



*High Commissioner of India
Brunei Darussalam*

**PROPOSED CONSTRUCTION OF CHANCERY, HIGH
COMMISSIONER'S RESIDENCE, STAFF RESIDENCES AND
AUXILIARY FACILITIES BUILDINGS
FOR THE HIGH COMMISSION OF INDIA
BRUNEI DARUSSALAM**

**FINANCIAL BID DOCUMENT
(VOLUME 2 OF 2)**

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**PROPOSED CONSTRUCTION OF CHANCERY, HIGH
COMMISSIONER'S RESIDENCE, STAFF RESIDENCES AND
AUXILIARY FACILITIES BUILDINGS
FOR THE HIGH COMMISSION OF INDIA
BRUNEI DARUSSALAM**

TABLE OF CONTENTS:

1. FINANCIAL BID DOCUMENT

A. BILL OF QUANTITIES

- a. CHANCERY, NON-RG & RG – M&E**
- b. RESIDENCE – M&E**

B. M&E SPECIFICATIONS

- a. MECHANICAL**
- b. ELECTRICAL**
- c. LIFT**

C. M&E TECHNICAL DATA

- a. MECHANICAL**
- b. ELECTRICAL**

2. M&E DRAWINGS

M&E BILL OF QUANTITIES

BILL 8A
(RESIDENCE)

Section	Description	Bill No.	Amount	
			\$	c
BILL 8A	<p><u>SUMMARY OF PRICES OF M&E WORKS FOR HIGH COMMISSIONER'S RESIDENCE</u></p> <p>R/M <u>Mechanical Services</u></p> <p>[1] EQUIPMENT</p> <p>[2] PIPEWORK</p> <p>[3] ELECTRICAL</p> <p>[4] POOL POND & PLUMBING</p> <p>R/E <u>Electrical Services</u></p> <p>[1] SWITCHBOARDS and LV RETICULATION MAINS</p> <p>[2] GENERAL LIGHTING and POWER SERVICES</p> <p>[3] LIGHT FITTINGS and ACCESSORIES</p> <p>[4] TELEPHONE and COMPUTER SYSTEM</p> <p>[5] FIRE PROTECTION SYSTEM</p> <p>[6] MATV SYSTEM</p> <p>[7] SECURITY SYSTEM</p> <p>[8] LIGHTNING PROTECTION SYSTEM</p> <p>[9] EXTERNAL WORKS</p> <p>[10] STANDBY GENERATOR SET</p> <p>TUC <u>Tests Upon Completion</u></p>			
TO M&E SUMMARY PAGE (BILL 8A) :				

MECHANICAL SERVICES
(BILL OF QUANTITIES)

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
R/M	<u>MECHANICAL SERVICES FOR HIGH COMMISSIONER'S RESIDENCE</u>					
[1]	<u>EQUIPMENT</u>					
	<u>INVERTER SPLIT SYSTEM EQUIPMENT (Carrier or approved equivalent)</u>					
	Supply, installation, testing and commissioning of the Air Conditioning System as shown and indicated in the drawing. All material supply & works carry out shall be as per DES requirements and approved vendors products.					
	Rate quoted shall be inclusive of supply and termination of all power and control cables to equipment including necessary cable, glands, lugs, earthing, conduit/ HDGS cable tray and other necessary accessories.					
	Air Cooled Split Conditioning system consisting of AHU and matching air cooled condensing unit compressor shall be fully inverter type c/w sight glass, refrigerant & oil, refrigerant filter, air filter, brackets and supports, power & control wiring and other necessary accessories as specified and as shown in the drawing.					
	<u>1. INVERTER MULTI SYSTEM EQUIPMENT (Carrier or approved equivalent)</u>					
	Air Cooled Condensing Unit (CU) shall be floor mounted type, each unit shall have a minimum of 2 compressors per module and all compressors shall be fully inverter type and completely possible to operate at ranges of partial loads. Compressors shall be reliable twin rotary type with DC motors. condenser fan motor shall be high efficiency DC motor capable of operating at 32 different steps. Condensers shall be copper tube and aluminum-type. The outdoor unit shall be able to handle equivalent pipe lengths up to 235 meters. Fan Coil Unit (FCU) complete with air filter and all necessary accessories for satisfactory operation.					
	Outdoor condition: 34.0 deg C/28.5 deg C DB/WB Indoor condition: 21.0 deg C DB, 55%RH and as per drawings.					
	<u>OUTDOOR CONDENSING UNIT</u>					
	<u>RATING CAPACITY</u>					
A	VRF-G1 (51.8 Kw)	set	1			
B	VEF-G2 (48.1 Kw)	set	1			
C	VRF-F1 (58.5 Kw)	set	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	<u>INVERTER TYPE FAN COIL UNITS</u>					
	Cassette (Ceiling Mounted Type Unit)					
	<u>RATING CAPACITY</u>					
A	FCU-R1 to R4 (11.5 Kw each)	nos.	4			
B	FCU-R5 (6.2 Kw)	no.	1			
C	FCU-G1 & G2 (7.0 Kw each)	nos.	2			
D	FCU-G3 & G4 (7.3 Kw each)	nos.	2			
E	FCU-G5 (11.3 Kw)	no	1			
F	FCU-G6 (5.6 Kw)	no	1			
G	FCU-G7 (2.6 Kw)	no	1			
H	FCU-F1 & F2 (8.0 Kw each)	no	2			
I	FCU-F3 (6.5 Kw)	no	1			
J	FCU-F4 (9.0 Kw)	no	1			
K	FCU-F5 (6.5 Kw)	no	1			
L	FCU-F6 (8.2 Kw)	no	1			
M	FCU-F7 (12.3 Kw)	no	1			
	<u>2. DX SPLIT TYPE UNITS (Carrier or approved equivalent)</u>					
	To supply and install DX Split systems each comprising unit c/w brackets, supports, wireless controller and with all necessary accessories for a complete operable system.					
N	FCU/CU - (2.6 KW)	nos.	9			
To Collection:						
	<u>COLLECTION</u>					
	<u>PAGE</u>					
	R/M1 (page 1/1) - - - - -	-	-	-		
	R/M1 (page 2/2) - - - - -	-	-	-		
TO R/M1 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
R/M	<u>MECHANICAL SERVICES FOR HIGH COMMISSIONER'S RESIDENCE</u>					
[2]	<u>PIPEWORK</u>					
	<u>REFRIGERANT PIPEWORK</u>					
	Solid drawn copper tube c/w 20mm thick THERMAL insulation and white PVC Denso wrap tape encased in heavy duty PVC impact resistant industrial trunking, fittings, liquid line solenoid valves, TX valves, sight glasses and filter driers, supports, brackets and as specified. All systems to be pressure tested, evacuated and dehydrated before charging with refrigerant. (where two refrigerant lines system is offered Tenderer is to price for the 2 lines accordingly). Testing, evacuation and dehydration of both refrigeration systems, before charging with refrigerant, and include initial refrigerant charge. Note : All test pressures and evacuation pressures to be submitted in type written form to the Engineer.					
	<u>REFRIGERANT PIPE (INVERTER SYSTEM)</u>					
A	FCU-R1 to R4 (11.5 Kw each)	lot	4			
B	FCU-R5 (6.2 Kw)	lot	1			
C	FCU-G1 & G2 (7.0 Kw each)	lot	2			
D	FCU-G3 & G4 (7.3 Kw each)	lot	2			
E	FCU-G5 (11.3 Kw)	lot	1			
F	FCU-G6 (5.6 Kw)	lot	1			
G	FCU-G7 (2.6 Kw)	lot	1			
H	FCU-F1 & F2 (8.0 Kw each)	lot	2			
I	FCU-F3 (6.5 Kw)	lot	1			
J	FCU-F4 (9.0 Kw)	lot	1			
K	FCU-F5 (6.5 Kw)	lot	1			
L	FCU-F6 (8.2 Kw)	lot	1			
M	FCU-F7 (12.3 Kw)	lot	1			
	<u>MAIN LINE</u>					
N	VRF-G1 (51.8 Kw)	lot	1			
O	VEF-G2 (48.1 Kw)	lot	1			
P	VRF-F1 (58.5 Kw)	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	<u>CARRIER DX SPLIT TYPE UNITS</u>					
A	FCU/CU - (2.6 Kw)	lot	9			
	<u>VRF DISTRIBUTION JOINT KITS</u>					
B	VRF-G1 (51.8 Kw)	m	14			
C	VEF-G2 (48.1 Kw)	m	18			
D	VRF-F1 (58.5 Kw)	m	98			
E	FCU-R1 to R4 (11.5 Kw each)	lot	4			
F	FCU-R5 (6.2 Kw)	lot	1			
G	FCU-G1 & G2 (7.0 Kw each)	lot	2			
H	FCU-G3 & G4 (7.3 Kw each)	lot	2			
I	FCU-G5 (11.3 Kw)	lot	1			
J	FCU-G6 (5.6 Kw)	lot	1			
K	FCU-G7 (2.6 Kw)	lot	1			
L	FCU-F1 & F2 (8.0 Kw each)	lot	2			
M	FCU-F3 (6.5 Kw)	lot	1			
N	FCU-F4 (9.0 Kw)	lot	1			
O	FCU-F5 (6.5 Kw)	lot	1			
P	FCU-F6 (8.2 Kw)	lot	1			
Q	FCU-F7 (12.3 Kw)	lot	1			
	<u>SOLENOID VALVE KITS</u>					
R	VRF-G1 (51.8 Kw)	lot	1			
S	VEF-G2 (48.1 Kw)	lot	1			
T	VRF-F1 (58.5 Kw)	lot	1			
U	FCU-R1 to R4 (11.5 Kw each)	lot	4			
V	FCU-R5 (6.2 Kw)	lot	1			
W	FCU-G1 & G2 (7.0 Kw each)	lot	2			
X	FCU-G3 & G4 (7.3 Kw each)	lot	2			
Y	FCU-G5 (11.3 Kw)	lot	1			
Z	FCU-G6 (5.6 Kw)	lot	1			
AA	FCU-G7 (2.6 Kw)	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
A	FCU-F1 & F2 (8.0 Kw each)	lot	2			
B	FCU-F3 (6.5 Kw)	lot	1			
C	FCU-F4 (9.0 Kw)	lot	1			
D	FCU-F5 (6.5 Kw)	lot	1			
E	FCU-F6 (8.2 Kw)	lot	1			
F	FCU-F7 (12.3 Kw)	lot	1			
	<u>BALL VALVE AND FITTINGS</u>					
G	VRF-G1 (51.8 Kw)	lot	1			
H	VEF-G2 (48.1 Kw)	lot	1			
I	VRF-F1 (58.5 Kw)	lot	1			
J	FCU-R1 to R4 (11.5 Kw each)	lot	4			
K	FCU-R5 (6.2 Kw)	lot	1			
L	FCU-G1 & G2 (7.0 Kw each)	lot	2			
M	FCU-G3 & G4 (7.3 Kw each)	lot	2			
N	FCU-G5 (11.3 Kw)	lot	1			
O	FCU-G6 (5.6 Kw)	lot	1			
P	FCU-G7 (2.6 Kw)	lot	1			
Q	FCU-F1 & F2 (8.0 Kw each)	lot	2			
R	FCU-F3 (6.5 Kw)	lot	1			
S	FCU-F4 (9.0 Kw)	lot	1			
T	FCU-F5 (6.5 Kw)	lot	1			
U	FCU-F6 (8.2 Kw)	lot	1			
V	FCU-F7 (12.3 Kw)	lot	1			
	<u>CONDENSATE DRAIN PIPE</u> 32mm dia. pipes (unless otherwise specified) to BS 3505 Class D c/w 15mm thick insulation concealed within walls and run in HD UPVC trunking c/w traps, fittings, brackets and supports.					
W	FCU-R1 to R4 (11.5 Kw each)	lot	4			
X	FCU-R5 (6.2 Kw)	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
A	FCU-G1 & G2 (7.0 Kw each)	lot	2			
B	FCU-G3 & G4 (7.3 Kw each)	lot	2			
C	FCU-G5 (11.3 Kw)	lot	1			
D	FCU-G6 (5.6 Kw)	lot	1			
E	FCU-G7 (2.6 Kw)	lot	1			
F	FCU-F1 & F2 (8.0 Kw each)	lot	2			
G	FCU-F3 (6.5 Kw)	lot	1			
H	FCU-F4 (9.0 Kw)	lot	1			
I	FCU-F5 (6.5 Kw)	lot	1			
J	FCU-F6 (8.2 Kw)	lot	1			
K	FCU-F7 (12.3 Kw)	lot	1			
L	FCU/CU (2.6 Kw)	lots	9			
To Collection:						
	<p style="text-align: center;"><u>COLLECTION</u></p> <p><u>PAGE</u></p> <p>R/M2 (page 1/4) - - - - -</p> <p>R/M2 (page 2/4) - - - - -</p> <p>R/M2 (page 3/4) - - - - -</p> <p>R/M2 (page 4/4) - - - - -</p>					
TO R/M2 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
R/M	<u>MECHANICAL SERVICES FOR HIGH COMMISSIONER'S RESIDENCE</u>					
[3]	<u>ELECTRICAL</u>					
	<u>Electrical and Controls</u> All components, cables and controls shall be of types and qualities as specified in Section 3, "ELECTRICAL", of the DES General Specification for Air Conditioning Installations, the Electrical Installation Part of this Specification and IEE Regulations and installed to standards as similarly specified.					
	<u>Automatic Controls</u> All automatic controls necessary for the operation and control of the Inverter Split System including thermostat and associated electrical power and control wiring.					
	<u>VRF SYSTEM (Carrier or approved equivalent)</u>					
A	Simplified Remote Controllers (Chancery-Grd flr)	lot	1			
B	Simplified Remote Controllers (Chancery-Grd flr)	lot	1			
C	Simplified Remote Controllers (Chancery- 1st flr)	lot	1			
	<u>Power Supply and Control Cables</u> All interconnecting power supply wiring between local isolating switch and condensing unit and all interconnecting power and control wiring between condensing unit and associated indoor unit, run in high impact conduit, trunking and HDGS cable tray.					
D	VRF-G1 (51.8 Kw)	lot	1			
E	VEF-G2 (48.1 Kw)	lot	1			
F	VRF-F1 (58.5 Kw)	lot	1			
G	FCU-R1 to R4 (11.5 Kw each)	lots	4			
H	FCU-R5 (6.2 Kw)	lot	1			
I	FCU-G1 & G2 (7.0 Kw each)	lots	2			
J	FCU-G3 & G4 (7.3 Kw each)	lots	2			
K	FCU-G5 (11.3 Kw)	lot	1			
L	FCU-G6 (5.6 Kw)	lot	1			
M	FCU-G7 (2.6 Kw)	lot	1			
N	FCU-F1 & F2 (8.0 Kw each)	lots	2			
O	FCU-F3 (6.5 Kw)	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	<u>Power Supply and Control Cables (Continued)</u>					
A	FCU-F4 (9.0 Kw)	lot	1			
B	FCU-F5 (6.5 Kw)	lot	1			
C	FCU-F6 (8.2 Kw)	lot	1			
D	FCU-F7 (12.3 Kw)	lot	1			
E	FCU/CU (2.6 Kw)	lots	9			
	<u>EXHAUST FANS (KDK or approved equivalent)</u>					
	Ceiling Mount Ducted Type					
	c/w backdraft damper and fresh air louvre.					
F	EF.RG-1 - (Capacity: 105 cmh, S.P.: 20 Pa)	lot	1			
G	EF.RG-2 - (Capacity: 435 cmh, S.P.: 20 Pa) each	lots	2			
	EF.RG-3 - (Capacity: 125 cmh, S.P.: 20 Pa)	lot	1			
	EF.RG-4 - (Capacity: 324 cmh, S.P.: 20 Pa)	lot	1			
	EF.RF-5 - (Capacity: 210 cmh, S.P.: 20 Pa)	lots	2			
	Wall Mounted type c/w automatic backdraft damper					
H	EF.RG-1 - (Capacity: 210 cmh)	lot	1			
I	EF.RG-2 - (Capacity: 150 cmh)	lot	1			
J	EF.RG-3 - (Capacity: 75 cmh) each	lots	2			
K	EF.RG-5 - (Capacity: 678 cmh)	lot	1			
L	EF.RG-6 - (Capacity: 120 cmh)	lots	2			
M	EF.RF-8 - (Capacity: 370 cmh)	lot	1			
N	EF.RF-9 - (Capacity: 270 cmh)	lot	1			
O	EF.RF-10 - (Capacity: 105 cmh)	lots	2			
P	EF.RF-12 - (Capacity: 165 cmh)	lots	2			
Q	EF.RF-13 - (Capacity: 360 cmh)	lots	2			
	<u>ISOLATOR SWITCHES</u>					
R	VRF Units	lots	3			
	(i) VRF-G1 (80A)					
	(ii) VEF-G2 (80A)					
	(iii) VRF-F1 (85A)					
S	Condensing Units (20A each)	lots	9			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	<p><u>KITCHEN EXHAUST HOOD</u></p> <p>Supply & installation of Canopy & 3-sided Type Kitchen Exhaust Hood constructed from 1.5mm thk. SS 316 finish with welds ground smooth and polished c/w Firestat, hood light, grease filter, hangers etc and as per specifications, drawings and all accessories for a complete satisfactory and operational system</p>					
A	<p><u>KITCHEN EXHAUST HOOD (CONTINUED)</u></p> <p>Size: 1200mm(L) x 700mm(W) 3-Sided Type</p>					
B	<p><u>GREASE BAFFLE FILTER</u></p> <p>Aluminium Grease Baffle Filter (3 nos. -500mm x 400mm x 50mm) shall be "AAF" brand, baffle type or other approved equal</p>	lot	1			
C	<p><u>KITCHEN EXHAUST VENTILATION</u></p> <p><u>BIFURCATED EXHAUST FAN</u></p> <p>Axial type axial fan (split air way and direct motor isolated from air stream) complete with flexible connections, bracket and supports.</p> <p>a) Capacity : 5058 cmh</p> <p>b) Static pressure loss : 532 Pa</p> <p>c) Max. Speed : 25rps</p>	lot	1			
D	<p><u>FRESH AIR FAN (AXIAL TYPE)</u></p> <p>Axial type fan with direct coupled motor complete with flexible connections, bracket and supports.</p> <p>a) Capacity : 4552</p> <p>b) Static pressure loss : 41 Pa</p> <p>c) Max. Speed : 25rps</p>	lot	1			
E	<p><u>Firestat</u> (to be set to stop the fan when exhaust air temperature rises to 96°C).</p>	lot	1			
F	<p><u>Hood Light</u> (The bulb shall be enclosed in a vapor proof fixture with nickel plated socket and heat resistant globe c/w heat and oil resistant wire and cast fitting junction box) c/w ON/OFF Switch and all associated wiring.</p>	lot	1			
G	<p><u>Ductwork</u> c/w bends, transformation connection etc. (SS 304)</p>	lot	1			
H	<p>All hangers, supports, bolts and nuts (Stainless Steel type 316) including HDGS bracket and angle bar terminated/welded to structure for supporting fans and duct work</p>	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
A	EF-CP (Control Panel) Manual and automatic control operation, Start and Stop push button switch, indication of fan(s) run and trip, wiring in G.I. concealed conduit, etc as per drawings and as specified. AUTOMATIC SECURITY GATE SYSTEM Supply and installation of Heavy duty high quality automatic gate system c/w motorised control and interconnecting power wiring, and complete all necessary accessories including remote controls. The automatic gate shall be control and manually open and close from a switch located inside the residence (2-location to be confirmed).	lot	1			
B	Automatic Gate Motor (gate approx. wt.=1000kg) c/w all accessories.	lot	1			
C	Manually operated switch c/w power and control wiring and all accessories for a complete operable system.	lot	1			
<p style="text-align: center;"><u>COLLECTION</u></p> <p style="text-align: center;"><u>PAGE</u></p> <p>R/M3 (page 1/4) - - - - -</p> <p>R/M3 (page 2/4) - - - - -</p> <p>R/M3 (page 3/4) - - - - -</p> <p>R/M3 (page 4/4) - - - - -</p>						
TO R/M3 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
R/M	<u>MECHANICAL SERVICES FOR HIGH COMMISSIONER'S RESIDENCE</u>					
[4]	<u>POOL POND EQUIPMENTS</u> To supply and install the following equipment and materials inclusive of all associated mechanical and electrical controls, power cables, interconnection control wiring as specified and shown on the drawings					
A	Pool Pond Self-Priming Pumpset (Made of Hyward or approved equivalent). Single stage end suction centrifugal pump c/w squirrel cage electric motor, TEFC, 415V/3 PH/50HZ 2900 rpm (max.) Capacity: 183 l/min at 42 TDH	sets	2			
B	Sand Filter c/w accessories Capacity: 183 l/min	lot	1			
C	<u>CONTROL PANEL (PP-CP) - PKS or approved equivalent</u> Manual and automatic control operation, Start and Stop push button switch, indication of pump run and trip, wiring in G.I. concealed conduit, and etc as specified.	lot	1			
D	Control and power wiring to pumpset, float and pressure switches, complete with inter-connecting control wiring in PVC conduit/HDGS tray	lot	1			
	<u>PIPEWORK, FITTINGS AND ACCESSORIES</u> Supply and install the following, including all accessories and fixtures necessary and in accordance with the specifications described herein and as shown on the drawings. All piping and fittings shall be HDPE pipe c/w HDGS (hanger, bracket and support), etc.					
	<u>PIPE</u>					
E	50 mm diameter	m	50			
F	25 mm diameter	lot	1			
	<u>Gate Valves</u>					
G	50 mm diameter	nos	7			
H	25 mm diameter	nos	2			
	<u>Check Valves</u>					
I	50 mm diameter	nos	2			
	<u>Strainers</u>					
J	50 mm diameter	nos	2			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	<u>PIPEWORK, FITTINGS AND ACCESSORIES (CONTINUED)</u>					
A	Flexible Connections 50mm diameter	nos	4			
	<u>Fitting and Accessories</u>					
B	Pressure gauge c/w petcock (0-100 psi).	nos	4			
C	25 mm dia . Automatic Air Relief Valve.	nos	1			
	<u>Painting of Pipework & Pumps</u>					
D	Painting including one rust inhibitive primer, one undercoat and 2 finishing red gloss paint for all pipeworks, pumps, brackets and supports.	lot	1			
E	Pool Basket Strainer c/w all accessories and as per drawings. (Hayward or approved equivalent)	lot	1			
F	Chlorinator Feeder (2gpm) - Hayward or approved equivalent	lot	1			
G	Submersible Pumpset (Made of Flyght or approved equivalent) Capacity: 90 l/min; TDH: 3.0m	nos	1			
	<u>PLUMBING</u>					
H	Domestic Water Storage Tank (Made of LSL or approved equivalent). Capacity: 2.5 cubic metre c/w accessories including R.C. plinth and as per drawing and specification.	lot	1			
I	Water Pumpset (Made of CNP or approved equivalent) Capacity: 44 L/min TDH: 40m	sets	2			
J	Control and power wiring to pumpset, float and pressure switches, complete with inter-connecting control wiring in PVC conduit/HDGS tray	lot	1			
K	Outdoor Sand Filter (Stainless Steel 304) - Made of Backfree or approved equivalent. Cap: 44 L/min	lot	1			
L	Valves and fittings as per drawings (inside the pump room)	lot	1			
To Collection:						
	<u>COLLECTION</u>					
	<u>PAGE</u>					
	R/M4 (page 1/2) - - - - -	-	-	-		
	R/M4 (page 2/2) - - - - -	-	-	-		
TO R/M4 SUMMARY:						

ELECTRICAL SERVICES
(BILL OF QUANTITIES)

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
A	4x1c/25mm ² PVC cable + 1c/16mm ² CPC laid in trunking c/w necessary accessories from SSB-RS to DB-RA.	m	10			
B	4x1c/25mm ² PVC cable + 1c/16mm ² CPC laid in trunking c/w necessary accessories from SSB-RS to DB/RG-PP.	m	15			
C	4x1c/25mm ² PVC cable + 1c/16mm ² CPC laid in trunking c/w necessary accessories from SSB-RS to DB/RF-LP.	m	60			
D	1x4c/16mm ² PVC cable + 1c/16mm ² CPC laid in trunking c/w necessary accessories from SSB-RS to PP-CP.	m	60			
E	1x2c/10mm ² PVC/SWA/PVC cable laid underground, pipesleeves and cable tray c/w necessary accessories from SSB-RS to DB-GH.	m	60			
	<u>Miscellaneous and Related Works</u>					
F	Allow miscellaneous cost for concrete encased pipesleeves of 150mm dia for all road crossing, pipe jacking, hard standing areas, returfing, refurbishment and making good of existing ground.	lot	1			
G	Allow miscellaneous cost for providing floor openings, pipe sleeves through RC beams & slabs, fire stop barrier, fire seal pillows, etc for passage of sub-main cables, lighting and power wiring, telephone & computer system, fire alarm & fire protection system, water services, aircon services and other disciplines.	lot	1			
H	Allow cost for liaison with Authorities regarding power supply application and energization of the system.	lot	1			
	<u>Upgrading Works (if required)</u>					
I	Allow cost for the upgrading of the existing substation inclusive of necessary and required materials. Cost to include liason to authorities and nearby residences.	lot	1			
J	Supply, install and commissioning of 500 kVA 11kV/433V outdoor type Distribution Transformer c/w all necessary accessories to DES specification ref: DES/11KV/TRF/REV '0' dated 26-7-1997.	lot	1			
K	800A Outdoor type 433V 3 Phase 50Hz Low Voltage Distribution Feeder Pillar as per DES Specification.	lot	1			
L	4x1c/500mm ² XLPE/AWA/PVC cable from transformer to MFP laid underground.	m	15			
M	Equipment body earthing system c/w necessary accessories to achieve below 1 ohm (for MFP, RMU & Transformer)	lot	1			
N	Transformer neutral earthing using 2x120mm ² PVC earth cable c/w heavy duty earth chamber and necessary accessories to achieve 1 ohm or less link to main earthing system.	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	<p style="text-align: center;"><u>COLLECTION</u></p> <p><u>PAGE</u></p> <p>R/E1 (Page 1/3) - - - - -</p> <p>R/E1 (Page 2/3) - - - - -</p> <p>R/E1 (Page 3/3) - - - - -</p>					
TO R/E1 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
R/E	<p align="center"><u>ELECTRICAL INSTALLATION FOR HIGH COMMISSIONER'S RESIDENCE</u></p> <p>[2] <u>GENERAL LIGHTING AND POWER SERVICES</u> Supply, installation and termination of light and power point in conduit/trunking as per drawing and specification.</p> <p>Rates for lighting and power point shall be inclusive of providing cable marker sleeved with the circuit number identified. Unless otherwise specified all switch plates and power point switch plate shall be of moulded white plastic range accessories approved by DES. CPC earth cable shall be provided inside back box and terminated with cable connector whether the switch plate is of plastic or of metallic range.</p> <p>Cost quoted to be inclusive of termination of all incoming/ outgoing cables including cable glands, lugs, etc as per drawing and specifications.</p> <p>NOTES:</p> <p>i) all utility boxes for switches, outlets, etc shall be of flush mounted, factory fitted with moulded brass nut and not of self tapping screw type.</p> <p>ii) conduit adapter fitted to boxes for use of switches, outlets, etc shall be with lock nuts and securely tightened.</p> <p>iii) all exposed conduit and flexible conduit inside ceiling voids shall be of color coded.</p> <p>iv) flexible conduit shall be of corrugated polyamide (nylon) flexible conduit and fittings shall be of manufacturer recommended.</p> <p>v) light fittings shall be of factory provided supports and brackets with independent hangers from other installations.</p> <p>vi) for bedroom areas, SSO switches are to T&J Electric "Radiance" Champagne with decorate frame matte black.</p> <p>vii) all other areas, SSO switches to T&J Electric "Radiance" Champagne.</p> <p><u>Unless otherwise specified Color Code for Service Raceway & Conduits are as follows:</u></p> <p>- lighting and power - - - - - orange</p> <p>- fire detection - - - - - red</p> <p>- telephone & computer - - - - green</p> <p>- PA system - - - - - yellow</p> <p>- security system - - - - - white</p> <p>- AC & BMS - - - - - blue</p>					
A	Lighting point c/w wiring in PVC conduit using 3x1c/1.5mm ² PVC cable c/w 10A switch plate and gang as per switching arrangement shown in the lighting drawings.	nos	390			
B	Emergency lighting point in PVC conduit using 3x1c/1.5mm ² PVC cable c/w key switch as shown in the drawing.	nos	4			
C	Exhaust fan wiring point in concealed PVC conduit using 3x1c/2.5mm ² PVC cable c/w fused spur outlet similar to MK, Clipsal, Legrand or equivalent next to fan and switch at the door.	nos	22			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
A	Power point in concealed PVC conduit using 6 nos 2.5mm² PVC cable as per single line diagram and terminated with the following outlets priced separately as below.	nos	127			
B	Power point in concealed PVC conduit using 3x1c/4mm² PVC cable as per single line diagram and terminated with the following outlets priced separately as below.	nos.	5			
C	13A single SSO mounted as shown in the drawing similar to MK, Clipsal, T&J white plastic finish or equivalent.	nos	56			
D	13A single weatherproof SSO mounted as shown in the drawing similar to MK, Clipsal, T&J white plastic finish or equivalent.	nos	7			
E	13A twin SSO mounted as shown in the drawing similar to MK, Clipsal, legrand or equivalent.	nos	64			
F	15A single SSO using 3x1c/4mm² PVC cable mounted as shown in the drawing similar to MK, Clipsal, T&J white plastic finish or equivalent.	no	5			
G	Cooker SSO w/ neon indicator using 3x1c/6mm² PVC cable in concealed PVC conduit mounted as shown in the drawing.	no	3			
H	Water heater point in concealed PVC conduit using 3x1c/4mm² PVC cable c/w connection outlet and flush 20A DP switch and pilot lamp and marked "water heater" similar to MK Logic 5423 WH WHI, Clipsal, T&J or equivalent.	nos	8			
I	Dimmer rack/controller and switch for Formal Dining lighting to DES approved equivalent.	lots	1			
J	Power point using 3x1c/4mm² PVC cable in concealed PVC conduit c/w 20A SPN weatherproof isolator for A/C units.	nos	2			
<u>Miscellaneous and Related Works</u>						
K	Allow cost for circuit tagging and labelling of all cables and wiring circuits (incoming/outgoing cables and corresponding DB name) using numeric sleeves or self laminating wrapped around oil resistant nylon cable identification labels to brother, winco, brady, thorpe or approved equivalent. Labels shall apply to but not limited to the following: i) all DB, MSB, SSB, FAP, Tel & Computer, Secuty System, etc ii) socket outlets iii) switches iv) light fittings	lot	1			
To Collection:						
	<u>COLLECTION</u>					
	<u>PAGE</u>					
	R/E2 (Page 1/2) - - - - -					
	R/E2 (Page 2/2) - - - - -					
TO R/E2 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
R/E	<p style="text-align: center;"><u>ELECTRICAL INSTALLATION FOR HIGH COMMISSIONER'S RESIDENCE</u></p>					
[3]	<p><u>LIGHT FITTINGS AND ACCESSORIES</u></p> <p>Supply and install DES approved light fittings as specified in the drawings and as indicated below or as per Engineer/SO requirement. All light fittings shall be provided with independent support to the structure and shall not depend to other system.</p> <p>Rates for light fittings shall be inclusive of providing a tape label with the circuit number identified and a strong adhesive used to bond the tape to the fittings. A system guarantee of 3 years by means of factory warranty certificate for all the light fittings.</p> <p>All LED light fittings offered must be of non degradable diffusers. All LEDs in the light fitting offered shall have a minimum lifetime to 70% luminuos flux at 50,000 hours and shall be CREE, Nichia, Lumiled LEDs or approved equivalent. A system guarantee of 3 years by means of factory warranty certificate shall be submitted for all LED light fittings. Contractor to ensure LED light fitting offered shall met the design illumination requirement.</p> <p>Emergency packs are to be rated for a minimum of 2 hours duration or as specified and shall be non-maintained type.</p>					
A	F1 - 12W LED Bollard 750mm high 3000k sanded black to NVC NGLED 5612-1 or approved equivalent, mounted as shown in the drawing.	nos.	16			
B	F2 - 18.5W LED Wall-mounted luminaire 3000k 25° to NVC NWLED3544 fencing light, mounted as shown in the drawing.	nos	25			
C	F4 - 9W LED Uplighter 3000K to NVC NFLED5012 or approved equivalent, as shown in the drawing. (Garden Light Spike)	nos	20			
D	F5 - 6W LED Inground uplight 3000K 20° to NVC NLED4203 or approved equivalent, as shown in the drawing.	nos	31			
E	F5B - 6W LED Inground uplight 3000K 45° to NVC NLED4203 or approved equivalent, as shown in the drawing.	nos	8			
F	F6 - 36W LED Inground uplight 3000K 60° to Luminconnect HD-MD1201, mounted as shown in the drawing.	nos	5			
G	F7 - 17W LED downlight 4000K 6inch IP44 to NVC NLED09506E-D or approved equivalent, mounted as shown in the drawing.	nos	17			
H	F8 - 9W LED surface mounted downlight white 3000K to NVC NLLED9184M or approved equivalent, mounted as shown in the drawing.	nos	23			
I	F10 - 12W LED Recessed downlight 6500K to NVC NDLED9314E or approved equivalent, mounted as shown in the drawing.	nos	27			
J	F11 - 2W LED Recessed spotlight 6500K to NVC NLED105 or approved equivalent, mounted as shown in the drawing.	nos	8			
K	F13 - 12.5W LED Rectangular IP68 underwater luminaire, 3000K, 50° beam angle to NVC NSLED4315 or approved equivalent, mounted as shown in the drawing.	nos	22			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
A	F16 - 35W LED Recessed adjustable spotlight 4000K honeycomb collimator to NVC NLED1807C/S or approved equivalent, mounted as shown in the drawing.	nos	12			
B	F17 - 18 LED T8 1200mm batten fitting to PHILIPS or approved equivalent.	nos	6			
C	F19 - 8W LED Recessed round downlight 3inch 4000K matte gold shield cover to NVC 8113A or approved equivalent, mounted as shown in the drawing.	nos	63			
D	F19B - 8W Recessed round downlight 3inch 4000K white shield cover to NVC 8113A or approved equivalent, mounted as shown in the drawing.	nos	12			
E	F19C - 8W Recessed round wall washer 3inch 4000K matte gold shield cover to NVC 81132A or approved equivalent, mounted as shown in the drawing.	nos	18			
F	F20A - 5W LED Wall luminaire 4000K copper to Demilux Intevision 9060 A-1 or approved equivalent, mounted as shown in the drawing.	nos	5			
G	F20B - 2x5W LED Wall luminaire 4000K copper to Demilux Intevision 9060 A-1 or approved equivalent, mounted as shown in the drawing.	no	1			
H	F21B - 3W LED Recessed downlight 2inch 4000K to NVC 8112D matte white shield cover or approved equivalent, mounted as shown in the drawing.	nos	33			
I	F21C - 3W LED Recessed wall washer 2inch 4000K to NVC 8113A2 matte gold shield cover or approved equivalent, mounted as shown in the drawing.	nos	6			
J	F22 - 12W LED Recessed spotlight IP65 4000K to NVC NSPLED181W or approved equivalent, mounted as shown in the drawing.	nos	14			
K	F25A - 80W LED Circular luminaire 1500mm dia 4000K gold 120° to Demilux Intevision 9063 c/w necessary accessories or approved equivalent.	no	1			
L	F25B - 70W LED Circular luminaire 1200mm dia 4000K gold 120° to Demilux Intevision 9063 c/w necessary accessories or approved equivalent.	no	1			
M	F25C - 55W LED Circular luminaire 1000mm dia 4000K gold 120° to Demilux Intevision 9063 c/w necessary accessories or approved equivalent.	no	1			
N	F25D - 48W LED Circular luminaire 1500mm dia 4000K gold 120° to Demilux Intevision 9063 800 c/w necessary accessories or approved equivalent.	no	1			
O	F26 - 5W LED Pendant luminaire 4000K white to Demilux Intevision MD9017B-300 or approved equivalent, mounted as shown in the drawing.	nos.	3			
P	F27 - 5W LED Pendant luminaire 4000K gold 120° c/w cable to Demilux Intevision 9060 pendant A-1 or approved equivalent, mounted as shown in the drawing.	nos.	5			
Q	F28 - 11x5W LED Chandelier 4000K gold c/w required accessories to Demilux Intevision 9028 square with module B5, mounted as shown in the drawing.	nos.	2			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
A	F31 - 145W LED Pendant luminaire 4000K white to Demilux Intevision MD9058-1200 or approved equivalent, mounted as shown in the drawing.	nos.	4			
B	F40 - 2x3W LED Wall mounted emergency lighting c/w 2hrs battery backup to Maxspid Minnie or approved equivalent, mounted as shown in the drawing.	no	4			
To Collection:						
<p style="text-align: center;"><u>COLLECTION</u></p> <p><u>PAGE</u></p> <p>R/E3 (Page 1/3) - - - - -</p> <p>R/E3 (Page 2/3) - - - - -</p> <p>R/E3 (Page 3/3) - - - - -</p>						
TO R/E3 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
R/E	<p style="text-align: center;"><u>ELECTRICAL INSTALLATION FOR HIGH COMMISSIONER'S RESIDENCE</u></p>					
[4]	<p><u>TELEPHONE AND COMPUTER SYSTEM</u></p> <p><u>Telephone Services Installation</u></p> <p>Supply, install, test and commission telephone system, PABX system and computer system in accordance with the specifications and drawings. All works herein shall be approved TelBru standards. Tenderer shall submit a complete detailed proposal including all equipment offered, catalogues and brochures together with this tender. The equipment and accessories listed below are for tendering purpose. The tenderer is to include all other equipment and accessories not included herein but deemed necessary to the intent of the specifications and requirement. Proposed brands for all the items shall be Dell/Cisco or equivalent.</p> <p>Bidder is to take note that the estimated quantity in this BOQ is for reference only. Bidder shall make necessary allowances and no additional claims will be allowed.</p>					
A	Supply and installation of Wall mounted FAT and ATB c/w suitable Splitters and other necessary accessories including termination, splicing of cables and testing as shown and indicated in the drawing.	lot	1			
B	Telephone point using 4 pair Cat 6 STP cable in concealed pvc conduit/trunking to outlets as shown and indicated in the drawing. Cost to include RJ45 shutter faceplate outlet, utility boxes, etc inclusive of termination at both ends, testing of Cat 6 cable, etc.	nos	12			
	<u>IP Telephony (PABX) System</u>					
C	Supply & Install includes IP Telephony server, IP telephone Gateway user end point Licence. Tenderer must include all the necessary accessories to proper function of PABX network (Cisco or approved equivalent)					
D	Supply and install factory fabricated 22U 19" Wall/Floor mounted equipment rack, fully vented, front safety glass door & lock set, quick release side doors, 8 way power bar, etc. Cost inclusive of patch panels, management panels, other necessary accessories to cater for the above services for PABX Services.					
E	24 Port POE Switch for IP PABX	nos	2			
F	12 Core Rack mount ODF c/w accessories as shown and indicated in the drawing.	lots	2			
G	12 core single mode outdoor type fibre optic cable run in cable trunking for computer backbone structured cabling inclusive of both ends termination and testing as shown in the drawing from and to PABX Racks. Contractor to verify exact length of cable.	lot	1			
H	Operator Level IP Phone	lot	1			
I	Executive Level IP Phone	lot	2			
J	Staff Level IP Phone	lot	12			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
A	Interconnection works for the new PABX equipment and accessories as indicated in the drawings/specification inclusive of all manufacturer specified cable, suitable sized MDF, patchcord, pigtail, adaptors, connectors, and all necessary accessories, etc. This include interlinking works to the other system/services where specified/required (i.e Fire Alarm System, CCTV system, Computer Structure Cabling System) with neccessary works such as programming, calibration, configuring, etc.	lot	1			
B	2c single mode FO cable in concealed conduit for the interconnection between ATB, FAT, modem etc, c/w termination, FO connectors, and other accessories. <u>Computer Network Installation</u>	lot	1			
C	Supply and install factory fabricated 42U 19" wall mounted 1000 x 1000 equipment rack, fully vented, front safety glass door & lock set, quick release side doors, 8 way power bar, etc. Cost inclusive of patch panels, switch panels, management panels, other necessary accessories to cater for the above services.	lot	1			
D	24 core single mode outdoor type incoming fibre optic cable run in telephone pipe duct, trunking/cable tray inclusive of both ends termination/splicing and testing as shown in the drawing from existing TelBru FO Exchange Station to Equipment Rack. Contractor to verify exact length of cable and coordinate with authorities the nearest tapping point works shall be c/w termination, connection, adaptors, joint kits, connectors, and all necessary accessories, etc.	m	1,000			
E	Termination of telecommunication cable at MDF/PABX, FAT, ATB, ODF etc. This include sufficient telephone cable module block, fibre optic termination kits, and label with all necessary accessories, etc.	lot	1			
F	Computer point using 4 pair Cat 6 STP cable in concealed pvc conduit/trunking to outlets as shown and indicated in the drawing. Cost to include RJ45 shutter faceplate outlet, utility boxes, etc inclusive of termination at both ends, testing of Cat 6 cable, etc.	nos	3			
G	Supply and installation of Patch Panel for the above network switch c/w termination and all the necessary accessories.	lot	1			
H	Supply and installation of Cable Management Panel for the above network switch c/w termination and all the necessary accessories.	lot	1			
I	1 meter length factory terminated Cat 6 patch cord for equipment rack.	lot	1			
J	3 meter length factory terminated Cat 6 patch cord for work station.	nos	6			
	<u>Telephone & Computer Ducts</u>					
K	Construct 4 way telephone foot way joint box no. 3 (FJB3) in situ mix on site c/w foot way covers, cable bearers and reinforced concrete work etc to TelBru standard. Indicative location shown in the site plan. All works and materials to TelBru standards.	nos	2			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
A	2 x 100 dia uPVC telephone cable duct encased in concrete c/w nylon pull cables, end caps, laid approx. 1m from ground, asphalt & across drain inclusive of excavation, sand fill, compaction, cutting and reinstatement to approval.	m	60			
B	Allow costs for draw pit of 600 x 600 mm for telephone & fiber cable duct entry to building c/w chequered plate cover, draw rope, 2 way 100 dia uPVC with sealant at both ends as shown in the drawing.	lot	1			
C	Allow cost for taping 2 x 100 dia telephone pipe duct into existing telephone manhole.	lot	1			
D	Comms earthing using 1c/70mm² PVC earth cable c/w earth bar, insulator, heavy duty earth chamber and necessary accessories to achieve 1 ohm or less link to main earthing system	lot	1			
E	Liaison with TelBru or relevant authorities on incoming telephone and fibre optic connection.	lot	1			
To Collection:						
	<p style="text-align: center;"><u>COLLECTION</u></p> <p><u>PAGE</u></p> <p>R/E4 (Page 1/3) - - - - -</p> <p>R/E4 (Page 2/3) - - - - -</p> <p>R/E4 (Page 3/3) - - - - -</p>					
TO R/E4 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
R/E	<u>ELECTRICAL INSTALLATION FOR HIGH COMMISSIONER'S RESIDENCE</u>					
[5]	<u>FIRE PROTECTION SERVICES</u> Supply and install Fire Alarm Devices as per specification and drawings. All fire alarm devices shall be by Multron or equivalent and of approved Bomba Vendors. <u>Self-contained fire alarm devices c/w battery, detector base, etc and other necessary accessories:</u>					
A	Smoke detector <u>Supply and install of fire extinguishers and shall be by SRI or equivalent.</u>	no	6			
B	2.5 kg ABC dry powder extinguisher	no	6			
C	2.5 kg co ₂ fire extinguisher	no	2			
D	Fire blanket	no	6			
To Collection:						
	<u>COLLECTION</u> <u>PAGE</u> R/E5 (Page 1/1) - - - - -					
TO R/E5 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
R/E	<u>ELECTRICAL INSTALLATION FOR HIGH COMMISSIONER'S RESIDENCE</u>					
[6]	<u>MATV SYSTEM</u> Supply and installation of MATV system as per drawings and specifications. Tenderer shall submit a complete detailed system proposal including all equipment offered, catalogues and brochures together with this tender. The equipment and accessories listed below are for tendering purpose. The tenderer is to include all other equipment and accessories not included herein but deemed necessary to the intent of the specifications and requirement. Proposed brands shall be Ikusi/Televes or equivalent.					
	<u>Antennae/Headend, Distribution Equipment and Accessories</u>					
A	RTB Analog and Digital Antennae c/w necessary accessories inclusive steel mounting stand/ supports/ mast.	lot	1			
B	Headend MATV Amplifier c/w necessary accessories	lot	1			
C	Astro 65cm dish w/ Televes Quattro LNBF or equivalent and necessary accessories inclusive steel mounting stand/ supports/ mast.	lot	1			
D	5in, 5out Amplifier to Televes or equivalent	lot	1			
E	5in, 8out/16out Multiswitch to Televes or equivalent	nos	2			
F	IF Tap-Off units to Televes or equivalent	nos	1			
G	Wiring of TV/SAT/FM 2 gang socket outlet by using of 2xRG6 (coaxial) cable in concealed conduit. Proposed brand for RG6 cable shall be Belden or equivalent.	nos	10			
H	Custom-made metal enclosure with hinged door for installation of amplifier and multiswitch c/w accessories.	nos	1			
I	Combiners, connectors and necessary accessories	lot	1			
J	Installation, termination, testing and commissioning for the whole system	lot	1			
	<u>Conduit and Trunking Works</u>					
K	Allow cost for labelling and marking of all cables, tap -off units and splitters.	lot	1			
L	Supply and install hot dipped galvanised heavy duty cable trunking c/w all necessary supports. Trunking covers shall utilise a quarter turn screw. Trunking for shall be of different colour from lighting, power and other services.	lot	1			
M	Supply and install various lengths of 25Ø/32Ø PVC conduit as per drawing and where necessary cast/concealed in wall/slab.	lot	1			
N	Allow cost for the engineering, design proposal, shop drawing and catalogues for approval.	lot	1			
O	Testing and Commissioning of MATV System	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	<p style="text-align: center;"><u>COLLECTION</u></p> <p><u>PAGE</u></p> <p>R/E6 (Page 1/2) - - - - -</p> <p>R/E6 (Page 2/2) - - - - -</p>					
TO R/E6 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
R/E	<u>ELECTRICAL INSTALLATION FOR HIGH COMMISSIONER'S RESIDENCE</u>					
[7]	<u>SECURITY SYSTEM</u> Supply and install card access control system integrated with IP video surveillance system as per drawing and specifications. Tenderer shall submit a complete detailed system proposal including all equipment offered, catalogues and brochures together with this tender. The equipment and accessories listed below are for tendering purpose. The tenderer is to include all other equipment and accessories for proper functioning and operation of the security system to the intent of specification and requirement.					
	<u>Camera System</u> Supply and install indoor and outdoor camera c/w but not limited to the following: i) DVD quality, day/night function, min lux 0.05 lux at F= 1.2 ii) Dual stream MPEG-4 SP video upto 4CIF/30pfs iii) Power over Ethernet (PoE) ready iv) One way audio supported v) QoS enabled (L3) video streaming vi) Backlight compensation vii) Auto iris control, variable focal c/w camera licenses viii) Other features that deemed necessary and required by the Client					
A	Fixed indoor IP mini dome camera to Samsung or equivalent	sets	6			
B	<u>Video Management System Software</u> Video Management System (VMS) software and licenses for efficient viewing, recording, replaying of acquired video/audio complying with requirements and specifications including but not limited to the following functions:- - 4CIF, 30 fps video stream - Health monitoring and analysis functions - Software development kit (SDK) - High level integration with card access system and IP cameras - Single and multi-site support - Support distributed remote viewing and remote storage - Able to export to DVD-RW driver	lot	1			
C	<u>Master Server</u> <u>Minimum Hardware Requirements:-</u> - Operating System: Windows 2003 SP1 <u>Master Server Cont'd</u> - Processor: Intel Pentium 4 or Pentium D or Pentium Xeon, 2.8 GHz Hyper-Thread enabled - Memory: 4 GB	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	<u>Network: 10/100/1000Base-T</u> - DVD R/W Drive: Required - Hard Disk Petitions: C: (Operating System) = 15 GB D: (Database) = 10 GB L: DVD Drive c/w 20" LCD monitor <u>Required Software:</u> - Microsoft SQL Server 2000 with Service Pack 3 or latest - Microsoft Operations Manager 2005 or better - Video Management Software - all other necessary software and licenses and proper management and functioning of IP video surveillance system. <u>Digital Video Recorder</u> Supply and install Recorder Server to Samsung SRN-1670D/470D or equivalent c/w external Raid 5 hot-swappable SATA hard disk array for recording and viewing of video images and which support minimum 15 channel recording at Full D1 at 30 fps. Disk array to be sized for fulltime recording for 30 days based on minimum 12.5 fps (at MPEG 4, CIF-4kb) for 15 no of IP cameras <u>Minimum Hardware Requirements:-</u> Operating System: Windows 2003 SP1, Windows XP SP2 Processor: Intel Pentium 4 or Pentium D or Pentium Xeon, 2.8 GHz Memory: 4 GB Network: 10.100/1000 Base-T DVD reader drive: Required C: (Operating System) = 15 GB D: (Database) = 10 GB L: DVD Drive c/w 20" high resolution LCD monitors	Inclus ive				
A	Allow for necessary management software, operation system software and licenses for recorder server for proper management of larger-scale distributed video operations as specified	lot	1			
	<u>Network Devices</u>					
B	24 port network switch with 24 port 10/100 Base-T PoE ready Ethernet interface modules & 1x1000 Base-T module	no	1			
C	Network patch panels as required	lot	1			
D	Redundant power supply units, chasis fan, patch chords all necessary accessories required	lot	1			
E	Allow for all necessary management software for configuration of the switches and accessories	lot	1			
F	22U 19" equipment rack to house the CCTV equipment c/w all necessary accessories.	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
A	Supply and install of CAT 6 STP cabling of approved make, inclusive of conduit, trunking where required (average length 70m) from security equipment racks to camera points - ceiling of wall mounted.	nos	15			
B	Allow for CAT 6 patch chords from patch panels to the network devices (including network and distribution switches)	lot	1			
C	Cost & expenses for complete configuration, testing and commissioning of the transmission system to the satisfaction of consulting engineers and client.	lot	1			
D	Allow cost for the engineering, design proposal, shop drawing and catalogues for approval.	lot	1			
To Collection:						
	<p style="text-align: center;"><u>COLLECTION</u></p> <p><u>PAGE</u></p> <p>R/E7 (Page 1/3) - - - - -</p> <p>R/E7 (Page 2/3) - - - - -</p> <p>R/E7 (Page 3/3) - - - - -</p>					
TO R/E7 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
R/E	<u>ELECTRICAL INSTALLATION FOR HIGH COMMISSIONER'S RESIDENCE</u>					
[8]	<u>LIGHTNING PROTECTION SYSTEM</u> Supply, Install, Testing and Commissioning of the following including all necessary termination/fixing accessories as per drawing of Electrical Services and specifications:- Bidder is to take note that the estimated quantity in this BOQ is for reference only. Bidder shall make necessary allowances and no additional claims will be allowed.					
A	Air termination rod c/w the base. Make: D.E.S approved brand.	nos.	6			
B	25 x 3mm bare copper tape horizontal conductor c/w fixing accessories (saddle screws, square clamp, etc) run on roof level.	m	250			
C	1C x 70mm ² down conductor in 50mm dia. uPVC conduit chased in wall/column. Make: D.E.S approved brand.	m	120			
D	Oblong test joint clamp c/w recessed w/p termination box. Make: D.E.S approved brand.	nos.	6			
E	Earthing pit c/w copperbond earth rod & H.D. cover. Make: D.E.S approved brand.	set	6			
F	Testing and commissioning of lightning protection system.	lot	1			
To Collection:						
	<u>COLLECTION</u> <u>PAGE</u> R/E8 (Page 1/1) - - - - -					
TO R/E8 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
R/E	<u>ELECTRICAL INSTALLATION FOR HIGH COMMISSIONER'S RESIDENCE</u>					
[9]	<u>EXTERNAL WORKS</u> <u>LV Reticulation Mains</u> Supply and install submain cables as per drawings & specification. Cost of hot dipped galvanised cable ladder, tray, trunking, required shall be included in the pricing of cable. The size of cable ladder/cable tray and containment provided shall be adequate for cable spacings factor as per latest EIR and IEE Regulations. Rates of cable laid underground shall include cost of trench excavation, sand bedding, pipesleeves, protective tile and reinstatement. Rates for cables shall be inclusive of cable identification tags at 10m intervals and at every bend. Cost quoted to be inclusive of termination of all incoming and outgoing cables including cable glands, lugs, etc as per drawing and specifications. Bidder is to take note that the estimated quantity in this BOQ is for reference only. Bidder shall make necessary allowances and no additional claims will be allowed.					
A	1x4c/95mm ² XLPE/SWA/PVC cable laid underground as per the DES specifications, c/w necessary pipesleeves and cable tray/trunking from the existing Feeder Pillar to SSB-RS. <u>Miscellaneous and Related Works</u>	lot	1			
B	Allow miscellaneous cost for concrete encased pipesleeves of 150mm dia for all road crossing, pipe jacking, hard standing areas, returfing, refurbishment and making good of existing ground.	lot	1			
C	Allow miscellaneous cost for providing floor openings, pipe sleeves through RC beams & slabs, fire stop barrier, fire seal pillows, etc for passage of sub-main cables, lighting and power wiring, telephone & computer system, fire alarm & fire protection system, water services, aircon services and other disciplines.	lot	1			
D	Allow cost for liaison with Authorities regarding power supply application and energization of the system. <u>Upgrading Works (if required)</u>	lot	1			
E	Allow cost for the upgrading of the existing substation inclusive of necessary and required materials. Cost to include liason to authorities and nearby residences.	lot	1			
F	Supply, install and commissioning of 500 kVA 11kV/433V outdoor type Distribution Transformer c/w all necessary accessories to DES specification ref: DES/11KV/TRF/REV '0' dated 26-7-1997.	lot	1			
G	800A Outdoor type 433V 3 Phase 50Hz Low Voltage Distribution Feeder Pillar as per DES Specification.	lot	1			
H	4x1c/500mm ² XLPE/AWA/PVC cable from transformer to MFP laid underground.	m	15			
I	Equipment body earthing system c/w necessary accessories to achieve below 1 ohm (for MFP, RMU & Transformer)	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
A	Transformer neutral earthing using 2x120mm ² PVC earth cable c/w heavy duty earth chamber and necessary accessories to achieve 1 ohm or less link to main earthing system.	lot	1			
To Collection:						
	<p style="text-align: center;"><u>COLLECTION</u></p> <p><u>PAGE</u></p> <p>R/E9 (Page 1/2) - - - - -</p> <p>R/E9 (Page 2/2) - - - - -</p>					
TO R/E9 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
R/E	<u>ELECTRICAL INSTALLATION FOR HIGH COMMISSIONER'S RESIDENCE</u>					
[10]	<u>STANDBY DIESEL GENERATOR SET</u>					
	Supply, install, test and commission the standby generator system as per below mentioned specification.					
	<u>Generator</u>					
A	Standby generator set of 200 kVA capacity at 0.8 power factor, 415V 3 phase, 50Hz (prime - rating), less noise type c/w the following : - skid base fuel tank type (minimum 8 hours backup) - fabricated steel underframe - diesel engine c/w accessories - alternator c/w AVR - radiator - electronic governor - flexible connection to fuel piping and flexible below for connection to exhaust piping - Meters for water temperature, oil pressure, oil temperature, tachometer hour run - 2 nos starter motors - diesel fuel, oil, water and air filters - safety overspeed, high water temperature, low oil pressure trip and alarm devices - guards of all moving parts and all necessary labelling and name plates - anti vibration mounting pads - rate to include cable terminations, glands and lugs	lot	1			
	<u>Batteries</u>					
B	Lead acid batteries c/w a non ferrous battery rack, interconnecting links, terminal shrouds and flexible cable tails to connect the battery to the starter. The battery should be sized for 6 successive starts of 6 seconds each with a 15 seconds rest period.	lot	1			
	<u>AMF Switchboard</u>					
C	Automatic mains failure switchboard of metalclad enclosure, floor standing to specification with front and rear access and complete with but not limited to the following : - 1 x 250A 4P MCCB/ACB - main - External O/C & E/F protection of MCCB/ACB - Voltmeter c/w a selector switch - Ammeter c/w a selector switch - KWH, power factor, hour run and frequency meter - Mains available and generator available indicating lights - Battery charger c/w boost/trickle charger selector - Battery voltmeter and ammeter - Indicator lamps for operation of engine and controls protective devices - Selector switch for "Off" "Auto" "Manual" and "Test" - Push buttons for start/stop/alarm, cancel/lamp test/reset - Alarm siren - Contacts for remote monitoring	lot	1			
To Collection:					-	

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	<u>AMF Switchboard Cont'd</u> - Control relays, timer, under voltage sensing relay, low battery, voltage relay, etc to effect automatic main failure sensing and control of the generator - Cable termination plate, lugs and glands - Rates for switchboards to include cost for cable termination at the board - All necessary labels <u>Exhaust System</u> A Radiator exhaust ducting c/w a flexible canvas section to connect the radiator to the discharge shaft. The ducting should be provided with an access hatch for cleaning out and should be constructed in accordance with BS DW142 with 1.2 mm thick galvanised sheet steel. The ducting should be reinforced with angle iron brackets. B Residential type exhaust silencer and piping using BS3601 pipes with welded joints c/w necessary spring isolation supports. C Allow cost of necessary inlet air attenuator and outlet air attenuator/silencer as per manufacturer's recommendation. D Exhaust piping to be lagged with 50mm thick sectional rock wool and clad with a 0.6mm thick stainless steel. E The discharge outlet shall be angled at 30 degree and provided with an anti vermin mesh. Where the exhaust pipes penetrate through the building structure, a G.I. sleeve shall be provided. F The sleeves shall be one pipe diameter larger than the exhaust pipe and space between the sleeved and pipe packed with rock wool and sealed with a rock wool and sealed with a non setting heat resistant compound. <u>Power and Control Wiring</u> Bidder is to take note that the estimated quantity in this BOQ is for reference only. Bidder shall make necessary allowances and no additional claims will be allowed. G 4C/120mm ² XLPE/SWA/PVC on cable laid underground as per the DES specifications, c/w necessary pipesleeves and cable tray/trunking from the existing Feeder Pillar to SSB-RS. H Multicore control cable 5c/2.5mm ² between the generator and the AMF panel laid on tray & power supply sensing cable from AMF to SSB-RS. <u>Earthing System</u> I Neutral earthing using 2 x 120 mm ² PVC earth cable c/w earth chamber and necessary accessories to achieve below 1 ohm. J Frame earthing using 70 mm ² PVC earth cable linking the generator, AMF panel, fuel tank frame in ring formation to earth rods in earth chamber to achieve the earthing value as per DES requirements. K 1m wide x 6mm thick rubber along the front and back of the AMF panel. L Provide a framed schematic and control drawing in the genset room.	lot	1			
		lot	1			
		lot	1			
		lot	1			
		inclusive	-			
		inclusive	-			
		m	100			
		lot	1			
		lot	1			
		lot	1			
		lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
A	Allow cost for mild steel checkered plate with anti-rust painting finish covering all HV and LV electrical trenches, genset trenches, etc that is within this contract. Contractor to propose plate arrangements.	lot	1			
To Collection:						
	<p style="text-align: center;"><u>COLLECTION</u></p> <p><u>PAGE</u></p> <p>R/E10 (Page 1/3) - - - - -</p> <p>R/E10 (Page 2/3) - - - - -</p> <p>R/E10 (Page 3/3) - - - - -</p>					
TO R/E10 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
TUC	<u>TESTS UPON COMPLETION</u>					
A	<p>Cost and expenses for the complete acceptance testing and commissioning of the entire M&E Services Installation to the satisfaction of the consulting engineers and authority.</p> <p>A complete testing and commissioning reports and test data shall be provided and documented for submission. Cost shall include all expenses for plant, tools, test instrument and agents, electricity, water, and factory's commissioning expenses for major equipment and relevant authorities inspection fees.</p> <p>The complete system testing and commissioning and documentation shall cover the entire installation under this contract but not limited to the following:</p> <ul style="list-style-type: none">- Main Switchboard and Control Panels- Air Conditioning System- Exhaust & Ventilation System- Electrical System- Fire Detection & Protection System- Telecommunication System- MATV System- Access Control & CCTV System- Specialist System- and all other works associated with other M&E services installation and works covered in main contract <p><u>Contract Comprehensive Maintenance</u></p>	lot	1			
B	<p>Provide all-in comprehensive and routine maintenance for the whole of Mechanical and Electrical Services Installation covering the twelve (12) months defect liability period or as stipulated in the contract including replacement of wear and tear and consumable parts.</p> <p>The contractor is required to produce record of monthly maintenance log sheets and trend log data of the entire system installation for record and for sign off by client for maintenance works performed.</p> <p><u>Submissions</u></p>	lot	1			
C	Submit design calculations and engineering drawings for major equipments, M&E services shop drawings coordinated with other services for review/ approval.	lot	1			
D	Submit necessary samples for review/ approval and display at site office where appropriate.	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
A	<u>As-Built Drawings and O&M Manual</u> Submit six (6) sets of hard copies final as-built record drawings, equipment engineering drawings properly bound in folder files along with soft copies and O&M manual and necessary parts replacements as recommended by manufacturer. Costs shall include spare parts lists of the major equipments, components and consumables.	lot	1			
	<u>List of O&M Manual</u> (A) Air -conditioning and Mechanical Ventilaiton (i) Equipment (ii) Pipe work (iii) Duct work (iv) Diffusers, grilles and dampers (B) Fire protection (C) Plumbing (D) Electrical (E) Telecommunication (F) Specialist Services <u>Content of O&M Manuals</u> a) SOP (normal operation, service, breakdown, emergency) b) Catalogues and technical literature c) Maintenance Schedule and checklist d) As-Built Drawings e) Consumables and spare parts list f) Contact Person in case of emergency g) Coordinated Drawings /Schematic diagram/ IO list points h) Equipment certificate / calibration certificated / warning i) T&C report document					
To Collection:						
	<p style="text-align: center;"><u>COLLECTION</u></p> <p><u>PAGE</u></p> <p>TUC/1 - - - - -</p> <p>TUC/2 - - - - -</p>					
TO TUC (8A) SUMMARY:						

BILL 8B

(CHANCERY, NON-RG & RG)

Section	Description	Bill No.	Amount	
			\$	c
BILL 8B	<p><u>SUMMARY OF PRICES OF M&E WORKS FOR CHANCERY, STAFF RESIDENCES AND AUXILIARY FACILITIES BUILDING</u></p> <p><u>CHANCERY</u></p> <p>CH/M <u>Mechanical Services</u></p> <p>[1] EQUIPMENT</p> <p>[2] PIPEWORK</p> <p>[3] DUCTWORK</p> <p>[4] DIFFUSERS, GRILLES & DAMPERS</p> <p>[5] ELECTRICAL</p> <p>[6] FIRE HOSE REEL</p> <p>[7] POOL POND</p> <p>[8] PLUMBING</p> <p>CH/E <u>Electrical Services</u></p> <p>[1] SWITCHBOARDS AND DISTRIBUTION BOARDS</p> <p>[2] LV RETICULATION MAINS</p> <p>[3] GENERAL LIGHTING AND POWER SERVICES</p> <p>[4] LIGHT FITTINGS AND ACCESSORIES</p> <p>[5] TELEPHONE AND COMPUTER SYSTEM</p> <p>[6] CONVENTIONAL FIRE ALARM SYSTEM</p> <p>[7] STANDBY DIESEL GENERATOR SET</p> <p>[8] HT CABLES AND RELATED EQUIPMENT</p> <p>[9] PA SYSTEM</p> <p>[10] MATV SYSTEM</p> <p>[11] SECURITY SYSTEM</p> <p>[12] LIGHTNING PROTECTION SYSTEM</p> <p>[13] EXTERNAL WORKS</p> <p>CH/L <u>Lift Services</u></p> <p>[1] LIFT SERVICES INSTALLATION</p> <p><u>NON-REPRESENTATIONAL GRADE (BLOCK A)</u></p> <p>NRG/M <u>Mechanical Services</u></p> <p>[1] EQUIPMENT</p> <p>[2] PIPEWORK</p> <p>[3] ELECTRICAL</p> <p>NRG/E <u>Electrical Services</u></p> <p>[1] SWITCHBOARDS and LV RETICULATION MAINS</p> <p>[2] GENERAL LIGHTING and POWER SERVICES</p> <p>[3] LIGHT FITTINGS and ACCESSORIES</p> <p>[4] TELEPHONE SYSTEM</p> <p>[5] FIRE ALARM SYSTEM</p> <p>[6] MATV SYSTEM</p> <p>[7] LIGHTNING PROTECTION SYSTEM</p> <p>[8] TESTS UPON COMPLETION</p> <p>NRG/L <u>Lift Services</u></p> <p>[1] LIFT SERVICES INSTALLATION</p>			
TOTAL CARRIED FORWARD TO NEXT PAGE :				

Section	Description	Bill No.	Amount	
			\$	c
	TOTAL CARRIED FORWARD FROM PREVIOUS PAGE :			
	<u>REPRESENTATIONAL GRADE (BLOCK B)</u>			
RG/M	<u>Mechanical Services</u>			
[1]	EQUIPMENT			
[2]	PIPEWORK			
[3]	ELECTRICAL			
RG/E	<u>Electrical Services</u>			
[1]	SWITCHBOARDS and LV RETICULATION MAINS			
[2]	GENERAL LIGHTING and POWER SERVICES			
[3]	LIGHT FITTINGS and ACCESSORIES			
[4]	TELEPHONE SYSTEM			
[5]	FIRE ALARM SYSTEM			
[6]	MATV SYSTEM			
[7]	SECURITY SYSTEM			
[8]	LIGHTNING PROTECTION SYSTEM			
TUC	<u>Tests Upon Completion</u>			
TO M&E SUMMARY PAGE (BILL 8B) :				

MECHANICAL SERVICES
(BILL OF QUANTITIES)

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
CH/M	<u>MECHANICAL SERVICES FOR CHANCERY</u>					
[1]	<u>EQUIPMENT</u>					
	<p>DUCTED DX SPLIT SYSTEM (Carrier or approved equivalent) Supply, installation, testing and commissioning of the Air Conditioning System as shown and indicated in the drawing. All material supply & works carry out shall be as per DES requirements and approved vendors products.</p> <p>Rate quoted shall be inclusive of supply and termination of all power and control cables to equipment including necessary cable, glands, lugs, earthing, conduit/ HDGS cable tray and other necessary accessories.</p> <p>Air Cooled Split Conditioning system consisting of AHU and matching air cooled condensing unit compressor shall be fully inverter type) c/w sight glass, refrigerant & oil, refrigerant filter, brackets and supports, power & control wiring and other necessary accessories as specified and as shown in the drawing.</p> <p>Outdoor condition: 34.0 deg C/28.5 deg C DB/WB Indoor condition: 22.0 deg C DB, +/- 1 deg C, 55% +/-5% RH please refer to technical specifications</p>					
A	<p>Air Handling Unit (AHU-1) Air flow capacity: 5,516 L/S (19,867 CMH) Total static pressure: 610 Pa (indicative only) Total coil load: 112.2 KW Total sensible load: 79.8 KW</p>	set	1			
B	Matching Air Cooled Condensing Unit	set	1			
C	<p>Air Handling Unit (AHU-2) Air flow capacity: 3,773 L/S (13,589 CMH) Total static pressure: 623 Pa (indicative only) Total coil load: 63.6 KW Total sensible load: 51.8 KW</p>	set	1			
D	Matching Air Cooled Condensing Unit	set	1			
E	<p>Ducted Fan coil Unitt (DFCU-G) Air flow capacity: 1266 L/S (4560CMH) Total static pressure: 623 Pa (indicative only) Total coil load: 22 KW Total sensible load: 16.6 KW</p>	set	1			
F	Matching Air Cooled Condensing Unit	set	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	<p><u>INVERTER MULTI SYSTEM (Carrier or approved equivalent)</u></p> <p>Air Cooled Condensing Unit (CU) shall be floor mounted type, each unit shall have a minimum of 2 compressors per module and all compressors shall be fully inverter type and completely possible to operate at ranges of partial loads. Compressors shall be reliable twin rotary type with DC motors. condenser fan motor shall be high efficiency DC motor capable of operating at 32 different steps. Condensers shall be copper tube and aluminum-type. The outdoor unit shall be able to handle equivalent pipe lengths up to 235 meters. Fan Coil Unit (FCU) complete with air filter and all necessary accessories for satisfactory operation.</p> <p>Outdoor condition: 34.0 deg C/28.5 deg C DB/WB Indoor condition: 22.0 deg C DB, +/- 1 deg C, 55% +/-5% RH please refer to technical specifications</p> <p><u>OUTDOOR CONDENSING UNIT</u> RATING CAPACITY</p> <p>A VRF-G1 (40.1 KW) set 1</p> <p>B VRF-G2 (55.5 KW) set 1</p> <p>C VRF-F1 (54.6 KW) set 1</p> <p>D VRF-F2 (47.6 KW) set 1</p> <p><u>INVERTER TYPE FAN COIL UNITS</u> Inclusive of remote THERMOSTAT control unit Cassette (Ceiling Mounted Type Unit)</p> <p>RATING CAPACITY</p> <p>E FCU-G1.1 (4.0 KW) no 1</p> <p>F FCU-G1.2 (4.0 KW) no 1</p> <p>G FCU-G1.3 (1.5 KW) no 1</p> <p>H FCU-G1.4 (4.8 KW) no 1</p> <p>I FCU-G1.5 (4.8 KW) no 1</p> <p>J FCU-G1.6 (3.4 KW) no 1</p> <p>K FCU-G1.7 (0.8 KW) no 1</p> <p>L FCU-G1.8 (2.7 KW) no 1</p> <p>M FCU-G1.9 (5.4 KW) no 1</p>					
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	<u>INVERTER TYPE FAN COIL UNITS (CONTINUED)</u>					
A	FCU-G1.10 (5.4 KW)	no	1			
B	FCU-G1.11 (3.1KW)	no	1			
C	FCU-G2.1 (0.9 KW)	no	1			
D	FCU-G2.2 (6.7 KW)	no	1			
E	FCU-G2.3 (8.9 KW)	no	1			
F	FCU-G2.4 (8.6 KW)	no	1			
G	FCU-G2.5 (5.8 KW)	no	1			
H	FCU-G2.6 (5.8 KW)	no	1			
I	FCU-G2.7 (7.5 KW)	no	1			
J	FCU-G2.8 (11.3 KW)	no	1			
K	FCU-G2.9 (11 KW)	no	1			
L	FCU-F1.1 (2.5 KW)	no	1			
M	FCU-F1.2 (3.7 KW)	no	1			
N	FCU-F1.3 (3.7 KW)	no	1			
O	FCU-F1.4 (3.1 KW)	no	1			
P	FCU-F1.5 (7.2KW)	no	1			
Q	FCU-F1.6 (3.6 KW)	no	1			
R	FCU-F1.7 (3.3 KW)	no	1			
S	FCU-F1.8 (2.6 KW)	no	1			
T	FCU-F1.9 (3.3 KW)	no	1			
U	FCU-F1.10 (5.3 KW)	no	1			
V	FCU-F1.11 (5.3 KW)	no	1			
W	FCU-F1.12 (10.9 KW)	no	1			
X	FCU-F2.1 (10.1 KW)	no	1			
Y	FCU-F2.2 (3.3 KW)	no	1			
Z	FCU-F2.3 (5.9 KW)	no	1			
AA	FCU-F2.4 (5.4 KW)	no	1			
AB	FCU-F2.5 (5.4 KW)	no	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	<u>INVERTER TYPE FAN COIL UNITS (CONTINUED)</u>					
A	FCU-F2.6 (5.9 KW)	no	1			
B	FCU-F2.7 (4.0 KW)	no	1			
C	FCU-F2.8 (4.0 KW)	no	1			
D	FCU-F2.9 (3.6 KW)	no	1			
E	CONTINGENCY SUM				15,000.00	
	DX-Split Air Conditioning system consisting of fan coil unit (Cassette Type) and matching air cooled condensing unit, refrigerant, brackets and supports, power & control wiring and other necessary accessories as specified and as shown in the drawing.					
F	FCU/CU-G (11.0 KW)	set	1			
G	FCU/CU-GH (2.6 KW)	sets	2			
To Collection:						
	<u>COLLECTION</u>					
	<u>PAGE</u>					
	CH./M1 (page 1/4) - - - - -	-	-	-		
	CH./M1 (page 2/4) - - - - -	-	-	-		
	CH./M1 (page 3/4) - - - - -	-	-	-		
	CH./M1 (page 4/4) - - - - -	-	-	-		
TO CH/M1 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
CH/M	<u>MECHANICAL SERVICES FOR CHANCERY</u>					
[2]	<u>PIPEWORK</u>					
	<u>REFRIGERANT PIPEWORK</u>					
	Solid drawn copper tube c/w 20mm thick THERMAL insulation and white PVC Denso wrap tape encased in heavy duty PVC impact resistant industrial trunking, fittings, liquid line solenoid valves, TX valves, sight glasses and filter driers, supports, brackets and as specified. All systems to be pressure tested, evacuated and dehydrated before charging with refrigerant. (where two refrigerant lines system is offered Tenderer is to price for the 2 lines accordingly). Testing, evacuation and dehydration of both refrigeration systems, before charging with refrigerant, and include initial refrigerant charge. Note : All test pressures and evacuation pressures to be submitted in type written form to the Engineer.					
	<u>REFRIGERANT PIPE</u>					
	<u>(DX SYSTEM)</u>					
A	AHU-1/CU-1	lot	1			
B	AHU-2/CU-2	lot	1			
C	DFCU-G	lot	1			
D	FCU/CU-G	lot	1			
	<u>(INVERTER SYSTEM)</u>					
	MAIN LINE					
E	VRF-G1 9 (40.1 KW)	lot	1			
F	VRF-G2 (55.5 KW)	lot	1			
G	VRF-F1 (54.6 KW)	lot	1			
H	VRF-F2 (47.6 KW)	lot	1			
	BRANCH LINE					
I	FCU-G1.1 (4.0 KW)	lot	1			
J	FCU-G1.2 (4.0 KW)	lot	1			
K	FCU-G1.3 (1.5 KW)	lot	1			
L	FCU-G1.4 (4.8 KW)	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
A	FCU-G1.5 (4.8 KW)	lot	1			
B	FCU-G1.6 (3.4 KW)	lot	1			
C	FCU-G1.7 (0.8 KW)	lot	1			
D	FCU-G1.8 (2.7 KW)	lot	1			
E	FCU-G1.9 (5.4 KW)	lot	1			
F	FCU-G1.10 (3.1 KW)	lot	1			
G	FCU-G1.11 (4.0 KW)	lot	1			
H	FCU-G2.1 (0.9 KW)	lot	1			
I	FCU-G2.2 (11.6 KW)	lot	2			
J	FCU-G2.3 (8.9 KW)	lot	1			
K	FCU-G2.4 (8.6 KW)	lot	1			
L	FCU-G2.5 (5.8 KW)	lot	1			
M	FCU-G2.6 (5.8 KW)	lot	1			
N	FCU-G2.7 (7.5 KW)	lot	1			
O	FCU-G2.8 (4.3 KW)	lot	1			
P	FCU-F1.1 (2.5 KW)	lot	1			
Q	FCU-F1.2 (3.7 KW)	lot	1			
R	FCU-F1.3 (3.7 KW)	lot	1			
S	FCU-F1.4 (3.1 KW)	lot	1			
T	FCU-F1.5 (7.2KW)	lot	1			
U	FCU-F1.6 (3.6 KW)	lot	1			
V	FCU-F1.7 (3.3 KW)	lot	1			
W	FCU-F1.8 (2.6 KW)	lot	1			
X	FCU-F1.9 (3.3 KW)	lot	1			
Y	FCU-F1.10 (5.3 KW)	lot	1			
Z	FCU-F1.11 (5.3 KW)	lot	1			
AA	FCU-F1.12 (10.9 KW)	lot	1			
AB	FCU-F2.1 (10.1 KW)	lot	1			
AC	FCU-F2.2 (3.3 KW)	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	BRANCH LINE (CONTINUED)					
A	FCU-F2.3 (5.9 KW)	lot	1			
B	FCU-F2.4 (5.4 KW)	lot	1			
C	FCU-F2.5 (5.4 KW)	lot	1			
D	FCU-F2.6 (5.9 KW)	lot	1			
E	FCU-F2.7 (4.0 KW)	lot	1			
F	FCU-F2.8 (4.0 KW)					
G	FCU-F2.9 (3.6 KW)	lot	1			
	<u>VRF DISTRIBUTION JOINT KITS</u>	lot	1			
H	VRF-G1 9 (40.1 KW)	lot	1			
I	VRF-G2 (55.5 KW)	lot	1			
J	VRF-F1 (54.6 KW)	lot	1			
K	VRF-F2 (47.6 KW)	lot	1			
L	FCU-G1.1 (4.0 KW)	lot	1			
M	FCU-G1.2 (4.0 KW)	lot	1			
N	FCU-G1.3 (1.5 KW)	lot	1			
O	FCU-G1.4 (4.8 KW)	lot	1			
P	FCU-G1.5 (4.8 KW)	lot	1			
Q	FCU-G1.6 (3.4 KW)	lot	1			
R	FCU-G1.7 (0.8 KW)	lot	1			
S	FCU-G1.8 (2.7 KW)	lot	1			
T	FCU-G1.9 (5.4 KW)	lot	1			
U	FCU-G1.10 (5.4 KW)	lot	1			
V	FCU-G1.11 (4.0KW)	lot	1			
W	FCU-G2.1 (0.9 KW)	lot	1			
X	FCU-G2.2 (11.6 KW)	lot	2			
Y	FCU-G2.3 (8.9 KW)	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	<u>VRF DISTRIBUTION JOINT KITS (CONTINUED)</u>					
A	FCU-G2.4 (8.6 KW)	lot	1			
B	FCU-G2.5 (5.8 KW)	lot	1			
C	FCU-G2.6 (5.8 KW)	lot	1			
D	FCU-G2.7 (7.5 KW)	lot	1			
E	FCU-G2.8 (11.3 KW)	lot	1			
F	FCU-F1.1 (2.5 KW)	lot	1			
G	FCU-F1.2 (3.7 KW)	lot	1			
H	FCU-F1.3 (3.7 KW)	lot	1			
I	FCU-F1.4 (3.1 KW)	lot	1			
J	FCU-F1.5 (7.2KW)	lot	1			
K	FCU-F1.6 (3.6 KW)	lot	1			
L	FCU-F1.7 (3.3 KW)	lot	1			
M	FCU-F1.8 (2.6 KW)	lot	1			
N	FCU-F1.9 (3.3 KW)	lot	1			
O	FCU-F1.10 (5.3 KW)	lot	1			
P	FCU-F1.11 (5.3 KW)	lot	1			
Q	FCU-F1.12 (10.9 KW)	lot	1			
R	FCU-F2.1 (10.1 KW)	lot	1			
S	FCU-F2.2 (3.3 KW)	lot	1			
T	FCU-F2.3 (5.9 KW)	lot	1			
U	FCU-F2.4 (5.4 KW)	lot	1			
V	FCU-F2.5 (5.4 KW)	lot	1			
W	FCU-F2.6 (5.9 KW)	lot	1			
X	FCU-F2.7 (4.0 KW)	lot	1			
Y	FCU-F2.8 (4.0 KW)	lot	1			
Z	FCU-F2.9 (3.6 KW)	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	<u>SOLENOID VALVE KITS</u>					
A	VRF-G1 9 (40.1 KW)	lot	1			
B	VRF-G2 (55.5 KW)	lot	1			
C	VRF-F1 (54.6 KW)	lot	1			
D	VRF-F2 (47.6 KW)	lot	1			
E	FCU-G1.1 (4.0 KW)	lot	1			
F	FCU-G1.2 (4.0 KW)	lot	1			
G	FCU-G1.3 (1.5 KW)	lot	1			
H	FCU-G1.4 (4.8 KW)	lot	1			
I	FCU-G1.5 (4.8 KW)	lot	1			
J	FCU-G1.6 (3.4 KW)	lot	1			
K	FCU-G1.7 (0.8 KW)	lot	1			
L	FCU-G1.8 (2.7 KW)	lot	1			
M	FCU-G1.9 (5.4 KW)	lot	1			
N	FCU-G1.10 (5.4 KW)	lot	1			
O	FCU-G1.11 (4.0KW)	lot	1			
P	FCU-G2.1 (0.9 KW)	lot	1			
Q	FCU-G2.2 (11.6 KW)	lot	2			
R	FCU-G2.3 (8.9 KW)	lot	1			
S	FCU-G2.4 (8.6 KW)	lot	1			
T	FCU-G2.5 (5.8 KW)	lot	1			
U	FCU-G2.6 (5.8 KW)	lot	1			
V	FCU-G2.7 (7.5 KW)	lot	1			
W	FCU-G2.8 (11.3 KW)	lot	1			
X	FCU-F1.1 (2.5 KW)	lot	1			
Y	FCU-F1.2 (3.7 KW)	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	<u>SOLENOID VALVE KITS (CONTINUED)</u>					
A	FCU-F1.3 (3.7 KW)	lot	1			
B	FCU-F1.4 (3.1 KW)	lot	1			
C	FCU-F1.5 (7.2KW)	lot	1			
D	FCU-F1.6 (3.6 KW)	lot	1			
E	FCU-F1.7 (3.3 KW)	lot	1			
F	FCU-F1.8 (2.6 KW)	lot	1			
G	FCU-F1.9 (3.3 KW)	lot	1			
H	FCU-F1.10 (5.3 KW)	lot	1			
I	FCU-F1.11 (5.3 KW)	lot	1			
J	FCU-F1.12 (10.9 KW)	lot	1			
K	FCU-F2.1 (10.1 KW)	lot	1			
L	FCU-F2.2 (3.3 KW)	lot	1			
M	FCU-F2.3 (5.9 KW)	lot	1			
N	FCU-F2.4 (5.4 KW)	lot	1			
O	FCU-F2.5 (5.4 KW)	lot	1			
P	FCU-F2.6 (5.9 KW)	lot	1			
Q	FCU-F2.7 (4.0 KW)	lot	1			
R	FCU-F2.8 (4.0 KW)	lot	1			
S	FCU-F2.9 (3.6 KW)	lot	1			
	<u>BALL VALVE AND FITTINGS</u>					
T	VRF-G1 9 (40.1 KW)	lot	1			
U	VRF-G2 (55.5 KW)	lot	1			
V	VRF-F1 (54.6 KW)	lot	1			
W	VRF-F2 (47.6 KW)	lot	1			
X	FCU-G1.1 (4.0 KW)	lot	1			
Y	FCU-G1.2 (4.0 KW)	lot	1			
Z	FCU-G1.3 (1.5 KW)	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	<u>BALL VALVE AND FITTINGS (CONTINUED)</u>					
A	FCU-G1.4 (4.8 KW)	lot	1			
B	FCU-G1.5 (4.8 KW)	lot	1			
C	FCU-G1.6 (3.4 KW)	lot	1			
D	FCU-G1.7 (0.8 KW)	lot	1			
E	FCU-G1.8 (2.7 KW)	lot	1			
F	FCU-G1.9 (5.4 KW)	lot	1			
G	FCU-G1.10 (5.4 KW)	lot	1			
H	FCU-G1.11 (3.1KW)	lot	1			
I	FCU-G2.1 (0.9 KW)	lot	2			
J	FCU-G2.2 (6.7 KW)	lot	1			
K	FCU-G2.3 (8.9 KW)	lot	1			
L	FCU-G2.4 (8.6 KW)	lot	1			
M	FCU-G2.5 (5.8 KW)	lot	1			
N	FCU-G2.6 (5.8 KW)	lot	1			
O	FCU-G2.7 (7.5 KW)	lot	1			
P	FCU-G2.8 (11.3 KW)	lot	1			
Q	FCU-F1.1 (2.5 KW)	lot	1			
R	FCU-F1.2 (3.7 KW)	lot	1			
S	FCU-F1.3 (3.7 KW)	lot	1			
T	FCU-F1.4 (3.1 KW)	lot	1			
U	FCU-F1.5 (7.2KW)	lot	1			
V	FCU-F1.6 (3.6 KW)	lot	1			
W	FCU-F1.7 (3.3 KW)	lot	1			
X	FCU-F1.8 (2.6 KW)	lot	1			
Y	FCU-F1.9 (3.3 KW)	lot	1			
Z	FCU-F1.10 (5.3 KW)	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	<u>BALL VALVE AND FITTINGS (CONTINUED)</u>					
A	FCU-F1.11 (5.3 KW)	lot	1			
B	FCU-F1.12 (10.9 KW)	lot	1			
C	FCU-F2.1 (10.1 KW)	lot	1			
D	FCU-F2.2 (3.3 KW)	lot	1			
E	FCU-F2.3 (5.9 KW)	lot	1			
F	FCU-F2.4 (5.4 KW)	lot	1			
G	FCU-F2.6 (5.9 KW)	lot	1			
H	FCU-F2.7 (4.0 KW)	lot	1			
I	FCU-F2.8 (4.0 KW)	lot	1			
J	FCU-F2.9 (3.6 KW)	lot	1			
	CONDENSATE DRAIN PIPE 20mm dia. pipes (unless otherwise specified) to BS 3505 Class D c/w 15mm thick insulation concealed within walls and run in HD UPVC trunking c/w traps, fittings, brackets and supports.					
K	<u>AHU-1/CU-1</u>	lot	1			
L	<u>AHU-2/CU-2</u>	lot	1			
M	<u>DFCU-G</u>	lot	1			
N	<u>FCU/CU-G</u>	lot	1			
O	FCU-G1.1 (4.0 KW)	lot	1			
P	FCU-G1.2 (4.0 KW)	lot	1			
Q	FCU-G1.3 (1.5 KW)	lot	1			
R	FCU-G1.4 (4.8 KW)	lot	1			
S	FCU-G1.5 (4.8 KW)	lot	1			
T	FCU-G1.6 (3.4 KW)	lot	1			
U	FCU-G1.7 (0.8 KW)	lot	1			
V	FCU-G1.8 (2.7 KW)	lot	1			
W	FCU-G1.8 (2.7 KW)	lot	1			
X	FCU-G1.9 (5.4 KW)	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	CONDENSATE DRAIN PIPE (CONTINUED)					
A	FCU-G1.10 (5.4 KW)	lot	1			
B	FCU-G1.11 (3.1KW)	lot	1			
C	FCU-G2.1 (0.9 KW)	lot	1			
D	FCU-G2.2 (6.7 KW)	lot	2			
E	FCU-G2.3 (8.9 KW)	lot	1			
F	FCU-G2.4 (8.6 KW)	lot	1			
G	FCU-G2.5 (5.8 KW)	lot	1			
H	FCU-G2.6 (5.8 KW)	lot	1			
I	FCU-G2.7 (7.5 KW)	lot	1			
J	FCU-G2.8 (11.3 KW)	lot	1			
K	FCU-F1.1 (2.5 KW)	lot	1			
L	FCU-F1.2 (3.7 KW)	lot	1			
M	FCU-F1.3 (3.7 KW)	lot	1			
N	FCU-F1.4 (3.1 KW)	lot	1			
O	FCU-F1.5 (7.2KW)	lot	1			
P	FCU-F1.6 (3.6 KW)	lot	1			
Q	FCU-F1.7 (3.3 KW)	lot	1			
R	FCU-F1.8 (2.6 KW)	lot	1			
S	FCU-F1.9 (3.3 KW)	lot	1			
T	FCU-F1.10 (5.3 KW)	lot	1			
U	FCU-F1.11 (5.3 KW)	lot	1			
V	FCU-F1.12 (10.9 KW)	lot	1			
W	FCU-F2.1 (10.1 KW)	lot	1			
X	FCU-F2.2 (3.3 KW)	lot	1			
Y	FCU-F2.3 (5.9 KW)	lot	1			
Z	FCU-F2.4 (5.4 KW)	lot	1			
AA	FCU-F2.5 (5.4 KW)	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	CONDENSATE DRAIN PIPE (CONTINUED)					
A	FCU-F2.6 (5.9 KW)	lot	1			
B	FCU-F2.7 (4.0 KW)	lot	1			
C	FCU-F2.8 (4.0 KW)	lot	1			
D	FCU-F2.9 (3.6 KW)	lot	1			
E	FCU-GH (2.6 KW)	lot	1			
To Collection:						
	<u>PAGE</u>					
	CH./M2 (page 1/10) - - - - -	-	-	-		
	CH./M2 (page 2/10) - - - - -	-	-	-		
	CH./M2 (page 3/10) - - - - -	-	-	-		
	CH./M2 (page 4/10) - - - - -	-	-	-		
	CH./M2 (page 5/10) - - - - -	-	-	-		
	CH./M2 (page 6/10) - - - - -	-	-	-		
	CH./M2 (page 7/10) - - - - -	-	-	-		
	CH./M2 (page 8/10) - - - - -	-	-	-		
	CH./M2 (page 9/10) - - - - -	-	-	-		
	CH./M2 (page 10/10) - - - - -	-	-	-		
TO CH/M2 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
CH/M	<u>MECHANICAL SERVICES FOR CHANCERY</u>					
[3]	<u>DUCTWORK</u>					
	Ductwork shall comply with Section 5 of the General Specification of the Department of Electrical Services, specification for the Heating and Ventilating Contractors' Association, DW/142 for Sheet Metal Ductwork specification.					
	The price and rate submitted by the tenderer shall be fully inclusive value of work described herein, as shown on specification, drawings as well as inclusive of all expenses, wastage, incidental works, accessories, anchorage, support and other details specified in the specification drawings or indicated in technical specifications.					
	SUPPLY AND RETURN AIR DUCT (c/w 48kg/cu.m. thermal insulation)					
A	0.6mm (22G)	sq.m.	193			
B	0.8mm (20G)	sq.m.	275			
C	1.0mm (18G)	sq.m.	365			
	<u>Supply/Return Air Duct</u> (c/w 48kg/cu.m. thermal insulation)					
D	200 mm dia. flexible pre-insulated duct	m	114			
E	250 mm dia. flexible pre-insulated duct	m	26			
	<u>Fresh Air Duct (Bare Duct)</u>					
F	0.8mm (20G)	sq.m.	10			
	<u>Exhaust Air Duct (Bare Duct)</u>					
G	200 mm dia. flexible duct	m	65			
	<u>Sound Attenuation</u>					
H	AHU - 1 (15mm thk. Internal duct lined)	lot	1			
I	AHU - 2 (15mm thk. Internal duct lined)	lot	1			
J	Vibration Isolator (for DFCU-G)	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
CH/M	<u>MECHANICAL SERVICES FOR CHANCERY</u>					
[4]	<u>DIFFUSERS, GRILLES, AND DAMPERS</u> Diffuser, Grilles & Dampers shall be manufactured by ASLI or approved equivalent. Material: Aluminium A6063. Surface Finished: Baked White Powder Coat. Extruded Aluminium with powdered coated oven baked diffuser c/w opposed blade damper.					
	Supply Air Grilles (Wall Mount Double Deflection) c/w OBD <u>NECK SIZE</u>					
A	900 mm x 300 mm, 45 deg. 6.0m air throw, NC (less than 20)	no.	1			
B	4-Slots Linear Air Diffuser (1.2m) c/w Plenum Box with 48 Kg/cu.m. insulation	nos.	102			
C	4-Slots Linear Air Diffuser (1.2m) c/w BLANK-OFF Supply Air Diffuser (Directional Ceiling Diffuser) c/w OBD <u>NECK SIZE</u>	nos.	60			
D	500mm x 500 mm	no.	3			
E	550mm x 550 mm	nos.	2			
F	2-00mm x 200 mm	nos.	2			
G	150mm x 150 mm Single Deflection Return Air Grilles c/w OBD <u>NECK SIZE</u>	nos.	1			
H	600 mm x 600 mm	nos.	2			
I	600 mm x 450 mm	nos.	3			
J	200 mm x 125 mm <u>VOLUME CONTROL DAMPER</u> Volume Control Balancing Damper (Aerofoil V-groove profile) Gear/Steel linkage drive with double nylon bushing (for friction free operation). Opposed blade type c/w quadrant regulator shafting to indicate blade position. <u>NECK SIZE</u>	nos.	2			
K	1600 mm x 550 mm	no	1			
L	1350 mm x 400 mm	no	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	VOLUME CONTROL DAMPER (CONTINUED)					
A	1300 mm x 400 mm	no	1			
B	1150 mm x 400 mm	no	2			
C	1050 mm x 350 mm	no	1			
D	1000 mm x 300 mm	no	1			
E	850 mm x 300 mm	no	1			
F	800 mm x 400 mm	no	2			
G	600 mm x 300 mm	nos	1			
H	550 mm x 350 mm	nos	4			
I	550 mm x 300 mm	nos	6			
J	500 mm x 300 mm	nos	7			
K	500 mm x 250 mm	nos	2			
L	400 mm x 300 mm	no	2			
M	350 mm x 200 mm	nos	5			
N	300 mm x 300 mm	nos	1			
O	200 mm dia.	nos	74			
P	250 mm dia.	nos	24			
Q	300 mm dia.	nos	4			
	<u>FRESH AIR LOUVERS</u>					
	Extruded Aluminium wall mounted external air intake louvre (powdered coated oven baked) complete with stainless steel insect proof screen mounting frame and lockable opposed blade damper. Complete with SS Insect Screen wire mesh and OBD					
	<u>NECK SIZE</u>					
R	750 mm x 450 mm	no	1			
S	600 mm x 300 mm	no	1			
T	350 mm x 200 mm	no	1			
U	350 mm x 200 mm	no	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
CH/M	<u>MECHANICAL SERVICES FOR CHANCERY</u>					
[5]	<u>ELECTRICAL</u> Electrical and Controls All components, cables and controls shall be of types and qualities as specified in Section 3, "ELECTRICAL", of the DES General Specification for Air Conditioning Installations, the Electrical Installation Part of this Specification and IEE Regulations and installed to standards as similarly specified.					
	<u>AC Switchboard (Control Panel)</u> c/w main Isolator, earth-fault relay, 7-days programmable time switch, DPU Controller, timer controlled timer switch bypass (0-8 hr adjustable), Auto-Off Manual switch, Start and Stop push button switch, provision for fire link connection, all switchgear, run/trip/stop indicator lights for AHU(fans)/CU (compressors) and all accessories as specified and as shown on the drawings.					
A	AHU-1/CU-1 (Location : AHU Rm, Multi Purpose Hall)	lot	1			
B	AHU-2/CU-2 (Location: AHU Rm-Chancery Hall)	lot	1			
	<u>Automatic Controls</u> All automatic controls necessary for the operation and control of the Inverter Split System including thermostat and associated electrical power and control wiring.					
C	AHU-1/CU-1	lot	1			
D	AHU-2/CU-2	lot	1			
E	DFCU-G	lot	1			
	<u>VRF SYSTEM</u>					
F	Simplified Remote Controllers (VFR G1)	lot	1			
G	Simplified Remote Controllers (VFR G2)	lot	1			
H	Simplified Remote Controllers (VFR F1)	lot	1			
I	Simplified Remote Controllers (VFR F2)	lot	1			
	<u>Power Supply and Control Cables</u> All interconnecting power supply wiring between local isolating switch and condensing unit and associated indoor unit, run in high impact conduit, trunking and HDGS cable tray.					
J	AHU-1/CU-1	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	<u>Power Supply and Control Cables (Continued)</u>					
A	AHU-2/CU-2	lot	1			
B	DFCU-G	lot	1			
	<u>VRF SYSTEM</u>					
C	VFR G1	lot	1			
D	VFR G2	lot	1			
E	VFR F1	lot	1			
F	VFR F2	lot	1			
G	FCU- Chancery (Ground Floor)	lots	19			
H	FCU- Chancery (First Floor)	lots	21			
I	FCU - Consular (Ground)	lots	9			
	<u>DX SYSTEM</u>					
J	DFCU-G1/CU-G1 - (Ground Floor)	lots	1			
K	FCU/CU- (Ground Floor)	lots	3			
L	REMOTE CONTROL	lots	58			
	<u>EXHAUST FAN (Made of KDK or approved equiv.)</u> c/w automatic backdraft damper and terminated to architectural louvre.					
	<u>Ceiling Mount Ducted Fan</u>					
M	EF/C-(G1&G2) Cap: 255 cmh; SP: 25 Pa	set	2			
N	EF/C-G5 (Cap: 128 cmh; SP: 40 Pa)	set	1			
O	EF/C-G10 (Cap: 128 cmh; SP: 40 Pa)	set	1			
	<u>Inline Exhaust Ducted Fan</u>					
P	EF/C-(G3&G4) Cap: 380 cmh; SP: 50 Pa	sets	2			
	<u>Inline Ducted Fresh Air Fan</u>					
Q	EF/C-G11 (Cap: 1380 cmh; SP: 50 Pa)	set	1			
	<u>Wall Mounted type c/w automatic backdraft damper</u>					
R	EF/C-G6 (Cap: 540 cmh)	set	1			
S	EF/C-G7,G8,G9,F1) Cap: 128 cmh	sets	3			
T	EF/C-(F2,F3,F4,F5,&F6) Cap: 255 cmh	sets	5			
U	EF/C-G12 (Cap: 1380 cmh; SP: 25Pa)	set	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	ISOLATOR SWITCHES					
A	VFR G1	no	1			
B	VFR G2	no	1			
C	VFR F1	no	1			
D	VFR F2	no	1			
E	CU-1	no	1			
F	CU-2	no	1			
G	DCU-G1	no	1			
H	AIR CURTAIN (Made of KDK) c/w bracket and support Length: 1400mm; Air Throw: 3-3.5m	sets	6			
	<u>Variable Speed Drive</u> (Made of Schneider or approved equivalent)					
I	For AHU-1	no.	1			
J	For AHU-2	no.	1			
To Collection:						
	<u>COLLECTION</u>					
	<u>PAGE</u>					
	CH/M5/(page 1/3) - - - - -					
	CH/M5/(page 2/3) - - - - -					
	CH/M5/(page 3/3) - - - - -					
TO CH/M5 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
CH/M	<u>MECHANICAL SERVICES FOR CHANCERY</u>					
[6]	<u>FIRE HOSE REEL</u>					
	<u>EQUIPMENTS</u> To supply and install the following equipment and materials inclusive of all associated mechanical and electrical controls, power cables, interconnection control wiring as specified and shown on the drawings					
A	Electric driven pumpset single stage end suction centrifugal pump c/w squirrel cage electric motor, TEFC, 415V/3 PH/50HZ 2900 rpm (max.) Capacity: 3.0 l/s at 42M TDH	sets	2			
B	Diaphragm Tank Capacity: 60 liters	lot	1			
	<u>FIRE INDICATION PANEL</u>					
C	Manual and automatic control operation, Start and Stop push button	lot	1			
D	Control and power wiring to pumpset, float and pressure switches, complete with alarm bell, sensing devices inter-connecting control wiring in G.I. conduit/HDGS trunking. All cables to be heat resistant shielded type.	lot	1			
	<u>PIPEWORK, FITTINGS AND ACCESSORIES</u> Supply and install the following, including all accessories and fixtures necessary and in accordance with the specifications described herein and as shown on the drawings. All piping (above ground) should be medium gauge black steel pipe to BS 1387, c/w fittings, bends, elbows, joints, hanger, bracket and support, etc.					
	<u>PIPE</u>					
E	50 mm diameter	m	175			
F	25 mm diameter	m	175			
	<u>Gate Valves</u>					
G	50 mm diameter	nos	8			
H	25 mm diameter	nos	6			
	<u>Check Valves</u>					
I	50mm diameter	nos	2			
	<u>Strainers</u>					
J	50mm diameter	nos	2			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	<u>PIPEWORK, FITTINGS AND ACCESSORIES (CONTINUED)</u>					
A	Flexible Connections 50mm diameter	nos	6			
B	Fire Hydrant (Pillar Type) c/w 80mm dia. Sluice valve and adaptor	lot	2			
	<u>Fire Hosereel Fitting Accessories</u>					
C	Pressure gauge c/w petcock (0-100 psi).	nos	5			
D	25 mm dia . Automatic Air Relief Valve.	nos	2			
E	Float and Pressure Switches	lot	1			
	Painting of Pipework & Pumps Painting including one rust inhibitive primer, one undercoat and 2 finishing red gloss paint for all pipeworks, pumps, brackets and supports.	lot	1			
F	Hose reel breakglass outlet plate and key for hose reel compartment.	nos	4			
G	Fire Hose Reel c/w 30M 20mm hose, 20mm s.s.nozzle, gate valve, valve locking device, and all accessories.	lots	4			
H	All perspex signage/nameplates as specified and shown on the drawing including hosereel signboard	nos	4			
I	4.5 kg. CO2 portable Fire Extinguisher c/w stainless steel bracket	nos	4			
J	9 litres water/CO2 portable Fire Extinguisher c/w stainless steel bracket	nos	4			
	FHR Water Storage Tank Pressed stainless steel (304) water storage tank c/w all stainless steel nuts and bolts, accessories, as specified and shown on drawings. Including 150mm I-beam base tank, anchor to 750mm high R.C. plinth.					
K	Size: 2m x 2m x 2m (Location - Ground Level)	lot	1			
To Collection:						
	<u>COLLECTION</u>					
	<u>PAGE</u>					
	CH./M6 (page 1/2) - - - - -	-	-	-		
	CH./M6 (page 2/2) - - - - -	-	-	-		
TO CH/6 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
CH/M	<u>MECHANICAL SERVICES FOR CHANCERY</u>					
[7]	<u>POOL POND</u>					
	<u>EQUIPMENTS</u>					
	To supply and install the following equipment and materials inclusive of all associated mechanical and electrical controls, power cables, interconnection control wiring as specified and shown on the drawings					
A	Pool Pond Self-Priming Pumpset (Made of Hyward or approved equivalent). Single stage end suction centrifugal pump c/w squirrel cage electric motor, TEFC, 415V/3 PH/50HZ 2900 rpm (max.) Capacity: 183 l/min at 42 TDH	sets	4			
B	Sand Filter c/w accessories Capacity: 183 L/min	lot	2			
C	<u>CONTROL PANEL (PP-CP) - PKS or approved equivalent</u> Manual and automatic control operation, Start and Stop push button switch, indication of pump run and trip, wiring in G.I. concealed conduit, and etc as specified.	lot	2			
D	Control and power wiring to pumpset, float and pressure switches, complete with inter-connecting control wiring in PVC conduit/HDGS tray	lot	2			
	<u>PIPEWORK, FITTINGS AND ACCESSORIES</u>					
	Supply and install the following, including all accessories and fixtures necessary and in accordance with the specifications described herein and as shown on the drawings.					
	All piping and fittings shall be HDPE pipe c/w HDGS (hanger, bracket and and support), etc.					
	<u>PIPE</u>					
E	50 mm diameter	m	80			
F	25 mm diameter	lot	2			
	<u>Gate Valves</u>					
G	50 mm diameter	nos	14			
H	25 mm diameter	nos	4			
	<u>Check Valves</u>					
I	50 mm diameter	nos	4			
	<u>Strainers</u>					
J	50 mm diameter	nos	4			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
CH/M	<u>MECHANICAL SERVICES FOR CHANCERY</u>					
[8]	<u>PLUMBING EQUIPMENTS</u> To supply and install the following equipment and materials inclusive of all associated mechanical and electrical controls, power cables, interconnection control wiring as specified and shown on the drawings					
A	Domestic water pumpset Single stage end suction centrifugal pump c/w squirrel cage electric motor, TEFC, 415V/3 PH/50HZ 2900 rpm (max.) Capacity: 3.0 l/s at 42m TDH	sets	2			
B	Diaphragm Tank c/w accessories Capacity: 227 liters	lot	1			
C	<u>CONTROL PANEL (DWP)</u> Manual and automatic control operation, Start and Stop push button switch, indication of pump run and trip, wiring in G.I. concealed conduit, and etc as specified.	lot	1			
D	Control and power wiring to pumpset, float and pressure switches, complete with inter-connecting control wiring in PVC conduit/HDGS tray	lot	1			
E	Sand Filter c/w accessories Capacity: 353 l/min	lot	1			
	<u>PIPEWORK, FITTINGS AND ACCESSORIES</u> Supply and install the following, including all accessories and fixtures necessary and in accordance with the specifications described herein and as shown on the drawings. All piping and fittings should be stainless steel to BS 304 c/w HDGS (hanger, bracket and support), etc.					
	<u>PIPE</u>					
F	65 mm diameter	m	50			
G	25 mm diameter	m	110			
	<u>Gate Valves</u>					
H	65 mm diameter	nos	8			
I	25 mm diameter	nos	3			
	<u>Check Valves</u>					
J	65 mm diameter	nos	2			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
NRG/M	<u>MECHANICAL SERVICES FOR NON-REPRESENTATIONAL GRADE (BLOCK A)</u>					
[1]	<u>EQUIPMENT</u> Supply, installation, testing and commissioning of the Air Conditioning System as shown and indicated in the drawing. All material supply & works carry out shall be as per DES requirements and approved vendors products. DX-Split Air Conditioning system consisting of fan coil unit and matching air cooled condensing unit, refrigerant, brackets and supports, power & control wiring and other necessary accessories as specified and as shown in the drawing. Rate quoted shall be inclusive of supply and termination of all power and control cables to equipment including necessary cable, glands, lugs, earthing, conduit/ HDGS cable tray and other necessary accessories. <u>DX SPLIT SYSTEM (Carrier or approved equivalent)</u>					
	<u>GROUND FLOOR</u>					
A	STORAGE (6.5 KW)	set	1			
B	LIVING & DINING AREA (5.2 KW)	set	1			
C	BEDROOM (2.6 KW)	set	1			
	<u>FIRST & SECOND FLOOR</u>					
D	LIVING/DINING AREA (9.75 KW)	set	4			
E	MASTER BEDROOM (3.9 KW)	set	4			
F	BEDROOM 01 (3.9KW)	set	4			
G	BEDROOM 02 (2.6 KW)	set	4			
H	KITCHEN (2.6 KW)	set	4			
	<u>THIRD FLOOR</u>					
I	LIVING/DINING AREA (9.7.5 KW)	set	2			
J	MASTER BEDROOM (3.9 KW)	set	1			
K	BEDROOM 01 (3.9KW)	set	1			
L	BEDROOM 02 (2.6 KW)	set	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	<u>DX SPLIT SYSTEM (Carrier or approved equivalent)</u> <u>CONTINUED</u>					
	<u>THIRD FLOOR</u>					
A	BEDROOM 03 (2.6 KW)	set	1			
B	KITCHEN (2.6 KW)	set	1			
To Collection:						
	<u>COLLECTION</u>					
	<u>PAGE</u>					
	NRG/M1 (page 1/2) - - - - -	-	-	-		
	NRG/M1 (page 2/2) - - - - -	-	-	-		
TO NRG/M1 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
NRG/M	<u>MECHANICAL SERVICES FOR NON-REPRESENTATIONAL GRADE (BLOCK A)</u>					
[2]	<u>PIPEWORK</u>					
	<u>REFRIGERANT PIPEWORK</u>					
	Solid drawn copper tube c/w 20mm thick THERMAL insulation and white PVC Denso wrap tape encased in heavy duty PVC impact resistant industrial trunking, fittings, liquid line solenoid valves, TX valves, sight glasses and filter driers, supports, brackets and as specified. All systems to be pressure tested, evacuated and dehydrated before charging with refrigerant. (where two refrigerant lines system is offered Tenderer is to price for the 2 lines accordingly).					
	Testing, evacuation and dehydration of both refrigeration systems, before charging with refrigerant, and include initial refrigerant charge. Note : All test pressures and evacuation pressures to be submitted in type written form to the Engineer.					
	<u>REFRIGERANT PIPE</u>					
	<u>GROUND FLOOR</u>					
A	STORAGE (6.5 KW)	lot	1			
B	LIVING & DINING AREA (5.2 KW)	lot	1			
C	BEDROOM (2.6 KW)	lot	1			
	<u>FIRST & SECOND FLOOR</u>					
D	LIVING/DINING AREA (9.7 KW)	lots	4			
E	MASTER BEDROOM (3.9 KW)	lots	4			
F	BEDROOM 01 (3.9KW)	lots	4			
G	BEDROOM 02 (2.6 KW)	lots	4			
H	KITCHEN (2.6 KW)	lots	4			
I	<u>THIRD FLOOR</u>					
J	LIVING/DINING AREA (9.7 KW)	lot	2			
K	MASTER BEDROOM (3.9 KW)	lot	1			
L	BEDROOM 01 (3.9KW)	lot	1			
M	BEDROOM 02 (2.6 KW)	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	<u>REFRIGERANT PIPE (CONTINUED)</u>					
A	BEDROOM 03 (2.6 KW)	lot	1			
B	KITCHEN (2.6 KW)	lot	1			
	CONDENSATE DRAIN PIPE 20mm dia. pipes (unless otherwise specified) to BS 3505 Class D c/w 15mm thick insulation concealed within walls and run in HD UPVC trunking c/w traps, fittings, brackets and supports.					
	<u>GROUND FLOOR</u>					
C	STORAGE (6.5 KW)	lot	1			
D	LIVING & DINING AREA (5.2 KW)	lot	1			
E	BEDROOM (2.6 KW)	lot	1			
	<u>FIRST AND SECOND FLOOR</u>					
F	LIVING/DINING AREA (9.7 KW)	lot	4			
G	MASTER BEDROOM (3.9 KW)	lot	4			
H	BEDROOM 01 (3.9KW)	lot	4			
I	BEDROOM 02 (2.6 KW)	lot	4			
J	KITCHEN (2.6 KW)	lot	4			
	<u>THIRD FLOOR</u>					
K	LIVING/DINING AREA (9.7 KW)	lot	2			
L	MASTER BEDROOM (3.9 KW)	lot	1			
M	BEDROOM 01 (3.9KW)	lot	1			
N	BEDROOM 02 (2.6 KW)	lot	1			
O	BEDROOM 03 (2.6 KW)	lot	1			
P	KITCHEN (2.6 KW)	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	<p style="text-align: center;"><u>COLLECTION</u></p> <p><u>PAGE</u></p> <p>NRG/M2 (page 1/3) - - - - -</p> <p>NRG/M2 (page 2/3) - - - - -</p> <p>NRG/M2 (page 3/3) - - - - -</p>					
TO NGR/M2 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
NRG/M	<u>MECHANICAL SERVICES FOR NON-REPRESENTATIONAL GRADE (BLOCK A)</u>					
[3]	<u>ELECTRICAL</u>					
	<u>Electrical and Controls</u> All components, cables and controls shall be of types and qualities as specified in Section 3, "ELECTRICAL", of the DES General Specification for Air Conditioning Installations, the Electrical Installation Part of this Specification and IEE Regulations and installed to standards as similarly specified.					
	<u>Power Supply and Control Cables</u> All interconnecting power supply wiring between local isolating switch and condensing unit and all interconnecting power and control wiring between condensing unit and associated indoor unit, run in high impact conduit, trunking and HDGS cable tray.					
	<u>DX SINGLE SPLIT SYSTEM (Carrier or approved equivalent)</u>					
A	Ground Floor	lots	4			
B	First Floor	lots	10			
C	Second Floor	lots	10			
D	Third Floor	lots	7			
E	REMOTE CONTROLLERS	lots	31			
	<u>EXHAUST AIR FAN (Made of KDK or approved equiv.)</u>					
	Ceiling Mount Ducted Exhaust Fan c/w backdraft damper and EAL					
F	EF/NRG-(G1) Cap: 145 cmh; SP: 50 Pa	set	1			
G	EF/NRG-(F1&F5) Cap: 383 cmh; SP: 50 Pa	sets	2			
H	EF/NRG-(S1&S5) Cap: 383 cmh; SP: 50 Pa	sets	2			
I	EF/NRG-(T1) Cap: 300 cmh; SP: 50 Pa	set	1			
J	Wall Mounted type c/w automatic backdraft damper EF/NRG-(G2) Cap: 128 cmh	set	1			
K	EF/NRG-(F2,F3,F4,F6,F7&F8) Cap: 128 cmh	sets	6			
L	EF/NRG-(S2,S3,S4,S6,S7&S8) Cap: 128 cmh	sets	6			
M	EF/NRG-(T2,T3,T4,T5,T6&T7) Cap: 128 cmh	sets	6			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	<u>KITCHEN EXHAUST HOOD</u> Supply & installation of 3-sided Type Kitchen Exhaust Hood constructed from HIGH QUALITY finish c/w hood light, grease filter, hangers etc and as per specifications, drawings and all accessories for a complete satisfactory and operational system					
A	<u>DUCTED WALL MOUNT RANGE HOOD</u> <u>Size: 750mm x 750mm</u> 4-speed motor with timer/auto-shut-off control 430 grade high quality stainless steel Dishwasher-safe baffle filters Directional lighting Made of Zline or approved equal	lot	6			
B	<u>DUCTWORK/LOUVER</u> 1. 300mmx250mm stainless steel exhaust duct c/w bends, transformation and connected to EAL 2. 450mmx400mm Exhaust Air Louver c/w S.S. bird's wire mesh	lot	6			
C	<u>GAS COOKER RANGE</u> Dual fuel cooker with 4-burner gas hob, conventional oven and grill and main oven c/w gas 45kg LPG tank, pressure hose, and gas regulator. Made of Belling or approved equal.	lot	6			
To Collection:						
	<p style="text-align: center;"><u>COLLECTION</u></p> <u>PAGE</u> NRG/M3 (page 1/3) - - - - - NRG/M3 (page 2/3) - - - - - NRG/M3 (page 3/3) - - - - -					
TO NRG/M3 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
RG/M	<u>MECHANICAL SERVICES FOR REPRESENTATIONAL GRADE (BLOCK B)</u>					
[1]	<u>EQUIPMENT</u>					
	Supply, installation, testing and commissioning of the Air Conditioning System as shown and indicated in the drawing. All material supply & works carry out shall be as per DES requirements and approved vendors products.					
	DX-Split Air Conditioning system consisting of fan coil unit and matching air cooled condensing unit, refrigerant, brackets and supports, power & control wiring and other necessary accessories as specified and as shown in the drawing.					
	Rate quoted shall be inclusive of supply and termination of all power and control cables to equipment including necessary cable, glands, lugs, earthing, conduit/ HDGS cable tray and other necessary accessories.					
	<u>DX SPLIT SYSTEM (Carrier or approved equivalent)</u>					
	<u>GROUND FLOOR</u>					
A	LIVING ROOM (3.9 KW)	set	2			
B	BEDROOM (2.6KW)	set	2			
	<u>FIRST & SECOND FLOOR</u>					
C	LIVING AREA (6.5 KW)	set	2			
D	DINING AREA (3.9 KW)	set	2			
E	BEDROOM 01 (2.6KW)	set	2			
F	KITCHEN (2.6KW)	set	2			
	<u>SECOND FLOOR</u>					
G	MASTER BEDROOM (3.9KW)	set	2			
H	FAMILY LOUNGE (3.9KW)	set	2			
I	FAMILY LOUNGE CORRIDOR (7.8 KW)	set	2			
J	BEDROOM 02 (2.6KW)	set	2			
K	BEDROOM 03 (2.6KW)	set	2			
TO RG/M1 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
RG/M	<u>MECHANICAL SERVICES FOR REPRESENTATIONAL GRADE (BLOCK B)</u>					
[2]	<u>PIPEWORK</u>					
	<u>REFRIGERANT PIPEWORK</u>					
	Solid drawn copper tube c/w 20mm thick THERMAL insulation and white PVC Denso wrap tape encased in heavy duty PVC impact resistant industrial trunking, fittings, liquid line solenoid valves, TX valves, sight glasses and filter driers, supports, brackets and as specified. All systems to be pressure tested, evacuated and dehydrated before charging with refrigerant. (where two refrigerant lines system is offered Tenderer is to price for the 2 lines accordingly).					
	Testing, evacuation and dehydration of both refrigeration systems, before charging with refrigerant, and include initial refrigerant charge.					
	Note : All test pressures and evacuation pressures to be submitted in type written form to the Engineer.					
	<u>REFRIGERANT PIPE</u>					
	<u>BLOCK B</u>					
A	<u>GROUND FLOOR</u>					
B	LIVING ROOM (3.9 KW)	lots	2			
	BEDROOM (2.6KW)	lots	2			
	<u>FIRST FLOOR</u>					
C	LIVING AREA (6.5 KW)	lots	2			
D	DINING AREA (3.9 KW)	lots	2			
E	BEDROOM 01 (2.6KW)	lots	2			
	KITCHEN (2.6KW)	lots	2			
	<u>SECOND FLOOR</u>					
F	MASTER BEDROOM (3.9KW)	lots	2			
G	FAMILY LOUNGE (3.9KW)	lots	2			
H	FAMILY LOUNGE CORRIDOR (7.8 KW)	lots	2			
I	BEDROOM 02 (2.6KW)	lots	2			
J	BEDROOM 03 (2.6KW)	lots	2			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
RG/M	<u>MECHANICAL SERVICES FOR REPRESENTATIONAL GRADE (BLOCK B)</u>					
[3]	<u>ELECTRICAL</u>					
	<u>Electrical and Controls</u> All components, cables and controls shall be of types and qualities as specified in Section 3, "ELECTRICAL", of the DES General Specification for Air Conditioning Installations, the Electrical Installation Part of this Specification and IEE Regulations and installed to standards as similarly specified.					
	<u>Power Supply and Control Cables</u> All interconnecting power supply wiring between local isolating switch and condensing unit and all interconnecting power and control wiring between condensing unit and associated indoor unit, run in high impact conduit, trunking and HDGS cable tray.					
	<u>DX SINGLE SPLIT SYSTEM (Carrier or approved equivalent)</u>					
A	Ground Floor	lots	4			
B	First Floor	lots	8			
C	Second Floor	lots	10			
D	REMOTE CONTROLLERS	lots	22			
	<u>EXHAUST AIR FAN (Made of KDK or approved equiv.)</u>					
	Ceiling Mount Ducted Exhaust Fan c/w backdraft damper and EAL					
E	EF/RG-(G1&G2) Cap: 128 cmh; SP: 50 Pa	set	2			
F	EF/RG-(F5,F6,F7,F8,F9&F10) Cap: 128 cmh; SP: 50 Pa	sets	6			
G	EF/RG-(T1,T2,T3,T4,T5&T6) Cap: 128 cmh; SP: 50 Pa	sets	6			
	Wall Mounted type c/w automatic backdraft damper					
H	EF/RG-(G3&G4) Cap: 128 cmh	set	2			
I	EF/RG-(F1,F2,F3&F4) Cap: 128 cmh	sets	4			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	<u>KITCHEN EXHAUST HOOD</u> Supply & installation of 3-sided Type Kitchen Exhaust Hood constructed from HIGH QUALITY finish c/w hood light, grease filter, hangers etc and as per specifications, drawings and all accessories for a complete satisfactory and operational system					
A	DUCTED WALL MOUNT RANGE HOOD <u>Size: 750mm x 750mm</u> 4-speed motor with timer/auto-shut-off control 430 grade high quality stainless steel Dishwasher-safe baffle filters Directional lighting Made of Zline or approved equal	lots	4			
B	DUCTWORK/LOUVER 1. 300mmx250mm stainless steel exhaust duct c/w bends, transformation and connected to EAL 2. 450mmx400mm Exhaust Air Louver c/w S.S. bird's wire mesh	lots	4			
		lots	4			
C	GAS COOKER RANGE Dual fuel cooker with 4-burner gas hob, conventional oven and grill and main oven c/w gas 45kg LPG tank, pressure hose, and gas regulator. Made of Belling or approved equal.	lots	4			
To Collection:						
A	AUTOMATIC SECURITY GATE SYSTEM Supply and installation of Heavy duty high quality automatic gate system c/w motorised control and interconnecting power wiring, and complete all necessary accessories including remote controls. The automatic gate shall be control and manually open and close from a switch located inside the residence (2-location to be confirmed). Automatic Gate Motor (gate approx. wt.=1000kg) c/w all accessories.	lot	1			
B	Gate Remote Control Access	nos.	20			
C	Manually operated switch c/w power and control wiring and all accessories for a complete operable system.	lot	1			
	<u>COLLECTION</u>					
	<u>PAGE</u>					
	RG/M3 (page 1/2) - - - - -	-	-	-		
	RG/M3 (page 2/2) - - - - -	-	-	-		
TO RG/M3 SUMMARY:						

