Marine Navigation - Engine Power, Load Factor and Emission Factors

Table 1: Main Engine of Marine Vessels

Company	Vessel Type	Engine Model	No. of Engine	Engine Type	Total Engine Power (kW)	No. of Vessels	Engine Power Source	
Turbojet	Tricat	Caterpillar Solar Taurus	2	Gas Turbine	8664	10	EPD's Study on Marine Vessels Emission Inventory	
Turbojet	Flying Cat	MTU 16V 396 TE 74L	2	Diesel	4000	4	EPD's Study on Marine Vessels Emission Inventory	
Turbojet	Jetfoil	Allison Gas Turbine 501-KF	2	Gas Turbine	5534	16	EPD's Study on Marine Vessels Emission Inventory	
Cotai water jet ^[1]	Austal	MTU 16V 4000 M70	4	Diesel	9280	N/A	Operator's Website	
PRD Ferry [1]	PRD Ferry	N/A	N/A	Diesel	3150	N/A	EPD's Study on Marine Vessels Emission Inventory	
Chu Kwong Barge	Barge A	101TEU	2	Diesel	678	1	Operator	
Chu Kwong Barge	Barge B	101TEU	2	Diesel	678	1	Operator	
Chu Kwong Barge	Barge C	16TEU	2	Diesel	220	1	Operator	
Chu Kwong Barge	Barge D	16TEU	2	Diesel	220	1	Operator	
Note:								

[1] Otai water jet and PRD ferry services are operated by Chu Kong Passenger Transport Company Limited and its subsidiary company. The Catai water jet responsible for the Hong Kong-Macau Ferry Services.

Table 2: Auxiliary Engine of Marine Vessels

Company	Vessel Type	Engine Model	No. of Engine	Engine Type	Total Engine Power (kW)	No. of Vessels	Engine Power Source
Turbojet	Tricat	N/A	1	Gas Turbine	326	10	EPD's Study on Marine Vessels Emission Inventory
Turbojet	Flying Cat	N/A	1	Diesel	326	4	EPD's Study on Marine Vessels Emission Inventory
Turbojet	Jetfoil	N/A	1	Gas Turbine	326	16	EPD's Study on Marine Vessels Emission Inventory
Cotai water jet ^[2]	Austal	N/A	1	Diesel	326	N/A	EPD's Study on Marine Vessels Emission Inventory
PRD Ferry [2]	PRD Ferry	N/A	1	Diesel	188	N/A	EPD's Study on Marine Vessels Emission Inventory
Chu Kwong Barge	Barge A	N/A	1	Diesel	66	1	Operator
Chu Kwong Barge	Barge B	N/A	1	Diesel	66	1	Operator
Chu Kwong Barge	Barge C	N/A	1	Diesel	35	1	Operator
Chu Kwong Barge	Barge D	N/A	1	Diesel	35	1	Operator

Table: [2] Cotai water jet and PRD ferry services are operated by Chu Kong Passenger Transport Company Limited and its subsidiary company. The Catai water jet responsible for the Hong Kong-Macau Ferry Services.

