Alpha
Consulting Engineers Pte Ltd

PROJECT QUALITY PLAN

PROPOSED REDEVELOPMENT OF EXISTING KEPPEL TOWER/GE TOWER (KTGE) AT HOE CHIANG/KEE SENG ROAD

For

MANSFIELD DEVELOPMENTS PTE LTD

Copy No.	1

Prepared By : Koh Yong Huat/ Lim Chai Hoon

Authorised By : Choong Choon Guan

Date : 10 January 2025

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SECTION 1

QUALITY PLAN CONTROL AND DISTRIBUTION

1.1 List of Copy Holders

Copy No.	Copy Holder	Date of Issue
1	6207-PQP	10 January 2025

1.2 Revision Record

Revision	Date of Issue	Section Reference	Page(s)	Remarks
0	1 July 2019	1 to 11	29	+ 1 pg (Section 4.1 Overall Programme)
1	12 January 2021	1 to 11	29	+ 1 pg (Section 4.1 Overall Programme) + 27 pages (Section 9.1 Green Mark Requirements)
2	30 March 2022	1 to 11	29	+ 4 pages (Section 4.1 Overall Programme) + 27 pages (Section 9.1 Green Mark Requirements)
3	6 January 2023	1 to 11	29	+ 4 pages (Section 4.1 Overall Programme) + 27 pages (Section 9.1 Green Mark Requirements)
4	20 December 2023	1 to 11	29	+ 4 pages (Section 4.1 Overall Programme) + 27 pages (Section 9.1 Green Mark Requirements)
5	10 January 2025	1 to 11	29	+ 4 pages (Section 4.1 Overall Programme) + 27 pages (Section 9.1 Green Mark Requirements)

SECTION 2

PROJECT INFORMATION

2.1 Project Description

Type of Development	Office Block

Statistics of Development	
Site Area, m²	7,947.40
Nett Floor Area, m²	-
Gross Floor Area, m²	58,609
Covered Carpark, m²	3,445
No. of Covered Carpark Lots	77 (basement)
No. of Apartments/Houses	-
No. of Beds (for Hospitals)	-
No. of Guestroom (for Hotels)	-
No. of Blocks / No. of Storeys	1 block of 32-storey Office Tower
Green Mark Category	Platinum
No. of Phases	1

2.2 Project Cost

M&E Services Cost Plan (S$ x 1M)										
Services	EI	ACVI	LEI	FFAI	PSI	SPFI				
Estimate	18.61	20.56	14.00	4.72	4.06	0.16				
Awarded	16.49	30.67	7.88	4.73	5.76	0.83				

Total Project Construction Cost (S$ x1M)			
	Site Clearance	Piling Works	Main Contract
Estimate	-	-	-
Awarded	-	-	290.5

Site Clearance shall include earth work, soil improvement, service diversion and termination.

2.3 Scope of Works

2.3.1 Scope of Consultancy Services

Conceptual/Schematic Design	✓
Detailed Design	✓
Tender Documentation	✓
Tender Evaluation	✓
Contract Supervision	✓
M&E Costing	✓
Submissions to Authority	✓

(✓*where applicable*)

2.3.2 Scope of M&E Services

ELECTRICAL	✓	AIR CONDITIONING	✓	SPRINKLER	✓	SANITARY	✓	SWIMMING POOL	✓
LIFT	✓	MECHANICAL VENTILATION	✓	FIRE ALARM	✓	COLD WATER	✓	STEAM BOILER	
ESCALATOR		MECHANICAL SMOKE EXTRACT	✓	HOSEREEL	✓	HOT WATER	✓	FUEL STORAGE	✓
PABX		COMPUTER A/C		WET RISER	✓	TOWN GAS	✓		
SECURITY	✓	BST CARPARK EXH	✓	DRY RISER	✓	LPG GAS			
TELELIFT		HEATING				MEDICAL GAS			
DATA COMM.									
FLUSHFLOOR TRUNKING									

(✓ where applicable)

2.3.3 Submission to Relevant Authorities by Others

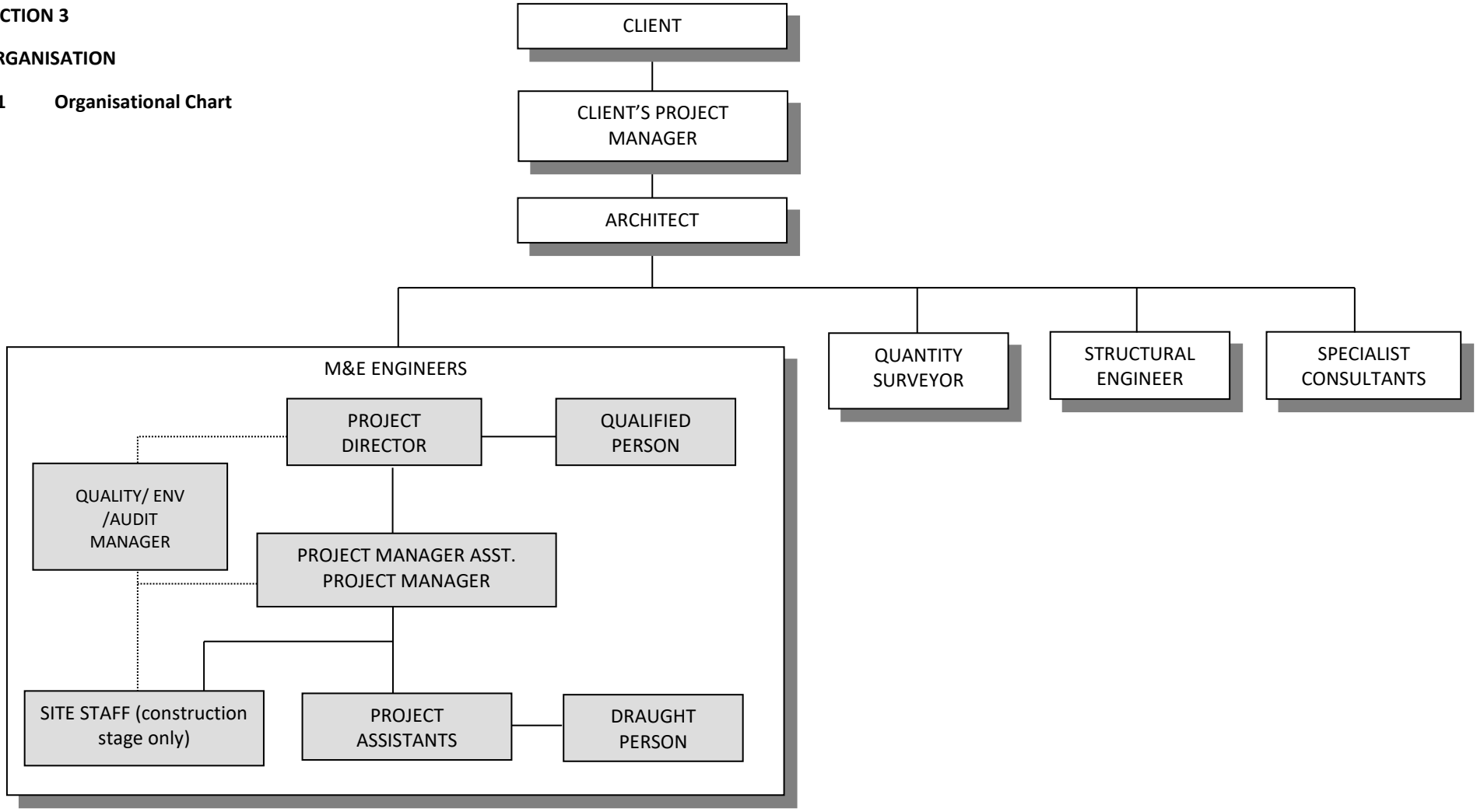
EJECTOR & DIVERTER	✓	SUMP PUMP	✓	FUEL OIL TANK	✓	LIFT & ESCALATOR	✓	PRESSURE VESSEL		HOISTS	✓	FOAM	

(✓ where applicable)

SECTION 3

ORGANISATION

3.1 Organisational Chart



SECTION 3

ORGANISATION

3.2 ACEPL's Project Team Member

TITLE		NAME
Project Director		Choong Choon Guan (CCG)
Qualified Person	Mechanical	Choong Choon Guan (CCG)
	Electrical	Loh Fook Yuen (LFY)
Project Manager		Koh Yong Huat (KYH)
Assistant Project Manager		Lim Chai Hoon (LCY)
Project Assistant (Mech)		Low Qi Fan (LQF)
Project Assistant (Elect)		Bervyn Tan (TWS)
Draughtsperson		Common Pool
Resident Engineer (M&E)		–
Assistant Resident Engineer (M&E)		–
Clerk-of-Work (M&E)		–

3.3 Client/Client's Representatives

Client: K-Commercial Pte Ltd

Address: 1 Harbourfront Avenue
Level 2 Keppel Bay Tower
Singapore 098632

Tel: 6338 8111

Fax: 6339 9767

Client's Representatives: Mr Paul Lau/Mr David Yeoh Chia Kiat

Name of Company	Contact Person	Contact
K-Commercial Pte Ltd	Name: Mr Paul Lau Position: General Manager	Tel: 6338 8111 Fax: – Handphone: 9772 7123 Email: paul.lau@keppelland.com
	Name: Mr David Yeoh Chia Kiat Position: Deputy General Manager	Tel: 6338 8111 Fax: – Handphone: 9665 8930 Email: david.yeoh@keppelland.com

3.4 Other Consultants (Local)

Function / Name of Company	Contact Person	Contact
Architect Architects 61 Pte Ltd	Name: Ms Serena Tan Position: Senior Associate	Tel: 6393 6869 Fax: 6732 5439 Handphone: – Email: rs507@a61.com.sg
Quantity Surveyor AECOM Cost Consulting and Project Management (Singapore) Pte Ltd	Name: Mr Lim Haw Keat Position: Associate	Tel: 6299 2466 Fax: 6299 0297 Handphone: – Email: 14082KTGEDLKPK@davislangdon.com
Structural Engineer Meinhardt (Singapore) Pte Ltd	Name: Mr Philip Pham Position: Technical Director	Tel: 6273 5255 Fax: 6274 0788 Handphone: 9327 6869 Email: philip.pham@meinhardtgroup.com / mscs148080@meinhardtgroup.com
Interior Designer Woods Bagot Asia Ltd	Name: Ms Meliaty Wong Position: Associate	Tel: 6932 1011 Fax: – Handphone: 8481 0038 Email: meliaty.wong@woodsbagot.com
Lighting Consultant The Lightbox Pte Ltd	Name: Ms Warinya Pintongkam Position: Managing Director	Tel: 6294 6803 Fax: 6324 0868 Handphone: 9741 1599 Email: design@lightboxlighting.com / jui@lightboxlighting.com
Traffic Consultant Vertix Asia Pacific	Name: Mr Leow Bok Wee Position: Transportation Consultant	Tel: 6536 8714 Fax: – Handphone: 8200 0184 Email: leow.bokwee@vertixap.com
Landscape Consultant EcoPlan Asia Pte Ltd	Name: Mr Thanapong (Gong) Position: Lead Landscape Architect	Tel: 6235 3825 Fax: – Handphone: 90214341 Email: gong@ecoplanasia.com
ESD Consultant G-Energy Global Pte Ltd	Name: Mr Vincent Low Position: Vice President	Tel: 3109 1388 Fax: – Handphone: 9385 2901 Email: vincentlow@genergy.com.sg / zeb0053_KTGE@zeb-tech.com

3.4 Other Consultants (Overseas)

Function / Name of Company	Contact Person	Contact
Architect NBBJ Design, New York	Name: Ms Ana Sotrel Position: Senior Associate / Project Manager	Tel: 646 767 2199 Fax: – Handphone: 917 453 8196 Email: ASotrel@nbbj.com
M&E Consultant (QAQC) WSP Consultancy Pte Ltd	Name: Ms Sophia Chua Position: Project Lead	Tel: 6533 7333 Fax: 6533 7707 Handphone: 9745 1713 Email: SG-KT-QAQC@wsp.com
Façade Consultant Arup Singapore Pte Ltd	Name: Mr Michael Chin Position: Project Director	Tel: 6411 2596 Fax: – Handphone: 9731 0676 Email: michael.chin@arup.com
Structural Engineer (QAQC) WSP Consultancy Pte Ltd	Name: Mr Brian Chan Position: C&S Lead	Tel: 6533 7333 Fax: 6533 7707 Handphone: 9338 9395 Email: SG-CS-KeppelQAQC@wsp.com
Design for Safety Professional PE Consultants Pte Ltd	Name: Mr David Zheng Zhijian Position: Managing Director	Tel: 6464 0691 Fax: 6464 0692 Handphone: 9800 4385 Email: pe@pecon.sg
Fire Safety Engineer (FSE) Ignesis Consultants Pte Ltd	Name: Er. Henry Ho Position: FSE/Managing Director	Tel: 6293 5431 Fax: 6509 3676 Handphone: 9685 9425 Email: henry@ignesisconsultants.com
Acoustic Consultant CCW Associates Pte Ltd	Name: Mr Goh Meng Teik Position: Senior Consultant	Tel: 6278 4918 Fax: 6275 7206 Handphone: 9387 2676 Email: mengteik@ccw.com.sg
Wayfinding & Signage There Design Pte Ltd	Name: Ms Kaitland Burrows Position: –	Tel: 6817 8695 / (612) Fax: – Handphone: – Email: kaitland@therestudio.com

3.5 Contractors/Sub-Contractors

Function / Name of Company	Contract *	Contact Person	Contact
Main Contract Obayashi Singapore Private Limited	DC	Name: Mr Winston Chiew Soon Kiat Position: Project Manager	Tel: 65 6220 6333 Fax: 65 6235 0825 Handphone: 9147 9790 Email: winston_chiew@obayashi.com.sg
Electrical Installation LSK Engineering Pte Ltd	DSC	Name: Mr. Johnny Ong Position: Senior Project Manager	Tel: – Fax: – Handphone: – Email: 1094ktr@lsk.com.sg
ACMV Installation Kurihara Kogyo Co., Pte Ltd	DSC	Name: Mr Tamilkumaran Position: Project Manager	Tel: – Fax: – Handphone: 9339 3329 Email: tamilkumaran@kurihara.com.sg
FFAI Installation Rico Engineering Works Pte Ltd	DSC	Name: Mr Nicholas Cheah Position: Project Manager	Tel: – Fax: – Handphone: 9236 8875 Email: nicholas.cheah@ricoeng.com.sg
PSI Installation Markpoint Engineering Pte Ltd	DSC	Name: Mr Sidney Kong Position: Project Manager	Tel: – Fax: – Handphone: 9067 8893 Email: sidney.kong@markpoint.com.sg
Lift Installation Kone Pte Ltd	NSC	Name: Mr George Chen Position: Project Manager	Tel: – Fax: – Handphone: 8481 6172 Email: fugeorge.chen@kone.com
		Name: Position:	Tel: Fax: Handphone: Email:
		Name: Position:	Tel: Fax: Handphone: Email:

** Type of Contract*
- *NSC (Nominated Sub-Contract)*
- *DSC (Domesticated Sub-Contract)*
- *DC (Direct Contract)*
- *NS (Nominated Supplier)*

3.6 Authorities

Authorities/Department	Contact Person	Tel/Fax Nos./E-mail
SP PowerGrid:		
(a) Sub-Station	Mr Goh Li Qing	6916 8679
(b) Diversion		
SP Services:		
(a) Customer Supply		
(b) Installation		
(c) Meter Section		
(d) Road Lighting		
TFCC:		
(a) SCV		
(b) SingTel	Mr Sunny Long	9118 0374
(c) IDA		
BCA:		
(a) Building Plan		
(b) Green Mark		
FSSD:		
(a) Building Plan		
(b) M&E Plan		
PUB (Water Supply) Network Dept:		
(a) Water Conservation		
(b) Plumbing Plan	Ms Paithra Krishnan	6731 3722
(c) Diversion		
PUB Water Reclamation (Network) Dept:		
(a) Building Plan/CBPU	Mr Ler Seng Chye	6731 3264
(b) M&E Plan		
(c) Diversion		
(d) NEWater	Ms Khin Phyu Pwint	6885 2502
City Gas Pte Ltd:		
(a) Planning/Submission	Mr Brandon Er	6578 7861
(b) Installation/Inspection		
PowerGas Pte Ltd		
(a) Diversion		
NEA (Pollution Control)		
(a) Planning/Submission		
(b) Inspection		

