建築署
Architectural Services Department

Crematoria Air Quality Impact Study
Kwai Chung Crematorium

Final Report

July 1998

Hyder
Consulting

125 Years of Pedigree as Freeman Fox & John Taylor

Architectural Services Department
Crematoria Air Quality Impact Study
Kwai Chung Crematorium
Final Report

July 1998

Table of Contents

LIST OF FIGURES

LIST OF TABLES

APPENDICES

1. INTRODUCTION

1.1 BACKGROUND AND STUDY OBJECTIVES

Regional Services Department (RSD) are responsible for the operation of crematoria in the New Territories. In order to cope with the increasing demand for cremation services, RSD have an intention to re-new and expand the existing facility of Kwai Chung Crematorium. Architectural Services Department (Arch S D) are responsible for the management and design of all technical aspects relating to the new crematorium. Hyder Consulting Ltd have been commissioned by Arch S D to undertake an environmental study for this project.

This study has reviewed the nature and extent of the air pollution impacts of the new crematorium, and provide mitigation recommendations for implementation possibly at later stages of this project. The outcome of the study will be the compilation of an Air Pollution Control Plan (APCP) and the provision of information which ensure the design of the proposed crematorium is environmentally acceptable. Environmental guidelines for monitoring and management of the facility have been developed so that the operators can achieve the environmental standards recommended by the Environmental Protection Department (EPD).

1.2 PROPOSED PROJECT DESCRIPTION

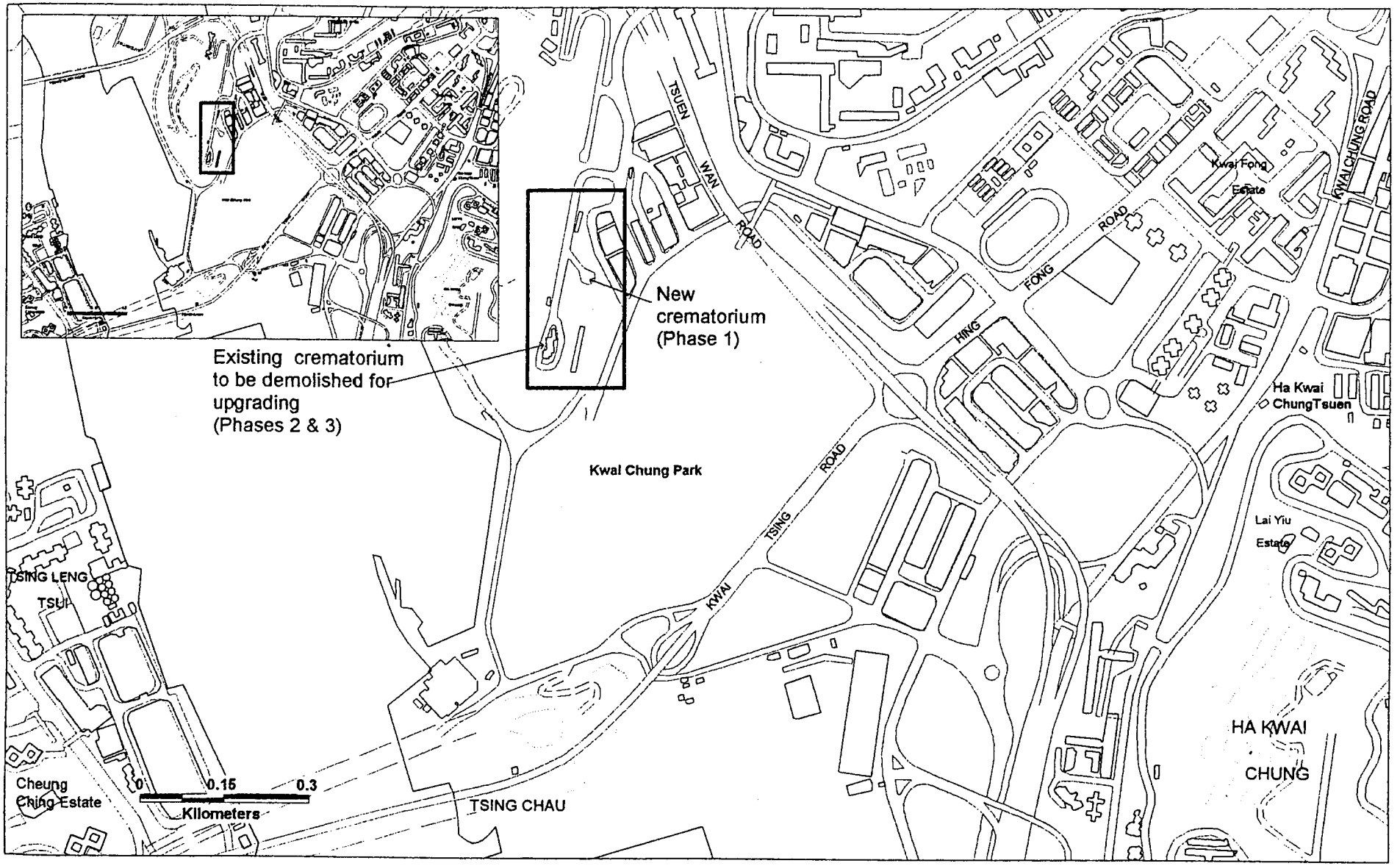
Figure 1.1 shows the location of the existing crematorium in Kwai Chung, which was built 18 years ago, and consists of two twin cremators with the provision for accommodating an additional twin cremators in the future. The proposed schedule for the planning, upgrading and expansion of the crematorium will be undertaken as follows:

Phase 1 — Construction of the new Crematorium B on the lawn within the existing premises incorporating four single cremators; this will eventually provide a total installed capacity of 630 kg/hr. Following completion of the new crematorium the existing crematorium will be closed down.

Phase 2 — Demolition of the existing Crematorium A.

Phase 3 — Construction of the new Crematorium C (four single cremators) with an installed capacity of 630 kg/hr at the prime site.

The total installed capacity will be 1260 kg/hr for both Crematoria B and C in operation at the same time.



Hyder Consulting

Figure 1.1 Site Location Map of Kwai Chung Crematorium

2. LITERATURE REVIEW

2.1 TYPICAL CREMATOR DESIGN

Most crematoria have two combustion chambers, the primary and secondary chambers. The primary chamber (main chamber), which receives the coffin, is usually fitted with a forced air supply and a gas or oil fired burner. The combustion of the coffin and cadaver occurs on the grate of the primary chamber. Combustion gases and products of incomplete combustion, such as, carbon monoxide and nitrogen oxides together with particulates, then pass to the secondary chamber. The secondary combustion chamber may have provision for the introduction of make-up air and a afterburner system for the elevation of chamber gas temperature. The products of incomplete combustion should be destroyed when gas phase combustion is completed in the secondary chamber. Combustion gases are normally drawn from the cremator by a venturi evacuator system or by an induced draught fan. The exhaust gases are discharged directly to atmosphere from a stack discharge. A number of cremation units may be linked together by ducting to a single discharge stack or chimney.

Most cremation units are manually charged and de-ashed and are not fitted with pollution control equipment other than combustion control devices.

Older Units

Older crematoria units usually fail to control combustion due to a number of reasons such as these units normally do not have secondary combustion chambers, even they do, the secondary chambers are small so that the gas residence time is less than one second; the burning duration and air settings are controlled manually; and there is no induced flow in the discharge stack.

Modern Units

Modern cremation units are similar in design to older plants, but are normally fitted with large secondary combustion chambers and advanced control systems. They have unrated heating systems and the most advanced units are fitted with several air injectors to the second chamber to increase $O_2 > 6\%$ and the chamber is fitted with partitions to enhance mixing.

Modern units are usually designed to meet the technical combustion requirements laid down in PG5/2(95). For example, the calculated residence time of gases in the secondary combustion chamber is at least 2 seconds, temperatures are maintained above 850°C and carbon monoxide levels are kept below 100 mg/m^3. In order to consistently achieve these conditions, the most modern cremators employ computer controlled operating systems.

2.2 TYPICAL PROCESS OPERATION AND EMISSION CHARACTERISTICS

The typical cycle of cremation can be broken down into a number of stages which are summarised as follows:

- Start-up (pre-heat) on gas or other support fuel

- Charging the coffin
- Volatilisation of materials from the coffin surface
- Impingement of the burner on the coffin
- Break-up of the casket
- Main cremation period
- Burn-down/cooling
- Raking out
- Treatment of ashes.

Metallic residues, such as coffin nails and pins, artificial joints etc, are removed from the recovered residues by magnetic sieving when the residues have cooled. The ashes are crushed in a cremulator and placed in a casket for delivery to next of kin. Power-up (lighting of burners) is expected to result in emissions of carbon monoxide and organic compounds due to initial incomplete combustion of the fuel gas. Charging the coffin and volatilisation of materials from the coffin surface will result in further emissions of organic compounds and carbon monoxide. During the main cremation period, the action of the burner on the coffin and the subsequent break-up of the casket produces the main emissions of particulate matter.

The secondary combustion chamber is not the whole solution to abate the particulate emissions during casket break up. Some units have long horizontal ducts from the unit to the final emission stack, these allow particulates to settle out and hence reduce the particulate emission. To achieve a high level of particulate emission control, bag filters or electrostatic precipitators would be required after the secondary chamber.

As this burning continues, the emissions of carbon monoxide, volatile organic compounds and particulates would decline. The hydrogen chloride emissions occurs mainly during the material of the coffin breaks down. In units with effective combustion control the emissions of carbon monoxide are generally low. The raking out stage and final treatment of the ashes may produce a final burst of particulate emissions.

2.3 VARIATION OF EMISSIONS DURING CREMATION CYCLE

Cremation is a batch process consisting (neglecting pre-heating and shutdown) of the brief 'flash-off' volatiles from the veneer on the outside of the coffin, burning of the coffin, after the coffin breaks open the burning of the coffin and the cremation of the body and finally the calcification of the remains and ashing. The batch cycle will therefore show variation in the emission of pollutants during the cycle.

There are limited published data on the variations of air pollutant emissions during a cremation cycle. Those available data suggest wide variations from one cremation to another. However, they are presented as follows.

2.3.1 Total Particulate Matter

The concentration of particulate matter is normally low during the volatilization of the veneer. During the break-up of the casket, it tends to increase, and remain high during the main cremation period. It would reduce significantly in burn-down period. Concentrations may again rise during the short final raking out stage. The distribution of particle size tends to be heterogeneous, ranging from some very large ash platelets greater than 200 microns to fine dusts less than 75 microns. There may also be emissions of sub-micron metal salts (metal fume) and sub-micron particulate material formed from the condensing products of incomplete combustion (soot).

Visible smoke emissions are closely related to total particulate matter. Dark smoke is associated with sub-micron particles, formed from condensing products of incomplete combustion (soot). Modern, secondary, combustion control cremator units should be able to destroy these species effectively. The emissions from modern units are free from visible smoke during normal running.

2.3.2 Organic Compounds and Carbon Monoxide

The emissions of carbon monoxide and organic compounds peak during the charging the coffin. The emissions are high at this early stage because of the initial volatilisation of lacquers from the coffin. The ingress of cold air from the opening of the primary chamber door also reduces combustion efficiency. Concentrations increase again as the volume of combustible gases and vapours increase with the break-up of the casket.

A field study[1] of air pollutant emissions from crematoria suggests that the organic compounds emitted during the cremation are mainly hydrocarbons, with the greatest proportion being methane, other oxygenated species such as formaldehyde can be expected in lower concentrations. Dioxin is a potential concern particularly for old cremators which do not meet the modern design standards (2 seconds gas residence, at 850^0C, 6% oxygen and 100 mg/m^3 for carbon monoxide at secondary combustion chamber). Nevertheless, it should not be assumed that cremators which meet these combustion conditions emit low levels of dioxin. Modern cremators employing secondary combustion control technologies should be able to control organic pollutants and carbon monoxide.

2.3.3 Oxygen

From an initial peak, as a result of the ingress of air from the opening of the primary chamber door, oxygen levels in the combustion chambers tend to fall and stabilize due to combustion. Modern cremators employing secondary combustion control technologies are equipped with oxygen monitors to ensure levels of oxygen are high in the secondary combustion chamber and combustion remains optimized .

[1] Mitchell D., Loader A. Investigation of Pollutant Emissions from Crematoria. WSL Laboratory Report 908 (1993).

3. AIR QUALITY ASSESSMENT

3.1 ENVIRONMENTAL CRITERIA FOR CREMATORIA

3.1.1 EPD Notes on Best Practicable Means

The EPD notes on Best Practicable Means (BPM) for Incinerators list the minimum requirements for operating incinerators for destruction of general wastes including carcasses with incineration capacity greater than 0.5 tonnes per hour. The proposed crematorium is considered to fall within the category of incinerators. These BPM requirements cover aspects of (i) chimney design, (ii) stack emission limits of certain air pollutants, (iii) design of incinerator, (iv) fugitive emission control, (v) type of fuel to be used, (vi) environmental monitoring, (vii) commissioning, and (viii) operation and maintenance. The pollutant emission limits given in the BPM are summarised in Table 3.1 below. The stack emissions of the proposed facility should be controlled within these limits in order for EPD to grant a Specified Process licence.

Table 3.1 Stack Emission Limits from EPD Notes on BPM for Incinerators

Parameter	Concentration Limits (273K, 101.3kPa, 11% O_2 dry)
Particulates	100 mg/ m^3
Total cadmium (Cd) and mercury (Hg) and their compounds	0.2 mg/ m^3
Total nickel (Ni) and arsenic (As) and their compounds	1 mg/ m^3
Total heavy metals	5 mg/ m^3
Hydrogen sulphide (H_2S)	5 mg/ m^3
Hydrogen chloride (HCl)	100 mg/ m^3
Hydrogen fluoride (HF)	4 mg/ m^3
Sulphur dioxide (SO_2)	500 mg/ m^3
Carbon monoxide (CO)	100 mg/ m^3
Total organic compounds	20 mg/ m^3

According to the BPM, the design of the cremators should meet the technical specifications given in Table 3.2 unless it can be demonstrated that alternative design with equivalent performance and destruction & removal efficiency of 99.99 percent will be achieved.

Table 3.2 Specifications for Secondary Combustion Chambers of Incinerators (from EPD BPM for Incinerators)

Parameter	Requirement
Combustion temperature	≥ 850°C
Residence time of flue gas	≥ 2 seconds
Oxygen content	≥ 6%

3.1.2 Assessment Criteria

The resultant air pollutant concentrations at air sensitive receivers (ASRs) in the vicinity of the crematorium should comply with the *Air Quality Objectives* (AQO) stipulated by the *Air Pollution Control Ordinance* (APCO). The AQO are summarised in Table 3.3 below.

Table 3.3 Hong Kong Air Quality Objectives

Pollutant	Concentration in Micrograms Per Cubic Metre (i)				
	Averaging Time				
	1 Hour (ii)	8 Hours (iii)	24 Hours (iii)	3 Months (iv)	1 Year (iv)
Sulphur dioxide	800		350		80
Total suspended particulates			260		80
Respirable suspended particulates (v)			180		55
Nitrogen dioxide	300		150		80
Carbon monoxide	30000	10000			
Photochemical oxidants (as ozone) (vi)	240				
Lead				1.5	

(i) Measured at 298 K (25°C) and 101.325 kPa (one atmosphere).

(ii) Not to be exceeded more than three times per year.

(iii) Not to be exceeded more than once per year.

(iv) Arithmetic means.

(v) Respirable suspended particulates mean suspended particles in air with a nominal aerodynamic diameter of 10 micrometres and smaller.

(vi) Photochemical oxidants are determined by measurement of ozone only.