ELECTRICAL SERVICES
(BILL OF QUANTITIES)

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
CH/E	<u>ELECTRICAL INSTALLATION FOR CHANCERY</u>					
[1]	<u>SWITCHBOARDS AND DISTRIBUTION BOARDS</u>					
	<u>Main Switchboard</u> Supply, install, test and commission factory assembled modular type tested Form 4 construction, front access IP42 (IEC) floor mounted metal clad board and other accessories as detailed in the drawings and specifications. (Cost to be inclusive of termination of all cables, including cable glands, lugs, etc. as per drawings/ specifications).					
A	800A MSB (Main switchboard) c/w metering and instrumentation, etc as per the drawing and the DES standards.	lot	1			
B	Allow cost for liaison with Authorities regarding power supply application and energization of the system.	lot	1			
C	Allow cost for providing first aid resuscitation chart near the main switchboards.	lot	1			
D	Supply and installation of CT KWH meter complete with linking of telephone outlet and allow for the necessary liaison with Authorities (including QP testing and certification).	lot	1			
E	Earthing of the switchboards and distribution boards as per specifications and drawings. <u>Sub-Switchboard / Distribution Boards</u> Distribution boards shall be constructed to Form I and IP42, electrical grounding, all necessary accessories as shown in the drawing, . All cable terminals shall be provided with numbered identification ferrules. Cost quoted to be inclusive of termination of all incoming/ outgoing cables including cable gland, lugs, number ferrules, etc. as per drawings/specifications.	lot	1			
F	SSB-CH (including CH-GLP) as per drawing	lot	1			
G	SSB-MPH (including MPH-LP) as per drawing	lot	1			
H	SSB-CON as per drawing	lot	1			
I	DBCH-PP as per drawing	lot	1			
J	DBCH-FF as per drawing	lot	1			
K	DB-GH1 as per drawing	lot	1			
L	DB-GH2 as per drawing	lot	1			
M	DBMPH - PP as per drawing	lot	1			
N	DBCON - PP as per drawing	lot	1			
O	DB-SS as per drawing	lot	1			
P	<u>Miscellaneous and Related Works</u> Allow miscellaneous cost for concrete encased pipesleeves of 150mm dia for all road crossing, hard standing areas, returfing, refurbishment and making good of existing ground.	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
A	Allow miscellaneous cost for providing floor openings, pipe sleeves through RC beams & slabs, fire stop barrier, fire seal pillows, etc for passage of sub-main cables, lighting and power wiring, telephone & computer system, fire alarm & fire protection system, water services, aircon services and other disciplines.	lot	1			
To Collection:						
	<p style="text-align: center;"><u>COLLECTION</u></p> <p><u>PAGE</u></p> <p>CH/E1 (Page 1/2) - - - - -</p> <p>CH/E1 (Page 2/2) - - - - -</p>					
TO CH/E1 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
CH/E	<u>ELECTRICAL INSTALLATION FOR CHANCERY</u>					
[2]	<u>LV RETICULATION MAINS (INTERNAL)</u> Supply and install submain cables as per drawings & specification. Cost of hot dipped galvanised cable ladder, tray, trunking, required as specified shall be included in the pricing of cable. The size of cable ladder/cable tray and containment provided shall be adequate for cable spacings factor as per latest EIR and IEE Regulations. Rates of cable laid underground shall include cost of trench excavation, sand bedding, pipesleeves, protective tile and reinstatement. Rates for cables shall be inclusive of cable identification tags at 10m intervals and at every bend. Cost quoted to be inclusive of termination of all incoming and outgoing cables including cable glands, lugs, etc as per drawing and specifications. Bidder is to take note that the estimated quantity in this BOQ is for reference only. Bidder shall make necessary allowances and no additional claims will be allowed. 4x1c/25mm² PVC/SWA/PVC cable + 1c/16mm² CPC laid in cable tray/trunking c/w necessary accessories to the following:					
A	From SSB-CH to DBCH-FF (inclusive of CH-FPP)	m	15			
B	From SSB-CH to DBCH-PP	m	10			
C	From SSB-CON to CON-PP	m	10			
D	1x2c/16mm² PVC/SWA/PVC cable laid underground, pipesleeves and cable tray c/w necessary accessories from SSB-CON to DB-GH1.	m	60			
E	1x4c/25mm² FR/LSZH armoured cable + 1c/16mm² CPC in cable c/w necessary accessories from SSB-CH to Lift-1.	m	40			
F	1x4c/16mm² PVC/SWA/PVC cable laid underground, pipesleeves and cable tray c/w necessary accessories from SSB-MPH to MPH-PP.	m	10			
G	1x2c/10mm² PVC/SWA/PVC cable laid underground, pipesleeves and cable tray c/w necessary accessories from DB-GH1 to DB-GH2.	m	15			
To Collection:						
	<u>COLLECTION</u> <u>PAGE</u> CH/E2 (Page 1/1) - - - - -					
TO CH/E2 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
CH/E	<u>ELECTRICAL INSTALLATION FOR CHANCERY</u>					
[3]	<u>GENERAL LIGHTING AND POWER SERVICES</u> Supply, installation and termination of light and power point in conduit/trunking as per drawing and specification. Rates for lighting and power point shall be inclusive of providing cable marker sleeved with the circuit number identified. Unless otherwise specified all switch plates and power point switch plate shall be of moulded white plastic range accessories approved by DES. CPC earth cable shall be provided inside back box and terminated with cable connector whether the switch plate is of plastic or of metallic range. Cost quoted to be inclusive of termination of all incoming/ outgoing cables including cable galnds, lugs, etc as per drawing and specifications. NOTES: i) all utility boxes for switches, outlets, etc shall be of flush mounted, factory fitted with moulded brass nut and not of self tapping screw type. ii) conduit adapter fitted to boxes for use of switches, outlets, etc shall be with lock nuts and securely tightened. iii) all exposed conduit and flexible conduit inside ceiling voids shall be of color coded. iv) flexible conduit shall be of corrugated polyamide (nylon) flexible conduit and fittings shall be of manufacturer recommended. v) light fittings shall be of factory provided supports and brackets with independent hangers from other installations. vi) SSO switches are to T&J Electric "Radiance" White. <u>Unless otherwise specified Color Code for Service Raceway & Conduits are as follows:</u> - lighting and power - - - - - orange - fire detction - - - - - red - telephone & computer - - - - green - PA system - - - - - yellow - security system - - - - - white - AC & BMS - - - - - blue					
A	Lighting point c/w wiring in PVC conduit using 3x1c/1.5mm² PVC cable c/w 10A switch plate and gang as per switching arrangement shown in the lighting drawings.	nos	788			
B	Emergency lighting point in PVC conduit using 3x1c/1.5mm² PVC cable c/w key switch as shown in the drawing.	nos	50			
C	Exit sign lighting point in concealed PVC conduit using 3x1c/1.5mm² PVC cable.	nos	30			
D	Exhaust fan wiring point in concealed PVC conduit using 3x1c/2.5mm² PVC cable c/w fused spur outlet similar to MK, Clipsal, Legrand or equivalent next to fan and switch at the door.	nos	14			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
A	In-line Exhaust fan wiring point in concealed PVC conduit using 3x1c/2.5mm² PVC cable c/w fused spur outlet, control timer and accessories similar to MK, Clipsal, Legrand or equivalent next to fan and 2nos 2way 10A switch at the door.	nos	2			
B	Double pole power switch c/w indicating lamp for LCD projectors to MK, Clipsal, Legrand or approved equivalent.	no	1			
C	Power point in concealed PVC conduit using 6 nos 2.5mm² PVC cable as per single line diagram and terminated with the following outlets priced separately as below.	nos	178			
D	Power point in concealed PVC conduit using 3x1c/4mm² PVC cable as per single line diagram and terminated with the following outlets priced separately as below.	nos.	2			
E	13A single SSO mounted as shown in the drawing similar to MK, Clipsal, T&J white plastic finish or equivalent.	nos	100			
F	13A twin weatherproof SSO mounted as shown in the drawing similar to MK, Clipsal, T&J white plastic finish or equivalent.	nos	4			
G	13A twin SSO mounted as shown in the drawing similar to MK, Clipsal, legrand or equivalent.	nos	74			
H	15A single SSO using 3x1c/4mm² PVC cable mounted as shown in the drawing similar to MK, Clipsal, T&J white plastic finish or equivalent.	nos	2			
I	Supply and installation of hand dryer wiring point in concealed PVC conduit using 3x1c/4mm² PVC cable c/w fused spur outlet similar to MK Logic 1067, Clipsal, T&J or equivalent.	nos	6			
J	20A fused spur outlet with indicating lamp (For fire alarm panel) similar to MK, Clipsal, Legrand or approved equivalent.	no	1			
K	Supply and installation of 300 x 300 x 80mm floor mounted service box, 3 compartment single trap c/w accessories similar to MK or equivalent. Cost to include 1 no twin 13A SSO, 1 no RJ45 outlet and 1 no RJ11 outlet to suit service box. Service box cover c/w lifting handle, cable outlet and to suit floor finish.	nos	48			
L	Dimmer rack/controller and switch for Multi Purpose Hall lighting to DES approved equivalent.	lot	1			
M	Power point using 3x1c/4mm² PVC cable in concealed PVC conduit c/w 20A SPN weatherproof isolator for Motor Gate.	nos	4			
N	<u>Miscellaneous and Related Works</u> Allow cost for circuit tagging and labelling of all cables and wiring circuits (incoming/outgoing cables and corresponding DB name) using numeric sleeves or self laminating wrapped around oil resistant nylon cable identification labels to brother, winco, brady, thorpe or approved equivalent. Labels shall apply to but not limited to the following: i) all DB, MSB, SSB, FAP, Tel & Computer, Secuty System, etc ii) socket outlets iii) switches iv) light fittings	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	<p style="text-align: center;"><u>COLLECTION</u></p> <p><u>PAGE</u></p> <p>CH/E3 (Page 1/3) - - - - -</p> <p>CH/E3 (Page 2/3) - - - - -</p> <p>CH/E3 (Page 3/3) - - - - -</p>					
TO CH/E3 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
CH/E	<u>ELECTRICAL INSTALLATION FOR CHANCERY</u>					
[4]	<u>LIGHT FITTINGS AND ACCESSORIES</u> Supply and install DES approved light fittings as specified in the drawings and as indicated below or as per Engineer/SO requirement. All light fittings shall be provided with independent support to the structure and shall not depend to other system. Rates for light fittings shall be inclusive of providing a tape label with the circuit number identified and a strong adhesive used to bond the tape to the fittings. A system guarantee of 3 years by means of factory warranty certificate for all the light fittings. All LED light fittings offered must be of non degradable diffusers. All LEDs in the light fitting offered shall have a minimum lifetime to 70% luminuos flux at 50,000 hours and shall be CREE, Nichia, Lumiled LEDs or approved equivalent. A system guarantee of 3 years by means of factory warranty certificate shall be submitted for all LED light fittings. Contractor to ensure LED light fitting offered shall met the design illumination requirement. Emergency packs are to be rated for a minimum of 2 hours duration or as specified and shall be non-maintained type.					
A	F1 - 12W LED Bollard 750mm high 3000k sanded black to NVC NGLED 5612-1 or approved equivalent, mounted as shown in the drawing.	nos.	66			
B	F2 - 18.5W LED Wall-mounted luminaire 3000k 25° to NVC NWLED3544 fencing light, mounted as shown in the drawing.	nos	36			
C	F3 - 36W LED Post Top luminaire 3000K c/w 2500mm diecast aluminium pole foundation c/w required accessories to NVC NPTLED352 or approved equivalent, mounted as shown in the drawing.	no	18			
D	F4 - 9W LED Uplighter 3000K to NVC NFLED5012 or approved equivalent, as shown in the drawing.	nos	25			
E	F5 - 6W LED Inground Uplight 3000K 20° to NVC NLED4203 or approved equivalent, as shown in the drawing.	nos	65			
F	F7 - 17W LED downlight 4000K 6inch IP44 to NVC NLED09506E-D or approved equivalent, mounted as shown in the drawing.	nos	20			
G	F8 - 9W LED surface mounted downlight white 3000K to NVC NLLED9184M or approved equivalent, mounted as shown in the drawing.	nos	15			
H	F9 - LED Linear recessed lighting aluminium white 70mm 6000K to Colours D8420-24-52mm 420 LEDs/m c/w required accessories or approved equivalent, as shown in the drawing. (Refer to details)	m	30			
I	F10 - 12W LED recessed downlight 6500K to NVC NDLLED9314E or approved equivalent, mounted as shown in the drawing.	nos	98			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
A	F11 - 2W LED Recessed spotlight 6500K to NVC NLED105 or approved equivalent, mounted as shown in the drawing.	nos	4			
B	F12 - LED Linear recessed lighting aluminium trimless white 70mm 6000K to Colours D8420-24-52mm 420 LEDs/m c/w required accessories or approved equivalent, as shown in the drawing. (Refer to details)	nos	7			
C	F13 - 12.5W LED Rectangular IP68 underwater luminaire, 3000K, 50° beam angle to NVC NSLED4315 or approved equivalent, mounted as shown in the drawing.	nos	27			
D	F14 - 4W LED Recessed wall step light 3000K to NVC NWLED5566, mounted as shown in the drawing.	nos	31			
E	F15 - 43W LED Recessed 600x600mm lighting luminaire 6500K to NVC NPNLED4514/43W/66 or approved equivalent, mounted as shown in the drawing.	nos	43			
F	F16 - 35W LED Recessed adjustable spotlight 4000K honeycomb collimator to NVC NLED1807C/S or approved equivalent, mounted as shown in the drawing.	nos	16			
G	F17 - 18 LED T8 1200mm batten fitting to PHILIPS or approved equivalent.	nos	24			
H	F19 - 8W LED Recessed round downlight 3inch 4000K matte gold shield cover to NVC 8113A or approved equivalent, mounted as shown in the drawing.	nos	60			
I	F19C - 8W LED Recessed round wall washer 3inch 4000K matte gold shield cover to NVC 81132A or approved equivalent, mounted as shown in the drawing.	nos	3			
J	F21A - 3W LED Recessed downlight 2inch 4000K to NVC 8112D matte gold shield cover or approved equivalent, mounted as shown in the drawing.	nos	20			
K	F22 - 12W LED Recessed spotlight IP65 4000K to NVC NSPLED181W or approved equivalent, mounted as shown in the drawing.	nos	4			
L	F24 - Chandelier 24 x 5W LED H5 light fitting 4000K copper with 3 ring layers c/w necessary accessories to Demilux Intevision MD9028R3IN1 or approved equivalent.	no	1			
M	F29 - 28W LED Linear recessed wall washer 1229mm 4000K to Colours LES0FW c/w required accessories or approved equivalent, mounted as shown in the drawing.	nos.	21			
N	F30 - 38W LED Linear recessed lighting aluminium 1229mm 70mm 4000K to Colours LR70DD c/w required accessories or approved equivalent, mounted as shown in the drawing.	nos.	120			
O	F32 - 2W LED Recessed downlight 4000K white to NVC NLED105 or approved equivalent, mounted as shown in the drawing.	nos	5			
P	F33 - 4W LED Recessed steplight 3000K to NVC NWLED5572A or approved equivalent, mounted as shown in the drawing.	nos	11			
Q	F34 - 40W LED Pendant array 4000K to Demilux Intevision 9060 Line Down A-8 or approved equivalent, mounted as shown in the drawing.	no	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
A	F35 - 48W LED Circular pendant 6500K to Demilux Intevision 9072IN800 or approved equivalent, mounted as shown in the drawing.	no	2			
B	F36 - 3x28W LED Linear pendant 1210mm black module to Colours LS50G c/w necessary accessories or approved equivalent, mounted as shown in the drawing.	no	1			
C	F37 - 20W LED Wall mounted luminaire 24° white 4000K to Demilux Intevision 0549W2 20 or approved equivalent.	nos.	14			
D	F39 - 1W LED Recessed round emergency lighting c/w 1hr battery backup to Maxspid Minnie or approved equivalent, mounted as shown in the drawing.	nos.	31			
E	F40 - 2x3W LED Wall mounted emergency lighting c/w 2hrs battery backup to Maxspid Minnie or approved equivalent.	nos.	20			
F	F41 - "KELUAR" LED double/single-sided, self-contained, ceiling/wall mounted sign light c/w 2 hrs emergency battery pack to Maxspid Leder or approved equivalent, mounted as shown in the drawing.	nos.	30			
G	Flexible LED Strip, 160 LEDs/m 24V to Colours or approved equivalent.	m	130			
H	Power supply, connectors and necessary accessories for maximum 15m per installation for flexible LED strip.	sets	6			
To Collection:						
	<p style="text-align: center;"><u>COLLECTION</u></p> <p><u>PAGE</u></p> <p>CH/E4 (Page 1/3) - - - - -</p> <p>CH/E4 (Page 2/3) - - - - -</p> <p>CH/E4 (Page 3/3) - - - - -</p>					
TO CH/E4 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
CH/E	<u>ELECTRICAL INSTALLATION FOR CHANCERY</u>					
[5]	<u>TELEPHONE AND COMPUTER SYSTEM</u>					
	<u>Telephone Services Installation</u> Supply, install, test and commission telephone system, PABX system and computer system in accordance with the specifications and drawings. All works herein shall be approved TelBru standards. Tenderer shall submit a complete detailed proposal including all equipment offered, catalogues and brochures together with this tender. The equipment and accessories listed below are for tendering purpose. The tenderer is to include all other equipment and accessories not included herein but deemed necessary to the intent of the specifications and requirement. Proposed brands for all the items shall be Dell/Cisco or equivalent. Bidder is to take note that the estimated quantity in this BOQ is for reference only. Bidder shall make necessary allowances and no additional claims will be allowed.					
A	Supply and installation of wall-mounted FAT and ATB c/w suitable Splitters and other necessary accessories including termination, splicing of cables and testing as shown and indicated in the drawing.	lot	1			
B	Supply and install wall mounted Fibre Joint Enclosure as per specifications and JTB approved make. Rates to include termination of all incoming and outgoing cable and jumper cable, provision of a laminated schematic diagram, termination chart, identification label and 1 set of layout drawing showing the location of telephone outlets in the area served.	lot	1			
C	Telephone point using 4 pair Cat 6 STP cable in concealed pvc conduit/trunking to outlets as shown and indicated in the drawing. Cost to include RJ45 shutter faceplate outlet, utility boxes, etc inclusive of termination at both ends, testing of Cat 6 cable, etc.	nos	45			
	<u>IP Telephony (PABX) System</u>					
D	Supply & Install includes IP Telephony server, IP telephone Gateway user end point Licence. Tenderer must include all the necessary accessories to proper function of PABX network (Cisco or approved equivalent)	lot	1			
E	Supply and install factory fabricated 22U 19" Floor mounted equipment rack, fully vented, front safety glass door & lock set, quick release side doors, 8 way power bar, etc. Cost inclusive of patch panels, management panels, other necessary accessories to cater for the above services for PABX Services.	lot	1			
F	24 Port POE Switch for IP PABX	nos	2			
G	12 Core Rack mount ODF c/w accessories as shown and indicated in	lots	2			
H	12 core single mode outdoor type fibre optic cable run in cable trunking for computer backbone structured cabling inclusive of both ends termination and testing as shown in the drawing from and to PABX Racks. Contractor to verify exact length of cable.	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
A	Operator Level IP Phone	lot	2			
B	Executive Level IP Phone	lot	2			
C	Staff Level IP Phone	lot	45			
D	Interconnection works for the new PABX equipment and accessories as indicated in the drawings/specification inclusive of all manufacturer specified cable, suitable sized MDF, patchcord, pigtail, adaptors, connectors, and all necessary accessories, etc. This include interlinking works to the other system/services where specified/required (i.e Fire Alarm System, CCTV system, Computer Structure Cabling System) with necessary works such as programming, calibration, configuring, etc.	lot	1			
E	2c single mode FO cable in concealed conduit for the interconnection between ATB, FAT, modem etc, c/w termination, FO connectors, and other accessories.	lot	1			
	<u>Computer Network Installation</u>					
F	Supply and install factory fabricated 42U 19" wall mounted 1000 x 1000 equipment rack, fully vented, front safety glass door & lock set, quick release side doors, 8 way power bar, etc. Cost inclusive of patch panels, switch panels, management panels, other necessary accessories to cater for the above services.	lots	2			
G	24 core single mode outdoor type incoming fibre optic cable run in telephone pipe duct, trunking/cable tray inclusive of both ends termination/splicing and testing as shown in the drawing from existing TelBru FO Exchange Station to Equipment Rack. Contractor to verify exact length of cable and coordinate with authorities the nearest tapping point works shall be c/w termination, connection, adaptors, joint kits, connectors, and all necessary accessories, etc.	m	1,000			
H	Termination of telecommunication cable at MDF/PABX, FAT, ATB, ODF etc. This include sufficient telephone cable module block, fibre optic termination kits, and label with all necessary accessories, etc.	lot	1			
I	Computer point using 4 pair Cat 6 STP cable in concealed pvc conduit/trunking to outlets as shown and indicated in the drawing. Cost to include RJ45 shutter faceplate outlet, utility boxes, etc inclusive of termination at both ends, testing of Cat 6 cable, etc.	nos	32			
J	Supply and installation of Patch Panel for the above network switch c/w termination and all the necessary accessories.	lots	2			
K	Supply and installation of Cable Management Panel for the above network switch c/w termination and all the necessary accessories.	lots	2			
L	Supply and laying of 4c fibre optic cable for the interconnection between two racks c/w termination and splicing.	lot	1			
M	Supply and laying of 50 pairs jelly-filled cable for the interconnection between two racks c/w termination, splicing and all the necessary accessories.	lot	1			
N	Supply and installation of suitable-sized MDF/ODF c/w termination, splicing and all the necessary accessories.	lots	2			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
A	1 meter length factory terminated Cat 6 patch cord for equipment rack.	lot	1			
B	3 meter length factory terminated Cat 6 patch cord for work station.	nos	42			
	<u>Telephone & Computer Ducts</u>					
C	Construct 4 way telephone foot way joint box no. 3 (FJB3) in situ mix on site c/w foot way covers, cable bearers and reinforced concrete work etc to TelBru standard. Indicative location shown in the site plan. All works and materials to TelBru standards.	nos	5			
D	2 x 100 dia uPVC telephone cable duct encased in concrete c/w nylon pull cables, end caps, laid approx. 1m from ground, asphalt & across drain inclusive of excavation, sand fill, compaction, cutting and reinstatement to approval.	m	250			
E	Allow costs for draw pit of 600 x 600 mm for telephone & fiber cable duct entry to building c/w chequered plate cover, draw rope, 2 way 100 dia uPVC with sealant at both ends as shown in the drawing.	lots	2			
F	Allow cost for taping 2 x 100 dia telephone pipe duct into existing telephone manhole.	lot	1			
G	Comms earthing using 1c/70mm² PVC earth cable c/w earth bar, insulator, heavy duty earth chamber and necessary accessories to achieve 1 ohm or less link to main earthing system.	lots	2			
H	Liaison with TelBru or relevant authorities on incoming telephone and fibre optic connection.	lot	1			
To Collection:						
	<u>COLLECTION</u> <u>PAGE</u> CH/E5 (Page 1/3) - - - - - CH/E5 (Page 2/3) - - - - - CH/E5 (Page 3/3) - - - - -					
TO CH/E5 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
CH/E	<u>ELECTRICAL INSTALLATION FOR CHANCERY</u>					
[6]	<u>CONVENTIONAL FIRE ALARM SYSTEM</u> Supply and install of an Analogue Addressable microprocessor type automatic fire alarm system as per specification and drawings.					
A	4-Zone Conventional Fire Alarm panel c/w text display, keyboard printer, sealed maintenance batteries and all accessories to Multron or approved equivalent.	lot	1			
B	Mimic panel with programmable LED's showing silk screen diagrammatic layout plan of the whole building. The silkscreen shall clearly identify the location of all the fire protection detectors, devices, escape routes and individual alarm zones. Coloured and numbered for easy identification. <u>Supply and installation c/w wiring point using 1x2c/1.5mm² fire resistant cable in conduit from the fire alarm panel to the following devices</u>	lot	1			
C	Smoke detector	no	44			
D	Heat detector	no	7			
E	Manual breakglass	no	11			
	<u>Supply and installation c/w wiring point using 1x2c/2.5mm² fire resistant cable in conduit from the fire alarm panel to the following devices</u>					
F	Alarm Bell <u>Wiring point using 1x2c/1.5mm² fire resistant cable or as per requirement in conduit from interface unit to the following devices. Cost inclusive of providing relay to the panel/equipment as per requirement.</u>	no	11			
G	Lift control panel	lot	1			
H	Power supply for the Fire Alarm Panel using 2x4mm ² + 1x4mm ² CPC cable run through PVC conduit or trunking. <u>Supply of Spare Detector/Devices only</u>	lot	1			
I	Smoke detectors	no	5			
J	Heat detectors	no	5			
K	Manual breakglass	no	5			
L	Loop card module	no	1			
M	Glass for breakglass	no	5			
N	Fire alarm transmitter/digital communication to link fire alarm panel to alarm signal to Fire Department.	lot	1			
O	Allow cost for lightning surge protection devices for fire alarm panel and external signal cables	lot	1			
P	1 set of log book, manuals re cord drawing, checklists, component list and test form for the above control panel <u>Supply and install of fire extinguishers and shall be by SRI or</u>	lot	1			
Q	2.0 kg ABC dry powder extinguisher	no	9			
R	2.0 kg co ₂ fire extinguisher	no	6			
S	Fire blanket	no	3			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
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TO CH/E6 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
CH/E	<u>ELECTRICAL INSTALLATION FOR CHANCERY</u>					
[7]	<u>STANDBY DIESEL GENERATOR SET</u> Supply, install, test and commission the standby generator system as shown in the drawings and in accordance with the specification. Bidder is to take note that the estimated quantity in this BOQ is for reference only. Bidder shall make necessary allowances and no additional claims will be allowed. <u>Generator</u>					
A	Standby generator set of 500 kVA capacity at 0.8 power factor, 415V 3 phase, 50Hz (prime - rating) c/w the following : - skid base fuel tank type (minimum 8 hours backup) - fabricated steel underframe - diesel engine c/w accessories - alternator c/w AVR - radiator - electronic governor - flexible connection to fuel piping and flexible below for connection to exhaust piping - Meters for water temperature, oil pressure, oil temperature, tachometer hour run - 2 nos starter motors - diesel fuel, oil, water and air filters - safety overspeed, high water temperature, low oil pressure trip and alarm devices - guards of all moving parts and all necessary labelling and name plates - anti vibration mounting pads - rate to include cable terminations, glands and lugs <u>Batteries</u>	lot	1			
B	Lead acid batteries c/w a non ferrous battery rack, interconnecting links, terminal shrouds and flexible cable tails to connect the battery to the starter. The battery should be sized for 6 successive starts of 6 seconds each with a 15 seconds rest period.	lot	1			
C	<u>AMF Switchboard</u> Automatic mains failure switchboard of metalclad enclosure, floor standing to specification with front and rear access and complete with but not limited to the following : - 1 x 800A 4P MCCB/ACB - main - External O/C & E/F protection of MCCB/ACB - Voltmeter c/w a selector switch - Ammeter c/w a selector switch - KWH, power factor, hour run and frequency meter - Mains available and generator available indicating lights - Battery charger c/w boost/trickle charger selector - Battery voltmeter and ammeter - Indicator lamps for operation of engine and controls protective devices - Selector switch for "Off" "Auto" "Manual" and "Test"	lot	1			
To Collection:					-	

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	<ul style="list-style-type: none"> - Push buttons for start/stop/alarm, cancel/lamp test/reset - Alarm siren - Contacts for remote monitoring - Control relays, timer, under voltage sensing relay, low battery, voltage relay, etc to effect automatic main failure sensing and control of the generator - Cable termination plate, lugs and glands - Rates for switchboards to include cost for cable termination at the board - All necessary labels 					
	<u>Exhaust System</u>					
A	Radiator exhaust ducting c/w a flexible canvas section to connect the radiator to the discharge shaft. The ducting should be provided with an access hatch for cleaning out and should be constructed in accordance with BS DW142 with 1.2 mm thick galvanised sheet steel. The ducting should be reinforced with angle iron brackets.	lot	1			
B	Residential type exhaust silencer and piping using BS3601 pipes with welded joints c/w necessary spring isolation supports.	lot	1			
C	Allow cost of necessary inlet air attenuator and outlet air attenuator/silencer as per manufacturer's recommendation.	lot	1			
D	Exhaust piping to be lagged with 50mm thick sectional rock wool and clad with a 0.6mm thick stainless steel.	lot	1			
E	The discharge outlet shall be angled at 30 degree and provided with an anti vermin mesh. Where the exhaust pipes penetrate through the building structure, a G.I. sleeve shall be provided.	inclusive				
F	The sleeves shall be one pipe diameter larger than the exhaust pipe and space between the sleeved and pipe packed with rock wool and sealed with a rock wool and sealed with a non setting heat resistant compound.	clusive				
	<u>Fuel Tank</u>					
G	Design and construct cylindrical fuel tank of mild steel construction and anti-rust paint finishes c/w 48 hours diesel fuel reserved (80% tank capacity), level indicator, low fuel level switch, vent cowl, drain pipe, support and mounting brackets, and other accessories.	lot	1			
H	Wiring from low fuel level switch to AMF panel consisting of 3x1c/1.5 mm ² PVC in conduit.	lot	1			
I	Construct a bund wall of 300mm high all around the fuel day tank. Walls and floor shall be finished w/ an impervious material coating and non-chemical reaction to fuel.	lot	1			
	<u>Power and Control Wiring</u>					
J	4nos 1C/500mm ² XLPE/AWA/PVC on cable ladder or tray from the generator to the MSB..	m	20			
K	Multicore control cable 5c/2.5mm ² between the generator and the AMF panel laid on tray & power supply sensing cable from AMF to MSB.	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
A	<u>Earthing System</u> Neutral earthing using 2 x 120 mm ² PVC earth cable c/w earth chamber and necessary accessories to achieve below 1 ohm.	lot	1			
B	Frame earthing using 70 mm ² PVC earth cable linking the generator, AMF panel, fuel tank frame in ring formation to earth rods in earth chamber to achieve the earthing value as per DES requirements.	lot	1			
C	<u>Genset Plant Room Earthing</u> Allow cost for common earth bar and necessary earthing to the whole of electrical and genset installation.	lot	1			
	<u>Fuel Piping</u> All the piping shall be ASTM grade A53 Sch 40 pipes. Rates shall be inclusive of all elbows, tees, brackets and accessories. Rates should include for painting with 2 coats of primer and 2 coats of bituminous paint.					
D	25mm dia supply pipe from the day tank to the generator.	lot	1			
E	25mm dia return pipe from the generator to the day tank.	lot	1			
F	1m wide x 6mm thick rubber along the front and back of the AMF panel.	lot	1			
G	Provide a framed schematic and control drawing in the genset room.	lot	1			
H	Supply a manual and in-line rotary vane pump specifically designed for petroleum products and install a supply fuel oil line feeding the day tank. The pump shall have a built in rotary vane head and easy turn crank handle, cast iron body, 19mm inlet and outlet with removable steel spout 100mm suction pipe and a 50 mm bung adapter. It shall be capable of delivering at a rate of about 12 turns per gallon with a suction lift on 1500mm.	lot	1			
I	Allow cost for mild steel checkered plate with anti-rust painting finish covering all HV and LV electrical trenches, genset trenches, etc that is within this contract. Contractor to propose plate arrangements.	lot	1			
To Collection:						
	<u>COLLECTION</u> <u>PAGE</u> CH/E7 (Page 1/3) - - - - - CH/E7 (Page 2/3) - - - - - CH/E7 (Page 3/3) - - - - -					
TO CH/E7 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
CH/E	<u>ELECTRICAL INSTALLATION FOR CHANCERY</u>					
[8]	<u>HT CABLES AND RELATED EQUIPMENTS</u>					
	Supply, installation, testing and commissioning of the 11kV cables based on engineering, procurement and construct basis. (All material supply & works carry out shall be as per DES requirements).					
	The works call for the supply and installation of 11kV cables, 11kV ring main unit, distribution transformer, HV earthing, jointing, related accessories and all associated works for the 11kV power system installation.					
	The tendering party shall liaise with DES on the scope of works, specifications, schedule of works in this bill noting that the work undertaken shall be by approved specialist Contractor.					
	Bidder is to take note that the estimated quantity in this BOQ is for reference only. Bidder shall make necessary allowances and no additional claims will be allowed.					
A	Allow cost for mobilisation and demobilisation of plant/equipment, setting out of works, transportation of materials, insurances and associated works.	lot	1			
B	Supply, install and commissioning of 500 kVA 11kV/433V outdoor type Distribution Transformer c/w all necessary accessories to DES specification ref: DES/11KV/TRF/REV '0' dated 26-7-1997.	lot	1			
C	Supply, install and commissioning of 2R1T Non-extensible Ring Main Unit (RMU) equipment c/w all necessary accessories to DES specification ref: DES/11KV/RMU/REV '0' dated 26-7-1997.	lot	1			
D	Supply and delivery of 1 x 3C/185 mm ² XLPE, Leadsheathed/DSTA/PVC 6.35/11KV cable as shown on the drawings and as per DES Specification as DES/11KV/HVC (Rev. "1" dated 11th October 2001).	m	1650			
	Price quoted above inclusive of supply & delivery of cables, excavation, preparation of cable trench, timber shoring, installation of cable rollers & pulling wires, laying of cables, backfilling, compaction, dewatering of cable trench, PVC protective tiles, concrete cable markers, turfing, making good of surface, manpower, discard of unwanted earth & debris and all associated works.					
E	Jointing and termination of 11kV 185mm ² HV cables.	lot	1			
	The quoted price is inclusive of all jointing and termination materials, accessories, jointing and termination service by specialist joiner, all preparation and associated works.					
F	Allow cost for the testing & commissioning of 11/0.433kV transformers, 11kV RMU, 11kV earthing grid, 11kV cable system & protection system, etc.	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
A	Allow cost for the isolation and disconnection of the existing 11kV network by authorities engineers inclusive of switching operation and related work at 11kV switchgears, cable identification, spiking of cables, skilled manpower for supervision, witnessing of site testing of LV MSB and all associated testing to ensure safety & engineering requirement is complied.	lot	1			
B	All cost for liaison with authorities, survey works, mapping of existing cables, investigation works, trial pits, excavation, backfilling, returfing, protective measures and materials for existing HT cable, other related works in conjunction with HT power connection.	lot	1			
C	<u>Miscellaneous and Related Works</u> Encased in concrete for open road cutting and crossing inclusive of Class C uPVC pipe, safety signage & lighting, excavation, backfilling of pits after completion of work, clearing of site and all associated works.	lot	1			
D	Road crossing pipe sleeves installation by pipe jacking inclusive of 4-way cable ducts across main road. Works inclusive of excavation work for drilling pit & receiving pit, site preparation work, pipe jacking equipment, supply & installation of 150mm dia, danger and warning signs at roads, application and approval by authorities, etc. Pipesleeves for electrical services entering the building, substation, external lighting, power cables etc in concrete encased and road crossing inclusive of excavation, backfill materials etc as per drawing and as necessary. Pipesleeves shall be 2ways minimum unless otherwise specified.	m	20			
E	200mm diameter uPVC pipesleeves	m	50			
F	150mm diameter uPVC pipesleeves	m	40			
G	100mm diameter uPVC pipesleeves	m	20			
H	Equipment grounding system as per DES standards c/w necessary accessories to achieve less than 1 ohm (for MSB, MSB & Genset, RMU & Transformer)	lot	1			
I	Transformer neutral earthing using 2x120mm ² PVC earth cable c/w heavy duty earth chamber and necessary accessories to achieve less than 1 ohm.	lot	1			
To Collection:						
<u>COLLECTION</u>						
<u>PAGE</u>						
CH/E8 (Page 1/2) - - - - -						
CH/E8 (Page 2/2) - - - - -						
TO CH/E8 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
CH/E	<u>ELECTRICAL INSTALLATION FOR CHANCERY</u>					
[9]	<u>PA SYSTEM</u> Supply and installation of PA system as per drawings and specifications. Tenderer shall submit a complete detailed system proposal including all equipment offered, catalogues and brochures together with this tender. The equipment and accessories listed below are for tendering purpose. The tenderer is to include all other equipment and accessories not included herein but deemed necessary to the intent of the specifications and requirement.					
	<u>Sound System</u>					
A	8-Channel Audio Mixer (Rack Mountable)	unit	1			
B	Monitoring speaker c/w Line Matching Transformer 70V/100V, Enclosure & Ceiling Baffle	lot	1			
C	Ceiling mounted Loudspeaker c/w Line Matching Transformer 70V/100V, Enclosure & Baffle	units	12			
D	Power Amplifier c/w Line Transformer 100W 70V/100V (Rack Mountable)	unit	2			
E	Graphic Equaliser, 1-Ch 31-Bands (Rack Mountable)	unit	1			
F	Mic XLR Wall Receptacles	no	1			
G	Handheld dynamic microphone c/w 5 meter cable	no	2			
H	Computer RGBHV\Audio; Audio Input Receptacles on Wall.	lot	1			
I	22U 19" Equipment Rack on castors c/w Front Glass Lockable Door, side & rear doors, mounting hardwares & accessories, power/mains supply rail, ventilation fans, cable straps, etc.	no	1			
J	Supply & Install Audio Cables as laid in Conduits, Trunkings & Trays	lot	1			
K	Equipment Installation & Termination, Testing & Commissioning	lot	1			
L	DVD/VCD/CD cum VCR player (multi-system) c/w IR remote controller.	lot	1			
M	Allow cost for the engineering, design proposal, shop drawing and catalogues for approval.	lot	1			
To Collection:						
	<u>COLLECTION</u>					
	<u>PAGE</u>					
	CH/E9 (Page 1/1) - - - - -					
TO CH/E9 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
CH/E	<u>ELECTRICAL INSTALLATION FOR CHANCERY</u>					
[10]	<u>MATV SYSTEM</u> Supply and installation of MATV system as per drawings and specifications. Tenderer shall submit a complete detailed proposal including all equipment offered, catalogues and brochures together with this tender. The equipment and accessories listed below are for tendering purpose. The tenderer is to include all other equipment and accessories not included herein but deemed necessary to the intent of the specifications and requirement. Proposed brands shall be Ikusi/Televes or equivalent.					
	<u>Antennae/Headend, Distribution Equipment and Accessories</u>					
A	RTB Analog and Digital Antennae c/w necessary accessories inclusive steel mounting stand/ supports/ mast.	lot	1			
B	Headend MATV Amplifier c/w necessary accessories	lot	1			
C	Astro 65cm dish w/ Televes Quattro LNBF or equivalent and necessary accessories inclusive steel mounting stand/ supports/ mast.	lot	1			
D	5in, 5out Amplifier to Televes or equivalent	lot	1			
E	5in, 8out/16out Multiswitch to Televes or equivalent	nos	2			
F	IF Tap-Off units to Televes or equivalent	nos	2			
G	Wiring of TV/SAT/FM 2 gang socket outlet by using of 2xRG6 (coaxial) cable in concealed conduit. Proposed brand RG6 cable shall be Belden or equivalent.	nos	8			
H	Custom-made metal enclosure with hinged door for installation of amplifier and multiswitch c/w accessories.	nos	1			
I	Combiners, connectors and necessary accessories.	lot	1			
J	Installation, termination, testing and commissioning for the whole system.	lot	1			
	<u>Conduit and Trunking Works</u>					
K	Allow cost for labelling and marking of all cables, tap -off units and splitters.	lot	1			
L	Supply and install hot dipped galvanised heavy duty cable trunking c/w all necessary supports. Trunking covers shall utilise a quarter turn screw. Trunking for shall be of different colour from lighting , power and other services.	lot	1			
M	Supply and install various lengths of 25Ø/32Ø PVC conduit as per drawing and where necessary cast/concealed in wall/slab.	lot	1			
N	Allow cost for the engineering, design proposal, shop drawing and catalogues for approval.	lot	1			
O	Testing and Commissioning of MATV System	lot	1			
To Collection:						
	<u>PAGE</u> CH/E10 (Page 1/1) - - - - -					
TO CH/10 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
CH/E	<u>ELECTRICAL INSTALLATION FOR CHANCERY</u>					
[11]	<u>SECURITY SYSTEM</u> Supply and install card access control system integrated with IP video surveillance system as per drawing and specifications. Tenderer shall submit a complete detailed proposal including all equipment offered, catalogues and brochures together with this tender. The equipment and accessories listed below are for tendering purpose. The tenderer is to include all other equipment and accessories for proper functioning and operation of the security system to the intent of specification and requirement. <u>Camera System</u> Supply and install indoor and outdoor camera c/w but not limited to the following: i) DVD quality, day/night function, min lux 0.05 lux at F= 1.2 ii) Dual stream MPEG-4 SP video upto 4CIF/30pfs iii) Power over Ethernet (PoE) ready iv) One way audio supported v) QoS enabled (L3) video streaming vi) Backlight compensation vii) Auto iris control, variable focal c/w camera licenses vii) Other features that deemed necessary and required by the Client					
A	Fixed indoor IP mini dome camera to Samsung or equivalent	sets	17			
B	<u>Video Management System Software</u> Video Management System (VMS) software and licenses for efficient viewing, recording, replaying of acquired video/audio complying with requirements and specifications including but not limited to the following functions:- - 4CIF, 30 fps video stream - Health monitoring and analysis functions Software development kit (SDK) - High level integration with card access system and IP cameras - Single and multi-site support - Support distributed remote viewing and remote storage - Able to export to DVD-RW driver	lot	1			
C	<u>Master Server</u> <u>Minimum Hardware Requirements:-</u> - Operating System: Windows 2003 SP1 - Processor: Intel Pentium 4 or Pentium D or Pentium Xeon, 2.8 GHz Hyper-Thread enabled - Memory: 4 GB <u>Network: 10/100/1000Base-T</u> - DVD R/W Drive: Required - Hard Disk Partitions: C: (Operating System) = 15 GB D: (Database) = 10 GB L: DVD Drive c/w 20" LCD monitor	lot Inclusive	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	<u>Required Software:</u> - Microsoft SQL Server 2000 with Service Pack 3 or latest - Microsoft Operations Manager 2005 or better - Video Management Software - all other necessary software and licenses and proper management and functioning of IP video surveillance system <u>Digital Video Recorder</u> Supply and install Recorder Server to Samsung SRN-1670D/470D or equivalent c/w external Raid 5 hot-swappable SATA hard disk array for recording and viewing of video images and which support minimum 15 channel recording at Full D1 at 30 fps. Disk array to be sized for fulltime recording for 30 days based on minimum 12.5 fps (at MPEG 4, CIF-4kb) for 15 no of IP cameras <u>Minimum Hardware Requirements:-</u> Operating System: Windows 2003 SP1, Windows XP SP2 Processor: Intel Pentium 4 or Pentium D or Pentium Xeon, 2.8 GHz Hyper-Thread enabled Memory: 4 GB Network: 10.100/1000 Base-T DVD reader drive: Required C: (Operating System) = 15 GB D: (Database) = 10 GB L: DVD Drive c/w 20" high resolution LCD monitors	Inclusive				
A	Allow for necessary management software, operation system software and licenses for recorder server for proper management of larger-scale distributed video operations as specified	lot	1			
	<u>Network Devices</u>					
B	24 port network switch with 24 port 10/100 Base-T PoE ready Ethernet interface modules & 1x1000 Base-T module	no	1			
C	Network patch panels as required	lot	1			
D	Redundant power supply units, chasis fan, patch chords all necessary accessories required	lot	1			
E	Allow for all necessary management software for configuration of the switches and accessories	lot	1			
F	22U 19" equipment rack to house the CCTV equipment c/w all necessary accessories	lot	1			
G	Supply and install of CAT 6 STP cabling of approved make, inclusive of conduit, trunking where required (average length 70m) from security equipment racks to camera points - ceiling of wall mounted	nos	17			
H	Allow for CAT 6 patch chords from patch panels to the network devices (including network and distribution switches)	lot	1			
I	Cost & expenses for complete configuration, testing and commissioning of the transmission system to the satisfaction of consulting engineers and client	lot	1			
J	Allow cost for the engineering, design proposal, shop drawing and catalogues for approval.	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	<p style="text-align: center;"><u>COLLECTION</u></p> <p><u>PAGE</u></p> <p>CH/E11 (Page 1/3) - - - - -</p> <p>CH/E11 (Page 2/3) - - - - -</p> <p>CH/E11 (Page 3/3) - - - - -</p>					
TO CH/E11 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
CH/E	<u>ELECTRICAL INSTALLATION FOR CHANCERY</u>					
[12]	<u>LIGHTNING PROTECTION SYSTEM</u> Supply, Install, Testing and Commissioning of the following including all necessary termination/fixing accessories as per drawing of Electrical Services and specifications:- Bidder is to take note that the estimated quantity in this BOQ is for reference only. Bidder shall make necessary allowances and no additional claims will be allowed.					
A	Air termination rod c/w the base. Make: D.E.S approved brand.	nos.	6			
B	25 x 3mm bare copper tape horizontal conductor c/w fixing accessories (saddle screws, square clamp, etc) run on roof level.	m	180			
C	1C x 70mm ² down conductor in 50mm dia. uPVC conduit chased in wall/column. Make: D.E.S approved brand.	m	120			
D	Oblong test joint clamp c/w recessed w/p termination box. Make: D.E.S approved brand.	nos.	6			
E	Earthing pit c/w copperbond earth rod & H.D. cover. Make: D.E.S approved brand.	set	6			
F	Testing and commissioning of lightning protection system.	lot	1			
To Collection:						
	<u>COLLECTION</u> <u>PAGE</u> CH/E12 (Page 1/1) - - - - -					
TO CH/E12 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
CH/E	<u>ELECTRICAL INSTALLATION FOR CHANCERY</u>					
[13]	<u>EXTERNAL WORKS</u>					
	<u>LV Reticulation Mains</u>					
	Supply and install submain cables as per drawings & specification. Cost of hot dipped galvanised cable ladder, tray, trunking, required as specified shall be included in the pricing of cable. The size of cable ladder/cable tray and containment provided shall be adequate for cable spacings factor as per latest EIR and IEE Regulations.					
	Rates of cable laid underground shall include cost of trench excavation, sand bedding, pipesleeves, protective tile and reinstatement. Rates for cables shall be inclusive of cable identification tags at 10m intervals and at every bend.					
	Cost quoted to be inclusive of termination of all incoming and outgoing cables including cable glands, lugs, etc as per drawing and specifications.					
	Bidder is to take note that the estimated quantity in this BOQ is for reference only. Bidder shall make necessary allowances and no additional claims will be allowed.					
A	4nos 1x4c/500mm ² XLPE/AWA/PVC cable from transformer to MSB laid inside cable trench.	m	20			
B	1x4c/120mm ² XLPE/SWA/PVC cable + 1c/70mm ² CPC laid underground, pipesleeves and cable tray from MSB to SSB-CH (including CH-GLP)	m	35			
C	1x4c/70mm ² XLPE/SWA/PVC cable + 1c/50mm ² CPC laid underground, pipesleeves and cable tray from MSB to SSB-MPH (inclusive of MPH-LP)	m	70			
D	1x4c/70mm ² PVC/SWA/PVC cable + 1c/35mm ² CPC laid underground, pipesleeves and cable tray from MSB to SSB-CON.	m	150			
	4x1c/25mm ² PVC cable + 1c/16mm ² CPC laid in trunking c/w necessary accessories.					
E	From MSB to DB-SS 1x4c/16mm ² PVC/SWA/PVC cable + 1c/16mm ² CPC laid in cable tray c/w necessary accessories.	m	10			
F	From MSB to HR - CP	m	15			
G	From MSB to DWP - CP	m	15			
H	1x4c/10mm ² PVC/SWA/PVC cable laid underground, pipesleeves and cable tray c/w necessary accessories for fencing lighting.	m	350			
I	1x4c/6mm ² PVC/SWA/PVC cable laid underground, pipesleeves and cable tray c/w necessary accessories for bollard lighting.	m	260			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	<p style="text-align: center;"><u>COLLECTION</u></p> <p><u>PAGE</u></p> <p>CH/E13 (Page 1/2) - - - - -</p> <p>CH/E13 (Page 2/2) - - - - -</p>					
TO ELECTRICAL SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
NRG/E	<p align="center"><u>ELECTRICAL INSTALLATION FOR NON-REPRESENTATIONAL GRADE (BLOCK A)</u></p> <p>[1] <u>SWITCHBOARDS AND LV RETICULATION MAINS</u></p> <p><u>Sub-Switchboard / Distribution Boards</u> Supply, install, test and commission factory assembled modular type tested Form 4 construction, front access IP42 (IEC) floor mounted metal clad board and other accessories as detailed in the drawings and specifications. (Cost to be inclusive of termination of all cables, including cable glands, lugs, etc. as per drawings/ specifications).</p> <p>Distribution boards shall be constructed to Form I and IP42, electrical grounding, all necessary accessories as shown in the drawing, . All cable terminals shall be provided with numbered identification ferrules.</p> <p>Cost quoted to be inclusive of termination of all incoming/ outgoing cables including cable gland, lugs, number ferrules, etc. as per drawings/specifications.</p> <p>A SSB-RHA as per drawing lot 1</p> <p>B DB-CLP as per drawing lot 1</p> <p>C DB-AG as per drawing lot 1</p> <p>D DB-AF1 as per drawing lot 1</p> <p>E DB-AF2 as per drawing lot 1</p> <p>F DB-AS1 as per drawing lot 1</p> <p>G DB-AS2 as per drawing lot 1</p> <p>H DB-AT as per drawing lot 1</p> <p><u>LV Reticulation Mains</u> Supply and install submain cables as per drawings & specification. Cost of hot dipped galvanised cable ladder, tray, trunking, required as specified shall be included in the pricing of cable. The size of cable ladder/cable tray and containment provided shall be adequate for cable spacings factor as per latest EIR and IEE Regulations.</p> <p>Rates of cable laid underground shall include cost of trench excavation, sand bedding, pipesleeves, protective tile and reinstatement. Rates for cables shall be inclusive of cable identification tags at 10m intervals and at every bend.</p> <p>Cost quoted to be inclusive of termination of all incoming and outgoing cables including cable galnds, lugs, etc as per drawing and specifications.</p> <p>Bidder is to take note that the estimated quantity in this BOQ is for reference only. Bidder shall make necessary allowances and no additional claims will be allowed.</p> <p>I 1x4c/70mm² XLPE/SWA/PVC cable + 1c/35mm² CPC laid underground, pipesleeves and cable tray from MSB to SSB-RHA. m 50</p> <p>J 1x4c/25mm² PVC cable + 1c/16mm² CPC laid in trunking c/w necessary accessories from SSB-RHA to DB-AG. m 15</p> <p>K 1x4c/25mm² PVC cable + 1c/16mm² CPC laid in trunking c/w necessary accessories from SSB-RHA to DB-AF1. m 15</p>					
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
A	1x4c/16mm ² PVC cable + 1c/16mm ² CPC laid in trunking c/w necessary accessories from SSB-RHA to DB-AF2.	m	15			
B	1x4c/16mm ² PVC cable + 1c/16mm ² CPC laid in trunking c/w necessary accessories from SSB-RHA to DB-AS1.	m	15			
C	1x4c/16mm ² PVC cable + 1c/16mm ² CPC laid in trunking c/w necessary accessories from SSB-RHA to DB-AS2.	m	15			
D	1x4c/16mm ² PVC cable + 1c/16mm ² CPC laid in trunking c/w necessary accessories from SSB-RHA to DB-AT.	m	20			
	<u>Miscellaneous and Related Works</u>					
E	Allow miscellaneous cost for concrete encased pipesleeves of 150mm dia for all road crossing, pipe jacking, hard standing areas, returfing, refurbishment and making good of existing ground.	lot	1			
F	Allow miscellaneous cost for providing floor openings, pipe sleeves through RC beams & slabs, fire stop barrier, fire seal pillows, etc for passage of sub-main cables, lighting and power wiring, telephone & computer system, fire alarm & fire protection system, water services, aircon services and other disciplines.	lot	1			
To Collection:						
	<p style="text-align: center;"><u>COLLECTION</u></p> <p><u>PAGE</u></p> <p>NRG/E1 (Page 1/2) - - - - -</p> <p>NRG/E1 (Page 2/2) - - - - -</p>					
TO NRG/E1 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
NRG/E	<p align="center"><u>ELECTRICAL INSTALLATION FOR NON-REPRESENTATIONAL GRADE (BLOCK A)</u></p> <p>[2] <u>GENERAL LIGHTING AND POWER SERVICES</u> Supply, installation and termination of light and power point in conduit/trunking as per drawing and specification. Rates for lighting and power point shall be inclusive of providing cable marker sleeved with the circuit number identified. Unless otherwise specified all switch plates and power point switch plate shall be of moulded white plastic range accessories approved by DES. CPC earth cable shall be provided inside back box and terminated with cable connector whether the switch plate is of plastic or of metallic range. Cost quoted to be inclusive of termination of all incoming/ outgoing cables including cable glands, lugs, etc as per drawing and specifications. NOTES: i) all utility boxes for switches, outlets, etc shall be of flush mounted, factory fitted with moulded brass nut and not of self tapping screw type. ii) conduit adapter fitted to boxes for use of switches, outlets, etc shall be with lock nuts and securely tightened. iii) all exposed conduit and flexible conduit inside ceiling voids shall be of color coded. iv) flexible conduit shall be of corrugated polyamide (nylon) flexible conduit and fittings shall be of manufacturer recommended. v) light fittings shall be of factory provided supports and brackets with independent hangers from other installations. vi) SSO switches are to T&J Electric "Radiance" White. <u>Unless otherwise specified Color Code for Service Raceway & Conduits are as follows:</u> - lighting and power - - - - - orange - fire detection - - - - - red - telephone & computer - - - green - PA system - - - - - yellow - security system - - - - - white - AC & BMS - - - - - blue</p>					
A	Lighting point c/w wiring in PVC conduit using 3x1c/1.5mm² PVC cable c/w 10A switch plate and gang as per switching arrangement shown in the lighting drawings.	nos	299			
B	Emergency lighting point in PVC conduit using 3x1c/1.5mm² PVC cable c/w key switch as shown in the drawing.	nos	15			
C	Exhaust fan wiring point in concealed PVC conduit using 3x1c/2.5mm² PVC cable c/w fused spur outlet similar to MK, Clipsal, Legrand or equivalent next to fan and switch at the door.	nos	25			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
A	Power point in concealed PVC conduit using 6 nos 2.5mm ² PVC cable as per single line diagram and terminated with the following outlets priced separately as below.	nos	131			
B	Power point in concealed PVC conduit using 3x1c/4mm ² PVC cable as per single line diagram and terminated with the following outlets priced separately as below.	nos.	29			
C	13A single SSO mounted as shown in the drawing similar to MK, Clipsal, T&J white plastic finish or equivalent.	nos	21			
D	13A twin weatherproof SSO mounted as shown in the drawing similar to MK, Clipsal, T&J white plastic finish or equivalent.	nos	10			
E	13A twin SSO mounted as shown in the drawing similar to MK, Clipsal, legrand or equivalent.	nos	100			
F	15A single SSO using 3x1c/4mm ² PVC cable mounted as shown in the drawing similar to MK, Clipsal, T&J white plastic finish or equivalent.	no	29			
G	Cooker SSO w/ neon indicator using 3x1c/6mm ² PVC cable in concealed PVC conduit mounted as shown in the drawing.	no	6			
H	Water heater point in concealed PVC conduit using 3x1c/4mm ² PVC cable c/w connection outlet and flush 20A DP switch and pilot lamp and marked "water heater" similar to MK Logic 5423 WH WHI, Clipsal, T&J or equivalent.	nos	14			
I	<u>Miscellaneous and Related Works</u> Allow cost for circuit tagging and labelling of all cables and wiring circuits (incoming/outgoing cables and corresponding DB name) using numeric sleeves or self laminating wrapped around oil resistant nylon cable identification labels to brother, winco, brady, thorpe or approved equivalent. Labels shall apply to but not limited to the following: i) all DB, MSB, SSB, FAP, Tel & Computer, Secuty System, etc ii) socket outlets iii) switches iv) light fittings	lot	1			
To Collection:						
	<u>COLLECTION</u> <u>PAGE</u> NRG/E2 (Page 1/2) - - - - - NRG/E2 (Page 2/2) - - - - -					
TO NRG/E2 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
NRG/E	<p align="center"><u>ELECTRICAL INSTALLATION FOR NON-REPRESENTATIONAL GRADE (BLOCK A)</u></p> <p>[3] <u>LIGHT FITTINGS AND ACCESSORIES</u> Supply and install DES approved light fittings as specified in the drawings and as indicated below or as per Engineer/SO requirement. All light fittings shall be provided with independent support to the structure and shall not depend to other system.</p> <p>Rates for light fittings shall be inclusive of providing a tape label with the circuit number identified and a strong adhesive used to bond the tape to the fittings. A system guarantee of 3 years by means of factory warranty certificate for all the light fittings.</p> <p>All LED light fittings offered must be of non degradable diffusers. All LEDs in the light fitting offered shall have a minimum lifetime to 70% luminous flux at 50,000 hours and shall be CREE, Nichia, Lumiled LEDs or approved equivalent. A system guarantee of 3 years by means of factory warranty certificate shall be submitted for all LED light fittings. Contractor to ensure LED light fitting offered shall met the design illumination requirement.</p> <p>Emergency packs are to be rated for a minimum of 2 hours duration or as specified and shall be non-maintained type.</p>					
A	F1 - 6W LED Inground uplight 3000K 20° to NVC NLED4203 or approved equivalent, mounted as shown in the drawing.	nos	19			
B	F8 - 9W LED Surface-mounted downlight white 3000K to NVC NLLED9184M or approved equivalent, mounted as shown in the drawing.	nos	21			
C	F10 - 12W LED Recessed downlight 6500K to NVC NDLED9314E or approved equivalent, mounted as shown in the drawing.	nos	48			
D	F19B - 8W LED Recessed round downlight 3inch 4000K white shield cover to NVC 8113A or approved equivalent, mounted as shown in the drawing.	nos	91			
E	F21B - 3W LED Recessed downlight 2inch 4000K to NVC 8112D matte white shield cover or approved equivalent, mounted as shown in the drawing.	nos	48			
F	F21C - 3W LED Recessed wall washer 2inch 4000K to NVC 8113A2 matte gold shield cover or approved equivalent, mounted as shown in the drawing.	nos	19			
G	F22 - 12W LED Recessed spotlight IP65 4000K to NVC NSPLED181W or approved equivalent, mounted as shown in the drawing.	nos	38			
H	F25D - 48W LED Circular luminaire 800mm dia 4000K gold 120° to Demilux Intevision 9063 800c/w necessary accessories or approved equivalent, mounted as shown in the drawing.	nos	5			
I	F38 - 6W LED Wall mounted luminaire 4000K to LUTEC CITY or approved equivalent, mounted as shown in the drawing.	nos	10			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
A	F39 - 1W LED recessed round Emergency lighting c/w 2hr battery backup to Maxspid Minnie or approved equivalent, mounted as shown in the drawing.	nos.	12			
B	F40 - 2x3W LED Wall mounted emergency lighting c/w 2hr battery backup to Maxspid Minnie or approved equivalent, mounted as shown in the drawing.	nos.	3			
To Collection:						
	<p style="text-align: center;"><u>COLLECTION</u></p> <p><u>PAGE</u></p> <p>NRG/E3 (Page 1/2) - - - - -</p> <p>NRG/E3 (Page 2/2) - - - - -</p>					
TO NRG/E3 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
NRG/E	<p align="center"><u>ELECTRICAL INSTALLATION FOR NON-REPRESENTATIONAL GRADE (BLOCK A)</u></p> <p>[4] <u>TELEPHONE SYSTEM</u></p> <p><u>Telephone Services Installation</u> Supply, install, test and commission telephone system in accordance with the specifications and drawings. All works herein shall be approved TelBru standards. Tenderer shall submit a complete detailed proposal including all equipment offered, catalogues and brochures together with this tender. The equipment and accessories listed below are for tendering purpose. The tenderer is to include all other equipment and accessories not included herein but deemed necessary to the intent of the specifications and requirement. Proposed brands for all the items shall be Dell/Cisco or equivalent.</p> <p>Bidder is to take note that the estimated quantity in this BOQ is for reference only. Bidder shall make necessary allowances and no additional claims will be allowed.</p> <p>A 4c FOC cable run from Fibre Joint Enclosure to FAT at Block A c/w necessary accessories.</p> <p>B Supply and installation of wall mounted FAT c/w suitable Splitters and other necessary accessories including termination, splicing of cables testing as shown and indicated in the drawing.</p> <p>C Supply and installation of wall mounted ATB c/w suitable Splitters and other necessary accessories including termination, splicing of cables testing as shown and indicated in the drawing.</p> <p>D Telephone point using 4 pair Cat 6 STP cable in concealed pvc conduit/trunking to outlets as shown and indicated in the drawing. Cost to include RJ45 shutter faceplate outlet, utility boxes, etc inclusive of termination at both ends, testing of Cat 6 cable, etc.</p> <p>E 2c single mode FO cable in concealed conduit for the interconnection between ATB, FAT etc, c/w termination, FO connectors, and other accessories.</p> <p><u>Computer Network Installation</u></p> <p>F Termination of telecommunication cable at FAT, ATB, ONT, TB, modem, etc. This include sufficient telephone cable module black, fibre optic termination kits, and label with all necessary accessories, etc.</p> <p>G Supply and installation of access point using 4 pair Cat 6 STP cable in concealed pvc conduit/trunking to outlets as shown and indicated in the drawing. Cost to include RJ45 shutter faceplate outlet, utility boxes, etc inclusive of termination at both ends, testing of Cat 6 cable, etc.</p> <p><u>Telephone & Computer Ducts</u></p> <p>H Allow costs for draw pit of 600 x 600 mm for telephone & fiber cable duct entry to building c/w chequered plate cover, draw rope, 2 way 100 dia uPVC with sealant at both ends as shown in the drawing.</p>					
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
A	Liaison with TelBru or relevant authorities on incoming telephone and fibre optic connection.	lot	1			
To Collection:						
	<p style="text-align: center;"><u>COLLECTION</u></p> <p><u>PAGE</u></p> <p>NRG/E4 (Page 1/2) - - - - -</p> <p>NRG/E4 (Page 2/2) - - - - -</p>					
TO NRG/E4 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
NRG/E	<p align="center"><u>ELECTRICAL INSTALLATION FOR NON-REPRESENTATIONAL GRADE (BLOCK A)</u></p> <p>[5] <u>FIRE ALARM SYSTEM</u> Supply and install Fire Alarm Devices as per specification and drawings. All fire alarm devices shall be Multon or equivalent of approved Bomba Vendors. <u>Self-contained fire alarm devices c/w battery, detector base, etc and other necessary accessories:</u></p> <p>A Smoke detector <u>Supply and install of fire extinguishers shall be SRI or equivalent.</u></p> <p>B 2.5 kg ABC dry powder extinguisher C Fire blanket</p>	no no no	8 6 6			
To Collection:						
	<p align="center"><u>COLLECTION</u></p> <p><u>PAGE</u></p> <p>NRG/E5 (Page 1/1) - - - - -</p>					
TO NRG/E5 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
NRG/E	<p align="center"><u>ELECTRICAL INSTALLATION FOR NON-REPRESENTATIONAL GRADE (BLOCK A)</u></p> <p>[6] <u>MATV SYSTEM</u> Supply and installation of MATV system as per drawings and specifications. Tenderer shall submit a complete detailed proposal including all equipment offered, catalogues and brochures together with this tender. The equipment and accessories listed below are for tendering purpose. The tenderer is to include all other equipment and accessories not included herein but deemed necessary to the intent of the specifications and requirement. Proposed brands shall be Ikusi/Televes or equivalent.</p> <p><u>Antennae/Headend, Distribution Equipment and Accessories</u></p> <p>A RTB Analog and Digital Antennae c/w necessary accessories inclusive steel mounting stand/ supports/ mast. lot 1</p> <p>B Headend MATV Amplifier c/w necessary accessories lot 1</p> <p>C Astro 65cm dish w/ Televes Quattro LNB or equivalent and necessary accessories inclusive steel mounting stand/ supports/ mast. lot 1</p> <p>D 5in, 5out Amplifier to Televes or equivalent lot 1</p> <p>E 5in, 8out/16out Multiswitch to Televes or equivalent lot 1</p> <p>F IF Tap-Off units to Televes or equivalent lot 1</p> <p>G Supply and installation for wiring of TV/SAT/FM 2 gang socket outlet by using of 2xRG6 (coaxial) cable in concealed conduit. (Proposed brand shall be of Belden or approved equivalent.) nos 6</p> <p>H Custom-made metal enclosure with hinged door for installation of amplifier and multiswitch c/w accessories. nos 1</p> <p>I Combiners, connectors and necessary accessories lot 1</p> <p>J Installation, termination, testing and commissioning for the whole system lot 1</p> <p><u>Conduit and Trunking Works</u></p> <p>K Allow cost for labelling and marking of all cables, tap -off units and splitters. lot 1</p> <p>L Supply and install hot dipped galvanised heavy duty cable trunking c/w all necessary supports. Trunking covers shall utilise a quarter turn screw. Trunking for shall be of different colour from lighting , power and other services. lot 1</p> <p>M Supply and install various lengths of 25Ø/32Ø PVC conduit as per drawing and where necessary cast/concealed in wall/slab. lot 1</p> <p>N Allow cost for the engineering, design proposal, shop drawing and catalogues for approval. lot 1</p> <p>O Testing and Commissioning of MATV System lot 1</p>					
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	<p style="text-align: center;"><u>COLLECTION</u></p> <p><u>PAGE</u></p> <p>NRG/E6 (Page 1/2) - - - - -</p> <p>NRG/E6 (Page 2/2) - - - - -</p>					
TO NRG/E6 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
NRG/E	<p><u>ELECTRICAL INSTALLATION FOR NON-REPRESENTATIONAL GRADE (BLOCK A)</u></p> <p><u>[7] LIGHTNING PROTECTION SYSTEM</u> Supply, Install, Testing and Commissioning of the following including all necessary termination/fixing accessories as per drawing of Electrical Services and specifications:- Bidder is to take note that the estimated quantity in this BOQ is for reference only. Bidder shall make necessary allowances and no additional claims will be allowed.</p> <p>A Air termination rod c/w the base. Make: D.E.S approved brand.</p> <p>B 25 x 3mm bare copper tape horizontal conductor c/w fixing accessories (saddle screws, square clamp, etc) run on roof level.</p> <p>C 1C x 70mm² down conductor in 50mm dia. uPVC conduit chased in wall/column. Make: D.E.S approved brand.</p> <p>D Oblong test joint clamp c/w recessed w/p termination box. Make: D.E.S approved brand.</p> <p>E Earthing pit c/w copperbond earth rod & H.D. cover. Make: D.E.S approved brand.</p> <p>F Testing and commissioning of lightning protection system.</p>					
To Collection:						
	<p><u>COLLECTION</u></p> <p><u>PAGE</u></p> <p>NRG/E7 (Page 1/1) - - - - -</p>					
TO NRG/E7 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
RG/E	<u>ELECTRICAL INSTALLATION FOR REPRESENTATIONAL GRADE (BLOCK B)</u>					
[1]	<u>SWITCHBOARDS AND LV RETICULATION MAINS</u>					
	<u>Sub-Switchboard / Distribution Boards</u>					
	Supply, install, test and commission factory assembled modular type tested Form 4 construction, front access IP42 (IEC) floor mounted metalclad board and other accessories as detailed in the drawings and specifications. (Cost to be inclusive of termination of all cables, including cable glands, lugs, etc. as per drawings/ specifications).					
	Distribution boards shall be constructed to Form I and IP42, electrical grounding, all necessary accessories as shown in the drawing, . All cable terminals shall be provided with numbered identification ferrules.					
	Cost quoted to be inclusive of termination of all incoming/ outgoing cables including cable gland, lugs, number ferrules, etc. as per drawings/specifications.					
A	SSB-RHB as per drawing	lot	1			
B	DB-BG1 as per drawing	lot	1			
C	DB-BG2 as per drawing	lot	1			
D	DB-BF1 as per drawing	lot	1			
E	DB-BF2 as per drawing	lot	1			
	<u>LV Reticulation Mains</u>					
	Supply and install submain cables as per drawings & specification.					
	Cost of hot dipped galvanised cable ladder, tray, trunking, required as specified shall be included in the pricing of cable. The size of cable ladder/cable tray and containment provided shall be adequate for cable spacings factor as per latest EIR and IEE Regulations.					
	Rates of cable laid underground shall include cost of trench excavation, sand bedding, pipesleeves, protective tile and reinstatement. Rates for cables shall be inclusive of cable identification tags at 10m intervals and at every bend.					
	Cost quoted to be inclusive of termination of all incoming and outgoing cables including cable glands, lugs, etc as per drawing and specifications.					
	Bidder is to take note that the estimated quantity in this BOQ is for reference only. Bidder shall make necessary allowances and no additional claims will be allowed.					
F	1x4c/700mm ² XLPE/SWA/PVC cable + 1c/35mm ² CPC laid underground, pipesleeves and cable tray from MSB to SSB-RHB.	lot	1			
G	4x1c/25mm ² PVC cable + 1c/16mm ² CPC laid in trunking c/w necessary accessories from SSB-RHB to DB-BG1.	m	20			
H	4x1c/25mm ² PVC cable + 1c/16mm ² CPC laid in trunking c/w necessary accessories from SSB-RHB to DB-BG2.	m	20			
I	4x1c/25mm ² PVC cable + 1c/16mm ² CPC laid in trunking c/w necessary accessories from SSB-RHB to DB-BF1.	m	30			
J	4x1c/25mm ² PVC cable + 1c/16mm ² CPC laid in trunking c/w necessary accessories from SSB-RHB to DB-BF2.	m	30			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
	<u>Miscellaneous and Related Works</u>					
A	Allow miscellaneous cost for concrete encased pipesleeves of 150mm dia for all road crossing, pipe jacking, hard standing areas, returfing, refurbishment and making good of existing ground.	lot	1			
B	Allow miscellaneous cost for providing floor openings, pipe sleeves through RC beams & slabs, fire stop barrier, fire seal pillows, etc for passage of sub-main cables, lighting and power wiring, telephone & computer system, fire alarm & fire protection system, water services, aircon services and other disciplines.	lot	1			
C	Allow cost for liaison with Authorities regarding power supply application and energization of the system.	lot	1			
To Collection:						
	<p style="text-align: center;"><u>COLLECTION</u></p> <p><u>PAGE</u></p> <p>RG/E1 (Page 1/2) - - - - -</p> <p>RG/E1 (Page 2/2) - - - - -</p>					
TO RG/E1 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
RG/E	<p><u>ELECTRICAL INSTALLATION FOR REPRESENTATIONAL GRADE (BLOCK B)</u></p> <p>[2] <u>GENERAL LIGHTING AND POWER SERVICES</u> Supply, installation and termination of light and power point in conduit/trunking as per drawing and specification.</p> <p>Rates for lighting and power point shall be inclusive of providing cable marker sleeved with the circuit number identified. Unless otherwise specified all switch plates and power point switch plate shall be of moulded white plastic range accessories approved by DES. CPC earth cable shall be provided inside back box and terminated with cable connector whether the switch plate is of plastic or of metallic range.</p> <p>Cost quoted to be inclusive of termination of all incoming/ outgoing cables including cable glands, lugs, etc as per drawing and specifications.</p> <p>NOTES:</p> <p>i) all utility boxes for switches, outlets, etc shall be of flush mounted, factory fitted with moulded brass nut and not of self tapping screw type.</p> <p>ii) conduit adapter fitted to boxes for use of switches, outlets, etc shall be with lock nuts and securely tightened.</p> <p>iii) all exposed conduit and flexible conduit inside ceiling voids shall be of color coded.</p> <p>iv) flexible conduit shall be of corrugated polyamide (nylon) flexible conduit and fittings shall be of manufacturer recommended.</p> <p>v) light fittings shall be of factory provided supports and brackets with independent hangers from other installations.</p> <p>vi) SSO switches are to T&J Electric "Radiance" White.</p> <p><u>Unless otherwise specified Color Code for Service Raceway & Conduits are as follows:</u></p> <p>- lighting and power - - - - - orange</p> <p>- fire detection - - - - - red</p> <p>- telephone & computer - - - green</p> <p>- PA system - - - - - yellow</p> <p>- security system - - - - - white</p> <p>- AC & BMS - - - - - blue</p> <p>A Lighting point c/w wiring in PVC conduit using 3x1c/1.5mm² PVC cable c/w 10A switch plate and gang as per switching arrangement shown in the lighting drawings.</p> <p>B Emergency lighting point in PVC conduit using 3x1c/1.5mm² PVC cable c/w key switch as shown in the drawing.</p> <p>C Exhaust fan wiring point in concealed PVC conduit using 3x1c/2.5mm² PVC cable c/w fused spur outlet similar to MK, Clipsal, Legrand or equivalent next to fan and switch at the door.</p> <p>D Power point in concealed PVC conduit using 6 nos 2.5mm² PVC cable as per single line diagram and terminated with the following outlets priced separately as below.</p>					
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
A	Power point in concealed PVC conduit using 3x1c/4mm² PVC cable as per single line diagram and terminated with the following outlets priced separately as below.	nos.	18			
B	13A single SSO mounted as shown in the drawing similar to MK, Clipsal, T&J white plastic finish or equivalent.	nos	3			
C	13A twin weatherproof SSO mounted as shown in the drawing similar to MK, Clipsal, T&J white plastic finish or equivalent.	nos	6			
D	13A twin SSO mounted as shown in the drawing similar to MK, Clipsal, legrand or equivalent.	nos	77			
E	15A single SSO using 3x1c/4mm² PVC cable mounted as shown in the drawing similar to MK, Clipsal, T&J white plastic finish or equivalent.	no	18			
F	Cooker SSO w/ neon indicator using 3x1c/6mm² PVC cable in concealed PVC conduit mounted as shown in the drawing.	no	4			
G	Water heater point in concealed PVC conduit using 3x1c/4mm² PVC cable c/w connection outlet and flush 20A DP switch and pilot lamp and marked "water heater" similar to MK Logic 5423 WH WHI, Clipsal, T&J or equivalent.	nos	12			
	<u>Miscellaneous and Related Works</u>					
H	Allow cost for circuit tagging and labelling of all cables and wiring circuits (incoming/outgoing cables and corresponding DB name) using numeric sleeves or self laminating wrapped around oil resistant nylon cable identification labels to brother, winco, brady, thorpe or approved equivalent. Labels shall apply to but not limited to the following: i) all DB, MSB, SSB, FAP, Tel & Computer, Secuty System, etc ii) socket outlets iii) switches iv) light fittings	lot	1			
To Collection:						
	<u>COLLECTION</u> <u>PAGE</u> RG/E2 (Page 1/2) - - - - - RG/E2 (Page 2/2) - - - - -					
TO RG/E2 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
RG/E	<p><u>ELECTRICAL INSTALLATION FOR REPRESENTATIONAL GRADE (BLOCK B)</u></p> <p>[3] <u>LIGHT FITTINGS AND ACCESSORIES</u> Supply and install DES approved light fittings as specified in the drawings and as indicated below or as per Engineer/SO requirement. All light fittings shall be provided with independent support to the structure and shall not depend to other system.</p> <p>Rates for light fittings shall be inclusive of providing a tape label with the circuit number identified and a strong adhesive used to bond the tape to the fittings. A system guarantee of 3 years by means of factory warranty certificate for all the light fittings.</p> <p>All LED light fittings offered must be of non degradable diffusers. All LEDs in the light fitting offered shall have a minimum lifetime to 70% luminous flux at 50,000 hours and shall be CREE, Nichia, Lumiled LEDs or approved equivalent. A system guarantee of 3 years by means of factory warranty certificate shall be submitted for all LED light fittings. Contractor to ensure LED light fitting offered shall met the design illumination requirement.</p> <p>Emergency packs are to be rated for a minimum of 2 hours duration or as specified and shall be non-maintained type.</p>					
A	F8 - 9W LED surface mounted downlight white 3000K to NVC NLLED9184M or approved equivalent, mounted as shown in the drawing.	nos	20			
B	F10 - 12W LED recessed downlight 6500K to NVC NDLED9314E or approved equivalent, mounted as shown in the drawing.	nos	14			
C	F17 - 18 LED T8 1200mm batten fitting to PHILIPS or approved equivalent, mounted as shown in the drawing.	nos	2			
D	F19B - 8W LED Recessed round downlight 3inch 4000K white shield cover to NVC 8113A or approved equivalent, mounted as shown in the drawing.	nos	60			
E	F21B - 3W LED Recessed downlight 2inch 4000K to NVC 8112D matte white shield cover or approved equivalent, mounted as shown in the drawing.	nos	28			
F	F21C - 3W LED wall washer 2inch 4000K to NVC 8113A2 matte gold shield cover or approved equivalent, mounted as shown in the drawing.	nos	14			
G	F22 - 12W LED Recessed spotlight IP65 4000K to NVC NSPLED181W or approved equivalent, mounted as shown in the drawing.	nos	20			
H	F25D - 48W LED Circular luminaire 800mm dia 4000K gold 120° to Demilux Intevision 9063 800 c/w necessary accessories or approved equivalent, mounted as shown in the drawing.	nos	4			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
A	F38 - 6W LED Wall mounted luminaire 24" white 4000K to LUTEC CITY or approved equivalent, mounted as shown in the drawing.	nos.	18			
B	F39 - 1W LED Recessed round emergency lighting c/w 2hr battery to Maxspid Minnie or approved equivalent, mounted as shown in the drawing.	nos.	18			
C	F40 - 2x3W LED Wall mounted emergency lighting c/w 2hr battery to Maxspid Minnie or approved equivalent, mounted as shown in the drawing.	nos	5			
To Collection:						
<p style="text-align: center;"><u>COLLECTION</u></p> <p><u>PAGE</u></p> <p>RG/E3 (Page 1/1) - - - - -</p> <p>RG/E3 (Page 1/2) - - - - -</p>						
TO NRG/E3 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
RG/E	<u>ELECTRICAL INSTALLATION FOR REPRESENTATIONAL GRADE (BLOCK B)</u>					
[4]	<u>TELEPHONE SYSTEM</u>					
	<u>Telephone Services Installation</u> Supply, install, test and commission telephone system in accordance with the specifications and drawings. All works herein shall be approved TelBru standards. Tenderer shall submit a complete detailed proposal including all equipment offered, catalogues and brochures together with this tender. The equipment and accessories listed below are for tendering purpose. The tenderer is to include all other equipment and accessories not included herein but deemed necessary to the intent of the specifications and requirement. Proposed brands for all the items shall be Dell/Cisco or equivalent.					
	Bidder is to take note that the estimated quantity in this BOQ is for reference only. Bidder shall make necessary allowances and no additional claims will be allowed.					
A	4c FOC cable run from Fibre Joint Enclosure to FAT at Block A c/w necessary accessories.	m	100			
B	Supply and installation of wall mounted FAT c/w suitable Splitters and other necessary accessories including termination, splicing of cables testing as shown and indicated in the drawing.	lot	1			
C	Supply and installation of wall mounted ATB c/w suitable Splitters and other necessary accessories including termination, splicing of cables testing as shown and indicated in the drawing.	lots	5			
D	Telephone point using 4 pair Cat 6 STP cable in concealed pvc conduit/trunking to outlets as shown and indicated in the drawing. Cost to include RJ45 shutter faceplate outlet, utility boxes, etc inclusive of termination at both ends, testing of Cat 6 cable, etc.	nos	8			
E	2c single mode FO cable in concealed conduit for the interconnection between ATB, FAT etc, c/w termination, FO connectors, and other accessories.	lot	1			
F	<u>Computer Network Installation</u> Termination of telecommunication cable at FAT, ATB, ONT, TB, modem, etc. This include sufficient telephone cable module black, fibre optic termination kits, and label with all necessary accessories, etc.	lot	1			
G	Supply and installation of access point using 4 pair Cat 6 STP cable in concealed pvc conduit/trunking to outlets as shown and indicated in the drawing. Cost to include RJ45 shutter faceplate outlet, utility boxes, etc inclusive of termination at both ends, testing of Cat 6 cable, etc.	nos	4			
H	<u>Telephone & Computer Ducts</u> Allow costs for draw pit of 600 x 600 mm for telephone & fiber cable duct entry to building c/w chequered plate cover, draw rope, 2 way 100 dia uPVC with sealant at both ends as shown in the drawing.	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
A	Liaison with TelBru or relevant authorities on incoming telephone and fibre optic connection.	lot	1			
To Collection:						
	<p style="text-align: center;"><u>COLLECTION</u></p> <p><u>PAGE</u></p> <p>RG/E4 (Page 1/2) - - - - -</p> <p>RG/E4 (Page 2/2) - - - - -</p>					
TO RG/E4 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
RG/E	<u>ELECTRICAL INSTALLATION FOR REPRESENTATIONAL GRADE (BLOCK B)</u>					
[5]	<u>FIRE ALARM SYSTEM</u> Supply and install Fire Alarm Devices as per specification and drawings. All fire alarm devices shall be Multon or equivalent of approved Bomba Vendors. <u>Self-contained smoke detector c/w battery, detector base, etc and other necessary accessories:</u>					
A	Smoke detector <u>Supply and install of fire extinguishers (SRI or equivalent)</u>	no	6			
B	2.5 kg ABC dry powder extinguisher	no	4			
C	Fire blanket	no	4			
To Collection:						
	<u>COLLECTION</u> <u>PAGE</u> RG/E5 (Page 1/1) - - - - -					
TO RG/5 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
RG/E	<u>ELECTRICAL INSTALLATION FOR REPRESENTATIONAL GRADE (BLOCK B)</u>					
[6]	<u>MATV SYSTEM</u> Supply and installation of MATV system as per drawings and specifications. Tenderer shall submit a complete detailed system proposal including all equipment offered, catalogues and brochures together with this tender. The equipment and accessories listed below are for tendering purpose. The tenderer is to include all other equipment and accessories not included herein but deemed necessary to the intent of the specifications and requirement. Proposed brands shall be Ikusi/Televes or equivalent.					
	<u>Antennae/Headend, Distribution Equipment and Accessories</u>					
A	RTB Analog and Digital Antennae c/w necessary accessories inclusive steel mounting stand/ supports/ mast.	lot	1			
B	Headend MATV Amplifier c/w necessary accessories	lot	1			
C	Astro 65cm dish w/ Televes Quattro LNBF or equivalent and necessary accessories inclusive steel mounting stand/ supports/ mast.	lot	1			
D	5in, 5out Amplifier to Televes or equivalent	lot	1			
E	5in, 8out/16out Multiswitch to Televes or equivalent	lot	1			
F	IF Tap-Off units to Televes or equivalent	lot	1			
G	Wiring of TV/SAT/FM 2 gang socket outlet by using of 2xRG6 (coaxial) cable in concealed conduit. Proposed brand RG6 cable shall be Belden or equivalent.	nos	6			
H	Custom-made metal enclosure with hinged door for installation of amplifier and multiswitch c/w accessories.	nos	1			
I	Combiners, connectors and necessary accessories	lot	1			
J	Installation, termination, testing and commissioning for the whole system	lot	1			
	<u>Conduit and Trunking Works</u>					
K	Allow cost for labelling and marking of all cables, tap -off units and splitters.	lot	1			
L	Supply and install hot dipped galvanised heavy duty cable trunking c/w all necessary supports. Trunking covers shall utilise a quarter turn screw. Trunking for shall be of different colour from lighting , power and other services.	lot	1			
M	Supply and install various lengths of 25Ø/32Ø PVC conduit as per drawing and where necessary cast/concealed in wall/slab.	lot	1			
N	Allow cost for the engineering, design proposal, shop drawing and catalogues for approval.	lot	1			
O	Testing and Commissioning of MATV System	lot	1			
To Collection:						
	<u>COLLECTION</u>					
	<u>PAGE</u>					
	RG/E6 (Page 1/1) - - - - -					
TO RG/E6 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
RG/E	<u>ELECTRICAL INSTALLATION FOR REPRESENTATIONAL GRADE (BLOCK B)</u>					
[7]	<u>LIGHTNING PROTECTION SYSTEM</u> Supply, Install, Testing and Commissioning of the following including all necessary termination/fixing accessories as per drawing of Electrical Services and specifications:- Bidder is to take note that the estimated quantity in this BOQ is for reference only. Bidder shall make necessary allowances and no additional claims will be allowed.					
A	Air termination rod c/w the base. Make: D.E.S approved brand.	nos.	8			
B	25 x 3mm bare copper tape horizontal conductor c/w fixing accessories (saddle screws, square clamp, etc) run on roof level.	m	180			
C	1C x 70mm ² down conductor in 50mm dia. uPVC conduit chased in wall/column. Make: D.E.S approved brand.	m	390			
D	Oblong test joint clamp c/w recessed w/p termination box. Make: D.E.S approved brand.	nos.	8			
E	Earthing pit c/w copperbond earth rod & H.D. cover. Make: D.E.S approved brand.	set	8			
F	Testing and commissioning of lightning protection system.	lot	1			
To Collection:						
	<u>COLLECTION</u> <u>PAGE</u> RG/E7 (Page 1/1) - - - - -					
TO RG/E7 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
TUC	<u>TESTS UPON COMPLETION</u>					
A	<p>Cost and expenses for the complete acceptance testing and commissioning of the entire M&E Services Installation to the satisfaction of the consulting engineers and authority.</p> <p>A complete testing and commissioning reports and test data shall be provided and documented for submission. Cost shall include all expenses for plant, tools, test instrument and agents, electricity, water, and factory's commissioning expenses for major equipment and relevant authorities inspection fees.</p> <p>The complete system testing and commissioning and documentation shall cover the entire installation under this contract but not limited to the following:</p> <ul style="list-style-type: none">- Main Switchboard and Control Panels- Air Conditioning System- Exhaust & Ventilation System- Electrical System- Fire Detection & Protection System- Telecommunication System- MATV System- Access Control & CCTV System- Specialist System- and all other works associated with other M&E services installation and works covered in main contract <p><u>Contract Comprehensive Maintenance</u></p>	lot	1			
B	<p>Provide all-in comprehensive and routine maintenance for the whole of Mechanical and Electrical Services Installation covering the twelve (12) months defect liability period or as stipulated in the contract including replacement of wear and tear and consumable parts.</p> <p>The contractor is required to produce record of monthly maintenance log sheets and trend log data of the entire system installation for record and for sign off by client for maintenance works performed.</p> <p><u>Submissions</u></p>	lot	1			
C	Submit design calculations and engineering drawings for major equipments, M&E services shop drawings coordinated with other services for review/ approval.	lot	1			
D	Submit necessary samples for review/ approval and display at site office where appropriate.	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
A	<u>As-Built Drawings and O&M Manual</u> Submit six (6) sets of hard copies final as-built record drawings, equipment engineering drawings properly bound in folder files along with soft copies and O&M manual and necessary parts replacements as recommended by manufacturer. Costs shall include spare parts lists of the major equipments, components and consumables. <u>List of O&M Manual</u> (A) Air -conditioning and Mechanical Ventilaiton (i) Equipment (ii) Pipe work (iii) Duct work (iv) Diffusers, grilles and dampers (B) Fire protection (C) Plumbing (D) Electrical (E) Telecommunication (F) Specialist Services <u>Content of O&M Manuals</u> a) SOP (normal operation, service, breakdown, emergency) b) Catalogues and technical literature c) Maintenance Schedule and checklist d) As-Built Drawings e) Consumables and spare parts list f) Contact Person in case of emergency g) Coordinanated Drawings /Schematic diagram/ IO list points h) Equipment certificate / calibration certificated / warning i) T&C report document	lot	1			
To Collection:						
	<div><div>COLLECTION</div><div>PAGE</div><div>TUC/1 - - - - -</div><div>TUC/2 - - - - -</div></div>					
TO TUC (8B) SUMMARY:						