SECTION 4

PROGRAMME

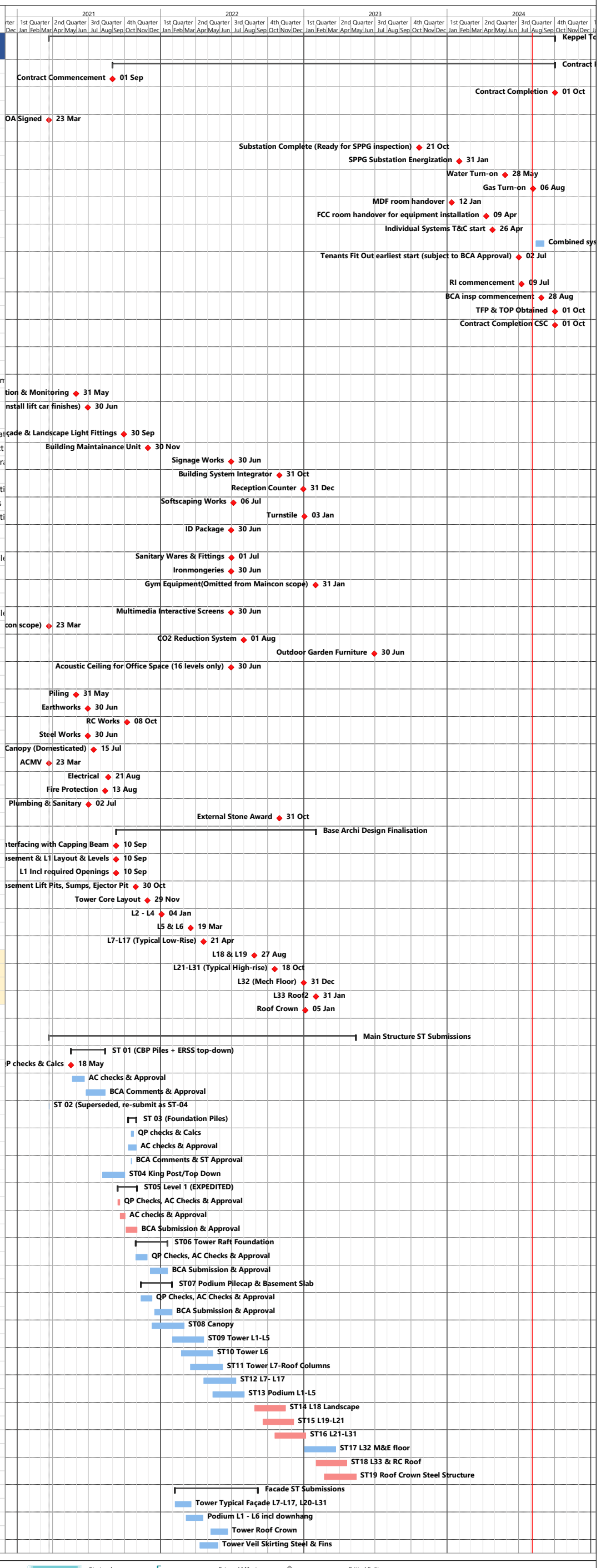
4.1 Overall Programme (Refer to attached Master Programme) – Refer to attached

ID	TASK NAME	MONTHS	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
1.	Preliminary Planning																									
2.	Planning Submission																									
3.	Detail Design																									
4.	BP Submission																									
5.	BP Submission (Amendments)																									
6.	Tender Period for Piling																									
7.	Tender Period for Sub-Structure																									
8.	Tender Period for Super-Structure																									
9.	Piling Period																									
10.	Sub-Structure Construction Period																									
11.	Super-Structure Construction Period																									
12.	TOP																									
13.	CSC																									

Keppel Tower Redevelopment Baseline Programme Rev 1.2 (04-Mar-2022)

OBAYASHI Singapore

ID	Task Name	Duration	Start	Finish	Quantities/Remarks
1	**Keppel Tower Redevelopment_High Level Preliminary Programme**	**1067 days**	**Tue 23-03-21**	**Tue 01-10-24**	
2	**Contract Period (37months)**	**934 days**	**Wed 01-09-21**	**Tue 01-10-24**	**Nett Working = 30.7mths**
3	Contract Commencement	0 days	Wed 01-09-21	Wed 01-09-21	
4	Contract Completion	0 days	Tue 01-10-24	Tue 01-10-24	
5	**Contract Milestones**				
6	LOA Signed	0 days	Tue 23-03-21	Tue 23-03-21	
7	**Project Milestones**				
8	Substation Complete (Ready for SPPG inspection)	0 days	Sat 21-10-23	Sat 21-10-23	
9	SPPG Substation Energization	0 days	Wed 31-01-24	Wed 31-01-24	SPPG 10 weeks to energize
10	Water Turn-on	0 days	Tue 28-05-24	Tue 28-05-24	4mths before TOP
11	Gas Turn-on	0 days	Tue 06-08-24	Tue 06-08-24	2mths before TOP
12	MDF room handover	0 days	Fri 12-01-24	Fri 12-01-24	8.5mths before TOP
13	FCC room handover for equipment installation	0 days	Tue 09-04-24	Tue 09-04-24	5.5mths before TOP
14	Individual Systems T&C start	0 days	Fri 26-04-24	Fri 26-04-24	
15	Combined systems T&C	18 days	Wed 14-08-24	Tue 03-09-24	14 weeks before TOP
16	Tenants Fit Out earliest start (subject to BCA Approval)	0 days	Tue 02-07-24	Tue 02-07-24	
17	RI commencement	0 days	Tue 09-07-24	Tue 09-07-24	
18	BCA insp commencement	0 days	Wed 28-08-24	Wed 28-08-24	
19	TFP & TOP Obtained	0 days	Tue 01-10-24	Tue 01-10-24	
20	Contract Completion CSC	0 days	Tue 01-10-24	Tue 01-10-24	
21					
22					
33	**Procurement**	**685 days**	**Tue 23-03-21**	**Fri 30-06-23**	
34	**NSC Award**	**484 days**	**Mon 31-05-21**	**Tue 03-01-23**	From 38mth tender programm
35	Instrumentation & Monitoring	0 days	Mon 31-05-21	Mon 31-05-21	
36	Lift Installation (incl Supply & install lift car finishes)	0 days	Wed 30-06-21	Wed 30-06-21	
37	Façade & Landscape Light Fittings	0 days	Thu 30-09-21	Thu 30-09-21	M+4 L1 Cast in Items/Penetrat
38	Building Maintainance Unit	0 days	Tue 30-11-21	Tue 30-11-21	Brought forward to reflect act
39	Signage Works	0 days	Thu 30-06-22	Thu 30-06-22	M+14 L1 Cast in Items/Penetra
40	Building System Integrator	0 days	Mon 31-10-22	Mon 31-10-22	M+6. ACE projected date
41	Reception Counter	0 days	Sat 31-12-22	Sat 31-12-22	M+14 Finalise minor penetrati
42	Softscaping Works	0 days	Wed 06-07-22	Wed 06-07-22	M+11 per Ecoplan comments
43	Turnstile	0 days	Tue 03-01-23	Tue 03-01-23	M+14 Finalise minor penetrati
44	ID Package	0 days	Thu 30-06-22	Thu 30-06-22	Not indicated
45	**Nominated Supplier**	**178 days**	**Thu 30-06-22**	**Tue 31-01-23**	
46	Sanitary Wares & Fittings	0 days	Fri 01-07-22	Fri 01-07-22	M+12 Penetrations for B1 toil
47	Ironmongeries	0 days	Thu 30-06-22	Thu 30-06-22	M+12
48	Gym Equipment(Omitted from Maincon scope)				
49	**Provisional Sum**	**685 days**	**Tue 23-03-21**	**Fri 30-06-23**	
50	Multimedia Interactive Screens	0 days	Thu 30-06-22	Thu 30-06-22	M+12 Penetrations for B1 toil
51	High Volume Low Speed Fan(under Maincon scope)				
52	CO2 Reduction System	0 days	Mon 01-08-22	Mon 01-08-22	M+6. ACE projected date
53	Outdoor Garden Furniture	0 days	Fri 30-06-23	Fri 30-06-23	M+16
54	Acoustic Ceiling for Office Space (16 levels only)	0 days	Thu 30-06-22	Thu 30-06-22	Not indicated in tender
55	**DSC Award (Main Trades)**	**485 days**	**Tue 23-03-21**	**Mon 31-10-22**	
56	Piling	0 days	Mon 31-05-21	Mon 31-05-21	updated to actual
57	Earthworks	0 days	Wed 30-06-21	Wed 30-06-21	updated to actual
58	RC Works	0 days	Fri 08-10-21	Fri 08-10-21	updated to actual
59	Steel Works	0 days	Wed 30-06-21	Wed 30-06-21	updated to actual
60	Façade & Canopy (Domesticated)	0 days	Thu 15-07-21	Thu 15-07-21	
61	ACMV	0 days	Tue 23-03-21	Tue 23-03-21	updated to actual
62	Electrical	0 days	Sat 21-08-21	Sat 21-08-21	updated to actual
63	Fire Protection	0 days	Fri 13-08-21	Fri 13-08-21	updated to actual
64	Plumbing & Sanitary	0 days	Fri 02-07-21	Fri 02-07-21	updated to actual
65	External Stone Award	0 days	Mon 31-10-22	Mon 31-10-22	
66	**Base Archi Design Finalisation**	**421 days**	**Fri 10-09-21**	**Tue 31-01-23**	
67	L1 interfacing with Capping Beam	0 days	Fri 10-09-21	Fri 10-09-21	CBP Cut Off Levels
68	Basement & L1 Layout & Levels	0 days	Fri 10-09-21	Fri 10-09-21	King Post & Foundation Piles
69	L1 Incl required Openings	0 days	Fri 10-09-21	Fri 10-09-21	L1 Perimeter Slab
70	Basement Lift Pits, Sumps, Ejector Pit	0 days	Sat 30-10-21	Sat 30-10-21	Excavation to FEL
71	Tower Core Layout	0 days	Mon 29-11-21	Mon 29-11-21	Basement Core Wall
72	L2 - L4	0 days	Tue 04-01-22	Tue 04-01-22	L2 Core Wall
73	L5 & L6	0 days	Sat 19-03-22	Sat 19-03-22	
74	L7-L17 (Typical Low-Rise)	0 days	Thu 21-04-22	Thu 21-04-22	
75	L18 & L19	0 days	Sat 27-08-22	Sat 27-08-22	Rev 0 = 27-08-22
76	L21-L31 (Typical High-rise)	0 days	Tue 18-10-22	Tue 18-10-22	Rev 0 = 21-12-22
77	L32 (Mech Floor)	0 days	Sat 31-12-22	Sat 31-12-22	Rev 0 = 21-12-22
78	L33 Roof2	0 days	Tue 31-01-23	Tue 31-01-23	Rev 0 = 18-02-23
79	Roof Crown	0 days	Thu 05-01-23	Thu 05-01-23	= rev0
80					
81	**Main Structure ST Submissions**	**646 days?**	**Tue 23-03-21**	**Sat 13-05-23**	
82	ST 01 (CBP Piles + ERSS top-down)	72 days	Tue 18-05-21	Thu 12-08-21	
83	QP checks & Calcs	0 days	Tue 18-05-21	Tue 18-05-21	
84	AC checks & Approval	25 days	Fri 21-05-21	Sun 20-06-21	
85	BCA Comments & Approval	40 days	Fri 25-06-21	Thu 12-08-21	
86	ST 02 (Superseded, re-submit as ST-04	1 day?	Tue 23-03-21	Tue 23-03-21	
87	ST 03 (Foundation Piles)	18 days	Mon 11-10-21	Sat 30-10-21	
88	QP checks & Calcs	6 days	Mon 18-10-21	Sat 23-10-21	
89	AC checks & Approval	18 days	Mon 11-10-21	Sat 30-10-21	
90	BCA Comments & ST Approval	1 day	Mon 18-10-21	Mon 18-10-21	
91	ST04 King Post/Top Down	48 days	Fri 06-08-21	Fri 01-10-21	
92	**ST05 Level 1 (EXPEDITED)**	**42 days**	**Tue 14-09-21**	**Mon 01-11-21**	
93	QP Checks, AC Checks & Approval	5 days	Tue 14-09-21	Sat 18-09-21	
94	AC checks & Approval	12 days	Mon 20-09-21	Sat 02-10-21	
95	BCA Submission & Approval	24 days	Tue 05-10-21	Mon 01-11-21	
96	**ST06 Tower Raft Foundation**	**66 days**	**Sat 30-10-21**	**Tue 18-01-22**	
97	QP Checks, AC Checks & Approval	24 days	Sat 30-10-21	Sat 27-11-21	
98	BCA Submission & Approval	36 days	Mon 06-12-21	Tue 18-01-22	
99	**ST07 Podium Pilecap & Basement Slab**	**66 days**	**Fri 12-11-21**	**Sat 29-01-22**	
100	QP Checks, AC Checks & Approval	24 days	Fri 12-11-21	Thu 09-12-21	
101	BCA Submission & Approval	36 days	Fri 17-12-21	Sat 29-01-22	
102	**ST08 Canopy**	**66 days**	**Fri 10-12-21**	**Tue 01-03-22**	
103	**ST09 Tower L1-L5**	**66 days**	**Mon 31-01-22**	**Wed 20-04-22**	
104	**ST10 Tower L6**	**66 days**	**Wed 23-02-22**	**Fri 13-05-22**	
105	**ST11 Tower L7-Roof Columns**	**66 days**	**Fri 18-03-22**	**Tue 07-06-22**	
106	**ST12 L7- L17**	**66 days**	**Thu 21-04-22**	**Mon 11-07-22**	
107	**ST13 Podium L1-L5**	**66 days**	**Sat 14-05-22**	**Mon 01-08-22**	
108	**ST14 L18 Landscape**	**66 days**	**Mon 29-08-22**	**Mon 14-11-22**	
109	**ST15 L19-L21**	**66 days**	**Mon 19-09-22**	**Mon 05-12-22**	
110	**ST16 L21-L31**	**66 days**	**Wed 19-10-22**	**Thu 05-01-23**	
111	**ST17 L32 M&E floor**	**66 days**	**Tue 03-01-23**	**Wed 22-03-23**	
112	**ST18 L33 & RC Roof**	**66 days**	**Wed 01-02-23**	**Wed 19-04-23**	
113	**ST19 Roof Crown Steel Structure**	**66 days**	**Wed 22-02-23**	**Sat 13-05-23**	
114	**Facade ST Submissions**	**175 days**	**Mon 07-02-22**	**Mon 05-09-22**	
115	Tower Typical Façade L7-L17, L20-L31	36 days	Mon 07-02-22	Sat 19-03-22	
116	Podium L1 - L6 incl downhang	36 days	Mon 07-03-22	Mon 18-04-22	
117	Tower Roof Crown	36 days	Mon 09-05-22	Mon 20-06-22	
118	Tower Veil Skirting Steel & Fins	36 days	Mon 11-04-22	Thu 26-05-22	



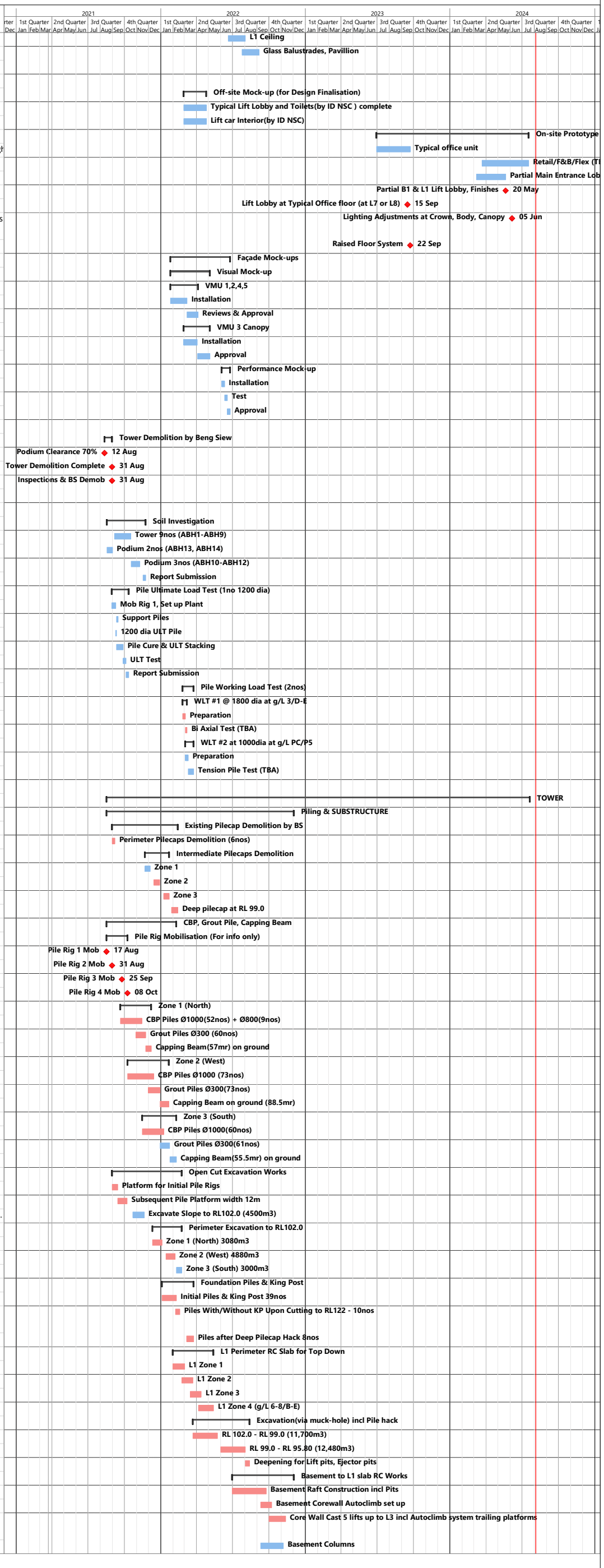
Keppel Tower Redevelopment
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Keppel Tower Redevelopment Baseline Programme Rev 1.2 (04-Mar-2022)