The AQO do not provide criteria for all of the air pollutants as listed in the BPM except total particulates, carbon monoxide and sulphur dioxide. Therefore, alternative criteria have been used for these pollutants (see Table 3.4 below) as the assessment criteria. The criteria are based on the ambient air quality guidelines of the World Health Organization [2] (WHO) for mercury, cadmium and hydrogen sulphide, the Canadian National Air Quality Objectives[3] for hydrogen fluoride, the California Air Resources Board (CARB) for hydrogen chloride, the risk assessment guidelines of the California Air Pollution Control Officers Association (CAPCOA) for nickel and arsenic. However, total organic compounds cannot be assessed as no appropriate guidelines have been identified.

Table 3.4 Air Quality Criteria Other Than HK Air Quality Objectives

Parameter	Criterion ($\mu g/m^3$)	Averaging Time	Source
Total mercury (Hg)	3	1 hour	WHO
	1	annual	
Cadmium (Cd)	0.02	annual	WHO
	3.5		CARB/CAPCOA
Nickel (Ni)	1	1 hour	CAPCOA
	0.24	annual	
Arsenic (As)	0.5	annual	CAPCOA
Hydrogen sulphide (H_2S)	42	1 hour	CAPCOA
	150	24 hours	WHO
Hydrogen chloride (HCl)	3000	1 hour	CARB/USEPA
	7	annual	
Hydrogen fluoride (HF)	580	1 hour	CARB/CAPCOA
	40	24 hours	CNAQO
	5.9	annual	CARB/CAPCOA
Total organic compound (TOC)	N/A	N/A	N/A

(i) N/A - Not Available
(ii) CNAQO - Canadian National Air Quality Objectives
(iii) CAPCOA - Air Toxics "Hot Spots" Program - Revised 1992 Risk Assessment Guidelines, Oct 1993
(iv) CARB - Draft Toxic Air Contaminant Identification List - Compound Summaries, Jan 1996

Cadmium, nickel and arsenic are toxic air pollutants (TAPs) which are potential sources of cancer health impacts, the acceptability of the resultant lifetime cancer health risks of the nearby community due to the exposure of these TAPs emitted from Kwai Chung Crematorium should satisfy the guidelines in Table 3.5.

[2] **World Health Organization Regional Office for Europe Copenhagen.** Air Quality Guidelines for Europe (1987). WHO Regional Publications, European Series No. 23.

[3] **International Union of Air Pollution Prevention Associations.** Clean Air Around the World. National and International Approaches to Air Pollution Control. 2nd edition (1991).

Table 3.5 Acceptability of Cancer Risks

Reference Levels
(i) Individual TAP Exposure
Maximum Acceptable To bring the risk from exposure to individual TAP to below 10^{-6} per year (Lifetime = 7 x 10^{-5})
ALARP For those TAPs with risk level between 10^{-6} per year and 10^{-8} per year (Lifetime between 7 x 10^{-5} - 7 x 10^{-7}), the best available control technology should be adopted to ensure emissions of individual TAP are as low as reasonably practicable.
Negligible Ultimate goal would be to bring the risk form exposure to individual TAP to below the negligible risk level of 10^{-8} per year (Lifetime = 7 x 10^{-7}).
(ii) Multiple TAPs Exposure
Total risk from the facility should not exceed a level of 10^{-5} per year (Lifetime risk of 7 x 10^{-4})

3.2 BASELINE CONDITIONS

Kwai Chung is one of the major industrial areas of Hong Kong. It is expected that road traffic, industrial emissions and construction are the dominant sources of the ambient air quality in Kwai Chung area. Road traffic emissions contribute to the ambient nitrogen oxides, carbon monoxide and suspended particulate matters; industrial emissions due to the combustion of fossil fuels contribute sulphur dioxide, nitrogen oxides and particulates; and construction activities give rise to dust emissions which increase the ambient levels of suspended particulates. However, sulphur dioxide, carbon monoxide and total suspended particulates are the only relevant pollutants which need to be considered with respect to the air pollutant limits given in the EPD BPM and the AQO.

The EPD 1996 air quality monitoring data of Kwai Chung indicate the ambient levels of sulphur dioxide, total suspended particulates and carbon monoxide within this area were within the AQO (see below). The air quality modelling results have been corrected for the background levels of sulphur dioxide, carbon monoxide and total suspended particulates.

Table 3.6 EPD 1996 Ambient Air Quality Monitoring Data in $\mu g/m^3$

Pollutant	Concentration ($\mu g/m^3$)			
	1 hour	8 hours	24 hours	Annual Average
Sulphur dioxide	213*	-	85**	21
Carbon monoxide	7610*	-	-	
Total suspended particulates	-	-	171**	-

* *1st highest 1 hr*
** *1st highest 24 hr*

3.2.1 Air Sensitive Receivers

The Hong Kong Planning Standards and Guidelines (HKPSG) define air sensitive receivers (ASR) as land uses which, by virtue of the nature of the activities thereon or resources therein, are susceptible to the influence of residuals or physical changes generated by polluting uses. Examples are schools, hospitals and clinics and residential areas. As identified from the survey maps, the nearby ASR are factory buildings along Wing Lap Street, Kwai Chung Park, Tsing Chau Temporary Housing Area, Kwai Shing Estate (including some primary and secondary schools), Typhoon Shelter, etc. Figure 3.1 shows these ASR locations, and Table 3.7 gives the approximate distances of these ASR from the site.

Table 3.7 Air Sensitive Receivers in the Vicinity of Kwai Chung Crematorium

ASR Name	Co-ordinates	Distance from Site
1. Factory Buildings along Wing Lap Street	824220N, 830290E	75m
2. Kwai Chung Park	830300N, 824255E	200m
3. Tsing Chau Temporary Housing Area	830710N, 824000E	650m
4. Typhoon Shelter	829850N, 824250E	300m
5. Kwai Shing Estate	830505N, 824290E	700m

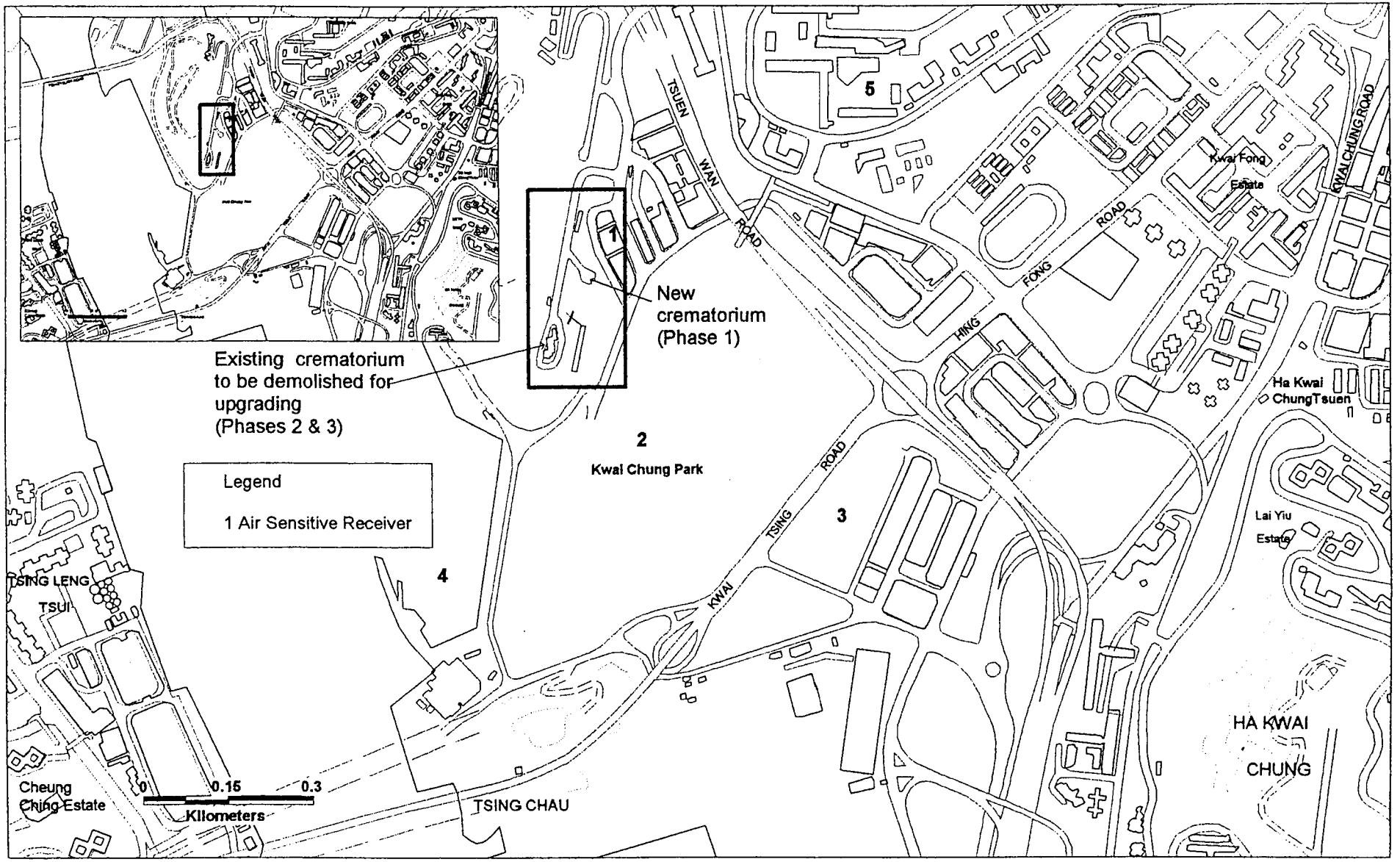
3.3 IMPACT ASSESSMENT METHODOLOGY

3.3.1 Air Quality

The pollutant dispersion was modelled using the USEPA Industrial Source Complex Short Term (ISCST3) software package. The results were then compared with the air quality criteria given in the above Tables 3.3 and 3.4 for impact identification and determining the necessary air pollution abatement measures. Background corrections have been made for the predicted levels of sulphur dioxide and total suspended particulates. The study findings will provide input for the detailed design of the new cremators at Kwai Chung Crematorium.

The ISCST3 model is a recognised methodology by the EPD. Input parameters to the ISCST3 model include data related to the source such as pollutant emission rates, chimney dimension, efflux velocities and temperature, operating hours and process duration; meteorological data in terms of annual statistics of wind speed and direction, air temperature and atmospheric stability class. Other required parameters are topographical information, and the source and receiver co-ordinates.

Several basic assumptions have been made for undertaking the air quality modelling, such as (i) individual crematorium building (Crematoria B & C) would have its own stack (hence the total number of stacks within Kwai Chung Crematorium would be two); (ii) the pollutant emissions from each stack would comply with the EPD BPM



Hyder Consulting

Figure 3.1 Locations of Air Sensitive Receivers in the Vicinity of Kwai Chung Crematorium

limits; (iii) the crematorium buildings would be 6m high; and (iv) the stack height would be 15m above ground or 9m above the building roof.

As EPD have confirmed that all new cremators within Kwai Chung Crematorium need to be considered together within a single Specified Process licence, this air quality study has considered and modelled the effect of the cumulative emissions from both proposed Crematoria B & C.

Source Emission Data

The emission rates are given in Table 3.8. They are obtained by multiplying the BPM limits in Table 3.1 (except for SO_2) by the gas volume flow rate which is 10 m^3/s. This flow rate has been corrected to a condition of 273 K, 101.3 kPa, 11 % O_2 and dry. The uncorrected gas volume flow rate is 5.5 m^3/s. Its calculation assumed a 750mm internal stack diameter, 12.5 m/s gas exit velocity, and similar characteristics of the gas stream as Cape Collinson Crematorium (see Stack Parameters Section below), i.e. 473 K, 101.3 kPa, 17.9 % O_2 and 2.13 % moisture.

The SO_2 emission factor is based on the fuel consumption rate at Cape Collinson. It is expected that new cremators will consume more fuel than the existing cremators in Kwai Chung. The SO_2 emissions should be much lower than the BPM as light diesel will be used. However, diesel fuel with sulphur content <0.3% by weight is necessary as a preliminary modelling indicated that the AQO would be exceeded if using diesel with 0.5% sulphur content.

Table 3.8 Estimated Pollutant Emission Factors from Each Incinerator Stack

Parameter	BPM Limits (273K, 101.3kPa, 11% O_2 dry)	Emission Factors
Particulates	100 mg/ m^3	1 g/ s
Total cadmium (Cd) and mercury (Hg) and their compounds	0.2 mg/ m^3	0.002 g/ s
Total nickel (Ni) and arsenic (As) and their compounds	1 mg/ m^3	0.01 g/ s
Total heavy metals	5 mg/ m^3	0.05 g/ s
Hydrogen sulphide (H_2S)	5 mg/ m^3	0.05 g/ s
Hydrogen chloride (HCl)	100 mg/ m^3	1 g/ s
Hydrogen fluoride (HF)	4 mg/ m^3	0.04 g/ s
Sulphur dioxide (SO_2)	500 mg/ m^3	0.54 g/ s (see note)
Carbon monoxide (CO)	100 mg/ m^3	1 g/ s
Total organic compounds	20 mg/ m^3	0.2 g/ s

Emission rate is obtained by multiplying BPM by volume flow rate except for SO_2 which is based on fuel consumption rate at Cape Collinson Crematorium

Stack Parameters

Due to the preliminary stage of this project, detailed information regarding the physical dimensions of the proposed crematorium building and chimneys was not available from Arch S D. It is understood that Arch S D have the intention to adopt a similar cremator design as in Cape Collinson if it is suitable for this project. EPD and Arch S D have agreed that preliminary assumptions for the stack dimension and plume characteristics would be based on the existing crematorium facility in Cape Collinson Crematorium. Details of these assumptions are given below:

(i) stack physical dimension : ⌀750mm and 15m above ground;

(ii) stack gas exit velocity: 12.5m/s;

(iii) stack gas exit temperature : 473K;

(iv) total number of stacks: 2 (one for Crematorium B and one for Crematorium C).

The modelling has included all two stacks (i.e. each crematorium has one stack), and assumed the pollutant emissions from the individual stack would comply with the BPM limits. In order to make appropriate assumptions for the stack gas velocity and temperature, consideration has been given to the design capacity of the proposed cremators. The stack height assumption takes into account the 6m minimum headroom requirement for the crematorium building specified by Arch S D, and the Chimney Height Memorandum. The above chimney design should be considered as a working model, and requires an engineering feasibility study to be undertaken by the engineers of Arch S D.

Meteorological Data

Meteorological information, e.g. wind speed, wind direction, air temperature and atmospheric stability class, for the modelling has been based on a full year meteorology data provided by the Hong Kong Observatory measured at the Kwai Chung International Terminal.

Operational Parameters

The future daily operation of the extended Kwai Chung Crematorium in terms of frequency and duration of each cremation process has been assumed to be the same as the existing operation. The crematorium operators on duty were interviewed during a site visit on 18th April 1997. The collected operational information of the existing Crematorium A is summarised below:

(i) type of process: cremation of cadaver and coffin

(ii) operation hour: 10:00am to 5:30pm, seven days a week

(iii) number of cremators: four (2 large and 2 small)

(iv) frequency of cremation: 12 times/day or 3 times/cremator/day

(v) time required for each cremation: ~1.5-2 hours.

(vi) type of fuel: diesel

(vii) combustion chamber temperature: ~800°C

Average diesel consumption rate per cremation at the Kwai Chung Crematorium is 31 litres. Detail of the monthly fuel consumption during 1996-97 is given in Table 3.9 below.

