Economic Zone). Findings from this large scale regional study would provide technical supports for promoting and implementing the co-prevention and co-control of regional air pollution.

- To develop a comprehensive study programme on anthropogenic VOC emissions in the PRD region, which include VOC sources such as container terminals, land/sea/air transportation, agricultural activities, open burning, waste incineration, and small and medium scale coal-fired boilers, etc., to quantify the different VOC species and conduct measurements on VOC species with high ozone formation potential.

- To develop the observation on the composition spectrum of fuel gas from typical air emission sources and update dynamically the emission inventory in the PRD region.
- To conduct study on fugitive emission of air pollution sources, such as fugitive emission of PM from non-metallic mineral products and iron and steel industry, and fugitive emissions of VOC from oil refining and petrochemical industry, gas service stations and oil depots, etc., On-site monitoring shall be conducted, whose results could be compared with estimated data produced by commercial models, such as TANK Model, etc.
- To draft technical guideline on VOC control technology applicable to major industrial VOC emission sources in the PRD region. Representative from industry of concerns, technical specialists, industry administration and government representatives shall be consulted. Technical specifications should cover Cleaner Production (source control) and flue gas treatment (end- of-pipe control).