Calculations of Time-In-Mode (TIM) for Barge to/ from the Concrete Batching Plant (CBP)

Premise	Vessel Type	Length of Sailing Route (m) [1]	Design Speed (m/s)	Speed Under Various Mode (m/s)		Time-In-Mode (min)	
				Hotelling	Maneuvering [2]	Hotelling [3]	Maneuvering [4]
China Concrete Co. Ltd.	Barge	581.7	NA	0	3.09	60	3.14
HK Concrete Co. Ltd.	Barge	592.4	NA	0	3.09	60	3.20
Redland Concrete Ltd.	Barge	483.5	NA	0	3.09	60	2.61

Notes:
[1] Length of sailing route within 500m assessment area.
[2] No information is available from the operator. The travelling speed of sand barges with similar nature and operation mode are recorded and can be found at https://www.marinetraffic.com. The recorded averaged speed of sand barges (i.e. about 6 knots, 3.09m/s) is adopted in this assessment, assuming the travelling speed of the barges is the same during their journey. According to EPD's study on marine vessel (2012), the speed in maneuvering mode ranges from 1 to 8 knots (i.e. 0.51 and 4.12m/s). Therefore, the barges are travelling under maneuvering mode within the assessment area for assessment purpose.
[3] Time-In-Mode (TIM) for hotelling - As advised by the operator, there would be one barge at one time serving each CBP and the barges would stay for around one to two days then depart. Given that the long duration of stay and infrequent sailing schedule of the barges, it is assumed that there would be one barge for each CBP hotelling continuously during the operation hours as a conservative assessment.
[4] TIM for maneuvering is estimated based on the recorded averaged speed of the barges and the length of sailing route within 500m assessment area.

Emisson Factor for Barge of Concrete Batching Plant (CBP)
Marine Emission
Emission Rate = Engine Power x Loading Factor x Emission Factor x Time-in -mode

Premise	Vessel Type	Engine Type	Average Engine Power (kW) [1]	Loading Factor [4]		Time-In-Mode (min) [5]		Emission Factor (g/kWh)			
				Hotelling	Maneuvering	Hotelling	Maneuvering	SO_2 [2]	NOx [2]	RSP [2]	FSP [2]
China Concrete Co. Ltd.	Barge	Main Engine	727	0.00	0.30	60	3.14	0.21	10.00	0.30	0.29
		Auxiliary Engine	116	0.43	0.43	60	3.14	0.21	10.00	0.40	0.39
HK Concrete Co. Ltd.	Barge	Main Engine	727	0.00	0.30	60	3.20	0.21	10.00	0.30	0.29
		Auxiliary Engine	116	0.43	0.43	60	3.20	0.21	10.00	0.40	0.39
Redland Concrete Ltd.	Barge	Main Engine	727	0.00	0.30	60	2.61	0.21	10.00	0.30	0.29
		Auxiliary Engine	116	0.43	0.43	60	2.61	0.21	10.00	0.40	0.39

Note:
[1] Engine Power for Main Engine and Auxiliary Engine - No information from operator is available. Referenced to Table 4-5 and 4-6 of the Study on Marine Vessels Emissions Inventory, February 2012, Main Engine Power and Auxiliary Engine of Barge at GRT Class >=1000 for conservative purpose.
[2] Emission Factor for Main Engine and Auxiliary Engine - No information from operator is available. Reference to EPD's Table 4-16 of the Study on Marine Vessels Emissions Inventory, February 2012, engine type of ME(Cat.1) for main engine and AE for Auxiliary Engine.
[3] The emission factor of SO_2 is corrected with the fuel sulphur content according to Section 4.2.31 of EPD's "Study on Marine Vessels Emission Inventory" using the following equation: SO_2 Emission Factor (Auxiliary Engine) = BSFC x 2 x 0.9755 x Fuel Sulphur Fraction
where
BSFC of the vessel is referenced to Section 4.2.27 of EPD's "Study on Marine Vessels Emission Inventory", i.e. 213 g/kWh.
Fuel Sulphur Fraction refers to the fuel sulphur content limit of the MLD i.e. 0.05% with effective of the Air Pollution Control (Marine Light Diesel) Regulation on 1st April, 2014.
Therefore, SO_2 Emission Factor of Auxiliary Engine = 213 x 2 x 0.9755 x (0.05/100) = 0.21 g/kWh
[4] Loading Factor for Main Engine and Auxiliary Engine - No information from operator is available. Reference to EPD's Tables 4-7 and 4-10 of the Study on Marine Vessels Emissions Inventory, February 2012, vessel type of All except tug and All RTVs respectively for conservative purpose.
[5] Time-In-Mode (TIM) Estimation - Refer to Calculations of TIM for Barge to / from the concrete batching plant.