Table 3.9 Monthly Fuel Consumption and Number of Corpses Cremated Between August 1996 and July 1997 at Kwai Chung Crematorium

Month/Year	Monthly Diesel Consumption, (litres)	Number of Corpses Cremated	Average Diesel Consumption Per Corpse, (litres)
Aug 96	7600	261	29.12
Sept 96	4900	179	27.37
Oct 96	7950	235	33.83
Nov 96	11600	365	31.78
Dec 96	12600	400	31.50
Jan 97	13750	439	31.32
Feb 97	8800	277	31.77
March 97	7200	218	33.03
April 97	8750	266	32.89
May 97	12650	422	29.98
June 97	11850	399	29.70
July 97	8050	259	31.08

It is expected that the fuel consumption by cremators of new design will be more than the existing cremators at Kwai Chung, which are of old design and were built eighteen years ago. It has been confirmed that the average diesel consumption at Cape Collinson Crematorium is 194 litres per corpse which is about six times of the Kwai Chung Crematorium; the operating temperature for the cremators at Cape Collinson usually reaches 850°C before a cremation takes place. The operating temperature is then kept at approximately 1000°C during the cremation.

Modelled Parameters

The modelling has predicted the highest time average concentrations for each of the pollutants. The averaging time depends on the time period specified by the air quality criterion of a pollutant, which is usually an 8 hour and/or a 24 hour duration. As the pollutant concentrations vary against height, the worst impacted receptor height was determined by an initial modelling at different elevations (between 0 and 80m above

ground) of the nearest ASR. It was then followed by a full modelling at the worst receptor height to cover all ASR identified within 1km of the site.

3.3.2 Cancer Health Risks

The cancer risks due to exposure to each TAP is determined by multiplying the predicted annual average TAP concentration with the unit risk factor of that TAP. The total risk due to a multiple TAP exposure is the arithmetic sum of the individual risk. A preliminary set of Hong Kong Unit Risk Factors for these TAPs is as follows.

Table 3.10 Preliminary Set of Hong Kong Unit Risk Factors

TAP	Cancer Classification (IARC/US EPA)	Hong Kong Unite Risk Factor (URF) (Lifetime = 70 years)	Source
Cadmium (Cd)	1/B1	2.70E-03	Geometric mean of URF available form other international organizations
Nickel (Ni)	1/B2	2.90E-04	Geometric mean of URF available form other international organizations
Arsenic (As)	1/-	3.80E-03	Geometric mean of URF available from other international organizations

As Total Cd & Hg and Total Ni & As were predicted by ISCST modelling, a set of conversion factors for estimating concentrations of individual TAP have been derived from the emission data of Cape Collinson Crematorium, and they are summarised in Table 3.11 below.

Table 3.11 Conversion Factors Applied for Risk Calculations

Multiply	By	To Obtain
Total Cd & Hg	0.86[(a)]	Cd
Total Ni & As	0.95[(b)]	Ni
Total Ni & As	0.05[(b)]	As

(a) Derived from Cape Collinson data, based on average ratio of Hg & Cd in stack gas

(b) Derived from Cape Collinson data, based on average ratio of Ni & As in stack gas

3.4 IMPACT EVALUATION

3.4.1 Air Quality

The initial modelling confirms the worst receptor height of the nearest ASR would be between 60m and 70m above ground (or between 68.4 - 78.4 mPD). The highest predicted pollutant levels of the nearest ASR are summarised in Table 3.12.1. Predicted ground level pollutant levels for other ASRs are summarised from Table 3.12.2. The SO_2 isopleth at 60m above ground level is shown in Figure 3.2. For the predictions at the nearest ASR, all results except the hourly Ni concentration are within the relevant criteria. All predicted ground level pollutant concentrations are within the relevant criteria.

Table 3.12.1 Predicted Highest Pollutant Concentrations at the Nearest ASR

Parameter	Predicted Maximum Concentration* ($\mu g/m^3$)	Criterion ($\mu g/m^3$)
Particulates	260 (24 hours)	260 (24 hours)
Total mercury (Hg) & cadmium (Cd)	1.40 (1 hour) 0.017 (annual)	N/A
Hg*	0.2 (1 hour) 2×10^{-3} (annual)	3 (1 hour) 1 (annual)
Cd*	0.01 (annual)	0.02 or 3.5 (annual)
Total nickel (Ni) & arsenic (As)	7.02 (1 hour) 0.084 (annual)	N/A
Ni*	7 (1 hour) 0.08 (annual)	1 (1 hour) 0.24 (annual)
As*	0.004 (annual)	0.5 (annual)
Carbon monoxide (CO)	8312 (1 hour) 7820 (8 hours)	30000 (1 hour) 10000 (8 hours)
Hydrogen sulphide (H_2S)	35 (1 hour) 5 (24 hours)	42 (1 hour) 150 (24 hours)
Hydrogen chloride (HCl)	702 (1 hour) 5 (annual)	3000 (1 hour) 7 (annual)
Hydrogen fluoride (HF)	28 (1 hour) 4 (24 hours) 0.3 (annual)	580 (1 hour) 40 (24 hours) 5.9 (annual)
Sulphur dioxide (SO_2)*	591(1 hour) 133 (24 hours)	800 (1 hour) 350 (24 hours)
Total organic compound (TOC)	140 (1 hour)	N/A

* *Remarks :*

Only SO_2 concentrations at the ASRs were based on the actual fuel consumption rate of the Cape Collinson Crematorium while the concentrations of other pollutants were based on emission data according to EPD BPM.

Individual concentrations of Hg and Cd were calculated from Total Hg & Cd using conversion factor in Table 3.11. Same for Ni and As.

The predicted SO_2 levels within the crematorium (at the breathing zone and about 1.5m above ground) are 342μg/m^3 and 127μg/m^3 for an exposure period of one hour and 24 hours, respectively. All these levels do not exceed the AQO criteria of 800μg/m^3 for one hour and 350μg/m^3 for 24 hours.

Table 3.12.2 Predicted Ground Level Pollutant Concentrations in Micrograms Per Cubic Metre of Air

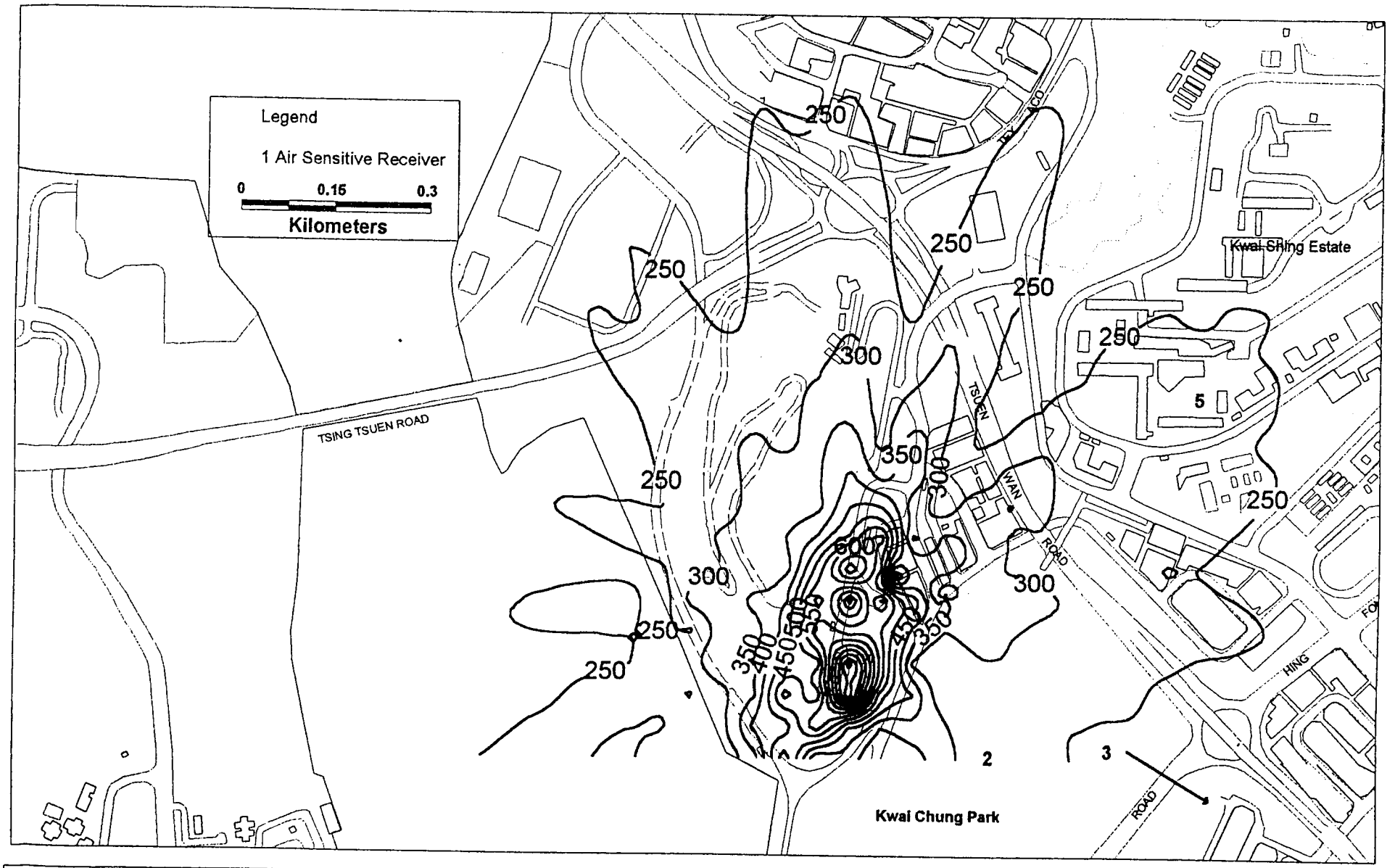
Parameter	Averaging Time	KCP	TCTHA	TS	KSWE
Particulates	24 hours	176	176	173	180
Total mercury (Hg) & cadmium (Cd)	1 hour	0.05	0.05	0.04	0.22
	annual	0.0036	0.00144	0.00018	0.00126
Hg*	1 hour	0.007	0.007	0.006	0.031
	annual	0.001	0.0002	3×10^{-5}	2×10^{-4}
Cd*	annual	0.003	0.001	1.5×10^{-4}	1.1×10^{-3}
Total nickel (Ni) & arsenic (As)	1 hour	0.24	0.23	0.21	1.10
	annual	0.14	7.6×10^{-3}	1.2×10^{-3}	6.3×10^{-3}
Ni*	1 hour	0.2	0.2	0.2	1
	annual	0.14	7.2×10^{-3}	1.2×10^{-3}	6×10^{-3}
As*	annual	7.2×10^{-3}	3.8×10^{-4}	6.1×10^{-5}	3.2×10^{-4}
Carbon monoxide (CO)	1 hour	7633	7633	7632	7720
	8 hours	7628	7621	7617	7633
Hydrogen sulphide (H_2S)	1 hour	1	1	1	6
	24 hours	0.3	0.2	0.1	0.5
Hydrogen chloride (HCl)	1 hour	24	23	21	109
	annual	1	1	0.1	1
Hydrogen fluoride (HF)	1 hour	1	1	1	4
	24 hours	0.2	0.2	0.1	0.4
	annual	0.1	3×10^{-2}	5×10^{-3}	3×10^{-2}
Sulphur dioxide (SO_2)	1 hour	226	225	224	271
	24 hours	88	88	86	90
Total organic compound (TOC)	1 hour	5	5	4	22

** Remarks :*

Only SO_2 concentrations at the ASRs were based on the actual fuel consumption rate of the Cape Collinson Crematorium while the concentrations of other pollutants were based on emission data according to EPD BPM.

Individual concentration of Hg and Cd were calculated from Total Hg & Cd using conversion factor in Table 3.11. Same for Ni and As.

KCP - Kwai Chung Park; TCTHA - Tsing Chau Temporary Housing Area; TS - Typhoon Shelter; KSWE - Kwai Shing West Estate



Hyder Consulting

Figure 3.2 Sulphur Dioxide Hourly Average Concentrations at 60m above Ground (microgram/cubic metre)

In order to meet the hourly criterion of Ni, the source emission of Ni should be limited to be at least 0.15 times of the existing BPM limit. This corresponds to a Ni concentration at the stack exit point of 82.2μg/m^3 (@ 473K, 101.3kPa, 17.9% O_2 and 2.13% moisture). Such emission level is within the typical range for the existing cremators (see Table 4.1) which do not equipped with pollution control equipment. Therefore, it suggests the above control limit is realistic and achievable. We expect the health issue of Ni at the nearest ASR will be resolved if the design of the new cremators adopt the best available control technology to limit its pollutant emissions to be as low as possible. It should be noted that the same recommendation is made for minimising the cancer health risk related to the crematorium operations. Details can be found in the following section.

3.4.2 Cancer Health Risks

The predicted lifetime cancer risks are summarised in Tables 3.13.1 and 3.13.2 below. The predicted highest risk levels related to exposure to individual TAP are all within the ALARP. The risks due to the exposure to ground level concentrations of Cd, Ni and As are within the ALARP. The total risks related to multiple TAPs exposure are acceptable as they are within the guideline of 7 x 10^{-4} as given in Table 3.5 above.

Although the TAP emissions during the future operation of the Kwai Chung Crematorium should not pose a cancer risk to the nearby community, the best available control technology should be adopted to ensure these emissions will be as low as reasonably practicable.

Table 3.13.1 Predicted Highest Risks at the Nearest ASR

TAP	Predicated Maximum Concentration (μg/m^3)	Predicted Highest Risk
Cadmium (Cd)	0.01 (annual)	2.7 x 10^{-5}
Nickel (Ni)	0.08 (annual)	2.3 x 10^{-5}
Arsenic (As)	4 x 10^{-3} (annual)	1.5 x 10^{-5}
	Total Risk	6.5 x 10^{-5}

Table 3.13.2 Predicted Risks According to Ground Level TAP Concentrations

TAP	KCP	TCTHA	TS	KSWE
Cadmium (Cd)	8.36 x 10^{-6}	3.34 x 10^{-6}	4.18 x 10^{-7}	2.93 x 10^{-6}
Nickel (Ni)	3.98 x 10^{-5}	2.08 x 10^{-6}	3.36 x 10^{-7}	1.74 x 10^{-6}
Arsenic (As)	2.74 x 10^{-5}	1.44 x 10^{-6}	2.32 x 10^{-7}	1.20 x 10^{-6}
Total Risk	7.55 x 10^{-5}	6.86 x 10^{-6}	9.86 x 10^{-7}	5.86 x 10^{-6}

KCP - Kwai Chung Park; TCTHA - Tsing Chau Temporary Housing Area; TS - Typhoon Shelter; KSWE - Kwai Shing West Estate

4. RECOMMENDATIONS

The following recommendations aim to ensure the compliance of the EPD BPM, which mainly concern the aspects of cremator design, operation and management of the cremator facility. They should be incorporated into the APCP for supporting the Specified Process Licence application of this project at the next stage

4.1 CREMATOR DESIGN

The cremator design should make reference to the existing facilities of the Cape Collinson Crematorium. The final design should ensure that the resultant stack emissions from each crematorium during its normal operation satisfy all BPM limits. The emission data of Cape Collinson Crematorium are given in Table 4.1 below, which indicate the emissions are well within the BPM requirements.

The new cremators should also adopt the best available control technology to limit its emissions of Cd, Ni and As to be as low as reasonably practicable. In particular, the source emission of Ni should be limited to within 0.15mg/m^3 (@ 273K, 101.3kPa, 11% O_2 dry) or 0.15 times of the EPD BPM.

Table 4.1 Typical Emissions from Cape Collinson Crematorium (Per Twin Cremator Set)

Parameter	BPM ($\mu g/m^3$)	Typical Range* ($\mu g/m^3$)
Particulates	100000	31000-90000
Mercury (Hg) & cadmium (Cd)	200	0.29-10(Hg), 5-39(Cd)
Total nickel (Ni) & arsenic (As)	1000*	17-289(Ni), 0.2-20(As)
Carbon monoxide (CO)	100000	1800-5600
Hydrogen sulphide (H_2S)	5000	1500-3000
Hydrogen chloride (HCl)	100000	500-1500
Hydrogen fluoride (HF)	4000	300-800
Total organic compound (TOC)	20000	2090-7330

**Emission data of individual twin cremators set measured at Cape Collinson Crematorium.*
For Ni, an emission limit of 0.15 times the BPM limit is recommended.