LIFT SERVICES
(BILL OF QUANTITIES)

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
CH/L	<u>LIFT SERVICES INSTALLATION</u>					
	Supply, installation, testing and commissioning of passenger/fireman's lift as detailed in general specification, schedule of lift technical specification , requirements and finishes, drawings inclusive comprehensive warranty and maintenance for 12 months period.					
	<u>PASSENGER LIFT (SIGMA OR APPROVED EQUAL)</u>					
A	MRL - Motor Room Less Lift 13 persons capacity 885 kg) No. of stops: 2 Rated Speed: 1.0m/sec (60mpm) Door opening: 900mm (2 panel centre opening)	lot	1			
B	Emergency battery operated power supply with sealed type lead acid battery bank c/w battery charger and inverter for lift car lighting and ventilation and control (EBOPS).	lot	1			
C	All necessary equipment like COP,HPI/HBT as required. Provision for handicap use shall be included.					
D	Automatic Rescue Device operated power supply with leaded type lead acid battery bank c/w battery charge and inverter for emergency landing and rescue (ARD).	lot	1			
E	Lift supervisory and monitoring panel c/w master intercom and slave intercom at lift car and car machine.	lot	1			
F	Signal, power and control wirings from lift to lift supervisory and monitoring panel.	lot	1			
G	Automatic sump pump with integrated float switch (lift pit). Capacity: 2.5 l/s @ 4.5m(H) similar to Grundfos KP300 stainless steel submersible pump 450W/1ph/50Hz. Cost shall include 50 mm dia PVC piping discharge to nearest drain and piping connection c/w check valve as shown in drawings.	lot	1			
H	Galvanised iron (GI) cat ladder for lift pit	lot	1			
I	Lift Hoist Beams	lot	1			
J	Lift Power Distribution Board (DBS) as required.	lot	1			
K	Power and Lighting Services as shown in drawings for the servicing and maintenance lift and inside lift pits and sump power points.	lot	1			
L	To include the cost for interfacing with Fire Alarm Panel and lift system; i.e. laying of cables within the hoistway, interfacing, programming, testing and commissioning.	lot	1			
To Collection:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
A	All finishes like jamb door, hall indicators, wall finishesd, ceiling finished, handrails, floor finishes shall be to S.O. approval. <u>Miscellaneous and Related Works</u>	lot	1			
B	Preparation of 3 sets shop drawings, as-built drawings, operational & maintenance manuals, test reports, "PE" and safe operation certificate and 5 sets of landing door key, 5 sets of COP keys.	lot	1			
C	Permits, notices, fees, etc.	lot	1			
D	Protection of work, etc.	lot	1			
E	Cleaning up, etc.	lot	1			
F	Notices & sign boards, etc.	lot	1			
G	Inspection fees for Bomba's inspection	lot	1			
				To Collection:		
<u>COLLECTION</u>						
<u>PAGE</u>						
CH/L1 (page 1/2) - - - - -		-	-	-		
CH/L1 (page 2/2) - - - - -		-	-	-		
TO CH/L1 SUMMARY:						

Item No.	Description	Unit	Qty	Rate	Amount	
					\$	c
NRG/L	<u>LIFT SERVICES INSTALLATION</u>					
	Supply, installation, testing and commissioning of passenger/fireman's lift as detailed in general specification, schedule of lift technical specification , requirements and finishes, drawings inclusive comprehensive warranty and maintenance for 12 months period.					
	<u>PASSENGER LIFT (SIGMA OR APPROVED EQUAL)</u>					
A	MRL - Motor Room Less Lift 11 persons capacity 750 kg) No. of stops: 4 Rated Speed: 1.0m/sec (60mpm) Door opening: 800mm (2 panel centre opening)	lot	1			
B	Emergency battery operated power supply with sealed type lead acid battery bank c/w battery charger and inverter for lift car lighting and ventilation and control (EBOPS).	lot	1			
C	All necessary equipment like COP,HPI/HBT as required. Provision for handicap use shall be included.					
D	Automatic Rescue Device operated power supply with leaded type lead acid battery bank c/w battery charge and inverter for emergency landing and rescue (ARD).	lot	1			
E	Lift supervisory and monitoring panel c/w master intercom and slave intercom at lift car and car machine.	lot	1			
F	Signal, power and control wirings from lift to lift supervisory and monitoring panel.	lot	1			
G	Automatic sump pump with integrated float switch (lift pit). Capacity: 2.5 l/s @ 4.5m(H) similar to Grundfos KP300 stainless steel submersible pump 450W/1ph/50Hz. Cost shall include 50 mm dia PVC piping discharge to nearest drain and piping connection c/w check valve as shown in drawings.	lot	1			
H	Galvanised iron (GI) cat ladder for lift pit	lot	1			
I	Lift Hoist Beams	lot	1			
J	Lift Power Distribution Board (DBS) as required.	lot	1			
K	Power and Lighting Services as shown in drawings for the servicing and maintenance lift and inside lift pits and sump power points.	lot	1			
L	To include the cost for interfacing with Fire Alarm Panel and lift system; i.e. laying of cables within the hoistway, interfacing, programming, testing and commissioning.	lot	1			
To Collection:						

MECHANICAL AND ELECTRICAL
SERVICES
(SPECIFICATIONS)

AIR CONDITIONING AND
VENTILATION SERVICES
(SPECIFICATIONS)

SPECIFICATION FOR AIRCONDITIONING AND VENTILATION INSTALLATION

<u>ITEM</u>	<u>DESCRIPTION</u>	<u>PAGE</u>
SECTION 1	Design Information	D/1 - D/1
SECTION 2	General Specifications	GS/1 - GS/3
SECTION 3	DX & VRF Air Conditioning System	DX/1 - DX/12
SECTION 4	Automatic Control System	ACC/1 - ACC/4
SECTION 5	Electrical Requirements	(Refer to Elect'l Specs)
SECTION 6	Thermal & Acoustic Insulation	TA/1 - TA/4
SECTION 7	Noise Control & Vibration Elimination	NVC/1 - NVC/4
SECTION 8	Testing, Balancing & Commissioning	T&C/1 - T&C/6
SECTION 9	<i>Deleted</i>	-
SECTION 10	Ductwork & Air Distribution	DAD/1 - DAD/15
SECTION 11	<i>Deleted</i>	-
SECTION 12	Pipework	PW/1 - PW/9
SECTION 13	<i>Deleted</i>	-
SECTION 14	Service and Maintenance	S&M/1 - S&M/7
SECTION 15	<i>Deleted</i>	-
SECTION 16	Ventilating Fan	V/1 - V/3
SECTION 17	Central Station Air Handling Unit	AHU/1 - AHU/2

SECTION 1 : DESIGN INFORMATION**1.1 General**

Design Parameters:

- | | | |
|-----|------------------------------|---------------------------------------|
| (a) | Ambient : | 35°C DB/ 27.7°C WB |
| (b) | Indoor Air-conditioned Areas | 22°C DB \pm 1.0 °C; RH 55% \pm 5% |

SECTION 2 - GENERAL SPECIFICATION

2.1 Scope

This section of the Specification gives an overall view of the work to be carried, and Conditions and Regulations to be adhered to.

2.2 Scope of Work

The Contractor shall supply, install, commission and test the entire Air Conditioning and Ventilating System in accordance with the Specification and Tender Drawings and the *General Specifications for Air Conditioning Installation, December 1987* published by Department of Electrical Services.

The scope of works is for **Proposed Chancery, High Commissioner's Residence, Staff Residences and Auxiliary Facilities Building for the High Commission of India Brunei Darussalam**, but not limited to the following: furnishing of all labour, materials, drawings, catalogues and manuals, equipment and carrying out the installation, testing and commissioning of the Air Conditioning and Ventilating System.

The Contractor shall prepare all drawings as required by local authorities and include in his tender all costs incurred in submission. All testings required by the authorities shall be arranged by the Contractor and all costs incurred in all the testings shall be borne by the Contractor.

The Contractor shall be responsible for the separate earthing to all the switchboards installed by him.

2.3 System Description

2.3.1 *Dx Split and Inverter System*

The *Dx Split and Inverter System* shall be complete with AHU/FCU and its matching air-cooled condensing units and Inverter units, control electrical switchboard, control wiring, power cables, drain pipe, thermometers, pressure gauges, refrigerant pipe, valves and other necessary accessories required for the efficient and satisfactory operation of the entire system.

2.3.2 *Air Handling Units and Air Distribution System*

Furnish, install and commission where indicated on the Tender Drawings or as described in the Specification *Double Skinned Air Handling Units* and air distribution network. Ductwork shall be low pressure type. Noise levels within the air conditioned space shall not exceed the permissible limits recommended by the ASHRAE Standard.

2.3.3 *Ventilation And Exhaust System*

Supply, install and commission where indicated on the Tender Drawings or described in the specification the ventilation and exhaust system. The ventilation system shall provide sufficient fresh air not less than the quantity specified.

2.3.4 *Automatic Control System*

Provide complete automatic control system for the entire air conditioning and ventilating system as per Section 4.

2.4 Drain

Provide all drain pipings between relevant mechanical equipment and the adjacent drain points provided by others.

2.5 **Testing**

The Contractor shall perform pressure and performance testing of all equipment, pipework and ductwork forming part of the specified installation in accordance with *General Specifications for Air Conditioning Installations, December 1987* from Department of Electrical Services.

2.6 **Electrical Work**

Provide all electrical works associated with the mechanical installations as indicated in the Tender Drawings or as specified. These comprise switchboards, contactors, fuses; circuit breakers, relays, switchgears, indicating lights, wiring, fittings and equipment necessary for the proper functioning of all mechanical equipment and their control system in accordance with Section 5 herein.

2.7 **Concrete Plinths and Access Ladders**

The Contractor shall provide the miscellaneous incidental work associated with the above.

The extent of work is indicated in general terms on the Tender drawings or mechanical details which form part of this specification. These plans are listed in the Schedule of Drawings.

The Contractor shall ascertain for himself all exact dimensions, positions, heights and sequence of installations during the course of the works, either from the builder or through him from the suppliers of the specialised equipment so that full information and cooperation are obtained prior to the manufacture and installation of the various portions of his contract.

2.8 **Equipment and Materials**

2.8.1 *Locating Equipment*

All equipment within the buildings shall be entirely out of the way of lighting fixtures, doors, windows and other opening.

2.8.2 *Inspections & Tests*

The equipment and materials shall be inspected upon delivery. Equipment and appurtenances shall not be buried, concealed or insulated until they have been inspected, tested and approved.

All equipment, piping and accessories shall withstand the specified maximum test pressure. Tubes shall be plugged to prevent dirt and other unwanted materials from damaging the system.

2.8.3 *Guarantees*

All air conditioning and ventilating system shall be guaranteed by the Contractor for a period of Twelve (12) months from the date of final acceptance, viz. against defective materials and improper workmanship. Any part that fails, or any part of which failure become apparent within the said guarantee period shall be replaced promptly by the Contractor at his own cost.

2.8.4 *Time of Completion*

The Contractor shall complete the whole of the works covered by this specification, excluding defects liability and operational maintenance provisions, on or before the contract date for Practical Completion. The Contractor shall co-ordinate his work with the works of the Builder and shall comply with the Time Schedule prepared by the Builder.

2.9 **Operating and Maintenance Manuals**

The Contractor shall provide three (3) sets of comprehensive operating and maintenance manuals at the time of completion, in accordance with the *General Specifications for Air Conditioning Installation, December 1987* published by Department of Electrical Services.

- END OF SECTION 2 -

SECTION 3 - AIR CONDITIONING SYSTEM (PART 1)

3.0 DIRECT EXPANSION SYSTEM

3.1 Scope

This section of the Specification covers the provision of Direct Expansion Air Conditioning System.

3.2 Scope of Work

The Air Conditioning Nominated Sub-Contractor shall furnish, install, test and commission where shown in the Tender Drawings package direct expansion air conditioning unit in compliance with *General Specifications for Air Conditioning Installations, December 1987* from Department of Electrical Services, Negara Brunei Darussalam, except where otherwise specified.

The unit shall be delivered complete with condensing and fan coil units factory assembled and factory tested and the necessary accessories such as refrigerant filter drier, service valves, oil separator, muffler, solenoid valve, high and low pressure switches, under voltage and phase failure protection to ensure proper and smooth operation of the system.

3.3 Performance

Performance ratings of the unit shall comply with ARI Standard, ARI 210-74. The saturated suction temperature shall be $40 \pm ^\circ\text{F}$ and the saturated condensing temperature shall not exceed 105°F . The tenderer shall provide published performance data from the manufacturer. Where published combination ratings for the condensing units and the fan coil units are not available, system balance diagrams are to be provided, indicating clearly the saturated condensing temperature and saturated suction temperature.

3.4 System Components

3.4.1 Compressor

Reciprocating compressors shall be installed in accordance *General Specifications for Air Conditioning Installations, December 1987* as per DES requirements. Compressor shall be complete with high and low pressure safety switches, oil pressure switch and oil pressure regulating valve. Compressor motor shall have inherent thermal overload and overcurrent protection and be provide with under voltage and single phasing protection. Motors greater than 2 HP shall be 3 phase squirrel cage, totally enclosed type suitable for 415 Volt AC, 50Hz operation. Each motor shall have a rating of not less than 125% of the rated equipment brake horsepower, inherent overcurrent and shall be permanently lubricated. Motor winding shall have Class F insulation.

3.4.2 Air Cooled Condenser - General

Installation and selection of all air cooled condensers is to comply with *General Specifications for Air Conditioning Installations, December 1987* as per DES requirements.

The condenser shall be:-

- a) standard product of a well-known make.
- b) outdoor, low profile, heavy duty type and weather proof.
- c) complete with condenser coil, condenser fan, motor drives, moisture indicating glass, integral sub cooler and holding charge or refrigerant R-22.
- d) tested and rated in accordance with BS1586.

Condensing coil shall be constructed from seamless copper tubes and may either have copper or aluminium fins mechanically bonded to copper tubes with a maximum of 10 fins/inch. Coil shall be circuited for sub-cooling. The condenser shall be fitted with approved make propeller fans of ample capacity to provide the necessary air flow over the condensing coil arranged for vertical discharge. Fans shall be multi-blades type arranged so that the rotors may be removed from the unit without removing the casing and fan guards shall be provided for each fan. Fans shall be quiet in operation with tip speeds not exceeding 5,000 fpm. Fan bearing shall be ball or roller bearings rigidly mounted. Fan speed shall not exceed 1,000 rpm.

3.4.3 Evaporator Unit

Evaporator unit shall be complete with blower fan and cooling coil. Cooling coil shall be of direct expansion type complete with thermostatic expansion valve; constructed of seamless copper tubes of 1/2 in outside diameter mechanically expanded into the corrugated aluminium fins; designed and tested in accordance with the American National Standards Safety Code for Mechanical Refrigeration (ANS B9.1).

Fan shall be centrifugal type; have quiet operation; dynamically and statically balanced; of double width; designed for continuous operation at the maximum rated fan speed and motor horsepower. Fan shaft shall be solid steel, turned, ground and polished. Bearings shall be self-aligning and be provided with grease line extending to the drive side of the fan scroll.

Fan motor shall be totally enclosed fan cooled type and be provided with inherent thermal overload and overcurrent protection; class B insulation windings; power factor correction capacitor to achieve a minimum power factor of 0.85 operating at all load conditions; under voltage and single phasing protection; starter in accordance with DES requirements. Fan motor shall have sufficient capacity of not less than 20 per cent more than the fan brake-horse-power at design condition.

Condensate drain pain with 'Armaflex' type of insulation of thickness not less than 5/8 in thick shall be provided on each cooling coil.

3.5 Refrigerant Circuits

3.5.1 General

The refrigerant circuits, shall be designed and arranged in accordance with ASHRAE Standard and manufacturer's recommendation.

3.5.2 Design and Layout

The Nominated Sub-Contractor shall adhere to the circuit design, layout and pipe sizes as given in the drawings. A working layout drawing of the piping for the actual installation shall be prepared and submitted for the Engineer's approval, before installation of the pipes. Where pipe sizes differ from the Manufacturer's recommendation, the Air-Conditioning Nominated Sub-Contractor shall indicated clearly in his shop drawings.

The Nominated Sub-Contractor shall provide multiple independent refrigerant circuits for multiple (two or more) compressors system for easy part load and independent operations.

3.5.3 Suction Lines

3.5.3.1 General

Horizontal lines shall not be graded, but where a suction trap or suction line oil separator is provided, the suction line to the trap or oil separator shall have a grade of not less than 1/2 inch in 10 feet.

Suction piping shall be designed to give flexibility and to absorb the vibration from the compressors. Vibration shall not be transmitted to the building structure. At least three changes in direction shall be employed to achieve flexibility.

3.5.3.2 Suction Risers

Install double suction risers where load reduction affects the oil return or when multiple compressors are interconnected and controlled so that one or more may shut down while another continues to operate.

All vertical risers shall be sized for velocities that assure oil return at minimum load and total suction pressure drop shall be within practical limits and shall not reduce the cooling capacity required at design full load conditions.

3.5.4 Piping

a) Materials

Piping shall be Air Conditioning and Refrigeration (ACR) seamless copper tube as per BS 1306 - "Copper and Copper Alloy Pressure Piping System" and BS 2871 Part 2 and ANSI B9.1-1971 'Safety Code for Mechanical Refrigeration' Clause 9.3.

The wall thickness of copper tubes shall not be less than the thickness given in the following tables.

Outside Diameter (in)	Nominal Tube Size (in)	Type	Wall Thickness (in)
1/4	c	Soft 'K'	0.030
d	1/4	Soft 'K'	0.035
1/2	d	Soft 'K'	0.049
e	1/2	Soft 'K'	0.049
3/4	e	Hard	0.042
f	3/4	Hard	0.045
1 c	1	Hard	0.050
1 d	1 1/4	Hard	0.055
1 e	1 1/2	Hard	0.060
2 c	2	Hard	0.070
2 e	2 1/2	Hard	0.080
3 c	3	Hard	0.090
3 e	3 1/2	Hard	0.100
4 c	4	Hard	0.110
5 c	5	Hard	0.125

Type K shall be used for high pressure piping and Type L for 'Low side' piping. All buried underground piping shall be type 'K' hard drawn.

Tubes shall be supplied sealed and shall remain sealed from manufactured to installation.

b) Pipe Joints

Pipe joints shall of the following types :-

i) Brazed (Capillary) Joints

Joints shall be of the socket type in which the joint is made by the flow of brazing alloy by capillary action along the annular space between the two mating surfaces. Joints shall be made by either forming a socket in the end of one of the pipes to be joined or by use of a capillary fitting complying with Clause 3.6.6 (c). Forming a socket in the end of the pipes shall be done by heating and by use of approved forming tools. Joints made by belling the end of one of the tubes to be joined are not acceptable.

The brazing alloy shall be of the silver-copper-phosphorus type containing not less than 15% silver. Tubes to be jointed shall be cut so that the ends are perfectly square. There shall be no gaps left through which alloy can run into the line.

If possible, a pipe cutter shall be used. If a hack saw must be used, it shall always be guided with a mitre box to ensure a square even cut. Tubing shall be reamed to remove burr, being careful not to expand tubing while reaming. The mating surfaces where brazing alloy will be applied should be burnished until all dirt and oxide are removed.

Fine crocus cloth or fitting brushes especially made for this type of work shall be used. Inaccessible internal surfaces shall be cleaned with white spirit. Mating tubes shall overlap for a sufficient length to ensure that the joint will develop a strength equivalent the strength of the tube. The diametral clearance in the joint shall be approximately 0.005 inch to 0.010 inch.

Dry nitrogen shall be used to purge all air from the tubes before brazing. During the brazing process, a flow of nitrogen shall be maintained through the tubes to prevent oxidation. The nitrogen flow shall be kept to a minimum consistent with the making of a good clean joint free of oxidation on the internal tube surface.

ii) Flare Compression Joints

Flare compression fittings may be used for tubes up to and including 3/4 inch O.D. Tubes shall be fully annealed at the flare before and after flaring and shall seal without being strained.

Fittings shall comply with BSS 2051 Part 2, "Tube and Pipe Fittings for Engineering Purposes" and shall be of copper or copper alloy. They shall be of a type which maintains the full bore of the pipe. "Frost Proof" nuts shall be used. Flare fittings shall not be used where vibration occurs, or in positions where the piping is built-in or inaccessible.

c) Tube Fittings

i) Brazed (Capillary) Fittings

These fittings include bends, tees, sockets and the like which are of the type in which the joint is made to the tube by the flow of brazing alloy by capillary action along the annular space between the outside of the tube and the inside of the socket fitting.

Fittings shall be of copper of suitable corrosion resisting copper alloy, shall be of approved manufacture and shall be suitable for use in refrigeration piping. Fittings may be supplied with or without a groove containing silver brazing alloy.

The socket of each fitting shall be a close fit on the tube to which it is to be connected with a clearance in the annular space of approximately 0.005 inch to 0.019 inch and the length of the socket shall be such that the finished joints will develop sufficient strength for the service required.

d) Bends

For 90° bends, tubes up to and including ¾ inch O.D. may be bent to shape. Above ¾ inch O.D. bent tubes will be accepted and bend fittings complying with Clause 3.6.6 (c) shall be used. Bends shall be of long radius unless space limitations prevent their use, in which case, short radius may be used. The bending of tubes shall be carried out in an approved manner and care shall be taken to prevent malformation or damage to the structure of the materials. The inside radius of bent tubes shall not be less than two times the tube diameter.

Valves shall be of the packed back seating, key operated type fitted with suitable screwed sealing caps. Valves shall be forged brass construction where possible but cast iron or steel or cast brass valves may be approved. Precautions shall be taken to prevent valve distortion whilst the joint is being heated. Valves for pipes less than ¾ inch O.D. may be connected to tube by approved compression fittings, provided there is no vibration at the fittings. Valves for pipes over ¾ inch O.D. shall be capillary soldered connections.

3.5.5 Thermostatic Expansion Valves

Each thermostatic expansion valve shall be of diaphragm type fitted with an external equaliser bulb and tubing and adjustable external superheat control with seal cap. Thermostatic expansion valves shall have flare connections. The equaliser line shall be connected into the suction line adjacent to and on the compressor side of the remote sensing bulb. Connections to horizontal lines shall be made from the top to prevent oil logging.

The valve shall be tested and rated in accordance with BS 4740 Part1. Each expansion valve or its working parts shall be easily removable for cleaning. All adjusting screws etc., shall be fitted with sealing caps. A small easily removable strainer shall be incorporated in each expansion valve. Each expansion valve shall be individually adjusted to give minimum superheat at each coil suction header consistent with "dry gas" being delivered to the compressor. The thermal bulb shall be clamped securely to the suction pipe as recommended by the valve manufacturer to ensure intimate contact and rapid response.

3.5.6 Refrigerant Filter Drier

An angle-replaceable core type filter drier shall be installed in each liquid line. The filter drier shall be installed in each liquid line. The filter drier shall be sized for a maximum of 2 psi pressure drop at the design conditions. Filter drier shall have flare connections. After the system has been operating for one month, the filter drier core shall be discarded and shall be replaced by a new filter drier core.

3.5.7 Compressor Safety Controls

Each compressor shall be fitted with a combined high and low pressure safety cutout switch with manual re-set on both high and low side.

The high discharge pressure and low suction pressure cutout shall be connected to the compressor side of the isolating valves.

3.5.8 Refrigerant

Refer to *General Specifications for Air Conditioning Installations, December 1987*.

Pressure Testing will be carried out in compliance with *General Specifications for Air Conditioning Installations, December 1987*.

a) Initial Pressure Test

Upon completion of erection, the refrigeration circuit, except for pressure gauges, controls, and compressors, which may be valved off, shall be pressure tested with dry inert gas at the following pressures for the particular refrigerant to be used.

Refrigerant	Test Pressure	
	High Pressure Side	Low Pressure Side
R - 12	235 psig	140 psig
R - 22	435 psig	230 psig

A quantity of refrigerant should be added to the test gas to enable any leakage to be easily detected with a halide torch or electronic leak detector. If refrigerant is not added to the test gas, all joints, flanges and the line shall be tested for leaks with a mixture of four parts water, one part liquid soap and a small amount of glycerine, the mixture to be applied with a brush.

b) Repair of Leaks

Where leaks are detected, they shall be marked and repaired after the pressure of the system has been released. Brazed joints which leak shall be opened and re-made and shall not be repaired by the addition of silver brazing alloy to the joints. Component parts leaking from porosity shall be replaced.

c) Final Pressure Test

After all leaks have been repaired, the system shall be re-tested, with the test pressure maintained for a period of not less than 8 hours. No measurable drop in pressure should be detected after pressure measurements have been adjusted for temperature changes.

3.6 Installation and Erection of Refrigerant Systems

3.6.1 Piping Arrangement and Sizes

When final working drawings have been prepared by the Nominated Sub-Contractor and approval of the drawings has been received in writing from the Engineer, all work shall be in accordance with these drawings. Where the Engineer has arranged for modifications to the drawings, the modified drawings shall be adhered to without alteration.

3.6.2 Sealing of Tubes

Tube ends shall be plugged or kept closed at all times before installation and where practical; during construction, to prevent ingress of moisture and foreign matter.

3.6.3 Cleaning & Grading

Particular attention shall be paid to removing all dirt and foreign matter including flux, swarf and turnings from tubing and to keeping it dry.

Tubing shall be arranged in a workmanlike manner, true to alignment and grade - crooked or sagging tubing will not be accepted.

3.7 Condensate Drains

The insulation to be used on all condensate drain piping shall be chemically blown P.V.C. nitrile black-coloured rubber sponge type of material having a thermal conductivity not greater than 0.30 BTU/Hr/Sq.Ft/in/°F at a mean temperature of 75°F. It shall be supplied in tubular form, preferably without a longitudinal joint. The insulation shall be 1/2"-inch thick unless otherwise specified.

SECTION 3 - AIR CONDITIONING (PART 2)

3.8 VARIABLE REFRIGERANT FLOW

3.8.0 General Description of Works

The air-conditioning system shall exhibit 'Capacity Control' operating features providing very efficient energy conservation and maximum comfort to the users.

The system shall be air-cooled, variable refrigerant flow system consisting of modular outdoor units and multiple indoor units, each having capability to cool or heat at a time and serving the different requirements of the rooms and users.

The system shall be equipped with variable refrigerant flow controller, enabling to control the smallest indoor unit of 2.2 kW alone and the largest indoor unit of 28.0kW alone, without the aid of the hot gas by-pass system or variable air volume system.

The air-conditioning system of a particular zone shall automatically adapt to the number of fan coil units turned on by the room tenants. The system shall allow user-driven operating environment to be established where users can directly request their own choice of temperature, on / off, etc.

The condensing units shall be suitable for mix-match connection of 1-way air discharge cassette type, 2-way air discharge cassette type, 4-way air discharge cassette type, 4-way air discharge compact type,

, concealed ducted standard type, concealed duct high static pressure type, concealed duct slim type, under ceiling type, high wall type, floor standing cabinet type, floor standing concealed type, floor standing tall type and fresh air intake indoor unit type indoor units as shown in the drawing.

The condensing units shall be able to connect to a maximum of 13 indoor units for 8-HP system and 48 indoor units for the 48-HP system that is subjected to the maximum of 135% connectable outdoor / indoor capacity ratio.

The actual refrigerant piping length shall be extended up to 190 m (one way), and the equivalent refrigerant piping length shall be up to 235 m. The equivalent length of farthest piping from the 1st branch shall be 90m. When the outdoor unit is installed higher than the indoor unit, the vertical lift shall be up to 70 m, and when the outdoor unit is installed lower than the indoor unit, the vertical lift shall be up to 40m at the maximum case. The level difference between the indoor units shall be up to 40 m. Any oil traps shall not be required for the refrigerant piping system.

The piping branching flexibility shall be applicable any of Y-joint branching, header joint branching, header branching after Y branching, Y branching after header branching, header branching after header branching.

The system shall be suitable for operating on 230 (220-240) Volts / 50 Hz / 1 phase for fan coil unit and 400 (380-415) Volts / 50Hz / 3 phase for the condensing unit.

3.8.1 **REFRIGERANT**

The equipment shall run HFC refrigerant R410A , not on CFC or HCFC refrigerant.

3.8.2 **AIR COOLED CONDENSING UNIT**

The condensing unit shall be a factory-assembled unit consisting of individual compressor-condenser section and condenser fan housed in a sturdy weatherproof casing constructed from galvanized steel bonderised and finish with baked resin paint.

The chassis dimension is standardized as two type modular chassis with small capacity models and large capacity models. But the anchor bolt pitch is same as both models and previous model(SMMS). Therefore the chassis is for easier installation layout and easier handling in stock,moving.

Panel shall be easily removable to provide access for servicing. The condensing unit shall be fitted with its own electrical compartment with all necessary electrical and control components.

The condensing unit shall be designed to operate safely when connected to multiple fan coil units, which have a combined operating nominal capacity varying from 50 % to 135 % of indoor units. However, the actual system capacity shall increase up to maximum 110 % against outdoor cool capacity when outdoor / indoor cooling capacity ration of 135%.

The noise level for each unit shall not be more than 55 dBA (8HP single),57dBA(10HPsingle),59dBA(12HPsingle),60dBA(14HPsingle),61dBA(16HPsingle)and 66dBA (48HP 4 modular system) for system in cooling, which is, measured horizontally 1 m away and 1 m above ground at the standard conditions.

The condensing unit shall be modular in design and should be allowed for side by side installation with provision for piping connection at the front or at the bottom.

3.8.3 **COMPRESSOR**

The compressor shall be a highly efficient hermetic type DC twin rotary inverter compressor system of two(8 to 12HP)/three(14 to 16HP) independent system in a condensing unit ,which can control capacity seamlessly, also enables rotation operation of the two/three in the condenser unit for higher reliability by reducing imbalance in operating hours and start-up times of the two/three.

It shall be equipped with vector controlled inverter unit for both/triple compressors together with electronic expansion valve in the refrigerant circuit to precisely control the refrigerant volume and maintain comfort level in accordance to the room load requirement.

And it also has ultra-precise 0.1 Hz control over compressors rotation speed. Infinity variable control adjusts compressor rotation speed in near-seamless 0.1 Hz steps. Responding precisely to the capacity needs of the moment, this fine control minimizes energy loss when changing frequencies, and also creates a comfortable environment subject to minimal temperature variations.

3.8.4 **CONDENSER COIL**

The condenser coil shall be constructed with copper tubes mechanically bonded to aluminum fins. The condenser shall have large face area to minimize noise give a high COP for heat transfer. The sub-cool heat exchanger is equipped with the main heat exchanger for higher COP .The condensing unit shall be chemically coated with fins.

3.8.5 **CONDENSER FAN AND MOTOR**

The Condenser fan shall be of multi-blade low noise level type and dynamically and statically balanced for minimum noise and vibration with recessed circular arc shape blade to reduce turbulence at blade end edge for higher fan efficiency.

The condenser fan shall be directly coupled and driven by drip proof permanently lubricated DC motor. The condenser fan and motor shall be able correspond to the heat load changes by stepping up or down according to the load requirements.

3.8.6 **REFRIGERANT CIRCUIT**

The refrigerant circuit shall include an accumulator, liquid tank, oil separator, oil tank, liquid, and gas shut off valves, solenoid valves and an electronic expansion valve. All necessary safety devices should provided to ensure the safety operation of the system.

3.8.7 **ACCUMULATOR**

The cylindrical accumulator shall be constructed from mild steel plates pressed into shape. The accumulator shall have sufficient capacity to prevent any liquid refrigerant from flowing back into the compressor suction.

3.8.9 **SAFETY DEVICES**

The following safety devices shall be part of the condensing unit:

- High pressure switch
- Fuses
- Crankcase heater
- Fusible plug
- Over current relay for the compressor
- Thermal protectors for compressor and fan motor
- Recycling guard timer
- Oil Recovery system
- Oil level sensor
- Over-current sensor
- Compressor suction and discharge temperature sensor
- Compressor suction and discharge pressure sensor

3.8.10 **PRESSURE TESTING**

Upon completion of installation, the entire refrigerant circuit shall be subject to a pressure test of 3.73MPa(38kg / cm²)for at least 24 hours without any drop in pressure. Nitrogen gas shall be used in pressure testing.

3.8.11 **OIL MANAGEMENT SYSTEM**

Unit shall be equipped with oil management system to ensure stable operation with long refrigerant tubing.

The system shall contain self oil balance circuit , oil supply control, inter-unit oil supply control with the aid of oil level detection.

The oil retrieval control through the indoor units is also conducted.

3.8.12 **FAN COIL UNITS**

Each fan coil unit shall be of 1-way air discharge cassette type, 2-way air discharge cassette type, 4-way air discharge cassette type, 4-way air discharge compact cassette type, concealed ducted standard type, concealed duct high static pressure type, concealed duct slim type, under ceiling type, high wall type, floor standing cabinet type, floor standing concealed type, floor standing tall type and fresh air intake indoor unit type indoor units.

Each fan coil unit shall be connectable with a self-diagnosis remote controller and having the features of setting of the room temperature (with digital indicator of room temperature), timer, air discharge direction (for cassette units, ceiling unit, high wall unit), auto and 3 fan speed selection self diagnosis circuit with malfunction code display.

The ceiling recessed type fan coil units must be equipped with condensate drain- pump.

3.8.13 **COOLING COIL**

The coil shall be constructed from strong clean copper tubes bonded to aluminum fins suitably spaced to ensure maximum heat transfer. The inlet of the coil shall be exceptional low to ensure quiet operation.

3.8.14 **ELECTRONIC REFRIGERANT CONTROL VALVE**

An electronic expansion valve shall be factory brazed to the inlet of the coil. It shall modulate the refrigerant volume continuously in respond to load variations of the room. Thus, maintain a precise constant temperature of ± 0.5 C.

3.8.15 **EVAPORATOR FAN**

The evaporator fan shall be of the multi-blade type with its performance designed to match the coil performance. The fan shall be statically and dynamically balanced to ensure low noise and vibration operations. It shall be driven by a permanently lubricated motor and shall operate on 220 -240 volts single phase 50 Hz.

3.8.16 **CONTROL**

The system shall be microprocessor controlled to achieve precise room temperature control and minimum power consumption. The controls system shall employ algorithm temperature control and shall have an accuracy of ± 0.5 C.

The control system should connected by using 2-core cable with non-polarity BUS transmission system (outdoor-outdoor, outdoor-indoor.)

In addition, the checking function for connection error of wiring must come standard with the system.

Micro-processor control shall be used to maintain a correct room temperature with minimum power consumption. Unit shall be equipped with automatic fan speed and its own 3 speed fan controller, thermostat, LCD indicators.

It also is equipped with a self- diagnosis circuit for easy and quick maintenance and service. It shall also be able to indicate malfunction code displays.

3.8.17 **CENTRAL REMOTE CONTROLLER SYSTEM**

A centralized control system shall consist of a Central Remote Controller and a Schedule Timer. They shall be provided to control all the functions of the indoor units either together as a central control system or individually as specified.

The function of each controller should be follows:

3.8.18 **CENTRAL REMOTE CONTROL**

It should be able to control up to 128 indoor units with two buses . It can separate into maximum 16 zones; moreover, each zone can be controlled individually.

It should be able to function as follows.

- a) Temperature setting for each Fan Coil Unit of group or zone
- b) Air Flow setting for each Fan Coil Unit of group or zone
- c) Fault indication of each Fan Coil Unit of group
- d) It should be able to ON / OF each individual or zone
- e) It should also have the function to ON or OFF the entire system
- f) Remote controller less system is available
- g) Alarm indicator and external operation output are available (no-voltage dry contact)
- h) Maximum wiring length of two kilometer.

3.8.19 **SCHEDULE TIMER**

The timer should be able to connected to each central remote controller or each remote controller. It should have the following functions as schedule timer mode :

- a) 6 programming per day
- b) Enabling 8 groups to be programmed
- c) A maximum of 64 indoor units can be controlled
- d) A maximum of 100 hours back-up power supply

3.8.20 **SOFT START**

All condensing units shall be soft-start at to ensure low starting current.

The rotary compressor shall be to start at the minimum load and increased to the required power (refrigerant volume) according to the actual load requirement, without large star-up current during switching into two compressor operation.

A recycling guard timer shall be provided to prevent the compressor to restart again immediately after it was stopped.

3.8.21 **AIR FILTER**

Resin net (washable) type air filter shall be provided for under ceiling type, hi-wall type and floor standing type fan coil units.

Long life type air filter shall be provided for cassette type fan coil units. The return air filter shall be of approved low velocity cleanable type with the material having the following characteristics:-

- a) Odorless
- b) Temperature resistant up to a continuous of 85 degree C
- c) Humidity resistant up to a continuous RH of 95 %

The filter shall be supported in a resin filter frame. The thickness of the filter shall be such that it possess as an efficiency rating of 15 % (AFI) as measured by the atmospheric dust spot test in accordance with JIS B-9908.

The air filter shall have a minimum effective life of 2500 hours.

3.8.22 **REFRIGERANT PIPING**

All refrigerant piping for the air conditioning system shall be constructed from hard drawn seamless copper refrigerant pipes with copper fittings and silver-soldered joints. The refrigerant piping arrangements shall be in accordance with good practice within the air conditioning industry, and are to include expansion valves, solenoid valves, shut off valves, strainers, charging connections, suction line insulation and all other items normally forming part of proper refrigerant circuits.

The air-conditioning contractor will entirely responsible for the correct refrigerant piping design and the proper interconnections of the complete refrigerant circuit.

The suction line pipe size and the liquid line pipe size shall be selected according to the manufacturer's specified outer diameter. All refrigerant pipes shall be properly supported and anchored to the building structure using steel hangers, anchors, brackets and supports which shall be fixed to the building structure by means of inserts or expansion shields of adequate size and number to support the load imposed thereon.

Additional charge of refrigerant for the piping way of the air conditioning system shall be furnished and installed by the air conditioning contractor on site.

3.8.23 **PIPE INSULATION**

a. Refrigerant Pipe Insulation

The whole of the liquid and suction refrigerant lines including all fittings, valves etc. shall be insulated with foamed polyethylene of an adequate thickness.

b. Drain Pipe Insulation

Drain pipes carrying condensate water shall be insulated with foamed polyethylene of an adequate thickness

- END OF SECTION 3 -

SECTION 4 - AUTOMATIC CONTROL SYSTEM

4.1 Scope

This section of the Specification covers the provision, commissioning and testing of automatic control systems for the Air-Conditioning and Ventilating Systems. All installation shall be carried out in accordance with *General Specifications for Air Conditioning Installation, December 1987* published by Department of Electrical Services. It also covers items of instrumentation used.

4.2 General

- a) The Contractor shall engineer, supply and install all automatic control systems inclusive of all labour, material and equipment in accordance with the Specification.
- b) All controls, except those supplied as 'Original Equipment' by the equipment manufacturer, shall be the standard product of one reputable control manufacturer.
- c) All controls shall be of the same manufacture. Where this is not practicable, proposed controls not of the same manufacture as the majority of controls shall be approved by the Engineer prior to installation. Any such alternative controls installed without prior approval of the Engineer may be rejected and required to be replaced without cost to the Employer.
- d) All automatic controls shall be installed, set and commissioned by personnel fully trained and experienced in this field and such personnel shall preferably be employees or representative of the control equipment manufacturer.
- e) The automatic control systems shall be complete, including all necessary thermostats, relays, manual switches, controllers, control valves, actuators, dampers, damper motor, auxiliary contacts, thermal overloads, piping, wiring and all auxiliary items necessary to perform the intended operation as specified irrespective of failure to mention in the Specifications or to show on the drawings each individual item.
- f) Submit shop drawings for examination showing schematic and wiring diagrams and components for all control systems.
- g) All electrical components of the automatic control system shall have the approval of all authorities, including DES, having jurisdiction over the works.
- h) All motors, controllers, relays and operating mechanism shall be so located as to be readily accessible for maintenance. Supply and install access doors for this purpose.
- i) Equipment will not be accepted without identifying name plate or stencil.
- j) The Contractor shall be responsible for the correct setting, calibration and adjustment to conform with the design conditions as specified. All calibrations for the controllers shall be carried out by the manufacturer's representative.
- k) All controls as manufactured by Honeywell, or approved equal shall be installed in strict accordance with the manufacturer's instructions and fully automatic in operation.
- l) The Contractor shall train the Employer's representatives in the proper operation and maintenance of the system. He shall furnish to the Employer's operating personnel 5 days of on-the-job training or longer period when necessary and turn over to the Employer two complete sets of written operating instructions, as-built drawings, specification data sheets and maintenance schedules. Furnish another set of the same to the Engineer.

4.3 **Coordination of Work**

Setting and commissioning of the Automatic System control shall be done in conjunction with testing and balancing of the Air-Conditioning and Ventilation System. Personnels engaged in these functions shall be required to coordinate their work. The Contractor shall be responsible for ensuring the coordination of these operations.

4.4 **Labels**

All controls shall be provided with ivorine labels engraved to indicate the function of the particular item. Labels shall be of minimum height ½ in. and shall be black with ¼ in. white lettering. The use of metal embossed tapes will NOT be permitted. Labels shall be fixed with approved steel escutcheon pins. Fixing by adhesives will NOT be accepted.

4.5 **Local Panels**

Provide local start-stop switches for all air-conditioning and ventilating equipment. Local panel shall be constructed of gal. steel of minimum thickness 14 BSWG. It shall be secured to walls, columns or floors with ample clearance at the rear for access to piping and wiring. Identify each piece of panel by name-plates, either plastic or metal and attach to the panel or integral with it. Cut lettering into the plate to a depth of not less than 1/64 inch and produce a contrasting colour. Painting of lettering directly on the surfaces of the plate or panel will not be permitted. Mount all control devices, relays and switches other than thermostats and motors on the control panel.

4.6 **Shop Drawings**

Include complete schematic control diagrams. Diagrams shall show a large scale outline of each air handling unit, chiller control circuit, cooling tower control circuit, pump control circuit and other auxiliary control circuit with control devices correctly located thereon and piping and wiring shown. Item numbers shall correspond with those shown on the drawings. Frame on set corrected control diagrams under glass and mount where directed.

4.11 **Automatic Controls**

4.11.1 **General**

The automatic control system shall be of electronic and/or microprocessor-based type, as per *General Specifications for Air Conditioning Installation, December 1987* published by Department of Electrical Services.

All controllers for modulating functions shall be of proportional integral (PI) action type unless specified otherwise.

4.11.2 **Room Temperature Controller (Room Thermostat)**

The room type temperature controller for air handling units shall be proportional integral (PI) type with a control output of 2-10 volts. Installation of the thermostat should be in accordance with *General Specifications for Air Conditioning Installation, December 1987* published by Department of Electrical Services.

4.11.3 **Temperature Sensors**

All temperature sensors used in conjunction with controllers shall be of Platinum RTD type with an internal resistance of 2,000 ohms.

Water temperature detector shall be of the Platinum RTD type and shall be complete with integral copper pocket for pipe mounting.

4.11.4 Low Voltage System

- a) All controllers and actuators shall be of the low voltage type and shall operate on 24 volts, 50 Hertz and single phase.
- b) The low voltage supply shall be limited to one transformer for a maximum of 3 motors of single transformer for each motor. The transformer shall be supplied by the controller's manufacturer.

4.11.5 Electronic controllers (Single, Dual or 3 input)

Controllers shall be of the electronic type; modular in form and module cassette system and shall be mounted in lockable casing with transparent cover controllers mounted in steel cubicles; suitable for standard dia-rail mounting; accept input signals of the thermistor type and shall have output of 2-10 volts; have built-in energy-saving designs; of P.I. type. Each controller shall have single or multiple outputs for sequencing of motors and shall be equipped with high and low limit travels, high and low limit temperature settings.

4.12 Control Wiring

Control wiring shall be run in galvanised steel conduit for thin-wall metal tube galvanised. Provide all wiring to perform the function specified. Power supply wiring for all electronic panels shall be not less than 0.0045 inch in diameter. They shall be run directly from the respective main air conditioning switch board or form an auxiliary distribution panel and the shielded cables shall be connected to the earth of the main building service panel. In no case the power supply neutral wire be used for earthing connection.

4.17 Relays

Relays shall be of open-contact type, mercury-tube type of electronic type and they shall be totally enclosed in steel cabinets with conduit connections. Their capabilities shall be as specified for thermostats.

4.18 Contact

Contact shall be of fine silver or other approved non-rusting metal and, if they carry the current of a running valve motor or a running damper motor, or if they start motor driven machines, they shall be snap acting which shall be accomplished by springs or magnets.

4.20 Test Switch for Indicating Light

Provide a push-to-make switch to test the condition of the bulbs of the indicating lights.

4.21 Operation of Air Handling Systems in Fire Situation

Under a fire alarm situation, various air handling systems shall be automatically cut off by the tripping function of the smoke detector installed in the return air duct or in the air handling unit room or in a place approved by the Fire Authority. Manual starting and stopping of all fans for the air conditioning and ventilation systems will be effected when required by the Fire Brigade.

Supply air fan(s) of the system(s) in which the smoke detectors have operated shall be stopped automatically upon receiving a fire alarm signal. The system(s) shall return to normal operation only when clearance and permission have been given by the Fire Brigade Officer from the Fire Authority Brunei Darussalam.

4.23 Starting and Stopping

4.23.1 General

All systems and equipment unless specified otherwise shall be started either manually or under a programme timer switch. In addition, each motor-driven item of equipment shall be provided with a key-operated rotary four-position control switch labelled "AUTO-OFF-MANUAL" mounted in the Electrical Switchboard, to permit manual or automatic start-stop operation.

4.23.2 Sequence of Operation

When automatic starting, all units of plants shall be switched to the "Auto" position to be energised in the following sequences:

1. Air Handling Unit
2. Air-cooled condenser fans then Compressors

4.23.3 Sequence Timer Switch

The sequence timer switch shall be programmed to operate the air-conditioning equipment in the required sequence.

The sequence timer switch shall be electronic type and shall have sufficient steps to energise various contactor coils of various equipment being controlled by the sequence timer switch. The control system shall be arranged so that on automatic shut-down, all items cease to function in the reverse cycle as that stated above in 4.23.2.

4.23.4 Interlocking

Fan coil units, chilled water pumps, condenser fans and refrigeration machines shall be electrically interlocked in the said sequence so that the refrigeration machine can only be started after the air handling units, chilled water pumps, condenser fans are in sequence.

- END OF SECTION 4 -

SECTION 5 - ELECTRICAL REQUIREMENTS

5.1 Scope

This section of the Specification sets out the Electrical Requirements for the proper functioning of the Air Conditioning and Ventilating systems, in accordance with *General Specifications for Air Conditioning Installations, December 1987* from Department of Electrical Services, Negara Brunei Darussalam, except where otherwise specified. The scope of work shall be include:

- (a) Provide a complete installation of all electrical, automatic control, power control and motor systems as specified or indicated in the drawings.
- (b) Unless otherwise specified, the installation of electrical systems shall be complete in details, including all material required to make a complete installation.
- (c) Compare the drawings and specifications, check all measurements and note the conditions under which the installation is to be made. Include all items of labour and materials shown or implied necessary to make this installation completely conform to the requirements irrespective of failure to mention in the specifications or shown on the drawings each individual item.

5.2 General

5.2.1 Materials

Provide evidence that the materials supplied and installed conform to the relevant British Standards and test methods prevailing throughout the industry and show that the materials have been tested in a recognized laboratory utilizing methods of test in accordance with the relevant British Standards and IEE regulations. All materials supplied shall have DES approval.

5.2.2 Drawings

5.3.1 General

The drawings indicate in diagrammatic form the layout of the electrical system. Actual locations, distances and levels shall be governed by field conditions. Include all items not specifically mentioned in the specifications or noted on the drawings but which are obviously necessary to make a complete working installation for all systems.

5.3.2 Shop Drawings

Submit shop drawings for all apparatus specified prior to installation. Shop drawings shall clearly indicate which item is being submitted. Shop drawings shall include:

- (a) Complete wiring diagrams of all equipment furnished under this division of the work.
- (b) Detailed dimensioned layouts of the panelboards, disconnect switches, motor starters, control centres and control devices.

All shop drawings and equipment shall be thoroughly checked before presenting them for review.

5.3.3 Record of Drawings

Maintain at the project site, during the entire time of the project, two complete sets of prints upon which are marked all as-built conditions of the electrical system. Those prints shall at all times be available for examination by the Engineer.

At the completion of the project, the Contractor shall provide 'as-built drawings' in accordance to the two marked sets of prints kept at the project site. Submit as many sets of the 'as-built' drawings as required by the Engineer together with the two marked sets of prints.

5.4 Switchboard

The switchboard shall be supplied and installed including all necessary outgoing connections. The switchboard shall be self-contained, extensible, floor-mounted, metalclad, flush-fronted, cubicle type suitable for operation at 415V/240V, 3-phase, 50 Hz with continuous rating as indicated in the drawings without exceeding the permissible temperatures of all the components in accordance with the relevant British Standards.

The protection of the busbar circuit and switching devices shall be of the Class 3C equipment of BS. 4070:1966.

All floor-mounting, free-standing switchboards (either Main Plant switchboards or AHU switchboard mounted on walls shall be of cubicle construction and suitable for the current ratings and rupturing capacities of their respective incoming supplies as stated on the relevant schematic diagrams.

Each switchboard shall consist of the required number of sheet steel enclosures for mounting all the items of electrical equipment and components as required. The structural work of the cubicle shall comprise welded m.s. angles with bolted frames provided at the rear to house and support busbars, cables boxes, cable glands, terminal blocks and other relevant items.

The cubicle shall be enclosed on the front, sides, rear and top with removable sheet steel panels of not less than 12 SWG thickness (in the case of small wall-mounted switchboards, the panels shall not be thinner than 14 SWG). The controlling ACB or isolator of each switchboard shall be mounted in its own separate cubicle which shall be completely isolated from the rest of the equipment and components and all incoming 'live' terminals of the controlling ACB or isolator shall be fully insulated by means of insulated paneling or other means in such a manner as to prevent accidental touch of the 'live' metal parts or conductors of the incoming supply cable from its point of entry to the switchboard to the incoming terminals of the controlling ACB or isolator.

Busbars and busbar connections to switching devices shall comprise high-conductivity, tinned copper bars of sufficient cross-sectional areas and rupturing capacities to cater for the voltage and current ratings indicated on the schematic diagrams. The busbars shall also be of sufficient capacities to limit temperature rise as required by BSS. 159:1957 and busbars markings, clearances between busbars, other current-carrying conductors and the structural framework of the switchboard shall be in accordance with the requirements of BSS. 158:1961. All 'Phase' and 'Neutral' busbars shall be of the same cross-sectional areas in each case, ('Neutral' busbars of half the cross-sectional areas of their respective 'Phase' busbars may be accepted only on condition that prior approval in writing has been obtained from the Supply Authority to the used of such 'Neutral' busbars and a copy of such letter is submitted to the Consulting Engineer for his reference). Busbar supports shall be of the heavy-duty type, fabricated from porcelain or other non-hygroscopic insulated material of adequate mechanical strength and shall be so spaced within the switchboard for busbars to be installed in parallel or edge-to-edge disposition.

PVC insulated cables of appropriate current ratings and voltage grades to suit the circuits concerned, shall be utilized for interconnecting switching devices and instruments within each switchboard. All such cables shall be neatly bound to frame supports by means of PVC binding strips or PVC insulated copper saddles and brass screws. Where it is necessary to use busbar interconnections in lieu of PVC cable interconnection, then clearance between such busbars and the framework of the switchboard shall be in accordance with the requirements of BSS. 158:1961. Termination of PVC interconnecting cables shall be by means of soldered-type or compression-type, copper lugs fitted to either end of each cable run and these, in turn, shall be fastened to the busbars and terminals of switching devices by means of suitable brass bolts, brass washers, steel spring washers and brass nuts with lock-nuts.

An earth-continuity busbar of tinned copper (not less than 25.6 mm x 3.2 mm cross-section) shall be provided internally throughout the full length of each switchboard. The switchboard's framework, main earthing lead, outgoing feeder and final sub-circuit earthing leads, shall be

securely bonded to this earthing busbar. It is to be noted that earth-continuity busbars of aluminium shall not be permitted for use in the installation.

Black, ivory labels with white or chrome-yellow lettering engraved thereon (PVC adhesive labels shall not be accepted) shall be placed immediately below or on panels of switching devices, stating the details of the circuits controlled by such devices. In addition, a main label with 25 mm high lettering engraved thereon and stating the designation of the switchboard, shall be fitted on the top of the front panel of the switchboard.

The switchboard and all the components shall be fully tropicalised and suitable for use in an ambient temperature of 90 °F under very humid, tropical conditions. An anti-condensation heating element of minimum 500W capacity with adjustable thermostat control shall be supplied and installed in each switchboard.

Each switchboard shall be treated internally and externally with two (2) coats of an approved-type, anti-corrosive paint and finished with two (2) coats of an approved-type enamel paint of dark battle-ship grey colour (matte finish). After the switchboard has been delivered to the site and installed in position with all incoming and outgoing cable termination completed, touch-up of all scratched or chipped portions of the paintwork that may have occurred due to mishandling during transportation of installation shall be carried out. All touched-up portions of paintwork shall be sprayed-on (brushing-in of paint for this purpose shall not be allowed) so as to present a clean surface, free from patches.

Prior to the delivery of each switchboard to the site, the switchboard shall be tested at the Manufacturer's Works, and the results of the test shall be submitted by the Manufacturer to the Engineer for his written approval of the acceptance of the switchboard for use in installation. The Contractor shall inform the Engineer shall witness the testing at his discretion. It is to be noted that only after the receipt of the Engineer's letter of approval as stated above, shall each switchboard be delivered to the site for installation.

5.5 Push-Button Stations

Wherever it is desired on the Drawings to provide push-button stations for the remote control of electric motors, such units as shown on the Drawings and described hereunder shall be supplied and installed adjacent to the motors or as near as practicable to the motor they control.

5.6 "Stop" Push-Button Stations

All such push-buttons station shall comprise machine-stamped or moulded, m.s. or cast-metal boxes fitted with cylindrical-type, push-button units with heavy-duty type, "normally-closed" contacts. Where such stations are installed within visible distance of the main starter panel from which they are connected, the push-button units shall be of the auto-latch-type which, when the buttons are depressed to trip the relevant motor starters, the buttons remain in the depressed position until manually released by turning their respective sleeves. Such push-button units shall be fitted with red colour, "mushroom" or "palm" type buttons, with the word: "STOP" either engraved thereon or with similar engraved labels fitted below the buttons. Where such stations are to be installed in different rooms from the rooms where the starter panels to which they are connected are installed, or if such stations are installed at considerable distance away from their respective starter panels within the same room then such stations shall have lockable-type, push-button units. Lockable type push-button units shall each be of the cylinder type which, when the cylinder is depressed to trip the motor starter, a key could be used to lock the cylinder in its depressed state, thereby permanently switching-off the supply to the motor until the cylinder is once again released by un-locking it with the key. The cylinders mechanism shall be so designed that key removal is possible at the cylinder's normal and depressed positions. The face of the cylinder unit shall be in red colour with words: "STOP" engraved thereon.

5.7 "Start" Push-Button Stations

"Start" push-button stations shall comprise machine-stamped or m.s. or cast-metal boxes fitted with green-coloured, moulded push-button units with heavy-duty type, "normally-open" spring-loaded contacts which close in circuit when the buttons are depressed and break the circuits upon released of the buttons. The words: "START" shall either be engraved on the buttons or similar, engraved labels shall be fitted directly below the buttons.

"Start/Stop" push-button stations shall be a combination of "START" and "STOP" push-button units as described above, encased in common machine-stamped or moulded, m.s. or cast-metal boxes.

Where push-button stations are located outdoors or in areas susceptible to weather conditions or the constant presence of moisture, such station shall be encased in weatherproof, m.s. machine-stamped or cast-metal castings and fitted with facilities for conduit or armoured cable entries, as the case may be.

All push-button stations located adjacent to motors or as near as practicable to motors, shall be installed on m.s. stands or framework. Such m.s. stands or framework shall be painted in the same manner as described of switchboards.

5.8 Air-Circuit Breakers (ACBS)

Air-circuit breakers (ACBs), where specified for use on switchboards, control boards and distribution boards, shall be TP, metalclad, manually-operate or electrically-operated with drawable types, suitable for flush-mounting in switchboard, control board or distribution board panels and shall generally conform to the following requirements and feature the following components installed with their units:-

(a) For ACBs not exceeding 600A current rating, the rupturing capacity of such ACBs shall be 26MVA at 415V, A.C., however, where the current ratings of ACBs exceed 600A, the rupturing capacity of all such units shall be 31 MVA at 415V, A.C.

(b) All ACBs shall be manufactured in accordance with BSS 4752:1971 and shall be of suitable voltage ratings to suit the voltages of the circuits they control.

(c) Each ACB shall be fitted with a shunt-trip coil and provided with a bolted-type solid Neutral link-installed in its own compartment, unless otherwise stated by the Engineer. The ACB shall be provided with current-transformer operated, magnetic over-current trips on all 3-poles (i.e. on all 3 'Phase' of the supply) and fitted with adjustable settings. The ACB must be provided with a high-set element.

(d) Every ACB shall be provided with interlocking facilities to prevent closing of the ACB in its withdrawn position. A mechanical 'ON/OFF' indicator shall ACBs built-up with the mechanism of the ACB operating handle and provision for padlocking the handle in the 'OFF' position shall also be made.

5.9 Isolators

Isolators where required for installation, shall be metalclad, SP&N, DP, TP or TPN types as indicated on the Schematic Diagrams. The units shall conform to the requirements of BS. 5419 where applicable. They shall be suitable for the voltages of the circuits which they control and fitted with contacts generally constructed in the same manner as for fuse gear units described below. Mechanical 'ON/OFF' indicators shall be fitted to the units for operation in ACBs with their respective operating handles. Operating handles of all isolator units shall be fitted with facilities for padlocking their handles in the 'OFF' position and the units shall be provided with inter-locking arrangements whereby their respective unit covers may not be opened when the switch handles are in the 'ON' position. Isolators which are built-in with switchboards and distribution boards shall be installed in their respective dustproof, metalclad casings. All

necessary m.s. brackets or stands for the installation of isolators adjacent to machine or motor control equipment shall be provided and painted with two (2) finishing coats of an anti-corrosive paint, followed by two (2) finishing coats of an approved-type paint to suit the colour/colours of their surroundings.

5.10 **Miniature Circuit Breaker**

The Contractor shall ensure that the miniature and moulded case circuit breakers are trip-free, quick-make, quick-break type. All breakers shall have inverse-time tripping with thermal magnetic trip elements. The rating of the m.c.b. shall be such as to carry full load with ambient temperature of 150 °C with a rated breaking capacity of 3 KA to conform to BS. 3871 Part 1.

All m.c.b.s. shall be limited to circuits controlling current of less than 100 Amp. and may be used in general for final Distribution Board Circuits.

5.11 **Moulded Case Circuit Breaker**

The moulded case circuit breaker for the main service switch feeder, main switchboard, sub-switchboard or in the individual enclosures shall consist of a moulded housing in which is combined a standard moulded case circuit breaker providing over load/short circuit protection within its interrupting capacity and ON-OFF switching function. The moulded case circuit breakers shall be ambient temperature compensating. The circuit breaker shall be provided with thermal magnetic trip and shall be manufactured to BS 3871.

5.12 **HRC Fuse-Links**

All fuse-ways of distribution fuse boards, cut-outs, switch-fuse and fuse-switch units installed shall be fitted with HRC fuse-links affording close excess-current protection which will enable them to operate within four (4) hours at 1.5 times the designed load currents for the circuits which they protect. Such HRC fuse-links shall be those complying with BSS 88:1975 and fitted with fuse-links marked to indicate a Class 'Q' fusing factor.

For motor starting or other transient duties, the fuse installed shall offer proper short circuit protection and at the same time will not rupture due to normal inrush currents associated with the particular installation. All fuse, fuse carriers and fuse links shall be correctly sized to requirements.

5.13 **Earth-Fault Relays**

Where earth-fault relays are to be provided for earth-fault protection of circuits and are to be used in conjunction with circuit breakers controlling the relevant circuits, such relays shall be of the unrestricted type (unless otherwise stated on the Schematic Diagrams) and operated through a set of four (4) current transformers per relay. The relay units shall be suitable for either flush-mountings or surface-mounting on switchboard panels and manufactured in accordance with BSS 142:1966. Each relay unit shall be fitted with a hand-reset type mechanical flag indicator and provided with adjustable settings having a range of 10% to 40%.

5.14 **Current Transformer (C/Ts)**

Ring-type, current transformers of appropriate ratios, burdens and classes shall be provided for the position of ammeters, power factor indicator, kilowatt-hour meters, earth-fault relays and magnetic overcurrent tripping devices built-in with circuit breakers. For operation of ammeters and power factor indicators, the C/Ts shall have a burden of 5 VA, unless when used in conjunction with kilowatt-hour meters when they shall be of 15 VA burden. All current transformers shall be correct dimensions for fixing in busbars and shall be manufactured to BSS 3938:1973.

5.15 Measuring Instruments

Wherever instruments for measuring or indication are required to be incorporated in switchboards, control boards or distribution boards, they shall be flush-mounted on the instrument panels fitted to their respective switchboards, control boards or distribution boards. For main switchboards, instruments shall be fitted with 150mm x 150mm dials, while instruments for sub-switchboards, control boards and distribution boards shall be provided with 100mm x 100mm dials. Measuring instruments shall be manufactured in accordance with the relevant BSS and shall generally comprise the following types.

5.16 Voltmeters

Every voltmeter shall be of the M.I.S.C type, of suitable voltage range and of a high degree of accuracy. The voltmeter shall be connected in circuit with a 7-position selector switch, and protective cut-outs fitted with 2A, HRC fuse-links, giving the following indications:-

- (a) Off
- (b) 3 phase-to-phase voltages
- (c) 3 phase-to-neutral voltages

5.17 Ammeters

Each ammeter shall be of the M.I.S.C. type, of suitable range to suit the current rating of the circuit it is meant to operate on, through current transformers. It shall have high degree of accuracy provided with three (3) current transformers (fitted to the busbars of the circuit whose current is to be measured by the ammeters) of ratio as stated on the relevant Schematic Diagram. The ammeter shall be connected in circuit with a 4-position selector switch giving the following indicators:-

- (a) Off
- (b) Red phase amps
- (c) Yellow phase amps
- (d) Blue phase amps

5.18 Power Factor Indicators

These shall be of appropriate range and type and shall be suitable for operation through current transformers.

5.19 Indicator Lamps

Where indicator lamps are to be utilised on switchboards and elsewhere, they shall be of installed in accordance with *with General Specifications for Air Conditioning Installation, December 1987*

5.20 A.C. Contactors For L.V. Circuits

Where contactors are to be utilised for controlling circuits connected to inductive or capacitive loads such as motors, capacitor units and small transformers, the contactors shall be of the heavy-duty type with a making and breaking category of A4. They shall be of current ratings as stated on the Schematic Diagrams, suitable for operation on the voltage ratings of the circuits they control and manufactured in accordance with BSS 775:Part 1:1969 A.C. operating coils of contactors shall be suitable for connection to the voltages and frequencies of the A.C. control circuit supplies which are connected to them. For D.C. voltages connected to them. For D.C. operating coils, these shall be suitable for operation on the D.C. voltages connected to them.

Where contactors are to be installed in switchboards, control boards, distribution boards and power factor correction boards, they shall be suitable for panel-mounting within their respective compartments. For external mounting, contactors shall be housed in dust-proof, pressed-steel casings, fitted with hinged, lockable doors and suitable for wall-mounting or for installation on

floor stands. Where contactors are exposed to weather conditions they shall be accommodated in cast metal alloy casings of weather-proof construction. All casings for contactor units shall have provisions for the entry and termination of incoming and outgoing cables to wiring conduits, as the case may be.

5.21 **Time Switches**

Time switches where used shall be of the synchronous motor wound, handset dial, single pole, plug-in type to provide facilities as required of time switch control of any selected service.

The clock shall be suitable for connection to a 230 Volt, 50 Hz. A.C. supply and shall be provided with a 9-hours spring reserve complete with stop/start device, high quality jewel escapement and fully temperature compensate balance, four-way terminal block separate clock and switching terminals, motor circuit single pole fuse and facility for internal manual operation independent of the clock. All components shall be approved by CEI, fully tropicalised and the time switches shall be of reputable manufacture.

5.22 **Electrical Motors**

All motors shall be in accordance with BSS. 2613, "The Electrical Performance of Rotating Electrical Machinery" and BS. 170, "Electrical Performance of Fractional Horsepower Electric Motors and Generators" and *General Specifications for Air Conditioning Installation, December 1987*, from DES

They shall be of vertical or horizontal spindle as appropriate, totally enclosed, fan cooled induction motors, suitable for continuous operations, with Class E insulation in accordance with BS. 2757, "Classification of Insulating Materials for Electrical Machinery and Apparatus on the Basis of Thermal Stability in Service".

Motor shall be capable of operating continuously at rated output at any frequency between 48 and 52 cycles per second and at any voltage within the range of normal voltage fluctuations. Motors shall be designed to operate for a period of not less than 5 minutes at a voltage of 25 per cent below nominal value and at normal frequency without injurious overheating. If required by the Engineer, demonstration that the motors comply with these requirements shall be conducted. The starting torque of motors shall be not less than twice the normal rate torque.

Motor bearings shall be of the roller type and the cage locating the rollers shall not be in contact with the races. All bearings shall be fitted with oil or grease lubricators. The shaft cap remote from the driving end shall be provided with a removable plug to enable the speed to be checked by a portable tachometer. Separate terminals are to be provided for internal and external connections.

The ends of the motor windings shall be brought out to terminal boxes and the arrangement shall be such as to permit the easy changing over of any two phase leads without disturbing the sealing compound when used at cable termination.

All terminals shall be of the stud type of adequate size for the particular duty, marked in accordance with BS. 822, "Terminal Markings for Electrical Machinery and Apparatus" and enclosed in a weatherproof box, which shall be securely fixed to the motor frame.

All terminal boxes shall be fitted with an approved sealing chamber conduit entry or adaptor plate as required together with the necessary fittings to suit the type of cable recommended. All motors shall be adequately earthed to meet the requirements of the Department of Electrical Services. A suitable earthing terminal shall be provided for the earth wire on the main body of each motor. All motors shall be equipped with heat sensing devices embedded in the windings, with connections brought out to a separate terminal box and arrangements made to trip the starter in the event of overheating.

The power factor of motors below 100 HP shall be less than 0.85 lagging under any conditions of load and for motors for 100 HP and above, the power factor shall not be less than 0.90 at 80% load. Tenderers shall include in his tender price the cost for a suitable sized capacitor to raise the inherent motor power factor to this figure.

The indicated horsepower of motors are those estimated to be required, and have been used to determine the electric feeder sizes. Should motors of greater horsepower be furnished, increase the sizes of electrical feeders and controllers correspondingly where the Engineer determines that motors of the indicated horsepower, capable of performing the functions shown, are available, such feeder and controller changes shall be made at no extra cost to the Employer.

5.23 **Motor Starters**

All starters shall, unless otherwise specified, be 3-phase, 415V 50 cycles per second manufactured to BS 387 and 775 each incorporating shrouded flush mounting start/stop push buttons, indirect type release, magnetic type overload protection complete with adjustable time delay hand reset overload trips, separate single phase protection relays, under-voltage release, 'on load' integral isolating switch mechanically interlocked with access door, HRC back-up fuses to BS. 88, auxiliary contact, red pilot lamp to indicate motor "running" and control circuit fuses.

Starters shall also be provided with a temperature sensitive device in order that the motor shall be isolated should an excessive temperature in the motor windings be detected by the embedded element. All starters should preferably be supplied by one manufacturer and shall be of robust construction, suitable for minimum maintenance.

Starters and components and related parts shall be properly designed and coordinated to suit the characteristics of the motor controlled and the equipment driven. Starters provided with automatic control shall be capable of as frequent operation as the control devices demand. The horsepower rating of each starter shall not be less than the rating of the motor it controls.

In accordance with the Department of Electrical Services :-

- (i) A.C. Motors - single phase A.C. motors shall not exceed 1 HP, and if over 1/2 HP shall be fitted with a suitable starter designed to limit the starting current and including a no volt release.
- (ii) Three phase A.C. motors up to and including 10 HP may be of the squirrel cage type. Up to 3 HP direct on line starting may be used, and above 3 HP a star Delta or auto transformer starter shall be provided, with a no volt release provided.
- (iii) Three phase motors exceeding 10 HP shall be of the wound rotor type, and a suitable starter of the rotor resistance type shall be provided together with no volt release. Auto transformer type of starters may be used to limit the starting current to 1.6 times the normal free load current.
- (iv) For three phase motors exceeding 25 HP the rotor starter shall also have a mechanical device to prevent the starting handle being moved quickly, and an interlock prevent starting up the motor unless all the rotor resistance is in circuit.

(a) **Star Delta Starters**

These shall be of the automatic type. The change-over from 'Star' to 'Delta' shall be through time delay switching device of the synchronous motor-driven type.

(b) **Auto-transformer Starters**

The general design and construction shall comply to relevant BS Standards. Transformer tapplings shall be provided from 50% to 100% at 10% intervals. The final tapping connection shall be so chose as to limit the starting current to not more than 1.6 times the Full Load current of the motor. The switching operation shall be automatic through timer device of the synchronous motor-driven type. Interlocking arrangements similar to those for Secondary Resistance Starters below shall be provided.

(c) **Secondary Resistance Starters**

These shall be of the automatic type. The secondary resistance shall be arranged in suitable steps/banks so as to limit the starting inrush current to not more than 1.5 times the full load current of the motor. The switching operation of the resistance banks shall be either through a timer device or be motor-driven. The stator contactor and the motor resistance starter shall be interlocked such that the stator contactor shall not close without all the secondary resistances in the circuit. The device shall also ensure that once the motor is stopped all the secondary resistances shall be brought into the circuit before the motor could be started again.

Different type of starters to suit the drives system may be used provided prior approval from DES for deviation from regulations has been obtained.

Contactors shall be of robust design and shall comply with BS 775. They shall operate without undue noise or vibration. Contactors shall be mounted in ventilated metal cubicles. Unless otherwise approved the metal surfaces of the cubicle wall adjacent to the contactor shall be protected by fireproof insulating material. The cubicles shall be complete with all locks, cable sealing boxes, busbars, internal wiring, terminal boards and accessories. All bare copper connections shall be taped an all secondary wiring so arranged and protected as to prevent its being damaged by arcing.

All motor contactor and their associated apparatus shall be capable of operating without overheating for a period of five minutes if the supply voltage falls to 75 percent of the normal value at normal periodicity. All motors shall be connected through suitable MCCB's, and switches in addition to the starters.

All starter cubicles shall be fitted with adjustable thermostatically controlled heaters to maintain the temperature within the cubicle above dewpoint. Heaters shall generally be located in the bottom of the cubicle with the thermostat at the top.

Unless otherwise shown, locate starters where motor and starter are fully visible and not more than fifty feet apart from each other. Provide a disconnecting device in the motor leads located so that it is visible and not more over fifty feet from the motor location wherever :-

- (a) the motor is controlled only by a manual device at the starter location and is not visible or is more than fifty feet from the starter location.
- (b) the motor is automatically controlled, or controlled from a point other than the starter location, and the manual control device is not visible or is more than fifty feet from the control locations.

Where interlocking or sequence starting of motors is indicated, the sequencing shall be done in such a manner that, when the disconnect switch of any starter in the sequence is open, no part of the starter beyond the live side of the switch will be left alive. Opening the disconnect switch shall break the control circuit. Furnish all equipment, such as relays or auxiliary contacts on disconnect switches, necessary to accomplish the foregoing. No unprotected cross-connection shall be made between the holding coil of one starter and the auxiliary contacts of another starter.

5.24 **Overload Relay**

All starters shall include a manual reset over-load cut-out of either the thermal or magnetic type which shall give perfect overload protection to all poles supplying the motor. These shall be adjustable and contain a built-in SPDT switch to be operated by the overload heaters. If such switch is not provided in the overload relay, then a separate relay performing the same function must be provided.

5.25 **Earthing**

The Contractor shall be responsible for the earth connection of metal parts of all switchgears, distribution boards, control boards, starter panels, metal conduits, motors and all other metalwork installed by him liable to become "live" in the event of the electrical installation becoming defective, shall be effectively bonded to earth by means of copper earth-continuity conductors of sized given in Table D.2M of the I.E.E. Regulations (15th edition), or as indicated on the drawings. Earth lead sizes shall also follow Table D.2M of the I.E.E. Regulations, or as indicated on the drawings.

Earth continuity conductors and earth leads shall be of high-conductivity copper (aluminium earth conductors shall not be permitted for use), continuous throughout their whole lengths and without joints, except by means of approved mechanical clamps. Where connections are made at switchgear and such items of electrical equipment, the conductors shall terminate in soldered or compression-type sockets. In the case of MICC/PVC cables, the copper outer sheaths of the cables may be utilised as earth continuity conductors, provided that at the termination of each cable-run the copper sheaths (or sheaths in the case of single-core, multiple runs of MICC/PVC cables) shall be effectively bonded to earth.

Every circuit off a switchboard, distribution board, control board, tap-off unit and splitter switchfuse unit shall be provided with its own earth-continuity conductor.

In hazardous locations, additional earth continuity conductor networks with their own earth electrode systems shall be provided for bonding metalwork to earth. Such networks, when required, shall be indicated on relevant layout drawings.

The electrical resistance of any earth-continuity conductor or earthing lead measured from its connection with the main earth electrode system of a building to any other position in the complete installation the building shall not exceed one (1) Ohm.

The main earthing leads of the installation shall be taken from the earth connection of each Main Switchboard or Sub-Switchboard or Motor Control Centre as directly as possible without looping into any accessory or equipment, to the earth electrodes. Such earthing lead shall be mechanically protected by means of conduit or similar means, which shall be surface-run on walls and buried in the ground at depth of not less than 460 mm below finished ground round level.

5.26 **Wiring and Cables**

5.26.1 **General**

All wiring to equipment and controls shall be in conduit complying to I.E.E. Regulations B 87 to B 100, or in cable trunking where applicable and no joints will be permitted. All conduits used for electrical wiring shall be painted orange for identification from other services. The installation of cabling shall comply in every respect to I.E.E. Regulations B 25 to B 31.

All cables shall be of size capable of carrying the maximum current without exceeding 1 Volt plus 2% of nominal voltage drop from consumer's terminals to any point in the installation under normal conditions of service in accordance with the 14th Edition of the I.E.E. Regulations for the Electrical Equipment of Buildings, and no cable smaller than 7/029 inch shall be used for power Sub-Circuits.

In the main plant rooms, wiring to motors and equipment shall be done using MICC Cables. Cables shall be neatly run on cable trays in the space under the floor ducts if provided or

overhead exposed in the plantroom, wherever applicable. The bending radius of cables shall be not less than eight (8) times the overall diameter. The termination of cables shall be at the provided earth bar inside the switchboard and at a brass junction box near the motor or equipment terminal block.

The connection between the junction box and motor or equipment shall be made with PVC cables and PVC heavy duty flexible conduit, fitted with approved brass screw-type flexible conduit couplings. Cables from above 0.1 square inch shall be terminated with a lug type or grip cable sockets of approved manufacture.

The Contractor shall provide a steel sleeve where MICC cable passes through a concrete floor. This sleeve shall extend at least 9 inches above the floor to afford mechanical protection to the cable. After inserting the cables, the sleeve shall be effectively sealed with bitumen.

Cable trunking may be employed in lieu of conduit where multiple runs would otherwise occur. Trunking shall be manufactured from good quality hot dipped galvanized mild steel of not less than 18 s.w.g. for sizes up to 4" x 4", and not less than 16 s.w.g. for sizes up to 6" x 6" and not less than 14 s.w.g. for larger sizes.

Perforated hot dip galvanized mild steel cable trays shall be supplied and installed. Trays shall be 12" wide with an upturned flange both sided 3/4 inch deep and shall be complete with all necessary long radius bends and tees and fixing brackets fabricated from galvanized mild steel flats.

5.26.2 **PVC Cables**

PVC cables for sub-mains shall comprise high conductivity stranded copper conductors of the sizes shown on the drawings to BS 3360, PVC insulated to BS 2004 and 2746 as applicable. Cables drawn into non-metallic pipe conduits or fixed to cable trays shall be PVC sheathed.

Insulant colours shall be in accordance with Table B.4 of the 14th Edition of the I.E.E. Regulations for the Electrical Equipment of Buildings.

5.26.3 **PVC Armoured Cables**

PVC insulated steel wire armoured PVC sheathed cable shall be manufactured and tested to BS 3346:1961.

5.26.4 **Paper Insulated Cables**

Paper cables shall be manufactured and tested in accordance to BS 480 Part 1 : 1954 and shall be of the mass impregnated non-draining paper insulated type. Cables for 415V (M.V.) service shall be insulated for 1,100 Volts when operating on a system with an effectively earthed neutral.