Detailed Emission Rate

Premise	Vessel Type	Engine Type	Emission Factor (kg/hour)							
			Hotelling				Maneuvering			
			SO_2	NOx	RSP	FSP	SO_2	NOx	RSP	FSP
China Concrete Co. Ltd.	Barge	Main Engine	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.370E-03	1.141E-01	3.422E-03	3.308E-03
		Auxiliary Engine	1.04E-02	4.99E-01	2.00E-02	1.95E-02	5.420E-04	2.608E-02	1.043E-03	1.017E-03
HK Concrete Co. Ltd.	Barge	Main Engine	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.413E-03	1.162E-01	3.485E-03	3.368E-03
		Auxiliary Engine	1.04E-02	4.99E-01	2.00E-02	1.95E-02	5.520E-04	2.656E-02	1.063E-03	1.036E-03
Redland Concrete Ltd.	Barge	Main Engine	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.970E-03	9.480E-02	2.844E-03	2.749E-03
		Auxiliary Engine	1.04E-02	4.99E-01	2.00E-02	1.95E-02	4.505E-04	2.168E-02	8.672E-04	8.455E-04

Note:
[1] It is assumed that there would be one barge hotelling at each concrete batching plant during the operation hours.
[2] *Emission = Engine Power (kW) x Loading Factor x Time-in-mode (hr) x Emission Factor (g/kWh)*
e.g. NOx emission factor of auxiliary engine under maneuvering at China Concrete Co. Ltd. (kg/hour)
= Engine Power (kW) x Loading Factor x Emission Factor (g/kWh) x Time-in-mode (hr) / 1000
= (116 x 0.43 x 10.0 x 3.246 / 60 / 1000)
= 0.02698 kg/hour

Calculations of Emission Factor for Wind Erosion within Concrete Batching Plant (CBP)

		Emission Factor	Unit	Reference
TSP	=	0.85	Mg/hectare/yr	Table 11.9.4 of AP-42 S11.9

Therefore,

RSP	=	0.40	Mg/hectare/yr	Multiplied by a conversion factor of 0.47 for TSP to RSP according to Table 2 of AP-42 S13.2.4
	=	1.27E-06	g/sq.m/s	24 hour emission. No watering and covering are assumed in emission rate calculation as a conservative approach.
FSP	=	0.06	Mg/hectare/yr	Multiplied by a conversion factor of 0.07 for TSP to FSP according to Table 2 of AP-42 S13.2.4
	=	1.89E-07	g/sq.m/s	24 hour emission. No watering and covering are assumed in emission rate calculation as a conservative approach.

Calculations of Emission Factor for Paved Road within Concrete Batching Plant (CBP)

$$E = k\,(sL)^{0.91} \times (W)^{1.02}$$

where

E= Emission factor in grams per vehicle kilomter travelled (g/veh-km)

k= Particle size multiplier, k = 0.62 g/veh-km for RSP and 0.15 g/veh-km for FSP as defined according to Table 2 of AP42 S13.2.1-1

sL= Road surface silt loading (g/m^2), as per AP-42 Table 13.2.1-3, mean silt loading for concrete batching plant is 12 g/m^2

W= Average weight (ton) of vehicles travelling on road, 22 tons is assumed as full load condition

RSP Emission Factor = 0.139 g/veh-m

FSP Emission Factor = 0.034 g/veh-m

Description	Source ID	Distance (m)	Road Width (m)	Road Surface Area (m^2)	Peak Hourly Flow of Mixer Trucks [1]	Dust Removal Efficiency (%) [2]	Emission Rate [3][5]	
							RSP ($g/s/m^2$)	FSP ($g/s/m^2$)
China Concrete Co. Ltd. [4]	L11	17	6	102	-	-	3.10E-05	7.49E-06
	L12	6	45	268	-	-	3.10E-05	7.49E-06
HK Concrete Co. Ltd.	L31	3	18	53	22	91.70%	4.01E-06	9.70E-07
	L32	37	3	113	22	91.70%	2.35E-05	5.69E-06
Redland Concrete Ltd.	L21	7	16	110	22	91.70%	4.44E-06	1.08E-06

Note:

1. Peak hourly mixer trucks count of each concrete batching plants based on site observations.
2. Calculation of Dust Removal Efficiency for HK Concrete Co. Ltd. and Redland Concrete Ltd.

$$C = 100 - \frac{0.8pdt}{i}$$

(ref.: Eq. 3-2 in Section 3.3.3 of USEPA Control of Open Fugitive Duat Sources - Final Report)

where

C = Average control efficiency, in percent

p = Potenial average hourly daytime evaporation rate, 0.23676 mm/h (p = 0.0049 x 48.3189 inch is equivalent to total evaporation of 1227.3mm obtained from Hong Kong Observatory)

d = Average hourly daytime traffic rate per hour, 22 veh/hr based on site observation

t = Time between applications in hour, once in each working hour as observed during site visit

i = Application intensity, 0.5 L/m^2 for haul road as minimum application intensity