The Kwai Chung Crematorium requires a more stringent requirement for the type of low sulphur diesel fuel to be used (sulphur content not more than 0.3% by weight), the BPM for sulphur dioxide is therefore not specified.

The recommended stack dimension is 15m above ground and 750mm in diameter, or any dimension which can achieve a stack gas exit velocity of at least 7m/s. Note that

the stack of Crematorium B should be located at least 35m away from the slope and at least 30m from the factories along Wing Lap Street.

Other design requirements include:

- The efflux temperature at full load condition should not be less than 80 degree Celsius.
- Each cremator should have a secondary combustion chamber. The residence time of the flue gas should be least two seconds. The combustion temperature and oxygen content within the secondary chamber should be at least 850°C and 6 per cent, respectively.

It is recommended that the cremator's charging system should have an interlocking mechanism to prevent a coffin from being fed into the primary combustion chamber until the temperature within the secondary combustion chamber is above 850°C.

4.2 OPERATION AND MANAGEMENT

4.2.1 Fuel Restriction

Low sulphur liquid fuel must be used. The sulphur content of the liquid fuel should be at least less than 0.3 per cent by weight, and its viscosity not to exceed 6 centistokes at 40°C. Gaseous fuel can be considered as an alternative if connection to the gas supply is made available.

4.2.2 Monitoring, Sampling and Measurement of Emissions

In-stack levels of particulate matters and carbon monoxide should be monitored and recorded continuously. The oxygen levels and gas temperature at the outlet of the secondary combustion chamber should be monitored and recorded continuously as well. The monitors for continuous monitoring of particulate matters, carbon monoxide, oxygen and gas temperature should provide immediate displays to the operating staff, and fitted with audible and visual alarms. The alarm triggering levels for the four parameters are as follows:

Table 4.2 The Alarm Triggering Levels for Particulate Matter, Carbon Monoxide , Oxygen and Temperature

Sampling Point Location	Parameter to be Monitored	Alarm Trigger Level
In stack	Particulate matters	> 100 mg/m^3
	Carbon monoxide	> 100 mg/m^3
Outlet of secondary combustion chamber	Oxygen	< 6 %
	Flue gas temperature	< 850°C

During the commissioning and operational phase of the facility, sampling and analyses of the stack emissions should be undertaken to confirm the compliance of the BPM limits.

The recommended frequency of compliance monitoring during the operational phase is every six months. All monitoring instrument should be checked for correct functioning, and calibrated prior to use.

The recommended sampling and analysis methodology are given in Appendix A. Any subsequent laboratory analyses for air samples should be carried out by an independent HKOLAS[4] accredited laboratory. The report of the commissioning test and routine compliance monitoring should be submitted to EPD for record.

4.2.3 General Operation

A high standard of housekeeping should always be maintained. There should be an effective preventive maintenance for all plant and equipment concerned with the control of air pollutant emissions. Essential spare parts and consumable should be kept on site, or should be readily available from suppliers so that problems due to equipment failure or breakdown of plant can be rectified within a short time.

Any malfunction or breakdown that leads to abnormal emissions should be fixed promptly and process adjusted until normal operations can be restored. Typical reporting requirements set in a specified process licence for these malfunctioning is to inform EPD within two hours from the incident, followed by a written notification within three working days for time of the incident occurred, and nature or cause of the incident. RSD should inform EPD in writing who is the responsible staff for the operational control of the crematorium.

4.2.4 Material Handling, Storage and Disposal

The removal of ash and non combustible residues should be handled with care in order to avoid fugitive dust emissions:

- Remains in the cremator should only be moved when each incineration is complete.
- Cremated remains should be moved and stored in a covered container.
- Local extraction hoods connecting to a bag filter should be provided above workstations where treatment of cremated remains usually takes place.

4.2.5 Staff Training

Proper training and clear instruction should be provided to crematorium staff who have responsibilities to control the cremation process. There should be training for start up, shut down and handling procedures for abnormal conditions in order to avoid unacceptable air pollutant emissions. These procedures should be in strict compliance to the equipment's manufacturer instructions.

[4] Hong Kong Laboratories Accreditation Scheme

Professional training opportunities are available from overseas institutions. For example, there is a correspondence diploma course run by the UK Institute of Burial and Cremation Administration (IBCA). The course syllabus covers provision, management and layout of crematories and crematoria; financial management, conservation and environmental issues, manpower resource management, contract specification and management, and horticulture. The IBCA together with the Federation of British Cremation Authorities also run a Crematorium Technicians Training Scheme.

5. CONCLUSIONS

The future operation of the Kwai Chung Crematorium is unlikely to cause air quality impacts to the surroundings provided that the design and operation of the cremators ensure the pollutant emissions from the cremator stacks meet the EPD BPM limits and the design of the cremators adopts the best available control technology to limit the emissions of toxic air pollutants to be as low as reasonably practicable.

Appendix A

Monitoring Requirements and Methodology

Monitoring Requirements and Methodology

Sampling Position	General	• Provision of suitable sampling points should be included in the design of any new installations, and meet the requirements described in the US EPA Method 1.
	Particulate Matter	• The sampling points should be located on a straight duct, which are at least one stack diameter (D) upstream from a bend and at least 2D downstream of a bend. Also, it should be as far downstream from dampers, fans or other obstruction as possible. Sampling at horizontal ducts is not desirable owing to the stratification of particulate matter through the duct. Should sampling in horizontal duct be unavoidable, sampling positions should be situated in the top of a stack to take account of material deposited in the floor of the flue.
	Gaseous Pollutants	• The choice of sampling positions for gaseous pollutants is not critical. It is not so prone to the inertial separation problems experienced by the sampling of particulate matter. A single point sampling is acceptable provided that there is no stratification. However, sampling positions should meet the general requirements laid out for the particulate sampling. They should be close to the plane used for simultaneous particulate measurement. Any probe used to extract a sample of gas should not cause interference to the other sampling equipment in the stack and vice-versa.
Continuous Monitoring	Opacity	• A single or double beam opacity meter should be used. The operating principle of a single beam opacity meter is by transmitting a visible or infra-red light beam across the stack to a sensor on the opposite side. The light intensity is reduced at the receiving end by absorption and scattering which are related to the obscurity of the emission and the mass of particulate matter in the stack. The double beam opacity meter use the same principle but it has a higher sensitivity. The opacity meter requires calibration by extractive methods.
	Carbon Monoxide	• Several methods are available and almost all employs spectrophotometric principles which rely on absorption or emission of electromagnetic radiations (infra-red in many cases). Both *in situ* and extractive instrumental monitoring types are in common use. Verification of these indicative tests should be through extractive manual wet chemical techniques based on EPA Method 10.
	Oxygen	• Oxygen should be measured at the outlet of the secondary combustion chamber. Several methods are available, these include both in situ and extractive techniques employing electrocatalytic methods, extractive electrochemical cells, and extractive paramagnetic methods. Reference should be made to EPA Method 3A.

Commissioning and Routine Monitoring	Particulate Matter	• Samples should be collected by glass filters according to US EPA Method 5. Isokinetic sampling is required for obtaining a meaning result.
	Visual Smoke	• Ringelmann Chart for visual assessments.
	Sulphur Dioxide	• Samples should be extracted from the stack and then determined by titration using barium thorin in accordance to EPA Method 6. The sampling procedures of the EPA's method can separate the sulphur dioxide and the sulphuric acid mist which will also contain sulphur trioxide.
	Organic Compounds (VOC)	• VOC should be sampled and measured according to EPA Method 25a which uses a Flame Ionization Detector (FID) analyser. The FID analyser should be zeroed and calibrated with test gases according to EPA Method 10. Hydrocarbons and other organic species detected should be expressed in terms of total carbon. The EPA Method 25a may suffer from flame suppression effects and oxygenated species, such as formaldehyde levels may be under-estimated. However, the main organic species from the cremation process is methane with smaller quantities of other hydrocarbons. Therefore, the Method 25a should offer a very good detection of these compounds as total carbon equivalents. The VOC measurements can be affected by oxygen synergism effects but it can be overcome by employing a fuel gas containing a hydrogen/helium gas mixture, rather than pure hydrogen.
	Hydrogen Chloride	• A portion of the stack gas should be passed though a wet absorbing solution which will then be analysed by ion chromatography to determine the concentration of HCl. This method is based on the extractive manual wet chemical techniques given in EPA Method 26 for periodic monitoring of HCl.
	Hydrogen Fluoride	• Draft EPA method for the determination of hydrogen fluoride or equivalent is recommended.
	Hydrogen Sulphide	• Hydrogen sulphide should be collected from the stack using a series of midget impingers and absorbed in pH 3.0 cadmium sulfate solution to form cadmium sulfide which is then measured iodometrically. Reference should be based on EPA Method 11.
	Humidity	• It will be required only if the dry gas volume has not been determined instrumentally. The method involves drawing a metered volume of sample gas through a chilled drying train consisting of a series of at least three pre-weighed drying bottles containing dried calcium chloride or silica gel. The mass of water extracted is then determined gravimetrically.
	Metals (Hg, Cd, As & Ni)	• Sampling of particulate matter should follow EPA Method 5. The metal contents in the collected particulate matter should be determined by Atomic Absorption Spectroscopy.