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ID	Task Name	Duration	Start	Finish	Quantities/Remarks
119	L1 Ceiling	36 days	Mon 20-06-22	Mon 01-08-22	
120	Glass Balustrades, Pavillion	36 days	Mon 25-07-22	Mon 05-09-22	
121					
122	**Mock-up**	**748 days**	**Tue 25-01-22**	**Wed 17-07-24**	
123	**Off-site Mock-up (for Design Finalisation)**	**48 days**	**Mon 28-02-22**	**Mon 25-04-22**	
124	Typical Lift Lobby and Toilets(by ID NSC) complete	48 days	Mon 28-02-22	Mon 25-04-22	A61 Target Q1 2022
125	Lift car Interior(by ID NSC)	48 days	Mon 28-02-22	Mon 25-04-22	
126	**On-site Prototype (for Quality Control) complete**	**318 days**	**Fri 30-06-23**	**Wed 17-07-24**	
127	Typical office unit	72 days	Fri 30-06-23	Fri 22-09-23	after L10 façade and watertigh
128	Retail/F&B/Flex (TBD)	96 days	Fri 22-03-24	Wed 17-07-24	
129	Partial Main Entrance Lobby	60 days	Fri 08-03-24	Mon 20-05-24	
130	Partial B1 & L1 Lift Lobby, Finishes	0 days	Mon 20-05-24	Mon 20-05-24	
131	Lift Lobby at Typical Office floor (at L7 or L8)	0 days	Fri 15-09-23	Fri 15-09-23	
132	Lighting Adjustments at Crown, Body, Canopy	0 days	Wed 05-06-24	Wed 05-06-24	Refers to lighting adjustments of angles etc
133	Raised Floor System	0 days	Fri 22-09-23	Fri 22-09-23	
134	**Façade Mock-ups**	**124 days**	**Tue 25-01-22**	**Fri 24-06-22**	
135	**Visual Mock-up**	**81 days**	**Tue 25-01-22**	**Wed 04-05-22**	
136	**VMU 1,2,4,5**	**58 days**	**Tue 25-01-22**	**Mon 04-04-22**	
137	Installation	34 days	Tue 25-01-22	Mon 07-03-22	
138	Reviews & Approval	24 days	Tue 08-03-22	Mon 04-04-22	
139	**VMU 3 Canopy**	**54 days**	**Mon 28-02-22**	**Wed 04-05-22**	
140	Installation	30 days	Mon 28-02-22	Sat 02-04-22	
141	Approval	24 days	Mon 04-04-22	Wed 04-05-22	
142	**Performance Mock-up**	**18 days**	**Sat 04-06-22**	**Fri 24-06-22**	approx 3mths after VMU
143	Installation	6 days	Sat 04-06-22	Fri 10-06-22	
144	Test	6 days	Sat 11-06-22	Fri 17-06-22	
145	Approval	6 days	Sat 18-06-22	Fri 24-06-22	
146					
147	***Tower Demolition by Beng Siew***	***16 days***	***Thu 12-08-21***	***Tue 31-08-21***	
148	*Podium Clearance 70%*	*0 days*	*Thu 12-08-21*	*Thu 12-08-21*	*11/Aug Joint Inspection*
149	*Tower Demolition Complete*	*0 days*	*Tue 31-08-21*	*Tue 31-08-21*	*30/Aug Joint Inspection*
150	*Inspections & BS Demob*	*0 days*	*Tue 31-08-21*	*Tue 31-08-21*	
151					
152	**Initial Advanced Works**	**183 days**	**Wed 18-08-21**	**Thu 24-03-22**	
153	**Soil Investigation**	**83 days**	**Wed 18-08-21**	**Tue 23-11-21**	1week/no/machine
154	Tower 9nos (ABH1-ABH9)	36 days	Mon 06-09-21	Sat 16-10-21	Mob 2 rigs.
155	Podium 2nos (ABH13, ABH14)	12 days	Wed 18-08-21	Tue 31-08-21	
156	Podium 3nos (ABH10-ABH12)	18 days	Mon 18-10-21	Mon 08-11-21	
157	Report Submission	6 days	Wed 17-11-21	Tue 23-11-21	
158	**Pile Ultimate Load Test (1no 1200 dia)**	**37 days**	**Mon 30-08-21**	**Mon 11-10-21**	
159	Mob Rig 1, Set up Plant	9 days	Mon 30-08-21	Wed 08-09-21	
160	Support Piles	3 days	Sat 11-09-21	Tue 14-09-21	
161	1200 dia ULT Pile	2 days	Thu 09-09-21	Fri 10-09-21	
162	Pile Cure & ULT Stacking	14 days	Sat 11-09-21	Mon 27-09-21	
163	ULT Test	6 days	Tue 28-09-21	Mon 04-10-21	
164	Report Submission	6 days	Tue 05-10-21	Mon 11-10-21	
165	**Pile Working Load Test (2nos)**	**24 days**	**Fri 25-02-22**	**Thu 24-03-22**	
166	**WLT #1 @ 1800 dia at g/L 3/D-E**	**9 days**	**Fri 25-02-22**	**Mon 07-03-22**	
167	Preparation	6 days	Fri 25-02-22	Thu 03-03-22	
168	Bi Axial Test (TBA)	3 days	Fri 04-03-22	Mon 07-03-22	
169	**WLT #2 at 1000dia at g/L PC/P5**	**18 days**	**Fri 04-03-22**	**Thu 24-03-22**	
170	Preparation	6 days	Fri 04-03-22	Thu 10-03-22	
171	Tension Pile Test (TBA)	12 days	Fri 11-03-22	Thu 24-03-22	
172					
173	**TOWER**	**886 days**	**Tue 17-08-21**	**Sat 20-07-24**	
174	**Piling & SUBSTRUCTURE**	**394 days**	**Tue 17-08-21**	**Fri 02-12-22**	
175	***Existing Pilecap Demolition by BS***	***138 days***	***Tue 31-08-21***	***Sat 12-02-22***	
176	*Perimeter Pilecaps Demolition (6nos)*	*6 days*	*Tue 31-08-21*	*Mon 06-09-21*	*6nos 1.4 x 1.4 x 1.4*
177	***Intermediate Pilecaps Demolition***	***51 days***	***Mon 22-11-21***	***Fri 21-01-22***	
178	*Zone 1*	*12 days*	*Mon 22-11-21*	*Sat 04-12-21*	
179	*Zone 2*	*12 days*	*Tue 14-12-21*	*Tue 28-12-21*	
180	*Zone 3*	*12 days*	*Sat 08-01-22*	*Fri 21-01-22*	
181	*Deep pilecap at RL 99.0*	*12 days*	*Fri 28-01-22*	*Sat 12-02-22*	
182	**CBP, Grout Pile, Capping Beam**	**146 days**	**Tue 17-08-21**	**Tue 08-02-22**	
183	**Pile Rig Mobilisation (For info only)**	**46 days**	**Tue 17-08-21**	**Fri 08-10-21**	
184	Pile Rig 1 Mob	0 days	Tue 17-08-21	Tue 17-08-21	
185	Pile Rig 2 Mob	0 days	Tue 31-08-21	Tue 31-08-21	
186	Pile Rig 3 Mob	0 days	Sat 25-09-21	Sat 25-09-21	
187	Pile Rig 4 Mob	0 days	Fri 08-10-21	Fri 08-10-21	
188	**Zone 1 (North)**	**66 days**	**Tue 21-09-21**	**Tue 07-12-21**	
189	CBP Piles Ø1000(52nos) + Ø800(9nos)	46 days	Tue 21-09-21	Sat 13-11-21	1.5d/pile/rig. 2 rigs
190	Grout Piles Ø300 (60nos)	20 days	Sat 30-10-21	Tue 23-11-21	3piles/day/rig. 1 rig
191	Capping Beam(57mr) on ground	12 days	Wed 24-11-21	Tue 07-12-21	
192	**Zone 2 (West)**	**86 days**	**Sat 09-10-21**	**Thu 20-01-22**	
193	CBP Piles Ø1000 (73nos)	55 days	Sat 09-10-21	Mon 13-12-21	Rig 3 & Rig 4
194	Grout Piles Ø300(73nos)	25 days	Tue 30-11-21	Wed 29-12-21	
195	Capping Beam on ground (88.5mr)	18 days	Thu 30-12-21	Thu 20-01-22	
196	**Zone 3 (South)**	**70 days**	**Mon 15-11-21**	**Tue 08-02-22**	
197	CBP Piles Ø1000(60nos)	45 days	Mon 15-11-21	Fri 07-01-22	Rig 1 & 2
198	Grout Piles Ø300(61nos)	20 days	Thu 30-12-21	Sat 22-01-22	
199	Capping Beam(55.5mr) on ground	12 days	Mon 24-01-22	Tue 08-02-22	
200	**Open Cut Excavation Works**	**146 days**	**Tue 31-08-21**	**Tue 22-02-22**	
201	Platform for Initial Pile Rigs	12 days	Tue 31-08-21	Mon 13-09-21	740m2
202	Subsequent Pile Platform width 12m	21 days	Tue 14-09-21	Thu 07-10-21	2100m2
203	Excavate Slope to RL102.0 (4500m3)	24 days	Fri 22-10-21	Fri 19-11-21	1400m2 x 2m + 33x15 x 3.5m.
204	**Perimeter Excavation to RL102.0**	**59 days**	**Sat 11-12-21**	**Tue 22-02-22**	
205	Zone 1 (North) 3080m3	18 days	Sat 11-12-21	Mon 03-01-22	160m3/day
206	Zone 2 (West) 4880m3	18 days	Fri 14-01-22	Sat 05-02-22	240m3/day
207	Zone 3 (South) 3000m3	12 days	Wed 09-02-22	Tue 22-02-22	240m3/day
208	**Foundation Piles & King Post**	**67 days**	**Tue 04-01-22**	**Thu 24-03-22**	2d/pile/rig.
209	Initial Piles & King Post 39nos	29 days	Tue 04-01-22	Tue 08-02-22	3rigs
210	Piles With/Without KP Upon Cutting to RL122 - 10nos	10 days	Mon 07-02-22	Thu 17-02-22	2rigs
211	Piles after Deep Pilecap Hack 8nos	16 days	Mon 07-03-22	Thu 24-03-22	1 rig
212	**L1 Perimeter RC Slab for Top Down**	**84 days**	**Mon 31-01-22**	**Fri 13-05-22**	
213	L1 Zone 1	24 days	Mon 31-01-22	Tue 01-03-22	
214	L1 Zone 2	24 days	Wed 23-02-22	Tue 22-03-22	
215	L1 Zone 3	24 days	Wed 16-03-22	Tue 12-04-22	
216	L1 Zone 4 (g/L 6-8/B-E)	30 days	Wed 06-04-22	Fri 13-05-22	Left out for Pile Rig access
217	**Excavation(via muck-hole) incl Pile hack**	**117 days**	**Wed 23-03-22**	**Fri 12-08-22**	
218	RL 102.0 - RL 99.0 (11,700m3)	49 days	Wed 23-03-22	Mon 23-05-22	3900m2 x 3m. 30loads/day
219	RL 99.0 - RL 95.80 (12,480m3)	52 days	Wed 01-06-22	Mon 01-08-22	3900m2 x 3.2m 30loads/day
220	Deepening for Lift pits, Ejector pits	9 days	Tue 02-08-22	Fri 12-08-22	
221	**Basement to L1 slab RC Works**	**131 days**	**Thu 30-06-22**	**Fri 02-12-22**	
222	Basement Raft Construction incl Pits	72 days	Thu 30-06-22	Fri 23-09-22	
223	Basement Corewall Autoclimb set up	24 days	Sat 10-09-22	Fri 07-10-22	
224	Core Wall Cast 5 lifts up to L3 incl Autoclimb system trailing platforms	35 days	Sat 01-10-22	Fri 11-11-22	
225	Basement Columns	48 days	Sat 10-09-22	Sat 05-11-22	