Therefore,

C = 100-(0.8)(0.2368)(22)(1)/0.5 = 91.7%

3. Emission Rate(g/s) = Emission Factor x (1- Dust Removal Efficiently) x No. of Trucks per hour x Travelling Distance/Road Surface Area
4. According to the SP License for China Concret Co. Ltd. (L-3-194(4)), the maximum dust emission rate from paved roads is 0.215kg/hr with dust control equipment (i.e. water spray).
5. According to Table 2 of AP42 S13.2.1-1, Particle size multiplier (k) of TSP, RSP and FSP for paved road is defined as 3.23 g/veh-km, 0.62 g/veh-km and 0.15 g/veh-km, respectively. The conversion ratio of TSP to RSP and FSP for paved road has thus referenced to the particle size multiplier.

Calculations of Emission Sources within Concrete Batching Plant (CBP)

Description	Fugitive Emission (Y/N)	Source ID	Source ID from SPL	Emissions/ Parameters extracted from SP License [1]							Concentration	Emission Rate adjusted to Emission Concentration Limit (10 mg/m^3) [2][3]		Exit Velocity (m/s)	Operation Hours [4]
				Exhaust Gas Flowrate (m^3/h)	Exit Temp (K)	Emission Height (mAG)	Stack Width (m)	Stack Length (m)	Stack Diameter (m)	Max Emission Rate (kg/hr)	RSP (mg/m3)	RSP (g/s)	FSP (g/s)		
China Concrete Co. Ltd. [1][2]	N	P101	1	1750	298.15	31	0.125	0.25	0.20	0.0875	26	0.00486	0.00143	15.6	0700 to 2100 (14 hours)
	N	P102	2	1750	298.15	31	0.125	0.25	0.20	0.0875	26	0.00486	0.00143	15.6	
	N	P103	3	1750	298.15	8	0.125	0.25	0.20	0.0875	26	0.00486	0.00143	15.6	
	N	P104	4	1750	298.15	8	0.125	0.25	0.20	0.0875	26	0.00486	0.00143	15.6	
	Y	P105	5 or 5a	-	298.15	6	4	4	-	0.7750	-	0.00686	0.00202	-	
	N	P106	6	1750	298.15	30	0.125	0.25	0.20	0.0875	26	0.00486	0.00143	15.6	
	N	P107	7	1750	298.15	30	0.125	0.25	0.20	0.0875	26	0.00486	0.00143	15.6	
	N	P108	8	1750	298.15	30	0.125	0.25	0.20	0.0875	26	0.00486	0.00143	15.6	
	N	P109	9	1750	298.15	30	0.125	0.25	0.20	0.0875	26	0.00486	0.00143	15.6	
	N	P110	10	3500	298.15	12	0.25	0.25	0.28	0.1750	26	0.00972	0.00286	15.6	
	N	P111	11	3500	298.15	12	0.25	0.25	0.28	0.1750	26	0.00972	0.00286	15.6	
HK Concrete Co. Ltd. [1][2]	N	P301	EP1A (1)	1550	298.15	33	0.125	0.25	0.20	0.0775	26	0.00431	0.00127	13.8	0700 to 1900 (12 hours)
	N	P302	EP1B (2)	1550	298.15	33	0.125	0.25	0.20	0.0775	26	0.00431	0.00127	13.8	
	N	P303	EP1C (3)	1550	298.15	33	0.125	0.25	0.20	0.0775	26	0.00431	0.00127	13.8	
	N	P304	EP1D (4)	1550	298.15	33	0.125	0.25	0.20	0.0775	26	0.00431	0.00127	13.8	
	N	P305	EP1E (5)	1550	298.15	33	0.125	0.25	0.20	0.0775	26	0.00431	0.00127	13.8	
	N	P306	EP1F (6)	1550	298.15	33	0.125	0.25	0.20	0.0775	26	0.00431	0.00127	13.8	
	N	P307	EP1G (7)	1550	298.15	33	0.125	0.25	0.20	0.0775	26	0.00431	0.00127	13.8	
	N	P308	EP1H (8)	1550	298.15	28	0.125	0.25	0.20	0.0775	26	0.00431	0.00127	13.8	
	N	P309	EP1I (9)	1550	298.15	33	0.125	0.25	0.20	0.0775	26	0.00431	0.00127	13.8	
	N	P310	EP2A (10)	1550	298.15	13	0.125	0.25	0.20	0.0775	26	0.00431	0.00127	13.8	
	N	P311	EP2B (11)	1550	298.15	13	0.125	0.25	0.20	0.0775	26	0.00431	0.00127	13.8	
	N	P312	EP2C (12)	1550	298.15	13	0.125	0.25	0.20	0.0775	26	0.00431	0.00127	13.8	
