EIA Reports Related to HZMB

Supplementary Information on Consideration and Assessment of Ozone in EIAs

1. Introduction

In the operation phase air quality impact assessment under the EIA Reports for HKLR & HKBCF and TMCLKL, the key pollutants from road emissions have been identified as NO_2 and RSP. The concentrations of these pollutants have been predicted for the assessment year at 2031 and have been assessed accordingly. The EIA Reports have stated that since O_3 is not a pollutant directly emitted from vehicular emission, it has not been included in the EIA for assessment with the AQO. **This approach is consistent with all the previously approved EIA reports for highway infrastructures in HK.**

However, it should be highlighted that the predicted O_3 level has already been assessed in the modeling of background air quality, and that the effect of O_3 (from various sources including those in PRDEZ, etc.) in the generation of NO_2 has in fact been taken into consideration in the assessment. This Special Paper provides further explanations on this aspect.

2. Ozone as a Regional Issue

There have been extensive researches in O_3 episodes in the Pearl River Delta Economic Zone (PRDEZ), in which different pollutant emission sources are located, including transportation, airports, power stations, industries etc. According to the research findings [1, 2, 3, 4], O_3 is not a pollutant directly emitted from man-made sources, and the formation of O_3 involves a complex interaction between a large number of chemical substances such as NO_x and VOC when meteorological conditions (e.g. sunlight, temperature) "favour" such interaction. These findings also conclude that the formation of O_3 is largely attributable to the cumulative effects of all the different emission sources within the PRDEZ, instead of just the emission sources in HK.

3. Various Emission Sources for NO_x and VOC in the Region and in HK

It is therefore important to consider the regional NO_x and VOC emission inventory.

3.1 **NO_x Inventory at 2031**

[1] Study of Air Quality in the Pearl River Delta Region – Final Report (Agreement No. CE 106/98)
[2] Study of Visibility Reduction and its Causes in Hong Kong (Tender Ref. AS 01-286)
[3] J.P. Wang, C. H. Fung, K. H. Lau, Integrated processes analysis and systematic meteorological classification of ozone episodes in Hong Kong
[4] Air Quality in Hong Kong 2008, by EPD, HKSAR Government

Appendix 5D of the EIA Reports for HKLR, HKBCF and TMCLKL has presented the NO_x emission inventory for 2031.

The NO_x emission from PRDEZ would constitute about 85% and that from HKSAR would be about 15%. For the NO_x emissions in HKSAR, the NO_x from marine constitute about 45% and the emission from power station would be about 22%. The total from marine emission and power plant would add up to more than 65% already. Those from industries and vehicles would be about 9% for each.

As such, for the entire PRDEZ and HKSAR, the NO_x emission from vehicular emission in HK would constitute only about 1.6% of the total NO_x generated in the region. The annual NOx contribution from HKLR, HKBCF and TMCLKL is only 0.09% of the regional total. The following **Tables 1 & 2** summarise the relative proportion of the NO_x generation from different source groups in the PRDEZ and HK.

Table 1 : Comparison of NO_x Emission in PRDEZ and HKSAR at 2031

Area	Percentage
PRDEZ	85%
HKSAR	15%

Table 2 : Comparison of NO_x Emission in HKSAR at 2031

Emission Source Groups	Percentage of Proportion	
	% in HKSAR	% in PRDEZ & HKSAR
Aviation	11%	1.7%
Power Stations	22%	3.3%
Industries	9%	1.4%
Marine	45%	6.9%
Motor vehicles	10%	1.6%
Non-road mobile source	<0.1%	<0.01%
Commercial and domestic fuel combustion	2%	0.4%
VOC Containing Products	0%	0%
Biogenics	0%	0%
Others	<0.1%	<0.01%
Total	100%	13%

3.2 VOC Inventory at 2031

As explained in the EIA Report, the prediction model has actually included the regional emission sources for different pollutants including VOC. Emission sources that have been incorporated in the model include transportation, airports, power stations, industries, biogenic sources, VOC containing sources etc.