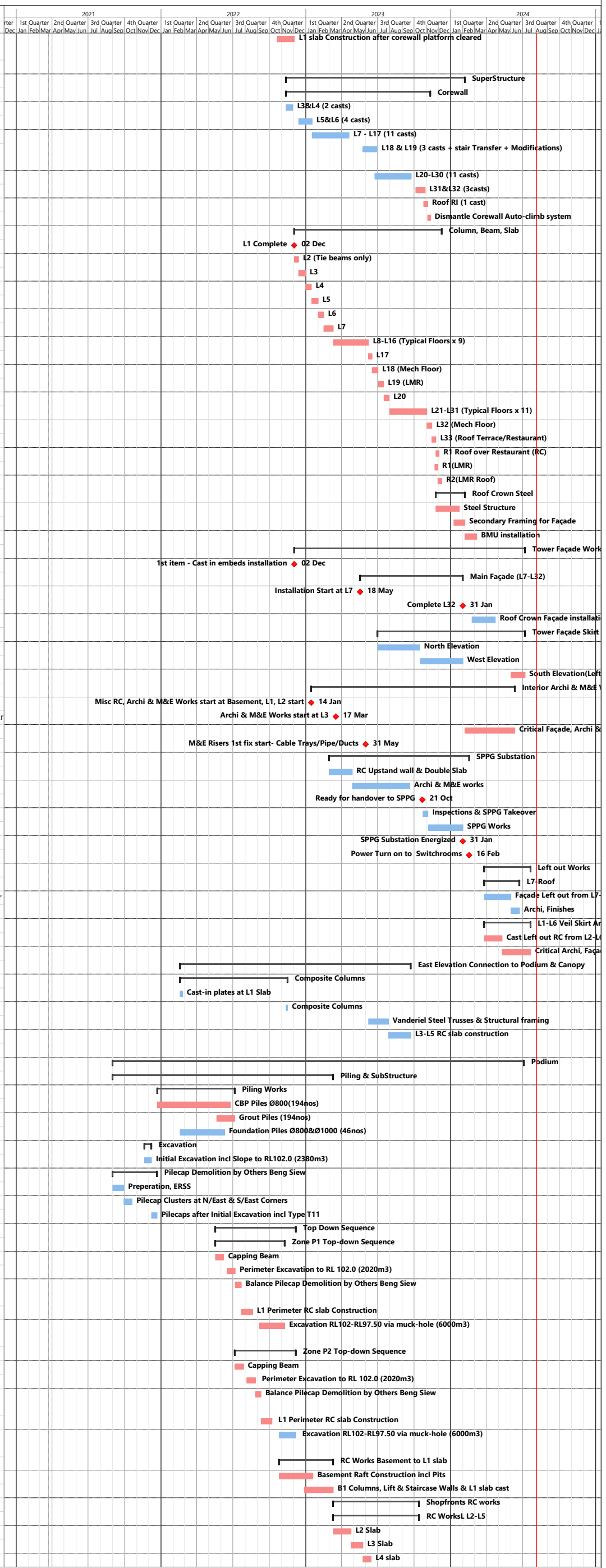
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ID	Task Name	Duration	Start	Finish	Quantities/Remarks
226	L1 slab Construction after corewall platform cleared	36 days	Fri 21-10-22	Fri 02-12-22	
227					
228	**SuperStructure**	**374 days**	**Sat 12-11-22**	**Mon 05-02-24**	
229	**Corewall**	**303 days**	**Sat 12-11-22**	**Fri 10-11-23**	7d/cast
230	L3&L4 (2 casts)	14 days	Sat 12-11-22	Mon 28-11-22	
231	L5&L6 (4 casts)	28 days	Wed 14-12-22	Mon 16-01-23	
232	L7 - L17 (11 casts)	77 days	Tue 17-01-23	Wed 19-04-23	
233	L18 & L19 (3 casts + stair Transfer + Modifications)	30 days	Thu 25-05-23	Thu 29-06-23	
234	L20-L30 (11 casts)	77 days	Sat 24-06-23	Sat 23-09-23	
235	L31&L32 (3casts)	21 days	Thu 05-10-23	Sat 28-10-23	
236	Roof RI (1 cast)	9 days	Wed 25-10-23	Fri 03-11-23	
237	Dismantle Corewall Auto-climb system	6 days	Sat 04-11-23	Fri 10-11-23	
238	**Column, Beam, Slab**	**309 days**	**Fri 02-12-22**	**Sat 09-12-23**	
239	L1 Complete	0 days	Fri 02-12-22	Fri 02-12-22	5.25m
240	L2 (Tie beams only)	9 days	Sat 03-12-22	Tue 13-12-22	6.3m
241	L3	15 days	Wed 14-12-22	Fri 30-12-22	5.95m
242	L4	12 days	Sat 31-12-22	Sat 14-01-23	5.95m
243	L5	12 days	Mon 16-01-23	Tue 31-01-23	5.95m
244	L6	12 days	Wed 01-02-23	Tue 14-02-23	13.65m
245	L7	21 days	Wed 15-02-23	Fri 10-03-23	4.9m
246	L8-L16 (Typical Floors x 9)	72 days	Sat 11-03-23	Wed 07-06-23	4.9m
247	L17	8 days	Thu 08-06-23	Fri 16-06-23	5.25m
248	L18 (Mech Floor)	12 days	Sat 17-06-23	Sat 01-07-23	8.225
249	L19 (LMR)	12 days	Mon 03-07-23	Sat 15-07-23	5.25m
250	L20	12 days	Mon 17-07-23	Sat 29-07-23	4.9m
251	L21-L31 (Typical Floors x 11)	80 days	Mon 31-07-23	Wed 01-11-23	4.9m
252	L32 (Mech Floor)	10 days	Thu 02-11-23	Tue 14-11-23	6.125n
253	L33 (Roof Terrace/Restaurant)	9 days	Wed 15-11-23	Fri 24-11-23	4.2m
254	R1 Roof over Restaurant (RC)	7 days	Sat 25-11-23	Sat 02-12-23	4.8m
255	R1(LMR)	7 days	Wed 22-11-23	Wed 29-11-23	4.8m
256	R2(LMR Roof)	9 days	Thu 30-11-23	Sat 09-12-23	4.0m
257	**Roof Crown Steel**	**60 days**	**Sat 25-11-23**	**Mon 05-02-24**	
258	Steel Structure	48 days	Sat 25-11-23	Mon 22-01-24	
259	Secondary Framing for Façade	24 days	Tue 09-01-24	Mon 05-02-24	
260	BMU installation	24 days	Tue 06-02-24	Wed 06-03-24	
261	**Tower Façade Works**	**480 days**	**Fri 02-12-22**	**Sat 06-07-24**	
262	1st item - Cast in embeds installation	0 days	Fri 02-12-22	Fri 02-12-22	
263	**Main Façade (L7-L32)**	**217 days**	**Thu 18-05-23**	**Wed 31-01-24**	128 panels/flr. 7d/layer
264	Installation Start at L7	0 days	Thu 18-05-23	Thu 18-05-23	Upon L13 slab cast
265	Complete L32	0 days	Wed 31-01-24	Wed 31-01-24	
266	Roof Crown Façade installation incl fin	48 days	Sat 24-02-24	Mon 22-04-24	
267	**Tower Façade Skirt Steel & Fin (L1-L6)**	**308 days**	**Sat 01-07-23**	**Sat 06-07-24**	
268	North Elevation	90 days	Sat 01-07-23	Sat 14-10-23	
269	West Elevation	90 days	Mon 16-10-23	Wed 31-01-24	
270	South Elevation(Left out Area)	30 days	Sat 01-06-24	Sat 06-07-24	
271	**Interior Archi & M&E Works**	**422 days**	**Sat 14-01-23**	**Mon 10-06-24**	
272	Misc RC, Archi & M&E Works start at Basement, L1, L2 s	0 days	Sat 14-01-23	Sat 14-01-23	
273	Archi & M&E Works start at L3	0 days	Fri 17-03-23	Fri 17-03-23	upon L8 slab cast, water tightr
274	Critical Façade, Archi & M&E Works	102 days	Tue 06-02-24	Mon 10-06-24	
275	M&E Risers 1st fix start- Cable Trays/Pipe/Ducts	0 days	Wed 31-05-23	Wed 31-05-23	after L8 watertight
276	**SPPG Substation**	**292 days**	**Wed 01-03-23**	**Fri 16-02-24**	
277	RC Upstand wall & Double Slab	48 days	Wed 01-03-23	Thu 27-04-23	
278	Archi & M&E works	120 days	Fri 28-04-23	Tue 19-09-23	
279	Ready for handover to SPPG	0 days	Sat 21-10-23	Sat 21-10-23	
280	Inspections & SPPG Takeover	12 days	Mon 23-10-23	Sat 04-11-23	
281	SPPG Works	72 days	Mon 06-11-23	Wed 31-01-24	
282	SPPG Substation Energized	0 days	Wed 31-01-24	Wed 31-01-24	
283	Power Turn on to Switchrooms	0 days	Fri 16-02-24	Fri 16-02-24	
284	**Left out Works**	**96 days**	**Tue 26-03-24**	**Sat 20-07-24**	
285	**L7-Roof**	**72 days**	**Tue 26-03-24**	**Sat 22-06-24**	
286	Façade Left out from L7-Roof	54 days	Tue 26-03-24	Fri 31-05-24	1.5d/flr possible? Omit gutter
287	Archi, Finishes	18 days	Sat 01-06-24	Sat 22-06-24	
288	**L1-L6 Veil Skirt Area Works**	**96 days**	**Tue 26-03-24**	**Sat 20-07-24**	
289	Cast Left out RC from L2-L6	36 days	Tue 26-03-24	Thu 09-05-24	
290	Critical Archi, Façade Finishes	60 days	Fri 10-05-24	Sat 20-07-24	
291	**East Elevation Connection to Podium & Canopy**	**483 days**	**Fri 18-02-22**	**Fri 22-09-23**	
292	**Composite Columns**	**225 days**	**Fri 18-02-22**	**Tue 15-11-22**	
293	Cast-in plates at L1 Slab	5 days	Fri 18-02-22	Wed 23-02-22	
294	Composite Columns	3 days	Sat 12-11-22	Tue 15-11-22	
295	Vanderiel Steel Trusses & Structural framing	42 days	Thu 08-06-23	Thu 27-07-23	
296	L3-L5 RC slab construction	48 days	Fri 28-07-23	Fri 22-09-23	
297					
298	**Podium**	**858 days**	**Wed 01-09-21**	**Wed 03-07-24**	
299	**Piling & SubStructure**	**462 days**	**Wed 01-09-21**	**Fri 10-03-23**	
300	**Piling Works**	**159 days**	**Thu 23-12-21**	**Tue 05-07-22**	
301	CBP Piles Ø800(194nos)	150 days	Thu 23-12-21	Fri 24-06-22	1.5d/pile/rig. Average 2 rigs
302	Grout Piles (194nos)	39 days	Sat 21-05-22	Tue 05-07-22	5nos/day
303	Foundation Piles Ø800&Ø1000 (46nos)	92 days	Fri 18-02-22	Thu 09-06-22	17.5 - 22.5m pile length. 1 rig
304	**Excavation**	**15 days**	**Sat 20-11-21**	**Tue 07-12-21**	
305	Initial Excavation incl Slope to RL102.0 (2380m3)	15 days	Sat 20-11-21	Tue 07-12-21	1193m2 x average 2.0m
306	**Pilecap Demolition by Others Beng Siew**	**95 days**	**Wed 01-09-21**	**Tue 21-12-21**	
307	Preperation, ERSS	24 days	Wed 01-09-21	Tue 28-09-21	
308	Pilecap Clusters at N/East & S/East Corners	18 days	Wed 29-09-21	Tue 19-10-21	
309	Pilecaps after Initial Excavation incl Type T11	12 days	Wed 08-12-21	Tue 21-12-21	
310	**Top Down Sequence**	**171 days**	**Wed 18-05-22**	**Tue 06-12-22**	
311	**Zone P1 Top-down Sequence**	**147 days**	**Wed 18-05-22**	**Tue 08-11-22**	
312	Capping Beam	18 days	Wed 18-05-22	Tue 07-06-22	
313	Perimeter Excavation to RL 102.0 (2020m3)	18 days	Thu 16-06-22	Wed 06-07-22	
314	Balance Pilecap Demolition by Others Beng Siew	12 days	Thu 07-07-22	Thu 21-07-22	
315	L1 Perimeter RC slab Construction	24 days	Fri 22-07-22	Fri 19-08-22	
316	Excavation RL102-RL97.50 via muck-hole (6000m3)	54 days	Tue 06-09-22	Tue 08-11-22	
317	**Zone P2 Top-down Sequence**	**129 days**	**Wed 06-07-22**	**Tue 06-12-22**	
318	Capping Beam	18 days	Wed 06-07-22	Wed 27-07-22	
319	Perimeter Excavation to RL 102.0 (2020m3)	18 days	Fri 05-08-22	Fri 26-08-22	
320	Balance Pilecap Demolition by Others Beng Siew	12 days	Sat 27-08-22	Fri 09-09-22	
321	L1 Perimeter RC slab Construction	24 days	Sat 10-09-22	Fri 07-10-22	
322	Excavation RL102-RL97.50 via muck-hole (6000m3)	36 days	Wed 26-10-22	Tue 06-12-22	
323	**RC Works Basement to L1 slab**	**114 days**	**Wed 26-10-22**	**Fri 10-03-23**	
324	Basement Raft Construction incl Pits	72 days	Wed 26-10-22	Wed 18-01-23	2820m2
325	B1 Columns, Lift & Staircase Walls & L1 slab cast	60 days	Wed 28-12-22	Fri 10-03-23	
326	**Shopfronts RC works**	**180 days**	**Sat 11-03-23**	**Fri 13-10-23**	
327	**RC WorksL L2-L5**	**180 days**	**Sat 11-03-23**	**Fri 13-10-23**	
328	L2 Slab	36 days	Sat 11-03-23	Mon 24-04-23	
329	L3 Slab	24 days	Tue 25-04-23	Wed 24-05-23	
330	L4 slab	18 days	Thu 25-05-23	Wed 14-06-23	



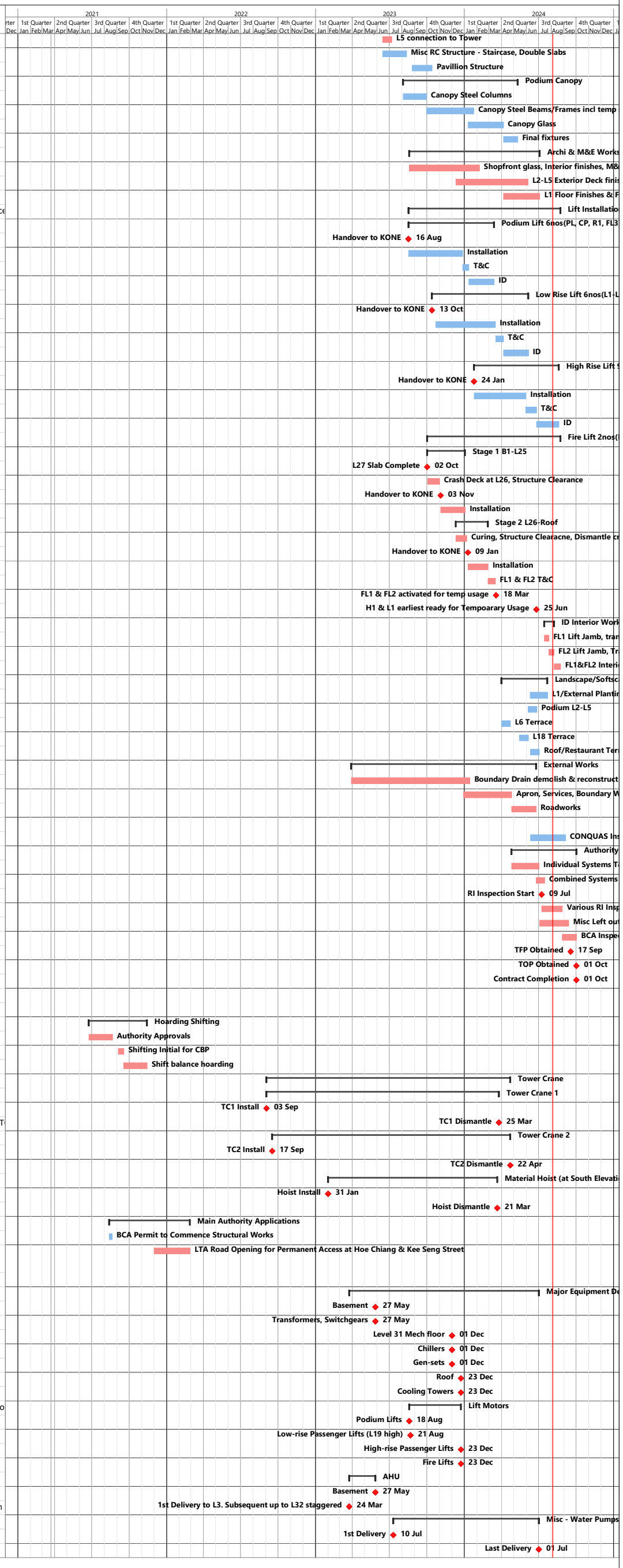
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ID	Task Name	Duration	Start	Finish	Quantities/Remarks
331	L5 connection to Tower	18 days	Thu 15-06-23	Thu 06-07-23	
332	Misc RC Structure - Staircase, Double Slabs	48 days	Thu 15-06-23	Fri 11-08-23	
333	Pavillion Structure	42 days	Sat 26-08-23	Fri 13-10-23	
334	**Podium Canopy**	**232 days**	**Fri 04-08-23**	**Fri 10-05-24**	
335	Canopy Steel Columns	48 days	Fri 04-08-23	Fri 29-09-23	
336	Canopy Steel Beams/Frames incl temp support	96 days	Sat 30-09-23	Tue 23-01-24	
337	Canopy Glass	72 days	Wed 10-01-24	Fri 05-04-24	
338	Final fixtures	28 days	Sat 06-04-24	Fri 10-05-24	
339	**Archi & M&E Works**	**264 days**	**Sat 19-08-23**	**Wed 03-07-24**	
340	Shopfront glass, Interior finishes, M&E Works	144 days	Sat 19-08-23	Tue 06-02-24	
341	L2-L5 Exterior Deck finishing, M&E, Landscape	144 days	Mon 11-12-23	Tue 04-06-24	
342	L1 Floor Finishes & Fixtures	72 days	Sat 06-04-24	Wed 03-07-24	
343	**Lift Installation**	**309 days**	**Wed 16-08-23**	**Fri 23-08-24**	per KONE discussion Sequence
344	**Podium Lift 6nos(PL, CP, R1, FL3) Level B1-6**	**175 days**	**Wed 16-08-23**	**Wed 13-03-24**	
345	Handover to KONE	0 days	Wed 16-08-23	Wed 16-08-23	
346	Installation	112 days	Thu 17-08-23	Wed 27-12-23	
347	T&C	12 days	Thu 28-12-23	Thu 11-01-24	
348	ID	51 days	Fri 12-01-24	Wed 13-03-24	
349	**Low Rise Lift 6nos(L1-L6) Level 1-20**	**193 days**	**Fri 13-10-23**	**Wed 05-06-24**	
350	Handover to KONE	0 days	Fri 13-10-23	Fri 13-10-23	
351	Installation	121 days	Mon 23-10-23	Sat 16-03-24	
352	T&C	16 days	Mon 18-03-24	Fri 05-04-24	
353	ID	49 days	Sat 06-04-24	Wed 05-06-24	
354	**High Rise Lift 9nos(H1-H8, VIP) Level 1-Roof**	**170 days**	**Wed 24-01-24**	**Mon 19-08-24**	
355	Handover to KONE	0 days	Wed 24-01-24	Wed 24-01-24	
356	Installation	103 days	Thu 25-01-24	Thu 30-05-24	
357	T&C	21 days	Fri 31-05-24	Tue 25-06-24	
358	ID	46 days	Wed 26-06-24	Mon 19-08-24	
359	**Fire Lift 2nos(FL1&FL2) Level B1-Roof**	**270 days**	**Mon 02-10-23**	**Fri 23-08-24**	8 weeks - 18hrs shift
360	**Stage 1 B1-L25**	**77 days**	**Mon 02-10-23**	**Tue 02-01-24**	
361	L27 Slab Complete	0 days	Mon 02-10-23	Mon 02-10-23	
362	Crash Deck at L26, Structure Clearance	25 days	Tue 03-10-23	Tue 31-10-23	
363	Handover to KONE	0 days	Fri 03-11-23	Fri 03-11-23	
364	Installation	48 days	Sat 04-11-23	Tue 02-01-24	
365	**Stage 2 L26-Roof**	**64 days**	**Mon 11-12-23**	**Tue 27-02-24**	
366	Curing, Structure Clearacne, Dismantle crash deck	22 days	Mon 11-12-23	Sat 06-01-24	
367	Handover to KONE	0 days	Tue 09-01-24	Tue 09-01-24	
368	Installation	40 days	Wed 10-01-24	Tue 27-02-24	
369	FL1 & FL2 T&C	16 days	Wed 28-02-24	Sat 16-03-24	
370	FL1 & FL2 activated for temp usage	0 days	Mon 18-03-24	Mon 18-03-24	
371	H1 & L1 earliest ready for Tempoarary Usage	0 days	Tue 25-06-24	Tue 25-06-24	
372	**ID Interior Works**	**21 days**	**Mon 15-07-24**	**Wed 07-08-24**	
373	FL1 Lift Jamb, transom etc	10 days	Mon 15-07-24	Thu 25-07-24	
374	FL2 Lift Jamb, Transom etc	11 days	Fri 26-07-24	Wed 07-08-24	
375	FL1&FL2 Interior Car finishes & Reconditioning	13 days	Thu 08-08-24	Fri 23-08-24	
376	**Landscape/Softscape Works**	**93 days**	**Mon 01-04-24**	**Mon 22-07-24**	
377	L1/External Planting/Green Verge	36 days	Mon 10-06-24	Mon 22-07-24	
378	Podium L2-L5	18 days	Wed 05-06-24	Wed 26-06-24	
379	L6 Terrace	18 days	Mon 01-04-24	Mon 22-04-24	
380	L18 Terrace	18 days	Wed 15-05-24	Wed 05-06-24	
381	Roof/Restaurant Terrace	18 days	Tue 11-06-24	Tue 02-07-24	
382	**External Works**	**372 days**	**Thu 30-03-23**	**Mon 24-06-24**	
383	Boundary Drain demolish & reconstruct	240 days	Thu 30-03-23	Sat 13-01-24	385mr
384	Apron, Services, Boundary Works	96 days	Sat 30-12-23	Thu 25-04-24	
385	Roadworks	48 days	Fri 26-04-24	Mon 24-06-24	
386					
387	CONQUAS Inspections	72 days	Tue 11-06-24	Wed 04-09-24	
388	**Authority Inspections & Completion**	**132 days**	**Fri 26-04-24**	**Tue 01-10-24**	
389	Individual Systems T&C start	54 days	Fri 26-04-24	Mon 01-07-24	
390	Combined Systems T&C	18 days	Tue 25-06-24	Mon 15-07-24	
391	RI Inspection Start	0 days	Tue 09-07-24	Tue 09-07-24	
392	Various RI Inspections & Approvals	42 days	Tue 09-07-24	Tue 27-08-24	
393	Misc Left out & Touch up Works	60 days	Thu 04-07-24	Thu 12-09-24	
394	BCA Inspections	30 days	Wed 28-08-24	Tue 01-10-24	
395	TFP Obtained	0 days	Tue 17-09-24	Tue 17-09-24	
396	TOP Obtained	0 days	Tue 01-10-24	Tue 01-10-24	
397	Contract Completion	0 days	Tue 01-10-24	Tue 01-10-24	
398					
399	**Main Temp Works**	**913 days**	**Thu 24-06-21**	**Mon 01-07-24**	
400	**Hoarding Shifting**	**120 days**	**Thu 24-06-21**	**Sat 13-11-21**	
401	Authority Approvals	48 days	Thu 24-06-21	Fri 20-08-21	
402	Shifting Initial for CBP	12 days	Sat 04-09-21	Fri 17-09-21	
403	Shift balance hoarding	48 days	Sat 18-09-21	Sat 13-11-21	
404	**Tower Crane**	**495 days**	**Sat 03-09-22**	**Mon 22-04-24**	
405	**Tower Crane 1**	**473 days**	**Sat 03-09-22**	**Mon 25-03-24**	
406	TC1 Install	0 days	Sat 03-09-22	Sat 03-09-22	
407	TC1 Dismantle	0 days	Mon 25-03-24	Mon 25-03-24	Roof Crown Façade requires T
408	**Tower Crane 2**	**483 days**	**Sat 17-09-22**	**Mon 22-04-24**	
409	TC2 Install	0 days	Sat 17-09-22	Sat 17-09-22	
410	TC2 Dismantle	0 days	Mon 22-04-24	Mon 22-04-24	
411	**Material Hoist (at South Elevation)**	**345 days**	**Tue 31-01-23**	**Thu 21-03-24**	
412	Hoist Install	0 days	Tue 31-01-23	Tue 31-01-23	2 wks after L4 cast
413	Hoist Dismantle	0 days	Thu 21-03-24	Thu 21-03-24	
414	**Main Authority Applications**	**165 days**	**Fri 13-08-21**	**Sat 26-02-22**	
415	BCA Permit to Commence Structural Works	6 days	Fri 13-08-21	Thu 19-08-21	
416	LTA Road Opening for Permanent Access at Hoe Chiang & Kee Seng Street	72 days	Wed 01-12-21	Sat 26-02-22	
417					
418	**Major Equipment Deliveries (earliest start dates)**	**382 days**	**Fri 24-03-23**	**Mon 01-07-24**	
419	**Basement**	**0 days**	**Sat 27-05-23**	**Sat 27-05-23**	
420	Transformers, Switchgears	0 days	Sat 27-05-23	Sat 27-05-23	6mths after L1 slab cast
421	**Level 31 Mech floor**	**0 days**	**Fri 01-12-23**	**Fri 01-12-23**	
422	Chillers	0 days	Fri 01-12-23	Fri 01-12-23	
423	Gen-sets	0 days	Fri 01-12-23	Fri 01-12-23	
424	**Roof**	**0 days**	**Sat 23-12-23**	**Sat 23-12-23**	
425	Cooling Towers	0 days	Sat 23-12-23	Sat 23-12-23	
426	**Lift Motors**	**108 days**	**Fri 18-08-23**	**Sat 23-12-23**	To re-confirm if hoist before o
427	Podium Lifts	0 days	Fri 18-08-23	Fri 18-08-23	
428	Low-rise Passenger Lifts (L19 high)	0 days	Mon 21-08-23	Mon 21-08-23	
429	High-rise Passenger Lifts	0 days	Sat 23-12-23	Sat 23-12-23	
430	Fire Lifts	0 days	Sat 23-12-23	Sat 23-12-23	
431	**AHU**	**51 days**	**Fri 24-03-23**	**Sat 27-05-23**	
432	Basement	0 days	Sat 27-05-23	Sat 27-05-23	6mths after L1 slab cast
433	1st Delivery to L3. Subsequent up to L32 staggered	0 days	Fri 24-03-23	Fri 24-03-23	delivery logistics TBC. Hoist in
434	**Misc - Water Pumps, Main Control Panels**	**295 days**	**Mon 10-07-23**	**Mon 01-07-24**	
435	1st Delivery	0 days	Mon 10-07-23	Mon 10-07-23	
436	Last Delivery	0 days	Mon 01-07-24	Mon 01-07-24	