Paper insulated cables are designed on the Specification Drawings and herein as : -

PLYSTS (MIND) - Paper insulated lead alloy, steel tape armoured and PVC served. (mineral impregnated non-draining)

PILCDSTAS (MIND) - Paper insulated lead covered double steel tape armoured and served. (mineral impregnated non-draining)

5.26.5 **MICC Cables (Mineral Insulated Copper Sheathed)**

Where specified, installation work shall be carried out with MICC cables. The size of the cables shall be suitable to ensure adequate current carrying capacity and that the voltage drop at the apparatus is not excessive. All work and material must be in accordance with the relevant British Standard Specification listed and the current rating shall be as listed by the I.E.E. All joints and termination of the conductors shall be securely attached by fittings of an approved type which

provide effective insulation and continuity of conductors and prevent the entry of moisture into the mineral insulation of the cable. The sealing compound shall be of the "Pyrotenax SILEPOS" type. The cable shall be supported by means of approved copper saddled "Multiway saddles" may be used.

- END OF SECTION 5 -

SECTION 6 - THERMAL AND ACOUSTIC INSULATION

6.1 Scope

This section of the Specification sets out the requirements for the materials, and performance of all operations necessary for the proper installation of all thermal and acoustic insulation for all pipework, ductwork and equipment as required for the proper operation of the air conditioning and mechanical ventilation systems.

6.2 General

All insulation material, vapour barrier and accessories such as adhesive shall be treated on total composite basis and materials offered must be of the type approved for use in air conditioning and mechanical ventilation installation for high rise buildings.

Unless otherwise specified, all thermal and acoustic insulation materials shall be resin bonded fibreglass with a factory applied fire retardant aluminium vapour barrier and of, such thickness, density and thermal conductivity performance as specified hereinafter.

The fibreglass insulation, vapour barrier and accessories, such as adhesives, mastic, cements etc. on a total composite basis shall be non-combustible and non-hygroscopic. These materials shall have a Class 'O' rating when tested for combustibility according to the procedures of BS 476, Part 6 & 6 or an approved equivalent standard on 25/50 fire hazard tests such as UL723, NFPA255 and ASTM E84.

The tenderers shall submit to the Engineer a list of materials intended to be used for this project and their test report together with the tender document. Successful Contractor shall submit to the Engineers relevant test reports, product catalogues, manufacturer's installation recommendation and samples of relevant size before proceeding the actual installation works. Materials installed at site without approval of the Engineers will not be accepted and all costs associated to the replacement will not be entertained.

6.3 Adhesives

Adhesives shall be waterproof compounds formulated for long life and suitable for the particular materials and service temperature specified.

Adhesives shall be tested in accordance with BS 476, Part 3 after uniform application to asbestos millboard to the thickness recommended by the manufacturer for the proposed application and shall meet the following requirements after the manufacturer's specified drying time.

Ignitability Index	0
Spread of Flame Index	0
Heat Evolved Index	0
Smoke Developed Index less than	2

Adhesives shall be applied strictly in accordance with the manufacturer's recommendations for the particular application.

6.4 Rectangular Air Ducts

6.4.1 General

All rectangular sheet metal supply air duct and only return air duct passing in non-return air space shall be insulated internally or externally as specified hereinafter. The air conditioning duct as indicated in the drawing shall be a composite fibreglass ductwork of approved standard as specified hereinafter.

6.4.2 Internal Insulation

Ducts shall be insulated internally for all supply air ducts in the shafts up the first take off or at locations where both thermal insulation and sound absorption are required as indicated in the drawings. All supply and return air ductwork for a minimum distance of thirty feet from an air handling unit shall be internally lined unless specified otherwise.

Material shall be **Barafire insulation** designed exclusively for duct lining work of 2 inch thick with density not less than 2 lb/cu.ft. and thermal conductivity factor shall not be exceeding 0.28 BTU/Hr/in/deg F/sq.ft. at 75 °F mean temperature. The internal insulation shall conform to the requirement of class 'O' BS 476 Part 5 & 6 and NFPA 90A and 90B when tested in accordance to UL 181 Class 1 standards for safety of airducts and shall be capable of withstanding air velocity of up to 4500 fpm without delamination or erosion. The facing of the duct liner shall be treated to prevent erosion and factory laminated.

Test reports must be submitted for examination before actual carrying out of work. The material shall comply to the following sound absorption coefficient:

Frequency (Hz)	125	250	500	1000	2000	4000
Sound absorption co-efficient	0.22	0.49	0.59	0.80	0.89	0.75

Sheathing shall be 26 SWG proprietary made perforated galvanised iron sheet of free area not less than 20 per cent and to the approval of the Engineer.

Perforated metal shall be fastened to the interior of the duct by pins or studs suitably glued to the duct and shall be retained by washers. Internally insulated ductwork shall be fabricated off-site, unless otherwise approved. Rust proof pins of studs shall be provided with at least 6-inch centres on the top surfaces, 9-inches centres on the vertical surfaces and 12-inch centres on the bottom, pins or studs in the longitudinal direction shall be staggered.

Exhaust air ducts at the suction and discharge ends shall be internally insulated to reduce discharge noise levels. Where the duct dimension exceed 18-inch at the longer side, 24 SWG galvanised cover angles shall be fitted.

Alternatively, stud welded rust proof pins of spot welded sheet metal split long pins may be used to hold the insulation in place.

All dimensions given on the drawings shall be cleared inside dimensions for airflow. Where internal insulation is installed, duct size shall be increased accordingly. Samples of lined-duct section must be submitted to the site engineer for approval before work can be carried out.

6.4.3 Thermal Insulation

All ductwork within the plant room, immediately below the roof and the vertical duct shaft shall be insulated with 2 inches thick fibre glass insulation of density not less than 2 lb/cu.ft. and thermal conductivity not more than 0.13 BTU/Hr/in/sq.ft./deg F. All ductwork exposed to the weather shall be insulated with 2 inches thick cork insulation and "hyrib" plaster finish.

All supply air duct and other ductwork where required shall generally be insulated with 1 inch thick fibreglass having a thermal conductivity value (k factor) of not more than 0.26 BTU/in/Hr/sq.ft./deg F at 75°F mean temperature not less than 1 lb/cu.ft. density. The vapour barrier shall consist of at

least one layer double sided aluminium foil/kraft laminate, with fibreglass yarn reinforcement. The insulation shall be carried over all flexible connections and points subject to condensation.

The surfaces of ducts and their insulation material shall be coated with an approved flame proof adhesive of 1/16 inch thick layer of flintcote before pressing together. The cork and fibreglass insulation shall be sealed with one layer of fire-resistant double sided fibreglass reinforced aluminium foil.

The aluminium foil shall overlap at all joints by a minimum of 3 inches and shall be securely cemented and taped with a 6 inch wide pressure sensitive aluminium adhesive to ensure a thoroughly effective vapour seal. The vapour permeability shall not exceed 0.02 perm.

Care shall be exercised to ensure that the vapour seal is completed. The vapour seal shall be extended over all flanges, at the hangers and the like so that it is continuous. An overlapped of 3 inches is required or a 6 inches wide strip vapour-sealer tape could be cemented over such joint.

Ducts shall be well insulated to ensure a rectangular and neat appearance. Where ductwork exceed 12 inch the insulation shall be held securely with pins or studs suitably glued to the duct and retained by washers. The pins or studs shall be provided at 6 inch centres, except for insulation to top of horizontal duct runs. Additional patches shall be neatly glued over any damaged section of the vapour seal and over holes for supports. The ends of joints in the insulation shall be coated with adhesive and stuck together to ensure that the insulation is continuous. Thermal insulation shall not be required for supply air ductwork internally lined with 2 inch thick insulation located in the return air stream.

6.5 Flexible Ductwork

The insulation shall be protected with a tough seamless fire-retardant aluminised vinyl vapour barrier jacket.

The insulation shall be made of long, fine, glass fibre, bonded with thermosetting resin. The density of the insulation shall be at least 1 lb/cu.ft. and the thickness shall not be less than 1 inch having a thermal conductivity K of not greater than 0.24 Btu/Hr/in/deg F/sq.ft. at 75 °F mean temperature.

6.6 Cleaning of Ducts

All ducts shall be thoroughly cleaned on installation so that when the plant is placed in operation, dirt and dust will not be discharged from the diffusers and registers. Care must be taken that no discolouring of the ceiling takes place due to the neglect of this requirement.

6.7 Insulation of Refrigerant Piping

Refrigerant piping system shall be insulated with closed cell Rubber insulated selected as per manufacturer's recommendation.

6.8 Condensate Drains

Condensate drain pipe shall be insulated with closed cell Rubber insulation selected as per manufacturer's recommendation.

6.11 Sealing of Joints

All segments of pipe insulation shall be firmly butted against the preceding sections and the joint shall be sealed with a butt strip. The butt strip shall be applied with aluminium pressure sensitive adhesive tape with a minimum width of 3 inch. Joint of aluminium foil vapour barrier shall be overlapped 4 inch minimum and sealed with an approved brand of vapour seal adhesive.

6.12 Installation Details

6.12.1 General

All insulating material, shall be fitted tightly to the surface which it is applied, and edges or ends of preformed sections shall butt up firmly close to one another over the whole surface to be insulated. Insulation at bends, tees and fittings shall be cut or shaped on site where necessary.

Before application of the insulation all surfaces shall be cleaned to remove any scale, rust, grease or dirt. Provide adhesive to pipe surface before application of the insulation.

Pipe insulation shall be continuous through wall, floor and ceiling openings. Where an adhesive is utilized the insulation shall be firmly held in place until the adhesive has set.

- END OF SECTION 6 -

SECTION 7 - NOISE CONTROL AND VIBRATION ELIMINATION

7.1 Scope

This section of the Specification sets out the requirements for the materials, and performance of all operations necessary for the proper installation of all noise control and vibration elimination for all pipework, ductwork and equipment as required for the proper operation of the air conditioning and mechanical ventilation system.

7.2 General

All machinery or equipment, interconnected piping, ductwork or conduits shall be provided with adequate vibration isolating devices for the avoidance of excessive noise or vibration in the building. Isolators shall, as far as possible, prevent the transmission of vibration noise (including hum) and 'feelable' vibration to any part of the building.

All isolators shall be designed to suit the vibration frequency to be absorbed and the load imposed. Isolator units shall have adequate area and load ratings to obtain proper resiliency under load and impact without permitting excessive movement when starting.

Where equipment is belt driven and motor is not mounted on equipment, the motor and driven equipment shall be mounted on unitized support and the entire supported on subject isolators. The unitized support shall be provided with adjustable slide rails sizes for the motor.

Prior to the installation of any equipment, the following items shall be submitted for certification by the Engineer:-

- a) Catalogues : Cuts and data sheet on specific vibration isolators to be utilized showing compliance with the specifications.
- b) List showing items of equipment, piping, etc., to be isolated, the isolator type and model number selected, isolator loading and deflection, and reference to specific drawing showing frame construction where applicable.
- c) Drawings showing equipment frame construction for each machine including dimensions, structural member sizes, support point locations, etc.
- d) Written approval of the frame design to be used, obtained from the equipment manufacturer.
- e) Drawings showing methods for suspension, support, restraint, guides, etc. for piping and ductwork, etc.
- f) Drawings showing methods for isolation of pipes, etc. piercing slabs, beams, etc.
- g) Linear load versus deflection curves of selected isolators.

7.3 General Requirements of Isolators

Vibration isolators proposed for use in the works shall have the following general properties:-

- a) To have either known undeflected heights or other markings so that, after adjustment, when carrying their load, the deflection under load can be verified, thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to the design.
- b) All isolators to operate in the linear portion of their load versus deflection curves to be furnished by manufacturer and must be linear over a deflection range 50 percent above the design deflection.
- c) Ratio of lateral of vertical stiffness of isolator types shall be not less than 1.0 or greater than 2.0.

- d) Wave motion through the isolator shall be reduced to the following extent: Isolation above the resonant frequency shall follow the theoretical prediction based upon undamped single degree of freedom system with minimum isolation of 50 decibels above 150 Hertz.
- e) Vibration isolator spring diameter shall not be less than their deflected height. Select spring with a 50 percent overload safety factor.
- f) Unless otherwise indicated all equipment mounted on vibration bases shall have a minimum operating clearance of one inch (25 mm) between structural steel base and floor or support base beneath. Check clearance space to ensure that no scrap of material has been left to possibly short circuit isolation base.
- g) Where necessary due to height limitations, provide structural steel bases with height saving brackets, and minimum of four points of support. Isolators shall have a method of levelling and where spring isolators are used, shall have gussets on both sides of the isolator.
- h) Design isolators for positive anchorage against up-lift and turning.
- i) Provide and install under this Section of the Specification structural steel required to properly support equipment.
- j) For steel spring isolators, springs shall be designed so that the ratio of horizontal to vertical spring constant is between 0.9 and 1.3. The natural frequency of the isolator must be 1/6 to 1/10 of the driving frequency that is to be controlled. Isolators to have minimum additional travel to solid equal to 50 percent of rated deflection. Floor mounted isolators to be equipped with built-in levelling bolts complete with sound isolation pads. Static deflection as specified herein.

In the even that the isolators do not meet the specified requirements or the equipment fails to meet specified requirements, revisions/modifications shall be made as required with no additional cost.

7.4 Bases

Rotating and reciprocating machinery shall be mounted on rigid steel or concrete bases. Steel bases shall be constructed of WF beams of a depth equal to at least 1/10th of the longest dimension at the base. Concrete bases shall be of reinforced concrete of a depth equal to at least 1/12th of the longest dimension of the base but not less than six inches. Machinery with self-contained legs or bases which are at least as rigid as the bases described do not require additional bases.

Poured concrete foundations shall have 3000 psi compressive strength at 28 days case. Provide wood float finish with chamfered corners. Both shall have bottom plates and pipes sleeves securely embedded in the concrete. Bottom plates shall be welded to bolts to prevent bolts from turning. Grout under the entire machine bedplate or frame bearing surface. After grout has set, remove all wedges, shims and jack bolts and fill the space with grout. Mounted electric motors on the same foundations as the driven machine.

7.5 Springs

Free-standing, with the ratio of horizontal spring constant to vertical spring constant at least 1.0. Steel spring diameter shall be at least 0.8 times the spring operating height. The difference between spring operating height and solid spring height shall be at least 0.5 times the static deflection.

7.6 Levelling

Provide steel spring anti-vibration mountings with levelling bolts and mount on rubber pads at least 1/4 inch thick or rubber shearflex.

7.7 Mountings

Equip bases with mounting brackets and steel spring type anti-vibration mountings which satisfy the following requirements with provisions for reactive forces. Steel spring static deflections shall be greater than the minimum deflections shown below:-

Lowest Rotational Speed RPM	Min. Static Deflection Inches
-----	-----
Less than 300	10
300 - 399	6
400 - 499	3.5
500 - 599	2.5
600 - 699	1.5
700 - 799	1.25
800 - 899	1.0
Greater than 900	0.8

7.8 Variable Loads

For machinery with operating weight greater than installed weight and machinery subject to varying loads, steel spring anti-vibration mountings shall be equipped with limit stops to prevent over-extension of springs when operating forces or weight are removed. Limit stops shall not interfere with normal operation of the anti-vibration mounting in any way.

7.9 Suspension

Where machinery is to be suspended from the structure, each hanger shall be equipped with a double deflecting steel spring and rubber-in-shear anti-vibration hanger. The steel spring for each such hanger shall satisfy the requirements herein specified. The rubber-in-shear mounting for each such hanger shall provide a static deflection at least equivalent to the static deflection for a 1/4 inch rubber pad as specified. Anti-vibration mounting shall be equipped with adequate levelling mechanisms which do not interfere with proper hanger operation.

7.10 Service Connections

In order that the anti-vibration mountings not be bypassed, all service connections to machinery on anti-vibration mountings through ductwork, piping or conduit shall be equipped with flexible connectors.

7.11 Vibration Control for Electrical Conduit

Isolate electrical conduit from all rotating or reciprocating machinery with 360° loops of flexible conduit. The diameter of the loops shall be at least ten times the diameter of the conduit.

7.12 Vibration Control for Ductwork

All supply and return ductwork connections to rotating or reciprocating machinery shall be through flexible connectors as hereinbefore specified. Connector size and ductwork support shall be selected to prevent either contact between the collars on either side of the connector or tautness of the flexible material in the connector under operating conditions.

7.13 Vibration Control for Piping

Isolate all piping from rotating and reciprocating machinery and from the building structure. Piping connections to rotating or reciprocating machinery shall be through flexible rubber hoses, flexible metal hoses or metal expansion joints. Rubber hoses shall be used for flexible connectors except where operating conditions prohibit their use. Whenever rubber hoses cannot be used, flexible metal hoses or metal expansion joints shall be used. The lengths of flexible metal hoses or metal expansion joints shall be at least six times the nominal pipe diameter but not be longer than 36 inches. Valves shall be located so that the rubber hose, metal hose or metal expansion joint is between the valve and the machinery to which the hose or joint is connected unless otherwise specified. Wherever possible, rubber or metal hoses shall be installed horizontally and parallel to the shafts of any rotating or reciprocating machinery to which they are connected. Flexible connectors shall be rated and suitable for the working pressure of system.

7.14 Installation of Anti-Vibration Isolators

All isolators shall be installed accordance with manufacturer's printed installation directions. In supporting any component or piping, the Contractor shall observe the following:-

- (a) Coordinate work with other trades to avoid short circulating of vibration isolators.
- (b) Bring to the attention of the Engineer or his Representative prior to installation, any conflict with other trades that would result in solid (hard) contact to equipment or piping, etc., due to inadequate space, etc. Cost of corrective work necessitated by conflicts after installation shall be at the Contractor's expense.
- (c) Obtain inspection and certification by the Engineer or his Representative for all concealed work prior to enclosure.
- (d) The Contractor is to notify the Engineer or his Representative prior to the installation of vibration isolation devices so that he may review the Contractor's technique for proper installation of the vibration isolators.

The installation or use of vibration isolators must not cause any change or position of equipment or piping which would result in stresses in piping connections or misalignment of shafts or bearings. In order to meet this objective, equipment and piping shall be maintained in a rigid position during installation. The load shall not be transferred to the isolator until the installation is complete and under full operation load.

For isolating pipework, the first three pipe hangers at all insulated water line equipment connections shall contain combination spring and neoprene hangers with positioning plates. One inch minimum static deflection for lines 3" and smaller, and 2" (5mm) for lines over 3" (7.6 mm) in size shall be used. Uninsulated water lines shall be provided with metalclad hairfelt specifically manufactured for isolating pipe from hanger at all hangers. For isolating equipment, suspend each unit on a minimum of our combination spring and neoprene hangers with positioning plates.

Internally isolated equipment (Air-Handling Units and Air Conditioning Units Wether Internally Isolated Fan and Motor Assemblies) shall be mounted on rigid baseplate with spring isolators as specified. Static deflection shall be minimum of 2" (50 mm) for fans operating at 500 rpm and below and 1½" (38 mm) for fans operating at 501 rpm and above.

- END OF SECTION 7 -

SECTION 8 - TESTING, BALANCING AND COMMISSIONING

8.1 Scope

This section of the Specification sets out the requirements for testing, balancing and commissioning of all equipment installed by the Air-Conditioning Contractor.

8.2 General

All instruments and appliances required for testing, except those specifically mentioned herein as being provided, shall be furnished by the Contractor for the duration of the tests.

The gauges, thermometers and other instruments specified as a permanent part of the installation may be used for testing purposes. Test instruments shall be checked for accuracy by an approved laboratory and test certificates shall be submitted to the Engineer prior to site testing.

Proper facilities and appliances for testing of materials, equipment and work supplied shall be provided during normal working hours as may be necessary to satisfy the Engineer that the installation meets the requirements of this Specification.

In general, all field testing of equipment shall be conducted in accordance with the best and latest relevant standard. During the testing period, each trade shall have his supervising foreman and mechanic available to aid in testing and to perform any adjustments as directed. All adjustments and testing shall be carried out under the direction of either a competent registered Professional Engineer or Qualified Technician or other approved personnel, who must be a permanent full-time employee of the Contractor.

Results of all tests shall be tabulated in an appropriate form. The format of the forms shall be submitted to the Engineer for approval prior to testing. The capacity of each equipment shall be checked and recorded under design conditions. Where required, the Contractor shall provide equipment performance data to permit interpolation of test results for non-design conditions.

Prior to carrying out any test, fourteen (14) days' notice in writing shall be given to the Engineer informing him of the nature of such test and the proposed time, date and location of such test. A copy of test results shall be forwarded to the Engineer. No equipment shall be transported until approval of the test results has been given by the Engineer.

All expenses incurred by the Engineer during the test which require his presence shall be borne by the Air-Conditioning Contractor. The tender sum shall include such expenses and other expenses incurred on testing.

8.3 Testing Equipment and Accessories

The Contractor shall supply all necessary balancing, testing, calibrating instruments and labour required and these shall be available on site continuously during the testing period.

The Contractor shall provide the following instruments for testing, balancing and commissioning.

- (a) Inclined manometer calibrated in no less than 0.005 inch divisions.
- (b) Combination inclined and vertical manometer (0 to 10 inch).
- (c) Pitot Tubes.
- (d) Electronic stroboscopic Tachometer with direct digital readout.
- (e) Clamp on ampere meter with voltage scales.
- (f) Deflecting vane anemometer.
- (g) Rotating vane anemometer.
- (h) Thermal type (hot wire) anemometer.
- (i) Hook gauge.
- (j) Dial, glass stem and electronic digital thermometers.

- (k) Sling psychrometer.

All instruments shall be calibrated and have suitable scales such that the measure variable is within 1/2 to 3/4 of the full scale reading.

All separable sockets, tappings and tees for testing, shall be furnished and installed as required and instruments calibrated before tests are conducted.

8.4 Lubrication and Setting in Operation

Before testing or preparing any item of plant, ensure that such item of plant is fully charged with the correct grade of oil, grease or other lubricant as the case may be, all in accordance with the manufacturer's recommendations. All such initial charges of lubricant shall be supplied by the Contractor.

Make all necessary adjustments and set in operation all equipment described in this Specification.

The complete installation shall be handed over in complete and proper working order to the satisfaction of the Engineer.

8.5 Commissioning of Refrigerating System

8.5.1 Code

Commissioning of Refrigerating System shall be carried out in accordance with Chartered Institution of Building Services Code Series R 'Commissioning of Refrigerating System' Code Series C 'Commissioning of Control System' and Code Series W 'Commissioning of Water Distribution'.

8.5.2 Scope of Work

The Contractor shall carry out the following work strictly in accordance with the codes specified in Section 8.6.1 herein and all settings shall conform to the equipment manufacturers' recommendations.

- (a) Pressure and Leak Testing of Refrigeration System.
- (b) Evacuation and Dehydration of Refrigeration System.
- (c) Charging.
- (d) Lubrication.
- (e) Testing of all safety and interlocking devices.
- (f) Setting to work and adjusting of Reciprocating Compressor or Centrifugal Compressor.

The Contractor shall submit detailed procedures to carry out the above work to the Engineer for approval.

8.6 Commissioning of Air Distribution Systems

8.6.1 Code

The commissioning of air distribution system shall comply with the Chartered Institution of Building Services Code Series A 'The Commissioning of Air Distribution System, High and Low Velocity'.

8.6.2 Instruments

The types of instruments to be used for the measurement of air quantities and pressures are set out below. All instruments shall be in good condition and where applicable shall be covered by recent calibration certified from an independent certified Testing Laboratory.

- (a) A deflecting vane anemometer for measuring air velocity.
- (b) A rotating Vanes Anemometer, four (4) inches diameter with in built one minute timer if an approved make.
- (c) A pitot-static tube of stainless steel construction and rubber sensing hose for sensing duct pressure.
- (d) U-tube, slope Gauge or Magnehelic Gauge for indicating pressure.
- (e) Electronic digital thermometer for measuring temperature at various duct and room locations.
- (f) A tachometer for measuring fan Rpm.
- (g) Volt-Amp meter for measuring fan motor Voltage and current.
- (h) A good quality direct reading velometer of an approved make capable of direct velocity reading with the range of 100-4000 fpm.

Instruments shall be used in accordance with the Manufacturer's instructions. If possible, the same instrument shall be used to make similar measurements for the entire job. If more than one instrument is used for similar measurements, variation between instruments' calibration should be less than 10 per cent.

8.6.3 Initial Running of Electrically Driven Fan Set

(a) Limiting the Load

Wherever possible the first start of any motor shall be on light load. With centrifugal fan sets this will normally be achieved by limiting the mass flow by operation of the main damper; a knowledge of the fan characteristic is required so that excessive suction or delivery pressures are not applied to the ductwork system.

(b) Initial Start

On activating the motor starter, check;

- 1) direction of rotation of motor shaft;
- 2) motor, drive and fan free from vibration or undue noise;
- 3) motor starting current for sequence timing adjustment;
- 4) motor running current on all phases;
- 5) no sparking at commutator or slip rings;
- 6) no overheating of motor (see BS587 and BS170);
- 7) no seepage of lubricant from housing;
- 8) no overheating of bearings;
- 9) oil rings running freely;
- 10) on multi-speed motors check reduced speed rev/s and motor running currents.

(c) Initial Run

A light load run shall be sustained until the commissioning engineer is satisfied from the checks listed in 8.6.3 (a) above and from motor insulation test readings that further load may be applied. Repetitive starting of the motor should be avoided to prevent over-stressing of fuses, switchgear and motor.

(d) Start at Normal Load

Subsequent to the satisfactory conclusion of the initial light load run, the machine shall be stopped and restarted at normal starting load, and the checks listed in 8.4.3 (b) repeated. Again avoid repetitive starting.

(e) Running in Period

After a short run at normal load (a few minutes' run will normally suffice) flexible connections to terminal units etc., shall be restored to position. Subsequently a running in period shall be sustained until the commissioning engineer is satisfied that the fan set is a reliable continuous running machine that can safely be placed under the normal operation and maintenance regime. The regulation of the air distribution system shall be delayed until the running in period (which may last some days) is completed satisfactorily. During the running-in period the dynamic balance of the fan and motor shall be investigated and corrected if necessary.

8.6.4 Preliminary Steps

Before beginning to balance the system, eliminate every possible air flow restriction. Open oil air valves, fire dampers, and volume controls in both the supply and return ducts. Adjust outside air dampers for minimum and maximum position and adjust return air dampers for maximum air flow. Set adjustable pattern ceiling diffusers for horizontal air discharge patterns, wherever possible.

8.6.5 Fan Performance

Before any system can be balanced properly the fan must provide enough static pressure for the system, and the air volume handled by the fan must be adequate for the system. Therefore, measure and compare with Specifications:

The following shall be measured by the Contractor and the result shall be tabulated with design data and submitted to the Engineer for acceptance.

- (a) System static pressure
- (b) Fan Rpm, voltage at fan motor and current drawn
- (c) Total air volume

Prior to taking any measurement, the Contractor shall submit his procedure for measurement to the Engineer for approval.

8.6.6 Balancing Test Points

Balancing points shall be provided in ducts in sufficient number to facilitate the proper testing and commissioning of the air distribution system. All balancing points shall be located in readily accessible positions as shown on the drawings.

Balancing points shall consist of a set of one inch diameter holes drilled in the duct and sealed by plates of the same thickness as the duct. Plates shall be attached by two self tapping screws and the covers made air tight by using neoprene gaskets. The numbers and positions of test holes in rectangular ductwork shall be as given on the drawings.

8.6.7 Outside Air Quantities

Outside air quantities coincided with the correct total air flows shall be very carefully measured for each system by the methods specified. This shall be carried out with the outside air cooling coils in operation. If the initial balancing takes place prior to the commissioning of the refrigeration systems then the air quantities shall be initially set at 15% above the specified figures, and later retested and adjusted as necessary with the coils operating at full load. The damper quadrants shall be carefully locked in position by an approved method and the settings shall be clearly and neatly marked in red paint.

8.6.8 Branch Duct Air Quantities

Air flows in all main branch ducts and zone where test points have been specified shall be ascertained by means of a Pitot tube or an approved Velometer. At each test point the number of measurements shall equal the square of the number of the test openings provided e.g. with three (3) holes, a total of nine (9) readings shall be taken and average.

8.6.9 Return Air Quantities

Return air quantities from the various floors or zones as applicable shall be measured with the aid of a Rotary Vane Anemometer traversing the face of the return air grilles, held approximately one

inch away from the face of the grille. The method shall be otherwise be the as the described in Clause 8.6.8.

8.6.10 Balancing of Air Flow

Balancing of air flow shall be carried out in accordance with the Chartered Institution of Building Services Code Series A Clause 2.7. Balancing shall be done by working back to the fan from the remote branches by setting the correct proportional air flow at each junction of the system in turn (without regard for absolute valves of air flow). This done, the absolute valves of air flow throughout the system shall then be brought to their design valves simply by adjusting the main damper only (next to the fan) until the design total rate of air flow is established at the fan.

8.6.11 Test Data

The number of readings per measurement shall not be less than five and average values shall be tabulated before submitting to the Engineer. All apparatus connections, unit casing, ductwork, inspection doors and the like shall be checked for air leakage. Special attention shall be given to sealing around filters.

When checking air quantities at fans, due allowance shall be made for duct leakage and dust loading of filters corresponding to 50% design dust holding capacity. Total air quantities shall be obtained by the adjustment of fan speed or fan pitch angle. Branch duct air quantities shall be adjusted by means of volume or splitter damper. Volume control dampers at outlets may be used to balance air quantities only if the final adjustments do not produce objectionable draughts or noise levels in excess of the specified limits.

The positions of all volume control and splitter type dampers shall be checked to ensure that minimum resistance has been imposed on the system. Inlet dampers on fans, if provided, shall only be used for final fine adjustment of total air quantity. Filter manometer assemblies shall be inspected for correct operation. The work to be carried out in adjusting and balancing the air handling systems shall comprise the followings:-

1. Check and adjust fan speed to design requirements.
2. Check and record motor full load amperes.
3. Make pitot tube traverse of main supply and obtain design air flow in c.f.m. at fan.
4. Test and record system static pressures in inch W.G. at suction and discharge.
5. Test and adjust system for design recirculated air in c.f.m. to within $\pm 10\%$.
6. Test and adjust system for design outside air in c.f.m. to within $\pm 5\%$.
7. Test and record cooling cycle entering air temperatures (Dry bulb and Wet bulb $^{\circ}\text{F}$).
8. Test and record cooling cycle leaving air temperatures (Dry bulb and Wet bulb $^{\circ}\text{F}$).
9. Adjust all main supply and return air ducts to design air flow rate in c.f.m. to within $\pm 10\%$.
10. Adjust all zone supply and return air ducts to design air flow rate in c.f.m. to within $\pm 10\%$.
11. Test and adjust each diffuser, grille and register to within $\pm 10\%$ of design air flow requirements.
12. Identify each diffuser, grille and register as to location and areas.
13. Identify and list size, type and manufacturer of diffusers, grilles, registers and all testing equipment. Use manufacturer's or approved ratings on all equipment to make required calculations.
14. In readings and tests of diffusers, grilles and registers, include f.p.m. velocity and test f.p.m. velocity and required c.f.m. after adjustments in accordance with Clause 8.4.12.
15. In co-operation with control manufacturer's representative, set adjustments of automatically operated dampers.
16. Adjust all diffusers, grilles and registers to minimise draughts in all areas.

On completion of the above tests and air balance report shall be compiled incorporating the test results and submitted to the Engineer for acceptance.

8.6.12 Air Diffusers

After the fan is checked, the total air volume is measured, and the main and branch ducts are balanced, air flow at each diffuser shall be adjusted and measured. The average velocity or air through a diffuser shall be measured around and cross the diffuser. Not less than five readings shall be taken. The air flow volume delivered through the diffuser shall be the product of average velocity and flow factor. The flow factors shall be provided by the Manufacturer based upon laboratory measurements made with specific instruments in controlled conditions. Tabulated data shall be submitted to the Engineer for acceptance.

8.9 General Performance Tests

8.9.1 General

When all equipment specified herein has been correctly installed and the balancing of air and water systems completed and approved, the Contractor shall carry out general performance tests to satisfy the Engineer that all equipment as installed operates as required by the specification.

These performance tests shall be of not less than three weeks duration. The Contractor shall be responsible for the operation of all plant and equipment installed by him until the general and specific performance test have been completed to the satisfaction of the Engineer.

8.9.3 Air Handling Plant

All fans shall be checked for correct operation, excessive noise and vibration and correct starting without belt slippage. All fire dampers shall be tested for correct operation.

8.9.4 Electrical Equipment

The operation of all motors, starters, electrical interlocks, relays, switchgear, meters and the like shall be demonstrated under full working conditions. Each set of thermal overloads shall be adjusted for the actual load of each motor on a day of maximum temperature. The overloads shall be demonstrated to function by trial setting below normal trip conditions.

- All alarm and safety devices shall be checked and tested.
- Motor indicators shall be set to the normal current in the respective motors.
- All motor currents and power consumption shall be recorded and scheduled.
- Phase readings shall be tabulated against the name plate rating of the respective motor.

8.9.5 Miscellaneous Equipment

All the other items of plant installed shall be tested for satisfactory operation and compliance with the specification.

8.9.6 Noise Level Tests

Noise level tests, complete with octave band analyses, shall be made in all areas including the roof and where directed around the site boundary. With all plant operating the noise levels in the various areas and at site boundaries shall not exceed the noise levels in the various areas and at site boundaries shall not exceed the noise levels specified herein.

Three (3) sets of the recorded results shall be forwarded to the Engineer.

- END OF SECTION 8 -

SECTION 10 - DUCTWORK AND AIR DISTRIBUTION

10.1 Scope

This section of the Specification sets out the requirements for the types, quality of materials and standards of construction which shall be adopted in the fabrication, supply and installation of the ductwork and associated accessories and fittings.

10.2 General

For the purposes of this Specification, the following definitions shall be adopted:

- (a) "Medium Pressure High Velocity Ductwork" shall mean all supply air ductwork of static pressures in duct exceeding 2 inch w.g. but not more than 6 inch in w.g.
- (b) "Low Pressure Ductwork" shall mean all supply air ductwork of static pressures in duct more than 2 inch static and velocities not more than 2,000 fpm.

All ductwork shall be constructed from hot-dip galvanised sheet steel.

10.3 Dimensions

All ductwork dimensions shown on the drawings are the MINIMUM internal dimensions of the air passage, e.g. inside of insulation or acoustic lining where fitted. Where air quantities delivered by the equipment installed by the Contractor are more than the design quantities, the Contractor shall modify the duct dimensions to maintain the design air velocities of the duct and such modifications shall comply with the specification described hereinafter.

Where the Contractor desires to change the size of a duct from the dimensions shown on the drawings, to obtain more economical sheet cutting or to avoid an obstruction, he may do so providing that:-

- (a) The ductwork designed by him has not less than a capacity and the total frictional resistance not greater than that of the ductwork specified.
- (b) The Contractor accepts the responsibility of ensuring that the duct size when varied will not obstruct the building structure or any other services to be installed.
- (c) The change is approved by the Engineer.

10.4 Materials

10.4.1 Sheet Metal

This Specification is based on the use of galvanised sheet steel for rigid duct. Duct gauges specified refer to the thickness of the ungalvanised sheet, in terms of Birmingham Standard Wire Gauge.

Ductwork shall be manufactured from galvanised sheet steel to BS 2989, "Hot-Dip Zinc Coated Steel Sheet and Coil". The zinc coating mass designation shall equal to Class 2A. The sheet metal shall be new, clean and lock-forming quality (LFQ) suitable for use in lock-forming machines without cracking of the sheet or otherwise damaging the protective galvanised coating. Sheets which split or crack, or on which the galvanising flakes when rolled for jointing, shall be rejected. The Engineer shall be at liberty to request Test Samples in accordance with this Standard.

Where specifically approved or instructed by the Engineer, ductwork material other than galvanised sheet metal, such as aluminium or aluminium alloy, stainless steel, asbestos, plastics and fibre glass ducts may be used where required to meet the requirements of particular applications.

10.4.2 Rolled Steel Angles

Rolled steel angle shall be of mild steel to BS 5535, "Specification for Right Angle and Box Angle Plates".

10.4.3 Rivets

Rivets shall be galvanised tinsmith's rivets or expanding solid end type rivets of 5% magnesium aluminium alloy. Rivets fixing sheet metal shall be 1/8 inch diameter and rivets fixing rolled steel angles to sheet metal shall be 3/16 inch diameter.

10.4.4 Self-Tapping Screws

Self-tapping screws shall be of bright zinc plated steel and shall only be used where specified.

10.4.5 Bolts

Bolts, nuts and washers shall be of bright zinc plated steel to BS 916 and BS 1083.

10.4.6 Duct Hardware

Duct fittings, e.g. bearing housings, damper quadrants, etc. shall be made from any of the following materials:-

- (a) Mild steel galvanised or electro zinc plated
- (b) Bronze - good quality cast or rolled
- (c) Aluminium alloy die castings
- (d) Zinc alloy die castings

10.5 Corrosion Protection of Angle Flanges, Stiffening and Hangers

Prior to painting the ferrous metal, surfaces shall be thoroughly cleaned of rust, loose scale dirt, oil or grease and other foreign matter by wire-brushing or with ICI Deoxidising 125. After cleaning, brush one coat of Grey Green Chromate Metal primer F500-388 or equivalent allowing overnight drying. After this first coat has dried, apply one coat of Dulux undercoat A522-line or equivalent, allowing overnight drying. After this second coat, apply 2 coats of Dulux Glass Finish or equivalent to appropriate shade. Allow 16 hours drying time between coats.

10.6 Erection of Exposed Ductwork

Where two or more ducts are installed adjacent to each other and are in view, angle flanges and stiffeners shall be in line to present a neat appearance, where space limitation prevents the lining up of angle flanges and stiffeners, they shall be nested together.

10.7 Duct Constructions

10.7.1 General

The Tenderer's attention is called to the positioning of the ductwork and associated fittings and plant in areas where space is limited.

Necessary additional cost should be included for prefabricating, and insulating sections of the ductwork in lengths suitable for installation as shown.

No further allowances will be made at any later date for negotiation of additional space than that generally shown on the accompanying drawing.

All ductwork shall be constructed of galvanised sheet steel.

Unless otherwise approved, all ductwork and fittings shall be constructed strictly to the dimensions indicated and in accordance with practice recommended in the current editions of the Sheet Metal and Air Conditioning Contractors National Association Incorporated (USA) and DW/142 of Heating and Ventilating Contractor's Association whichever is applicable.

Full size standard galvanised sheet steel shall be used, and any patches, made on second-hand sheets will be rejected.

10.7.2 Workmanship

Unless specified otherwise, ductwork shall be rectangular type. Any ductwork and fittings considered unsatisfactory by the Engineer shall be removed from the site by the Contractor within 3 days.

The Contractor is required at the discretion of the Engineer to carry out leakage test for the first 50 ft. of ductwork before fabricating and installing any more ducts. This will ensure a check of workmanship and quality to make the joint air-tight promptly and economically. All tests shall be carried out under the supervision and to the satisfaction of the Engineer.

All high velocity ductwork whether low pressure or medium pressure shall be tested for leakage under the supervision and to the satisfaction of the Engineer. Testing procedures shall be in accordance with duct leakage testing procedures as described in the latest edition of the and DW/142 of HVCA and/or in "Section 8 - Testing, Balancing and Commissioning" herein.

At the discretion of the Engineer, the Air-Conditioning Contractor shall provide a sample of the following duct fittings and insulation used in ductwork for the Engineer's approval:-

- (a) All typical joints
- (b) High velocity main duct take-off
- (c) High velocity branch duct take-off
- (d) Low velocity main duct take-off
- (e) Flanged joints for high velocity duct
- (f) 90 °F bend with double thickness turning vanes
- (g) High velocity duct with acoustic and thermal insulation
- (h) Low velocity duct with acoustic and thermal insulation
- (i) Exposed to weather duct
- (j) Acoustic flexible ducting
- (k) Flexible duct connection
 - Single take-off
 - Double take-off
- (l) Splitter dampers
- (m) Grilles, diffusers and registers
- (n) Volume dampers
- (o) Linear diffuser complete with plenum box
- (p) Fire damper
- (q) Variable air volume box

Ductwork shall not commence until the samples have been approved. The samples shall be retained by the Engineer and shall be considered to be the standard of workmanship for the project.

10.7.3 Duct Length

There is no restriction on the length of duct sections between joints assembled in the field. The factor that will usually determine length module will be:-

- (a) Available shops manufacturing facilities
- (b) Handling
- (c) Transportation and storage to and on the site

(d) Physical limitations created by the ductwork layout or building construction methods.

Duct shall be machine-bent and shall be free of waves and buckles.

10.7.4 Stiffeners

Ductwork shall be cross-braked or provided with steel angle bracing for additional stiffness to prevent sagging and drumming of ductwork.

Where transverse reinforcing is required on all four sides, it must be tied together at each corner by welding. Where transverse reinforcing is required on only two side, it must be tied together with either tie rods or angles at the ends.

The transverse reinforcing size is determined by the dimension of the side to which the angle is applied. The rods where used shall be 1/4" minimum diameter. Where two tie rods are required, installation shall be 1/3 point across the duct.

Angles shall be cut from rolled steel angle sections or folded steel plate and drilled for rivets in accordance with a detail shown on the drawing. Dimensions of rolled steel angles shall be as referred to in Clause 10.4.2.

Where transverse joints are of a type incorporating reinforcing angles, then the transverse stiffeners angles may be omitted where a transverse joint of one of these type occur.

10.8 Joint Sealants

10.8.1 General

All joints in the medium velocity ductwork shall be made air-tight with the aid of a sealant. The sealant shall be such that it remains in place during the assembly and after completion of the joint. When cured, the sealant shall retain its adhesive and elastic properties, and be resistant to air entrained water an oil.

The sealants shall conform to the following index ratings for early fire hazard as specified in BS 4106 Parts 5, 6 and 7:-

Ignition Index	0
Spread of Flame Index	0
Heat Evolved	0
Smoke Development Index	0

10.8.2 Liquid Sealants

Liquid sealants shall be used for sleeve and slip type joints where a sealant is required to fill the small space between the overlap. Liquid sealant shall not be used except on flexible ductwork.

Liquid sealants are not acceptable for sealing airtight joints unless the sealant is held in the joint by lapping metal surfaces. Application of sealant is by brush, chulking gun or pressure extruding equipment. Where metal clearance exceed approximately 0.04 inch, several applications may be necessary to fill the void caused by shrinkage and run out of the sealant.

10.8.3 High Viscosity Sealants

High viscosity sealant shall be used as a filler or in grooves or where the sealant is held in the joint by surfaces in compression.

The sealant shall be applied by pressure gun to the inside of the assembled joint, such that the internal air pressure tends to force the sealing into the joints.

10.8.4 Adhesive Tapes

Adhesive tapes shall not be used for sealing of duct joints unless specifically approved.

10.8.5 Gaskets

Long life materials such as rubber, extruded forms of soft neoprene used in certain wall sealants shall be used in flanged joints. Extruded sealants shall have cloth filler so that they will not be forced completely out of the joint by air pressure. For ease of application, gaskets should have adhesive backing or otherwise be tacky enough to adhere to the metal while assembling the joint.

10.9 Joints

The acceptable types of joints are specified in DW/142 of HVCA or smacker whichever is applicable.

Sheet metal joints shall be roll-formed in a correctly set and adjusted machine to form a tight fitting joint.

No free or cut edges of ductwork shall appear within ducts, and where seams or joints protrude into air stream, they shall be arranged in the direction of air flow.

No ductwork joints, bends or other fittings will be permitted within the thickness of the wall, floor or ceiling structure.

Angle flanges shall be fabricated from rolled steel angles referred to in Clause 10.4 and shall be coated for corrosion protection in accordance with Clause 10.5 and be of the sizes in the following table:-

Longest Duct Side	Angle Size (inch)
Up to 24 inches	1 1/4 x 1 1/4 x 1/8
25 inch to 48 inch	1 1/4 x 1 1/4 x 1/8
49 inch to 60 inch	1 1/2 x 1 1/2 x 3/16
61 inch to 100 inch	2 x 2 x 3/16
Above 100 inches	2 1/2 x 2 1/2 x 1/4

Holes in flanges angle shall be drilled or punched in a jig or a template. Bolt holes shall have a clearance of 3/32 inch diameter over bolts and may be slotted. Bolts shall be 1/4 inch diameter for used with 1 inch and 1 1/4 inch angles and 3/8 inch diameter for use with 1 1/2 inch and 2 inch angles. Rivets shall be 3/16 inch diameter.

Angles shall be welded into frames prior to attachment to duct. Attachment of angle frames to duct shall be by riveting or spot welding. Spot welding where permitted shall be subjected to the conditions specified in Clause 10.8. The weld spots on the inside of the duct shall be painted for anti-corrosion.

The double thickness of longitudinal joints shall be cut away either before rolling the joints, or after the flange is assembled to the duct, but before knocking down. The ends of the ducts shall be knocked down to a minimum of 3/8 inch across flange faces, and the corners sealed by welding or blazing as illustrated.

Flanged sections shall be bolted together with gasket between the faces to give an air-tight joint and after bolting up, the distance between flange faces shall not exceed 3/16 inch. The gasket shall be full-faced type, carefully mitred and joined at the corners to ensure a continuous air-tight seal.

Flanges may be outside or inside of ducts if specifically called for on the drawings or in the Specification. The flange angles shall be covered with a sheet metal fairing, riveted to the duct. The fairing shall be of the same material thickness as the duct.

Sealant shall be applied between the duct and the flange all round to ensure a continuous air-tight seal.

10.10 Tapers and Offsets

Tapers and offers in ductwork shall be carried out in accordance with the appropriate Mechanical Details.

Changes in section of ductwork are to be effected by tapering the ducts with a slope not greater than 1:4 but preferably 1:10 slope or less.

10.11 Obstructions to Ducts, Streamlines and Restrictions

10.11.1 Streamlines

Where it is impossible to offset a duct around an obstruction such as a pipe or small beam or around a small building column, the obstruction may be encompassed with a two piece streamliner. Such a proposal can only be carried out with the approval of the Engineers.

The area of duct at the obstruction shall be not less than 80% of the area of duct before the obstruction. The tapers on the converging and diverging sections shall comply with Clause 10.11. The streamliner around the obstruction shall be rounded on air entering side and be tapered to a 60° point on the air leaving side.

Cross joints shall be as specified in the Tender Specifications for straight ducts except those adjacent to the obstruction where slip joints or flanges (if the duct depth allows for access to the bolts) shall be used.

10.11.2 Obstruction in Contact with Airstream

An obstruction may pass through a duct provided that it does not decrease the duct area by more than 20%. Where the obstruction is of circular cross-section up to and including 3 inches outside diameter, the decrease of duct area due to the obstruction may exceed 20%.

Notwithstanding the above, such passing of obstruction through any ducts can only be carried out with the approval of the Engineers. A slotted hole shall be cut in one section of the ductwork to permit installation of the ductwork around the obstruction. The slotted hole shall be patched as shown before the flange is riveted in place. The obstruction shall be sealed to the ductwork with rubber grommets.

10.11.3 Restrictions

Where one side of a duct or a corner of a duct is obstructed by part of a structure or building and space is restricted, the duct may be locally reduced to clear the obstruction, provided that the reduction of duct does not exceed 20% of the initial area of the duct.

The tapers on the duct diverging and converging sections shall comply with Clause 10.11. In arranging a local reduction, the effect of the building obstruction shall be borne in mind when selecting types and locations of field assembled cross joints so that the joint can be satisfactorily assembled without clashing with the obstruction.

Where a duct passing through a beam opening is restricted, the duct may be transformed to the equivalent size of the straight duct to suit such opening.

10.12 **Bends**

The method of construction of bends is illustrated in the Mechanical Details. Construction shall in all respects be as detailed for ductwork in the preceding Clauses.

The type of bend to be used may depend on the duct location and on other site restrictions. The particular type which shall be used in each location shall be as shown on the drawings, unless specifically approved by the Engineer.

10.13 **Tees, Branch Connection and End Closures**

Typical details of approved fittings are shown on the Mechanical Details. Types of fittings to be used shall be as shown on the duct layout drawings.

With these fittings, the longitudinal seams may be Acme Grooved Seam or continuously welded. The branch is continuously welded into the side or the main run.

During fabrication, care should be taken to eliminate projection of metal edges into the air stream. If the zinc coating is burnt off the steel during welding, the joint shall be painted inside and outside with zinc chromate rust inhibitor to prevent corrosion.

10.14 **Access Doors and Test Openings**

Access doors and openings shall be provided at all positions of dampers, turning vane coils, thermostats and other apparatus requiring service and inspection in the duct system. Doors shall be minimum 15 inch x 18 inch (380mm x 460mm) unless otherwise required by the actual conditions. Where size of duct will not accommodate this size, doors shall be made as large as practicable.

Doors shall be of rigid construction with provision for air-tight felt or sponge rubber or neoprene gaskets and galvanised hinges, bronze pins, brass fasteners and other necessary hardware and accessories. All doors shall be furnished with suitable sash locks and latches. Doors shall be hinged to swing so that fan pressure or suction holds the door closed.

Where ductwork exceeds 48 inches (1.2m) in any one dimension, access manways at not less than 40 ft. (12m) intervals shall be provided in all duct runs and on both sides of turning vanes. Access manways shall be not less than 20 inch by 42 inch (500mm by 1,000mm).

Where directed by the Engineer or where necessary for use for taking air measurements, such as at the discharge of air handling units or at each individual zone of the ductwork system, test openings shall be provided. Openings shall be formed with suitable screwed caps and extension plugs for insertion or pitot tubes. All test openings shall be insulated to approval.

Access doors shall be so constructed that no part of the access door shall project into the airstream and the cover when shut shall be flush with the inside surface of the duct. The edges of the door shall be turned back to make a rounded edge or alternatively a piece of pressed galvanised steel shall be fitted to obtain a similar result.

Access door shall be made from 18 ga. galvanised steel sheet. Door shall be attached to the duct with suitable sash locks, latches and hinges. Where the duct is insulated, the door shall be insulated to the same thickness and to the same requirements as the duct. Where insulation is inside the duct, the surface of the door or cover insulation shall be flush with that of the duct. The edges of the insulation shall be covered with G.I. channel or 'Z' sections. Doors and levers shall be sealed air-tight to the duct with rubber or neoprene gasket which shall be securely fixed to either the door cover or the level or the duct.

10.15 Splitter Dampers

10.15.1 Adjustable Turning Vanes

This may be used as a damper for a wall supply register or as a turning vane.

Construction on this type of turning vane is shown on the drawings. Blades shall be constructed from 20 ga. galvanised steel sheet, pivoted at each end on steel rods supported by steel sheet side plates and tie bars.

A means for adjusting the setting of the blades shall be provided. Access for this adjustment shall be either through an air outlet, where this is close enough to the adjusting device, or through a handhole located in the duct for this purpose. The frame of the turning vane shall be fixed into the duct by riveting.

10.15.2 Single Blade Splitter Dampers

Splitter damper shall be of sufficient length to close off either branch duct. The blade shall not be less than the width of the branch duct and not less than 12 inches. Splitters shall not be used where their length will exceed 24 inches.

To blade shall be pivoted on cadmium or zinc plated steel butt hinges of not less than 2 inches. The hinges shall be attached to the blade and duct with three 3/8 inch diameter rivets per hinge leaf. Blades up to 18 inch wide shall be constructed of 18 ga. galvanised steel sheets turned down 1 inch at the sides and turned back 1/2 inch at the leading edge.

Blades exceeding 18 inches wide shall be constructed of 20 ga. galvanised sheet in a double streamline section and pivoted on a hinge rod of not less than 1/2 inch diameter. The hinge rod shall be cadmium plated steel and shall be supported at each end by bearings as shown. The double streamline blade shall be securely fixed to the hinge rod by spot welding, riveting or screwing.

10.15.3 Linkage

Splitter damper quadrant up to 20 inches shall be operated by 3/8 inch rod and for larger damper by 1/2 inch rod.

10.16 Hangers for Ducts

10.16.1 General

All ductwork shall be supported rigidly and at a center to prevent sagging and vibration on hangers, supports and cantilever brackets. However, they shall be arranged to allow for expansion due to thermal stresses without distortion to the ductworks. Unless otherwise specified, hangers for vertical and horizontal ducts shall comply with the details, material sizes and spacing shown on the drawings and as specified herein.

Supports for rectangular ducts shall generally be trapeze type hangers comprising angle bearers (supporting shelf) of galvanised steel hung from mild steel rods or galvanised steel angle hangers. These shall be of size and spacing as indicated below:-

Hanger	Sizes of Rectangular Duct		
Longest Dimension of Duct	Size of Hanger Rods	Size of Trapeze Angles and Bearers	Maximum Spacing
Up to 18"	¼"	1" x 1" x c"	10'
19" to 30"	¼"	1" x 1" x c"	10'
31" to 42"	d"	1½" x 1½" x c"	10'
43" to 60"	d"	1 ½" x 1½" x c"	10'
61" to 84"	d"	2" x 2" x c"	8'
85" to 96"	½"	2" x 2" x 3/16"	8'
Over 96"	½"	2" x 2" x ½"	4'

NOTE: Where two ducts are hung one beneath the other, then the drop rod sizes and the top duct support angle size shall be given by the sum of their longest sides.

The attachment of the angle bearers to the hangers shall preferably be by bolts, push nuts or fixture clips to enable ease of adjustment.

Where horizontal ducts are to be supported on walls, band iron strap type hangers shall be used. These are recommended for small size ducts having widths less than the height of the duct. The band shall be anchored into the wall at the top and bottom using approved type anchors or fasteners. For horizontal ducts where the widths are greater than the height, neat shelf type bracket angle irons shall be used.

Supports for round ducts shall be band iron strap type hangers with sizes and spacing as indicated below:-

Hanger Sizes for Round Duct				
Duct Diameter	Size of Hanger Rods	Size of Band and Straps	Maximum Spacing	Number of Hangers
Up to 18"	-	1" x 16 SWG	10'	1
19" - 36"	-	1" x 12 SWG	10'	1
37" - 50"	-	2" x 16 SWG	10'	1
51" - 84"	d"	2" x 16 SWG	10'	2

Notwithstanding the schedule of hanger type and size given hereabove, the Contractor shall be deemed to be responsible for ensuring that all items used for the duct supports are adequate for the duty, load and conditions imposed.

Unless approved otherwise duct hangers shall not be used to hang piping, ceilings or other loads. Where it is necessary to hang items other than ductwork from duct hangers, the maximum stress in

hanger rods, straps and bolts shall not exceed 6000 psi. Hangers shall be fabricated from strips of galvanised sheet, rolled steel angles and rolled steel flat round bars as shown in this Specification.

All rolled steel angles and rolled steel flat used for hangers shall be coated for protection against corrosion in accordance with Clause 10.5. The Air-Conditioning Contractor shall with other trades ensure that hangers are not in the way of pipes, conduit, etc. running above ducts. All hangers, straps, bands and angles used for supporting ductwork shall generally be suitably treated against corrosion by galvanising or painting with aluminium paints.

All ducts shall be suitably supported at appropriate intervals to comply with the requirements of the SMACNA Standards.

10.16.2 Fixing of Hangers

All fastening and anchoring of supports to structural slabs, ceiling beams, walls and decking shall be by approved means. Unless specifically approved by the Engineer, only approved type concrete anchors and inserts, expansion bolts, ramsets, c-clamps, beam clamps, etc shall be used. Suitable receiving holes shall be cut by approved rotary percussion electric drills to give time and accurate drilling.

Explosive power fasteners, wooden plugs and straight nails shall not be used.

The following fixing method are approved for attaching hangers to structure except where otherwise specified in the Specification:-

- (a) The steel or timber structures - Mild steel bolts of the size listed.
- (b) The masonry structures - Expanding type plugs used with steel bolts of threaded drop rods of the sizes listed. Plugs used shall be approved by the Engineer. Bolts or nuts cast into concrete structures are acceptable provided that they are fitted with steel washer to adequately distribute the load into the concrete.

Prior to the installation of any supports, the Contractor shall submit detailed layout drawings indicating location of all supports, the loads imposed on each fastener or anchor, typical details for hangers and anchorages, details of special anchorages and suspensions. These shall be required to be approved by the Engineer before actual installation.

10.17 Flexible Ducting

10.17.1 General

Flexible ducts are used to connect terminal devices such as mixing boxes and diffusers to medium or low velocity ducts. Although flexible ducts are capable of following an indirect route, the runs shall be as short and straight as possible in order to minimise pressure losses and noise generation. The duct shall be stretched to smooth out internal corrugations and long radius bends shall be used where possible.

Flexible ducting shall be to the sizes and installed in the locations shown on the drawings. Flexible ducting shall be manufactured from corrugated roll strip of grade 3003 aluminium, constructed with a four-ply lock seam to form a continuous flexible spiral duct.

10.17.2 Insulated Ducting

All flexible supply air ducting shall be insulated. Insulation shall consist of fibre-glass blanket 1 inch thick enclosed in a continuous sisalation sleeve.

10.17.3 Uninsulated Ducting

Unless shown on the drawings, all exhaust and return air ducting shall be of the insulated type.

10.17.4 Joining of Flexible Ducting

When flexible ducting is used to connect the sheet metal duct to the supply air boots, sufficient clearances shall be allowed between the light fittings and flexible ducting.

Joining of flexible ducting either to other flexible ducting or to rigid ducting and fittings shall be carried out to details shown on the drawings.

10.18 Flexible Connections

Flexible connections shall be air-tight and resistant to fire, water and mildew and shall be made with tight weave asbestos factory-attached to a galvanised steel strip.

Flexible connections shall be fitted to isolate fans and/or air handling unit casing from ductwork. The connections shall be of at least 6 inch width and shall be arranged to permit to renewal of the connection without disturbing the ductwork or the plant. The metal parts of connected equipment shall be separated by not less than four inches and installed with sufficient slack to compensate for free movement of fans or spring vibration isolators.

Flexible connections in supply air ducts surrounded by unconditioned air shall be insulated by 1/2 inch thick steel of closed cell flexible insulation securely glued and clamped to the outside of the flexible connection. Flexible connections shall be of 20 oz (.6 Kg) woven asbestos, glass cloth, canvas or other approved non-combustible material.

10.19 Flashing

All ducts passing through the roof shall be flashed by the Contractor in a manner shown in the drawings. However, this shall not include any upstands or kerbing around the roof openings which will be provided by others.

10.20 Cleaning of Ductwork and Protection during Construction

All ducts shall be thoroughly cleaned inside to the satisfaction of the Engineer, before starting the fans. Covers shall be provided during installation to prevent building material or rubbish entering the ducts and fans.

10.21 Duct Sleeves and Prepared Openings

Where ducts pass through walls or partitioning, floors, ceilings and roofs, suitable galvanised sheet steel sleeves of a gauge not less than the duct concerned shall be located into place by the Contractor in liaison with the Main Contractor.

Sleeves shall be used for round ducts 15 inch (380 mm) diameter or less. For all other ducts (rectangular or round ducts above 15 inch (280 mm) diameter), prepared openings shall be used. All sleeves and prepared openings shall be constructed with one inch (25 mm) of clearance between duct and the opening or, for insulated ductwork, between the insulation and the opening.

Unless approved by the Engineer, the free space between the sleeve or opening and the duct or duct insulation shall be caulked tight using felt gasket, asbestos rope or sealing compound and a neat sheet metal collar or angle flange arranged to cover the free space. The closure collar shall fit snugly around the duct or insulation and the edges ground smooth to preclude tearing or puncturing the insulation vapour barrier.

For ducts piercing through roofs, curb-type flashing shall be provided to prevent entry of rain and moisture. The sleeves shall be of lengths to suit the finished wall thickness and in the case of plastered and/or rendered walls shall not protrude more than 1/8 inch over the finished wall surface. In the case of insulated ductwork, the sleeves shall be oversized to allow the insulation and vapour sealing to be continuous through them.

10.22 Penetrations

Penetrations through ductwork and conditioner casings are to be avoided if possible or else installed behind bulk-heads formed to seal pipework and electrical services from the air stream.

Where these penetrations are unavoidable, the pipe shall be sealed to the duct wall in such a manner that an air-tight seal is achieved, while permitting movement of the pipe relative to the duct or housing. An approved method of sealing of pipework through a conditioner housing is shown on the drawings.

10.23 Alternative

The tenderers are at liberty to offer other methods of construction but details of which must be submitted at the time of tendering as an alternative to the basic tender.

10.24 Shut Off and Volume Control Dampers

10.24.1 General

The following clauses set out the requirements for control volume dampers other than splitter dampers specified in Clause 10.16 or proprietary damper supplied with air outlets.

These requirements apply to single blade dampers which may be used in ducts up to 8 inches width and to multi-blade damper which shall be used in all other cases. Sample dampers shall be submitted for approval to their manufacturer.

10.24.2 Single-Blade Dampers

Single-blade dampers in low velocity duct up to 26 inch x 8 inch may be installed in the duct without separate frames or flanges provided such dampers are only required for throttling and not for tight shut-off.

10.24.3 Multi-Blade Dampers

All multi-blade dampers shall be of the opposed blade type. The damper blades shall swing open in opposite directions so that the air stream is not deviated to one side. The damper shall be the product of an approved manufacturer.

10.24.4 Modulating Dampers

Modulating dampers shall be of the opposed blade type. The damper shall have face dimensions which comply with the sizes shown on the drawing, where the dampers are smaller than the duct size, blanking plates shall be provided unless convergent and divergent duct sections are shown on the drawings.

Dampers used for outdoor intakes, for mixing air and on hot air plenum shall have neoprene edges cemented and rivetted in place at the time of fabrication.

10.24.5 Manually Operated Dampers

Manually operated dampers shall be full duct size unless otherwise shown on the drawings. The damper shall be operated by lock-type quadrant operator.

10.24.6 Damper Frames

Frames shall be constructed of 10 BG. galvanised steel sheet folded to channel section not less than 6 inches wide. Frame shall be welded at the corners and painted. Damper frames shall be drilled to provided bolt hole for connections of the damper to the duct angle flanged cross joints.

Mullions shall be constructed of 16 BG. galvanised steel sheet folded to channel sections and rivetted into box section.

10.24.7 Damper Blades

Damper shall be of single blade type or of multi-louvre type with elliptic or flat steel blades mounted horizontally in a welded steel frame.

Rectangular damper, 12 inches long or more as measured in the direction perpendicular to its axis, shall be louvred with blades not over 10 inches wide and not exceeding 48 inches between supports Round dampers shall be of single blade type.

Blades shall be fabricated from 16 BG. galvanised sheet and shall interlock with adjacent blades as shown in the drawings. Neoprene, rubber or felt sealing strips shall be bonded to the tips of the blades to prevent air leakage. Damper leakage shall not exceed 5% of the maximum design air quantities for the particular damper.

10.24.8 Bearing and Spindles

Bearings shall be of ball bearing type or of self-oiling sintered bronze. The housing of the bearing shall be rivetted or where approved, spot welded to the damper side frames.

Spindles shall be of 5/8 inch diameter and shall be securely fixed to the centrefold of the blades. Spindles may be of the stub type or may run the full length of the blades. Spindles shall be cadmium or brass-plated.

10.24.9 Linkages

Dampers shall be linked with the bars and links arranged to give rotating action. The bars and links shall be fabricated from brass or bright steel flat or round bar which shall be adjustable in length. It should be able to withstand, without appreciable deflection, a compressive load equal to twice the maximum operating force of the damper motor. The rod shall be jig drilled. Drilling shall be carried out before plating.

Damper rods shall be brought through the sides of the duct with set screws and bushing.

Where two sets of dampers are operated from one motor, the linkage shall be such as to allow either damper to be adjusted as to position and/or amount of movement without affecting the adjustment of the other.

The linkage used with manually operated dampers shall incorporate a means for positioning, locking and indicating the positions of the dampers. For dampers over two (2) blades wide, linkage shall be of an approved proprietary type ensuring positive control and alignment of the damper blades. Joints in the linkage shall be made with steel or brass pins and clevises or with ball and socket joints capable of withstanding without suffering damage the service they are intended for.

10.24.10 Mounting and Linking of Damper Motors

Damper motors shall be rigidly mounted on robust fabricated mild steel bar or brackets supported from the duct or building structure so as to prevent any movement of the motor relative to the damper.

Motor to damper linkage shall be of proprietary type incorporating cadmium plated m.s. rods and ball-swivel joints. Where the length of the rods and/or the force exerted by the motor in the opinion of the Engineer could cause buckling of the rod, tubular linkage made of 1/2 inch galvanised m.s. pipe with solid bronze rods welded at both ends shall be used.

10.24.11 Access to Dampers

Dampers shall have accessible operating mechanism and where operating devices occur in finished portion of the buildings, such operating devices shall be chromium-plated with all exposed edges rounded.

10.24.12 **Finishing**

All steel part of the damper shall be finished with two coats of black enamel.

10.24.13 **Outside Air Dampers**

Special gate type outside air damper shall be provided. The damper shall be arranged and constructed as shown on the drawings, and their function shall be to admit outside air.

10.25 **Fire and Smoke Dampers**

10.25.1 **General**

Automatic type fire and smoke dampers shall be supplied and installed at all locations as shown in the drawings and/or all the following positions:-

Fire Dampers Penetrations through fire-rated walls, partitions, floors (except when enclosed in fire rated shafts), fire stops and ceilings. Unducted return, exhaust or transfer air openings in the above-mentioned closures. In addition, fire and smoke dampers shall be provided in all areas as required by the local Fire Authority, irrespective of whether it is shown in the drawings or not.

10.25.2 **Construction**

All dampers shall comply in all respects with the requirements of the Fire Authority and shall be of the following minimum standard of construction:-

- (a) The damper shall be of galvanised or stainless steel or other moisture resistant non-corroding material constructed to a minimum thickness of not less than 12 SWG or equivalent. Attachment of the damper to ductwork shall be in such manner that any deformation or collapse of the ductwork under fire conditions will not dislodge the damper or affect its operation or performance.
- (b) The damper blades shall be single or multiple blade steel curtain type or minimum thickness of not less than 14 SWG arranged to swing freely and automatically (by weighted device or constant tension springs) into place when released. Internal small angle iron guide-stops shall be fitted to ensure an efficient seal when the damper blades are in a closed position. The air leakage rate through the dampers when closed shall not exceed 2% at a pressure differential of 5 in. wg.
- (c) Fire dampers shall be fusible-link actuated. Fusible link shall be arranged to break at a maximum temperature of 155 °F (68 °C) and be connected and anchored to welded internal lugs by means of non-corrodible multicore wire. The position of the fusible links when assembled shall be chosen so that they may be easily inspected and adjusted through access panels cut in the ductwork. In all cases, the position of the ductwork access panels shall coincide with the removable portions of the false ceilings wherever they occur, and shall be clearly marked.

Access openings shall be covered with a 1/16 inch (15 mm) thick galvanised steel plate with self-tapping screws at 6 inch centres and sealed with mastic. Insulation and vapour seal over the opening shall be continuous.

The fusible link and smoke release connection shall be electrically interlocked with the motor circuits of the air supply system. This shall serve to stop the fan motors when the fire or smoke damper is closed.

- (d) The damper shall lock shut positively and shall be opened manually. The damper in the open or shut position shall be indicated by means of an external indicator.

- (e) The dampers shall have rating curves showing resistances to air flow of not to exceed 0.06 in. wg. static pressure at 1500 cfm per sq.ft. for low pressure applications, and 0.25 in.wg. at 3500 cfm per sq.ft. for medium and high pressure applications.

10.25.3 **Installation**

The space between the frames and the brickwall shall be packed with commercial-grade twisted asbestos ropes or approved fire seal before installation.

Arrangements of typical fire dampers are shown on the drawings.

10.25.4 **Access to Fire Dampers**

Opening as specified by Engineer shall be provided in the ducts were required to provide access to fire dampers to permit their resetting and replacement of fusible links.

The access panel shall coincide with the removal portions of the false ceiling where they occur.

- END OF SECTION 10 -

SECTION 12 - PIPEWORK

12.1 Scope

This section of the Specification sets out the requirements for the design, and standards of workmanship which shall be adopted in the supply, fabrication and installation of black and galvanized steel piping (other than refrigerant piping) and also of valves and fittings contained therein. It also includes the requirements for testing and insulation of piping.

12.2 Standards and Codes

This Specification is basically in accordance with BS 806, "Ferrous piping systems for and in connection with land boilers". However, when more detailed design, connection and testing information is required than provided in this Section of the Specification, the detailed provisions of these codes shall apply.

Where this Specification requires materials, construction, tests or performance to comply with any Standard or Code, that Standard or Code shall, unless specified otherwise, be that which is current at the closing date for tenders. If subsequent to the award of the contract any such Standard or Code is amended, the Engineer may direct that the Contractor comply with such amendment.

The installation of pipework shall conform to:-

BS 10:1962	Flanges and bolting for pipes, valves and fittings
BS 21:1973	Pipe threads for tubes and fittings where pressure-tight joints are made on the threads
BS 3974	Pipe supports
BS 1710	Identification of pipelines
CP 2010	Pipelines
BS 3601	Steel pipes and tubes for pressure purposes :carbon steel with specified room temperature properties

12.3 Responsibility for Piping Design and Approval of Drawings

Unless otherwise specified in the Specification, the Contractor shall be responsible for the design and construction of the piping system so that it will meet the capacity requirements of the Specification and the requirements of this Section. He shall prepare installation drawings showing full details of the piping arrangement, pipe sizes, pipe supports, connections to equipment and all other details to indicate how equipment and piping will be installed. These drawings shall be submitted to the Engineer for approval at least four weeks prior to the date it is intended to commence fabrication or installation.

12.4 Piping Materials

It shall be the successful Tenderer's responsibility to ensure that piping materials and wall thickness comply with the relevant Standard Codes or Statutory Authorities requirements.

However, the pipe schedule in Clause 12.5 lists the minimum standard which shall be acceptable. Should the successful tenderer wish to use alternative materials, substantive calculations shall be submitted and written approval shall be obtained from the Engineer prior to installation. Any variations to the schedule shall be as specified in the Specification.

12.5 Pipe Schedules

Piping of the following types and materials shall be used for the various services, in accordance with *General Specifications for Air Conditioning Installations, December 1987* from Department of Electrical Services.

12.6 Arrangement and Layout Piping

The drawings indicate the desired and approximate positions and arrangement of all piping.

In Contractor's installation drawings which will be subject to the Engineer's approval all pipework shall be arranged so as not to interfere with the removal of equipment or devices and to ensure clear access to doors, windows, manholes and other access openings. Pipework shall be arranged to allow easy removal of tube bundles and coils.

12.7 Preventing Transmission of Vibration

Where the piping has insufficient flexibility to prevent transmission of vibration through it to the building structure, or where specifically required by the Specification, flexible connections shall be provided at connections to rotating and vibrating machinery.

Where flexible pipe connections are used, they shall be selected to accommodate the axial and lateral dynamic deflections of the isolated equipment. Flexible connectors shall have a minimum length equal to six (6) times the nominal pipe diameter and a maximum length of 3 ft. Flexible connections shall be installed so that their axes are parallel to the axis of rotation of the equipment to which they are connected, and adequate pipe anchorage shall be provided to prevent stressing of the pipework or connected equipment by the longitudinal forces resulting from the flexible connection.

The installation recommendations of the manufacturer of the flexible connections shall be strictly observed. Approval to use flexible connections shall be obtained from the Engineer prior to the installation of these devices.

12.8 Pump Connections

Special care and precautions shall be taken in arranging and installing pipework connected to the suction and delivery side of pumps. Particular attention shall be given to the following:-

(a) Piping Sizing

Full line size pipework shall be taken right to the pump, with correctly proportioned tapered reduction pieces, if required, immediately at the suction and discharge connections. Any valves and fittings, in such piping shall be full line size.

(b) Piping Arrangement

A straight pipe of a length equal to at least four (4) pipe diameters shall be provided on the pump inlet. Where the pump is flexibly mounted but no flexible piping connections have been specified, the piping shall be arranged so as to ensure sufficient flexibility to allow for the slight movement of the pump on its mountings.

(c) Piping Supports

The piping adjacent to the pumps shall be positively and strongly supported so that the completed weight of the piping is taken by the supports and/or hangers and not by the pump. Unless specified otherwise, all piping attached to vibration isolated pumps shall be supported via approved flexible hangers or anti-vibration mounts, for a length equal to approximately 100 pipe diameters, or a minimum of 15 ft.

(d) Recommendations of Pump Makers

Any special recommendations or instructions of the pump maker concerning the piping connections to any particular pump shall be fully observed.

12.9 Pipe Supports

Pipe supports shall permit appropriate movement for expansion and contraction in the desired direction and prevent transmission of vibration. All pipe supports shall be installed in conjunction with *General Specifications for Air Conditioning Installations, December 1987* from Department of Electrical Services.

Vibration isolation supports shall consist of neoprene in shear and helical spring assemblies. Materials, design and dimensions of supports shall conform to the recommendations of BS 3974 "Pipe Supports".

12.10 Anchors

Anchors shall be provided where shown on the drawings to provide reactions for expansion devices and flexible type connections and to prevent excessive expansion or contraction forces in pipework from being transmitted to equipment. On steel pipes, anchors may be either welded or clamped securely to the bare pipe.

12.11 Grading

Piping shall be installed true to alignment and grade. Crooked or sagging pipes which will trap liquid or air are not acceptable.

Clips, hangers and supports shall be fabricated from mild steel hot dip galvanised after manufacture and shall be of proprietary manufacture and in quantity production and to the approval of the Engineer. Where the successful Tenderer wishes to use supports of his own manufacture, he shall submit drawings of samples to the Engineer for approval. Supports which have not been approved prior to installation may be rejected.

Where pipes run together in parallel, their supports shall be grouped. Fastening of supports to the building or structure shall be by means approved by the Engineer prior to any fixing being made. Wooden plugs and explosive powered fasteners are not acceptable. Steelwork shall not be drilled or welded to unless approval has been given by the Engineer. On cold insulated pipes, an insulation ferrule shall be placed between the pipe and the pipe support. The ferrule shall consist of a lightweight rigid cellular inorganic glass insulated block, having an average ultimate compressive strength of not less than 80 psi.

The ferrule shall have the same wall thickness as the adjacent pipe insulation and be of a length sufficient to ensure that the support does not contact the pipe insulation due to movement of the pipe. The ferrule shall be coated internally with an anti-abrasion compound compatible with the material of the ferrule, and held in place using reinforced aluminium foil such as Sisalation 450 or equivalent applied with a longitudinal lap using a non-flammable (dry state) adhesive.

The butt joints between, and continuity of vapour barrier over, the ferrule and insulation shall be as set out under 'Insulation of Piping'. Reducing fittings shall be of the eccentric type and installed to prevent liquid or air trapping at the fitting. Unless shown otherwise, all pipework shall be run truly horizontally with the exception of drain lines which shall have a minimum downward grade of 1:50.

Where piping has to clear an obstruction, piping carrying liquids shall pass under the obstruction and piping carrying air and vapours shall pass over the obstruction. In these cases grading, drains and vents shall be arranged to ensure that the piping can be drained and vented.

12.12 Drains

Sufficient drains shall be provided to allow the whole or any part of the system to be drained of fluid. Valved drains shall be provided at all low points on the piping systems. Refer to *General*

Specifications for Air Conditioning Installations, December 1987 from Department of Electrical Services for correct installation.

12.13 Automatic Vents

Refer to *General Specifications for Air Conditioning Installations, December 1987* from Department of Electrical Services for correct installation.

12.14 Storage & Cleaning

Where ferrous piping is stored in the open on site, it shall be supplied with an oiled or varnished finish prior to delivery to site. Open ends of pipe shall be plugged or kept closed.

Before erection, ferrous pipe shall be thoroughly cleaned of loose scale and dirt by blowing through with compressed air or by pulling a brush through the pipe. Any rusting on the exterior or ferrous piping shall be wire brushed clean and painted prior to erection with a rust inhibitor as detailed under Clause 12.56 "Corrosion Protection - Surface Preparation and Coatings".

After installation and before hydrostatic testing, all piping shall be thoroughly cleaned out by washing through with water until all foreign matter is removed, or if practicable, blown through with steam. Temporary filters shall be installed in inlet pipes to equipment at the commencement of commissioning and shall be removed just prior to handing over. Final cleaning shall be carried out in the presence, and to the satisfaction of the Engineer.

12.15 Cutting and Preparation

After cutting the pipes, all burrs shall be removed from both the inside and outside edges of the cut face.

12.16 Protection of Open Pipework

During the course of installation, any open ends of pipework left at the end of each day or each phase of work shall be sealed off by using caps or plugs to prevent the entry of foreign bodies, or refuse. Wooden plugs, rags or papers shall not be used to seal open ends.

12.17 Earthing

No piping shall be used for electrical earthing.

12.18 Drip Trays

Drip trays shall be installed under all cold exposed fittings, coils or pumps on which condensation may occur. The fixing, insulating and provisions for draining drip trays shall be as shown on the drawings.

12.19 Sleeves

Where pipes pass through walls, floors or ceilings, the holes and sleeves shall be positioned as shown on the drawings. Sleeves shall be formed from the same material as that of the pipe, but shall be not less than 16 ga. for steel pipe, and shall be of such a size as to ensure a clearance of not less than 5/8 in. in diameter.

Where pipes pass through a fire-rated wall, the annular space between the sleeve and the pipe shall be packed with asbestos fibre rope and tamped into the space. Sleeves set into "wet" floors, such as ceramic tiled or "grano" floors suitable for washing or hosing down, shall be of galvanized steel pipe and shall project 2 in. above finished floor level.

12.20 Pipe Joints

Where possible, long pipe lengths and permanent type joints, e.g. welded joints, brazed joints, screwed socket joints (as applicable) shall be used. The number of demountable joints, e.g. flanges, unions, compression joints (as applicable), shall be kept to a minimum. Joints in pipework shall be built with reference to *General Specifications for Air Conditioning Installations, December 1987* from Department of Electrical Services for correct installation.

12.21 Locations and Use of Demountable Joints

Demountable joints are joints which allow sections of piping to be disconnected from each other or from fittings or equipment. They include flanges, unions and compression fittings, but not screwed sockets. Demountable joints shall not be buried directly in the ground, but may be located in pits.

Demountable joints shall be provided as follows:-

- (a) Where pipework may have to be dismantled for maintenance purposes.
- (b) Where called for on the drawings.
- (c) At all connections of piping to plant (pumps, condensers, etc.)

The following demountable joints shall be used:-

- (a) All pipes over 2 in. diameter shall be provided with flanges.
- (b) Steel pipes up to and including 2 in. diameter may be provided with screws, unions or with flanges.

12.22 Removal of Screwed Valves

Where screwed valves are allowed, union or flanged joint shall be provided adjacent to the valve to allow disconnection of the item of equipment it serves or the valve itself without having to dismantle an extensive amount of pipework.

12.23 Connection to Plant

Connections to items of plant shall be provided with isolating valves and designed to permit dismantling of the plant item without disturbing other pipes, and to permit removal of the plant without removing the piping or draining the system.

12.24 Approved Types of Joints

Joints in pipes shall be of the types as allowed in *General Specifications for Air Conditioning Installations, December 1987* from Department of Electrical Services for correct installation.

12.25 Pipe Fittings

Tees and similar fittings, except where specified otherwise, are to be in accordance with *General Specifications for Air Conditioning Installations, December 1987* from Department of Electrical Services for correct installation.

12.26 Bends

12.26.1 General

The following requirements for bends in systems are based on consideration of piping system flexibility, stresses, matching of system component diameters and wall thickness, on frictional resistance to flow.

12.26.2 High Temperature Range Systems

For all piping systems joined by either welding, brazing or screwing, the use of bends formed from straight steel pipe, identical to the adjoining piping in the system is preferred. Bends shall have radii not less than those specified in BS 806, "Ferrous piping system for an in connection with land boilers" for bends made from steel pipe.

12.26.3 Welded Steel Bends and Elbows

For welded steel pipeline construction where it is not practicable to use pipe bends complying with the requirements of BS 806, butt welding long radius elbows may be used. Long radius elbows manufactured in either "Standard Strength" or "Extra Strong" thickness, in accordance with the requirements of BS 1640 Part 1, "Steel Butt Welding Pipe Fittings for the Petroleum Industry" are acceptable.

In order to obtain the correct matching between butt welding fittings and mating pipework, consideration shall be given to the following requirements before final selection of piping is made:

- (a) The use of "Standard Strength" butt welding elbows with "Medium Grade" steel pipe to BS 3602, "Steel pipe and tube for pressure purpose : Carbon steel with specified room temperature properties" shall be restricted to pipe sizes up to and including 2 inch. Above 2 inch "Standard Strength" butt welding elbows shall only be used with welded and seamless steel pipe to BS 1600, "Dimension of steel pipe for the Petroleum Industry", "Standard Strength" quality.
- (b) "Extra Strong" butt welding steel elbows shall only be used with welded and seamless steel piping to BS 1600, "Extra Strong" quality.

12.26.4 Screwed Steel Elbows and Bends

Where on pipelines up to 3/4 inch diameter it is not practicable to use screwed pipe bends complying with the requirements of BS 806, then steel elbows or bends up to and including 6" diameter made in accordance with BS 1740, may be used.

12.27 Procedures for Metal Arc and Gas Welding

Welding shall be in accordance with BS 2633, BS 2971, BS 1821 and BS 2640.

12.28 Testing of Piping

12.28.1 Material Tests

All piping and fittings used shall have been tested in accordance with the requirements of the relevant British Standard Specification and/or the requirements of any local Statutory Authority for the material concerned.

12.28.2 **Pressure Tests**

All piping shall be pressure tested during installation with water under a pressure of not less than 150 psi and not less than twice the working pressure.

Pressure testing shall be done before piping is insulated, painted or otherwise covered over.

The Engineer shall be notified in writing at least 48 hours before the test, of the date on which the test will take place. The test shall be witnessed by the Engineer. Testing shall not be accepted unless witnessed as specified.

Unless otherwise specified, testing shall be as follows:-

- (a) Close only those valves necessary or fit blank flanges necessary to hold the test media in the section or piping under test. Remove or isolate any fittings, controls or instruments not designed to withstand the test pressure.
- (b) Charge the system, to the test pressure specified, and maintain this pressure for sufficient time to allow all piping, joints and fittings to be inspected for leaks.
- (c) If any leaks are found, they shall be repaired and the pipework then retested as described above.

12.28.3 **Thermal Movement Tests**

After installation and pressure tests, pipework which operates at a temperature above or below normal ambient temperature shall be cycled between ambient and operating temperature at least three times, or until the Engineer is satisfied that the provisions made to cater for expansion and contraction function properly and that the piping remains tight, sound and true to line and will not damage itself or the insulation or cause damage to connected equipment or to the building structure.

The cycle time shall be of sufficient duration to ensure that each system reaches its normal operating temperature and pressure and remains at these conditions for at least one hour.

12.29 **Identification of Piping**

All pipework shall be identified in accordance with BS 1710, "Identification of Pipelines".

12.30 **Method to Identification**

Unless specified otherwise in the Specification, all piping except those built into walls or buried in the ground shall be painted throughout and the finished background colour shall be that described in BS 1710.

Piping shall then be further identified by markers applied at not more than 25 ft intervals on straight runs, both sides of any wall, floor or any other partition through which the pipe passes, adjacent to valve, branch line or control points, and any outlet. Rising pipes shall be marked at each accessible level, concealed pipes shall be marked where access panels occur.

Where a pipe is insulated, the background colour and identification markers shall be applied over the finished insulation.

12.31 **Marker Design**

All markers shall consist of a flexible glossy white pigmented film with the under side completely precoated with an aggressive pressure sensitive adhesive. The adhesive shall be protected by a

treated paper liner which shall be removable without soaking in water or other solvent and shall be scored to facilitate removal.

The adhesive shall be such as to bond in a manner not permitting the removal of the marker, in one piece, from a clean aluminium surface without the aid of physical tool. The adhesive shall be such as to provide adequate adhesion to sand cast or moderately rough, cleaned pipeline surface.

The markers shall retain adhesion and performance within the temperature range -50 °F to +212 °F. Marker to be installed where temperature is in excess of 212 °F, shall be of a type submitted to the Engineer for approval prior to being used. The design of the pipe marker shall incorporate a ground colour block not less than 15 inch in length. The ground colour shall be surrounded by a white border and at both ends, external to the ground colour block, directional chevrons shall be incorporated.

These shall be of a plain colour against a white background. The arms of the chevron shall be of uniform width throughout their length. The design around the ground colour may be retained intact to preserve the aesthetic balance of the marker.

12.32 Direction of Flow Chevrons

The Contractors shall in all cases of applying markers to pipelines determine the flow direction in the pipe, shear off the unwanted chevron and apply the marker with the correct flow direction indicated.

12.33 Flow and Return Indicators

The Contractor on all visible piping shall apply flow and return indicators, determining which are the flow and return pipes. Flow and return indicators shall consist of the letters "P" and "R" respectively, printed black on white materials, similar to that of the colour markers and shall be applied over the unwanted chevron of the colour marker.

12.34 Supplementary Safety Signals

Supplementary safety signals shall be over a length of not less than 3 inch and applied over the markers on all pipes carrying dangerous materials, fire fighting materials and potable water, the colour of the safety signal being governed by the nature of the pipeline contents.

12.35 Lettering

A description of the fluid carried shall be provided on the marker and shall be in accordance to BS 1710. On pipes smaller than 1/2 inch lettering may be applied to tags or plates, provided that these are securely attached to the pipe, Lettering on tags or plates shall be a minimum of 3/16 inch.

Pipes 1/2" - 1"	-	e" high letters on marker
Pipes 1 1/4" - 3"	-	1" high letters on marker
Pipes 4" and above	-	1 1/2" high letters on marker

12.36 Application Instructions

Comprehensive printed instructions shall be provided with each packet of markers. The instructions shall give full details of application techniques including precoating of surface where necessary and edge sealing. See the drawings for typical marker arrangements.

12.37 **Table of Colouring and Lettering Details**

Service	Base	Main	Lettering
Chilled water supply flow pipes	Green	Island 119	CHWS
Chilled water return pipes	Green	Tropicana 2026	CHWR
Refrigerant pipes	Brown	Brown	REFRIGERANT
Condensate pipes	Black	Black	CONDENSATE

* Colour references are base on ICI Dulux Colour Card.

Pipe identification shall conform to BS 1710, "Identification of Pipelines".

The Air-Conditioning Contractor shall submit samples of the paints for approval and no painting shall commence before approval is obtained from the Engineer. The final choice of the colours shall be determined by the Engineer.

Paint numbers quoted in the table in Clause 12.52 are from BS 381C "Colours for Specified Purposes" and colours shall comply with this Standard.

12.38 **Valves**

Supply and install valves where shown on the drawings and as described in *General Specifications for Air Conditioning Installations, December 1987* from Department of Electrical Services for correct installation.

12.39 **Corrosion Protection - Surface Preparation and Coatings**

Provide corrosion protection to all ungalvanised metal surfaces with appropriate coatings to the Engineer's approval, corrosion protection shall comply with BS 5493:1977 'Protective Coating of iron and steel structure against corrosion'.

Before application of any coating, the surface shall be dry and free from mill-scales, rust, dirt, grease and other chemical contaminants. All mill-scale and rust shall be removed by powered wire-brushing, discing, mechanical abrading etc. The mill-scale free surface shall then be treated with ICI Deoxidine 125 to remove rust. Two coats of ICI F 540-150 Dulux Quick Drying Read Lead primer shall be applied.

The welded part of any galvanised surface shall be made good by first removing all scale and heat-damaged coatings by local blast-cleaning and then applying zinc-rich paints to reinstate the original dry-film thickness. Surface preparation and coatings shall be in accordance with BS 5493:1977 and the Manufacturer's recommendations.

- END OF SECTION 12 -

SECTION 14 - SERVICE AND MAINTENANCE

14.1 Scope

This section of the Specification covers the provision of all materials, appliances, labour and necessary incidentals for the service and maintenance of the Air Conditioning and Ventilation Systems and the Ancillary Equipment for the Mechanical and Electrical Services within the Defect Liability Period under this Contract.

14.2 Workmanship and Materials

The work described in this section shall be performed by workmen skilled in the service, maintenance and repair of central air conditioning plant of all types and shall be executed in accordance with the best practice in the industry.

All materials supplied in connection with works under this section shall be new and unused and shall generally be of the best quality as regards manufacture and performance.

14.3 Instruction of Personnel

The Contractor shall provide an operator skilled in all aspects of the operation of the mechanical services installed (including refrigeration machines, pumps, air handling plant and instrumentation) within the Defect Liability Period from the date of practical completion of the installation to competently and thoroughly instruct the operating personnel in all aspects of operation, maintenance and trouble-shooting techniques associated with the installation.

This operator shall be required to work 40 man-hours per week, not necessarily during normal office hours. Reimbursement rates of properly authorised hours in excess of this figure will be subject to agreement between the Contractor and the Employer.

If so desired more than one operator may be supplied, each skilled in a certain aspect of the installation. In such circumstances, all aspects of expertise shall be represented on the site for the full period of instruction.

Persons so described above shall be acceptable to the Engineer. If a person is at any time deemed unsuitable by the Engineer, then he or she shall be replaced with a person acceptable to the Engineer.

14.4 Description of Work

The Contractor shall be required to carry out but not limited to the works described below:-

- (a) All machinery and equipment comprising the complete Air Conditioning System and Ancillary Equipment under this Contract shall be serviced and maintained strictly in accordance with the Service and Maintenance Schedule as set out below and/or in accordance with the manufacturers' recommendations.
- (b) The Contractor shall advise the Employer of any defects in any part of the complete air conditioning plant and ancillary equipment observed during the routine inspection and service, and shall repair such defects if required to do so by the Employer.
- (c) The Contractor shall provide emergency repair services during normal office hours and also during overtime hours if required to do so by the Employer without incurring additional expenses on the part of the Employer.
- (d) The Contractor shall keep a log book in the main plant to check the performance of the air conditioning system and the ancillary equipment.

14.5 Servicing and Maintenance Schedule

The Contractor shall inspect and service all machinery and equipment comprising the complete Air-Conditioning Plant and Ancillary Equipment under this Contract at least once a month, except where otherwise directed by the Employer and/or the Engineer.

At each such monthly inspection and service of the complete Air-Conditioning Plant and Ancillary Equipment, the Contractor shall carry out the periodic servicing and maintenance routines in strict accordance with the manufacturer's recommendations and the work detailed below:-

- i) Inspect all refrigerant compressors and refrigeration system and
 - (a) Check the whole refrigeration circuit for leaks with a standard halide gas leak detector and rectify as necessary.
 - (b) Check all refrigerant and oil levels and charge correct amount and proper type of refrigerant and lubrication oil into system as necessary.
 - (c) Inspect V-belts and pulleys for signs of abnormal wear or pulley misalignment. Adjust or replace worn-out parts as necessary and maintain proper belt tension by necessary adjustments.
 - (d) Check for oil leaks around packing and tighten packing glands sufficiently to prevent leakage only.
 - (e) Check the operation of all safety devices such as relief valves and clean, adjust and lubricate as necessary.
 - (f) Check the operation of all refrigerant controls such as that of expansion valves, pressure switches, thermostatic gas-filled bulbs and clean, adjust and lubricate as necessary.
 - (g) Check the suction and discharge pressure of all refrigerant compressors and if abnormal, trace the faults and rectify as necessary. Test cutting in and out points by proper adjustment of pressure control switches.
 - (h) Check all bolts and nuts for tightness and tighten as necessary especially foundation bolts for compressors.
 - (i) Check condition of vibration isolators of compressors and if faulty, rectify or replace as necessary.
 - (j) Check strainers installed on refrigerant lines and clean if necessary.
 - (k) Check for knocks, abnormal noise levels and excessive vibration in compressors and rectify as necessary.
 - (l) Purge system of air and non-condensable gases by following manufacturer's instructions.
- ii) Inspect all air handling and fan coil units, and
 - (a) Check all air filters and clean or replace as necessary.
 - (b) Check all cooling coils seals, fittings, connections and pipelines for leaks and rectify as necessary.
 - (c) Purge air and non-condensable gases from all cooling coils by adhering to manufacturer's instructions.

- (d) Check all fan bearings and lubricate with oil or grease as necessary.
- (e) Inspect belts and pulleys for wear and check tension of belting and adjust as necessary.
- (f) Check the operation of automatic water regulating valves and clean, adjust and lubricate as necessary.
- (g) Check the operation of all automatic multi-blade face and bypass dampers and clean, adjust and lubricate as necessary.
- (h) Clean all the condensate pans, trays and drains and also operation of drain pipes especially the traps. Rectify any leakage or corrosion as necessary.
- (i) Clean cooling coils to remove accumulated dirt and other foreign matter by washing with caustic soda solution and rinsing thoroughly with clean water.
- (j) Check condition of electric reheat coils, remove scale and products of oxidation from surface and replace damaged insulators as necessary.
- (k) Check surfaces of casing for signs of corrosion and retreat or repaint as necessary.
- (l) Check insulation and vapour barrier on casing and repair or replace as necessary.
- iii) Inspect all electric motors, and
 - (a) Check all motor bearings and lubricate with oil or grease as necessary.
 - (b) Check carbon brushes and slip rings for wear and clean or replace as necessary. Also check contact pressure of carbon brushes and adjust compression springs as necessary.
 - (c) Check commutator for presence of so-called commutator and polish with fine sand paper as necessary.
 - (d) Clean dust and dirt from all current carrying parts and from insulation.
 - (e) Clean all cooling air passages and external fins and retreat or repaint motor casing as necessary.
 - (f) Check starter contact are free from arcing during starting cycle and rectify as necessary.
 - (g) Check all safety devices, such as overcurrent protection devices fitted and clean, adjust and lubricate as necessary.
- iv) Inspect all air distribution equipment, and
 - (a) Clean and repaint all grilles, registers and diffusers as necessary.
 - (b) Clean or replace air filters on fresh air inlet grilles.
 - (c) Check and repair insulation on ducts and rectify leakage on joints as necessary.
 - (d) Check operation of all dampers and clean, adjust and lubricate as necessary.

- (e) Check operation of fire dampers and lubricate all moving parts. For installation with a number of such dampers, carry out a random check on the proper operation of the fusible links especially its rated fusing temperature. Also check on condition of insulation around framework and sealing capability of damper blades and rectify as necessary.
 - (f) Readjust all control dampers on diffusers and splitter dampers as necessary to obtain the proper amount of airflow desired.
- v) Inspect all condensers, and
 - (a) Check coils, connections, fittings and pipelines for leakage and rectify as necessary.
 - (b) Check casing for signs of corrosion and rectify as necessary.
 - (c) Purge air and non-condensable gases from coils by following manufacturer's recommendations.
 - (d) For air-cooled ones, clean cooling fins of dust and dirt by compressed air.
 - (e) Check condition and operation of safety devices such as relief valves and clean, adjust and lubricate as necessary.
 - (f) For air-cooled ones, check and lubricate fan and motor bearings with oil or grease as necessary, check condition of vibration isolators and rectify if necessary, check and adjust belt tension as necessary.
 - (g) For shell and tube condensers, clean water side tubes by mechanical or chemical means to remove scale, check condition and operation of all regulating valves.
- vi) Inspect and check the routine operation of all electrical starters, electrical control gears and ancillary electrical apparatus, and
 - (a) Clean, adjust and lubricate all bearings, pivots and other moving parts as necessary.
 - (b) Clean or renew electric contactors as necessary.
 - (c) Renew electric fuses as necessary.
 - (d) Clean dust and dirt from current-carrying parts and from insulation as necessary.
 - (e) Check contact points of contactors and relays for wear or pitting and for arcing during operation and rectify or renew as necessary.
- vii) Inspect and check the routine operation of all automatic temperature control gears and relays, and
 - (a) Clean, adjust and lubricate all bearings, pivots and other moving parts as necessary.
 - (b) Clean or renew electric contactors as necessary.
 - (c) Renew electric fuses as necessary.
- viii) Check the performance of the complete Air-Conditioning Plant and Ancillary Equipment and perform the necessary adjustments such as that for the air volume control dampers.