	Y	P313	EP4(13)	-	298.15	9	2.5	5	-	0.7750	-	0.00878	0.00258	-	
Redland Concrete Ltd. [1][2]	N	P201	EP2	1750	298.15	26	-	-	0.15	0.0880	26	0.00486	0.00143	27.5	0700 to 1900 (12 hours)
	N	P202	EP3	1750	298.15	26	-	-	0.15	0.0880	26	0.00486	0.00143	27.5	
	N	P203	EP4	1750	298.15	26	-	-	0.15	0.0880	26	0.00486	0.00143	27.5	
	N	P204	EP5	1750	298.15	26	-	-	0.15	0.0880	26	0.00486	0.00143	27.5	
	N	P205	EP6	200	298.15	8	-	-	0.20	0.0100	26	0.00056	0.00016	1.8	
	N	P206	EP7	1750	298.15	10	-	-	0.15	0.0880	26	0.00486	0.00143	27.5	
	N	P207	EP8	1750	298.15	10	-	-	0.15	0.0880	26	0.00486	0.00143	27.5	
	N	P208	EP9	1750	298.15	10	-	-	0.15	0.0880	26	0.00486	0.00143	27.5	
	N	P209	EP10	200	298.15	8	-	-	0.20	0.0100	26	0.00056	0.00016	1.8	
	N	P210	EP18	1750	298.15	26	-	-	0.15	0.0880	26	0.00486	0.00143	27.5	
	N	P211	EP19	1750	298.15	26	-	-	0.15	0.0880	26	0.00486	0.00143	27.5	
	N	P212	EP20	200	298.15	15	-	-	0.20	0.0100	26	0.00056	0.00016	1.8	
	N	P213	EP21	1750	298.15	12	-	-	0.15	0.0880	26	0.00486	0.00143	27.5	
	N	P214	EP22	1750	298.15	26	-	-	0.15	0.0880	26	0.00486	0.00143	27.5	
	N	P215	EP23	1750	298.15	26	-	-	0.15	0.0880	26	0.00486	0.00143	27.5	
	N	P216	EP24	200	298.15	15	-	-	0.20	0.0100	26	0.00056	0.00016	1.8	
	N	P217	EP25	1750	298.15	12	-	-	0.15	0.0880	26	0.00486	0.00143	27.5	
	N	P218	EP26	1750	298.15	26	-	-	0.15	0.0880	26	0.00486	0.00143	27.5	
	N	P219	EP27	1750	298.15	26	-	-	0.15	0.0880	26	0.00486	0.00143	27.5	
	N	P220	EP28	200	298.15	15	-	-	0.20	0.0100	26	0.00056	0.00016	1.8	
	N	P221	EP29	3500	298.15	12	0.4	0.4	0.45	0.1750	26	0.00972	0.00286	6.1	
	N	P222	EP30	1750	298.15	26	-	-	0.15	0.0880	26	0.00486	0.00143	27.5	
	N	P223	EP31	1750	298.15	26	-	-	0.15	0.0880	26	0.00486	0.00143	27.5	
	N	P224	EP32	200	298.15	15	-	-	0.20	0.0100	26	0.00056	0.00016	1.8	
	N	P225	EP33	3500	298.15	12	0.4	0.4	0.45	0.1750	26	0.00972	0.00286	6.1	
	N	P226	EP35	200	298.15	8	-	-	0.20	0.0100	26	0.00056	0.00016	1.8	
	N	P227	EP36	200	298.15	8	-	-	0.20	0.0100	26	0.00056	0.00016	1.8	
	N	P228	EP38	200	298.15	12	-	-	0.20	0.0100	26	0.00056	0.00016	1.8	
	N	P229	EP39	200	298.15	12	-	-	0.20	0.0100	26	0.00056	0.00016	1.8	
	N	P230	EP46	10200	298.15	3	0.5	0.5	0.56	0.1700	9	0.02408	0.00708	11.3	

Note:

1. No information is provided by the operators, reference has been made to the Specified Processes (SP) License (L-3-194(4) for China Concrete Co. Ltd.; L-3-218(3) for HK Concrete Co. Ltd.; and L-3-117 (6) for Redland Concrete Ltd.).
2. According to Appendix B.2, General Particle Size Distributions, page B.2-13, AP-42, 1/95 version, USEPA, RSP and FSP are 51% and 15% of TSP for general concrete batching activity.
3. According to Annex I of A Guidance Note on the Technical, Management and Monitoring Requirements for Specified Process - Cement Works (Concrete Batching Plant) BPM3/2(16) (Februrary 2016), the concentration limit of Particulate Matter (PM) would be limited to 10mg/m^3 for license renewal by 1 January 2018 for all plants.
4. Operation hours of these three CBPs were made reference to Approved Lei Yue Mun Waterfront Enhancement Project EIA (EIA258/2018).