Appendix B

ISCST3 Modelling Output Sample

```
1          ISCST3 - (DATED 96113)

        IBM-PC VERSION (3.06)  ISCST3R
   (C) COPYRIGHT 1992-1997, TRINITY CONSULTANTS, INC.

Run Began on  6/03/1998 at 15:33:57

** BREEZE AIR ISCST3 - U:\PROJECTS\ISCDAT\BPM\98CO.DAT
** Trinity Consultants Incorporated, Dallas, TX

CO STARTING
CO TITLEONE CO
CO MODELOPT CONC URBAN GRDRIS MSGPRO
CO AVERTIME 1 8
CO POLLUTID CO
CO TERRHGTS ELEV
CO FLAGPOLE
CO RUNORNOT RUN
CO FINISHED

SO STARTING
SO ELEVUNIT METERS
SO LOCATION STACK1 POINT 125.0 125.0 37
SO LOCATION STACK2 POINT 160.0 240.0 20.7
SO SRCPARAM STACK1 1.000000E+00 15 473 12.5 0.75
SO SRCPARAM STACK2 1.000000E+00 15 473 12.5 0.75
SO EMISFACT STACK2 HROFDY 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 1.0
SO EMISFACT STACK2 HROFDY 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0.0 0.0 0.0
SO EMISFACT STACK2 HROFDY 0.0 0.0 0.0 0.0
SO EMISFACT STACK1 HROFDY 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 1.0
SO EMISFACT STACK1 HROFDY 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0.0 0.0 0.0
SO EMISFACT STACK1 HROFDY 0.0 0.0 0.0 0.0
SO EMISUNIT 1000000.000000 GRAMS/SEC MICROGRAMS/M**3
SO SRCGROUP ALL
SO FINISHED

RE STARTING
RE ELEVUNIT METERS
RE GRIDCART CART1 STA
RE GRIDCART CART1 XYINC -500 31 50 0 31 50
RE GRIDCART CART1 ELEV 1 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CART1 ELEV 1 20.0 40.0 6.0 6.6 6.6 15.0 20.0 20.0 20.0
RE GRIDCART CART1 ELEV 1 20.0 20.0 20.0 15.0 15.0 5.6 5.6 6.0 0.0
RE GRIDCART CART1 ELEV 1 0.0 0.0 0.0
RE GRIDCART CART1 ELEV 2 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CART1 ELEV 2 40.0 50.0 22.0 15.0 10.0 15.0 20.0 20.0 20.0
RE GRIDCART CART1 ELEV 2 20.0 20.0 20.0 20.0 15.0 5.6 5.6 6.0 0.0
RE GRIDCART CART1 ELEV 2 0.0 0.0 0.0
RE GRIDCART CART1 ELEV 3 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 10.0
RE GRIDCART CART1 ELEV 3 50.0 60.0 40.0 25.0 20.0 15.0 15.0 20.0 20.0
RE GRIDCART CART1 ELEV 3 20.0 20.0 20.0 20.0 8.0 5.6 5.6 6.0 0.0
RE GRIDCART CART1 ELEV 3 0.0 0.0 0.0
RE GRIDCART CART1 ELEV 4 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 20.0
RE GRIDCART CART1 ELEV 4 60.0 64.0 40.0 30.0 20.0 7.0 15.0 20.0 20.0
RE GRIDCART CART1 ELEV 4 20.0 20.0 20.0 15.0 13.0 6.0 7.0 6.0 0.0
RE GRIDCART CART1 ELEV 4 0.0 0.0 0.0
RE GRIDCART CART1 ELEV 5 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 20.0
RE GRIDCART CART1 ELEV 5 70.0 70.0 40.0 35.0 20.0 7.2 7.0 20.0 20.0
RE GRIDCART CART1 ELEV 5 20.0 20.0 15.0 12.0 12.0 8.0 7.5 6.0 0.0
RE GRIDCART CART1 ELEV 5 0.0 0.0 0.0
RE GRIDCART CART1 ELEV 6 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 10.0 40.0
RE GRIDCART CART1 ELEV 6 80.0 70.0 40.0 37.0 20.7 7.2 7.2 7.2 18.0
RE GRIDCART CART1 ELEV 6 20.0 18.0 12.4 0.0 8.0 8.0 7.5 6.0 0.0 0.0
RE GRIDCART CART1 ELEV 6 0.0 0.0
RE GRIDCART CART1 ELEV 7 0.0 0.0 0.0 0.0 0.0 0.0 0.0 5.0 20.0 60.0
RE GRIDCART CART1 ELEV 7 90.0 70.0 40.0 37.0 24.0 7.2 7.2 7.2 7.2
RE GRIDCART CART1 ELEV 7 15.0 7.0 13.0 14.0 8.0 18.0 8.0 6.0 0.0
RE GRIDCART CART1 ELEV 7 0.0 0.0 0.0
RE GRIDCART CART1 ELEV 8 0.0 0.0 0.0 0.0 0.0 0.0 0.0 5.0 30.0 60.0
RE GRIDCART CART1 ELEV 8 90.0 70.0 55.0 37.0 25.0 7.2 7.2 7.2 7.2
RE GRIDCART CART1 ELEV 8 7.2 7.0 13.0 8.0 15.0 21.0 15.2 6.0 0.0
RE GRIDCART CART1 ELEV 8 0.0 0.0 0.0
RE GRIDCART CART1 ELEV 9 0.0 0.0 0.0 0.0 0.0 0.0 0.0 6.0 30.0 60.0
RE GRIDCART CART1 ELEV 9 80.0 70.0 57.6 40.0 25.0 10.0 10.0 10.0 7.2
RE GRIDCART CART1 ELEV 9 15.0 7.0 20.0 15.0 22.0 21.0 21.0 6.0 0.0
RE GRIDCART CART1 ELEV 9 0.0 0.0 0.0 •
RE GRIDCART CART1 ELEV 10 0.0 0.0 0.0 0.0 0.0 0.0 0.0 9.0 30.0 60.0
RE GRIDCART CART1 ELEV 10 80.0 70.0 60.0 45.0 25.0 15.0 15.0 15.0 15.0
RE GRIDCART CART1 ELEV 10 21.0 10.0 24.0 22.0 19.0 28.0 21.0 10.0 0.0
RE GRIDCART CART1 ELEV 10 0.0 0.0 0.0
RE GRIDCART CART1 ELEV 11 0.0 0.0 0.0 0.0 0.0 0.0 0.0 9.0 30.0 60.0
RE GRIDCART CART1 ELEV 11 80.0 70.0 60.0 32.0 30.0 18.0 18.0 18.0 18.0
RE GRIDCART CART1 ELEV 11 20.0 10.0 24.0 24.0 27.0 0.0 28.0 15.0 0.0
RE GRIDCART CART1 ELEV 11 0.0 0.0 0.0
RE GRIDCART CART1 ELEV 12 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CART1 ELEV 12 60.0 60.0 60.0 53.0 21.0 17.0 14.0 14.0 14.0
RE GRIDCART CART1 ELEV 12 21.0 34.0 50.0 27.0 28.0 28.0 28.2 20.0 0.0
RE GRIDCART CART1 ELEV 12 0.0 0.0 0.0
RE GRIDCART CART1 ELEV 13 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CART1 ELEV 13 50.0 50.0 50.0 60.0 21.0 17.0 14.0 14.0 14.0
RE GRIDCART CART1 ELEV 13 20.0 61.0 31.0 50.0 0.0 61.0 30.0 61.0 0.0
RE GRIDCART CART1 ELEV 13 0.0 0.0 0.0
RE GRIDCART CART1 ELEV 14 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CART1 ELEV 14 50.0 50.0 50.0 50.0 21.0 17.0 14.0 14.0 14.0
RE GRIDCART CART1 ELEV 14 20.0 61.0 61.0 61.0 61.0 70.0 61.0 61.0 0.0
RE GRIDCART CART1 ELEV 14 0.0 0.0 0.0
```

```
RE GRIDCART CARTI ELEV 15 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI ELEV 15 30.0 30.0 30.0 50.0 21.0 17.0 14.0 14.0 14.0
RE GRIDCART CARTI ELEV 15 30.0 61.0 61.0 61.0 61.0 94.0 61.0 80.0 0.0
RE GRIDCART CARTI ELEV 15 0.0 0.0 0.0
RE GRIDCART CARTI ELEV 16 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI ELEV 16 20.0 20.0 20.0 50.0 21.0 17.0 14.0 14.0 20.0
RE GRIDCART CARTI ELEV 16 40.0 40.0 60.0 55.0 94.0 94.0 90.0 94.0 0.0
RE GRIDCART CARTI ELEV 16 0.0 0.0 0.0
RE GRIDCART CARTI ELEV 17 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI ELEV 17 20.0 20.0 20.0 50.0 7.0 17.0 14.0 14.0 20.0
RE GRIDCART CARTI ELEV 17 40.0 30.0 50.0 40.0 60.0 80.0 97.0 94.0 0.0
RE GRIDCART CARTI ELEV 17 0.0 0.0 0.0
RE GRIDCART CARTI ELEV 18 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI ELEV 18 20.0 20.0 20.0 6.0 7.0 36.0 14.0 14.0 20.0
RE GRIDCART CARTI ELEV 18 40.0 20.0 30.0 40.0 60.0 80.0 80.0 80.0 0.0
RE GRIDCART CARTI ELEV 18 0.0 0.0 0.0
RE GRIDCART CARTI ELEV 19 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI ELEV 19 20.0 20.0 20.0 6.0 7.0 36.0 14.0 14.0 20.0
RE GRIDCART CARTI ELEV 19 30.0 20.0 30.0 38.0 60.0 80.0 100.0 80.0
RE GRIDCART CARTI ELEV 19 0.0 0.0 0.0 0.0
RE GRIDCART CARTI ELEV 20 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI ELEV 20 20.0 20.0 20.0 6.0 7.0 17.0 14.0 14.0 20.0
RE GRIDCART CARTI ELEV 20 30.0 20.0 20.0 46.0 0.0 85.0 100.0 77.0 0.0
RE GRIDCART CARTI ELEV 20 0.0 0.0 0.0
RE GRIDCART CARTI ELEV 21 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI ELEV 21 20.0 20.0 20.0 6.0 7.0 8.0 14.0 14.0 7.0
RE GRIDCART CARTI ELEV 21 30.0 20.0 20.0 50.0 60.0 77.0 77.0 77.0 0.0
RE GRIDCART CARTI ELEV 21 0.0 0.0 0.0
RE GRIDCART CARTI ELEV 22 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI ELEV 22 20.0 20.0 20.0 6.0 7.0 8.0 7.0 7.0 7.0 7.0
RE GRIDCART CARTI ELEV 22 8.0 20.0 50.0 60.0 40.0 65.0 70.0 0.0 0.0
RE GRIDCART CARTI ELEV 22 0.0 0.0
RE GRIDCART CARTI ELEV 23 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI ELEV 23 20.0 20.0 20.0 5.0 7.0 8.0 7.0 7.0 7.0 7.0
RE GRIDCART CARTI ELEV 23 8.0 20.0 50.0 80.0 40.0 68.0 40.0 0.0 0.0
RE GRIDCART CARTI ELEV 23 0.0 0.0
RE GRIDCART CARTI ELEV 24 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI ELEV 24 20.0 20.0 20.0 5.0 7.0 7.0 7.0 7.0 7.0 7.0
RE GRIDCART CARTI ELEV 24 8.0 10.0 50.0 77.0 40.0 40.0 40.0 0.0 0.0
RE GRIDCART CARTI ELEV 24 0.0 0.0
RE GRIDCART CARTI ELEV 25 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI ELEV 25 20.0 20.0 20.0 5.0 7.0 6.0 7.0 7.0 7.0 7.0
RE GRIDCART CARTI ELEV 25 8.0 10.0 50.0 70.0 40.0 39.0 40.0 0.0 0.0
RE GRIDCART CARTI ELEV 25 0.0 0.0
RE GRIDCART CARTI ELEV 26 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI ELEV 26 20.0 20.0 20.0 5.0 6.0 6.0 7.0 7.0 7.0 7.0
RE GRIDCART CARTI ELEV 26 8.0 10.0 50.0 60.0 40.0 36.0 40.0 0.0 0.0
RE GRIDCART CARTI ELEV 26 0.0 0.0
RE GRIDCART CARTI ELEV 27 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI ELEV 27 20.0 20.0 20.0 5.0 6.0 6.0 7.0 7.0 7.0 7.0
RE GRIDCART CARTI ELEV 27 8.0 10.0 50.0 70.0 40.0 36.0 40.0 0.0 0.0
RE GRIDCART CARTI ELEV 27 0.0 0.0
RE GRIDCART CARTI ELEV 28 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI ELEV 28 20.0 20.0 20.0 5.0 6.0 5.0 7.0 7.0 7.0 7.0
RE GRIDCART CARTI ELEV 28 8.0 10.0 50.0 40.0 40.0 6.4 40.0 0.0 0.0
RE GRIDCART CARTI ELEV 28 0.0 0.0
RE GRIDCART CARTI ELEV 29 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI ELEV 29 20.0 20.0 20.0 5.0 6.0 5.0 7.0 7.0 7.0 7.0
RE GRIDCART CARTI ELEV 29 8.0 10.0 36.0 35.0 40.0 6.4 40.0 0.0 0.0
RE GRIDCART CARTI ELEV 29 0.0 0.0
RE GRIDCART CARTI ELEV 30 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI ELEV 30 20.0 20.0 20.0 5.0 6.0 5.0 7.0 7.0 7.0 7.0
RE GRIDCART CARTI ELEV 30 8.0 10.0 5.2 8.0 40.0 6.4 40.0 0.0 0.0 0.0
RE GRIDCART CARTI ELEV 30 0.0
RE GRIDCART CARTI ELEV 31 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI ELEV 31 20.0 20.0 20.0 5.0 0.0 4.0 7.0 7.0 7.0 7.0
RE GRIDCART CARTI ELEV 31 8.0 10.0 5.2 6.0 40.0 6.4 40.0 0.0 0.0 0.0
RE GRIDCART CARTI ELEV 31 0.0
RE GRIDCART CARTI FLAG 1 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI FLAG 1 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI FLAG 1 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI FLAG 1 0.0
RE GRIDCART CARTI FLAG 2 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI FLAG 2 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI FLAG 2 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI FLAG 2 0.0
RE GRIDCART CARTI FLAG 3 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI FLAG 3 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI FLAG 3 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI FLAG 3 0.0
RE GRIDCART CARTI FLAG 4 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI FLAG 4 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI FLAG 4 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI FLAG 4 0.0
RE GRIDCART CARTI FLAG 5 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI FLAG 5 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI FLAG 5 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI FLAG 5 0.0
RE GRIDCART CARTI FLAG 6 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI FLAG 6 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI FLAG 6 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI FLAG 6 0.0
RE GRIDCART CARTI FLAG 7 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI FLAG 7 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI FLAG 7 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RE GRIDCART CARTI FLAG 7 0.0
```

```
RE GRIDCART CART1 END
RE DISCCART 300.0 255.0 7.2 0
RE DISCCART 710.0 0.0 5.6 0
RE DISCCART -150.0 250.0 0 0
RE DISCCART 505.0 600.0 61 0
RE DISCCART 505.0 600.0 61 20
RE DISCCART 505.0 600.0 61 40
RE DISCCART 505.0 600.0 61 60
RE DISCCART 505.0 600.0 61 70
RE DISCCART 505.0 600.0 61 80
RE DISCCART 220.0 290.0 8.4 0
RE DISCCART 220.0 290.0 8.4 15
RE DISCCART 220.0 290.0 8.4 45
RE DISCCART 220.0 290.0 8.4 65
RE DISCCART 220.0 290.0 8.4 75
RE DISCCART 220.0 290.0 8.4 85
RE FINISHED

ME STARTING
ME INPUTFIL U:\PROJECTS\RODATA\HI89\HI89ISC.MET FREE
ME ANEMHGHT 57.7 METERS
ME SURFDATA 14742 1994
ME UAIRDATA 14635 1994
ME STARTEND 1994 01 01 1 1994 12 31 24
ME FINISHED

OU STARTING
OU RECTABLE 1 FIRST
OU RECTABLE 8 FIRST
OU PLOTFILE 1 ALL FIRST U:\PROJECTS\ISCDAT\BPM\98CO.GPH 70
OU FINISHED
```

*** Message Summary For ISC3 Model Setup ***

——— Summary of Total Messages ———

A Total of 0 Fatal Error Message(s)
A Total of 1 Warning Message(s)
A Total of 0 Informational Message(s)

******** FATAL ERROR MESSAGES ********
*** NONE ***

******** WARNING MESSAGES ********
CO W205 17 FLAGDF:No Option Parameter Setting. Forced by Default to ZFLAG=0.

****
*** SETUP Finishes Successfully ***
****

*** ISCST3 - VERSION 96113 *** *** CO *** 06/03/98
*** *** 15:33:58
PAGE 1
**MODELOPTs: CONC URBAN ELEV FLGPOL GRDRIS MSGPRO

*** MODEL SETUP OPTIONS SUMMARY ***

- -

**Intermediate Terrain Processing is Selected

**Model Is Setup For Calculation of Average CONCentration Values.

-- SCAVENGING/DEPOSITION LOGIC --
**Model Uses NO DRY DEPLETION. DDPLETE = F
**Model Uses NO WET DEPLETION. WDPLETE = F
**NO WET SCAVENGING Data Provided.
**Model Does NOT Use GRIDDED TERRAIN Data for Depletion Calculations

**Model Uses URBAN Dispersion.

**Model Uses User-Specified Options:
1. Gradual Plume Rise.
2. Stack-tip Downwash.
3. Buoyancy-induced Dispersion.
4. Calms Processing Routine.
5. Missing Data Processing Routine.
6. Default Wind Profile Exponents.
7. Default Vertical Potential Temperature Gradients.

**Model Accepts Receptors on ELEV Terrain.

**Model Accepts FLAGPOLE Receptor Heights.

**Model Calculates 2 Short Term Average(s) of: 1-HR 8-HR

**This Run Includes: 2 Source(s); 1 Source Group(s); and 976 Receptor(s)

**The Model Assumes A Pollutant Type of: CO

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
Model Outputs Tables of Highest Short Term Values by Receptor (RECTABLE Keyword)

Model Outputs External File(s) of High Values for Plotting (PLOTFILE Keyword)

**NOTE: The Following Flags May Appear Following CONC Values: c for Calm Hours
m for Missing Hours
b for Both Calm and Missing Hours

**Misc. Inputs: Anem. Hgt. (m) = 57.70 ; Decay Coef. = .0000 ; Rot. Angle = .0
Emission Units = GRAMS/SEC ; Emission Rate Unit Factor = .10000E+07
Output Units = MICROGRAMS/M**3

**Input Runstream File: U:\PROJECTS\ISCDAT\BPM\98CO.DAT ; **Output Print File: U:\PROJECTS\ISCDAT\BPM\98CO.LST

Appendix C

Correspondences

ARCHITECTURAL SERVICES DEPARTMENT 建築署

QUEENSWAY GOVERNMENT OFFICES, 66 QUEENSWAY, HONG KONG. 香港金鐘道六十六號金鐘道政府

Our ref. : ASD/62/5415/IC/RC/590

FAX

Hyder Consulting Limited
8/F Somerset House
TaiKoo Place, Hong Kong

November 11, 97

Attention : Mr Martin Chan

Revised Final Report for Kwai Cung Crematorium

Your fax ref. 1655001/mc dated 7.11.97 and our subsequent telephone conversation on 11.11.97 refers.

It was noted that there were a lot of amendment on the draft final report as compared with previous version which has been agreed with RSD in the meeting in our office on 3.11.97. There is no objection on my side for you to proceed with the formal submission of the final report (latest version) to EPD but I wish to highlight some amendment which have been discussed between us as follows for your action and the attention of the RSD and PA who are required to render their input to different extent.

Ref.	Comments/Amendment
P.2/2 in Content Pages	List of figures to be updated and the result/summary of the computer modelling to included in the report.
p.1, clause 1.2	Two twin cremators instead of four single units for the existing installation.
p.3, clause 2.2	There is a major revision in this section. Provisions of bag filters and electrostatic precipitators are some suggestion for consideration only but is not an absolute requirement.
p.7, clause 3.1.3	Previous assessment criteria with Occupational Exposure Limits was replaced by a more stringent guideline of other international standards. It was confirmed that there is no underlying meaning or implications associated with the fact that some parameters mentioned in your report could not be checked at the moment.
p.9, clause 3.4	It is your recommendation to the Project Architect that the minimum chimney height required for both phases of the crematorium is 15m which is about 3 times of the existing one. It was also confirmed that with such chimney height, outlet of chimney at phase 1 is well above the premises at phase 2 and the emission from phase 1 would be properly dispersed such that there will be no adverse health effect to the RSD's staff who will be subject to prolonged exposure to such emission.
p.12, clause 3.4	It is the first time mentioned in the report that the fuel consumption rate of a new cremator complying with latest statutory requirement is more than six (6) times of the existing cremators. S of A of the U/G fuel tank have to be critically reviewed. Written advice from USD regarding the statistic of the operation in Cape collinson will be provided by you under a separate cover. It appears to me that such a high fuel consumption for compliance of BPM may be a new finding of your investigation that at different perspective, clean emission is not environmentally viable at the expense of global warming effect which is not expressly addressed in the report though it is not the concern of the statutory requirement under your consideration. Nevertheless, being an impartial investigator, I think you may wish to make this point clear in your report as a response to clause no. 6(b) in your consultancy agreement to "review the requirement set down in BPM notes for incinerators in connection with cremation operation".
p.12, clause 3.5	Figure 3.2 is not included in your table of content

Hyder Consulting Limited
Date received 17 NOV 1997
Reg no. 1997-F0890
Div/Dep EN
Manager B. TODD
Date received in Div/Dep 17/11

For Action	For Info	Sign	Date
MU			17.11.97

Copy to
Reply date
File ref

file : 971111

38

p.14, clause 4.1
p.15, clause 4.2.1 Your new recommendation of the low sulphur fuel upgraded from 0.5% to 0.3% without major change in the result of the dispersion modelling is noted. It was confirmed that consultation with the oil companies on the availability and cost of such low sulphur fuel has been conducted. Additional information on these two aspects associated with your new recommendation will be provided to RSD by you under a separate cover.

p.15, clause 4.1 Your recommended requirement to the Project Architect which dictate the location of the chimney relative to the adjacent buildings is noted.

p.15, clause 4.2.2 Your new recommendation to RSD for appointing specialist to carry out stack samplings for every six months interval is noted.

p.16, clause 4.2.3
clause 4.2.4
clause 4.2.5 There are substantial amendments and additional requirement relating to the daily operations and staff training which require the attention of RSD, especially the recommended reporting system to EPD and oversea training for qualified operator. It seems to me that all these recommendation are reasonable and practicable. Therefore, there would be not much grounds for RSD not enforcing these recommendations if EPD eventually impose all of them in the licence.