- ix) Inspect and check all insulation and vapour barrier on chilled water pipes, allied fittings such as valves, refrigerant lines and chilled water expansion tanks for signs of damage or wear and rectify as necessary.
- x) Check operation and condition of all valves in system and inspect corresponding flanged, welded, soldered or screwed connections for leakage and rectify as necessary. For leaky valves, tighten packing gland or nut or replace packing or stem as necessary. Examine valve seats and if pitted, grind with fine abrasive to alleviate leakage.
- xi) Check operation of air handling unit cut-out relay by activation of smoke detector(s) in plantroom and rectify if necessary.
- xii) Inspect and check all other equipment under this Contract, whether or not these are specifically mentioned in this Schedule.
- xiii) Instruct the operators responsible for the operation of the plant and equipment on correct method of operating the plant and equipment, and on the maintenance points to be watched.
- xiv) Report in writing to the Employer any defect(s) observed in any part of parts of the complete Air-Conditioning Plant and Ancillary Equipment. The report shall state the cause(s) of the defect(s) observed, and shall include an estimate of the cost of repairs required.
- xv) Inspect all water pumps, and
 - (a) Check all seals, glands, fittings, connections and pipelines for leaks and rectify as necessary.
 - (b) Repack and adjust packing glands as necessary. Allow for a small amount of drip to prevent excessive friction.
 - (c) Check all pump bearings and bushings and lubricate with the correct amount of lubricating oil or grease as necessary.
 - (d) Check alignment between pump and driver and condition of all elastomer couplings between them and rectify or replace as necessary.
 - (e) Check tension of all belt drives and adjust as necessary.
 - (f) Inspect pulleys for worn or damage grooves and belts for abnormal wear and rectify as necessary.
 - (g) Check condition of contact faces of mechanical seals and rectify as necessary.
 - (h) Check casing and baseplate for signs of corrosion and rectify as necessary.
 - (i) Check condition and operation of associated fittings such as gate valves, check valves, globe valves, vibration isolators and strainers and rectify or replace as necessary. Clean all strainers as necessary.
 - (j) Check all bolts and nuts for tightness and tighten as necessary especially the foundation bolts.
 - (k) During normal operation of pumps, check for abnormal sounds or vibration, suction and discharge pressure and bearing temperatures and rectify as necessary.
- xvi) Inspect, check, repair as necessary all automatic control including DDC control related instrument and sensors as per Section 3.

- xvii) Inspect all chilled water storage and expansion tanks and drains, clean and flush out the tanks as necessary and retreat or repaint all areas showing signs of corrosion and similarly to maintain all other services water tanks.
- xviii) Half Yearly Tasks
 - (a) Check all direct-expansion refrigeration systems for operating pressures, temperatures, undue vibration, refrigerant leaks, also cleanliness of condenser fans.
 - (b) Arrange for a specialist inspection and check-up of the automatic control.
 - (c) Arrange for a specialist service to check chiller sets for correct operation. Check operating temperatures and pressures, operating and safety controls. Top up refrigerant and/or oil changes as required.
- xix) Yearly Tasks

As half-yearly, and in addition:-

 - (a) Inspect and repack with grease fan and motor bearings.
 - (b) Inspect, clean, tighten, adjust and otherwise rectify any faults in the electrical switchboards and installation.
 - (c) Clean condenser water tubes in chiller sets.
 - (d) Thoroughly inspect, flush out and clean cooling towers, including fans and drives. Remove any rust and make good corrosion protection as required.
 - (e) Dismantle pumps, clean out internally and externally, grease bearings and repack glands. De-rust and make good anti-corrosive coatings.
 - (f) Dismantle and clean all water strainers.

14.6 Consumable Materials

The Contractor shall supply the following consumable materials as and when required.

- i) All oils and greases required for lubrication of compressors, bearings, pivots and other moving parts.
- ii) All refrigerant required to replace refrigerant losses in the refrigerant systems and for testing purposes.
- iii) All consumable filter elements.
- iv) All carbon brushes and slip rings required to replace worn ones in electric motors.
- v) All electric contact points required to replace worn electric contact points in switch gears, motor starter gears, electric control gears and electric relays.
- vi) All electric fuses required to replace blown fuses. All materials for patch-up jobs such as primer and gloss finish paint, insulation, vapour barrier and gland packing.
- vii) All materials for replacing or worn-out ones such as bearings, bushings, belts, pulleys and fusible links.

- viii) All incidental consumable such as adhesives, screws and allied fixing materials, sandpaper, abrasive, chemicals for cleaning purposes, solvents, solder, welding and brazing rods and so on. These shall be of the best quality suitable to the job envisaged.
- ix) All cotton waste, soap detergent and other cleaning materials required for cleaning purposes.

The cost of these consumable materials shall not be charged for separately by the Contractor, but shall be included in the fixed monthly rate quoted by the Contractor for the service and maintenance of the complete Air-Conditioning Plant and Ancillary Equipment.

All replacement materials or items shall be new and of the same quality and type as the original ones. Approval shall be sought from the Engineer if alternatives are to be used. If such prior approval is not obtained, the material or item shall be rejected and the Contractor shall replace it to the satisfaction of the Engineer with no extra cost incurred on the Employer.

14.7 Service and Maintenance Record

The Contractor shall provide a service and maintenance record book for the complete Air-Conditioning Plant and Ancillary Equipment being serviced and maintained by him. This record book shall be kept in the plantroom of the Air-Conditioning Plant and Ancillary Equipment being serviced and maintained and brief details of all service, maintenance and repairs carried out on the complete Air-Conditioning Plant and Ancillary Equipment shall be entered by the Contractor into this book for checking purposes. The address and telephone number of the Contractor's service office shall also be entered into this record book to facilitate emergency service calls.

The Contractor shall also keep an accurate detailed record in duplicate of all service, maintenance and repair work carried out by him on the complete Air-Conditioning Plant and Ancillary Equipment. This record shall be in the form of a Maintenance/Repair Sheet and shall be countersigned by the Employer each time the Air-Conditioning Plant and Ancillary Equipment is attended to by the Contractor.

- END OF SECTION 14 -

SECTION 16 - VENTILATING FAN

16.1 Scope

This section of the Specification sets out the requirements for the design, materials and the standard of performance which shall be adopted in the manufacture and installation of ventilating fans.

16.2 General

The Contractor shall engineer, supply and install all fans and ventilators where shown on accompanying drawings for the proper and efficient ventilation of the building. Fans and ventilators shall be of the type and arrangement suitable for achieving the requirements of the ventilating system design.

16.3 Capacity

All fans and ventilators shall be of size and capacity not less than the minimum required for the design when operating under the specified conditions.

All fans shall be tested in accordance with AMCA Standard 210, 'Test Code for Air Moving Devices' and BS 848.

16.4 Fan Types

(a) Propeller Fans

Propeller type fans shall generally be used for the movement of relatively large volumes of air at low static pressures or at free-delivery conditions. The fan shall consist of a multi-blade impeller arranged for ring or diaphragm-mounting and connected to a direct driving electric motor. Impeller and mounting frames shall be manufactured from heavy gauge metal or other approved type materials designed for industrial or commercial uses and capable of continuous operation under the conditions encountered. Fans shall be carefully selected to suit the capacity and service required and shall be protected with due respect to corrosion, inflammability or other hazardous application. Fans shall be designed for balanced and vibration-free operation with a minimum noise level and power consumption. Unless specifically approved by the Engineer, fan speeds shall not exceed 1450 rpm. Fans shall be generally ring or diaphragm-mounted to suit the particular installation. Where required, all fan ancillaries such as external grilles, wire guards, cowls, bell mouth entry or automatic louvre shutters shall be provided. The sound levels of fan shall not exceed NC 45 and shall be tested to BS 848 Part 2, 'Fan Noise Testing'.

(b) Aerofoil Axial Flow Fans

Aerofoil axial type fans shall generally be applied to the supply and extraction of air against system static pressure due to ductwork, filters, grilles, dampers and other losses.

Unless otherwise required, aerofoil axial fans shall be of tube axial arrangement with the impellers mounted within a casing of heavy gauge hot-dipped galvanized steel. Impellers shall be manufactured of die-cast aluminium alloy or other approved suitable material to suit the conditions of operation. Impellers shall be of adjustable pitch and capable of producing the flow and pressure required.

Fans shall be designed for balanced and vibration-free operation with a minimum of noise level and power consumption. Unless specifically approved by the Engineer, fan speeds shall not exceed 1450 rpm. The noise levels of fan shall not exceed NC 45 and shall be tested in accordance with BS 848 Part 2. The fan and casing shall be carefully selected to suit the service conditions encountered and shall be protected with due respect to corrosion, inflammability or other hazardous applications.

Connection of the fan casing of air ductwork shall be by means of flexible connections. Where required, all ancillaries such as wire guards, cowls, bell mouth entry, volume dampers or automatic louver shutters shall also be provided.

(c) Air Curtain

Air curtains shall be provided wherever necessary for isolating cooling, heating or air movement between different compartments. The design of the unit shall ensure high efficiency in heating/cooling retention and to provide for efficient dust-proofing, deodorizing and insect-proofing effect.

The unit shall be suitable of either inside, outside, ceiling-mounted or concealed installation. Fans shall be of large size, double suction centrifugal type. The size and capacity shall be selected to suit the service required, and shall be capable of continuous operation under the conditions encountered. The air curtain casing shall be of elegant design and finish, with air deflection vanes designed for easy adjustment. Filters shall be provided at the inlet side for the removal of dust particles and these shall be of the replaceable type.

Operation of the fan shall include for a 3-speed changeover switch for remote control for "High", "Medium" and "Low" air discharge requirements.

16.5 Fan Motors and Drives

Fans may generally be direct motor driven or connected to the motor by means of a V-belt drive. Motors shall be of the constant speed, squirrel cage induction, totally enclosed type. Fan motors shall be rated for continuous operation in ambient temperatures of up to at least 40 °C and shall be of sufficient size to efficiently fulfill the fan brake horsepower requirements, including for drive losses.

The motor shall comply with all the regulations of the local authorities and manufactured and rated to BS 2613. Class of insulation shall normally be Class E unless otherwise specified for application in high ambient temperatures. The motor shall generally be designed for weatherproof operation and protected to IP 44 Classification. Where applications under corrosive, inflammable or other hazardous conditions are encountered, motors shall be accordingly protected.

Motors shall be suitable for either 240V, single phase or 415V, 3 phase operation on a 50 Hz AC supply. The motor starter shall be of direct-on-line, star-delta or auto-transformer type to suit the situation in full compliance of the electricity regulations.

Where V-belt drives are used, the drives shall be designed for not less than 150% of the connected driving horsepower. Two belt drives shall be rated at 100% for each belt. Drives shall be adjustable variable-pitch type for units rated up to and including 25 HP. Adjustment shall allow for not less than 20% speed variation of the fan. Fan motors larger than 25 HP, final adjustment of fan speed shall be made during testing and balancing by changing the sheaves as required. Belt drive motors shall be provided with adjustable rails or bases and the drive provided with removable drive guard and screen.

Motors shall be fitted with suitable ball and/or roller bearings. Bearing tolerances and cage design shall be selected to ensure that specified noise levels can be achieved when the fan is in operation. The bearing shall be grease-lubricated and sealed for life.

16.6 Volume Dampers for Fans

Where required for air volume modulation, dampers provided shall be of the butterfly or airstream operated depending on the requirements of the situation. The dampers shall consist of two or more semi-circular vanes pivoted within the damper casing and carried by permanently lubricated bearings. The casing and vanes shall be hot-dip galvanized.

Where hand operated dampers are furnished, the volume modulation shall be by a screw and link mechanism with a hand-wheel control on the outside of the casing. For automatic volume modulation, the dampers shall be motorised with the actuator motor unit and limit switches carefully selected to suit the torque and system characteristics required.

The volume damper shall hold the vanes firmly against air pressure of up to 20 in wg.

16.7 Anti-Vibration Mountings

The installation of all fans shall be complete with all necessary anti-vibration mountings to effectively damper any transmission of fan noise and vibration.

16.8 Acoustic Performance

Each fan and motor shall be selected to ensure that the maximum allowable sound power level stated in the Specification is not exceeded at any specified operating condition.

The Tenderer shall supply with his tender the overall sound power level for each fan and motor operating at the design conditions as per specifications. An octave band analysis of the fan and motor sound power levels for the octave bands 125 Hz to 4,000 Hz shall be supplied. Fans found exceeding the maximum allowable noise levels as specified in Section 7 shall be replaced at no extra cost to the Employer. Sound power levels measurement shall be in accordance with BS 848 Part 2, 'Fan Noise Testing'.

- END OF SECTION 16 -

SECTION 17 - CENTRAL STATION AIR HANDLING UNIT

17.1 Scope

This section of the Specification sets out the requirements for the central handling equipment to be used in conjunction with the air distribution system.

17.2 General

The Contractor shall engineer, supply and install where indicated on the drawings, central station air handling units of the single-zone draw through or multizone blow through with configuration as required for the design. The installation of the unit shall be in accordance with *General Specifications for Air Conditioning Installation, December 1987* published by Department of Electrical Services. The air handling unit shall be tested and constructed in accordance with ARI standard 430.

17.3 Size and Capacity

The unit shall be of the type and size suitable for ensuring a performance and capacity not less than the minimum required for the design when operating under the specified conditions.

17.4 Unit Casing

The casing of the air handling unit shall be of double skinned type and sectionalized construction in accordance with *General Specifications for Air Conditioning Installation, December 1987* published by Department of Electrical Services. All connections of the air handling unit to air ductwork shall be by means of flexible connections on site. Flexible connections shall be of neoprene coated fabric.

(a) Fan Section & Coil Section

The fan section shall house the centrifugal fans and shall be furnished with visual inspection openings. The coil section shall be manufactured same as fan section. Coils shall be mounted on slide tracks. Coil section with cooling coils shall slope towards centre with drain connections on both side. The drain pan shall be adequately insulated to prevent condensation.

(b) Return Air Bypass Damper Section

The bypass damper section shall be supplied in accordance with *General Specifications for Air Conditioning Installation, December 1987* published by Department of Electrical Services.

(c) Return Air and Fresh Air Mixing Box Section

The mixing box section shall be a separate section bolted to the before filter section. Mixing damper blades shall be paralleled acting type, positioned to blend and thoroughly mix the fresh air and return air streams. Damper blade shafts shall be square cross-section, positively locked into V-shape blade channels to prevent blade slippage. Damper bearings shall be nylon in bronze bushings.

(d) Air Filter Section

The flat and V air-filter section shall be manufactured of 16 gauge minimum galvanized steel sheets, securely bolted and braced, and with 18 gauge minimum galvanized steel top and bottom panels. Hinged and latched doors shall be provided on both sides.

17.5 Fans and Motors

Fans shall be of the double-width, double inlet air foil backward curved blade type suitable for the size and characteristics of the system and capable of maintaining the required air flow rate against the total system resistance of ductwork, filters coils, dampers and other losses. Installation shall be in line with *General Specifications for Air Conditioning Installation, December 1987* published by Department of Electrical Services.

17.6 Cooling Coils

The chilled water coils provided for the unit shall be of the extended-fin type selected to suit the capacity and conditions required, to the standards set out in *General Specifications for Air Conditioning Installation, December 1987* published by Department of Electrical Services. The ratings of the coil shall be certified in accordance to ARI Standard 410.

17.7 Filters

Filters to be furnished for use with the air handling unit shall be in accordance with *General Specifications for Air Conditioning Installation, December 1987* published by Department of Electrical Services.

17.8 Condensate Drain Pipe

Provide all insulated condensate pipes from drip condensate drain pan to the floor waste provided by others. Provide U-trap to prevent blow-in.

17.9 Operating Controls

The air handling unit shall be furnished with all the operating and safety controls necessary for the safe and proper functioning of the system. Controls and controllers shall be of the electronic type of approved make and design.

Each air handling unit shall be provided with both local and remote "ON-OFF" switches to be located as specified. When the blower fan in the air handling unit is started, its control system shall be energised. Suitable interlocks shall be incorporated for operating the unit in conjunction with the rest of the air conditioning system. To maintain the discharge air at the pre-determined dew point temperature, an insertion type thermostat shall be provided to modulate the two-way valve in the chilled water line. A return air thermostat shall modulate the face and bypass damper to maintain the room temperature required for constant volume system. Suitable humidistats shall also be installed at appropriate locations to control the plant and maintain the specified conditions.

17.10 Installation

The air handling unit shall be designed for either horizontal, vertical or suspended mounting in accordance with the requirements of the situation. All mounting channels, foundation blocks, holding bolts, vibration isolators or hangers shall be furnished as required to ensure safe and quiet operation. The unit shall be installed with ample allowance for maintenance and service access.

- END OF SECTION 17 -

FIRE PROTECTION SERVICES
(SPECIFICATIONS)

SPECIFICATION FOR FIRE PROTECTION SERVICES

<u>ITEM</u>	<u>DESCRIPTION</u>	<u>PAGE</u>
SECTION 1	Base Specifications	FBS/1 – FBS/1
SECTION 2	Portable Fire Extinguishers & fire Blankets	PFE/1 – PFE/1
SECTION 3	Fire Hydrants	FH/1 – FH/1
SECTION 4	Hose Reel System Installation	FHR/1 – FHR/2
SECTION 5	Pump Installation	FP/1 – FP/2
SECTION 6	Valves & Accessories	FV/1 – FV/2
SECTION 7	Pipework & Fittings	FPW/1 – FPW/4
SECTION 8	Control Panels	(Refer to Elect'l Specs)
SECTION 9	Material Identification	FMI/1 – FMI/2
SECTION 10	Testing & Commissioning of Fire Fighting Systems	FT&C/1 – FT&C/3

SECTION 1 - BASE SPECIFICATION

All equipment and materials to be supplied and installed under this sub-contract shall be of first grade design and manufacture and shall comply with latest British Standard.

Uniformity of equipment shall be complying throughout the installation.

Where manufacturers are nominated in the Specification or in the following schedule they are intended to define acceptable standards of equipment. Tenderers may submit alternate equipment which are at least equal in every respect to the nominated items.

Steel piping	Maruichi/Nippon Steel/ Kawasaki/Sumitomo
Ductile Iron Pipe	Stanton/Kubota/Von ROL/Pont A Maussom
Copper Pipes	Crane enfield/Yorkshire
Pumps	Worthington/Grundfos/Ajax/Regent
Motors	ABB/Crompton/TECO/GEC
Control Panels	PKS/Power Teck/CE
Valves	Toyo/Hattersley/Pegler/Kitazawa/Bestobell
Vibration Isolators	Kinetic/Mason/Nap
Sprinklers and Sprinkler Accessories	Spraysafe/Viking/Grinell/Angus
Hose Reels	Hart/Sri/Chubb
Dry Riser Landing Valve	Hart/Sri/Chubb
Hydrants, Breeching Inlets	Hart/Sri/Chubb
Dry Riser Hose	Hart/Sri/Chubb
Flow Switches	Saginomaya/Honeywell/Johnson
Pressure Switches	Saginomaya/Honeywell/Johnson
Extinguishers	Killfire/Angus/Chubb
Fire Blanket	Angus/Chubb

SECTION 2 - PORTABLE FIRE EXTINGUISHERS AND FIRE BLANKET

Portable fire extinguisher and fire blanket to the approval of Local Fire Services Department shall be supplied and installed by this Sub-Contractor. The number and types of extinguishers and fire blanket are as shown on the drawings. The extinguishers and fire blanket shall be hung or hook or securely placed on brackets fastened to wall, partition or column in a suitable conspicuous and accessible position. Cost of the brackets shall be included in the tender price. All extinguishers should be installed at height of 1m from the floor level to the handle, unless otherwise indicated.

ABC DRY POWDER FIRE EXTINGUISHER

The dry powder shall be a safe and versatile extinguishing medium ideally suited for high risk environments. The dry powder medium shall be non-conductor of electricity. The headcap shall be corrosive resistant and shall ensure ultimate fluidisation of the powder prior to commencement of discharge. The powder extinguishers shall be designed and constructed in accordance with BS5423.

CO₂ EXTINGUISHERS

This shall be an efficient fire extinguishing medium. It shall smother flames and reduce the oxygen content of air around the fire, thus ensuring extinction. It shall be non-conductive and effective against fires in electrical plant. The extinguisher casing shall be of aluminium alloy with a swivel horn applicator. The CO₂ extinguisher shall be designed and constructed in accordance with BS5423.

Water CO₂ EXTINGUISHERS

This shall have a long life operating efficiency. A special protective coating to prevent corrosion to the containers made of polyethylene base coating shall be applied. The extinguisher bodies shall be prefabricated from steel sheets which are preformed and welded together. The neck rims shall be machined copper plated steel components welded into position on the tops of the extinguisher bodies. Caps shall be of Lexan and hoses shall be of pvc with moulded polycarbonate nozzle.

FIRE BLANKETS

Fire blankets shall be in accordance with BS6575 and shall be made of woven glass fibre giving them a rough surface providing stability. They shall be designed to enable simple storage of the blanket, the container shall be non-corrosive, rigid self-extinguishing white plastic. Instruction on usage should be provided on the cover.

SECTION 3 - FIRE HYDRANTS

The works shall consists of the complete supply and installation of external fire hydrants as per drawings.

HYDRANTS

Hydrants shall be of underground or pillar type as shown in the drawings.

Underground hydrants shall comply with BS750 and shall be fitted with a 65mm "V" thread outlet. Hydrants shall also be equipped with a captive internal valve. Hydrants shall be installed with their outlets not lower than 300mm from the surface. a drain off pipe shall be provided within the hydrant chamber to ensure that the valve chamber is free of water.

Pillar hydrants shall be constructed from cast iron and have a nominal bore of 100mm. Pillar hydrants shall be fitted with 2 numbers 65mm dia oblique type brass/bronze landing valve with a female instantaneous coupling. Valve outlets shall be fitted with a plastic cap and the hydrant shall be finished in signal red. Landing valve shall be manufactured to comply with BS5041 Part 2.

MARKER POSTS

Precast reinforced concrete marker posts with an indicator plate shall be supplied and installed at all sluice valve, air valves, washout and underground hydrant positions and at 150m intervals and changes of directions, on all main supply pipelines. Indicator plates shall be of aluminium alloy construction in accordance with BS3251. Hydrant markers shall be painted in yellow colour while markers for water services shall be painted in a blue colour, with markings as detailed in the drawings.

THRUST AND ANCHOR BLOCKS

Thrust and anchor blocks shall be provided at all bends, tapers, tees and other points where horizontal thrust will occur and also where pipelines are laid on steep grades (1:10 and above). The bearing faces of thrust blocks shall be cast against the bearing side of the excavation.

The dimensions of thrust and anchor blocks are shown on the Drawings.

SECTION 4 - HOSEREEL SYSTEM INSTALLATION

This section of the specification shall cover the supply, installation, testing and commissioning of the hydraulic hosereel pump, along with all accessories like hose, reel, pipework, valves etc. as shown on drawings. The system shall be in accordance with the requirements of BS 5306 Part 1.

WATER TANK/ HOSEREEL PUMP SYSTEM

Water tank (if required/specified in Bill of Quantities) shall be of sectionalised construction and made of Stainless Steel. The hosereel pump shall be vertical in-line type. The hosereel pump system shall comprise of one duty and one standby pump for transfer of water from a suction tank directly to the fittings. A hydro-pneumatic tank shall be provided to store water under pressure to increase the duration between pump starts. Level control shall be by extra low voltage no float level sensing electrodes and controllers.

A set of low level sensing electrodes shall be installed at the suction tank and shall cut out the pump if the water level falls below the preset low level. A low level indicating light shall be provided at the control panel and audio alarm shall be provided outside the plant room to indicate low level of water in tanks. The pump should only restart after the water in the suction tank has reached a preset start level. A high level sensor shall also be provided to annunciate a high level alarm. The pump operation shall be controlled by means of 2 pressure switches. Activation of pressure switch no. 1 shall activate pump no. 1, while activation of pressure switch no. 2 shall activate pump no. 2. Deactivation of pressure switch no. 1 should cut out both the duty and standby pump. A time delay switch shall be provided to prevent the starting surge from cutting out the pump. The time delay shall be adjustable from 10 to 60 seconds.

In the event of overload tripping of the duty pump the standby pump shall be brought into operation automatically. The overload failure shall be annunciated audibly and visually at the control panel and by means of a red strobe light fitted outside the pump room. Means shall be provided in the control panel to silence the audible alarm manually. The pump control system shall also alternate the operation of the pumps by ratchet relay to even out the wear and tear.

HYDROPNEUMATIC TANK

Pre-pressurised, sealed air charged, diaphragm type tanks shall be of capacities as shown in the drawings. The tank shall be constructed from steel plate built to ASME standards for Unfired Pressure Vessel and finished smooth internally and externally to prevent rough spots and sharp edges from damaging the liner. All metal surfaces shall be protected with enamel finish or equivalent to prevent corrosion. The pressure tank shall be suitable for a minimum working pressure of 150 psi or 1½ times maximum working pressure whichever is greater. All tanks shall be ASME certified models and shall be factory tested for leaks. A tamper proof air valve shall be provided for adjusting the air pressure in the tank. The cost of this valve to be included in the cost of the tank.

The water reservoir shall be of non-metallic construction. The diaphragm shall be of heavy duty butyl with seamless constructions for uniform strength. The diaphragm shall match the shell design to prevent bubbles or corner which trap water and sediment. All materials in contact with the water shall be of non-toxic corrosion resistant construction. The pre-charge pressure shall be adjustable and a charging port with non-return device shall be provided. All hydro-pneumatic tanks are to be factory fitted with a 100mm dia pressure gauge to indicate the air pressure in the tank.

VALVES AND GAUGES/ HOSE/ REEL

A 25mm diameter isolating brass stop valve shall be provided on the feed pipe to each hosereel. The hose shall be made of continuous non-kinking reinforced rubber hose complying to BS3169, type 'A' fitted with a shut-off-type nozzle by means of steel cadmium plated hose clips. The nozzle shall be made of corrosion resisting metal material. It shall be adjustable for jet and spray pattern with complete shut-off. The nozzle shall be in compliance with BS 336. The length of hose shall be 30m and 25mm bore with 6.5mm discharge nozzle. The hose shall be suitable for operation at a maximum working pressure of 1600kpa.

The discharge nozzle and isolating gate valve shall be easily accessible; in no case shall be more than 900mm above the finished floor level. Reel shall be of double swivel type unless otherwise indicated on the drawings. Drum shall

be constructed of 1.6mm thick pressed steel free from denting and twisting, and finished in red epoxy polyester paint. The hub and shaft shall be of brass, fitted with a device to prevent overrun of the hose, having glandless centre seal. In case of fixed type reels, a swivel hose guide with swing-arms of nylon rollers or similar material shall be provided adjacent to enable the hose to be pulled in any direction as required. Every reel shall be marked with the following information in a prominent position:

- a. Manufacturer's name and trade mark.
- b. Instruction for operation and use should include the following:-
 - i. Turn on stop valve to release nozzle
 - ii. Run-out hose
 - iii. Turn on water at nozzle
 - iv. The year of manufacturer
 - v. The test pressure of hose in kpa

The whole assembly of hose and reel shall be in compliance with BS(EN) 671. The hosereel shall achieve a throw of 6M at 0.4l/s with a input pressure of 150kpa. Where reel cabinets are specified they shall be of steel construction (1.6mm) with a wire-glass front labelled "Fire hosereel" in letters 50mm high in English. The door shall be fitted with a spring lock.

PUMP SWITCHBOARD

The hosereel pump control panel shall be of IP54 construction and shall have the following features and controls.

1. On-off isolators and residual current device (RCD) breaker.
2. Separate power and control MCB for each pumpset.
3. Up to 8kw direct on-line starter
8 - 25kw star-delta starter
4. Labelling: "Hosereel Pumps", "Pump no. 1", "Pump no. 2" etc.
5. Auto/off/manual selector switch for duty and standby pump.
6. Phase indicator lights (red, yellow, blue).
7. Pump run (green) and fail (red) indicators.
8. Audible and visual warning for pump fail and high water level (amber) and low water level (red).
9. Alarm mute and reset button.
10. Voltmeter and ammeter c/w a selector switch
11. Overload trip device with single phasing protection capability.
12. Manual start and stop push buttons.
13. Ratchet relay for alternating operation.
14. All rating of contactors, relays, etc. must be at least 130% higher than the max. full load conditions.
15. One hour run meter for each pump
16. Alarm bell and red strobe light at the entrance to the pump room.
17. Volt free contacts for pump status/trip/power failure remote indication.

NOTICES

Operating instructions shall be affixed to the wall in prominent position adjacent to the reel.

IMPORTANT TURN ON VALVE BELOW BEFORE RUNNING OUT HOSE

Hosereel located in the recesses or cabinets/risers shall bear the words "Fire Hose Reel" on the door in red letters at least 50mm high on a white background. All notices shall be prominently displayed and they shall not be unreasonably affected by weathering or by corrosion caused by any processes in the vicinity.

SECTION 5 - PUMP INSTALLATION

This section of the specification shall cover the supply, installation, testing and commissioning of the fire pumps along with all accessories as shown on drawings or elsewhere in the specification. Pumps shall be new and shall be of the type and performance as shown in the drawing or as specified in the bill of quantities. Pumps shall be UL, FM or LPC approved and shall be factory tested before shipment. Pumps shall comply with the requirements of BS 5306 Part 2, BS 599 and BS 5316. Pumps curves with the operating point marked-on, shall be submitted for approval before the pumps are ordered.

All pumps assemblies shall be factory aligned complete units comprising of pump and motor, coupled together on a common base plate.

CONSTRUCTION

The pumps shall be of centrifugal constant speed, single or multi-stage, and shall be driven by a electric motor operating at a speed of 2900 rpm. The pump shall be selected for a operating flow and pressure as shown on the drawing. The pump efficiency should not be less than 70% at the design point. Pumps shall be selected with a steep curve to enable proper setting of the pressure switches.

Casing/ Impeller/ Shaft

The casing shall be constructed of high grade close grained cast iron with integral connections. A tapped drain shall be provided at the lowest point, while a air release point provided at the highest point. The pump casing shall be of adequate strength to withstand the pressure in the system or a minimum of 150 psi whichever is greater. The impeller shall be of high grade bronze, gunmetal or stainless steel, statically and dynamically balanced at the factory.

The impeller shall be firmly secured to the shaft by a key and by external shaft nuts. The shaft shall be constructed of high tensile steel or stainless steel. The diameter of the shaft shall be sized to withstand all induced stresses. The shaft shall be protected by renewable bronze or stainless steel sleeves.

Bearings/ Seal/ Motor

The bearings unless sealed in bearing housing and protected from moisture and dust, shall be of sealed and lubricated for life type ball or roller bearings. Bearings shall be designed and sized for an operating life of 50,000 hours. All seals shall be of the mechanical seal type and should be of tungsten carbide faces.

The motor shall be of totally enclosed, IP55 construction, fan cooled, squirrel cage type suitable for 415V/3 ph/50Hz, 2900 rpm operation. The motor shall be selected at 125% of the pump overload rating. The motor shall be suitable for continuous operation, 20 starts per hour for motor less than 25kw and 10 starts per hour per larger motors and Class H insulation with Class B temperature rise. Where the coupling between the motor and the pump is exposed it shall be protected by a sheet metal guard.

Mounting/ Accessories

Pumps shall be mounted on a fabricated steel base which shall be heavily reinforced and braced to ensure correct alignment. The base plate shall be mounted on a concrete plinth of minimum 150mm height using neoprene in shear or spring, vibration isolation mounts as shown in the drawings. Neoprene in shear mounts shall be used for situations where the plinth is located on the ground and spring vibration isolation mounts shall be used where the pump is installed on a suspended slab. The number and type of vibration isolators selected shall be such that a uniform deflection is obtained under all operating conditions. Inertia blocks shall be incorporated into the base plate to reduce the amplitude of vibration where shown in the drawing.

The pump shall be fitted with flexible connections, gate valves, check valve, strainers, reducers, air valves, closed head relief valve, pressure gauges at inlet and outlet etc.

INSTALLATION

Fit pumps and appurtenances to the space provided and make readily serviceable. Provide steel framework, inertia

blocks, hangers, anchor bolts and vibration isolators for pumps. Provide flanges and flexible pipe connectors to the suction and discharge connections of pumps. Provide supports to both sides of the flexible connection to prevent undue strain on pumps. Such support shall be mounted so as not to transmit vibration to the building. Each pump shall be fitted with an air cocks, drain plugs and a pressure gauge on both side of the pump. Supply and advise the location of holding bolts and fixing for incorporation in the concrete work.

All pumps shall be properly labelled. All pumps shall bear the manufacturers nameplate giving the manufacturer's name, pump serial number, model number and date of manufacture including listed recognised institution approval plate. Any damage to finishes which have occurred during transit, storage, installation or otherwise shall be made good in the manner recommended by the manufacturer and to the satisfaction of the Architect. All pumps shall be factory painted in accordance with the manufacturer's recommendations. The colour of the pumps shall be signal red.

TYPE HORIZONTAL SPLIT CASING PUMP

The horizontal split casing pump shall be of single stage, single volute centrifugal type. The casing shall be horizontally split. A flexible self-aligning centre dropout spacer type coupling, capable of absorbing torsional vibration shall be employed between the pump and the motor. A metal self supporting easily removable guard shall be provided around the coupling.

TYPE HORIZONTAL END SUCTION PUMP

The horizontal end suction pump shall be of single stage, single volute, centrifugal type, with a back pull out construction. A flexible self aligning centre dropout spacer type coupling, capable of absorbing torsional vibration shall be employed between the pump and the motor. A metal self supporting easily removable guard shall be provided around the coupling.

TYPE VERTICAL MULTISTAGE PUMP

Multistage pumps shall be of centrifugal type and arranged with the shaft vertically installed. The motor shall be supported on the pump casing and directly coupled to the pump shaft. A safety mesh screen cover shall be provided around the coupling.

SECTION 6 - VALVES AND ACCESSORIES

This section covers the supply, installation, testing and commissioning of all valves and accessories. Valves and accessories shall be supplied and installed as shown on the drawings. All valves shall be constructed and applied in accordance with the relevant British Standards and shall be fitted in accessible positions for operation and repair. All stop valves shall be right handed and shall have indication whether the valve is open or shut. The controlling wheel must have markings of the direction on how the wheel is to be turned to close the valve. Valves shall generally be arranged to close on clockwise rotation of the handwheel.

The connection between each valve and the adjacent equipment shall be made with a union for sizes up to 50mm or a flange (BS 4504), for ease of dismantling. Before installation, all valves shall be blown to remove any foreign matter that might have lodged in them. Valves spindles shall be adequately lubricated with graphite and all glands shall be freshly packed before installation. The size of the valves shall be of the same diameter as the pipe for which they are to be fitted except for pressure reducing and control valve which shall be designed for the duty concerned. All valves shall be suitable for the working and test pressure of the system in which they are installed and shall be of approved manufacture as per basic equipment standards and shall be of the same manufacture. Valves shall of minimum rating PN 10.

All valves shall be padlocked in their operating position using a 6mm thick canvas strap. The padlocks shall work on a master key system. Micro switches shall be provided on all sprinkler system subsidiary valves. The micro switch shall operate when the valve is 50% closed. The operation of the micro switch shall be monitored by the fire alarm system. Each valve shall be provided with a brass identification plate which indicates the valve number, area served, and usage. Each valve shall also have on it a identification of the make, model and service pressure rating. Valves larger than 65mm shall be fitted with a indicator plate to clearly indicate if the valve is in the open or close position.

STOP/ GATE/ SLUICE VALVES

All fittings shall be provided with a screwdown brass or chromed stop valve complying with BS1010 alternatively if specified a quarter turn ball valve shall be used. Ball valve shall comply with BS5154. Gate valves less than 50mm dia shall comply to BS5154 and shall be constructed from copper alloy. Valves less than 50mm dia may be with threaded ends while larger valve shall use flanges to BS4504. Valves larger than 65mm diameter shall be of double flanged cast iron body construction to BS5150 with non rising stem and solid gun metal wedge. Valves handles shall be of similar materials as the valve body and should be easily removable with a tool to prevent unauthorised use. Gate valves shall also comply with BS5151 while globe valves shall comply with BS5152.

Sluice valves shall be clockwise closing, cast iron construction, non rising spindle, solid wedge type gate, BS10 flanged valve, complying with the requirements of BS5163. The valves shall be supplied with iron caps and operating keys. The wedge and face shall be of gunmetal construction while the spindle shall be of high tensile bronze construction. Valves shall be coated in accordance with BS4147.

BUTTERFLY/ CHECK VALVES

Butterfly valves shall comply with BS5155. The valves shall be of cast steel body and shall be double flanged wafer type designed to give a tight shut off with renewable nitrile rubber sealing rings and nylon coated bronze discs with stainless steel shaft. Valves up to 150mm dia shall be fitted with a 10 position locked lever handle, while larger valves shall be provided with a worm gear type handwheel with position indicators and limit stops. Check valves of 50mm diameter and below shall be with threaded ends and of copper alloy construction and shall comply with BS5154. Check valves shall be spring assisted non slam type. Check valves larger than 50mm diameter shall be of cast iron construction, double flanged or wafer type complying to BS 5153. Check valves shall be non slam, centre guided, spring assisted, disc type.

PRESSURE RELIEF/ AIR VALVES

Pressure relief valves shall be of fully spring loaded type in accordance with BS 1271, and shall be installed in locations as shown in the drawings. Air valves shall be 25mm single and 50mm double orifice valves incorporating a screw on isolating valve. Body of air valve shall be cast iron to BS 1452. Floating ball and valve shall be stainless steel to BS 970 : Part 4 Grade 303 S21 and float shall be stainless steel to BS 1449 : Part 2 Grade 316. Air valves shall be coated in accordance to BS 4147 : 1980 Type 1. The discharge of the air valves shall be piped to the nearest drain.

BALL FLOAT VALVE/ STRAINERS

Ball valve of 25mm diameter and below shall be of copper alloy construction equilibrium diaphragm type complying with BS1212 Part 2 and have copper floats to BS1968. Valves larger than 25mm dia shall be of cast iron construction and with piston type valve complying to BS1212 Part 1 and have copper float complying with BS1968. A silencing pipe shall be fitted at the discharge of all float valves. Strainers of 50mm diameter and below shall be with threaded ends and of copper alloy construction while larger strainers up to 300mm dia shall be of double flanged cast iron construction. Strainers shall be of the "Y" pattern. Strainer cages shall be of 22 swg 18/8 stainless

steel and have 0.8mm perforations, the free area of which shall be not less than 5 times the cross sectional area of the pipe and shall be easily removal for maintenance. Valves larger than 150mm shall incorporate basket type strainers and shall incorporate a drain cock.

PRESSURE REGULATING VALVES

Pressure regulating valves shall be provided at the incoming supply line and elsewhere as shown on the drawings and shall comply with BS6494. The pressure reducing mechanism should be able to regulate the pressure within the set limit irrespective of flow rate or incoming water pressure fluctuations. Manual adjustment of the setting should be possible and a inlet and outlet pressure guage should be provided to facilitate setting.

HYDRANTS/ MARKER POSTS

Hydrants shall be of underground or pillar type as shown in the drawings. Underground hydrants shall comply with BS750 and shall be fitted with a 65mm "V" thread outlet. Hydrants shall also be equipped with a captive internal valve. Hydrants shall be installed with their outlets not lower than 300mm from the surface. A drain off pipe shall be provided within the hydrant chamber to ensure that the valve chamber is free of water. Pillar hydrants shall be constructed from cast iron with a nominal bore of 100mm and shall be fitted with 2 numbers 65mm dia oblique type brass/bronze landing valve with a female instantaneous coupling. Valve outlets shall be fitted with a plastic cap and the hydrant shall be finished in signal red. Landing valve shall be manufactured to comply with BS5041 Part2.

Precast reinforced concrete marker posts with an indicator plate shall be supplied and installed at all sluice valve, air valves, washout and underground hydrant positions and at 150m intervals and changes of directions, on all main supply pipelines. Indicator plates shall be of aluminium alloy construction in accordance with BS3251. Hydrant markers shall be painted in yellow colour while markers for water services shall be painted in a blue colour, with markings as detailed in the drawings.

FLEXIBLE COUPLING

Piping connections to all pumps and all equipment shall be by means of wire and fabric reinforced moulded high pressure convoluted rubber connectors. The fittings shall have integral rubber flanges, and be bolted onto the pipe lines using flanges for 50mm diameter and larger. Smaller coupling shall utilise a screw connection.

PRESSURE SWITCHES/ FLOW SWITCH/ PRESSURE GAUGES

Pressure switches shall be of the diaphragm, bellow or bourdon tube type, micro switch activated using a normally open and normally closed contact with adjustable cut-in and cut-out setting. Maximum cut out setting should not exceed 20% of the operating cut out setting and the minimum differential between the two settings shall not exceed 5% of the cut out setting. Contacts shall be rated for the required duty.

Flow switches shall be of paddle type suitable for the specified flow. Flow switches shall be fitted with a electronic relay to prevent false actuation by water surges. The flow switch shall be of non corrosive construction and the parts exposed to water shall be of stainless steel. The paddle should be able to be trimmed to suit the pipe size and flow. Flow switches shall be located on a straight length of pipe and at least 5 pipe diameter away from elbows and fittings. Flow switches should operate on the activation of one sprinkler or hose reel or landing valve. Flow switches shall be equipped with one number of normally closed and one number normally open contact suitable rated for the required duty.

WATER LEVEL SENSORS/ WATER LEVEL INDICATORS

Water level sensors shall be of the non float type using low voltage stainless steel electrodes and relays, or ultrasonic type which do not require any contact with the fluid. Water level indicator for water tanks shall be of the glass tube type with a protective metal casing. A valve shall be fitted at the lower end of the tank and a red float provided within the tube for easy viewing of the water level.

Pressure gauges shall conform to BS 1780 and shall be of minimum 150mm dial bourden tube type, with a brass dust and moisture proof case with a thick protective glass and legible white face and black figures. The scale value of the gauges shall be of the order of 150% of the maximum operating pressure and the graduations shall be in both in psi and pascals. All pressure gauges shall be fitted with gauge cocks. Pressure gauges shall be fitted at 1350mm above floor level.

SECTION 7 - PIPEWORK & FITTINGS

The section of the specification shall cover the supply, installation, testing and commissioning of the fire protection piping system.

PIPE MATERIALS

Unless otherwise stated in the drawings or elsewhere in the Specification, all piping shall comply with the following:

Pipes For Sprinkler, Wet Riser, Dry Riser & Hosereel System			Joints		Fitting
Material	BS	Size, mm	Type	BS	BS
Hot dipped galvanised steel pipe	BS 1387 heavy grade	≤50mm	screwed	BS21	BS1740
		65 to 150mm	welded	BS2971 BS2640	Galvanised wrought steel to BS1965
	BS 3600 (seamless) HFS grade 27 ERW grade 410	>150mm	screwed	BS2971 BS2640	Galvanised wrought steel to BS1965
		≤50mm	screwed	BS21	Galvanised wrought steel to BS 1965
Underground pipes Ductile Iron	4772 Class 9 PN 16 rating	65 to 600mm	welded	BS2971 BS2640	Galvanised wrought to BS 1965
		100 to 300mm	Spigot socket push in sealing ring joints	2494	Ductile iron

A mechanical grooved jointing system (victaulic system may be used instead of a welded joints).

PIPE INSTALLATION

All installation shall be done according to the drawings. Special care shall be taken in the arrangement of piping to ensure a neat finish and alignment. All piping and tubing used in the construction shall be straight, cleanly finished, round in cross section, free from cracks, surfaces flaws, laminations, scale and other defects and shall be supplied to site with the ends capped. All pipes and fittings should be thoroughly cleaned and free from burrs, swarf, scale and obstructions before erection. Clean sharp pipe cutters not hacksaws, shall be used to cut metal pipes. Threads shall be cut with clean sharp die. Bevels for welding shall be filed or ground.

Connections shall be as direct and as few as possible. Valves and fittings shall be grouped where this will not affect their operation. Supply and install all necessary isolating valves, check valves and other fittings as required and as shown on the drawings. Every section of major branch supply piping shall be controlled by a stop-valve at the point of connection to the main pipe. The valves shall be sited on a easily accessible position

for ease of operation. Pipe connection of 65mm dia. and above connected to equipment shall be flanged joints in accordance with BS4505 and pipe connections below 65mm dia. shall be screwed unions to permit removal for maintenance without disturbing other pipes.

Flanges shall be welded to the pipes. Flanged joints shall be flush and aligned and shall utilize corrugated jointing rings (BS 4865), coated on both sides with a non toxic jointing compound (BS 5292). The grade and thickness of jointing rings shall be suitable for the service conditions. Excess jointing compound shall be removed. All pipework other than in pump rooms and where stated shall be run in false ceilings, ducts, or chased in wall. Pipes shall be cut accurately to measurements at site and connected without any springing or forcing. Reduction in diameter for through flow pipes shall be made with eccentric reducer for horizontal pipes and concentric reducers for vertical pipes. Open end of all piping shall be capped with a plastic or wooden plug during construction to prevent the ingress of foreign matter. Joints shall not be made in inaccessible positions.

EXPANSION OF PIPEWORK

Pipe supports shall be selected to provide movement due to expansion. The amount of such movement shall be proportioned throughout the system by the provision of suitable anchor points. If tap-off are taken at points remote from the anchor point, it shall be arranged with a offset, expansion joint or other means, to take up expansion without axial movement of the branch. Expansion joint shall be provided for pipeworks as shown on the drawing for straight pipe run and wherever pipework runs across structural expansion joint. Expansion joints shall be of stainless steel guided bellow type.

SCREWED/ WELDED JOINTS

Screwed joint shall be made by means of screwed connections in accordance with BS21. All screwed joints shall be made with teflon thread sealing tape. Welding in steel pipe shall be single "V" butt weld type and shall be in accordance with BS2633 and BS 1971. Only approved qualified welders with a competency certificate shall be permitted to do the welding in accordance with BS 4872 Part 1. Welding rods for oxy-acetylene welding shall be copper coated low carbon steel to BS 1453 and for metal arc welding shall be in accordance with BS 639

MECHANICAL GROOVED JOINTING SYSTEM

Mechanical joints for use on a grooved jointing system shall be similar to the type manufactured by victaulic systems. Joints shall comprise of two or more identical housing manufactured from one of the following materials.

- 1) Malleable iron to BS 6681 grade B32-10
- 2) Carbon steel to BS EN 10025, grade FE 430A
- 3) Ductile iron to BS 2784 grade 420/12

Joint housing shall be positive and effected by 2 or more oval neck or "D" neck bolts and nuts of material quality not less than BS 970 grade 070 M20. Sealing action shall be effected by pressure sensitive elastomeric gasket stretched over both pipe ends, using a suitable lubricant. The gasket shall be in compliance with the requirement of BS 5306 part 1 & 2 and shall be non toxic and manufactured in accordance with the IEE regulations. The joints shall be suitable for the type of services, working and test pressure and temperature. Joints shall allow limited angular movement and expansion and contraction in service. Grooves shall be prepared by rolling on pipes less than 300mm dia and may be rolled on cut in larger pipes. The grooved end shall be coated with a zinc rich primer paint to regain the coating thickness. The pipework installed shall be in accordance with the manufacturers or victaulic systems latest published recommendation.

PIPE SUPPORTS

The Contractor shall supply and install all necessary, pipe supports, hangers, anchors, guides as required for proper support in accordance with BS 3974. Risers shall be supported at each floor with mild steel riser clamps. Horizontal pipe runs shall be supported on hangers of split ring or clevis type. Where practical supports and

hangers shall be located immediately adjacent to any change in direction and at valves and heavy equipment. Where pipe lines run in a common group they shall be supported from a common hanger bar fabricated from mild steel sections. The spacing of the support shall be based on the smallest pipe in the group. Pipe supports shall be as per Table 1 on page PF/5

Vertical pipes shall be also be supported at the top and bottom of each riser, at each floor level, and at each isolating valve. The support at the lowest point shall be a tubular support feet. Pipe risers higher than 30 meters shall be provided with spring cushion supports to accommodate pipe expansion. Pipes shall be run with a minimum clearance of 100mm from the structure and between pipes to accommodate pipe expansion and clearance for joints and accessories. The first 3 supports adjoining a pump shall be fitted with a vibration isolation support with a minimum deflection of 10mm. Piping connections to equipments to be independently supported to prevent stress on the equipment. Attach supports only to structural members and framing. Where supports are required between intermediate structural members, provide suitable intermediate metal support framing.

The Contractor shall supply and install sleeves where pipes penetrate through walls, floors etc. All exposed piping in occupied rooms shall be chrome plated. Pipe sleeves passing through walls or fire partitions shall be of medium gauge galvanised steel pipes to BS1387 or BS 3601. Sleeves shall be sized to give a clearance of 15 to 25mm around the pipe to allow for expansion/contraction of the pipe. Sleeves through exterior walls below ground, through foundation and floors below ground shall be of puddle flange construction using PVC to BS 3505 class D and of watertight construction. A proprietary water stop device shall be used to prevent ingress of water. Sleeves through fire rated shafts, walls, floors and roofs shall be tightly packed with rockwool and caulked with a intumescent fire seal and finished flush to the face of pipe sleeve to maintain the fire integrity of the wall. Sleeves through roof slabs shall project at least 150mm above roof. A proprietary type flashing system shall be used to ensure water tightness. Sleeves through floor slabs shall project at least 25mm above the floor to prevent water from flowing through the sleeve. Pipes penetrating through wall, floors, ceilings and partitions of occupied rooms or in public areas, shall be provided with a stainless steel or chrome plated cover plate, which shall be snug fit to the pipe and with concealed fixings.

AIR VENTS AND DRAINS

Automatic air vents shall be provided at each high point and drains and traps at each low point. Where possible, drains at low points shall be valved. Air vents shall also be installed at the top of all pump casings, except if the pumps are self venting. Drain pipe shall be provided from each automatic air vents, pump glands, and to the nearest waste traps or surface drains and arranged in such a way that the discharge are visible to show leakage, if any. At changes of direction plugged tees and unions shall be installed on the condensate piping for easy cleaning and disconnection.

FLUSHING OUT PIPES

Pipes shall be cleaned out in sections. Pipes larger than 200mm diameter shall be cleaned by having a wire brush followed by a fibre brush being drawn through followed by flushing out as described below. The system shall be filled with portable water to which has be added 50mg of chlorine and descaling agent for every litre of water. The system shall remain charged for 12 hours before being flushed out to remove dirt, debris, scale. etc. The flushing process shall be repeated until the discharge water is clean.

TABLE 1. Interval between supports for steel pipe

Size of Tube (mm)	Intervals for vertical runs (m)	Intervals for horizontal runs (m)	Hanger Rod dia (mm)
25	2.4	1.8	6
25 to 50mm	3.0	2.4	10
65 to 100mm	4.5	3.0	12
125 to 200mm	4.5	3.7	16
225 and larger	5	5	20

SECTION 8 - CONTROL PANELS

The control panels shall be built in accordance with IEC 439 "Factory Built Assemblies for low voltage" or BS5486 "Factory-built assemblies of Switchgear and Control Gear for voltage up to and including 1000V AC and 1200V dc". Switchboard and motor control centers shall be of **type tested design** conforming to tests conducted by ASTA or other recognised testing authority. Type test certificates obtained from the testing authority together with the construction details of the board on which the approval was obtained shall be submitted at the time of tender submission.

All factory built assemblies shall be capable of withstanding the electrical, mechanical and thermal stresses of making and breaking the prospective fault level and normal loads without any damage. The prospective fault levels of the various factory built assemblies are as indicated in drawings. All equipment used in the factory built assembly shall have been type tested. Type test certificates shall be submitted for all major equipment if requested. All factory built assemblies, as a complete unit shall have a rating equal to or greater than the integrated equipment rating as shown in the drawing.

Factory built assemblies shall be suitable for indoor installation unless specifically indicated otherwise in the drawings. All items of equipment used shall be suitable for a service condition of ambient air temperature not exceeding 40°C and average of 35°C over a 24 hours period, with relative humidity of 100%. The altitude does not exceed 2000m.

CONSTRUCTION

The factory built assemblies shall be of the totally enclosed, modular, cubicle type, which are extensible and suitable for floor or wall mounting as shown in the drawings. The factory built assemblies shall be compartmentalised and utilise sheet steel plates of thickness as detailed below. The panels shall be vermin proof and constructed to a minimum degree of protection of IP ratings to BS EN60947-1. The IP ratings indicated below shall be applicable unless otherwise indicated in the Bill of Quantities.

Motor Control Centers

- a. 2mm thick sheet steel
- b. Form 3 to BS5486 with separate compartment for busbar section, functional unit section and terminal compartment.
- c. IP54

Control Panels

- a. 1.6mm thick sheet steel
- b. Form 1 to BS5486 with all equipment in the same compartment.
- c. IP42

Each cubicle frame work shall be fabricated from rolled steel angle section and be self supporting when assembled. All cubicles shall be of standard size, uniform in height and depth from front and back. The maximum height of switchboards shall not exceed 2.1m. The top sides and back panels and doors shall be fabricated from sheet steel plate with edges rounded or turned at the front and sides to provide a neat, flush and pleasing appearance and rigid construction without welded cross struts. Full access shall be provided to service and maintain all equipment inside each cubicle by means of a suitable lift off hinged door which shall open a minimum of 150 degrees. Panels longer than 1.2 metres shall be provided with 3 point locking system while smaller panels shall be provided with 2 point locking system. All doors shall be provided with approved gaskets. For circuit breakers, the doors shall be mechanically interlocked with the circuit breaker to prevent any door being opened with the circuit breaker in the "ON" position.

Door fastener shall be a screw type where they are exposed to the public. Switchboard located in service area shall utilize a quarter turn lock or thumb screw. Distribution board shall utilise a push button spring release lock. A key lockable type handle shall be used where specified in the Bill of Quantities or drawings. All panels shall be protected against corrosion. Panels shall be degreased primed and powder spray finished to a thickness of 50 micron to colour BS 381C grey semi textured or RAL7032. Alternative thickness of sheet steel will be considered if additional bracing are provided to suit the sheet steel thickness offered. Synthetic transparent material for the front and back panels covers are preferred to be used instead of sheet steel. The plinth steel shall

be constructed from minimum 5 mm thick steel and suitable to support the weight of the panel.

No "Live" parts of components shall be mounted on the door. Operating devices such as Indicating lamps, push buttons, selector switches, meters, etc. shall be so mounted that all live carrying parts are mounted within the panels when the doors are open. Only the operating handle and non "Live" parts shall be allowed to be mounted on the door. If live parts are to be mounted on the door they must be double insulated and the back terminals protected with a transparent polycarbonate cover. All doors shall be independently earthed to the switchboard frame using a braided or coiled copper cable. All non current carrying metalwork on the switchboard shall be bonded to the main earth bar.

The switchboards and motor control centers shall generally be arranged with the busbar at the top, meters and indicating instruments at eye level and not below a height of 1600mm and operating handles at a minimum height of 800mm above floor level and a maximum of 1880mm above floor level. Provision shall be made within the factory built assemblies for the proper support and bracing of outgoing and incoming cables. Weatherproof cable glands and removable gland plates shall be provided for all cables entering or leaving the switchboard. The type of cable entry (ie top or bottom is as shown of the layout drawings).

All equipment and terminals shall be labelled as detailed on the drawings. Labels shall be of clear perspex, reverse engraved and filled flush with red filling. Labels shall be attached by means of chrome finished counter sunk screws and nuts. Cable tails shall be labelled using a cable tag or plastic ferrules. Labels shall indicate circuit number, source and destination, Danger sign labels shall be affixed adjacent to removable panels and covers.

The incoming section shall be separated from the other sections. All terminals bars, and lugs which are live after isolation of the main switch shall be fully shrouded/insulated. Sufficient auxiliary poles or shrouded isolating relays shall be provided to isolate all incoming low voltage live feeds. Warning labels shall be provided to indicate source of external supply. Voltmeters, ammeters, selector switches, relays, etc. shall be provided as shown in the drawing. The instrumentation section shall be segregated from other sections.

CONTROL & INSTRUMENTATION WIRING

Cables for control & instrumentation wiring shall be PVC insulated to BS6231 and the insulation shall be appropriately colour coded to correspond to the various phases, neutral and earth wiring. Wiring for controls shall be minimum 1.5mm² and those for current measurement shall be minimum 2.5mm². Where multistrand cables are used crimp type cable lugs shall be provided. All wiring shall be neatly run in plastic wiring channels with clip on cover and shall be bundled together in maximum group of 30 conductors using cable ties at maximum intervals of 300mm with additional strapping at bends. Separate cable channels shall be provided for different voltage categories and the utilisation factor shall not exceed 40%. All cables shall be identified at all terminals by means of numbered interlocking ferrules of white PVC with black characters.

Wiring to hinged doors shall be enclosed in spiral cable wrapping in flexible loom arrangement, and secured with fixed stud clamps. Terminal blocks shall be provided for all control cabling entering or leaving the factory built assembly. These blocks shall be located in a separate cubicle. Terminal blocks of different voltage groups shall be separated by barriers and distinctly labelled. Terminal blocks shall be polyamide construction and suitable for rail mounting. The terminals shall be **spring loaded** to ensure minimum contact pressure even if screws are loosened. All terminals and screws shall be fully shrouded. Terminal screws shall be of the captive type. Labels shall be provided for each terminal and shall be of the clip on type. Only one cable shall be terminated at each terminal. Where multiple cables are to be shorted, external links shall be used. Provision shall be made for a test socket to enable testing from the front of the panel. 20% spare terminals with a maximum of 10 terminals for each group shall be provided.

MCCB/MCB/RCD

The breakers shall comply with BS EN60947-2. The breakers shall be provided with overcurrent protection by means of thermal and magnetic tripping element. MCCB's shall have a mechanical endurance life of not less than 15000 operations. All breaker tripping mechanisms shall be ambient temperature compensated. Breakers of frame sizes greater than 150 amps shall be equipped with continuously adjustable magnetic pick up setting. MCCB's used for incoming main feeders shall in addition be provided with continuously adjustable rated current

settings in the range of 60 to 100% rated current. Where earth leakage relays are indicated in the drawings they shall be integral with the MCCB's. The earth leakage relays shall have an adjustable current sensitivity of 100mA to 1A and an adjustable time delay of 0.1 to 1 sec. The MCCB's shall have quick make and quick break mechanism independent of the operating speed. The tripping mechanism shall be mechanically "trip free" from the handle so that the handle cannot be closed against fault conditions.

The MCCB shall be provided with **door interlock** handles. All handles shall be large and robust to carry out the switching operation with ease. The handle shall clearly indicate the "on" "off" and trip positions. The handle shall be able to be locked in the "on" or "Off" positions. When locked in the "on" position it shall still be possible for the handle to indicate trip when the breaker has tripped. A interlock release mechanism shall be provided to enable the door to be opened when the breaker is locked in the on position. Multipole breakers shall have a common-trip bar so that a fault condition on any one pole of the breaker will cause all poles to trip simultaneously. The MCCB interrupting capacity shall be not less than that indicated on the drawings unless alternative schemes using cascading protection or other schemes are utilised.

MCCB when used for motor protection shall have characteristics suitable for the motor starting current characteristics. Standard range MCCB shall not be substituted for motor protection circuits. All moulded case circuit breaker protecting Supply Authorities incoming supply circuits shall be fully withdrawable for easy maintenance. The breaker shall have interlocks to prevent withdrawal when the MCCB is "on". All main moulded case circuit breaker shall be provided with at least 2 N/O and N/C Auxiliary contacts. All busbar couplers shall be fully withdrawable and of the four pole moulded case circuit switch type.

MCB's shall comply to BS 3871 Part 1 and shall be of the **current limiting** type having a sealed ambient temperature independent thermal magnetic tripping mechanism providing overload and short circuit protection. All MCB's shall be suitable for rail mounting and shall have a minimum mechanical and electrical service life of 20,000 operations. MCB's shall have minimum M6 category of duty with Type 1 time current characteristics. Those MCB's feeding motor circuits shall have type 3 time current characteristics.

Each pole of the circuit breaker shall have quick make & quick break mechanism and be fully rated and protected with suitable arc-control devices, so that every pole is capable of making and breaking both rated and short circuit fault current. The handles shall be provided with trip free features enabling the breaker to trip even if the handle is held in the closed position. RCB's shall comply to BS 4293 and shall be of the current operated type. The RCB shall be designed to trip within 20m sec at a current sensitivity of 30mA. The breakers shall be of 2 pole construction for single phase and 4 pole construction for 3 phase. All breakers shall be complete with test buttons. RCB shall have a minimum life expectancy of 20,000 operations.

METERS AND RELAYS/ISOLATORS, SWITCHES AND CONTROL SWITCHES

Indicating instruments shall comply with BS89. Meters and relays for external panel mounting shall be of the flush pattern type with square escutcheon plates finished matt black and polycarbonate cases. Ammeter and voltmeters shall be of moving iron spring controlled type with 96mm square dials, accuracy Class 2.5 with external zero adjustment screws which are accessible from the front. Ammeters shall be selected such that full load current indications are not less the two thirds of linear scale of the meter.

Ammeters shall be capable of taking overloads of 2 times continuously and voltmeter 1.2 times continuously. Ammeters at the main incoming feeders shall in addition to the moving iron mechanism be provided with thermal bimetal indicators with draw pointers to record maximum demands. The mechanism shall not respond to short current peaks and shall be manually resettable. Hour run meters shall be motor driven type without reset features and able to register to at least 99 thousand hours.

Frequency indicators shall be of the vibrating reed type. The meter shall be capable of proper operation for voltage variations of $\pm 20\%$ rated voltage. Power factor meters shall be of the electrodynamic crossed coil mechanism suitable for balanced load, three phase four wire system. The accuracy class shall be 1.5 and range 0.5 lag to 0.5 lead. Ammeter select switches shall have make before break contacts to ensure that the current transformers are never open circuited. Voltmeter selector switches shall have break before make contacts.

Protective relays shall comply to B.S. 142. Standard Inverse Definite Minimum Time (IDMT) earth fault relays shall have a definite minimum time variable from 0 to 2.2 seconds on a time multiplier of 1.0. They shall have

nominal current plug settings variable from 10% to 40% in steps of 5%. Withdrawable type relays shall be provided with automatic means of short-circuiting the current transformer secondary circuits and capable of breaking tripping circuits when the relay element is removed. Relays shall have a rated current equal to secondary current of the current transformer. The relay shall be complete with mechanically operated flag indicator.

Instruments, meters and relays located on the front of the switchboard shall be so positioned that as far as possible, each instrument, meter and relay is adjacent to the unit with which it is associated. Other relays more suitable for mounting inside the cubicle such as those required for back indication and tripping etc. shall be grouped conveniently in dust proof cases with removable covers to provide easy access for cleaning and adjustment without dismantling. All relays shall be heavy duty pattern, unaffected by external vibration and capable of operation in any position. Meter panels shall be hinged to provide ready access to connections and small wiring shall be enclosed in flexible plastic conduit. All meters and relays shall be fully tropicalised. All terminals shall be completely insulated and potential circuits shall be suitably fused.

Isolators and switches shall be of the on-load type, capable of interrupting the full load of current, and shall comply with BS EN 60947-3. They shall have quick make and break type operating mechanism. When installed inside a control panel, it should be door interlocked, to prevent access to the panel unless the switch is in the open position. It should also not be possible to switch on unless the door is closed or the interlock purposely defected. Isolator installed individually shall preferably be of moulded case weatherproof construction. All isolators shall be provided with padlocking facilities to lock the isolator in the 'off' position. Control switches shall be of the multi position rotary type. Each switch shall be provided with normally open or closed contacts as required. Switches shall be rated for at least 10A, 240V. All terminals shall be fully shrouded and labelled. The high rupturing capacity (HRC) cartridge fuses of rating shown shall conform to B.S.88 Part 2 Class Q1 with minimum breaking capacity of 80KA. When fuses are used for motor protection they shall have motor rated class. Fuse bases and carriers shall be made of high grade phenolic moulding.

INDICATOR LAMPS/ CONTACTORS

Indicating lamps shall be neon blub type with a minimum service life of 20,000 hours. Lamps shall be easily removed or replaced from the front of the panel without the use of extractors. The body shall be reinforced thermoplastic while the lens cover shall be thermal resistant thermoplastic. Pilot light identification shall be engraved on the lens cover. The colour coding of the lamps shall be in accordance to BS EN60073.

Contactors shall be manufactured in accordance with BS EN60947-4-1. Contactors shall be of AC3 duty category and selected to suit the load such that a minimum electrical life of one million operations is ensured. The mechanical life shall be at least 5 million operations. Contacts shall be renewable and constructed from silver faced hard copper, and designed to ensure freedom from contact bounce. Coils shall be Class B Insulated to BS 2613 and suitable for continuous operation. All live parts shall be fully shrouded. Arc chutes and magnetic blow out coils shall be fitted to contacts larger than 200A.

Contactors shall have at least 15 times making capacity and 10 times breaking capacity for contactors less than 100 amps and 10 times and 8 times respectively for contactors above 100 amps. The selection of contactors shall be coordinated with the prospective fault levels suitable at that point of installation. The devices used for motor starting shall be coordinated to provide a class 2 level of continuity of service and safety as defined in IEC 947-4-1. Contactors shall generally be suitable for rail mounting and be of modular design. The coil shall be suitable for +10% and -15% of nominal mains voltage. Provision shall be made on the contactors for affixing of termination and contactor identification labels.

TERMINATIONS

Tunnel type terminals shall be provided for cables up to 6mm². Cables larger than 6mm² shall be terminated with compression cable lugs or propriatory makes of termination approved by the Engineer. All cable terminals shall be labelled. Cable lugs shall be of the annealed copper one piece seamless construction type. Lugs shall be burr free and tin plated to prevent corrosion. All crimping of lugs shall be done using proper crimping tools. Terminal compartments with minimum space of 600mm shall be provided in the panel. All incoming and outgoing circuits shall be terminated in a terminal compartment. The terminal compartment shall be closed with a door for access to the terminals in the compartment. Support brackets/trays shall be provided

within the termination compartment for proper support of cables. Where single core cables are installed, brass or polyamide plates of 6mm thickness shall be provided to serve as gland plates and the glands and plates effectively earthed. Earthing of the armour of single core cable shall only be effected on the source side of the cable, while the other end is left unconnected.

TIMERS, RELAYS, TIME SWITCHES AND ACCESSORIES

Timers and time switches shall be of electronic type and provided with 2 sets of change over contacts. Timers shall have an setting accuracy of $\pm 5\%$. Time switches shall have 2 channel programmable change over contacts and minimum 48 hours battery back up. All timers relays and time switches shall have contacts rated for a minimum mechanical life of 2 million operations and electrical life of 1 million operations. Standard plug in bases suitable for rail mounting shall be provided. Connection diagrams shall be imprinted on the body of the accessories.

MOTOR STARTERS

Motor starters shall comply with BS EN60947-4 and BS5424. The type of starter used shall be as shown in the schematic drawings. The starter cubicles shall incorporate the components scheduled below together with any associated control items indicated on the schematic drawing.

Direct On-Line (DOL) Starters (for motors small than 8kw)

DOL starter shall contain the following:-

- Suitably rated circuit breaker, contactors and overload relays.
- Control fuses, selector switches, start/stop push buttons
- Green run, red tripped, amber alarm condition indicating lights.
- Auxillary contacts, relays, terminals, hour run meter, etc. if required.
- Direct reading ammeter on one phase for motors larger than 0.37kw and less than 5kw
- CT type ammeters for motors larger than 5kw c/w a selector switch.

Star Delta Starter (for motor smaller than 25kw)

Star Delta starters shall in addition to the item listed above for DOL starters include adjustable timers to control the run-up time in star connection. Closed transition Star Delta starters (for motor smaller than 37kw) shall in addition include a resistor incorporated with a manual reset type high temperature thermostat to trip the starter and operate the fault light. Resistors shall be sized for a minimum of 10 starts per hour. Resistors shall be housed in a well ventilated enclosure, outside of the switchboard.

Closed Transition Auto Transformer Starters (for motors small than 50kw)

Closed transition auto transformer starter shall in addition to the items listed above incorporate a autotransformer with 2 tapping (50% and 65%) and sized for 6 starts per hour. A set of 3 thermistors shall be incorporated in the autotransformer winding to cut out the starter if the winding temperature exceeds the maximum rated temperature. Motors larger than 50kw shall utilise starters as individually specified in the drawings and schedules.

Where the starter is not within view of the motor a latch off "stop" push button or isolator shall be installed in close proximity of the motor. Thermal bimetal overload relays shall have differential, temperature compensated operation to protect against phase imbalance and phase failure. The trip current setting shall be adjustable within $\pm 20\%$ full load and have a setting accuracy of $\pm 5\%$. A mechanical trip indicator which shall also be used to reset the overload relay shall be provided. Overloads shall have trip characteristics to trip the motor within 2 hours at 115% set load. All motors larger than 8 kw shall be provided with thermistor protection to trip the starter when the winding temperature exceed rated values. Auxiliary contacts as required plus one set of spare contacts shall be provided.

INTERFASING WITH OTHER SYSTEMS

The building monitoring system should monitor the main incoming voltage, current, power factor, and status of all circuit breakers. Sensing circuits and auxillary contacts shall be wired to a separate compartment within the main switchboard. The compartment should be sized to accommodate the necessary transducers and connection

terminals. All starters and motorised circuit breaker units shall allow for the starting and stopping by the building automation system. Auxillary contacts shall be provided for monitoring the run trip and off indications. Terminals shall be brought out to a separate compartment form where the building automation system wiring will be taken off.

FLOOR MATS/ CIRCUIT DIAGRAMS/SHOPDRAWING

Rubber floor mats of 6mm thickness and 1 metre width shall be provided for the complete length of all switchboards and motor control centers. Circuit diagrams affixed to a wooden base and covered by clear transparency shall be affixed next to all factory built assemblies. These circuit diagrams shall indicate the wiring schematics and control logic diagrams. For distribution boards and control panels a laminated schematic fixed on the inside cover of the panel will be accepted. The contractor shall submit shop drawings showing equipment type, arrangement, actual dimensions, schematics, wiring, labels, weights, fixing details etc. The construction shall only proceed after the drawings are approved.

SECTION 9 - MATERIAL IDENTIFICATION

This section of the Specification covers the painting of all equipment, hangers, brackets, etc. installed under other sections of the Specification. The work involved includes but shall not be limited to the supply and application of primer paint, thinners, identification labels, etc. unless specifically excluded elsewhere in this Specification. Factory fabricated equipment shall be painted at the factory and paintwork damaged at site shall be repainted to match the original finish. Tarpaulins, sheets and protective covers shall be provided over floor, walls, etc. before commencing painting.

PAINTING & PROCEDURE

All paints supplied and applied to the various surfaces shall be suitable for the surface to be painted and shall be best quality of an approved manufacturer. They shall be delivered to the site in the manufacturer's containers with the seal, etc. unbroken the manufacturer's name or trademark and contents and colour clearly marked. The paints used must be proven for use in local climatic conditions. All materials for the work, e.g. primers, under-coatings and finishing paints shall be obtained from the same manufacturer and shall be those recommended by the manufacturer as suitable for application together and for the type and duty of surfaces concerned.

No painting on exterior work to be done during wet weather, or upon surfaces that are not thoroughly clean and dry. During the execution of painter's work the contractor is responsible for taking all precautions necessary for the health and safety of his workmen. The paint shall be kept stirred during use and when more than one coat is specified, subsequent coats shall not be applied until preceding coats have thoroughly hardened, and are smoothed down with abrasive paper. Painting shall be carried out with one primer coat, 1 undercoat and two gloss finishing coat. All works before painting shall be thoroughly cleaned down to remove all dirt, grease, scale rust, powdery residues by wire brushing, scrapping or other means. Surfaces shall be washed with solvent to remove oil/grease and with water to remove powdery residues. After any cleaning treatment, sufficient time shall be allowed for the surface to dry. All painting shall be carried out within seven (7) days of delivery and erection on site.

METAL SURFACE

Primer for metal surfaces shall be red lead or chromate metal prime or other approved equivalent. If the primer has thoroughly dried, apply one undercoat of appropriate shade, allow at least 24 hours drying time under normal weather conditions before application of each subsequent finishing coat. Finishing coat shall be high gloss paint. All galvanised steel surfaces shall be primed with a etching primer before application of the finishing coats.

EQUIPMENT / CABLES LABELLING

All cables shall be identified at terminals using a cable tag, engraved copper ring, or pvc furels. Submain cables shall be identified at 10m intervals along its route. All equipment like pumps, control panels, water heaters, AHU's etc. shall be labelled using black or white engraved laminated plastic labels identifying the equipment number and area of coverage. Labels shall be fixed using brass countersunk screws. Refer to individual sections of the specification for details of labels required for that particular section of work. Labels shall be between 1/10th and 1/20th the height of equipment being labelled and not less than 10mm.

PIPE & VALVE LABELING

Lettering on piping shall be painted in contrasting colours and shall be in centre of bands. The lettering shall be in block letter with minimum dimensions of 12mm high for pipes 50mm and under 38mm high for pipe over 50mm. Directional arrows shall be in white or two visible sides of all piping at each valve, fittings and long runs at 1.8m centres. The size of arrows shall be 75mm long on pipes up to and including 50mm diameter and 150mm long on pipe over 50mm diameter. Every valve in the installation, shall be provided with a 50mm diameter brass tag secured to it with a chain and stamped with the valve number, service and area of the valve controls. Each valve shall have on it a identification of the make, model and service pressure rating.

BASE COLOUR SCHEME

All pipework and equipment installed under this contract shall be painted in accordance with the following colour scheme:

<u>Pipe/Equipment</u>	<u>Base Colour</u>
Cold water service pipe	Light green
Fire protection pipes	Signal red
Valves normally open	Green
Valves normally closed	Red
Water pump & motors	Light blue
Steel work	To follow colour of pipe or equipment
Electrical containment	Orange
Emergency shut of devices	Red

On completion, the contractor shall make good all painting works which have been damaged during the progress of works for the handing over.

SECTION 10 - TESTING AND COMMISSIONING OF FIRE FIGHTING SYSTEMS

Before any of the systems in this contract are put into service, they shall be subject to a testing and commissioning procedure. Test instruments and qualified personnel required to verify the system and equipment performance shall be provided by the contractor. All test instruments are to be calibrated by an accredited laboratory. All equipment supplied should be factory tested before shipment and the contractor shall submit the factory test certificates, mill certificate etc. before site testing.

CHECK LIST /TEST RECORD

The contractor shall prepare and submit a detailed and comprehensive checklist prior to commissioning and testing. The purpose of the checklist is to:

- a) Ensure that all items that should be checked are checked
- b) Produce a permanent record of the commissioning checks carried out.

Accordingly, the checklist must be built up from information contained in this Specification, from suppliers, manufacturers' installation and commissioning data. The detail of the checklist must be such that it can be completed with a reading or a tick.

A permanent record of all inspection and acceptance test should be prepared by the contractor. These records shall form part of the operation and Maintenance Manual.

- a) Data and time of inspection or test.
- b) Persons carrying out the test.
- c) Test results noted.
- d) Any external factors significantly affecting the results.
- e) Follow-up action required
- f) Work carried as a result of (e) with data and results of retest
- g) Final test results

HYDRAULIC TEST-PIPEWORKS

Pipework shall be hydraulically tested in convenient sections as the work proceeds and witnessed by representative from the Consulting engineer. Pipework shall be tested to 1½ times normal working pressure but not less than 1033 kPa (150 psig) and shall be applied and held for 24 hours. Pressure shall not show a drop more than 4% in 24 hours. In the event of test failure, leak shall be found, made good and the line retested. Hydraulic test on pipework shall be carried out before pipe concealment work. Any item which is liable to damage at the test pressure shall be isolated in an approved manner. During the test pipework under test shall be fully vented.

TESTING OF ELECTRICAL WORKS

The testing and commissioning procedures shall include the following:

- a) Visual check of all work for completeness
- b) Check that all work complies with the latest regulations, specifications, performance criteria.
- c) Check that all equipment is safe to operate, and that overloads, safety devices and interlocks are all in working order.
- d) Check operating sequences, function of all devices and rotation of motors.
- e) Verification of performance under site conditions, under load and simulated "Worst case" condition.
- f) Insulation tests shall be made with 500V "Meggar". No cable will be accepted with an insulation resistance, including termination of less than 50 meg-ohms.
- g) Test continuity and unique identification of all conductors in all cables.
- h) Measure resistance on main earth and test all earth continuity connections.
- i) Check polarity and phase rotation of supply and at all outlets

All tests shall be carried out in accordance with relevant BS standards and the latest IEE regulations. The test to be carried out on the hose reel system shall include the following:

- a) Flushing out and checking outlet connections.
- b) Hydraulic pressure test
- c) Flow test to record flow and pressure, while the maximum number of outlets required by the Code are operational. The pressure at the outlet of pressure reducing landing valves shall be adjusted to fall within the specified range.
- d) Every outlet to be tested for flow and pressure
- e) Verify operation of check valve at the breeching inlet, and all valves in the system
- f) Visual inspection of pipes, sleeves, valves, hoses, cradle, pipe supports labels and accessories.
- g) Refer to section on testing of pumps systems

PUMP INSTALLATION

The tests to be carried out on the pump installation should include the following:

- a) Visual inspection of the installation
- b) Verify that all supports, vibration isolators and connection are properly secured.
- c) Verify setting of controls, pressure switches, flow switches, timers and accessories are properly set.
- d) Conduct electrical test as specified in section “Testing of Electrical Works”.
- e) Ensure that tanks are full of water, make-up pipes operational and level switch interlocks operational.
- f) Ensure that all stop valves are in the appropriate position.

Start all pumping units, by operating the test valve in a manner which will simulate fire conditions and check the following:

- 1) Correct cut-in pressure and cut out pressure
- 2) Efficient pump gland operation
- 3) Operation of both local and remote ‘pump run’ alarms
- 4) Pump priming water
- 5) Verify motor current, temperature rise, speed and direction of rotation

On electric motor driven pump, check the phase failure alarm and check that there is no excessive vibration or noise. Pump shall be fully operational within 30 seconds.

- a) Verify that the necessary pressure and flow are achieved.
- h) Ensure that accessories like pressure gauges, check valves, water alarm gong, etc. are operating properly
- i) Verify operation of compression-ignition engine driven pumps and check the following items:-
 - Water, oil and fuel leaks and for loose fittings and ancillary equipment.
 - Belt drives
 - Battery charger power failure alarm
 - Check batteries including terminals for cleanliness and correct level of electrolyte in each cell to ensure that they are in good serviceable condition.
 - Obvious out of balance
 - Correct running speed
 - Before and after running, check water, oil and fuel levels. Top up if required.
 - After running, ensure that the engine stop mechanism automatically returns to the start position
- j) Test the interchangeability and function of the duty and standby pumps.
- k) After testing of the pumps and resetting of the systems, check and record the pressure at the installation gauge and water supply gauge to ensure that normal water pressure is being maintained.

ACOUSTICS

Measure and record octave band sound levels at designated locations and ensure that readings are within the specified parameters.

COMMISSIONING/ ACCEPTANCE CHECKS

Commissioning shall be deemed to include all operations required in order to correctly set the plant to work, adjust and calibrate to design conditions to comply with relevant CIBSE or BS Commissioning Codes and to the satisfaction of the Engineer. The above shall include, but not limited to, the testing and balancing of all systems, including associated plant and equipment. Balancing and adjusting to achieved correct pressure and flow rates, including setting and adjusting valves and other regulating devices. All valves shall be locked and marked in final setting positions. Final setting positions for all regulating and controlling devices shall be recorded, and such records shall form part of the Manual of Operating and Maintenance Instructions called for in this specification.

The subcontractor must carry out full scale commissioning, testing and balancing of all system before requesting the attendance at site of the Engineers and the representatives from client and authorities for carry out acceptance checks. The contractor is required to make application to the Engineer giving at least seven days notice in writing when requesting acceptance test on any portion of the works. The application must be accompanied by a completed set of record indicating all plant settings, water flow rates, pump and fan heads and noise level readings as adjusted by the sub-contractor, together with the respective design values.

The Engineer reserves the right to refuse any application which is not accompanied by this information. The subcontractor must have available at site during balancing operations calibration data including pump and fan characteristic curves to assist the Engineer in checking the balance of the system. The contractor must have staff available to operate and adjust all systems as required by the Engineer during testing. He must also be represented by a member of his technical staff. The contractor shall also provide the services of a skilled mechanic and electrician who shall stand by, operate and maintain the installation for a period of two weeks after the installation has been taken over and the building occupied. During this period, final adjustment and other essential rectifications are to be carried out.

ELECTRICAL SERVICES
(SPECIFICATIONS)

PECIFICATION FOR ELECTRICAL SERVICES

<u>ITEM</u>	<u>DESCRIPTION</u>	<u>PAGE</u>
SECTION 1	General Specifications	GS/1 – GS/12
SECTION 2	LV Main Switchboard & Sub-board	M/1 – M/5
SECTION 3	Switchboards & DB's	SB/1 – SB/5
SECTION 4	Cabling	C/1 – C/4
SECTION 5	Light Fittings	LF/1 – LF/5
SECTION 6	Switches and SSO	SSO/1 – SSO/2
SECTION 7	- Deleted -	-
SECTION 8	Genset	GS/1 – GS/10
SECTION 9	AMF	AMF/1 – AMF/5
SECTION 10	Earthing System	ES/1 – ES/2
SECTION 11	External Lighting	EL/1 – EL/1
SECTION 12	Street Lighting	SL/1 – SL/2
SECTION 13	Lightning Protection	LP/1 – LP/5
SECTION 14	Surge Protection	SP/1 – SP/7
SECTION 15	Addressable Fire Alarm System	AFS/1 – AFS/8
SECTION 16	Fire Extinguisher	FE/1 – FE/2
SECTION 17	Telephone	T/1 – T/3
SECTION 18	Defects Liabilities Period	SP/1 – SP/7

GENERAL SPECIFICATION**1.0 Scope of Work**

The scope of works shall include supply, delivery, installation, testing, commissioning, completion, handling over, operational maintenance and servicing during the guarantee period of the entire electrical and associated works and allied works as described in this specification, drawings and schedules.

All works, performed under this contract must be in accordance with: -

- a) Regulations of the Institution of Electrical Engineers (latest edition)/BS 7671.
- b) Rules and Regulations of Department of Electrical Services, Negara Brunei Darussalam.
- c) Relevant British Standard Code of Practices.

Where the requirement shall be of the different rules, regulations or codes differ, the most stringent requirements shall prevail.

All materials shall be manufactured in accordance with the appropriate British Standards or such other National Standard as may be approved by the S.O.

The works to be performed under this tender shall comprise or but not limited to the following: -

- a) Supply and install electrical and associated works as described in the specifications and drawings.
- b) Supply three (3) complete sets of prints and one (1) set of reproducible tracings and one set of computer diskettes in AUTOCAD format of “As fitted/Installed” drawings, size of prints shall be A1 size (841mm x 594mm) for Electrical & Mechanical Installation and other services in the contract.
- c) Supply five (5) complete bind operation manuals for Electrical & Mechanical Installation and other services in this contract
- d) Testing and commissioning of the completion installation.

The Tenderer shall be fully responsible for the submission of all application forms, plans and drawings to maintain the necessary liaison with Department of electrical Services and other authorities having jurisdiction over the works and obtain approval from them for the complete installation specified.

3.0 Tenderer to Visit Sites

The tenderer shall be deemed to have visited the site so as to take into consideration of the existing conditions and to have satisfied himself as to the facilities for access, existing services and other site conditions prior to tendering. No claims will be allowed on the grounds of ignorance of the conditions under which the works will be executed.

4.0 Customs Restrictions, Quotas and Duties

The tenderer shall thoroughly acquaint himself with all the customs restrictions, quotas and duties imposed in Brunei and shall allow in his rates for such contingencies for which he may be liable and no claim in respect of these items will be entertained.

5.0 Progress, Completion and Maintenance of works

The successful tenderer shall before proceeding with the work, prepare in cooperation with the Employer and other tenderers a programme of work for the approval of the S.O. He shall further co-ordinate his work with the requirements of the Employer and other tenderers and the S.O.

After the certified date of practical completion, the tenderer shall provide 12 months free maintenance service.

6.0 Site Supervisor and Engineer

The tenderer shall supply a competent English speaking qualified and registered project engineer and a qualified and registered foreman or supervisor to be at the site during working hours. This project engineer and supervisor shall be empowered to receive and set upon instructions given by the S.O. and shall attend site meetings. Instructions given to them shall be taken as having been given to the tenderer.

7.0 Substitutions

Should the tenderer consider that any part of the work could be carried out quicker, better or more effectively by the substitution of materials or methods other than those specified, he may suggest them in writing to the S.O. for consideration.

Where the words “or equivalent” are used, the tenderer may request permission to use a substitute for what is specified, provide that the substitute is equal or better quality and effectiveness than that specified. However, the tenderer shall refer to the section “Instruction to Tenderers.”

8.0 Prototype

The tender shall supply drawings and prototype samples of items required in the specification/drawings and at the direction of the S.O.

Approved prototypes may be retained by the S.O. until the work is completed.

Samples and drawings shall be submitted for approval in sufficient time to allow for manufacture to commence to fulfill the required delivery site.

9.0 Failure to Comply with Space Limitation

Should the whole or any part of the installation be unable to fit into the space allocated, the S.O. may at his discretion permit the tenderer to carry out at his own cost such modifications to the equipment as he may propose to improve its adaptability and allow such time as he considers to be reasonable for the execution of such modifications.

Such permission will not be granted if S.O. considers the carrying out of the modification proposed by the tenderer to be not in the best interest of the Employer.

Notwithstanding the above, should the equipment be unable to fit into the space allocated, the S.O. may reject the whole or part of it.

The Tenderer shall at his own cost dismantle and remove from site the whole or part of the equipment which has been rejected and, at the discretion of the S.O., will be required to replace it with an approved alternative or to reimburse the Employer for the cost of such replacement carried out by others.

10.0 Failure to Achieve Guaranteed Performance

Should the whole or part of the installation be unable to produce on test the performance guaranteed in the Tender, the S.O. may, at his discretion, permit the tenderer to carry out at his own cost such modifications to the installation as he may propose to improve its performance and allow such time as he considers to be reasonable for the execution of such modification.

Such permission will not be granted if the S.O. considers the carry out of the modification proposed by the tenderer to be not in the best interest of the Employer.

Notwithstanding the above, should the installation be unable to produce on test (or on retest after the approved modification) the performance guaranteed in the Tender, the S.O. may reject the whole or any part of it.

The tenderer shall at his own cost dismantle and remove from site the whole or any part of the work which has been rejected and at the discretion of the S.O. will be required to replace it with an approved alternative or to reimburse the Employer for the cost of such replacement carried out by others, provided that the total amount of such reimbursement shall not exceed the original Total Tender Price.

11.0 Drawings.

The successful tender shall upon the award of this tender submit equipment details and scales (1:50) shop drawings for the approval of S.O. and shall within Three (3) weeks submit manufacturers certified drawings showing overall weights and dimensions and dimensioned fixing or mounting details particularly where such details have to be incorporated into building structures.

The tenderer shall on completion of this project supply one complete set of reproducible tracings and three complete sets of “as-installed” drawing to the S.O..

12.0 Operation, Maintenance Manuals and Instructions

On the completion of the project, the tenderer shall supply to the satisfaction of the S.O. five (5) copies of comprehensive operating and maintenance instructions for the equipment installed under this tender.

The form of the Maintenance manuals shall be as follows: -

- 1) General Description;
- 2) List of Equipment giving manufacturer, names and addresses;
- 3) Maintenance instructions for each item of equipment;
- 4) Catalogue list of spare parts;

- 5) List of spare parts supplied under this tenderer;
- 6) Instructions for adjusting controls and cut-outs;
- 7) Operating Instructions;
- 8) Emergency directions.

13.0 Cleaning Up

From time to time during the progress of the works, the tenderer shall arrange for cleaning and removal of accumulated debris as directed by the S.O. and shall at all times keep his working areas clean and tidy.

On completion, he shall remove from the site all plant, surplus materials and rubbish and clean up all floors, walls, ceilings and structures of dirt and stains resulting from his work and make good all tainted painting and finishing, all to the satisfaction of the S.O.

14.0 Safety Regulation

The tenderer and his personnel whilst working on site shall at all times observe all relevant safety regulations and rules.

15.0 Accommodation, Water, Lighting etc.

The Tenderer and Main Tenderer shall arrange for the use of water, artificial lighting, temporary power supply, etc. where available and requested.

16.0 Cutting and Making Good

The Tenderer shall do all cutting, drilling, etc. necessary for the installation of the work of this tender. This includes any chipping, cutting, etc. and subsequent making good of complete brick walls or other partitions.

Where openings are required to be formed in floors, beams, walls, partitions, ceilings or other sections as and when required for the installation, the main tenderer shall fix and provide/cut the location of such openings.

Failure on the part of the tenderer to provide the location of the openings in advance to the construction will result in the tenderer having to carry out this work at his own expense.

The Tenderer shall co-operate with other tenderers to the fullest extent possible to reduce cutting, drilling, etc. of finished work to a minimum.

Structural members shall not be cut or drilled with prior consent of the Structural Engineer.

Any Damage to the finished building work caused by the main tenderer or tenderer shall be made good at his own expense.

17.0 Other Requirements

17.1 Drawings

The tenderer shall submit the drawings for approval on or before the date named in the specification such drawings may as may be called for therein.

Drawings signed as above described shall not be departed from without the permission of the S.O. or the tenderer.

The S.O. shall have the right at all reasonable times to inspect at the factory of the tenderer all drawings of any portion of the works.

The Tenderer shall, if desired by the Client, furnish to the S.O. at the commencement of the maintenance period drawings other than shop drawings of the works as complete, in sufficient detail to enable the S.O. to maintain, dismantle, reassemble and adjust all parts of the works.

17.2 Mistakes in Drawing

The tenderer shall be responsible for any discrepancies errors or omissions in the drawings and other particulars supplied by him, whether such drawings and particulars having been approved by the S.O. or not.

17.3 Operation and Maintenance Instructions

The tenderer shall furnish to the S.O. before the works are taken over, operating and Maintenance Instructions together with drawings (other than shop drawings) of the works as completed in sufficient detail to enable the S.O. to maintain, dismantle, reassemble and adjust all parts of the Works. The Works shall not be considered to be completed for purposes of taking over under the terms of Clause 17.7 (Taking Over) until such instructions and drawings have been supplied to the S.O. But in any case, Operation and Maintenance Instructions shall be submitted not later than 6 weeks upon practical completion.

17.4 Manner of Execution

All plant to be supplied and all work to be done under this tender shall be manufactured and executed in the manner set out in the specification or, where not so set out, to the reasonable satisfaction of the S.O.

17.5 Inspection Testing

The S.O. shall be entitled at all reasonable times during manufacture to inspect, examine and test on the tenderer's premises the materials and workmanship of all plant to be supplied under the tender, and if part of the said plant is being manufactured on other premises, the tenderer shall obtain for the S.O.'s permission to inspect, examine and test as if the said tenderer's premises. Such inspection, examination or testing, if made, shall not release the tenderer from any obligation under the tender.

The tenderer shall give the S.O. written notice of the date on the place at which any plant will be ready for testing as provided in this tender and unless the S.O. shall attend at the place so named within 15 days of the date which the tenderer has stated in his notice the tender may proceed with the tests, which shall be deemed to have made in the S.O.'s presence and shall forthwith forward to the S.O. duly certified copies of the test readings.

Where the tender provides for test on the premises of the tenderer or any other tender, the tenderer except where otherwise specified shall provide free of charge such assistance, labour, material, electricity, fuel, stores, apparatus and instruments as may be requisite and as may be reasonably demanded to carry out such tests efficiently.

If after inspection, examination or testing any plant, the S.O. shall decide that such plant or any part thereof is defective or not in accordance with the tender, the S.O. may reject the said plant thereof by giving the tenderer within a reasonable time notice in writing of such rejection, stating therein the grounds upon which the said decision is based.

Where the tender provides for tests on the site, the tenderer, except where otherwise specified, shall provide free of charge, subject to the provisions of Clause 17.6 – Tests on completion, such labour, materials, electricity, fuel, stores and apparatus as may be required and as may be reasonably demanded to carry out such tests efficiently.

17.6 Tests on Completion

The tenderer shall give to the S.O. in writing twenty-one days notice of the date after which he will be ready to make the tests on completion. Unless otherwise agreed, the tests shall take place within ten days after the said date on such day or days as the S.O. shall in writing notify the tenderer.

If the S.O. fail to appoint a time being having being asked to do so or to attend or to arrange for his assign to attend at any time or place duly appointed for making the said test, the tenderer shall entitle to proceed in his or their absence and the said tests shall deem to have been made in the present of the S.O.

If, in the opinion of the S.O., the tests are being duly delayed, he may by notice in writing call upon the tenderer to make such test within ten days from the receipt of the said notice and the tenderer shall make the said tests on such days within the said ten days as the tenderer may fix and of which he shall be give notice to the S.O.. If the tenderer fails to make the test. All tests as made by the S.O. shall be at the risk and expense of the tenderer unless the tenderer shall establish that the tests so made shall be at the risk and expense of the S.O.

If any portion of the works fails to pass the tests of the said portion shall, if required by the S.O. be repeated within a reasonable time upon the same terms and conditions, save that all reasonable expenses to which the S.O. may be put by the repetition of the tests shall be deducted from the tenderer's Price.

17.7 Taking Over

As soon as the works have been completed in accordance with the tenderer, except in minor respects that do not affect their use of the purpose for which they are intended and except for the maintenance thereof and have passed the tests in completion, the tenderer shall obtain from the S.O. a Certification (herein called a certificate of practical completion) in which he shall certify the date on which the works have been so completed and have passed the said tests and the Employer shall e deemed to have taken over the works on the date so certified but the issue of a certificate or practical completion shall not operate as an admission that the works have been completed in every respect. In the event of the works being divided by the tenderer into two or more sections, the tenderer or the Employer shall be entitled to take over any section or sections before the other or others and thereupon the tenderer shall issue or obtain from the S.O. a certificate in respect thereof. If by agreement between the tenderer of the Employer and the tenderer any portion of the works (other than a section or sections) shall be taken over before the remainder of the works. The tenderer shall issue or obtain from the S.O. a certificate of practical completion in respect of that portion.