Keppel Tower Redevelopment
Baseline Programe Rev 1.2
Date: 04/Mar/2022

Task, Split, Milestone, Summary, Project Summary, Inactive Task, Inactive Milestone, Inactive Summary, Manual Task, Duration-only, Manual Summary Rollup, Manual Summary, Start-only, Finish-only, External Tasks, External Milestone, Deadline, Critical, Critical Split, Progress, Manual Progress

SECTION 4

PROGRAMME

4.2 Authority Submission Status for M&E Services

Service	Authority	Original Submission			Comments/Resubmission			Approval/		
		Scheduled	Actual	Comment	Resubmit	Comment	Resubmit	Comment	Resubmit	Clearance
Application for Electricity Supply	SP Services Ltd	16/3/2020	16/3/2020							4/5/2020
Power Supply Substation	SP PowerGrid Ltd	12/10/2020	12/10/2020	15/10/2020	4/8/2022					15/8/2022
Metering Layout	SP Services Ltd									
Sanitary Installation	PUB Water Reclamation (Network) Dept	11/8/2022	11/8/2022							30/8/2022
Domestic Water Supply	PUB (Water Supply) Network Dept	29/6/2022	29/6/2022	19/8/2022	5/9/2022	21/9/2022	1/11/2022	2/12/2022	16/12/2022	
Gas Supply Installation	City Gas Pte Ltd	9/5/2022	9/5/2022	11/5/2022	26/7/2022	8/8/2022	16/8/2022			31/8/2022
Air Conditioning & Ventilation Inst.	FSSD									
Fire Fighting & Alarm Installation	FSSD									
Telephone Installation	TFCC	4/10/2022	4/10/2022							31/10/2022
Fuel Storage	FSSD									
	NEA (Pollution Control)									

SECTION 4

PROGRAMME

4.3 Authority Submission Status for M&E Services (Amendments) - 2nd Submission

Service	Authority	Original Submission		Comments/Resubmission						Approval/
		Scheduled	Actual	Comment	Resubmit	Comment	Resubmit	Comment	Resubmit	Clearance
Application for Electricity Supply	SP Services Ltd									
Power Supply Substation	SP PowerGrid Ltd									
Metering Layout	SP Services Ltd									
Sanitary Installation	PUB Water Reclamation (Network) Dept	20/9/2024	17/9/2024							17/9/2024
Domestic Water Supply	PUB (Water Supply) Network Dept	3/7/2024	3/7/2024	1/8/2024	13/8/2024	11/9/2024	13/9/2024			22/9/2024
Gas Supply Installation	City Gas Pte Ltd	10/1/2024								30/1/2024
Air Conditioning & Ventilation Inst.	FSSD	1/10/2024	1/10/2024							11/10/2024
Fire Fighting & Alarm Installation	FSSD	14/10/2024								18/10/2024
Telephone Installation	TFCC									
Broadband Co-axial Cable System (BCS)	Starhub Cable Vision									
Fuel Storage	FSSD									
	NEA (Pollution Control)									

SECTION 5

PROJECT RECORDS

5.1 List of Internal Files

Standard Files

File Ref:		File Ref:	
- Owner	✓	- Architect	✓
- Authorities	✓	- Other Consultants	✓
- Contractors	–	- CC	✓
- CF	✓	- PQP/QSP	✓

Project Files to be initiated by PM as and when required

File Ref:		File Ref:		File Ref:	

(✓*where applicable*)

SECTION 5

PROJECT RECORDS

5.2 Filing of Drawings

The following team members shall take charge of filing of drawings, stamping "SUPERSEDED" drawings, etc.

Description	Team Member
Incoming Architectural Floor Plans	Common Pool
Incoming Architectural Sketches/Details	Common Pool
Incoming Structural Drawings	Common Pool
M&E Drawings - Electrical Installation	
- Lift Installation	
- Air Conditioning & Ventilation Installation	
- Fire Fighting & Alarm Installation	
- Plumbing & Sanitary Installation	
- Swimming Pool & Filtration Installation	
Other Drawings	

SECTION 6

INTERFACING

6.1 Method of Interface

Description	Method of Interface	
Client's Review & Approval	M&E Design Report	✓
	Pre-planned meeting at fixed intervals	✓
	Telefax, letter and telephone	✓
	Email	✓
Interface With External Design Teams	M&E Design Report	✓
	Pre-planned meeting at fixed intervals	✓
	Telefax, letter and telephone	✓
	Email	✓
Interface Between Internal Design Teams	Telephone	✓
	Email	✓
	Internal Project Team Meeting	
	Circulation of Information	✓

(✓*where applicable*)

SECTION 6

INTERFACING

6.2 Internal Design Interface – NOT APPLICABLE

Item No.	Description*	Required From	Required By	Date Required	Remarks

** Information required by INTERNAL DESIGN TEAM MEMBERS*

SECTION 6

INTERFACING

6.3 Circulation of Documents to External Parties

	Code: A - Approval Required C - For Comments I - For Information Only	Client/ Client Rep.	* Client's Project Manager	Architect	Structural Engineer	Quantity Surveyor	
1.	**Letters/Fax:**						
a.	Project Design	A	I	I	–	–	
b.	Project Administration						
c.	Project Cost Estimate/Contract Cost	A	I	I	–	I	
2.	**Drawings**						
a.	Outline Design Drgs.	A	I	C	I	I	
b.	Sketch Design Drgs.	A	I	C	I	I	
c.	Final Design Drgs.	A	I	C	I	I	
d.	Shop Drawings	I	I	A	–	–	
e.	As Built Drgs.	I	I	I	–	–	
3.	**Other Document**						
a.	Specification	A	I	I	I	I	
b.	Tender Document	A	I	I	I	I	
c.	Tender Evaluation Report	A	I	I	I	I	
d.	Design Report	A	I	I	–	–	
e.	Progress Report	–	–	–	–	–	
f.	Financial Report	–	–	–	–	–	
g.	Minutes of Meeting	A	I	I	–	–	
h.	Inspection Report	I	I	I	–	–	
i.	Testing & Comm. Report	I	I	I	–	–	
j.	O & M Manual	I	I	I	–	–	

*Note: Applicable only, if the client engaged a Project Manager.

SECTION 7

WORK AUTHORISATION

Activity \ Authorised Signatories	PD	QP	PM	AE	SS
General Correspondences with Client			✓	✓	
General Correspondences with Other Consultants			✓	✓	
M&E Cost Estimate Report	✓	✓	✓		
M&E Design Report	✓	✓	✓		
Check Prints	✓	✓	✓		
Tender Drawing Approval	✓	✓	✓		
Tender Specification Approval	✓	✓	✓		
List of Tenderers	✓	✓	✓		
Tender Questionnaires	✓	✓	✓		
Tender Reports	✓	✓	✓		
Draft Letter of Award	✓	✓	✓		
Review of Contractor's Shop Drawing			✓	✓	
Review of Contractor's Technical Submittal			✓	✓	
Review of Contractor's Sample Submittal			✓	✓	
Contractor's Request for Deviation		✓	✓		
Progress Payment Valuation Form	✓		✓		
Final Account Valuation	✓		✓		
Draft Variation Order	✓		✓		
Engineer/Architect's Instruction/Direction	✓		✓		
Site Instruction/Direction			✓		
Correspondence/Submission to Authorities	✓	✓			

(✓*where authorised*)

Key to abbreviations:

PD : Project Director
QP : Qualified Person
PM : Project Manager/Assistant Project Manager
AE : Assistant Engineer
SS : ACEPL Site Staff

SECTION 8

DESIGN INPUT & METHODOLOGY

8.1 List of Client's Standards, Reference Documents or Brief – NOT APPLICABLE

ITEM	KEPT BY

8.2 List of Applicable Code of Practice and Regulations

Services	Title of Code of Practice/Standard
Electrical Wiring	SS 638 : 2018
Lightning Protection System	SS 555 : 2018
Emergency Voice Communication System	SS 546 : 2009
Air Conditioning & Ventilation Installation	SS 553 : 2016
Lift Installation	SS 550 : 2009
Sprinkler System	CP 52 : 2004
Wet Riser System	SS 575 : 2012
Automatic Fire Alarm System	SS 645 : 2019
Sanitary System	Code of Practice on Sewerage & Sanitary Works, 2019
Plumbing System	SS 636 : 2018
Town Gas/LPG Supply System	SS 608 : 2015
Boiler and Steam Supply System	–
Mechanical Smoke Control System	–

SECTION 8

DESIGN INPUT & METHODOLOGY

8.3 List of Design Guide or Handbook Used

Carrier's Handbook of Air Conditioning System Design

ASHRAE Handbooks

Institute of Plumbing's Plumbing Services Design Guide

8.4 List of Pre-Consultation and Waiver

S/N	Description	Date of Application	Date of Approval	Remarks
1	Fire Code 2018 Clause 7.1.10(b) and 7.2.6(b) Supply Air Shall Be Drawn Directly from External Consultation Ref No. – Waiver Ref. No. ES20201218-34917	19 December 2020	4 January 2021 (rejected)	Waiver application result: Disapproved
2	Fire Code 2018 Clause 7.4.3(d) To permit fresh air louvers (serving mechanical ventilation/smoke purging system in basement carpark) to set back from glass canopy edge by 600mm (not directly from external space) Consultation Ref No. – Waiver Ref. No. ES20221115-26869	14 November 2022	23 December 2022	Waiver application result : Approved
3	*Clause number in Code of Practice for (Services) which require clarification or waiver. Consultation Ref No. Waiver Ref. No.			

*To fill in actual information

8.5 List of Applicable Quality System Procedures

Alpha Consulting Engineers Pte Ltd's Quality Management System Procedures

Section	Title	✓ where applicable
M1	Preparation of Consultancy Offer	✓
M2	Project Commissioning and Service Agreement	✓
M3	Design Control	✓
M4	Design Change Control	✓
M5	Tender Process and Evaluation	✓
M6	Authority Submission	✓
M7	Construction Process Control	✓
M8	Testing and Commissioning	✓
S1	Document Control	✓
S2	Documentation of Quality & Environmental Management System Procedure	✓
S3	Documentation of Project Quality Plan	✓
S4	Specification Control	✓
S5	Library Control	✓
S6	Archive Control	✓
S7	Filing Control	✓
S8	Drawing Control	✓
S9	Administration Control	✓
S10	Purchasing Control	
S11	Training Control	
S12	Computer Control	
QE1	Quality & Environmental System Audit	✓
QE2	Feedback Reporting	✓
QE3	Clients Feedback	✓
QE4	Management Review	✓

8.6 List of Software Used For Design/Analysis

DESCRIPTION/ PACKAGE NAME	VERSION	SUPPLIER/ SOURCE	PURPOSE	
Cophos	3.31	Zumtobel	Lighting design	
Carrier E20-II	3.21	Carrier	Programme for determination of heat load, duct size and its losses, etc.	✓
Gensize 2	2.1	Onan	Generator sizing	
Lift Traffic	-	Elevate v 8.22, Peters Research Ltd	Lift traffic calculation	✓
Econdial	2.5	Merlin Gerlin	Design for low voltage network	
Fault Level Calculation	–	ETAP	Calculation of voltage drop and fault level	

(✓*where applicable*)

SECTION 9

ENVIRONMENTAL CONSIDERATIONS

9.1 Sustainable Design Features/Criteria

Item	Remarks
Green Mark criteria	Platinum
Green Design Features	Refers to attached Green Mark Requirements

9.2 Site PPE Requirement – NOT APPLICABLE

The necessary Personal Protective Equipment (detailed below) shall be provided by the main contractor/Company in accordance to the site EHS requirements prior to the site monitoring.

