

Appendix 3.19 Derivation of Cumulative Annual Average NO_x-to-NO₂ Conversion Equation using Jenkin Method

Jenkin Method for Long-term Cumulative NO₂ Assessment

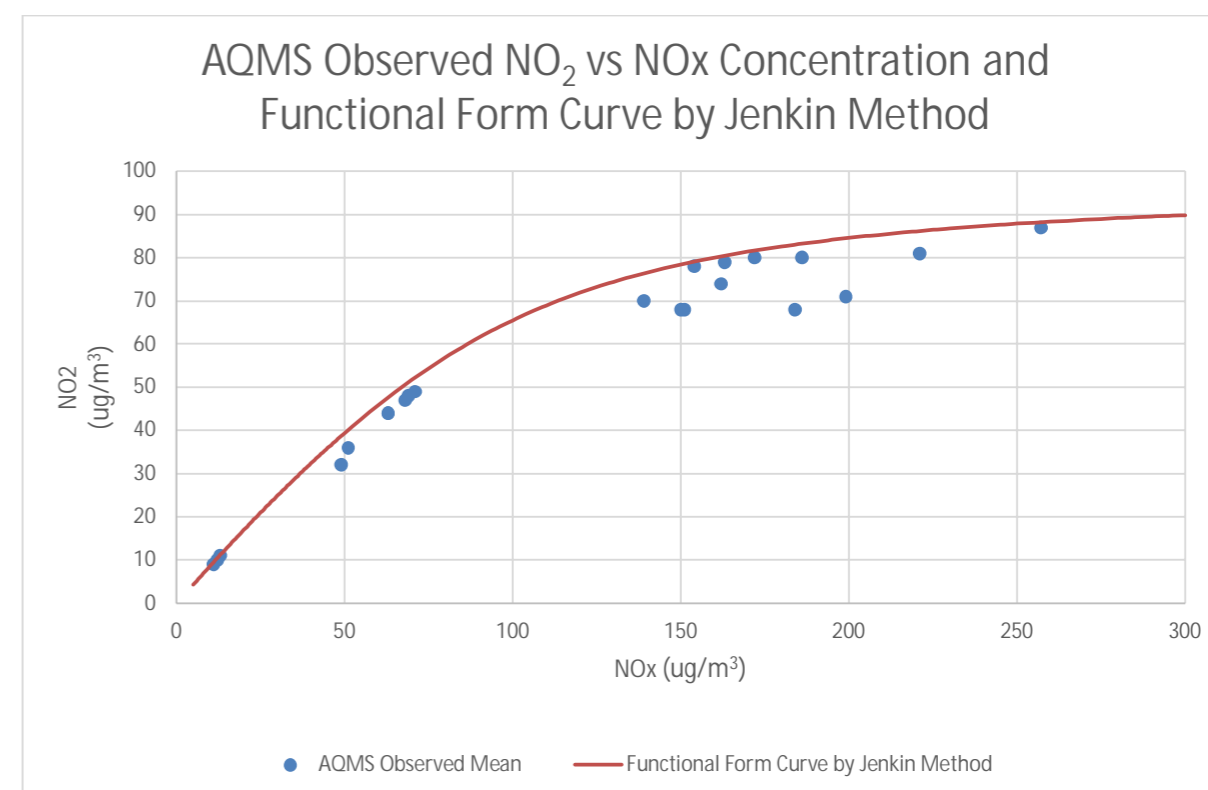
With reference to the *Review of Methods for NO to NO₂ Conversion in plumes at short ranges*¹, Jenkin method was adopted for the conversion of cumulative annual average NO_x to NO₂ by using the functional form of annual mean of NO₂-to-NO_x. The mentioned functional form is referenced from Jenkin, 2004a² and is presented below:

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

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 relevant EPD's air quality monitoring stations (AQMS) including Yuen Long general station, North general station, Sham Shui Po general station, Tap Mun general station and three roadside stations (i.e. Causeway Bay, Central and Mong Kok roadside stations). The recent five years annual mean data are extracted and presented in below table. Scattered plot for recent 5 years annual means NO₂ versus NO_x concentrations obtained from relevant AQMS was created. The functional form curve would fit the annual mean data when [OX] = 92.97 µg/m³ and J/k = 18.42 µg/m³. The value of [OX] and J/k are considered reasonable as they are within typical value range for Hong Kong. The range of annual average [OX] from the selected air quality monitoring stations is 80 – 116 µg/m³. The resulting 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, the calculated annual average NO₂ concentration using the obtained functional form curve based on the observed annual average NO_x obtained from AQMS are presented in below table, the calculated annual average NO₂ concentration are higher than the observed annual average NO₂ concentration, no underestimation of the annual average NO₂ concentration is expected.



For the 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:

$$[NO_2]_c = \frac{([NO_x]_c + 92.97 + 18.42) - \sqrt{([NO_x]_c + 92.97 + 18.42)^2 - 4[NO_x]_c \times 92.97}}{2}$$

where

[NO ₂] _c	is the predicted cumulative NO ₂ concentration
[NO _x] _c	is the predicted cumulative NO _x concentration

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

² Jenkin. 2004a. *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, 5117-5129.

Appendix 3.19 Derivation of Cumulative Annual Average NOX-to-NO2 Conversion Equation using Jenkin Method

Annual Average NO_x, NO₂ and O₃ concentration in Recent Five Years (Year 2018-2022) at Selected EPD AQMS

AQMS	Year	Observed NO _x (µg/m ³)	Observed NO ₂ (µg/m ³)	Observed NO ₂ + O ₃ (µg/m ³) Named as [OX]	Calculated NO ₂ using the functional form curve based on observed NO _x (µg/m ³)
Yuen Long	2018	63	43	86	48
	2019	63	44	97	48
	2020	49	32	75	39
	2021	56	40	89	43
	2022	52	37	89	41
North	2021	51	36	93	40
	2022	42	31	90	34
Sham Shui Po	2018	71	49	93	52
	2019	69	48	99	51
	2020	68	45	92	51
	2021	68	47	97	51
	2022	61	43	97	46
Tap Mun	2018	13	11	83	11
	2019	12	10	90	10
	2020	11	9	80	9
	2021	12	10	85	10
	2022	13	8	84	11
Causeway Bay	2018	257	87	108	88
	2019	221	81	110	86
	2020	184	68	98	83
	2021	199	71	100	84
	2022	178	65	97	82
Central	2018	186	80	105	83
	2019	172	80	116	82
	2020	151	68	103	79
	2021	150	68	100	78
	2022	132	62	99	75
Mong Kok	2018	163	79	106	80
	2019	154	78	110	79
	2020	162	74	104	80
	2021	139	70	102	76
	2022	131	64	98	75