The VOC emission from PRDEZ would constitute about 91% and that from HKSAR would be 9%. For the VOC emissions in HKSAR, the VOC containing products dominate the total emission by about 42%. Those from industries and biogenic sources

would constitute about 11% and 28% respectively. The VOC generated from all the motor vehicles in HK would only constitute about 9%. The annual VOC contribution from HKLR, HKBCF and TMCLKL is only 0.01% of the regional total. The following **Tables 3 & 4** summarise the relative proportion of the VOC generation from different source groups in the PRDEZ and HK.

Table 3 : Comparison of VOC Emission in PRDEZ and HKSAR at 2031

Area	**Percentage**
PRDEZ	91%
HKSAR	9%

Table 4 : Comparison of VOC Emission in HKSAR at 2031

Emission Source Groups	**Percentage of Proportion**	
	% in HKSAR	**% in PRDEZ & HKSAR**
Aviation	3%	0.2%
Power Stations	1%	0.1%
Industries	11%	1%
Marine	3%	0.3%
Motor vehicles	9%	0.8%
Non-road mobile source	<0.1%	<0.01%
Commercial and domestic fuel combustion	<0.1%	<0.01%
VOC Containing Products	42%	4%
Biogenics	28%	2.6%
Others	4%	0.3%
Total	100%	9%

4. Assessment of Ozone Formation

As explained above, O_3 is not a pollutant directly emitted from man-made sources and it involves a set of complex reaction chains between other pollutants including NO_x and VOC. As it would takes several hours for these photochemical reactions to take place, O_3 recorded locally (eg in Tung Chung) could be attributed to VOC and NO_x emissions generated from places afar[5].

To model the long range formation of O_3 (and other pollutants as well), the PATH model developed by EPD has been adopted which has been implemented with the Carbon Bond IV photochemical scheme, developed by the USEPA. This photochemical scheme constitutes 89 photochemical and chemical reactions. It is a generalized chemistry scheme designed for simulating the major features of the complex chemical processes in the atmosphere and has been evaluated against approximately 170 experimental data sets of smog chamber facilities from the University of North Carolina and University of

[5] Air Quality Objective Review – Public Consultation – Environmental Bureau, Hong Kong SAR Government

California-Riverside. Carbon Bond IV is one of the state-of-the art chemical schemes that has been widely adopted in related research activities in HK and other areas.

The assessment indicated that the maximum 1-hr O_3 level in Tung Chung area in the assessment year of 2031 would vary with different meteorological conditions, with an average concentration of about 62 ugm^{-3}. It should be noted that a portion of O_3 would react with the NO_x emissions from vehicles to form NO_2 as reported in the EIA Reports.

5. Conclusion

The following summarises the reasons for adopting NO_2 as the key indicator and not accounting O_3 as a pollutant directly for this air quality assessment.

- The O_3 generation from regional pollutants (ie NO_x, VOC with appropriate sunlight and temperature) in the assessment year has been accounted for in the air quality modeling.
- Vehicles would not generate O_3 directly but would however generate NO_x and a smaller amount of VOC.
- Unlike NO_2, the O_3 formation by photochemical reaction would take several hours and O_3 recorded locally (eg at Tung Chung) could be attributed to VOC and NO_x emissions from places afar. Hence, the formation of O_3 is largely attributable to the cumulative effects of all the emission sources within the PRD and the amount of VOC generated by the vehicles would have little effect on the O_3 generation locally. (NB : The NO_x from the Projects only constitute 0.09% of the regional total, while that the VOC from the Projects would constitute only 0.01% of the regional total).
- The NO_x generated from vehicles would quickly react with the O_3 in the background to form NO_2.
- NO_2 is therefore the key pollutant assessed in the EIA reports and this approach is adopted in all the other previous EIA Reports for highway infrastructure projects.