PPE	✓ where applicable
Safety Helmet	N.A
Safety Shoes	N.A
Eye Protection	N.A
Ear Protection	N.A
Safety Harness / Belt	N.A
Others:	N.A

9.3 Site Emergency Preparedness – NOT APPLICABLE

Site staff shall comply with the site emergency preparedness and response procedure, established by the main contractor/owner, which shall include the following details.

Items	✓ where applicable
Evacuation Route	N.A
Emergency Exit	N.A
Assembly Point	N.A
Emergency Contact List/Person	N.A
Alarm system/methods	N.A

Green Mark Requirement

KT REDEVELOPMENT Rev 2

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GENERAL

This Section includes general requirements and procedures for achieving the most environmentally friendly works possible in conformance with the environmental sustainability standard stipulated in the Building Control (Environmental Sustainability) Regulations or the Employer's intended Green Mark rating, whichever is the higher.

It is important that in the execution of construction work, the Main Contractor do not deviate in any way from the targets set by the Employer. This must be translated into actions on the site and the successful certification of BCA's Final Assessment and Site Verification Stage 1 & Stage 2 clearance.

Tender Documents

All work of this Section shall comply with the requirements of the Tender Documents for the Main Building Works, the Drawings, Schedules and all other Tender Documents or subsequent Corrigendum's (if any) shall form part of Contract Documents if awarded the Contract.

Note:
If there are any discrepancies between the specifications in the section with the other related sections in the tender, the more stringent performance specifications shall be followed.

BCA Green Mark Platinum Award

The performance target for this development is set to achieve a Green Mark Platinum Award under the Building and Construction Authority's (BCA) Green Mark for Non-residential buildings NRB: 2015 in Singapore.

General Roles & Responsibility of the Contractor for Green Mark Certification

The "Contractor" stipulated herein includes any sub-contractor, domestic, designated and nominated. The Contractor shall have joint responsibility with the Consultant team towards achieving the BCA Green Mark Platinum Award. The Contractor shall be liable to complete Final Assessment, Site Verification Stage 1& 2 and shall not discharge his duty upon DLP expiry.

The Main Contractor shall note that the Works are built to achieve the required Green Mark Platinum Certification Award. The design shall achieve the minimum points in each category and meet all pre-requisites for Green Mark Platinum as set for the different categories and sub-categories of buildings. Should there be any lost of Green Mark score due to the Contractor's own inability to comply with the requirement, he shall propose to make up the lost of credit point at own time and cost but not affecting the project's timeline.

The BCA Pre-Assessment shall be conducted by the Consultant Team. BCA Green Mark Final Assessment shall be conducted within 10 months after the Main Contractor is appointed, after all M&E equipments are pre-selected and pre-approved by the M&E Consultant and ESD Consultant, before procurement. It is the responsibility of the Main Contractor to plan ahead for pre-selections and pre-approvals by the Consultant team towards the 10 months stipulated deadline. As the equipments selections are subject to BCA's clearance for Final Assessment, the Contractor shall ensure that it shall not delay the lead time for procurement that may otherwise jeopardise the construction progress. In such instance, the Contractor shall take all measures to prevent and/or mitigate the delay of progress at own time and cost.

For all the scored credits, the Contractor shall provide documentary evidence as per required by the Green Mark Consultant and BCA for all the assessments and site verifications. For this purpose, the Contractor shall appoint a BCA certified Green Mark Manager (with minimum 3 years of experience with Green Mark Platinum New

non-residential projects), for the coordination, consolidation and submission of all supporting documents required for assessments and site verification to the Green Mark Consultant.

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Documentary Evidence

For all scored credits, the Contractor shall provide documentary evidence as per BCA GM NRB: 2015 Technical Guide and Requirement and as required by BCA during the assessment and site verifications.

The Contractor shall be required to also submit the relevant submittals with supporting documents, drawings and obtain approval from the Green Mark Consultant and Consultants of relevant disciplines prior to the commencement of procurement for any equipment, systems, products or materials related to Green Mark

CODES AND STANDARDS

The relevant codes and guidelines to be read in conjunction with this specification are:

Code	Guidelines/ Standards/ Code of Practices
AHRI Standard 550/590	Performance Rating Of Water-Chilling and Heat Pump Water-Heating Packages Using the Vapor Compression Cycle
ASHRAE Standard 189.1 (2010)	Standard for the Design of High-Performance Green Buildings
ASHRAE Standard 90.1 (2013)	Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE Guideline 22	Instrumentation for Monitoring Central Chilled Water Plant Efficiency
ASHRAE 52.2: 2012	Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency of Particle Size
ANSI/ASHRAE Standard 135	BACnet – A Data Communication Protocol for Building Automation and Control Networks
ASHRAE Guideline 0 (2013)	The Commissioning Process
ASHRAE Guideline 1.1 (2007)	HVAC & R Technical Requirements for the Commissioning Process
ASHRAE Guideline 1.4 (2014)	Procedures for Preparing Facility Systems Manuals
ASHRAE Guideline 11 (2009)	Field Testing of HVAC Controls Components
BCA Carbon Calculator	https://www.bca.gov.sg/Carboncalculator
BCA (2013)	Code of Accessibility in the Built Environment 2013
BCA Singapore Demolition Protocol (2009)	Pre-Demolition Audit, Sequential Demolition and Site Waste Management Plan
BCA GM NRB: 2015	Green Mark For Non-Residential Buildings NRB: 2015
BCA GM NRB: 2015	GM NRB: 2015 Technical Guide and Requirements
BCA (2008)	Code on Envelope Thermal Performance for Buildings
CS E09: 2012	Guidelines on Planting of Trees, Palms and Tall Shrubs on Rooftop
CP 5: 1998	Code of Practice for Electrical Installations
CP 48: 2005	Code of Practice for Water Services
EN779: 2012	Filter classification standard
Energy Performance Points Calculator	https://www.bca.gov.sg/GreenMark/others/BCA_Energy_Performance_Points_Calculator.xlsx
ISO/TS 14067 (2013)	Greenhouse Gases – Carbon Footprint of Products
LTA Code of Practice Version 1.2	Street Work Proposal Relating to Development Works
LTA Car Park Standard	Range Based Car Parking Standard (RCPS)
Modbus Organisation, Inc (2016)	The Modbus Organisation and Specifications
NEA (2015)	Ozone Depleting Substances
NParks LEAF	NParks Landscape Excellence Assessment Framework (LEAF) certification
PUB ABC Waters	PUB Active, Beautiful and Clean Waters (ABC Waters) certification
SGBC/SEC	Singapore Green Building Council and Singapore Environmental Council
SS EN 197-1 Cement – Part 1 (2014)	Composition, Specifications and Conformity Criteria for Common Cements
SS EN 12620 (2008)	Specification for Aggregates for Concrete

SS EN 15232: 2012	Energy Performance of Buildings – Impact of Building Automation, Controls, and Building Management
SS 212: 2007	Specification for Aluminium Alloy Windows
SS 381: 1996 (2007)	Materials and Performance Tests for Aluminium Curtain Walls
SS 530: 2014	Code of Practice for Energy Efficiency Standard for Building Services and Equipment
SS 531-1: 2006 (2013)	Code of Practice for Lighting of Workplaces
SS 553: 2016	Code of Practice for Air-Conditioning and Mechanical Ventilation in Buildings
SS 544-1 Concrete (2014)	Complementary to SS EN 206-1 – Part 1: Method of Specifying and Guidance for The Specified
SS 544-2 Concrete (2014)	Complementary to SS EN 206-1 – Part 2: Specification for Constituent Materials and Concrete
SS552: 2016	Code of Practice for Air-Conditioning and Mechanical Ventilation in Buildings
SS554: 2016	Code of Practice for Indoor Air Quality for Air-Conditioned Buildings
SS 577: 2012	Water Efficiency Management Systems – Requirements with guidance for use
Singapore Institute of Architects (2013)	Attributes of a Sustainable Built Environment
Sinclair, D (2013)	Guide to Using the RIBA Plan of Work 2013
URA (2013)	Circular Package: Landscaping for Urban Spaces and High-Rises (LUSH) 2.0 Programme
WELS	Water Efficiency Labelling Scheme

ENERGY SAVINGS REQUIREMENT

A minimum of 40% energy savings over its reference model using an energy modelling framework (as defined in Appendix E of the BCA Green Mark certification standard) shall be demonstrated as part of the prerequisite for Green Mark Platinum Award. The Main Contractor shall ensure that all selections of equipments and systems are of high efficiency in order to achieve excellent energy savings.

PART 1: CLIMATIC RESPONSIVE DESIGN

P.01 Envelope and Roof Thermal Transfer

The Envelope Thermal Transfer Value (ETTV) is the key to improving energy efficiency in air-conditioned buildings through the reduction of solar heat gain through the envelope (walls, windows, roofs) that contribute to cooling load of the building.

The façade to be high performance façade system that would offer both thermal and optical performance necessary to satisfy the user requirements for the internal spaces, occupant comfort while also reducing the cooling load of the building. The façade ETTV shall meet the overall ETTV target of ≤ 38W/m^2.

Glazing Specification:

The project provides for high performance insulated glass with low-e coating and high performance insulated spandrel panels given in Architectural and Facade performance specifications to meet the ETTV target for the project.

Minimum 50% of the west facing walls is provided with U-Value of less than 2 W/m²K as per ***Table 1*** below.

		Buildings with aggregate air-conditioned area >500m^2	**Buildings with aggregate air-conditioned area ≤500m^2**
Weight Group	Weight range (kg/m^2)	Max. U-value (W/m^2K)	
Light	Under 50	0.5	0.8
Medium	50 to 230	0.8	1.1
Heavy	Over 230	1.2	1.5

Table 1. Max. Thermal transmittance for roof

Optimal performance to be addressed through the use of performance specifications of the glass as given in the related performance specifications for façade under Architectural and Façade
Visible Light Transmittance of Glass: >55% to allow for improved day lighting.

P.02 Air Tightness and Leakage

For windows and curtain wall systems, air leakage rates shall not exceed the limit specified in SS 212: 2007 – Specification for Aluminum Alloy Windows and SS 381: 1996 (2007) – Materials and Performance Tests for Aluminum Curtain Walls respectively.

P.03 Bicycle Parking

There shall be a minimum of 149 bicycle lots to be installed and located in line with LTA's Code of Practice – Street Work Proposal Relating to Development Works.

1.01 Leadership

a. Climatic & Contextually Responsive Brief
   This credit is scored and under the responsibility of the Building Owner & Consultant Team.

b. Integrative Design Process
This credit is scored and under the responsibility of the Consultant Team.

c. Environmental Credentials of Project Team
- The Main Contractor shall have good track records in the adoption of sustainable, environmentally friendly and considerate practices during construction with a valid Green and Gracious Builder Award and ISO 14000 certified.
- The Architect from A61, ESD Consultant from G-Energy Global, Structural Consultant from Meinhardt and M&E Consultants from Alpha Consulting Engineers are ISO 14001 certified.
- The Architect from A61 and ESD Consultant from G-Energy Global are SGBC certified companies.
- The ESD Consultant from G-Energy Global is the GMAAP for this development.

d. Building Information Modelling
Collaborative BIM is scored under this credit and the contractor shall implement BIM coordination to optimise construction methodologies. Proper records of the BIM coordination shall be provided by the Main Contractor.

e. User Engagement
Building User Guide is provided overview of the design, the passive and environmental strategies employed and benefit the users like Energy, Water, Waste & Recycling, Green Transportation and access, local amenities, responsible and healthy Fit out, responsible purchasing and others. The Main Contractor shall provide the draft Building User Guide on green features within development for approval.

1.02 Urban Harmony

a. Sustainable Urbanism

ii. Response to Site Context
Site analysis such as traffic and site access studies has been conducted to incorporate into the design of the building layout. For this credit, no document is required by the Contractor

iv. Provision of electrical vehicle charging and parking infrastructure.

b. Integrated Landscape and Waterscape

i. Greenery Provision (GnPr)
The Green Plot Ratio (GnPR) is design to achieve GnPr of 0.5 to < 1.0, calculated by considering the 3D volume covered by plant using the prescribed Leaf Area Index (LAI). The Contractor shall calculate the actual GnPr.

iv. Sustainable Landscape Management
- The Contractor shall propose landscape management plan by established the following:
-The use of organic compost from horticultural waste
-The Potential for onsite composting
-General landscape maintenance and management plan during building occupation include implementation record supported by photographic evidences, delivery order of composts with reports of soil/compost mixes as well as the landscape maintenance manual.

1.03 Topicality

a. Tropical Façade Performance

The holistic consideration of façade performance can reduce direct sunlight into building and minimise thermal heat gain, enhancing indoor comfort and lowering the energy for conditioning the indoor environment. The contractor has to provide the glass with performance according to architect & ME consultant approval that achieves the ETTV value less 38W/m2.

b. Internal Spatial Organisation

The non-thermally critical non-a/c spaces are deliberately located on the east and west facing walls to reduce thermal heat gain into occupied spaces. These spaces include the staircases, lift cores, toilets and M&E rooms.

All Staircases and all toilets are design with mechanical ventilation. A pro-rated 1 points is scored under this credit.

c. Ventilation Performance

Natural ventilation simulation for this project is NOT applicable as all functional spaces are either air-conditioned or mechanically ventilated.

PART 2: BUILDING ENERGY PERFORMANCE

P.04 Lighting Efficiency and Controls

The maximum lighting power budget for artificial lighting and lighting controls in each space shall not exceed the baseline stipulated in Clause 7 – Lighting Power Density and Control of SS 530:2014.

P.06 Vertical Transportation

All lifts shall be equipped with AC Variable Voltage and Variable Frequency (VVVF) motor drive and sleep mode features.

2.01 Energy Efficiency

a. Air Conditioning Total System Efficiency

1.2.1 Design for an overall chiller plant efficiency of equal to or better than 0.49kW/RT during the building operation hours. The chiller plant system efficiency is calculated inclusive of water-cooled chillers, chilled water pumps, condenser water pumps and cooling towers.

The Total Air-conditioning Design System Efficiency (DSE) inclusive of airside efficiency shall not exceed 0.58kW/RT. The efficiency of the Chiller system shall not exceed 0.49kW/RT and 0.09kW/RT for the air distribution equipment. Refer to ***Table 2*** below for the baseline and proposed Total Air-conditioning Design System Efficiency requirement.

S.No	***Total Air-conditioning System Efficiency***	***Peak cooling load >500RT***	
		Baseline	*Proposed*
	Chiller Plant Design System Efficiency	0.728 kW/RT	0.49 kW/RT
	Air-side Design System Efficiency	0.25 kW/RT	0.09 kW/RT
	Total Air-conditioning Design System Efficiency including airside	0.98 kW/RT	0.58 kW/RT

Table 2. *Total Air-conditioning System Efficiency*

Chiller:

- Provision of water cooled chiller that uses VSD (Variable Speed Drive) or equivalent
- The chilled water and condenser water pump efficiency shall not be less than 85% and the motor efficiency shall be no less than 90%
- Selection of chiller shall be based on Chilled water supply temperature of minimum 9° C and return at 19°C.

Cooling Towers:

- Provide VSD for the cooling tower fans modulated by condenser water supply temperature. Cooling tower's heat rejection capacity shall be at least 150% more than chillers capacity.

Chilled Water & Condenser Pump:

- The air-conditioning water pumps shall be certified by Singapore Green Building Council (SGBC) or Singapore Environment Council (SEC):
- Provide VSD for chilled water pumps modulated by chilled water differential pressure.
- Provide VSD for condenser water pumps

- Variable Speed Drives (VSDs) shall be installed with a bypass switch to revert to normal operation if necessary.
- All pumps shall be selected for the highest efficiency (80% or better desired) consistent with the specified duty. Further, the selected pumps shall be capable of operating at 115% of the design head without stalling or greater than a 5% reduction in design flow rate.

Motor:

- Motors supplied should be compatible for use with standard variable speed drives with frequency ranging from 20 to 50 Hz.
- The motor must comply with IEC 60034-30:2008.
- Only motors with minimum efficiency class of IE3 are acceptable. The motor must also have a power factor of not less than 0.85.

Variable Speed Drive (VSD):

- Variable Speed Drive (VSD) Starter - Frequency converter to be supplied for fan and pump speed control. All standard and optional features shall be included within the VSD. The VSD shall not be a general-purpose product, but a dedicated designed and packaged for the ACMV application for controlling the speed of AC three-phase induction motor.
- All VSDs shall contain integral EMC filters to attenuate radio frequency interference conducted to the AC power line.
- The VSD shall provide full motor torque at any selected frequency from 20 Hz to base speed while providing a variable torque V/Hz output at reduced speed. This is to allow driving direct drive fans without high speed derating or low speed excessive magnetization, as would occur if a constant torque V/Hz curve was used at reduced speeds. Breakaway current of 160% shall be available.
- A programmable automatic energy optimization selection feature shall be provided as standard in the VSD. This feature shall automatically and continuously monitor the motor's speed and load to adjust the applied voltage to maximize energy savings.
- VSD shall minimize the audible motor noise through the use of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VSD operation while reducing motor noise. VSDs with fixed carrier frequency are not acceptable.