Table 3: Load Factor of Main Engine and Auxiliary Engine

		Main Engine					
Company	Vessel Type					Source	
		Fairway Cruise ^[3]	Slow Cruise ^[4]	Maneuvering ^[0]	Hotelling ¹⁰		
Turbojet	Tricat	0.34	0.28	0.18	0.00	Note [7][8]	
Turbojet	Flying Cat	0.34	0.28	0.18	0.00	Note [7][8]	
Turbojet	Jetfoil	0.34	0.28	0.18	0.00	Note [7][8]	
Cotai water jet	Austal	0.35	0.28	0.19	0.00	Note [7][8]	
PRD Ferry (CKS)	PRD Ferry (CKS)	0.49	0.39	0.26	0.00	Note [7][8]	
PRD Ferry (Turbojet)	PRD Ferry (Turbojet)	0.34	0.28	0.18	0.00	Note [7][8]	
Chu Kong Barge	Barge A	0.45	0.45	0.30	0.00	Operator	
Chu Kong Barge	Barge B	0.45	0.45	0.30	0.00	Operator	
Chu Kong Barge	Barge C	0.45	0.45	0.30	0.00	Operator	
Chu Kong Barge	Barge D	0.45	0.45	0.30	0.00	Operator	
			Auxiliary	/ Engine			
Company	Vessel Type		Auxiliary	/ Engine		Source	
Company	Vessel Type	Fairway Cruise ^[3]	Auxiliary Slow Cruise ^[4]	/ Engine Maneuvering ^[5]	Hotelling ^[6]	Source	
Company Turbojet	Vessel Type Tricat	Fairway Cruise ^[3] 0.45	Auxiliary Slow Cruise ^[4] 0.45	Maneuvering ^[5] 0.45	Hotelling ^[6] 0.45	Source EPD's Study on Marine Vessels Emission Inventory	
Company Turbojet Turbojet	Vessel Type Tricat Flying Cat	Fairway Cruise ^[3] 0.45 0.45	Auxiliary Slow Cruise ^[4] 0.45 0.45	/ Engine Maneuvering ^[5] 0.45 0.45	Hotelling ^[6] 0.45 0.45	Source EPD's Study on Marine Vessels Emission Inventory EPD's Study on Marine Vessels Emission Inventory	
Company Turbojet Turbojet Turbojet	Vessel Type Tricat Flying Cat Jetfoil	Fairway Cruise ^[3] 0.45 0.45 0.45	Auxiliary Slow Cruise ^[4] 0.45 0.45 0.45	V Engine Maneuvering ^[5] 0.45 0.45 0.45	Hotelling ^[6] 0.45 0.45 0.45	Source EPD's Study on Marine Vessels Emission Inventory EPD's Study on Marine Vessels Emission Inventory EPD's Study on Marine Vessels Emission Inventory	
Company Turbojet Turbojet Turbojet Cotai water jet	Vessel Type Tricat Flying Cat Jetfoil Austal	Fairway Cruise ^[3] 0.45 0.45 0.45 0.45	Auxiliary Slow Cruise ^[4] 0.45 0.45 0.45 0.45 0.45	/ Engine Maneuvering ^[5] 0.45 0.45 0.45 0.45	Hotelling ⁽⁶⁾ 0.45 0.45 0.45 0.45	Source EPD's Study on Marine Vessels Emission Inventory EPD's Study on Marine Vessels Emission Inventory EPD's Study on Marine Vessels Emission Inventory EPD's Study on Marine Vessels Emission Inventory	
Company Turbojet Turbojet Cotai water jet PRD Ferry (CKS)	Vessel Type Tricat Flying Cat Jetfoil Austal PRD Ferry (CKS)	Fairway Cruise ^[3] 0.45 0.45 0.45 0.45 0.45	Auxiliary Slow Cruise ^[4] 0.45 0.45 0.45 0.45 0.45	V Engine Maneuvering ^[5] 0.45 0.45 0.45 0.45 0.45	Hotelling ^[6] 0.45 0.45 0.45 0.45 0.45	Source EPD's Study on Marine Vessels Emission Inventory EPD's Study on Marine Vessels	
Company Turbojet Turbojet Cotai water jet PRD Ferry (CKS) PRD Ferry (Turbojet)	Vessel Type Tricat Flying Cat Jetfoil Austal PRD Ferry (CKS) PRD Ferry (Turbojet)	Fairway Cruise ^[3] 0.45 0.45 0.45 0.45 0.45 0.45	Auxiliary Slow Cruise ^[4] 0.45 0.45 0.45 0.45 0.45 0.45	V Engine Maneuvering ^[5] 0.45 0.45 0.45 0.45 0.45 0.45	Hotelling ^[6] 0.45 0.45 0.45 0.45 0.45 0.45	Source EPD's Study on Marine Vessels Emission Inventory	
Company Turbojet Turbojet Cotai water jet PRD Ferry (CKS) PRD Ferry (Turbojet) Chu Kong Barge	Vessel Type Tricat Flying Cat Jetfoil Austal PRD Ferry (CKS) PRD Ferry (CKS) Barge A	Fairway Cruise ^[3] 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.43	Auxiliary 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.43	/ Engine Maneuvering ⁽⁵⁾ 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.43	Hotelling ⁽⁶⁾ 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.43	Source EPD's Study on Marine Vessels Emission Inventory Deprot	
Company Turbojet Turbojet Cotai water jet PRD Ferry (CKS) PRD Ferry (CKS) Chu Kong Barge Chu Kong Barge	Vessel Type Tricat Flying Cat Jetfoll Austal PRD Ferry (CKS) PRD Ferry (Turbojet) Barge A Barge B	Fairway Cruise ^[3] 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.43 0.43	Auxiliary Slow Cruise ^[4] 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.43 0.43	/ Engine Maneuvering ⁽⁵⁾ 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.43 0.43	Hotelling ⁽⁶⁾ 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.43 0.43	Source EPD's Study on Marine Vessels Emission Inventory Operator Operator Operator	
Company Turbojet Turbojet Turbojet Cotai water jet PRD Ferry (CKS) PRD Ferry (Turbojet) Chu Kong Barge Chu Kong Barge Chu Kong Barge	Vessel Type Tricat Flying Cat Jetfoil Austal PRD Ferry (CKS) PRD Ferry (Turbojet) Barge A Barge B Barge C	Fairway Cruise ⁸³ 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.43 0.43 0.43	Auxiliary 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.45	/ Engine Maneuvering ^[5] 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.43 0.43 0.43	Hotelling ^[6] 0.45 0.45 0.45 0.45 0.45 0.45 0.45 0.43 0.43 0.43	Source EPD's Study on Marine Vessels Emission Inventory Operator Operator Operator	