Please also take into consideration of the abovementioned in your report for Wo Hop Shek where appropriate though a confined scope of the project is the preliminary concern of the project team and RSD.

A copy of the revised report is attached herewith for the attention of the relevant parties.

Yours faithfully,

(Raymond Kan)
for Chief Building Services Engineer/2

Encl.

cc PM321 - Mr Wilson Lee (w/e)
PM323 - Ms Susanna Cheung
PA - Ms Jane Au Yeung (w/e)
Director of RS - Mr S S Chung (w/e)
Director of RS - Mr F K Tong (w/e)
Director of EP - Mr C H Yung

file : 971111

39

H.K. REGIONAL OFFICE
(ENVIRONMENTAL HYGIENE)
市政總署港島區環境衞生總部事處
8TH FLOOR,
URBAN COUNCIL LOCKHART ROAD COMPLEX,
225 HENNESSY ROAD,
WANCHAI, HONG KONG.

TEL NO.: 電話： 2578 9406
Fax No. 2566 7000

Office of
Cemeteries and Crematoria (Hong Kong),
No. 18, Oil Street, North Point,
Hong Kong.

26 September 1997

Mr. Martin Chan,
Senior Enviornmental Consultant,
Hyder Consulting Ltd.,
Enviornmental Division,
3/F, Somerset House,
Taikoo Place,
979, King's Road,
Quarry Bay, Hong Kong.

Dear Mr. Chan,

Re: Crematoria Air Quality Study

I refer to your FAX letter and would like to furnish you the following for your information:

a) Diesel Light (0.5% Sulphur).

b) 194 Litres per cremation.

c) Daily maximum cremation is 24.

d) No. of cremations during past year is 7,291.

Should you wish to have further information, please feel free to contact me.

Yours faithfully,

(LEUNG Kwok-yuen)
for Director of Urban Services

市政總署 URBAN SERVICES DEPARTMENT

USD403(8/86)

40

ARCHITECTURAL SERVICES DEPARTMENT 建築署
QUEENSWAY GOVERNMENT OFFICES, 66 QUEENSWAY, HONG KONG. 香港金鐘道六十六號金鐘道政府合

Our ref. : ASD/62/5415/IC/RC/590

Hyder Consulting Limited
3/F Somerset House
TaiKoo Place, Hong Kong

July 23, 97

Attention : Mr Martin Chan

Preliminary Modelling for Kwai Cung Crematorium

With reference to your fax dated 17.7.97 and our subsequent telephone conversation on 21.7.97, I am pleased to response and point out the following for your attention.

1) I would consider your following assumption on the future engineering design at Kwai Chung Crematorium is reasonable.

Stack diameter	:	750 mm
Stack gas exit velocity	:	12.5 m/s
Stack gas exit temperature	:	473 K

2) I do not anticipate any engineering problem for having your proposed stack height of 3 metres above the building roof. However, please note that a minimium head room of 6 metre at cremation room will be required. Please ensure that dispersion modelling for two different phases of redevelopment has been covered. Besides, your recommendation of stack height has taken into account the level different between the two crematoria and emission from individual stacks could be properly dispersed without any adverse health effect to RSD's staff working in the phase two crematorium.

3) As your initial findings reveals that concentrations of all pollutants are acceptable except the emission of sulphur dioxide, I wish to you to have more trials on modelling and advise me on the following.
- Is it critrical for the final conclusion of the air impact assessment ?
- Have you attempted for more realistic or representative figure of liquid fuel instead of using BPM only ?
- Have you seek for EPD's views on your inital finding and in particular the locations of sensitive receiver ?

4) If your answer to abovementioned are still negative after more trails, please explain in detail why the computer dispersion modelling will have such result which is simply a typical problem of combustion process with diesel in the vicinity of an industrial area instead of the public's major concern for a cremation process.

5) I have already written to the Gas Company to check for the availability of town gas supply and the rely is still awaiting. Please provide more details of desulphurization system mentioned in your fax and advise if there is any successful application of desulphurization installation for crematorium in the other country. Please note any that drawbacks of the proposed desulphurization system on cremation and any significant cost effect which may critical for further implementation of the projects shall be addressed explicitly.

As you may be aware, the progress of the air impact assessment is not satisfactory and the assignment are supposed to be completed in four months time after the commencement of work in April. However, initial modelling for Wo Hop Shek is still processing. Your effort to expedite the progress of the air impact assessment will be highly appreciated.

Yours faithfully,

(Raymond Kan)
for Chief Building Services Engineer/2

Hyder Consulting Limited
Date received 29 JUL 1997
Reg no. 4745944
Div/Dep EPD
Manager
Date received in Div/Dep 1/8

For Action	For Info	Sign	Date

Copy to
Reply date
File ref. J655001A

cc PM321 - Mr Wilson Lee
PM323 - Ms Susanna Cheung
PA - Ms Jane Au Yeung
Director of EP - Mr C H Yung
Director of RS - Mr F K Tong

file : 979723

41

ARCHITECTURAL SERVICES DEPARTMENT 建築署
QUEENSWAY GOVERNMENT OFFICES, 66 QUEENSWAY, HONG KONG. 香港金鐘道六十六號金鐘道政府合

Our Ref.: ASD/62/5415/IC/RCC/500
ASD/62/5549/IC/RCC/500

Hong Kong & China Gas Co., Ltd.
24/F, Leighton Centre
77 Leighton Road
Hong Kong

Town Gas Supply
Kwai Chung Crematorium & Wo Hop Shek Skeletal Crematorium

I attach herewith the site plan, in duplicate, of the proposed Kwai Chung Crematorium at Wing Hau Road and Wo Hop Shek Skeletal Crematorium for application of town gas supply to the two crematory. As requested by EPD, it is intended to replace the existing facilities by gas fired cremators in phases as follows:-

Kwai Chung Crematory

Phase 1 : 4,000,000 BTU/hr (by June, 2000) ~ 1.172 MW
Phase 2 : 4,000,000 BTU/hr (by June, 2002)
Total Burner Capacity : 8,000,000 BTU/hr approximately ~ 2.344 MW

Wo Hop Shek Crematory

Skeletal Crematorium : 1,500,000 BTU/hr (by June, 2000) 0.44 MW
Body Crematorium : 6,000,000 BTU/hr (by June, 2005) 1.758 MW
Total Burner Capacity : 7,500,000 approximately ~ 2.198 MW

Hyder Consulting Limited
Date received 13 JUN 1997
Reg no. 97-39690
Div/Dep ZxIV.1
Manager A. Tam
Date received in Div/Dep 16/6

For Action	For Info	Sign	Date
IMC			

Copy to
Reply via
File ref.

It would be appreciated if you could confirm the availability of gas supply and return to me one copy of the site plan marked up with the proposed route of your underground gas piping or other requirement. Should you have any query, please contact our Project Electrical & Mechanical Engineer, Mr. Raymond Kan, at 2867 3773.

Yours faithfully,

(Raymond Kan)
for Chief Building Services Engineer/2

Encl.

c.c. PM321 - Mr. Wilson Lee
PM323 - Mrs. Susanna Cheung
PA - Mrs. Jane Au Yeung
Hyder Environmental Consultant - Mr. Martin Chan
Director of RS - Mr. F.K. Tong

RK/ic
Filecode: 5415.doc

ARCHITECTURAL SERVICES DEPARTMENT 建築署
QUEENSWAY GOVERNMENT OFFICES, 66 QUEENSWAY, HONG KONG. 香港金鐘道六十六號金鐘道政府合署
Our Ref.: ASD/62/5549/IC/RCC/590

Hyder Consulting Limited.
3/F Somerset House, Taikoo Pace
979 King's Road,
Quarry Bay, Hong Kong

28 MAY 1997.

Attention: Mr. Martin Chan

Air Impact Assessment
Kwai Chung Crematorium & Wo Hop Shek Skeletal Crematorium

Our telephone conversation on 22.5.96 regarding your current progress of air impact assessment and initial findings with EPD refers. I wish to address and response to the following two points we have discussed.

1) Stack Commission

Your agreement with EPD on using the stack emission from cape collinson crematorium currently operated by USD and previously designed by EMSD as reference for predication of the future crematorium is noted.

Notwithing your obligation to acquire such information from the relevant government department as stipulated in the technical brief, I have subsequently approached a specialist E&M contractor, Messrs. Swedish Trading Co., Ltd., who have released a copy of report titled "2nd Report on Emission Tests of Cremators at Cape Collinson Crematorium". I was told that such report and stack emission measurement was carried out by H.K. Productivity Council, who was commissioned by Swedish Trading, for submission to EPD in July, 94. Please vertify the accuracy of the report or carry out any stack emission measurement where appropriate. Besides, you may contact Mr. Spencer Li of Swedish Trading at 2953 5111 if necessary.

2) Licencing and Improvement Works on Existing Facilities in Wo Hop Shek Crematorium

It was noted that EPD wish to initiate a meeting with all concerned parties including the officers from planning and operation division of RSD and the captioned will be one of the topic in the agenda.

As discussed, I believe that RSD would agree to implement some practical measures to enchance the existing stack emission in Wo Hop Shek whilst I would definitely not support imposing emission limit to the existing facilities without any action plan being given. As such, would you please work out a proposed action plan with a list of reasonable suggestion with EPD before I arrange such a meeting with RSD and other project team members.

Yours faithfully,

(Raymond Kan)
for Chief Building Services Engineer/2

Encl.

-3 JUN 1997
97-37123
EPD
MC

RK/ic
Filecode: b\5549c.doc

LL3

2nd REPORT ON EMISSION TESTS OF CREMATORS AT CAPE COLLINSON CREMATORIUM

(Project No.: 1A 13463)

Environmental Management Division
Hong Kong Productivity Council

28th July, 1994

CONTENTS

SUMMARY OF THE TEST RESULTS (1 of 2)

Results of Particulates (Grit and Dust) Measurement

DATE	TIME	PARTICULATES CONCENTRATION[1] (mg/dscm[2])
30.6.94	11:35 - 12:55	55
30.6.94	15:00 - 16:30	90

Results of Metals Measurement

DATE	TIME	METAL CONCENTRATION[1] (µg/dscm[2])							
		Hg	Cd	Sn	Pb	Cu	As	Ni	Cr
30.6.94	11:35 - 15:55	1	5	<164	263	33	2	49	33
30.6.94	15:00 - 16:30	1	8	166	282	83	1	17	17

Results of Sulphur Dioxide (SO_2) Measurement

DATE	TIME	SO_2 CONCENTRATION[1] (mg/scm[3])
30.6.94	11:30 - 12:30	169
30.6.94	15:00 - 16:00	124

Certified by:

Raymond C.L. Fong
Consultant
Environmental Management Division
Hong Kong Productivity Council

---

1 All pollutant concentrations are corrected to 0°C, 101.325 kPa and 11% oxygen condition.

2 dscm stands for dry standard cubic meter measured at 0°C, 101.325 kPa and dry condition.

3 scm stands for standard cubic meter measured at 0°C and 101.325 kPa condition.

SUMMARY OF THE TEST RESULTS (2 of 2)

Results of Total Hydrocarbon (THC) Measurement

DATE	TIME	THC (as carbon) CONCENTRATION[4] (mg/scm^5)
30.6.94	12.05 - 12:20	6.37
30.6.94	15:15 - 15:30	6.62

Results of Other Pollutants Measurement

DATE	TIME	CONCENTRATION[4] (mg/scm^5)			
		CO	HCl	H_2S	HF
30.6.94	11:50 - 12:05	< 4.1	< 1.1	< 1.5	< 0.6
	12:05 - 12:20	< 4.1	< 1.1	< 1.5	< 0.6
	12:20 - 12:30	< 4.1	< 1.1	< 1.5	< 0.6
30.6.94	15:00 - 15:15	< 4.1	< 1.1	< 1.5	< 0.6
	15:15 - 15:30	< 4.1	< 1.1	< 1.5	< 0.6
	15:30 - 15:45	< 4.1	< 1.1	< 1.5	< 0.6

Results of Smoke Measurement

The smoke emission of the two sampling periods are both less than Ringelmann Shade 1.

Certified by:

Raymond C.L. Fong
Consultant
Environmental Management Division
Hong Kong Productivity Council

---

4 All pollutants concentrations are corrected to 0°C, 101.325 kPa and 11% oxygen condition.

5 scm stands for stand cubic meter measured at 0°C and 101.325 kPa condition.

47

2ND REPORT ON EMISSION TEST OF CREMATORS AT CAPE COLLINSON CREMATOTIUM

(Project No.: 1A 13463)

1. BACKGROUND

The client, Swedish Trading Co., Ltd., was contracted to install ten cremators served by five chimneys in Cape Collinson Crematorium, and was required to conduct performance test of the cremation system. The Council was commissioned to perform the stack emission tests of the cremators. This is the second emission test report for the emission point EP2 serving the pair of cremators denoted C9 & C10.

2. TIME SCHEDULE OF STACK EMISSION TESTS

The time schedule of the stack emission test was shown in Table 1 and the locations of the sampling points were shown in Appendix I for reference:

Table 1: Time Schedule of Stack Emission Test

PARAMETERS	NO. OF MEASUREMENT	
	Stack Emission Test on 30.6.94 (a.m.)	Stack Emission Test on 30.6.94 (p.m.)
Particulates	1	1
Metals	1	1
Sulphur Dioxide	1	1
Total Hydrocarbon	1	1
Carbon Monoxide	3	3
Hydrogen Chloride	3	3
Hydrogen Sulphide	3	3
Hydrogen Fluoride	3	3
Smoke	Continuous	Continuous

3. METHODOLOGY OF THE STACK EMISSION TEST

(a) Particulates (Grit and Dust) Measurement

The stack emission tests for measuring the particulates (grit and dust) emission were carried out by using an Isokinetic Stack Sampling System of Nutech Corporation and the procedures adopted were in accordance with the USEPA Method 5 (Determination of Particulate Emission from Stationary Sources). Each of the two particulate samples was collected from 24 sampling positions inside the stack along one axis, and the duration of the particulate sampling was three minutes at each sampling positions.

The results of particulates concentration were corrected to 0°C, 101.325 kPa and 11% O_2 content.

(b) Metals Measurement

Heavy metals (Hg, Cd, Sn, Pb, Cu, As, Ni & Cr) emissions were determined by analysing the metals content in the particulates collected in item (a) above using atomic absorption spectroscopy.

The results of metals concentration were corrected to 0°C, 101.325 kPa and 11% O_2 content.

(c) Sulphur Dioxide Measurement

The determination of sulphur dioxide was conformed to the USEPA Method 6 (Determination of sulphur dioxide emissions from stationary sources). Each of the two samples was collected from the stack inside, and the duration of sampling was one hour each.

The results of sulphur dioxide concentration was corrected to 0°C, 101.325 kPa and 11% O_2 content.