Air Handling Units & Pre-Air Handling Units:

- Air handling units is to design at 9°C chilled water supply.
- Design air handling units with low face velocity of approx 1.5m/sec, cooling coils to achieve off-coil temperature not greater than 19°C.
- For Fan coil units with EC motors and variable controllers, it should be designed to modulate the flow rate to achieve off-coil temperature not more than 14°C.
- Provide VSD for air handling units with stand alone controllers, such that when VAV boxes closes during part load, the VSD can reduce AHU fan speed based on static duct pressure.

The proposed PAU, AHU, FCU and MV Fan efficiency shall not exceed the requirement stipulated in ***Table 3*** below.

EQUIPMENT	Baseline W/CMH	Target W/CMH
PAU/ AHU ≥4kW (Variable volume)	0.58	0.12
PAU/ AHU≥4kW (Constant volume)	0.42	0.12
Ducted FCU	0.17	0.05
MV fans≥4kW	0.30	0.12
MV fans≤4kW	0.17	0.06

Table 3. *PAU, AHU, FCU and MV Fan efficiency*

- Provide Pre & secondary filter for all air handling units.(provision MERV 14 housing)
- Provide MERV 14 for the Pre-Air Handling Unit

b. Lighting System Efficiency

- Lighting power budget for all spaces shall meet the minimum the lux requirements of SS531 – 1: 2006 (2013) – Code of Practice for Lighting of Workplaces.
- The corresponding Lighting Power Density (W/sqm) shall be less than or equal to the maximum LPD stipulated as per the requirements of SS530: 2014 – Code of Practice for Energy Efficiency Standard for Building Service and Equipment.
- For areas not specified, the Contractor shall adopt best energy efficient lighting design by incorporating the use of energy efficient lighting and comply with SS: 530 and SS: 531, wherever applicable.
- Lighting Power Budget shall meet a minimum of **50%** improvement from the baseline stated in SS 530L 2014, to work towards achieving the total energy savings of 40% from the reference energy modelling.
- The proposed Lighting Power Density (LPD) of this development shall not exceed the requirement stipulated in ***Table 4*** below.

Space type	Proposed Lighting Power Density (W/sqm)
Office	6
Production Room	7
Meeting Room	6
Corridor	3.5
Carpark	1.5
Lobbies(Lift, Fire Fighting, smoke stop)	3.5
Staircase	3
Toilet Pantry/Lactation Room/changing Room	5
M&E Room	5
Gym	5.5
Retail (General)	7.5
Retail (Jewelry & Crystal)	17.5
Retail (Furniture, Clothing and accessories)	12.5

Supermarket, Pharmacy	10
Store	5
Food Court, Canteen	5
Restaurant, Lounges, Bar	6

Table 4. *Proposed Lighting Power Density*

- Occupancy sensors shall be provided at all smoke stop lobbies, all toilets and staircases, please refer to M&E Consultant specification.

c. Carpark System Efficiency
Carpark System efficiency and Carpark Lighting Power Budget shall meet a minimum of **50%** improvement from the baseline stated in SS 530L 2014, to work towards achieving the total energy savings of 40% from the reference energy modelling.

2.02 Energy Effectiveness

a. Building Energy

The design energy consumption of the base building excluding carpark and receptacle loads shall meet a minimum of 40% improvement against the notional reference baseline. The Energy Performance Points Calculator shall be used to generate the percentage improvement of the energy consumption of the base building against the notional reference.

2.03 Renewable Energy

A Solar Energy Feasibility Study and Solar Ready Roof will be conducted by the Employer with support from Architect, Structure & M&E consultants. Contactor to ensure development provision for this point is scored.
The solar feasibility report had detailed the following aspects:

- Roof characteristics and shading considerations
- Technical solar energy generation potential
- Economics of solar installation
- Roof access and safety requirements
- Roof spatial optimisation recommendations

The solar ready roof report had detailed the following aspects:

- **Structural readiness:** Roof designed to accommodate optimised easy structural installation of solar panels on rooftops spaces and included proof that the building and roof can support any additional static and wind load imposed by future PV system.
- **Electrical readiness**: Provision to accommodate optimised easy electrical installation of solar panels on rooftop spaces
- **Spatial readiness**: Roof designed to accommodate optimised the available non shaded roof top area for solar panels- adoption of roof spatial optimisation recommendation outlined in Solar Energy Feasibility Study

PART 3: RESOURCE STEWARDSHIP

P.07 Water Efficient Fittings

The project shall be provided with water efficient fittings that meet minimum requirements as detailed in the following ***Table 5***.

Type of Water Fitting	PUB WELS Rating	Remarks
Shower taps & mixers/ Showerheads	Excellent Rating (3 ticks)	Includes All sink taps/mixers, bib taps, garden taps, general washing taps within the project development boundary
Basin taps & mixers	Excellent Rating (3 ticks)	
Sink/bib taps & mixers	Excellent Rating (3 ticks)	
Dual-flush low cap flushing cisterns for WC and urinals	Excellent Rating (3 ticks)	

Table 5. *WELS rating requirement for water fitting*

All other water fittings such as flush valves, bib taps that are not listed in the above table shall comply with the mandatory standards stipulated in the Singapore Standard CP 48: 2005 – Code of Practice for Water Services.

3.01 Water

a. Water Efficient Systems

i. Landscape Irrigation
At least 50% of the landscape areas shall be served by water efficient irrigation systems with automatic sub-soil drop irrigation system with moisture or rain sensor control specified by the Landscape Architect.

ii. Water Consumption of Cooling Towers:
The cooling tower treatment system shall able to achieve 7 or better cycles of concentration at acceptable water quality.

iii. Better Water Efficient Fittings ***(Advanced Green Effort)***
All water fittings shall be certified "Excellent" rating under the Singapore's PUB Water Efficient Labelling Scheme (WELS).

b. Water Monitoring

i. Water Monitoring and Leak Detection:
All private sub-meters for all major water usage in the development shall be linked the Building Management System (BMS) for monitoring and leak detection. The BMS shall have specific alert features that can be set and triggered to detect the possibility of water leakage during operation. Common major water uses for building where private meters should be installed to monitor the amount of water used area are as listed:

- Cooling towers
- Toilets
- Pantries
- Food and beverage outlet
- Irrigation
- Gym
- Production and processes

ii. Water Usage Portal and Dashboard
Prbovision of water management portal, dashboard or other equivalent forms that display metered data, trending of water consumption, capability of data acquisition system to store the measured water consumption for at least 24 months and to create reports minimally monthly and annual water consumption associated with each meters are to be included and relevant parameters which facilitate better management of water consumption during building operation.
.

iii. Alternative Water Sources

- >50% of AHU condensate shall be collected and to be used for the cooling tower make up water tank/washing of external areas/carpark areas.
- NEWater supply shall serve as a secondary water supply for cooling tower make-up water.
- Rainwater harvesting

3.02 Materials

a. Sustainable Construction

ii. Resource Efficient Building Design

Concrete Usage Index (CUI) is an indicator of the amount of concrete used to construct the superstructure which includes both the structural and non-structural elements. CUI does not include the concrete used for external works and sub-structural works such as basements and foundations. CUI is defined as the volume of concrete in cubic metres needed to cast a square metre of constructed floor area. Targeted CUI is ≤0.5 m^3/m^2 .

CUI = Concrete Volume (m3) / Constructed Floor Area (m2)

Note: The quantities of the concrete for all the structural and non-structural elements for each floor level shall be computed. All the elements listed in the table such as columns, beams, slabs, suspended structures (like planter boxes, bay windows and ledges etc) , parapets, walls and others (service risers, kerbs, ramps etc) are to be included.
[Please refer to BCA Green Mark "GM NRB: 2015 Technical Guide & Requirement" for a worked example of detailed CUI computation]
The Main Contractor shall assist the Structural Consultant with the calculation of Concrete Usage Index (CUI) for building components.

The adoption of sustainable building systems shall cover more than or equal to 50% of Constructed Floor Area (CFA).

Sustainable Building Systems
High Strength Concrete Elements (Concrete grade >60MPa)
Structural Steel Elements
Composite Structural Elements

Table 6. Sustainable Building Systems

Platinum pre-requisite requirement
Score minimum 3.5 points under Part 3.02a Sustainable Construction.

iii. Low Carbon Concrete

Clinker Content: Concrete used shall contain clinker ≤ 400kg/m^3 for grades up to C50/60 for ≥80% of the applicable super-structural concrete by volume. Concrete used shall be of at least SGBC-Certified 1-Tick.

Using BIM to calculate Concrete Usage Index ***(Advanced Green Effort).***

- BIM shall be used to compute the Concrete Usage Index (CUI) of the project.

b. Embodied Carbon

The embodied carbon footprint of the following materials shall be computed by Main Contractor using BCA Carbon Calculators:

- Concrete used in the development

- Glass used in the development
- Steel used in the development
- And 4 more materials

Platinum pre-requisite requirement
Score minimum 1 point under Part 3.02b Embodied Carbon.

c. Sustainable Products
   - Environmentally friendly products shall be certified by SGLS (Singapore Green Labelling Scheme) or SGBC (Singapore Green Building Council) which are applicable to non-structural and architectural related building components.
   - Points are scored based on the extent of coverage of each functional system; the total scoring shall achieve 6 points.
   - Green products used shall have a minimum coverage of ≥80% of the total area. The functional systems considered are external wall, internal wall, flooring, doors, ceiling and roofing.
   - The Main Contractor may wish to propose further construction products. However, the product(s) shall be SGLS/SGBC certified equivalent or better than the original design intended green score, taking in consideration of the extent of coverage (also named as "impact" under this chapter) and subject to Consultants' approval.
   - The following is a list of materials (***Table 7***) that shall be SGLS/SGBC certified products. The Contractor shall be obliged to also, where possible to provide SGLS/SGBC certified products if there is no cost difference with a normal product without SGLS/SGBC certification.

S.No	Material	Certification body	Weightage	Impact
1	Waterproofing material	SGLS/SGBC	Good or better	High
2	Ceiling Board (Gypsum)	SGBC	Very Good or better	High
3	Ceiling Board (Calcium Silicate)	SGBC	Very Good or better	High
4	Wall panels (Acoustic)	SGLS/SGBC	Good or better	High
5	Architectural/Non-structural precast elements(Pre cast drain, Pre cast road kerbs, Pre-cast carpark wheel stopper)	SGLS/SGBC	Good or better	Low
6	Dry wall partitions (except for wet areas)	SGLS/SGBC	Good or better	High
7	Carpet tiles	SGBC	Very Good or better	High
8	Drainage cells With Recycled content	SGLS/SGBC	Good or better	Low
9	Toilet cubical (phenolic)	SGLS/SGBC	Good or better	Low
10	Screed	SGLS/SGBC	Good or better	High
11	Grout	SGLS/SGBC	Good or better	Low
12	Mortar	SGBC	Very Good or better	Low
13	System Furniture	SGLS/SGBC	Good or better	High
14	Pre-mix (driveway)	SGLS/SGBC	Good or better	Low
15	Access raised floor	SGBC	Very Good or better	High
16	Rockwool insulation	SGBC	Very Good or better	High
17	Laminated & joinery work	SGLS/SGBC	Good or better	Low

Table 7. List of Sustainable products - SGLS/SGBC certified

Functional spaces

- The use of SGLS/SGBC certified products used for the main building elements or functional spaces will be considered as *high impact* if the quantities used by percentage are more than 80% (i.e., extent of coverage) as compared to the total quantities used for the same intended purpose.
- Items do not meet the minimum coverage or are used in other common area, external works will be considered as *low impact.*
- Products are groups within respective Groups-Base or Finishes Group- to form a holistic system. The Base Group will be pre-requisite for its respective Finishes Groups

i. Singular Sustainable Products outside of Functional systems

- The usage of SGLS/SGBC certified sustainable hard cape, building services and M&E products for at least 80% of the respective applicable use (minimum to score for 8 products), examples are given in the a ***Table 8*** below:

S.No	Material	Certification Body	Usage (Area of Coverage)
1	Drainage Cells	SGLS/SGBC	At least 80% of applicable use
2	Certified Termite Treatment	SGLS/SGBC	
4	Chillers, pumps, transformers, switchboards, fans, distribution boards, power backs, motors, sensors	SGLS/SGBC	
5	Pavers, road humps, wheel stoppers, road kerbs	SGLS/SGBC	
6	System Furniture	SGLS/SGBC	
7	Ducting, Cabling	SGLS/SGBC	
8	Plumbing sewerage: piping and joints	SGLS/SGBC	

Table 8. Singular Sustainable Products

- At least select 4 product with at least 2ticks SGBC certified sustainable product for at least 80% of the respective applicable use examples are given in the a ***Table 8*** above:

Platinum pre-requisite requirement
Score minimum 4 points under Part 3.02c Sustainable Products.

3.03 Waste

a. Environmental Construction Management Plan

The Main Contractor shall be responsible for Construction site upkeep to have minimal environmental impacts. These environmental impacts could arise from site disturbance, pollution, construction waste, water and energy use. It is important that the construction team takes responsibility to create and execute a policy to minimize these impacts.

The Main Contractor shall implement effective environmental friendly management programmes including monitoring and setting targets to minimize energy use, water use and construction waste. The Main Contractor shall monitor and set targets to reduce electricity, diesel, waste generation and water consumption on site:
Records of implementation plan and monitoring its progress shall be as follows:

- Identify materials recycled and to be salvaged.

- Identify products or packaging which will be picked up and recycled by the manufacturer.
- Proper collection, segregation and storage of the identified materials.
- Waste prevention measures such as reuse of salvaged material at the site, ordering materials accurately and as needed, etc.
- For the remaining construction debris that cannot be re-used or recycled, collection will be done safety and must be sent for proper dumping
- Dispose of all hazardous materials properly.
- Source separation collects recyclables in separate containers. This yields the highest recycling rate.

The Contractor shall submit the proposed methodology / write up on the following:

- Monitoring and setting target to reduce energy consumption on site by monthly data collection (Tables/Charts) of electricity / diesel usage during construction and installation of measuring devices to record and monitor energy usage on site is highly preferred.
- Monitoring and setting target to reduce water consumption used on site by monthly data collection (Tables/Charts) of water usage during construction and installation of measuring devices to record and monitor water usage on site.
- Implementation of recycling system for truck wheel washing is compulsory.
- Using of membrane filtration system to recycle water during construction to reduce the portable water usage is highly preferred.

b. Operational Waste Management

Recycling bins with permanent labels at all lift lobbies for the segregation of paper, plastic, glass and metal shall be provided at all lifts lobbies by Employer.

PART 4: SMART AND HEALTHY BUILDING

P.08 Thermal Comfort

The dry-bulb temperature for comfort air-conditioning shall be within 23 deg C to 25 deg C, and resultant relative humidity ≤ 65% in accordance with SS 553: 2016 – Code of Practice for Air-Conditioning and Mechanical Ventilation in Buildings.

P.09 Minimum Ventilation Rate

The provision of adequate ventilation in a building is of fundamental importance to ensure the health of occupants. The building's air-conditioning and mechanical ventilation systems shall be designed to provide appropriate minimum quantum of outdoor air rates as stated in Table 1 and Table 5 of SS 553: 2016.

P.10 Filtration Media for Times of Pollution

Pre-Air Handling Units in shall be provided with extra slot to allow for fine dust filters of at least a rating of Minimum Efficiency Reporting Value (MERV) 14 (ASHRAE 52.2: 2012), when the outdoor pollution level is in the unhealthy range in accordance with MH's guidelines, as stipulated in SS 553: 2016.

P.11 Low Volatile Organic Compound (VOC) Paints

Low VOC paints certified by SGBC/SGLS shall be used for at least 90% of the total painted internal wall areas.

P.12 Refrigerants

- All air-conditioning systems used in this development shall use Ozone Depleting Potential (ODP) of 0 or Global Warming Potential (GWP) of less than 100 refrigerants R134a/R410a.
- Refrigerant leak detection system shall be installed in the Chiller Plant Room and linked to BMS system for monitoring and alert purpose.

P.13 Sound Levels

Mechanical and Electrical equipment serving occupied spaces of building developments shall be designed to comply with the recommended ambient sound levels in Table 4 of SS 553: 2016.

P.14 Permanent Instrumentation for Measurement and Verification of Air Conditioning Systems

Permanent instrumentation to monitor the water cooled chilled water plant efficiency shall be provided. The installed instrumentation shall have the capability to calculate the resultant efficiency (i.e. kW/RT) within 5% of its true value, in accordance with ASHRAE Guideline 22 and AHRI Standard 550/590. The data monitoring and collation shall be via a proper data acquisition system and wiring connecting them. This data Acquisition system i.e. Analogy-to-digital or A/D converter used shall have a minimum resolution of 16-bit. Manual taking off readings will not be accepted.