17.8 Maintenance Period

For a period of 12 months after the works or any portion thereof have been taken over, the tenderer shall be responsible for making good with all possible speed any defects arising from defective design (other than a design made, furnished, or specified by the tenderer) materials or workmanship or from any act or omission of the tenderer that may develop in the works under the conditions provided for by the tender and under proper use.

If any such defect shall occur the S.O. shall inform the tenderer thereof stating in writing the nature of the defect. If the tenderer replaces or renews any portion of the works, the provisions

of this clause shall apply to the portion of the works so replaced or renewed until the expiration of 12 months from the date of such replacement or renewal.

If the replacement or renewals are of such a character as may affect the efficiency of the works of any portion thereof, the S.O. may within one month of such replacement or renewal give to the tenderer notice in writing requiring that tests on completion be carried out as provided in Clause 17.6.

These conditions shall apply to all inspections, adjustment, replacements and renewals and to all tests occasioned thereby, carried out by the tenderer during the maintenance period.

17.9 Tender Change

The S.O. shall have full power from time to time during the execution of the tender by notice in writing to direct the tender to alter, amend, omit, add to or otherwise vary any of the “Works” and the tenderer shall carry out such variations and be bounded by the same conditions as far as applicable as though the said variations were stated in the specification. If, in the opinion of the S.O. or tenderer, any instruction to vary the works will involve an increase or decrease in the tender Price, the amount of such increase or decrease shall be determined before the work is put in hand unless the tenderer is otherwise instructed in writing by the S.O. The tender or prices analogous thereto, or if such prices are not applicable, at rates generally ruling at the date of the tender for the type of work concerned.

No claims shall be made by the tenderer for payment in respect of any alleged increase or decrease in the quantity or type of work on account of alternations made in the work to comply with the requirements of the specification, or to suit the tender’s method of working or to suit the tenderer’s requirements.

MAINTENANCE AND MANUALS

1.0 MAINTENANCE

The contractor shall nominate and confirm the list of personnel/specialists to fully maintain the whole installation for twelve (12) months during the defect and liability period.

The Contractor shall be responsible to carry out all maintenance and inspection works recommended by the Manufacturer for all the equipment included in the Contract to ensure that the equipment will operate under optimum condition with long service life.

The maintenance work shall ensure a safe, proper and satisfactory function of the system to facilitate maximum operation continuity and minimum breakdown stoppage.

It is the responsibility of the Contractor to provide an efficient and effective breakdown maintenance at all time. In this manner, the Contractor shall provide 24-hour standby to answer call for attendance to failure of equipment.

2.0 OPERATION AND MAINTENANCE MANUALS

2.1 GENERAL

The operation and maintenance manuals shall cover the following aspects and shall be provided in separate volumes: -

- Equipment installation,
- Equipment operation,
- Workshop repair and system maintenance, and
- System description

The Manuals shall deal with all the standard options and arrangements provided in the Contract,

If there is more than one version of a particular type of equipment supplied, then the one volume shall cover all versions of the equipment and include sections showing the variations between the different versions of that equipment.

The manuals shall include the following:

- a) Instructions and procedures for placing equipment in initial operation or start-up instruction, controls and accessories operation sequence and interlocks including operation parameters and/or data
- b) Operation and use
- c) Troubleshooting malfunctions
- d) Routine Maintenance including recommended schedules
- e) Disassembly and re-assembly
- f) Illustrated parts breakdown of each major assembly. Parts lists shall include a complete list of component part of an item of equipment together with an expanded view or equivalent means to identify the parts
- g) Special tool lists shall include all tools and devices required for assembly and disassembly, operation and maintenance of the equipment and an indication of the use of each item. The lists shall further identify the source of manufacture, consumable supplies and special tools that are normally furnished with the purchase of the equipment or to be furnished as part of the contract. In addition, a list shall be provided showing items recommended by the manufacturer for two years operation including bench level materials.

2.2 PRESENTATION

All manuals shall be in English. Printing and drawings shall be clearly presented. Covers shall be durable and strong. A description title of equipment and/or subject shall be printed on the front and the spine, together with the type and identification number of the equipment. The schedule and the Contract number of the plant to which the manuals refer shall be shown on the first sheet inside the cover.

Manufacturer's standard brochures may be incorporated provided they refer particularly to the Plant and all extraneous matter shall have been marked as inapplicable.

The Original manufacturer's drawing numbers, spare parts, name plates, serial numbers, part names and numbers and all other details in respect of the Plant shall not in any way be changed.

The manuals and the parts list referred to in the specification which may include approved Contractor's drawings reduced to a convenience size, shall be bound in a loose-leaf style and not inserted into cover pockets. Manuals shall be convenient to handle and suitable for addition of amendments. If any volume should be unduly bulky, then the volume shall be subdivided and produced in multi-volume form.

Each Volume shall contain an index to the sections included. Explanation and descriptions shall be accompanied by photographs and drawings inter spread throughout the text. Drawings shall fold out clear of the text where appropriate. It shall be possible to fold out and read drawings when the handbook is closed.

Terminology shall comply with that normally used by civil aviation electrical and electronic personnel. All terms, abbreviations and symbols shall be defined in glossary of terms in each volume. Different groups of information within one handbook shall be separated by means of robust separating cards with a form of identification such as an edge strip clearly visible with the book closed.

2.3 INSTALLATION MANUALS

These manuals shall be generally used by the Contractor's installation staff. They shall describe and illustrate the installation of the equipment, commencing with transporting and unpacking, these instructions shall continue in a logical sequence until the equipment is fully assembled, erected, wired and connected to power and associated equipment. The basic electrical testing shall be described.

The manuals shall describe the complete mechanical installation of the equipment in its various standard applications. For example, equipment may be floor mounted either back-to-back or against a wall, suite mounted or wall mounted.

All mechanical components of the Contractor's mounting arrangement shall be completely listed and clearly depicted in drawings and photographs.

Sufficient details shall be given to enable all necessary installation works and part of the works to be correctly carried out by others. The manuals must include complete details of standard alternative equipment arrangements and rack assemblies appropriate to the works, fully dimensioned and illustrated by photographs with all sub-units, terminals, test points, etc. labeled for identification.

Drawing shall be provided showing details of mounting requirements, cable entries, air ducts, interfaces, connection pressurizing equipment and features requiring special building design.

Sizes and weights of all major items making up the installation shall be given.

Drawing shall show interconnection wiring and station cabling etc., and all other appropriate items.

The manuals shall prominently state precautions to be observed by installers to avoid risk of damage to the equipment.

2.3 OPERATION MANUALS

Information in these manuals shall be sufficient for semi-skilled staff to operate and maintain the system in an operational condition.

The approach to these handbooks shall be determined by the maintenance philosophy that the field staff will replace faulty units with equivalent working units from the stock of spares and, the faulty units subsequently repaired at the electrical maintenance depot.

Clear instructions shall be given for:

- a) Undertaking first-in maintenance and sub-sequent routine maintenance (e.g. meter checks cleaning).
- b) Procedure for routine system measurements including arrangement of test instrument.
- c) Checking equipment operational condition by meter readings and procedure of identification of faulty unit.

Test instruments shall be accompanied by their own operational handbooks explaining facilities and application.

The manuals shall make full use of drawings and photographs as part of the instructions. They shall include:

- a) Drawings and photographs of racks or assemblies for all standard applications appropriate to the Works.
- b) All units shall be clearly labeled and inert-connections shall be clearly shown.
- c) Functional block diagrams of the rack of assembly.
- d) Functional block diagrams of units.
- e) Drawing indicating test and metering points and showing frequencies, level and impedances at interfaces of units.
- f) Drawings showing test arrangements for all re-commended routine test procedures.
- g) Description of equipment functions and circuits.

All equipment supplied shall be fully described. The test shall incorporate a complete series of illustrations and drawings explaining the equipment from general principles to details necessary for complete operation, maintenance and repair by maintenance staff.

- h) Performance specification and physical details of all equipment assemblies and sub-units.

The guaranteed performance specification shall be explicitly stated. Other performance figures shall also be stated such as expected performance, line-up figures (with limits) and operational figure (with limits). These figures shall be quoted against all items and sub-items as far as practicable. Physical dimensions and weights of items shall be stated. The power consumption of each active unit shall be stated.

- i) The description of equipment supplied shall be supported by complete sets of drawings and photographs for each basic maintenance unit and for each sub-unit.

A complete set, unless otherwise approved, shall consist of:

- Photograph(s)
- Component layout drawings,
- Schematic drawings of circuits, jack strips, interconnections, and
- Functional drawings which shall include levels and impedances at interfaces and other appropriate points, test points and metering points.

2.4 WORKSHOP MANUALS

These manuals will be the reference for skilled staff based at repair and control centres when they initially line-up and test the equipment, periodically maintain the system, analyze supervisory indications, locate faults and repairs faulty units.

The manuals shall comprehensively describe the equipment, its performance, operation and maintenance with full supporting technical details.

The manuals shall include the following:

a) Alignment and Commissioning of new Equipment

The full sequent of steps to commission equipment shall be detailed. Equipment required to test and align each system shall be listed and describe with illustrations, in particular, any special adaptors and non-standard materials and alignment tools.

b) Maintenance of Equipment

The Maintenance routines recommended by the Contractor shall be specified, particularly the routines which must be observed to ensure validity of the Contractor's guarantees or warranties.

c) Techniques for Alignment and Maintenance

Full and detailed instructions shall be included to enable line-up and repairs to be undertaken by skilled staff. All techniques normally followed by the Contractor's factory shall be included, together with values and ranges for all equipment parameters measured in the course of completion line-up.

d) Description of Equipment Functions and Circuits.

All equipment purchased shall be fully describe, the test incorporating a complete series of illustrations and drawings explaining the equipment from general principles down to the details necessary for complete operation, maintenance and repair by maintenance staff.

e) Performance Specifications and Physical details of all Equipment Assemblies and Sub-units.

The guaranteed performance specification shall be explicitly stated. Other performance figures shall also be stated such as expected performance, line-up figures (with limits) and operational figures (with limits). These figures shall be quoted against all items and sub-items as far as practicable. Physical dimensions and weights of items shall be stated. The power consumption of each active unit shall be stated.

f) Drawing and Photographs

The description of the equipment supplied shall be supported by complete sets of drawing and photographs for each basic maintenance unit and for each sub-unit.

A complete set, depending on the type of equipment being provided, shall consist of:

- Photographs(s)
- Component layout drawings,
- Schematic drawings of circuits, jack strips, interconnections,
- Functional drawings which shall include levels and impedances at interfaces and other appropriate points, test points and metering points and
- Component listing indicating components of a special or critical nature which have to be supplied by the equipment manufacturer on a continuing basis to ensure equipment performance is maintained.

In addition, drawings shall be provided showing:

- Equipment assemblies at terminals and repeaters showing standard options provided,
- Assemblies of units making up standard racks or their equivalent, and
- Functional block diagrams of typical standard stations and racks.

2.5 SYSTEM MANUALS

The system manuals will be used by staff as reference manuals for description of the overall system. The manuals shall have a format and indexing system which permits ready access to the information sought.

System manuals shall contain the following information.

- a) System description,
- b) Description of system facilities,
- c) A summary of the electrical performance characteristics of the equipment,
- d) Station inventories for the equipment type supplied,
- e) A schedule of system maintenance,
- f) Description of the tests to determine the overall system performance and
- g) Block schematic diagrams for each station.

2.6 FEATURES OF TECHNICAL DRAWING FOR MANUALS

Contractor shall pay particular attention to the following features which are required:

- a) Drawing numbers and titles shall enable ready identification of the drawings with the relevant units. The descriptive title of the unit, the type number and any appropriate serial number shall feature clearly in the title blocks of the drawings.
- b) Drawing showing an assembly of units and sub-units shall incorporate standard drafting techniques (such as clearly recognizable border lines or area shading or colouring) to indicate particular units which are modular or discrete and which can be replaced as a whole. The units which are sub-units shall be clearly labeled.

MAIN SWITCHBOARDS AND SUB-SWITCHBOARDS

2.00 TYPE AND RUPTURING CAPACITY

The Main and Sub-Switchboards shall be the self-contained, extensible floor or wall mounting, metal clad, flush fronted, cubicle type as shown on the Specification Drawings for front and/or rear access built up from completely enclosed units housing main circuit breakers, contactors, moulded selector switches, indication lamps, meters, bus bars, sealing glands, anti-condensation cubicle heaters complete with indicating lamp and switch relays and other necessary items of equipment whether specified hereinafter or not suitable for indoor service in an ambient temperature of up to 40° C with 100% R.H. at maximum continuous rating without exceeding the maximum temperature permitted by the relevant B.S. Specification to which reference is made herein for operation on a 415/240 Volts 3 phase 50 Hz system operating with solidly earthed neutral.

Generally, the Main and Sub-Switchboards shall be capable as a whole of withstanding without damage the electrical, mechanical and thermal stresses produced under short circuit conditions equivalent to 31 MVA at 415 volts for 3 seconds and shall comply with all requirements of B.S. 162. However, lower rupturing capacity switchboards compatible with the prospective fault levels at the points of application may be permitted if details could be submitted to substantiate the fault levels at the locations concerned.

Special attention shall be given to insulation and finish of all items and no linseed oil varnish, press pan, fiber to hygroscopic material shall be used in any position and all components shall have a tropical finish including electro tinning of non-ferrous parts and vacuum impregnation of operating coils.

All items of equipment of similar design and dimensions shall be, wherever possible, made to jig and be fully interchangeable with each other and care shall be taken to ensure that all parts fit accurately.

The switchboard shall be factory assembled and tested before delivery to site in sections and of suitable sizes for installation in the situation as shown on the Specification Drawings.

2.01 CONSTRUCTION

Each cubicle framework shall be fabricated from electro galvanized angle sections of not less than No.12 SWG electro galvanized sheet metal and self supporting when assembled and of standard size, uniform in height and depth from front to back. The cubicle roof, side panels and doors shall be of not less than No. 14 SWG sheet steel with turned edges to the front panels and so framed as to provide a clean, flush and pleasing and rigid construction without welded cross-structs. Where necessary, the cubicle shall be strengthened by horizontal and vertical folded channels and corner gussets.

Full access shall be provided to control equipment inside cubicles by means of suitable hinged doors secured with adequate numbers of captive thumb screws. Full access shall be provided to control equipment inside cubicles by means of suitable doors with car type handle and integral cylinder lock. For circuit breakers, the doors shall be mechanically interlocked with the main switch to prevent any door being opened with the circuit breaker in the 'ON' position. All doors shall be provided with approved type of gasket. The front, top, back and bottom of all cubicles together with switch/circuit breakers chassis, access doors and other ferrous components shall be manufactured from electro-zinc plated metal sheet. The exterior of the cubicles shall be finished semi-gloss grey to colour No. 631 of B.S. 381C with end plates and heads of any external fixing bolts or set screws similarly finished except those steel parts normally left bright which shall be cadmium plated and operating parts finished semi-gloss black.

The interior of each cubicle shall be finished matt white and shall be dust, insect and vermin proof. The interior of each piece of equipment shall be clearly marked to show the phases with either colored plastic disc screwed to fixed components or with colored plastic sleeving for identification. Plastic tape will be permitted. Proposed Fisheries Processing Complex for "Golden Corporation Sdn Bhd" on lot 6079 ('A'), Kg. Serasa, Muara Brunei Darussalam

Proper steel mounting frame and other steel support shall be provided where required.

2.02 BUSBARS AND SECONDARY WIRING

Busbar markings and arrangements, connections and grade of copper shall all comply as appropriate with B.S. 158, 159, 1433 and 1977.

The Switchboard shall be so arranged that the main busbars run horizontally through each sectionalized length in a ventilated separate compartment. The busbars shall be of adequate cross-sectional area to give the current ratings as shown in the drawings after allowing for derating factors. The main busbars shall comprise four rectangular section bars of equal cross-sectional area (i.e. full size neutral) fabricated from hard drawn high conductivity copper, electro-tinned for the entire length, rigidly mounted on non-hygroscopic insulators with connections from the busbars to the circuit breakers and switches effected by means of copper bars or rods securely clamped to the bars and identified by means of colored plastic sleeving or proper painting to indicate the phase colors.

Secondary busbars where used shall be HDCH copper similar to the main bars. Copper connections shall be provided from busbars to the distribution equipment and when required from distribution equipment to the cable terminations. Connection shall be so arranged that they do not impede access to cable entries and also subsequent maintenance of the switchboards. All connections shall be manufactured from HDHC copper, however for lower rated circuits of 100 Amp or below PVC single core cables may be permitted for connection provided the cables are the double PVC insulated type and of adequate cross-sectional area to withstand the prospective fault level. PVC/PVC Cable connections where permitted shall be identified with PVC sleeving.

All secondary wiring shall be of 600-volt grade PVC Cables with multistrand copper conductor of not less than 1.5 sq.mm section and shall be fixed securely without strain by cleats of the compression type. Multiples runs of wiring shall be enclosed in proprietary make PVC trunking specially designed for installation within the switchboard. For the purpose of identification different insulant colors shall be provided to distinguish the various circuits and each connection shall terminate at an approved type of terminal block place in an easily accessible position for testing at site with coded ferrules of an approved type on both ends of each conductor.

No connections or soldered joints shall be permitted in the wiring. The wiring shall be formed in a neat and systematic manner, with cables supported clear of panels and without crossovers. Bushes shall be provided as necessary to prevent chaffing of cables.

2.03 CABLE ARRANGEMENT

The switchboards shall be wall mounted as shown on the Specification Drawings and shall be designed for cables entering and leaving the switchboards vertically from above or below as appropriate.

Unless otherwise indicated, cable boxes for the termination of paper insulated cables entering or leaving the cubicle from below shall be mounted at or near the bases of cubicles whereas cable boxes for cables entering or leaving the cubicles from above shall inverted type and be mounted at the top portion of the cubicles, cable boxes shall be of the split type manufactured from good quality cast iron free from blow-holes complete with filling orifice, drain, plug, expansion dome, brass cone shaped wiping gland of appropriate size, armoured clamp and of such design as is

suitable for attachment to the adjustment served and such as to permit cable conductors to be formed into equipment terminal without undue bending.

Cable termination shall be mounted adjacent to the associated equipment. The bottom and top sheets of the cubicles shall be sectionalized and vermin proof for bottom and top entry cables respectively, entry plates shall be provided for top entry cables. Where necessary, cables clamps or pins racks as appropriate. Cubicles shall be arranged to accommodate entries of all types of cables and gland plates.

The Contractor shall liaise with the Department of Electrical Services authorities and provide acceptable cable dividing box complete with glands etc. for termination of the incoming DES service to consumer's MV Switchboard.

The various cubicle housing the respective control units shall be grouped in multi tier arrangement and a further part shall constitute a cabling and wiring chamber of ample dimensions in which terminal boards, cable boxes and gland plates shall be located.

2.04 SWITCHBOARD ARRANGEMENT

The Contractor shall provide the proposed switchboards layout drawings for the Engineer's approval before fabrication of switchboards. The switchboards shall be arranged to suit the spaces provided.

2.05 EARTHING

A suitable earthing terminal shall be provided on the frame of each section of the Switchboard for connection to earth. A suitable HDHC copper earth bar to be extended the entire length of the switchboard shall be provided in each switchboard for connection to all outgoing circuits and equipment frames.

2.06 METERS AND RELAYS

Meters and relays for external panel mounting shall be of the flush pattern, with square escutcheon plates finished matt black and pressed steel cases. Indicating instruments shall be to B.S. 89 1st grade, moving iron spring controlled with 100mm diameter dials (240 deg. scale) with external zero adjustment, integrating meters shall be to B.S. 37 Parts 1 and 2 and Part 4 with cyclometer registers and protective relays to B.S. 142.

The main incoming circuit breaker shall be provided with both over-current and earth fault protection. The Contractors shall liaise with the Department of Electrical Services in providing the correct types of these devices prior to installation.

The over-current relays shall have adjustable over-current settings 50% to 200% of rated values and adjustable time lag setting of 0 to 3.0 seconds, instantaneous high-set elements shall be provided for the main circuit breaker. The earth fault relays shall incorporate adjustable time lag 0 to 1.0 second and adjustable current settings from 5% to 40% in steps of 5%.

Voltmeters shall incorporate selector switches to enable phase to phase to neutral voltage to be read. Ammeters, being provided with selector switches shall be able to read all the line currents. Generally, ammeters shall be 20% over scaled, however ammeters associate with motor circuits shall be 500% over scaled.

Instruments, meters and relays located on the front of the switchboard shall be segregated from the interior of the cubicle and so positioned that as far as possible, each instrument meter and relay is flushed with the hinged dust proof access doors and is adjacent to the unit with which it is associated.

Other relays more suitable for mounting inside the cubicle such as those required for back indication and tripping etc. shall be grouped conveniently in dust proof cases with removable covers to provide easy access for cleaning and adjustment without dismantling. All relays shall be heavy duty pattern, unaffected by external vibration and capable of operation in any position.

Meter panels shall be hinged to provide ready access to connections and small wiring shall be enclosed in flexible plastic conduit. All meters and relays shall be fully tropicalized. All terminals shall be completely insulated and potential circuits shall be suitably fused.

Approved means shall be provided on the relays panels for the testing of protective relays and associated circuits.

2.07 MOULDED CASES CIRCUIT BREAKERS (MCCBs)

Moulded case circuit breakers shall comply fully with B.S. 4752: Part 1 and the case shall be of moulded insulating material of good mechanical strength and non-tracking properties. The tripping mechanism shall be calibrated in compliance with British Standards at the factory and the breaker shall be sealed to prevent tampering.

Moulded case circuit breakers shall be of manual or automatic tripping operation as required. The automatic type shall each incorporate a trip unit to provide overload and short circuit protection. The trip unit for each pole shall provide inverse time delay under overload conditions and instantaneous magnetic tripping for short circuit protection. The trip unit for each pole shall provide inverse time delay under overload conditions and instantaneous magnetic tripping for short circuit protection. The trip units in all the circuit breakers shall be interchangeable.

The MCCBs shall be so designed that when on tripped conditions, the circuit breakers cannot be switched on again unless it has been reset switching to OFF position first. The operation condition (i.e. ON, OFF or TRIP) of the circuit breaker shall be clearly indicated.

Moulded case circuit breakers shall be Single Pole and Neutral (SPN) Double Pole (DP) or Triple Pole and Neutral (TPN) Type as required. The construction and operation of the circuit breakers shall be such that if a fault occurs, all the poles of the circuit breakers shall have operated simultaneously to isolate and clear the fault efficiently and safely without any possible risk to the operator or to the installation.

Each circuit breaker shall incorporate 'trip-free' mechanism to ensure that the breaker cannot be held closed in fault conditions.

The operating mechanism of the circuit breakers shall be hermetically sealed at the factory and all metallic parts associated with the operating mechanism shall be treated against rust and corrosion. The short-circuit breaking capacity of the MCCBs shall not be less than the maximum prospective fault levels at the point where the MCCB is installed.

The Contractor shall be responsible to select and provide the correct type of circuit breakers for protection of the types of circuit involved. The Contractor shall also be responsible to ensure that the fuses where used in connection with MCCBs shall coordinate with the circuit breakers to give good and proper protection and discrimination of the electrical system.

The respective fault level at the Main Switchboard and Sub-switchboard are taken to be 31 MVA (43 kA) and 16 MVA (22 kA) respectively.

Moulded case circuit breakers may be used in location where the short-circuit current exceeds the breaker's established interrupting ratings provided suitable current limiting fuses are incorporated in the breakers. The rating of the breaker and fuse must be carefully selected to prevent damage to the breaker and to ensure co-ordination and high short circuit protection

required. Tenderer must provide the relevant data for formal approved by the Engineer before the use of integrally fused MCCBs.

2.08 CURRENT AND VOLTAGE TRANSFORMER

Current and voltage transformers shall comply with BS 3938 and BS 3941 as appropriate. They shall be of suitable ratio, output, type and class of accuracy for their function.

Current transformers for protection purposes shall be rated Class 5P20, 15 VA unless otherwise stated in the specification drawings.

Current transformers for indicative metering shall be rated Class 1, 15 VA unless otherwise stated in the specification drawing.

Secondary windings shall be wiring to suitable terminal boards and earthed at one point in the circuit.

All transformers shall be wired with an identifying label giving type, ratio, class output and serial number.

2.9 LABELS All cubicle doors shall be appropriately labelled to indicate the service. Labels shall also be provided to identify all items of equipment, circuits, cables and where applicable current rating of fuses and setting of relays. Labels on the exterior of equipment shall be clear perspex, reverse engraved filled flush with black (or red as suitable) filling and the back painted the same colour as the equipment. Labels shall be attached by means of machine screws and nuts or machine screws driven into drilled and tapped holes.

2.10 INDICATION LAMPS

Indicating lamps shall be the type with built-in transformer and made of brass with chromium plated bezel and locking ring. The lamps shall be adequately ventilated and easily removed or replaced from the front of the panel without the use of extractors. Lamps shall be clear and fit into an accepted standard form of lamp holder.

The colour in coloured lamp glasses shall be in the glass and not an applied coating. Transparent synthetic materials may, however, be used instead of glass, provided no material flow or discolouration takes place due to heat from lamps.

2.11 FUSE

Cartridge fuses complete with carriers for protection of auxiliary circuits shall be provided. Fuses shall be of the HRC type category 440/AC 4 class Q to BS 88.

2.12 SAFETY ARRANGEMENT AND WARNING LABELS

All terminals, connections, relays and other components which may be alive when the front access doors are open shall be adequately screened and suitable warning labels shall be fitted. Components within the cubicles shall also be adequately labelled to facilitate testing.

Isolators or links clearly labeled shall be provided in such positions and so connected that maintenance can be carried out with the maximum safety. This particular applies to control circuits fed from a remote position. Where it is necessary to maintain certain components in a cubicle in a live condition when the isolator is in the off position, such apparatus shall be so screened and labeled as to eliminate the possibility of any accident.

- END OF SECTION 2 -

SWITCHBOARDS AND DISTRIBUTION BOARDS

The switchboards, motor control centers, distribution boards and control desks shall be built in accordance with IEC 439 "Factory Built Assemblies for low voltage" or BS5486 "Factory-built assemblies of Switchgear and Control Gear for voltage up to and including 1000V AC and 1200V dc". All factory-built assemblies shall be capable of withstanding the electrical, mechanical and thermal stresses of the prospective fault level experienced. The prospective fault levels of the various factory-built assemblies are as indicated in drawings.

All equipment used in the factory-built assembly shall have been type tested. Type test certificates shall be submitted for all major equipment if requested. All factory-built assemblies, as a complete unit shall have a rating equal to or greater than the integrated equipment rating as shown in the drawing. Factory built assemblies shall be suitable for indoor installation unless specifically indicated otherwise in the drawings. All items of equipment used shall be suitable for a service condition of ambient air temperature not exceeding 40°C and average of 35°C over a 24 hours period, with relative humidity of 100%. The altitude does not exceed 2000m.

CONSTRUCTION

The factory-built assemblies shall be of the totally enclosed, cubicle type, which are extensible and suitable for floor or wall mounting as shown in the drawings. The factory-built assemblies shall be compartmented and utilize sheet steel plates of minimum 1.6mm thickness. The panels shall be vermin proof and constructed to a minimum degree of protection of IP22 ratings to BS EN 60947-1. All panels shall be protected against corrosion. Panels shall be degreased primed and powder spray finished to a thickness of 50 micron to colour BS 381C grey semi textured or RAL7032.

Alternative thickness of sheet steel will be considered if additional bracing is provided to suit the sheet steel thickness offered. Synthetic transparent material for the front and back panels covers are preferred to be used instead of sheet steel. The plinth steel shall be constructed from minimum 5 mm thick steel and suitable to support the weight of the panel. No "Live" parts of components shall be mounted on the door. Operating devices such as Indicating lamps, push buttons, selector switches, meters, etc. shall be so mounted that all live carrying parts are mounted within the panels when the doors are open. Only the operating handle and non "Live" parts shall be allowed to be mounted on the door. If live parts are to be mounted on the door they must be double insulated. All doors shall be independently earthed to the switchboard frame using a braided or coiled copper cable.

The switchboards and motor control centers shall generally be arranged with the busbar at the top, meters and indicating instruments at eye level and not below a height of 1600mm and operating handles at a minimum height of 800mm above floor level and a maximum of 1880mm above floor level. Provision shall be made within the factory-built assemblies for the proper support and bracing of outgoing and incoming cables. Weatherproof cable glands shall be provided for all cables entering or leaving the switchboard. The type of cable entry (i.e. top or bottom is as shown of the layout drawings). Panels shall be divided into sections of about 2 meters width to enable easy handling and transportation. Panels shall be transported to site on fully enclosed timber pellets. Transportation eye bolts shall be provided for handling at site. Panels which are poorly packed and result in signs of corrosion will be rejected. All equipment and terminals shall be labelled as detailed on the drawings. Labels shall be of clear perspex, reverse engraved and filled flush with red filling. Labels shall be attached by means of chrome finished counter sunk screws and nuts. Cable tails shall be labelled using a cable tag or plastic ferrules.

BUSBARS AND CONNECTIONS

Busbar shall be of hard drawn high conductivity copper or Hybrid Bus bars of aluminium core and copper sheath. The current rating, temperature rise and spacing between conductors shall comply with B.S. 159. The minimum clearance between phases and earth shall be 19mm. The minimum creepage distance in air shall be 38mm between phases and 25mm to earth. The main busbar shall be sized to carry the specified current rating and busbar connections to air circuit breakers, fuse switches and moulded case circuit breakers and shall be adequately sized so that temperature rise in any part will not exceed 30 degrees Celsius above ambient. Busbar selection charts and support spacing charts shall be submitted at the time of submission of shop drawing.

All busbars shall be heat shrink insulated (rachem or equivalent) and rectangular cross- section type. They shall be rigidly supported and have a short circuit rating as specified in the drawings for a duration of 1 sec. They shall be so arranged that extension can be done without difficulty and the resistance of any length of busbar with a joint shall not be greater than that of an equal length of similar bar without a joint. Busbars shall not be drilled to make connections. All busbar joints shall be clamped. If busbars are to be drilled for connections, then the cross-sectional area must be increased in proportion to the size of the drill hole. All busbar connections shall be

made in an approved manner to ensure faultless contacts. Bolts shall be tightened with an even tension and approved washers shall be used at all joints. Cadmium plated, high tensile steel bolts and nuts shall be used. Access to the busbars and busbar connections shall be gained by removal of cover plates secured by bolts or screws. Busbars which extend outside the busbar chamber to connect to circuit breakers, etc., shall be shrouded with insulating sleeves designed to prevent accidental contact with the live parts. Sleeves should be of the heat shrinkable type suitable for the operating temperature and voltages.

An earth bar of minimum size 50mm x 6mm or half the live bar size shall be run the full length at the bottom of each switchboard and motor control centre and the neutral bar shall be the same size as that of the phase bars. Before assembly, all busbar joint surfaces shall be filed or finished to remove burrs, dents and oxides and silvered to maintain good continuity at all joints. All busbars shall be painted with red, yellow, blue, black and green colours at appropriate points to distinguish the phases, neutral and earth bars respectively. All busbars and switchgear terminals to which outgoing or incoming cables are terminated shall be designed for a maximum temperature rise of 30°C above ambient.

CONTROL & INSTRUMENTATION WIRING

Cables for control & instrumentation wiring shall be PVC insulated to BS6004 and the insulation shall be appropriately colour coded to correspond to the various phases, neutral and earth wiring. Wiring for controls shall be minimum 1.5mm² and those for current measurement shall be minimum 2.5mm². Where multi-strand cables are used crimp type cable lugs shall be provided. All wiring shall be neatly run in plastic wiring channels and shall be bundled together using cable ties. All cables shall be identified at all terminals by means of numbered interlocking ferrules of white PVC with black characters. Terminal blocks shall be provided for all control cabling entering or leaving the factory-built assembly. These blocks shall be located in a separate cubicle. Terminal block of different voltage groups shall be separated by barriers and distinctly labelled.

Terminal blocks shall be polyamide construction and suitable for rail mounting. The terminals shall be spring loaded to ensure minimum contact pressure even if screws are loosened. All terminals and screw shall be fully shrouded. Terminal screws shall be of the captive type. Labels shall be provided for each terminal and shall be of the clip-on type. Only one cable shall be terminated at each terminal. Where multiple cables are to be shorted, external links shall be used. Provision shall be made for test socket to enable testing from the front of the panel. 20% spare terminals with a maximum of 10 terminal for each group shall be provided.

MOULDED CASE CIRCUIT BREAKER (MCCB)

The breakers shall comply with IEC157 or BS EN 60947-2. The breakers shall be provided with overcurrent protection by means of thermal and magnetic tripping element. MCCB's shall have a mechanical endurance life of not less than 15000 operations. All breakers tripping mechanism shall be **ambient temperature compensated**. Breakers of frame sizes greater than 160 amps shall be equipped with continuously adjustable magnetic pick up setting (2 to 10 times nominal setting). MCCB's used for incoming main feeders shall in addition be provided with continuously adjustable rated current settings in the range of 60 to 100% rated current. Where earth leakage relays are indicated in the drawings they shall be of definite time lag type which have a adjustable current sensitivity of 100mA to 1A as shown in the drawings and an adjustable time delay of 0.1 to 1 sec. All MCCB's larger than 400A shall be equipped with a earth leakage/earth fault relay.

The MCCB's shall have quick make and quick break mechanism independent of the operating speed. The tripping mechanism shall be mechanically "trip free" from the handle so that the handle cannot be closed against fault conditions. The MCCB shall be provided with **door interlock** handles. All handles shall be large and robust to carry out the switching operation with ease. The handle shall clearly indicate the "on" "off" and trip positions. The handle shall be able to be locked in the "on" or "Off" positions. When locked in the "on" position it shall still be possible for the handle to indicate trip when the breaker has tripped. An interlock release mechanism shall be provided to enable the door to be opened when the breaker is locked in the on position. Multipole breakers shall have a common-trip bar so that a fault condition on any one pole of the breaker will cause all poles to trip simultaneously. The MCCB interrupting capacity shall be not less than that indicated on the drawings unless alternative scheme using cascading protection or other schemes are utilized.

Automatic change over MCCB's shall be of the **motorized** type with both **mechanical and electrical interlock**.

The transfer operation shall be controllable by a adjustable time delay of between 0.1 to 30 sec. The actual transfer time of the MCCB's shall not exceed 2 sec. The motor mechanism shall utilize universal motor with electro magnetic clutch and shall be equipped with pull handles to allow manual operation of the circuit breaker.

All automatic change over MCCB's shall have a minimum mechanical life of 10,000 operations. MCCB when used for motor protection shall have characteristics suitable for the motor starting, current characteristics.

Standard range MCCB shall not be substituted for motor protection circuits. All moulded case circuit breaker

protecting Supply Authorities supply incoming circuits shall be fully withdrawable for easy maintenance. The breaker shall have interlocks to prevent withdrawal when the MCCB is "on". All busbar couplers shall be fully withdrawable and of four pole type moulded case circuit switch.

MINIATURE CIRCUIT BREAKERS (MCB)

MCB's shall comply to BS 3871 Part 1 and shall be of the **current limiting** type having a sealed ambient temperature independent thermal magnetic tripping mechanism providing overload and short circuit protection. All MCB's shall be suitable for rail mounting and shall have a minimum mechanical and electrical service life of 20,000 operations. MCB's shall have minimum M6 category of duty with Type 1-time current characteristics. Those MCB's feeding motor circuits shall have type 3-time current characteristics.

Each pole of the circuit breaker shall have quick make & quick break mechanism and be fully rated and protected with suitable arc-control devices, so that every pole is capable of making and breaking both rated and short circuit fault current. The handles shall be provided with trip free features enabling the breaker to trip even if the handle is held in the closed position.

RESIDUAL CURRENT BREAKERS (RCB)

RCB's shall comply to BS 4293 and shall be of the current operated type. The RCB shall be designed to trip within 20m sec at a current sensitivity of 30mA. The breakers shall be of 2 poles] construction for single phase and 4 pole constructions for 3 phase. All breakers shall be complete with test buttons. RCB shall have a minimum life expectancy of 20,000 operations.

METERS AND RELAYS

Indicating instruments shall comply with BS89. Meters and relays for external panel mounting shall be of the flush pattern type with square escutcheon plates finished matt black and polycarbonate cases. Ammeter and voltmeters shall be of moving iron spring-controlled type with 96mm square dials, accuracy Class 1.5 with external zero adjustment screw which are accessible from the front. Ammeters shall be selected such that full load current indications are not less the two thirds of linear scale of the meter. Ammeters shall be capable of taking overloads of 2 times continuously and voltmeter 1.2 times continuously.

Ammeters at the main incoming feeders shall in addition to the moving iron mechanism be provided with thermal bimetal indicators with draw pointers to record maximum demands. The mechanism shall not respond to short current peaks and shall be manually resettable. Frequency indicators shall be of the vibrating read type. The meter shall be capable of proper operation for voltage variations of $\pm 20\%$ rated voltage. Power factor meters shall be of the electrodynamic crossed coil mechanism suitable for balanced load, three phase four wire system. The accuracy class shall be 1.5 and range 0.5 lag to 0.5 lead. Ammeter select switches shall have make before break contacts to ensure that the current transformers are never open circuited. Voltmeter selector switches shall have break before make contacts.

Protective relays shall comply to B.S. 142. Withdrawable type relays shall be provided with automatic means of short-circuiting the current transformer secondary circuits and capable of breaking tripping circuits when the relay element is removed. Relays shall have a rated current equal to secondary current of the current transformer. The relay shall be complete with mechanically operated flag indicator. Instruments, meters and relays located on the front of the switchboard shall be so positioned that as far as possible, each instrument, meter and relay is adjacent to the unit with which it is associated. Other relays more suitable for mounting inside the cubicle such as those required for back indication and tripping etc. shall be grouped conveniently in dust proof cases with removable covers to provide easy access for cleaning and adjustment without dismantling. All relays shall be heavy duty pattern, unaffected by external vibration and capable of operation in any position. Meter panels shall be hinged to provide ready access to connections and small wiring shall be enclosed in flexible plastic conduit. All meters and relays shall be fully tropicalized. All terminals shall be completely insulated and potential circuits shall be suitably fused.

FUSES/ CURRENT TRANSFORMERS

The high rupturing capacity (HRC) cartridge fuses of rating shown shall conform to B.S.88 Part 2 Class Q1 with minimum breaking capacity of 80KA. When fuses are used for motor protection they shall have motor rated class and rating. Fuse bases and carriers shall be made of high grade phenolic moulding.

Current transformers shall comply to BS3938. Measuring current transformer shall be of accuracy Class 1 and for metering of accuracy Class 0.5. Protection current transformer shall be of accuracy Class 5P20. The burden requirements shall be selected according to the load and in no case, shall be less than 15VA. The output secondary current shall be 5 amps. Links shall be provided on the bus bars for the installation of the Supply

Authorities metering current transformers.

INDICATOR LAMPS

Indicating lamps shall be neon blub type with a minimum service life of 20,000 hours. Double insulated transformer type indicating lights where specified shall utilize lamps with a life of 4000 hours. Lamps shall be easily removed or replaced from the front of the panel without the use of extractors. The body shall be reinforced thermoplastic while the lens cover shall be thermal resistant thermoplastic. Pilot light identification shall be engraved on the lens cover. The colour coding of the lamps shall be in accordance to BS EN60073.

CONTACTORS

Contactors shall be manufactured in accordance with BS EN60947-4-1. Contactors shall be of AC3 duty category and selected to suit the load such that a minimum electrical life of one million operations is ensured. The mechanical life shall be at least 5 million operations. Contacts shall be renewable and constructed from silver faced hard copper and designed to ensure freedom from contact bounce. Coils shall be Class B Insulated to BS 2613 and suitable for continuous operation. All live parts shall be fully shrouded. Arc chutes and magnetic blow out coils shall be fitted to contacts larger than 200A.

Contactors shall have at least 15 times making capacity and 10 times breaking capacity for contactors less than 100 amps and 10 times and 8 times respectively for contactors above 100 amps. The selection of contactors shall be coordinated with the prospective fault levels suitable at that point of installation. The devices used for motor starting shall be coordinated to provide a class 2 level of continuity of service as defined in IEC 947-4-1. Contactors shall generally be suitable for rail mounting and be of modular design. The coil shall be suitable for +10% and -15% of nominal mains voltage. Provision shall be made on the contactors for affixing of termination and contactor identification labels.

TERMINATIONS

Tunnel type terminals shall be provided for cables up to and below 6mm². Cables larger than 6mm² shall be terminated with compression cable lugs or proprietary makes of termination approved by the Architect. Cable lugs shall be of the annealed copper one-piece seamless construction type. Lugs shall be burr free and tin plated to prevent corrosion. All crimping of lugs shall be done using proper crimping tools. Where single core cables are installed, brass or polyamide plates of 6mm thickness shall be provided to serve as gland plates and the glands and plates effectively earthed. Earthing of the armour of single core cables shall only be affected on the source side of the cable, while the other and is left unconnected.

TIMERS, RELAYS, TIME SWITCHES AND ACCESSORIES

Timers and time switches shall be of electronic type and provided with 2 sets change over contacts. Timers shall have a setting accuracy of $\pm 5\%$. Time switches shall have 2 channel programmable change over contacts and minimum 48 hours battery back up. All timer's relays and time switches shall have contacts rated for a minimum mechanical life of 2 million operations and electrical life of 1 million operations. Standard plug in bases suitable for rail mounting shall be provided. Connection diagrams shall be imprinted on the body of the accessories.

DISTRIBUTION BOARD

The equipment used and construction details shall be as detailed in earlier sections of this specifications. Additional space shall be allowed in each distribution board for increasing the no. of circuit way by at least 10% and suitable blank plates shall be provided for the initial installation. Each distribution board shall be complete with a neutral and earth bar of square or rectangular cross section having terminal connections for each single-phase way on the board. For termination of conductors larger than 4 square millimeters cross sectional area, cable sockets with four screw cable clamp pattern terminations shall be used. The neutral and earth bar provided in each distribution board shall have adequate number of terminals. Spare terminals shall be provided for future circuit which may be connected to the spare ways provided. A schedule of circuit shall be provided inside of the hinged cover of the distribution board on clear transparency.

FLOOR MATS/ CIRCUIT DIAGRAMS/ DANGER SIGNS & ARTIFICIAL RESPIRATION CHARTS

Rubber floor mats of 6mm thickness and 1-meter width shall be provided for the complete width of all switchboards and motor control centers. Circuit diagrams affixed to a wooden base frame and covered by clear transparency shall be affixed next to all factory-built assemblies. These circuit diagrams shall indicate the schematic diagram and control wirings diagram. For disruption boards and control panels a laminated schematic fixed on the inside cover of the panel will be accepted. Danger signs shall be affixed on all factory-built assemblies to warn of possible danger. Artificial respiration charts shall be affixed in all main switch rooms, and

genset rooms.

TESTS AT SITE

After construction the following minimum tests shall be carried out at the factory. All tests shall be carried out in the presence of the Supervising Engineer.

1. Insulation and continuity test
2. Di-electric test - 3kv for 1 minute
3. Primary injection tests to verify settings of current tripping devices.
4. Check of clearances and creepage distances.
5. Physical inspection of the assembly and finishes
6. Verification of CT polarity and ratio
7. Mechanical operation, Control interlock, and functional tests
8. Earth continuity tests
9. Verification of Phase sequence after the switchboard is energized
10. Verification of busbar contact resistance

After installation at the site, all the tests mentioned above, except for tests 2 and 4, shall be repeated in the presence of the engineer. All costs, materials, equipment, labour etc necessary for the execution of the testing shall be provided by the contractor.

SHOP DRAWINGS

The contractor shall submit shop drawings showing equipment type, arrangement, actual dimensions, schematics, wiring, labels, weights, fixing details etc. The construction shall only proceed after the drawings are approved.

ELECTRICAL CABLING

The cabling system shall comply with the requirements of the latest IEE Regulations, Building Codes, Fire Codes and Authorities requirements. Cables shall be installed in one continuous length and straight through joints shall only be permitted on cables where length exceed the standard drum length. All joints shall be identified on the as built drawings. Terminations and joints shall be made without the reduction in the number of strands. Proprietary type straight through joints shall be used. The type of system used shall be submitted for the approval of the Engineer. Cables shall be colour coded by Pigmentation on the Insulation using red, yellow and blue for Phase wires, black for neutral and green/ yellow for protective conductor. Control cables shall be white and numbered in black.

Cables should be delivered to site with the seals intact, and bearing the manufacturer's name, classifications, size, type, length and grade marked on. Fire stopping of the same rating as the compartment wall shall be provided for all cables, trays, trunkings and sleeves which pass through a fire compartment. Cables of different categories shall be segregated in accordance with the latest IEE Regulations. All cables shall be of copper in accordance with BS 6360. The single line wiring diagram indicates the type and size of cable required, while the layout drawings indicates the routes of all submain cables.

FINAL SUB-CIRCUIT/ FLEXIBLE CABLE

Wiring of final sub-circuits for lighting and power shall generally be carried out in P.V.C. Cables of 450/750 volts grade and rating manufactured in compliance with the BS 6004. Cables having insulation of Butyl rubber or silicon rubber to BS 6007 or other heat resisting cables shall be used for termination to luminaries or where cables pass through luminaries. The type of cable used shall be suitable for the operating temperature. The minimum size of multistrand cable used for final sub-circuits shall be as shown in the drawings and schedule.

Flexible cables shall be minimum 1 mm² or larger and of circular construction, colour coded and incorporating a earth conductor. Cables shall be PVC to BS 6004 or Butyl rubber to BS 6007, when used in higher temperature conditions, while the conductor shall be of copper and comply with BS 6360. The flexile cable shall be multicore, multistranded and of sufficient strength to support the mass of the luminaire or equipment supported.

RECTICULATION MAINS CABLES

Submain cables shall be copper cables of 600/1000 volts grade and shall be manufactured to the following standards.

PVC	- BS6004, BS6469, BS6746, BS6360
PVC/SWA/PVC	- BS6346, BS6746, BS6469, BS6360
XLPE/SWA/PVC	- BS5467, BS6360, BS6234, BS6746, BS6467
XLPE/AWA/PVC	- BS5467, BS6360, BS6234, BS6746, BS6467
FIRE RESISTANT CABLE (Silicon rubber insulated)	- IEC 331 and BS6387 category C.W.Z, BS4066

Low smoke (LSF) cables shall have an extruded layer of low smoke Zero halogen material and shall comply with BS 6724. The outer sheath of all armoured cable shall be anti termite treated. The type and make of all cables shall be embossed on the outer sheath. Bending and termination of the cables must be done by a qualified electrician and proper tools are to be used. A minimum bending radius of ten times the diameter of the cable should be used.

Submain cables shall be installed spaced to ensure effective heat dissipation. Grouping of cables will only be permitted if specifically shown on the drawing, or if the contractor resizes the cable accounting for all the necessary factors. Every length of cable shall be tested before and after termination and the reading should be greater than 50m ohm It should be tested again after a period of 24 hours to be certain that no moisture has been absorbed. Submain cables shall be labelled at 10m intervals using a cable tag or engraved copper rings, all cable ends shall also be labelled.

CONDUIT WIRING

PVC conduits shall generally be used except when liable to mechanical damage & direct sunlight. PVC conduits and fitting shall comply with BS 6099 and BS 4607. PVC conduits shall be classified for heavy mechanical stress and non-flame propagating (ie High impact heavy gauge conduit). All jointing of PVC conduits shall be by means of adhesive jointing. Adequate expansion joints shall be allowed to take up the expansion of PVC conduits. Conduit shall be galvanized steel where exposed to mechanical damage and direct sunlight. Conduits shall be Class "B" galvanized steel screwed conduit to B.S.31 and BS4568. Fittings and accessories shall be galvanized and manufactured from steel to B.S. 31. Conduits shall be concealed where possible. Where conduits are installed

directly on walls and concrete works, they shall be fastened by means of heavy gauge spacer-bar saddles and rawl plugs at maximum intervals of 1.2 meters for straight runs and at all bends. Rawl plugs shall be drilled into walls and concrete work. Spacer-bar saddles shall be fastened by means of round head, brass screws and washers. All exposed conduits shall be painted orange in colour, unless otherwise specified.

Where conduits are to be concealed in the plasterwork of walls, the contractor is required to cut the necessary chases in the walls for the installation of the conduits. Initial plastering of chases shall be undertaken by the subcontractor after the conduits have been installed, but the final plastering of chases shall be undertaken by the Main Contractor. Conduits buried in the slab shall have a minimum cover of 15mm while those in the wall shall have a minimum cover of 5mm. Wherever the exposed galvanized surface has been cut or otherwise damaged, a layer of rust inhibiting paint shall be applied. Conduits shall be securely fixed to prevent movement and all ends and joint boxes shall be effectively plugged to prevent the ingress of water and dirt before concrete is poured. All bends must be made with the proper conduit bending machine so that the inner radius of any bend is not less than 2.5 times the outer diameter of the conduit. Where condensation is likely to take place, provision shall be made for the water to drain off without entry into terminations. The detailed layout of conduit shall be the responsibility of the sub-contractor. Conduit shall be run neatly in straight lines parallel to walls, and building lines wherever possible.

The ends of conduit shall be cut square, filed and reamed out and care shall be taken to ensure removal of cutting oil and swarf. The finished end shall be free from sharp corners which will damage the cable insulation when it is drawn. Conduit terminations at switches, switchboards, distribution boards, socket outlet boxes, etc are to be properly secured with couplers and male bushes. Conduit and terminations to apparatus subject to vibration or movement shall be made off in flexible conduit with adaptors for connection to the rigid conduit system at each end. Flexible conduits for connection to outdoor devices and equipment subject to vibration shall be in PVC sheathed metallic conduit with heavy brass adaptors. The length of the flexible cable shall be adequate to permit withdrawal of the equipment or to absorb the vibration without any stress. Flexible conduits shall be in accordance with BS 731 and the minimum length shall be 300 mm. Where conduits cross the expansion joints purpose made expansion coupling shall be used to facilitate relative movement of the sections. Where long runs of conduit are unavoidable, junction boxes shall be provided at 8m intervals for ease of drawing-in of cables. Junction boxes shall also be provided within 300mm of bends. Draw-in wires shall be provided inside each conduit to facilitate the drawing-in of cables.

Conduits sizes shall be selected as to allow removal or replacement of any one cable without disturbing the others and shall not be less than 20mm diameter or larger than 32 mm diameter. In no circumstances shall the number of cables drawn into any one conduit exceed that stated in the latest Edition of the I.E.E. Regulations. All conduits shall be swabbed out and free from moisture before wiring is installed. The use of the metallic conduit system as a sole means of earthing will not be permitted. A separate earth continuity conductor of suitable size shall be used and run inside the conduit. The whole conduit system shall be effectively earthed.

Cables for power and lighting circuits and extra low voltage systems shall not be drawn into the same conduit. Lighting and power final sub- circuits shall be run in separate conduits except, where an adaptor box is employed as final distribution point, a number of final sub- circuits may be grouped together in larger conduits between the distribution board and the adaptor box provided that all sub-circuits in one conduit are of the same phase. In the case of three phase circuits, all three phases including neutral, if any, shall be drawn into the same conduit.

PVC CASINGS AND TRUNKINGS/TRAYS/TRUNKING/LADDERS

PVC casings and mini trunking shall comply with BS 4678 and be classified for heavy mechanical stress, non-flame propagating, white finish, with a clip-on cover. All corners, tees, adaptors etc shall be factory fabricated accessories. PVC casings and trunking should only be used if specifically specified.

Cable trays shall be fabricated from perforated galvanized steel with 12mm return edges at each side, and sized in accordance with the numbers of cables they are required to support, plus 20% spare provision for future cables. In this regard, cables shall be installed in a single layer formation, with the exception of single core cables required to be installed in a trefoil configuration, with adequate space allowed for air circulation. cable tray shall be capable of carrying the total weight of the cables without undue deflection (ie maximum deflection of 20 mm). Cables laid horizontally in the tray shall be secured with cable ties spaced at an interval of 600mm and at all bends. Cables installed in the vertical plane shall be supported at 1-meter interval by cable cleats or cable saddles and clips for MICC cables. Cable trays shall be manufactured from steel 1.6mm in thickness for those not exceeding 300mm in

width, 2mm where wider sections up to 600mm are required, finished using a hot dip galvanizing or approved equivalent process, and provided with factory made sets, bends and intersection pieces as required, the finishes of any cut sections being made good with cold galvanizing paint. Where cable trays wider than 600mm are required multiple cable trays of maximum 600mm dimension are to be used.

Cable trays shall be supported using purpose made brackets or proprietary accessories fixed such that there is an air space of 75mm minimum to the structure to which they are secured, and installed in straight runs, true, horizontal or perpendicular to building line in a manner such as to reduce the number of bends and sets to a minimum. The spacing between brackets shall be 1 meter on straight runs and additional brackets at bends. The sub-contractor shall be responsible for checking the size and routes of all cable trays where indicated on the drawings to determine that they are adequate for the cables to be installed and that the routes are fully coordinated with all other trades. Should the size of any cable tray require resizing, this shall be advised to the Engineer prior to ordering and/or installation. Cable trays shall be sized to permit the cables to be installed spaced apart (ie grouping factor of 1).

Cable trunking shall be manufactured from galvanized steel sheets of not less than 1.2mm for trunking up to 50mm and 1.6mm minimum for trunking up to 200 mm and 2 mm for larger sizes. The trunking shall be filled with cables to not more than 45% of its usable capacity. Trunking lids shall be removable and secured at centres not exceeding 600mm by cadmium plated mushroom head screws. The screws shall seat into bushes on the trunking return edges. Trunking lids shall be clip on with quarter turn lock nuts where specified. Cable trunking shall be employed to replace multiple runs of conduit in addition to the instances where specifically indicated, and provided with removable cable retaining straps installed at a maximum interval of 600mm along the length to permit covers being removed and replaced without impedance from the cables enclosed.

Cables in steel trunking shall be supported by means of hardwood clamps spaced at 600mm centres. Fire barriers shall be provided where trunking passes through compartment slabs. The rating of the fire barriers shall be the same as that of the compartment.

Internal fish plate couplings of 2.5mm thickness c/w tinned copper bonding links shall be installed between adjacent lengths to facilitate electrical conductivity and mechanical union. Each side of the couplings shall be secured by means of four (4) mushroom head screws with the nuts installed external to the trunking. Integral partitions shall be provided throughout the length of ducting where it is necessary to accommodate services of different voltages and frequencies within a common trunking run. Each service shall be mutually segregated and completely surrounded by earthed metal. Cable trunking shall be installed complete with all requisite accessories in straight runs true, horizontal or perpendicular to building lines to reduce the number of bends and sets to a minimum, where necessary factory-made bends, sets and sections and intersection pieces shall be used. The spacing between support brackets shall be 1 meter on straight runs and additional brackets at bends.

Where multiple circuits are installed in the same trunking each circuit shall be grouped together by cable ties at 2m intervals and distinguished by identification label at 20m intervals. Cable trunkings shall be installed such that there is a minimum clearance of 10mm to the structure to which they are secured. Trunking covers shall be installed either on the top or sides but not at the bottom.

Cable ladders shall be of hot-dipped galvanized steel construction. The thickness of steel used for both rungs and side rails shall be not less than 1.6mm for widths up to 450mm and 2.0mm for longer width. The depth of side rail shall be not less than 1.5 times the overall diameter of the biggest cable fixed on to the cable ladder. Generally, the rung spacing shall not be more than 300mm in straight runs. Cable ladders shall generally be sized with a 20% spare space provision for future cables. Cable ladders shall be completed as required with prefabricated reducers, elbows, tees, crosses, splice plates so as to form a complete installation. Cable ladders installed horizontally shall be adequately supported by galvanized steel Channel and rods fixed to structure in an approved manner. For vertical runs, hold down clamps shall be used to secure cable ladder to walls. Support spacings shall be such that the cable ladder does not deflect by more than 10mm when loaded. In any case the minimum distance between support shall not exceed 2 metres. The entire cable ladder shall be earthed to the system earth by means of earth continuity conductor of suitable size. Copper grounding straps shall be used to improve earth continuity across splice joints. Cables fixed on to the cable ladder shall be clipped with heavy duty galvanized saddles and bolts. Three phase circuits using single-core cables shall be bunched with the neutral and secured as a group. Saddles shall not be spaced at more than 600mm apart.

CABLE TERMINATION AND JOINTING

Cables shall be run continuous from one termination point to the other without any joints. Approval must be sought before any cable joints are made. Jointing and termination of cables shall be carried out by accredited and fully experienced jointers or electricians and evidence of this shall be produced before jointing or termination is started. All joint boxes, jointing materials, and tools shall be of the type recommended and approval by the cable manufacturers. All joints which are buried in the ground shall be compound filled. The design of the box and the composition shall provide an effective seal to prevent moisture gaining access to the conductor ferrules and armour clamps. Provisions shall be made for earthing the wire armour of single core cables to the main earth bar at the supply end by means of a metallic bond of adequate conductance. Bonding connection should be as short and straight as possible. For multicore cables, both ends of the armour shall be bonded to the earth bar.

The wire armouring shall be maintained electrically continuous, and careful attention shall be paid to the design of all bonding clamps in joints and termination to ensure that the resistance across a clamp is not higher than that of the equivalent length of the complete wire armour of the cable. All cables shall terminate with glands complying with BS 6121. Cable gland installed outdoor shall provide a seal onto the outer sheath and be moisture proof. Additional protection shall be provided to all glands by means of PVC shrouds. All glands shall also be equipped with a earthing tag for equipotential bonding of the armour to the switchboard earth bar. Glands for flame proof and explosion proof locations shall be similarly rated. Cables terminals shall be fitted with electro tinned cable lugs which shall be compression fitted to the cable. All cable lugs shall be fitted with a colour coded PVC shroud for a neat finish.

All cable ends shall be properly sealed during storage and such time till they are ready for termination. Cable armouring shall not be used as the sole means of earth continuity (e.c.c.). A dedicated earth continuity cable shall be run alongside the armoured cable to provide earth continuity. The earth cable shall be sized in accordance with the latest IEE Regulations. Where the subcontractor proposed alternative routes, to those shown in the drawing, they shall resize the cable to take into consideration the new derating factors for temperature, grouping, voltage drop and fault level.

LIGHT FITTING

Luminaire's shall comply with B.S. 4533 unless otherwise specified or scheduled. Luminaire's shall be arranged such that control gear and auxiliary wiring is separated from the lamp compartment by means of removable covers which prevent inadvertent contact during re-lamping operations; access between compartments for wiring shall be through holes fitted with grommets. Each luminary shall be fitted with a fused terminal block and earthing terminal and be suitable for 20mm conduit entry. The fitting shall be embossed with the logo of the manufacturer on its body at a position visible during inspection. Stick on logos are not acceptable. Comply with BS5394 with regards to radio interference. All luminaries shall be labelled on the inside cover. The labels shall identify the circuit number. Labels shall use a strong adhesive.

FINISHES

All equipment shall be protected to minimize the effects of corrosion and galvanic action. Ferrous metal casings used shall be of gauge not less than 0.8mm and treated against corrosion by galvanizing, cadmium plating, chroming or painting. All surfaces to be painted shall be cleaned, degreased, primed, painted with an undercoat of finished stove enameled to a suitable colour. Internal reflecting surfaces shall be painted matt white. Powder spray painting using thermosetting epoxy paint shall be accepted as an alternative to enameled paint finish. For proprietary equipment, the manufacturer's standard finishes may be accepted provided they are, equal or superior to the standards of finishes described.

DIFUSSER/LOUVRES

Where indicated, luminaires shall be fitted with diffusers/louvres which shall:

- have good light transmitting and diffusing properties;
- in the case of plastic diffusers/louvres be made from acrylic; and be resistant to colour change, stable in relation to heat distortion and not affected by aging;
- be held securely to the body of the luminaire without any visible deflection being perceived;
- diffusers shall be fitted with gaskets and secured to prevent ingress of insects or foreign matter into outdoor luminaire;
- be of adequate thickness and strength to prevent sag under normal operating conditions. Acrylic diffusers shall be minimum 3mm thickness.
- the diffusers shall be of hinged on clip on construction, to allow easy access for relamping and servicing.
- aluminium reflectors and louvres should be aluminium alloy with an anodic coating of AA10 to B.S. 1615 for enclosed fittings and AA15 for open light fittings. Minimum thickness of reflectors shall be 0.6mm.

WIRING WITHIN FITTINGS

Luminaries shall be supplied with all internal wiring colour coded and completed. Wiring shall have Class 105 deg C PVC insulation except where internal temperatures are likely to exceed the safe limits of such insulation, in which case braided (Class C) glass wool insulation shall be used. Conductors shall be of adequate size and rating for the particular duties and terminations. Single strand conductors shall be used for clip connections and multi-stranded conductors for screw connections. Wiring shall be neatly arranged within the fittings and clipped to the metal ware at intervals not exceeding 200mm.

Wires shall be kept clear of auxiliary components. The method of clipping shall be such as to prevent damaged to the insulation. Adhesive tape shall not be used for clipping or looping of wires. A fixed two terminal fused connector blocks with an earth terminal adjacent or integral shall be provided near the incoming cable entry of each fluorescent and discharge fitting. The fuse shall comply with requirements of B.S. 88 and generally be of 2A rating. Luminaire's shall be designed to promote cooling, ensuring that in service, temperatures in excess of the thermal ratings of any of the components are not exceeded. The external housing of the light fitting shall be designed such that its temperature does not exceed 70°C.

BALLASTS

Fluorescent ballasts shall comply with B.S. EN 60920, 60921 and BS 5394. All ballasts shall be polyester impregnated low power loss, silent operation type unless otherwise specified. Switch start ballasts shall be of low power factor induction type. Separate ballasts shall be used for each light fittings. The power loss for ballasts shall not exceed: -20W - 5.5W, 40W - 6.5W, 65W - 10.0W. When measured at the maximum normal operating temperature. Noisy or otherwise defective drivers or ballasts will not be accepted. Drivers and Ballasts shall be an approved type or acceptable alternative.

Fully electronic high frequency ballasts where specified shall have the following characteristics: -

1. Have excellent radio interference suppression, inductive interference elimination, silent operation and

harmonic limitation and comply with BS 5394.

2. Have a operating range from 200V to 240 Volts.
3. Ensure power factors of greater than 0.9, low power loss and elimination of stroboscopic effects. Wave form distortion shall be kept to a minimum and shall comply with IEC 82.
4. Ensure reliable lamp starting (within 0.2 second) without flickers.
5. Shut down automatically on failure of a lamp. Circuit should reset automatically where lamp is fitted.
6. Be able to operate with all type of fluorescent tubes.
7. Be capable of dimming when used in dimmed circuits.

Discharge and fluorescent fittings shall be fitted with metallized polypropylene capacitors to correct power factor of 0.85 lagging. Capacitors shall comply with B.S. EN 61048/49. Discharge resistors shall be provided on all capacitors. Capacitors shall not use PCB or have liquid fillings and shall be suitable for ambient temperature up to 85°C.

STARTER

Where installed, starters must be compatible with, and in accordance with, the ballast and lamp and tube manufacturer's recommendations. Starters used for fluorescent lamps shall be of the electronic quick start type with built-in cut out features similar to OSRAM DEOS series. Starter sockets shall have metal strip spring type contacts for connection by twist action. Housings shall be moulded plastic. Thermoplastic materials used in the construction of starter switches and holders shall comply with B.S. 3772.

LAMP HOLDER

Lamp holders shall be constructed of non-flammable high impact resistant materials which do not deteriorate under the temperatures encountered during service (porcelain or brass type). Lamp holders shall be secured to the body of the luminaires such that they maintain their position and plane during lamp replacement. Lamp holders for fluorescent tubes shall comply with the requirements of B.S. 5101 Part 1 and Part 3 and B.S. 5042 Part 4 and be of the two-pin retractable or counter twist type with metal strip spring type contacts, designed to positively retain the lamps.

LED LIGHTING FIXTURES

LED lighting is a combination of a solid state light source, a control gear for operation of the LED lighting and optics for light distribution. The key aspects to be taken into account in specifying LED products are the following - LED lighting construction and light distribution, LED driver and lighting controls, thermal management, energy efficiency, colour quality, life and lumen maintenance, and performance and quality assurance.

LED lighting construction and light distribution

LED luminaire consists of LED modules, ballast or driver where applicable, heat-sink for thermal management, fixture and optics assembly. A self-ballasted lamp or luminaire can be connected to the supply mains directly, whereas a non-self-ballasted lamp or luminaire is to be connected to the supply mains via a separate driver. Control gear for starting and operating LED lighting is often called a driver.

Ingress protection class

Adequate ingress protection (IP) rating of the LED luminaire should be prescribed for the intended application under specific environmental conditions. IEC 60529 specifies the degree of ingress protection by enclosure. IP54 or IP55 may be required for luminaires for general outdoor applications. Other weather specific factors (e.g. sunlight, temperature, rainwater) should also be considered for outdoor luminaires.

Glare control

Reflectors, diffusers or other features may be incorporated to control glare. Glare rating GR and UGR could be used to evaluate quantitatively disability glare and discomfort glare respectively of lighting design schemes.

Safety and environmental requirements

LED modules and luminaire should comply with relevant safety and environmental standards. With reference to IEC 62471 for photo-biological safety, the risk group of potential optical safety hazard of LED luminaires should be checked.

Key safety standards include IEC 62031 for LED modules, IEC 61347-2-13 for LED drivers, IEC 62471 for photo-biological safety, IEC 60598 for aspects similar to general luminaire, IEC 62560 for self-ballasted LED lamps (>50V), IEC 60838-2-2 for particular requirements on connectors for LED modules. EC Directive

2002/95/EC and related Commission Regulations specify restriction of the use of certain hazardous substances (RoHS) in electrical and electronic equipment including lighting.

Safety considerations on retrofit LED tubes

If an LED replacement tube solution is deemed to be appropriate, it is essential that the equipment used is safe and the replacement lamp installed in a safe manner, to avoid risk during installation and also for future maintenance or subsequent replacement. IEC 62776 specifies the safety and interchangeability requirements, and the exchange operation together with the test methods and conditions required to show compliance of double-capped LED lamps with G5 and G13 caps, intended for replacing fluorescent lamps with the same caps.

Radio frequency interference and electromagnetic compatibility

LED lighting and the associated control gear (i.e. the driver) are to comply with the Telecommunications (Control of Interference). The LED lighting and control gear should also comply with the relevant electromagnetic compatibility standards. Electromagnetic compatibility refers to the ability of the LED lighting system and components to function satisfactorily under the electromagnetic environment without unduly affecting the environment. Key electromagnetic compatibility standards include IEC 61000-3-2 for limits on harmonic current emissions, IEC 61000-3-3 for limits on voltage changes, voltage fluctuations and flicker, and IEC 61547 for immunity requirements.

LED driver and lighting controls

A basic LED driver consists of two stages, i.e. a power supply for converting the alternating current in the supply mains into direct current for the LED and a current control unit for providing constant current supply for stable operation of the LED. Suppliers could be asked to provide substantiation or warranty on compatibility between the driver and the LED lighting. Dimmable drivers are designed for broader current range to suit the dimming operation of the LED lighting. LED drivers may also incorporate devices to handle power quality issues e.g. power factor correction, filter for harmonic distortion.

Maximum allowable ambient temperature

Maximum allowable ambient temperature for the LED lighting should be considered so that the LED lighting can operate without adversely affecting its life or colour stability. This is to ensure that the maximum case temperature of the driver and the design LED junction temperature not be exceeded. Typical ambient temperature for continuous service of the lighting to be up to around 35 to 40 deg C depending on the environmental condition for the lighting.

Energy efficiency

Luminous efficacy is a measure of energy performance of the lighting. Luminaire efficacy also accounts for driver, thermal and luminaire optical losses, in addition to the efficacy of the LED modules. In general, luminaire efficacy = LED efficacy x driver efficiency x optical efficiency x thermal efficiency.

Rated power and measured input power - Overdriving (i.e. driving beyond the rated current) may increase lumen output but would be at the expense of lamp life due to increased junction temperature. Lighting manufacturers may choose driving current ranges for their LED lighting taking into account different luminaire design factors, e.g. thermal management, ambient temperature condition, service life, light output and power consumption. For LED lighting with dimming operation, design may need to be compromised so that the LED driver could deliver broader range of driving current to meet the design light output range. It is desirable to have a high power factor for LED lighting as a low power factor load will draw more current for the same amount of real power in the electrical circuit.

Colour Quality

Correlated Colour Temperature (CCT) of the LED light source should be considered. CCT describes the colour appearance of a light source. In general, CCT for warm white light ranges from around 2600K to 3500K and that for cool white light is over around 5000K. LEDs with higher CCT are generally more energy efficient. It is noted that perception of colour consistency may be affected by the viewing angle.

Colour Rendering Index

Colour Rendering Index (CRI) of the LED light source should be considered. CRI describes the degree of change in colour appearance of an object when illuminated by LED light source as compared with that when

illuminated by a reference light source. For general applications such as in offices, CRI of 80 or above is good enough. LEDs with higher CRI normally have lower efficacy.

L80B10 – B value means the failure data at the L data. LB value indicate the real lifetime at a certain hours. Like L80B10 at 50,000 hours means the LED lamp keeping 80% lumen from initial lumen and only 10% light failed to reach 80% lumen.

Overall Summary LED Light Fitting Construction

LED lighting brand should be an approved type and shall comply and generally be of the switch start type. Specified Wattage, Lumens and IP, CCT: 3000K, 4000K, 6000K or other equal manufacture. LED's shall have a guaranteed life span of 25,000hrs to 50,000hrs. Power Factor of >0.9, 220-240 VAC, L80B10, UGR <16 or <19, CRI>90.

FIXINGS

Luminaries shall be provided with standard means of achieving satisfactory fixings;

- in the case of pendant types, have 85 deg C suspension cords, and where the suspension is metal or other arrangement with the cable inside, the cable shall be glass or PTFE insulation;
- in the case of recessed or semi-recessed type, in addition, be provided with concealed holes for side screw fixings into the ceiling aperture trimming;
- in the case of surface mounted type, be furnished with minimum of two fixing supports at the ends of the fitting. Fittings wider than 150mm shall be provided with 4 fixing supports. Surface mounted florescent fittings where installed on flammable surfaces shall be provided with a 15mm non-flammable heat insulating backing.

All ceiling recessed luminaire fittings wider than 150mm shall be individually secured with 2mm dia. galvanized steel wire to the building structure. Where chain suspensions are required they shall be of welded, twisted link pattern, minimum 18-gauge (1.20mm) diameter. Fixings shall be brass screws sunk at least 25mm into rawl plugs or plastic expansion devices properly set in, or standard BSF bolts screwed into properly placed metal sockets.

FINAL CONNECTIONS

All recessed luminaires shall be connected to the fixed wiring system by a length of flexible conduit. The cables within the conduit shall be looped into and terminate only in the luminaries. All fixed wiring within the luminaire shall be sleeved with braided glass wool high temperature insulation.

`EXIT' SIGN LIGHTS

`Exit' sign lights shall be supplied and installed as shown on the drawings. The exit lights shall generally use a 2W LED c/w driver. The `Exit' sign light fitting shall generally be a maintained unit i.e. the lamp is continuously lit from normal mains supply and upon mains failure powered by a sealed nickel cadmium battery. The illumination level shall be uniform throughout the sign fixture with sufficient downward illumination. The exit sign light fitting shall utilize a graphic sign or the words "Keluar" as detailed in the equipment schedule or bill of quantities. The sign shall utilize luminous paint to ensure that the signage is visible even when the lamps have failed.

The graphic sign when specified shall be detailed by the architect during the construction stage. The graphic sign may be single or double sided as specified in the bill of quantities/equipment schedule. The word `Keluar' shall be in letters 150mm high, 75mm wide and 19mm wide strokes. The lettering shall be illuminated white against a green background. The `Keluar' signs shall consist of the following types.

- a) Single sided signs with the lettering `KELUAR' with or without directional arrows.
- b) Double sided signs with the lettering `KELUAR' with or without directional arrows.

The `Exit' sign light units shall be provided with high temperature rated nickel cadmium batteries in replaceable packs having a minimum capacity capable of maintaining the units in full illumination for a period of at least 3 hours (after 24 hours charge) when the mains supply is interrupted. An automatic 2 rate solid state charger unit with voltage regulated, temperature compensated, trickle charge, and low voltage cut out feature, which maintains the battery in a fully charged condition shall be incorporated within each unit. The battery and charger system should be designed for a useful life of 4 years or 400 charge-discharge cycles to 50% depth of discharge at an operating temperature of 45°C. The units shall also be provided with a red LED for mains and charger healthy indication, and a mains failure simulation micro press button test switch.

SELF CONTAINED EMERGENCY LIGHTS

Emergency light units of the type specified shall be supplied and installed as shown on the drawings. The Emergency Light shall generally be a 'non-maintained' unit i.e. the lamp is off as long as there is mains supply, and the same lamp is illuminated from a nickel cadmium battery when the mains is interrupted. Maintained and switchable type emergency lights shall be supplied, when specified. The battery and charger shall be as described above for 'exit' lights.

SWITCHES, SOCKET OUTLET AND ACCESSORIES

The location of outlets shown on the drawings are approximate and the exact location shall be determined prior to installation. Location of outlets may be varied at any time up to the time of roughing in and such variations shall be carried out at no extra cost provided that the variations are within 5 meters of the indicated location.

Where switches, plug receptacle, etc. are located in tile work, face brick or similar surfaces with exposed lines they shall be placed symmetrically in the pattern. The locations of switches and outlets, etc shall be coordinated with the fittings (thermostat, volume controllers, etc) installed at the same location, by other trades. All final outlets shall be labelled. The label shall identify the circuit number. Labels shall be fixed on the front or back of the outlet as instructed. Labels shall use a strong adhesive.

Switch locations shall be as shown on the plans. Switches shown adjacent to doors shall be placed about 150mm from the edge of the switch plate to the edge of the door frame and on the lock side. Switches shall be mounted unless otherwise indicated with the base at 1350mm above floor level. Where several switches occur at the same location, multi gang units mounted on single plates may be used.

Switches shall be rocker operated type, grid pattern, single pole, one way or two ways or intermediate as required on the layout drawings. Switches shall be of the quick make and slow break, silent switch action type with solid silver alloy contacts and in accordance to B.S. 3676.

Dimmers shall be fixed with RF interference suppression filter to BS EN 55014 and fuse links and comply to BS5518. Dimmers shall be rated from 60W to 1000W. Switches shall be suitable for flush or surface mounting, as required, and be complete with PVC base box with brass thread screw inserts box, adjustable grid plate, switch interior and cover plate. A minimum clearance of 9mm shall be provided between the back of the switch and the back of the conduit box. The switches of each phase shall be grouped in row(s) and adequate insulation shall be provided between the phases. A warning sign "DANGER 415 VOLTS" shall be placed near switch centre where different phases are grouped together.

SWITCH SOCKET OUTLETS

Switch socket outlets shall be of the three pins (i.e. 2 poles and earth), shuttered type conforming to B.S. 1363. Industrial plugs, socket outlets and couplers shall conform to BS 4343. Switch socket outlets exposed to weather shall be die cast aluminium or polycarbonate weatherproof type complete with protective captive screw- on cap to cover the socket orifice when not in use. Weatherproof plug tops shall be provided together with the outlet. Generally, switch socket outlets shall be installed with the base at 225mm above floor level. Switch socket outlets shall be installed at 1350mm above floor level in kitchens, plant rooms, car parks and other service areas.

HAND DRYERS

Hand dryers shall be of the slimline moulded case automatic type and shall be installed at a height of 1300 to base of unit. The power to the hand drier shall be through a base box located at the back of the hand dryer. Hand dryers shall be of double insulated construction to ensure safety. The hand dryer shall start operation when the hands are placed below the outlet and shall stop when the hands are withdrawn. The electronics should be able to distinguish between a static object and a hand. The infra red automatic sensing system shall have a safety cut out after 60 sec. The unit shall be quiet in operation (65 db at 1 m). The heating element should be rated about 2 kw, while the air discharge shall be about 200 m³/hr at 50°C. The unit shall be approved type and unless otherwise specified.

SHAVER SUPPLY UNIT

Electric shaver supply units shall comply with BS 3535, and shall incorporate a double wound isolating transformer rated at 20 VA at 230 and 115 volts and shall be safe for use in bathrooms. The unit shall be shuttered, and the transformer shall be protected against overloads by an electronic overload device with auto reset features.

ACCESSORIES

The accessories used throughout the installation shall be in accordance with the following:

- | | |
|---|------------------------------|
| 1. Fused connection units | BS 5733 |
| 2. RCD protected 13A switch socket outlet | BS 7288 |
| 3. 5A & 15A socket outlets and plugs | BS 546 |
| 4. Blank plates | BS 5733 |
| 5. 13A fused plugs and SSO | BS 1363/BS 1363A + BS1362 |
| 6. Cooker control units | BS 4177 and BS 1363 |
| 7. Light and shaver unit | BS 4533 |
| 8. Safety lamp holders | BS 5042 |
| 9. Ceiling roses | BS 67 |
| 10. Coaxial outlets | BS 3041 |
| 11. Telephone outlets | BS 5733/Brunei telecoms |
| 12. Weatherproof SSO | BS 3676, BS 1363, BS EN60529 |
| 13. Weatherproof isolators | BS EN 60947 IP 56 |
| 14. Junction boxes | BS 6220 |

The finish of the accessories shall be as described in the drawings and Bill of Quantities.

EMERGENCY STANDBY GENERATORS

1. SCOPE OF WORK

The Contractor shall supply, deliver to site, install, test and commissioning, and hand over in proper running order a complete Standby Generating System.

The installation shall be in accordance with the accompanying drawings, specification and schedule of contained herein.

The Contractor shall carry out the following and/or and unspecified, undersigned or non-indicated work which becomes necessary in the course of the installation.

The work involved is defined below but not limited to the following general section:-

- a. The supply, delivery to site, installation, testing and commissioning of one (1) Diesel Generator sets complete with accessories as per specification, drawings and as follows :
 - i. Diesel generator including supporting frame and spring type anti-vibration dampers.
 - ii. Complete wiring installation of all internal circuits of generators.
 - iii. Radiator including all connection pipework, fan, pump, pipework and other accessories for fuel transfer.
 - iv. Fuel supply system complete with fuel tank, pump, pipework and other accessories for fuel transfer.
 - v. Electric starting equipment including batteries, battery charger, starting motor, etc.
 - vi. Complete exhaust system to the requirement of the relevant governing authorities.
 - vii. Internal sound proofing of the generator room.
- b. The successful tenderer shall liaise with the DES, Fire Department and relevant bodies in all matters regarding private power generator and test setting of the generator set.
- c. The Contractor is to include for the specialist services necessary for the proper erection and setting to work, commissioning and testing of all items of the generator set and the cost of this is deemed to be included in the Contract price. The extent of these services is to be given in the Tender.
- d. Repairing, patching and making good all building works inclusive of plinth.
- e. All requirements of the relevant local authority, Department of Environment shall be complied by the Contractor to ensure a complete installation of the Generating Set.

2. GENERAL SPECIFICATION

The sets shall be rated as follows:-

Rated continuous output	-	As specified in drawing or schedules
Speed	-	1,500 rpm or 1,000 rpm
Voltage	-	415/420 Volts 3 phase star connected
Frequency	-	50 Hz
Power Factor	-	0.8 lagging

The Diesel Generating set shall operate as an emergency power supply and shall be able for automatic starting on complete or partial power failure of the main power supply and automatically stopping the engine on the restoration of the main supply.

3. DIESEL ENGINE

The diesel engine shall be of multi-cylinder, four stroke, direct injection, water cooled with honeycomb radiator, turbo-charged intercooled type designed of instant starting and in general compliance with B.S 49/1958 as minimum and also be suitable for local condition of maximum temperature 105⁰F and 100% R.H.

The crankcase shall be single unit cast-iron type and shall be protected against explosion. The cylinder leads shall be single- and one-piece casting type with valve seat insert. Cylinder liners shall be centrifugally cast, removable wet type, complete with seals at both ends of the liners.

The piston shall be light aluminum forging type complete with cast ring groove and cooling system. The crankshaft shall be drop forged, tempered and nitride steel. The connecting rod shall be drop-forged and treated steel type.

The cooling system shall be close water circuit complete with centrifugal pumps and thermostatic control facilities. Shut down facilities shall be provided.

a. ACCESSORIES

The following shall be a complete standard accessories :-

24 Volts DC heavy duty axial type electric starter motor.

24 Volt heavy Nickle Cadmium Battery of sufficient capacity suitable to provide six (6) successive abortive starts of engine without recharging.

Automatic battery charger complete with Ammeter, Voltmeter suitable of 2 rates of charging.

Switching cabinet for electric starting by automatic or manual control.

Electronic governor, with speed drop adjustable from isochronous to 5 percent of Hydraulic governor as specified in the drawing and tender schedules.

Mechanical force-feed lubricating system gear type oil pump.

Full flow oil pan with a minimum capacity of 12 imperial gallon.

Lubricating oil pressure gauge.

Engine mounted tachometer with normal working speed marker.

Thermometer for exhaust temperature.

Exhaust silencer of the absorptive type capable of reducing the exhaust noises of the engine to an acceptable level.

Engine driven cooling fan.

Flexible, laterally coupling for positive alignment between the engine and the alternator.

Flywheel, coupling bolts, foundation bolts and vibration mountings.

Good quality standard tools in metal box for normal maintenance to manufacturer's recommendation.

Erection drawing and erection, operation and maintenance instruction manuals.

6 set of operation instruction manual.

One unit of diesel fuel storage tank.

b. PROTECTIVE DEVICES

The generator set shall be complete with protective devices as follows:-

- a. High Cooling water temperature thermostat arranged to trip the fuel cut off solenoid and lock out the engine start relay when the operating temperature rises above 195⁰f.
- b. Low oil pressure warning and cut off when the oil pressure goes below the recommended pressure.
- c. Overspeed trip to trip the fuel oil pump rack to the 'No Fuel' position and to trip the fuel cut out solenoid and to lock out engine start relay when the engine overspeed 20%.
- d. Low fuel level warning arranged to give warning in good time before the fuel tank become empty.
- e. Failure to start, arranged to lock out the starting relay in the event that the engine fails to start for a period of a one minute.
- f. Overvoltage protection, arranged to shut down when the A.C output voltage exceeds a pre-set value.

All the protective devices shall energize the audible alarm and visual indication on the control panel when they are in the tripping position.

c. EXHAUST SYSTEM

The engine shall be provided with exhaust system to carry the exhaust gases from engine and to dissipate them to the atmosphere. All piping for the exhaust system shall be Class 'B' type and be protected from corrosion by application of heat resistant paint.

Flexible connection shall be provided between the piping fixed to the building structure to minimize the vibration of the engine from the engine to the building. A sleeve shall be provided wherever exhaust piping is required to pass through the wall.

Suitable sound insulation shall be provided to keep ambient sound to acceptable level.

d. FUEL OIL STORAGE TANK

The Contractor shall supply and install one unit of fuel storage tank with a capacity to permit 24 hours for continuous operation on full-load. It shall be non-pressure type, fabricated from M.S. sheet and be painted both inside and outside with minimum two coats undercoat and two coats of oil resistant enamel.

A semi rotary hand operated oil pump shall be provided and installed for filling the tank with suitable length of oil resistant hose for off-loading fuel from drums. The piping connected between the fuel tank and the engine oil pump shall be of galvanized iron Class 'B' type and to be welded to BS 1387. A drain cork with suitable locking device to be provided.

The Contractor shall supply full tank of Diesel fuel before handing over the installation to the employer and the cost for this fuel shall be included in the Schedule of Prices.

e. ALTERNATOR

The alternator shall be brushless self-regulating, with static control drip proof screen protected fan ventilated industrial type in accordance in all respect with BS 2613/1970. The winding shall be tropically impregnated to suit local condition of maximum ambient air temperature of 105°F and 100% R.H. It shall be rated continuously not less than the specified KVA at 0.8 p.f. lagging when wound for 415 Volts, 3 Phase 4 Wire, 50 Hz supply. It shall be capable of maintaining without damages a sustained overload of 10% in current at full rated voltage for one hour in any 12-hour period. Good output wave with the waveform deviation of less than 5% shall be maintained both at no load and full load with lagging power factor of 0.8.

4. VOLTAGE REGULATORS

The voltage regulator shall be of solid-state SCR type with ample capacity of maintaining with + 2 ½% from no load to full load at any power factor from 0.8 lagging to unity.

The system must be able to reduce output voltage automatically if the load exceeds the engine capacity.

5. BEDPLATE

The engine and alternator shall be mounted on a heavy fabricated steel bedplate produced from high rolled channel electrically welded with mechanical engine and alternator mounting pad.

6. MODE OF OPERATION

On failure of any phase of mains supply or of low voltage, the voltage sensing relays in the control panel, after receiving the signal, shall automatically start the standby generating set within 01-10 sec. and as soon as the speed/frequency and voltage reach the normal limits, the voltage and frequency speed sensing relay shall signal the automatic changeover switch over from the main supply to the supply from the generator set. When the mains supply is restored, the sensing relays shall trip the generator set and signal the automatic changeover switch to switch back to its original mains supply position after a short time delay of 10 minutes. Final settings of the above-mentioned modes of operation shall comply with the Fire Department requirements.

7. CONTROL PANEL

- a. The control panel shall be metal clad, flush fronted, totally enclosed cubicle pattern, free standing with adequate ventilation and back entry removal cover giving access to the control gears terminal and connection blocks. The dimensions of the panel shall be kept to a minimum. It shall incorporated two sets of the equipment as listed below :-

1	3 inches scale voltmeter – flushed mounted
1	Voltmeter selector switch
3	Current transformers
1	Plant control switch
1	Battery charger switch
1	Fail-to-start indicator lamp
1	Overload indicator lamp
1	Standby test on lamp
1	Start/stop button
1	Emergency stop button (latch type)

1	Voltage sensing relay
1	Overcurrent earth leakage relay IDMT (Non -directional
1	Frequency meter
1	KWH meter
1	KW meter
1	Hour counter
1	Standby test button
1	Pair N/O and N/C auxiliary contactor
1	Mains contactor
1	Alternative contactor
1	Selector switch giving 'Auto', 'Off' and 'Manual'
1	Time delay adjustable from 0-60 seconds
1	Alarm with ON/OFF and reset switch

Fuse switch/switch fuse/A.C.B. as indicated in the drawings.

Both the mains and alternator contactor forming the automatic changeover switch shall be of 4 pole type capable of separating the neutral of the main supply. They shall be electrically and mechanically interlocked to prevent parallel operation. The contactors shall be provided with a short time delay device to ensure a clean break between opening of one and closing of the other. A rated capacitor of suitable to provide stored energy so that the contactor will remain sealed in for about one second before dropout in the event of momentary interruption of power supply.

A standby test button shall be operative only with the selector switch in 'Manual' position and the 'Standby' test on lamp shall be energized over contacts of the first relay to operate the engine start cycle and shall remain lit until the automatic test is complete.

8. WIRING

All necessary power cables and auxiliary cables between the M.V Switchboard and the stated shall be supplied and installed in G.I. conduit with PVC Cable in accordance with appropriate clause of this specification

9. FINISHING

All metal parts of the generating set shall be suitably prepared to achieve high quality finishing. The metal parts shall be treated first with an etching primer followed by three coats of undercoat and lastly two coats of oil-proof enamel.

10. EARTHING

The generating set and the neutral shall be solidly earthed and the system of earthing shall fully comply with the rules of DES. It shall be the responsibility of the Contractor to investigate the earth condition on site so that this quotation cover the cost of installing a complete earthing system which complies with the above requirements.

11. FACTORY TEST

Factory load test shall be carried out in the presence of the Engineer and three officials (two from DES and one from DCA). The approval by the Engineer of the results of any such test shall not prejudice the right of the Engineer to reject the equipment if it fails to comply with the Specification when erected or give complete satisfaction in service.

The cost to carry out all tests shall be borne by the Contractor and shall be deemed to be included on the contract price.

Factory load test shall be carried out for the following loads and period :-

<u>Load</u>	<u>Period</u>
25% f.l	One Hour
50% f.l	One Hour
75% f.l	One Hour
100% f.l	Two Hours
110% f.l	One Hour

The Contractor shall submit factory certified test log in triplicate on all readings and curve showing the results obtained to the Engineer for approval. The results recorded at half hour intervals throughout the test, shall indicate fuel consumption in lbs/kw, exhaust temperature, cooling water temperature, lubricating oil temperature, oil pressure, engine speed and shall alternate output at rated voltage and frequency. Governor trials shall be carried out in accordance with BS 649 immediately after the load test.

Any defects, in the opinion of the Engineer, which become evident during these test shall be corrected and certified by the Contractor at his own expense and tests be repeated to the satisfaction of the Engineer.

12. TEST ON SITE

Test on the generating set shall be carried out on the completion of plant erection. The test shall include the test on the electrical control switchgears and the test on the generating set on starting, stopping, running and full loading. The Contractor shall provide all facilities such as water, oil, instruments, fuel, labour, etc. without extra charge to the Employer for carrying out the testing of the generating set. Any defects, in the opinion of the Engineer which become evident during this test shall be corrected by the

Contractor at his own expense and tests on generating set, after the rectification shall be repeated to the satisfaction of the Engineer.

13. MAINTENANCE AND WARRANTY

The Contractor shall provide 12 months of free service to the generating set commencing from the date of handing over the set in approved working order and also a minimum of 13 months operation guarantee against all defects and parts of the generating set.

14. INSTRUCTION BOOK

The Contractor shall provide to the Owner three sets of Erection, Operation, Maintenance Instruction and spare parts list, bound in stiff cardboard covers covering the whole of the plant for Owners record and reference.

15. BATTERY CHARGER

The battery charger shall be of the static automatic type with two rates of charging and shall be suitable for continuous operation at full rated load output at an input of 240V single phase without the temperature rise of the transformer choke or any other component exceeding 55⁰C.

The charge shall be provided with manually operated boost charging switch and a separate ammeter.

The charger shall be housed in a sheet metal enclosure and shall be complete with the necessary control gear, double pole input switch and output switch, input and output HRC fuses, double wound transformer(s), set of rectifiers, smoothing choke, battery ballast resistance, voltage control equipment, input and output terminals. It is preferred that the unit be housed in the lower compartment of the Control Panel.

In the event of a battery earth fault or mains failure to the charger, audio and visual alarms and warning indicating should be shown on the Control Panel.

16. TESTING OF MECHANICAL AND ELECTRICAL SERVICES

The generator set may be used for testing of the Mechanical and Electrical Services as directed by the Engineer.

The duration of the testing shall be as stipulated in the drawings or other schedules.

The testing may be carried out before handing over but after Practically Completion of the installation.

The warranty and maintenance period of the installation shall not be affected by this testing.

The tenderer shall provide at least one qualified site personnel to attend the whole testing period and ensure that the generator set is operated properly.

Genset Maintenance and Training

01 MAINTENANCE DURING THE WARRANTY PERIOD

The sub-contractor shall guarantee against fault or defect, all materials and work as set out in this specification for the duration of the defects liability period. The sub-contractor shall at his own expense pay for spare parts, and other items necessary for the operation of the system.

The maintenance shall consist of all required servicing of the plant installed including attention to emergency call.

The Engineer may issue the Certificate of Practical Completion at his discretion provided that:-

- a) All required testing has been completed and approved.
- b) All adjustment to equipment which may be necessary to ensure satisfactory operation have been made.
- c) All operation instruction, wiring diagrams and layouts have been received.
- d) A maintenance schedule setting out the proposed programme of maintenance inspections and servicing together with advice of arrangements of prompt attention to emergency call has been submitted and approved by the Engineer.

At the beginning of the Maintenance Period, the sub- contractor shall provide a log book which shall be lodged with a person nominated by the Engineer. The log book shall remain at the site and shall be used to accurately record all service calls whether emergency of routine, setting out the work performed the date, the duration of each visit, the repair or adjustment made.

02 TRAINING

The sub-contractor shall provide the services of a suitably qualified operator for a period of two (2) days during the Defects Liability Period as and when nominated by the Engineer. The operator shall be required to train the employer's services personnel on all aspects of the operation and maintenance of the installation.

03 SERVICE CONTRACT

The Owner shall have the option to enter into an annual service contract, after the sub-contractor has fulfilled the obligations of maintenance during the warranty period. The service contract shall include emergency service and regular maintenance. The cost of spare parts and materials shall be charged to the Owner in the case of "non-comprehensive" coverage, and covered by the Contractor in the case of "comprehensive coverage".

04 SUGGESTED MAINTENANCE SCHEDULE

The following is intended to indicate the items, where applicable, requiring inspection and attention during weekly, monthly and yearly maintenance service. A detailed list shall be prepared by the contractor based on the equipment manufactures recommended maintenance schedule.

Item		Check Point	Action	10 Hrs or Weekly	100 hrs or monthly	200 hrs or yearly
1	Engine	1.1	Check lubricating oil level	x		
		1.2	Change lubricating oil/filter			x
		1.3	Check fuel tank level	x		
		1.4	Check water coolant level	x		
		1.5	Check fuel filter			x
		1.6	Check vee belt tension			x
		1.7	Clean air filter or if oil bath type check level	x		
		1.8	Check all for fuel, exhaust, water/oil leaks			x
		1.9	Drain sediment from fuel tank		x	
		1.10	Check fuel tank breather		x	
2	Engine Electrics	2.1	Check electrolyte level in battery and verify operation of charger	x		
		2.2	Check state of charge with hydrometer		x	
		2.3	Clean cable terminations on battery and regrease			x
		2.4	Check fuel solenoid is operating correctly		x	
		2.5	Check auxiliary terminal box connection	x		

Item		Check Point	Action	10 Hrs or Weekly	100 hrs or monthly	200 hrs or yearly
3	Generator	3.1	Clean apertures and inlets with a dry air supply		x	
		3.2	Grease bearings (if required)			x
		3.3	Check ventilation areas for obstructions	x		
		3.4	Check electrical connections		x	

Item		Check Point	Action	10 Hrs or Weekly	100 hrs or monthly	200 hrs or yearly
4	Switchgear	4.1	Check functioning of all relays, lamps, fuses, meters and switches	x		
		4.2	Check functioning of all switches (including engine)			x
		4.3	Check that contacts of circuit breakers and contactors are clean			x
		4.4	Check condition and rating of fuses and trip devices		x	
5	General	5.1	Check and tighten all nuts and bolts (as required)			x
		5.2	Check condition of anti-vibration mountings (if fitted) & unusual vibration			x
		5.3	Check cable tightness			x
		5.4	Check ATS operation	x		
		5.5	Verify fuel pump system operation		x	
6	Complete Set	6.1	Run set for one hour on load and verify 1.Approx starting time. 2.That all engine instruments are functioning. 3.That all meters are functioning 4.All lamps are operating correctly. 5.All switches are functioning. 6.Unusual vibration & loose	x		

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Item		Check Point	Action	10 Hrs or Weekly	100 hrs or monthly	200 hrs or yearly
			parts 7.Record all meter readings 8.Adjust AVR, RPM, Etc as necessary 9.Verify exhaust smoke colour			
		6.2	Clean complete set and exterior of panel and remove dust		x	
7		7.1	Have generating set inspected by manufacturer			x

AUTOMATIC MAINS FAILURE GENERATOR

The sub-contract shall include the complete supply, installation, testing, commissioning, handing over in approved working order and maintenance during the defect's liability period the whole of the sub-contract work as detailed hereafter and as shown on the drawings. The diesel generator set shall be of the "package" type, complete with all accessories on a combined under frame. The generator shall have a duty output rating as shown on the drawings and at 0.8 power factor lagging, 415 volts, three phase, 4 wire and 50 Hz. at 1500 rpm. Standard range of generator units with rating within plus or minus 2.5% of the specified rating may be offered. The generator must be appropriately derated for the ambient conditions of 40°C and 90% RH, at 2000 m attitude.