49

(d) Total Hydrocarbon Measurement

Total hydrocarbon emission was measured by grabbing flue gas sample in Tedlar bag and then analysed by flame ionization detection method. The sampling time for each samples was about 15 minutes.

The results of total hydrocarbon concentration were corrected to 0°C, 101.325 kPa and 11% O_2 content.

(e) Other Gaseous Pollutant Measurement

Carbon monoxide was measured by electro-chemical cell detection method. Hydrogen chloride, hydrogen sulphide and hydrogen fluoride emissions were measured by Kitagawa detector tubes.

The results of above pollutants concentration were corrected to 0°C, 101.325 kPa and 11% O_2 content.

(f) Smoke Measurement

Smoke emission were determined by observation using the Micro-Ringlemann Chart during the sampling periods.

Notes:

The oxygen content of the flue gas during the sampling periods were determined by the orsat apparatus. The obtained values were used for the convertion of the measurement results to standard reference condition.

4. RESULTS OF THE STACK EMISSSION TEST

(a) Particulates (Grit and Dust) Measurement

The results of the particulates (grit and dust) measurement are summarized in Table 2.

Table 2: Results of Particulates (Grit and Dust) Measurement

DATE	TIME	PARTICULATES CONCENTRATION (mg/dscm)
30.6.94	11:35 - 12:55	55
30.6.94	15:00 - 16:30	90

Detailed results of particulates emission can be found in Appendix II.

(b) Metals Measurement

The results of the metals (Hg, Cd, Sn, Pb, Cu, As, Ni, Cr) measurement are summarized in Table 3.

Table 3: Results of Metals Measurement

DATE	TIME	METAL CONCENTRATION (µg/dscm)							
		Hg	Cd	Sn	Pb	Cu	As	Ni	Cr
30.6.94	11:35 - 15:55	1	5	<164	263	33	2	49	33
30.6.94	15:00 - 16:30	1	8	166	282	83	1	17	17

Detailed results of the metals measurement can be found in Appendix III.

(c) Sulphur Dioxide Measurement

The results of the sulphur dioxide (SO_2) measurement are summarized in Table 4.

Table 4: Results of Sulphur Dioxide Measurement

DATE	TIME	SO_2 CONCENTRATION (mg/scm)
30.6.94	11:30 - 12:30	169
30.6.94	15:00 - 16:00	124

Detailed results of sulphur dioxide emission can be found in Appendix IV.

(d) Total Hydrocarbon Measurement

The results of the total hydrocarbon (THC) measurement are summarized in Table 5.

Table 5: Results of Total Hydrocarbon Measurement

DATE	TIME	THC (as carbon) CONCENTRATION (mg/scm)
30.6.94	12.05 - 12:20	6.37
30.6.94	15:15 - 15:30	6.62

Detailed results of total hydrocarbon emission can be found in Appendix V.

(e) Other Pollutants Measurement

The results of other pollutants (i.e. CO, HCl, H_2S, HF) measurement are summarized in Table 6.

Table 6: Results of other Pollutants Measurement

DATE	TIME	CONCENTRATION (mg/scm)			
		CO	HCl	H_2S	HF
30.6.94	11:50 - 12:05	< 4.1	< 1.1	< 1.5	< 0.6
	12:05 - 12:20	< 4.1	< 1.1	< 1.5	< 0.6
	12:20 - 12:30	< 4.1	< 1.1	< 1.5	< 0.6
30.6.94	15:00 - 15:15	< 4.1	< 1.1	< 1.5	< 0.6
	15:15 - 15:30	< 4.1	< 1.1	< 1.5	< 0.6
	15:30 - 15:45	< 4.1	< 1.1	< 1.5	< 0.6

Detailed results of other pollutants emission can be found in Appendix VI.

(f) Smoke Measurement

The smoke emission as observed during the two sampling periods were both less than Ringelmann Shade 1.

APPENDIX I

Locations of Sampling Points

5. OPERATING CONDITION OF CREMATION SYSTEM

The client informed that the pair of the cremators being tested were at their full load conditions during the sampling periods of the stack emission test.

6. LIMITATION OF MEASUREMENT

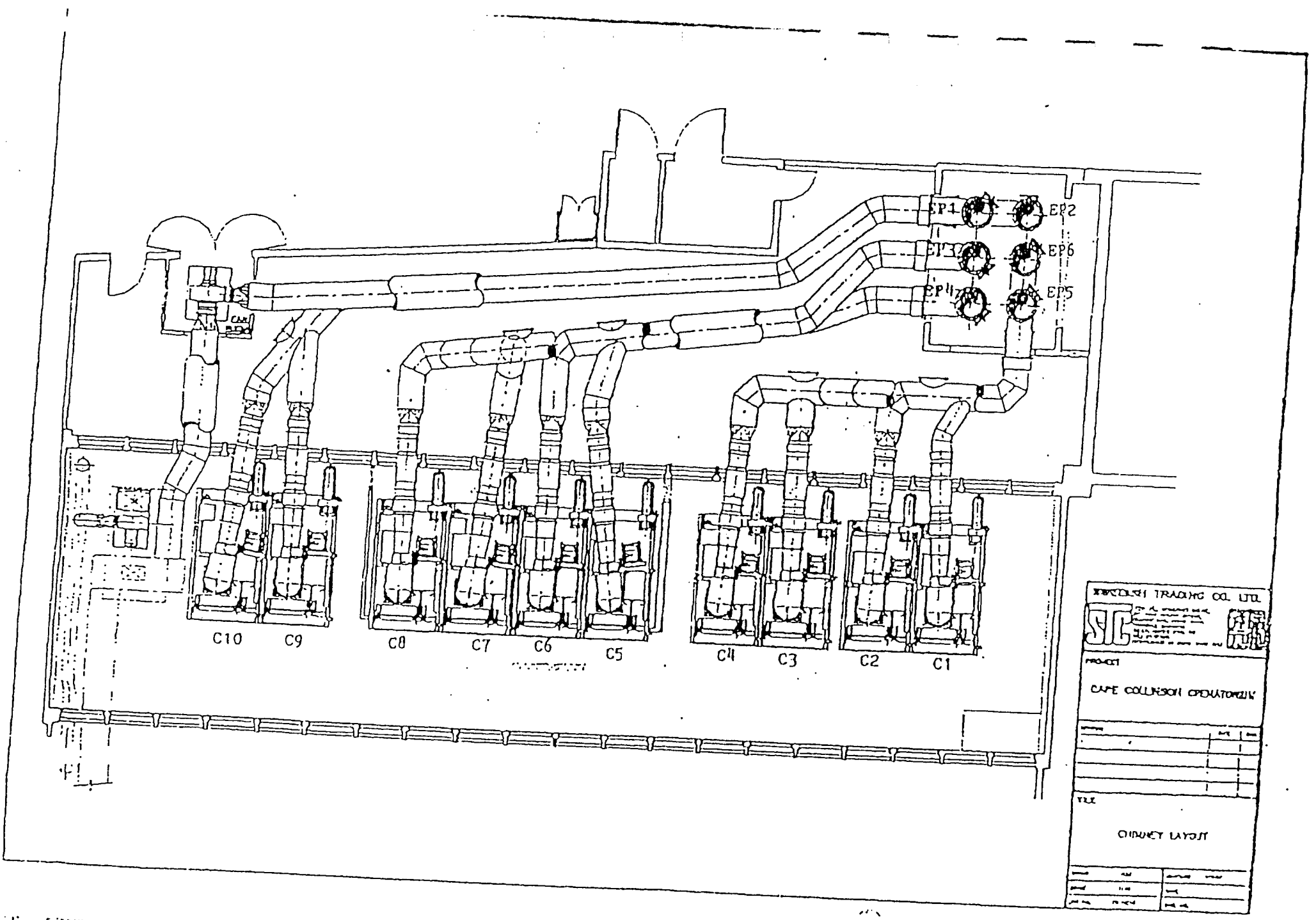
The results obtained in this stack emission test are only representative of the pollutants concentration of the stack over the specified sampling periods. The results should not be used to extrapolate for the stack emission levels in other conditions.

Environmental Management Division
Hong Kong Productivity Council

28th July, 1994

APPENDIX I

Locations of Sampling Points


EP1
EP2
EP3
EP6
EP4
EP5
C10
C9
C8
C7
C6
C5
C4
C3
C2
C1

APPENDIX II

Detailed Results of Particulates (Grit and Dust) Emission

USEPA METHOD 5 CALCULATION WORKSHEET

Date :	30.6.94	Time :	11:35 - 12:55
Site :	Cape Collinson Crematorium - EP2		
Sample No.:			1
Shape of Stack:			Circular
Internal Diameter of Stack:			0.75 m
Number of sampling positions:			24
Time for each sampling positions:			3 min
Stack Gas Temp.:			476 K
Stack Gas Velocity:			12.8 m/s
Volume of Gas Sample: at 0°C & 101.325 kPa & dry condition			1.004 dscm
Mass of Solids Collected:			16.6 mg
Moisture Content of the Stack Gas			2.13 %
Average O_2 Content during sampling			17.9 %
Concentration of Particulate in the Stack Gas at 0°C & 101.325 kPa & 11% O_2			55 mg/dscm

USEPA METHOD 5 CALCULATION WORKSHEET

Date :	30.6.94	Time :	15:00 - 16:30
Site :	Cape Collinson Crematorium - EP2		
Sample No.:			2
Shape of Stack:			Circular
Internal Diameter of Stack:			0.75 m
Number of sampling positions:			24
Time for each sampling positions:			3 min
Stack Gas Temp.:			473 K
Stack Gas Velocity:			12.5 m/s
Volume of Gas Sample: at 0°C & 101.325 kPa & dry condition			0.994 dscm
Mass of Solids Collected:			26.8 mg
Moisture Content of the Stack Gas			2.13 %
Average O_2 Content during sampling			17.9 %
Concentration of Particulate in the Stack Gas at 0°C & 101.325 kPa & 11% O_2			90 mg/dscm

APPENDIX III

Detailed Results of Metals Emission

Detailed Results of Metals Emission

Date : 30.6.94

Time : 11:35 - 12:55

Site : Cape Collinson Crematorium

Emission Point : EP2

Sample No. : 1

Average O_2 Content : 17.9%

METALS	SAMPLE GAS VOL. (dscm)	MASS COLLECTED (μg)	CONCENTRATION AT S.T.P. (μg/dscm)	CONCENTRATION CORRECTED TO 11% O_2 (μg/dscm)
Hg	1.004	0.18	0.18	1
Cd	1.004	1.5	1.49	5
Sn	1.004	< 50	< 49.80	< 164
Pb	1.004	80	79.68	263
Cu	1.004	10	9.96	33
As	1.004	0.48	0.48	2
Ni	1.004	15	14.94	49
Cr	1.004	10	9.96	33

Detailed Results of Metals Emission

Date : 30.6.94

Time : 15:00 - 16:30

Site : Cape Collinson Crematorium

Emission Point : EP2

Sample No. : 2

Average O_2 Content : 17.9%

METALS	SAMPLE GAS VOL. (dscm)	MASS COLLECTED (μg)	CONCENTRATION at S.T.P. (μg/dscm)	CONCENTRATION corrected to 11% O_2 (μg/dscm)
Hg	0.994	0.24	0.24	1
Cd	0.994	2.5	2.52	8
Sn	0.994	50	50.30	166
Pb	0.994	85	85.51	282
Cu	0.994	25	25.15	83
As	0.994	0.40	0.40	1
Ni	0.994	5	5.03	17
Cr	0.994	5	5.03	17

APPENDIX IV

Detailed Results of Sulphur Dioxide Emission

USEPA METHOD 6 CALCULATION WORKSHEET

Date :	30.6.94	Time :	11:30 - 12:30
Site :	Cape Collinson Crematorium - EP2		
Sample No.:			1
Shape of Stack:			Circular
Internal Diameter of Stack:			0.75 m
Stack Gas Temp.:			476 K
Stack Gas Velocity:			12.8 m/s
Volume of Gas Sample: at 0°C & 101.325 kPa			0.045 scm
Mass of SO_2 Collected:			2.31 mg
Average O_2 Content during sampling			17.9 %
Concentration of Sulphur Dioxide in the Stack Gas at 0°C & 101.325 kPa & 11% O_2			169 mg/scm

USEPA METHOD 6 CALCULATION WORKSHEET

Date :	30.6.94	Time :	15:00 - 16:00
Site :	Cape Collinson Crematorium - EP2		
Sample No.:			2
Shape of Stack:			Circular
Internal Diameter of Stack:			0.75 m
Stack Gas Temp.:			473 K
Stack Gas Velocity:			12.5 m/s
Volume of Gas Sample: at 0°C & 101.325 kPa			0.068 scm
Mass of SO_2 Collected:			2.56 mg
Average O_2 Content during sampling			17.9 %
Concentration of Sulphur Dioxide in the Stack Gas at 0°C & 101.325 kPa & 11% O_2			124 mg/scm

APPENDIX V

Detailed Results of Total Hydrocarbon Emission

Detailed Results of Total Hydrocarbon Emission

DATE	30.6.94	30.6.94
TIME	12:05 - 12:20	15:15 - 15:30
AVERAGE O_2 (%)	17.9	17.9
CONCENTRATION (ppmc)	3.60	3.74
CONCENTRATION ac S.T.P. (mg/scm)	1.93	2.00
CONCENTRATION corrected to 11% O_2 (mg/scm)	6.37	6.62

APPENDIX VI

Detailed Results of Other Pollutants Emission

Detailed Results of Hydrogen Chloride (HCl) Emission

DATE	TIME	AVERAGE O_2 (%)	CONCENTRATION (ppm)	CONCENTRATION at S.T.P. (mg/scm)	CONCENTRATION corrected to 11% O_2 (mg/scm)
30.6.94	11:50 - 12:05	17.9	< 0.2	< 0.326	< 1.1
	12:05 - 12:20	17.9	< 0.2	< 0.326	< 1.1
	12:20 - 12:30	17.9	< 0.2	< 0.326	< 1.1
30.6.94	15:00 - 15:15	17.9	< 0.2	< 0.326	< 1.1
	15:15 - 15:30	17.9	< 0.2	< 0.326	< 1.1
	15:30 - 15:45	17.9	< 0.2	< 0.326	< 1.1

Detailed Results of Carbon Monoxide (CO) Emission

DATE	TIME	AVERAGE O_2 (%)	CONCENTRATION (ppm)	CONCENTRATION at S.T.P. (mg/scm)	CONCENTRATION corrected to 11% O_2 (mg/scm)
30.6.94	11:50 - 12:05	17.9	< 1	< 1.25	< 4.1
	12:05 - 12:20	17.9	< 1	< 1.25	< 4.1
	12:20 - 12:30	17.9	< 1	< 1.25	< 4.1
30.6.94	15:00 - 15:15	17.9	< 1	< 1.25	< 4.1
	15:15 - 15:30	17.9	< 1	< 1.25	< 4.1
	15:30 - 15:45	17.9	< 1	< 1.25	< 4.1

Detailed Results of Hydrogen Fluoride (HF) Emission

DATE	TIME	AVERAGE O_2 (%)	CONCENTRATION (ppm)	CONCENTRATION at S.T.P. (mg/scm)	CONCENTRATION corrected to 11% O_2 (mg/scm)
30.6.94	11:50 - 12:05	17.9	< 0.2	< 0.179	< 0.6
	12:05 - 12:20	17.9	< 0.2	< 0.179	< 0.6
	12:20 - 12:30	17.9	< 0.2	< 0.179	< 0.6
30.6.94	15:00 - 15:15	17.9	< 0.2	< 0.179	< 0.6
	15:15 - 15:30	17.9	< 0.2	< 0.179	< 0.6
	15:30 - 15:45	17.9	< 0.2	< 0.179	< 0.6

Detailed Results of Hydrogen Sulphide (H_2S) Emission

DATE	TIME	AVERAGE O_2 (%)	CONCENTRATION (ppm)	CONCENTRATION at S.T.P. (mg/scm)	CONCENTRATION corrected to 11% O_2 (mg/scm)
30.6.94	11:50 - 12:05	17.9	< 0.3	< 0.455	< 1.5
	12:05 - 12:20	17.9	< 0.3	< 0.455	< 1.5
	12:20 - 12:30	17.9	< 0.3	< 0.455	< 1.5
30.6.94	15:00 - 15:15	17.9	< 0.3	< 0.455	< 1.5
	15:15 - 15:30	17.9	< 0.3	< 0.455	< 1.5
	15:30 - 15:45	17.9	< 0.3	< 0.455	< 1.5

ARCHITECTURAL SERVICES DEPARTMENT 建築署
QUEENSWAY GOVERNMENT OFFICES, 66 QUEENSWAY, HONG KONG. 香港金鐘道六十六號金鐘道政府合署

Our Ref.: ASD/62/5549/IC/RCC/590

Hyder Consulting Limited.
3/F Somerset House, Taikoo Pace
979 King's Road,
Quarry Bay,
Hong Kong

12 MAY 1997

Attention: Mr. Martin Chan

Inception Report
Kwai Chung Crematorium & Wo Hop Shek Skeletal Crematorium

With reference to your fax dated 2.5.97 and our subsequent telephone conversation on 7.5.97, I wish to point out the following for your attention.

