APPENDIX R

Calculation of Benzene Emission

FAX MESSAGE

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FAXED
DATE

TO: COMPANY	EPD	DATE	3 Feb 1999
ATTN OF	- Steve T. S. Li	FAX NO.	2591 0558
FROM	Matthew Ko	SHEET 1 OF	4
REF. NO.	C418\wp\FMK90203.01		

SUBJECT **Kai Tak Airport North Apron Decommissioning**
Environmental Permit (EP) No. EP-006/1998
Draft Pilot Test Report

Dear Sirs,

We refer to your fax dated 3 February 1999 (Your ref. EP2/K19/PT2/05 Pt5) regarding the VOC emissions aspects. Please see the attached calculations and references for your information.

Please contact the undersigned should you have any queries.

Regards,

Matthew Ko
Associate

Encl. 1. "Calculation to show benzene emission acceptable"
2. Appendix 4C of Technical Report RA16
3. Section 5.2.2 of KTA North Apron Decommissioning EIA Report.

c.c. MCAL (Attn: Peter Yung) Fax. 2375 6399

3-2-1999

CALCULATION to show benzene emission acceptable

Objective: to show that the 50 ppm VOC is much less than what was assumed in the EIA assessment report.

Benzene vapour conc in Jetfuel by mass = 0.74% (Source: RA16 - App. 4)

" " " " " " volume = $0.74 \times \frac{M_{Jetfuel}}{M_{Benzene}}$

$= 0.74 \times \frac{116}{78}$

$= 1.1\%$ by volume

Benzene emission Conc = 50 ppmv VOC × 1.1% $\frac{\text{Benzene}}{\text{VOC}}$

= 0.55 ppmv

= 550 ppbv << 4500 ppbv

figure used in EIA report (Section 5.2.2)

Remarks

Note that in Calculation of Section 5.2.2., a conservative safety factor of 10 is multiplied to 4,500 ppbv ie 45,000 ppbv. Therefore, even with the quenching effect of methane gas on PID detection taken into account (say several times of 550 ppbv), the final adjusted measurement is still much less than 45,000 ppbv.

APPENDIX 4C BENZENE CORRELATION TEST

An experimental test was conducted to correlate the PID readings recorded by the PID meter with the benzene concentration of the soil gas. Soil gas over the headspace of soil contaminated with Jet-A1 fuel was considered in the test.

A known amount of Jet-A1 fuel was injected into soil to simulate the condition of fuel leakage. The soil was prepared in accordance with on-site soil composition (20% gravel, 50% sand, 20% silt and 10% clay). The soil with the injected Jet-A1 fuel was contained in a 500ml glass beaker and covered by aluminium foil. The entire test kit was left in room conditions for about 20 minutes in order to achieve a steady state.

After 20 minutes, total VOC was measured in the headspace of the soil using the PID meter of a Foxboro TVA-1000 Toxic Gas Analyser. A sample of headspace vapour was then collected by pumping the vapour into a charcoal tube and recording the sample volume. Total mass of benzene in the sample was analysed by GC/MS.

The test was repeated three times for different headspace sample volume. The laboratory analysis results of the headspace samples indicated an average headspace benzene vapour concentration of 0.74% by mass in Jet-A1 fuel. The average % difference of the three samples was less than 10%.

With reference to an article released by Foxboro, the PID meter manufacturer, the response factor of the PID metre for Jet-A1 fuel vapour is 36 PID units per mg per litre. Therefore for PID readings of Jet-A1 fuel vapour of x PID units,

Benzene vapour concentration

$$= \frac{x}{36} \times 0.74\% \ mg \ / \ litre \ of \ soil \ gas$$

$$= \frac{0.21x \ \mu g \ / \ litre \ of \ soil \ gas}{vapour \ density \ of \ benzene}$$

$$= 0.06x \ ppm \ (by \ volume)$$

where	x	= PID reading of Jet-A1 fuel vapour
	vapour density of benzene	= 3.47 g l^{-1}

With reference to "Air Monitoring Instrumentation", Carol J. Maslansky, Steven P. Maslansky, the best available estimate of headspace vapour concentration of benzene is 97,500 ppm, which can be applied to a condition of 1 atmospheric pressure and room temperature, assuming homogeneous mixing of benzene (liquid phase) with soil,

Benzene (liquid phase) concentration in soil

$$= \frac{0.06x}{97400} \times liquid \ density \ of \ benzene$$

$$= 540x \ \mu g \ / \ litre \ of \ soil$$

$$= 540x \ \mu g \ / \ density \ of \ soil$$

$$= 0.28x \ \mu g \ / \ g \ of \ soil$$

where	x	= PID reading of Jet-A1 fuel vapour
	liquid density of benzene	= 877 g l^{-1}
	density of soil	= 1900 g l^{-1}

incorporating 50% dust suppression, are shown in Figures 7.1 and 7.2 respectively. The dispersion modelling was undertaken based on the meteorological data of KTA station for year 1993. A sample FDM model output file is included in Appendix D of this report.

5.2.2 Nitrogen Dioxides and Benzene Assessment Methodology of the Soil Treatment System

The major potential air quality impacts from the operation of the catalytic incinerator will be emissions from fuel combustion and residual benzene emitted after the catalytic oxidation of soil vapour extracted from the contaminated site. The catalytic incineration is scheduled to commence operation in early 1999.

The catalytic incinerator is an emission control device where fuel, in this case Towngas, and soil vapour extracted from the contaminated site are added to a combustion chamber to maintain a high minimum operating temperature. A catalyst is used to promote oxidation of the vapour at the operating temperature. A typical destruction efficiency of 95% would be achieved by the catalytic incinerator as suggested by the engineer. All the emissions from the catalytic incinerator will be exhausted to the atmosphere through a stack.

Air quality impacts were assessed at different elevations (every 5 metres intervals starting from ground level) over the catalytic incinerator. The worst affected elevation was predicted to be 25 metres above local ground level. Pollutant concentration contours are presented at this elevation to visualise the predicted air quality impacts.

Nitrogen Dioxides and Benzene Emissions Calculations

Nitrogen oxides (NO_x) are considered as the major pollutants of concern when burning Towngas in the catalytic incinerator. The prediction of NO_x emissions was based on typical values and emission factors for natural gas combustion from USEPA *Compilation of Air Pollution Emission Factors (AP-42)*, 5th Edition. With a designed maximum heat input of 1,700,000 BTU per hour for the incinerator, the total NO_x emission was calculated using the emission factor for commercial boilers. For the purpose of this assessment, a conservative assumption of 100% conversion of NO_x to NO_2 was taken.

With reference to the results of the soil gas monitoring conducted as part of the contamination assessment conducted in 1997 during the SEKDFS, the highest benzene concentration in the soil gas extracted from the site was 4,500 ppbv or 14.4 mgm^{-3}. Based on the designed maximum extraction rate of the soil vapour extraction system at 8000 scfm and a typical destruction efficiency of the catalytic incinerator of 95%, the benzene emission factor of the catalytic incinerator was calculated to be 2.8 mgs^{-1}. For the purpose of this assessment, a safety factor of 10 was multiplied to the benzene emission factor to produce a conservative assessment.

Nitrogen Dioxides and Benzene Dispersion Modelling

Dispersion modelling was undertaken using the USEPA approved Industrial Source Complex Short Term (ISCST) model to assess potential air quality impacts from the catalytic incinerator.