Note:

Note: [3] Fairway Cruise: Vassel Speed - Over 12 knots (As advised by fast ferry captain, the maximum speed within 500m of airport is 15 knots) (15 knots are adopted for calculating the load factor as conservative approach) [4] Slow Cruise: Vessel Speed - 8 to 12 knots (12 knots are adopted for calculating the load factor as conservative approach) [5] Maneuvering: Vessel Speed - 10 e8 knots (8 knots are adopted for calculating the load factor as conservative approach) [6] Hotelling: Vessel Speed - 10 e8 knots (8 knots are adopted for calculating the load factor as conservative approach) [7] Mechanical Power = Force x Velocity Assume force is constant, thus load factor is proportional to speed (with reference to approved EIA for West Kowloon Cultural District (AEIAR-178/2013)) E.g. Turbojet to Macau (Tricat, Flying Cat and Jetfoil), Max Speed = 43.5 knot, Load Factor of Fairway Cruise = 15/43.5 = 0.34 Load Factor of Fairway Cruise = 15/43.5 = 0.18

Load Factor of Slow (Cruse = 12/43, 5 = 0.28 Load Factor of Maneuvering = 8/43, 5 = 0.18 [8] Max Speed of Turbojet to Macau (Tricat, Flying Cat and Jetfoil) = 43.5 knots Max Speed of Cotali water jet = 42.5 knots Max Speed of PRD Ferry (CS) = 30.75 knots Max Speed of PRD Ferry (Turbojet) = 43.5 knots

Table 4: Emission Factor of Main Engine and Auxiliary Engine Macau and PRD Ferry Macau and PRD Barge (Diesel

	(Diesel Engine)	Ferry (Gas Turbine Engine)	Engine)				
Main Engine							
Sulphur Content (%)	0.50	0.50	0.40				
SO ₂ (g/kWh)	2.08	2.93	1.66				
NO _x (g/kWh)	13.20	5.70	10.00				
PM ₁₀ (RSP) (g/kWh)	0.31	0.35	0.30				
PM _{2.5} (FSP) (g/kWh)	0.29	0.32	0.23				
HC (g/kWh)	0.47	0.10	0.27				
CO (g/kWh)	1.10	0.20	1.50				
Auxiliary Engine							
Sulphur Content (%)	0.50	0.50	0.40				
SO ₂ (g/kWh)	2.12	2.93	1.66				
NO _x (g/kWh)	10.00	5.70	10.00				
PM ₁₀ (RSP) (g/kWh)	0.31	0.35	0.40				
PM _{2.5} (FSP) (g/kWh)	0.29	0.32	0.31				
HC (g/kWh)	0.26	0.10	0.27				
CO (g/kWh)	1.50	0.20	1.70				

[9] Diesel sulphur content for Barge is provided by the operators.
[10] Diesel sulphur content for Macau and PRD Ferry is reference from EPD's study on Marine Vessels Emission Inventory.
[11] Emission Indices are reference from EPD's study on Marine Vessels Emission Inventory. Emission Indices of sulphur dioxide are corrected with the diesel sulphur content.