1) Page 3 of your report was missing

2) There is an intention to replace the existing cadaver & coffin cremators in Wo Hop Shek in long term but its priority is relatively low among the others. year 2005 serves as an indicator of time by which no major alteration works would be considered. Therefore, the current project phasing plan does not include the works of "phase 2" as mentioned in item 1.1.2. The related statements and assumption in item 2.2 of your report should be refined accordingly.

3) I have reservation on your proposed baseline air quality data in item 3.1 but I would have no objection to your proposed method if you could convince the same to EPD.

4) Para. 3 of item 3.3 refers. Please clarify if it is your recommendation and conclusion that all the existing and future crematoria in Wo Hop Shek should be controlled under one single licence. If it is your conclusion, please address this issue under a separate cover as a response to the requirement in Technical Brief. Besides, any improvement works required on the existing cadaver & coffin cremators should be being up for the attention of RSD.

5) Para. 1 & 2 of item 3-4 is referred. It is understood that actual mode of operation and local practice are also essential for the overall performance of the cremation. Apart from the experience in U.K., reference of other Urban Council's Crematoria which have been licenced may be useful for making recommendation to RSD.

6) Please copy all your future correspondence to other project team members as follows:-

PM321 - Mr. Wilson Lee (Kwai Chung)
PM323 - Mrs. Susanna Cheung (Wo Hop Shek)
PA - Mr. Simon Kong

Hyder Consulting Limited
Date received 14 MAY 1997
Reg no. 97-32018
Div/Dep ENV.
Manager
Data received in Div/Dep 14/5/97

For Action	For Info	Sign	Date
MC			

Copy to
Reply date
File ref 16-5-5001

(Raymond Kan)
for Chief Building Services Engineer/2

RK/ic
Filecode: b\5549b.doc

7/F

Appendix D

EPD Comments

FAX MESSAGE

Original copy NOT sent/to be sent separately
Total no. of pages including this page: ____

Environmental Protection Department
環境保護署
FAX EP

FROM: Director of Environmental Protection

OUR REF.: ( ) in EP 1/KC/26/28

TEL. NO.: 25946318

DATE: 8 July 1998

OUR FAX NO.: 28278040

TO: Hyder Consulting Limited

(Attn.: ~~Mr. Martin Chan~~)

YOUR REF.: ( ) in ENV98-146717 & 149548 EA00060/MC/SO/el

YOUR FAX NO.: 28272891

Dear Sirs,

Kwai Chung Crematorium
Crematoria Air Quality Study

I refer to your fax messages of the above reference dated 26.6 and 8.7.98 enclosing respectively the further revised sections and your responses-to-comments of the captioned report.

I am pleased to inform you that I have no further comments on the captioned report. On the other hand, please be advised that the issue of limiting source emission of Ni as mentioned in the last para., S.3.4.1(p.16) of the revised sections should be fully addressed during the future licence application for the crematorium under the Air Pollution Control Ordinance.

Yours faithfully,

(Eric S.W.Wong)
for Director of Environmental Protection

c.c. Arch SD - Wilson Lee (2810-5372)

Internal
S(AM)1
E(UA)1

a:\per\kcc1.wpd

Hyder Consulting Limited
Date received - 8 JUL 1998
Reg no. 1998-149716
Div/Dep ENV
Manager Wodd
Date received in Div/Dep 8 7 98

For Action	For Info	Sign	Date
MC			8.7.98

Copy to
Reply date
File ref EA00060

TOTAL P.01

FAX

FACSIMILE

Original copy NOT sent/to be sent separately
Total no. of pages including this page: ______

Environmental Protection Department

環境保護署

FROM: Director of Environmental Protection

OUR REF.: ( ) in EP

TEL NO.: 2594 6318

DATE: 30 June 1998

OUR FAX NO.: 2827 8040

TO: Hyder Consulting Limited

(Attn: Mr. Martin Chan)

YOUR REF.: ( ) in ENV98-141586/EA00060/MC/SO/cl

YOUR FAX NO.: 28272891

Hyder Consulting Limited			
received	30 JUN 1998		
Reg no.	1998-1971542		
Div/Dep	ENV		
Manager	B. Todd		
Date received in Div/Dep	30/6/98		
For Action	For Info	Sign	Date
MC			
Copy to			
Reply date			
File ref	EA00060		

Dear Mr. Chan,

Kwai Chung Crematorium

Crematoria Air Quality Study

I refer to your fax message of the above reference dated 9.6.98 enclosing the revised sections of the captioned report. My comments on the revised sections had already been provided to you through our telephone conversation on 25.6.98. This fax letter is for record purpose of the comments given as below:

General :

a) It is noted from S.3.4.2(p.16-17) for the cancer health assessment that the impact related to nickel has exceeded the maximum acceptable level. Effective mitigation measures should be proposed in the report to reduce the impact from the proposal to acceptable level.

b) For the non-cancer health assessment, both acute and chronic heath effect of the pollutants should be assessed.

c) From the stack parameters(p.12), there are totally 2 stacks. Please clarify whether emission rates from total stacks have been taken into account in the modelling exercise.

Specific :

d) 1st sentence, 2nd para, Source Emission Data(p.11)
"The SO_2 emission factor" should be replaced by " The SO_2 emission rate".

e) Table 3.8(p.11)
"273K, 101.3kPa, 11% O_2 dry" should be deleted after the item "Emission Rate" because emission rate is independent on temperature, pressure and oxygen content.

f) Table 3.12.1(p.15)

The criteria for nickel, arsenic and hydrogen chloride indicated in Table 3.4 should also be shown in Table 3.12.1.

g) Table 3.13.1 (p.16)
Please review the calculations.

Yours faithfully,

(Eric S.W.Wong)
for Director of Environmental Protection

c.c. Internal
S(AM)1
E(UA)1

FAX

Environmental Protection Department

環境保護署

Original copy NOT sent/to be sent separately

Total no. of pages including this page: 1

FROM: Director of Environmental Protecti

OUR REF.: ( ) in EP 1/KC/26/28

TO: Hyder Consulting Limited
(Attn.: Mr. Martin Chan)

TEL NO.: 2594 6314 (2514631 8)

YOUR REF.: ( ) in ENV98-126726/EA00060/MC/e1

DATE: 22 May 1998

YOUR FAX NO.: 2827 2891

OUR FAX NO.: 2827 8040

Dear Sirs,

Kwai Chung Crematorium
Crematoria Air Quality Study

I refer to your fax message of the above reference dated 21.4.1998 enclosing the amended sections of the Crematoria Air Quality Study. I have provided the following comments on the amended sections through telephone to your Mr. Martin Chan on 1.5.1998. This fax letter is issued for record purposes.

1. Table 3.4 - Please also refer to other organisations such as the USEPA, California Air Resources Board (CARB), California Air Pollution Control Officers Association (CAPCOA) etc. for the standards in the assessment.

2. Table 3.6 - "7610" should be hourly CO concentration.

3. Table 3.8 - The meaning of "BPM by BPM" in the footnote is unclear, please clarify.

4. Section 3.3.1 - Referring to the calculation of pollutants emission rates, it is noted that the emission rates were derived from the actual flue gas flow rate of 5.5 m^3/s, please note that the BPM limits are expressed with the reference conditions of 273K, 101.3 kPa and 11% O_2 dry conditions, the actual flue gas flow rate of 5.5 m^3/s should be corrected to these reference conditions in the calculation.

5. Table 3.1.3.1 - Please review the calculation of the predicted risk.

If you have any query on the above, please feel free to contact the undersigned.

Yours faithfully,

(MAK Chak-yin)
Environmental Protection Officer
for Director of Environmental Protection

c.c. E(UA)1

Hyder Consulting Limited
Date received 23 MAY 1998
Reg. no. 1998/56719
Div/Dep ENV
Manager
Date received in Div/Dep 25/5/98

For Action	For Info	Sign	Date
MC			25.5.98

Copy to
Reply date
EA00060

TOTAL P. 01

OUR REF: EP/AC/S/15/9599/15
YOUR REF: ENV9761685/1655001/mc
TEL NO.: 2594 6244
FAX NO.: 2827 8040

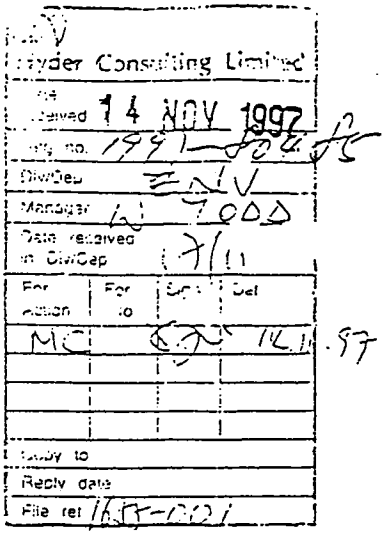
Environmental Protection Department
Branch Office
33/F, Revenue Tower,
5 Gloucester Road,
Wan Chai, Hong Kong.

環境保護署分處
香港
灣仔告士打道五號
稅務大廈三十三樓

12 NOV 1997

Hyder Environmental Ltd.
3/F, Somerset House
Taikoo Place
979 King's Road
Quarry Bay
Hong Kong

(Attn: Mr. Martin Chan, Senior Environmental Consultant)



Dear Mr. Chan,

Re: Kwai Chung Crematorium

Thank you for your draft final report.

Having gone through the draft report, I have the following comments:-

i) Section 3.1.2 - 1st paragraph - The last sentence should be revised as "The AQO are summarised in Table 2.3 below."

ii) Section 3.1.2 - The 2nd paragraphs should be deleted.

iii) Section 3.1.3 - The ambient standards stipulating in WHO (World Health Organization) should be used to assess the impact of the non-AQO pollutants. Please revise this section.

iv) Section 3.4 (Source Emission Data) - The fuel consumption rate of the existing crematorium should not be used for estimating the SO2 emission as the fuel consumption rate of the new cremators will be much higher than that of the existing units. Instead, you should make reference to the fuel consumption rate of the units of Cape Collinson Crematorium.

v) Section 4 - This section should be revised as "Based on the modelling results, the operation of the new Kwai Chung Crematorium will not cause unacceptable air quality impacts on the nearby areas. However, the following requirements should be incorporated into the APCP ..... of the cremator facility."

/.....P.2

SP

vi) Section A.1.2 - Referring to the sampling methods to be used for each pollutant, the relevant EPA reference methods should be used. Please amend the text to excluded other methods in order to avoid unnecessary confusion.

Please let me know if you need clarification for the above.

Yours sincerely,

(YUNG Ching-hung)
for Director of Environmental Protection

c.c. Arch SD (Attn: Mr. Raymond Kan)
Ref: ASD/62/5415/IC/RCC/500

87

(6) in L/M. #1 to EP/AC

來函檔號 OUR REF: /S/15/9599/15
來函檔號 YOUR REF: 1655-001/9730015/mc
電話 TEL. NO.: 2827 8040
圖文傳真 FAX NO.: 2594 6244

Hong Kong Government
Environmental Protection Department
Branch Office
33/F, Revenue Tower,
5 Gloucester Road,
Wan Chai, Hong Kong.

環境保護署分處
香港
灣仔告士打道五號
稅務大樓三十三樓

Hyder Consulting Limited
3/F Somerset House
Taikoo Place
979 King's Road
Quarry Bay
Hong Kong
(Attn.: Mr. Martin Chan, Senior Environmental Consultant)

20 MAY 1997

Dear Mr. Chan,

Re.: Draft Inception Report for Crematoria Air Quality Impact Study

Thank you for your above report for Kwai Chung and Wo Hop Shek Crematoria. Our comments are given below for your reference:-

(i) Section 2.1 - The determination of the design of the cremators and the associated chimneys should be one of the objectives of the study.

(ii) Section 2.2 first paragraph - It is not appropriate to say that "It is considered that the requirements given in this EPD BPM are not specific to and may not be fully applicable to crematoria.". We suggest to delete this statement.

(iii) Section 2.2 third paragraph - To be more realistic and given the old cremators will be replaced in 2005, the emission levels of the old cremators should be used to estimate the cumulative "air quality impact" before 2005 when these cremators are still in operation.

(iv) Section 2.2 fourth paragraph - Emission data of local cremators instead of overseas cremators should be used as the material of both the coffin and its contents are quite different in Hong Kong.

(v) Section 2.2 last paragraph - It should be noted that the overseas experience for complaint handling procedure may not be applicable to Hong Kong.

(vi) Section 3.1 - In addition to technical and operation data of existing cremators, their emission data should also be considered for the air quality impact assessment.

(vii) Section 3.2.2 first paragraph - The emission rate of existing licensed cremators instead of overseas emission data should be used for the modelling.

/.....

(viii) Section 3.2.2 second paragraph - We don't agreed that the SO_2 emission should not be an issue if low sulphur diesel will be used. This should, therefore, be estimated by modelling. Furthermore, the statement "It is assumed that as long as the HKAQO of TSP and CO can be met, the potential impacts of other pollutants such as Hydrogen Chloride (HCl) and Total Organic Compound (TOC) will be acceptable." is not appropriate. This should also be demonstrated by modelling.

(ix) Section 3.2.3 - Gas fired equipment should be considered as one of the mitigation measures to control the emissions. Continuous monitoring of various parameters should be at the outlet of secondary combustion chamber (SCC) instead of "within the SCC".

(x) Section 3.4 first paragraph - In developing the practical guidelines for the operation of the crematoria, the local practice adopted by the licensed crematorium should be considered.

(xi) Section 3.4 second paragraph - It should be noted that according to the BPM requirements, some key process and emission parameters should be monitored continuously and transmitted to EPD through the telephone line. In this respect, recommendations to meet this requirement should be provided.

(xii) General - Having gone through the draft report, it seems to us that the preparation of the report will rely very much on overseas experience both in carrying out the impact assessment and providing recommendations for the design and operation of the creamtoria. It should be reminded that there is a licensed crematorium, Cape Collinson Crematorium, in Hong Kong. You are, therefore, strongly advised to make reference to the emission data, cremator and chimney design, management and practice as well as monitoring requirements of this crematorium as these data will be more appropriate for estimating the air impact. You should note that the future licence conditions for the crematoria will be based on the recommendations of the assessment report, particularly when emission limits and mitigation measures are concerned.

We will be happy to discuss with you should you have any query on our above comments.

Yours sincerely,

(YUNG Ching-hung)
for Director of Environmental Protection

c.c. DAS (Mr. Raymond Kan)
DRS (Mr. F.K. Tong)

83