The location and installation of the measuring devices shall not only meet the manufacturer's recommendation but also take into consideration the best location to achieve accurate data for good data analysis. It shall also be located in areas with good access for field measurement and maintenance.

Temperature sensors system shall has a minimum end-to-end accuracy of +/- 0.05^{o}C over the entire measurement range. All thermo-wells shall be installed in a manner which ensures that the sensors can be in direct contact with fluid flow. Provisions shall be made for each temperature measurement location to have two spare thermo-wells located at both side of the temperature sensor for verification of measurement accuracy.

Calculation of the overall uncertainty of measurement of the resultant chiller plant efficiency in kW/RT to be within +/- 5% of the true value based on instrumentation specifications. (Instruments' calibration certificates from accredited laboratory or batch calibration certificates from manufacturers.) The methodology for determining the total uncertainty of measurement at

design stage can be computed using the root sum square formula found in ASHRAE Guideline 22-2008 as follows:

$Error_{rms} = \sqrt{(\sum (U_N)^2)}$

Where,

U_N = individual uncertainty of variable N (%)

N = mass flow rate, electrical power input or delta T

In deriving the measurement errors contributed by flow meters, an additional 1% is to be included in the computation.

Full-bore magnetic in-line flow meters, with 1% uncertainty and capable of electronic in-situ verification to within ±2% of its original factory calibration, shall be provided for chilled-water and condenser water loop. Where circumstances do not allow the installation of magnetic in-line flow meters, ultrasonic flow meters may be used.

Temperature sensors shall be provided for chilled water and condenser water loop with end-to-end measurement uncertainly within ±0.05ºC over the entire measurement/calibration range. Thermowells shall be installed in a manner that enables the sensor to be in direct contact with fluid flow. Each temperature measurement location shall have 2 spare thermo-wells located at both sides of the sensors for verification of measurement accuracy.

Dedicated power meters (of IEC Class 1 or equivalent) and associated current transformers (Class 0.5 or equivalent) shall be provided for monitoring of the power consumption of each of the following groups of equipment:

- Chillers
- Chilled water pumps
- Condenser water pumps
- Cooling towers
- Air distribution system

P.15 Electrical Sub-Metering & BMS

Subsystem measurement devices with remote capability shall be provided and linked to a monitoring system and measure and trend energy consumption data of the following:

- Each of the following energy sub system:

Use (Sum of all loads)	Sub –system Thresholds
Lift & Escalator	Sum if all feeders>50kVA
Heater, including heat pump	>50kWth
Process loads	Connected load>50kVA Connected gas or district services load>75kW
Mechanical Ventilation	The subsystem's load >15kW

Table 9. *Electrical loads*

- *Each floors as wells as high energy load areas exceeding 50kVA such as carpark, data center, IT closets and process areas.*

BCA Measurement and Verification:

The Main Contractor shall bear in mind that after 12 months and not more than 18 months after commencement of meter data collection and with a minimum of 80% occupancy, all measured energy consumption from the main meters and sub-meters would be compared against the predicted energy consumption of the system and sub-systems. The energy simulation model for the whole building shall be based on the pre-selected equipments submitted and pre-approved by the M&E Consultant and approved by BCA during the Final Assessment stage.

In event where there is a change in equipment selection or specification that has impact on the energy efficiency, subject to approval of BCA, a new energy simulation model shall be created

using as-built construction documentation and following the modelling methodology and requirements of the Green Mark award. If the change of equipment is due to the default by the Main Contractor, the cost of the energy model rerun shall be bound him.

a. Instrumentation

- All measurement instrumentation (including instantaneous and permanent feature) shall be fully calibrated by BCA approved test lab and calibration certificate shall be valid at the time of document submission and site verification.
- Main Contractor shall submit valid calibration test report and certificate, detailed testing and commissioning methodology report and control logic/ strategy at any time requested by the Consultants and prior to commencement of works.
- Sensors accuracy shall fully comply within the allowable limits stipulated in "GM NRB: 2015 Technical Guide and Requirements".

b. Data Trend log

All data trend-log shall be able to take instantaneous readings for monitoring purposes. All data logging shall have the capability to trend at 1 minute sampling time interval, and recorded to the 3rd decimal digit.

All monitored equipment shall be presented in extractable format (excel) and schematic diagram to illustrate control logics and instantaneous data for system such as Chiller Plant, MV Fans, sensors, etc.

- Chiller Plant trend-log
- Data to be taken at per minute intervals
- BMS shall be able to store past trending records for at least 12mths.
- During BCA site verification, BMS shall be able to set to 10sec logging intervals
- Temperature readings shall be able to read 3 decimal places

Temperature (Deg C) and Flow-rate (l/s) shall be measured from the main headers:

- Chilled Water Supply
- Chilled Water Return
- Condenser Water Supply
- Condenser Water Return

Flow meters for chilled-water and condenser water loop shall be ultrasonic / full bore magnetic type or equivalent.

- Chilled Water Supply
- Chilled Water Return
- Condenser Water Supply
- Condenser Water Return

Power consumption (kwh) shall be measured at every individual equipment via digital power meter, feed back to BMS monitoring:

- Each Chiller
- Each Chilled Water Pump
- Each Condenser Water Pump
- Each Cooling Tower

Cooling Tower:

- Wet & Dry bulb Temperature (Deg C)
- Outdoor Relative Humidity (RH %)
- Water Flow-rate (l/s)
- Cooling Tower Cycle of concentration

Chilled Water & Condenser Water Pumps:

- Power consumption (kwh)

- Water Flow-rate (l/s)

Chiller Plant monitoring (instantaneous and trend-log):
Heat Load (Tonnage)

- Total Power consumption (kwh)
- Overall chiller efficiency (kw/ton)
- Overall chiller plant efficiency (kw/ton)
- Overall Cooling Tower efficiency (kw/ton)
- Overall Pumps efficiency (kw/ton)

Airside AHU/PAU monitoring (instantaneous and trend-log):

- Total Power consumption (kwh)
- Overall efficiency (kw/ton)
- On-coil temperature (Deg C)
- Off-coil temperature (Deg C)
- Fresh Air Damper (% opening)
- Relative Humidity (RH %)

c. Data Monitoring

Monitoring of energy consumption (kwh):

- All energy consumption to be recorded on accumulated hourly logging and taken on monthly basis (extract reading from same day & same time every month)
- BMS shall be able to store past trending records for at least 12mths.
- to provide raw data taken from every DB (each DB shall be labeled clearly on the area/ service it serves)

d. Power Meter (kwh)

Major energy consuming equipments should be separately measured as stated in SS553:2009

Data Storage and Retrieval:
The data management system shall be capable of electronically storing energy metered and measured data and creating user reports showing calculated hourly, daily, monthly and annual energy consumption for each meter and performance parameters of the plant.

All BMS monitoring shall provide clear formula of how efficiency are calculated and capable of display of all parameters required herein the specification and will be determined during the construction stage and cost deem inclusive.

In event the BMS programming does not satisfy BCA requirement, the BMS Contractor shall amend the programme up to the satisfaction of BCA up till the closure of BCA Site Verification Stage 2.

Energy Efficiency:
The energy metering collection or storage system shall be used to collect and store meter data for each meter and sub-meter immediately upon building commissioning and issuance of Temporary Occupation Permit or Certificate of Statutory Completion, whichever is earlier.

Power meter shall be provided to monitor energy consumption for each mechanical/ electrical system separately listed below:

- Chiller plant room for individual equipment
- Air distribution fans (PAHUs, AHUs & FCUs)
- Mechanical ventilation (MV) fans
- Lighting (Internal, external and façade separately metered)
- Lifts
- Escalators

- Receptacle loads (Plug load, etc.)
- Domestic water pumps
- Hot water usage (If applicable)
- Data centre lighting
- Data centre receptacle

Feature	Indication	value to reflect on BMS	Monitoring from
CO2 Level at AHU return duct	CO2 sensor	ppm	BMS
CO level at carpark	CO sensors	ppm	BMS
Water leak detection	Yes/No	cm3	BMS
Refrigerant leak detection	Yes/No	R134a/R410	BMS

Table 10. *Green Features monitoring*

4.01 Indoor Air Quality

a. Occupant Comfort

i. Indoor Air Quality (IAQ) Surveillance Audit

The IAQ surveillance audit shall be based on the reference methods described in SS 554: 2016 Code of Practice for Indoor Air Quality for Air-Conditioned Buildings. This audit shall be conducted for the building within one year after occupancy and the auditor shall be engaged by the Employer.

ii. Post Occupancy Evaluation

A Post Occupancy Evaluation (POE) questionnaire shall be conducted within a year after building occupancy to assess occupancy wellbeing and interactions with their indoor environment. This will be carried out by the Employer.

b. Outdoor Air

i. Ventilation Rates

The outdoor airflow volume of all AHUs shall be measured and monitored via BMS system in accordance with desired ventilation rates for each space.
All PAU & AHU shall be provided with CO2 sensors and pressure differential monitoring device to regulate the amount of fresh air supply to meet the quality of indoor air from each space including tenant spaces.

ii. Enhanced filtration Media

Permanent provision of Minimum Efficiency Rating Value (MERV) 14 (ASHRAE 52.2: 2012) class filter shall be provided for the PAU.

c. Indoor Contaminants

i. Air Purging System

The PAU and AHU shall allow for reverse airflow capability for local exhaust air purging to remove the source of pollutants and replacement contaminated indoor air with outdoor fresh air. This system shall be controlled via BMS system and programmed for scheduled periodic air purging.

ii. More Stringent VOC Limits for Interior Fittings and Finishes

The following products (***Table 10***) used within the “Finishes Group” or “Other Systems” shall be applied for ≥80% of applicable areas must be SGBP certified Very Good (2ticks) or above, of which the VOC emission rate standards meet more stringent VOC emission limits.

Finishes Group	**External Wall**
	Internal Wall
	Internal Flooring
	Ceiling
	Doors
Other Systems	Fixed Furniture/ System Furniture

Table 11. *Sustainable products category*

iii. Use of Persistent Bio-cumulative and Toxic (PBT) free lighting
All Luminaries provided in this development shall be PBT-reduced or free luminaries.

4.02 Spatial Quality

a. Lighting

ii. Quality of Artificial Lighting

- Provision of high frequency ballasts for all fluorescent luminaries and LED lighting with driver output frequency <200Hz and <30% flicker.
- All LED Luminaries shall be certified under SGBP scheme.

b. Acoustic

i. Sound Transmission Reduction

Contractor to demonstrate that they are following Architect's design of the acoustic performance of the internal partitions between adjoining spaces will be constructed to achieve the following performance levels:

Description	Sound Transmission Class (STC)
Between general office spaces	40-50
Spaces where confidential speech are required/Between mechanical and equipment spaces and occupied spaces:	50-60

c. Wellbeing

i. Biophilic Design

- Sky Garden are designated gardens to be accessible by staff for respite purpose.
- Image of nature for 5% of common areas are to implement by Contractor.

ii. Universal Design (UD) Mark

- Development will be adopting a users-centric philosophy in design, operations and maintenance to achieve UD Mark Certified award.

4.03 Smart Building Operations

a. Energy Monitoring

i. Energy Portal and Dashboard

- The energy portal and dashboard in form of digital display or web-based/mobile application shall extend beyond BMS control room to the User's level where the energy consumption in their functional and common spaces can be displayed. The function of this dashboard shall enable displaying metered energy data by area or by system, and cost of energy used, trend of energy use and energy benchmark.
- Portal's requirement must be able to store the measured data for at least 36months and to create reports showing hourly, daily, monthly and annual

energy consumption associated with each meters with option to export data to a text format.

ii. BAS and Controllers with Open Protocol

The system design shall utilise the latest technology in “open” network architecture, distributive intelligence and processing, and direct digital control. It shall be from the latest offerings and be of freely programmable management and automation stations for the full spectrum of today’s building application services.

All peripheral equipment e.g. sensors, pressure switches, control valves and actuators and the like, shall be of the same manufacture as the direct digital control modules and outstations and all working according open field bus protocols as LonWorks, Modbus or BACNET.

The system shall be completely modular in structure and freely expandable at any stage from the smallest system through to large distributed systems. Each level of the system shall operate independently of the next level up.

The system shall fully be consistent with the latest industry standards, operating on Windows 10 or later, allowing the user to make full use of the features provided with these operating systems. It shall provide maximum flexibility and to respond to changes in the building use, the system offered shall support the use of BACNET, LonWorks, Modbus and Ethernet TCP/IP communication technologies. The system shall enable scheduled export of a set of any chosen data points to commonly used file formats.

The MEP sub-contractors and BMS sub-contractor shall establish the number of equipment to be controlled / monitored by the BMS from the drawing / schedule / specifications for approval by the Consultant team. All plant and equipment requiring control and / or monitoring functions shall be fitted with all necessary interfacing equipment readable by the BMS network. The Contractor shall co-ordinate and ensure that all the afore-mentioned established equipment shall provide the required signals to the BMS.

b. Demand Control

i. Lighting Demand Control:

Occupancy/vacancy sensing: control automatically turn lighting off when motion is no longer detected and provide method statement of the lighting controls including the sensors regulation of lighting level (brightness) or demonstrate control system screens showing the sensors input and corresponding controller outputs

Motion sensors shall be installed at all transient areas:

- Toilets and staircases
- lobby & corridors with alternate loop circuitry

c. Integration and Analytics

i. Basic Integration and Analytics

Basic fault detection and diagnostics (FDD) of sensors shall be provided but not limited to:

- Use adaptive control algorithms
- Exception handling by identifying systems that deviates from expected performance /setting
- Detect equipment that rub outside intended hours or settings
- Monitoring equipment condition for preventive maintenance
- Basic fault detection and diagnostics(FDD) of sensors by finding failed or improperly operating sensors or actuators

ii. Advanced Integration and Analytics

The Building Management System (BMS) shall be a fully integrated building automation system, incorporating direct digital controllers (DDC) for energy management, equipment monitoring and control, suitable for the building usage. The control strategies shall be developed to ensure that the specified environmental conditions are maintained, whilst giving due regard to minimizing of energy consumption.

The BMS shall not be limited to the basic controls and building automation but also provide for an advanced detection and diagnostics of deviation from normal expected behaviour of a network of HVAC equipment for root causes of equipment or system wide faults or inefficiencies (but not limited to):

- Whole system optimisation using a network of HVAC equipment
- Integration of sub-systems to optimise resource use or improve user experience
- Use of Building Information Modelling (BIM) or similar applications that provide location-based visualisation of multiple sensors
- Participate in a Demand Response programme with electricity retailer

d. System Handover and Documentation

Proper system verification and handover is crucial to the functional and system level performance of building control systems, mechanical systems and electrical systems. The project is committed to comply with verification requirements by BCA Green Mark requirement and the Main Contractor shall show evidence of relevant schedules and documentation not limited to the following:

- Green Mark Site Verification final compiled documents
- Operation and Maintenance Manual for all building systems including building monitoring systems.
- Testing and commissioning of all building systems shall be properly recorded and a copy of the records shall be given to the Employer.
- Conduct trainings to ensure Facilities Management team (FM) and Operation Management team (OM) of the development are aware of how to operate and maintain the building systems as per design intent. These trainings shall be properly recorded and a copy of the trainings shall be given to the Employer.

The format of the above documentation shall be in both softcopies in CD-Rom and duplicated hardcopies that bares the original signatory of the relevant disciplinary authorised personnel.

PART 5: ADVANCED GREEN EFFORT

5.01 Enhanced Performance

- Better Water Efficient Fitting- Refer t0 *3.01a*
- Using BIM to calculate Concrete Usage Index (CUI) – Refer to *3.02* above
- Use of 4 nos. SGBP Very Good(2ticks) or above rated products- Refer to 3.02c

SECTION 9

ENVIRONMENTAL CONSIDERATIONS

9.4 Reporting of Environmental Non-conformances

When encountering environmental non-conformances, Site Staff shall be responsible to feedback to the main contractor.

9.5 List of Applicable Environmental management system Procedures

Alpha Consulting Engineers Pte Ltd's Environmental Management System Procedures

Section	Title	✓ where applicable
E1	Aspect/Impact Identification, Risk Assessment & Risk Control	✓
E2	Identifying Legal & Other Requirements	✓
E3	Objectives, Targets & Programmes	✓
E4	Communication	✓
E5	Emergency Preparedness & Response	✓
E6	Monitoring & Measurement	✓
E7	Control of Air & Noise Pollution	✓
E8	Management of Wastes	✓

SECTION 10

CLIENT'S REQUIREMENTS

10.1 List of Output Required by Client:

Item	* Remarks
M&E Design Report	A
M&E Cost Estimate Report	A
Pre-Qualification of Tenderers	–
Tender Documents	A
Tender Report	A
Payment Valuation for QS	–
Certificates of Supervision for TOP/CSC	RE

* *Remarks*

A: for approval *C: for comment* *I: for Information* *Re: for record*

Other purposes and for action: please specify.

10.2 Specific Procedures Required By Client *(If applicable)* **– NOT APPLICABLE**

SECTION 11

LIST OF SUB-JOB

11.1 List of Sub-Job Numbers – NOT APPLICABLE

Sub Job No	Description	Allocation Details