PERFORMANCE

The generator shall exhibit the following characteristics at load power factor of 0.8 lagging.

- (a) Steady state, load change: 0 - 100% F.L., Voltage - $\pm 1\%$, Frequency - $\pm 0.5\%$
- (b) One Step load change of 60% from no load with initial voltage transient limited to $\pm 15\%$ of rated voltage, recovering to within $\pm 3\%$ of rated voltage in less than 0.2 s and frequency at $\pm 6\%$ to $\pm 8\%$ returning to steady state within 0.5 seconds.
- (c) With a 50% out of balance load the voltage regulation should be within $\pm 6\%$.
- (d) To withstand a 3 phase short circuit current of approximately 3 times rated value for 5 seconds.
- (e) The generator should generate a waveform with deviations from a sine wave not exceeding 1.5% on open circuit and 4% on balanced load conditions as defined in B.S. 5000 Part 99.

MAIN COMPONENTS

The engine shall be of the multi-cylinder water cooled, direct injection, two (2) or four (4) stroke diesel engine, turbo charged with air to air charge cooling or naturally aspirated, vee form, heavy duty, compression ignition type in compliance with BS 5514, BS 1649, BS 3926, BS 4675 & BS 4959. The charge cooler shall be integral with engine cooling radiator. The power output developed shall meet the output rating specified, at normal temperatures and pressures in accordance with BS5514, at a speed of 1500 rpm.

In addition, the engine shall be capable of a 10% overload for a period of one hour in any consecutive 12-hour period. The machine should also be able to withstand 150% overload for 2 minutes. The governor shall be of the electronic type giving regulation complying to B.S.5514 Class "A1" governing. The governor shall have provision for varying the speed droop from 0 to 4.5%. The engine shall be complete with Fuel injection pump, fuel lift pump and duplicate fuel filters, lubricating oil pump and filters, circulating water pump and filters, duplicate full flow lubricating oil filters, lubricating oil pressure gauge, tachometers, integrating hour run recorder, air inlet filter, Water temperature gauges, Electronic governor with hand operated fine speed control, Overspeed trip, high water temperature trip and low oil pressure shut down protection and alarm, 24 volts D.C. operated starting motor, Guards on all exposed moving parts & 24 volts alternator. The engine shall be capable of cold starting and shall start within 10 seconds automatically upon public main supply failure. The engine shall be suitable for running on Class "A" oil engine fuel, generally complying with B.S. 2869. Proper filter shall be provided for fuel, oil and air. A drip tray of 2mm galvanized sheet steel with minimum 12mm high sides shall be provided where drips are likely to occur. A label "DANGER - KEEP CLEAR OF THIS SET. IT IS REMOTELY CONTROLLED AND MAY START AT ANY TIME" shall be clearly visible and provided in suitable location in the genset room.

The alternator shall be a 4-pole self-exciting, self-regulating single bearing, brushless, type fitted with a damper winding and complying with the requirements of BS 4999/5000. The unit shall be screen protected and drip proof to IP22. The rotor assembly shall be carried on a heavy shaft and shall be dynamically balanced to BS 5625 grade 12.5. The rotor shaft shall support the centrifugal ventilation fan, rotor, excitor rotor assembly and rotating rectifier assembly. The design of the core should permit and good ventilation for proper cooling. The alternator shall be fitted with a sealed for life bearing and a flexible drive disc for close coupling to the engine. The excitation system shall comprise a separate excitation winding to provide a low voltage D.C. supply for energizing the exciter field winding through a solid state transistorized AVR to control the level of excitation in response to changes in load temperature and engine speed. Rapid voltage build up shall be assured by the use of permanent magnet inserts in the exciter pole system. The power to the excitation winding shall be obtained through a rotating rectifier unit.

Current compounding circuit shall provide additional excitation proportional to load current to give much faster

response to load change, increasing circuit fault current capability and improving motor starting performance. The alternator performance characteristics shall be as described in the earlier section. A voltage trimmer shall be provided on the AVR for fine adjustment. The starter winding shall be epoxy coated. The rotor and excitor shall be triple, dipped in moisture, oil and acid resisting polyester varnish, and coated with anti tracking varnish. All windings shall be Class H insulated in accordance with BS 2757. The continuous operation of the machine at rated load shall result in Class 'F' temperature rises. All machines shall be capable of 10% overload for 1 hour in any 12. In addition, the machine should withstand 150% rated current for 2 minutes. The generator shall be provided with electric heater on the stator to prevent condensation and the neutral shall be solidly earthed to less than one ohm.

GENERAL ARRANGEMENT

The diesel engine and alternator assembly shall be mounted upon a fabricated steel under frame or base frame, by means of oil resistant mounting, of shear-compression type. The base frame shall also carry the radiator. The alternator shall be close coupled through a flex disc coupling bolted directly to the engine fly wheel. High tensile bolts shall be used. This assembly shall then be bolted down to a concrete plinth through oil resistant anti-vibration mountings of the adjustable level, bonded rubber type. Generator larger than 600kw shall be provided with housed steel spring supports with limit stops. Springs selected shall have additional travel to solid of 50% of deflection. All piping's, conduits and cables connected with the generator shall be provided with flexible coupling, or below, as necessary to prevent transmission of the vibration.

BATTERY/CHARGER UNIT

The engine shall be arranged for 24 volts starting by means of an axial type starter motor and contactor, engaging on tooth ring on the flywheel on generators larger than 600 KW 2 nos starter motors shall be provided. Batteries shall be 24 volts heavy duty lead-acid or nickel-cadmium type as indicated in the Bill of Quantities, with ample capacity for six (6) successive starts or attempts of 6 secs with a 15 sec rest period. Terminals and bare connections of batteries shall be suitably covered and protected against accidental shorting by tools.

The Battery Charger Unit shall be of the solid-state type capable of maintaining the batteries in a charged condition for optimum fully automatic operation. The charger unit shall incorporate a 2-stage charger selector switch. The charger stages being a) Automatic and b) High Boost Rate. For automatic charging the charger shall have constant voltage charging characteristics with a stability of $\pm 2\%$. Under automatic operation the charger shall provide automatic boost and float/trickle charging to maintain the battery bank in a fully charged state. Under the automatic mode of operation, the charger shall be capable of charging the battery bank from a fully discharged condition to a fully charged condition within a maximum period of 24 hours. The charger output voltage shall be adjustable between 1.35 and 1.7 volts per cell. The charger shall maintain any set voltage between $\pm 2\%$ with charger input AC voltage fluctuation of $\pm 10\%$, AC supply frequency fluctuation of $\pm 5\%$, and output load variations between 0 and 100%. The charger unit shall be provided with an output voltmeter, charging ammeters, D.C. fuses, Off/Auto/High Boost Rate charge selector switch, switches and relays.

The voltmeter shall monitor continuously the charge voltage and shall have a scale that reads within 0.5 volt. The charge voltage of the battery shall be marked in red on the inside of the instrument face plate. The ammeter shall be connected in the battery supply circuit to measure the charge and discharge of the battery. The ammeter shall be provided with a range switch which shall be non-locking in the low current range to facilitate reading of the battery charging current within 20mA. If one instrument is unable to provide the above facilities, then more instruments shall be provided as required. The normal float charge and high boost rate current for the battery shall be marked as specified for the voltmeter. The charger unit shall be provided with overload and short circuit protection. Current limiting devices shall be provided to limit short-circuit current to 120% of full load current.

COOLING/EXHAUST SYSTEM

The double belt driven radiator cooling air fan, shall be connected by means of a flexible canvas section and galvanized sheet steel ducting to a louvred air outlet, set in the wall. The fan shall be capable of developing the necessary static pressure to achieve the required air flow. The duct work, louvred frame and all necessary works associated shall be provided and installed by this sub- contractor. Shop drawing showing construction details shall be submitted for approval prior to installation. Ductwork shall be constructed in accordance with BS DW 142. An efficient silencer of residential type with stainless steel bellow section shall be provided and installed integral with the exhaust piping. Exhaust piping shall be of steel to BS1387/BS3601. All pipework shall be insulated with 50mm thick rock wool and covered with a layer of 0.6mm thick polished aluminium cladding.

The resulting noise level shall not exceed 85 dBA at 1 meter from the exhaust pipe under true field conditions. Exhaust piping though the wall shall be sleeved, the outer pipe being provided with a split circular flange properly fixed to each side of the wall, the sleeve to be packed internally with rock wool and grouted to the wall. Exhaust piping shall be supported by means of static deflection type supports using steel springs in series with neoprene such as manufactured by Kinetics type SH or MASON type HS. A moisture trap with drain cock shall be fitted at the lowest point. Shop drawing showing construction details shall be submitted prior to installation. The discharge of the combustion products shall be located such as to meet the requirements of the relevant authorities.

DAY FUEL TANK/FUEL PIPING

An elevated rectangular fuel tank manufactured from minimum 3mm thick grade CR4 carbon steel plates with welded seams and suitably stiffened internally of capacity as shown in the drawings shall be provided. Galvanised steel shall not be used. The tank shall be constructed in accordance with BS799. All welding shall comply with the requirements of BS5135. The tank shall feed the engine by gravity, and the inside and outside to be painted with oil-resistant primer and externally finished with oil resistant paintwork. The fuel tank shall be mounted on angle iron supports. The bottom of the tank to be 300mm higher than the fuel inlet of the Engine.

The following accessories and fitting shall be provided on the tank:

- a) A 300 x 300 inspection opening with hinged cover
- b) A calibrated PVC content gauge with protection guard
- c) 1 no. M10 bolt for earthing terminal
- d) A 12mm dia screwed socket for drainage c/w gate valve and plug
- e) A 50 dia mm fill-in pipe with filter cap
- f) A 50 dia mm goose-neck vent pipe with S.S. wire gauge covered opening.
- g) A 25mm dia screwed socket for fuel supply to genset c/w gate valve and strainer filter.
- h) A 25 dia mm screwed socket for fuel return from genset
- i) Level sensing device c/w mercury switch for high/low level alarm
- j) A handpump c/w 20 dia mm bend pipe to tank and 1500mm length flexible hose.

Where bulk fuel storage tank is required, the following accessories shall also be provided at the tank.

- a) A 50mm dia flanged connection for feed-in pipe from bulk tank
- b) A 50mm dia flanged connection for fuel overflow back to bulk tank

A manual refilling pump shall be provided complete with all necessary valves and fittings. The hand pump should have a capacity of 20 times the rate of fuel consumption of the engine.

Fuel piping shall be in copper to BS 2871 table X with silver brazed joints to BS 1845 and fittings to BS 864 Part 2. Brazing alloy filler shall have a minimum 15% silver content and shall be in accordance with BS 1845. Fuel piping laid below ground shall be black steel pipe to BS 1387, with welded joints. Pipes shall be protected against corrosion by painting with 2 layers of bitumastic paint and wrapping with a 3 mm thick bitumastic tape. All pipes and fittings should be thoroughly cleaned and free from burrs, scale and obstructions before erection. Pipe supports shall be in accordance with BS 3974. Supports for copper pipes shall incorporate an insulation strip to protect against the effects of dis-similar metals in contact. All pipes shall be hydrostatically tested to 150 PSI for a duration of 24 hours. A maximum pressure drop of 3% shall be acceptable.

PROTECTION DEVICES

The generator shall be provided with the following protection devices: engine low lub. oil pressure alarm and trip, engine high water temperature alarm and trip, overspeed trip and alarm, failure to start circuit, permitting 6 successive attempts before automatic lockout and alarm operation, Underspeed trip and alarm, overload trip and alarm, low battery voltage alarm, terminals for connection of remote alarms, battery charger failure alarm & main tank and day tank low fuel level alarm.

AMF SWITCHBOARD

The switchboard shall be floor mounted, free standing cubicle type. Construction of the board shall conform to specification detailed under the section "Switchboard & Distribution Boards". The following are principal features required for the control panel.

- a) Indicator lamp to show operation of engine protective device with "test" and "reset" buttons.
- b) Selector switch for operation on "off" "auto" and "manual" positions.
- c) A test switch for testing of the entire system including main failure detection time delay, engine starting and automatic shut down, with or without operation of the load changeover contactors.
- d) Push buttons for manual start and emergency stop
- e) Lamp test push, reset and alarm cancel buttons
- f) IDMT overload and earth fault protection relays.
- g) voltmeter, ammeter c/w selector switches
- h) battery charger c/w selector switch, charging ammeter & voltmeter
- i) frequency, kwh and hour-run meter
- j) Indication Lamps for low battery voltage, battery charger failure, low fuel level, plant failed to start, low oil pressure shut down warning, overheat shut down warning, underspeed shut down warning, overcurrent warning, mains "available" indication, standby available indicator, heater on indicator, non automatic flashing indicator,

All interconnection wiring shall be factory built with proper colour cables in accordance to colour coding scheme "IEE & B.S. Code of Practice".

The generator control system shall include dry contacts and terminals for remote monitoring. The contacts and terminals shall be centralised on a common terminal strip and appropriately labelled. The provision required are as Voltage terminals c/w space for mounting of voltage and frequency transducers, Current terminals c/w space for mounting of current transducers, Generator main ACB/MCCB status, Fail to start, Low oil pressure, High water temperature, Overspeed trip, Switchgear fault, Overload/earth fault trip, Low fuel level in day tank, Low fuel level in bulk tank, Charger failure, Low battery voltage alarm & Underspeed trip.

MODE OF OPERATION

Mains Failure The generator set shall give full automatic main. Failure operation so designed that the plant will start at a preset voltage variation adjustable between 10 to 30% of the nominal voltage of any one of the phases. The genset should be fully operational within 10 seconds and be capable of accepting in one step 60% load and the remaining 40% in the next 10 seconds. The operation of the Generator Set Installation shall be such that under normal condition, the essential loads shall be supplied via the mains contactor/MCCB/ACB by the mains supply. The mains and emergency changeover contactor/MCCB/ACB shall be mechanically and electrically interlocked to prevent ☺parallel operation. It shall be positively interlocked mechanically in either the normal or emergency position. The contactors shall be provided with a short time delay device to ensure a clean break between opening of one and closing of the other.

Transient Disturbance To guard against unnecessary operation on transient disturbances, an adjustable time delay shall be provided after which the engine start/run circuit shall be energized (0-5 seconds).

Run-Up Period Provided the mains supply is still unavailable when the correct voltage and frequency is obtained, then the emergency load shall be transferred to the generator via the change-over. The time lag between starting of emergency set and closing of emergency contactor shall be adjustable between 0 to 5 seconds. Should the mains supply be once again available during the engine 'Run-up' period, the automatic changeover switching shall abort. However, the genset shall run-up, ready to assume load for the present run-on period and be available during this period for essential load supply. On expiry of the run-on period the shutdown sequence shall commence.

Mains Return When the normal supply is restored i.e. all phase voltages return to above 90% of its rated value, the genset shall continue to run on load for an adjustable period (normally 0-60 secs) after which the load shall automatically switch over to the mains supply. The genset shall then commence the shutdown sequence.

Shutdown Sequence (Run-on Period) The shutdown sequence shall incorporate a time- delay to allow the engine to run unloaded for a short period before stopping the engine (1-10 mins). All settings must then return to the normal position for automatic operation.

If the mains fails during the shutdown sequence when the genset is running unloaded, then the genset shall (after a predetermined period (0-5 secs) to guard against operation on transient disturbance of mains supply) take on the load.

TOOLS AND ACCESSORIES

Each unit system unit shall be supplied complete with the following:

- 1 set of AVR
- 1 set of engine manufacturers standard tools
- 1 set outlet fuel nozzles
- 1 set of engine gaskets
- 2 sets of belts, fuel filter, air filter and lub oil filter.

MAINTENANCE & TRAINING

The sub-contractor shall guarantee against fault or defect, all materials and work as set out in this specification for the duration of the defects liability period. The sub-contractor shall at his own expense pay for spare parts, and other items necessary for the operation of the system. The maintenance shall consist of all required servicing of the plant installed including attention to emergency call. The Engineer may issue the Certificate of Practical Completion at his discretion provided that:-

- a) All required testing has been completed and approved.
- b) All adjustment to equipment which may be necessary to ensure satisfactory operation have been made.
- c) All operation instruction, wiring diagrams and layouts have been received.
- d) A maintenance schedule setting out the proposed programme of maintenance inspections and servicing together with advice of arrangements of prompt attention to emergency call has been submitted and approved by the Engineer.

At the beginning of the Maintenance Period, the sub- contractor shall provide a log book which shall be lodged with a person nominated by the Engineer. The log book shall remain at the site and shall be used to accurately record all service calls whether emergency or routine, setting out the work performed the date, the duration of each visit, the repair or adjustment made. All entries to the log book shall be handed over to the Engineer on completion of the maintenance period.

The sub-contractor shall provide the services of a suitably qualified operator for a period of two (2) weeks during the Defects Liability Period as and when nominated by the Engineer. The operator shall be engaged all time at site and shall be fully responsible for the starting, shut down, cleaning, servicing and general maintenance of the installation. The operator shall also be required to train the employer's services personnel on all aspects of the operation and maintenance of the installation.

EARTHING SYSTEM

This section of the specification shall cover the supply, installation, testing & commissioning of the earthing system. The system shall be in accordance with the requirements of B.S 7430 & latest IEE wiring regulations BS 7671, and as shown in the drawings.

EARTH ELECTRODE

Earth electrode shall be 16mm dia. copper clad low carbon steel rod section of 1.5m length. Rod shall have tensile strength of 600N/mm² (approx.) and a quality of not less than grade 43 of BS4360. Copper cladding should be 99.9% pure electrolytic copper molecularly bounded to the steel core. The thickness of the copper should not be less than 0.25mm. Rods shall be interconnected by screwed coupling made from silicon bronze alloy of grade CS 101 of BS 2874. A hardened steel tip shall be fitted as the driving cap. Electrode terminal connections shall be 'U' type cast gunmetal clamps with phosphor bronze bolts or exothermic welding.

The earth electrode shall preferably be driven to a minimum depth of 6 metres. Multiple earth rods are to be used to achieve the specified earth resistance. (Typically, less than one ohm for the electrical earth and less than 10 ohms for the lightning protection earth.) Spacing between the electrodes shall be at least equal to the depth of the earth rod and not greater than twice the depth of the earth rod. Interconnecting links between rods and main earth bar shall be as shown in the drawings.

INSPECTION CHAMBER

Polycarbonate earth inspection chambers complete with cover shall be used to protect/inspect each earth electrode. The earth inspection chamber shall extend to a depth of 200mm below finished ground level and kept free of soil. Each earth electrode shall be clearly marked 'SAFETY EARTH - DO NOT REMOVE' A heavy duty steel cover (Grade A BS497) shall be used when the earthing chamber is located on the road.

EARTH CONNECTION

An earth cable shall be extended to all electrical equipment and accessories, from the main earth bar via main switchboards, sub switchboards and distribution boards. All extraneous metalwork, cable trays, trunkings, metallic conduits, pipes, ceiling frames, structural steel, metallic flag posts, aerial, etc. shall also be bonded to the electrical earth with appropriately sized earth conductors. The minimum size of the earth conductor shall be as shown in the drawings and not less than the sizes indicated in the following tables or calculated in accordance with IEE regulations.

Buried copper tapes/cables shall be installed at a minimum depth of 750mm below finished ground level and mechanically protected by means of upvc conduit, brick cover or cable tile marker. Earth cables for submains shall preferably be installed spaced one cable diameter away from the main power cables and clipped separately. Earth cables may be installed bunched or as a core in a cable provided the appropriate rating factors have been considered in the calculations for sizing the earth cable. The insulation for safety earth cable shall be colour coded green with yellow strips, while the insulation for the neutral earth conductor shall be colour coded black.

Earth conductors up to 10 sq mm may be terminated with tunnel type connectors while cables above 10sq mm shall be terminated with crimping type cable lugs and nuts and bolts. Single core armoured cable glands shall be earthed only at the source end and cable glands on the receiving end shall be mounted on an insulated gland plate. Multicore armoured cable glands shall be earthed at both ends. Where the gland is terminated on a painted sheet steel plate, a cable gland earth tag and earth cable link shall be provided to bond the gland to the main earth bar in the switchboard. Alternatively, the glands may terminate on a brass plate which has a common link to the main earth bar.

Table 1 Minimum cross-sectional area of protective conductors in relation to the area of associated phase conductors.

Cross-sectional area of phase conductor (S)	Minimum cross-sectional area of the corresponding protective conductor (Sp)
mm ² S < 16 16 < S ≤ 35 S > 35	mm ² S 16 S/2

Table 2 Minimum cross-sectional area of protective conductor where it does not form part of a multicore cable or run in a cable containment system.

(a)	2.5mm ² if mechanical protection is provided
(b)	4.0mm ² if mechanical protection is not provided

Table 3 Minimum cross-sectional areas of buried earthing conductors

	Protected against mechanical damage	Not protected against mechanical damage
Protected against corrosion	normal sizing	16mm ² copper
Not protected against corrosion	25mm ² copper	25mm ² copper

CLEAN EARTHING

For telecommunication, audio, computer and other systems which require a clean earth, an independent, insulated earthing lead shall be brought directly from separate earth electrodes or a separate earth cable from the main switchboard main earth bar to the equipment earthing point as specified in the drawings.

EXTERNAL LIGHTING

Supply and install external lighting comprising of lighting columns, floodlights, bollards, wall, ceiling and decorative garden lights inclusive of all cabling as shown on the drawings and described in the bill of quantities.

Light fittings shall be supplied complete with control gear, cut off fuses, lamps, mounting brackets, adaptors, weatherproof cable glands and accessories.

All lighting columns shall be complete with a flush fitted door, backboard for mounting the MCB cut out and cable slot suitable for looping in and out 3 nos 3 core PVC/SWA/PVC cables at the bottom. Each armoured cable shall be fitted with an armoured clamp earthing device to ensure earth continuity to meet the IEE regulation. A 2.5 mm² or larger PVC/PVC line and earth cable shall be extended from the cut out to the lantern.

Lighting columns shall comply with the following British Standards :

BS 5369 lighting Columns

BS 1308 Concrete Street Lighting Columns

BS 1840 Steel Columns for Street Lighting

BS 3989 Aluminum Street Lighting Columns

INSTALLATION

The light fittings shall be installed as per manufacturers instructions. All necessary concrete plinths and anchors shall be provided as shown in the drawings. All lighting columns and bollards shall be installed plumb, and in correct relationship to the footpath, kerb or road.

CABLE LAYING

The cable shall be installed as shown in the drawing and in accordance with the specification section "cabling". Excavation of cable trenches may either be carried out normally or by using a mechanical excavator with the provision that other services such as power, telephone, water or sewerage will not be damaged. The cable trenches shall be clear of any form of hard materials such as stones, roots or any debris that may damage the cable to be laid. The cable trench shall be excavated to a depth of 750mm with a width of 200mm.

After the cable has been laid along the bed of the trench, loose earth shall be used to cover the cable and compacted up to a depth of 300mm from the bottom of the trench. Approved cable markers shall then be laid before complete backfilling and re-instatement of the trench is made. Insulation and short-circuit tests shall be performed on the cable by the contractor before and after cable laying works to ensure that the cable is serviceable. Unterminated cable ends, exposed to weather, shall be protected with PVC tape to prevent the ingress of moisture. All debris resulting from the excavation or cable termination works shall be cleared from the site. The trench work is to be inspected by the engineer before backfilling and compacting the trench.

LABELLING

All light fittings shall be labelled, identifying the fitting number and circuit number. Labels shall be fitted beside the terminal block or on the inside cover of the door. All incoming cables shall be labelled to identify the source and outgoing loop cable labelled to identify the destination.

STREET LIGHTING INSTALLATION

LIGHTING POLE

Light pole shall be manufacturing and designed to BS 5649. The columns shall be manufactured from steel conforming to BS4360:72 Grade 43C or BS4360:72 - Grade 50C, and welded in accordance to BS 5135.

The columns shall consist of tapered octagonal sections which shall be connected together be forced fit slip joints with a minimum overlap of 1.25 times their width at the joints. The intermediate sections shall be less than 5.6m. The bracket arm shall finish in a round pipe with a "spigot" for the safe mounting of the lantern.

A weatherproof lockable hinged-door shall be provided for access to the cable termination compartment. A baseboard of non-hygroscopic material shall be provided for mounting of cable termination accessories. An earthing boss of 6mm diameter shall be provided within the cable termination compartment.

The columns shall be designed to withstand loading comprising the weight of the column, luminaries and wind loads up to 27m/sec. The column shall be protected against corrosion by hot dip galvanising internally and externally in accordance to BS729.

ERECTION OF LIGHTING COLUMN

The lighting column shall be assembled on site as per manufacturers instructions. The sub-contractor shall be responsible for the provision of all necessary tools and equipment for the assembly works.

The lighting column shall be installed as shown in the drawing. All necessary steps shall be taken to ensure that the lighting column is installed vertically. The contractor shall provide a suitable crane to lift the lighting column into position. A concrete mixture of 1:2:4 in volume shall be used for the base and top foundation at the column.

CABLE LAYING

Excavation of cable trenches may either be carried out normally or by using a mechanical excavator with the provision that other services such as power, telephone, water or sewerage will not be damaged.

The cable trenches shall be clear of any form of hard materials such as stones, roots or any debris that may damage the cable to be laid. The cable trench shall be excavated to a depth of 750mm with a width of 200mm. After the cable has been laid along the bed of the trench, loose earth shall be used to cover the cable and compacted up to a depth of 300mm from the bottom of the trench. Approved cable markers shall then be laid before complete backfilling and re-instatement of the trench is made.

Insulation and short-circuit tests shall be performed on the cable by the contractor before and after cable laying works to ensure that the cable is serviceable. Un-terminated cable ends that are exposed to weather, shall be protected with PVC tape to prevent the ingress of moisture. The trench work is to be inspected by the Engineer before backfilling and compacting the trench.

LANTERN & LAMPS

All lantern shall comply with BS4533 and shall be:

- Provided with integral control gears in a separate compartment from the lamp compartment
- The lamp compartment shall have a minimum index of protection of IP54 and gear compartment IP43.
- Be provided with power factor correction capacitors to maintain a minimum power factor of 0.95

- Utilise non-corrosion type housing
- Utilise a polyester impregnated low power loss choke to BS EN 61048/49.
- Utilise electronic ignitor which switches off the lamp if it fails to ignite within 90 sec.

PHOTOCELL CONTROL UNIT

The photocell unit shall switch on at 55 lux and have a switch off/on differential of 1.5 to 2. The unit shall have an inherent time delay to prevent false operation.

CUT OUT UNIT

The cut off unit used shall be complete with a cable gland plate, terminal lugs and a 10A Type 3, M6 MCB. The unit shall be similar to that manufactured by TOFCO Ltd., UK or BICC, UK, TOFCO Ltd. model no HK/1F/435. The cable gland plate used shall be suitable for 3 nos. 4 core 16mm² PVC/SWA/PVC cable.

LABELLING

All street light columns shall be labelled to identify the pole number and circuit number. Labelling shall be stencilled on a yellow background, with 60 mm high lettering in black or vice versa for black poles.

LIGHTNING PROTECTION SYSTEM

The lightning protection system for the building shall comply with the recommendations of the British Standard Code of Practice BS 6651 & BS EN 62305. The Protection of Structures against Lightning". The system supplied shall be from Furse or other recognized manufacturers.

AIR TERMINATION NETWORK

The air termination network shall consist of roof conductors run along the ridges of pitched roofs, or parapet walls or as shown on the drawings.

The materials used for the air termination network shall comprise of roof conductors using 25mm x 3mm annealed copper tape to BS 1432 grade C101 and 8mm dia annealed copper to BS1432 grade C101, and air terminals using 15mm dia annealed copper rods of 500mm height and tapered at the tip. The fixing centers for horizontal conductors fixed on horizontal surfaces shall be 1000mm and for horizontal conductors on vertical surfaces shall be 500mm. Fixing shall be by means of purpose made metal saddles. The nuts, bolts, screws, washers and saddles used shall be made from phosphor bronze or bronze or navel bronze complying to BS 2874. Purpose made fixings shall be used for securing to ridges, slate roofs and corrugated roofs. The fixing shall be designed to ensure water tightness of the roof.

DOWN CONDUCTORS

Down conductors shall be of the same size and type of materials as used for the air termination network. Down conductors shall be securely jointed to the roof conductors and to the earth electrodes at ground level. Down conductors shall run on the outside of the building at positions shown in the drawings and shall be secured by specially made clips and saddles. Down conductors shall be as direct and vertical as possible. Right angle bends are not permissible. All bends must be made with as large a bending radius as possible.

The fixing covers for vertical conductors shall generally be at 1000mm. Where vertical conductors exceed 20 metres and 25 meters the fixing centers shall be at 750mm and 500mm respectively. A test joint shall be provided at 0.5m above ground level or as shown in the drawings at every down conductor. All down conductors shall be protected by PVC sleeving from 2.4m downwards to ground. Down conductors shall be painted to a similar colour as the surrounding finishes.

JOINTS/ BONDING

Joints shall be avoided as far as possible. Where unavoidable, conductors shall be welded using an exothermic process similar to the system used by Furse or Cadweld. All metallic parts of the building within 3m of the lightning protection network shall be bonded to the lightning protection network. Where dissimilar metals are bonded together steps shall be taken to avoid electrolytic action.

EARTH TERMINATION NETWORKS

The earth termination network shall comprise of a system of earth electrodes interconnected by copper tape. All jointing shall be by exothermic welding. The earth electrode shall be driven to a minimum depth of 6 meters. The electrodes shall be built from copper clad steel rod sections of 1.5 meter length and 16mm diameter interconnected by screwed couplings. Interconnection between electrodes shall be by means of a 25mm x 3mm copper tape buried at a minimum depth of 0.6 meter depth. The interconnecting copper tape shall be protected by a brick cover. Where multiple earth rods are required to achieve the required earth resistance of less than 10 ohms, the additional earth electrodes shall be placed in a triangular arrangement with a maximum spacing of 3 meters.

Copper clad steel rods shall have cores of low carbon steel with a tensile strength of approximately 600N/mm² and a quality of not less than grade 43A of BS4360. The cladding should be of 99.91 pure electrolytic copper monocrystallic bonded to the steel core. The radial thickness of the copper should not

be less than 0.25mm. Couplings for copper clad steel rods should be made from silicon bronze allow grade CS101 of BS2874. A hardened steel tip shall be fitted as the driving cap.

Earth electrodes shall be installed as close as possible to the building being protected. Polycarbonate earth inspection chambers complete with cover shall be used to protect each earth electrode. The earth inspection chamber shall extend to a depth of 500mm below finished ground level and kept free of soil.

Each earth electrode shall be clearly marked "Safety Lightning Connection - Do Not Remove". A heavy-duty steel cover shall be used when earthing chambers are located on the road.

SURGE PROTECTION SPECIFICATION

1 Surge Protection Standard - AS 1768: 1991

In selecting a lightning surge protector, it is important the device complies to the recommendations of most of the International Standards. Among the most prestigious standards are Australia Standard AS 1768:2003, British Standard BS 6651:1999, ANSI IEEE C62.41:1991 and The International Electro-Technical Committee IEC 1024-1.

Australia Standard AS 1768 outlines the major factors to consider when choosing and specifying lightning surge protection such as Location Categories, Modes of Protection, Product Testing and Let Through Voltage, apart from the other criteria that must be taken into consideration such as Survivability, System Compatibility, End of Life and Warranty Period. Others relevant standard are stated below:

- AS 3000-2000 Wiring Rules
- AS 3015-1993 Electrical Installations-Extra-low voltage DC power supplies within public telecommunications networks
- AS 4070-1992 Recommended practices for protection of low-voltage electrical installations and equipment in MEN systems from transient over voltages
- AS/NZ 4117:1996 Surge suppression devices for telecommunication applications
- AS 4262.1-1 995 Telecommunication over voltages - Part 1: Protection of persons
-

1.1 Location Categories for retail station application

AS 1768 divides a typical low voltage distribution network into 3 categories broadly described below. The surge protector shall survive and provide a low let through voltage as required by this standard.

Location Category C is classified as:

- Point of entry at highly exposed elevated and critical positions with voltage waveform of 6kV at 1.2/50us and m n t waveform of 70kA at 8/20us.
- Point of entry for external services such as supply mains with voltage waveform of 6kV at 1.2/50us and current waveform of 20kA at 8/20us.

Location Category B is classified as:

- On the power distribution system between the load side of the incoming distribution board and the supply side of a socket outlet within 30m. The surge voltage waveform can be as high as 6kV at 1.2/50uS and current waveform of 3kA at this sub-circuit level.

Location Category A is classified as:

- On the power distribution system between the load side of the incoming distribution board and the supply side of a socket outlet within 60m. The surge voltage waveform can be 6kV at 0.5/100kHz and current waveform of 200A or 500A may appear at the final sub-circuit.

1.2 Modes of Protection

Transient voltages appearing between line and ground are called common mode disturbances. Typical of these includes lightning strikes where equal voltages can be induced into both conductors with respect to earth. Certain types of electrical system earth faults will also create common mode voltages.

Transient voltages existing From line to line are called transverse or differential mode voltages. These are commonly created by power system operations, motor starts etc.

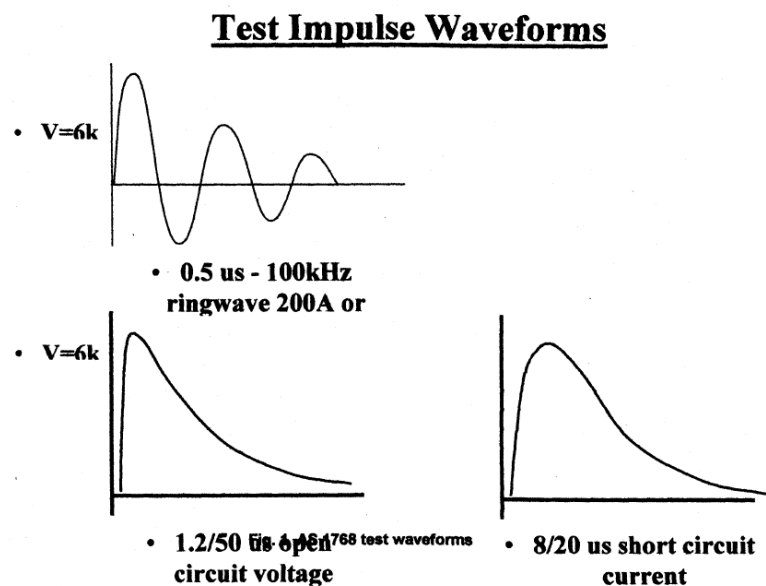
For full and effective protection, a surge protection device must provide protection for both common and transverse mode disturbances.

1.3 Product Testing

A well-equipped laboratory shall be able to testify the following: -

- The effectiveness of the surge protector.
- The let through voltage of the surge protector.
- The electronic component damage limits against lightning surge.

AS 1768 specifies the surge impulse waveform used for testing equipment to be installed at Category B and C locations shall be a combined waveform of 6kV, 1.2/50us and 3kA 8/20us as shown in the following waveform diagram. This combined waveform is also called for in BS 6651:1999 Appendix C and IEEE C62.41:1991.



1.4 Surge Rating

A higher quality surge protector shall be able to withstand multiple strikes without any destruction. A single lightning surge discharge can have surge current up to 100kA at one time. Lightning activity varies from region to region; therefore, it is important to install a surge protector that has proven performance in the region it is intended for.

1.5 System Compatibility

The surge protector shall not interfere or restrict the normal operation of the electrical distribution system. It is undesirable for mains power supply protector to disrupt or corrupt the continuity of electrical supply and introduce any high earth leakage currents.

1.6 Alarm Indication

It is important that the surge protector has a properly indicated pre-failure warning, whilst still providing protection for the equipment. A Set of dedicated monitoring contacts shall be provided from the lightning and surge protection system for direct connection to the central monitoring system. The monitoring contacts shall be volt free with normally open and normally closed position for status monitoring of individual suppressor components.

1.7 Warranty Period

The surge protector unit shall have a written warranty of 5 years against any manufacturing defects and 2 year against direct lightning strike incident. A full manufacturer's certificate shall be obtained for the respective units of suppressor supplied. The surge suppressor must be purchased from the authorized agent to ensure 24 hours back-up service and replacement parts within the warranty period.

2 Product specification

The specifications below reflect the requirement and performance of Tercel International products or approved equivalent as recommended for this tender.

2.1 Main Switchboard Protection - to provide base level of protection for all circuits against induced surge on the incoming mains power supply

A three-phase surge divertor including neutral and ground protection, ISOSURGE 120kA 3ph 50Hz shall be installed at the Main Switchboard (MSB) to provide shunt protection for all loads fed from the MSB.

2.1.1 Technical Specification

The divertor shall meet all the specification requirements:

- Three stages iTMOV™ high energy protection with 120kA surge rating
- operating voltage to suit 415V AC, 50Hz system
- let through voltage of <800V for AS1768 Category B 3kA 8/20usec pulse
- let through voltage of <900V for AS1768 Category C 20kA 8/20usec pulse
- let through voltage of <1400V for AS1768 Category C 70kA 8/20usec pulse
- LED indicators monitoring MOV integrity for each phase
- opto-isolated alarm terminals for connection to external alarm, indicating divertor condition and power on/off
- standard DIN rail mount MCB profile, 2U wide - 101H x 35W x 76D (mm) per module
- screw terminals - maximum 10mm sq. cable

2.2 Sub Switchboard Protection - to provide a second level of Protection for all circuits against induced surge on the incoming mains power supply

A three-phase surge divertor including neutral and ground protection, ISOSURGE 50kA 3ph 50Hz shall be installed at the Main Switchboard (MSB) to provide shunt protection for all loads fed from the MSB.

2.2.1 Technical Specification

The divertor shall meet all the specification requirements:

- Three stages iTMOV™ high energy protection with 50kA surge rating
- operating voltage to suit 415V AC, 50Hz system
- let through voltage of <800V for AS1768 Category B 3kA 8/20usec pulse
- let through voltage of <1000V for AS1768 Category C 20kA 8/20usec pulse
- LED indicators monitoring MOV integrity for each phase
- opto-isolated alarm terminals for connection to external alarm, indicating divertor condition and power on/off
- standard DIN rail mount MCB profile, 2U wide - 101H x 35W x 76D (mm) per module
- screw terminals - maximum 10mm sq. cable

2.3 4 x 500kVA RPA UPS protection - to provide protection for the UPS which fed on this circuit

A three phase, multi-stage power series filter ISOPULSE rated at minimum 1000A continuous per phase with neutral protection c/w bypass system shall be installed on the power circuit feeding the UPS. The power filter shall be located in series with the supply feeding to the UPS.

2.3.1 Technical Specification

The power filter shall meet all the specification requirements:

- series filter's current rating of 100A continuous per phase, three phase with operating voltage to suit 415V AC
- series power filter with three stage protection consisting of MOV, low pass LC filter, MOV
- MOV protection with 70kA surge rating at front end of LC filter and 40kA surge rating MOV at rear end of LC filter
- protection modes must be transverse and common
- capacitor figuration in LC filter must be self-healing, polypropylene, 'Y' type to earth, protected by series fusing
- efficiency must be 99% and voltage drop less than or equal to 3V at full load
- leakage to earth must be less than or equal to 1.5mA
- let through voltage of less than 400V for AS1768 Category B 8/20usec pulse
- neon alarm indicating divertor condition and power on/off available on front panel of filter
- dimensions - 1940H x 915W x 320D (with enclosure)
- metal enclosure, powder coat (bright white) finish over zinc plate steel, IP54 rating

- Connections - MI2 threaded posts (Power) and 2.5mm² terminals (Alarm)

2.4 Plugable UPS, Server, Monitor, Card Access Control module, Fire Control Panel, 19" Rack power supply, Video Monitor/Recorder, Time Division Multiplexer, PA Amplifier and control module - to provide protection for the sensitive electronics equipment which fed on this circuit.

A single phase, multi-stage power filter ISOPULSE shall be installed on the power circuit feeding the sensitive electronics equipment. The filter shall be located in series with the supply from the 13A SSO to protect circuit feeding to the POS and UPS.

2.4.1 Technical Specification

The power filter shall meet all the specification requirements:

- series filter's current rating of 10A, single phase with operating voltage to suit 240V AC
- series power filter with three stage protection consisting of MOV, low pass LC filter, MOV
- MOV protection with 8kA surge rating at front end of LC filter end 8kA surge rating MOV at rear end of LC filter
- protection modes must be transverse and common
- capacitor figuration in LC filter must be self-healing, polypropylene, 'Y' type to earth, protected by series fusing
- efficiency must be 99% and voltage drop less than or equal to 3V at full load
- leakage to earth must be less than or equal to 1.5mA
- let through voltage of less than 400V for AS1768 Category B 8/20usec pulse
- neon alarm indicating divertor condition and power on/off available on front panel of filter
- dimensions - 270 mm x 100 mm x 65 mm for floor am wall mounting
- metal enclosure, powder coat (bright white) finish over zinc plate steel, IP54 rating
- 13Amp input plug socket with 1.5m cable length and fuses protection.
- 2/4 x 13Arnp Single socket Outlet shall be provided.

2.5 CCTV power protection – to protect power module inside CCTV against induced surges on external power circuits

A single phase, multi-stage power filter shall be installed on the 5A power circuits to the electronic power module inside CCTV.

2.5.1 Technical Specification

The power filter shall meet all the specification requirements:

- current rating of 5A single phase with operating voltage to suit 240 VAC, 50 Hz system or
- series power filter with three stage protection consisting of MOV (8kA surge rating), law pass LC filter, MOV (8kA surge rating)
- protection for both transverse and common mode disturbances
- capacitor figuration in LC filter must be self-healing, polypropylene, 'Y' type to earth, protected by series fusing
- efficiency must be 99% and voltage drop less than or equal to 3V at full load
- leakage to earth must be less than or equal to 1.5mA

- let through voltage <60W for AS1768 Category 6 3kA B120usec pulse for IL5H275
- dimensions - 80mm x 74mm x 25mm polyamide enclosure with integral DIN rail mount footing, screw terminals
- cable entry must be ensuring segregation of input cables from output cables

2.6 CCTV data line protection - to protect CCTV against induced surges on coaxial line

A coaxial cable surge protector each contains a fast response gas filled arrester shall be installed on the communication connected between the CCTV and Time Division Multiplexer. Both of the CCTV and Time Division Multiplexer shall be protected by individual coaxial surge protector separately. The module shall be installed as close as possible to the equipment.

2.6.1 Technical Specification

The protection module shall meet all the specification requirements:

- one stage protection consisting of fast response gas filled arrester rated at minimum 20kA
- protection for both transverse and common mode disturbances
- to suit coaxial signal cable - maximum working voltage (line to line) 90V DC
- surge withstand rating of 20kA for 8/20u/s pulse
- let through voltage for AS1768 Category B 6kV 1.2/50u/s, 3kA 8/20us pulse
- insertion loss shall be less than 2.0 dB at 2.5GHz
- maximum capacitance shall be 2.0pF
- insulation resistance shall be more than 1010
- characteristic impedance shall be 75 ohms with operating bandwidth within 2.5GHz
- dimensions 25mm x 25mm with max 57mm for length
- temperature range 0-45degC, 10% - 95% RH
- Casing shall be silver plated brass
- Connectors will be F/F or M/F

2.7 PABX and incoming telephone lines protection - to provide protection for telephone incoming lines to PABX and MDF

A multistage ISOKRONE krone plug-in multistage protection for 10 pairs telephone lines shall be installed on incoming telecommunications lines at the Main Distribution Frame (MDF), Intermediate Distribution Frame (IDF), Building Distributor (BD), Campus Distributor (CD), Floor Distributor (FD) and PABX.

The module shall be installed into Krone LSA* disconnect termination blocks with the 'LINE SIDE' side components facing the direction of the incoming surge.

2.7.1 Technical Specification

The protection module shall meet all the specification requirements:

- three stages protection consisting of gas arrester / series impedance / silicon avalanche diode (SAD) components mounted on single PCB rated at minimum 20kA.

- module to have Beryllium Copper Spring earth clips on each end with clear per spec cover to allow inspection of surge suppression components and PCB tracks
- protection for both transverse and common mode disturbances
- nominal DC breakdown 490V line to earth and 265V line to line
- surge rating 20kA a+b-e, 10kA a-b for 8/20u/s pulse
- let through voltage <80V for AS1768 Category B 3kA 8/20u/s pulse
- AC discharge current a+b-e is 10A at 50Hz for 1s
- insulation resistance >5Meg ohms at 200VDC
- capacitance a-e, b-e <5pf, a-b <100pf
- loop resistance 16.4 ohms
- loop inductance 2uH
- insertion loss <0.5dB at 600 ohms, 100kHz and <3dB at 600 ohms, 20MHz
- dimensions 136mm long x 39mm from front of Krone* block when fully inserted x 200mm high - weight 80gms
- temperature range 0-45degC, 10%-95% RH
- tested to ACA TS001-1997, ACA TS002-1997, ASNZ3260 or approved equivalent

2.8 RS485 Data Line Protection for security card control system and PMCS - protect against induced surges on external data circuits

A single pair, hard-wire module with multiple stages of protection shall be installed on RS485 line feedback to control module and PLC, where DC isolation is required between signal line screen (shield) and the safety earth.

The module shall be installed as close as possible to the control module with the LINE side components facing the direction of the incoming surge.

2.8.1 Technical Specification

The protection module shall meet all the specification requirements:

- four stages protection consisting of gas arrestor / series inductance / MOV / silicon avalanche components
- additional gas arrestor between chassis and protection circuit to ensure 'floating earth' for noise free operation
- protection for both transverse and common mode disturbances
- overcurrent protection using PTCs
- maximum working voltage (line to line) 18V DC
- surge withstand rating of 20kA for 8/20u/s pulse
- let through voltage for AS1768 Category B 6kV 1.2/50u/s, 3kA 8/20us pulse - 22V (common mode)
- maximum loop resistance 20 ohms
- frequency response 3dB point > 1MHz
- dimensions 80mm x 74mm x 25mm, screw terminals 2.5mm sq. maximum
- universal DIN rail mounting
- temperature range 0-45degC, 10%-95% RH

Addressable Microprocessor Type Automatic Fire Alarm System

The contractor shall supply, install, commission and maintain an automatic addressable analogue microprocessor fire alarm system in accordance with the specifications and drawings. All main equipment shall be from the same manufacturer, this applies in particular to the detectors, control units and central operating equipment. The system shall comply with the requirements of BS 5839 and shall include but not limited to the following:

- Fire indicator board with text display, keyboard and printer
- Mimic panel with programmable LEDs
- Repeater panel with LCD display, keyboard and printer if specified
- Addressable field devices and bells / sounders
- Interface units for controlling and monitoring associated services

The system should be capable of modular expansion, networking and interfacing with advanced building monitoring systems.

FIRE ALARM CONTROL PANEL (Master, and Sub Panels)

The fire alarm control panel shall be constructed as a wall mounted unit to IP42 rating using 1.6mm thick sheet steel sections suitably reinforced. The panel shall be fitted with a lockable front door with a transparent viewing panel or alternatively in the absence of a door a key switch which disables the control keys.

The system shall be microprocessor based. All operating programs and data's for system configuration shall be held in updatable non-volatile memory (EEPROM), or shall be battery backed up on the board itself using batteries with a 10-year life span and 72 hours capacity. The control panel shall incorporate a real time memory log capable of storing up to a minimum of 255 events, including the time and date information.

The fire alarm panel shall incorporate a sequential polling system which polls each device individually and transmits or read information from it. The information is compared with all possible fire patterns in the software (algorithms) and a decision made as to the status of the device (pre-alarm, fire, short/open circuit fault, incorrect addressing, unauthorized device removal or exchange, detector contaminated or normal) and events annunciated. The System polling time shall not exceed 1 second for each complete scan of all devices attached. Upon receiving an alarm signal the panel shall enter a 2nd stage verification process, which shall consist of verifying if the alarm signal persists for the second scan, while simultaneously comparing the temperature and smoke levels of adjacent detectors. If the alarm persists during the 2nd scan or adjacent detectors indicate readings in the pre-alarm conditions the alarm shall be initiated.

The panel shall also check the self-test function results of the detectors during polling and display maintenance signal if these are out of range. When contamination causes a detector's sensitivity to shift, the panel shall recalibrate the device to compensate (i.e. adjust threshold levels). When contamination becomes excessive, the panel shall indicate a "detector maintenance required" signal. The alarm threshold of individual or group of detectors shall be programmable from the alarm panel. It should also be possible to link the threshold levels to the time of day to suit the occupancy.

All devices in the system shall have a unique address and a 32-character alpha-numeric label. The addresses shall be automatically assigned by the control panel during commissioning stage while the label and data entry for the devices is either through the host computer or keyboard in the control panel. The control panel shall be capable of zoning a group of detectors from various loops. The zoning shall be done using alpha-numeric designation (keyboard entry from control panel or from host computer) or geographically mapped (using interactive colour graphics software and host computer).

The system shall be capable of accommodating alterations/extensions without need for relabeling (i.e. allocation of address shall be independent of the physical arrangement in the loop). The labelling shall be stored in a non-erasable memory within the control panel. The address and label shall not change due to replacement of sensor heads or removal of other input/output devices. The panel shall be fully field programmable, with no special RAM burning equipment using the panel keyboard or a portable pc. Configuration data's shall be backed up on disk, with a copy retained by the contractor and one copy by the owner. Wiring shall be of return loop arrangement and the panel shall be able to be configured in multiple loops. The loops shall be capable of

accepting a minimum of 99 devices, which shall include fire detectors, break glass, contacts such as sprinkler flow switches (with delay timer incorporated), alarm sounders, interface for trip relays, solenoid valves and other evacuation/alarm systems. Faults on one loop should not affect the other loops.

Removal of any sensor head or device from its base shall not impair the function of other devices, or break the loop. Loop isolators shall be fitted on all addressable field devices to protect against single open or short circuit faults within the loop by isolating the faulty section of the loop. The fault and location shall be annunciated on the main panel. The addressable line and sounder circuit must be fully protected against short and open circuits. The alarm panel shall electrically supervise the zone circuits. The following shall be indicated as faults in the alarm panel, but shall not affect its operation.

1. Removal of any detector or disconnection of call points and other alarm devices from its circuit
2. Short circuit and/or disconnection of cables to alarm and detection zone circuits, failure of battery charging equipment, batteries and fire alarm devices (Sounders) external to the main fire alarm panel
3. Electrical earth fault of cables containing direct power source
4. Short circuit or disconnection of mains power supply
5. Cessation of any scanning or interrogating process within the control equipment.
6. Faults on any of the interfaced panels and associated communication cabling.

The panels shall be designed to annunciate visually and audibly a fire situation and the existence of fault in the system. The following facilities shall be provided.

1. Mains on Indicator (green LED)
2. Fault Annunciator (yellow LED)
3. Fire Annunciator (dual red LED)
4. Fire/Fault Buzzer
5. Zone/Loop Isolate Annunciator (yellow LED)
6. Evacuate push button
7. Sounder/Buzzer Silence push button with auto reset upon activation of a new alarm
8. Cancel Fault and Acknowledge Fault push button
9. Fuses (screwed on type)
10. Lamp Test push button
11. Reset push button
12. 2/4 line 40 Character Scrolling LCD display
13. 40 Character Thermal Printer
14. Key Board and Menu function Keys.
15. Fire Brigade Link Facility
16. Fire Brigade Link Indicator
17. Label (Manufacturer/Serial No./Date of manufacturer/ model No./Panel identification)

The panel shall incorporate a display which shall indicate the event type, alarm count, the zone label and device number/label in the event of a fire alarm. It must be possible to check device status as well as device type on the display. When the panel is in a normal condition the display shall indicate the time and date with an option of a system or building title. The control panel shall utilise a multitasking programmable software, which shall be capable of monitoring and controlling fire doors, smoke spill fans, dampers, alarm sounders, etc to suit the alarm event. It should also be possible to operate the remote devices by issuing commands from the fire alarm panel or central monitoring system. An RS232C or RS485 serial communications port shall be provided together with the communication Protocol software to enable the control unit to be connected to an external computer and printer. Provision must also be made for zonal fire outputs to switch external relays and indicators for mimic purposes.

A printer shall be incorporated into the panel for event logging onto a hard copy. All print text shall be field programmable without the need of special RAM burning equipment. Simple menu driven facilities shall be provided for the alteration of the stored program and for maintenance. These facilities shall be protected against unauthorised alterations by means of user defined multilevel access code. There shall be a minimum of 4 access levels (ie information, user operator, user engineer, specialist). The functions and operations of the system shall not depend on the programs stored on rotating disks or storage media using moving parts, or any other form of corruptible memory. When a CPU is used to record the events and/or generate graphics, this equipment is acceptable as an enhancement to the main fire alarm system only.

The menu driven functions shall include but not limited to the following minimum requirements: -

- Display all point log or that of selected zone or subsystem
- Display alarm summary (minimum of last 99 events)

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- Lock out or unlock selected items
 - Display summary of locked out items
 - Assign time and date
 - Display points and associated datas
 - Enter or delete programmed on / off times
 - Modify time delays and alarm sounder modes
 - Activate / deactivate output relays controlling fire protection devices
 - summary of dirt levels in detectors and disconnected point list
 - Trend report of smoke levels and temperatures

The operation of the panel shall be continuously monitored. When the stored program be accidentally corrupted in such a way as to interfere with the correct operation of the system and/or in the event of failure, a fault warning shall be given which shall be automatically reset after the system has been restarted. The panel shall incorporate on line diagnostic software which regularly runs diagnostic tests up to chip level to reflect component failure. Under normal circumstance, where the response is a detector the time taken for scanning, interrogation, decision or other signal processing either within the control equipment or controlled by it, shall not delay the response by more than 10 seconds. Where the response is to the operation of manual call point, the delay shall not exceed 3 seconds. The delay due to the response from other interfaced fire alarm devices shall be to suit the connected device.

POWER SUPPLY

Each fire alarm Panel LED mimic panel and sub system shall operate on a 240V AC supply and on a 24V DC standby battery supply. The 240V AC supply shall be taken from the live side of the incoming public utilities supply or from the generator mains where available. The circuit protective device for the fire alarm system should be reserved for the purpose and its cover coloured red and labelled:

"FIRE ALARM SUPPLY: DO NOT SWITCH OFF."

"THIS SUPPLY REMAINS ALIVE WHEN THE MAIN SWITCH IS TURNED OFF"

The power supply should be extended to the fire alarm panel using fire resistant cable and terminated within the panel through a double pole switch. The power supply should be extended through an unswitched spur unit located adjacent to the fire alarm panel. The spur unit should be finished in red and labelled "Fire alarm supply - Do not switch off".

The batteries shall be sealed maintenance free nickel cadmium type of sufficient capacity to maintain the standing losses of the system together with the fault signal load resulting from mains failure for a continuous period of at least 24 hours or longer as stated in the bill of quantities/drawings. Thereafter the battery provided shall be able to supply the full emergency evacuation alarm load to operate all sounders, indicating lights, detectors, auxiliary systems etc for a period of at least 1/2 hour. The mains supply should be capable of supplying the maximum battery charging load and at the same time supply the full evacuation alarm load. Batteries shall have a label stating date of installation and expected life time expiry date which shall not be less than 4 years.

The charger shall be able to provide automatic boost and trickle charging. It shall be complete with a current limiter, voltage regulator, diode reverse polarity protection, overload protection and input/output fuse and necessary relays. The charger shall be capable of charging the fully discharged battery within 24 hours, by its normal charging method to a fully charged condition. Automatic control features shall be provided to ensure that the batteries are maintained and charged within the Limits Set by the battery manufacturers.

The operation of all equipment shall be inherently stable for voltages of $\pm 10\%$ of nominal voltage. A surge suppression device shall be provided on the incoming power supply line to protect against transient surges and electromagnetic interference. Calculations on the charger and battery selection shall be provided. Batteries shall be sized for a end voltage of 80% of system voltage or 1V/cell.

DETECTORS

All electronic circuits and devices in the detectors shall be hermetically sealed to protect from dust, dirt or humidity. All circuitry shall be protected against electrical transients and electromagnetic interference while the sensor element is protected against dust and vermin. The detectors shall be compensated for temperature,

humidity and barometric changes. The detector shall be of low profile, small footprint, aesthetically pleasing off white appearance.

The design of each detector shall consist of a terminal base with a plug and twist fix electronic module and replaceable or serviceable sensor element, should it become dirty. Bases should have cable terminals for the loop connection, connection of a remote LED, spur loop connection, or auxiliary contact terminals as required for the specified configuration. The base shall be common for point type, thermal and smoke detectors. The detector should incorporate an anti-tamper locking device which could be enabled if required. Each detector shall incorporate a red L.E.D. Indicator to annunciate alarm condition. The placement of the LED on the detector base should permit a wide viewing angle. The system shall provide for connection of a remote L.E.D. unit when necessary. The remote L.E.D. unit shall be minimum 3mm diameter, with a diffuse lens cover and mounted on a base plate, engraved with the wordings "Fire Alarm Activated" in red letters not less than 3mm high.

Detectors shall be loop wired and loop powered using a two-wire screened cable. The sensitivity of addressable detectors shall be individually adjustable from the control panel. Every detector base shall have a short circuit isolating device. It shall be possible to measure and display the detectors sensitivity at the control panel. The detector shall incorporate a identification code and self-test function, which shall be reported to the panel. If the detector is removed or the wrong type of detector is plugged in or the data returned is incompatible as compared to the database in the control panel, it must be annunciated at the control panel. The quiescent current shall be minimal and should not exceed 0.1mA

All detectors and devices should have a clear visual marker externally attached (Transfer tape or equivalent) stating the zone number followed by the point number eg:- **01 05** (ie Zone 01 and point 05). The visual marker should correspond with the diagrammatic representation and also the line identification form.

THERMAL DETECTOR

Thermal detectors shall comply with BS 5445 part 5 for installation in normal environments and BS 5445 part 8 for high ambient temperatures. Thermal detectors shall have rate-of-rise and fixed temperature detection characteristics and shall generally be of Grade 1 type. Grade 2 & 3 and fixed temperature thermal detectors shall used if specifically shown in the drawings.

The point type thermal detector shall utilize a thermistor sensing element, which provides close tolerance performance under all rates-of temperature rise condition. Linear detectors shall be of the integrating type. The detector should monitor the linear detecting element for open and short circuit faults and annunciate the same at the detector base.

SMOKE DETECTOR

The smoke detector shall be in accordance with BS 5445 part 7 and part 9. Photoelectric type detectors shall respond to visible smoke concentrations and shall consist of a light source in a labyrinth chamber, such that no direct light normally reaches the sensor, but the presence of smoke scatters the beam and activates the sensor. Alternatively, sensors based on the obscuration principle may be used.

The Ionization detector shall respond to the first traces of fire in the form of visible smoke or invisible products of combustion and shall be a dual chamber type. The radio-active source shall be less than 1 micro-curie of Americium 241, and shall comply with all atomic energy Agency requirements. Sensors for monitoring air flow shall be optical type and shall incorporate an airtight sampling housing and twin probes.

SOUNDERS (ALARM BELL / SIRENS)

The bell shall generally be 150mm diameter pressed steel dome shaped type. Sirens shall be pressed steel or high impact ABS. Sounder shall be substantially finished in red colour and shall be mounted at a height of 2250mm above finished floor level. Sounders installed externally shall be of weatherproof construction.

Bells shall sound at least 95 dB at 1m and sirens 100dB at 1m when activated. The contractor shall check the sound levels, which shall be 65dB or 5dB above the background noise all over the protected area, whichever is higher. Bells shall be connected to the loop using an addressable interphase unit. Electronic sounders shall be loop wired, loop signaled and addressable units. The frequency of the sound produced shall be clearly in the

audible range, somewhere nearby 1KHz. Sounders shall be configured and monitored by the alarm panel. The sounders shall operate individually or in sectorised groups as instructed by the alarm panel, totally independent of the way they have been physically connected to the loop.

The sounders shall be able to produce three different tones (alert with 1 sec on and 1 sec off, continuous tone for evacuate and a used defined tone for specialized events) that are totally in phase and hence clearly distinguished from one another. The output of all sounders shall be synchronized with one another. Sounder throughout the premises should be connected on at least 2 separate circuits to ensure that the failure of one circuit does not leave the system inoperable.

MANUAL CALL POINT

The call point shall be of the break glass type, with casing finished signal red. The lettering "Fire-Break Glass" shall be inscribed or printed on a thin plastic film laminated on the exterior surface of the glass. The call point shall be electrically compatible with the standard range of automatic detectors so that it can be connected directly into a addressable supervised two-wire zone. The call point shall comply to BS 5839 part 2. It shall be possible to test the Manual call point with the use of the test key provided and without breaking the glass or removing the cover.

Call points shall be flush mounted directly onto conduit junction boxes at a mounting height of 1400mm above finished floor level to the centre of the call point. Where call points require additional protection, they shall be supplied with a hinged transparent polycarbonate cover with the wordings "Lift cover before breaking glass". Call points exposed to the weather shall be provided with weather gaskets.

INTERFACE UNITS

Interface units shall be capable of either being used for an input to the fire alarm loop such as conventional zones of detectors, sprinkler system etc. or an output from the fire alarm panel to other site services such as lift homing signals, AHU trip signals, sound evacuation signals, etc. The type of voltfree contact (normally closed/normally open) with minimum 6A, 240v ac rating shall be as specified in the drawings/Bill of Quantities. The interface shall be a self-contained wall mounted unit which is loop powered. In multi-port interface units, each input/output shall have its own address. The address setting shall not be from the interface unit, but it shall be from the fire alarm panel itself. All inputs/outputs shall be fully monitored for open and short cable faults. LED's shall be provided on the interface unit base to indicate activation/ faults.

MISCELLANEOUS DEVICES

The system supplied should include in its standard range, accessories to facilitate a flexible configuration of the system. The accessories should include but not limited to the following:

1. Sounder-Sensor base combination with a common address.
2. Combination sensors with a thermal and smoke sensing element, and time zoning feature, which enable either or both sensors to be active in line with the user defined programming.
3. Beam sensor pair
4. Flame sensor
5. Xenon Beacon
6. Magnetic Door Release Unit

SILK SCREEN DIAGRAMMATIC LAYOUT PLAN

A silk screen diagrammatic layout plan shall be provided at each of the alarm panel locations. The silk screen shall cover the whole building on a 1:500 scale, or otherwise as mentioned in the bill of quantities. The silk screen shall clearly identify the location of all the fire protection detectors, devices, escape routes and individual alarm zones, which shall be coloured and numbered for easy identification. The diagrammatic layout should also include a legend to identify the various devices, emergency call telephone number and service call telephone number.

LED MIMIC PANEL

Since the addressable fire alarm panel is capable of identifying every address, the LED mimic panel if specified need only have LED indicators for each zone. The system shall illuminate an entire section or area that is on fire at the mimic panel. The construction of the diagrammatic panel shall be similar to that described above in the section "Silk Screen".

The mimic panel shall also incorporate LED's for indication of mains failure, battery failure, status of standby generators, low water levels in fire tanks, status of fire pumps, status of smoke spill fans etc. The mimic panel shall be fully supervised by the control panel. The control panel shall monitor for the cable faults (short and/or open circuits) and loss of communication between them. Under Fire condition, the word "FIRE" shall be indicated on the mimic panel. Lamp test facility shall be provided at the mimic panel. The mimic panel shall contain an integral battery back-up with capacity similar to the requirements of the main alarm panel.

REPEATER PANEL

The repeater panel shall display all the messages and information of the system. It should include text display, a printer and keyboard. The repeater panel acts similar to a parallel display unit of the main panel. The repeater panel shall have basic and essential controls, i.e. evacuate, start sounders/bells and stop sounders/bells push buttons. The repeater panel shall also have the function keys and keyboard to operate the system menus and to enable and disable the devices. The repeater panels shall be monitored by the main panel. In addition, the main panel shall supervise the wiring to the repeater panel and the loss of communication between them. The repeater panel shall have integral battery back-up with capacity similar to the requirements of the main alarm panel.

WIRING

All internal wiring shall be fire resistant screened cables to BS 6387 with minimum categorization AWX or SWX or equivalent cable in accordance to the manufacturers requirements and run in conduit. Underground cabling shall utilize PVC/SWA/PVC multicore control cables to BS 6346. All wiring shall be in accordance to the requirement of the specification detailed in the section "CABLING" and in accordance with BS 7671 "IEE wiring regulations.

Fire alarm cabling shall be run in its own containment and shall be segregated from other services. Containment transversing external walls and floors shall be effectively sealed using a non-setting compound to ensure water tightness. Containment transversing a fire rated compartment shall be fire sealed to the same rating as the compartment wall. Containment transversing floors shall in addition be provided with a 50 mm high watertight curb. Conduits shall preferably be run in the structure or in the wall with minimum 12mm plaster cover. all conduit supports shall be of metallic construction. Containment which are run surface or subject to mechanical damage or exposed to the weather shall be of metallic construction. Conduits which are embedded in the structure or plaster may be pvc conduit.

Cables shall generally be routed as shown in the drawings and through routes of low fire risk. Conduit/trunking entry from a non-air-conditioned space to a conditioned space shall be sealed using silicon or equivalent compound to prevent the egress of fresh air and resulting condensation. Conduit entries to detectors and devices shall be provided with a seal to prevent egress of moisture, dirt and dust. All exposed conduit/trunking for the fire alarm system shall be painted signed red or identified with the words "fire" at 3m intervals. Cables shall generally be 1.5 sq mm for detector circuits and 2.5 sq mm for alarm circuits unless otherwise shown in the drawings. Cables and route selected should limit the voltage drop to less than 10% of nominal voltage. Zone wiring shall generally be in a closed loop arrangement (class a)

All cable tails at detectors, devices and control panels shall be identified by means of numbered ferrules in accordance with the cable schedule. (ie zone number and device number). Cable tails shall be appropriately glanded or sealed to suit the type of cable installed. Where the outer insulation of screened cables is removed, heat shrinkable irradiated polyolefin tubing shall be used. All indication and stimulation signals between other services & the fire alarm panel shall be supplied installed and terminated by the fire services contractor. All necessary interfacing relays shall also be provided.

OPERATION UNDER FIRE SITUATION

Upon activation of any smoke detector, thermal detector, manual call point, flow switch, or FM200 system, or other fire inputs, the fire alarm system shall initiate the following operations:

1. Indication at the fire alarm panel and mimic panel of the zones and detectors which are activated.
2. Initiate the buzzer within the fire alarm panel and then after 15 seconds initiate the alarm. This time delay shall be continuously adjustable between 0 to 30 seconds. Initiate a signal to the audio evacuation system to broadcast the evacuation message after one minute of continuous bell ringing.
3. Tripping of air conditioning equipment at the zone on fire and activation of pressurization, smoke extract fans, pre-action sprinklers, audio evacuation system and other fire protection related systems.
4. Activation of the lift fire mode of operation and lift homing
5. Transmit signal to central fire station, system printer and other panels networked.

A single stage alarm system shall activate all sounding devices continuously on activation of any alarms. For a two-stage alarm system the following sequence shall be adopted.

1. The alarm sounders on the zone on fire shall sound continuously and those on the adjoining zones, shall sound intermittently (1 sec on and 1 sec off) to indicate alert condition.
2. After 2 minutes the alarm on the zones on fire and the adjoining zones, shall sound continuously and all other zones intermittent.

Where an audio evacuation or PA system is provided the emergency paging signal shall silence the alarm sounders for the duration of the voice message. The activation of the alarm sounder should also activate relays to silence background music and other non-essential sound reinforcement systems.

INSPECTION TESTING AND COMMISSIONING

The tests to be carried out shall include but not limited to :

1. Insulation test of wiring using a 500V megger before devices are connected.
2. Earth continuity tests
3. Visual inspection of the system to ensure compliance with the specifications
4. Dynamic testing of each detector/device and sounder for correct operation installation
5. Operation of ancillary equipment and linkage to fire department,
6. Verification that the software meets design intents and specifications

SPARES AND TOOLS

A stock of 10% of manual call point glasses, 10% of indicator panel lamps, 2 nos bells/sounders and 4 nos smoke detectors and 4 nos thermal detectors shall be provided and located within the fire alarm panel or in a lockable cabinet beside the fire alarm panel. The contractor should also supply any special tools required for routine maintenance of the system (ie Detector removal tool, break glass activation key, programming tools etc)

PAPERWORK

The following paperwork are to be maintained at site adjacent to the control panel or in the control room:-

1. Log book
2. User operation manual and AS installed drawings
3. Cable/line identification form, commissioning checklist and test records.
4. Maintenance schedules and emergency contact numbers
5. Programming data input in hardcopy and disk format
6. Component and equipment list and source of spares

BAS/BMS INTERFACE

When a BAS/BMS is interfaced with fire alarm panel, it shall only monitor and display the fire status/information. The BAS/BMS system shall not control the fire alarm panel. The interface shall be through RS232 or equivalent communication port. The contractor supplying the fire alarm panel shall provide all the necessary cabling/interface connection and all necessary interfacing software.

PORTABLE FIRE EXTINGUISHERS AND FIRE BLANKET

Portable fire extinguisher and fire blanket to the approval of Local Fire Services Department shall be supplied and installed by this Sub-Contractor. The number and types of extinguishers and fire blanket are as shown on the drawings. The extinguishers and fire blanket shall be hung or hook or securely placed on brackets fastened to wall, partition or column in a suitable conspicuous and accessible position. Cost of the brackets shall be included in the tender price. All extinguishers should be installed at height of 1m from the floor level to the handle, unless otherwise indicated.

ABC DRY POWDER FIRE EXTINGUISHER

The dry powder shall be a safe and versatile extinguishing medium ideally suited for high risk environments. The dry powder medium shall be non-conductor of electricity. The head cap shall be corrosive resistant and shall ensure ultimate fluidisation of the powder prior to commencement of discharge. The powder extinguishers shall be designed and constructed in accordance with BS5423.

CO₂ EXTINGUISHERS

This shall be an efficient fire extinguishing medium. It shall smother flames and reduce the oxygen content of air around the fire, thus ensuring extinction. It shall be non-conductive and effective against fires in electrical plant. The extinguisher casing shall be of aluminium alloy with a swivel horn applicator. The CO₂ extinguisher shall be designed and constructed in accordance with BS5423.

Water CO₂ EXTINGUISHERS

This shall have a long life operating efficiency. A special protective coating to prevent corrosion to the containers made of polyethylene base coating shall be applied. The extinguisher bodies shall be prefabricated from steel sheets which are preformed and welded together. The neck rims shall be machined copper plated steel components welded into position on the tops of the extinguisher bodies. Caps shall be of Lexan and hoses shall be of pvc with moulded polycarbonate nozzle.

FIRE BLANKETS

Fire blankets shall be in accordance with BS6575 and shall be made of woven glass fibre giving them a rough surface providing stability. They shall be designed to enable simple storage of the blanket, the container shall be non-corrosive, rigid self-extinguishing white plastic. Instruction on usage should be provided on the cover.

TELEPHONE MANHOLES AND DUCTS

The telephone ducting installation shall be executed in accordance with Tel Bru requirements and their guidelines document for provision of telecommunication facilities.

EXCAVATION OF TRENCHES

Trenches shall be kept as straight as possible and shall be excavated to approved formation and dimensions and shall generally be 750mm deep. Trenches shall have vertical sides and are to be timbered and sheeted where necessary to prevent subsidence. The excavation of trenches shall include by way of amplification but not of limitation, all timbering, pumping and bailing required and the provision for all necessary labour, plant, tools, additional soil, fuel and motive power for such purpose and the cost of this service and of the expendable materials shall be included. Before the ducts are laid, the bottom of the trench is to be punned down and filled with sand bedding to a thickness of 75mm. After the ducts are laid, the first 75mm depth of cover backfill shall consist of sand or sifted soil.

Backfilling and reinstatement of open trenches shall then be immediately carried out, a green coloured PVC service identification tape of 150 mm width (0.1 mm thick) shall then be placed about 300 mm above the ducts for the entire length of the duct. The wording on the tape should read "Awat-Kabel Tel Bru di bawah". Excavation of trenches shall be carried out to suit the programme of duct installation work at that location and only enough ground shall be opened such that duct laying and backfilling may proceed without delay and trenches are not left open for long periods. After all ducts have been laid, the trenches shall be refilled in 150mm layers, each layer being well rammed and consolidated.

The surface of refilled trenches shall be temporarily reinstated and maintained in a thoroughly safe condition until complete consolidation of the soil is achieved. Necessary backfill material shall be supplied for the replacement of unsuitable excavation material and the cost of this material together with the backfilling and reinstatement deemed is to be included in the works.

DUCT LAYING/ PVC DUCTS

The line of duct shall be kept as straight as possible. Where ducts are cut, the inside edges of cut ducts shall be thoroughly rounded off before installation. On completion of the duct line between any two jointing chamber or sites thereof a cylindrical brush connected to the following end of a mandrel shall be passed twice through each "way" to clean the duct and to remove any foreign matter which may have entered. The contractor shall supply labour needed for the testing operations.

All tests shall be carried out in the presence of the Engineer and if any obstruction or other defect be discovered, it shall be rectified and the duct retested. A plug shall be inserted at the ends of each "way" in a line of ducts until the length has been tested and passed. To ensure the alignment of the ducts, a working mandrel 450 mm in length and 80 mm in diameter shall be drawn through as the ducts are laid. These ducts are to be supplied in 6 metre lengths. These ducts should be stored away from the direct rays of the sun, as they tend to deteriorate and go out of shape. Solvent cement should be used for the joint. PVC ducts shall be in accordance with BS 3505 class "B".

ENCASING IN CONCRETE

The method of encasing ducts in concrete is the layer-by-layer method where each duct is completely surrounded by concrete. The following procedure shall be adopted:

- i) Open trench to required length. Minimum opening is approximately 1½ times length of conduits being used.
- ii) Place a 50 mm thick bed of concrete on the trench floor.

- iii) In unstable ground or locations where high security is required, place a wire mesh vertically on either side of nest of ducts. The concrete when poured should fully cover the reinforcement which shall be a 150 x 150 x 6 mm dia welded mesh.
- iv) Install a layer of conduits along the trench keeping them evenly spaced by using wooden combs at intervals of 2 metre.
- v) Place a layer of concrete over the conduits and compact in so as to fill the spaces between the conduits by using an approved wooden tool. Provide an approximate 50mm cover above the conduits to form a bed for the second layer.
- vi) Repeat the process for the next and subsequent layer of conduits, raising the spacing comb as each layer is completed.
- vii) UNDER NO CIRCUMSTANCES shall any batch of concrete be off-loaded from wheel barrow, bucket, dumper, chute or similar equipment, directly onto the assembled duct nest. It should first be off-loaded onto suitable boards prior to placing around the ducts. Spades or shovels used for placing must not be pushed into the placed concrete.

Rigid PVC conduits may be bent to avoid obstacles or to negotiate curves. The conduit may be cold bent around stakes for radii above 10 metre. To provide favourable cable hauling conditions the bend radii should be as large as possible.

MANHOLES AND JOINTS BOXES

The type of manholes and joint boxes used shall be as shown on the layout drawings. The manholes should be constructed in accordance with Tel Bru standard drawings. Where the duct capacity of any proposed manhole is not fully utilised the space shall be fitted with dummy ducts for future duct growth by laying initially at standard depth. The dummy ducts shall be sealed with 150 mm cement mortar inside the chamber wall.

TELEPHONE TRUNKING AND CABLING

The entire work on the telephone system shall be in confirmation with the latest JTB specification guide lines for the provision of telecommunication facilities.

DISTRIBUTION BOXES

Distribution boxes shall be supplied to Brunei Telecoms specification. The contractor shall install the distribution box at locations as shown on the drawings. Each distribution box shall be provided with the following:

- a. A traffalite label identifying the DB and area served.
- b. A reduced size laminated drawing (A4 size) of the schematic drawing and layout drawing affixed besides the distribution board.

Termination of the cables at the distribution box would be executed by sub-contractor/technicians registered/approved by Brunei Telecoms. The contractor is required to identify and terminate the cables.

CABLING

Cables shall be supplied to Brunei Telecoms specification. The contractor shall supply and install the cables as shown on the drawings and as per the specifications. Cables shall be installed in conduits or trunkings in one continuous length. Cable installation in trunking/conduits/tray or ducts shall be as specified in the section "Cabling". All conduits/ trunking/trays/ ducts and accessories shall be supplied by the contractor. The material supplied and installation shall be in confirming with JTB specification for cable distribution system.

All cables shall be identified at either end by numbered plastic ferrules. Submain cable in trunkings and on tray shall be identified at 10 metre intervals by means of a stamped copper sheet wrapped around the cable. Cables installed within ducts shall be identified as above at each manhole.

WALL/FLOOR SOCKET OUTLETS/ EARTHING

All telephone socket outlets shall be supplied to Brunei Telekom specification. The contractor shall take delivery and install the socket outlets according to Jabatan Telekom's requirement. The sub-contractor shall provide earthing of values less than 1 ohm at the MDF and to be extended to every telephone DB's of earthing less than 3 ohms. The size of the ground wire (green) shall be 4mm² and shall be pulled from MDF at PABX room, to every telephone DB's. The telephone earthing system must be separated from the Electrical earthing system.

TESTING

All cables shall be tested for insulation resistance and continuity.

MAINTENANCE AND TRAINING OF ELECTRICAL SYSTEM

MAINTENANCE DURING THE WARRANTY PERIOD

The sub-contractor shall guarantee against fault or defect, all materials and work as set out in this specification for the duration of the defect's liability period. The sub-contractor shall at his own expense pay for spare parts, and other items necessary for the operation of the system. The maintenance shall consist of all required servicing of the plant installed including attention to emergency call.

The Engineer may issue the Certificate of Practical Completion at his discretion provided that: -

- a) All required testing has been completed and approved.
- b) All adjustment to equipment which may be necessary to ensure satisfactory operation have been made.
- c) All operation instruction, wiring diagrams and layouts have been received.
- d) A maintenance schedule setting out the proposed programmed of maintenance inspections and servicing together with advice of arrangements of prompt attention to emergency call has been submitted and approved by the Engineer.

At the beginning of the Maintenance Period, the sub- contractor shall provide a log book which shall be lodged with a person nominated by the Engineer. The log book shall remain at the site and shall be used to accurately record all service calls whether emergency or routine, setting out the work performed the date, the duration of each visit, the repair or adjustment made.

TRAINING

The sub-contractor shall provide the services of a suitably qualified operator for a period of two (2) days during the Defects Liability Period as and when nominated by the Engineer. The operator shall be required to train the employer's services personnel on all aspects of the operation and maintenance of the installation.

SERVICE CONTRACT

The Owner shall have the option to enter into an annual service contract, after the sub-contractor has fulfilled the obligations of maintenance during the warranty period. The service contract shall include emergency service and regular maintenance. The cost of spare parts and materials shall be charged to the Owner in the case of "non-comprehensive" coverage, and covered by the Contractor in the case of "comprehensive coverage".

MAINTENANCE SCHEDULE

The following is intended to indicate the items, where applicable, requiring inspection and attention during weekly, monthly and yearly maintenance service. A detailed list shall be prepared by the contractor based on the equipment manufactures recommended maintenance schedule.

Switchboards, Distribution Boards and Control Panels

a. Service to be performed every two weeks

- 1.Clean the switch rooms and switchboard.
- 2.Replace blown indicating lamps
- 3.Inspect switchboard for any faults, overheating, contactor hum and replace/repair faulty parts
- 4.Verify proper operation of control circuits, change over ATS, etc.

b. Service to be performed every 6 months

- 1.Check tightness of all bolts on the busbar
- 2.Verify earth continuity and earth resistance
- 3.Verify settings of protection devices
- 4.Clean ACB contacts

Light Fittings and Accessories

- a. Clean diffusers at time of handover and at the end of the defect's liability period
- b. Replace bulbs, control gear, fuses etc on a daily basis as the need arise
- c. Replace faulty/damaged accessories
- d. Verify functioning of emergency lights and exit lights on a monthly basis and replace faulty parts.

AIR CONDITIONING & MECHANICAL VENTILATION INSTALLATION

1 SERVICING AND MAINTENANCE

1.1 General

The works covered by this Section is for the supply of all materials, tools, apparatus, equipment and appliances, labour and necessary incidentals for the servicing and maintenance of all the systems and ancillary plant, machineries and equipment supplied and installed under this Sub-contract during the Maintenance Period as well as for the future servicing and maintenance thereof after the expiry of the Maintenance Period.

All works to be performed under this Section shall be in accordance with the best commercial, technical and engineering practice, and must be strictly in accordance with this Specification.

During the Maintenance Period, the Sub-contractor shall replace and/or repair all defective plants, machineries and equipment and installations or any parts thereof entirely free of charge to the Employer whenever directed by the Architect if such repairs or replacements are necessitated by reason of defective design, materials or workmanship or parts thereof replaced during the Maintenance Period shall carry a fresh warranty for a period of twelve (12) months or the balance of the Maintenance Period whichever is the longer with effect from the date of replacement or completion of repair thereof.

For servicing and maintenance after the Maintenance Period, all labour costs involved in the carrying out of servicing, maintenance, replacement and/or repair of defective parts or items and the costs of supplying consumable materials (as listed hereinafter), incidental materials and of using tools, apparatus, equipment or appliances required for carrying out such tasks, shall be deemed to have been Included in the prices quoted for future servicing and maintenance after the Maintenance Period.

1.2 Workmanship and Materials

The works described hereunder shall be performed by workmen skilled in the servicing, maintenance and repair (or replacement) of the plant, machinery, equipment of all types supplied and installed under this Sub-contract, and shall be executed in accordance with the best commercial and technical (or engineering) practice.

All materials to be supplied in connection with the Works under this Section shall be new and unused, and shall generally be of the best quality as regards manufacture and performance.

1.3 Supervision

The Sub-contractor shall have a Supervisor in charge of the servicing, maintenance and repair (or replacement) works required to be carried out under this Specification. For works which required by the local laws and regulations to be performed by personnel who is licensed or registered with the relevant local regulating bodies, the Supervisor as proposed by the Sub-Contractor shall deem to have the appropriate licence or registration. This Supervisor shall also be fully competent in supervising the servicing, maintenance and repair (or replacement) of plant, machinery, equipment of all types, and shall be in direct employ of the Sub-Contractor and acceptable to the Employer.

1.4 Scope of Work

All plant, machineries and equipment comprising the complete systems and ancillary equipment supplied and installed under this Sub-Contract shall be serviced and maintained strictly in accordance with the requirements/recommendations stipulated by all the plant and equipment manufacturers as well as in compliance with all by-laws, rules, regulations and requirements of the Local Authorities and shall also satisfy all appropriate Singapore and British Standards including all relevant Codes of Practice. The Sub-Contract includes the preparation of comprehensive servicing and maintenance schedule to meet these requirements for the entire Works, during and after the expiry of the Maintenance Period; this schedule shall be submitted to the Architect for review after the award of the Sub-Contract. The Architect's reviewed schedule shall be included and form an integral part of the Operating and Maintenance Instructions and Parts List specified elsewhere in this Sub-Contract.

The Sub-Contractor shall be contractually bound to advise the Employer of any defects or deterioration in any part of the equipment/materials observed during the routine inspection and servicing, and shall repair such defects if required to do so by the Employer.

The Sub-contractor shall include the services of a Registered Professional Engineer and/or Licensed Electrical Worker/Licensed Plumber, as required by the Local Authorities to take complete charge of the entire works and all costs connected herewith including fees payable to the Authorities are deemed to have been included in the Sub-Contract and in the Maintenance Prices submitted.

1.5 Regular Servicing and Maintenance

1.5.1 General

The Sub-Contractor shall inspect and service all plant, machineries, equipment and installations supplied and installed by him (irrespective of whether or not there are specifically listed in this Section) at least once a month, except when otherwise directed by the Employer.

During every regular inspection, he shall:

- 1.5.1.1** *Check the performance of the complete air-conditioning system, including adjusting various controls as and when technically necessary.*
- 1.5.1.2** *Instructed the Employer's operators who are responsible for the operation of the system with regards to the correct method of operation and the proper maintenance procedure.*
- 1.5.1.3** *Report in writing to the Employer any defects discovered, coming to light or observed in any part of the Air-Conditioning Systems. Such report shall state fully the cause(s) of such defect(s) and shall include an estimate of the cost of repairs required.*
- 1.5.1.4** *Record in the log book for each element of the system kept by the Employer particulars of all maintenance or repair works carried out and initial all entries in the log book.*
- 1.5.1.5** *Report in writing to the Employer all works carried out in accordance with the Servicing and Maintenance Schedules as specified.*

The minimum items of work to be performed by the Sub-Contractor at each regular monthly inspection and servicing of all the plant, machineries and equipment, are detailed in the Schedules hereinafter stated.

1.5.2 Schedule for Refrigeration Equipment

Inspection and servicing of refrigerant equipment shall include all refrigerant compressors and components in chillers, direct-expansion units, water-cooled packaged units, after-coolers, etc.

The following minimum items of work shall be performed by the Sub-Contractor at least once a month:

- 1.5.2.1** *Check all seals and pipe lines for leaks, and rectify as and when necessary.*
- 1.5.2.2** *Check all refrigerant and oil levels, and charge refrigerant and oil into refrigerant systems as and when necessary.*
- 1.5.2.3** *Check the tension of all belt drives, and adjust as and when necessary.*
- 1.5.2.4** *Check the proper functioning of all refrigerant controls and clean, adjust and lubricate as and when necessary.*
- 1.5.2.5** *Check the proper functioning of all safety devices, and clean, adjust and lubricate as and when necessary.*
- 1.5.2.6** *Check the suction and discharge pressures of all refrigerant compressors, and if the pressures are found abnormal, trace the faults and rectify them as and when necessary.*
- 1.5.2.7** *Check all bolts and nuts for tightness, and tighten them as and when necessary.*

1.5.3 Schedule of Pumps

The inspection and servicing of pumps shall include all water pumps, chemical pumps, water treatment pumps, condensate water pumps, etc. The following minimum items of work shall be performed by the Sub-Contractor at least once a month:

- 1.5.3.1** *Check all seals, glands and pipe lines for leaks, and rectify as and when necessary.*
- 1.5.3.2** *Re-pack and adjust pump glands as and when necessary. All nuts on the packing gland should be tightened uniformly.*
- 1.5.3.3** *Check all pump bearings and lubricate with oil or grease as and when necessary.*
- 1.5.3.4** *Check the alignment and condition of all rubber couplings between pumps and drive motors, and rectify as and when necessary.*
- 1.5.3.5** *Check the tension of all belt drives, and adjust as and when necessary.*

1.5.4 Schedule for Blowers, Fans, etc.

The inspection and servicing of blowers, fans, etc. shall include all fan pulleys, fan bearings, air filters, dampers and other accessories of ventilation equipment and installations, air handling units, packaged units, cooling towers, etc. The following minimum items of work shall be performed by the Sub-Contractor at least once a month:

- 1.5.4.1** *Check all fan bearings, and lubricate with grease as and when necessary.*
- 1.5.4.2** *Check the tension of ail belt drives, and adjust as and when necessary.*
- 1.5.4.3** *Check all air filters, and clean or change filters as and when necessary.*
- 1.5.4.4** *Check the operation of all dampers, automatic multi-blade face and by-pass dampers, and clean, adjust and lubricate as and when necessary.*
- 1.5.4.5** *Check all bolts and nuts for tightness, and tighten as and when necessary.*

1.5.5 Schedule for Water Coils, Water Valves, etc.

The inspection and servicing of water coils and water valves, etc. shall include ail such coils and valves, pans, trays, drains and other accessories in chillers, air handling units, water-cooled packaged units, etc. The following minimum items of work shall be performed by the Sub-contractor at least once a month:

- 1.5.5.1** *Check all water coils, seals and pipe lines for leaks and rectify as and when necessary.*
- 1.5.5.2** *Blow out all dirt pockets, drip legs, strainers, and other points arranged for blow-off of water from the system.*
- 1.5.5.3** *Purge air from all water coifs.*
- 1.5.5.4** *Check the operation of automatic water regulating valves, and clean, adjust and lubricate as and when necessary.*
- 1.5.5.5** *Check all pans, trays and drains.*

1.5.6 Schedule for Cooling Towers and Water Treatment Systems

The inspection and servicing of cooling towers and water treatment systems shall include all parts and components thereof. The following minimum items of work shall be performed by the Sub-Contractor at least once a month:

- 1.5.6.1** *Check all fans as in Schedule for Blowers, Fans, etc.*
- 1.5.6.2** *Clean all water screens.*
- 1.5.6.3** *Drain, clean and flush out the water basins of cooling towers.*
- 1.5.6.4** *Check and adjust float valves as and when necessary.*
- 1.5.6.5** *Check all pumps as in Schedule of Pumps.*
- 1.5.6.6** *Carry out analysis of condenser water and check all components of the water treatment systems and top-up chemicals.*

In addition, the regular servicing and maintenance of cooling towers and water treatment system shall comply with the Code of Practice for the Control of Legionella Bacteria in Air-Conditioning Cooling Towers in Singapore, published by the Ministry of the Environment.

1.5.7 Schedule for Air Compressors and Pneumatic Systems

The inspection and servicing of air compressors and pneumatic systems shall include all parts and components thereof. The following minimum items of work shall be performed by the Sub-Contractor at least once a month:

- 1.5.7.1** *Check all valves, actuators, seals, joints and pipe lines for leaks, and rectify as and when necessary.*
- 1.5.7.2** *Check oil levels and change oil in compressor systems as and when necessary.*
- 1.5.7.3** *Check the tension of all belt drives, and adjust as and when necessary.*
- 1.5.7.4** *Check the operation of all pneumatic controls and safety devices, and clean, adjust and lubricate as and when necessary.*
- 1.5.7.5** *Blow out all dirt pockets, drip legs, filters and other points arranged for blow-off of oil from the system.*
- 1.5.7.6** *Check all bolts and nuts for tightness, and tighten as and when necessary.*

1.5.8 Schedule for Water Tanks

The inspection and servicing of water tanks shall include all chilled water storage tanks, chilled water expansion tanks, cooling tower water storage tanks, condensate water tanks, etc.

At each monthly inspection and servicing, the Sub-Contractor shall inspect all water tanks and drain, clean and flush out the tanks as and when necessary.

1.5.9 Schedule for Electrical Equipment

The inspection and servicing of electrical equipment shall include all electric motors, starters, contactors, relays, control gears, control panels, alarm panels, supervisory data panels, sub-panels, etc., whether complete by themselves or as components of other systems. The following minimum items of work shall be performed by the Sub-Contractor at least once a month:

1.5.9.1 *Inspect all electric motors, and*

- Check all motor bearings, and lubricate with grease as and when necessary.
- Check carbon brushes and slip rings of all motors and clean as and when necessary. Renew carbon brushes as and when necessary.
- Check safety devices fitted to all motors, and clean, adjust and lubricate as and when necessary.

1.5.9.2 *Inspect and check the routine operation of all electrical starters, electrical control gears, and ancillary electrical apparatus, and*

- Clean, adjust and lubricate all bearings, pivots and other moving parts as and when necessary.
- Clean or renew electric contactors as and when necessary.
- Renew electric fuses as and when necessary.

1.5.9.3 *Inspect and check the routine operation of all automatic control gears and relays and*

- Clean, adjust and lubricate all bearings, pivots and other moving parts as and when necessary.
- Clean or renew electric contactors as and when necessary.
- Renew electric fuses as and when necessary.

1.5.9.4 *Inspect all control panels, alarm panels, supervisory data panels, sub-panels, etc. and*

- Check the routine operation of all contactors, MCCBs, relays, ELCBs, time switches, etc.
- Clean and adjust pivots and other moving parts or relays, contactors, time switches.
- Tighten all connections, joints, terminations, etc.
- Replace blown indicating lamps.
- Test the earth resistance value of the main earthing system.
- Clean all panels.
- Check battery voltage and terminals,
- Top up battery water as and when necessary.
- Test all indicating lamps and alarm circuits.

1.5.9.5 *Check and adjust all float switches, limit switches, time switches, sequence controllers, etc.*

1.6 Additional Servicing and Maintenance

In addition to the regular monthly inspection and servicing, the Sub-Contractor shall also perform the following items of work:

Every 3 months, check and analyses the oil and refrigerant of all water chilling units and replace the oil and refrigerant if necessary.

1.6.1 Every 3 months, check and balance outside air quantities for all air handling units.

1.6.2 Every 4 months, check and clean all cooling coils.

1.6.3 Every 6 months, check and clean all strainers on pipework's.

1.6.4 Every 6 months, check and clean the VAV boxes mechanism.

1.6.5 Every 12 months, check and balance water flow rates for all equipment.

Notwithstanding the period of 12 months mentioned therein, the works specified under these two Clauses shall be carried out before the expiry of the Maintenance Period or the expiry of the future servicing and maintenance contract if such works had previously been carried out more than 6 months before the expiry.

1.6.6 Every 12 months, overhaul all water chilling units including inspection and cleaning of heat exchanger tubes of condenser and chiller.

Notwithstanding the period of 12 months mentioned therein, the works specified under these two Clauses shall be carried out before the expiry of the Maintenance Period or the expiry of the future servicing and maintenance contract if such works had previously been carried out more than 6 months before the expiry.

1.7 Consumable Materials

The Sub-contractor shall supply the following consumable materials as and when required:

All oil and grease required for lubrication of compressors, fan bearings, motor bearings, pivots and other moving parts. All refrigerant required to replace refrigerant losses in the systems.

1.7.1 All carbon brushes required to replace worn brushes in electric motors.

1.7.2 All electric contact points required to replace worn electric contact points in switch gears, motor starter gears, electric control gears and electric relays.

1.7.3 All electric fuses required to replace blown fuses.

1.7.4 All cotton waste, soap detergent and other cleaning materials required for cleaning purposes.

The costs of these consumable materials shall not be charged separately by the Sub-Contractor but shall be included in the Sub-Contract as well as the price quoted for future servicing and maintenance after the Maintenance Period.

LIFT SERVICES
(SPECIFICATIONS)

SPECIFICATION FOR PASSENGER LIFT INSTALLATION

<u>ITEM</u>	<u>DESCRIPTION</u>	<u>PAGE</u>
SECTION 1	General Requirements	LGR/1 - LGR/1
SECTION 2	Lift Machinery	LM/1 - LM/4
SECTION 3	Lift Car	LC/1 - LC/4
SECTION 4	Safety Equipment & Earthing	LSEE/1 - LSEE/4
SECTION 5	Electrical Work	(Refer to Elect'l Specs)
SECTION 6	Site Tests	LT&C/1 - LT&C/1

SECTION 1 - GENERAL REQUIREMENTS

1.00 GENERAL

The Tenderer shall have visited the site and to include all incidental costs in the installation of lifts in his tender.

