

Appendix 3.11 Derivation of Cumulative Annual Average NO_x to NO₂ Conversion Equation using Jenkin Method

Jenkin Method for Long-term Cumulative NO₂ Assessment

With reference to the *Review of Methods for NO to NO₂ Conversion in plumes at short ranges*¹, Jenkin method was adopted for the conversion of cumulative annual average NO_x to NO₂ by using the functional form of annual mean of NO₂-to-NO_x. The mentioned functional form is referenced from (Jenkin, 2004)² and is presented below:

$$[NO_2] = \frac{\left([NO_x] + [OX] + \frac{J}{k} \right) - \sqrt{\left([NO_x] + [OX] + \frac{J}{k} \right)^2 - 4[NO_x][OX]}}{2}$$

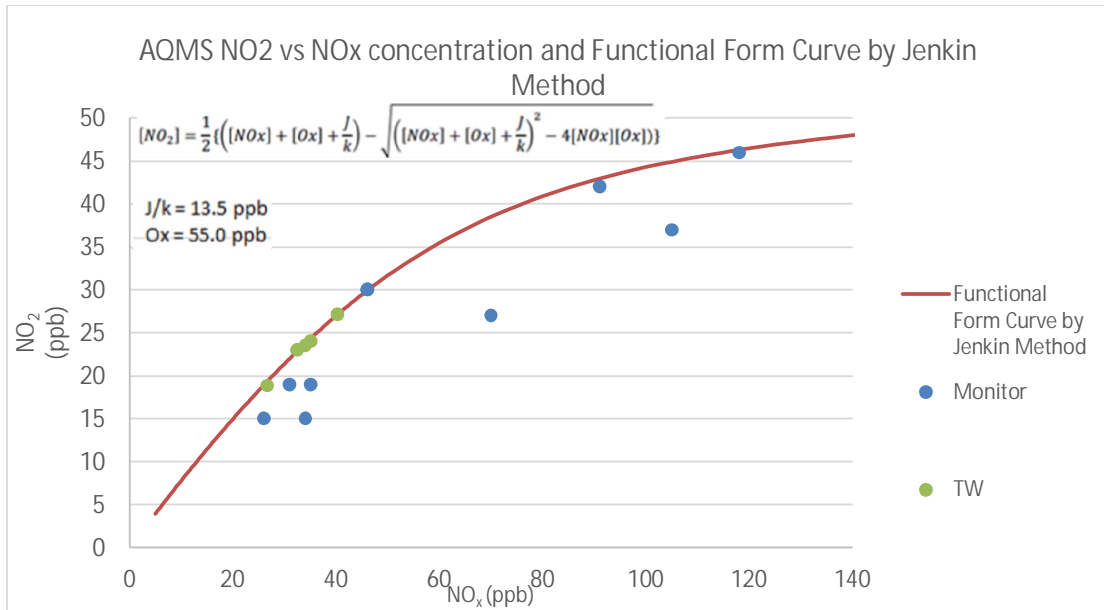
where

[NO ₂]	is the NO ₂ concentration
[NO _x]	is the NO _x concentration
[OX]	is the sum of NO ₂ concentration and O ₃ concentration (i.e. [OX] = [NO ₂] + [O ₃])
J	is the photolysis rate of NO ₂
k	is the rate coefficient for reaction between NO and O ₃

The above functional form was used to analyze the annual mean data obtained from EPD's air quality monitoring stations (AQMS) at Tsuen Wan and on-site measurement data on Tsuen Wan Road. The functional form curve would fit the annual mean data and on-site measurement data when [OX] = 55.0 ppb and J/k = 13.5 ppb. The obtained functional form curve was adopted for the cumulative annual average NO_x to NO₂ conversion. The curve is slightly higher than all the annual mean data obtained from AQMS and on-site measurement data. The calculated annual average NO₂ concentration using the obtained functional form curve based on the measured annual average NO_x obtained from AQMS are presented in **Annex A**. The calculated annual average NO₂ concentration are higher than the measured annual average NO₂ concentration to ensure no underestimation of the annual average NO₂ concentration is expected.

¹ Environment Agency. 2007. *Review of methods for NO to NO₂ conversion in plumes at short range*. Prepared by Environmental Agency.

² Jenkin, M.E. (2004). Analysis of sources and partitioning of oxidant in the UK – Part 1: The NO_x-dependence of annual mean concentrations of nitrogen dioxide and ozone. *Atmospheric Environment*, 38(30), 5117-5129.



For long-term cumulative NO₂ assessment (i.e., predictions of annual average NO₂ concentration), cumulative annual average NO_x to NO₂ conversion equation for this assessment was calculated as follows:

$$[NO_2]_c = \frac{([NO_x]_c + 55 + 13.5) - \sqrt{([NO_x]_c + 55 + 13.5)^2 - 4[NO_x]_c \times 55}}{2}$$

where

[NO₂]_c is the predicted cumulative NO₂ concentration in ppb

[NO_x]_c is the predicted cumulative NO_x concentration in ppb

Annex A

Annual Average NO_x, NO₂ and OX concentration in Recent Five Years (Year 2017 – 2021) at Selected EPD AQMS

AQMS	Year	Measured NO _x (ppb)	Measured NO ₂ (ppb)	Measured NO ₂ + O ₃ (ppb) Named as [OX]	Calculated NO ₂ using the functional form curve based on measured NO _x (ppb)
Tsuen Wan	2017	40	27	48	27
	2018	34	24	46	24
	2019	35	24	49	24
	2020	27	19	40	19
	2021	32	23	45	23

Average On-site Measurement Data of NO_x, NO₂ and OX concentrations at Tsuen Wan Road

Location	Average Measured NO _x (ppb)	Average Measured NO ₂ (ppb)	Average Measured NO ₂ + O ₃ (ppb) Named as [OX]	Calculated NO ₂ using the functional form curve based on measured NO _x (ppb)
A	91	42	54	43
B	31	19	40	22
C	70	27	41	39
D	26	15	37	19
E	105	37	52	45
F	34	15	40	24
G	46	28	45	30
H	46	30	47	30
I	35	19	38	25
J	118	46	60	46