1.01 SCOPE OF WORKS

The works shall generally include but shall not be limited to the followings:-

- Supply, delivery to site, installation, wiring, testing and commissioning, handing over the whole of the Lift Installation to the satisfaction and approval of the Lift Engineer and the Factories and shall strictly comply to all the requirements as specified further in this specification and in accordance with the details shown in the Tender Drawings.
- Installing the equipment in strict accordance with the manufacturer's recommendations and should the recommendation of the manufacturer involve modification on the existing structure or should the installation of the equipment requires any modification on the existing structure, the Tenderer shall make mention of such modification explicitly and to include the cost of such modification in his tender. No claim of such modification shall be entertained after the award of the Tender.
- Preparing all drawings required for submissions to the authorities, arranging with the authorities for inspection and testing and obtaining the necessary approval for the operation of the lift system.

All tenders shall be deemed to have included all the works mentioned above and no qualification whatsoever shall be made in the tender to exclude any of the works described above. Failure of the tenderer to comply with this section shall render the tender to be rejected.

1.02 LIFT MOTOR ROOM

The lift motor rooms are located directly above the lift shafts.

1.03 CODE OF PRACTICE AND STANDARDS

The lifts shall be constructed and installed strictly in accordance with the requirements stated in the following publication:

- a) The latest edition of the British Standard Specifications for Electric Lifts - B.S. 2655, Part 1, 2 and 3.
- b) Singapore Code of Practice (1979).
 - The Fire Feature System of the lift shall comply with the latest requirements of the local Fire Authority and other related Authorities.

- **END OF SECTION 1 –**

SECTION 2 - LIFT MACHINERY

2.00 GENERAL

The lift machinery located in the Lift Motor Rooms shall be provided and installed complete with hoisting machines, motors and motor traction sets, microprocessor units, control equipment, cables and cable anchorages and associated wirings as detailed in the specification.

2.01 HOISTING MACHINES

The lift machine for the lift shall be of geared traction type for speed 60 m/min of approved design and shall include an alternating current motor, ferro-molybdenum sheave and electromechanical brake, all mounted on a cast iron or steel bedplate unless otherwise specified. The worm gear shall be provided with roller bearings to take the end thrust and roller bearings shall be furnished for the sheave shaft to ensure alignment. All the bearing shall be of the roller type and shall be dust-proof and provided with adequate means of lubrication. The brake pulleys and traction sheaves on the motor armature spindles shall be designed to minimise torsional stress in the main shaft.

The hoisting motor shall be of one speed, alternating current reversible type with high starting torque and low starting current, particularly designed for lift service.

The construction of all lift machines shall conform generally with Clause 19 B.S. 2655 : Part 1 viz :

- a) The factor of safety used in the design of the lift machine shall be not less than 10 for cast iron, cast steel or other materials.
- b) No friction gearing shall be used for connecting the main driving gear to the sheave or drum.
- c) Provision shall be made on lift machine for the lift for manual raising and lowering of the lift car in an emergency.
- d) The lift machine shall be provided with a brake that is mechanically spring applied and electrically released. The brake shall be capable of bringing the lift car to rest under maximum conditions of load and speed and maintaining it stationary when loaded to 125% of its rated capacity. No brakes shall be released in normal operation unless power is applied to the lift motor. When springs are used to apply the brake shoes, such springs shall be in impression and adequately supported. Brakes of the lift shall have at least two brake shoe with renewable linings. No earth fault, short circuit or residual magnetism shall prevent the brake from being applied or cause it to be released when the power supply to the lift machines. Vibration mountings shall be provided with each traction machine, if required.

2.02 CONTROL SYSTEMS

The control system shall be of A.C. variable voltage variable frequency type complete with rectifier, frequency inverter, velocity transducer, current feedback, pulse width modulation control unit, logic control unit and microprocessor based operation control unit.

A.C. power shall be converted to D.C. power by a converter and then inverted by control signals from an inverter to A.C. power with its current and supply frequency to the A.C. motor

controlled simultaneously by means of a Pulse Width Modulation control unit such that the lift's performance conforms closely to the ideal speed pattern. The control system with the Pulse Width Modulation unit shall optimize the frequency and voltage of power supplied for maximum efficiency of operation. A microprocessor based operation control unit shall be provided to accurately control the inverter's varying frequency from 0 to the required point, raise the power factor to almost 100%, minimize the reactive power and reduce motor heat release.

The control system shall be designed such as to include a speed regulator, acceleration control, selector and loading control which shall be entirely automatic and shall ensure smooth, jerk free starting, acceleration, running, deceleration and stopping of each car. Suitable load weighing device to ensure smooth starting shall be provided to form part of feedback loop in control system if required.

Direct current brake shall be provided. It shall be spring applied and electrically released and shall be capable of providing smooth stops under variable loads.

The lift shall be equipped with an automatic stopping device to bring the cars to rest at the terminal landings. Final limit switches shall be provided in the lift shaft to stop the car and to prevent normal operation should it travel beyond the operational zone.

In addition, an automatic self-levelling feature shall be provided that will bring the car exactly to the floor landings. This device shall correct for over-travel and rope stretch and shall keep the car level and at the correct landing position irrespective of the load in the car. Under no circumstances shall jerking in any feature of the normal car operation be tolerated, special attention being expected to be given to this requirement.

2.03 EQUIPMENT PANELS

Power receiving panels, starter panels, control, selector cabinets and relay panels for the lift shall be provided and installed where applicable in the lift motor rooms. These panels shall be of approved design, and located in sheet steel, robust, vermin, insect and dust proofed cabinets which shall be provided with double length swing doors of metal construction complete with hinges, and locking devices. The rear of all cabinets shall be provided with similar, but perforated doors with vermin proofing to allow adequate heat dissipation and ease of access to the equipment located therein. All cabinets shall be thoroughly clean, free of rust, treated with a rust inhibitor such as phosphatic coating, and painted with red lead primer, undercoat and top coat of approved paint.

The panels shall include all necessary isolating switches, contactors, indicating lamps, meters, busbars, sealing glands anti-condensation cubicle heaters complete with indicating lamp and switch, relay and other necessary items of equipment whether specified herein or not and suitable for indoor service in an ambient temperature of up to 40 deg with 100% R.H. at maximum temperature permitted by the relevant B.S. specification.

Special attention shall be given to insulation and finish to all items and no linseed oil varnish, presspahn, fibre or hygroscopic materials shall be used in any position and components shall have a tropical finish including electro-tinning of non-ferrous parts and vacuum impregnation of operating coils.

All cables inside control panels shall be adequately colour coded using PVC sleeves of appropriate colour to denote the phase of electric supply.

All switches and contacts shall be of the heavy duty type designed especially for lift installations and should be capable of handling 150 starts per hour.

The panels shall be factory assembled and tested before delivery to site in suitable sizes for installation in the lift motor rooms.

2.04 POWER FACTOR CORRECTION

Power factor correction capacitors shall be provided as required to correct the power factor of all motors to 0.85 lagging or better when the lift is travelling upwards with rated load.

The capacitors shall be installed preferable within the starter or control panels, but consideration will be given to separately mounted capacitors provided that full dimensioned details are provided with the Tender.

2.05 GUIDE RAIL AND FASTENINGS

Accurately planned tees section shall be provided as guide rails for the car. These tees shall be erected plumb and fastened securely to the hoistway framing by heavy steel brackets. The guide rails contact of these plates and the back of the guide rails ends shall be accurately machined to form smooth joints. The ends of all guides shall be tongued and grooves to provide matched joints.

The guides shall be sufficient strength and rigidity to withstand all stresses which may be associated with loading operation.

Car guide rails shall be at least 24 kg/m sections. The selection of rail sections shall take into consideration of the sectional modulus and sufficient area to withstand compressive forces due to safety application.

The guides shall be held by clips of suitable design to their fastenings by through bolts or by clips of such at any rotary movement of the clip will not release the guide. Guide brackets shall be bolted to the beam or structure steelwork. Wood or fibre block or plugs shall be of metal. It is to note that guide brackets are not allowed to be grouted into the wall.

Sliding-type guide shoes shall be fitted. The guide shoes shall be of the self aligning, adjustable type with removable linings. The sliding guide shoes for the counterweight may be of the fixed type.

2.06 BUFFERS

Buffers of the spring type or oil type to the Authorities' requirement shall be installed under the car. Pipe struts and steadiers for buffers shall be provided if required.

They shall be designed to provide a smooth retardation of not more than 1.8m (5.9 feet) per second when subjected to the total impact of a fully load lift travelling at the governor tripping speed.

For oil buffers, means shall be provided for ascertaining that there is an adequate supply of oil in the buffers, and the construction shall ensure that any oil displaced during the operation is contained within the buffer. The buffers shall be self-resetting.

2.07 TERMINAL SLOW-DOWN

Terminal slow-down switches shall be supplied and fixed at both, top and bottom terminals. If for any reason, the normal electrical slow-down fails to operate, these switches shall become operative and stop the lift at terminal floors.

2.08 LEVELLING DEVICE

The lift shall be provided with an automatic levelling device which will bring the car to a stop within 3 mm of the landing level regardless of load or direction of travel. Landing level will be maintained within the levelling zone irrespective of the hoistway doors being opened or closed.

2.09 SAFETY DEVICE

Safety devices shall be provided in accordance with the current Factories and Machinery Act and Regulations and Rules.

An emergency stop switch shall be located in the pit. Any and/or all other safety devices required, whether mentioned specifically or not, which shall be required by Local Codes, Regulations and/or Codes now in force or brought into force prior to the commissioning of the lift on this project shall be fitted into the lift.

2.10 CAR STALL PROTECTIVE CIRCUIT

A protective circuit shall be provided which will stop the motor and the pump and return the car, while travelling up, does not reach its designated landing with a predetermined time interval. This circuit shall permit exist from the elevator until the trouble has been corrected.

2.11 POWER FAILURE PROTECTION

Reverse phase protection relay shall be provided.

Automatic landing device.

Should power failure occur under normal operation, car shall put into operation with sequence as follows :-

- a) Car stops to the nearest floor when power failure occurs.
- b) Emergency lamp and exhaust fan is turned on in car.
- c) Sensing program in control circuit checks if car is within specified zone of landing.
- d) If car is within specified zone of landing, door opens for passengers getting off.
- e) If car is outside the zone of landing, car descends at low speed 2 - 10 m/min, stops at nearest landing and door opens for passengers getting off.

2.12 OVERLOADING

A floor switch operated by a floating floor supported by springs, shall be provided for the prevention of overloading in the lift.

When the weight of passengers exceeds the capacity of the lift, the motor and car doors ceased from operating until the excess load is removed.

- END OF SECTION 2 -

SECTION 3 - LIFT CAR

3.00 GENERAL

The Contractor shall provide and install lift car complete with anti-rust protected roof, car enclosures, doors and all accessories. The lift car shall not include any open work panels, except ventilating panels within a height of 8 feet from the car floor. The apertures in any open work in the car roof shall be designed such as to reject a 1-inch diameter sphere.

The car enclosures for the lift capable of carrying passengers shall be of steel and capable of withstanding a thrust of 75 lbs applied normally by a flat or well-round object at any part without permanent deformation and shall be so secured to the car frame and car platform that it cannot work loose or become displace in ordinary service.

The lift car shall be located in the shaft such that when levelled at lift landing with the doors open, it is impossible for an object to become trapped between car platform and the lift landing while the car is within the landing zone.

All internal finishes of lift car must be approved by the S.O./Engineer in writing before ordering is proceeded with. If possible, actual samples of the materials to be used are to be submitted for approval. However, consideration will be given to well illustrated and detailed descriptive leaflets together with a view of similar finishes on lift installations in Negara Brunei darussalam or this part of the world.

3.01 CAR FRAME

The passenger car shall be carried in a steel sufficiently rigid to withstand the operation of the safety gear without permanent deformation to the car frame. The safety factor for these frames shall be of not less than five (5).

At least four renewable guide shoes, or guide shoes with renewable linings or sets of roller guides shall be provided, two at the top and two at the bottom of the car frame. These guides shall be held in contact with the guide rail surfaces by means of adjustable cushioning devices and in case of roller guides, these shall run or dry, unlubricated guide rails.

The support frame of lift core shall carry rubber pads upon which the car platform shall rest. Where the upper part of the car is braced to the frame, additional rubber pads shall be provided to form an effective isolating cushion between the car and the steel frame.

3.02 CAR PLATFORM

Car platform shall be of framed construction. The platform for the passenger/fireman's lift shall be designed on the basis of the contract load being evenly distribution. The platforms shall consist of a structural steel frame and a substantial timber floor, approved by Jabatan Bomba.

The underside of the timber flooring shall be fire-proofed by means of sheet steels coated with an approved fire proofing material.

Lift car kick plates (skirting) for the passenger lift shall be of stainless steel with hairline finish.

For the purpose of design, the minimum factors of safety shall be five (5) for steel and eight (8) for timber.

3.03 FLOOR FINISH

The lift cars floor shall be finished with 3/16" thick heavy-duty PVC tiles or marble/granite and the colour of the tiles shall be decided by the S.O./Engineer.

3.04 CAR WALLS

The wall of the lift car shall be etched mirror or hairline stainless steel finish as required.

3.05 SUSPENDED CEILINGS

Ceilings for the car shall be para-lite louvres and shall be injection moulded with a primary aluminium undercoat with highly specular vacuum metalized and incapsulated in a protective acrylic lacquer coating. The cell dimensions shall be 1 1/2" x 1 1/2" x 1" and shall provide 45 x 45 shielding.

The height of the ceiling shall not be less than 2.4m.

3.06 ILLUMINATION

The lift car shall be illuminated by 4 x 40 watts fluorescent lighting fittings of approved type.

3.07 VENTILATION

The lift car shall be provided with exhaust fan located at the canopy level with vents and recessed base of approved type.

3.08 EMERGENCY EXITS

Emergency exit shall be provided in the lift car under this Contract. The exits shall be in the roof of the lift car and panels for top openings shall not open inwards, be clear of any apparatus mounted above the roof of the lift car and be held by suitable fasteners that can be opened from outside the lift car and not from inside.

Panel for all emergency exits shall be provided with an electric switch which will prevent operation of the lift when the panel is open. Emergency exits located on side walls of lift cars will not be permitted.

3.09 CAR POSITION INDICATOR

One horizontal type of approved design electrically operated car position indicator shall be installed above the car entrance inside the car.

Digital indicator shall be installed.

3.10 CAPACITY PLATE

A capacity plate showing the contract load of the lift shall be fitted in the lift car in a conspicuous position. The contract load shall be shown in kilogram (kg) and in number of persons.

3.12 DOOR

The door shall be formed of at least 16-gauge stainless steel with welded joints, of flush construction and shall contained suitable materials for sound deadening. The door shall be reinforced, provided with keyways for interlocks. It shall be thoroughly cleaned, free of rust and treated with a rust inhibitor prior to painting.

Every landing door shall be provided with an electro-mechanical interlock which will prevent the lift from being started or kept in motion unless all landing doors are closed, and the interlock contacts made.

Door for the passenger/fireman's lifts shall be of two-panelled automatic centre opening type, designed to fill an opening and operated by ACVVVF. All landing doors shall be of etched mirror stainless steel finish to the approval of the S.O./Engineer.

3.12 DOOR HANGERS AND TRACKS

Both car and landing doors shall be fitted with sheave type door hangers. The sheave wheels shall be tyred with a sound reducing material and shall rotate on a grease packed precision ball bearing. The up thrust of the door shall be taken by a roller mounted on a hanger and arranged to ride on the underside of the hanger track.

The roller shall be mounted on an eccentric stud to provide for adjustment. The hanger tracks shall be of either formed cold rolled steel or cold drawn steel of heavy section with surfaces shaped to conform to the tread of the hanger sheaves and rollers. Suitable means shall be used to transmit motion from one door panel to the other.

3.13 MANUAL OPENING

Provision shall be made to open manually every power operated landing door in the event of failure of power supply, at any landing at which the car is standing. The apparatus shall be so arranged that in case of interruption of failure of electricity supply, the doors can be opened by hand from within the car.

3.14 DOOR OPERATORS

The VVVVF door operator with operating mechanism, linkages and switches to give adjustable or variable speed of door operation, and shall be adjusted to ensure the smoothest, fastest opening and closing possible.

The car and landing door shall operate simultaneously and quietly while the elevator is levelling and shall close either after the expiration of a time interval, or when the 'DOOR CLOSE' button is pressed by an attendant manually operating the lift.

3.15 DOOR PROTECTIVE DEVICE

A mechanical door safety edge of anodized aluminium extending the full height of the entrance shall be provided for the car door to protect passengers entering or leaving the car. Should the door be closing while passengers are still entering or leaving the car, the safety edge on the car door panel, on touching the passenger, shall cause the door to re-open immediately to prevent crushing the passenger. The doors shall re-close immediately thereafter.

3.16 CAR OPERATING PANELS

One car operating panels shall be installed on one side of the front panels. Each panel shall be of stainless steel with mirror front and shall contain the following indicators and controls:-

- a) An 'ALARM' button which, when pressed, shall cause a battery-operated alarm bell to sound in the lift corridor on the main floor.
- b) An 'Up' arrow direction with green light when illuminated and a 'DOWN' arrow direction indicator with red light when illuminated to shown direction at which the lift car is travelling. Alternatively, these lights could be incorporated on the car operating panel mounted on the right side front return panel of each lift.
- c) One row of round recessed conventional micro-movement call registered type floor dispatching touch buttons bearing lettering and numerals for designed stopping floors.

- d) A 'DOOR OPEN' button which, when pressed, shall cause the closing doors to re-open, or when continuously pressed, shall keep the doors open.
- e) A 'DOOR CLOSE' button which, when pressed, shall cause the doors to close to shorten the door open time.
- f) An 'OVERLOAD' indicating light shall be provided on top of the car operating panel.
- g) A 3- position switch whereby the ventilation fan speed can be set at either 'high speed' or 'low speed' or be switched off as required.
- h) A car light switch where the lift car light can be switched on or off.
- i) A 'DOOR' switch whereby the door operation can be switched off. It is intended that this particular switch shall be used when it is desired that the door be kept open over prolonged intervals for loading and unloading purposes.
- j) Slow-speed or hand operation for service and maintenance purposes whereby the lift can be made to travel at the standard reduced servicing speed of approximately 50 fpm. Item (f) to (h) being intended for use by the Lift Attendant during the 'ATTENDANT' operations with 'ATTENDANT SWITCH', to bring the lift to the desired floor level without answering the Hall Call Button, shall be located together in a recessed switch cabinet with a sliding cover which shall form part of and be integral with the car operating panel. The cover of this recessed switch cabinet shall be of stainless steel with hairline finish similar to the face-plate of the car operation panel, and shall be provided with a lock. It is intended that once the switches have been set to fully automatic operation, only those buttons which are essential shall be exposed to the passengers, with other switches as described above for the 'ATTENDANT' or 'SLOW SPEED SERVICE' operations well removed from the public and made inaccessible to them.

3.17 MAINTENANCE PANEL

A panel to include an emergency stop switch, a door controller switch and a maintenance Fully Automatic/Service speed selection switch and shall be provided on the top of the car. The emergency stop switch shall prevent the car from being operated while the switch is open. The door controller switch shall prevent the door from being operated during testing and adjustment. The fully Automatic/Service speed selection switch shall ensure that while the servicemen are standing on top of the lift car servicing or adjusting the equipment, the lift cannot be switched to full speed operation accidentally by someone in the lift car, thus endangering the servicemen on the car top.

3.18 INTERCOM UNITS

A cabinet or panel incorporating an approved type two-way intercom slave unit shall be installed above the car control panel inside car operating panel in each lift and one unit at lift lobby ground floor. These units shall be connected to an approved convenient point in the motor room where connection shall be made to the master units in the lift motor room and security room at ground floor. The faceplate shall be engraved to read 'LIFT INTERCOM BOX'.

- END OF SECTION 3 -

SECTION 5 - SAFETY EQUIPMENT AND EARTHING

5.00 General

In addition to the safety equipment previously mentioned, the Contractor shall provide and install such equipment associate with the lift installation as shall provided the safest transportation available. This equipment shall include speed governors, safety gear, fire alarm control and fireman switch. All metalwork excepting conductors, in exposed positions which may be liable to become electrically charged, shall be effectively bonded and earthed.

5.01 SPEED

A centrifugal type speed governor shall be provided for each lift with a tripping speed set in accordance with B.S. 2655 : Part 1 and the ASE Code. The electrical contacts actuated by the over- speed action of the governor shall cut off electricity supply to the traction equipment prior to the mechanical tripping of the governor.

5.02 SAFETY GEAR

The lift car shall be provided with a flexible guide clamp type safety gear, in accordance with B.S. 2655, mounted on the bottom member of the car frame. This gear shall be arranged to stop the car gradually whenever excessive descending speed is attained, and means shall be provided to cut off electricity supply to the traction equipment, and apply the brake prior to the application of the safety gear.

5.03 FIRE EMERGENCY

In the event of a fire alarm operation in the building or the Fireman's switch being operated, the lift shall travel immediately to the Ground Floor irrespective of any car or hall calls registered and shall park with the door open until the systems has been reset by the Fire Department. All necessary equipment to bring the lift down shall be provided under this Contract.

5.04 FIREMAN'S SWITCH

An approved Fireman's Switch shall be provided in addition to this protection to provide a similar condition to the above mentioned, manually, and shall be located as required by the Fire Department.

5.05 EARTHING

An earthing system comprising cables, conduit and copper tape earth connectors necessary to bond permanently and effectively to the main earthing system of the building all non-current carrying metal shall be supplied, erected and connected under this section of the Specification.

The requirements for earthing shall be as detailed in Section D of the 14th Edition of the I.E.E. Regulations. The earth connections for all sections of the installation shall be electrically continuous throughout.

Joint shall be tinned riveted and soldered. All connections to electrical apparatus shall be made by a bolted connection in a visible and accessible position.

A 1-inch by 1/8 inch annealed copper tape earth tape will be installed between the building main earth bar and the switchboards in the passenger lift motor rooms by others. All other earthing necessary shall be carried out under this Contract.

Earthing connections shall be run in approved positions and fixed in an symmetrical line using Furze No.44 gunmetal saddles of appropriate size for securing tapes at intervals not exceeding 3 feet, and the copper tapes shall be supplied in long unbroken lengths to avoid unnecessary jointing.

The earthing system including measuring, marking off, cutting, fitting and erection, supply of necessary clamps and rag bolts complete with all fixing screws and rivets for fixing and jointing of the copper tape including the necessary lugs, consumable stores and the use of jointers tools.

- END OF SECTION 5 -

SECTION 6 - SITE TESTS

COMMISSIONING TESTS

The complete installation or any part thereof shall be tested, both before and after being connected up to the requirement of the S.O./Engineer.

The Contractor shall be responsible for all electrical tests at the Site and shall be represented by a capable S.O./Engineer during the whole of the period required for the tests.

All materials and equipment supplied or erected under this Contract which fail the tests shall be replaced or rectified at once by the Contractor without cost to the purchaser and the tests shall be repeated.

All tests shall be conducted in the presence of, and to the satisfaction of the S.O./Engineer. The Contractor shall supply all necessary instruments, apparatus, connection, skilled and unskilled labour required for tests to the satisfaction of the S.O./Engineer, the cost of so doing shall be included in the Contract Price.

The Contractor shall make accurate records of all tests and shall furnish test certificates and schedule of the results in an approval form. Four copies of such schedules and of each test certificate will be required.

Any circuit or section of the installation failing to reach the required for acceptance shall be made good by the Contractor without cost to the Purchases.

The minimum of site tests to be carried out shall be as follows:-

- a) Insulation resistance test to earth for all power and control cables to permit compliance with the 14th Edition of the I.E.E. Regulations for the Electrical Equipment of Building.
- b) Earth continuity tests for each circuit of the installation to ensure that the impedance of the earth fault loop is such as to permit compliance with the requirements of Section D of the 14th Edition of the I.E.E. Regulations for the Electrical Equipment of Buildings.

A suitable instruments is the Ferranti Phase - Earth Loop Impedance Tester (Model 2) and the Contractor shall employ such an instrument of or other approved or equal type.

- c) Tests to determine that motor, brakes, control equipment and door locking devices function correctly for the lifts.
- d) Tests to determine that the lift car will raise and lower the contract load.
- e) Tests to determine that the lift car will attain the contract speed.
- f) Tests to determine that the safety gear will stop the lift car when loaded with the contract loads. Overspeed tests shall be made with ropes attached and all electrical apparatus operative except the overspeed switches on the governor for the lifts.
- g) Tests on the Fireman's Lift.

- END OF SECTION 6 -

MECHANICAL
(SCHEDULE OF TECHNICAL DATA)

ITEM **TECHNICAL PARTICULARS****Ducted DX Single Split System****LOCATION:****AHU-1/CU-1****CHANCERY****AHU-2/CU-2****CHANCERY**

a	Manufacturer	:	_____	_____
b	Make/Country of Origin	:	_____	_____
c	Model No.	:	_____	_____
d	Unit Cap. (at 35°C Condenser Air Temp)	:	_____	_____
e	Suction Temp. (°C)	:	_____	_____
f	No. of Refrigerant Circuits	:	_____	_____
g	Type of Refrigerant	:	_____	_____
h	No. of Compressors	:	_____	_____
i	Unit Step %	:	_____	_____
j	Compressor H.P.	:	_____	_____
k	Compressor Type	:	_____	_____
l	Compressor Speed	:	_____	_____
m	Vibration Isolation Make/Type	:	_____	_____
n	Fan Blade Protective Coating	:	_____	_____
o	Type of Casing Protective Coating	:	_____	_____
p	Full Load Current	:	_____	_____
q	Overall Dimension (L x W x H)	:	_____	_____
r	Operating Weight	:	_____	_____
s	Delivery (months)	:	_____	_____
t	Minimum Space required (L x W)	:	_____	_____
u	V/ph/Hz	:	_____	_____
v	Minimum Capacity (Available with Hot Gas Bypass)	:	_____	_____

ITEM	TECHNICAL PARTICULARS
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Variable Refrigerant Flow System

VRF-CG1

VRF-CG2

LOCATION:

CHANCERY

CHANCERY

a	Manufacturer	:		
b	Make/Country of Origin	:		
c	Model No.	:		
d	Unit Cap. (at 35°C Condenser Air Temp)	:		
e	Suction Temp. (°C)	:		
f	No. of Refrigerant Circuits	:		
g	Type of Refrigerant	:		
h	No. of Compressors	:		
i	Unit Step %	:		
j	Compressor H.P.	:		
k	Compressor Type	:		
l	Compressor Speed	:		
m	Vibration Isolation Make/Type	:		
n	Fan Blade Protective Coating	:		
o	Type of Casing Protective Coating	:		
p	Full Load Current	:		
q	Overall Dimension (L x W x H)	:		
r	Operating Weight	:		
s	Delivery (months)	:		
t	Minimum Space required (L x W)	:		
u	V/ph/Hz	:		
v	Minimum Capacity (Available with Hot Gas Bypass)	:		

ITEM	<u>TECHNICAL PARTICULARS</u>		
	<u>Variable Refrigerant Flow System</u>	VRF-CF1	VRF-CF2
	<u>LOCATION:</u>	CHANCERY	CHANCERY
a	Manufacturer	: _____	_____
b	Make/Country of Origin	: _____	_____
c	Model No.	: _____	_____
d	Unit Cap. (at 35°C Condenser Air Temp)	: _____	_____
e	Suction Temp. (°C)	: _____	_____
f	No. of Refrigerant Circuits	: _____	_____
g	Type of Refrigerant	: _____	_____
h	No. of Compressors	: _____	_____
i	Unit Step %	: _____	_____
j	Compressor H.P.	: _____	_____
k	Compressor Type	: _____	_____
l	Compressor Speed	: _____	_____
m	Vibration Isolation Make/Type	: _____	_____
n	Fan Blade Protective Coating	: _____	_____
o	Type of Casing Protective Coating	: _____	_____
p	Full Load Current	: _____	_____
q	Overall Dimension (L x W x H)	: _____	_____
r	Operating Weight	: _____	_____
s	Delivery (months)	: _____	_____
t	Minimum Space required (L x W)	: _____	_____
u	V/ph/Hz	: _____	_____
v	Minimum Capacity (Available with Hot Gas Bypass)	: _____	_____

ITEM TECHNICAL PARTICULARS

	<u>Variable Refrigerant Flow System</u> <u>LOCATION:</u>	VRF-RG1 RESIDENCE	VRF-RG2 RESIDENCE
a	Manufacturer	: _____	_____
b	Make/Country of Origin	: _____	_____
c	Model No.	: _____	_____
d	Unit Cap. (at 35°C Condenser Air Temp)	: _____	_____
e	Suction Temp. (°C)	: _____	_____
f	No. of Refrigerant Circuits	: _____	_____
g	Type of Refrigerant	: _____	_____
h	No. of Compressors	: _____	_____
i	Unit Step %	: _____	_____
j	Compressor H.P.	: _____	_____
k	Compressor Type	: _____	_____
l	Compressor Speed	: _____	_____
m	Vibration Isolation Make/Type	: _____	_____
n	Fan Blade Protective Coating	: _____	_____
o	Type of Casing Protective Coating	: _____	_____
p	Full Load Current	: _____	_____
q	Overall Dimension (L x W x H)	: _____	_____
r	Operating Weight	: _____	_____
s	Delivery (months)	: _____	_____
t	Minimum Space required (L x W)	: _____	_____
u	V/ph/Hz	: _____	_____
v	Minimum Capacity (Available with Hot Gas Bypass)	: _____	_____

ITEM TECHNICAL PARTICULARS

Variable Refrigerant Flow System

LOCATION:

**VRF-RF1
RESIDENCE**

a	Manufacturer	:	_____	_____
b	Make/Country of Origin	:	_____	_____
c	Model No.	:	_____	_____
d	Unit Cap. (at 35°C Condenser Air Temp)	:	_____	_____
e	Suction Temp. (°C)	:	_____	_____
f	No. of Refrigerant Circuits	:	_____	_____
g	Type of Refrigerant	:	_____	_____
h	No. of Compressors	:	_____	_____
i	Unit Step %	:	_____	_____
j	Compressor H.P.	:	_____	_____
k	Compressor Type	:	_____	_____
l	Compressor Speed	:	_____	_____
m	Vibration Isolation Make/Type	:	_____	_____
n	Fan Blade Protective Coating	:	_____	_____
o	Type of Casing Protective Coating	:	_____	_____
p	Full Load Current	:	_____	_____
q	Overall Dimension (L x W x H)	:	_____	_____
r	Operating Weight	:	_____	_____
s	Delivery (months)	:	_____	_____
t	Minimum Space required (L x W)	:	_____	_____
u	V/ph/Hz	:	_____	_____
v	Minimum Capacity (Available with Hot Gas Bypass)	:	_____	_____

ITEM TECHNICAL PARTICULARS

	<u>INVERTER TYPE FAN COIL UNITS</u> <u>LOCATION:</u>	FCU-R1 TO R4 RESIDENCE	FCU-R5 RESIDENCE
a	Manufacturer	: _____	_____
b	Make/Country of Origin	: _____	_____
c	Model No.	: _____	_____
d	Cooling Capacity	: _____	_____
e	Sensible Capacity	: _____	_____
f	Air Flow Rate	: _____	_____
g	Full Load Current	: _____	_____
h	Overall Dimension (L xW x H)	: _____	_____
	<u>INVERTER TYPE FAN COIL UNITS</u> <u>LOCATION:</u>	FCU-G1 & G2 RESIDENCE	FCU-G3 & G4 RESIDENCE
a	Manufacturer	: _____	_____
b	Make/Country of Origin	: _____	_____
c	Model No.	: _____	_____
d	Cooling Capacity	: _____	_____
e	Sensible Capacity	: _____	_____
f	Air Flow Rate	: _____	_____
g	Full Load Current	: _____	_____
h	Overall Dimension (L xW x H)	: _____	_____
	<u>INVERTER TYPE FAN COIL UNITS</u> <u>LOCATION:</u>	FCU-G5 RESIDENCE	FCU-G6 RESIDENCE
a	Manufacturer	: _____	_____
b	Make/Country of Origin	: _____	_____
c	Model No.	: _____	_____
d	Cooling Capacity	: _____	_____
e	Sensible Capacity	: _____	_____
f	Air Flow Rate	: _____	_____
g	Full Load Current	: _____	_____
h	Overall Dimension (L xW x H)	: _____	_____

ITEM TECHNICAL PARTICULARS

INVERTER TYPE FAN COIL UNITS

LOCATION:

**FCU-G7
RESIDENCE**

**FCU-F1 & F2
RESIDENCE**

a	Manufacturer	:	_____	_____
b	Make/Country of Origin	:	_____	_____
c	Model No.	:	_____	_____
d	Cooling Capacity	:	_____	_____
e	Sensible Capacity	:	_____	_____
f	Air Flow Rate	:	_____	_____
g	Full Load Current	:	_____	_____
h	Overall Dimension (L xW x H)	:	_____	_____

INVERTER TYPE FAN COIL UNITS

LOCATION:

**FCU-F3
RESIDENCE**

**FCU-F4
RESIDENCE**

a	Manufacturer	:	_____	_____
b	Make/Country of Origin	:	_____	_____
c	Model No.	:	_____	_____
d	Cooling Capacity	:	_____	_____
e	Sensible Capacity	:	_____	_____
f	Air Flow Rate	:	_____	_____
g	Full Load Current	:	_____	_____
h	Overall Dimension (L xW x H)	:	_____	_____

INVERTER TYPE FAN COIL UNITS

LOCATION:

**FCU-F5
RESIDENCE**

**FCU-F6
RESIDENCE**

a	Manufacturer	:	_____	_____
b	Make/Country of Origin	:	_____	_____
c	Model No.	:	_____	_____
d	Cooling Capacity	:	_____	_____
e	Sensible Capacity	:	_____	_____
f	Air Flow Rate	:	_____	_____
g	Full Load Current	:	_____	_____
h	Overall Dimension (L xW x H)	:	_____	_____

ITEM TECHNICAL PARTICULARS

	<u>INVERTER TYPE FAN COIL UNITS</u> <u>LOCATION:</u>	FCU-F7 RESIDENCE	FCU-(G1.1, G1.2, & G1.11) CHANCERY
a	Manufacturer	: _____	_____
b	Make/Country of Origin	: _____	_____
c	Model No.	: _____	_____
d	Cooling Capacity	: _____	_____
e	Sensible Capacity	: _____	_____
f	Air Flow Rate	: _____	_____
g	Full Load Current	: _____	_____
h	Overall Dimension (L xW x H)	: _____	_____
	<u>INVERTER TYPE FAN COIL UNITS</u> <u>LOCATION:</u>	FCU-G1.3 CHANCERY	FCU-G1.4 & FCU-G1.5 CHANCERY
a	Manufacturer	: _____	_____
b	Make/Country of Origin	: _____	_____
c	Model No.	: _____	_____
d	Cooling Capacity	: _____	_____
e	Sensible Capacity	: _____	_____
f	Air Flow Rate	: _____	_____
g	Full Load Current	: _____	_____
h	Overall Dimension (L xW x H)	: _____	_____
	<u>INVERTER TYPE FAN COIL UNITS</u> <u>LOCATION:</u>	FCU-G1.6 CHANCERY	FCU-G1.7 CHANCERY
a	Manufacturer	: _____	_____
b	Make/Country of Origin	: _____	_____
c	Model No.	: _____	_____
d	Cooling Capacity	: _____	_____
e	Sensible Capacity	: _____	_____
f	Air Flow Rate	: _____	_____
g	Full Load Current	: _____	_____
h	Overall Dimension (L xW x H)	: _____	_____

ITEM	TECHNICAL PARTICULARS
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INVERTER TYPE FAN COIL UNITS		FCU-G1.8	FCU-G1.9
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LOCATION:		CHANCERY	CHANCERY
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a	Manufacturer	:	
b	Make/Country of Origin	:	
c	Model No.	:	
d	Cooling Capacity	:	
e	Sensible Capacity	:	
f	Air Flow Rate	:	
g	Full Load Current	:	
h	Overall Dimension (L xW x H)	:	

INVERTER TYPE FAN COIL UNITS		FCU-G1.10	FCU-G2.1
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LOCATION:		CHANCERY	CHANCERY
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a	Manufacturer	:	
b	Make/Country of Origin	:	
c	Model No.	:	
d	Cooling Capacity	:	
e	Sensible Capacity	:	
f	Air Flow Rate	:	
g	Full Load Current	:	
h	Overall Dimension (L xW x H)	:	

INVERTER TYPE FAN COIL UNITS		FCU-G2.2	FCU-G2.3
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LOCATION:		CHANCERY	CHANCERY
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a	Manufacturer	:	
b	Make/Country of Origin	:	
c	Model No.	:	
d	Cooling Capacity	:	
e	Sensible Capacity	:	
f	Air Flow Rate	:	
g	Full Load Current	:	
h	Overall Dimension (L xW x H)	:	

ITEM TECHNICAL PARTICULARS

INVERTER TYPE FAN COIL UNITS

LOCATION:

**FCU-G2.4
CHANCERY**

**FCU-G2.5 & FCU-G2.6
CHANCERY**

a	Manufacturer	:	_____	_____
b	Make/Country of Origin	:	_____	_____
c	Model No.	:	_____	_____
d	Cooling Capacity	:	_____	_____
e	Sensible Capacity	:	_____	_____
f	Air Flow Rate	:	_____	_____
g	Full Load Current	:	_____	_____
h	Overall Dimension (L xW x H)	:	_____	_____

INVERTER TYPE FAN COIL UNITS

LOCATION:

**FCU-G2.7
CHANCERY**

**FCU-G2.8
CHANCERY**

a	Manufacturer	:	_____	_____
b	Make/Country of Origin	:	_____	_____
c	Model No.	:	_____	_____
d	Cooling Capacity	:	_____	_____
e	Sensible Capacity	:	_____	_____
f	Air Flow Rate	:	_____	_____
g	Full Load Current	:	_____	_____
h	Overall Dimension (L xW x H)	:	_____	_____

INVERTER TYPE FAN COIL UNITS

LOCATION:

**FCU-F1.1
CHANCERY**

**FCU-F1.2 & FCU-F1.3
CHANCERY**

a	Manufacturer	:	_____	_____
b	Make/Country of Origin	:	_____	_____
c	Model No.	:	_____	_____
d	Cooling Capacity	:	_____	_____
e	Sensible Capacity	:	_____	_____
f	Air Flow Rate	:	_____	_____
g	Full Load Current	:	_____	_____
h	Overall Dimension (L xW x H)	:	_____	_____

ITEM TECHNICAL PARTICULARS

INVERTER TYPE FAN COIL UNITS
LOCATION:

FCU-F1.4
CHANCERY

FCU-F1.5
CHANCERY

a	Manufacturer	:	_____	_____
b	Make/Country of Origin	:	_____	_____
c	Model No.	:	_____	_____
d	Cooling Capacity	:	_____	_____
e	Sensible Capacity	:	_____	_____
f	Air Flow Rate	:	_____	_____
g	Full Load Current	:	_____	_____
h	Overall Dimension (L xW x H)	:	_____	_____

INVERTER TYPE FAN COIL UNITS
LOCATION:

FCU-F1.6
CHANCERY

FCU-F1.7 & FCU-1.9
CHANCERY

a	Manufacturer	:	_____	_____
b	Make/Country of Origin	:	_____	_____
c	Model No.	:	_____	_____
d	Cooling Capacity	:	_____	_____
e	Sensible Capacity	:	_____	_____
f	Air Flow Rate	:	_____	_____
g	Full Load Current	:	_____	_____
h	Overall Dimension (L xW x H)	:	_____	_____

INVERTER TYPE FAN COIL UNITS
LOCATION:

FCU-F1.8
CHANCERY

FCU-F1.10 & FCU-1.11
CHANCERY

a	Manufacturer	:	_____	_____
b	Make/Country of Origin	:	_____	_____
c	Model No.	:	_____	_____
d	Cooling Capacity	:	_____	_____
e	Sensible Capacity	:	_____	_____
f	Air Flow Rate	:	_____	_____
g	Full Load Current	:	_____	_____
h	Overall Dimension (L xW x H)	:	_____	_____

ITEM TECHNICAL PARTICULARS

INVERTER TYPE FAN COIL UNITS

LOCATION:

**FCU-F1.12
CHANCERY**

**FCU-F2.1
CHANCERY**

a	Manufacturer	:	_____	_____
b	Make/Country of Origin	:	_____	_____
c	Model No.	:	_____	_____
d	Cooling Capacity	:	_____	_____
e	Sensible Capacity	:	_____	_____
f	Air Flow Rate	:	_____	_____
g	Full Load Current	:	_____	_____
h	Overall Dimension (L xW x H)	:	_____	_____

INVERTER TYPE FAN COIL UNITS

LOCATION:

**FCU-F2.2
CHANCERY**

**FCU-F2.3
CHANCERY**

a	Manufacturer	:	_____	_____
b	Make/Country of Origin	:	_____	_____
c	Model No.	:	_____	_____
d	Cooling Capacity	:	_____	_____
e	Sensible Capacity	:	_____	_____
f	Air Flow Rate	:	_____	_____
g	Full Load Current	:	_____	_____
h	Overall Dimension (L xW x H)	:	_____	_____

INVERTER TYPE FAN COIL UNITS

LOCATION:

**FCU-F2.4 & FCU-F2.5
CHANCERY**

**FCU-F2.4 & FCU-F2.5
CHANCERY**

a	Manufacturer	:	_____	_____
b	Make/Country of Origin	:	_____	_____
c	Model No.	:	_____	_____
d	Cooling Capacity	:	_____	_____
e	Sensible Capacity	:	_____	_____
f	Air Flow Rate	:	_____	_____
g	Full Load Current	:	_____	_____
h	Overall Dimension (L xW x H)	:	_____	_____

ITEM TECHNICAL PARTICULARS

<u>INVERTER TYPE FAN COIL UNITS</u>		FCU-F2.6	FCU-F2.7 & FCU-F2.8
<u>LOCATION:</u>		CHANCERY	CHANCERY
a	Manufacturer	: _____	_____
b	Make/Country of Origin	: _____	_____
c	Model No.	: _____	_____
d	Cooling Capacity	: _____	_____
e	Sensible Capacity	: _____	_____
f	Air Flow Rate	: _____	_____
g	Full Load Current	: _____	_____
h	Overall Dimension (L xW x H)	: _____	_____
<u>INVERTER TYPE FAN COIL UNITS</u>		FCU-F2.9	FCU (2.6KW)
<u>LOCATION:</u>		CHANCERY	NRG/RG
a	Manufacturer	: _____	_____
b	Make/Country of Origin	: _____	_____
c	Model No.	: _____	_____
d	Cooling Capacity	: _____	_____
e	Sensible Capacity	: _____	_____
f	Air Flow Rate	: _____	_____
g	Full Load Current	: _____	_____
h	Overall Dimension (L xW x H)	: _____	_____
<u>INVERTER TYPE FAN COIL UNITS</u>		FCU (3.9KW)	FCU (5.2KW)
<u>LOCATION:</u>		NRG/RG	NRG
a	Manufacturer	: _____	_____
b	Make/Country of Origin	: _____	_____
c	Model No.	: _____	_____
d	Cooling Capacity	: _____	_____
e	Sensible Capacity	: _____	_____
f	Air Flow Rate	: _____	_____
g	Full Load Current	: _____	_____
h	Overall Dimension (L xW x H)	: _____	_____

ITEM TECHNICAL PARTICULARS

INVERTER TYPE FAN COIL UNITS

LOCATION:

FCU (6.5KW)

NRG/RG

FCU (7.8KW)

RG

a	Manufacturer	:	_____	_____
b	Make/Country of Origin	:	_____	_____
c	Model No.	:	_____	_____
d	Cooling Capacity	:	_____	_____
e	Sensible Capacity	:	_____	_____
f	Air Flow Rate	:	_____	_____
g	Full Load Current	:	_____	_____
h	Overall Dimension (L xW x H)	:	_____	_____

INVERTER TYPE FAN COIL UNITS

LOCATION:

FCU (9.7KW)

NRG

a	Manufacturer	:	_____	_____
b	Make/Country of Origin	:	_____	_____
c	Model No.	:	_____	_____
d	Cooling Capacity	:	_____	_____
e	Sensible Capacity	:	_____	_____
f	Air Flow Rate	:	_____	_____
g	Full Load Current	:	_____	_____
h	Overall Dimension (L xW x H)	:	_____	_____

Ductwork and Accessories

a	Manufacturer	:	_____
b	Country Of Origin	:	_____
c	Type/material/thickness	:	_____
d	Type of joint/sealant	:	_____
e	Material use for bolts & nuts	:	_____

SMOKE DETECTOR (DUCT MOUNT TYPE)

a	Manufacturer	:	_____
b	Country of Origin	:	_____
c	Model No.	:	_____

<u>ITEM</u>	<u>TECHNICAL PARTICULARS</u>
--------------------	-------------------------------------

Duct Temperature Sensor

- | | | | |
|---|-------------------|---|--|
| a | Manufacturer | : | |
| b | Country of Origin | : | |
| c | Model No. | : | |

Thermal & Acoustic Insulation

- | | | | Supply & Return
Air duct insulation | | Supply & Return
Acoustic |
|---|---------------------------------|---|--|--|-----------------------------|
| a | Manufacture/Country of Origin | : | | | |
| b | Type/Material/Thickness | : | | | |
| c | Density (Kg/Cu.m.) | : | | | |
| d | Thermal Conductivity | : | | | |
| e | Absorption Coefficient 100Hz | : | | | |
| f | Type of Material of Vapour Seal | : | | | |

Refrigerant Pipes

- | | | |
|---|--------------------------------|--|
| a | Manufacturer | |
| b | Make/Country of Origin | |
| c | Standard Grade (Seam/Seamless) | |
| d | Material Pipe/Thickness | |
| e | Relevant Standard | |

Valves & Fittings

- | | | |
|---|--------------------------------|--|
| a | Make/Country of Origin | |
| b | Standard Grade (Seam/Seamless) | |
| c | Material Pipe/Thickness | |
| d | Type (Screw/Flanged) | |
| e | Max Working Pressure (Pa) | |
| c | Standard Grade (Seam/Seamless) | |
| d | Material Pipe/Thickness | |
| e | Relevant Standard | |

<u>ITEM</u>	<u>TECHNICAL PARTICULARS</u>
-------------	------------------------------

AIR DIFFUSION

		DIFFUSER	GRILLES	DAMPER (OVD)
a	Manufacture	: _____	_____	_____
b	Country of Origin	: _____	_____	_____
c	Material	: _____	_____	_____
d	Gauge/thickness	: _____	_____	_____
e	Finishes	: _____	_____	_____
f	Relevant Standards	: _____	_____	_____

LAD PLENUM BOX

a	Manufacture	: _____
b	Country of Origin	: _____
c	Material	: _____
d	Gauge/thickness	: _____
e.	Insulation (Material&Density-Kg/cu.m.)	: _____

FRESH AIR LOUVER

a	Manufacture	: _____
b	Country of Origin	: _____
c	Material	: _____
d	Gauge/thickness	: _____
e	Finishes	: _____
f	Relevant Standards	: _____

ITEM	TECHNICAL PARTICULARS
------	-----------------------

EXHAUST FANS

CEILING MOUNT

WALL MOUNT

INLINE DUCTED

a	Manufacturer	:	_____	_____	_____
b	Country of Origin	:	_____	_____	_____
c	Make and Model No.	:	_____	_____	_____

BIFURCATED FAN

a	Manufacturer/Country of Origin	:	_____
b	Air Quantity (cmh)	:	_____
c	Model No.	:	_____
d	Duty (Pa)	:	_____
e	Diameter (mm)	:	_____
f	Rotational Speed (rps)	:	_____
g	Blade Pitch (Deg.)	:	_____
h	Sound Pressure Lev. at 3m in a free field	:	_____
i	Fan Motor Speed	:	_____
j	Fan Motor Rating (kW)	:	_____
k	Electrical Data	:	_____

FRESH AIR FAN

a	Manufacturer/Country of Origin	:	_____
b	Air Quantity (cmh)	:	_____
c	Model No.	:	_____
d	Duty (Pa)	:	_____
e	Diameter (mm)	:	_____
f	Rotational Speed (rps)	:	_____
g	Blade Pitch (Deg.)	:	_____
h	Sound Pressure Lev. at 3m in a free field	:	_____
i	Fan Motor Speed	:	_____
j	Fan Motor Rating (kW)	:	_____
k	Electrical Data	:	_____

ITEM	TECHNICAL PARTICULARS
------	-----------------------

CEILING FAN

- | | | | |
|---|--------------------|---|-------|
| a | Manufacturer | : | _____ |
| b | Country of Origin | : | _____ |
| c | Make and Model No. | : | _____ |

AIR CURTAINS

- | | | | |
|---|-----------------------|---|-------|
| a | Manufacturer | : | _____ |
| b | Country of Origin | : | _____ |
| c | Make and Model No. | : | _____ |
| d | Length of Unit | : | _____ |
| e | Distance of Air throw | : | _____ |

KITCHEN HOOD

- | | | | |
|---|------------------------|---|----------------|
| a | Manufacturer | : | _____ |
| b | Country of Origin | : | _____ |
| c | Local Agent | : | _____ |
| d | Type/Model | : | _____ |
| e | Dimensions (L x W x D) | : | _____ |
| f | Material | : | _____ |
| g | Standard | | <u>NFPA 96</u> |

RANGE HOOD

- | | | | |
|---|------------------------|---|----------------|
| a | Manufacturer | : | _____ |
| b | Country of Origin | : | _____ |
| c | Local Agent | : | _____ |
| d | Type/Model No. | : | _____ |
| e | Dimensions (L x W x D) | : | _____ |
| f | Material | : | _____ |
| g | Standard | | <u>NFPA 96</u> |

COOKER

- a Manufacturer/Country of Origin : _____
- b Type/Model No. : _____

<u>ITEM</u>	<u>TECHNICAL PARTICULARS</u>
-------------	------------------------------

Control Panel (EF-CP)

- a Manufacturer/country of Origin : _____
- c Make and Model No. : _____
- d Standard : _____

Electric Driven Pump (FHR)

- | | | |
|---------------------------------|---|--|
| Manufacturer/Country of Origin | : | |
| Make and Model | : | |
| Local Agent | : | |
| Casing Material | : | |
| Shaft Material | : | |
| Impeller Material | : | |
| Nominal rating | : | |
| Flow rate (cmh) /HEAD | : | |
| Max. pressure at no flow (bars) | : | |
| Min. continuous flow (cmh) | : | |
| Pump BHP | : | |
| F.O.C Approval | : | |
| Pump Efficiency | : | |

Pump Motor

- | | | | |
|---|--|---|--|
| a | Manufacturer | : | |
| b | Type/Model | : | |
| c | Name plate HP/kW output | : | |
| d | Rated speed/voltage | : | |
| e | Rated F.L. Current | : | |
| f | Max. starting current | : | |
| g | Power factor at full load - at specified | : | |
| h | Efficiency at full load - at specified | : | |
| i | Type of anti-vibration mounting | : | |
| j | Motor starter | : | |
| k | Type of motor insulation | : | |

<u>ITEM</u>	<u>TECHNICAL PARTICULARS</u>
-------------	------------------------------

DIAPHRAGM TANK

- | | | | |
|---|------------------------|---|-------|
| a | Manufacturer | : | _____ |
| b | Country of Origin | : | _____ |
| c | Capacity: (liters) | : | _____ |
| c | Maximum Pressure (Kpa) | : | _____ |
| c | Make and Model No. | : | _____ |

FIRE INDICATION PANEL

- | | | | |
|---|---------------------------------|---|--|
| a | Manufacturer | : | |
| b | Model | : | |
| c | Dimensions | : | |
| d | Weight | : | |
| e | Plate thickness | : | |
| f | Finishes | : | |
| g | Type | : | |
| h | Standing current load per loop | : | |
| i | Operating current load per loop | : | |
| j | Number of loops | : | |
| k | No. of devices per loop | : | |
| l | Battery charger | | |
| | >Manufacturer | : | |
| | >Model/Type | : | |
| | >Trickle Charging Rate | : | |
| | >Booster Charging Rate | : | |

Maintenance-Free Nickel Batteries

- | | | | |
|---|----------------------|---|-------|
| a | Manufacturer/Country | : | _____ |
| b | Type/Model | : | _____ |
| c | No. of cells | : | _____ |
| d | Capacity | : | _____ |
| e | Voltage per cell | : | _____ |

ITEM	TECHNICAL PARTICULARS
------	-----------------------

Alarm Bell (24V DC)

- | | | | |
|---|--------------|---|-------|
| a | Manufacturer | : | _____ |
| b | Type/Model | : | _____ |
| c | Diameter | : | _____ |
| d | Current Load | : | _____ |

Break Glass Call Point

- | | | | |
|---|----------------|---|-------|
| a | Manufacturer | : | _____ |
| b | Local Agent | : | _____ |
| c | Type Model | : | _____ |
| d | F.O.C Approval | : | _____ |

Portable Fire Extinguisher

- | | | | |
|---|-------------------------|---|-------|
| a | Manufacturer | : | _____ |
| b | Country of Manufacturer | : | _____ |
| c | Local Agent | : | _____ |
| d | Type/Model | : | _____ |
| e | Capacity | : | _____ |
| f | F.O.C Approval | : | _____ |

Fire Hose Reel

- | | | | |
|---|-----------------------|---|-------|
| a | Manufacturer | : | _____ |
| b | Local Agent | : | _____ |
| c | Type/Model | : | _____ |
| d | Jet Range | : | _____ |
| e | Length of hose | : | _____ |
| f | Material of hose | : | _____ |
| g | Max. Working Pressure | : | _____ |

Gate Valve

- | | | | |
|---|-------------------|---|-------|
| a | Manufacturer | : | _____ |
| b | Type/Model | : | _____ |
| c | Material of body | : | _____ |
| d | Max. Working body | : | _____ |

ITEM	TECHNICAL PARTICULARS
------	-----------------------

Piping Material

- | | | | |
|---|--------------------|---|--|
| | | : | |
| a | Make/Country | : | |
| b | B.S. Specification | : | |
| c | Class | : | |
| d | Type | : | |
| e | Working Pressure | : | |

Air Relief Valve

- | | | | |
|---|-----------------------|---|--|
| a | Manufacturer | : | |
| b | Country of Origin | : | |
| c | Make and Model | : | |
| d | Max. Working Pressure | : | |

Water Tank

- | | | | |
|---|-------------------------------|---|--|
| a | Manufacturer | : | |
| b | Country of origin | : | |
| c | Type of material/thickness | : | |
| d | Material use for bolts & nuts | : | |
| e | Type of float valve | : | |
| f | Relevant standard | : | |

Domestic Water Pumpset

- | | | | |
|---|---|---|--|
| a | Manufacturer | : | |
| b | Local Agent | : | |
| c | Type/Model | : | |
| d | Casing Material | : | |
| e | Shaft Material | : | |
| f | Flow Rate (cmh) /HEAD (Kpa) | : | |
| g | Pump characteristic | : | |
| h | Max. pressure at no flow (Kpa) | : | |
| i | Min. continuous flow (cubic metre per hour) | : | |
| j | F.O.C Approval | : | |

<u>ITEM</u>	<u>TECHNICAL PARTICULARS</u>
-------------	------------------------------

<u>Variable Speed Drive (AHU)</u>	
-----------------------------------	--

- | | | | |
|---|-------------------|---|-------|
| a | Manufacturer | : | _____ |
| b | Country of Origin | : | _____ |
| c | Type/Model No. | : | _____ |

<u>LIFT</u>	
-------------	--

- | | | | |
|---|---|---|-------|
| a | Manufacturer | : | _____ |
| b | Country of Origin | : | _____ |
| c | Type/Model | : | _____ |
| d | Car Material Finish | : | _____ |
| e | Shaft Material | : | _____ |
| f | Flow Rate (cmh) /HEAD (Kpa) | : | _____ |
| g | Pump characteristic | : | _____ |
| h | Max. pressure at no flow (Kpa) | : | _____ |
| i | Min. continuous flow (cubic metre per hour) | : | _____ |
| j | F.O.C Approval | : | _____ |

ELECTRICAL
(SCHEDULE OF TECHNICAL DATA)

SCHEDULE OF TECHNICAL DATA

Description	Tender Specification	Equipment as Offered
<u>ELECTRICAL INSTALLATION</u>		
1. MAIN SWITCHBOARD		
a) Manufacturer Name :	From DES / ABCI vendor list	
b) Country of Manufacturer :		
2. SUB-SWITCHBOARDS & DISTRIBUTION BOARD		
a) Manufacturer Name :	From DES / ABCI vendor list	
b) Country of Manufacturer :		
3. AIR CIRCUIT BREAKER(ACB)		
a) Manufacturer Name :	From DES / ABCI vendor list	
b) Country of Manufacturer :		
4. MINIATURE CIRCUIT BREAKER(MCB)& MOULDED CASE CIRCUIT BREAKER(MCCB)		
a) Manufacturer Name :	From DES / ABCI vendor list	
b) Country of Manufacturer :		
5. EARTHING ACCESSORIES		
a) Manufacturer Name :	From DES / ABCI vendor list	
b) Country of Manufacturer :		
6. LOW VOLTAGE CABLES OF ALL SIZES		
a) Manufacturer Name :	LKH / SCM / Master Tec / Equivalent	
b) Country of Manufacturer :		
7. FIRE RESISTANCE CABLES		
a) Manufacturer Name :	Master Tec / Wilson / Tonn Cables / Equivalent	
b) Country of Manufacturer :		
8. NEOPRENE CABLES		
a) Manufacturer Name :	LKH / SCM / Master Tec / Equivalent	
b) Country of Manufacturer :		

SCHEDULE OF TECHNICAL DATA

Description	Tender Specification	Equipment as Offered
9. CABLE TRAY AND TRUNKING		
a) Manufacturer Name :	From DES / ABCI vendor list	
b) Country of Manufacturer :		
10. PVC CONDUITS & ACCESSORIES		
a) Manufacturer Name :	From DES / ABCI vendor list	
b) Country of Manufacturer :		
11. LIGHTNING PROTECTION SYSTEM & ACCESSORIES		
a) Manufacturer Name :	Furse / Heng / Unitech / Equivalent	
b) Country of Manufacturer :		
12. CABLE GLAND, CABLE LUGS ETC		
a) Manufacturer Name :	From DES / ABCI vendor list	
b) Country of Manufacturer :		
13. SWITCHES & SWITCH SOCKET OUTLETS		
a) Manufacturer Name :	Legrand / Schneider / T & J / MK / Clinsal	
b) Country of Manufacturer :		
14. SPN & TPN ISOLATOR		
a) Manufacturer Name :	Legrand / Schneider / T & J / MK / Clipsal	
b) Country of Manufacturer :		
15. STANDBY DIESEL GENERATOR SET		
a) Manufacturer Name :	From DES / ABCI vendor list	
b) Country of Manufacturer :		
16. 11KV/433V DISTRIBUTION TRANSFORMER		
a) Manufacturer Name :	From DES / ABCI vendor list	
b) Country of Manufacturer :		
17. 2R1T RING MAIN UNIT		
a) Manufacturer Name :	From DES / ABCI vendor list	

SCHEDULE OF TECHNICAL DATA

Description		Tender Specification	Equipment as Offered
b) Country of Manufacturer	:		
18. 3C/185SQMM XLPE/LS/DSTA/PVC 11KV CABLE			
a) Manufacturer Name	:	From DES / ABCI vendor list	
b) Country of Manufacturer	:		
19. 3C/185SQMM 11KV CABLE JOINT KIT			
a) Manufacturer Name	:	From DES / ABCI vendor list	
b) Country of Manufacturer	:		
20. 3C/185SQMM 11KV CABLE TERMINATION KIT			
a) Manufacturer Name	:	From DES / ABCI vendor list	
b) Country of Manufacturer	:		

SCHEDULE OF TECHNICAL DATA

Description	Tender Specification	Equipment as Offered
<u>TELECOM, COMPUTER & MA TV SYSTEM</u>		
1. PABX SYSTEM		
a) Manufacturer Name :	Cisco / approved equivalent	
b) Country of Manufacturer :		
2. RG6 CO-AXIAL CABLE		
a) Manufacturer Name :	Beldon / Digital / Approved Equivalent	
b) Country of Manufacturer :		
3. CAT6 STP/UTP CABLE		
a) Manufacturer Name :	From Telbru vendor list	
b) Country of Manufacturer :		
4. NETWORK SWITCH, PATCH PANEL, CABLE MANAGEMENT SYSTEM, ETC		
a) Manufacturer Name :	Dell / Cisco / Telbru Approved equivalent	
b) Country of Manufacturer :		
5. FIBRE JOINT ENCLOSURES, FAT, ODF, MDF ETC		
a) Manufacturer Name :	Dell / Cisco / Telbru Approved equivalent	
b) Country of Manufacturer :		
6. FIBRE OPTIC CABLE FOR ALL SIZES		
a) Manufacturer Name :	From Telbru vendor list	
b) Country of Manufacturer :		
7. MA TV AMPLIFIERS, MULTISWITCH & TAP OFF		
a) Manufacturer Name :	Ikusi / Televes / Equivalent	
b) Country of Manufacturer :		

SCHEDULE OF TECHNICAL DATA

Description	Tender Specification	Equipment as Offered
<u>FIRE ALARM, PA SYSTEM & SECURITY SYSTEM</u>		
1. FIRE ALARM PANEL & MIMIC DIAGRAM a) Manufacturer Name : b) Country of Manufacturer :	Multron / approved equivalent 	
2. SMOKE DETECTOR, HEAT DETECTOR, MANUAL BREAKGLASS, ALARM BELL a) Manufacturer Name : b) Country of Manufacturer :	Multron / approved equivalent 	
3. FIRE EXTINGUISHER AND FIRE BLANKET a) Manufacturer Name : b) Country of Manufacturer :	SRI / approved equivalent 	
4. PA SYSTEM a) Manufacturer Name : b) Country of Manufacturer :	 	
5. IP MINI DOME CAMERA a) Manufacturer Name : b) Country of Manufacturer :	Samsung / approved equivalent 	
6. NETWORK SWITCH, PATCH PANEL, CABLE MANAGFMFNT SYSTEM, ETC. a) Manufacturer Name : b) Country of Manufacturer :	Dell / Cisco / Telbru Approved equivalent 	

SCHEDULE OF TECHNICAL DATA - LIGHT FITTINGS

SI No.	Item No.	Tender Specification	Offered Items	
			Brand / Country of Origin	Model
1	F1	NVC NGLED5612-1 or DES / ABCI approved equivalent		
2	F2	NVC NWLED3544 or DES / ABCI approved equivalent		
3	F3	NVC NPTLED352 or DES / ABCI approved equivalent		
4	F4	NVC NFLED5012 or DES / ABCI approved equivalent		
5	F5	NVC NLED4203 or DES / ABCI approved equivalent		
6	F5B	NVC NLED4203 or DES / ABCI approved equivalent		
7	F6	Luminconnect HD-MD1201 or DES / ABCI approved equivalent		
8	F7	NVC NLED09506E-D or DES / ABCI approved equivalent		
9	F8	NVC NLLED9184M or DES / ABCI approved equivalent		
10	F9	Colours D8420-24- 52mm or DES / ABCI approved equivalent		
11	F10	NVC NDLED9314E or DES / ABCI approved equivalent		
12	F11	NVC NLED105 or DES / ABCI approved equivalent		
13	F12	Colours D8420-24- 52mm or DES / ABCI approved equivalent		
14	F13	NVC NSLED4315 or DES / ABCI approved equivalent		
15	F14	NVC NWED5566 or DES / ABCI approved equivalent		
16	F15	NVC NPNLED4514/43W/66 or DES / ABCI approved equivalent		
17	F16	NVC NLED1807C/S or DES / ABCI approved equivalent		
18	F17	PHILIPS or DES / ABCI approved equivalent		
19	F18	NVC NDLED9295/R15W or DES / ABCI approved equivalent		
20	F19	NVC 8113A or DES / ABCI approved equivalent		
21	F19B	NVC 8113A or DES / ABCI approved equivalent		
22	F19C	NVC 81132A or DES / ABCI approved equivalent		
23	F20A	Demilux Intevision 9060 A-1 or DES / ABCI approved equivalent		
24	F20B	Demilux Intevision 9060 A-1 or DES / ABCI approved equivalent		

SCHEDULE OF TECHNICAL DATA - LIGHT FITTINGS

SI No.	Item No.	Tender Specification	Offered Items	
			Brand / Country of Origin	Model
25	F21A	NVC 8112D matte gold shield cover or DES / ABCI approved equivalent		
26	F21B	NVC 8112D matte white shield cover or DES / ABCI approved equivalent		
27	F21C	PHILIPS or DES / ABCI approved equivalent		
28	F22	NVC NSPLED181W or DES / ABCI approved equivalent		
29	F23	NVC NLED9184MIR or DES / ABCI approved equivalent		
30	F24	Demilux Intevision MD9028R3IN1 or DES / ABCI approved equivalent		
31	F25A	Demilux Intevision 9063 1500 or DES / ABCI approved equivalent		
32	F25B	Demilux Intevision 9063 1200 or DES / ABCI approved equivalent		
33	F25C	Demilux Intevision 9063 1000 or DES / ABCI approved equivalent		
34	F25D	Demilux Intevision 9063 800 or DES / ABCI approved equivalent		
35	F26	Demilux Intevision MD9017B-300 or DES / ABCI approved equivalent		
36	F27	Demilux Intevision 9060 pendant A-1 or DES / ABCI approved equivalent		
37	F28	Demilux Intevision 9028 square with module B5 or DES / ABCI approved equivalent		
38	F29	Colours LES0FW or DES / ABCI approved equivalent		
39	F30	Colours LR70DD or DES / ABCI approved equivalent		
40	F31	Demilux Intevision MD9058-1200 or DES / ABCI approved equivalent		
41	F32	NVC NLED105 or DES / ABCI approved equivalent		
42	F33	NVC NWLED5572A or DES / ABCI approved equivalent		
43	F34	Demilux Intevision 9060 Line Down A-8 or DES / ABCI approved equivalent		
44	F35	Demilux Intevision 9072IN800 or DES / ABCI approved equivalent		
45	F36	Colours LS50G or DES / ABCI approved equivalent		
46	F37	Demilux Intevision 0549W2 20 or DES / ABCI approved equivalent		
47	F38	LUTEC CITY or DES / ABCI approved equivalent		
48	F39	Maxspid Minnie or DES / ABCI approved equivalent		

SCHEDULE OF TECHNICAL DATA - LIGHT FITTINGS

Sl No.	Item No.	Tender Specification	Offered Items	
			Brand / Country of Origin	Model
49	F40	Maxspid Minnie or DES / ABCI approved equivalent		
50	F41	Maxspid Leder or DES / ABCI approved equivalent		

LIFT
(SCHEDULE OF TECHNICAL DATA)

TECHNICAL DATA

Description	Tender Specifications	Data of Equipment As Offered
I <u>GENERAL</u>		
1 Name of Manufacturer	: Tenderer to state	_____
2 Country of Origin	: Tenderer to state	_____
3 Travel or Rise	: Tenderer to state	_____
4 Floor to Floor Heights:-		
5 Overhead	: Tenderer to state	_____
6 Pit depth	: 1500 mm	_____
7 Hoistway Dimensions	: 2200 width x 1800 deep (mm)	_____
8 Structural Opening Size for Door	: Tenderer to state	_____
9 Total Height	: Tenderer to state	_____
10 Machine Room Size (WxDxH)	: Motor Roomless	_____
11 No. of Floors Served	: 2	_____
12 No. of Landing Openings/Stops	: 2	_____
13 Contract Speed	: 1.0 m/s	_____
14 Contract Load	: 1000 kg	_____
15 Passenger Capacity	: 13 persons	_____
16 Car Drive/Control System	: ACVVVF	_____
17 Operation System	: duplex	_____
18 Power Supply	: 415V(Nominal), 3ph, 50Hz	_____
19 Lighting Supply	: 240V(Nominal), 1ph, 50Hz	_____
20 Capacity of Power Supply	: 20 KVA/lift 63A Main isolator available	_____
21 Car Safety Gear	: Progressive Safety Gear	_____
22 Door type	: Center opening	_____
II <u>CAR DESIGN</u>		
1 Minimum Car Internal Height	: 2300mm	_____
2 Car Operating Panel	: brushed stainless steel panel with dot matrix indicator	_____
3 Ceiling	: Hairline Stainless Steel + Transparent Plate + Painted Steel + Down Lamp (LUXURY CABIN PACKAGE)	_____

Description	Tender Specifications	Data of Equipment As Offered
4 Lighting	: LED light	_____
5 Wall	: Mirror Finish + Titanium Hairline Stainless Steel	_____
6 Kickplates	: Hairline Stainless Steel	_____
7 Flooring	: Marble / Granite flooring	_____
8 Platform	: structural steel frame & substantial stainless steel floor	_____
9 Sills	: Extruded hard aluminium	_____
10 Entrance Columns	: brushed stainless steel	_____
11 Car Internal Dimension	: 1600 (W) x 1450 (D) x 2300 mm (H)	_____

III ENTRANCES AND SIGNAL FIXTURES

1 Entrances Design	: Narrow door jamb and landing doors of stainless steel sheet	_____
2 Landing Door & Finish	: Hairline Stainless Steel	_____
3 Minimum Door Height	: 2100mm	_____
4 Minimum Door Entrance Width	: 1000mm	_____
5 Hall Call Button (s)	: micro push buttons with brushed stainless steel finish	_____
6 Narrow Jamb	: Stainless Steel hairline	_____

IV LIFT PIT

1 Pit Ladder	: mild steel cat ladder	_____
2 Pit Safety Switch	: to provide at the lift pit to stop the lift	_____
3 Pit Lighting & Power	: to provide lighting and power	_____
4 Counterweight Screen	: to provide counterweight screen inside the hoistway	_____
5 Buffers		
a Manufacturer	: Tenderer to state	_____
b Country of Manufacture	: Tenderer to state	_____
c Type of Car Buffer	: Tenderer to state	_____
d Stroke of Car Buffer	: Tenderer to state	_____
e Max. Retardation of Car Buffer	: Tenderer to state	_____
f No. of Car Buffer	: Tenderer to state	_____
g Type of Counterweight Buffer	: Tenderer to state	_____
h Stroke of Counterweight	: Tenderer to state	_____

Description	Tender Specifications	Data of Equipment As Offered
i Max. Retardation of Counterweight Buffer	: Tenderer to state	
j No. of Counterweight Buffer	: Tenderer to state	
V <u>MACHINE ROOM EQUIPMENT</u>		
(A) Lift Controller		
1 Model	: Tenderer to state	
2 Manufacturer	: Tenderer to state	
3 Country of Manufacture	: Tenderer to state	
(B) Type of Control System		
1 Make of Rectifier	: Tenderer to state	
2 Make of Inverter	: Tenderer to state	
3 Method of Controlling Frequency and Modulation	: Pulse width modulation unit	
(C) Traction Motor		
1 Make	: Tenderer to state	
2 Manufacturer	: Tenderer to state	
3 Country of Manufacturer	: Tenderer to state	
4 Type	: Gearless Machine	
5 Rated Voltage/Frequency	: 3 phase/415V/50Hz	
6 Class of Insulation	: F	
7 KW Rating	: Max.20 KW	
8 Type of Internal Overload Protection	: Tenderer to state	
9 Starting Current (No Load)	: Tenderer to state	
10 Normal Running Current	: Tenderer to state	
11 Max. Full Load Acceleration Current	: Tenderer to state	
12 Efficiency & Power Factor at:		
Full Load	: Tenderer to state	
Half Load	: Tenderer to state	
13 Power Isolator Rating Required	: Tenderer to state	
(D) Speed Governor Details		
1 Type	: Tenderer to state	

Description	Tender Specifications	Data of Equipment As Offered
2 Tripping Speed	: Tenderer to state	_____
3 Diameter of Governor Ropes	: Tenderer to state	_____
4 Stopping Distance	: Tenderer to state	_____
VI <u>HOISTWAY EQUIPMENT</u>		
1 Manufacturer	: Tenderer to state	_____
2 Country of Manufacturer	: Tenderer to state	_____
3 Construction	: Tenderer to state	_____
4 Safe Working Load	: Tenderer to state	_____
5 Actual Breaking Strength	: Tenderer to state	_____
6 No.of Ropes	: Tenderer to state	_____
VII <u>STANDARD FEATURES</u>		
1 Overload Non-start Device	: To install overload non-start device c/w visual light an audio buzzer at the car operating panel.	_____
2 Interphone	: To be located at ground floor in a concealed stainless steel operated enclosure flushed to the wall or surface mounted type in H.S.S Box	_____
3 Emergency Exit switch	: Safety limit switch to be provided for emergency exit door at the top in order to stop the lift when it is open.	_____
4 Socket Outlet and Lighting	: To provide 3 pin 13A switch socket outlet (3 sets) and lighting (3 sets) underneath car.	_____
5 Power Saver	: Automatic tun-off of car light, fan & other hall lantern indicators when there are no calls for a predetermined period of time.	_____
6 Emergency Battery Operated Power Supply ("EBOPS")	: To provide EVER-power "EBOPS" maintance free rechargeable battery or other standard accessories.	_____
VIII <u>ADDITIONAL FEATURES</u>		
1 Emergency Landing Device (ELD)	: System shall consist of adequate capacity Ni-Cad Rechargeable maintenance free battery.	_____
IX <u>NOTICES</u>		
1 Sign Boards/Notices	: To provide necessary sign board/notice. All notices shall be of screw/rivet type and case glueing is NOT allowed.	_____

TECHNICAL DATA		
Description	Tender Specifications	Data of Equipment As Offered
I GENERAL		
1 Name of Manufacturer	: Tenderer to state	_____
2 Country of Origin	: Tenderer to state	_____
3 Travel or Rise	: Tenderer to state	_____
4 Floor to Floor Heights:-		
5 Overhead	: Tenderer to state	_____
6 Pit depth	: 1500 mm	_____
7 Hoistway Dimensions	: 2000 width x 1800 deep (mm)	_____
8 Structural Opening Size for Door	: Tenderer to state	_____
9 Total Height	: Tenderer to state	_____
10 Machine Room Size (WxDxH)	: Motor Roomless	_____
11 No. of Floors Served	: 4	_____
12 No. of Landing Openings/Stops	: 4	_____
13 Contract Speed	: 1.0 m/s	_____
14 Contract Load	: 750 kg	_____
15 Passenger Capacity	: 11 persons	_____
16 Car Drive/Control System	: ACVVVF	_____
17 Operation System	: duplex	_____
18 Power Supply	: 415V(Nominal), 3ph, 50Hz	_____
19 Lighting Supply	: 240V(Nominal), 1ph, 50Hz	_____
20 Capacity of Power Supply	: 20 KVA/lift 63A Main isolator available	_____
21 Car Safety Gear	: Progressive Safety Gear	_____
22 Door type	: Side opening	_____
II CAR DESIGN		
1 Minimum Car Internal Height	: 2300mm	_____
2 Car Operating Panel	: brushed stainless steel panel with dot matrix indicator	_____
3 Ceiling	: Hairline Stainless Steel + Transparent Plate + Painted Steel + Down Lamp (LUXURY CABIN PACKAGE)	_____

Description	Tender Specifications	Data of Equipment As Offered
4 Lighting	: LED light	_____
5 Wall	: Mirror Finish + Titanium Hairline Stainless Steel	_____
6 Kickplates	: Hairline Stainless Steel	_____
7 Flooring	: Marble / Granite flooring	_____
8 Platform	: structural steel frame & substantial stainless steel floor	_____
9 Sills	: Extruded hard aluminium	_____
10 Entrance Columns	: brushed stainless steel	_____
11 Car Internal Dimension	: 1400 (W) x 1450 (D) x 2300 mm (H)	_____

III ENTRANCES AND SIGNAL FIXTURES

1 Entrances Design	: Narrow door jamb and landing doors of stainless steel sheet	_____
2 Landing Door & Finish	: Hairline Stainless Steel	_____
3 Minimum Door Height	: 2100mm	_____
4 Minimum Door Entrance Width	: 800mm	_____
5 Hall Call Button (s)	: micro push buttons with brushed stainless steel finish	_____
6 Narrow Jamb	: Stainless Steel hairline	_____

IV LIFT PIT

1 Pit Ladder	: mild steel cat ladder	_____
2 Pit Safety Switch	: to provide at the lift pit to stop the lift	_____
3 Pit Lighting & Power	: to provide lighting and power	_____
4 Counterweight Screen	: to provide counterweight screen inside the hoistway	_____
5 Buffers		_____
a Manufacturer	: Tenderer to state	_____
b Country of Manufacture	: Tenderer to state	_____
c Type of Car Buffer	: Tenderer to state	_____
d Stroke of Car Buffer	: Tenderer to state	_____
e Max. Retardation of Car Buffer	: Tenderer to state	_____
f No. of Car Buffer	: Tenderer to state	_____
g Type of Counterweight Buffer	: Tenderer to state	_____
h Stroke of Counterweight	: Tenderer to state	_____

Description	Tender Specifications	Data of Equipment As Offered
i Max. Retardation of Counterweight Buffer	: Tenderer to state	_____
j No. of Counterweight Buffer	: Tenderer to state	_____
V <u>MACHINE ROOM EQUIPMENT</u>		
(A) Lift Controller		
1 Model	: Tenderer to state	_____
2 Manufacturer	: Tenderer to state	_____
3 Country of Manufacture	: Tenderer to state	_____
(B) Type of Control System : ACVVVF		
1 Make of Rectifier	: Tenderer to state	_____
2 Make of Inverter	: Tenderer to state	_____
3 Method of Controlling Frequency and Modulation	: Pulse width modulation unit	_____
(C) Traction Motor		
1 Make	: Tenderer to state	_____
2 Manufacturer	: Tenderer to state	_____
3 Country of Manufacturer	: Tenderer to state	_____
4 Type	: Gearless Machine	_____
5 Rated Voltage/Frequency	: 3 phase/415V/50Hz	_____
6 Class of Insulation	: F	_____
7 KW Rating	: Max.20 KW	_____
8 Type of Internal Overload Protection	: Tenderer to state	_____
9 Starting Current (No Load)	: Tenderer to state	_____
10 Normal Running Current	: Tenderer to state	_____
11 Max. Full Load Acceleration Current	: Tenderer to state	_____
12 Efficiency & Power Factor at:		
Full Load	: Tenderer to state	_____
Half Load	: Tenderer to state	_____
13 Power Isolator Rating Required	: Tenderer to state	_____
(D) Speed Governor Details		
1 Type	: Tenderer to state	_____

Description	Tender Specifications	Data of Equipment As Offered
2 Tripping Speed	: Tenderer to state	_____
3 Diameter of Governor Ropes	: Tenderer to state	_____
4 Stopping Distance	: Tenderer to state	_____
VI <u>HOISTWAY EQUIPMENT</u>		
1 Manufacturer	: Tenderer to state	_____
2 Country of Manufacturer	: Tenderer to state	_____
3 Construction	: Tenderer to state	_____
4 Safe Working Load	: Tenderer to state	_____
5 Actual Breaking Strength	: Tenderer to state	_____
6 No.of Ropes	: Tenderer to state	_____
VII <u>STANDARD FEATURES</u>		
1 Overload Non-start Device	: To install overload non-start device c/w visual light an audio buzzer at the car operating panel.	_____
2 Interphone	: To be located at ground floor in a concealed stainless steel operated enclosure flushed to the wall or surface mounted type in H.S.S Box	_____
3 Emergency Exit switch	: Safety limit switch to be provided for emergency exit door at the top in order to stop the lift when it is open.	_____
4 Socket Outlet and Lighting	: To provide 3 pin 13A switch socket outlet (3 sets) and lighting (3 sets) underneath car.	_____
5 Power Saver	: Automatic tun-off of car light, fan & other hall lantern indicators when there are no calls for a predetermined period of time.	_____
6 Emergency Battery Operated Power Supply ("EBOPS")	: To provide EVER-power "EBOPS" maintance free rechargeable battery or other standard accessories.	_____
VIII <u>ADDITIONAL FEATURES</u>		
1 Emergency Landing Device (ELD)	: System shall consist of adequate capacity Ni-Cad Rechargeable maintenance free battery.	_____
IX <u>NOTICES</u>		
1 Sign Boards/Notices	: To provide necessary sign board/notice. All notices shall be of screw/rivet type and case glueing is NOT allowed.	_____

LIST OF DRAWINGS

**PROPOSED HIGH COMMISSIONER'S RESIDENCES ON LOT 64081
FOR THE HIGH COMMISSION OF INDIA IN BRUNEI DARUSSALAM**

FOR TENDER – 25.09.19

LIST OF DRAWINGS

ITEM	DWG NO.	DESCRIPTION	SIZE	REV
1	LKA/RES/001/EL-100	LEGEND ELECTRICAL LIGHTING AND POWER	A1	-
2	LKA/RES/001/EL-101	EXTERNAL LIGHTING LAYOUT - SITE DEVELOPMENT PLAN AND LIGHTING & POWER LAYOUT FOR GUARD HOUSE	A1	-
3	LKA/RES/001/EL-201	LIGHTING LAYOUT – GROUND FLOOR PLAN	A1	-
4	LKA/RES/001/EL-202	LIGHTING LAYOUT – FIRST FLOOR PLAN	A1	-
5	LKA/RES/001/EP-201	POWER LAYOUT – GROUND FLOOR PLAN	A1	-
6	LKA/RES/001/EP-202	POWER LAYOUT – FIRST FLOOR PLAN	A1	-
7	LKA/RES/001/SL-301	SINGLE LINE DIAGRAMS - 1	A1	-
8	LKA/RES/001/SL-302	SINGLE LINE DIAGRAMS - 2	A1	-
9	LKA/RES/001/TEL-101	EXTERNAL TELEPHONE LAYOUT – SITE DEVELOPMENT PLAN	A1	-
10	LKA/RES/001/TEL-201	TELEPHONE LAYOUT – GROUND FLOOR PLAN	A1	-
11	LKA/RES/001/TEL-202	TELEPHONE LAYOUT – FIRST FLOOR PLAN	A1	-
12	LKA/RES/001/TEL-301	STANDARD DETAILS TELEPHONE FOOTWAY JUNCTION BOX NO. 3 (FJB-3)	A1	-
13	LKA/RES/001/SC-201	SECURITY SYSTEM LAYOUT – GROUND FLOOR PLAN AND SCHEMATIC DIAGRAM	A1	-
14	LKA/RES/001/TV-201	MATV LAYOUT – GROUND FLOOR PLAN	A1	-
15	LKA/RES/001/TV-202	MATV LAYOUT – FIRST FLOOR PLAN AND SCHEMATIC DIAGRAM	A1	-
16	LKA/RES/001/LP-201	LIGHTNING PROTECTION LAYOUT SITE DEVELOPMENT/ ROOF PLAN & DETAILS	A1	-
17	LKA/RES/001/AC-201	A/C & VENTILATION LAYOUT – GROUND FLOOR PLAN	A1	-
18	LKA/RES/001/AC-202	A/C & VENTILATION LAYOUT – FIRST FLOOR PLAN AND GUARD HOUSE	A1	-
19	LKA/RES/001/PL-101	WATER LAYOUT – SITE DEVELOPMENT PLAN	A1	-
20	LKA/RES/001/PL-201	WATER LAYOUT – GROUND FLOOR PLAN	A1	-
21	LKA/RES/001/PL-202	WATER LAYOUT – FIRST FLOOR PLAN AND GUARD HOUSE	A1	-
22	LKA/RES/001/PL-301	WATER SCHEMATIC & STANDARD DETAILS - 1	A1	-
23	LKA/RES/001/PL-302	STANDARD DETAILS - 2	A1	-
24	LKA/RES/001/PL-303	STANDARD DETAILS - 3	A1	-
25	LKA/RES/001/SN-201	SANITARY LAYOUT – SITE DEVELOPMENT PLAN / GROUND FLOOR PLAN	A1	-
26	LKA/RES/001/SN-202	SANITARY LAYOUT – FIRST FLOOR PLAN	A1	-
27	LKA/RES/001/SN-301	SANITARY SCHEMATIC DIAGRAMS	A1	-
28	LKA/RES/001/SN-302	MISCELLANEOUS DETAILS - 1	A1	-
29	LKA/RES/001/SN-303	MISCELLANEOUS DETAILS - 2	A1	-

**PROPOSED CHANCERY, STAFF RESIDENCE AND AUXILIARY FACILITIES BUILDING
ON LOT 62514 FOR THE HIGH COMMISSION OF INDIA BRUNEI DARUSSALAM**

FOR TENDER – 25.09.19

LIST OF DRAWINGS

ITEM	DWG NO.	DESCRIPTION	SIZE	REV
1	LKA/IND/001/LV-101	LV CABLE ROUTE LAYOUT – SITE DEVELOPMENT PLAN	A1	-
2	LKA/IND/001/EL-100	LEGEND ELECTRICAL LIGHTING AND POWER	A1	-
3	LKA/IND/001/EL-101	EXTERNAL LIGHTING LAYOUT - SITE DEVELOPMENT PLAN (PART 1 OF 2)	A1	-
4	LKA/IND/001/EL-102	EXTERNAL LIGHTING LAYOUT - SITE DEVELOPMENT PLAN (PART 2 OF 2)	A1	-
5	LKA/IND/001/EL-201	LIGHTING LAYOUT – GROUND FLOOR PLAN	A1	-
6	LKA/IND/001/EL-202	LIGHTING LAYOUT – FIRST FLOOR PLAN	A1	-
7	LKA/IND/001/EL-203	RESIDENCE HOUSE BLOCK A (NRG) LIGHTING LAYOUT FLOOR PLANS	A1	-
8	LKA/IND/001/EL-204	RESIDENCE HOUSE BLOCK B (RG) LIGHTING LAYOUT FLOOR PLANS	A1	-
9	LKA/IND/001/EP-201	POWER LAYOUT – GROUND FLOOR PLAN	A1	-
10	LKA/IND/001/EP-202	POWER LAYOUT – FIRST FLOOR PLAN	A1	-
11	LKA/IND/001/EP-203	RESIDENCE HOUSE BLOCK A (NRG) POWER LAYOUT FLOOR PLANS	A1	-
12	LKA/IND/001/EP-204	RESIDENCE HOUSE BLOCK B (RG) POWER LAYOUT FLOOR PLANS	A1	-
13	LKA/IND/001/SL-201	SINGLE LINE DIAGRAMS - 1	A1	-
14	LKA/IND/001/SL-202	SINGLE LINE DIAGRAMS - 2	A1	-
15	LKA/IND/001/SL-203	SINGLE LINE DIAGRAMS - 3	A1	-
16	LKA/IND/001/SL-204	SINGLE LINE DIAGRAMS - 4	A1	-
17	LKA/IND/001/SL-205	SINGLE LINE DIAGRAMS - 5	A1	-
18	LKA/IND/001/SL-206	SINGLE LINE DIAGRAMS - 6	A1	-
19	LKA/IND/001/SL-205	SINGLE LINE DIAGRAMS - 7	A1	-
20	LKA/IND/001/SL-206	SINGLE LINE DIAGRAMS - 8	A1	-
21	LKA/IND/001/SS-201	M&E PLANT ROOM PLAN, ELEVATIONS, SECTIONS AND DETAILS	A1	-
22	LKA/IND/001/SS-202	M&E PLANT ROOM, ROOF PLAN, SIGNAGES AND NOTES	A1	-
23	LKA/IND/001/LP-201	LIGHTNING PROTECTION LAYOUT – ROOF PLAN	A1	-
24	LKA/IND/001/LP-202	RESIDENCE HOUSE BLOCK A (NRG) & B (RG) LIGHTNING PROTECTION LAYOUT ROOF PLANS AND DETAILS	A1	-
25	LKA/IND/001/TEL-101	EXTERNAL TELEPHONE LAYOUT – SITE DEVELOPMENT PLAN	A1	-
26	LKA/IND/001/TEL-201	TELEPHONE & COMPUTER LAYOUT – GROUND FLOOR PLAN	A1	-
27	LKA/IND/001/TEL-202	TELEPHONE & COMPUTER LAYOUT – FIRST FLOOR PLAN AND SCHEMATIC DIAGRAM	A1	-
28	LKA/IND/001/TEL-203	RESIDENCE HOUSE BLOCK A (NRG) TELEPHONE LAYOUT – FLOOR PLANS	A1	-
29	LKA/IND/001/TEL-204	RESIDENCE HOUSE BLOCK B (RG) TELEPHONE LAYOUT – FLOOR PLANS AND SCHEMATIC DIAGRAM	A1	-

ITEM	DWG NO.	DESCRIPTION	SIZE	REV
30	LKA/IND/001/TEL-301	STANDARD DETAIL TELEPHONE FOOTWAY JUNCTION BOX NO. 3 (FJB-3)	A1	-
31	LKA/IND/001/AV-201	AUDIO VISUAL LAYOUT – GROUND FLOOR PLAN	A1	-
32	LKA/IND/001/MATV-201	MATV LAYOUT GROUND FLOOR PLAN	A1	-
33	LKA/IND/001/MATV-202	MATV LAYOUT FIRST FLOOR PLAN AND SCHEMATIC DIAGRAM	A1	-
34	LKA/IND/001/MATV-203	RESIDENCE HOUSE BLOCK A (NRG) MATV LAYOUT – FLOOR PLANS AND SCHEMATIC DIAGRAM	A1	-
35	LKA/IND/001/MATV-204	RESIDENCE HOUSE BLOCK B (RG) MATV LAYOUT – FLOOR PLANS AND SCHEMATIC DIAGRAM	A1	-
36	LKA/IND/001/SC-201	SECURITY SYSTEM LAYOUT - GROUND & FIRST FLOOR PLANS AND SCHEMATIC DIAGRAM	A1	-
37	LKA/IND/001/LF-201	LIFT INSTALLATION AND DETAILS	A1	-
38	LKA/IND/001/FA-201	FIRE ALARM LAYOUT – GROUND FLOOR PLAN	A1	-
39	LKA/IND/001/FA-202	FIRE ALARM LAYOUT – FIRST FLOOR PLAN AND SCHEMATIC DIAGRAM	A1	-
40	LKA/IND/001/FA-203	RESIDENCE HOUSE BLOCK A (NRG) FIRE ALARM LAYOUT FLOOR PLANS	A1	-
41	LKA/IND/001/FA-204	RESIDENCE HOUSE BLOCK B (RG) FIRE ALARM LAYOUT FLOOR PLANS	A1	-
42	LKA/IND/001/AC-201	A/C & VENTILATION LAYOUT – GROUND FLOOR PLAN	A1	-
43	LKA/IND/001/AC-202	A/C & VENTILATION LAYOUT – FIRST FLOOR PLAN	A1	-
44	LKA/IND/001/AC-203	A/C & VENTILATION LAYOUT – ROOF DECK PLAN	A1	-
45	LKA/IND/001/AC-204	RESIDENCE HOUSE BLOCK A (NRG) A/C & VENTILATION LAYOUT FLOOR PLANS	A1	-
46	LKA/IND/001/AC-205	RESIDENCE HOUSE BLOCK B (RG) A/C & VENTILATION LAYOUT FLOOR PLANS	A1	-
47	LKA/IND/001/AC-301	SCHEMATIC & MISCELLANEOUS DETAILS	A1	-
48	LKA/IND/001/AC-302	SECTION FOR SUPPLY AIR DUCT	A1	-
49	LKA/IND/001/FHR-201	FIRE HOSEREEL LAYOUT – GROUND & FIRST FLOOR PLANS	A1	-
50	LKA/IND/001/FHR-301	FIRE HOSEREEL SYSTEM EQUIPMENT & PIPING – ENLARGED PLAN AND EQUIPMENT SCHEDULES	A1	-
51	LKA/IND/001/FHR-302	FIRE HOSEREEL SYSTEM SCHEMATIC DIAGRAM AND MISCELLANEOUS DETAIL	A1	-
52	LKA/IND/001/PL-101	PLUMBING LAYOUT - SITE DEVELOPMENT PLAN	A1	-
53	LKA/IND/001/PL-201	PLUMBING LAYOUT - GROUND FLOOR PLAN PART 1 OF 2	A1	-
54	LKA/IND/001/PL-202	PLUMBING LAYOUT - GROUND FLOOR PLAN PART 2 OF 2	A1	-
55	LKA/IND/001/PL-203	PLUMBING LAYOUT GROUND, FIRST, SECOND & THIRD FLOOR PLAN RESIDENCE HOUSE BLOCK A (NRG)	A1	-
56	LKA/IND/001/PL-204	PLUMBING LAYOUT GROUND, FIRST & SECOND FLOOR PLAN RESIDENCE HOUSE BLOCK B (RG)	A1	-
57	LKA/IND/001/PL-205	PLUMBING LAYOUT FIRST FLOOR PLAN OF CHANCERY BUILDING	A1	-
58	LKA/IND/001/PL-301	PLUMBING SCHEMATIC DIAGRAM PART 1 OF 3 & DETAILS	A1	-
59	LKA/IND/001/PL-302	PLUMBING LAYOUT SCHEMATIC DIAGRAM PART 2 & 3	A1	-
60	LKA/IND/001/PL-303	DOMESTIC WATER SYSTEM EQUIPMENT & PIPING - ENLARGED PLAN & EQUIPMENT SCHEDULES	A1	-
61	LKA/IND/001/PL-304	MISCELLANEOUS DETAIL	A1	-

ITEM	DWG NO.	DESCRIPTION	SIZE	REV
62	LKA/IND/001/PL-305	MISCELLANEOUS DETAIL	A1	-
63	LKA/IND/001/PL-306	MISCELLANEOUS DETAIL	A1	-
64	LKA/IND/001/SN-101	SANITARY LAYOUT – SITE DEVELOPMENT PLAN	A1	-
65	LKA/IND/001/SN-201	SANITARY LAYOUT – GROUND FLOOR PLAN	A1	-
66	LKA/IND/001/SN-202	SANITARY LAYOUT – FIRST FLOOR PLAN, CONSULAR BLDG. AND GUARD HOUSE FLOOR PLANS	A1	-
67	LKA/IND/001/SN-203	SANITARY LAYOUT GROUND, FIRST & SECOND FLOOR PLAN RESIDENCE HOUSE BLOCK A (NRG)	A1	-
68	LKA/IND/001/SN-204	SANITARY LAYOUT THIRD FLOOR PLAN RESIDENCE HOUSE BLOCK 'A' (NRG) & GROUND FLOOR PLAN RESIDENCE BLOCK 'B' (RG)	A1	-
69	LKA/IND/001/SN-205	SANITARY LAYOUT FIRST & SECOND FLOOR PLAN RESIDENCE HOUSE BLOCK 'B' (RG)	A1	-
70	LKA/IND/001/SN-301	SEWER PROFILES - 1	A1	-
71	LKA/IND/001/SN-302	SEWER PROFILES - 2	A1	-
72	LKA/IND/001/SN-303	SANITARY SCHEMATIC DIAGRAMS - 1	A1	-
73	LKA/IND/001/SN-304	SANITARY SCHEMATIC DIAGRAMS - 2	A1	-
74	LKA/IND/001/SN-305	SANITARY SCHEMATIC DIAGRAMS - 3	A1	-
75	LKA/IND/001/SN-306	MISCELLANEOUS DETAIL - 1	A1	-
76	LKA/IND/001/SN-307	MISCELLANEOUS DETAIL - 2	A1	-